

B.Sc. INDUSTRIAL MICROBIOLOGY
Revised Scheme of Examination (w.e.f. 2011-2012)
(Based on the Kurukshetra university notification)

B.Sc.-I				
Paper No.	Nomenclature	Max. Marks	(Ext. + Int.)	Hours
Semester-I				
IMB Paper - 101	Fundamentals of Industrial Microbiology	50	(40+10)	3 hrs
IMB Paper - 102	Microbial Biochemistry	50	(40+10)	3 hrs
Paper-III	Practical (Continued)			
Semester-II				
IMB Paper-201	Basic Microbial Techniques	50	(40+10)	3 hrs
IMB Paper-202	Microbial Genetics	50	(40+10)	3 hrs
IMB Paper-203	Practical (based on theory papers of I & II nd semesters)	100		6 hrs
Total		300		
B.Sc.-II				
Semester-III				
IMB Paper-301	Microbial Physiology	50	(40+10)	3 hrs
IMB Paper-302	Environmental Microbiology-I	50	(40+10)	3 hrs
Paper-III	Practical (Continued)			
Semester-IV				
IMB Paper-401	Food Microbiology	50	(40+10)	3 hrs
IMB Paper-402	Environmental Microbiology-II	50	(40+10)	3 hrs
IMB Paper-403	Practical (based on theory papers of III rd & IV th semesters)	100		6 hrs
Total		300		
Job Summer Training (One Month) in an Institute/Industry (Summer Vacations)				
B.Sc.-III				
Semester-V				
IMB Paper-501	Agricultural Microbiology	50	(40+10)	3 hrs
IMB Paper-502	Fermentation Technology	50	(40+10)	3 hrs
Paper-III	Practical (Continued)			
Semester-VI				
IMB Paper-601	Microbial Biofertilizer	50	(40+10)	3 hrs
IMB Paper-602	Microbial Biotechnology	50	(40+10)	3 hrs
IMB Paper-603	Practical (based on theory papers of V th & VI th semester)	70		6 hrs
IMB Paper-604	Evaluation & Viva-voce of 'job summer training' report	30		
Total		300		
Grand Total		900		

Practical Examinations will be held at the end of Semesters II, IV & VI

B.SC Ist SEMESTER (INDUSTRIAL MICROBIOLOGY)

IMB-101 FUNDAMENTALS OF INDUSTRIAL MICROBIOLOGY

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Scope and historical development in Microbiology

Introduction, scope and historical development of microbiology (discovery era, transition period, golden age and microbiology in the twenty first century). Applied branches of Microbiology and industrial importance of microorganisms in various industries.

UNIT-II

Biology of microorganisms

Morphology and characteristics of various groups of prokaryotic and eukaryotic microorganisms (Bacteria, Archaea, Fungi, Viruses, Protozoa and Algae). Carl Woese three Domain system of classification. Simple and differentiating staining of bacteria (simple, Gram, endospore, capsule, flagella and negative) and fungi (molds and yeast).

UNIT- III

Fundamentals of nutrition and culture techniques

Nutritional requirements and nutritional types of microorganisms. Aseptic techniques and isolation of pure cultures (Pour plate, spread plate, streak plate, and serial dilution agar plate method).

UNIT-IV

Culture media and preservation of cultures

Sterilization techniques used in industrial microbiology (physical and chemical). Culture media-Preparation and types. Maintenance and Preservation of pure cultures, Sources of obtaining cultures of industrial importance.

Text and Reference Books:

- Aneja, K.R. *et al.*: A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi.
- Patel, A.H.: Industrial Microbiology. McMillan India.
- Tauro, Yadav & Kapoor. : Microbiology. New Age International Publishers, New Delhi.
- Aneja, K.R.: Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers, New Delhi.

B.SC Ist SEMESTER (INDUSTRIAL MICROBIOLOGY)

IBM-102 MICROBIAL BIOCHEMISTRY

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Cell and its macromolecules:-Cellular organization of prokaryotes & eukaryotes and their macromolecules.

Water: -Structure, hydrogen bonding, solvent properties, ionization and fitness of the aqueous environment for living organisms.

UNIT-II

Carbohydrates:-Classification, physical and Chemical Properties of Carbohydrates, Structure and properties of Starch, Cellulose, Glycogen.

