B.Sc. I

B.Sc. I: Three papers and a practical examination as follows:

Paper I: Fundamental of Industrial Microbiology	45 Marks
Papers II: Biostatistics Tools and Technology	45 Marks
Papers III: Microbial Genetics and Molecular Biology	45 Marks
Practical: Including Job Training	65 Marks
	Total: 200 Marks

PAPER I

FUNDAMENTAL OF INDUSTRIAL MICROBIOLOGY

1. General Introduction, History and Development of Microbiology

- Scope of Industrial Microbiology
- Introduction
- Discovery of Microbial world
- The experiments of Pasteur, The discovery of the anaerobic life
- The era of the discovery of antibiotics
- The physiological significance of fermentation

2. Classification, Isolation, characterization and ultra structure of microbes

- Viruses
- Bacteria: Cynobacteria, Eubacteria, Myxobacteria, Rickettsias, Spirochaites, Micoplasmas, Actinomycetes, Archaebacteria
- Algae
- Protozon
- Fungi
- Criteria of identification of microorganisms
- Methods of staining of different microbes

3. Biological and Biochemical fundamentals

- Introduction
- The microorganisms and biotechnology
- Sterilization
- Preparation of media
- Isolation methods and Staining
- Preservation of Microbes
- Serial subculture, preservation with mineral oil
- Lyophilisation
- Principles of storage of microbes at very low temperature or in liquid nitrogen
- Other methods for storage of fungi
- Over production of microbial metabolites
- Preparation of inoculation

4. Fundamental of genetics

- Introduction
- Method for the selection of mutants, direct selection methods for resistant mutants, Penicillin selection technique, replica plating technique, other technique mutant selection, conditional lethality and its use in mutant selection.
- General account about the transfer of genetic information in prokaryotes
- Scope of genetic Engineering

PRACTICAL ON PAPER I

- Preparation of media, Autoclaving and sterilization of glassware, Maintenance of culture room.
- Isolation and maintenance of microbes of different groups;
  a. Bacteria
  b. Algae
  c. Bacteriophage
  d. Fungi
- Single spore culture of *Fusarium*
- Camera Lucida drawing
- Haemocytometer
- Isolation of phytopathogens

PAPER II

BIOSTATISTICS TOOLS AND TECHNIQUES

1. Biostatistics: Basic idea of probability, distribution patterns, normal, binomial and poison distribution, sampling methods mean, mode and media, chi-square statistics analysis of variance transformation, exponential, logarithmic functions.

2. Microscopy: Light microscopy, phase contrast microscopy, florescence and electron microscopy.

3. Chromatographic and Electrophoretic techniques: Basic idea of chromatography, electrophoresis, immune-electrophoresis and iso-elctrofocussing

4. Instruments, basic principles and uses: pH meter, densietometry, fluorimetry, calorimetry, spectrophotometry, manometry, centrifugation.

5. Principal types of fermentations: Fermenter design, differences between biochemical and chemical process, Classification of biochemical reaction rate process, Operational consideration, local condition within a fermenter, fermenter confugaration, the Bach fermenter, continuous stirred rank fermenter, the tubular fermenter, the condensed bed fermenter, solid state fermenter, Computer control fermentation process. Computer hardware and software, Hardware graphics, Lotus and das, Computer application in fermentation technology. Justification and Planning

PRACTICAL ON PAPER-II

1. Biostatistics: Problems on chi-square test, Problems on mean, mode and median
2. Protein estimation by colorimeter with folin ciocoltura reagent
3. Estimation of reducing sugars by colorimeter
4. Paper chromatographic separation of amino acid and pigments by one way descending
5. Paper chromatographic separation of sugars
6. Paper chromatographic separation of organic acids
7. Measurement of pH of fruits juice by pH meter
8. Demonstration of electrophoretic separation of proteins

PAPER III

MICROBIAL GENETICS AND MOLECULAR BIOLOGY

1. **Nucleic acid:**

   DNA as a genetic material, structure of DNA, RNA, DNA replication (conservative and semi-conservative replication, conformational flexibility of DNA), Replication of Eukaryotes. The Genetic codes, central dogma, reverse transcriptase, gene transcription polymerases, transcription product of DNA, t-RNA, mRNA. Synthesis of RNA in eukaryotes and prokaryotes, Catabolite effect, Operators and repressors, post transcriptional processing of RNA.

2. **Protein Synthesis:**

   Translation and protein synthesis in eukaryotes and prokaryotes, t-RNA synthetase, activation of amino acid, inhibitors of protein synthesis. Gene expression catabolite repression, regulation of gene expression, Operon concept $_{C}$AMP, catabolite activator protein (CAP), positive and negative control and gene expression in prokaryotes, Lac operon, Britten-Davidson model of gene regulation in eukaryotes.

