

Syllabus and Course Scheme

Academic year 2020-21



*B.Sc.- Microbiology  
Exam.-2021*

**UNIVERSITY OF KOTA**

***MBS Marg, Swami Vivekanand Nagar, Kota -  
324 005, Rajasthan, India***

***Website: uok.ac.in***

## B.Sc. -Microbiology

*Eligibility: 10+2 Science Biology /Agriculture*

### **Scheme of Examination and Courses of Study**

The number of papers and maximum marks for each paper together with the minimum marks required for a pass are shown against each paper separately. It will be necessary for a candidate to pass in the theory papers as well as in practical separately.

First Division 60% of the maximum marks prescribed at part

Second Division 48% I, II and III Examination, taken together.

Rest of the candidates shall be declared to have passed the examination, if they obtain the minimum pass marks in each paper viz. 36%. No division shall be awarded at Part I and Part II Examination.

A candidate may be allowed to appear at the Supplementary examination upto a maximum of two theory papers, provided that she/he has passed in all the practical examination.

A candidate may be allowed grace marks in two theory papers upto the extent of 1% of the total marks prescribed for the examination.

### **TEACHING AND EXAMINATION SCHEME FOR B.Sc. Microbiology Pt-I Examination**

<b>Compulsory paper</b>	<b>Lec Hrs/week</b>	<b>Exam hrs.</b>	<b>Max Marks</b>
BMB – 00 Environmental studies	3	3	50
<b>Core paper (Theory)</b>			
BMB – 01 Principles of microbiology	3	3	50
BMB – 02 Cell Biology and Microbial Genetics	3	3	50
BMB – 03 Biology & Diversity of Microbes	3	3	50
BMB – 04 Fundamentals of Biochemistry	3	3	50
BMB – 05 Fundamentals of Molecular Biology	3	3	50
BMB – 06 Basic Immunology			
<b>Total of Theory Papers</b>			<b>300</b>
<b>Core Paper (Practicals)</b>			
BMB – 07 Principles of microbiology + Cell Biology and Microbial Genetics		3	50
BMB – 08 Biology and Diversity of Microbes + Fundamentals of Biochemistry		3	50

BMB – 09 Fundamentals of Molecular Biology + Basic Immunology	3	50
<b>Total of Practical Papers</b>		<b>150</b>
<b>Grand Total (Theory+ Practicals)</b>		<b>450</b>

### B.Sc. Microbiology Pt-II Examination

	<b>Lec Hrs/week</b>	<b>Exam hrs.</b>	<b>Max Marks</b>
<b>Core paper (Theory)</b>			
BMB – 10 Microbial Ecology	3	3	50
BMB – 11 Microbial Physiology and Metabolism	3	3	50
BMB – 12 Medical Microbiology	3	3	50
BMB – 13 Genetic Engineering and rDNA technology	3	3	50
BMB – 14 Food & Dairy Microbiology	3	3	50
BMB – 15 Environmental Microbiology	3	3	50
<b>Total of Theory Papers</b>			<b>300</b>
<b>Core Paper (Practicals)</b>			
BMB –16 Microbial Ecology+ Microbial Physiology & Metabolism		3	50
BMB –17 Medical Microbiology+ Genetic Engineering and rDNA technology		3	50
BMB – 18 Food & Dairy Microbiology + Environmental Microbiology		3	50
<b>Total of Practical Papers</b>			<b>150</b>
<b>Grand Total (Theory+ Practicals)</b>			<b>450</b>

### B.Sc. Microbiology Pt-III Examination

	<b>Lec Hrs/week</b>	<b>Exam hrs.</b>	<b>Max Marks</b>
<b>Core paper (Theory)</b>			
BMB – 19 Biosafety & IPR	3	3	50
BMB – 20 Soil and Agriculture Microbiology	3	3	50
BMB – 21 Tools and Techniques in Microbiology	3	3	50

BMB – 22 Computer Applications & Biostatistics	3	3	50
BMB – 23 Biophysics and Instrumentation	3	3	50
BMB – 24 Industrial Microbiology	3	3	50
<b>Total of Theory Papers</b>			<b>300</b>
<b>Core Paper (Practicals)</b>			
BMB –25 Biosafety & IPR + Soil and Agriculture Microbiology		3	50
BMB –26 Tools and Techniques in Microbiology+ Computer Applications and Biostatistics		3	50
BMB –27 Biophysics and Instrumentation+ Industrial Microbiology		3	50
<b>Total of Practical Papers</b>			<b>150</b>
<b>Grand Total (Theory+ Practical)</b>			<b>450</b>

The marks secured in the Compulsory paper of Environmental Studies shall not be counted in awarding the division to a candidate.

Maximum of three chances will be given to a candidate to pass compulsory paper.

Non appearing or absent in the Examination of compulsory paper will be counted a chance.

A candidate shall be eligible to appear in supplementary examination in maximum of two Core theory papers as per University Rules.

One percent of the maximum marks may be awarded as Grace Marks to the candidates in accordance to the University Rules as applicable to all other Under Graduate examinations. Minimum requirement of lectures completing each core theory and compulsory paper shall be 78 hours, and for each practical 156 hours.

## MICROBIOLOGY PRACTICALS – (I, II, III)

### *Distribution of Marks*

<b>Min. pass marks: 18</b>	<b>Duration: 3 hours</b>	<b>Max. Marks: 50</b>
	<b>REGULAR</b>	<b>EX-STUDENT</b>
1. Major Exercise	12	12
2. Minor Exercise	10	10
3. Preparation	8	8
4. Spots (5)	10	10
5. Record	5	-
6. Viva-voce	5	10
<b>TOTAL</b>	<b>50</b>	<b>50</b>

### **BMB – 01 PRINCIPLES OF MICROBIOLOGY**

Duration :3 hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

#### **UNIT- I**

Contributions of the following scientists in various areas of Microbiology - Anton Van Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Waksman. Branches of Microbiology. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology Economic importance of microbes. Branches and scope of microbiology.

Microscopy –Principle, construction, operation and application.

