B.Sc. Industrial Microbiology

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Offered By:

Department of Industrial Microbiology
Faculty of Science
Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur

Course Code: **IMB 101**	
Course Title: Introductory Microbiology	
Credits:2+0	
Unit	**Topic**
I	What are microbes? Habitat and general diversity. Scope of microbiology and its allied field.
II	Microbes in agriculture Importance and diversity of microbes in soil. Basic concept of Biofertilizer, Biological control, Bio pesticides. Role of microbes in plant diseases.
III	Microbes in Human welfare- Basic concept of antibiotics from microbes. Fermented foods and beverages. Mushrooms and basic of its cultivation.
IV	Microbes in Industry. Industrial use in enzyme and organic and production. Role of microbes in Sewage treatment. Basic concept of fermenters.

Course Code: IMB 102 (B017101T**)**	
Course Title: Fundamentals of Industrial Microbiology	
Credits:4+0	
Unit	**Topics**
I	**History of Industrial Microbiology** Introduction, scope and historical development of industrial microbiology (discovery era, transition period, golden age and microbiology in the 21st century), Applied branches of microbiology and industrial importance of various microorganisms of industrial importance.
II	**Microbial Diversity** Diversity of Microbial World, Prokaryotic cell, Structure of Bacterial cell, Archaebacteria and Eubacteria, Structure and function of Plasma membrane, cell wall, capsule, endospore, flagella, nucleod, plasmid, Gram positive and Gram negative bacteria, chromosomal & extra chromosomal genetic material and cell inclusions.
III	**Study of Fungi, Algae, Protozoans and viruses** Characteristics of Fungi, Algae, Protozoans, Viruses. Principles of classification of bacteria, algae, fungi, protozoa,viruses.
IV	**Methods for studying microorganisms** Culture media: preparation and types of defined, differential, selective and enrichment culture, Isolation techniques: Pour plate, spread plate, streak plate. Preservation and maintenance ofculture Methods of sterilization: physical and chemical, media types, Isolation and maintenance of pure cultures of microorganisms, and preservation techniques.
V	**Microbial growth** Microbial growth, phases of growth, conditions of growth, measurement of growth, bacterial sporulation and germination, binary fission.
VI	**Microscopy** Microscopy Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy
VII	**Equipments used in Microbiology** autoclave, oven, laminar air flow, centrifuge, colorimetry and spectrophotometry, Electrophoretic techniques for proteins and nucleic acids, PCR

VIII	**Microbial identification** Techniques used for identification of microorganisms biotyping, serotyping, molecular techniques.

Course Code: IMB 103 (B017102P**)**	
Course Title: Basic Techniques in Microbiology	
Credits:0+2	
S. No.	**Topics**
1.	Microbiology good laboratory practices and biosafety. Neutralization and cleaning of glassware. Measurement of microorganisms (Micrometry).
2.	To study the principle of and application of important instruments – Autoclave, Incubator, BOD Incubator, Hot Air Oven, pH Meter, spectrophotometer, Colony Counter, Centrifuge Machine and Laminar Air Flow.
3.	Preparation of different culture media- nutrient agar/nutrient broth for bacterial culture, PDA for fungal culture. Enumeration of colony forming unit (CFU) of microorganisms by spread plate and pour plate techniques. Isolation of pure culture of bacteria by streak-plate method.
4.	Staining of bacteria- Simple staining- methylene blue, Gram's staining, Acid fast staining, ZiehlNeelsen staining, Giemsa staining, Structural staining- capsule, endospore. Staining of fungi using lactophenol and cotton blue (*Rhizopus, Mucor,* *Aspergillus, Penicillium*).
5.	Sterilization of culture media using autoclave and assessment for sterility. Sterilization of glassware using hot air oven. Sterilization of heat sensitive material by membrane filtration and assessment for sterility. Demonstration of the presence of microorganisms in the environment by exposing nutrient agar plate to air.

