RAMAKRISHNA MISSION VIDYAMANDIRA

BELURMATH, HOWRAH, WEST BENGAL

DEPARTMENT OF MICROBIOLOGY

PROGRAMME OFFERED : B.Sc. MICROBIOLOGY HONOURS

PROGRAMME CODE : MCBA

DURATION : 6 SEMESTERS

TOTAL CREDIT : 148

FULL SYLLABUS WITH COURSE OUTCOME

VALID & ONGOING AS ON 30TH JUNE, 2019

Following is the credit distribution for B.Sc. Microbiology Hons. Programme:

	CR SEM 1	CR SEM 2	CR SEM 3	CR SEM 4	CR SEM 5	CR SEM 6	Total Credit
Core Course / Hons.	14	14	14	14	26	26	**108**
Generic Elective	6	6	6	6	--	--	**24**
AECC-Lang.	2	2	2	2	--	--	**4**
AECC-ENVS	--	--	--	--	--	--	**4**
SEC- ICSH	1	1	1	1	2	2	**8**
	23	**23**	**23**	**23**	**28**	**28**	**148**

Following is the Grade Point distribution:

% of Marks	Descriptor	Grade	Grade Point
85 - 100	OUTSTANDING	**O**	**10**
70 - 84.99	EXCELLENT	**A+**	**9**
60 - 69.99	VERY GOOD	**A**	**8**
55 - 59.99	GOOD	**B+**	**7**
50 - 54.99	ABOVE AVERAGE	**B**	**6**
40 - 49.99	AVERAGE	**C**	**5**
35 - 39.99	PASS (HONOURS)	**P**	**4**
30 - 34.99	PASS (OTHERS)	**P**	**4**
LESS THAN 35	FAILED (HONOURS)	**F**	**0**
LESS THAN 30	FAILED (OTHERS)	**F**	**0**

Name of the Core Course	Credit for the Core Course	Generic Elective Course and the Credit
Microbiology Hons	108	Total Credit : 24 Guidelines to make Choice : While Generic Elective subject Course 'a' is to be taken by all students, any one from Generic Elective subject Course 'b' may be chosen by the students a) Chemistry & b) Physics / Zoology

B.Sc. Microbiology Hons. Programme has introduced Discipline Specific Elective Course (DSE) and/or Project in 5th and/or 6th semester:

Sl. No.	**Name of the Programme**	**Discipline Specific Elective / Project**
1	Microbiology Hons	Project

Students of B.Sc. Microbiology Hons. Programme must take following courses :

- Ability Enhancement Compulsory Courses (AECC):
  - Environmental Science : 4 Credit
  - English Language and MIL (Bengali Language/ Alternative English) : 4 Credit
- Value-Oriented Course (Indian Cultural and Spiritual Heritage) : 8 Credit

Total Credit to be earned by a student to complete B.Sc. Microbiology Hons. Programme : 148 Credit
Mark sheet after each semester will be given both with SGPA and detailed marks obtained by the examinee.

Similarly Mark sheet after the final semester will be given with CGPA and detailed marks obtained by the examinee.

Calculation of SGPA = (Total Credit X Total Grade Point = Total Credit Point);
Total Credit Points / Total Credits
Calculation of CGPA = (Total SGPA X Total Credits in each Sem.) / Total Credits earned in all the semesters

B.Sc. Microbiology Honours

6 Semester Course

Course Structure

Sl No	Name of the Course	Semester	Course Code	Credit	Marks in the Course	Course outcome
1	GENERAL MICROBIOLOGY-I, MICROBIOLOGICAL METHODS, BIOPHYSICS, STEREOCHEMISTRY AND BIOMOLECULES-I, BIOMETRY I	1	MCBA P1 T	10	100	To understand some of the basic concepts of different aspects of biometry needed in Microbiology,To understand the basic classification system of different microbes,To understand some of the basic concepts of different aspects of biochemistry needed in Microbiology,To have a basic overview of history and developments of Microbiology
2	Operation of light microscope Preparation of culture media Cultivation of microorganisms Study of microorganisms by staining techniques Study of algae by temporary mounts Isolation of pure culture Micometry	1	MCBA P1 P	4	50	To have a basic overview of good laboratory practices of Microbiology, To understand the basic working principle of different instruments used in Microbiology,To understand the basic techniques used in Microbiology,To identify different microorganisms by their morphology from their slides
3	GENERAL MICROBIOLOGY-II BIOPHYSICS AND BIOMOLECULES-II CELL BIOLOGY- I MOLECULAR BIOLOGY-I BIOMETRY-II	2	MCBA P2 T	10	100	To have a basic overview microbial growth and nutrition,To understand the different aspects of cell and molecular biology, To understand some of the basic concepts of different aspects of biochemistry needed in Microbiology, To understand some of the basic concepts of different aspects of biophysical chemistry needed in Microbiology

4	Qualitative tests for carbohydrates Separation of amino acids Separation of lipids by thin layer chromatography Estimation of amino acid (glycine) by formol titration Staining of capsule Enumeration of microbes (yeast) by haemocytometer	2	MCBA P2 P	4	50	To have a basic overview statistical methods used in laboratory,To understand the process of capsule and endospore staining of microbes,To understand the underlying principle of partition coefficient,To understand nature of different biomolecules by various techniques
5	CELL BIOLOGY-II MOLECULAR BIOLOGY- II BIOCHEMISTRY-I MICROBIAL ECOLOGY- I	3	MCBA P3 T	10	100	To have a basic overview of different aspects of cell biology of organisms,To understand the different aspects of some aspects of enzyme biochemistry of cell,To understand some of the basic concepts of different aspects of microbial ecology,To understand some of the basic concepts of different aspects of molecular biology needed in Microbiology
6	Isolation of pure culture from natural resources Microbiological examination of water IMViC reactions Microbiological assay of antibiotics Determination of Minimal Inhibitory Concentration (MIC) by serial dilution method for assaying commonly used antibiotics Biochemical activities of microorganisms Measurement of growth by turbidometry Isolation of mutants of bacteria by UV exposure	3	MCBA P3 P	4	50	To have a basic understanding of microorganisms in some natural sources,To have a hands on experience of laboratory testing of water,To have a basic understanding biotyping of bacteria in laboratory,To understand the basic concept of mutation of bacteria due to physical means
7	CELL BIOLOGY-III METABOLISM AND BIOENERGETICS MICROBIAL ECOLOGY II A-FOOD MICROBIOLOGY MICROBIAL ECOLOGY IIB- SOIL MICROBIOLOGY IMMUNOLOGY – I	4	MCBA P4 T	10	100	To some of the basic concepts of different aspects of cell biology needed in Microbiology,To understand the basic aspects of plant pathology,To have a basic idea about different metabolism in cells,To have a basic idea about innate immune systems in organisms

8	Microbiological examination of milk Isolation of pure culture from natural resources Isolation, ammonium sulphate precipitation and quantitative estimation of protein by Folin-Lowry method Isolation of Protease, Amylase, Phosphatase producing microorganisms from soil Microbial quality study of fresh salad vegetables using dilution plating technique Observation of the stages of cell division and mitotic chromosomes Stain and identify the VAM from root samples.	4	MCBA P4 P	4	50	To experience the laboratory testing of milk quality,To experience isolation of microbes from various food sources,To isolate various attributed microbes from soil,To have a basic idea about various stages of cell division
9	GENETICS , GENOMICS - I AND BIOINFORMATICS INDUSTRIAL MICROBIOLOGY VIROLOGY I IMMUNOLOGY-II MEDICAL MICROBIOLOGY	5	MCBA P5 T	13	100	To have a preliminary idea about genetics needed in microbiology,To understand the basic concepts of bioinformatics needed in microbiology,To understand the basic concepts of virology and immunology,To understand the basic concepts of industrial microbiology
10	Molecular Biology Biochemistry Bioinformatics	5	MCBA P6 P	13	100	To have a hands on experience on molecular biology, To understand the basic concepts of enzyme biochemistry, To understand the basic concepts of bioinformatics used in laboratory
11	GENETICS AND GENOMICS-II IMMUNOLOGY-III VIROLOGY II RECOMBINANT DNA TECHNOLOGY MEDICAL MICROBIOLOGY	6	MCBA P7 T	13	100	To understand about genetic exchange and recombination,To understand about gene mutation and its repair,To understand about viral molecular biology,To understand about cancer, population and evolutionary genetics

12	GENETICS AND GENOMICS-II IMMUNOLOGY-III VIROLOGY II RECOMBINANT DNA TECHNOLOGY MEDICAL MICROBIOLOGY Antigen-Antibody interaction Restriction digestion of DNA Ligation of DNA fragment SDS-PAGE and Western Blotting Project/Review Grand Viva	6	MCBA P8 P	13	100	To understand about the concepts of immunology,To experience hands on project,To experience hands on VDRL and Widal test

B.Sc. Microbiology Honours
6 Semester Course
Mapping of Employability etc

Sl No	Name of the Course	Semester	Course Code	Employability/Skill
1	GENERAL MICROBIOLOGY-I, MICROBIOLOGICAL METHODS, BIOPHYSICS, STEREOCHEMISTRY AND BIOMOLECULES-I, BIOMETRY I	1	MCBA P1 T	Structure and function of bacterial, algal, fungal and protozoal cells and organelles; Knowledge on microscope, stains, acid, buffer, stereochemistry and biometry
2	Operation of light microscope Preparation of culture media Cultivation of microorganisms Study of microorganisms by staining techniques Study of algae by temporary mounts Isolation of pure culture Micometry	1	MCBA P1 P	Handling of microscopes, preparation of culture media, culturing bacteria, isolation of pure culture from mixed culture, staining and identification of algae, fungi; measurement of cells and spores.
3	GENERAL MICROBIOLOGY-II BIOPHYSICS AND BIOMOLECULES-II CELL BIOLOGY- I MOLECULAR BIOLOGY-I BIOMETRY-II	2	MCBA P2 T	Knowledge on bacterial nutrition, growth and their control; carbohydrates, lipids; principles of radioactivity and spectroscopy; structure and function of eukaryotic cells; genetic material, DNA replication; application of mathematics in biology
4	Qualitative tests for carbohydrates Separation of amino acids Separation of lipids by thin layer chromatography Estimation of amino acid (glycine) by formol titration Staining of capsule Enumeration of microbes (yeast) by haemocytometer	2	MCBA P2 P	Identification of carbohydrate; separation of amino acids and lipids; estimation of amino acids; capsule staining; enumeration of cells by haemocytometry; application of mathematics in biology
5	CELL BIOLOGY-II MOLECULAR BIOLOGY- II BIOCHEMISTRY-I MICROBIAL ECOLOGY- I	3	MCBA P3 T	Transport and cell signaling; transcription and translation of DNA; enzymology; microbes in natural habitats

6	Isolation of pure culture from natural resources Microbiological examination of water IMViC reactions Microbiological assay of antibiotics Determination of Minimal Inhibitory Concentration (MIC) by serial dilution method for assaying commonly used antibiotics Biochemical activities of microorganisms Measurement of growth by turbidometry Isolation of mutants of bacteria by UV exposure	3	MCBA P3 P **New Course vide Bos dated : 11.09.2015**	Emplyability in organizations and laboratories dealing with public health. Isolation of microorganisms from natural samples including soil, air, water; microabial analysis of water; generation of antibiogram patter; biochemical characterization of bacteria; study of bacterial growth.
7	CELL BIOLOGY-III METABOLISM AND BIOENERGETICS MICROBIAL ECOLOGY II A- FOOD MICROBIOLOGY MICROBIAL ECOLOGY IIB- SOIL MICROBIOLOGY IMMUNOLOGY – I	4	MCBA P4 T	Mating and secretoiry pathways of yeat; mitosis and meiosis; apoptosis; metabolism of carbohydrates, proteins, lipids and nucleic acids; microbiology of food; interaction of microorganisms in microhabitat; plant diseases; overview of immune system
8	Microbiological examination of milk Isolation of pure culture from natural resources Isolation, ammonium sulphate precipitation and quantitative estimation of protein by Folin-Lowry method Isolation of Protease, Amylase, Phosphatase producing microorganisms from soil Microbial quality study of fresh salad vegetables using dilution plating technique Observation of the stages of cell division and mitotic chromosomes Stain and identify the VAM from root samples.	4	MCBA P4 P	Emplyability in companies dealing with food processing, dairy industries. Microbiological analysis of food; study of mitoic and meiotic cells; screening mycorrhiza.