#### **UNIT- II**

Nutritional requirements in bacteria and nutritional categories. Culture media: Simple media, Synthetic or defined media, Complex media, Enriched media, Selective media, Differential media. Culture of microbes: Preparation of culture media, aseptic transfer of bacteria, Pure cultures and cultural characteristics: Serial dilution, Pure cultures by isolation -i) pour plate ii) spread plate iii) streak plate and iv) micromanipulator techniques : colony characteristics

#### **UNIT-III**

Microbial stains: Auxochrome ,chromophores, Stains v/s Dyes, various types of stains. Staining techniques: Simple staining, Differential (Gram and Acid fast),Special staining (Spore, capsule, negative).

Sterilization – Principle and methods: Physical Methods: Heat, Pasteurization, filtration, tyndallization, radiation.

Chemical methods: – disinfectant's, antiseptics, Sanitizers, microbicides – bactericide, virucide, fungicide and sporicide, microbistatic-bacteriostatic and fungistatic agents. Alcohol, Halogen, Aldehyde, Ethylene Dioxide.

#### UNIT- I V

Microbial Growth : Growth rate and generation time, growth curve – phases of growth and their significance. Physical and chemical factors affecting growth : temperature, light, pH, oxygen and saline requirements. Measurement of growth by cell number (Haemocytometer) and cell mass (Turbidometer, photometer)

#### UNIT- V

Bacterial Cell organization : Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, sphaeroplasts, protoplasts, and L-forms. Cell Membrane: Structure, function and chemical composition of bacterial cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids. Endospore: Structure, formation, stages of sporulation.

#### Reference Books:

1. Microbiology, Authors- Pelczar, Chan and Kreig.
2. Microbiology- an Introduction- (8th Edn), Authors- Tortora, G.J., Funke, B.R., Case, C.L.
3. General Microbiology, Authors- Stainer, Ingharam, Wheelis and Painter.
4. Microbial Physiology, Authors- Moat and Foster.
5. A Text book of Microbiology, Authors- P. Chakraborty.
6. Textbook of Microbiology, Authors- Dubey and Maheshwari.
7. Microbiology, A Practical Approach. Authors- Patel and Phanse
8. General Microbiology, Authors- Powar and Dagainawala.
9. Microbiology, Author- S.S. Purohit.
10. Microbiology, Authors- Presscott, Herley and Klein.
11. Bacteriology, Authors- Topley and Wilson.

## **BMB 02- CELL BIOLOGY AND MICROBIAL GENETICS**

Duration :3 hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### **UNIT- I**

Ultra Structure of Prokaryotic and Eukaryotic Cell.

Structure and Function of Cell components: Cell Wall, Plasma Membrane, Endoplasmic Reticulum, Golgi apparatus, Lysosome, Peroxisome, Ribosome, Chloroplast, Mitochondria, , cytoskeleton(Microfilament, Microtubule and Intermediate Filaments).

### **UNIT- II**

Nucleus: Nuclear envelope, nuclear pore complex and nuclear lamina. Chromatin – Molecular organization. Nucleolus.

Structure of chromosome –Prokaryotic and Eukaryotic Chromosome. Nucleosome model, euchromatin and heterochromatin, karyotype. Special types of Chromosomes (Polytene and Lampbrush Chromosome.)

### **UNIT- III**

Cell cycle: Amitosis, mitosis and meiosis. Components of cell cycle control system, Programmed cell death (Apoptosis). Cell signalling.: Signalling molecules and their receptors. Function of cell surface receptors.

### **UNIT- IV**

Methods of genetic recombination: Conjugation, transformation, transduction(Generalized transduction, specialized transduction) and sexduction.

Plasmid- Structure, properties and types. Genetic recombination and site-specific recombination.

### **UNIT -V**

Mutation: spontaneous and induced mutation. Mutagens –Physical and chemical mutagens.

DNA damage and repair: Photoreactivation & SOS repair. Transposable elements of prokaryotes– Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon. Types and significance.

### **Reference Books:**

1. Molecular Biology of Cell- Bruce Alberts et al, Grand publications.
2. Cell Biology- Ambrose & Dorothy Mastey, ELBS Publications.
3. Fundamentals of Cytology- Sharp, McGraw Hill Company.

4. Cytology- Wilson &Marrison, Reinform Publications.
5. Cell Biology and Molecular Biology- EDP Robertis and EMF robertis, Sauder College.
6. Cell Biology, Genetics and Evolution & Ecology P.S. Verma and Agarwal.
7. Cell Biology: A lab manual. Shanmucan. Mc Millan India Ltd.
8. Genetics- Strickberger, 2<sup>nd</sup>.
9. Microbial Genetics – D. Frifielder.
10. Baltimore- Molecular Biology of the Cell

### **BMB 03- BIOLOGY AND DIVERSITY OF MICROBES**

Duration :3 hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

#### **UNIT – I**

Whittaker's classification system of prokaryotes. Hackel's three kingdom, Carl Woes classification. Important archaeal and eubacterial groups according to Bergey's Manual of Systematic Bacteriology. Study of ultra structure of typical prokaryotic cell and eukaryotic cell, comparative account.

#### **UNIT – II**

Classification and General characteristics of algae - Occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae. Applications of algae in agriculture, industry and environment.

#### **UNIT – III**

Classification and General characteristics of fungi - habitat, nutritional requirements, ultra-structure, thallus organization, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance.  
Protozoa :General characteristics with special reference to *Amoeba*, *Paramecium* and *Plasmodium*.

#### **UNIT – IV**

Definition, history of virology, General characteristics of viruses – size, shape and chemical composition, properties used for classification of viruses, isolation and identification of viruses. Structure and General Characteristics of viroids, virusoids, satellite viruses and Prions. Multiplication of bacterial viruses (lytic and lysogenic cycles).

#### **UNIT – V**



Eubacteria: Cell morphology, function, reproduction of Photosynthetic eubacteria, Gram positive eubacteria (Actinomycetes), Spore forming bacteria (spore formation and germination), Sulfur bacteria, Nitrogen fixing bacteria and mycoplasma.

Archaea: General characteristics, structure, metabolic character, function, reproduction and application.

Cyanobacteria: General characteristics and importance.

