

## EXAMPLES OF “STEP-1” QUESTIONS

### Enzymes. Coenzymes. Bioenergetics. Citric Acid Cycle of Krebs. Tissue respiration.

1. Pain along large nervous stems and increased amount of pyruvate in the blood were revealed in the patient. Insufficiency of what vitamin can cause such change?  
A B1\*  
B B2  
C PP  
D Pantothenic acid  
E Biotin
2. In case of enterobiasis acridine - the structural analogue of vitamin B2 - is administered. The synthesis disorder of which enzymes does this medicine cause in microorganisms?  
A FAD-dependent dehydrogenases \*  
B Cytochromeoxidases  
C Peptidases  
D NAD-dependet dehydrogenases  
E Aminotransferases
3. A 10-year-old girl often experiences acute respiratory infections with multiple spotty haemorrhages in the places of clothes friction. Hypovitaminosis of what vitamin is present at the girl?  
A C \*  
B B6  
C B1  
D A  
E B2
4. There is observed inhibited fibrillation in the patients with bile ducts obstruction, bleeding due to low level of absorbtion of some vitamin. What vitamin is in deficit?  
A K \*  
B A  
C D  
D E  
E Carotene
5. During endotoxemia active forms of the oxygen including superoxide anion radical are formed in the human body. With help of what enzyme is this anion activated?  
A Superoxide dismutase\*  
B Catalase  
C Peroxidase  
D Glutathioneperoxidase  
E Glutathionereductase
6. A patient presents high activity of LDH1,2, aspartate aminotransferase, creatine phosphokinase. In what organ (organs) is the development of a pathological process the most probable?  
A In the heart muscle (initial stage of myocardium infarction) \*  
B In skeletal muscles (dystrophy, atrophy)  
C In kidneys and adrenals  
D In connective tissue  
E In liver and kidneys

7. While examining the child the doctor revealed symmetric cheeks roughness, diarrhea, disfunction of the nervous system. Lack of what food components caused it?

- A Nicotinic acid, tryptophane\*
- B Lysine, ascorbic acid
- C Threonine, pantothenic acid
- D Methionine, lipoic acid
- E Phenylalanine, pangamic acid

8. A 13-year-old boy complains of general weakness, dizziness, tiredness. He is mentally retarded. Increased level of valine, isoleucine, leucine is in the blood and urine. Urine has specific smell. What is the diagnosis?

- A Maple syrup urine disease\*
- B Addison's disease
- C Tyrosinosis
- D Histidinemia
- E Graves' disease

9. Increased breaking of vessels, enamel and dentine destruction in scurvy patients are caused by disorder of collagen maturing. What stage of modification of procollagen is disordered in this avitaminosis?

- A Hydroxylation of proline\*
- B Formation of polypeptide chains
- C Glycosylation of hydroxylysine residues
- D Removal of C-ended peptide from procollagen
- E Detaching of N-ended peptide

10. Aspirin has antiinflammatory effect due to inhibition of the cyclooxygenase activity. Level of what biological active acids will decrease?

- A Prostaglandins\*
- B Leucotriens
- C Catecholamines
- D Biogenic amines
- E Iodinethyronyns

11. Examination of a patient revealed typical presentations of collagenosis. This pathology is characterized by increase of the following urine index:

- A Hydroxyproline\*
- B Arginine
- C Glucose
- D Mineral salts
- E Ammonium salts

12. Marked increase of activity of MB-forms of CPK (creatinephosphokinase) and LDH1 were revealed on the examination of the patient's blood. What is the most likely pathology?

- A Miocardial infarction\*
- B Hepatitis
- C Rheumatism
- D Pancreatitis
- E Cholecystitis

13. Examination of a patient suffering from frequent haemorrhages in the inner organs and mucous membranes revealed proline and lysine being included in collagen fibers. Impairment of their hydroxylation is caused by lack of the following vitamin:

- A C \*
- B E
- C K
- D A
- E D

14. A patient has an increased pyruvate concentration in blood. A large amount of it is excreted with the urine. What vitamin is lacking in this patient?

- A B1\*
- B E
- C B3
- D B6
- E B2

15. Increased production of thyroidal hormones T<sub>3</sub> and T<sub>4</sub>, weight loss, tachycardia, psychic excitement and so on present on thyrotoxicosis. How do thyroidal hormones effect energy metabolism in the mitochondrion of cells?