9	GENETICS , GENOMICS - I AND BIOINFORMATICS INDUSTRIAL MICROBIOLOGY VIROLOGY I IMMUNOLOGY-II MEDICAL MICROBIOLOGY	5	MCBA P5 T	Eukaryotic and prokaryotic genome organization; linkage, crossing over, mapping; exchange of genetic material in bacteria; bioinformatics; industrial application of microbes; structure of virus; immunology ; human microbiome and pathogenesis.
10	Molecular Biology Biochemistry Bioinformatics	5	MCBA P5 P	Emplyability in biotechnological and pharmaceutical industries. Isolation of DNA and RNA; separation of nucleic acid by gel electrophoresis; transformation in bacteria; enzymology; bioinformatics
11	GENETICS AND GENOMICS-II IMMUNOLOGY-III VIROLOGY II RECOMBINANT DNA TECHNOLOGY MEDICAL MICROBIOLOGY	6	MCBA P6 T	Recombination of DNA; transposon; mutants and mutation; cancer biology; model organisms; population genetics; hypersensitivity and vaccines; replication of virus; recombinant DNA technology; microbial diseases and their control by chemotherapeutic agents
12	GENETICS AND GENOMICS-II IMMUNOLOGY-III VIROLOGY II RECOMBINANT DNA TECHNOLOGY MEDICAL MICROBIOLOGY Antigen-Antibody interaction Restriction digestion of DNA Ligation of DNA fragment SDS-PAGE and Western Blotting Project/Review Grand Viva	6	MCBA P6 P	Emplyability in pathological laboratories. Blood typing and other serotyping techniques; restriction digestion; western blotting; SDS_PAGE electrophoresis; scientific writing and oral presentation with power point
13	Basic Microbiology, Microscopy and Staining techniques Bacterial Morphology, Bacterial Growth and Eukaryotic Microbiology	1	MCBG P1T **New Course vide Bos dated : 02.03.2017**	Microscopy and stains; morphology of bacterial and eukaruotic cells; growth and nutrition of bacteria

14	Demonstration of Laboratory Instruments Microscopy Micrometry Staining Culture media Preparation Aseptic techniques	1	MCBG P1P **New Course vide Bos dated : 02.03.2017**	working with microscope; observing bacterial cells after staining; preparation of culture media and culturing bacteria in the laboratory; measuring cells
15	Virology, Biomolecules, Enzymes and Bacterial Metabolism Environmental Microbiology-I (Soil Microbiology and Plant Pathology) and Control of Microbial Growth	2	MCBG P2T **New Course vide Bos dated : 02.03.2017**	structure and role of virus; structure and function of biomolecules including enzymes; respirationof bacteria; microbial interactions; biogeochemical cycles; control of bacterial growth
16	Qualitative tests for carbohydrates (glucose, fructose, sucrose) and proteins. 2. Culture techniques	2	MCBG P2P **New Course vide Bos dated : 02.03.2017**	Isolation of pure culture from mixed culture; isolation of bacteria from soil; microbiological analysis of water
17	Environmental Microbiology-I I Molecular Biology-I and Industrial Microbiology	3	MCBG P3T **New Course vide Bos dated : 02.03.2017**	Role of microorganisms in air, water and food, transcription, translation and replication of DNA; microbes used in industry
18	Microbiological assay of antibiotics Determination of Minimal Inhibitory Concentration Biochemical activities of microorganisms	3	MCBG P3P **New Course vide Bos dated : 02.03.2017**	Generation of antibiogram; biochemical characterization of bacteria; isolation of industrially important microbes
19	Molecular Biology-II and Bacterial Genetics and Recombinant DNA Technology Immunology and Medical Microbiology	4	MCBG P4T **New Course vide Bos dated : 02.03.2017**	Mutagenic substances and mutation process; genetic exchange in bacteria; vector; immunological barriers; human microbiome and chemotherapeutic agents

20	1. Study of different stages of mitosis from onion root. 2. Demonstration of blood group typing. 3. Demonstration of antigen-antibody interaction by Ouchterlony double diffusion assay. 4. Demonstration of Radial immunodiffusion. 5. VDRL test 6. WIDAL test 7. Identification of normal microbial flora of the throat or skin. 8. Study of survival curve of bacteria after exposure to ultraviolet (UV) light.	4	MCBG P4P **New Course vide Bos dated : 02.03.2017**	Study of mitotic cells; Blood grouping and other serotyping procedures; isolation of bacteria from human body

SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

SEMESTER-I

THEORETICAL **Marks 100** **Credits 10**

Course Outcome (CO) of Semester I Theory (MCBA P1 T) :
Revision vide Bos dated : 20.02.2018

Course outcomes (COs) are,

CO1	To have a basic overview of history and developments of Microbiology
CO2	To understand the basic classification system of different microbes
CO3	To understand some of the basic concepts of different aspects of biochemistry needed in Microbiology
CO4	To understand some of the basic concepts of different aspects of biometry needed in Microbiology

MODULE-I (GENERAL MICROBIOLOGY-I)

1. Notable contributions in the development of Microbiology: (5)
- **a) Spontaneous Generation (Abiogenesis)**
- **b) Biogenesis**
- **c) Germ theory of disease**
- **d) Koch's Postulates**

e) Scope of Microbiology

2. Microbial Taxonomy and Diversity (10)

a) Whittaker's five-kingdom system of classification-Salient features of each kingdom

b) Woese's three domains of life- Salient features of each domain

c) Characterization of microorganisms

Classical- morphological, biochemical, cultural, metabolic, genetic, serological and ecological. Modern- Tm, G: C ratio, DNA-DNA and DNA-RNA hybridization, rRNA homology, DNA fingerprinting

d) Microbial taxonomy, systematics, identification, nomenclature and classification, aims and objectives of classification, types of classification- phenetic and phylogenetic , numerical taxonomy- dendrogram, concepts of genus, species, variety and strain

e) General features of Eubacteria and Archaebacteria (Major differences between eubacteria and archaebacteria)

2. Bacterial morphology and sub cellular structure (20)

a) Cell boundary: Cell wall, Cell membrane, Slime layer and capsule

b) Outer membrane projections: flagella, fimbriae and pili (structure, composition and function)

c) Subcellular structures: ribosomes, cytoplasmic inclusions (inorganic and organic)

d) Special structures: exospores and cysts (types and structure), endospore (structure, formation and maturation)

e) Nuclear material: structure of bacterial chromosome and its differences with the eukaryotic chromosome

f) Extra-chromosomal materials: plasmids and episomes (F-, R-, Ti- and Col plasmids as example)

3. Eukaryotic microbes:

a) Algae: (8)

1. General account- Habitat, structure of the vegetative body, cell structure, reproduction, life cycle types, alternation of generation

2. Salient features of the classes with reference to following genera

Chlorophyceae (*Chalamydomonas* , *Volvox, Spirogyra)*

Bacilloriophyceae (Centric and pinnate diatoms)

Pheophyceae (*Ectocarpus*)

Rhodophyceae (*Polysiphonia*)

3. Cyanobacteria- Ultrastructure of cell, structure and function of heterocyst.

4. Economic importance of algae

b) Fungi :

1. General characteristics- Distribution and habitat; morphology of somatic Structures; ultrastructure of fungal cells; specialized somatic structures: sclerotia, rhizoids, rhizomorphs, haustoria, appressoria, fructification; mode of nutrition: saprophytic, parasitic and symbiotic; reproduction: vegetative, asexual, sexual; parasexual cycle; life cycle pattern (3)

2. Characteristics of fungal divisions with reference to the following genera

Chytridiomycota (*Synchitrium*, *Monoblepharis)*

Zygomycota (*Mucor*)

Ascomycota *(Saccharomyces, Aspergillus*, *Penicillium*)

Basidiomycota (*Puccinia, Agaricus*)

Oomycota(*Saprolegnia*, *Phytophthora)*
Mitosporic fungi (*Helminthosporium, Candida*)
Myxomycota (8)

3. Life cycle of *Saccharomyces, Neurospora* (2)

4. Importance of fungi (1)

c) Protozoa: *Giardia* sp., *Plasmodium* sp. and *Entamoeba* sp. (3)

MODULE-II (MICROBIOLOGICAL METHODS)

4. Microscopy:

(10)

a) **General principles of optics in relation to microscopy**
b) **Different components of light wave**
c) **Principle and application of compound microscope: Light microscope, dark field microscope, bright field microscope, phase contrast microscope, electron microscope (TEM, SEM)**
d) **Resolving power, Numerical aperture, chromatic aberration**

5. Stains and Staining techniques:

(10)

a) **Definition of Auxochrome, chromophore; acidic and basic dyes, natural dyes, mordant and its function**
b) **Classification of stains; Simple and differential staining**
c) **Theories of staining**
d) **Mechanism and principles of Gram's staining, acid fast staining, endospore staining, capsule staining and flagella staining**

MODULE-III (BIOPHYSICS, STEREOCHEMISTRY AND BIOMOLECULES-I)

6. Physicochemical properties of water: (10)

a) **Ionic product of water**
b) **pH-Definition, effect of pH in enzyme catalyzed reactions**
c) **Arrhenius, Bronsted-Lowry and Lewis theories of acids and bases , neutralization curve of acids and bases, Henderson-Hasselbalch equation**
d) **Buffer solutions in biological systems (Definitions, types and examples);common ion effect and its application in separation and identification of common cations**
e) **Polyprotic acids; dissociation of polyprotic acids; titrable and true acidity,**
f) **Surface tension and viscosity**

7. Thermodynamics

Zero-th law, 1st law & 2nd law of thermodynamics: application in biological systems, Concept of free energy, standard free energy change. Equilibrium constant; enthalpy; entropy.