### **Reference Books:**

1. Microbiology: An Introduction by Tortora GJ, Funke BR and Case CL., 9th Ed., Person Education, 2008.
2. Microbiology by Pelczar Jr MJ, Chan ECS and Krieg NR. 5th Ed. Tata McGraw Hill, 2011 (Reprint),
3. Black JG (2008) Microbiology: Principles and Explorations. 7th edition. Prentice Hall.
4. Madigan MT and Martinko JM (2006) Brock Biology of Micro-organisms. 8th edition. Parker J. Prentice Hall International, Inc.
5. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005) General Microbiology. 5th edition. McMillan 4.
6. Srivastava S and Srivastava PS (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.

## **BMB-04 FUNDAMENTALS OF BIOCHEMISTRY**

Duration : 3 hrs

Max .Marks :50

Note - The paper is divided into five units. Two questions will be set from each unit.

The candidates are required to attempt one question from each unit. All questions carry equal marks.

### **UNIT – I**

Bioenergetics: Principles of bioenergetics. First and second laws of Thermodynamics. Definition of Gibb's Free Energy, Enthalpy and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant.  
Energy rich compounds: Phosphoenolpyruvate, 1, 3- Bisphosphoglycerate.

### **UNIT – II**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo-isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine,

muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin.

### UNIT – III

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its significance, classification, biochemical structure and notation of standard protein amino acids. Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and Quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure.

### UNIT – IV

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers and bilayers  
Structure of nucleic acids. Nucleoside, nucleotide

### UNIT – V

Enzymes: General properties, Classification. Role in metabolism, anabolism and catabolism. Coenzymes and Cofactors. Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis and Induced Fit hypothesis. Definitions of terms – enzyme unit, specific activity and turnover number, Effect of pH and temperature on enzyme activity. Enzyme Kinetics (derivation of Michaelis–Menten constant, linear transformation of the equation). Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts. Allosteric Enzymes and Isoenzymes. Mechanism of Enzyme Regulation.

#### References:

1. Lehninger. Principles of Biochemistry, Nelson & Cox, 4th Edition.
2. Voet & Voet Donald. 3rd Edition. Fundamentals of Biochemistry, J/W.
3. U Satyanarayan, Biochemistry, 3rd Edn, Books and Allied Pvt. Ltd.
4. Stryer – Biochemistry. W.H. Freeman & Co.
5. Price & Steven, Fundamentals of Enzymology, 3rd Edition
6. Geoffrey Cooper. The cell with CD- Rom. Sinauer Asso. Incorp.
7. Elliott & Elliot. 3rd Edition Biochemistry and molecular biology.
8. Boyer, Concepts in biochemistry. Thomson

9. Plummer. An introduction to practical Biochemistry, 3rd Edition
10. J. Jayaraman. Lab Manual in Biochemistry.

## **BMB-05 FUNDAMENTALS OF MOLECULAR BIOLOGY**

Min. passmarks: 18

Duration: 3 hours

Max. Marks: 50

**Note:** Attempt any five questions, taking at least one question from each unit. Each question carries equal marks.

### **UNIT-I**

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology: linking number, topoisomerases Organization of genetic material in prokaryotes and eukaryotes. Concept of gene. Evidence for the role of DNA and RNA as the genetic material.

### **UNIT-II**

DNA replication in prokaryotes and eukaryotes: Mechanism of DNA replication: Enzymes and proteins involved in DNA replication – DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D-loop (mitochondrial),  $\Theta$  (theta) mode of replication and other accessory protein, Mismatch and excision repair Enzymes and accessory proteins involved in DNA replication, Fidelity of DNA replication and proof reading.

### **UNIT-III**

Structural features of RNA (rRNA, tRNA, mRNA). Sn- RNA and HnRNA. Transcription in Prokaryotes and Eukaryotes: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors. Post transcriptional processing: capping, tailing and splicing.

### **UNIT-IV**

Genetic code, anticodon, Wobble hypothesis. Translation in Prokaryotes and Eukaryotes. Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of

initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote.

### **UNIT-V**

Regulation of gene expression in prokaryotes: Operon concept, positive and negative regulation. Examples of lac and trp- operon. Regulation of gene expression in eukaryotes (In brief)

#### **References:**

1. Genes V by Benjamin Lewin, Oxford University Press, New York.
2. Principles of Genetics, Snustad and Simmons, Fourth Edition, John Wiley and Sons, Inc.
3. Molecular Cell Biology, Lodish et al., W. H. Freeman and Company.
4. Genomes by T.A. Brown, John Wiley and sons (Asia)PTE LTD, New York.
5. Principles of Gene Manipulation and Genomics by S.B. Primrose and R. M. Twyman, Seventh edition, Blackwell Publishing, U.K.
6. Cell and Molecular Biology concepts and experiments By Gerald Karp, Third edition, John Wiley and sons, Inc., U.S.A.
7. Molecular Biology by Friefelder, David.

### **BMB 06- BASIC IMMUNOLOGY**

Duration: 3 hrs      Max .Marks 50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

#### **UNIT I**

Concept of Innate and Adaptive immunity.

Structure, Functions and Properties of Immune Cells: Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell

Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

#### **UNIT II**

Characteristics of an antigen; Haptens, Epitopes (T & B cell epitopes), T-dependent and independent antigens, Adjuvants.

Structure, Types, Functions of antibodies: Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic).

#### **UNIT III**

Antigen–Antibody Interaction: Principles of Precipitation, Agglutination, Immunodiffusion (ODD, RID), Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry.

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules.

#### **UNIT IV**

Complement- Components and biological activities. 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.

#### **UNIT V**

Hypersensitivity – (immediate and delayed types).

Autoimmune diseases: Good pastures syndrome, Rheumatoid arthritis (RA), Multiple sclerosis, Systemic lupus erythematosus (SLE), Type 1 diabetes,, Hashimoto's thyroiditis.

Transplantation immunology.

