

PCR amplification of DNA
Electrophoresis of DNA/RNA/Protein.
Isolation of DNA/RNA from plant, animal cell, bacteria.
Restriction digestion, ligation of DNA and cloning

M.Sc. Final Examination 2022
Paper- 5: Industrial and Food Microbiology
Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

Maximum Marks: 75

Duration: 3 Hrs

Minimum Passing Marks: 19

UNIT-I

Introduction to fermentation processes, history of fermentation process.
Bioreactors: Design and components- vessel materials, baffles, impellers, inoculation and sampling devices etc., biohazard and containment.
Use of biosensors in fermentation process.
Types of bioreactors: airlift, fluidized bed, micro carrier, photo bioreactor, stirred bioreactor.
Immobilization of cells and its industrial application (Pharmaceutical, food and chemical industries).

UNIT-II

Isolation, preservation and maintenance of industrially important microorganisms.
Selection and screening of microorganism for industrial processes.
Formulation of fermentation media: energy source, water, nitrogen source, minerals, chelators, growth factors, buffers, precursors, inhibitors and antifoam agents, Optimization of media. Media and air sterilization.

UNIT-III

Types of fermentation processes with Growth kinetics: Batch, continuous and fed batch. Downstream processing: foam separation, cell disruption, industrial scale centrifugation, liquid-liquid extraction, solvent recovery, chromatography, two phase aqueous extraction, supercritical fluid extraction, drying and crystallization.

UNIT-IV

Production process for food supplements: Yeast (Bakers, food and fodder), Single cell protein (SCP), Single cell and Single cell oil (SCO).
Production process for acids: Lysine, Glutamic acid, lactic acid and Citric acid.

Production process for alcohols and alcoholic beverages: Ethanol, Beer, Wine and Whisky.

Production process for food products: Sauerkraut, Bread, Cheese, Yoghurt.

Production process of enzymes for amylases and proteases.

Production process for antibiotics: penicillin, streptomycin and tetracycline.

Production of vitamins: Vitamin B, Riboflavin fermentation

UNIT-V

Production of non-microbial product through GEMs: insulin, interferon, cell growth factors, tissue plasminogen activator. Biogums, Bioplastic (PHB, PHA), Biochips and nanotechnology. Steroid transformation. Production of bioinsecticides.

Vaccine types: live, attenuated and recombinant and their production.

Parameters Affecting Microbial Growth in Foods: Intrinsic, Extrinsic. Food Preservation & Principles of Quality Control: Chemicals, antibiotics, Radiation, Low and high temperature, High-Pressure Processing. Aseptic Packaging, Microbiological quality standards of food, FDA, HACCP, ISI.

Microbial Food Spoilage and Food borne diseases: Staphylococcal, *E. coli*, Salmonellosis, shigellosis. Mycotoxins, Aflatoxins, and viruses.

Suggested Readings

Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore, 2000.

Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker & S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.

Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA., 2007.

Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.

Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989

Industrial Microbiology: An Introduction by Waites, Morgan, Rocky & Highton, Blackwell Science, 2001.

Biochemical Engineering and Biotechnology by B. Atkinson & F. Mavituna, The Nature Press, 1982

Microbial Biotechnology: Fundamentals of Applied Microbiology by Glazer & Nikaido, W.H. Freeman and Co., New York, 1995.

Modern Food Microbiology, 4th edition by J.M. Jay, Springer, 2006.

Fundamental Food Microbiology, 3rd edition by B. Ray., CRC press, 2006.

Food Microbiology: Fundamentals and Frontiers, 2nd edition by Michael P. Doyle, Larry R. Beuchat, Thomas J. Montville, ASM press, 2001.

Food Microbiology by M.R. Adams & M.O. Moss., Royal Society of Chemistry, 2000.

Food Microbiology by M.R. Adams, Royal Society of Chemistry, 2008.

Paper- 6: Microbial Ecology and Environmental Biotechnology

Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

Maximum Marks: 75

Duration: 3 Hrs

Minimum Passing Marks: 19

UNIT-I

Aero Microbiology : Droplet nuclei, aerosol, assessment of air quality,-solid - liquid - impingement methods,- Brief account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures. Assessment of air quality for microbial loads.

Aquatic microbiology: Water ecosystems - types -fresh water (ponds, lake, streams) - marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral-reefs). Zonations of water ecosystems -upwelling -eutrophication - food chain. Potability of water- microbial assessment of water quality- water purification - brief account of major water borne diseases and their control measures.

UNIT-II

Inter species interactions: Antagonism, competition, commensalisms, synergism, parasitism and predation. Gansse's and Hardin's principles of competition. Defense mechanisms (specific and non specific) of microorganisms.

Beneficial interactions of microbes with animals: Symbiosis of roaches and bacteriodes, bacteria and protozoa, algae and invertebrates. Symptiotic cellulose digestion in insects and vertebrates. Rumen microbiology, digestion, fermentation and detoxification by microbes, factors influencing rumen microbes.