Course Code: IMB 104 (B017201T**)**	
Course Title: Biochemistry & Microbial Physiology	
Credits:4+0	
Unit	**Topics**
I	**Biochemistry of Microbes** Bioenergetics basics, Chemical composition of cell, molecules of living systems, pH and pK, Buffers.
II	**Carbohydrates** Structure & classification of carbohydrates-monosaccharides, disaccharides, polysaccharides, storage and structural pilysaccharides; Carbohydrate metabolism pathways- EMP pathway, Pentose phosphate pathway (PPP), TCA Cycle, Electron transport chain (ETC), Gluconeogenesis
III	**Proteins** Amino acids, general formula and concept of zwitterion; Protein structure: primary, secondary- peptide unit salient features, α helix, β sheet, β turn, tertiary and quaternary structures of proteins, Protein folding
IV	**Lipids & Nucleic acids** Structure and classification of lipids- Fatty acids structure and functions; Saponification Structural lipids; Phosphoglycerides; Sphingolipids; Metabolism of lipids- Alpha and beta oxidation of lipids; Nucleic acids Structures, Double helical structure of DNA. Types of DNA: A, B, Z. Physic-chemical properties of DNA. RNA types-rRNA, mRNA, tRNA.
V	**Enzymology concepts** Enzymes and their classification, Enzyme kinetics, llosteric enzymes, Michaelis- Menten equation, coenzyme, isozyme, enzyme inhibition and regulation
VI	**Transport of solutes and nutrients** Nutrient uptake mechanisms-passive and facilitated diffusion; Primary and secondary active transport; Concept of uniport, symport, antiport, group translocation; Iron uptake
VII	**Photosynthetic microbes** Oxygenic photosynthetic bacteria- PSI and PSII, Z-scheme, Non- cyclic photophosphorylation; Anoxygenic photosynthetic bacteria- Cyclic photophosphorylation. Photosynthesisof Purple and Filamentous green bacteria, Cyanobacteria and Green sulphur bacteria. Calvin cycle.
VIII	**Microbial growth kinetics** Bacterial growth curve, Generation time and specific growth rate; Growth kinetics in Batch, Fed batch and continuous cultures.

Course Code: IMB 105 (B017202P**)**	
Course Title: Biochemistry & Physiology lab	
Credits:0+2	
S. No.	**Topics**
1.	Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts, Preparation of stock and working solutions, Handling of pipettes and micropipettes
2.	Qualitative/Quantitative tests for Carbohydrates: Fehling's Test, Benedict's Test, Iodine Test) Quantitative estimation of carbohydrate by DNSA method.
3.	Qualitative/Quantitative tests for Amino acids and Proteins: Ninhydrin test, Biuret test, Lowry test. Quantitative estimation of proteins by Lowry's method
4.	Qualitative/Quantitative tests for lipids**:** Solubility Test, Translucent Spot Test, Emulsification Test, Saponification Test, Tests for the Free Fatty Acids, Unsaturation Test, Burchard Test Determination of Iodine Number
5.	Study and plot the growth curve of E. coli by turbidometric method.
6.	Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
7.	Study of protein secondary and tertiary structures with the help of models

Course Code: IMB 201 (B017301T)	
Course Title: Fermentation Technology	
Credits:4+0	
Unit	**Topics**
I	**Introduction** Fermentation processes, Microbial culture selection for fermentation processes. Media formulation and optimization; inoculum development; strain improvement
II	**Microbial growth** Microbial growth kinetics in Batch, fed batch and continuous cultures
II	**Design of fermenters** Design and operation of Fermenters, Basic concepts for selection of a reactor, Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor, Scale up of Bioreactor.
III	**Processes involved in fermentation-I** Scale-up process and Scale down process: Purposes of scale-up; Stages of fermentation –laboratory scale, pilot-plant scale and production scale; Criteria of scale-up for critical parameters- aeration, agitation, broth rheology and sterilization; Scale-down
IV	**Processes involved in fermentation-II** Cell disruption; Filtration; Centrifugation; Liquid-liquid extraction; Solvent extraction (distillation);Chromatography; Electrophoresis; Lyophilization
V	**Quality control & quality assurance test** QC in fermentation processes: Principles of validation for pharmaceutical industry; QA Tests of finished product-Sterility testing, Pyrogen testing, Ames test and modified Ames test, toxicity testing, Shelf life testing
VI	**Food preservation methods** High temperatures, drying, food additives and radiation. Preservation of milk, meat, fish, fruits and vegetables; Food hygiene maintenance
VII	**Fermentation products** Large scale fermentaion of acetone, butanol and ethanol (ABE) and alcoholic Beverages -Beer and Wines; Vitamins -B12 and Riboflavin; Antibiotics-Penicillin and Streptomycin);Organic acids-Citric acid, Acetic acid and Lactic acid; Amino acid-Glutamic acid; Enzymes-Amylase, Lipases, Esterases and Restriction enzymes; Vaccines –Tetanus, Polio and Rabies.
VIII	**Biomass based products** Biopesticides- Thuricide and Trichoderma; Yeast: SCP, Baker's and Distiller's yeast; Milk products: Cheese and Yogurt; Microbial transformation products: Steroids