Lipids: - Classification, structure and functions. Physical and chemical properties of lipids.

Nucleic acids: - Structure, types and functions of DNA & RNA

UNIT-III

Amino acids and proteins

Classification, Structure and properties of amino acids. Henderson and Hesselbalch Equation for Ionization of amino acids and Zwitter Ionic Property. Classification, structure and properties of proteins.

UNIT-IV

Enzymes

Classification, coenzymes, cofactor, isozymes. Thermodynamics explanation of enzyme catalysis, reaction orders. Derivation of Michaelis Menton kinetic equation. Competitive, uncompetitive and noncompetitive inhibition.

Text and Reference Books:

- Jain, J.L.: General Biochemistry- S. Chand & Co.
- Nelson, David L. & Cox, Michael M.: Lehninger : Principles of Biochemistry, Freeman, W.H. and company.
- Powar, C.B. & Dagainawala, H.F.: General Microbiology vol.-I, Himalaya Publishing House, Bombay.
- Satyanarayan, U.: Biochemistry- Books & allied Pvt.Ltd.

B.SC IInd SEMESTER (INDUSTRIAL MICROBIOLOGY)

IBM- 201 BASIC MICROBIAL TECHNIQUES

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT -I

Microscopy & Micrometry

Simple Microscopy, Dark Field Microscopy, Phase Contrast Microscopy, Fluorescence and Electron Microscopy (TEM and SEM).

Calibration of ocular micrometer and measurement of microorganisms. Isolation & cultivation of microorganisms.

UNIT-II

Chromatography Techniques

Paper Chromatography, Thin Layer Chromatography, Column Chromatography. Types of Chromatography- Adsorption, Partition, Gas liquid Chromatography, Gel permeation, Ion exchange and Affinity Chromatography. Gel-electrophoresis.

UNIT- III

Instruments -Basic Principles and Usage

pH-Meter- Basic Principle, working and application.

Colorimetry, Spectrophotometry- Basic Principle, laws of absorption and absorption spectrum. The chromophore concept. The instrumentation of UV, visible and infrared spectrophotometry and its application.

Centrifugation- relative Centrifugation force, instrumentation and its application.

UNIT-IV

Fermentation and fermentor

Concept of fermentation and discovery of fermentation. Fermentor-its parts & function. Types of fermentor-batch, continuous and fed batch.

Text and Reference Books:

- Aneja, K.R. : Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Publishers, New Delhi
- Kathleen P.T& Arthur T. :Foundations in Microbiology. Basic Principles. McGraw Hill.
- Sawhney, S.K. & Singh, Randhir. : Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
- Welson and Goulding.: Tools and techniques in Biology

B.SC IInd SEMESTER (INDUSTRIAL MICROBIOLOGY)

IBM- 202 MICROBIAL GENETICS

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Nucleic acids: - DNA as genetic material, structure of DNA. Watson & Crick model of DNA. Conformational flexibility of DNA, DNA replication (conservative and semi conservative).

UNIT-II

Gene expression and regulation in prokaryotes: -The genetic code and its characteristics. Central dogma, transcription, translation and protein synthesis. Inhibitors of protein synthesis. Operon concept, inducible and repressible system. Lac operon, its positive and negative regulation.

UNIT- III

Mutation: -Molecular mechanism of mutation, forward and reverse mutation, transition, transversion, chemical induced, radiations and base analogues. Mutation frequency. Application of mutation, Auxotroph, Prototroph, Ames test & replica plating technique.

UNIT-IV

Genetic Recombination and extra-chromosomal inheritance

Transformation, Transduction and Conjugation. Concept of recombinant DNA technology and its application. Plasmids, Cosmids, Transposons, Overlapping genes, split genes, exon and introns in brief. Concept of genetic recombination.