3. **Mutagenesis and Gene Mutations:**

   Induced mutation, molecular mechanism of mutation, forward and reverse mutation, transition-transverson, Mutation frequency, applications of mutations.

4. **Genetic recombination in bacteria:**

   Transformation, transduction, Conjugation. Use of transformation, transduction and conjugation in genetic mapping.

5. **Basic idea of extra-chromosomal genetic material:**

   Plasmids, Cosmids, Transposons, Insertion sequence, Overlapping Genes, Silent genes, Exon and Intron, Evolutionary significance of silent genes, Basic of recombinant RNA and recombinant DNA Technology.

PRACTICAL ON PAPER –III

1. Isolation of antibiotics resistant bacteria
2. Replica plate technique for isolation of mutants
3. Measurement of mutation frequency in bacteria
4. Mutant isolation by gradient plate technique
5. Isolation of DNA and RNA
7. Effect of UV light on mutation frequency in bacteria.

B.Sc. II

B.Sc. II: Three papers and a practical examination as follows:

Paper I: Microbial Biochemistry and Physiology	45 Marks
Papers II: Environmental Microbiology and Biodegradation of wastes and pollutants	45 Marks
Papers III: Agricultural Microbiology	45 Marks
Practical: Including Job Training	65 Marks
	Total: 200 Marks

PAPER I

MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY

A-Microbial Biochemistry

1. **Carbohydrates:**

   Classification of carbohydrates, optical property, chemical properties of carbohydrates, chemical structure and property of starch, cellulose, glycogens.

2. **Lipids:**

   Saturated and unsaturated fatty acids, distribution and functions of lipids in microorganisms.

   Degradation of lipids by alpha, beta and omega oxidation, lipid per-oxidation

3. **Enzymes:**

   Classification, co-enzyme, cofactor, thermodynamic oxidation of enzyme catalysis, reaction orders, Michaels-Manton equation, competitive, uncompetitive and non-competitive inhibition, isozymes, factors contributing to catalytic efficiency of enzymes.

4. **Amino acids and Proteins:**

   Structure of amino acids, ionization of amino acids and zwitter ionic property, Synthesis of peptides, properties of proteins (acid base property and solubility), Primary, secondary and tertiary structure of proteins.

5. **Oxidation and Reduction Reactions:**

   Standard redox potential, Law of Thermodynamics, entropy-enthalpy and free energy of reaction, hydrolysis of energy rich intermediates and ATP.

B- Microbial Physiology

1. **Physiological properties:**

   Diffusion, osmosis, plasmolysis, biochemical properties of membranes, passive and active transport.

2. **Photosynthesis:**

   Photosynthetic microbes, oxygenic/non-oxygenic reaction centers, photophosphorelation, Calvin cycle (dark reaction), photorespiration and its significance, effect of light, temperature, pH, CO_2 concentration on photosynthesis, measurement of net photosynthetic yield.

3. **Respiratory Pathways:**

   Breakdown of carbohydrates through glycolysis, Kreb's cycle, substrate level phosphorelation.

4. **Nitrogen Metabolism:**

   Nitrogen fixation in symbiotic and free living system, photosynthetic and non-photosynthetic systems, oxygen and hydrogen regulation of nitrogen fixation, nitrification denitrification and ammonifying bacteria.

5. **Methylotrops:**

   Methylogens and Methylotrophs, sulphur utilizing bacteria, sulphure production pathways, economic importance of methylotrophs and sulphur utilizing bacteria

PRACTICAL ON PAPER I

A. Microbial Biochemistry:

1. Estimation of glycogen in a bacterial cell
2. Estimation of alkaline phosphatase activity
3. Demonstration of separation of isozymes by polyacrylamide electrophoresis
4. Measurement of Cellulose activity by reducing sugar assay test.

B. Microbial Physiology:

1. Demonstration of plasmolysis, osmosis, active and passive transport.
2. Demonstration of evolution of oxygen in light and uptake of oxygen in dark by Photosynthetic microorganisms
3. Demonstration of photosynthetic electron transport by 2-dichlorophenol reduction test
4. Effect of different factors dichlorophenol in dichlorophenol red drop

PAPER II

ENVIRONMENTAL MICROBIOLOGY AND BIODEGRADATION OF WASTES AND POLLUTANTS

A. Environmental Microbiology

1. **Environment:**

   Soil, water and air environment, Microbes and concept of environment, environmental induced genetic and physiological adaptation in microbes, Microbial population of air, water and soil.