8. Stereochemistry : (15)

a. **General concepts on – plane of symmetry, centre and axis of symmetry**
b. **Concepts of chirality; optical isomerism; geometrical isomerism; DL and RS systems of nomenclature**

c. **Representation of molecules in Fischer, Flying-Wedge, Sawhorse and Newman formulae and their inter translations**
d. **Isomers: anomers and epimers**
e. **Stereochemistry of cyclohexane: idea of axial and equatorial bonds (related to chair form conformation), important chemical reactions relating to configuration**
f. **Mutarotation and its mechanism**

9. Amino acids and proteins: (20)

a) Definition, classification, structure, stereochemistry of amino acids
b) Physicochemical properties of amino acids- ionization of amino acids (amphoteric molecule, zwitterions, pK values, isoelectric point), electrophoresis
c) Formol titration of glycine (only reaction and principle)
d) Separation of amino acids by ion exchange, gel filtration, paper and thin layer chromatography
e) Chemical properties of amino acids: Biuret reaction of amino acids, reaction with ninhydrin, FDNB, dansyl chloride and dabsyl chloride, fluorescamine, Van slykes reaction, reactions of carboxyl and amino terminal groups
f) Synthesis of glycine
g) Peptides: peptide bond, biologically important peptides and their functions (Glutathione, Oxytocin)
h) Proteins: Structure (primary, secondary, tertiary, quaternary – definition, examples), forces that stabilize structure of proteins (H-bonds, hydrophobic interaction, electrostatic attractions, Van der Waal's interaction, dipole-dipole interaction)
i) Types of protein (definition, structures and examples): fibrous (α-helix, β-sheet, e.g. collagen), globular (haemoglobin, myoglobin), simple and conjugated proteins (physical denaturation and renaturation)

10 . Nucleic acids: (revised as per BOS meeting dated 20/02/2018) (15)

a) Types of nitrogenous bases (purine, pyrimidine) and pentose sugars (ribose and deoxyribose)
b) Nucleosides, Nucleotides: Definition and structure
c) DNA: Double helical structures of A-DNA, B-DNA and Z-DNA and their differences
d) General structure and types of RNA (tRNA, mRNA, rRNA)
e) Physical properties of DNA: Viscosity, buoyant density, renaturation and denaturation kinetics ,hyperchromic effect, T_m
f) Chemical properties: Acid and alkali hydrolysis of DNA and RNA, enzymatic hydrolysis of DNA

MODULE- IV (BIOMETRY I) (15)

11. a) Introduction: Types of biological data, population and samples; Frequency distribution
b) Graphical representation of data:
i) Representation of ungrouped data-Line diagram, Bar diagram, Pie chart,

Pictogram

ii) Representation of grouped data-Histogram, Frequency polygon

c) Descriptive statistics:

i) Measurement of central tendency: Mean, Median, Mode, Quartiles, Deciles, and Percentiles

ii) Measures of dispersions: Mean Deviation, Standard deviation, Standard error of mean

Semester 1 PRACTICAL **Marks 50** **Credits 4**

Course Outcome (CO) of Semester I Practical (MCBA P1 P) :

Course outcomes(COs) are,

CO1	To have a basic overview of good laboratory practices of Microbiology
CO2	To understand the basic working principle of different instruments used in Microbiology
CO3	To understand the basic techniques used in Microbiology
CO4	To identify different microorganisms by their morphology from their slides

1. Operation of light microscope, use of oil immersion objective (3)

2. Preparation of culture media: Complex media (Nutrient broth, Nutrient agar, chemically defined media (Czapek Dox media), YEPD, potato-dextrose-agar (PDA) medium

(12)

3. Cultivation of microorganisms: Streaking on agar slant/agar plate of Bacteria, Yeast, and Moulds (12)

4. Study of microorganisms by staining techniques: Preparation of heat fixed smear of bacteria. Simple staining and Gram staining (Gram-positive: *B. subtilis*, *S. aureus*,; Gram-negative: *E. coli*, *Klebsiella aerogenes*)

(18)

5. Study of algae by temporary mounts- *Chlamydomonas* and *Spirogyra* (6)

6. Study of fungi following lactophenol-cotton blue staining- *Mucor, Saccharomyces, Aspergillus* and *Penicillum* (6)

7. Isolation of pure culture: by Streak and pour-plate method (12)

8. Micometry: Microscopic measurement of bacterial cell, Yeast , and fungal spores (6)

9. Spot Identification (3)

Bacteria- ***Bacillus, Spirillum,***
Cyanobacteria- ***Nostoc, Anabaena, Oscillatoria***
Algae- ***Chalamydomonas, Volvox, Spirogyra***
Fungi- ***Mucor (*****sporangia,zygospore),** ***Saccharomyces*** **(budding*), Aspergillus*(conidia)**
Penicillium**(conidia)** ***Puccinia (*****uredospore and**
teleutospore)*,*
Protozoa- ***Entamoeba, Plasmodium, Paramoecium***

REFERENCE:

1. **Prescott et al., Microbiology**
2. **Atlas., Principles of Microbiology**
3. **Roger Y. Stanier, Edward A. Adelberg, John L Ingraham .,General Microbiology**
5. **Pelczar et al., Microbiology**
4. **Salle A.S., Fundamental Principles of Bacteriology**
6. **Madigan et al., Brock biology of microorganisms**
7. **Black, Microbiology**
8. **Ingraham, Introduction to Microbiology**
9. **Nirmalya Banerjee and Ajit Banerjee, Microbiology and Immunology**
10. **Ganguly and Kar, College Botany**
11. **Voet and Voet., Biochemistry**
12. **Freifelder D., Physical Biochemistry**
13. **Upadhyay and Upadhyay., Biophysical Chemistry**
14. **Debjyoti Das, Biophysical Chemistry**
15. **Subrata Sengupta, Stereochemistry**
16. **P.K. Banerjee., Introduction to Biostatistics., S. Chand publications**
17. **Aneja K.R., Experiments in Microbiology, Plant Pathology and Biotechnology**
18. **Cappuccino and Sherman, Microbiology-A Lab Manual**
19. **Practical Microbiology, Dubey**
20. **P.K. Banerjee.,Introduction to Biophysics., S.Chand publications**

SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

SEMESTER-II

THEORETICAL **Marks 100** **Credits 10**

Course Outcome (CO) of Semester II Theory (MCBA P2 T) :

Course outcomes(COs) are,

CO1	To have a basic overview microbial growth and nutrition
CO2	To understand the different aspects of cell and molecular biology
CO3	To understand some of the basic concepts of different aspects of biochemistry needed in Microbiology
CO4	To understand some of the basic concepts of different aspects of biophysical chemistry needed in Microbiology

MODULE-I (GENERAL MICROBIOLOGY-II)

1. Microbial Growth: (10)

a) Growth phases of bacteria
b) Kinetics of growth: generation time, growth rate constant
c) Batch culture
d) Continuous culture: chemostat, turbidostat
e) The measurement of growth: cell mass, cell number, cell activity
f) Synchronous culture: definition and brief description
g) Physical factors influencing growth: temperature, pH, osmotic pressure, salt concentration

2. Microbial Nutrition: (10)

a) Microbiological nutrients
b) Effect of oxygen on growth: Classification on the basis of oxygen requirement and tolerance
c) Nutritional types: Photoautotrophs, Photoorganotrophs, Cemolithotrophs (ammonia, nitrite, sulphur, hydrogen, iron oxidizing bacteria), Chemoorganotrophs, Mixotrophs
c) Bacteriological media: synthetic, complex, selective, differential and enrichment media

3. Control of growth of microbes: (20)

a) Definition, application and examples: Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent

b) Physical methods of control: Mode of action and application of dry heat, moist heat, filtration, radiation, ultrasonication

c) Chemical methods of control: Mode of action and application of alcohol, acid, alkali, halogen, heavy metal, phenol, phenol derivatives, formaldehyde, ethylene oxide, detergents

d) Assessment of chemical disinfectant: phenol coefficient and tissue toxicity method

e) Chemotherapeutic agents: definition of antibiotics and sulphonamides. Mode of action (basic ideas) and antimicrobial spectrum of sulphonamides, penicillin, streptomycin, tetracycline, chloramphenicol, nalidixic acid and metronidazole

f) Microbial drug resistance: phenomenon and mechanism

MODULE-II (BIOPHYSICS AND BIOMOLECULES-II)

4. Carbohydrate (15)

a) Definition, classification and structural concept of

i) Monosaccharides: Hexoses (Glucose), Pentoses (Ribose, Ribulose, Xylose) ii) Disaccharides: Sucrose, Lactose, Maltose

iii) Amino sugars: Glucosamine, Muramic Acid

b) Inversion (Hydrolysis of cane sugar)

c) Chemical reactions of monosaccharides (Glucose and Fructose i.e. Aldose and Ketose) with HNO_3, Bromine water, HIO_4, Phenyl Hydrazine. Principle of chemical estimation of sugar. Anomeric effect (Methylation effect). Polysaccharides: Chemical structure of starch (α-amylose, amylopectin), glycogen and cellulose. Smith degradation and enzymic hydrolysis of α-amylose, amylopectin.

5. Lipids: (10)

a) Definition nomenclature and classification (structure of simple, complex and derived lipids with examples (special reference to phospholipids, glycolipids, cholesterol etc.)

b) Fatty acids- types (saturated and unsaturated), structure and isomerism (cis-trans isomerism)

c) General chemical reactions of fatty acids: Esterification, hydrogenation and halogenation

d) Fats and Oils: Definition, differences, types and structure

e) General chemical reactions of fats

f) Estimation of triglycerides and fatty acids- Saponificstion, I_2-number, acetylation, acetyl number, RM- & Polenski number etc.

6. Fundamentals of radioactivity: (10)

a) Law of radioactivity, decay constant, half life, average life, radioactive equilibrium, isotopes, isotones, isobars

b) Properties of α, β, γ radiations, unit of radioactivity (definition), radiocarbon dating

c) Application of radioactive isotopes (C^{14}, H^3, P^{32}) in biological system, radioimmuno assay, glucose metabolism and DNA synthesis.

d) Detection of radioactivity: Geiger Muller counter, liquid scintillation counter (principle and application)

e) Application of radioactivity in medical diagnosis (magnetic resonance imaging etc.) and in biological systems, radionuclides used in diagnosis, radiation dose in protection against radiation exposure, radiation therapy

7. Spectroscopy & Separation Techniques: (25)

a) Concept of Electromagnetic radiation UV, Visible, IR

b) Orbital theory-Bonding and antibonding; simple association of Pi (π) orbitals, Phi (Φ) orbitals

c) Concept of Chromophore and Auxochrome, Wit's Chromophore theory-Red shift, Blue shift

d) Lambert's-Beer's law-derivation and deviation

e) Spectroflurimetry (Intrinsic and Extrinsic fluorescence)

e) Absorptivity, Line diagram and working principle of spectrophotometer

f) Instrumentation and application of UV, Visible, IR spectrophotometer

g) ESR, Atomic absorption spectroscopy (basic ideas), mass spectrometry

h) Biophysical techniques ultracentrifugation, dialysis, ultrafiltration, chromatography (paper, thin layer, ion-exchange, HPLC, affinity chromatography techniques), electrophoresis (types of electrophoresis)

MODULE-III (CELL BIOLOGY- I)

8. Eukaryotic cell structure and composition (20)

a) Cell wall- Structure, composition and function, difference between prokaryotic and eukaryotic cell structure, cell-cell interactions

b) Cell Membrane- Structure, difference between membrane constituents of prokaryotes and eukaryotes, mechanism of membrane targeting drugs

c) Cytoplasmic organelles

Mitochondria and chloroplast- Structural organization and functions, marker enzymes, mitochondrial biogenesis, semiautonomous nature of mitochondria and chloroplplast

d) Endoplasmic reticulum, Golgi complex and lysosome - Structure and function, types of vesicular transports and their functions

e) Cytoskeleton and cell motility- Microtubule, MTOC, motor proteins, structure of cilia and flagella, basal bodies, intermediate fiber and microfilament

MODULE –IV (MOLECULAR BIOLOGY-I) (revised as per BOS meeting dated 5/3/2014)

9. Genetic material and functions

a) Experimental evidence for DNA as genetic material (Experiments of Griffith; Avery and MacLeod; Hershey and Chase)

b) Experimental evidence for RNA as genetic material (TMV)

c) Nucleic acid structure: DNA double helix; crystallographic proof; alternative forms of DNA; DNA supercoiling-superhelix topology, topoisomerases; intercalating agents; secondary and tertiary structure of RNA

10. DNA replication: (10)

a) Models of replication: conservative, semiconservative and dispersive
b) Meselson-Stahl experiment
c) Basics of replication: Replication models [Rolling circle and Theta (Θ) model (bidirectional)]
d) Enzymes of replication
e) Mechanism of replication in chromosomal and telomeric DNA
f) Difference between prokaryotic and eukaryotic replication

