Savitribai Phule Pune University

(Formerly University of Pune)

Syllabus for Ph.D. Entrance Exam (PET): Biochemistry

RESEARCH METHODOLOGY

1 **Foundation of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method -understanding the language of research - Concept, Construct, definition, Variable. Research Process

2 **Problem Identification & Formulation:** definition and formulating the research problem, Necessity of defining the problem, Importance of literature review in defining a problem, Research Question - Investigation Question - Measurement Issues – Hypothesis - Qualities of a good hypothesis - Null hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & importance

3 **Research Design:** Concept and Importance in Research - Features of a good research design- Exploratory Research Design - Concept, Types and uses, Descriptive Research Design- concept, types and uses. Experimental Design - Concept of Independent & Dependent variables

4 **Qualitative and Quantitative Research:** Qualitative - Quantitative Research - Concept of measurement, causality, generalization, replication. Merging the two approaches

5 **Data Collection and analysis:** Execution of the research - Observation and Collection of data - Methods of data collection, hypothesis-testing - Generalization and Interpretation

6 **Measurement:** Concept of measurement - what is measured? Problem in measurement in research - Validity and Reliability. Levels of measurement - Nominal, Ordinal, Interval, Ratio.

7 **Sampling:** Concept of Statistical population, Sample, Sampling Frame, Sampling Error, Sample size, Non Response. Characteristics of a good sample. Probability Sample - Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample - Practical considerations in sampling and sample size

8 **Data Analysis:** data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis - Cross tabulations and Chi-square test including testing hypothesis of association

9 **Interpretation of Data and Paper Writing:** Layout of a Research Paper, Journals in chemistry, Impact factor of journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic databases for concerned discipline

10 **Use of tools / techniques for Research:** methods to search required information effectively, Reference Management Software like Zotero/mendeley, Software for paper formatting like LaTeX/MSOffice, software for detection of Plagiarism

11 **Reporting and Thesis writing:** Structure and components of scientific reports- Types of report - Technical reports and thesis - Significance - Different steps in the preparation - Layout, Structure and Language of typical reports - Illustrations and tables -Bibliography, referencing and footnotes - Oral presentation - Planning - Preparation -Practice - Making presentation - Use of visual aids - Importance of effective communication

12 **Application of results and ethics:** Environmental impacts - Ethical issues – ethical committees - Commercialization - Copy right - royalty - Intellectual property rights and patent law - Trade related aspects of intellectual property Rights - Reproduction of published material - Plagiarism

- citation and acknowledgement - citation and acknowledgement - Reproducibility and accountability

13 **Reasoning and Mentalability**: Analogy, Classification, Series, Coding-Decoding, Direction Sense, Representation Through Venn Diagrams, Mathematical Operations, Arithmetical Reasoning, Inserting the Missing Character, Number, Ranking and Time Sequence Test, Eligibility Test**,** Representation through Venn-diagrams, Number & symbols ordering, Comprehension questions, Statement & assumptions, Statement & conclusions, Statement & actions

Subject Concerned Syllabus
BIOCHEMISTRY

BIOMOLECULES

1 **The molecular logic of life**: The chemical unity of diverse living organisms, composition of living matter. Macromolecules and their monomeric subunits.

2 **Properties of water**: With interactions in aqueous systems. Ionization of water, weak acid weak bases.

3 **Carbohydrates**: Classification, basic chemical structure, general reactions and properties, biological significance, Sugar derivatives, deoxy sugars, amino sugars, and sugar acids.

4 **Lipids**: Classification, structure and function of major lipid subclasses-acylglycerols, Lipoproteins, chylomicrons, LDL, HDL and VLDL, rancidity. Formation of micelles, monolayers, bilayer, liposomes.

5 **Vitamins and Co-enzymes**: Classification, watersoluble and fatsoluble vitamins. Structure, dietary requirements, deficiency conditions, coenzyme forms and their mechanism.

6 **Amino acids**: Classification, Properties, reactions, rare amino acids.

7 **Protein classification**: Reactions, functions, properties and Solid phase synthesis,

8 **Structural levels of protein:**

   a. Primary Structure: Peptide bond, importance of primary structure.
   b. Secondary structure: X ray diffraction, alpha-helix, β - structure, β-helix, super secondary structure.
   c. Tertiary Structure: Forces stabilizing, unfolding/ refolding expt. Prediction of tertiary Structure
   d. Quaternary structure – hemoglobin.