2. **Biogeochemical cycle**:

   The carbon cycle, Trophic relationship, Microbial mobilization of carbon within the biosphere, the hydrogen and oxygen cycle, The nitrogen cycle, Nitrogen fixation, Ammonification, Nitrification, Denitrification, Nitrite ammonification and sulphure cycle, Use of hydrogen sulphide by autotrophic microorganisms, Amino acid drainage, other element cycle phosphorus, iron.

3. **Population Interaction:**

   Neutralism, Commensalism, Synergisms, Mutualism- Microbe-microbe interaction, Plant-Microbe interaction, Animal Microbe interaction, Competition, Amensalism, Parasitism.

B. Biodegradation of wastes and pollutants

1. Solid waste disposal. Sanitary landfills. Composting.
2. Treatment of liquid waste- Sewage: Primary treatment, Secondary treatment, Tertiary treatment, Light production.
3. Treatment and safety of water supplies: Disinfection of potable water supplies, Bacterial indicators of water safety, Standards for tolerable of water safety.
4. Biodegradation of environmental pollutants: Alkyl- benzyl sulphonates, Oil Pollution.

PRACTICAL PAPER – II

1. Isolation of microorganisms from air.
2. Isolation of microorganisms from soil.
3. Isolation of microorganisms from water.
4. Total count of bacteria from water.
5. Isolation and counting of faecal bacteria from water.
6. Measurement of chloride phosphate and nitrogen in water.
7. Measurement of pathogenic and non-pathogenic bacteria from water sample.
8. Biochemical test for differentiation of different bacteria types from water.
9. Estimation of BOD and COD from water sample.
10. Standard method of water analysis.

PAPER – III
AGRICULTURE MICROBIOLOGY

1. Microbiology in relation to: Soil fertility and management of agriculture soils. Influence of available nitrogen of soil fertility, Soil management practices, crop rotation.
2. Elementary idea of Microbial disease of crops, Symptoms of plant diseases and mechanisms of microbial pathogenicity, Transmission of plant pathogens, Viral diseases. Bacterial diseases, Control of crop diseases.
3. Pesticide Microbiology: Biomagnifications, Biodegradation,.
4. Biological Control: General consideration, viral pesticides, Bacterial Pesticides and fungal pesticides.
5. Elementary idea of: Disease of farm animals and control of animal diseases.

PRACTICAL ON PAPER-III

1. Measurement of soil pH, temperature, moisture and electrical conductivity and correlation with the microbes.
2. Measurement of total phosphate, nitrate, nitrite and ammonium in soil.
3. Measurement of organic matter in soil.
4. Isolation of fungal phytopathogens from infected plants.
5. Isolation of soil fungi associated with composting for cellulose degradation.
6. Isolation of actinomycetes from soil.
7. Isolation of thermophilic microorganisms from soil.
8. Isolation of free living nitrogen fixer from soil.
9. Demonstration of mycorrhizal association in soil.

Industrial Microbiology
D. D. U. Gorakhpur University, Gorakhpur
B.Sc. III

B.Sc. II: Three papers and a practical examination as follows:

Paper I: Food Microbiology	50 Marks
Papers II: Fermentation Technology	50 Marks
Papers III: Bio-fertilizers	50 Marks
Paper IV: Immuno-biotechnology, Tissue Culture and Government regulations	50 Marks
Practical:	100 Marks
	Total: 300 Marks

The distribution of marks in practical shall be as follows:

1. Laboratory Practical	75 Marks
2. Entrepreneurship with project report	25 Marks

PAPER I

FOOD MICROBILOGY

1. **Food Spoilage:**

   Representative spoilage process, spoilage of fruits and vegetables, spoilage of meats, spoilage of other foods, Indicators of Human pathogens associated with food

2. **Food Preservation Methods:**

   Asepsis, Filtration and Centrifugation, High temperature, Pasteurization, Canning, Radiation, Low temperature, Desiccation, Anaerobiosis, Controlled atmosphere, Chemical Preservation, Salt and Sugar, Organic acids, Nitrates and Nitrites, Sulphure dioxides, Ethylene oxide, Propenyle oxide, Wood smoke, Antibiotics,.

3. **Microbiological Production of Food:**

   Fermented dairy products, Buttermilk, Sour cream, Indian Foods, Fermented meats, Leavening of Breads, Alcoholic beverages, Vinegar, Beer, Distilled liquor and wines, Fermented vegetables, Pickles, Soya sauce, Single cell protein, Bacterial examination of food.