#### **Reference Books:**

1. Essentials of Immunology, Author- Roitt, I.M., ELBS. Blackwell Scientific Publishers, London.
2. Immunology II Edition, Author- Kuby, J. WH., Freeman and Company, New York.
3. Immunology. Author- Klaus D. Elgert, Wiley-Liss. NY.
4. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes). Authors- Topley and Wilson's, Edward Arnold, London.
5. The Experimental Foundations of Modern Immunology. Authors- Clark, V.R., John Wiley and Sons, Incl.
6. Fundamental Immunology. Author – W.E. Paul, Raven Press, New York.
7. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard. 2<sup>nd</sup> ed. C. Brown publishers.

## PRACTICALS

### BMB – 07 PRINCIPLES OF MICROBIOLOGY + CELL BIOLOGY AND MICROBIAL GENETICS

Max. Marks– 50

Min Marks – 18

1. Microbiology Good Laboratory Practices
2. Principles, working knowledge of Instruments like Autoclave, pH meter, Incubator, Hot air oven, Centrifuge, Microscope, Refrigerator, Colony counter,
3. Laminar Air Flow. BOD incubator used in the microbiology laboratory.
4. Cleaning and sterilization of glasswares.
5. Measurement of microorganisms.
6. Preparation of culture media: PDA, BG-11, Nutrient Agar.
7. Preparation of stains.
8. Motility of bacteria by Hanging drop method.
9. Staining procedures I- Simple staining –Negative staining.
10. Staining procedures II- Differential staining - Gram Staining and Acid Fast Staining.
11. Staining procedures III- Special / Structural staining -Capsule staining, Endospore staining.
12. Sterilization of medium using Autoclave and assessment for sterility.
13. Sterilization of glassware using Hot Air Oven and assessment for sterility.
14. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
15. Study of *Rhizopus*, *Penicillium*, *Aspergillus*, *Saccharomyces* using temporary mounts.
16. Mitosis in onion root tip
17. Identification of giant chromosome in chironomous larvae
18. Cell Counting and viability
19. Blood Smear Preparation.
20. Separation of cell organelles by sucrose gradient.
21. Preparation and study of various stages of mitosis and meiosis.
22. Isolation of plasmid DNA from bacteria.
23. Preparation of competent.
24. Restriction enzyme digestions and its analysis by gel electrophoresis.

25. U.V. Induced Mutagenesis.
26. Bacterial transformation by CaCl<sub>2</sub> method)
27. Transduction in *E. coli*.
28. Conjugation in *E. coli*.

## **PRACTICALS**

### **BMB – 08 BIOLOGY AND DIVERSITY OF MICROBES + FUNDAMENTALS OF BIOCHEMISTRY**

Max. Marks – 50

Min Marks – 18

1. Study of *Rhizopus*, *Penicillium*, *Aspergillus*, *Saccharomyces* using temporary mounts.
2. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary mounts
3. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.
4. Analysis of Sugars
  - a) Monosaccharide-Glucose, Fructose, Galactose, Mannose, Pentose.
  - b) Disaccharides-Sucrose, Maltose and Lactose.
  - c) Polysaccharides-Starch and Dextrin.
5. Analysis of Amino Acids
6. Lipid Analysis [Group Experiments]
  - a) Determination of Saponification number.
  - b) Determination of Acid number.
  - c) Determination of Iodine number
7. Demonstration Experiments
  - a) Separation of amino acids by TLC.

### **PRACTICALS BMB – 09 FUNDAMENTALS OF MOLECULAR BIOLOGY + BASIC IMMUNOLOGY**

Max. Marks – 50

Min Marks – 18

1. Preparation of genomic DNA from bacteria.
2. Isolation of genomic DNA from Blood.
3. Quantitation of DNA by spectrophotometry.
4. Isolation of plasmid DNA from bacteria.
5. Restriction enzyme digestions and its analysis by gel electrophoresis.

6. Identification of human blood groups.
7. Perform Total Leukocyte Count of the given blood sample.
8. Perform Differential Leukocyte Count of the given blood sample.
9. Separate serum from the blood sample (demonstration).
10. Perform immunodiffusion by Ouchterlony method.
11. Perform DOT ELISA.
12. Perform immunoelectrophoresis



## **B.Sc. Microbiology Part-II Exam.-2020**

### **BMB 10- Microbial Ecology**

Duration :3hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

#### **UNIT-I**

Ecology - Development of ecology as a science, its significance and the history and development of microbial ecology. Definition and concept of ecology. Scope of ecology. Autecology and synecology. Ecosystems, components of ecosystems, levels of organizations, trophic levels, food chains, food webs, ecological pyramids and energetics.

#### **UNIT-II**

Biogeochemical Aspects of microbial ecology: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle, Sulphur oxidation, sulphur reduction. Other elemental cycles: Iron and manganese.

#### **UNIT-III**

Micro organisms and their natural habitats:

Terrestrial environment - Soil, physical and chemical properties of soil, Humus and humification. Aquatic Environment: Microflora of fresh water and marine habitats.

Atmosphere: Aeromicroflora and dispersal of microbes. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

#### **UNIT-IV**

Micro organisms and their natural habitats:

Aquatic environment - Fresh and marine water microflora, eutrophication, biomagnifications.

Atmospheric environment - Aero microflora, droplet nuclei, biofilms.

Extreme environment - Habitats and microbes: Thermophiles, barophiles, halophiles, osmophiles, acidophiles.

## UNIT-V

Biological interaction:

Microbe - Microbe interaction - Symbiosis, synergism, neutralism, commensalism, mutualism, amensalism, competition, parasitism, predation. Microbe Plant interaction – Symbiotic and non symbiotic, introduction of biological nitrogen fixation

Microbe - Animal interaction - Rumen micro biology: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.

### References:

1. Alexander, M. 1997. Introduction to soil Microbiology. John Wiley and sons Inc., New York.
2. Environmental microbiology: principles and applications by Patrick K. Jjemba. Science publisher, 2004.
3. Environmental microbiology by P. D. Sharma, Alpha Sciences international, 2005.
4. Environmental microbiology by Ian Papper and Charles Gerba, Elsevir Press.
5. Environmental microbiology by Rose Environmental microbiology Vol III-IV, 1999
6. Atlas R M and Bartha, 1993. Microbial Ecology, Bejaminn Cummings Publishing Co.Redwood City CA

## BMB 11- Microbial Physiology and Metabolism

Duration :3hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### UNIT-I

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate. Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles,extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles,xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic.

