

Biochemistry and Molecular Biology

Final exam question list

General Medicine 2015/2016.

Starting Questions I.:

GIVE THE MOLECULAR EXPLANATION OF THE FOLLOWING CLINICAL PROBLEMS

1. Laboratory examination of your African American patient shows anemia and the red blood cells have a sickle shape.
2. One of your patients receives long term coumarin derivative therapy and suddenly starts to bleed because of drug overdose.
3. Your patient complains that he/she has diarrhea after milk consumption.
4. A person can not make extensive physical effort and suffers painful muscle cramps even after a mild exercise.
5. As consequence of seemingly harmless drugs (such as antimalarials or sulfa antibiotics) acute hemolytic anemia develops.
6. A relatively healthy adult with much overweight comes to the office and asks the possible reason of being obese.
7. An unconscious patient; acetone is detectable in the breath.
8. Somebody takes too much aspirin to treat high fever for a couple of days and comes to the hospital with gastric bleeding.
9. A premature newborn is kept in an incubator under high oxygen concentration because of respiratory distress.
10. A patient with fresh myocardial infarction; the cholesterol level is high and he tells that both his father and brother died in myocardial infarction in their mid-forties.
11. Unconscious patient with high ammonia concentration in blood.
12. The blood test of the patient demonstrates megaloblastic anaemia. What can be the reasons for the development of this disease?
13. Mental retardation of a young child, with high phenylalanine concentration appearing in the urine; it turns out, that a compulsory enzyme test was not carried out following birth.
14. Metabolic abnormalities that may lead to the development of gout; treatment of gout with allopurine, its mode of action.
15. Give the possible explanation(s) – based on your biochemistry studies - of immunodeficient states.
16. A malignant tumor could be treated with gene therapy yielding p53 in the malignant cells. What kind of gene transfers could be used?
17. Vitamin D deficiency syndrome (rickets) which cannot be cured by the administration of vitamin D.

18. The ophthalmologist finds a retinoblastoma while examining a patient; there is no family history of similar cases.
19. What nutritional problems would you mention as a warning to your vegetarian friend?
20. A patient with hyperkeratosis who doesn't see properly at twilight.
21. A liver biopsy sample of a chronic alcoholic shows fatty liver and dying hepatocytes.
22. Major joints are dislocated, the skin easily bruises and is hyperextensible.
23. Your patient arrives with strong abdominal pain. He explains that his symptoms are stronger since he had taken painkillers, and noticed his urine was red.
24. C-Reactive Protein (CRP) level is increased to hundred times than normal in the serum of a patient with high fever.

Starting Questions II.:

MOLECULAR BIOLOGY

1. Composition, structure and functions of DNA and RNA.
2. Eukaryotic genome, structure of the nucleus.
3. Describe the hierarchy of protein structures!
4. Describe briefly the principles of the Michaelis-Menten kinetic model!
5. Describe briefly the types of enzyme inhibition!
6. Summarize the characteristics of DNA replication
7. Describe the main DNA repair systems!
8. Describe the basic steps of DNA cloning using a medical example
9. Summarize the principle and steps of PCR technique, give examples for it's practical use in the field of medicine!
10. Steps of eukaryotic gene expression.
11. Summarize the main processes of eukaryotic mRNA maturation!
12. Techniques which are suitable for mRNA detection and quantification
13. Describe the eukaryotic translation mechanism!
14. Briefly describe the Western blot method, including the principle of SDS polyacrylamide gel electrophoresis!
15. Antibody-based techniques in medical research.
16. What is a recombinant protein? Their utilization in medicine.
17. Posttranslational modifications and their importance.

METABOLISM

1. Enzymatic steps and regulation of the pyruvate dehydrogenase enzyme complex.
2. The citric acid cycle, its operation, requirements for its function, its regulation.
3. Terminal oxidation and oxidative phosphorylation. Sources of energy.
4. Digestion and absorption of food carbohydrates. GLUT proteins.
5. The glycolytic pathway, transport of $\text{NADH}+\text{H}^+$ into the mitochondrion.

