FACULTY OF SCIENCE
SYLLABI
FOR
INDUSTRIAL MICROBIOLOGY
(ADD-ON Course)
FOR
EXAMINATIONS
2020
**INDUSTRIAL MICROBIOLOGY**

**B.Sc. 1st YEAR**

Paper-I: 3 hours Marks-75 (67+8*)

Paper-II: 3 hours Marks-75 (67+8*)

Practical: One paper covering 4 hours Marks-50 (45+5*)
the entire syllabus of both papers.

*Note: * Denotes marks for the Internal Assessment.

**NOTE:**
1. The number of hours for theory and practical per week shall be 5 hours and 4 hours respectively.
2. There will be nine questions in all in each theory papers I and II. The first question will be compulsory and will be of short answer type covering the whole syllabus and will have ten parts of 1½ marks each in both papers I and II.
3. In papers I and II of the remaining eight questions, four questions will be set from each Section. The candidate will be required to attempt five questions in all including the first question and selecting two questions from each section in each paper.

**PAPER-I: FUNDAMENTALS OF INDUSTRIAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY.**

**Part-A: FUNDAMENTAL OF INDUSTRIAL MICROBIOLOGY**

**Objective:** To make the students aware with the history and basics of Microbiology along with the diversity of microorganisms.

1. General Introduction, History and Development of Industrial Microbiology, Scope of Industrial Microbiology.
   - Introduction
   - Discovery of Microbial World
   - The experiments of Pasteur
   - The era of the discovery of antibiotics
   - The discovery of the anaerobic life
   - The physiological significance of fermentation

2. Classification, Isolation, Characteristics and Ultra-structure of Microbes.
   - Bacteria
   - Algae
   - Fungi
   - Actinomycetes
   - Mycoplasma
   - Viruses Bacteriophages
   - Procedure of isolation and identification of micro organisms
   - Methods of staining of different microbes.

3. Biological and Biochemical Fundamentals.
   - Introduction
- The Micro-organisms and biotechnology
- Sterilization, preparation of media
- Isolation methods for micro-organisms
- Cultural preservation and stability
- Preservation of microbes, serial subculturing, preservation by overlaying culture with mineral oil, lyophilization or freeze drying
- Principles of storage at very low temperature or in liquid nitrogen
- Other methods of storage of fungi
- Over production of microbial metabolites
- Preparation of inoculums.


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

Part-B: MICROBIAL PHYSIOLOGY

Objective: To introduce the concept of various ongoing reactions with the microbial life and the role of diverse physical and chemical processes with in biology.

1. Physiological properties – Diffusion, gaseous exchange, osmosis, plasmolysis, bio-chemical properties of membranes, passive and active transport, bio-chemical factors regulating the transport, donnan equilibrium.


3. Respiratory pathway – Respiratory pathway, breakdown of carbohydrates through glycolysis, Kreb’s and substrate level photophorylation, significance of Kreb’s cycle, gluconeogenesis.

4. Nitrogen metabolism – Nitrogen fixation in symbiotic and free living system, photosynthetic and non-photosynthetic system, oxygen and hydrogen regulation of nitrogen fixation, nitrification, denitrification and ammonifying bacteria, pathway of nitrate assimilation in photosynthetic and non-photosynthetic systems, transamination and deamination reaction.

PRACTICALS

1. Preparation of Media, autoclaving and sterilization of glassware, maintenance of cultures.
2. Introduction to laboratory appliances.
3. Isolation, purification, maintenance and study of microbes of different groups-
   - Bacteria
   - Algae
   - Fungi – By staining procedure.
4. Single spore culture.
8. Isolation of Phytopathogens.
9. Demonstration of plasmolysis, osmosis, active and passive transport mechanism.
13. Effect of different inhibitors on dichlorophenol-indophenol reduction.

PAPER-II: MICROBIAL GENETICS & MOLECULAR BIOLOGY AND MICROBIAL BIOCHEMISTRY.

NOTE:
1. The number of hours for theory and practical per week shall be 5 hours and 4 hours respectively.
2. There will be nine questions in all in theory paper. The first question will be compulsory and will be of short answer type covering the whole syllabus and will have ten parts of 1½ mark. In the remaining eight questions, four questions will be set from each Section. The candidate will be required to attempt five questions in all including the first question and selecting two questions from each Section in each paper.

PART-A: MICROBIAL GENETICS AND MOLECULAR BIOLOGY.

Objective: To provide the in-depth knowledge of DNA structure, its role in life regulation and inheritance of characteristics along with protein synthesis, variations due to mutations.