MODULE-V (BIOMETRY-II) (10)

10. a) Probability: Introductory concepts, binomial distribution, random sampling
b) Distribution theory: Normal distribution and sampling distribution
c) Statistical inference: Statistical estimation, standard error of the mean, confidence interval and hypothesis testing of the population- t test. Brief discussions on the comparison of two independent population means. The Chi square test and its applications
d) Analysis of variance: Multi sample hypotheses
e) Analysis of bivariate data: Linear regression and Correlation

PRACTICAL Marks 50 Credits 4

Course Outcome (CO) of Semester II Practical (MCBA P2 P) :
Revision vide Bos dated : 12.03.2015

Course outcomes are,

CO1	To have a basic overview statistical methods used in laboratory
CO2	To understand the process of capsule and endospore staining of microbes
CO3	To understand nature of different biomolecules by various techniques
CO4	To understand the underlying principle of partition coefficient

1. Qualitative tests for carbohydrates (glucose, fructose, sucrose) proteins and lipids (6)

2. Separation of amino acids (lysine, glycine, tryptophan, proline) by thin layer chromatography (6)

3. Separation of lipids by thin layer chromatography (6)

4. Estimation of amino acid (glycine) by formol titration (6)
5. Determination of partition coefficient of acetic acid between n-butanol and water (6)
(Revised as per BOS meeting dated 28.02.2015)
6. Staining of capsule (*Klebsiella aerogenes*) and endospore (*Bacillus subtilis*) (9)
7. Enumeration of microbes (yeast) by haemocytometer (6)
8. a) χ^2 analysis: Testing goodness of fit, contingency and homogeneity chi-square tests; t- test for analysis of experimental samples (12)

b) Study of Poisson distribution of microbes in a sample (e.g. bacteria in a sample of water collected from a reservoir) using haemocytometer (9)

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1. Prescott et al., Microbiology.
2. Atlas., Principles of Microbiology
3. Roger Y. Stanier, Edward A. Adelberg, John L Ingraham .,General Microbiology.
4. Salle A.S., Fundamental Principles of Bacteriology.
5. Pelczar et al., Microbiology.
6. Madigan et al., Brock biology of microorganisms.
7. Freifelder D., Physical Biochemistry.
8. Voet and Voet., Biochemistry
9. Upadhyay and Upadhyay., Biophysical Chemistry.
10. Segel I.H., Biochemical Calculations
11. P.K. Banerjee., Introduction to Biostatistics.
12. Aneja K.R., Experiments in Microbiology, Plant Pathology and Biotechnology.

SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

SEMESTER-III

THEORETICAL **Marks 100** **Credits 10**

Course Outcome (CO) of Semester III Theory (MCBA P3 T) :
Revision vide Bos dated : 11.09.2015

Course outcomes are,

CO1	To have a basic overview of different aspects of cell biology of organisms
CO2	To understand the different aspects of some aspects of enzyme biochemistry of cell
CO3	To understand some of the basic concepts of different aspects of molecular biology needed in Microbiology
CO4	To understand some of the basic concepts of different aspects of microbial ecology

MODULE-I (CELL BIOLOGY-II))(revised as per BOS meeting dated 5/3/2014)

1. Transport across membrane (20)

a)Transport of small molecules

Passive diffusion, facilitated diffusion (GLUT transporter etc.) and active transport (definition and example with reference to sodium-potassium ATPase), proton pump, Gradient of chemical potential as driving force in transport , Equillibria and transport across membrane- diffusion and osmosis, osmoticpressure, membrane potential, diffusion potential, Donnan equilibrium

b) Macromolecules transport- endocytosis, exocytosis, post-translational uptake of proteins by peroxisomes, mitochondria, and chloroplast

c) Cell signaling-Signaling molecules and their receptors, SRP, intracellular signaling transport pathway (elementary idea)

MODULE-II (MOLECULAR BIOLOGY- II)(revised as per BOS meeting dated 5/3/2014, 11/09/2015)

2. Transcription in prokaryotes: (15)

a) Central Dogma
b) Mechanisms of initiation
c) Promoter structures
d) Subunits of bacterial polymerases: function and domain responsible for activity
e) Elongation process
f) Termination mechanism: Rho dependant and independent
g) Eukaryotic transcription (elementary idea on promoter structure and transcription factors), differences between prokaryotic and eukaryotic transcription
h)RNA Modification: 5'- capping, poly (A) tailing, concepts on split genes, introns and exons, removal of introns- RNA splicing, elementary idea on alternative splicing, exon shuffling, RNA editing, m- RNA transport(mechanisms not required)

3. Genetic code: (5)

a) Deciphering the genetic code (genetic and biochemical proof)
b) Nature of genetic code and code word dictionary
c) Initiator and terminator codons

4. Structure of RNA: (5)

a) tRNA: cloverleaf structure and function
b) rRNA: structure and function

5. Mechanism of translation in prokayotes: (15)

a) Description of ribosomal cycle including phenomenon of initiation, elongation, termination

b) Description of the factors used in these processes

c) Role of amino acyl tRNA synthatases

6. Regulation of transcription in prokaryotes: (10)

a) *lac* operon: components, discovery of regulator and operator genes, interaction between the components

b) *trp* operon: components, general and finer control mechanisms

c) *ara* operons : components and control mechanisms

7. RNAs in gene regulation : Riboswitches, RNA-induced gene silencing, bacterial sRNA, eukaryotic miRNAs (RNAi, miRNA,siRNA *) *(3)*

8. Non ribosomal peptide: (5)

Synthesis of non ribosomal peptides

MODULE-III (BIOCHEMISTRY-I) (revised as per BOS meeting dated 11/09/2015)

9. Enzymes: (25)

a) Basics of reaction Kinetics

b) General properties of enzymes

c) Nomenclature and classification

d) Enzyme purification

e) Cofactors: definition and function with special reference to representative substances-

i) Co-enzymes: NAD^+, $NADP^+$, Co-enzyme A, TPP, Pyridoxal phosphate

ii) Prosthetic groups: FAD-succinic dehydrogenase

iii) Metal ions: Zn^{+2}, Mg^{+2}, Fe^{+2}, Fe^{+3}, Mn^{+2} - required for enzyme action

f) Enzyme kinetics: Michaelis-Menten equation, Briggs-Haldane modification on Michaelis Menten equation,

g) Graphical representation of the velocity of enzyme catalyzed reaction- Lineweaver-Burke plot

h) Effect of pH and temperature on enzyme activity

i) Bisubstrate enzymatic reactions

j) Enzyme inhibition: Competitive (cite the action of malonate on succinate dehydrogenase, iodoacetate on triose phosphate dehydrogenase and EDTA as example), Mixed inhibition, Non competitive, Uncompetitive, Suicide inactivation (action of penicillin on bacterial peptidoglycan biosynthesis),

k) Allosteric enzyme and allosterism : allosteric modulator- positive and negative (Aspartate transcarbamylase as an example)

l) Regulation of enzyme activity: covalent modification (reversible and irreversible), feedback inhibition (cite threonine to isoleucine as an example)

m) Ribozyme (catalytic RNA) (definition only)

n) Abzyme (use of antibody as enzyme) (definition only)

o) Isozyme- definition and example

MODULE-IV (MICROBIAL ECOLOGY- I)

10. History of development in the field of microbial ecology: Contributions of Winogradsky, Beijerinck, Klnyver van Niel, Martin Alexander, Selman Waksman (15)

11. Microorganisms and their natural habitats

a) Aquatic Environments: Stratification & Microflora of Freshwater & Marine habitats Nutrients in aquatic environments, water pollution and waterborne diseases, purification of water, determination of BOD&COD and its implication, water quality assays and public health, IMViC test, waste water treatment

b*)* Hydrothermal vent ecosystem, barophilism

c) Atmosphere (Air microbiology): Stratification of atmosphere and diversity of aeromicroflora, bioaerosols, determination of microbial content of air, airborne transmission of diseases, methods for controlling microorganisms in air

PRACTICAL **Marks 50** **Credits 4**

Course Outcome (CO) of Semester III Practical (MCBA P3 P) :

Course outcomes are,

CO1	To have a basic understanding of microorganisms in some natural sources
CO2	To have a hands on experience of laboratory testing of water
CO3	To have a basic understanding biotyping of bacteria in laboratory
CO4	To understand the basic concept of mutation of bacteria due to physical means

1. Isolation of pure culture from natural resources:
- **a) Microbes from air by agar exposure method**
- **b) Algae from soil or water by suitable method**

2. Microbiological examination of water (drinking water /supply water/pond water): Multiple tube fermentation test method for detection of coliform bacteria
- **a) Presumptive test**
- **b) Confirmatory test**
- **c) Completed test**

3. IMViC reactions

4. Microbiological assay of antibiotics: Antibiotic sensitivity test by paper disc and cup-plate method

5. Determination of Minimal Inhibitory Concentration (MIC) by serial dilution method for assaying commonly used antibiotics (using appropriate test bacteria)

6. Biochemical activities of microorganisms(revised as per BOS meeting dated 11/09/2015)
- **a) Carbohydrate fermentation**
- **b) Triple sugar-iron agar test**
- **c) Hydrogen sulfide test**
- **d) Gelatinase production test**
- **e) Urease test**
- **f) Nitrate reduction test**
- **g) Catalase test**

h) Oxidase test

7. Measurement of growth by turbidometry.

8. Isolation of mutants of bacteria by UV exposure.

References:

1. **Prescott et al., Microbiology.**
2. **Atlas., Principles of Microbiology**
3. **Roger Y. Stanier, Edward A. Adelberg, John L Ingraham., General Microbiology.**
4. **Salle A.S., Fundamental Principles of Bacteriology.**
5. **Voet and Voet., Biochemistry**
6. **Segel I.H., Biochemical Calculations**
7. **Watson , Molecular biology of Gene**
8. **Karp D. Gerald , Cell and Molecular Biology**
9. **Alberts, B., et al. Molecular Biology of the Cell, Garland, 4th ed., 2002**
10. **Lodish, H., et al. Molecular Cell Biology, WH Freeman, 2003.**
11. **Palmer, Enzymes**
12. **Dr. P.K.Banerjee, Problems on Genetics, Molecular Genetics and Evolutionary Genetics, New Central Book Agency**
13. **Aneja K.R., Experiments in Microbiology, Plant Pathology and Biotechnology.**

SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

SEMESTER-IV

THEORETICAL **Marks 100** **Credits 10**

Course Outcome (CO) of Semester IV Theory (MCBA P4 T) :

Course outcomes are,

CO1	To some of the basic concepts of different aspects of cell biology needed in Microbiology
CO2	To understand the basic aspects of plant pathology
CO3	To have a basic idea about different metabolism in cells
CO4	To have a basic idea about innate immune systems in organisms

MODULE-I (CELL BIOLOGY-III))(revised as per BOS meeting dated 10/09/2016) [14]
Cellular functions:

a) Cell Biology of Yeast: Budding and fission yeasts, mating types and its determination (only elementary ideas)
b) Cell cycle, regulation of cell cycle progression, events of mitosis and meiosis, motor proteins and their functions in cell division
c) Secretory pathway in Yeasts (preliminary ideas about Sec mutants, transport of materials to the bud) and Secretion in bacteria (types of secretion, Sec proteins, secretory metabolites)
d) Protein folding (basic chaperons), Protein targeting, Protein degradation
e) Apoptosis, stem cells and maintenance of adult tissues, embryonic stem cells and its applications in medical sciences(therapeautic cloning)