Text and Reference Books:

- Dubey, R.C. & Maheshwari.: A Text book of Microbiology. S. Chand & Co.
- Gardner E.J., Simmons, M.J. & Snustard, D.P.: Principles of Genetics, John Wiley & Sons. Inc.
- Klug, W.S. & Cummings, M.R.: Concepts of Genetics, Prentice Hall International Inc.
- Powar, C.B. & Dagainawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay

List of practicals based on theory papers (IMB 101, 102, 201, 202) of Semesters Ist and IInd**SEMESTER-I**

1. Laboratory rules.
2. Principle, Construction and working of Microscope Autoclave, Oven, Incubator (Ordinary and B.O.D), Laminar air flow Hood. Water bath. Quebec colony counter.
3. Preparation of culture media: Nutrient agar, Potato dextrose agar, Czapek-Dox agar.
4. Preparation of agar plates, agar slants and deep tubes.
5. Study of
 - (a) Pour plate.
 - (b) Spread plate.
 - (c) Streak plate.
6. Standard plate count
7. Staining techniques: -
 - (a) Preparation of bacterial smear
 - (b) Simple staining
 - (c) Gram staining
 - (d) Negative staining
 - (e) Endospore staining.
8. Staining and examination of common molds and yeasts of industrial significance.
9. Staining and examination of Cyanobacteria or algae from fresh water.
10. Examination of a protozoan.

SEMESTER –II

- 1 Separation of amino acids by paper chromatography
- 2 Separation of amino acids and lipids by thin layer chromatography
- 3 Measurement of pH of fruit juice/Soil.
4. Carbohydrate estimation by colorimeter.
5. Protein estimation by colorimeter by Folin-ciocalteu reagent.
6. Estimation of DNA.
7. Estimation of RNA.
8. Calibration of an ocular micrometer.
9. Measurement of size of a cell/conidium/spore.

B.SC IIIrd SEMESTER (INDUSTRIAL MICROBIOLOGY)

IMB 301-MICROBIAL PHYSIOLOGY

Max. Marks: 50
(Ext.40+Int.-10)
Time: 3 Hours

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT- I

Microbial Growth:-Definition of growth, Mathematical nature and expression of growth, Generation time, Growth curve in bacteria, Measurement of Growth (cell number, cell mass and cell constituent), Effect of environment on the microbial growth, (temperature, pH and oxygen).

UNIT-II

Membrane Transport Process:-Different models of cell membrane, Biochemical properties of cell membrane, Functions of cell membrane, Types of cellular transport (diffusion, gaseous exchange, osmosis, plasmolysis, active & passive transport, group translocation).

UNIT-III

Bacterial Photosynthesis:-Classification of photosynthetic bacteria (Oxygenic & anoxygenic photosynthetic bacteria), Photosynthetic structure, Photosynthetic pigments, Photosynthetic electron transport system, Mechanism of Photosynthesis (Cyclic & Non cyclic).

UNIT-IV

Metabolic Pathways:-Respiratory Pathways (Glycolysis, Entner Daudoroff pathway, Pentose phosphate pathway, Krebs cycle), Calvin cycle, Substrate level & oxidative phosphorylation, Fermentation process & products.

Text & Reference Books :

- Text book of Pawar & Dagainawala: General Microbiology :Vol-I
- Purohit: Microbiology: Fundamentals & applications
- Pelczar, Reid & Chan.: Microbiology
- Lehninger: Principles of Biochemistry
- Moat & Foster: Microbial physiology & Metabolism
- Dubey & Maheshwari: A Text book of Microbiology

B.SC IIIrd SEMESTER (INDUSTRIAL MICROBIOLOGY)

IMB 302-ENVIRONMENTAL MICROBIOLOGY

Max. Marks: 50
(Ext.-40+Int.-10)
Time: 3 Hours

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Soil Microbiology:

Major contributions of soil microbiologists, Soil as dynamic ecosystem & Diversity of soil micro flora, Microbial flora of soil, Interaction among soil microorganisms (Neutralism, commensalism, mutualism, antagonism, competition, parasitism and predation),

UNIT-II

Biogeochemical cycles:

Factors affecting soil microflora (moisture, oxygen, pH, temperature), Biogeochemical cycles (carbon, nitrogen, sulphur, phosphorus, oxygen cycle).

UNIT-III

Air Microbiology:

Sampling of air micro flora, Biodiversity in Air, Out door and indoor microflora, Allergic disorders by air microflora, Enumeration of microflora of air (Liquid and solid impingement devices).

UNIT-IV

Water Microbiology:

Types of water (atmospheric, surface & stored), Effect of aquatic environment (temperature, light, pressure, pH, turbidity & inorganic and organic constituents), Biodiversity of aquatic environments (freshwater & marine microbiology).

