DAVANGERE UNIVERSITY

SHIVAGANGOTHRI – 577 007, DAVANGERE, INDIA.

SYLLABUS
FOR

MASTER OF SCIENCE (M. SC.)
SEMESTER SCHEME - CBCS

MICROBIOLOGY

.

With effect from 2020-21 & onwards

DAVANGERE UNIVERSITY

Department of Microbiology,
Shivagangothri, Davangere-577 007

Prof. Ramalingappa
Chairman-BoS

Ph No:9901120803

No: DU: MB:2019-20/249 **Date:25.02.2020**

PROCEEDINGS OF THE MEETING OF BOARD OF STUDIES IN MICROBIOLOGY (PG) HELD ON 25th FEBRUARY, 2020 AT THE DEPARTMENT OF MICROBIOLOGY, DAVANGERE UNIVERSITY, SHIVANGANGOTHRI, DAVANGERE. AT 11. 00 AM.

MEMBERS PRESENT:

1. Dr. V. Shyam Kumar, Professor -- External Member
2. Dr. S. Shishupala, Professor, -- Internal Member
3. Dr. Gayathri Devaraja. Professor, -- Internal Member
4. Dr. Ramalingappa, Professor, -- Chairman-BoS

MEMBERS ABSENT:

1. Dr. C Srinivas, Professor -- External Member

The Chairman welcomed the board members and placed the agenda before the committee for discussion.

1. **Revision of M.Sc. Microbiology Syllabus:**

All the paper titles were finalised and the changes in syllabus (2020-21 M.Sc. CBCS) was thoroughly discussed and approved.

2. **Inclusion of paper-IV for Ph.D. Course work.**

As per the guidelines of UGC letter No. D.O.No.F.1-1/2018(Journal/CARE) regarding inclusion of credit course on "Research and publication Ethics (RPF) the syllabus was approved.

PTO

3. Preparation of Model Question paper of M.Sc. Ph.D. M.Phil. in Microbiology:

Model question paper was prepared and approved.

The Chairman thanked all the members for their active participation and kind cooperation.

Dr. Ramalingappa
Chairman Board of Studies in Microbiology,
Davangere University,
Shivagangothri, Davangere.

Davangere University

Shivagangotri, Davangere-577 007, Karnataka

Department of Studies in Microbiology

Program Specific Objectives for M.Sc. Microbiology:

PO -1 At the time of completion of the programme the student will develop an extensive knowledge in various areas of Microbiology.

PO-2 Through the stimulus of scholarly progression and intellectual development the programme aims to equip students with excellence in education and skills, thus enabling the student to pursue a career of his/her choice.

PO-3 By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student.

PO-4 The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

Program Specific Outcome for M.Sc. Microbiology:

PSO-1 In depth understanding of basic and applied aspects of microbiology and develop inclination towards own professional goals over a wide range of career options expanding from R&D, Industrial or Govt. sector or as an Entrepreneur.

PSO-2 To independently be able to formulate research projects on microbiology and allied interdisciplinary or multidisciplinary fields through literature search, finding research gaps and framing objectives in order to strive for innovation.

PSO-3 Uphold the responsibility as a global citizen maintaining professional and ethical values and ability to upgrade knowledge independently and act upon means of improvement for lifelong learning.

Davangere University

Shivagangotri, Davangere-577 007, Karnataka

M.Sc. Microbiology (Academic Year 2020 onwards)

Semester scheme with Choice-Based Credit System (CBCS)

Course Structure

M. Sc Microbiology I Semester

	Subject/Paper Code	Title of the Paper	Instruction Hrs./week	Marks			Credits	Examination duration (Hrs.)
				Examination	Internal Assessment	Total Marks		
SEMESTER-I	**THEORY PAPERS**							
	MB 1.1	Biodiversity and Microbial taxonomy	**4**	**70**	**30**	**100**	**4**	**3**
	MB 1.2	Ecology and Environmental Microbiology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 1.3	Microbiological Methods	**4**	**70**	**30**	**100**	**4**	**3**
	MB 1.4	Cell Biology and Biochemistry	**4**	**70**	**30**	**100**	**4**	**3**
	PRACTICAL PAPERS							
	MB 1.5	Biodiversity and Microbial taxonomy	**4**	**40**	**10**	**50**	**2**	**3**
	MB 1.6	Ecology and Environmental Microbiology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 1.7	Microbiological Methods	**4**	**40**	**10**	**50**	**2**	**3**
	MB 1.8	Cell Biology and Biochemistry	**4**	**40**	**10**	**50**	**2**	**3**
	Mandatory Credits: English Language Communication Skill		**2**	**---**	**---**	**---**	**2**	**---**
			34			**600**	**26**	

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Semester scheme with Choice-Based Credit System (CBCS)

Course Structure

M. Sc Microbiology II Semester

	Subject/Paper Code	Title of the Paper	Instruction Hrs./week	Marks			Credits	duration (Hrs.)
				Examination	Internal Assessment	Total Marks		
SEMESTER-II	**THEORY PAPERS**							
	MB 2.1	Microbial Physiology and Metabolism	**4**	**70**	**30**	**100**	**4**	**3**
	MB 2.2	Microbial Genetics & Genomes	**4**	**70**	**30**	**100**	**4**	**3**
	MB 2.3	Molecular Biology and Genetic Engineering	**4**	**70**	**30**	**100**	**4**	**3**
	MB 2.4	Biophysics, Biostatistics and Bioinformatics	**4**	**70**	**30**	**100**	**4**	**3**
	PRACTICAL PAPERS							
	MB 2.5	Microbial Physiology and Metabolism	**4**	**40**	**10**	**50**	**2**	**3**
	MB 2.6	Microbial Genetics & Genomes	**4**	**40**	**10**	**50**	**2**	**3**
	MB 2.7	Molecular Biology and Genetic Engineering	**4**	**40**	**10**	**50**	**2**	**3**
	MB 2.8	Biophysics, Biostatistics and Bioinformatics	**4**	**40**	**10**	**50**	**2**	**3**
	Mandatory Credits: Computer Skill		**2**	---	---	---	**2**	---
			34			**600**	**26**	

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M.Sc. Microbiology (Academic Year 2020 onwards)

Semester scheme with Choice-Based Credit System (CBCS)

Course Structure

M. Sc Microbiology III Semester

	Subject/Paper Code	Title of the Paper	Instruction Hrs./week	Marks			Credits	Exam duration (Hrs.)
				Examination	Internal Assessment	Total Marks		
SEMESTER-III	**THEORY PAPERS**							
	MB 3.1	Agricultural Microbiology and Phytopathology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.2	Immunology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.3	Medical Microbiology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.4	(A) Mycology (B) Gut Microbiology (C) Microbial Enzymology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.5	(A) Microbial Genetics (B) Diagnostic Microbiology **(Interdisciplinary Elective Paper)**	**2**	**40**	**10**	**50**	**2**	**2**
	PRACTICAL PAPERS							
	MB 3.6	Agricultural Microbiology and Phytopathology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 3.7	Immunology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 3.8	Medical Microbiology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 3.9	(A) Mycology (B) Gut Microbiology (C) Microbial Enzymology	**4**	**40**	**10**	**50**	**2**	**3**
			34			650	**26**	

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M.Sc. Microbiology (Academic Year 2020 onwards)

Semester scheme with Choice-Based Credit System (CBCS)

Course Structure

M. Sc Microbiology IV Semester

	Subject/Paper Code	Title of the Paper	Instruction Hrs./week	Marks			Credits	Exam duration (Hrs.)
				Examination	Internal Assessment	Total Marks		
SEMESTER-IV	**THEORY PAPERS & PROJECT WORK/DISSERTATION**							
	MB 4.1	Food and Dairy Microbiology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 4.2	Biotechnology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 4.3	Industrial microbiology and Pharmaceutical microbiology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 4.4	Project work/Dissertation	**6**	**70**	**30**	**100**	**6**	**3**
	PRACTICAL PAPERS							
	MB 4.5	Food and Dairy Microbiology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 4.6	Biotechnology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 4.7	Industrial microbiology and Pharmaceutical microbiology	**4**	**40**	**10**	**50**	**2**	**3**
	Study Tour/Field Visit		**---**	**---**	**---**	**---**	**---**	**---**
	Mandatory Credits: Personality Development		**2**	**---**	**---**	**---**	**2**	**---**
			32			550	26	

Davangere University
Department of Studies in Microbiology

The Courses in the 2020-21 (CBCS) syllabus based for Skill based, Employability and entrepreneurship

S. No.	Course in the Microbiology programme	Course objective for Skill based /employability/ entrepreneurship oriented	Outcome of the course for potential skill, employability and entrepreneurship
1	MB 1.3 Microbiological Methods	Skill based learning and Employability	Make students skillful and provide employability in Microbiological labs
2	MB 2.1 Microbial Physiology and Metabolism	Skill based learning and Employability	Make students skillful in Microbial nutrition. Increase chance of employability in Microbiological industries
3	MB 2.4 Biophysics, Biostatistics and Bioinformatics	Employability	Make students skillful in handling of Microbiological Instruments and Employability in Research institutes for the Analysis of Biomolecules
4	Mb 3.1 Agricultural Microbiology and Phytopathology	Skill based learning, Employability and entrepreneurship	Train students and make them skillful in biofertilizerand Bio-pesticides. Student will have an opportunity to start small/medium/large scale manufacturing unit
5	MB 3.2 Immunology	Skill based learning and Employability	Equip students with skills of immunetechnology and there is chance of employability in medical research center
6	MB 3.3 Medical Microbiology	Skill based learning, Employability and entrepreneurship	Provide students and make them skillful in diagnostics practices.

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			Student will have an opportunity to start small/medium/large scale diagnostic center
7	MB 4.1 Food and Dairy Microbiology	Entrepreneurship	Equip students with skills of food processing and dairy technology. Students can start their own small/medium/ large scale manufacturing/food and dairy processing units.
8	MB 4.3 Industrial microbiology and Pharmaceutical microbiology	Skill based learningand entrepreneurship	Make students with skills of industrial and pharmaceutical practices Students can start their own small/medium/ large scale manufacturing/industrial and pharmaceutical units.

CHAIRMAN
Department of Microbiology
Davangere University
Shivagangothri, Davangere-577 002

Microbiology
SEMESTER-I
Core Code: MB. 1.1: BIODIVERSITY AND MICROBIAL TAXONOMY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- To Define Bio Diversity and apply its principles
- To Describe classification and organizational tools biologists use, including modern taxonomy
- List the defining characteristics of biological life

Unit1:Biodiversity: **10 Hrs**

a) Foundations of Microbiology: Historical perspectives of microbiology; developmental milestones of microbiology, scope of microbiology.

b) Biodiversity: concept, elements and documentation; conservation and significance of biodiversity; species diversity and richness, maintenance of biodiversity.