1. Nucleic Acids:
   DNA as genetic material, structure of DNA, RNA, DNA replication (conservative and semi-conservative replication, conformational flexibility of DNA), replication of DNA in eukaryotes, the genetic code, central dogma, reverse transcriptase, gene transcription, polymerases, transcription product of DNA, tRNA, mRNA and rRNA. Synthesis of RNA in eukaryotes and prokaryotes, catabolite effect, operators and repressors, post transcriptional processing of RNA.

2. Molecular biology of protein synthesis:
   Translation and protein synthesis in eukaryotes and prokaryotes, tRNA synthetase activation, operon concept, CAMP, catabolite activator protein (CAP). Positive and negative control and gene expression in prokaryotes, Lac operon.

3. Molecular mechanism of mutation:
   Forward and reverse mutation, transition, transversion, chemical induced mutations, radiations and base analogues, induced mutations, mutation frequency, applications of mutations. Mechanism of repair, repair of radiation induced damage, SOS repair.

4. Genetic recombination in bacteria:
   Transformation, transduction and conjugation, Use of transformation, transduction and conjugation in mapping. Preparation of genetic maps.

5. Extra chromosomal genetic material:
   Brief account of plasmids, cosmids transposons, insertion sequence, Overlapping genes, silent genes, exon and intron, evolutionary significance of silent genes, ribonucleoprotein, genetic recombination and its prospects, basics of recombinant RNA and recombinant DNA technology.
PART-B: MICROBIAL BIOCHEMISTRY

Objective: To understand the nature and functions of various macromolecules including enzymes and their role in physiological reactions and their regulation.

1. Carbohydrates:
   Classification of carbohydrates, optical property, chemical properties of carbohydrates, chemical structure and property of starch, cellulose, glycogen.

2. Lipids:

3. Enzymes:
   Classification, coenzyme, cofactor, thermodynamic explanation of enzyme catalysis, reaction orders, competitive, uncompetitive and noncompetitive inhibition, Isozymes, factors contributing to catalytic efficiency of enzymes (mode of catalysis).

4. Amino Acids:

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. Respiratory electron transport and proton pump, Oxidative phosphorylation (ATP synthesis).

PRACTICALS

1. Isolation of antibiotic resistant bacteria.
2. Extraction of lipids by thin layer chromatography.
3. Estimation of glycogen in a bacterial cell.
7. Isolation and purification of DNA, RNA.

RECOMMENDED BOOKS

3. Industrial Microbiology by A.H. Patel, Mc Millan India.
5. Microbiology by Moat and Foster.
10. The Genetics of Bacteria and their viruses by William Haynes Goyal Offset, Delhi.
11. General Microbiology by Davis and Harper.
Paper-I: Environmental Microbiology and Agricultural Microbiology

PART-A: ENVIRONMENTAL MICROBIOLOGY

Objective: To make the students aware with the role of microbes in maintaining environment, existing microbial interactions and recycling of nutrients in nature.

1. Environment:
   Soil, water and air environment, Microbes and concepts of environment, Environment induced genetic and physiological adaptation in microbes, Microbial population of air, water and soil.

2. Biogeochemical cycling:

3. The Sulphur cycle:
   Phosphoreus, Iron, Calcium, Silicon, Manganese, Heavy metals.

4. Population Interaction:
   Neutralism, Commensalism, Synergism, Mutualism, Microbe- microbe interaction, Plant-microbe interaction, Animal-Microbe interaction, Competition, Amensalism, Parasitism, Predation.

PART-B: AGRICULTURAL MICROBIOLOGY

Objective: To understand the microbial diseases which harm agricultural productivity and Live stock.


3. Control of Crop diseases.


5. Biological control, General considerations, Bacterial Pesticides and Fungal Pesticides.


**PRACTICALS**

1. Isolation of micro organisms from air.
2. Isolation of micro organisms from soil.
3. Isolation of micro organisms from water.
4. Total count of bacteria from water.
5. Isolation and counting of faecal bacteria from water.
6. IMViC test for faecal bacteria.
7. Detection of chloride, phosphate and nitrate in water.
8. Estimation of pathogenic and non pathogenic bacteria from water sample.
12. Isolation of fungal phytopathogens from infected plants.
13. Isolation of soil fungi associated with composting for cellulose degradation.
15. Isolation of thermophilic micro-organisms from soil.
16. Isolation of the free living nitrogen fixer from soil.
17. Demonstration of mycorrhizal association in soil.