### UNIT-II

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.  
Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation.

### UNIT-III

Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle.

Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation.

### UNIT-IV

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction).

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

### UNIT-V

Introduction to aerobic and anaerobic chemolithotrophy with an example of each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction).

Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria

Ammonia assimilation. Assimilatory nitrate reduction.

### References:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India.
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

## BMB-12-Medical Microbiology

Duration :3hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### UNIT- I

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin,throat, gastrointestinal tract, urogenital tract. Host pathogen interaction,Infection and

disease- Types of infections, Various sources of Infection, Carriers of infection. Definitions of MID, ID50, MLD, LD50, bacteremia, Septicemia, contagious epidemic, endemic, pandemic, sporadic and prosodesmic diseases. Epizootic and enzootic.

#### **UNIT-II**

Bacterial diseases: Causative agents, Symptoms, mode of transmission, prophylaxis and control:

Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*. Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*. Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*, *Treponema pallidum*.

#### **UNIT-III**

Viral diseases: Causative agents, Symptoms, mode of transmission, prophylaxis and control: Polio, Hepatitis, Small pox, Chicken pox, Mumps, AIDS

Protozoan diseases: Causative agents, Symptoms, mode of transmission, prophylaxis and control: Malaria, Kala-azar.

#### **UNIT-IV**

Fungal diseases: Causative agent, transmission, symptoms and prevention:

Cutaneous mycoses: Tinea pedis (Athlete's foot).

Opportunistic mycoses: Candidiasis.

#### **UNIT-V**

Diseases of human beings-II: Diagnosis, symptoms, toxic components, etiology and disease  
Sample collection, transport and diagnosis: Collection, transport and culturing of clinical samples.

Antimicrobial agents: Modes of action with one example of each Antibacterial agents, Antifungal agents, Antiviral agents

#### **References:**

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

## **BMB-13 Genetic Engineering and r-DNA Technology**

Duration :3hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### **UNIT- I**

Introduction of genetic engineering. Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern- blotting techniques, dot blot, SDS-PAGE and Western blotting.

DNA modifying enzymes and their applications: restriction enzymes, DNA polymerases. Terminal deoxynucleotidy ltransferase, kinases & phosphatases, and DNA ligases.

### **UNIT-II**

Polymerase chain reaction. C-DNA synthesis and cloning: mRNA enrichment, reverse transcription, Linkers, adapters, blunt end ligation, homopolymer tailing. Genomic and cDNA libraries: Preparation and uses, Genome sequencing.

DNA Sequencing: traditional and automated sequencing.

### **UNIT-III**

Cloning Vectors: Plasmid vectors (pBR and pUC), Bacteriophage (Lambda and M13), Cosmids, BACs, YACs. Cloning and expression of foreign genes in prokaryotes (*E.coli*). Cloning and expression of foreign genes in eukaryotes (eg. yeast). Gene tagging.

### **UNIT-IV**

Gene transfer-microinjection, electroporation, microprojectile, shot gun method ultra - sonication, Liposome fusion, microlasers. Use of *Agrobacterium tumefaciens* and *A.rhizogenes*, Ti plasmids,Application of molecular cloning.

### **UNIT-V**

Products of recombinant DNA technology: Products of human therapeutic interest (insulin, hGH), antisense molecules, recombinant vaccines. Gene therapy.

Transgenic plants: Bt transgenic (cotton, brinjal), flavosavr tomato, golden rice.

Protein engineering. Transgenic animals (cow, sheep, poultry, fish).

## References:

1. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
2. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford,
3. Brown TA. (2007). Genomes-3. Garland Science Publishers.
4. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of Genetically Modified Crops. WileyDreamtech India.
5. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and application of recombinant DNA. ASM Press.
6. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulation(6th Ed.). Black well publishers.
7. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen, K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
8. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific Publications.

## BMB-14 Food & Dairy Microbiology

Duration :3hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### UNIT- I

Food as a substrate for microorganisms Microbial flora of foods: Milk, fruits, vegetables, meat, eggs , Factors affecting kinds and numbers of microorganisms, intrinsic and extrinsic factors, Sources of contamination.

### UNIT- II

Food poisoning, Microorganisms involved, sources of contamination, Role of *Staphylococcus aureus*, *Clostridium botulinum* and *Salmonellaspp.*.Molds as poisoning agents.  
Microbial Spoilage of food,Causes of spoilage, Biochemical changes caused by microbes.

### UNIT-III

Spoilage of milk and milk products, fruits, vegetables, eggs, meat. Spoilage of canned foods  
Preservation of food and Milk: General principles and Methods of preservation: Physical methods - high temperature, low temperature, irradiation, aseptic packaging.  
Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite.  
Food sanitation and control – HACCP.

#### **UNIT- IV**

Microbes as Food and Food Products: Fermented dairy products, Starter culture, Cheese: Types, curdling, processing, ripening, Other fermented dairy products (yogurt, acidophilus milk, kefir). Introduction to probiotics, prebiotics and synbiotics. Indian fermented food products: Pickles, idli, Khaman and bread .

#### **UNIT- V**

Microbes as food: Mushrooms, spirulina and yeasts in food microbiology. Biological methods: Generalized scheme for microbiological examination, Direct microscopic examination, Most probable number (MPN), Bacteriological analysis of milk. Microbiological criteria of food safety.

#### **Text Books:**

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986), *Microbiology: An Application Based Approach*, 5th edn. McGraw-Hill Book Company, NY
2. Frazier W C and Westhoff D C (1988), *Food Microbiology*, 4th edn. McGraw-Hill Book Company, NY.
3. Prescott L, Harley J P, and Klein D A, (2008), *Microbiology*, 7th edn. WmC. Brown-McGraw Hill, Dubuque, IA.

### **BMB 15- Environmental Microbiology**

Duration :3hrs

Max .Marks50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

#### **UNIT-I**

Introduction : Definition, history and development, aim and scope of aerobiology. Microbes and atmosphere : Atmospheric layers, sources of microorganisms, Air spora of indoor and outdoor environment, factors affecting air spora, significance of air-borne microbes, management of air-borne microbes. Microbiological sampling of air.

