

General Microbiology

Milestones of the historical development of Microbiology- Discovery of Microorganisms- Contributions of Scientists of Microbiology. Theory of spontaneous generation and biogenesis. Different types of microscopes, their construction and working principles, Simple and Compound microscope. Stereomicroscope. Principles, construction and mode of operation of Scanning and transmission electron microscope, limitations. Preparation of specimens for electron microscopic studies. Simple staining (positive and negative), differential staining (Gram's staining and acid fast staining), structural staining (Capsule, Flagella, Cell wall and Endospore of bacteria), nuclear staining, wet mounting method staining of algae and fungi. Hanging drop method. Principles and methods of sterilization.

The Microbial World

Groups of microorganisms: Viruses, Prokaryotes, and Eukaryotes. Study of ultra structure of typical prokaryotic cell and eukaryotic cell, comparative account. General Principles of classification and nomenclature of microorganisms (Haeckel's three kingdom classification and Whittaker's five kingdom classification). General characteristics of viruses, classification of viruses, isolation and identification of viruses. Study of structure and replication of viruses: Bacteriophages T4 phage, Cyanophages. Phytophagenae TMV, Zoophagenae Influenza and HIV. Viroids and Prions. Ultra Structure of bacterial cell, classification of bacteria in brief as per Bergey's Manual of Systematic Bacteriology. Distribution, structure of typical algal cell. General thallus structure and reproduction in algae and fungi.

Microbial Growth and Metabolism

Major nutritional types of microorganisms. Nutritional requirements of microorganisms. Uptake of nutrients passive and active transport. Microbial

Growth rate and generation time, growth curve phases of growth and their significance. Nomenclature, classification, properties of microbial enzymes mode and mechanism of enzyme action, enzyme regulation, inhibition, cofactors and coenzymes. Photosynthetic microorganisms, photosynthetic pigments and apparatus in prokaryotes and eukaryotes. Mechanism of photosynthesis in bacteria. Anaerobic Respiration: breakdown of glucose to pyruvate EMP, HMP and ED pathways, Fermentation- conversion of pyruvate to ethanol and lactic acid. Aerobic Respiration: formation of acetyl CoA from pyruvate, TCA Cycle, Electron transport and oxidative phosphorylation, efficiency of aerobic and anaerobic respiration as energy yielding processes. Symbiotic and asymbiotic nitrogen fixation, nodule formation, bacteroids, leghaemoglobin, mechanism and biochemistry of N₂ fixation, amino acid synthesis, proteolysis, nitrification and denitrification. Biosynthesis of fatty acids, biosynthesis of triglycerides and phospholipids, degradation of fatty acids, oxidation of fatty acids.

Microbial Genetics

Chromosomes: Prokaryotic and eukaryotic organization. Recombination in Bacteria: Transformation, Transduction and Conjugation process – F – factor, Sexduction, Transposons. Extrachromosomal genetic elements and their importance. Structure and types of DNA and RNA. Replication – mode and mechanism, replication in prokaryotic DNA – general methodology, Gene – protein relationship: one gene – one enzyme and one gene – polypeptide concept. Protein synthesis – transcription and translation, genetic code – features, triplet code, Wobble hypothesis, nonsense codon, evolution of genetic code, regulation of gene expression in prokaryotes. Nature and types of mutation. Mutagenic agents: physical and chemical mutagens, damage and repair of DNA: Photoreactivation & SOS repair

Environmental microbiology

Microbes and atmosphere, Air spora of indoor and outdoor environment, factors affecting air spora, significance of air-borne microbes, management of airborne microbes. Microbiology of water: distribution of microorganisms in the aquatic environment. Water pollution: Sources, water-borne diseases-viral (jaundice), bacterial (cholera) and protozoan, (amoebic dysentery). Biological indicators of water pollution. Determination of sanitary quality of water: SPC, Tests for coliform, MPN, IMVIC reactions, membrane filter technique. Microbiology of waste water: Sources of waste water- domestic, agricultural and industrial, physical, chemical and microbiological characteristics of waste water. Waste water treatment: Single dwelling unit – septic tank: municipal waste water treatment- Primary, secondary (trickling filter, activated sludge process, oxidation pond), Tertiary (reverse osmosis, ion exchange method and dialysis) and reclamation of waste water. Solid waste recycling: Anaerobic digestion process, Biogas and composting

Genetic engineering

Tools involved in genetic engineering: Modifying enzymes: Restriction enzymes, ligases, methylases. Cloning vehicles – Naturally occurring plasmids, cloning plasmids (PBR 322 and PUC 18). Viruses as cloning vehicles (DNA, M 13) and hybrid vectors (cosmid, yac). DNA isolation, gel electrophoresis: Agarose gel-principle and method transformation methods. DNA libraries: Brief account of Genomic and cDNA libraries – applications. Blottings: Southern, Northern and Western. DNA sequencing: Brief account of Maxam and Gilbert’s methods, Sanger’s method, automated sequencing method. Restriction fragment length polymorphism. Molecular probes (Finger printing). Applications of genetic engineering in Agriculture, Waste water management, Industries, Human health, Potential problems of genetic engineering; social impact of genetic engineering.

Microorganisms in agriculture

Biofertilizers: Nitrogen fixing, Phosphate solubilizing and cellulolytic microbes, mass production of bacterial inoculants (Rhizobium, Azotobacter, Azospirillum, cyanobacteria) mode of applications, advantages and limitations. Biological control: mechanism of antagonism, amensalism, competition predation and parasitism. Application of biological control on field. Biopesticides: types – bacterial, viral, fungal and protozoan, mode of action, target pests, use of transgenic plants. Rhizosphere microorganisms: Rhizosphere and rhizoplane, interactions among micro organisms – neutralism, mutualism, commensalisms, antagonism and parasitism Plant – microbe interaction – mycorrhizae. Plant pathology: classification of plant diseases, principles of infection and spread of diseases in general.

Food Microbiology

Food as a substrate for growth of microorganism's. Microbial spoilage of food and food preservation techniques. Microbial spoilage of food – Fruits, vegetables, meat, poultry, canned foods. Important methods of food preservations. Physical method- High temperature, Canning, Low temperature, Drying, radiation and Chemical preservatives. Mycotoxin with reference to Aflatoxin, Staphylococcal intoxication, Botulism, Salmonellosis. Food safety and quality control. A brief account of food laws and standards. Sources of milk contamination. Methods to detect microbial spoilage by SPC, Reductase test, Biochemical changes of milk. Starter culture and its role. Fermented dairy products. Acidophilus milk, Yogurt, Butter milk, Srikhand. Types of cheese, Preparation of cheese. Preservation of milk and milk products – Pasteurization, Sterilization.

Industrial Microbiology

Microorganisms of industrial importance. Types of stock culture. Strain improvement. Fermentation media : A brief account of Production medium, Inoculum medium, Raw materials – Molasses and types, corn steep liquor, sulphite waste liquor and whey, Buffers, Precursors, Inhibitors, and Antifoam agents.

Design of typical fermentors, Devices for aeration, agitation. Fermentation process-Surface, Submerged and Solid state fermentation: Types-Batch and Continuous fermentation. Down stream processing – Precipitation, filtration, centrifugation, distillation, cell disruption, solvent recovery, drying, crystallization Industrial production and its uses of the following: Ethyl alcohol, Wine Antibiotics – Penicillin. Organic acid – Lactic acid. Enzymes – Amylase, Protease, Single Cell Protein, Mushroom cultivation, Role of microorganisms for production and recovery of minerals and petroleum.