**PAPER-II: FOOD MICROBIOLOGY AND FERMENTATION TECHNOLOGY.**

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PART-A: FOOD MICROBIOLOGY

Objective: To understand the role of microbes in food spoilage and role of useful microbes in production of various food varieties and their preservation to increase shelf-life.

1. Food Spoilage:
   Representative spoilage processes, Spoilage of fruits and vegetables, Spoilage of meats, Spoilage of other foods, Indicators of human pathogens associated with foods.

2. Food Preservation Methods:

3. Microbiological Production of Food:
   Fermented dairy products, Butter milk, Sour cream, Indian foods, Fermented meats, Leavening of breads, Alcoholic beverages, Beer, Distilled liquors and wines, Vinegar, Fermented vegetables, Pickles, Olives, Soya sauce, Single Cell Protein.

PART-B: FERMENTATION TECHNOLOGY

Objective: To understand the type of microbes involved in the fermentation processes and the varieties of products produced and their downstream processing including management of waste and generation of useful products from waste.

1. Fermentation Industry:
   Selection of Industrial micro-organisms, Production Process, Fermentation media, Aeration, of pH, Temperature, Batch versus Continuous culture, Immobilized enzymes, Down stream processing and product recovery.

2. Quality control of industrial products.


4. Production of Organic Acids: Acetic Acid, Citric Acid, Lactic Acid, Gibberellic Acid, Oxalic Acid.

5. Production of Amino Acids: Lysine, Glutamic Acid.

6. Production of enzymes, Production of solvents, Production of fuels: Ethanol, Methane, Other fuels.

7. Microbiologically enhanced recovery of mineral resources, Bioleaching of metals, Oil recovery.


9. Mushroom Cultivation.
**PRACTICALS**

1. Isolation and identification of micro-organisms of spoiled food, fungi and bacteria.
2. Isolation of *Aspergillus flavus* from spoiled food.
3. Inhibitory effect of low temperature on microbial growth.
4. Litmus milk reaction.
5. Methylene Blue test for microbial contamination of milk.
6. Isolation of lactobacilli and *Staphylococcus* from curd.
7. Isolation of Aspergillus niger from soil.
8. Demonstration for the cultivation of mushroom.
9. Demonstration for the identification of the mushroom by spore print.
10. Demonstration for the production of amino acid by soil fungi.
12. Production of Vinegar.
13. Lactic acid fermentation.

**RECOMMENDED BOOKS**

1. Standard methods APHA.
2. Microbiology for environmental scientists and engineers by Gandy and Gandy, McGraw Hill.
3. Microbiology by Pelczar, Reid and Chan.
4. Fundamentals and principles of microbiology by Carpenter.
6. Soil microbiology by Martin.
7. Pesticide microbiology by Hill land Wright.
9. Plant Pathology by R.S. Malhotra
11. Food Microbiology by Frazier.
12. Microbial World by Stanier.
13. General Microbiology by Powar and Daginwala
16. Fermentation technology by Whittaker.
17. Industrial Microbiology by A.H. Patel.
B.Sc. 3rd YEAR

Paper-I:  3 hours  Marks-75 (67+8*)

Paper-II:  3 hours  Marks-75 (67+8*)

Practical: One paper covering the entire syllabus of both papers.  4 hours  Marks-50 (45+5*)

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PART-A: BIODEGRADATION OF WASTES AND POLLUTANTS

Objective: To make the students understand the problems of generated waste and development of techniques to manage solid waste using microorganisms.


3. Treatment and safety of water supplies, Disinfection of potable water supplies, Bacterial indicators of water safety, Standards for tolerable levels of faecal contamination.


PART-B: BIOFERTILIZERS

Objective: To make the students aware about the means to replace harmful chemicals used as fertilizers with biological ones which are harmless and biodegradable.

1. Symbiotic association – General account about the microbes used as bio-fertilizers, Rhizobium – taxonomy, physiology, host rhizobium interaction, mass cultivation, carrier base inoculants and serology, Rhizobium – Woodland and Actinorrhizal nitrogen fixing plants – the endophytes, host plant.

2. Associative and non-symbiotic association –

Azospirillum rhizosphere competence and host plant specificity, taxonomy and physiology, carrier base inoculant, associative effect of different micro-organisms.

Azotobacter – Classification, characteristics, ecology, physiology, crop response, Azotobacter inoculum, maintenance and mass cultivation, Cyanobacteria (blue green
algae), Azolla and Anabaena-azollii association, nitrogen fixation factors affecting growth, blue green algae and Azolla in rice cultivation.

VAM mycorrhizal association, types of mycorrhizal association, taxonomy occurrence and distribution, phosphorous nutrition growth and yield, collection of VAM, isolation, stock plants and inoculum production of VAM.