PRACTICAL ON PAPER I

1. Isolation and identification of microorganisms of spoiled food, fungi and bacteria.
2. Isolation of *Aspergillus flavus* from spoiled food.
3. Identification of mycotoxins from spoiled food.
4. *In vitro* production of aflatoxin by *Aspergillus flavus*.
5. Inhibitory effect of low temperature on microbial growth.
6. Litmus milk reaction
7. Methylene blue test for microbial contamination of milk.
8. Isolation of *Lactobacilli* and *Streptococcus* from curd.

PAPER II

FERMENTATION TECHNOLOGY

1. **The Fermentation Industry:**

   Selection of industrial microorganisms, Production Process, Fermentation Media, Aeration Agitation, pH, Temperature, Batch versus Continuous culture, Immobilized enzymes, Downstream processing and product recovery.

2. **Quality Control of Industrial Products**
3. **Production of Pharmaceuticals:**

   Antibiotics, Steroids, Human Proteins, Vaccines, Vitamins.

4. **Production of organic acids:**

   Acetic acid, Citric acid, Lactic acid, Gibberelic acid, Oxalic acid.

5. **Production of Amino acids:** Lysine, Glutamic acid**.**
6. **Production of Enzymes:** Protease, Amylase, Other enzymes, Production of Solvents.
7. **Production of Fuels:** Ethanol, Methanol, Other Fuels.
8. **Microbially enhanced recovery of mineral resources:** Bioleaching of metals, Oil recovery**.**
9. **Bio-deterioration:** Papers, Woods, Paints, Textiles, Metal corrosion.
10. **Mushroom Cultivation**

PRACTICAL ON PAPER II

1. Isolation of *Aspergillus niger* from soil.
2. Measurement of production of Citric acid by *Aspergillus niger* by descending paper chromatography.
3. Measurement of microbial production of ethanol.
4. Demonstration of IAA production by soil fungi.
5. Demonstration of cultivation of mushroom.
6. Demonstration for the identification of mushrooms by spore print methods.
7. Demonstration of production of amino acids by soil fungi.

PAPER III

BIO-FERTILIZERS

1. **Symbiotic association:**

   General accounts about the microbes us as bio-fertilizers, Rhizobium-taxonomy, physiology, host-*Rhizobium* interaction, mass cultivation, carrier and base inoculants and serology, *Frankea*.

2. **Symbiotic and Non-Symbiotic association:**

   Azospirillum-rhizosphere competence and host plant interaction, taxonomy, physiology, carrier base inoculants and effect of different microorganisms on plant, crop response to *Azotobactor* inoculums, maintenance and mass cultivation. Cyanobacteria (Blue green algae), *Azolla* and *Anabaena azolli* association, nitrogen fixation, factor affecting growth, blue green algae and *Azolla* in rice cultivation. Types of mycorrhizal associations, VAM mycorrhizal association: taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield, collection of VAM, isolation, stock plants and inoculums production of VAM.

3. **Production and quality control in Bio-fertilizers:**

   Isolation and identification of different nitrogen fixing ability of different strains under controlled and field conditions, direct and indirect methods, culture production, fermenter, storage of culture, carrier, packing, quality control, ISI Standards, inoculums requirements, packing, marketing and storage, inoculums requirements methods of application.

PRACTICAL ON PAPER III

1. Nodulation by *Rhizobium*.

2. Counting of vital number of nodules from legume plant.

3. Isolation of VAM spores from soil sample.

4. Demonstration for the identification of VAM spores.

5. Demonstration for the nitrogen fixing ability of bacteria in different nitrogen medium.

6. Demonstration of cyanobacterial growth for nitrogen fixation and measurement of heterocyst frequency.

PAPER IV

IMMUNO-BIOTECHNOLOGY, TISSUE CULTURE AND GOVERNMENT REGULATION

1. **History and scope of Immunology:**
   Type of immunity, Physiology of immune response, Antigen-antibody reaction, Immunoglobulins-structure, distribution and function.
2. Production of Vaccines, monoclonal antibodies (Hybridoma Technology), siderophores.
3. Process and products of culture of animal and plant cell: Nature of cell culture, cell growth system, products from cell culture.
4. **Biotechnological programmes and regulations:**
   Role of International organization in Biotechnology, Govt. Programmes for Biotechnology development, Government regulations on recombinant DNA research, Regulation for disposal of bio-hazards materials, patenting biotechnological process and products, Mycotoxins, hazards in the production of microbial products, Health hazards during microbial spoilage: Carcinogenic, mutagenic and teratogenic biological.

PRACTICAL ON PAPER IV

1. Detection of blood groups.
2. Callus formation by root organ culture from egg plant.
3. Estimation of antigen and antibody.
4. Precipitation reaction of antigen and antibody.
5. Effect of physical and chemical mutagens on given microorganism.
6. Change of physiological properties of wild and mutant types.
7. Demonstration of immunity response in animals.