

Part I-Research Methodology

UNIT I: Introduction to Research Methodology

Research: meaning, definitions, scope, objectives, characteristics, importance, types, essential steps, significance, problems; Qualities of a good researcher; Experimental design; literature collection, review and citation. Methods of data collection, types of data, case and field studies. Sampling methods: Need for sampling, some fundamental definitions, sampling theory. Analysis and writing of research reports, abstracts, dissertation, synopsis, thesis, manuscripts, review papers, book reviews, conference and project reports; Bibliography and references, indexing, tables and illustrations. Research establishments, Research funding agencies and product development.

UNIT II: Computer and Internet Applications

Basic knowledge of computers, hardware and software, basic programmes, languages; Introduction to spreadsheet applications, features, using formulas and functions, data storing, features for statistical data analysis, generating charts/graph and other features using Microsoft excel or similar. Introduction to presentation tools, features and functions, power point presentation, internet browsing, WWW, use of search engines, biological data bases. Computer networking LAN and WAN. General awareness of popular commercial software packages and other Scientific application packages.

UNIT III: Biostatistics and Bioinformatics

Random sampling, use of random number tables. Classification & representation of data, histogram, frequency curve, pie chart. Normal and binomial distribution. Probabilities, error estimation, confidence levels, mean estimation, variance & standard deviations. Hypothesis and hypothesis testing, students "t" test, Chi-square test, test of independence, Anova.

Bioinformatics: database types, applications and limitations; Literature search databases - PUBMED, MEDLINE; Nucleic acid and protein databases - NCBI, EMBL, DDBJ, SWISS PROT, UNIPROT, etc.; Biotechnological databases - EST, STS, GSS, HTG, SNP, etc. iv. Web tools and resources for sequence analysis; Pair-wise and multiple sequence alignment; Sequence similarity search; BLAST & FASTA; Pattern recognition; Motif and family prediction; Restriction map analysis; Primer design; Gene prediction; Phylogenetic Tree.

UNIT IV: Research Ethics & IPR

Perspective of ethics, personal vs professional ethics. Moral reasoning, ethical theories, deontological, utilitarianism, ethical leadership (integrity and ingenuity). Framework for ethical decision making. Plagiarism software, intellectual property rights, types, patents, copy rights, trade marks, design rights, geographical indications. Patentable and non-patentable, legal protection of biotechnological inventions, world intellectual property rights organization (WIPO).

UNIT V: Biosafety Guidelines

Introduction to biosafety, biosafety issues in life sciences, risk assessment and risk management. Safety protocols, risk groups, biosafety levels, biosafety guidelines and regulations (National and International), Types of biosafety containment; depository regulation, national & international centres for biological databases.

UNIT VI: Research Tools and Techniques:

Chromatography-Thin layer, Gas, Column, Ion exchange and Gel exclusion chromatography. HPLC Affinity chromatography and Immunoabsorption.

Electrophoresis: Polyacrylamide gel electrophoresis (PAGE) – Nucleic acid and sequencing gels - Agarose gel electrophoresis, Two dimensional electrophoresis -Pulse Field Gel Electrophoresis (PFGE) isoelectric focusing - Gel documentation. Blotting - Western, Southern and Northern blots. PCR Techniques.

Colorimetry - ultraviolet - visible spectrophotometry - principles, instrumentation - applications, Fluorescence spectrophotometry. ELISA. Centrifugation - principles and instruments - applications. Enzymology- enzyme assay, enzyme activity and specific activity.

REFERENCES:

- A. Leon and M. Leon, Internet for Everyone, Vikas publishing House.
- Attwood T. K. and Parry-Smith D. J., (1999). Introduction to Bioinformatics Addison Wesley Longman Limited, Harlow.
- Everitt, B. S., and Hothorn, T., (2010). A Handbook of Statistical Analyses Using R, Second Edition, Chapman and Hall, CRC Press.
- Garg B. L., Karadia R, Agarwal F, and Agarwal, U. K., (2002). An Introduction to Research Methodology, RBSA Publishers.
- Gupta S. P., (2008). Statistical Methods, 37th Ed. (Rev) Sultan Chand and Sons, New Delhi. 1470 P.