Text & Reference Books:

- Aneja, K.R. *et al.*: A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi.
- Atlas, R.M. & Bartha, R.: Microbial ecology- Fundamentals & applications, Benjamin/Cummings
- Coyne, M.S. : Soil microbiology : An Exploratory Approach, Delimer

B.SC 1Vth SEMESTER (INDUSTRIAL MICROBIOLOGY)

IMB 401 FOOD MICROBIOLOGY

Max. Marks: 50
(Ext.40+Int.-10)
Time: 3 Hours

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT- I

Food Spoilage:

Microbes in food, Extrinsic and intrinsic factors affecting microbial growth in foods, Microbial spoilage of foods (General account). Microbial spoilage of specific food- Milk & milk products, Fruits & vegetables, Cereals & cereal products, Meat & meat products, Canned foods.

UNIT-II

Food Microbiology:

Significance of food microflora, constituents of foods, classification of foods, Preservation of foods, Aseptic handling, Use of temperature, dehydration, lyophilization, osmotic pressure, radiations canning, chemical preservatives

UNIT-III

Food Borne Diseases:

Food poisoning (Food intoxication & food infections), Bacterial food poisonings (Botulism, *Staphylococcus* & *E.coli.*), Fungal food poisonings (*Aspergillus*, *Penicillium* & *Claviceps*).

UNIT-IV

Microbiological Production of Food:

Fermented dairy products (yoghurt, butter milk & cheese), Fermented bakery products (bread), Fermented beverages (beer and wine), Single cell proteins, Probiotics & Prebiotics

Text & Reference Books:

- Aneja, K.R. *et al.*: A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi.
- Frazier: Food Microbiology
- Adams & Moss: Food Microbiology
- James Jay : Food Microbiology

B.SC IVth SEMESTER (INDUSTRIAL MICROBIOLOGY)

IMB 402 ENVIRONMENTAL MICROBIOLOGY II

Max. Marks: 50
(Ext.40+Int.-10)
Time: 3 Hours

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Microbiology of Domestic & Waste water:

Sewage/ waste water (physical, chemical & microbiological characteristics) BOD and COD, Water treatment (primary treatment, secondary treatment, tertiary treatment, water purification methods).

UNIT-II

Water and disease transmission

Water pollution, Brief account of water borne diseases, Water quality assays and public health (Standard plate count, most probable number procedure, membrane filter method), Coliforms as indicator organisms.

UNIT-III

Solid waste disposal:

Solid processing (landfills, composting & anaerobic sludge digestion), effect on public health and microbial pathogens in municipal solid waste, Green house gases.

UNIT-IV

Biodegradation of Environmental pollutants:

Alkyl benzyl sulphonates, Oil pollution, Regulation for disposal of biohazardous materials

Text & Reference Books:

- Aneja, K.R. *et al.*: A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi.
- Atlas, R.M. & Bartha, R.: Microbial ecology Fundamentals & applications, Benjamin/Cummings.
- Coyne, M.S. : Soil microbiology : An Exploratory Approach, Delimer.

List of practicals based on theory papers (IMB 301, 302, 401, 402) of Semesters IIIrd and IVth

SEMESTER-III

1. Determination of bacterial and fungal growths.
2. Effects of temperature on the growth of bacteria (TDP & TDT)
3. Effect of pH on growth of bacteria .
4. Effect of atmospheric oxygen (air) on growth of bacteria.
5. Isolation and enumeration of microorganisms from soil by different techniques.
6. Isolation of *Azotobacter* from soil.
7. Study of indoor and outdoor microflora.
8. Isolation of microorganisms from water.

SEMESTER - IV

1. Isolation and Identification of Microorganisms from spoiled foods (Bread, fruits, meat & cake).
2. To study Litmus milk reactions.
3. Methylene blue reductase test.
4. Isolation of *Lactobacilli* and *Streptococci* from curd.
5. Wine and sauerkraut production in the Lab.
6. Detection of coliforms in water by multiple tubes fermentation test (Presumptive, confirmed completed test).
7. IMVIC test for faecal bacteria.
8. Determination of BOD of water.
9. Determination of COD of water.