Unit 2:Taxonomy: **14 Hrs**

c) Classification concepts: Linnaeus concepts of taxonomy; binomial nomenclature, hierarchical organization. Five-kingdom classification system; Three-domain classification system; Evolutionary relationships, Universal phylogenetic tree.

d) Microbial Classification: Criteria- Morphological, physiological, ecological, genetic analysis, molecular characteristics, phage typing, serotyping, G+C ratio, comparison of proteins, nucleic acid hybridization, nucleic acid sequence comparison, DNA and RNA homology, significance of rRNA in microbial taxonomy, Chemotaxonomy and Numerical Taxonomy .

Unit 3: **12 Hrs**

a) Microbial evolution: History of life on earth, mechanisms of evolution, species formation.

b) Acellular infectious agents:

i) Viruses: Characteristics of viruses, components of viruses, genetic material, capsid morphology, size and shapes, viral envelop, viral enzymes. Viral classification, viral replication; Brief account of animal, plant and bacterial viruses with suitable examples.

ii) Viroids and Prions: General properties, study of significant diseases caused.

Unit 4: Prokaryotes **12 Hrs**

Prokaryotic cell structure, Cell walls in bacteria and Archae, Cell membranes, Cytoplasm, nucleoid, plasmids, Outer membrane, flagella, fimbriae, endospores.Criteria for bacterial classification. Brief account of Bergey's manual of systematic bacteriology. Methods of reproduction.

Unit -5:Eukaryotes: **16 Hrs**

a) Fungi:

Structural details of unicellular and multicellular fungi; cell wall composition and mycelial organization; types of spores; Homothallism and Heterothallism; Classification fungi to the level of divisions; Methods of reproduction in fungi.

b) Protists:

i) Algae:

Morphological features of microalgae; structure of unicellular and colonial forms; Classification of micro-algae to the level of divisions; Methods of reproduction.

ii) Protozoa:

Morphology; encystment, excystment, locomotory organelles; Classification of protozoa to the level of phyla; Methods of reproduction.

c) Lichens: Types and structural organization; Classification of lichens; Methods of reproduction**:**

d) Helminths: Characteristics, parasitic helminths, parasitic forms.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Develop an understanding of communities of microorganisms, including the roles of microbes within an ecosystem, the structure of microbial communities, and the impact of environment on the community (and vice versa).

CO-2 Understand and evaluate methods and approaches used to study **relationships and evolution (phylogeny) of microbes**, particularly *Prokaryotes* and *Eukaryotes*, to develop an understanding of the current classification of microbe groups.

CO-3 Explore taxonomic strategies and approaches used to name microorganisms, and the criteria used to define genome and species

CO-4 Understand the principles and methods behind studying and identifying cultured and uncultured microorganisms and use bioinformatics tools and databases that are used to study microbial diversity.

References:

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
2. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
3. Bauman, R.W. 2009. Microbiology with diseases by body system. 2nd edn. Pearsons Benjamin Cummings, San Francisco, 792 pp.
4. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
5. Chapman, J.L., and Reiss, M.J. 2006. Ecology: principles and applications. 2nd edn. Cambridge University Press, Cambridge.330 pp.
6. Dimmock, N.J., Easton, A.J. and Leppard, K.N. 2001.Introduction to Modern Virology. Blackwell Publishing, Oxford. 449 pp.
7. Krasner, R.I. 2010. The Microbial Challenge. 2nd edn. Jones and Bartlett Publishers, Sudbary. 476 pp.
8. Osborn, A.M., and Smith, C.J. (eds.).2008. Molecular Microbial Ecology. Taylor and Francis, New York, 381 pp.
9. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudburry, 835 pp.
10. Prescott, L.M., Harley, J. and Klein, D.A. 2002. Microbiology 5th ed. Tata McGraw-Hill, USA. 1147pp.
11. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.
12. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.

Microbiology
SEMESTER-I
Core - MB-1.2: ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Relate metabolic reactions carried out by microbes to global biogeochemical cycling of elements
- Understand these reactions in terms of chemistry, microbial physiology, and the importance in the environment.
- Understand the mechanisms how abiotic factors can influence on the microbial growth and microbial cells and how we can use these knowledge for controlling the growth of microorganisms.
- Understand the factors that regulate interactions between microbes. Understand the importance of these interactions in structuring microbial communities.

Unit 1: Ecosystem and Environment: **08 Hrs**

Introduction: Origin, Concept and Development of Ecology and Environmental Microbiology. Microbial Community: Ecosystem, habitat and niche. Concept and dynamics of microbial population and community. Structure and functions of microbial communities. Ecological succession Biogeochemical cycles.

Unit 2: Soil Microbiology: **12 Hrs**

Historical development of soil microbiology; Physical characteristics and nutrient status of soil. Distribution of microorganisms in soil, their importance in maintaining soil fertility, organic matter and composting. Influence of environmental factors on soil microorganisms. Role of microorganisms in formation of different soils. Enumeration of soil microorganisms.microbial interactions among soil microorganisms-mutualism, commensalism, antagonism, competition, synergism, parasitism and predation. Rumen microbiology; Significance of coprophilous microorganisms (composting)

Unit 3: Aquatic microbiology: **12 Hrs**

Aquatic environment: Physical parameters: temperature, hydrostatic pressure, light, salinity, turbidity, pH, nutrients. Fresh, brackish, marine and subterranean water environment and Distribution of microorganisms in the aquatic environment, planktons, microbial mats, biofilms Methods in the study of fresh and marine water microorganisms. Water Pollution: Sources, Characteristics of water pollutants, health hazards due to water pollution. Standard water quality criteria, Water quality testing (MPN technique). Eutrophication - causes, consequences and prevention. Waste water treatment: Primary-physical processes; Secondary-biological treatment by fixed biofilm systems (trickling filters, RBC, fluidized bed reactors), suspended systems (activated sludge process, oxidation lagoons, anaerobic digesters, septic tank); Tertiary- Filtration (sand beds & membrane filters) chlorination, ozonization, radiation and reverse osmosis.

Unit 4: Microbiology of the atmosphere: **10 Hrs**

Microorganisms in air, sources of air-borne microorganisms, aerosols microbial survival in air: pH, temperature, radiation, oxygen, and other factors. Air pollution and Radiation hazards: Sources and characteristics of air pollutants; Health hazards due to air pollution; Green house gases and green house effect. Ozone hole and acid rain. Radiation hazards and safety measures – sources, effect of radiations and safety measures.

Unit 5: a) Microorganisms in extreme environments: **12 Hrs**

Extreme environments: Physical environment: temperature, salinity, pressure, pH, magnetic force, starvation strategies. Extreme thermophiles, psychrophiles, halophiles, barophiles and other

microorganisms in extreme environments. Biotic and abiotic factors influencing survival and adaptations of extremophiles, mechanisms of survival. Biodeterioration and Bioremediation: Biodegradation of xenobiotics: Microbial degradation of pesticides, polycyclic aromatic hydrocarbons, natural and synthetic polymers (cellulose, pectin, lignin, detergents). Microbial remediation: Concept and scope of bioremediation.

b) Microorganisms and Bioterrorism: **10 Hrs**

Microbial agents as weapons of bioterrorism. Bioterrorism and potable water, real time monitoring in water distribution system, contaminant transport mechanisms and water quality modeling; Bioterrorism and agriculture**,** contamination through airborne microbial agents, foot and mouth diseases, transmission by formites.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Appreciate the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.

CO-2 Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection and characterization

CO-3 Competently explain various aspects of environmental microbiology and microbial ecology and to become familiar with current research in environmental microbiology.

CO-4 Understand various biogeochemical cycles – Carbon, Nitrogen, Phosphorus cycles etc. and microbes involved

Reference:

1. Brock T.D. Principles of Microbial Ecology. Prentice Hall Publ. Co. Philadelphia.
2. Martin Alexander. Microbial Ecology. John Willey & Sons. New York.
3. Atlas & Bertha. 1998. Microbial Ecology. 3rd Ed.
4. Gabriel Britton, 1994, Wastewater Microbiology, John Willey & Sons, New York.
5. Ralph Mitchell, 1995, Environmental Microbiology, Wiley Liss, New York.
6. Criston J. Hurst, Manual of Environmental Microbiology, ASM Publ., New York.
7. Raina, M.M, Ian, L.P, & Charles, P.G, 2009, Environmental Microbiology, Academic Press, UK

Microbiology
SEMESTER-I
Core : MB. 1.3 MICROBIOLOGIAL METHODS

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Introduce the basic concept of qualitative and quantitative analysis of a given sample.
- Study various spectroscopic techniques and its instrumentation.
- Study the concept of separation science and its applications.
- Study the concept of radiochemical analysis along with industrial analyzers.

Unit-1 Microbial Safety measures: **10 Hrs**

Concept, handling of microbiological specimen and microorganisms. Sterilization: Principles and applications of different methods of sterilization; physical- moist and dry heat, filtration, radiation and chemical methods of sterilization.

Unit-2 Nutrition: **10 Hrs**

Nutritional requirements, micro and macro nutrients, nutritional types of microorganisms, growth factors. Microbial culture media: Culture media, media components, formulation, types of bacteriological, fungal and algal media and uses of different microbial culture media.

Unit-3 Isolation and sampling techniques: **10 Hrs**

General isolation and sampling (streak, spread, pour plate, baiting) techniques for microorganisms from different sources. micromanipulator method, colony morphology and other characteristics of cultures.Automated microbial identification system, API, multitest system, Enterotube and other ready test systems.Cultivation of human virus: Egg, animal and cell culture methods

Unit-4 Cultivation of Anerobic microorganisms: **12 Hrs**

a) Staining techniques: Principles, protocols and applications of staining techniques. Simple,differential, vital, flagellar, cell wall, capsule and other staining techniques

b) Microbial growth; Concept, growth type, Measurement of microbial growth-cell number, turbidity and biomass, determination of microbial growth curve, Continuous and synchronous culture, balanced and unbalanced growth, influence of environmental factors on growth, dioxy-growth curve. Microbial culture preservation: Concept, types of microbial culture preservation; conventional and other methods, type culture collections centers- national and international.