#### **UNIT-II**

Aquatic environment, distribution of microorganisms in aquatic environment – fresh water, estuarine and marine water systems. Factors influencing growth and distributions. Water Purification procedures for single dwelling and municipal water supplies,

Concept of indicator organisms, Microbiological examination of water. BOD, COD, Waste water treatment steps and methods. Eutrophication and algal bloom.

### **UNIT -III**

Pollution of air, water and land with reference to their causes, nature of pollutions, impact and control strategies environmental damage by agriculture, perspectives of pollution in urban, industrial and rural areas. Habitat Pollution by Chlorinated Hydrocarbons (DDT, PCBs, Dioxin etc), Organophosphates, Heavy Metals, Die-offs, Endocrine disrupting chemicals.

### **UNIT-IV**

Bioremediation. Biodegradation of paints, rubber, wood, products and plastics. Degradation of pesticides and other toxic chemicals by microbes Biopesticides Enrichment of ores by microorganisms (Bioaccumulation and Biomineralisation).

### **UNIT-V**

Environmental Laws, national movements, sustainable development, environmental policies, environmental economics, environmental ethics – holistic approach of environmental protection and conservation, IUCN – role in environmental protection. Concept with reference to UN – declaration, aim and objectives of human right policies with reference to India, recent north-south debate on the priorities of implementation, Environmental Protection Agency (EPA).

### **References:**

1. Environmental microbiology: principles and applications by Patrick K. Jjemba. Science publisher, 2004.
2. Environmental microbiology by P. D. Sharma, Alpha Sciences international, 2005.
3. Environmental microbiology by Ian Papper and Charles Gerba, Elsevir Press.
4. Environmental microbiology by Rose Environmental microbiology Vol III-IV, 1999

### **PRACTICALS**

#### **BMB16-Microbial Ecology & Microbial Physiology and Metabolism**

1. To study the bacterial ecology in fresh water environment
2. To study the microbial diversity of soil.
3. To study the microbial ecology of the rhizosphere and determination of rhizospheric effect.
4. Demonstration of nitrate reduction
5. Demonstration of decarboxylation of amino acid.



6. Isolation of photosynthetic bacteria by column method
7. To study and plot the growth curve of *E. coli* using turbidometric method and to calculate specific growth rate and generation time.
8. To study and plot the growth curve of *Aspergillusniger* by radial growth measurements.
9. To study the effect of pH on the growth of *E. coli*
10. To study the effect of temperature of *Aspergillusniger* by dry weight method.
11. Demonstration of the thermal death time and decimal reduction time of *E. coli*.
12. Demonstration of alcoholic fermentation.
13. Effect of different nitrogen sources on growth of *E. coli*.
14. Effect of different carbon sources on growth of *E. coli*.

## **PRACTICALS**

### **BMB17- Medical Microbiology &Genetic Engineering and r-DNA Technology**

1. Identify bacteria, *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus* (any three) on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests.
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
3. Study of bacterial flora of skin by swab method.
4. Perform antibacterial sensitivity by Kirby-Bauer method.
5. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes,
  - a. chicken pox, AIDS, dermatomycoses (ring worms).
6. Study of various stages of Malarial parasite in RBCs using permanent mounts/Photomicrographs.
7. .Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
8. Ligation in DNA fragments.
9. Selection of recombinants by selectable markers.
5. Polymerase chain reaction (PCR).
6. Agarose Gel Electrophoresis
7. SDS-PAGE
8. Demonstration of RAPD.
9. Isolation of RNA.
10. Demonstration of Southern blotting.

## **PRACTICALS**

### **BMB 18-Food & Dairy Microbiology&Environmental Microbiology**

1. Microbiological analysis of food
  - A. Standard plate count of food sample
  - B. Determination of MPN of coliforms
2. Microbiological analysis of milk
  - A. Standard plate count of milk sample

B. Determination of microbial load of milk by use of MBRT of raw milk, boiled milk and pasteurized milk

3. Detection of acid-fast organisms in milk sample.
4. To determine the microbial biomass from different natural habitats.
5. Determination of dissolved oxygen of water.
6. Determination of BOD of water (raw/ treated).
7. Determination of COD of water (raw/ treated).
8. Demonstration of biological treatment.

**B.Sc. Microbiology Pt-III Examination**

	<b>Lec Hrs/week</b>	<b>Exam hrs.</b>	<b>Max Marks</b>
<b>Core paper (Theory)</b>			
BMB – 19 Biosafety & IPR	3	3	50
BMB – 20 Soil and Agriculture Microbiology	3	3	50
BMB – 21 Tools and Techniques in Microbiology	3	3	50
BMB – 22 Computer Applications & Biostatistics	3	3	50
BMB – 23 Biophysics and Instrumentation	3	3	50
BMB – 24 Industrial Microbiology	3	3	50
<b>Total of Theory Papers</b>			<b>300</b>
<b>Core Paper (Practicals)</b>			
BMB –25 Biosafety & IPR + Soil and Agriculture Microbiology		3	50
BMB –26 Tools and Techniques in Microbiology+ Computer Applications and Biostatistics		3	50
BMB –27 Biophysics and Instrumentation+ Industrial Microbiology		3	50
<b>Total of Practical Papers</b>			<b>150</b>
<b>Grand Total (Theory+ Practicals)</b>			<b>450</b>

# **BMB-19 Biosafety And Intellectual Property Rights (IPR)**

Duration : 3 hrs

Max .Marks 50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

## **Unit I**

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.

## **Unit II**

Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication;

## **Unit III**

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

## **Unit IV**

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

## **Unit V**

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

### **References:**

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

## **BMB-20-Soil and Agriculture Microbiology**

Duration : 3 hrs

Max .Marks 50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### **UNIT-I**

Soil-definition, types and physical and chemical properties, soil profile, classification of soil, soil profile, soil microflora and soil as a natural habitat for micro organisms. Soil formation, Lithification. Decomposition of organic matter by microorganisms - cellulose, hemicellulose, lignin and pectin.