6. Gluconeogenesis, Cori cycle, glucose-alanine cycle.
7. Regulatory mechanisms in the relationship of glycolysis and gluconeogenesis.
8. Synthesis and degradation of glycogen, regulation of the two processes.
9. The pentose phosphate pathway and its metabolic significance.
10. Metabolic effects of insulin. Biochemical aspects of diabetes mellitus.
11. Digestion and absorption of dietary lipids.
12. Biochemical characterization of plasma lipoproteins. Describe their fate and function.
13. Oxidation of fatty acids.
14. Synthesis of fatty acids. Regulation of the process.
15. Metabolic processes during carbohydrate-rich diet.
16. Metabolic processes in starvation. Synthesis and utilization of ketone bodies.
17. Synthesis of prostaglandins and leukotrienes, and their functions.
18. The mevalonate metabolic pathway and its regulation.
19. Synthesis, transport and elimination of cholesterol in the human body.
20. Synthesis of vitamin D and action of steroid hormones.
21. Gamma-glutamyl cycle. Amino acid transport. Essential amino acids.
22. Deamination and transamination reactions. The fate of ammonia in the human body: formation, biochemical effects, N-transport.
23. The urea cycle: its role, operation, regulation and enzyme deficiencies.
24. C₁ transfer, transmethylation. What kind of genetic or vitamin deficiencies could influence it?
25. Fate of the skeletons of amino acids. Ketogenic and glucogenic amino acids.
26. Biological function of nucleotides. Nucleotide pool, fate of food nucleoproteins, *de novo* synthesis of purine nucleotides.
27. Regulation of the purine nucleotide synthesis. Salvage pathways in purine metabolism. Diseases of purine metabolism
28. *De novo* synthesis of pyrimidine nucleotides and its regulation. Orotic aciduria. Salvage pathways for pyrimidines. Nucleoside and nucleotide kinases.
29. Synthesis of deoxynucleotides and thymidilate.
30. Nutritional biochemistry of vitamins.
31. Inorganic compounds of foods. Their biochemical role and importance in nutrition.
32. Biochemical importance of carbohydrates, lipids and proteins in human nutrition.

CELL BIOCHEMISTRY

1. The active chromatin and epigenetics.
2. Levels of eukaryotic gene expression. Regulation of transcription (promoters and enhancers), transcription factors.
3. The RNA world. mRNA stability, non-coding RNAs, micro RNAs.
4. Glucocorticoid (GR) and retinoic acid receptors (RARs) function and their activation.
5. Extra- and intracellular signals affecting cells. Receptors: term, significance, classification, diversity. DNA damage signaling pathway.

6. Role of G proteins and other GTP-ases in the signal-transduction pathways.
7. cAMP or cGMP mediated signal transduction pathways. NO signaling pathways
8. Phospholipase C signal transduction system. Other phospholipases.
9. Tyrosine kinase signal transduction pathway, formation of stable cyclin D, insulin signalling.
10. Signal transduction pathways by interleukins, TGF-beta, cell death receptors.
11. Biochemical interpretation of the cell cycle. Role of the G2-M-phase kinase.
12. Phosphorylation and proteolytic mechanisms in the regulation of the cell cycle.
13. The significance of the function of the protein p53.
14. The ras mitogenic signal transduction pathway.
15. Products and biochemical functions of protooncogenes.
16. Products and biochemical functions of tumor suppressor genes.
17. Biochemistry of apoptosis.
18. Formation and biological significance of the stress proteins.
19. Regulation of the formation of heat shock proteins.
20. Structure of platelets and their role in blood coagulation. Mechanism of platelet adhesion and aggregation.

TISSUE AND ORGAN BIOCHEMISTRY

1. Fate of glucose in various cells.
2. Amino acid metabolism of various cells and tissues.
3. Interconnections and regulation of metabolic processes between various cells and tissues associated with well-fed and starved state.
4. Cell types of the liver. Structural and functional organization. Metabolic functions of the hepatocytes. Zonal heterogeneity of hepatocytes.
5. The central role of liver in cholesterol metabolism. Biochemical explanation of hypercholesterolemia and possible ways of influencing this phenomenon.
6. Biochemical interpretation of the acute phase reaction.
7. Biotransformation, with emphasis on Phase I. and Phase II. reactions.
8. Oxidation of ethanol in the human body and its biochemical consequences.
9. Classification of blood coagulation factors, their activation and role in the blood coagulation. Proteolytic cascade of blood clotting in test tube and in the body.
10. Limiting factors of blood coagulation, the fibrinolytic system.
11. Iron metabolism: absorption, transport, storage. Iron containing proteins in the body.
12. Molecular regulation of the iron utilization: coordinated posttranscriptional regulation of the transferrin receptor and ferritin level. Role of hepcidin.
13. Synthesis and degradation of heme; metabolic disorders.
14. Storage and transport of oxygen. Structure and function of myoglobin and hemoglobin.
15. Cooperativity in the function of hemoglobin. The Bohr effect. Influence of pH, 2,3-bisphosphoglycerate and temperature.
16. Polymorphism of globins. Anomalous and pathological hemoglobins.

17. Metabolism of red blood cells.
18. Biochemistry of inflammation.
19. Energy producing processes in the muscle; differences in aerobic and anaerobic work, biochemical background and relation to the performance in the sport.
20. Types of doping agents, and their mode of action.
21. Regulatory effects of exercise induced PGC1alpha: implication for human health and disease.
22. Which biochemical processes are affected by exercise induced AMPK (AMP activated protein kinase), and the effects of these processes on human health.
23. Building molecules of the extracellular matrix: glucose aminoglycans, proteoglycans, elastin, fibronectin and their receptors.
24. Structure and properties of collagens. Formation of mature collagen fiber of type I. collagen.