Unit-5 a) Microscopy: **12 Hrs**

Working principle of bright field; magnification, resolution, Numerical aperture, defects of lens. Types of Microscopes- dark field, phase contrast microscopy, fluorescent microscopy, electron microscopy (TEM and SEM), techniques of sample preparation for electron microscopy and their staining techniques; confocal microscopy, scanning probe microscopy:Micrometry; caliberation and determination of size of microorganisms.

b) Instruments; **10 Hrs**

Autoclave: principle and types. Hot air oven: pH meter, nephalometer. Biosafety cabinets: types and applications. Colony counters: Incubators: types, CO_2 incubator and other instruments in Microbiology laboratory.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures

CO-2 Understand the structural similarities and differences among various physiological groups of microorganisms

CO-3 Know various Culture media and their applications and also understand various physical and chemical means of sterilization

CO-4 Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae and Autotrophy and heterotrophy

Reference:

1. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
2. Atlas, R.M. and Bartha, R. 2009. Microbial Ecology: Fundamentals and Appliations, 4thedn. Pearsons Education, New Delhi.705 pp.
3. Bauman, R.W. 2009. Microbiology with diseases by body system. 2ndedn. Pearsons Benjamin Cummings, San Francisco, 792 pp.
4. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
5. Naveen Kango (2009). Textbook of Microbiology. I.K. International Publishing House Ltd. New Delhi.
6. Jacquelyn G. Black, Larry M. Lewis. (2005). Microbiology: Principles & Explorations. Edition 6.Wiley, John & Sons.
7. Edward, K. Wanger& Martinez, J. Heweltt (2004). Basic virology.Blackwell publishing. 7. Lengeler, Joseph W./Drews, Gerhart. (1999). Biology of the Prokaryotes Blackwell Pub.
8. Atlas, R.M. (1998). Microbiology, Fundamentals and Applications (II ed) Macmillan Publishing Company.
9. Nester, E.W., Roberts, C.E., Pearsall, N.N., Anderson, D.G., Nester, M.T. (1998). Microbiology- A Human Perspective.2nd Edition.Mc Graw Hill.

Microbiology
SEMESTER-I
Core : M.B.1.4 CELL BIOLOGY AND BIOCHEMISTRY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Introduce the basic concept of qualitative and quantitative analysis of a given sample.
- Understand how these cellular components are used to generate and utilize energy in cells.
- Apply their knowledge of cell biology to selected examples of changes or losses in cell function.
- Provide the core principles and specialized knowledge of Carbohydrates, Lipids, Proteins, Vitamins, Porphyrin, cellular transport, law of thermodynamics, Lipid and Nitrogen metabolism.

Unit 1: a) Evolution of cell: **10 Hrs**

Cell as a unit of living organism, Cell organelles, structure of prokaryotic cell,\Cell cycle in bacteria, fungi and eukaryotes, endosymbiotic theory. Plasma membrane: structure and organization of plasma membrane, models if plasma membrane, membrane structure and transport mechanisms; membrane channels and pumps. cell signalling and signal transduction pathways; Molecular motors.

b) Bio-molecules **10 Hrs**

Chemical and physical foundations of biomolecules, water, water as solvent, theories of acids, bases and buffers, Stanley Miller experiment

Amino acids: Classification, chemical reactions and physical properties; biosynthesis and catabolism; principles of thermodynamics; Bioenergetics and energy metabolism in cells.

Unit 2: Nucleotides, lipids and carbohydrates **12 Hrs**

Chemistry of carbohydrates: Definition, Classification, Structure and general properties, inter conversion of monosaccharide's, . Importance and properties of glucose, ;Disaccharides fructose, sucrose, lactose, maltose,; Polysaccharides starch, celluolose, dextrins, hemicellulose, gellans, pulluans, lignins, agar and bacterial cell wall polysaccharides.

Nucleotides; biosynthesis and catabolism Classification, structure and function; synthesis and oxidation of fatty acids Vitamins; structure and functions.

Unit 3: a) Protein **08 Hrs**

Proteins Qualitative detection methods of protein structure of protein chemical reaction, classification.

b) Lipids : Properties classification, chemical reaction detection methods

Unit –4 : Enzymes: **10 Hrs**

Classification, nomenclature, general properties principles of catalytic power and specificity of enzymes, kinetics, coenzymes, activator inhibitors, isoenzymes, multi-enzyme complex, allosteric enzymes, mechanism of enzyme action.

Unit -5 : Biochemical techniques: **14 Hrs**

a. Centrifugation techniques: Basic principles of sedimentation. Methods and applications of density-gradient centrifugation, preparative centrifugation, ultracentrifugation.

b. Chromatographic techniques: General principles and techniques. Methods and applications of paper chromatography, thin-layer chromatography, exclusion chromatography affinity chromatography, ion-exchange chromatography, HPLC, Gas- liquid chromatography. MALDI-TOF, LC-MS/MS.

c. Electrophoretic techniques: General principles and applications of electrophoresis and isoelectric focusimg.

d. Spectroscopic techniques: General and laws of radiation, colorimetry, ultraviolet-visible spectrophotometry.

e. Radio isotopic techniques: General principles, nature of radio activity, detection and measurement of radioactivity, applications of radioisotopes in biological investigation.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Overview of major biomolecules –carbohydrates, lipids, proteins, aminoacids, nucleic acids, classification, structure, function of the above mentioned biomolecules

CO-2 Describe the concepts of electrolytes and electrolytic dissociation, pH and its biological significance, buffers, Henderson-Hasselbalch equation, biological buffer systems and their importance.

CO-3 Understanding the laws of thermodynamics, concepts of entropy, enthalpy and free energy changes and their application to biological systems and various biochemical studies and reactions.

CO-4 Conceptual knowledge of aerobic and anaerobic respiration and various intermediary mechanisms involved, oxidative phosphorylation properties, structure, function of enzymes, Application of enzymes in large scale industrial processes.

Reference:

1. Biochemistry: Lubert Stryer
2. Biochemistry:Lehninger
3. Microbial Physiology: Moat,Foster and Spector
4. Molecular Biology of the cell:Bruce Albertson
5. Cell and Molecular Biology: Gerald Karp
6. Cell and Molecular Biology: De-Robertis and De-Robertis
7. Molecular Cell Biology: Lodish

Davangere University

Shivagangotri, Davangere-577 007, Karnataka

M.Sc. Microbiology (Academic Year 2020 onwards)

Semester scheme with Choice-Based Credit System (CBCS)

Course Structure

M. Sc Microbiology II Semester

Subject/Paper Code		Title of the Paper	Instruction Hrs./week	Marks			Credits	Examination duration (Hrs.)
				Examination	Internal Assessment	Total Marks		
SEMESTER-II	**THEORY PAPERS**							
	MB 2.1	Microbial Physiology and Metabolism	**4**	**70**	**30**	**100**	**4**	**3**
	MB 2.2	Microbial Genetics & Genomes	**4**	**70**	**30**	**100**	**4**	**3**
	MB 2.3	Molecular Biology and Genetic Engineering	**4**	**70**	**30**	**100**	**4**	**3**
	MB 2.4	Biophysics, Biostatistics and Bioinformatics	**4**	**70**	**30**	**100**	**4**	**3**
	PRACTICAL PAPERS							
	MB 2.5	Microbial Physiology and Metabolism	**4**	**40**	**10**	**50**	**2**	**3**
	MB 2.6	Microbial Genetics & Genomes	**4**	**40**	**10**	**50**	**2**	**3**
	MB 2.7	Molecular Biology and Genetic Engineering	**4**	**40**	**10**	**50**	**2**	**3**
	MB 2.8	Biophysics, Biostatistics and Bioinformatics	**4**	**40**	**10**	**50**	**2**	**3**
	Mandatory Credits: Computer Skill		**2**	**---**	**---**	**---**	**2**	**---**
			34			**600**	**26**	

Microbiology
SEMESTER-II
CORE - MB-2.1: MICROBIAL PHYSIOLOGY AND METABOLISM

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Develop understanding about microbial metabolism, growth and energy generation.
- Gain knowledge of various fermentation pathways, microbial communication and energetics.
- Familiarize with concepts of nitrogen and phosphate assimilation, electron transport chain and transfer of genetic information among microbial communities.

Unit 1: Introduction to microbial physiology: **06 Hrs**

Concept, growth type, Measurement of microbial growth-cell number, turbidity and biomass, nutritional types of microorganisms – photolithotrophic autotrophy, photoorganotrophic heterotrophy, chemolithotrophic autotrophy, chemoorganotrophic heterotrophy; growth factors, uptake of nutrients by the cell- facilitation diffusion, active transport, group translocation, iron uptake; growth yields and limiting nutrients.

Unit 2: Enzyme Kinetics: **06 Hrs**

Structure-function relationship, protein-ligand binding; enzyme reactions – single-substrate and multiple substrates, chemical mechanism of enzyme catalysis; experimental measures of enzyme activity, inhibitors, time-dependent inhibition, cooperativity in enzyme catalysis.

Unit 3: Microbial Photosynthesis: **10 Hrs**

Light Energy, Photolysis of Water, Photosynthetic Pigments, Cyclic and Non-Cyclic Photophosphorylation, Calvin's Cycle.

Biological solvents:

Structure and properties of water molecule. Water as an universal solvent. Polarity, hydrophilic and hydrophobic properties.

Fermentation Reactions:

Types of fermentation reactions, Homo and Heterofermentation pathways; Alcohol and Lactic acid fermentation pathways.

Unit 4: (i) Metabolism: **12 Hrs**

Generation of energy – an overview of metabolism; Glycolytic pathway, Pentose Phosphate Pathway, Entner Doudoroff Pathway, Tricarboxylic Acid cycle; electron transport and oxidative phosphorylation, yield of ATP in glycolysis and aerobic respiration, fermentations, anerobic respiration, catabolism of carbohydrates, intracellular reserve polymers, lipid catabolism, protein and amino acid catabolism; oxidation of inorganic molecules.

(ii) Metabolism: **12 Hrs**

Use of energy in biosynthesis – principles, photosynthesis fixation of CO2; carboxylation, reduction, regeneration, synthesis of sugars and polysaccharides; phosphorus assimilation of phosphorus, sulphur and nitrogen, synthesis of amino acids, anaploerotic reactions biosynthsis of purines, pyrimidines and nucleotides; lipid synthesis; peptidoglycan and chitin synthesis.

(iii) Bioenergetics: **06 Hrs**

Principles of thermodynamics, high energy compounds-ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain, mechanism of oxidative and substrate level phosphorylation

Unit 5: Secondary metabolism: **12 Hrs**

Secondary metabolites from fungi and bacteria; regulation of secondary metabolism; structure and outline of synthesis of antibiotics; bacterial toxins; fungal toxins- patulin, aflatoxin, fuminosin; fungal pigments; fungal hormones- sirenin, sterols, trisporic acid; fungal alkaloids; bioluminescence in microorganisms – mechanisms and significance.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Acquaint with basics of metabolism and growth under normal and stressed conditions.