9 End group analysis, sequencing and peptide synthesis

10 Ramachandran plot.

ENZYMOLOGY

1 Historical aspect: Remarkable properties, cofactors, nomenclature, classification, isoenzymes and multienzymes.

2 Enzymes kinetics: One-substrate reactions, effect of pH, temperature, inhibitions, two substrate reactions: theory, order analysis, pre-steady state kinetics, stopped flow technique, relaxation methods.

3 Mechanism of enzymes action: Theoretical background, factors leading to rate enhancement of enzyme catalyzed reactions, acid-base catalysis, proximity and orientation effects, covalent catalysis, strain or distortion and change in environment. Experimental approaches of

determination of enzymes mechanism: Kinetics studies, detection of intermediates, X-ray crystallographic studies, chemical modification of amino acid side chain and affinity labeling. Examples of chymotrypsin, triose phosphate isomerases, Lysozymes and Ribonuclease.

4 Regulation of Enzyme activity: Control of activities of single enzyme: Inhibitor molecules, availability of substrate or cofactor and changes in covalent structure of enzymes. Zymogen activation and phosphorylation, dephosphorylation, ligand binding and induced changes, allosteric enzymes, theoretical models, Hill equation, Adair equation, M.W.C. and K.N.F. Models, usefulness of the models. Significance of allosteric and cooperative behavior in enzymes.

5 Enzyme turnover: Kinetics of enzyme turnover, measurement of enzyme turnover, Ks and Kd, correlation between the rates of enzyme turnover and structure and function of enzymes, mechanism of enzyme degradation, significance of enzyme turnover

BIOPHYSICAL TECHNIQUES

1 UV and visible Spectophotometry.

2 Membrane filtration and dialysis: Nitrocellulose, fibre glass, Polycarbonate filters, dialysis and Concentration, reverse dialysis, freeze drying and lyophilization.

3 Chromatography techniques: Partition and adsorption Chromatography- paper, TLC, GLC, gel filtration, ion exchange chromatography: properties of ion exchangers, choice, HPLC, HPTLC, affinity chromatography, hydrophobic interaction chromatography, metal chelate chromatography, covalent chromatography. Special chromatographic techniques for nucleic acids: DNA cellulose chromatography, MAK hydroxyl-apatite chromatography, separation of DNA fragments according to their base composition.

4 Electrophoretic techniques: Types of electrophoresis: moving boundary electrophoresis and zone electrophoresis (paper, celluse-acetate electrophoresis, gel Electrophoresis (starch gel, native PAGE, disc PAGE, gradient PAGE, SDS-PAGE, agarose gel electrophoresis, Isoelectric focusing, 2D gel electrophorosis)

5 Isolation, purification and criteria of purity of proteins and enzymes & other biomolecules.

6 Sedimentation: Theory, Preparatory and analytical ultracentrifuges, factors affecting sedimentation velocity, sedimentation coefficient, measurement of S, Zonal centrifugation, DNA analysis, Determination of molecular weight by sedimentation, diffusion and sedimentation equilibrium methods. Specific example of application.

7 Partial specific volume and the diffusion coefficient, Measurement of partial specific volume and diffusion coefficients.

8 Viscosity: Theory, effect of macromolecules on the viscosity of a solution, measurement, molecular weight determination.

9 Isotope Tracer Technique: Types of radiations, measurement scintillation and gamma counters. Background noise quenching, free radicals and raidiolysis of Water and its applications. Interaction of radiation with matter, passage of neutrons through, matter, interaction of gamma rays with matter, units of measuring radiation absorption.

10 Autoradiography

11 Atomic Absorption Spectroscopy

12 X-Ray diffraction studies

13 Spectroscopic methods: (a) NMR, (b) ESR, (c) IR, (d) Fluroscence, (e) ORD and CD

14 Mass Spectrometry: LCMS, GCMS, MALDI-MS, MALDI-TOF-MS

15 Biosensors

MICROBIOLOGY

1 Cell structure and components, characterization and classification of microorganisms.
2 Microscopy: Theory, phase contrast microscopy, fluorescence microscopy and electron microscopy: Theory, specimen preparation, freeze etching, freeze fracture, shadow casting, electron microscopy of nucleic acids, TEM, SEM.
3 Cultivation of Bacteria, nutrition, physiology and growth of microbial cells, reproduction and growth, synchronous growth, continuous culture of microorganisms.
4 Pure cultures and their characteristics.
5 Fundamentals of control of microbial growth control by physical agents and chemical agents.
6 Production of mutants by chemical and physical agents and their characterizations.
7 Host microbe interactions, endotoxins, exotoxins, enzymatic and other factors, tissue affinity, resistance and immunity.
8 Viruses of bacteria, plant and animal cells: Structure, classification and life cycle, mycoplasma and viriods, diseases.
9 Industrial microbiology: production of lysine, glutamic acid, alcohol, vinegar, citric acid
10 Nitrogen fixation: Historical background, nitrogen cycle in nature, symbiotic nitrogen fixation, nitrogenase system, nitrate reductase.

