

Karnataka State Open University, Mukthagangotri, Mysuru-570006

Ph.D. in Biotechnology

SYLLABUS FOR ENTRANCE TEST- 2023

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.

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- 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-Biotechnology (Core)

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.

Gene mapping methods: Linkage maps, tetrad analysis, 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.

Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating; Mutation: Types, causes and detection.

Cancer: Oncogenes, tumor suppressor genes, cancer and cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, chemotherapy.

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.

Developmental Biology

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Inheritance Biology

Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests.

Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination.

Diversity of life forms

Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants, animals and microorganisms.

Levels of structural organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.

Ecological Principles

The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Evolution and Behaviour

Emergence of evolutionary thoughts: Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.

Origin of cells and unicellular evolution: Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

Bioprocess and Microbial Technology

Primary and secondary metabolites, Batch culture, the growth cycle, effect of nutrients, energetics of growth.

Design of bioreactors: Biosensors, scale up of bioreactors

Transport phenomena in bioprocess: Mass transfer resistance, oxygen transfer coefficients, biological heat transfer, heat transfer coefficients.

Downstream processing of biologicals: Separation of cells, foam separation, flocculation, filtration, plate filters, rotary vacuum filter, centrifugation, Stokes law, basket centrifuge, bowl centrifuge, disintegration of microorganisms, mechanical and non-mechanical methods, membrane filtration, ultra filtration and reverse osmosis, chromatographic techniques, absorption, spray drier, drum dryers, freeze dryers.

Microbial products: Microbial production of vitamins, enzymes, organic acids, amino acids, antibiotics, ethanol.

Microbes for sustainable agriculture: Biological nitrogen fixation, Biofertilizers, Biological control, Biopesticides.

Plant Biotechnology

Cell and Tissue Culture Technology: Role of hormones in Callus Induction, Organogenesis, Somatic embryogenesis and synthetic seeds.

Micropropagation: Stages and applications.

Germplasm preservation: Short and long-term storages, gene banks, applications.

Haploid Technology: Methods of haploid culture and applications.

Protoplast Technology: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, applications of somatic hybrids.

Secondary metabolite production: Induction of secondary metabolites by plant cell culture; Bioreactor systems for mass cultivation of plant cells.

Seed Biotechnology: Seed development and structure, Hybrid seed production technology: Genetic determinants of flowering, seed development and germination, male sterility and apomixes.

Transgenics: Plant transformation techniques: Methods of gene transfer in plants, *Agrobacterium*-mediated gene transfer, direct gene transfer methods- electroporation, microinjection, particle bombardment, selection of transformants.

Transgenic plants: Herbicide resistance, resistance against biotic stress- bacterial, viral, fungal and insect resistance, abiotic stress, improved crop productivity, improved nutritional quality. Molecular pharming.

Animal Biotechnology

Culture of animal cells: Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation and routine maintenance.

Cell characterization: cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation, confocal microscopy. Stem cell culture and its applications

Cell and Tissue engineering: Growth factors for *in situ* tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts. Haemoglobin-based blood substitutes, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering.

In vitro fertilization and Embryo transfer: *In vitro* fertilization in Humans, Embryo transfer in Humans, Super ovulation and embryo transfer in farm animals e.g: Cow.

Cloning of Animals: Methods and uses. Introduction, nuclear transfer for cloning, cloning from- embryonic cells, adult and fetal cells. Cloning from short-term and long-term cultured cells: cloning of sheep, Cloning of cows from aged animals. human cloning: ethical issues and risks.

Transgenic animals: Transgenic animals and applications: mice and other animals,

Biosafety regulations- guidelines for research in transgenic animals, public awareness of the processes of producing transgenic organisms.

References

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