

# Maharashtra State Eligibility Test for Lectureship

महाराष्ट्र राज्य व्याख्यातापदासाठी राज्यस्तरीय पात्रता चाचणी (सेट) परीक्षा

Conducted by University of Pune

(AS THE STATE AGENCY)

## SYLLABUS AND SAMPLE QUESTIONS

*Subject*  
*Code No.*

**34**

*Subject*

**Life Sciences**



**UNIVERSITY OF PUNE**  
**Ganeshkhind, Pune-411007**

## [34] : LIFE SCIENCES

The syllabus consist of two papers as follows :

Paper II and Paper III will be of 75 minutes and 2½ hours duration respectively. Paper II will be of 100 marks and Paper III will be of 200 marks. In Paper III there will be 10 questions each of Botany, Zoology, Microbiology, Biochemistry and remaining 20 questions are of Genetics, etc. Students have to attempt any 20 questions.

### PAPER II

1. **Cell Biology** : Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes), Mechanism of cell division including (mitosis and meiosis) and cell differentiation; Cell-cell interaction, Malignant growth, Immune response : Dosage compensation and mechanism of sex determination.
2. **Biochemistry** : Structure of atoms, molecules and chemical bonds, Principles of physical chemistry, Thermodynamics, kinetics, dissociation and association constants, Nucleic acid structure, genetic code, replication, transcription and translation : Structure, function and metabolism of carbohydrates, lipids and proteins, Enzymes and coenzyme, Respiration and photosynthesis.
3. **Physiology** : Response to stress, Active transport across membranes, Plant and animal hormones Nutrition (including vitamins), Reproduction in plants, microbes, plant and animals, Sensory responses in microbes, plant and animals.
4. **Genetics** : Principles of Mendelian inheritance, chromosome structure and function, Gene Structure and regulation of gene expression, Linkage and genetic mapping, Extra-chromosomal inheritance (episomes, mitochondria and chloroplasts), Mutation, DNA damage and repair, chromosome aberrations, Transposons, Sex-linked inheritance and genetic disorders, Somatic cell genetics, Genome organisation (in both prokaryotes and eukaryotes).
5. **Evolutionary Biology** : Origin of life (including aspects of prebiotic environment and molecular evolution), Concepts of evolution, Theories of organic evolution, Mechanisms of speciation, Hardy-Weinberg genetic equilibrium, genetic polymorphism and selection, Origin and evolution of economically important microbes, plants and animals.
6. **Environmental biology** : Concept and dynamics of ecosystem, components, food chain and energy flow, productivity and biogeochemical cycles, Types of ecosystems, Population ecology and biological control, Community structure and organisation, Environmental pollution, Sustainable development, Economic importance of microbes, plants and animals.
7. **Biodiversity and Taxonomy** : Species concept, Biological nomenclature theories of biological classification, Structural biochemical and molecular systematics, DNA finger printing, numerical taxonomy, Biodiversity, characterization, generation, maintenance and loss, Magnitude and distribution of biodiversity, economic value, wildlife biology, conservation strategies, cryopreservation.

**PAPER III**

1. Principles of Taxonomy as applied to the systematics and Classification of Plant Kingdom, Taxonomic structure, Biosystematics, Plant geography, Floristics.
2. Patterns of variation in morphology and life history in plants, broad outlines of classification and evolutionary trends among algae, fungi, bryophytes and pteridophytes, Principles of palaeobotany, Economic importance of algae, fungi and lichens.
3. Comparative anatomy and developmental morphology of gymnosperms and angiosperms, Histochemical and ultrastructural aspects of development, Differentiation and morphogenesis.
4. Androgenesis and gynogenesis, Breeding systems, Pollination biology, structural and functional aspects of pollen and pistil, Male sterility, Self and inter-specific incompatibility, Fertilization, Embryo and seed development.
5. **Plants and civilization** : Centres of origin and gene diversity, Botany, utilization, cultivation and improvement of plants of food, drug, fibre and industrial values, Unexploited plants of potential economic value, Plants as a source of renewable energy, Genetic resources and their conservation.
6. **Water Relations** : Mineral nutrition, Photosynthesis and photorespiration : Nitrogen, Phosphorous and Sulphur metabolism, Stomatal physiology, Source and sink relationship.
7. Physiology and biochemistry of seed dormancy and germination, Hormonal regulation of growth and development, Photoregulation : Growth responses, Physiology of flowering, Senescence.
8. **Principles of plant breeding** : Important conventional methods of breeding self and cross pollinated and vegetatively propagated crops, Non-conventional methods, Polyploidy : Genetic variability, Plant diseases and defensive mechanism.
9. Principles of taxonomy as applied to the systematics and classification of the animal kingdom, Classification and interrelationship amongst the major invertebrate phyla, Minor invertebrate phyla, functional anatomy of the non-chordates, Larval forms and their evolutionary significance.
10. Classification and comparative anatomy of protochordates and chordates, Origin, evolution and distribution of chordate groups : Adaptive radiation.
11. Histology of mammalian organ systems, nutrition, digestion and absorption, Circulation (open and closed circular, lymphatic systems, blood composition and function), Muscular contraction and electric organs, Excretion and osmoregulation : Nerve conduction and neurotransmitter, major sense organs and receptors, Homeostasis (neural and hormonal), Bioluminescence, Reproduction.