CO-2 Understand major fermentation, aerobic and anaerobic pathways for energy generation in microbial cells.

CO-3 Knows the concepts of microbial nutrition.

CO-4 Understand the microbial transport systems and the modes and mechanisms of energy conservation in microbial metabolism.

Reference:

1. Felix Franks, 1993; Protein Biotechnology, Humana Press, New Jersey.
2. Stryer L, 1995; Biochemistry, Freeman and Company, New York.
3. Voet & Voet, 1995; Biochemistry, John Wiley & Sons, New York.
4. Nelson & Cox, 2000; Lehninger's Principles of Biochemistry, Elsevier Publ.
5. Freifelder D, 1982; Physical Biochemistry, Freeman & Co. New York.
6. Harper, 1999; Biochemistry, McGraw Hill, New York.
7. Colowick SP and Kaplan N D, 1955; Methods in Enzymology. Vol. I. Academic Press.
8. Sualter C H, 1985; Practical Guide to Enzymology. John Wiley & Son.
9. Price & Steeves, Fundamentals of Enzymology
10. Kapler, Advances in Enzymology, Academic Press

Microbiology
SEMESTER-II
CORE -MB 2.2 MICROBIAL GENETICS & GENOMES

Course Credits: 4	Total No. of Hours: 64 No. of Teaching Hours per Week: 4 Hrs

Course Learning Outcomes:

Students should be able to:

- Understand the Genetic constituents of bacteria with special emphasis on inheritance and mutations
- Develop the mechanism of genetic transfers in microbes
- Familiarize different techniques used to study the microbial genetics and utilizing the microbial phenomenon in various biotechnological applications

Unit 1 a) Prokaryotic Genome: **6 Hrs**

E coli chromosome- coiled, supercoiled (plectonemic, solenoid), folded fiber model. *Mycoplasma genitalium* and E. coli genome.

b) Eukaryotic Genome: **10 Hrs**

Structure of chromatin, chromosome, centromere, telomere, nucleosome, genome organization, split gene, overlapping genes and Cot curves, chromatin remodeling; types of histones, histone modifications-methylation, acetylation, phosphorylation and their effects on structure and function of chromatin, DNA methylation, repetitive and non-repetitive DNA sequence. Law of DNA constancy, C value paradox and genome size, karyotype and idiogram, chromosome banding pattern, types of chromosomes. Organelle genome.

Unit 2 Genetic recombination: **12 Hrs**

Genetic recombination in bacteriophages and E. coli, synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases, generalized & specialized transduction, transformation and conjugation, legitimate & illegitimate recombination, gene conversion, overview of bacterial genetic map.

Unit 3 Gene transfer mechanisms: **12 Hrs**

Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications, genetic analysis of virus, bacteria and yeast genomes. Genetics of fungi-alteration of generation, induction of mutation in *Neurospora* crassa and yeast, cytoplasmic inheritance and biochemical mutants.

Unit 4 Plasmids and Bacteriophages: **12 Hrs**

Plasmids, F-factors - description and their uses in genetic analysis, Colicins and Col Factors, R plasmids. Lysogeny and lytic cycle in bacteriophages, Life cycle and their uses in microbial genetics.Lytic phages-T7 and T4, Lysogenic phages Lamda, M13 and ΦX174.

12 Hrs

Unit 5 Genomics: Interdiction to Genomes, modern tools and techniques used in genomic analyses, variation and genome-scale analysis of gene/protein expression; Genome Mapping and Sequencing, Chromosome mapping; Nucleic acid Hybridization, Minisatellite and Microsatellite analysis, RFLP, microarray; Heteroduplex analysis, Genome Annotation and Assembly. Model organisms for genome analysis – *Escherichia, Neurospora, Saccharomyces, Caenorhabditis, Drosophila* and *Arabidopsis;* Human genome project, Metagenomics**:** Concepts, approaches for metagenome analysis.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Explain the structure, properties and function of genes in living organisms at the molecular level and knowledge about DNA as a genetic material, enzymology, and replication strategies molecular mechanisms involved in transcription and translation.

CO-2 Describe the importance of genetic code and wobble hypothesis and discuss the molecular

mechanisms underlying mutations, detection of mutations , DNA damage and repair mechanisms

CO-3 Explain the concept of recombination, linkage mapping and elucidate the gene transfer mechanisms in prokaryotes and eukaryotes

CO-4 Protocols involving molecular techniques

Reference:

1. Jeremy W Dale and Simon F Park. (2010). Molecular Genetics of Bacteria.Fifth Edition.Wiley-blackw.
2. Dale. J.W. (1994).Molecular Genetics of bacteria, John Wiley & Sons.
3. Robert J. Brooker. (2009). Genetics: Analysis and Principles, 3rd Edition. McGraw-Hill.
4. GeaorgeLipps. (2008).Plasmids: Current Research and Future Trends. Academic Press.
5. Streips&Yasbin (2001). Modern microbial Genetics.Wiley Ltd.
6. Bloom, Freyer, Micklos. (1996). Laboratory DNA Science.The Benjamin/Cummings Pub.
7. Miller, J.H. (1992). Short course in bacterial genetics, CSH Laboratories.
8. Roger L.P. Adams, Johm, T., Knowler and David P. Leader.(1992). TheBiochemistry of the Nucleic Acids.11th edition. Chapman and Hall

Microbiology
SEMESTER-II
CORE MB-2.3: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Understand about the structure and function of biologically important molecules.
- Familiarize the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
- Gain knowledge on procedural repertoire allows students to innovatively apply these in basic and applied fields of biological research.
- Learn theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants.
- Introduced to prominent nucleic acid labeling techniques. Introduction to various types of vectors viz. cloning, transformation, expression; and also vectors for genomic and cDNA library and whole genome sequencing will be provided

Unit 1: DNA the chemical nature of the gene: **10 Hrs**

DNA as the source of genetic information. Structure and types of DNA, Chargaff's rule; Watson-Crick's model of DNA; denaturation and renaturation kinetics of DNA; Replication: Semiconservative, Meselson and Stahl's experiment, modes of replication, requirements of replication, direction of replication, enzymes in replication, prokaryotic and eukaryotic DNA replication, end replication problem.

Unit 2: Transcription: **08 Hrs**

RNA as the genetic material, RNA structure and classes of RNA,template, substrate and transcription apparatus, mechanisms of prokaryotic and eukaryotic transcription; RNA splicing – spliceosome, 5'-capping, polyadenylation, RNA splicing, exon shuffling, RNA editing.

Genetic code:

Triplet codon, arrangement of condons, arrangement of initiation and termination codons, rules governing the genetic code.

Unit 3: Gene regulation: **12 Hrs**

Gene organization, regulation of gene expression in prokaryotes, Operon concepts: Lac-operon and Tryp-operon; gene regulation in prokaryotes and eukaryotes; principles of transcriptional regulation.

Translation:

tRNA charging, mechanisms of translation in prokaryotes and eukaryotes- initiation, elongation and termination, polyribosomes, post-translational modifications of proteins.

Unit 4: Mutation and DNA repair: **12 Hrs**

Nature, type and effects of mutations; molecular basis of spontaneous and induced mutations; Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation, repair mechanisms, reversal of damage, excision repair, mis-match repair, post-replication repair.

Unit 5: **10 Hrs**

a) Genetic Engineering:

Isolation and purification of DNA,Restriction endonucleases, Plasmic cloning vectors, Creating and screening a library, vectors for cloning large DNA fragments (phage vectors, cosmids, BAC), genetic transformation in prokaryotes (Transformation, Electroporation, Conjugation) and eukaryotes, yeast

expression systems, eukaryotic expression vectors, selectable markers.

b) Chemical synthesis, amplification and DNA sequencing: 12 Hrs

Chemical synthesis of DNA – Phosphoramidite method, oligonucleotide synthesis; Polymerase Chain reaction –amplification of full length cDNAs, gene synthesis by PCR, DNA sequencing techniques – Dideoxynuclotide procedure, primer walking, pyrosequencing, sequencing by ligation, large scale DNA sequencing, shotgun cloning strategy, Cyclic array sequencing, site-directed mutagenesis.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Understand the properties, structure and function of genes in living organisms at the molecular level

CO-2 Explain the significance of central dogma of gene action, have a conceptual knowledge about DNA as a genetic material, enzymology, and replication strategies

CO-3 Understand the molecular mechanisms involved in transcription, translation, importance of genetic code and discuss the molecular mechanisms underlying mutations, detection of mutations and DNA damage and repair mechanisms

CO-4 Explain the concept of recombination, linkage mapping and elucidate the gene transfer mechanisms in prokaryotes and eukaryotes

Reference:

1. Watson, J. D. Hoppkins N. H. Roberts J. W. Steitz J. A. & Weiner A. M. 1987. Molecular Biology of the Gene. Benjamin / Cummings Publications Co. Inc. California.
2. Lewin, B. 2000. Gene VII. Oxford University Press.
3. Friedberg C. Graham C. Walker & Wolfram S. 1995. DNA repair and mutagenesis. ASM Press.
4. Larry S. and Wendy 1997. Molecular Genetics of Bacteria. ASM Publications.
5. Nicholl D. S. T. 2008. An Introduction to Genetic Engineering, Cambridge University Press.
6. Glick BR, Pasternak JJ. 2003. Molecular Biotechnology. ASM Press, Washington D.C.
7. Old R.S.and Primrose 2001. Principles of Gene Manipulation. Blackwell Scientific Publication.
8. Brown T.A. 2006. Gene Cloning. Blackwell Publishing.
9. Sambrook J. & Russell D. W. 2001. Molecular cloning- A laboratory manual. Cold Spring HarberLaboratory Press.
10. Weaver R., (2007) *Molecular Biology*, 4th Edition, McGrew Hill Science.
11. Old, R.S.and Primrose ,(2005) An introduction to gene manipulation
12. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., and Losick, R. 2004. Molecular biology of the gene, 5th edn. Pearson Education, Delhi.