Course Code: IMB 202 (B017302P**)**	
Course Title: Fermentation Technology Practical	
Credits:0+2	
S. No.	**Topics**
1.	Fungal and Bacterial Fermentation
2.	Anaerobic fermentation for wine production
3.	Fermentation for the production of Citric acid
4.	Fermentation for the production of antibiotics
5.	Solid state fermentation for production of enzymes
6.	Shake flask fermentation (Study of effect of agitation)
7.	Yogurt fermentation
8.	Cheese fermentation

Course Code: IMB 203 (B017401T**)**	
Course Title: Environmental & Agricultural Microbiology	
Credits: 4+0	
Unit	**Topics**
I	**Habitat Ecology** Structure and function of ecosystem; Terrestrial environment: soil profile and soil microflora; Aquatic Environment: microflora of fresh water and marine habitats; Atmosphere: Aeromicroflora and dispersion of microbes; Animal Environment: Microbes in/on human body (microbiomes) & animal (Ruminants) body; Extreme habitats: Extremophiles: Microbes thriving at high & low temperature, pH. High hydrostatic & osmotic pressures, salinity and low nutrient level;Microbial succession in decomposition of plant organic matter.
II	**Microbial Interactions** Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; Microbe-Plant interaction: positive-negative interaction; Microbe-Animal interaction: positive-negative interaction; Microorganism of rhizosphere, rhizoplane and phylloplane, mycorrhiza (types and its applications).
III	**Biogeochemical cycling** Carbon cycle: Microbial degradation of cellulose, hemicellulase, lignin and chitin; Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction; Phosphorous cycle: Phosphate Immobilisation and solubilisation; Sulphur cycle: Microbes involved in sulphurcycle.
IV	**Waste management** Solid waste management: Source and type of solid waste, method of solid waste disposal (composting and sanitary landfill), Liquid waste management: composition and strength of sewage (BOD&COD), primary, secondary, (oxidation pond, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.
V	**Microbial Bioremediation and Bioleaching** Principle and degradation of common pesticides, organic (hydrocarbon, oil spills) and inorganic matter, biosurfactants. Copper and iron-ore form available areas of deposits, method of leaching, mechanism and significance.

VI	**Water potablity** Treatment and safety of drinking water; Methods to detect potability of water sample:Standard qualitative procedure-MPNtest/Presumptivetest,confirmedandcompletedtestfor faecal-coliforms Membrane filter technique, Presence/Absence test fecal coliform
VII	**Biofertilizer** Definition, Types- Bacterial, Fungal, Phosphate solubiliser, BGA & associative, Industrial biomass production; Mode of application; Advantages and Disadvantages. Mycorrhiza (types and its applications)
VIII	**Biopesticides and Biodegradation** Introduction and definition; Types of biopesticides; Integrated pest management (IPM); Mode of action; Factor influencing; Applications, advantages& disadvantages. Biodegradation of Xenobiotics, Bioaccumulation, Biodeterioration.

Course Code: IMB 204 (B017402P**)**	
Course Title: Environmental & Agricultural Microbiology Lab	
Credits: 0+2	
S. No.	**Topics**
1	• Qualitative and quantitative estimation ofwater. • Qualitative and quantitative examination of sewage water. • Microbial examination of water by coliform, MPN methods. For potable and sewagewater.
2	● Isolation of microbes (Bacteria, Yeast & Mold) from soil sample at different temperature (28º C & 45ºC) ● Isolation ofAzotobactor. ● Isolation of Rhizobium from rootnodule.
3	● Isolation and identification of microorganisms present in various airsamples. ● Microscopic observation root colonization by VAM fungi.
4	● Study of Plantpathogens. 1. Black rust ofwheat 2. White rust ofcrucifer 3. Leaf curl oftomato 4. Downymildow 5. Red rot ofsugarcane 6. To isolate *Rhizobium* from rootnodule.
5	Study of permanent slide and life materials ● *Cladosporium* ● *Helmithosporium* ● *Mucor* ● *Curvularia* ● *Alternaria* ● *Geotrichurn* ● *Trichoderma*(Specimens) ● *Rhizopus*