12. **Gametogenesis in animals** : Molecular events during fertilization, Cleavage patterns and fate maps, Concepts of determination, competence and induction, totipotency and nuclear transfer experiments, Cell differentiation and differential gene activity. Morphogenetic determinants in egg cytoplasm, Role of maternal contributions in early embryonic development, Genetic regulation of early embryonic development in *Drosophila*, Homeotic genes.
13. Feeding, learning, social and sexual behaviour of animals, Parental care, Circadian rhythms, Mimicry, Migration of fishes and birds, Sociobiology, Physiological adaptation at high altitude.
14. Important human and veterinary parasites (protozoans and helminths), Life cycle and biology of *Plasmodium*, *Trypanosoma*, *Ascaris*, *Wuchereria*, *Fasciola*, *Schistosoma* and *Leishmania*, Molecular, cellular and physiological basis of host-parasite interactions.
15. Arthropods and vectors of human diseases (mosquitoes, lice, flies, and ticks), Mode of transmission of pathogens by vectors, Chemical biological and environmental control of arthropod vectors, Biology and control of chief insect pests of agricultural importance, Plant host-insect interaction, insect-pest management, useful insects, Silkworm.
16. The law of DNA constancy and C-value paradox, Numerical and structural changes in chromosomes, Molecular basis of spontaneous and induced mutation and their role in evolution, Environment mutagenesis and toxicity testing, Population genetics.
17. Structure of pro and eukaryotic cells, Membrane structure and function, Intracellular compartments, protein sorting, secretory and endocytic pathways, Cytoskeleton, Nucleus, Mitochondria and chloroplasts and their genetic organisation, cell cycle, Structure and organisation of chromatin, polytene and lampbrush chromosomes, Dosage compensation and sex determination and sex-linked inheritance.
18. Interactions between environment and biota, Concept of habitat and ecological niches, Limiting factors, Energy flow, food chain, food web and trophic levels, Ecological pyramids and recycling, Biotic community—concept, structure, dominance, fluctuation and succession, N.P.C. and S Cycles in nature.
19. Ecosystem dynamics and management : Stability and complexity of ecosystems, Speciation and extinction, Environmental impact assessment, Principles of conservation, Conservation strategies, Sustainable development.
20. Physico-chemical properties of water, Kinds of aquatic habitats (fresh water and marine), Distribution of and impact of environmental factors on the aquatic biota, Productivity, mineral cycles and biodegradation in different aquatic ecosystems, Fish and Fisheries of India with respect to the management of estuarine, coastal water systems and man-made reservoirs, Biology and ecology of reservoirs.
21. Structure, classification, genetics, reproduction and physiology of bacteria and viruses (of bacteria, plants and animals), *Mycoplasma* protozoa and yeast (a general accounts).