UNIT-III

Microbial ecology: Concepts, microbial behavior in ecosystems, microbial biodiversity, interaction among the microbial populations, development of microbial communities. Oxygenic photosynthetic microbes and anoxygenic photosynthetic microbes. Oxidative transformation of metals: sulfur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation. Environmental stresses

UNIT-IV

Waste water treatment : Wastes - types- solid and liquid wastes characterization- solid - liquid; treatments- physical, chemical, biological- aerobic- anaerobic -primary - secondary- tertiary; solid waste treatment - saccharification- gasification- composting, utilization for solid wastes - (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer(composting), liquid waste treatment- trickling- activated sludge-oxidation pond- oxidation ditch. Subterranean microbes and bioremediation

UNIT-V

Biodeterioration and biodegradation: microbial degradation of paints, plastics, rubber, pharmaceuticals, paper, leather, wood, wool, petroleum and petroleum products, degradation of xenobiotics, pesticides and polymers. Microorganisms involved -its disadvantages- mode of prevention. GMO and their impact, Bioremediation.

Suggested Readings

Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA., 1993.

Environmental Microbiology by A.H. Varnam & M.G. Evans, Manson Publishing Ltd., 2000.

Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.

Environmental Microbiology by W.D. Grant & P.E. Long, Kluwer Academic Publishers, 1981.

Paper- 7: Geomicrobiology, Soil & Agricultural Microbiology

Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

Maximum Marks: 75

Duration: 3 Hrs

Minimum Passing Marks: 19

UNIT-I

Geomicrobiology: Origin of microbial life, Chemical and Biological evolution. Geomicrobiology of fossil fuels. Bioleaching and biomining.

Soils: Origin and evolution, soil profiles. Major physiochemical and biological characteristics. Soil microflora: distribution and contribution to ecosystem.

Biogeochemical cycles: Carbon cycle, Nitrogen Cycle, Phosphorus cycle, Sulphur cycle, Iron and Manganese cycle.

UNIT-II

Decomposition of Plant Litter: Microbes involved, fermentation of plant litter, Agricultural and urban waste compost, vermicompost, mushroom compost, silage, methane production, biogas plants.

Microbiology of Rhizospheres, phyllosphere and spermosphere, Mycorrhizal associations, Rhizobial and actinorhizal root nodules and stem nodules and nitrogen fixation.

UNIT-III

Plant Diseases: Physiology of parasitism, mechanism of disease resistance, host parasite relationship. Symptomatology and control measure of various diseases.

Viral diseases: TMV, Yellow vein mosaic of Bhindi, Papaya leaf curl, Cucumber mosaic and Tobacco necrosis.

Bacterial diseases: Citrus canker, Crown gall

Fungal diseases: Green ear of bajra, Cotton wilt, Tikka disease of groundnut, Wheat rusts and Loose and Covered smuts.

Mycoplasmal diseases: Witches broom of potato, Stripe disease of sugarcane

UNIT-IV

Microbial pathogens of plant roots and shoots, their control by competition and antagonism; importance of *Trichoderma viride*; *T.harzianum*; *Streptomyces*, *Rhizobacteria*, *Mycorrhiza* and *Thiobacillus* on the control of plant root pathogens; control of aerial pathogens, prophylaxis, pre-inoculation, and immunization with avirulent pathogens; role of microorganisms in protecting the wounds of trees; techniques of application of microorganisms for control of microbial diseases; seed treatment, aerial spray and soil treatment

UNIT-V

Biofertilizers: Production technology, standards, storage and application methods for *Rhizobium*, *Azotobacter*, *Azospirillum*, *Cyanobacteria*, *Azolla*. Biological nitrogen fixation - nitrogenase enzyme - nif genes; symbiotic nitrogen fixation - (*Rhizobium*, *Frankia*)- non-symbiotic microbes- *Azotobacter*-*Azospirillum* PSM, Cellulolytes, VAM and PGPR.

Microbial pesticides: biology and chemistry of the biocidal component, mode of action, effect on target organisms, production technology and commercial microbial pesticides.

Microbial insecticides; advantages of microbial insecticides, limitations-Mass production techniques; fermentation, formulation of insecticides, carrier materials quality control etc; compatibility of microbial and chemical insecticides; suitable insecticides for major pests; field application of microbial insecticides and its perpetuation.

Suggested Readings

Introduction to Geomicrobiology, Konhauser K. BlackWell Publishing, USA, 2007

Geomicrobiology and Biogeochemistry. Parmar N. & Singh A. Springer Heidelberg New York Dordrecht London, 2014

Plant Pathology by Agrios G. N. Academic Press, San Diego;1997.

The Nature and practice of Biological Control of Plant Pathogens by Cook R. J. & Baker K. F.; 1983.

AmericaPhytopathological Society Press, St. Paul, MN.

Environmental Biotechnology by Forster C. F. & John D.A. Ellis Horwood Ltd. Publication;2000.

A Manual of Environmental Microbiology by Christon J. H. ASM Publications;2001.

Soil Microbiology by Rao, N.S.S. Oxford & IBH Publishing Co., New Delhi;1999.