- Kothari C. R., (2008). Research Methodology: Methods and Techniques, 2nd Ed. New Age International (P) Ltd, Publishers, New Delhi.
- Pranavkumar, (2016). Fundamentals and Techniques of Biophysics and Molecular Biology. Pathfinder publication. Publishing House.
- Upadhyaya A., Upadhyaya K. and Nath N., (2009). Biophysical Chemistry, Himalayan
- Wilson and Walker (2000). Practical Biochemistry- Principles and Techniques. J. Cambridge Uni. Press.

Part II-Microbiology(Core)

Introduction to Microbiology

General account, ultrastructure, nutrition, reproduction, biology, salient features, classification and economic importance of archaebacteria, eubacteria, cyanobacteria, viruses, phytoplasmata, fungi, mycoplasma and algae. An account of virions, mycorrhizae, lichens and mushrooms.

Biomolecules

Structure of atoms, molecules and chemical bonds; Composition, structure and function of carbohydrates, lipids, proteins, nucleic acids and vitamins; Enzymology: Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes; Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

Cell and Molecular Biology

Membrane structure and function; Structural organization and function of intracellular organelles; Organization of genes and chromosomes; Cell division and cell cycle. Cell communication and cell signaling: DNA the genetic material DNA replication, repair and recombination Molecular nature of gene-gene function. Nucleic acids-Physical and Chemical structures of DNA-forms of DNA helix- size. Denaturation-Renaturation. Circular and superhelical DNA. RNA synthesis and processing; Protein synthesis and processing; Control of gene expression at transcription and translation level.

Immunology

Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity; congenital and acquired immunodeficiencies, vaccines. Immunological methods and diagnostic immunology.

Microbial Genetics

Generalized reproductive cycles of microbes; Viral lytic and lysogenic cycles, Phage phenotypes, phenotypic mixing, Recombination in viruses: Mapping of rII loci; Fungal genetics: *Neurospora* Tetrad Analysis linkage detection-2 point and 3 point crosses, chromatic and chiasma interference;

Mitotic recombination; Unordered tetrad analysis. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests; Gene mapping methods: Linkage maps, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Extra nuclear (Cytoplasmic) inheritance in Algae; Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating; Mutation: Types, causes and detection.

Genetic Engineering

Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, separation methods; Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels; Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; Expression of recombinant proteins using bacterial, animal and plant vectors; Isolation of specific nucleic acid sequences; Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. Protein sequencing methods, detection of post translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques; Isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques

Microbial Techniques

Microscopic techniques: light microscopy, scanning and transmission microscopes, different fixation and staining techniques, electron microscopy, image processing methods in microscopy. Histochemical and Immunotechniques: Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, FISH and GISH. Biophysical Method: Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods. Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. Methods of control of microorganisms by physical and chemical methods; Evaluation of antimicrobial agent effectiveness; media preparation and their types; Biological oxygen demand and Chemical oxygen demand; Pure culture techniques; identification, cultivation, maintenance and preservation of microorganisms.

Agricultural Microbiology: Physical and chemical characteristics of soil; microbiology of soil; Microbial ecology – nature of soil organisms and their interactions; mycorrhizal symbiosis; Rhizosphere and spenosphere, biofertilizers; biological nitrogen fixation; Nitrogenase enzyme complex; new developments in nitrogen fixation. Plant diseases caused by microorganisms; Microbial control of insect pests; interaction of pesticides with soil microorganisms; Effects of microorganisms on pesticides. Effect of plant protection chemicals on soil microorganisms; Microbial herbicides, biopesticides, integrated pest management. Strategies in bioconversion – utilization of farm wastes and residues in agriculture – microorganisms as a source of protein for animal nutrition – bioconversion of lignocelluloses into protein – rich food and feed. Production of biogas, ethanol from biomass. Mushroom cultivation. Reclamation of barren lands using microbial technology.