B.SC Vth SEMESTER (INDUSTRIAL MICROBIOLOGY)

IMB-501 AGRICULTURAL MICROBIOLOGY

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Development of soil microbiology emphasizing the contributions of M.W.Beijerinck and S.Winogradsky.

Diversity of soil microorganisms, Major soil borne diseases of plants and their transmission.

Fungi as saprotrophs and pattern of colonizers on a plant tissue.

UNIT-II

Biodegradation of cellulose, hemicellulose, lignin and pectin.

Biodegradation of pesticides and biodeterioration of useful products.

UNIT-III

Major types of symptoms, Koch's postulates, mode of infection, classification of plant diseases.

Disease cycle and control of following diseases caused by viruses, bacteria and fungi (White rust of crucifers, red rot of sugarcane, potato blights, citrus canker, bacterial blight of paddy and tobacco mosaic virus).

UNIT-IV

Principle of biological control, mechanism of action of biocontrol agents.

Classification and advantages of biopesticides

Major commercial biopesticides based on fungi, bacteria and viruses (in brief).

Text and Reference Books:

- Aneja, K.R. *et al.*: A Text book of Basic and Applied Microbiology, New Age International Publishers, New Delhi.
- Mehrotra, R.S.and Aggarwal, A. Plant Pathology, Tata McGrawHill, New Delhi.
- Aneja.K.R and Mehrotra R.S: Fungal Diversity & Biotechnology, New Age International Publishers, New Delhi.
- Coyne, M.Soil Microbiology; An Exploratory Approach, Delmar.
- Whipps, J.M and Lumsden, R.D. Biotechnology of Fungi for Improving Plant Growth. Cambridge University Press.
- Singh. J and Aneja, K.R. From Ethnomycology to Fungal Biotechnology. Kluwer Academic/ Plenum Publishers, USA.

B.SC Vth SEMESTER (INDUSTRIAL MICROBIOLOGY)

PAPER-502 FERMENTATION TECHNOLOGY

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

History and Scope of fermentation technology.

Industrial Microorganisms: Desirable characteristics and selection of industrial Microorganism, Isolation of suitable industrial microorganisms from natural habitat, Culture Collection Centres, Strain improvement and maintenance.

UNIT-II

Biology of industrial Microorganisms: Cell growth, Microbial growth kinetics, factors affecting growth, Basic nutrition, Primary metabolism, Secondary Metabolism, Regulation of Metabolism.

Fermentation Media: Media composition, Media sterilization, Contamination, Inoculum media, Media economics, Screening for fermentation media

UNIT-III

Fermentation system: Batch and continuous fermentation system, immobilized cell reactor system, solid state fermentation reactors.

UNIT-IV

Fermentor design: Basic design of Fermentor, Construction of bioreactors,, Requirements of aseptic operation, Aeration and mixing, Type of Fermentors stirrer tank bubble column and airlift, Instrumentation and control.

Scale up study: Product recovery, scale up of fermentation, Down-stream processing, Product development, Regulation and safety.

Text and Reference Books:

- Aneja.K.R *et al.*: A Text book of Basic and Applied Microbiology, New Age International Publishers, New Delhi.
- Aneja.K.R and Mehrotra R.S.: Fungal Diversity & Biotechnology, New Age International Publishers, New Delhi.
- Waites M.J. *et al.*: Industrial Microbiology, Blackwell Science Ltd.
- Casida L.E.: Industrial Microbiology, New Age International Publishers, New Delhi.
- Prescott and Dunn's.: Industrial Microbiology, AVI Publishing Co. USA.
- Glazer A.N and Nikaido, H.: Microbial Biotechnology, W.N. Freeman and Co.

B.SC VIth SEMESTER (INDUSTRIAL MICROBIOLOGY)

PAPER-601 MICROBIAL BIOFERTILIZERS

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Rhizosphere: Rhizosphere concept, R:S values, Mycorrhizosphere, Actinorhizae, Significance of rhizosphere microflora, Isolation of rhizosphere microflora.

UNIT-II

Biofertilizers: - General account about the microorganisms used as biofertilizers, Basic concept of nitrogen fixation process.

Mycorrhizal Biofertilizer: - Types of mycorrhizal association, taxonomy, occurrence and distribution, collection of VAM, inoculum production of VAM, phosphorus nutrition.