CELL BIOLOGY

1 Cell classification, cell variability, size, shape and complexity, function
2 Animal cell : Structure, sub cellular components: Nucleus, chromosomes, plasma membrane, endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus, mitochondria, cytoskeleton, sub-cellular fractionation: Differential and density gradient centrifugation, specific staining of organelles and marker enzymes.
3 Cell division: mitosis, meiosis and cell cycle
4 Plant cells: Cell wall and its function, chloroplast, xylem, phloem and epidermal cells. The interaction and communication between the cells, cell-cell reorganization in plants, role of Golgi vesicles in plasma membrane, cell growth and division.
5 Fungi: Cell structure, classification and biological importance.
6 Cell-cell adhesion and the extracellular matrix, intercellular recognization, specific cell aggregation in sponges, cell junctions, extracellular matrix and role of collagen, elastin and fibronectin.
7 Germ cells and fertilization, stem cells, cell differentiation, organogenesis, functional and biochemical maturation of tissues.

BIOENERGETICS AND METABOLISM-

1 Introduction of metabolism and overview.
2 Bioenergetics: Basic low of thermodynamic, internal energy, enthalpy, entropy, concept of free energy, standard free energy change of a chemical reaction, redox potentials, high energy compounds, structure and significance of ATP
3 Glycolysis: Detailed study, energetics, regulation and significance.
4 Citric acid cycle: Detailed study, energetics, regulation and significance.
5 Electron transport and oxidative phosphorylation, ATP synthase and mechanism
6 Alternate pathways of carbohydrate metabolism: Pentose phosphate pathway, glyoxalate cycle, glucuronic acid pathway, inter conversion of hexoses, Pasteur effect.

7 Polysaccharide metabolism: Biosynthesis, degradation and regulation of glycogen, metabolism starch and cellulose, inborn error of carbohydrate metabolism.
8 Gluconeogenesis
9 Lipid metabolism: Beta oxidation of even and odd number carbon atoms fatty acids, energetics and regulation. Formation of ketone bodies, other types of fatty acid oxidation.
10 Biosynthesis of lipids: Requirements of carbon dioxide and citrate for biosynthesis, fatty acid synthase complex, regulation of biosynthesis. Biosynthesis of triglycerides, cholesterol and phospholipids.
11 Oxidative degradation of amino acids: Proteolysis, transamination, oxidative deamination, acetyl CoA, alpha ketoglutarate, acetoacetyl CoA, succinate, fumarate and oxaloacetate pathway. Decarboxylation, urea cycle, ammonia excretion.
12 Biosynthesis of amino acids: Amino acid biosynthesis, precursor functions of amino acids, biosynthesis of aromatic amino acids, Histidine, one carbon atom transfer by folic acid (Biosynthesis of glycine, serine, cysteine, methionine, threonine.)
13 Inborn errors of amino acid metabolism
14 Peptides, polyamines, porphyrins, gamma glutamyl cycle, glutathione biosynthesis, nonribosomal protein biosynthesis.
15 Purine and pyrimidine degradation.
16 Biosynthesis of purine and pyrimidine nucleotides, regulation and biosynthesis of nucleotide coenzymes.

MEMBRANE BIOCHEMISTRY

1 Biological membrane, structure, and assembly: Constituents, asymmetry, flip flop, protein lipid interaction, factors affecting physical properties of membranes. Membrane models: biological and physical model, membrane associated diseases
2 Membrane transport: Diffusion, passive, active and facilitated, transport role of proteins in the process, exocytosis, receptor mediated endocytosis, osmoregulation and ATP-ADP exchanger.
3 Na, H dependent processes and phosphotransferase synthesis, specialized mechanism for transport of macromolecules, gap junctions, nuclear pores, toxins, control of transport processes and binding proteins.
4 Role of Na, K ATPase and passive permeability of the plasma membrane to Na, K and Cl, voltage and ligand gated ion channels.
5 Molecular mechanisms, ionophores, ion translocating antibiotics, valinomycin, gramicidin, group translocation.