- A Disconnect oxidation and oxidated phosphorylation \*
- B Activates phosphorylation of substance
- C Stops phosphorylation of substance
- D Stops respiratory chain
- E Activates oxidated phosphorylation

16. A patient consulted a doctor about symmetric dermatitis of open skin areas. It was found out that the patient lived mostly on cereals and ate too little meat, milk and eggs. What vitamin deficiency is the most evident?

- A Nicotinamide \*
- B Calciferol
- C Folic acid
- D Biotin
- E Tocopherol

17. 12 hours after an accute attack of retrosternal pain a patient presented a jump of aspartate aminotransferase activity in blood serum. What pathology is this deviation typical for?

- A Myocardium infarction \*
- B Viral hepatitis
- C Collagenosis
- D Diabetes mellitus
- E Diabetes insipidus

18. Profuse foam appeared when dentist put hydrogen peroxide on the mucous of the oral cavity. What enzyme caused such activity?

- A Catalase \*
- B Cholinesterase
- C Acetyltransferase
- D Glucose-6-phosphatdehydrogenase
- E Methemoglobin reductase

19. A newborn child has convulsions that have been observed after prescription of vitamin B6. This most probable cause of this effect is that vitamin B6 is a cofactor of the following enzyme:
- A Glutamate decarboxylase \*
  - B Pyruvate dehydrogenase
  - C Netoglutarate dehydrogenase
  - D Aminolevulinic acid synthase
  - E Glycogen phosphorylase
20. A woman who has been keeping to a clean-rice diet for a long time was diagnosed with polyneuritis (beriberi). What vitamin deficit results in development of this disease?
- A Thiamine \*
  - B Ascorbic acid
  - C Pyridoxine
  - D Folic acid
  - E Riboflavin
21. Removal of gall bladder of a patient has disturbed processes of Ca absorption through the intestinal wall. What vitamin will stimulate this process?
- A D3 \*
  - B PP
  - C C
  - D B12
  - E K
22. Examination of a patient with frequent hemorrhages from internal and mucous membranes revealed proline and lysine being a part of collagen fibers. What vitamin absence caused disturbance of their hydroxylation?
- A Vitamin C \*
  - B Vitamin K
  - C Vitamin A
  - D Thiamine
  - E Vitamin E
23. Vitamin A together with specific cytochrome receptors penetrates through the nuclear membranes, induces transcription processes that stimulate growth and differentiation of cells. This biological function is realized by the following form of vitamin A:
- A Trans-retinoic acid \*
  - B Trans-retinal
  - C Cis-retinal
  - D Retinol
  - E Carotin
24. A newborn child suffers from milk curdling in stomach, this means that soluble milk proteins (caseins) transform to insoluble proteins (paracaseins) by means of calcium ions and a certain enzyme. What enzyme takes part in this process?
- A Renin \*
  - B Pepsin
  - C Gastrin
  - D Secretin
  - E Lipase

25. To prevent postoperative bleeding a 6 y.o. child was administered vicasol that is a synthetic analogue of vitamin K. Name post-translational changes of blood coagulation factors that will be activated by vicasol:

- A Carboxylation of glutamin acid \*
- B Phosphorylation of serine radicals
- C Partial proteolysis
- D Polymerization
- E Glycosylation

26. According to clinical indications a patient was administered pyridoxal phosphate. What processes is this medication intended to correct?

- A Transamination and decarboxylation of aminoacids \*
- B Oxidative decarboxylation of ketoacids
- C Desamination of purine nucleotide
- D Synthesis of purine and pyrimidine bases
- E Protein synthesis

27. As a result of posttranslative modifications some proteins taking part in blood coagulation, particularly prothrombin, become capable of calcium binding. The following vitamin takes part in this process:

- A K \*
- B C
- C A
- D B1
- E B2

28. A 3 year old child with symptoms of stomatitis, gingivitis and dermatitis of open skin areas was delivered to a hospital. Examination revealed inherited disturbance of neutral amino acid transporting in the bowels. These symptoms were caused by the deficiency of the following vitamin:

- A Niacin \*
- B Pantothenic acid
- C Vitamin A
- D Cobalamin
- E Biotin

29. Surgical removal of a part of stomach resulted in disturbed absorption of vitamin B12, it is excreted with feces. The patient was diagnosed with anemia. What factor is necessary for absorption of this vitamin?