Microbiology
SEMESTER-II
CORE COURSE CODE: MB. 2.4 BIOPHYSICS, BIOSTATISTICS AND BIOINFORMATICS

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Recall the basic concepts of atomic structure and explain the fundamental principles and origin of spectral lines
- Recall and explain the techniques and underlying theory of UV- Visible, IR, NMR and Raman, AAS, XRD and mass spectroscopy
- Provide an overview of various bioinformatics tools, databases available and sequence analysis.
- Provide knowledge on database concept, management, retrieval along with utilization in gene and protein analysis.
- Impart basic knowledge of patenting, intellectual property rights, laws available and copyrights.
- Impart basic knowledge of statistics and tools used for several quantitative analysis in microbiology

Unit 1- Introduction to Biophysics **8 Hrs**

Chemical buildings blocks; structure of atoms, bonds within molecules – ionic, covalent, hydrogen, electrostatic, disulphide and peptidebonds, vander Waals forces, bond length, bond energies, bond angles; isomerism - structural, geometrical, optical isomerism; secondary bonding; weak interactions.

Unit 2 Proteins: **10 Hrs**

Molecular organization of proteins – primary, secondary, tertiary and quaternary structures; principles of ionization; predicting properties from amino acid composition; unusual amino acids, stabilizing forces, conformational properties of polypeptides, Ramchandran plot, domains and motifs; structure-function relationship; study of three dimensional structures of proteins – cytochromes, lysozyme, trypsin, immunoglobulins .

Unit 3- a) Nucleic acids: **6 Hrs**

Purine and pyrimidine bases, nucleosides and nucleotides, conformational parameters of nucleic acids and their constituents, nucleic acid geometrics, base pairing, base stacking, Chargaff's rule, DNA polymorphism, DNA supercoiling; hyperchromicity; modified nucleotides, tertiary structure of nucleic acids.

b) Membranes: **6 Hrs**

Lipid structure and their organization, phase titration in lipids, polysaccharides, molecular shapes and conformation; comparision of different membrane models.

c) Methods in biophysical analysis:

Spectorscopy – UV, IR, fluroscence, Raman spectroscopy; CD, ORD, EM, NMR, X-ray diffraction.

Unit 4- Introduction to Biostatistics: **20 Hrs**

Mean, median, mode, measure of dispersion, range, standard deviation, mean deviation, standard errors, confidence limits, simple significance tests based on the normal distribution; use of t-tests, regression analysis, ANOVA, multiple regression, LSD, Chi-square test, stastical basis of biological assays direct and indirect assays, probit, logit, LD_{50}, ED_{50}, slope ratio assay; use of calculators and computer programs for stastastical analysis.

Unit 5-Introduction to Bioinformatics: **14 Hrs**

data base types – nucleotide databases, protein data bases, NCBI, DDBJ, EMBO, OMIM, genomics and the genome projects, finding and retrieving sequences, similarity searching (BLAST), sequence allignments: pairwise and multiple allignments and comparision; Molecular phylogenetics – molecular clock hypothesis, concept of phylogenetic tree, types of trees, elementary idea of clustering and cladistic methods

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Understand the constituents and working of a cell as a whole

CO-2 Enumerate the various cell organelles with their function and the differences in cellular organization of various life forms

CO-3 Describe various types of cell multiplications and divisions and differences between them

CO-4 Retrieve information from available databases and use them for microbial identifications and drug designing.

Reference:

1. Voet,D., and Voet, .G. 2004 Biochemistry, John Wiley and Sons.
2. Upadhyay and Upadhyay. 2004. Biophysical Chemistry, Himalayan Publishing House.
3. Karp, G. 2011. Cell and Molecular Biology, 6th edition, John Wiley and Sons.
4. Harper's review of Biochemistry Eds. Martin et al. Lange, 26th Edn. 2012.
5. Nelson & Cox. 2008. Lehninger's principles of Biochemistry. 5th edn,CBS Publishers & Distributors.
6. Chang, R. 1977. Physical Chemistry with application to Biological Systems (2 Ed.)
7. Branden and Tooze, 1991, Introduction to protein structure, Garland publishing company.
8. Adams, 1992, Biochemistry of nucleic acids, Chapman and Hall.
9. Rhodes, G. 1993. Crystallography made crystal clear, Academic press.
10. Lacroix Z and Critchlow, Z. 2003, Bioinformatics, Morgan Kaufmann Publishers.
11. Wardlaw,A.C. 1985. Practical stastics for experimental biologists. John Wiley and Sons.,
12. Higgins and Taylor.2000. Bioinformatics. OUP.
13. V B Rastogi 2015 Biostatistics

Davangere University

Shivagangotri, Davangere-577 007, Karnataka

M.Sc. Microbiology (Academic Year 2020 onwards)

Semester scheme with Choice-Based Credit System (CBCS)

Course Structure

M. Sc Microbiology III Semester

	Subject/Paper Code	Title of the Paper	Instruction Hrs./week	Marks			Credits	Examination duration (Hrs.)
				Examination	Internal Assessment	Total Marks		
SEMESTER-III	**THEORY PAPERS**							
	MB 3.1	Agricultural Microbiology and Phytopathology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.2	Immunology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.3	Medical Microbiology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.4	(A) Mycology (B) Gut Microbiology (C) Microbial Enzymology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 3.5	(A) Microbial Genetics (B) Diagnostic Microbiology **(Interdisciplinary Elective Paper)**	**2**	**40**	**10**	**50**	**2**	**2**
	PRACTICAL PAPERS							
	MB 3.6	Agricultural Microbiology and Phytopathology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 3.7	Immunology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 3.8	Medical Microbiology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 3.9	(A) Mycology (B) Gut Microbiology (C) Microbial Enzymology	**4**	**40**	**10**	**50**	**2**	**3**
			34			650	**26**	

Microbiology
SEMESTER-III
Core MB-3.1: AGRICULTURAL MICROBIOLOGY AND PHYTOPATHOLOGY

Course Credits: 4	Total No. of Hours: 64 No. of Teaching Hours per Week: 4 Hrs

Course Learning Outcomes:

Students should be able to:

- Provide basic understanding of agricultural microbiology including; microbial diversity in relation to agricultural welfare, microbial interactions and the fate of microbial pathogens in the environment and agricultural fields.
- Topics covered in detail include soil microbiology, aquatic microbiology, aero microbiology, biofertilizers and pesticides, microbial waste recycling and bioremediation etc.
- Develop set of skills to recognise the agricultural problems and critical evaluation, climate changes and as well as environmental protection.
- Learning the basic principles of agricultural microbiology and be able to apply these principles to understanding and solving problems in current environmental and agricultural issues.
- Familiarize with general principles and subject knowledge in the field of agricultural microbiology.

Unit 1:Agricultural Microbiology- 10 Hrs

Concept and scope, beneficial microorganisms, Interactions of soil microorganisms with plants: Rhizosphere and phylloplane microorganisms**.** Influence of microorganisms in plant growth, modern concepts of microbial inoculants in agriculture.

Unit 2:Microbial inoculants: 12 Hrs

Mass culturing and quality control of microbial inoculants-mother culture, shake culture and brief account of large scale production of biofertilizers, types of carrier materials, packing, storage, bench life and transportation. Methods of application to seed, soil and nursery.Brief account of mass production and applications of *Rhizobium, Azotobacter, Azospirillum,* Cyanobacteria, *Azolla* and *Frankia.*Plant growth promoting rhizobacteria (PGPR), phosphate solubilizers.Beneficial fungi in agriculture, *Trichoderma*, Mycorrhizae - importance and applications.

Unit 3:Phytopathology: **12 Hrs**

significance of plant diseases, types of plant diseases, basic procedure of plant disease diagnosis; parasitism and pathogenicity; disease development in plants, disease cycle, infection cycle and plant disease triangle; Effects of pathogens on plant physiology – photosynthesis, nutrients uptake, respiration, membrane permeability, plant growth and reproduction.**Plant pathogenesis**: Process of pathogen attack; role of enzymes, toxins, growth regulators in plant disease.**Plant disease epidemiology:** Effect of environmental factors on disease development; Dissemination of plant pathogens; Disease forecasting and its significance. .

Unit 4: a) Plant defense mechanisms: **10 Hrs**

preexisting and induced structural and chemical defenses, role of elicitors, receptors and suppressors in disease development; systemic acquired resistance.

b) Genetics of plant disease: Variability in pathogens, stages of variation, types of plant resistance to pathogens; genetics of virulence in pathogens and resistance in plants,signaling in plant disease resistance, systemic acquired resistance.

Unit 5: a) Plant Disease Management: 10 Hrs

Quarantine regulations, cultural methods, physical methods, chemical control, biological control, cross protection, breeding for disease resistance, integrated disease management practices,transgenic plants for

disease resistance.

10 Hrs

b) Diseases: Brief account of some important plant diseases-rots, damping-offs, downy mildews, white rust, powdery mildews, smuts, rusts, wilts, leaf spots, anthracnose, galls, ergots, bacterial, viral, phytoplasmal, nematodal, protozoal, viroid, non-parasitic diseases, seed-borne diseases and post-harvest diseases.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Provide basic concepts of agricultural microbiology including; microbial diversity in the environment in relation to agricultural welfare, ecosystem wellness, microbial interactions with pollutants in the soil and environment and the fate of microbial pathogens in the environment and agricultural fields.

CO-2 Understand various plant microbes interactions especially rhizosphere, phyllosphere and mycorrhizae and their applications especially the biofertilizers and their production techniques

CO-3 Understand the basic principles of environment microbiology and be able to apply these principles to understanding and solving environmental problems – waste water treatment and bioremediation

CO-4 Know the Microorganisms responsible for water pollution especially Water-borne pathogenic microorganisms and their transmission

Reference:

1. G N Agrios 2006 Plant Pathology Elisevier Academic press Indian addition PP922
2. Dhingra and Sinclair Plant Pathology 2000.
3. Subba rao Soil Microbiology 2000.

Microbiology
SEMESTER-III
Core MB 3.2 IMMUNOLOGY

Course Credits: 4	Total No. of Hours: 64 No. of Teaching Hours per Week: 4 Hrs

Course Learning Outcomes:

Students should be able to:

- Provide overview of immune system, antigen antibody structure and interactions.
- Develop understanding of innate and adaptive immunity along with major cells and molecules involved.
- Integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction.

Unit – 1: Introduction: **12 Hrs**

Overview of the immune system; Historical perspective; innate immunity, acquired immunity and comparative immunity.

Cells and organs of immune system: Hematopoiesis, Lymphoid cells, Mononuclear cells, Granulocytic cells, Mast cells, Dendritic cells.

Organs of immune system: Primary and secondary lymphoid organs; lymphatic system; Cutaneous associated lymphoid tissue.

Unit-2 Antigens and antibodies: **14 Hrs**

Immunogenicity, antigenicity, factors influencing immunogenicity, epitopes, haptens, superantigen**,** mitogens. Immunoglobulins: basic structure, chemistry and biological functions of immunoglobulin classes; Antibody diversity; Antigenic determinants of immunoglobulins- isotypic, allotypic and idiotypic determinants.