Paper- 8: Medical Microbiology & Immunology

Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

Maximum Marks: 75

Duration: 3 Hrs

Minimum Passing Marks: 19

UNIT –I

Early discovery of pathogenic microorganisms. Normal microbial flora of human body; role of the resident flora. Nosocomial infection, common types of hospital infections and their diagnosis and control. Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts, Role of aggressins, depolymerizing enzymes, organotropisms, variation and virulence.

UNIT-II

Important diseases of human beings (short description of causal agent, pathogenesis, diagnosis, vaccine and treatment)

Bacterial diseases: Typhoid, Syphilis, Cholera, Gonorrhoeae, Tuberculosis, Diphtheria, Tetanus, Plague Botulism, Meningitis, Pneumonia, Enteritis.

Viral diseases: Influenza, Herpes, AIDS, Rabies, SARS, Human Pox, Yellow fever, Encephalitis Mumps and Measles.

Fungal diseases: Ringworm, Histoplasmosis.

Mycoplasmal diseases: inflammation of genitals, upper respiratory tract infection

Important bacterial (Anthrax, Black quarter, Tuberculosis, Brucellosis, Contagious pleuro pneumonia) and viral (Foot and mouth disease, Rinderpest, Cow pox, Sheep pox, Rabies, blue tongue) diseases of domestic animals (causal agent epidemiology, pathogenesis, diagnosis, vaccine and treatment).

UNIT-III

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and Schedules; passive prophylactic measures; Prokaryotic signaling mechanisms: Quorum sensing and bacterial pheromones, intracellular signaling, signaling pathways.

UNIT-IV

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation, Adaptive immunity. Cells and Organs of Immune System.

Antigens: Structure, properties, types, epitopes, haptens. Antibodies: Structure and function, antibody mediated functions, classes and biological activities. Monoclonal antibodies. Antigen-Antibody Interaction. Major Histocompatibility Complex- structure, functions, function and genes.

UNIT-V

Cytokines (Properties, receptors, antagonism & secretion). The complement system (functions, components, activation, regulation and deficiencies). Cell mediated effector responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity. Hypersensitive reactions (Type I,II,III and delayed type (DTH)).

Immune response to infectious diseases: viral, bacterial and protozoan. Vaccines. Immuno-deficiencies.

Transplantation; Graft rejection, mechanism and prevention, HLA and disease.

Autoimmunity; Organ specific and systemic, Autoantibodies, experimental models

Suggested Readings

Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E, Adelberg EA . 23rd edition. Lange Publication. 2004.

Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2nd edition. American Society for Microbiology Press. 2005.

Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society for Microbiology Press, Washington, DC USA. 2002.

Pathogenomics: Genome analysis of pathogenic microbes by Hacker J and Dörbandt U. ed. Wiley-VCH. 2006.

Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Versalovic J, Tang Y, Unger ER, Relman DA, White TJ eds. American Society for Microbiology Press, 2004.

Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM, Graham NMH eds. An Aspen Publication. 2001.

PRACTICAL

Isolation and cultivation of *Azotobacter*, *Rhizobium*, *Azospirillum*, *Cyanobacteria*, *Actinomycetes*, *Mycorrhiza*.

Soil analysis and soil microbial count.

Studies of soil protozoa.

Studies of soil Mycology.

Studies of bacterial, fungal and viral diseases and their diagnosis.

Study of airborne pollen and fungal spores.
Microbial examination of water, food and milk.
Laboratory production of Penicillin, Curd, Mushroom, Fermented food
Activity of amylase, cellulase and catalase.
Effect on growth of microbes-
Temperature, (b) Aeration, (c) pH, (d) Nutrients.
Normal micro flora studies of skin, Respiratory tract, Gastro-intestinal tract, uro-genital tract and important organisms causing disease in the above mentioned tracts.
Study of Leprosy, Tuberculosis, Brucellosis, Typhoid, Cholera, Syphilis, Meningitis, Herpes, AIDS disease of human beings by visiting near by hospital.
Study of Mastitis, Metritis, Anthrax, Rinderpest and Ranikhet, disease in animals and birds by visiting near by animal hospital.
Isolation of one pathogenic organism.
Ochterlony double diffusion, agglutination test, Fluorescent Antibody test.
Examination blood.
Examination urine.
Examination sputum.
Blood group and Rh factor.
ELISA test for AIDS.
Cultivation of animal cells.
Callus growth technique.
Testing of milk by MBRT.
Serological tests: Radio immuno-diffusion, Immuno-electrophoresis, DOT ELISA, Sandwich ELISA,

Paper-RP/CS

Scheme of examination

The student shall prepare a report of his/her work carried out as mentioned below and shall present it to the external examiner. The examiner will evaluate the work carried out and shall award the marks accordingly.

Maximum Marks: 50

Duration: 10 min per student

Minimum Passing Marks: 13

The student will select a topic of research in consultation with his/her supervisor/guide to do a research work or carry out a case study on any topic related to microbiology or allied sciences.