- A Gastromucoprotein \*
- B Gastrin
- C Hydrochloric acid
- D Pepsin
- E Folic acid

30. In clinical practice tuberculosis is treated with izoniazid preparation - that is an antivitamin able to penetrate into the tuberculosis bacillus. Tuberculostatic effect is induced by the interference with replication processes and oxidation-reduction reactions due to the buildup of pseudo-coenzyme:

- A NAD \*
- B FAD
- C FMN
- D TDP

E CoQ

31. In a patient's blood the activities of lactate dehydrogenase (LDH4,LDH5), alanine aminotransferase, carbamoyl ornithine transferase are increased. What organ is the pathological process developing in?

- A In skeletal muscles
- B In the myocardium (myocardial infarction is possible).
- C In the liver (hepatitis is possible)\*.
- D In kidneys
- E In connective tissue CoQ

32. An ophthalmologist found that an outpatient had the increase of the time of sight adaptation for darkness. What kind of vitamin deficiency can be the cause of the symptom?

- A. E.
- B. A\*
- C. C.
- D. K
- E. D.

33. A patient was diagnosed with megaloblastic anemia. The lack of which substance in the human organism can cause this disease"

- A. Copper.
- B. Glycine.
- C. Cobalamine\*
- D. Cholecalciferol.
- E. Magnesium.

34. Pathological processes associated with the development of hypoxia can be caused by incomplete reduction of an oxygen molecule in the electron transport chain and accumulation of hydrogen peroxide. Choose the enzyme which breaks the hydrogen peroxide.

- A. Catalase.\*
- B. Cytochrome oxidase.
- C. Succinate dehydrogenase.
- D. a-Ketoglutarate dehydrogenase.
- E. Aconitase.

35. There is an increase of the pyruvate level in the patient's blood and urine. What kind of avitaminosis developed in this case?

- A. B2 avitaminosis.
- B. E avitaminosis.
- C. B3 avitaminosis.
- D. B6 avitaminosis.
- E. B1 avitaminosis.\*

36. Potassium cyanide is a very dangerous poison that causes instantaneous death of a human organism. What mitochondrial enzyme is affected by potassium cyanide?

- A. Cytochrome P450.
- B. Flavine enzymes.
- C. Cytochrome b.
- D. NAD+-dependent dehydrogenases.
- E. Cytochrome oxidase (cytochrome aa3)\*.

37. A 47-year-old patient was brought to an emergency department with the diagnosis of myocardial infarction. What lactate dehydrogenase (LDH) fractions activity would prevail in the patient's blood serum during the first two days after hospitalization?
- A. LDH4.
  - B. LDH2
  - c. LDH3
  - D. LDH1\*
  - E. LDH5
38. A 50-year-old woman was brought to an emergency clinic with the diagnosis of myocardial infarction. The activity of what enzyme will prevail in her blood plasma during the first two days after hospitalization?
- A. Alkaline phosphatase.
  - B. g-Glutamyl transpeptidase.
  - C. Aspartate aminotransferase.\*
  - D. Acidic phosphatase.
  - E. Hexokinase.
39. A 2-year-old child developed intestinal dysbacteriosis with a hemorrhage syndrome. The most probable cause of this syndrome is:
- A. Vitamin K deficiency.\*
  - B. Activation of tissue thromboplastin.
  - C. Vitamin PP deficiency.
  - D. Fibrinogen deficiency.
  - E. Hypocalcemia.
40. The living organisms that did develop the system of defence against the unfavorable action of H<sub>2</sub>O<sub>2</sub> during the evolution can exist only in anaerobic conditions. Which of the enzymes can destroy hydrogen peroxide?
- A. Oxygenases and hydroxylases.
  - B. Peroxidase and catalase.\*
  - C. Cytochrome oxidase, cytochrome b.
  - D. Oxygenase and catalase.
  - E. Flavin-linked oxidases.
41. The central intermediate which is common for the catabolic pathways of proteins, carbohydrates and lipids is:
- A. Succinyl-CoA.
  - B. Acetyl-CoA.\*
  - C. Oxaloacetate.
  - D. Lactate.
  - E. Citrate.
42. During the necropsy of a 20-year old girl a pathologist concluded that the death of the patient had resulted from poisoning by cyanides. The activity of what enzyme is mostly inhibited by cyanides?
- A. Malate dehydrogenase.
  - B. Cytochrome oxidase.\*
  - C. Heme synthase.
  - D. Aspartate aminotransferase.
  - E. Carbamoyl phosphate synthetase.