MODULE-II (METABOLISM AND BIOENERGETICS) [20]
2. Carbohydrate metabolism
a) Catabolism of glucose:Glycolysis,Entner-Doudoroff pathway,Entry of hexoses other than glucose(galactose and fructose),Pentose Phosphate Pathway, Phosphoketolase Pathway, Anaerobic fate of pyruvate: Homolactic and Heterolactic fermentation
b) Tricarboxylic acid cycle with energy production, Amphibolic nature of TCA cycle
c) Electron Transport Chain and oxidative phosphorylation: Coupling of oxidative phosphorylation to electron transport, Components of Electron Transport Chain, Oxidation-reduction potential, Shuttle system, Chemiosmotic hypothesis, Proton gradient generation, Mechanism of ATP synthesis, ATP-ADP cycle
d) Anaerobis respiration-Utilizing NO_3, SO_4, CO_3 as electron acceptors, Stickland reaction
e) Phototrophy: General features of bacterial phoptosynthesis, differences between the bacterial and green plant photosynthesis. Light reaction in oxygenic and anoxygenic photosynthesis, Photophosphorylation, Calvin cycle, Comparative study of cyanobacterial, green sulphur, purple non-sulphur bacterial photosynthesis.
f) Chemolithotophy: Utilization of inorganic energy and electron source for biosynthesis

3. Amino acid metabolism [8]
a) Transmination, deamination, transmethylation and decarboxylation
b) Glucogenic and ketogenic amino acids; Urea Cycle and its regulation;
c) Microbial metabolism of glycine, phenylalanine and lysine
d) Inborn errors of metabolism (metabolic diseases): Phenylketonuria, Alkaptonuria, Maple Syrup Urine disease

4. Lipid metabolism [4]
a) Detailed account for oxidation of even and odd carbon numbered saturated and unsaturated fatty acids
b) Brief idea of fatty acid biosynthesis; Metabolism of triglycerides and phospholipids

5. Purine and Pyrimidine metabolism [8]
a) Synthesis of purines: elementary concept, source of the precursors of purines, ribose 5-phosphate; synthesis of AMP and GMP from IMP (only elementary idea); Elementary ideas of nucleotide biosynthesis (Salvage pathway)
b) Microbial reduction of purines to deoxy-purines: thioredoxine
c) Biosynthesis of pyrimidines: Aspartate transcarbamylase (ATCase)
d) Origin of Thymine: Importance of folic acid (conceptual) and target of sulphonamides
e) Degradation of nucleotides: xanthines, uric acid;

f) Catabolites of pyrimidines; NAD, FAD and Coenzyme A synthesis (only elementary ideas)

MODULE-III (MICROBIAL ECOLOGY II A-FOOD MICROBIOLOGY)

[20]

6 a) Normal microbiological quality of foods and its significance- raw and pasteurized milk, raw and ready-to-eat meat products, shell egg and liquid egg, fish and shellfish, vegetables, fruits, nuts, cereals.

b) Microbial spoilage of specific food groups- milk and milk products, fresh and ready-to-eatmeat products, egg and egg products, fish, vegetable and fruits, cereals and their products.

c) Microbiology of food preservation- Cleaning and sanitation, physical removal, high temperature, low temperature, reduced water activity, canning, low pH and organic acids,chemical preservatives, irradiation, combined methods.

d) Microbiology of fermented foods- curd, yoghurt, acidophilic milk, cheese, tempe, idli.

e) Activities of lactic acid bacteria in foods- probiotics, prebiotics and synbiotics.

f) Bacterial agents of foodborne illness- salmonellosis, shigellosis.

g) Methods of microbial examination of foods- microscopic count, plate counts, dye reduction test (MBRT), phosphatase test of milk.

MODULE-IV (MICROBIAL ECOLOGY IIB- SOIL MICROBIOLOGY))(revised as per BOS meeting dated 11/09/2015.10/02/2016) [28]

7. **Microorganisms and their natural habitat (revised as per BOS meeting dated 22/3/2013,5/3/2014)**

[4]

a) Terrestrial environment: Physical and chemical characteristics of various soil types- different microbial groups in soil, method of study -conventional and metagenomic studies

b) Microbial interactions: [10]

Microbe- microbe interactions: mutualism, synergism, commensalism, competition, ammensalism, parasitism, predation, biological control of pests

Microbe- plant interactions:

Rhizosphere and phyllosphere, biological nitrogen fixation, composts and biofertilizers

Microbe- animal interactions:

Role of microbes in ruminants, nematophagus fungi, luminescent bacteria as symbionts

c) Biogeochemical cycles-carbon, nitrogen, phosphorus and sulphur cycles; role of microorganisms in the process, bioleaching and biodeterioration [microbial deterioration of metals (corrosion), textile and paper]definitions and examples

d) Microbiology of methane production

8. Plant pathology [9]

a) History of development of plant pathology in India and abroad

b) Stages in development of a disease:elementary ideas on inoculation, pre-penetration phenomenon, penetration, infection, invasion, colonization, dissemination of pathogens and perennation

c) Host-pathogen interactions: effect of pathogens on host physiological functions (elementary idea)

d) Genetics of plant diseases- genes for pathogenicity, concept of resistance(R)and avirulence(avr) genes, types of plant resistance- horizontal, vertical and apparent resistance

e) Virulence factors (chemical weapons of pathogens): roles of enzymes, toxins, growth regulators in disease development, and virulence factors in viruses (replicase, coat protein, movement protein and silencing suppressors)

f) Defense mechanisms in plants- constitutive and inducible defenses

g) Control of plant diseases- principles and practices: regulatory, cultural, physical, chemical biological and genetic engineering

h) Specific Plant diseases: [5]

Fungal- late blight of potato, black stem rust of wheat
Bacterial- citrus canker
Viral- rice disease by tungo virus
Causal organism, major symptoms, dissemination and control measures

MODULE –V (IMMUNOLOGY – I) [10]

9. Introduction: Overview of the immune system

i) Concept of immunity

ii) History of immunology: variolation and vaccination

iii) Brief account of: active and passive immunity, natural and artificial immunity, innate and adaptive immunity

iv) Innate Immunity: Mechanism of immune response (anatomic, physiologic, phagocytic and inflammatory barriers)

PRACTICAL **Marks 50** **Credits 4**

Revision vide Bos dated : 02.03.2017

Course Outcome (CO) of Semester IV Practical (MCBA P4 P) :

Course outcomes are,

CO1	To experience the laboratory testing of milk quality
CO2	To experience isolation of microbes from various food sources
CO3	To isolate various attributed microbes from soil
CO4	To have a basic idea about various stages of cell division

1. Microbiological examination of milk: By methylene-blue dye reduction test;

2. Isolation of pure culture from natural resources:

a) Bacteria from soil by serial dilution and pour-plate/spread plate method
b) Yeast from rotten banana or apple by streak plate method
c) Molds from infected citrus fruit by streak plate method

3. Isolation, ammonium sulphate precipitation and quantitative estimation of protein by Folin-Lowry method

4. Isolation of Protease, Amylase, Phosphatase producing microorganisms from soil
5. Microbial quality study of fresh salad vegetables using dilution plating technique
6. Observation of the stages of cell division and mitotic chromosomes (revised as per BOS meeting dated 22/3/2013)
7. Stain and identify the VAM from root samples.)(revised as per BOS meeting dated 01/03/2017)

References:

1. Salle A.S., Fundamental Principles of Bacteriology, 7th ed., tata McGraw Hill Publishing Co.
2. Subba Rao, NS. Soil Microbiology, 4th Ed., Oxford & IBH Publishing Co., Pvt. Ltd.
3. Dubey, R.C., and Maheswari, DK. Textbook of Microbiology, S. Chand & Co. 4. 4. 4. Prescott et al., Microbiology.
5. Atlas., Principles of Microbiology
6. Roger Y. Stanier, Edward A. Adelberg, John L Ingraham .,General Microbiology.
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11. Roy B., Food Microbiology, CRC Press
12. Frazier and Westhoff, Food Microbiology
13. Voet and Voet, Biochemistry
14. Lubert Stryer, Biochemistry
15. Nelson and Cox, Lehninger Principles of biochemistry
16. Aneja K.R., Experiments in Microbiology, Plant Pathology and Biotechnology

17. Agrios, G. N., Plant Pathology (5th ed.)
18. Singh, R. S., Plant Pathology

SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

SEMESTER-V

THEORETICAL **Marks 100** **Credits 16**

Course Outcome (CO) of Semester V Theory (MCBA P5 T) :

Course outcomes are,

CO1	To have a preliminary idea about genetics needed in microbiology
CO2	To understand the basic concepts of bioinformatics needed in microbiology
CO3	To understand the basic concepts of virology and immunology
CO4	To understand the basic concepts of industrial microbiology

MODULE-I (GENETICS , GENOMICS - I AND BIOINFORMATICS) (revised as per BOS meeting dated 22/3/2013, 5/3/2014) [15]

1. Eukaryotic genetics

a) Mendelian genetics and its extension: Mendel's laws of inheritance, incomplete dominance, codominance, multiple allelism, lethal gene, pedigree analysis, gene interactions-epistasis, inhibitory and multiple factors, novel phenotypes, pleiotropy, dominant and recessive mutations, gene-environment interaction- penetrance and expressivity

b) Chromosome theory of heredity, sex dedetermination- chromosomal mechanisms, environmental factors affecting sex determination, Barr bodies and dosage compensation, sex-linked inheritance, epigenetic inheritance and genomic imprinting

c) Linkage, crossing over and recombination, linkage mapping in Drosophila- two- and three factor crosses, interference and coincidence

d) Cytogenetic mapping, somatic cell genetics-an alternative approach to gene mapping (elementary idea)

e) Quantitative genetics and polygenic inheritance

f) Extrachrosomal inheritance by chloroplast and mitochondria

[10]

2. Eukaryotic genome

a) Distinctive features, structure of chromosome and chromatin- nucleosome model (description and experimental proofs), base composition of DNA from Tm value, determination of genome size in eukaryotes from Cot value analysis; various forms of repetitive DNA (satellite, LINEs and SINEs)

b) Structure and function of ARS, centromere and telomere, pseudogenes, multigene family

3. Prokaryotic genome- Genome organization in prokaryotes- structure of nucleoid [2]

4. Prokaryotic genetics

a) Extrachromosomal inheritance: plasmids -detection, plasmid transfer, genes found, copy number, incompatibility, partitioning episomes

b) Genetic exchange and recombination in prokaryotes [15]

Transformation: competence factors-mechanism of development, factors controlling competence, mechanism of transformation in gram positive and gram negative bacteria, chromosome mapping by transformation

Conjugation: Hfr bacteria; $F^+ x F^-$ and Hfr x F^- , time of entry mapping

Transduction: Generalized (P1) and Specialized (λ phage)

Complementation analysis

Deletion mapping and fine structure of gene

4. Introduction to Bioinformatics: [8]

Bioinformatics Basic: Datamining and applications, Biological databases, Sequence alignment - Global and Local alignment, Scoring matrices and algorithm. Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment, Phylogenetic analysis.