GENETICS

1 Molecules of Heredity: Structure of DNA and RNA, DNA as genetic material, double helix, semi conservative mechanism of replication, nearest neighbor analysis, denaturation and renaturation, A, B, and Z forms of DNA.
2 Laws of Heredity: Genotype, Phenotype and Mendelian Laws of inheritance.
3 Basis of Biochemical genetics: Concept of gene by Benzer, One gene one cistron, complementation tests and Co-linearity.
4 Auxotroph, prototroph, conditional mutants, mutant isolation and selection. Transformation, conjugation and transduction.
5 Sex factors and Plasmids: Fertility factor, Hfr, mapping of *E. coli* chromosome, Cloning vectors: Plasmids, phases, cosmids. Introduction to Operon.

6 Genetic Code: Biochemical and genetic analysis of the genetic code.
7 Genetic disorders: Chromosomal origin, gene origin –mutation, human teratogenesis.

MOLECULAR BIOLOGY

1 DNA Replication: Enzymes involved in DNA synthesis e.g. topoisomerase, helicase, ligase and others. DNA polymerase I, II, III, origin of locus, Okazaki fragments, replication fork. Mechanism in Prokaryotes and Eukaryotes.
2 DNA Repair: DNA damages, detection and repair systems. Pyrimidine dimer formation and its repair. Defective repair system and diseases, Ames test.
3 Gene rearrangements: Recombination pathways, Holliday structures, rec A, B, C, D. SOS response, mobile genetic elements.
4 Transcription and splicing: RNA polymerases, promoters, sigma and Rho factors, initiation, elongation and termination of transcription (Prokaryotes), Inhibitors of transcription. Transcription in Eukaryotes, RNA pol I, II, III, enhancers. Post transcriptional modifications of t,r and m-RNA , 5' capping, 3' poly A tailing, RNA editing.
5 Splicing: Splicing phenomenon. Mechanism, spliceosomes, alternative splicing, self-splicing, ribozyme (catalytic RNA).
6 Translation: Role of t-RNA and Ribosome in protein synthesis. Mechanism in Prokaryotes and Eukaryotes. Inhibitors of protein synthesis.
7 Protein targeting: Intracellular protein targeting. Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, Peroxisomes, chloroplast, protein degradation.
8 Eukaryotic chromosome and gene expression: Chromatin structure, transcription factors, chromatin remodeling, control of gene expression at post transcription level.

MEDICAL BIOCHEMISTRY

1 Mechanism of action at molecular level of selected antibiotics: inhibitors of cell wall, plasma membrane, nucleic acids and protein synthesis. Mechanism of action of anti metabolites, analgesics, hallucinogens, antiviral, antifungal, antiprotozoal and mechanism of resistance to antibiotics and other drugs.
2 Lysosomes and their physiological role: Structure and function of lysosomes, role in animal and plant cells. Physiological role in various types of digestive phenomenon disturbances to lysosomes (lysosomal pathology), lysosomal storage disease.
3 Molecular basis of hemoglobinopathies: concept of hemoglobinopathies, β and α thalassemia's, sickle cell anemia, pathophysiology, biochemistry, types of mutations
4 Ischemic heart disease/CHD: myocardial infarction and coronary heart diseases (pathophysiology); laboratory findings, enzymes involved.
5 Cancer: carcinogenesis, microevolution process, molecular genetics of cancer, causative agents, role of viruses, control of cancer –basic approaches by WHO.
6 Biochemistry of diseases: Influenza: life cycle, transmission, biochemical mechanism, Malaria: epidemiology, life cycle, biochemical mechanism; Alzheimer: dementia, biochemical mechanism, formation and tangles and plaques.
7 Apoptosis: extrinsic and intrinsic mechanism, role in diseases and physiology.

IMMUNOLOGY

1 Cellular basis of immunity: immunological memory, specificity, diversity, discrimination between self and non self, primary and secondary lymphoid organs, cell mediated and humoral immune responses, T and B lymphocytes, autoimmune reactions.
2 Clonal selection theory of antibody production, monoclonal and polyclonal antibodies, catalytic antibodies (abzymes).
3 Antigen and antibody: antigen, antigenic determinant, immunopotency, structure of antibody, constant and variable regions, Fab, F(ab2) and Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, X ray diffraction studies, isotypes, allotypes and idiotypes.
4 Multi-gene Organization of Ig Genes: variable gene rearrangement, generation of antibody diversity and class switching among constant region genes.
5 Measurement of antigen- antibody interaction: immuno-diffusion, immuno-electrophoresis, radioimmunoassay, immunofluorescence, ELISA, Western blotting
6 Complement system: classical, alternate and lectin pathway
7 T lymphocytes and cell mediated immunity, T cell sub populations, immune response genes, MHC gene complex, polymorphism, graft rejection, graft versus host response
8 Hypersensitivity and allergy, immunodeficiency diseases (AIDS)
9 Vaccines
10 Blood antigens: blood group substances and Rh factor