UNIT-III

Bacterial Biofertilizers: Taxonomy, physiology and mass cultivation of Rhizobium Frankia, Azospirillum, Azotobacter and Cyanobacteria.

UNIT-IV

Production and Quality Control in Biofertilizers: Isolation and identification of different nitrogen fixing microbes, assessment of nitrogen fixing ability of different strains under controlled and field conditions. Direct and indirect methods, culture production, storage, culture, carrier, packing, quality control, ISI standards, inoculum requirements, packing, marketing and storage and methods of application.

Text and Reference Books: -

- Alexander, M. Introduction to Soil Microbiology. Wiley, New York.
- Aneja *et al.*: A Text book of Basic and Applied Microbiology, New Age International Publishers, New Delhi.
- Sperut and Spemt.: Nitrogen Fixation

B.SC VIth SEMESTER (INDUSTRIAL MICROBIOLOGY)

PAPER-602 MICROBIAL BIOTECHNOLOGY

Max Marks: 50
(Ext. 40+ Int. 10)
Time: 03 Hrs.

INSTRUCTIONS FOR THE PAPER- SETTERS

- *Nine* questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- *Eight* questions, *two* questions from each unit (I, II, III, IV) should be set.

INSTRUCTIONS FOR THE CANDIDATES

- Candidates will be required to attempt *five* questions in all, selecting *one* question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks.

UNIT-I

Microbial Products: - Application of microbial biotechnology, production of primary and secondary metabolites of industrial significance, A brief discussion about production of industrial products such as

Fuels: Ethanol, Methane

Alcoholic beverages: Beer, Wine.

UNIT-II

Organic acids: Citric acid, Lactic acid

Antibiotics: Penicillin, Streptomycin

Amino acids: Glutamic acid, Lysine

Enzymes: Protease, Amylase and Lipases

UNIT-III

Bioconversions: A brief account of steroid biotransformation.

Microbial Foods: Single cell proteins.

Sewage waste water treatment: Technique and plants.

Biogas production

UNIT-IV

Biodegradation of xenobiotic compounds.

Microbial technology in agriculture- Bioinsecticides, Bioherbicides, Biofungicides.

Biotechnology of mushroom cultivation.

Text and Reference Books:

- Aneja.K.R *et al.*: A Text book of Basic and Applied Microbiology, New Age International Publishers, New Delhi.
- Aneja.K.R and Mehrotra R.S.: Fungal Diversity & Biotechnology, New Age International Publishers, New Delhi.
- Waites M.J. *et al.*: Industrial Microbiology, Blackwell Science Ltd.
- Casida L.E: Industrial Microbiology, New Age International Publishers, New Delhi.
- Prescott and Dunn's.: Industrial Microbiology, AVI Publishing Co. USA.
- Glazer A.N and Nikaido H.: Microbial Biotechnology, W.N. Freeman and Co.

List of practicals based on theory papers (IMB 501, 502, 601, 602) of Semesters Vth and VIth

Vth SEMESTER

1. Isolation of antibiotic producing microorganisms from soil.
2. Isolation of soil microflora (bacteria and fungi) by serial dilution agar plate method.
3. Study and identification of viral, bacterial and fungal diseases of plants.
4. Isolation of a plant pathogenic bacterium or fungus from diseased tissues.
5. Demonstration of microbial antagonism in the laboratory.
6. Demonstration of degradation of cellulose by a mold/ bacterium in the lab.
7. Study of some common molds and bacteria from soil.

VIth SEMESTER

1. Production of wine from grapes in the laboratory.
2. Demonstration of mushroom production (White button mushroom).
3. Isolation of *Azotobacter* from soil.
4. Isolation of *Rhizobium* from legume root nodules.
5. Preparation of biofertilizer from *Azotobacter* and *Rhizobium* in the laboratory.
6. Demonstration of nodulation ability of rhizobia by inoculation of the legume seeds.
7. Culturing and identification of a yeast (*Saccharomyces cerevisiae*) in the lab.
8. Demonstration of amylolytic and proteolytic activity by a mold/bacterium.
9. Production of penicillin in the laboratory.
10. Demonstration of antibiotic sensitivity test.
11. Primary screening of amylase producing bacteria from soil.