Course Code: IMB 301 (B017501T**)**	
Course Title: Industrial Food Microbiology	
Credits: 4+0	
Unit	**Topics**
I	**Introduction to food & nutrition** History, Scope of Industrial food microbiology; Physiochemical properties of food; Importance and types of microorganisms in food (bacteria, mold and yeast); Intrinsic and extrinsic factors that affect growth and survival of microbes in food, natural flora and source of contamination of foods in general.
II	**Chemical composition of food** Carbohydrate, pectic substances, proteins, functional properties of proteins in food, changes in protein, lipids and carbohydrates during processing,
III	**Fermented food** Microbiology of: dairy products (cheese, yoghurt); cereal and vegetable products (bread, sauerkraut, pickles); beverages (kanji, vinegar, wine); fermented fish and meat products.
IV	**Microorganisms as food** Single cell proteins. prebiotics probiotics and synbiotics: health benefits, types of microorganisms used, probiotic foods available in market. Mushroom cultivation.
V	**Food borne diseases food poisoning** *Staphylococcus aureus*, *Clostridium botulinum*, *Vibrio cholerae*, *Escherichia coli* and *Salmonella* infections. Toxins of food borne pathogenic bacteria and fungi.
VI	**Food preservation** Basic Principles, Methods (heating, freezing, dehydration, chemical preservatives, radiation). Modern technologies in food preservation, Packaging material.
VII	**Microorganisms and milk** Physical and chemical properties of milk; Milk as a substrate for microorganisms; Microbiological analysis of milk – Rapid Platform test, standard plate count, MBRT test, alkaline phosphatase enzyme test, DMC; Method of preservation of milk and milk product, pasteurization sterilization and dehydration.
VIII	**Microbial quality control of food** Total quality management, HACCP for food safety. Indices of food quality (FSSAI, ISO); Microbiological quality standard of food. Introduction to food packaging; Need, role of packaging in extending shelf life of food and food packaging materials.

Course Code: IMB 302 (B017502T)	
Course Title: Immunology & Medical Microbiology	
Credits: 4+0	
Unit	**Topics**
I	**Overview of Immunology** History of immunology, Physical and physiological barriers, Innate and Acquired immunity, Organs and Cells of Immune system.
II	**Nonspecific immunity & Specific Immunity** Phagocytosis, Complement System Proteins, Complement System Activation by Classical, Alternate and Lectin Pathway, Humoral and Cell Mediated Immunity, Active And Passive Immunity
III	**Antigen, Immunogens, Antibody and MHC** Antigen Characteristics, Types of Antigens, Adjuvants, Immunogenicity and Antigenicity, Classes of immunoglobulin- structure and function, Major Histocompatibility Complex: Types-structure.
IV	**Immunotherapy, Immunodiagnostic, Hypersensitivity** Antibodies as therapeutic substances, Application of antibodies in diagnostics (Antigen-Antibody Reactions: Agglutination and immunodiffusion). Types of Hypersensitivity, Mechanism of hypersensitivities with examples,
V	**History of Medical Microbiology** Contribution of pioneers in the field of Medical Microbiology, Normal Microflora of human body: skin, mouth, alimentary canal and gintourinary tract
VI	**Food borne infectious pathogens** Diseases caused by bacteria (*Clostridium botulinum*, *Brucella*, *Campylobacter jejuni*, *Vibrio*, *E. coli*, *Salmonella*); fungi (*Aspergillus*, *Candida*); Virus (Hepatitis, Rotavirus)
VII	**Antibiotics and Chemotherapeutics** Historical development of chemotherapeutic and antibiotic substances, Major antimicrobial agents, Mode of action of chemotherapeutic and antibiotic substances.
VIII	**Antibiotic resistance, Sample collection and processing** Drug resistance, Mechanism of antibiotic resistance, Antibiotic susceptibility assay. Collection and transport of appropriate clinical sample specimen for clinical diagnostics.