NEUROCHEMISTRY

1 Brain and behavior, Nerve cells and behavior
2 Anotomical organization: Central nervous system, spinal cord, different regions of the brain, peripheral and autonomic nervous system afferent and efferent pathways.
3 Neurotransmitters: Synthesis, storage, uptake degradation and action of neurotransmitters. Acetyl choline, GABA, Serotonin, Dopamine, Glutamate Aspartate, Nitrous Oxide etc., Neuropeptides
4 Receptors: Types of receptors, properties of receptors, sensory modalities and sensory circuits. Sensory perception, Cerebrospinal fluid, blood- brain barrier
5 Learning and memory: Mechanism of short term memory and long term potentiation. NMDA and AMPA glutamate receptors. Retrograde messengers in synaptic transmission. Role of CAM kinase II, Calcium, Protein kinase, CAMP, No, Calpain and other proteins in memory and learning process.
6 Circadian rhythms

BIOCHEMISTRY OF SPECIALIZED TISSUES:

1 Muscle contraction and cell motility: skeletal muscle structure of muscle cell, ultra structural organization, protein components of myofibrils, molecular organization of thick and thin filaments, mechanism of muscle contraction, metabolism of muscle, cardiac muscle contraction, regulation of contraction, contractile proteins in cells other than muscle filaments, microfilaments, microtubules, cilia and flagella of eukaryotic cells, chemotaxis.
2 Nerve Conduction: Structure and composition of nervous tissue, creation and propagation of nerve impulse, action potential, Na^+ and K^+ channels, transmission of nerve impulse, cholinergic receptors, electroplates as a source of acetyl choline receptor, acetyl choline esterase, nerve poisons.

3 Biochemistry of vision: Structure of eye, lens, and retina, perception of light rods and cones, rhodopsin, primary events in visual excitation, cyclic GMP, transducin in generation of nerve impulse, colour vision.
4 Biochemistry of sense of taste and smell.
5 Biochemistry of sense of touch and hearing.

PLANT BIOCHEMISTRY

1 Mineral nutrition: micro and macro elements, requirement, role, excess and deficiency disorders.
2 Photosynthesis: chloroplasts, photosystem, mechanism CO2 fixation,C3 and C4 pathways
3 Nitrogen and Sulfur metabolism: Nitrogen cycle, nitrogen fixation, assimilation of nitrate and ammonium ions, nitrogen transformation during development, assimilation of sulfate.
4 Plant hormones: types and role in plant growth and development, Auxins gibberellins, cytokinins, ethylenes, abscisic acid, hormones in senescence and abscission.
5 Secondary metabolites: definition types, phenolics, flavanoids, lignins, terpenoids alkaloids, Gum Pectins Rubber: chemistry examples and applications
6 Biochemistry and physiology of seed germination and dormancy, seed storage proteins.
7 Plant diseases: Pest types, symptoms, treatment, pesticides.

PHYSIOLOGICAL BIOCHEMISTRY

1 Liver: anatomy, physiological functions, Liver function tests, Liver disorders:- hepatitis, cirrhosis, Jaundice: etiology and symptoms
2 Kidney: anatomy, physiological functions, diseases/disorder, diagnostic tests
4 Respiration: Principles of gaseous exchange during respiration, Bohr effect, transport of oxygen and carbon dioxide in the blood, regulation of respiration.
5 Digestion and Absorption of food: Generalized structure of digestive tract and associated digestive gland. Function of different parts- peristalsis, regulation of saliva, gastric, pancreatic, Intestinal and bile secretion (i.e. digestion), Absorption – (carbohydrate, protein, lipid, minerals and vitamin) transport and excretion of nutrients.
6 Biochemistry of blood clotting, clotting factors, intrinsic and extrinsic pathways, mechanism of formation of thrombin, fibrin, fibrin clot, role of vitamin K clotting process, lysis of fibrin clot. Conditions that cause excessive bleeding in humans.
7 Regulation of acid-base balance, types and functions of acid-base buffers, clinical abnormalities associated with acid-base imbalance.
8 Water and Mineral metabolism.

