MOHANLAL SUKHADIA UNIVERSITY UDAIPUR-313039

SYLLABUS FOR SCREENING TEST FOR THE POST OF ASSISTANT PROFESSOR

Subject : MICROBIOLOGY

Note: There shall be 100 questions with multiple Choices carrying 100 marks to be completed in 3 hrs duration.

1. Molecules and their Interaction Relevant to Biology

2. Cellular Organization

3. Fundamental Processes

4. Cell Communication and Cell Signaling

5. Microbial World

6. Microbial Ecology and Physiology

7. Soil, Air and Water Microbiology

8. Inheritance Biology

9. Medical Microbiology

10. Environmental Microbiology

11. Industrial Microbiology

12. Applied Biology

13. Methods in Biology

1. MOLECULES AND THEIR INTERACTION RELAVENT TO BIOLOGY

A. Structure of atoms, molecules and chemical bonds.

B Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

C. Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

D Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

E. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes

G. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

H. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

I. Stability of proteins and nucleic acids.

J. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

2. CELLULAR ORGANIZATION

A) Membrane structure and function

(Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport,electrical properties of membranes).

B) Structural organization and function of intracellular organelles

(Cell wall, nucleus,mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

C) **Organization of genes and chromosomes** (Operon, unique and repetitive DNA,interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).

D) **Cell division and cell cycle**(Mitosis and meiosis, their regulation, steps in cell cycle,regulation and control of cell cycle).

3. FUNDAMENTAL PROCESSES

A) **DNA replication, repair and recombination** (Unit of replication, enzymes involved,replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).

B**)** **RNA synthesis and processing** (transcription factors and machinery, formation ofinitiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

C) **Protein synthesis and processing** (Ribosome, formation of initiation complex, initiationfactors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyltRNAsynthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

D) **Control of gene expression at transcription and translation level** (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing)

4. CELL COMMUNICATION AND CELL SIGNALING

A) **Host parasite interaction**Recognition and entry processes of differentpathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

B) **Cell signaling** Hormones and their receptors, cell surface receptor, signalingthrough G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

C) **Cellular communication** Regulation of hematopoiesis, general principles of cellcommunication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

D) **Innate and adaptive immune system** Cells and molecules involved in innateand 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, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

5. MICROBIAL WORLD

A)Evolution of microbiology

History, development and scope of microbiology, evolution of microbial life.Theory of spontaneous generation.

B) Structural organization and classification of microbes

Prokaryotes, archaebacteria and eukaryotes. Classification of bacteria. Important groups of prokaryotes- photosynthetic bacteria, blue green algae, chemoautotrophic bacteria, spore forming bacteria, mycoplasma, viruses, bacteriophages and actinomycetes, heterotrophic bacteria, nitrogen fixing bacteria and cyanobacteria, lactic acid bacteria, halophiles, thermophiles, acidophiles and methanogens. Structure and classification of viruses, growth of viruses, lytic and lysogenic cycles, plant viruses, viroids.

6. MICROBIAL ECOLOGY AND PHYSIOLOGY

A)Principles of microbial ecology-microbiology of ecosystems-soil, rhizosphere, phyllosphere, water-fresh and marine and air.

B) Microbial interactions- symbiosis, synergism, commensalism, antagonism - amensalism, competition, parasitic and predation

C) Microbial Nutrition and Growth-Microbial growth curve. Mathematical expression of growth-continuous and batch cultures. Diauxic and synchronous growth. Microbial nutrition.

7. SOIL,AIR AND WATER MICROBIOLOGY

A) Soil microbiology

Soil microorganisms: major groups, decomposition of organic matter, soil health. Root exudates and rhizosphere effects. Manipulation of rhizospheremicroflora in plant productivity.Microbial biomass. Nitrogen cycle: ammonification, nitrification and denitrification.

B) Air microbiology

microbial population and its significance. Aerosol, droplet nuclei, air pollution- sources (Microbiological) – air quality analysis- air sampling devices. Isolation, enumeration and methods of studying.

C) Water microbiology

Methods of studying water microbiology. Eutrophication, algal blooms and red tides. Definition, causes, effects. Water treatment Primary, secondary and tertiary.

8. INHERITANCE BIOLOGY

A) **Mendelianprinciples** :Dominance, segregation, independent assortment.

B) **Concept of gene** : Allele, multiple alleles, pseudoallele, complementation tests

C) **Extensions of Mendelianprinciples** : Codominance, incomplete dominance, geneinteractions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

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

E) **Extra chromosomal inheritance** : Inheritance of Mitochondrial and chloroplast genes,maternal inheritance.

F) **Microbial genetics** :Methods of genetic transfers–transformation, conjugation, transductionand sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

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

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

9. MEDICAL MICROBIOLOGY

A) General Account of Epidemiology: Principles of epidemiology, Current epidemics (AIDS,Nosocomical, Acute respiratory Syndrome,) .

B) Measures for prevention of epidemics –Global health consideration, Emerging and reemerging infectious diseases Biological warfare and biological weapons.

C) Biohazards and Bio-safety in Microbiology: Basic concept on biohazard and bio-safety. Universal precaution.Laboratory waste products and disposal.

D) Epidemiology, causal organism, life cycle, mode of action ,transmission, detection, control, therapeutic measures of following bacterial and protozoan diseases: Tuberculosis, Diptheria, Meningitis, Pertussis, Streptococcal Pneumonia, Cholera, Botulism, Typhoid, Tetanus, Gonorrhoea, Syphilis, Leprosy, Malaria, Leishmaniasis, Toxoplasmosis, Meningitis, Balantidiosis, Vaginitis, Giardiasis, Trypanosomiasis, Amoebiasis.

10. ENVIRONMENTAL MICROBIOLOGY

A)Applications of microbes in biodegradation and bioremediation: Microbial degradation of cellulose, lignin, pesticides, xenobiotics and other recalcitrant chemicals, petroleum and hydrocarbons and its ecological significance.

B) Bioprospecting and bioleaching: Bioaccumulation of heavy metals ions from industrial effluents.

C) Nirogen fixation: Nitrogen fixing genes. Nonleguminous nitrogen fixers,.Factors affecting nitrogen transformation, nitrogen assimilation, incorporation of ammonia into organic compounds (GOGAT pathway), transporting of fixed nitrogen in symbiotic systems.PGPR.Phosphate solubilizing bacteria, Mechanism of Phosphate solubilisation.

11. INDUSTRIAL MICROBIOLOGY

A)Microbial fermentation and production of small and macro molecules.

B) Industrial production of metabolites-organic acids, alcohols, antibiotics.

C)Fermentor designs and types. Control of fermentation process – batch, feed batch and continuous.Downstream processing in fermentation industry.

D)Probiotic technology-Production of single cell proteins and probiotics

E)Fermented food- vinegar, wine, saucrkraut, pickles, cheese, and yogurt.

F)Food preservation, contamination and spoilage, food-borne illness and intoxication.

12. APPLIED BIOLOGY:

A. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals.

B. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.

C. Genomics and its application to health and agriculture, including gene therapy.

D. Bioresource and uses of biodiversity.

E. Breeding in plants and animals, including marker – assisted selection

F. Biosensors

13. METHODS IN BIOLOGY

A. Molecular Biology and Recombinant DNA methods:

Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different 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

B. Histochemical and Immunotechniques

Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

C 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.

D Statisitcal Methods:

Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X^2 test;; Basic introduction toMuetrovariate statistics, etc.

E. 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.

F. Microscopic techniques:

Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.