3. Production and quality control in Bio-fertilizers – 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, fermenter, storage culture, carrier packing, quality control, ISI standards, inoculum requirements, packing marketing and storage, inoculum requirements, methods of application.

PRACTICALS

1. Estimation of BOD and COD from water sample.
2. Standard methods of water analysis
3. IMVIC test for water analysis.
5. Counting of viable number of nodules from legume plants.
6. Isolation of VAM spores from soil samples.
7. Demonstration for the germination and identification of VAM spores.
8. Demonstration of cyanobacterial growth for nitrogen fixation and measurement of heterocyst frequency.
9. Preparation of Bio-fertilizers and testing.

Paper-II: Biostatistics, Tools & Techniques and Immuno Biotechnology, Tissue Culture and Government Regulations.

PART-A: BIOSTATISTICS, TOOLS AND TECHNIQUES

Objective: To introduce the importance of statistics of life science, role of various useful techniques of Biotechnology and the basic knowledge of computers in data analysis.

1. Biostatistics – Basic idea of probability, distribution patterns, normal binomial and Poisson distribution, sampling methods, mean, mode and median, chi-square statistics, Analysis of variance transformation, Exponential and logarithmic functions.
3. Chromatography techniques – Paper chromatography, thin layer chromatography, affinity chromatography, gel filtration, Electrophoresis moving boundary zone (paper, gel), Immuno-electrophoresis, Isoelectric focusing.
4. Instruments, basic principles and usage.
5. Principal types of Fermentation – Introduction, Factors involved in fermenter design, differences between biochemical and chemical process, classification of biochemical reactions, rate process, operational consideration, local conditions within a fermenter, Fermenter configurations, the batch fermenter, continuous stirred tank fermenter, the tubular fermenter, the fluidized bed fermenter, solid state fermenter, Principal operating characteristics of fermenters, Computer control of fermentation process.

Introduction - Computer hardware and software, Harward Graphics, LOTUS and DOS, Computer application in fermentation technology, Justification and planning.
PART-B: IMMUNOBIOTECHNOLOGY, TISSUE CULTURE AND GOVERNMENT REGULATIONS

Objective: To understand the basics of defense system working against microbial diseases, development of vaccines and latest developments in immunology, medical science like gene therapy and stem cell culturing. Further how to apply Biotechnology for tackling the modern biohazardous in the world with the help of Government programmes at national and international level.

1. History and scope of immunology, Types of Immunity, Physiology of immune response, Antigen – antibody reaction, Immunoglobulins – structure, distribution and function.

2. Production of vaccines, monoclonal antibodies (hybridoma technology, siderospores).

3. Process and products on culture animal and plant cell, Nature of cell culture, Cell growth systems, Products from cell culture, Genetically engineered animal cells and bacteria, Metabolites from recombinant DNA modified plants.

4. Biotechnology programmes and regulation, Role of International organizations in biotechnology, Government programmes for biotechnology development, governmental regulations of recombinant DNA research.

Regulation for disposal of biohazardous materials, patenting, biotechnological processes and products, Mycotoxins, hazards in the production of fungal products. Health hazards during microbial spoilage, carcinogenic, mutagenic, teratogenic biologicals.

PRACTICALS

2. Problems on Chi-square test.
3. Problems on mean, mode and median.
4. Study and use of spectrophotometer.
5. Protein/Carbohydrate/Organic acid estimation by colorimeter.
6. Paper chromatographic separation of amino acid by one way descending.
7. Measurement of pH, acidity and total soluble solids of fruit juice.
8. Detection of blood groups.
10. Study of antigen and antibodies.
11. Detail study of laboratory appliances.

RECOMMENDED BOOKS

2. Microbiology by Pelczar and Reid.
5. Statistics by D.N. Elhance.
7. General Microbiology by R.Y. Stanier.
8. Tools and techniques in biology by Swaroop, Pathak and Arora.
10. Immunology by Davis.
12. Immunology by G.P. Talwar.
ENTERPRENEURSHIP

The students will be delivered lectures on how to select for product line, design and development process, economies on materials and energy requirement, stock the product and release the same for marketing etc. The basic regulations of excise should be apprised to the candidates. In parallel the students will be asked to serve the demand for a given product, feasibility of its production under the given constraints of raw material, energy input, financial situations, export potentials etc. Procedural details on how to select, process, how to move for loans, how to operate and how to repay the loans in a phasic manner should also be highlighted during the lectures.

The students are required to submit a draft project during the session.

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