## Metabolism of carbohydrates

- Galactosemia is revealed in the child. Concentration of glucose in the blood is not considerably changed. Deficiency of what enzyme caused this illness?
  - Galactose-1-phosphate uridylyltransferase\*
  - Amylo-1,6-glucosidase
  - Phosphoglucomutase
  - Galactokinase
  - Hexokinase
- Characteristic sign of glycogenosis is muscle pain during physical work. Blood examination reveals usually hypoglycemia. This pathology is caused by congenital deficiency of the following enzyme:
  - Glycogen phosphorylase\*
  - Glucose 6-phosphate dehydrogenase
  - Alpha amylase
  - Gamma amylase
  - Lysosomal glycosidase
- A 34-year-old patient's resistance to heavy physical load is reduced while the skeletal muscles glycogen level is increased. By decreasing of the activity of what enzyme can this phenomenon be explained?
  - Phosphofructokinase.
  - Glucose-6-phosphate dehydrogenase.
  - Glycogen phosphorylase. \*
  - Glycogen synthetase.
  - Glucose-6-phosphatase.
- A patient is ill with diabetes mellitus that is accompanied by hyperglycemia of over 7,2 millimole/l on an empty stomach. The level of what blood plasma protein allows to estimate the glycemia rate retrospectively (4-8 weeks before examination)?
  - Glycated hemoglobin \*
  - Albumin
  - Fibrinogen
  - C-reactive protein
  - Ceruloplasmin
- A 62-year-old female patient has developed a cataract (lenticular opacity) secondary to the diabetes mellitus. What type of protein modification is observed in case of diabetic cataract?
  - Glycosylation \*
  - Phosphorylation
  - ADP-ribosylation
  - Methylation
  - Limited proteolysis
- The B cells of endocrine portion of pancreas are selectively damaged by alloxan poisoning. How will it be reflected in blood plasma?
  - The content of sugar increases \*
  - The content of fibrinogen decrease
  - The level of sugar decreases
  - The content of globulins decreases
  - The content of albumins decreases



7. Untrained people often have muscle pain after sprints as a result of lactate accumulation. This might be caused by intensification of the following biochemical process:
- Glycolysis \*
  - Gluconeogenesis
  - Pentose phosphate pathway
  - Lipogenesis
  - Glycogenesis
8. A patient was delivered to the hospital by an emergency team. Objectively: grave condition, unconscious, adynamy. Cutaneous surfaces are dry, eyes are sunken, face is cyanotic. There is tachycardia and smell of acetone from the mouth. Analysis results: blood glucose - 20,1 micromole/l, urine glucose - 3,5% . What is the most probable diagnosis?
- Hyperglycemic coma \*
  - Hypoglycemic coma
  - Acute heart failure
  - Acute alcoholic intoxication
  - Anaphylactic shock
9. Patient with diabetes mellitus experienced loss of consciousness and convulsions after injection of insulin. What is the result of biochemical blood analysis for concentration of the sugar?
- 1,5 mmol/L \*
  - 8,0 mmol/L
  - 10,0 mmol/L
  - 3,3 mmol/L
  - 5,5 mmol/L
10. On the empty stomach in the patients blood glucose level was 5,65 mmol/L, in an hour after usage of sugar it was 8,55 mmol/L, in a 2 hours - 4,95 mmol/L. Such indicators are typical for:
- Healthy person\*
  - Patient with hidden diabetes mellitus
  - Patient with insulin-dependent diabetes mellitus
  - Patient with non-insulin dependent diabetes mellitus
  - Patient with thyrotoxicosis
11. A child is languid, apathetic. Liver is enlarged and liver biopsy revealed a significant excess of glycogene. Glucose concentration in the blood stream is below normal. What is the cause of low glucose concentration?
- Low (absent) activity of glycogene phosphorylase in liver \*
  - Low (absent) activity of hexokinase
  - High activity of glycogen synthetase
  - Low (absent) activity of alfa-1,4- glucosidase
  - Deficit of glucose 1-phosphaturidine transferase
12. After a sprint an untrained person develops muscle hypoxia. This leads to the accumulation of the following metabolite in muscles:
- Lactate \*
  - Ketone bodies
  - Acetyl CoA
  - Glucose 6-phosphate
  - Oxaloacetate