Medical Microbiology: Introduction of medical microbiology – Infective aetiology of human diseases, microbial virulence factors; Infection Diseases process – diagnosis – process of sample collection, transport and examination of the specimens; morphology culture characteristics, pathogenicity and laboratory diagnosis of Gram positive and Gram negative bacteria; Virology: Basic concept of virology – general properties of human viruses, Approaches to viral diagnosis – serological and molecular techniques. Pathogenicity and laboratory diagnosis of viral infections; Mycology: General properties and approaches to laboratory diagnosis. Mycosis superficial, Subcutaneous and Systemic infections; Parasitology: pathogenicity and laboratory diagnosis of important human and animal parasites. Infective Syndromes, Septicemia, Diarrhoeal diseases, Soft tissue and wound infections, Nosocomial infections

Food & Dairy Microbiology: Intrinsic and Extrinsic factors of microbial food spoilage; Microbial spoilage of Meat, poultry, fruits, vegetables, cereals, and thermally processed products; Physical and Chemical food preservation methods; Food preservatives. Detection and control of food-borne and water-borne pathogens; toxins and food poisoning; mycotoxins, modification and detoxification; Prevention and control of toxin contamination of food. Composition of milk; role of microbes in milk and dairy products: Microbiological examination of milk; Manufacture of cheeses, butter, yoghurt and fermented milk; Probiotics and Prebiotics.

Industrial Microbiology: Industrially important microorganisms; Sources and characteristics of industrially potent microorganisms, their isolation, purification & maintenance; Screening and strain improvement; Microbial growth kinetics in batch, continuous & fed-batch fermentation process. Design of Fermenters; Raw materials used in industrial fermentation media. Solid state fermentation & submerged fermentation; Microbial production of organic acids, amino acids, vitamins, ethanol for beverages and biofuel. Microbial production of antibiotics, Microbial transformation of steroids & alkaloids; Bioleaching of minerals; Immobilization of microbial enzymes and cells and their applications Clinical uses of antimicrobial drugs, Microbial spoilage and preservation of pharmaceutical products, Sterilization of pharmaceutical products, Applications of microorganism in the pharmaceutical sciences.

Environmental Microbiology: Environment and ecosystems; Characteristic features of thermophiles, psychrophiles, methanogens, methylotrophs, acidophiles, alkalophiles, halophiles and their survival strategies; Biodegradation and biogeochemical cycling; Microbial degradation of lignocellulosic substances, keratin and chitin; Xenobiotics; Microbes in nutrient cycling with special reference to carbon, phosphorous, sulfur and nitrogen; Microbiology of Air; Microbiology of Water; Biodegradation of paper, textile, wood, paint and metal and their protection methods; Bioremediation: Microbial degradation of pesticides; hydrocarbons; Bioremediation of sites polluted with oil spills, heavy metals and chlorinated solvents; Biomagnification. Biological treatment of industrial effluents (sugar, pulp and paper industry); Biological treatment of Sewage; Disinfection of potable water supplies; Bacterial indicators of water safety; Water quality standards; Aquatic blooms in water bodies.

References

1. Alcamo. 2001. Fundamentals of Microbiology Sixth Edition. By, Edward Alcamo. Jones and Bartlett Publishers, London.
2. Ananthanarayan and Paniker. 2017. Ananthanarayan and Paniker's Textbook of Microbiology- Tenth edition with booklet Reba, K. (Editor). Universities Press.

3. Aneja K.R., Jain P. and Aneja R. 2008. A Text Book of Basic and Applied Microbiology. New Age International Pub. New Delhi
4. Arora, D.R., and Arora B.B. 2012. Textbook of microbiology. Fourth edition. CBS Publishers.
5. Joanne Willey, Linda Sherwood and Christopher J. Woolverton. 2016. Prescott's Microbiology - 10 edition McGraw-Hill Education.
6. Pelczar M.J., Chan E.C.S. and Kreig N.R. 1986. Microbiology – 5th edn., Tata McGraw-Hill Pub. Co. New Delhi.
7. Purohit, S.S. 2008. Microbiology – Fundamentals and Application. Sixth Edition. Student Edition Publishers, Jodhpur.
8. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. 2007. General Microbiology Fifth Edition. McMillan Publishers, London.
9. Tortora, G.J., Funke, B.R., Case, C.L., Weber, D., and Bair, W. 2018. Microbiology: An introduction. 13th Edition. Pearson Publishers.
10. Veena. 2008. Microbiology. Sonali Publications.