ENDOCRINOLOGY

1 General characteristics of hormones: chemistry, structure, synthesis, secretion, transport, metabolism & mechanism of action of hormones of the thyroid, hypothalamus, pituitary, pancreas, adrenals, glands, prostaglandins and gastro intestinal hormones, secondary messengers and their mode of action, calcium signaling, zinc fingers
2 Disorders related to hormones.
3 Cell membranes and intracellular receptors for hormones
4 Hormonal inter relationship
5 Biosynthesis of steroid hormones, cholera toxin, adenylate cyclase and TP, hormone overproduction and target cell insensitivity
6 EGF, NGF, PDGF, Enkephalin

GENETIC ENGINEERING

1 Genetic engineering concepts: early development in genetics, concept of gene cloning and its importance.

2 Manipulation of DNA: Enzymes in genetic engineering, Restriction endonucleases, restriction map, Ligase, polymerase modifying enzymes, ligation; putting sticky ends to blunt ended molecules.

3 Cloning vectors: Vectors for *E. coli*: Plasmids, M 13 bacteriophage vectors, λ bacteriophage, Cosmid. Eukaryotic cloning vectors: Cloning vectors for yeast, other fungi, YAC, cloning vectors for higher plants, Ti plasmid, Ri plasmid, plant viruses for cloning, cloning vectors for insects, viruses as cloning vectors for mammals.

4 Introduction of DNA in living cells: Transformation, identification of recombinants, introduction of phage DNA into bacterial cells (transfection), identification of recombinant phage.

5 Expression of foreign gene: gene expression in E coli, production of recombinant proteins in Eukaryotes, fungi, yeast, mammalian and insect cells systems.

6 Selection of recombinant DNA clones: construction of genomic and c DNA library, colony and plaque hybridization probing, Southern blotting,

7 Sequencing genes and genomes: chain termination using ddNTPs, pyrosequencing, shotgun and clone contig approaches, chromosome walking, and genetic maps.

8 Characterization of recombinant gene: studying RNA transcript of a gene S1 nuclease mapping, studying regulation of gene expression, foot printing using DNase 1, reporter genes.

9 Polymerase chain reaction: concept, types, methods and applications.

10 Genetic engineering of plants: Gene transfer methods, vectors; Transgenic plants: Pest resistant, herbicide resistant, antisense RNA and other applications.

11 Transgenic animals: Gene transfer strategies, production of recombinant proteins and other applications.

12 Recombinant DNA technology applications in medicine and industry: Recombinant hormones, recombinant vaccines. Human proteins (antibodies, clotting factors, antibody engineering) RFLP and application in forensic science.

13 Protein Engineering: In vitro mutagenesis, Oligonucleotide directed, PCR based, applications of protein engineering

14 Study of genomes: genome annotations, study of transcriptome, proteome.

15 RNA interference and its applications

16 DNA Microarray

FERMENTATION TECHNOLOGY

1 Characteristics of industrial microorganisms

2 Strain improvement, use of auxotrophic mutants

3 Methods and parameters of cultivation of microorganisms , media for industrial fermentation

4 Fermenters, design of fermenters, fermentation process, and maintenance of aseptic conditions, aeration and agitation.

5 Downstream processing, recovery and purification of fermentation products, effluent treatment

6 Applications of fermentation technology

7 Manufacturing by fermentative process: beer, Citric acid, Glutamic acid, lipase, Penicillin, L-asparginase

TISSUE CULTURE

A **Plant tissue culture**

1 Media requirements: Sterilization and role of growth regulators, Requirements of aplant tissue culture laboratory,

2 PTC Techniques: Callus and cell suspension culture, Micropropogation, Conditioning of tissue culture plants (weaning and hardening),Somatic cell hybridization, Haploid (anther) culture, Embryo culture, Protoplast fusion, Somatic embryogenesis, Somaclonal variations, Cybrids and Allopheny, Agrobacterium mediated hairy root culture

3 Active principles in medicinal plants and phytochemistry of the metabolites of medicinal importance.

B **Animal tissue culture**

1 Media requirements: preparation of medium and sterilization techniques, Advantages and disadvantages of natural and synthetic media

2 Cell culture methods: Hanging drop, suspension and monolayer culture, Behavior and characteristics of cells in culture, Primary and established cell lines, characteristics of transformed cells, Methods of cell preservation.

3 ATC techniques: Primary cultures and secondary cultures, cloning, heterocaryons, variant cells, contact inhibitions, Organ culture and cell and tissue banking

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