13. Myocyte cytoplasm contains a big number of dissolved metabolites of glucose oxidation. Name one of them that turns directly into a lactate:
- A. Pyruvate \*
  - B. Oxaloacetate
  - C. Glycerophosphate
  - D. Glucose 6-phosphate
  - E. Fructose 6-phosphate
14. A child's blood presents high content of galactose, glucose concentration is low. There are such presentations as cataract, mental deficiency, adipose degeneration of liver. What disease is it?
- A. Galactosemia \*
  - B. Diabetes mellitus
  - C. Lactosemia
  - D. Steroid diabetes
  - E. Fructosemia
15. A 45 y.o. woman suffers from Cushing's syndrome - steroid diabetes. Biochemical examination revealed: hyperglycemia, hypochloremia. Which of the under-mentioned processes is the first to be activated?
- A. Gluconeogenesis \*
  - B. Glycogenolysis
  - C. Glucose reabsorption
  - D. Glucose transport to the cell
  - E. Glycolysis
16. The patient with complaints of permanent thirst applied to the doctor. Hyperglycemia, polyuria and increased concentration of 17-ketosteroids in the urine were revealed. What disease is the most likely?
- A. Steroid diabetes \*
  - B. Insulin-dependent diabetes mellitus
  - C. Myxoedema
  - D. Type I glycogenosis
  - E. Addison's disease
17. When blood circulation in the damaged tissue is restored, then lactate accumulation comes to a stop and glucose consumption decelerates. These metabolic changes are caused by activation of the following process:
- A. Aerobic glycolysis \*
  - B. Anaerobic glycolysis
  - C. Lipolysis
  - D. Gluconeogenesis
  - E. Glycogen biosynthesis
18. During starvation muscle proteins break up into free amino acids. These compounds will be the most probably involved into the following process:
- A. Cori cycle \*
  - B. Gluconeogenesis in muscles
  - C. Synthesis of higher fatty acids
  - D. Glycogenolysis
  - E. Decarboxylation

19. A newborn develops dyspepsia after the milk feeding. When the milk is substituted by the glucose solution the dyspepsia symptoms disappear. The newborn has the subnormal activity of the following enzyme:

- A. Lactase \*
- B. Invertase
- C. Maltase
- D. Amylase
- E. Isomaltase

20. After taking sulfonamides and aspirin by a 38-year-old patient, hemolysis of erythrocytes caused by the insufficiency of glucose-6-phosphate dehydrogenase developed. The disturbance of what coenzyme formation does this pathology result from?

- A. Ubiquinone.
- B. FADH<sub>2</sub>
- C. Pyridoxal phosphate
- D. FMNH<sub>2</sub>.
- E. NADPH\*

21. A child with point mutation has the absence of glucose- 6- phosphate body tissues, hypoglycemia and hepatomegaly detected. Define the type of pathology which these symptoms are characteristic of:

- A. Girke's disease. \*
- B. Measles.
- C. Addison's disease.
- D. Parkinson's disease.
- E. McArdle's disease.

22. The concentration of glucose in the blood plasma of a healthy man varies within the following limits:

- A. 2.0-4.0 mM/L.
- B. 3.3-5.5 mM/L. \*
- C. 10.0-25.0 mM/L.
- D. 6.0-9.5 mM/L.
- E. 1.0-2.0 mM/L.

23. Some hours after an intensive physical training a sportsman showed activated gluconeogenesis. Which of the following is the basic substrate of gluconeogenesis?