MODULE-II (INDUSTRIAL MICROBIOLOGY)

1. Industrial Microbiology [18]

a) Isolation of industrially important microbial strains: Primary and secondary screening, strain development, preservation and maintenance of industrial strains
b) Bioreactors/fermenters: Components of a typical bioreactor, types of bioreactors- Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed
bed and fluidized bed bioreactors and air-lift fermenter.
c) Measurement and control of fermentation parameters:pH, temperature, dissolved oxygen, foaming and aeration
d)Media and ingredients for industrial fermentations: Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.
e) Fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatchand continuous fermentations
f) Enzyme immobilization: Methods of immobilization, advantages and applications of immobilization.
g) Microbial production of industrial products (micro-organisms involved media, fermentation conditions, downstream processing and uses):
Ethyl Alcohol, Acetic Acid, Penicillin, Vitamin B_{12}, Lysine, Alpha Amylase
h) Concept of primary and secondary metabolites in microorganisms
i) Microbial production of Bioplastics (PHA and PHB)

MODULE-III (VIROLOGY I)

Structure and classification of virus [22]

a) Definition, general characteristics of viruses, functions of virion proteins and difference between bacteria and viruses
b) Sizes and shapes and components of different viruses (describe with at least one example); host range and specificity
c) Classification of viruses based on
i) capsid symmetry- helical (TMV), icosahedral (polyoma), complex(bacteriophage)
ii) nucleic acid content; DNA (dsDNA, ssDNA) and RNA (ssRNA, dsRNA) viruses with examples; Human cancer virus (SV40, HTLV-1&2, Epstein- Barr virus only)
iii) Baltimore classification
d) Example of animal virus (retroviridae, poxviridae, herpesviridae, adenoviridae, orthomyxoviridae, paramyxoviridae)
e) Example of plant virus (TMV: interaction, disease, infection, pathogenesis) and

bacteriophage

f) Assay of bacteriophage and animal viruses (Physical and Biochemical assay), phage titre, phage typing

MODULE-IV (IMMUNOLOGY-II)(revised as per BOS meeting dated 22/3/2013)

1. Immune system of the body: [34]

a) Cells and organs of Immune system: Hematopoietic stem cells; stromal cells; hematopoietic growth factors; lymphoid organs (primary and secondary) and cells (mononuclear cells, granulocytic cells, mast cells, dendritic cells, NK cells, macrophages, T- lymphocyte, B-lymphocyte)-characteristics and functions

b) Types of Immunity:

i) Adaptive Immunity: Humoral and Cell-mediated immunity; mechanism of immune response; antigen processing and presentation *structures and functions of Major* Histocompatibilitry complex (MHC) and their role in antigen presentation (Cytosolic and Endocytic pathways); clonal selection of lymphocytes; cytokine and lymphokines (general concept only); Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells

d) Antigens: antigenicity; immunogenicity; Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity)hapten; epitopes; mitogens (definition, properties and examples); interferon (definition and function); adjuvant (definition, example and function)

e) Immunoglobulins: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic) monoclonal and polyclonal antibody (definition and characteristics)

f) Antigen-Antibody Interactions: Precipitation reactions- Radial immunodiffusion, Double immunodiffusion, Immunoelectrophoresis; Agglutination reactions- Hemagglutination, Passive agglutination, Bacterial agglutination; Agglutination inhibition, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST

MODULE-V (MEDICAL MICROBIOLOGY)(revised as per BOS meeting dated 22/3/2013)

1. a) Normal Microbial Flora of Human body: Skin, throat, gastrointestinal tract, urogenital tract

b) Mechanism of Bacterial Pathogenicity: Definition of the following parasite, pathogen, pathogenicity, toxigenicity, virulence, carriers and their types, nosocomial infections, opportunistic infections, bacteremia and septicemia, septic shock

Entry, Adhesion, Growth and Colonization, Invasion, Toxigenesis

c) Endo and exo toxins: Definition and general properties

d) Types of exotoxin

i) Neurotoxin: Botulinum toxin, Tetanus toxin

ii) Enterotoxin: Cholera toxin, Salmonella toxin

iii) Cytotoxin: Shigella toxin, Diphtheria toxin

d) Elementary idea of quorum Sensing and biofilm

References:

1. Molecular Biology of the Gene (5th Edition) by James D Watson *et al*
2. Concept of Genetics (6th edition) by Klug and Cummings
3. Immunology by Janis Kuby
4. Gene manipulation by Old and Primrose
5. Virology by Flint
6. Virology by Dimmock
7. Molecular biology by Padmanavan and Shastry
8. Virology by Carter
9. Cell and Molecular Biology by Lodish *et al*

semester V Paper 6 PRACTICAL

MCBA P6 P **Marks 100** **Credits 10**

Course Outcome (CO) of Semester V Practical (MCBA P6 P) :

Course outcomes are,

CO1	To have a hands on experience on molecular biology
CO2	To understand the basic concepts of enzyme biochemistry
CO3	To understand the basic concepts of bioinformatics used in laboratory

A. Molecular Biology

1. Isolation of bacterial genomic DNA, fungal genomic DNA algal genomic DNA and Plant and genomic DNA analyze it through agarose gel-electrophoresis.

2. Isolation of plasmid DNA from bacteria by using a standard protocol; gel-electrophoresis (Agarose gel).

3. Isolation of RNA from yeast or bacteria and analyze it through agarose gel electrophoresis.

4. Transformation of E.coli using standard protocol and calculation of transformation efficiency

B. Biochemistry

5. Determination of Progress curve, Km & Vmax of the enzyme α- amylase.

6. Determination of Progress curve, pH optima, Km & Vmax, effect of activators and inhibitors of the enzyme alkaline phosphatase.

7. Standard curve of reducing sugar (Maltose) and ρ-nitrophenol.

C. Bioinformatics

8. Bioinformatics Practicals

I. **Retrieval of Protein Sequence and Nucleotide Sequences**
II. **Retrieval of Protein Structure from PROTEIN DATA BANK and visualization using RasMol**
III. **Similarity Search using BLAST and FASTA**

IV. Pair wise Sequence Alignment Using EBI

V. Multiple Sequence Alignment Using CLUSTAL W

VI. Phylogenetic analysis of retrieved sequences

VII. Restriction mapping

SYLLABUS FOR THREE-YEAR HONOURS COURSE IN MICROBIOLOGY

SEMESTER-VI

THEORETICAL **Marks 100** **Credits 16**

Course Outcome (CO) of Semester VI Theory (MCBA P7 TH) :

Course outcomes are,

CO1	To understand about genetic exchange and recombination
CO2	To understand about gene mutation and its repair
CO3	To understand about cancer, population and evolutionary genetics
CO4	To understand about viral molecular biology

MODULE-I (GENETICS AND GENOMICS-II) (revised as per BOS meeting dated 22/3/2013)

1. Genetic exchange and recombination [10]

a) Homologous recombination (Holiday structure; RecBCD system)

b) Gene conversion, site specific recombination (λ)

c) Transposable elements: Discovery, Ac-Ds system in maize, bacterial transposons - types, mechanisms of transposition, biological significance

2. Mutation and Repair [20]

a) Spontaneous mutations:Luria-Delbruck's Fluctuation Test, Lederberg's Replica Plating Test

b) Induced mutations: Mutagenic agents- Physical, Chemical and Biologica (Phage μ)

c) Genetic techniques to detect mutations in bacteria and fungi: Isolation and characterization of nutritional auxotrophic mutation, Ames test to assess the mutagenecity of compounds

d) Different forms of mutations and their origin:Tautomeric shift ,base anlogue, alkylating agent, apurinic lesions, UV irradiation and thymine dimers, replication errors

e) Repair: Reversal of UV damage in prokaryotes; photorreactivation;base-exicion and nucleotide- excision repair; post replication repair; mismatch repair, SOS repair; error prone repair, examples of repair related diseases

3. Genetic basis of cancer [5]

Oncogenes (*ras-,src-,abl*- and *myc*-genes) and

tumour- suppressor genes(*RB* and *p53* genes)

4. Developmental Genetics and Model Systems [3]

Study of model systems in developmental genetics-*Drosophila melanogaster* and *Arabidopsis thaliana*

5. Population *and Evolutionary* Genetics [7]

Genetics of population: Allele frequencies, Genotype frequencies, Hardy- Weinberg Law, factors controlling changes in gene frequencies- mutation, migration and genetic drift- founder effect and genetic bottleneck

6. Evolutionary Genetics [6]

Genetic variation in natural populations, Darwin's theory of natural selection- present status, fitness and selection, types of natural selection, non-random mating, reduced gene flow, molecular evolution, molecular phylogeny and construction of phylogenetic trees from nucleic acid hybridizations, restriction sites, nucleic acid sequences and amino acid sequences of cytochrome c, protein

MODULE- II

A. (IMMUNOLOGY-III):

a) **Complement: The complement components; complement activation: Classical, Alternate and Lectin pathways (characteristics & functions) Biological consequences of complement activation**
b) **Hypersensitivity: Definition, , types and examples (overview),Allergy, Anaphylaxis and Graft rejection(brief ideas)**
c) **Autoimmunity (basic ideas, systemic and organ specific with examples)**
d) **Immunodeficiencies -Animal models (Nude and SCID mice), DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens**
e) **Vaccines: Attenuated and inactivated viral or bacterial vaccines (definition, characteristics, functions and examples)**

B. (VIROLOGY II)

1. Viral reproduction
a) General characteristics of viral replication, replication of T4 phage, phage growth and the estimation of phage numbers;
b) Lytic and Lysogenic life cycle of bacteriophage lambda (λ), Mechanism(s) that determines lytic and lysogenic life cycle, SOS response of *E. coli* host, replication of an animal virus (dsDNA), isolation of bacteriophage
c) Phage display

2. Definitions of virus like agents
a) prions, viroids and virusoids
b) Life cycle of animal viruses: Adenovirus, Poliovirus, SV40,HIV,HTLV-1, HTLV-2,EBV,CMV,Influenza (adsorption, penetration, replication, lysis, release and pathogenesis)

MODULE-III (RECOMBINANT DNA TECHNOLOGY)

11. Recombinant DNA technology and Applications: (revised as per BOS meeting dated 22/3/2013) [35]

Tools used in Recombinant DNA techniques: Restriction and modification enzymes used in genetic engineering,-DNA ligase, Polynucleotide kinase, DNA Polymerase. Terminal transferase, Alkaline phosphatase. Different methods of formation of recombinant DNA (use of linkers, adaptors, homopolymers)

Basic properties and types of vectors: Vector construction, Cloning vectors (pBR322, pUC8,19, YACs, ƛ Phage as vector, Cosmid, Phagemid, Fosmid, Shuttle vector), Ti plasmid as transformation vector, BAC, PAC vectors, Expression vectors.

Introduction of DNA into Living cells: Chemical (PEG, liposomes), Physical (electroporation, microinjection, biolistic) and biological (transformation, transfection & use of vectors).

Cloning strategies: Construction of DNA libraries (basic ideas and outlines of methods), cDNA libraries, PCR (different types).

Clone Identification: Identification of clone of a specific gene from libraries through hybridization probing and immunological screening methods, radioactive & non-radioactive labeling of probes.

Basic Techniques used in Modern Biology: DNA sequencing, RFLP; RAPD; Southern blotting; Dot blotting; Northern blotting; Western blotting, DNA microarray.

Application of RDT in agricultural, industry and medicine: Over expression of recombinant proteins in bacteria: Choice of expression system, Criteria of host selection, Production of biopharmaceuticals in recombinant system (Insulin, Human Growth Hormone, Blood clotting factors).