### **UNIT -II**

Biological nitrogen fixation (BNF): Nitrification, denitrification; symbiotic nitrogen fixation (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum); Nitrogenase enzyme, nif genes and molecular mechanism of nitrogen fixation. Genetic engineering of BNF. Biofertilizers: Definition, types- Nitrogen fixing, Phosphate solubilizing

### **UNIT -III**

Biopesticides-introduction, types, mode of action and factors influencing, target pests. Biological control: Introduction, mechanism of antagonism, amensalism, competition, predation and parasitism (mycoparasitism, nematophage, mycophagy), application of biological control on field.

#### **UNIT -IV**

Biofertilizer - types, Cultivation and mass production of bioinoculants- Azotobacter, Rhizobium, Cyanobacteria, Azolla.-Carrier-based inoculants - production and applications. PGPRs, phytoalexins, PR proteins, Transgenic approaches for crop protection.

#### **UNIT -V**

Plant pathology: Introduction : Historical developments in brief, classification of plant diseases, principles of infection and spread of diseases in general.

#### **References**

1. P.D.Sharma.2006. Plant pathology. Alpha Science International.19.
2. Sharma.P.G. 2006. Plant Pathology. Rastogi Publication.
3. Agrios G.N. (2009), Plant Pathology. 5th Ed. Academic Press.
4. Paul E.A.2007. Soil Microbiology: Ecology and Biochemistry,3Edn. Academic Press.
5. John L. Havlin et al., 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). Prentice Hall.
6. Coyne M. 1999. Soil Microbiology Delmar Cengage Learning
7. Mehrotra, Aggarwal R, Ashok.2004. Plant Pathology. 2nd Edition Tata McGraw-Hill..
8. Rangaswami . Gand D.J. Bagyaraj. (1998) Agricultural Microbiology. 2nd Ed. PHI. India.
9. Subbarao, N.S. and Dommergues, Y.R. (1998) Microbial interactions in agriculture and forestry. Science publishers.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition

#### **BMB – 21 Tools and Techniques in Microbiology**

Duration : 3 hrs

Max .Marks 50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

#### **Unit-I**

**Microscopy:** Basic idea of light microscopy, Principle, types and applications of - bright field, dark field, fluorescence and phase-contrast microscopes. Techniques in light microscopy-wet mount, hanging drop preparations.

## **Unit-II**

Electron microscope-Basic idea of structure and functioning of E.M., Preparation of material for electron microscopy, Types-TEM, SEM, Scanning probe microscope, scanning tunnel microscope, atomic force microscope.

## **Unit-III**

Principles, working and applications of- Autoclave, Laminar Airflow, Hot Air Oven, Analytical and differential pH meters.

Centrifuge: Rotors, Bench top, Low Speed, High Speed, Cooling Centrifuge, gradient centrifugation. Principles and Application of Ultracentrifugation. Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis.

## **Unit-IV**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC. Spectrophotometer: Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

## **Unit-V**

Microbiological stains and Staining techniques for light microscopy: Types of stains and principles of staining . Preparation of bacterial smears for light microscopy: Fixation, Simple staining (positive and negative), differential staining (Gram's staining and acid – fast staining), structural staining (Capsule, Flagella, Cell wall and Endospore of bacteria), nuclear staining. Wet mounting method – staining of algae and fungi. Hanging drop method.

## **References:**

1. Advances in Chromatography. Eli Grushka and Nelu Grinberg (2007). Publisher: CRC: 1st edition. ISBN-10: 1420060252, ISBN-13: 978-1420060256, Volume 46.
2. Understanding NMR Spectroscopy. James Keeler (2005). Publisher: Wiley; 1st edition ISBN-10: 0470017872, ISBN-13: 978-0470017876.27
3. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM. Ray F. Egerton (2005). Publisher: Springer; 1st ed.. ISBN-10: 0387258000, ISBN-13: 978-0387258003.
4. Fundamentals of Light Microscopy and Electronic Imaging. Douglas B. Murphy (2001). Publisher: Wiley-Liss; 1st edition ISBN-10: 047125391X, ISBN-13: 978-0471253914.
5. Principles and Techniques of Practical Biochemistry. Keith Wilson & John Walker(2000). Cambridge University Press.
6. Introduction to Spectroscopy. Donald L. Pavia, Gary M. Lampman, and George S. Kriz (2000).Publisher: Brooks Cole; 3rd edition. ISBN-10: 0030319617, ISBN-13: 978-0030319617

## **BMB – 22 Computer Applications & Biostatistics**

Duration : 3 hrs

Max.Marks 50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### **UNIT-I**

Introduction to computers – classification of computers – computer generation, software and hardware – operating systems – secondary storage media – personal, mini, main frame and super computers, their characteristics and application, BIT, BYTE, WORD, computer memory and its types; data representation and storage binary codes, binary system and its relationship to Boolean Operations.

### **UNIT-II**

Microsoft Excel – Data Entry – graphs – aggregate functions – formula and functions. Different number systems and conversions input-output devices, Types of networking- LAN, WAN and VPN, Benefits of internet.

### **UNIT-III**

Basic concepts in Statistics: Terms and Definitions in Statistics, Collection of Data, Types of variables: Continuous and discrete, Frequency Distribution, Classification of tabulation.

### **UNIT-IV**

Sample and Sampling techniques.  
Measurements of central tendency: Mean, Median, Mode  
Standard Deviation, Variance, Chi- Square test.

### **UNIT-V**

Correlation: types and methods.  
Regression analysis, multiple linear regressions.  
Standard error, Concept of Hypothesis, t-test, One way ANOVA.  
Probability: Definition and basic formula and theories.

### **Reference:**

1. Snedecar, G.W. and Cochran WG. (1967) Statistical Methods, Oxford Press.
2. Danial, W.W. (1995) : Biostatistics : A Foundation for analysis in Health Sciences (6<sup>th</sup> Ed.) John Wiley. 780pp
3. Cotton T. (1974); Statistics in Medicine, Little Brown, Boston.
4. Compbell, R.C. (1989): Statistics for Biologists, Cambridge University Press. 464 pp.



