List of the entrance examination questions

MSc program

Molecular biology and biotechnology

1. The central dogma of molecular biology. The history of genes discovery. The modern concept of the gene. The concept of gene expression.
2. Evidence for DNA as the genetic material. Avery, Hershey and Chase experiments.
3. Nucleosides, nucleotides and their examples. Purines and pyrimidines nitrogenous bases.
4. Chemical structure of oligonucleotides (ribo- and deoxyribo- nucleotides), polynucleotides, 5'- and 3'-ends.
5. The secondary structure of DNA (Watson-Crick model). Antiparallel polynucleotide chains. Chargaff's rules and the principle of complementarity.
6. DNA conformation: A, B and Z forms.
7. The principles of DNA packaging in eukaryotic and prokaryotic cells. The structure of nucleosomes.
8. The main types of RNA: structure and functions.
9. Genetic code. The essence of genetic coding. Basic properties and universality of the genetic code.
10. The structure of prokaryotic genes: coding sequence and promoter.
11. The mosaic structure of eukaryotic genes (introns and exons), organization of promoters.
12. Protein as a product of gene expression.
13. The chemical composition of proteins. Classification of amino acids.
14. Semi-conservative DNA replication. Replication stages in pro- and eukaryotes: initiation, elongation and termination.
15. Replication enzymes (helicase, DNA gyrase, DNA binding proteins, DNA polymerase, DNA ligase).
16. Replication in prokaryotic genome (theta-replicating and principle of rolling circle).
17. Transcription as an intermediate stage of gene expression. Stages of transcription (initiation, elongation and termination).
18. The products of transcription in pro- and eukaryotes.
19. Post-transcriptional RNA processing in eukaryotic cells and its biological significance: capping, polyadenylation and splicing.
20. The principles of gene expression regulation in prokaryotes. Biological feasibility of regulating expression.
21. Operon organization of the genes. Positive and negative regulation. Induction and repression.
22. Lactose operon. Functioning mechanism.
23. Recombinant DNA Technology: cloning vectors. Restriction enzymes and ligases.
24. Bacterial plasmids as vectors. Production of recombinant proteins.
25. Methods of nucleic acids analyzing: identification of unique nucleotide sequences. Polymerase chain reaction, blotting (Southern, Northern), DNA chips.
26. The practical application of DNA and RNA analysis.

27. Classification of DNA repair mechanisms. Direct repair of thymine dimers and methylated guanine. Cutting of nitrogenous bases. Glycosylase.

28. Mobile genetic elements in eukaryotes (types of mobile elements, displacement mechanisms, examples).

29. Attenuation of transcription. Mechanisms for transcription termination.

30. Regulation of gene expression in the tryptophan operon.

31. Taxonomy of bacteria. Principles of taxonomy: genetic, phenotypic, serological criteria.

32. Morphology and structural organization of bacterial cell

33. Cytoplasmic membrane: structure and functions. The cell wall of bacteria.

34. Flagella and fimbriae of bacteria. Bacterial motility.

35. The structure of bacteriophages. Virulent and moderate phages

36. Growth of bacterial population. Bacterial growth curve

37. Genetic exchange in bacteria: transformation, transduction, conjugation. State of competency.

38. Prokaryotic genome: nucleoid, plasmid, mobile genetic elements.

39. Major carbohydrate-containing polymers of the bacterial surface: CPS, LPS, EPS.

40. Social behavior in bacteria. Quorum-sensing, swarming, biofilms.

41. Phenotypic heterogeneity of bacterial populations. Uncultivated forms of bacteria, persisters, L-forms.

42. Genetic engineering. Bacteria as vectors for amplifying foreign DNA.

43. Differences in the structure of pro - and eukaryotic cells.

44. The structure of the cell nucleus.

45. Cell theory of Schleiden and Schwann.

46. Passive and active transport.

47. Membrane cell organoids: types, structure, functions.

48. Concept and stages of mitosis and meiosis.

49. Types of biological objects used in biotechnology, their classification and characteristics.

50. The main directions and sections of biotechnology: pharmaceutical (biotechnology of medicines), energy, food, environmental and space biotechnology. Characteristic.

51. Stages of biotechnological process: the main stage of fermentation, process parameters, regulation and control. Methods for quantifying biomass.

52. Improvement of producers. Preparation of biological agents by cell engineering methods in vivo. Hybridization and cloning.