MODULE-IV (MEDICAL MICROBIOLOGY)

12. Common Microbial Diseases [15]

a) Bacterial- Tuberculosis, Leprosy, Tetanus, Cholera, Gonorrhea, Typhoid
b) Viral- Flu, Polio, AIDS
c) Fungal- Candidiasis
d) Protozoan- Malaria, Amoebiasis, Leishmaniasis (Name of pathogens, disease symptoms, preventive measures and vector control where applicable)
e) Examples of bioterror agents (Anthrax)

13. Antimicrobial Therapy [20]

a) **General properties of antibacterial and antitubercular agents (inhibitors of cell wall synthesis, disruptors of cell membrane, inhibitors of protein synthesis, inhibitors of nucleic acid synthesis and antimetabolites);**
b) **Antifungal agents;**
c) **Antiviral agents;**

d) Antiprotozal agents and antihelminthic agents (general properties, selective toxicity, spectrum of activity, mechanism of action, side effects, resistance of microorganisms);

e) Anti-Retroviral drugs

f) Gene Therapy (definition and outlines of different methods)

References:

1. **Molecular Biology of the Gene (5th Edition) by James D Watson *et al***
2. **Concept of Genetics (6th edition) by Klug and Cummings**
3. **Immunology by Janis Kuby**
4. **Gene manipulation by Old and Primrose**
5. **Virology by Flint**
6. **Virology by Dimmock**
7. **Molecular biology by Padmanavan and Shastry**
8. **Virology by Carter**
9. **Cell and Molecular Biology by Lodish *et al***

Semester 6 Paper 8 PRACTICAL

Marks: 100 **Credits 10**

MCBA P8 P

Revision vide Bos dated : 08.08.2017

Course Outcome (CO) of Semester VI Practical (MCBA P8 P) :

Course outcomes are,

CO1	To understand about the concepts of immunology

CO2	To experience hands on project
CO3	To experience hands on VDRL and Widal test

1. Antigen-Antibody interaction:
i) Agglutination (blood typing)
ii) Ouchterlony's double diffusion method
iii) Mancini's radial Immunodiffusion technique
iv) Immunoelectrophoresis
v) VDRL and WIDAL test
2. Restriction digestion of DNA
3. Ligation of DNA fragment.
4. SDS-PAGE and Western Blotting (revised as per BOS meeting dated 08/08/2017)
5. Project/Review

6. Grand Viva

B.Sc. Microbiology Generic Elective

Course Structure

Sl No	Name of the Course	Semester	Course Code	Credit	Marks in the Course	Course outcome
1	Basic Microbiology, Microscopy and Staining techniques Bacterial Morphology, Bacterial Growth and Eukaryotic Microbiology	1	MCBG P1T	2	50	Understanding Scope of Microbiology, Whittaker's Five kingdom classification General principles of optics in relation to microscopy Definition of Auxochrome, chromophore Different cell morphology Nutritional types of bacteria Eukaryotic microbiology
2	Demonstration of Laboratory Instruments Microscopy Micrometry Staining Culture media Preparation Aseptic techniques	1	MCBG P1P	1	25	Direct hands-on training on Ethics of Culture room, operation of autoclave, hot air oven, laminar air flow, incubator: Principle and uses Description and operation of compound microscope. Use of oil immersion objective. cell measurement (using ocular micrometer and stage micrometer) Staining Culture transfer from solid to

						solid, solid to liquid.
3	Virology, Biomolecules, Enzymes and Bacterial Metabolism Environmental Microbiology-I (Soil Microbiology and Plant Pathology) and Control of Microbial Growth	2	MCBG P2T	2	50	Understnding and learning of Definition, general characteristics of viruses, functions of virion proteins and difference between bacteria and viruses Classification of viruses Viral reproduction Outline structure, function and examples of carbohydrates, amino acids, proteins (primary, secondary, tertiary and quarternary structure brief outlines only), lipids, DNA, RNA. General properties of enzymes Catabolism of glucose Soil Microbiology and Plant Pathology
4	Qualitative tests for carbohydrates (glucose, fructose, sucrose) and proteins. 2. Culture techniques	2	MCBG P2P	1	25	a) Isolation of pure culture by Streak plate technique. b) Viable counting of bacteria by serial dilution and pour plating, spread plating. c) Isolation of bacteria from soil by serial dilution and pour-plate/spread plate method. d) Testing milk samples: Methylene Blue reduction test of milk samples. e) Microbiological examination of water: Multiple tube fermentation test method for detection of coliform bacteria-

5	Environmental Microbiology-I I Molecular Biology-I and Industrial Microbiology	3	MCBG P3T	2	50	Attaining fundamental knowledge on Aeromicrobiology Air Sample Collection and Analysis Control Measures Food Microbiology Water Microbiology Structures of DNA and RNA / Genetic Material Replication of DNA Transcription Translation Regulation of gene Expression Industrial Microbiology
6	Microbiological assay of antibiotics Determination of Minimal Inhibitory Concentration Biochemical activities of microorganisms	3	MCBG P3P	1	25	Getting hands on knowledge Microbiological assay of antibiotics Determination of Minimal Inhibitory Concentration Biochemical activities of microorganisms
7	Molecular Biology-II and Bacterial Genetics and Recombinant DNA Technology Immunology and Medical Microbiology	4	MCBG P4T	2	50	Mutations and Repair Bacterial Transformation Attaining the basic knowledge on Basic properties and types of vectors Introduction of DNA into Living cells Overview of the immune system, Concept of immunity, History of immunology Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction

8	1. Study of different stages of mitosis from onion root. 2. Demonstration of blood group typing. 3. Demonstration of antigen-antibody interaction by Ouchterlony double diffusion assay. 4. Demonstration of Radial immunodiffusion. 5. VDRL test 6. WIDAL test 7. Identification of normal microbial flora of the throat or skin. 8. Study of survival curve of bacteria after exposure to ultraviolet (UV) light.	4	MCBG P4P	1	25	Acquiring the skill in Demonstration of blood group typing, Demonstration of antigen-antibody interaction, Demonstration of Radial immunodiffusion, VDRL test, WIDAL test

SYLLABUS FOR MICROBIOLOGY GENERIC ELECTIVE
COURSE CODE : MCBG
SEMESTER-I

MCBG P1T

Theory (Paper I) (50 marks)

GROUP A: Basic Microbiology, Microscopy and Staining techniques (20 marks)

1. Notable contributions in the development of Microbiology:

Spontaneous Generation (Abiogenesis), Biogenesis, Germ theory of disease, Koch's Postulates, Scope of Microbiology, Whittaker's Five kingdom classification.

2. Microscopy:

General principles of optics in relation to microscopy, Different components of light wave, Principle and application of compound microscope: Light microscope, dark field microscope, bright field microscope, phase contrast microscope, electron microscope (TEM, SEM). Resolving power, Numerical aperture, chromatic aberration.

3. Stains and Staining techniques:

Definition of Auxochrome, chromophore; acidic and basic dyes, natural dyes, mordant and its function, Classification of stains; Simple and differential staining ,Theories of staining, Mechanism and principles of Gram's staining, acid fast staining, endospore staining, capsule staining and flagella staining.

GROUP-B: Bacterial Morphology, Bacterial Growth and Eukaryotic Microbiology (30 marks)

4. Morphology and ultra structure of Bacteria:

Different cell morphology, flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: Nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly B hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores.

5. Nutrition and Growth:

Nutritional types of bacteria. Culture media: classification of media (Simple, complex and special media with example). Growth: nutritional uptake, growth kinetics, generation time, growth curve, factors affecting growth.

6. Eukaryotic microbiology:

Protozoa: Introduction, structure and significance: *Leishmania, Trichomonas, Entamoeba, Plasmodium*. **Algae**: General account- Habitat, structure and reproduction. Distinctive features of the classes with examples Chlorophyceae, Bacilloriophyceae, Pheophyceae, Rhodophyceae. Cyanobacteria – a general account. **Fungi:** General account- Habitat, structure and reproduction. Distinctive features of the classes with examples Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes.

MCBG P1P

Practical (Paper II) (25 marks)

1. Demonstration of Laboratory Instruments: Ethics of Culture room, operation of autoclave, hot air oven, laminar air flow, incubator: Principle and uses.

2. Microscopy: Description and operation of compound microscope. Use of oil immersion objective.

3. Micrometry: cell measurement (using ocular micrometer and stage micrometer) of *Bacillus subtilis* and *Saccharomyces cerevisiae*.

4. **Staining:** i) Simple staining of bacteria (*Bacillus subtilis*).

ii) Differential staining of bacteria (Gram staining of *B. subtilis* and *E. coli*).

iii) Yeast Staining (Methylene blue staining of *S. cerevisiae*).

iv) Fungal (mold) staining (Lactophenol cotton blue staining of *Aspergillus* sp. and *Penicillium* sp.).

5. **Culture media Preparation:** Nutrient agar slant, stab and plate, Nutrient broth.

6. Aseptic techniques: Culture transfer from solid to solid, solid to liquid.

SEMESTER-II

MCBG P2T

Theory (Paper II) (50 marks)

GROUP A: Virology, Biomolecules, Enzymes and Bacterial Metabolism (30 marks)

1. Virology:

a) Definition, general characteristics of viruses, functions of virion proteins and difference between bacteria and viruses.

b) Classification of viruses based on: i) capsid symmetry- helical (TMV), icosahedral (polyoma), complex (bacteriophage) ii) nucleic acid content; DNA (dsDNA, ssDNA) and RNA (ssRNA, dsRNA), viruses with examples; Human cancer virus (SV40, HTLV-1&2, Epstein- Bar virus only).

c) Viral reproduction : General characteristics of viral replication, replication of T4 phage, phage growth and the estimation of phage numbers; Lytic and Lysogenic life cycle of bacteriophage lambda (λ), replication of an animal virus (dsDNA), isolation of bacteriophage, Life cycle of animal viruses: Adenovirus, Poliovirus, HIV, Influenza (adsorption, penetration, replication, lysis, release and pathogenesis).

2. Biomolecules:

Outline structure, function and examples of carbohydrates, amino acids, proteins (primary, secondary, tertiary and quarternary structure brief outlines only), lipids, DNA, RNA.

3. Enzymes:

a) General properties of enzymes**,** Nomenclature and classification.
b) Cofactors: definition and function with special reference to representative substances-
i) Co-enzymes: NAD^+, $NADP^+$, Co-enzyme A, TPP, Pyridoxal phosphate.
ii) Prosthetic groups: FAD-succinic dehydrogenase.
iii) Metal ions: Zn^{+2}, Mg^{+2}, Fe^{+2}, Fe^{+3}, Mn^{+2} - required for enzyme action.
c) Enzyme kinetics: Michaelis-Menten equation, Briggs-Haldane modification on Michaelis Menten equation, Significance of Km and Vmax, Lineweaver-Burke plot, Bisubstrate enzymatic reactions.
d) Effect of pH and temperature on enzyme activity.
e) Enzyme inhibition: Competitive (cite the action of malonate on succinate dehydrogenase, iodoacetate on triose phosphate dehydrogenase and EDTA as example), Mixed inhibition, Non competitive, Uncompetitive, Suicide inactivation (action of penicillin on bacterial peptidoglycan biosynthesis), Feedback inhibition (cite threonine to isoleucine as an example).
f) Allosteric enzyme: allosteric modulator- positive and negative (Aspartate transcarbamylase as an example.
g) Ribozyme (catalytic RNA) (definition only), Abzyme (use of antibody as enzyme) (definition only), Isozyme- definition and example.

4. Bacterial Metabolism

a) Catabolism of glucose: Glycolysis, Entner-Doudoroff pathway,Entry of hexoses other than glucose(galactose and fructose),Pentose Phosphate Pathway, Phosphoketolase Pathway, Anaerobic fate of pyruvate: Homolactic and Heterolactic fermentation.
b) Tricarboxylic acid cycle with energy production, Amphibolic nature of TCA cycle.
c) Electron Transport Chain and oxidative phosphorylation: Coupling of oxidative phosphorylation to electron transport, Components of Electron Transport Chain, Oxidation-reduction potential, Shuttle system, Chemiosmotic hypothesis, Proton gradient generation, Mechanism of ATP synthesis, ATP-ADP cycle.
d) Anaerobis respiration-Utilizing NO_3, SO_4, CO_3 as electron acceptors, Stickland reaction.
e) Fermentation Pathways: Fermentation reactions, Homo and heterolactic Fermentation- lactic acid Fermentation, Alcohol fermentation, Acetic acid fermentation.