Unit – 3 (a) Immune response: **14 Hrs**

Primary and secondary response immunological memory, antigen processing and presentation. Cytokines- properties and functions. Complement system- components, activation and deficiencies.

(b) Cell-mediated response- Properties, effector cells, ADCC, Inflammation reactions, mediators of inflammation, anti-inflammatory drugs.

(c) Hypersensitivity- typer I, II, III and IV, mechanisms and therapy.

(d) Immunodeficiencies - Primary and secondary immunodeficiencies.

(e) Auto immunity- Organ-specific and systemic auto immune diseases, Treatment strategies.

(f) Transplantation immunology: Types of grafts, Immunologic basis of graft rejection, immunosuppressive therapy, clinical transplantations, compatibility assessment.

Unit-4 Antigen-antibody interactions: **12 Hrs**

Specificity, affinity, avidity, and cross reactivity neutralization, opsonization, agglutination, complement fixation, precipitation, immunofluorescence, immunoelectrophoresis, ELISA, RIA, Western blotting, Chemiluminescence, Immunosorbent electron microscopy, flow cytometry

Unit-5 Immunodiagnosis and Immunotherapy: **12 Hrs**

(a) Production and applications of polyclonal antibodies, Hydridoma Technology: production and selection of hybridoma. Applications: Diagnostic tools and detection.

(b) Immunotherapy: Therapeutic uses of cytokines, immunotoxin. Principle and strategies of vaccine production, types, significance and limitations.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Compare and contrast innate and adaptive immunity

CO-2 Design a model of Immunoglobulin's

CO-3 Describe which cell types and organs present in the immune response.

CO-4 To make them understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies. Illustrate various mechanisms that regulate immune responses and maintain tolerance

Reference:

1. Kuby Immunology 2006
2. Abbas Immunology 2006
3. G P Talavar and Talavar laboratory manual on Immunology 1996
4. Ananthanarayan and Paniker's tet book of Microbiology 8th edition 2011

Microbiology
SEMESTER-III
Core: MB 3.3. MEDICAL MICROBIOLOGY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Develop understanding about immune system, antigen antibody interactions.
- Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.

Unit 1- Concepts and historical development; **12 Hrs**

Clinical microbiology; outline, concepts, normal microflora of the human body, collection, handling and transport of Specimens; brief account of isolation and identification of microorganisms from specimens.Infection- types Factors involved in Pathogenesis –Establishment, spreading, tissues damage and anti-phagocytic factors. Mechanm of Pathogenesis-Bacterial adhesion, Colonization and invasion of mucus membranes of respiratory, enteric and urogenital tract, Role of aggressins, Depolymerizing enzymes, Cell tropisms**.** Quorum sensing in Staphylococcus pyogenes.

Unit 2- Medical Bacteriology and Parasitology: **20 Hrs**

Classification, Epidemiology, Pathogenesis, clinical conditions, laboratory diagnosis, epidemiology, chemotherapy and prevention of following infectious agents; *Staphylococcus, Streptococcus, Pneumococcus, Escherichia coli, Proteus Salmonella, Shigella, Neisseria: (meningo and gonococci), Corynebacterium, Pseudomonas, Vibrio, Clostridium spp, Haemophilus, Mycobacterium (typical and atypical), Spirochaetes (Treponema, Borrelia, Leptospira)* Dental infections: Dental plaque, dental caries, periodontal diseases. Emerging and reemerging pathogens.Entamoeba ,Giardia,*Balantidium, Plasmodium and Leishmania*

Unit 3- Medical Virology and Fungal infections: **12 Hrs**

Etiology, clinical symptoms, laboratory diagnosis and treatment: Pox virus, Herpes virus (HSV I & II) Varicella-zoster, Adenovirus, Picorna virus, Orthomyxoviruses (influenza), Paramyxoviruses (Mumps and Measles), Corona virus, Rhabdoviruses, Hepatitis viruses (HAV, HBV HCV, HDV), H1N1, Oncogenic viruses (HPV, epstein-barr virus, CMV), HIV, Arboviruses (Dengue, Encephalitis, chikungunya, rubella). Prion infection- Mad Cow, CJD, Kuru.

Unit 4- Fungi: **10 Hrs**

Aetiology, clinical symptoms, laboratory diagnosis and treatment of superficial infections (dermatomycoses): Epidermophyton, Microsporum and Trichophyton; Madura foot; Subcutaneous mycoses: Sporotrichosis and Systemicmycosis: Blastomycosis, Coccodiodomysis, Candidiasis, Opportunistic mycoses: Aspergillosis

Unit 5- Antimicrobial agents: **10 Hrs.**

Classification of antimicrobial agents, Mechanism of drug action – antibacterial (Bacteriostatic and bactericidal) antifungal and antiprotozoans drugs. Methods of testing drug sensitivity (in vitro and in vivo), antibiotic assay in body fluids.Mechanism of drug resistance and dissemination of multi drug resistance, cross resistance

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.

CO-2 It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the

role of the human body's normal microflora.

CO-3 The course provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.

CO-4 To understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue and explain the methods of microorganism's control, e.g. chemotherapy & vaccines

Reference:

1. Connie R Mahon. (2010). Textbook of Diagnostic Microbiology.3rd edition. Pearson.
2. Fritz H. Kayser. (2005). Medical microbiology.ThiemeVerlag.
3. Wadher, and Bhoosreddy.(2005). Manual of Diagnostic Microbiology.Himalaya Publisher.
4. Credric, A. Mims. (2004) Medical microbiology.(3rd Ed.).Moshy Inc.
5. Kufe, et al., (2003). Cancer Medicine. BC Decker Inc.
6. Frank, Steven A. (2002). Immunology and Evolution of Infectious Disease.Princeton University Press. 7. Warren Levinson Ernest Jawetz (2002), Medical Microbiology and Immunology: Examination and Board Review, 7th Edition. McGraw-Hill/Appleton and Laye.
7. Leslic Collier, John Oxford. (2000) Human virology: a text book for students of medicine, dentistry & microbiology (2nd Ed.) Oxford University Press.
8. Warren Levinson. (2000) Medical microbiology and immunology: examination and board review. (8th Ed.)McGraw Hill.
9. Nester, Roberts, Pearsall, Anderson. (1998). Microbiology -A Human Perspective, 2 nd edition, McGraw- Hill
10. Jenson, Wright, Robinson. (1997), Microbiology for the Health Sciences 4th edition, Prentice hall.
11. Mackie and McCarthey (1996), Medical microbiology vol 1, Microbial infection. vol 2, practical medicalmicrobiology, Churchil Livingstone

Microbiology
SEMESTER-III
SPECIALIZATION: MB-3.4 (A) MYCOLOGY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Unit-1 Introduction and ecology of fungi **10 Hrs**

Development of Mycology, Significance of fungi to human. Distribution of fungi in nature, factors in influencing fungal distribution

Characteristics of fungi

Morphological structural and ultrastructural details of fungi. chemistry of the fungal cell and molecular architecture

Unit-2 Mycological techniques **06 Hrs**

Isolation culturing and maintenance of fungi mycological media and methods culture collections.

Unit-3 a) Fungal biodiversity and systematic: **16 Hrs**

Diversity of fungi, systematic position of fungi, parameters for fungal systematic classification of fungi. Biochemical and molecular markers in fungal diversity assessment.

b) Reproduction in fungi:

Asexual and sexual reproduction. reproductive structures in different fungi, heterokaryosis, parasexuality and heterothallism.

Unit - 4 a) Physiology of fungi: **16 Hrs**

Fungal growth, nutritional requirements, assessment of fungal growth, effect of environmental factors on growth. Primary metabolism; Secondary metabolism in fungi-synthesis and activities of fungal antibiotics, mycotoxins, phytotoxins and other metabolites.

b) Fungal enzymes:

Nature of fungal enzymes, quantitative and qualitative assessment of fungal enzymes. Screening and selection of fungi for useful enzymes. Isozyme polymorphism in fungi; applications of fungal enzymes.

Unit-5 a) Fungal Proteomics and Genomics: **16 Hrs**

Identification of fungal proteins; techniques of studying fungal proteins; cellular and extracellular proteins of fungi; fungal protein antigens and their detection. Molecular biology of fungi; genome analysis; fungal genes and molecular methods for study of fungi.

b) Fungal Biotechnology:

Usefulness of fungi in biotechnology. Fungal products of commercial importance; fungi for the production of recombinant proteins

Microbiology
SEMESTER-III
SPECIALIZATION: MB 3.4 (B) GUT MICROBIOLOGY

Course Credits: 4	Total No. of Hours: 64 No. of Teaching Hours per Week: 4 Hrs

Unit-1 Introduction to gut microbiota; **10 Hrs**

Composition and structure of the human GI microbiota; Development of the human GI microbiota; Biogeography of the human microbiota in the GI tract; Factors shaping the GI microbiota

The Upper Gastrointestinal Tract

Esophagus and Stomach ;Introduction;The esophageal microbiome ;The microbiome in esophageal diseases ; Microbial niches of the intestines

Unit-2 a) Gut Microbiota; **20 Hrs**

Gut microbiota through life span; Gut microbiota in health and disease; Genetic and environmental factor of gut microbiota; Impact of nutrition on gut microbiota; Therapeutic manipulation of gut microbiota; Application of microbiota and nutrition; Future of gut microbiota and nutrition.

b) The Viruses of the Gut Microbiota;

The eukaryotic virome, a component of the gut microbiome;Interplay between gut virome and immune system;Pathogenic viruses of the gut virome: enteropathogenic viruses associated with systemic infections;Gut as a major source of neurotropic viruses, when pathogenesis and shedding is favored by humoral immune deficiency ;An uncertain status for diet-derived animal viruses

Unit-3 a) Food Substrates Important to the Microbiota; **14 Hrs**

Dietary Fiber, Soluble and Insoluble, Carbohydrates, Fructose, and Lipids; The Benefits of Yogurt, Cultures, and Fermentation ;General considerations about yogurt, fermented dairy products,; Yogurt and digestive function

b) Immunologic Response in the Host;

Intestinal epithelial cells ; Toll-like receptors and intestinal epithelial cells ; NOD receptors and intestinal epithelial cells;Immunoregulatory role of intestinal epithelial cells;Transcytosis of immunoglobulin A by intestinal epithelial cells ;Antigen presentation in the gut ;Role of dendritic cells ;Innate lymphoid cells;T cells;Microbial modulation of immune function

Unit-4 Role of the GI microbiota in health; **10 Hrs**

Bacterial Diarrheas; Enterotoxin-Mediated Diarrheal Diseases; Cholera; Enterotoxigenic E coli Diarrhea; Other Diarrhea-Causing Toxins; Gastrointestinal Disease Caused by Invasive Bacteria; *Salmonella* Enteritis; *Shigella* Dysentery; Fluid Production in Invasive Diarrhoeal Diseases; Viral Diarrhoea; Parasitic Diarrhoea.The Role of the Brain–Gut–Microbiome in Mental Health and Mental Disorders; Mood disorders;

Unit-5 Probiotics: **10 Hrs**

Probiotics: definition, types, properties, microbial group. Prebiotics: synbiotics and neutraceuticals, Taxonomy of Lactobacilli and Bifidobacteria, The Microecology of Lactobacilli in the Gastrointestinal Tract, Exopolysaccharide Production by Intestinal Lactobacilli

Microbiology
SEMESTER-III
SPECIALIZATION: MB-3.4 (C) MICROBIAL ENZYMOLOGY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Impart basic knowledge of enzyme kinetics, the parameters of the enzymatic reaction, mechanisms of action of enzymes and inhibitors, dependence on the temperature and pH of the enzymatic activity, knowledge of the structure of enzymes and amino acids that build active sites of enzymes.
- Integrate the practical aspects of enzymology with the kinetic theories to provide a mechanistic overview of enzyme activity and regulation in cells.
- Develop and understanding of enzyme development and rational drug designing.