## **BMB - 23 Biophysics and Instrumentation (Theory)**

**Min. pass marks: 18**

**Duration: 3 hours**

**Max.**

**Marks: 50**

**Note:** Attempt any five questions, taking at least one question from each unit. Each question carries equal marks.

### **UNIT-I**

Bioenergetics: Energy and its various forms, principle of Thermodynamics, energy exchange, conservation of energy.

Photobiology: Nature of light, Primary photochemical reactions, Photosynthesis, flowering, Solarization, Photo dynamism, Strategies in light reception, Photoreceptor in microbes. Plants and animals.

### **UNIT-II**

Biophysics of vision, vision fault and correlations, Bioluminance.

Biophysics of sound vibration, Phono-receptor, Auditory function, Location and origin of sound, Hearing aids.

Membrane conductivity, Diffusion, Active transport, Osmosis, Diffusion pressure deficit, Biosorption, Electrical properties of biological compartments, Electrochemical gradients, membrane potentials.

### **UNIT-III**

Molecular interaction: Intra- molecular and Inter- molecular interaction, Attractive and repulsive forces operating within molecules and their overall effects on molecular interactions. Radioactivity: Nucleus. Properties. Nuclear forces. Nuclear radiations and their properties - alpha, beta and gamma. Half life, physical and biological handling and standardization of alpha and beta emitting isotopes

### **UNIT-IV**

Radioimmunoassay. Radiopharmaceuticals and their uptake. Production of radionuclides.

Radiations and their interaction with matter, Electromagnetic radiation, Raman spectra,

Nuclear magnetic Resonance Measurement of radiation - Dosimetry and detectors.

Radioactive tracer techniques, Autoradiography.

### **UNIT-V**

Principle, construction and working of – GM counter. Scintillation Counter (Solid and liquid). Elucidation of intact biological structures in living organisms: Ultrasound. Optical filters, Computerized Axial Tomography, Electrocardiography, Electro- encephalography.

### **Reference Books:**

1. Fundamentals and Techniques of Biophysics and Molecular Biology” by Pranav Kumar.
2. Biophysics: A Physiological Approach” by Patrick F Dillon.
3. Fundamental of Biophysics By , S. K. Agrawal.
4. Bioinstrumentation by Willey.

## **BMB 24- Industrial Microbiology**

Duration: 3 hrs

Max .Marks 50

Note - The paper is divided into five units. Two questions will be set from each unit. The candidates are required to attempt one question from each unit. All questions carry equal marks.

### **UNIT-I**

Brief history and developments in industrial microbiology.

Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous.

Physicochemical standards used in fermentors /Bioreactor. Components of a typical bioreactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters.

### **UNIT-II**

Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.Primary and secondary screening of industrial strains.

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates,

### **UNIT-III**

Fermentation in batch culture: Microbial growth kinetics, measurement of growth (cell number direct and indirect method) Continuous culture system, Aeration, Agitation, Oxygen transfer kinetics.Sterilization.

### **UNIT-IV**

Downstream processing: Filtration, Precipitation, cell disintegration, solvent extraction, chromatographic separation. solvent recovery, drying, crystallization.

### **UNIT-V**

Biotransformation: Development of inoculum, Industrial production of Penicillin,ethyl alcohol, acetic acid, amylase and vitamin B<sub>12</sub>, Single cell protein.

### **References:**

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2ndEdition. Panima Publishing Company, New Delhi.
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishin Company Ltd. New Delhi, India.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition.

Pearson Education.

4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9thEdition. McGraw Hill Higher education.
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

### **Practicals**

#### **BMB –25 Biosafety & IPR + Soil and Agriculture Microbiology**

Max .Marks 50

Min .Marks 18

1. Study of components and design of a BSL-III laboratory.
2. Filing applications for approval from biosafety committee (IBSC).
3. Filing primary applications for patents.
4. Study of steps of a patenting process.
5. A case study.
6. Study soil profile
7. Study microflora of different types of soils.
8. Isolation and identification of fungi from soil.
9. Isolation and enumeration of bacteria from soil by serial dilution method
10. Rhizobium as soil inoculants characteristics and field application
11. Azotobacter as soil inoculants characteristics and field application
12. Design and functioning of a biogas plant
13. Isolation of cellulose degrading organisms
14. Study of VAM.
15. Study of the plant diseases: Gram staining of citrus canker specimen and mounting of fungal specimens

### **Practicals**

#### **BMB –26 Tools and Techniques in Microbiology+ Computer Applications and Biostatistics**

Max .Marks 50

Min .Marks 18

1. Study of organization and working of microscopes.
2. Optical Microscopes : dissecting and compound
3. Exposure to organization and working of phase contrast microscope and electron microscopes.

4. Sterilization of glassware and media (use of autoclave). Aseptic transfer.
5. Study and use of micro analytical techniques.
6. Separation of sub- cellular organelles (use of centrifuge and other techniques)
7. Separation of cell organelles by sucrose gradient.
8. Electrophoresis : SDS – PAGE
9. Thin layer chromatography
10. Paper chromatography : circular and vertical
11. Visit to microbiological laboratory for exposure of various advanced tools and techniques.
12. Creating charts in excel using different data.
13. Design a worksheet for numeric entries and perform required calculation.
14. Design a worksheet enter required data and perform aggregate function like sum, average, count etc.
15. Perform segremic analysis and calculate future value.
16. Changing settings of keyboard, mouse and display.
17. Perform file operation like copy, save, rename, delete using window explore.
18. Calculate mean, mode and median
19. Calculate correlation & regression.

### **Practicals**

#### **BMB –27 Biophysics and Instrumentation+ Industrial Microbiology**

Max .Marks 50

Min .Marks 18

1. Principles and application of instruments:
  - a. pH meters (digital).
  - b. Light and phase contrast microscope.
  - c. Colorimeter.
  - d. Spectrophotometer (Visible and UV).
  - e. Sound level meter.
  - f. Audiometer.
  - g. GM counter and Scintillation counter
  - h. Incubator
  - i. Shaker
  - j. Laminar flow bench
  - k. Hearing aids
2. Microbial fermentation for the production and estimation of amylase.
3. Microbial fermentation for the production and estimation of citric acid.
4. Microbial fermentation for the production and estimation of ethanol.
5. Culturing of Spirulina / Chlorella.
6. Fermenter design and components.