22. Microbial fermentation, Antibiotics, organic acids and vitamins, Microbes in decomposition and recycling processes, Symbiotic and asymbiotic N<sub>2</sub> - fixation, Microbiology of water, air, soil and sewage, Microbes as pathological agents in plants, animals and man, General design and applications of a biofermenter, Biofertilizer.
23. **Antigen** : Structure and functions of different classes of immunoglobulins, Primary and secondary immune response, Lymphocytes and accessory cells, Humoral and cell mediated immunity, MHC, Mechanism of immune response and generation of immunological diversity; Genetic control of immune response, Effector mechanism, Application of immunological techniques.
24. Enzyme kinetics (negative and positive cooperativity), Regulation of enzymatic activity, Active sites, Coenzymes, Activators and inhibitors, isoenzymes, allosteric enzymes, Ribozyme and abzyme.
25. Van der Waal's electrostatic, hydrogen bonding and hydrophobic interactions, Primary structure of proteins and nucleic acids, Conformation of proteins and polypeptides (secondary, tertiary, quaternary and domain structure), Reverse turns and Ramachandran plot, Structural polymorphism of DNA, RNA and three-dimensional structure of tRNA, Structure carbohydrates, polysaccharides, glycoproteins and peptido-glycans, Helix-coil transition, Energy terms in biopolymer conformational calculation.
26. Glycolysis and TCA cycle, Glycogen breakdown and synthesis, Gluconeogenesis, interconversion of hexoses and pentoses, Amino acid metabolism, Coordinated control of metabolism, Biosynthesis of purines and pyrimidines, Oxidation of lipids, Biosynthesis of fatty acids, Triglycerides, Phospholipids, Sterols.
27. Energy metabolism (concept of free energy), Thermodynamic principles in biology, Energy rich bonds, Weak interactions, Coupled reactions and oxidative phosphorylations, Group transfers, Biological energy transducers, Bioenergetics.
28. Fine structure of gene, Eukaryotic genome organisation (structure of chromatin, coding and non-coding sequences, satellite DNA), DNA damage and repair, DNA replication, amplification and rearrangements.
29. Organization of transcriptional units : Mechanism of transcription of prokaryotes and eukaryotes, RNA processing (capping, polyadenylation, splicing, introns and exons), Ribonucleoproteins, Structure of mRNA, Genetic code and protein synthesis.
30. Regulation of gene expression in pro-and eukaryotes, Attenuation and antitermination, Operon concept, DNA methylation, Heterochromatization, Transposition, Regulatory sequences and transcription factors, Environmental regulation of gene expression.
31. Biochemistry and molecular biology of cancer, Oncogenes, Chemical carcinogenesis, Genetic and metabolic disorders, Hormonal imbalances, Drug metabolism and detoxification, Genetic load and genetic counselling.

32. Lysogeny and lytic cycle in bacteriophages, Bacterial transformation, Host cell restriction, Transduction, Complementation, Molecular recombination, DNA ligases, Topoisomerases, gyrases, Methylases, Nucleases, Restriction endonucleases, Plasmids and bacteriophage based vectors for cDNA and genomic libraries.
33. Principles and methods of genetic engineering and Gene targeting, Application in agriculture, health and industry.
34. Cell and tissue culture in plants and animals, Primary culture, Cell line, Cell clones, Callus cultures, Somaclonal variation, Micropropagation, Somatic embryogenesis, Haploidy, Protoplast fusion and somatic hybridization, Cybrids, Gene transfer methods in plants and in animals, Transgenic biology, Allopheny, Artificial seeds, Hybridoma technology.
35. Structure and organisation of membranes, Glyconjugates and proteins in membrane systems, ion transport/Na/KATPase/Molecular basis of signal transduction in bacteria, plants and animals, Model membranes, Liposomes.
36. Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, Cytophotometry and flow cytometry, fixation and staining.
37. Principles and applications of gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography, High pressure liquid chromatography (HPLC), Electrophoresis and electrofocussing, Ultracentrifugation (velocity and buoyant density).
38. Principles and techniques of nucleic acid hybridization and Cot curves, Sequencing of proteins and nucleic acids, Southern, Northern and South-Western blotting techniques, Polymerase chain reaction, Methods for measuring nucleic acid and protein interactions.
39. Principles of biophysical methods used for analysis of biopolymer structure, X-ray diffraction, fluorescence, UV, ORD/CD Visible, NMR and ESR spectroscopy, Hydrodynamic methods, Atomic absorption and plasma emission spectroscopy.
40. Principles and applications of tracer techniques in biology, Radiation dosimetry, Radioactive isotopes and half life of isotopes, Effect of radiation on biological system, Autoradiography; Cerenkov radiation; Liquid scintillation spectroscopy.
41. Principles and practice of statistical methods in biological research, samples and populations; Basic statistics—average, statistics of dispersion, coefficient of variation, Standard error, Confidence limits, Probability distributions (binomial, poisson and normal); Tests of statistical significance, Simple correlation of regression, Analysis of variance.

### SAMPLE QUESTIONS

#### PAPER II

1. X chromosome heterochromatinization in mammalian female has been found to involve
  - (A) cytosine methylation
  - (B) DNA rearrangements
  - (C) activation of transposable sequences
  - (D) protein deacetylation

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2. One of the following is an *ex-situ* method of conservation of plants.
- |                       |                        |
|-----------------------|------------------------|
| (A) Biosphere reserve | (B) Wildlife sanctuary |
| (C) Protected forest  | (D) Micropropagation   |

**PAPER III**

1. Discuss the following :  
(A) Role of phytochrome in plants  
(B) Hormonal regulation of senescence of leaves.
  2. Give a reaction each involving the transfer of Pi and AMP from ATP.
  3. State the Hardy Weinberg principle. Give its utility. How can one check a population to find out if it has reached H-W equilibrium ?
  4. Describe in brief the stages in primary succession in an aquatic ecosystem.
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