Unit 1. Introduction to enzymes. **14 Hrs**

Historical developments. Classification of enzymes into six major groups with suitable examples. Numerical classification of enzymes. Methods & structural conformations of enzymes. Properties of Enzymes, laws of thermodynamics , factors affecting the rate of chemical reactions. Arrehenius theory, collision theory . free energy. Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site.

Unit 2. Enzyme kinetics: **14 Hrs**

Importance of enzyme kinetics, Variations of velocity with [E], [S], pH and temperature, time of incubation , Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Lineweaver-Burke plot, Haldane-Briggs relationship. Concept and significance of K_m and V_{max}. Concept of enzyme inhibition; types of enzyme inhibitors-reversible, competitive, non-competitive, uncompetitive and irreversible; significance and applications of enzyme inhibitors. Basics of enzyme turnover- Kinetics, measurement and rates of enzyme turn over..

Unit 3. Mechanism of enzyme action . **12 Hrs**

theories of mechanisms of enzyme action. Mechanism of action of lysozyme, chymotrypsin and ribonuclease.Monomeric, Oligomeric and multi-enzyme complex (PDH and fatty acid synthase), isozymes (Lactate dehydrogenase, creatine phosphokinase, alcohol dehydrogenase, alkaline phosphatase and isocitrate dehydragenase.) and Allosteric enzymes (Threonine dehydratase and aspartate transcarbomylase); covalently modulated enzymes (Glycogen phosphorylase) and Membrane bound enzymes (ATPase).

Unit 4. Enzymes from microbial sources. **12 Hrs**

screening by plate assay methods, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme reactors. Immobilized enzymes: Physical and chemical methods of immobilization, immobilization supports, kinetics of immobilized enzymes. Enzyme electrodes, Enzyme catalysis in a polar medium, reverse micellar entrapment of enzymes and its applications.

Unit 5. Application of enzymes: **12 Hrs**

synthesis of chemicals using enzymes, food technology and medicine. Enzymes in diagnostic assays. immunoenzyme techniques. Commercial products of microbes: Antibiotics, biopolymers, biosensors,

biopesticides Production of biofuels. Microbial toxins: Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, anti-plasmodial, anti-inflammatory compounds.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Acquire the knowledge of enzymes their properties and classification, Mechanism of action, Michaelis-Menten initial rate equation, methods for the determination of Km and Vmax.

CO-2 Analyses the mathematical derivations in understanding enzyme kinetics and different transformation and its application.

CO-3 Learn about enzyme kinetics, effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions, enzyme inhibition and activation, and Multi substrate enzyme kinetics.

CO-4 Learn different immobilization techniques and Industrial and clinical scope of enzymes and preparation of various culture media, Purification techniques

Reference:

1. T Palmer Textbook of Enzymes
2. West and told Textbook of Enzymology
3. Dr. S M Bhatt Enzymology and Enzyme Technology 2011
4. Punekar N S Enzymes 2020

Microbiology
SEMESTER-III
Elective: MB-3.5 (A) MICROBIAL GENETICS

Course Credits: 2	Total No. of Hours: 32 No. of Teaching Hours per Week: 2 Hrs

Unit-1 Genetics: **06 Hrs**

Historical development; basic principles of heredity, Mendelian principles, laws of inheritance; experimental proof of genetic material

Unit-2 Bacterial recombination **12 Hrs**

General Princeples; bacterial plasmids, fertility factors Distance factors, Col plasmids, other types of plasmids; transposable elements; bacterial conjugation – F+ x F- mating, Hfr conjugation, F' conjugation mapping, recombination mapping; bacterial transformation – mechanism; natural and artificial transformations; Transduction: generalized and specialized transduction; host restriction and modifications; mappings the genome.

Unit-3 Viral recombination: **07 Hrs**

Pahge phenotypes, phenotype mixing, mechanisms of replication in DNA and RNA viruses; recombination and mapping, circular map, lytic phages- T7 and T4 lysogenic phages I and P1 and Fx 173 and Their uses in microbial genetics.

Unit-4 Fungal recombination **07 Hrs**

Structural organization of fungal genome; Chromosomal genes, mitochondrial genes, plasmids and transposable elements, fungi as model organisms in genetics genome mapping in fungi.

Microbiology
SEMESTER-III
Elective: MB-3.5 (B) DIAGNOSTIC MICROBIOLOGY

Course Credits: 2	**Total No. of Hours: 32** **No. of Teaching Hours per Week: 2 Hrs**

Course Learning Outcomes:

Students should be able to:

- Identify and adhere to established guidelines for working with potential pathogens to ensure biohazard safety
- Demonstrate steps of proper procedure for microbiological staining, and interpret results for use with identification of pathogens
- Cultivate, isolate and identify infectious agents; and Interpret antimicrobial susceptibility testing.

06 Hrs

Unit-1 An overview of medical microbiology, significance of microbial diseases of humans. Laboratory safety measures and sample disposal

10 Hrs

Unit-2 Medical Specimens: collection procedure and transport of body fluid specimens gastrointestinal specimens, genital specimens, respiratory specimens, urine specimens and wound specimens. specimen processing General methods, microscopy, culture methods and serology

12 Hrs

Unit-3 Laboratory diagnosis of important bacterial, viral, fangal and protozoal infections *(Mycobacterium, Staphylococcus, Treponema, Salmonella, HIV, Hepatitis, Aspergillus Candida, Plasmodium)*

Unit-4 Antimicrobial drug testing procedures. **04 Hrs**

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Describe and post pre-examination procedures applicable to diagnostic microbiology

CO-2 Describe or perform standard microbiological staining techniques and set up and incubation of microbial specimens

CO-3 Explain the principles behind different media utilized for growth, isolation, or identification of microbes and use standard microbial techniques or procedures to identify unknown organisms

CO-4 Describe the use of molecular or serological methods for the detection or identification of microbes

Davangere University

Shivagangotri, Davangere-577 007, Karnataka

M.Sc. Microbiology (Academic Year 2020 onwards)

Semester scheme with Choice-Based Credit System (CBCS)

Course Structure

M. Sc Microbiology IV Semester

	Subject/Paper Code	Title of the Paper	Instruction Hrs./week	Marks			Credits	Examination duration (Hrs.)
				Examination	Internal Assessment	Total Marks		
SEMESTER-IV	**THEORY PAPERS & PROJECT WORK/DISSERTATION**							
	MB 4.1	Food and Dairy Microbiology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 4.2	Biotechnology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 4.3	Industrial microbiology and Pharmaceutical microbiology	**4**	**70**	**30**	**100**	**4**	**3**
	MB 4.4	Project work/Dissertation	**6**	**70**	**30**	**100**	**6**	**3**
	PRACTICAL PAPERS							
	MB 4.5	Food and Dairy Microbiology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 4.6	Biotechnology	**4**	**40**	**10**	**50**	**2**	**3**
	MB 4.7	Industrial microbiology and Pharmaceutical microbiology	**4**	**40**	**10**	**50**	**2**	**3**
	Study Tour/Field Visit		**---**	**---**	**---**	**---**	**---**	**---**
	Mandatory Credits: Personality Development		**2**	**---**	**---**	**---**	**2**	**---**
			32			550	26	

Microbiology
SEMESTER-IV
CORE MB 4.1: FOOD AND DAIRY MICROBIOLOGY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Provide instruction in the general principles of food microbiology.
- Explain the biology and epidemiology of food borne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses,
- Understand food spoilage microorganisms; the microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.

Unit-1 Introduction: **10 Hrs**

Development and scope of food microbiology; food as substrate for microorganisms (water activity, temperature, pH, O/R potential, accessory factors); important microorganisms in food (molds, yeasts and bacteria**).**

Food contamination and spoilage:

Sources of food contamination. Principles of food spoilage; spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, fish and other sea foods, poultry; spoilage of canned foods; conventional and modern methods for detection of spoilage and characterization.

Unit-2 a) Food preservation: **20 Hrs**

Principles and methods of food preservation- Physical (temperature, irradiation, drying, canning, processing for heat treatment - D, Z and F values) Chemical (Organic acids, food additives. Class I and Class II preservatives), Biopreservation (Lactic acid bacteria), Food Packaging- Types of packaging materials, properties and benefits.

b) Food-borne infections and intoxication:

Bacterial- *Brucella, Bacillus, Clostridium, Escherichia, Listeria;* Food intoxication- Botulism, Staphylococcal toxin. Mycotoxins (aflatoxins, patulins, ATA, ochratoxins, fuminosins, Trichothecenes, Zearalenone, ergot alkaloids); food borne outbreaks (laboratory testing procedures and preventive measures); Molds, Algae, Protozoa, Viruses, Biosensors in food industry.

c) Microbial and Fermented foods:

SCP- Nutritional & therapeutic importance, QUORN and SCO and their commercial production. Fermented Vegetables (Saurkraut, olives, cucumbers), Meat (sausages), Beverage (cocoa and coffee); Bread, Idli, Soy sauce; fermentation by molds, application of microbial enzymes in food industry (Protease, Lipases)

Unit-3 a) Food Biotechnology: **14 Hrs**

Single cell protein; algal biotechnology; fermented foods, mushroom technology; fungal foods; microbial production of flavours, enzymes for food processing, sweeteners, food wastes, genetically modified foods; current trends in manufactured foods; consumer acceptance and market forces.

b) Food and sanitation:

GHPs, Sanitation in manufacture and retail trade; food control agencies and their regulation, hazard analysis and critical control points (HACCP); GMP, plant sanitation – employees' health standard, quality assurance/control. Recent trends and developments of food technologies in India**.**Food Parks**.**

Unit- 4 Dairy Microbiology: **10 Hrs**

Biochemical composition of milk, microbial flora of milk, sources of milk contamination, Pathogenic (human, zoonotic) microorganisms in milk; Pasteurization, sterilization of milk and UHT. Types of microorganisms in chilled and refrigerated milk supplies and their importance; heat resistant types in milk and their role in milk spoilage; Quality maintenance in dairy industry (plant, equipment, barn); quality control tests for milk; microbiological grading, market milk (bulk) production and public health.