GROUP B: Environmental Microbiology-I (Soil Microbiology and Plant Pathology) and Control of Microbial Growth (20 marks)

5. Soil Microbiology and Plant Pathology:

a) Formation of soil

b) Physical and chemical characteristics of soil

c) Microbial interactions: mutualism, synergism, commensalism, competition, ammensalism, parasitism, predation

d) Microbe-plant interactions: Rhizosphere, rhizoplane, phyllosphere

e) Biological nitrogen fixation

f)Nitrogen cycle

g) Stages in development of plant disease: elementary ideas on inoculation, pre-penetration phenomenon, penetration, infection, invasion, growth and reproduction of pathogen, dissemination of pathogens and perennation

h) Control of plant diseases- principles and practices

6. Control of Microbial Growth:

Definition, application and examples: Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent, Physical methods of control: Mode of action and application of dry heat, moist heat, filtration, radiation, ultrasonication, Chemical methods of control: Mode of action and application of alcohol, acid, alkali, halogen, heavy metal, phenol and phenol derivatives, formaldehyde, ethylene oxide, detergents, Assessment of chemical disinfectant: phenol coefficient .

MCBG P2P

Practical (Paper II) (25 marks)

1. Qualitative tests for carbohydrates (glucose, fructose, sucrose) and proteins.
2. Culture techniques:

a) Isolation of pure culture by Streak plate technique.

b) Viable counting of bacteria by serial dilution and pour plating, spread plating.

3. Isolation of bacteria from soil by serial dilution and pour-plate/spread plate method.
4. Testing milk samples: Methylene Blue reduction test of milk samples.
5. Microbiological examination of water: Multiple tube fermentation test method for detection of coliform bacteria-

a) Presumptive test

b) Confirmatory test

c) Completed test

6. IMViC reactions.

SEMESTER-III

MCBG P3T

Theory (Paper III) (50 marks)

GROUP A: Environmental Microbiology-I I (Air Microbiology, Water Microbiology and Food Microbiology) (20marks)

I. Air microbiology:

Unit 1. Aeromicrobiology

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2. Air Sample Collection and Analysis

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3. Control Measures

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

II. Food Microbiology

Normal microbiological quality and spoilage of milk, meat, egg, vegetables and fruits; General idea of food preservation- high temperature, low temperature, reduced water activity, canning, chemical preservatives, irradiation, combined methods; Microbiology of fermented foods- yoghurt, acidophilic milk, cheese, idli; Concept of probiotics, prebiotics and synbiotics; Bacterial

agents of foodborne illness- salmonellosis, shigellosis; Methods of microbial examination of foods- dye reduction test (MBRT), phosphatase test of milk.

III. Water Microbiology

Water borne pathogens, water borne diseases, Sample Collection, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for coliforms (b) Membrane filter technique, IMViC test, treatment and safety of drinking (potable) water.

Group-B: Molecular Biology-I and Industrial Microbiology (30 marks)

I. Molecular Biology-I

Unit 1. Structures of DNA and RNA / Genetic Material - DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes. RNA Structure

Unit 2. Replication of DNA

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication, Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends

Unit 3. Transcription

Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

Unit 4. Translation

Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

Unit 5. Regulation of gene Expression

lac operon: components, interaction between the components, general control mechanisms, *trp* operon: components, general control mechanisms

II. Industrial Microbiology

Isolation of industrially important microbial strains, Bioreactors/fermenters: Components of a typical bioreactor, Measurement and control of fermentation parameters: pH, temperature, dissolved oxygen, foaming and aeration, Media and ingredients for industrial fermentations, Fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fed-batch and continuous fermentations, Microbial production of industrial products (micro-organisms involved media, fermentation conditions, downstream processing and uses): Ethyl Alcohol, Penicillin, Alpha Amylase, Concept of primary and secondary metabolites in microorganisms

MCBG P3P

Practical (Paper III) (25 marks)

1. Microbiological assay of antibiotics: Antibiotic sensitivity test by paper disc and cup-plate method
2. Determination of Minimal Inhibitory Concentration (MIC) by serial dilution method for assaying commonly used antibiotics (using appropriate test bacteria)
3. Biochemical activities of microorganisms
   a) Carbohydrate fermentation
   b) Triple sugar-iron agar test
   c) Hydrogen sulfide test
   d) Gelatinase production test
   e) Urease test
   f) Nitrate reduction test
   g) Catalase test
   h) Oxidase test
4. Isolation of Protease, Amylase, and Phosphatase producing microorganisms from soil.

SEMESTER-IV

MCBG P4T

Theory (Paper IV) (50 marks)

GROUP A: Molecular Biology-II and Bacterial Genetics and Recombinant DNA Technology (25 marks)

I. Mutations and Repair -

a) Spontaneous mutations: Luria-Delbruck's Fluctuation Test

b) Induced mutations: Mutagenic agents- Physical, Chemical and Biological (Phage μ)

c) Ames test to assess the mutagenecity of compounds

d) Different forms of mutations and their origin: Tautomeric shift ,base anlogue, alkylating agent, apurinic lesions, UV irradiation and thymine dimers, replication errors

e) Repair: Reversal of UV damage in prokaryotes; photo-reactivation; base-exicion and nucleotide- excision repair; post replication repair; mismatch repair, SOS repair; error prone repair, examples of repair related diseases.

II. Bacterial Genetics and Recombinant DNA Technology

Bacterial Transformation -Discovery, mechanism of natural competence, Conjugation -Discovery, mechanism, Hfr and F' strains, Transduction -Generalized transduction, specialized transduction.

Basic properties and types of vectors: Vector construction, Cloning vectors -pBR322, pUC, ƛ Phage as vector, Shuttle vector.

Introduction of DNA into Living cells: Chemical method - PEG, liposomes, Physical method-electroporation, microinjection.

GROUP B: Immunology and Medical Microbiology (25 marks)

I. Immunology

Overview of the immune system, Concept of immunity, History of immunology: variolation and vaccination , active and passive immunity, natural and artificial immunity, innate and adaptive immunity, Innate Immunity: Mechanism of immune response (anatomic, physiologic,

phagocytic and inflammatory barriers), Concept of Cells and organs of Immune system, Adaptive Immunity: Humoral and Cell-mediated immunity; Primary and Secondary Immune Response; Antigens and antigenicity; immunogenicity; hapten; epitopes; mitogens (definition, properties and examples); interferon (definition and function); adjuvant (definition, example and function), Type of Immunoglobulins: Structure, Types, and Functions, Antigen-Antibody Interactions: Precipitation reactions- Radial immunodiffusion, Double immunodiffusion, Immunoelectrophoresis; Agglutination reactions.

II. Medical Microbiology

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Opportunistic infections, Nosocomial infections. Transmission of infection.

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism.

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin.

Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.

MCBG P4P

Practical (Paper IV) (25 marks)

1. Study of different stages of mitosis from onion root.
2. Demonstration of blood group typing.
3. Demonstration of antigen-antibody interaction by Ouchterlony double diffusion assay.
4. Demonstration of Radial immunodiffusion.
5. VDRL test
6. WIDAL test
7. Identification of normal microbial flora of the throat or skin.
8. Study of survival curve of bacteria after exposure to ultraviolet (UV) light.

B.Sc (General) MICROBIOLOGY (CBCS STRUCTURE)

Semester-1/3

GE1(MCBGET1/3): INTRODUCTION AND SCOPE OF MICROBIOLOGY (THEORY)

TOTAL HOURS: 60 **CREDITS: 4**

Course Outcome (CO) of Generic Elective 1 (MCBGET1) :
Course outcomes (COs) are,

CO1	To have a basic overview of history and developments of Microbiology
CO2	To understand the basic classification system of different microbes
CO3	To understand the salient features of each class of microbes
CO4	To understand the basic cell organization of bacteria
CO5	To understand the basic concepts of bacterial staining and environmental microbiology

Unit 1 History of Development of Microbiology (No. of Hours: 8)

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of

Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Edward Jenner.

Unit 2 Diversity of Microorganisms (No. of Hours: 8)

Systems of classification: Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility, General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa) giving definitions and citing examples.

Unit 3 Bacterial Systematics and Taxonomy (No. of Hours: 12)

Taxonomy, nomenclature, systematics, types of classifications, Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles, Eubacteria: Gram negative and Gram positive.

Gram negative:

Non-proteobacteria– *Deinococcus, Chlamydiae,* Spirochetes

Alpha proteobacteria- *Rickettsia, Rhizobium, Agrobacterium*

Gamma proteobacteria –*Escherichia,Shigella,Pseudomonas.*

Gram positive:

Low G+C: *Mycoplasma*, *Bacillus, Clostridium, Staphylococcus* High G+C: *Streptomyces, Frankia.*

Unit 4 Microscopy (No. of Hours: 4)

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Transmission Electron Microscope, Scanning Electron Microscope, Numerical aperture, Resolving power, Chromatic aberration.

Unit 5 Bacterial growth and cultivation (No. of Hours: 8)

Bacterial Growth: Growth kinetics, generation time, growth curve, factors affecting growth.
Culture media: Components of media, Synthetic or defined media, Complex media, enriched Media, selective media, differential media.

Pure culture isolation: Streaking, serial dilution and plating methods, cultivation of anaerobic bacteria.

Unit 6 Stains and staining techniques (No. of Hours: 4)

Definition of Auxochrome, chromophore; acidic and basic dyes, natural dyes, mordant and its function, Classification of stains; Simple and differential staining ,Theories of staining, Mechanism and principles of Gram's staining, acid fast staining, endospore staining, capsule staining and flagella staining.

Unit 7 Environmental Microbiology (No. of Hours: 6)

Definitions and examples of important microbial interactions.

Definitions and microorganisms used as biopesticides, biofertilizers and bioremediation (*e.g.* hydrocarbons in oil spills). Rhizosphere and phyllosphere, biological nitrogen fixation, composts and biofertilizers.

Unit 8 Cell organization (No. of Hours: 10)

Cell size, shape and arrangements, capsule, flagella and pili, gram- positive and gram- negative and archaeal cell wall, bacterial and archaeal cell membranes, Ribosomes, cell inclusions, nucleoid, plasmids and Endospore.

GE1(MCBGEPR1/3): INTRODUCTION AND SCOPE OF MICROBIOLOGY (PRACTICALS)

Semester –1/3

TOTAL HOURS: 60 **CREDITS: 2**

Course Outcome (CO) of Generic Elective 1 (MCBGEPR1/3) :
Course outcomes (COs) are,

CO1	To have a basic overview of good laboratory practices of Microbiology
CO2	To understand the basic working principle of different instruments used in Microbiology
CO3	To understand the basic techniques used in Microbiology
CO4	To understand the basic concept about microbiological culture media

1. Microbiology Laboratory Management and Biosafety.

2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.

3. Preparation of culture media for bacterial cultivation.

4. Isolation of pure cultures of bacteria by streaking method.

5. To perform simple staining and Gram's staining of the bacterial smear.

6. Enumeration of colony forming units (CFU) count by spread plate method/pour plate.

7. Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.

8. Study of *Rhizopus, Spirogyra, Chlamydomonas, Amoeba*, *Entamoeba*, *Paramecium, Plasmodium* and *Penicillium* using permanent mounts.

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition.
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4.Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition., McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). GeneralMicrobiology. 5thedition. McMillan.