Course Code: IMB 303 (B017503P)	
Course Title: Experiments in Food and Immunology & Medical Microbiology	
Credits: 0+2	
S. No.	**Objectives**
1	Preparation of blood agar, chocolate agar, and other media required for medically important microorganisms
2	Isolation and characterization of skin normal microflora
3	Bacteriological analysis, isolation and characterization of bacteria and fungi from fresh and spoiled food products
4	Determination of the quality of milk by MBRT
5	Demonstration of serological tests: blood groups, Rh factor determination, pregnancy test, Widal, VDRL, ELISA
6	Antibiotic sensitivity test and MIC determination

Course Code: - IMB 304
Course Title: Compulsory Project
Credits: 0+4

Course Code: IMB 305 (B017601T)	
Course Title: Molecular Biology and Microbial Genetics	
Credits:4+0	
Unit	**Topics**
I	**Overview of the genome organization** DNA/and RNA as genetic material, DNA double helix structure salient features, types of DNA. RNA Structure. Denaturation and renaturation, cot curves. DNA topology: linking number, topoisomerases. DNA organization in prokaryotes, viruses, eukaryotes.
II	**DNA Replication in Prokaryotes and Eukaryotes** Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication. Mechanism of DNA replication, Replication of chromosome ends.
III	**Transcription in Prokaryotes and Eukaryotes** Concept of transcription unit. General transcription process in prokaryotes and eukaryotes; Post-Transcriptional modification in eukaryotes, Aternative splicing mechanism, RNA interference
IV	**Translation in prokaryotes and eukaryotes** Ribosome structure, tRNA structure and processing, Mechanism softranslation in both prokaryotes and eukaryotes, Genetic code, Wobble hypothesis, Fidelity of translation
V	**Regulation of gene expression** in prokaryotes and eukaryotes Overview of regulation of gene expression, Regulation of gene expression by DNA methylation, histone acetylation and histone methylation mechanisms; Transcription control mechanisms, Inducible Operon System, Repressible Operon System, Translation control mechanisms.
VI	**Plasmids in prokaryotes and eukaryotes** Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number, curing of plasmids. Types of plasmids.
VII	**Bacterial gene exchange processes** Mechanisms of Genetic Exchange, Horizontal gene transfer, Transformation; Conjugation; Transduction, Complementation.
VIII	**Mutations, mutagenesis and repair** Types of mutations, Physical and chemical mutagens. Loss and gain of function mutants. Reversion and suppression, Uses of mutations. Ames Test, DNA repair mechanism

Course Code: IMB 306 (B017602T)	
Course Title: Computers, Bioinformatics & Biostatistics	
Credits: 4+0	
Unit	**Topics**
I	**Introduction to Computers** Classification, Computer generation, low medium and high level languages, computer memory and its type. Data representation & storage.
II	**Microsoft Excel** Data entry, graphs, aggregate functions, conversion devices, secondary storage media.
III	**Bioinformatics** Overview and scope of bioinformatics, Genomics, Transcriptomics Proteomics, Metabolomics, Programming languages in bioinformatics.
IV	**Introduction to biological database** Primary secondary & composite data base. Computer tools for sequence analysis.
V	**Sequencing and alignment** Finding and retrieving sequences (SRS, Entrez). Gene sequencing, Protein sequencing Sequence submission tools. Similarity searching, pairwise and multiple sequence alignment
VI	**Biostatistics** Definition, Statistical Methods, compilation, classification, tabulation and application in Life Science, Graphical representation, Introduction to probability theory & distributions, Limitation and uses of statistics
VII	**Biometry** Data, Sample, Population, random sampling stratified systematic and cluster sampling procedure frequency distribution. Central tendency, Arithmetic mean, Mode and Median.
VIII	**Measurement of dispersion** Coefficient of variation standard deviation, standard error of mean, Test of significance: Chi-Square test. Computer application of biostatistics – MS Excel and SPSS.

Course Code: IMB 307 (B017603P)	
Course Title: Molecular Biology and Bioinformatics Lab	
Credits:0+2	
S. No.	**Objectives**
1	Isolation of genomic DNA from *E. coli* and analysis by agarose gel electrophoresis.
2	Estimation of DNA using diphenylamine reagent.
3	Resolution of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) and visualization using coomassie dye.
4	Study of the effect of chemical (nitrous acid) and physical (UV) mutagens on bacterial cells.
5	Acquaintance with the bioinformatics websites
6	Sequence alignment using clustal W2, Clustal Omega

Course Code: - IMB 308
Course Title: **Compulsory Project**
Credits: **0+4**