Unit-5 Dairy products: **10 Hrs.**

Production of Cream, curd, butter, ice-cream, milk powder, khoa, peda, yoghurt, acidophilus milk, condensed milk, kefir, koumiss, srikhand, cultured butter milk, cheese and other fermented milk products.

Microbiology of dairy industry: definition and properties starter cultures, starter selection, lactic and non-lactic starter cultures; use of pure and mixed starter cultures; production of flavour components by starter cultures; starter –production,maintenance, and preservation; assessment of quality of starter cultures; Defects associated with starter cultures and control**;** whey; dairy effluent treatment.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Know the details of food borne pathogens, fermented food products and role of microorganisms in dairy industry

CO-2 Understand concept and use of probiotics and illustrate the role of microorganisms in food safety

CO-3 Cultivate and enumerate microorganisms from various food samples

CO-4 Compare various physical and chemical methods used in the control of microorganisms

Microbiology
SEMESTER-IV
CORE MB 4.2 : BIOTECHNOLOGY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Recapitulate the previous knowledge of cell biology and to establish thorough understanding of various cell structure and function at molecular level.
- Provide a thorough understanding of the various molecular biology concepts in study of biotechnology and to study the different tools and techniques used to study the biology of cell at molecular level.
- Acquire in-depth knowledge of the molecular events involved in cell division which includes mitosis, meiosis, cell cycle and its regulation. Including. To provide wider and global perspective of cell cycle regulation and cancer, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of knowledge.
- To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation

Unit-1 An Introduction to Biotechnology: **10 Hrs**

Concept, Definitions of biotechnology; developmental milestones of biotechnology; scope of biotechnology; modern trends.

Microbial biotechnology:

Microbial synthesis of commercial products- protein pharmaceuticals (Interferons; Human Growth harmone) Restriction endonucleases, small biological molecules (amino acids, indigo) antibiotics; bioplastics (PHB, PHA), biopolymer (dextran, alginate, xanthan, pullulan), microbial enzymes, microbial metabolites – organs acids, amino acids, manipulation of gene expression in prokaryotes, heterologous protein production on eukaryotic cells; yeast cloning.

Unit-2 Plant Biotechnology: **20 Hrs**

Nitrogen fixation, nitrogenase, hydrogenase, nodulation siderophores, phytoharmones, trsgenic plants: principle, production method and development of pest and disease resistant plnats; tolerance to abiotic stress; genetic manipulation of flower pigmentation; nutritional improvement; modification of plant products, edible vaccines, anti-sense RNA technology; Biofertilizers, biopesticides, plant biotechnology in forestry; applications of plant cell and tissue culture technology.

Animal Biotechnology :

Cloning strategies, embryo stem cell technology homologous recombination and transgenesis; Methods and applications of transgenic animals; mammalian cell culture; human somatic cell gene therapy – ex vivo gene therapy antisense therapy; methods and applications; brief account of genetic diseases in humans, human genome project; molecular diagnosis of inherited diseases; DNA in forensic science.

Unit-3 Environmental Biotechnology: **14 Hrs**

Waste water and sewage treatment; landfall technologies, bioremediation –microbial degradation of xenobiotics; genetic engineering of biodegradative pathways; Biomass utilization- cellulose and starch; production of biofuels; Microbes in metal biotechnology; solid waste management.

Biosensors:

Brief account of Amperometric, Potentiometric, Conductometric, Thermometric, Piezoelectric, Optical, whole cell Biosensors, immunesensors.

Unit-4 Regulations and patenting in Biotechnology: **10 Hrs**

Regulation recombinant DNA technology; patenting biotechnology inventions; patenting organisms, patenting indifferent counties; patenting and fundamental research; intellectual property rights.

Unit-5 Biosafety and Bioethics: **10 Hrs**

Definitions of biosafety and bioethics; levels of biosafety; hazardous materials used in biotechnology; good laboratory practices and good manufacturing practices; bioethics in resource management, ethical issues of genetically modified organisms, ethical aspects of cloning and transplantations; social implications of biotechnological research.

Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Explain the physiological processes that occur during plant growth and development and describe the methodology involved in plant tissue culture and plant transgenics

CO-2 Discuss issues related to plant nutrition, quality improvement, environmental adaptation, transgenic crops and their use in agriculture

CO-3 Elucidate the significance of transgenic plants as bioreactors for the production of enzymes, plant bodies, edible vaccines and therapeutic protein

CO-4 Address bioethical and biosafety issues related to plant transgenics

Microbiology
SEMESTER-IV
PAPER: MB 4.3 INDUSTRIAL MICROBIOLOGY AND PHARMACEUTICAL MICROBIOLOGY

Course Credits: 4	**Total No. of Hours: 64** **No. of Teaching Hours per Week: 4 Hrs**

Course Learning Outcomes:

Students should be able to:

- Understand the basics of Industrial and pharmaceutical microbiology with important microorganism playing role pharmaceutically
- Understand different products of microbial origin playing key role in Industrial and pharmaceutical applications.
- Understand role of secondary metabolites in pharmaceutical industry.
- Understand good practices and regulation involved in utilizing microbial product for pharmaceutical application

Unit 1. Introduction to industrial microbiology: 08 Hrs

Brief history and developments in industrial microbiology**,** Isolation of industrially important microbial strains and fermentation mediaSources of industrially important microbes and methods for their isolation, preservation andMaintenance of industrial strains, strain improvement. Raw materials: Crude and synthetic media; molasses, corn-steep-liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.

Unit 2. Types of fermentation processes, bio-reactors and measurement of fermentation 12 Hrs

Parameters:

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged)fermentations; batch, fed-batch (e.g. baker's yeast) and continuous fermentations

Components of a typical bio-reactor,

Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

Unit 3. Down-stream processing: 10 Hrs

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray-drying **Enzyme immobilization** Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

Unit 4. A brief out lines of processes for the Microbial production of industrial products

a. Primary metabolites 10 Hrs

i. Organic acids : Citric acid, lactic acid, vinegar

ii. Amino acids : Glutamic acid, L – lysine, glutamic acid

iii. Solvents : Acetone, ethyl alcohol

b. Secondary metabolites

i. Antibiotics : Streptomycin, penicillin

ii. Vitamins : B12, Riboflavin,

iii. Microbial Enzymes(screening andproduction of amylase,protease,lipase)

Production of Wine, beer, whisky and their spoilage.

Unit 5.Nano-technology: **24 Hrs**

Introduction - history and recent developments - sources of nanoparticles - microbial producers of nanoparticles -advantages of microbial nanoparticles - applications . Good laboratory practices, –Good Manufacturing Procedures. process validation, ISO standards. Quality Assurance and Validation. Regulatory aspects of QC, QA, and QM.GMP , GLP and CMP in Pharma Industry. ISO, WHO, USFDA certification.Microbial Limit test of Pharma products. Sterility testing , pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators.Designing layout for microbiology laboratory.

Pharmaceutical microbiology

Introduction to drug discovery and development, sources of drugs, approaches to new drug discovery, role of molecular recognition in drug design, enzymes and receptors as drug targets, prodrug design and applications, computer aided drug design, preclinical and clinical trials

Biopharmaceuticals

Concepts of pharmaceuticals, biologics and biopharmaceuticals, sources of biopharmaceuticals, biopharmaceuticals in production and research, cytokines, heamopoetic growth factors, hormones, blood products, therapeutic enzymes (Asparaginase, Streptokinase, beta lactamases), bacterial and viral vaccines, New vaccine production (DNA vaccines, synthetic, peptide vaccines, multivalent subunit vaccines, edible vaccines and their trials), Case studies.

Spoilage of pharmaceutical products, regulatory practices and policies in pharmaceutical industries

Microbial production contamination and spoilage of pharmaceuticals products (sterile injectables, ophthalmic preparations and implements) and their sterilization, FDA, govt. Regulatory practices and polices, concept of R & D, quality control and market planning.

Significance of IP, BP and USP.

Reimbursement of drugs, biological and legislative aspects, patenting of drugs and biological products

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Course Outcome for M.Sc. Microbiology:

After successful completion of this course students are expected to be able to:

CO-1 Get equipped with a theoretical and practical understanding of industrial microbiology and appreciate how microbiology is applied in manufacture of industrial products

CO-2 Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air

CO-3 Appreciate the different types of fermentation processes and understand the biochemistry of various fermentations

CO-4 Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms comprehend the techniques and the underlying principles in downstream processing foods and in food processing and the microbiology of different types of fermented food products.

Reference

1. Pharmaceutical Microbiology- Edited by W. B. Hugo & A.R. Russel Sixth Edition. Blackwell Scientific Publications.
2. Lippincott's illustrative Reviews: Pharmacology Edition: 02 Maryjnycck by Lippincott's review Publisher Pheladelphia 1997.
3. Principles of medicinal chemistry Vol. 1 by Kadam S.S., Mahadik K.R., Bothra K.G. Edition: 18, Nirali Publication.
4. Pharmacognosy by Gokhle S.D., KoKateC.K.. Edition: 18, Nirali Publication.
5. Biotechnology – Expanding Horizon by B.D. Singh ., First Edition, Kalyani Publication, Delhi.
6. Analytical Microbiology- Edited by Fredrick Kavanagh volume I &II. Academic Press New York.
7. Pharmaceutical Biotechnology by S. P. Vyas & V.K. Dixit. CBS publishers & distributors, New Delhi.
8. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
9. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology.1st edition.Bios Scientific Publishers Limited. USA

10. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction.1st edition. Wiley – Blackwell
11. Glazer A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology.1st edition. W.H. Freeman and Company
12. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
13. Stanbury PF, Whitaker A and Hall SJ.(2006). Principles of Fermentation Technology.2nd edition, Elsevier Science Ltd.