- A. Serine.
- B. Aspartate.
- C. Glutamate.
- D. a-Ketoglutarate.
- E. Lactate. \*

24. A newborn child had dyspepsia phenomena (diarrhea, vomiting) detected after feeding with milk. After additional feeding with glucose the morbid symptoms disappeared. The insufficient activity of what enzyme that takes part in the carbohydrates breakdown causes the indicated disorders?

- A. Saccharase.
- B. Amylase.
- C. Lactase. \*
- D. Isomaltase.
- E. Maltase.

25. A 2-year-old boy has the increase of liver and spleen sizes detected and eye cataract present. The total sugar level in blood is increased, but glucose tolerance is within the normal range. The inherited disturbance of the metabolism of what substance is the cause of the indicated state?
- A. Glucose.
  - B. Fructose.
  - C. Galactose. \*
  - D. Maltose.
  - E. Saccharose.
26. A 57-year-old patient, suffering from insulin dependent diabetes mellitus, showed the development of ketoacidosis. The biochemical mechanism of the development of this pathology is decreasing of acetyl-CoA utilization due to the deficiency of:
- A. 2-Oxoglutarate.
  - B. Oxaloacetate.\*
  - C. Glutamate.
  - D. Aspartate.
  - E. Succinate.
27. A 38-year-old man is receiving treatment for schizophrenia in hospital. The initial levels of glucose, ketone bodies and urea in the blood are within the normal range. Shock therapy put into practice by regular insulin injections resulted in the development of the comatose state which improved the clinical status of the patient. What is the most probable cause of insulin coma?
- A. Hyperglycemia.
  - B. Dehydration of tissues.
  - C. Metabolic acidosis.
  - D. Ketonemia.
  - E. Hypoglycemia. \*
28. A 7-year-old girl manifests obvious signs of anemia. Laboratory tests showed the deficiency of pyruvate kinase activity in erythrocytes. The disorder of what biochemical process is a major factor in the development of anemia?
- A. Deamination of amino acid.
  - B. Oxidative phosphorylation.
  - C. Tissue respiration.
  - D. Breaking up of peroxides.
  - E. Anaerobic glycolysis. \*
29. A 45-year-old woman does not have any symptoms of insulin dependent diabetes mellitus but testing on an empty stomach showed the increase of the blood glucose level (7.5 mM/l). What additional laboratory test needs to be done to substantiate the diagnosis?
- A. Determination of tolerance to glucose.
  - B. Determination of ketone bodies concentration in the urine.
  - C. Determination of rest nitrogen level in the blood.
  - D. Determination of tolerance to glucose on an empty stomach. \*
  - E. Determination of glycosylated hemoglobin level.
30. What biochemical process is stimulated in the liver and kidneys of a patient exhausted by starvation?
- A. Synthesis of bilirubin.
  - B. Synthesis of urea.
  - C. Gluconeogenesis. \*
  - D. Formation of hippuric acid.
  - E. Synthesis of uric acid.

## Metabolism of lipids

1. After consumption of rich food a patient has nausea and heartburn, steatorrhea. This condition might be caused by:

- A Bile acid deficiency\*
- B Increased lipase secretion
- C Disturbed trypsin synthesis
- D Amylase deficiency
- E Disturbed phospholipase synthesis

2. Fatty acid synthesis is disordered due to fat infiltration of the liver. Indicate which of the presented substances can enhance the process of methylation during phospholipids synthesis?

- A Methionine \*
- B Ascorbic acid
- C Glucose
- D Glycerin
- E Citrate

3. Increased amount of free fatty acids is observed in the blood of the patients with diabetes mellitus. It can be caused by:

- A Increased activity of triglycerid lipase adipocytes\*
- B Storage of palmitoic-CoA
- C Activation of the ketone bodies utilization
- D Activation of the synthesis of the apolipoproteins
- E Decreased activity of phosphatidylcholine-cholesterol-acyltransferase blood plasma

4. A patient with high rate of obesity was advised to use carnitine as a food additive in order to enhance "fat burning". What is the role of carnitine in the process of fat oxidation?

- A Transport of FFA (free fatty acids) from cytosol to the mitochondria \*
- B Transport of FFA from fat depots to the tissues
- C It takes part in one of reactions of FFA beta-oxidation
- D FFA activation
- E Activation of intracellular lipolysis

5. An experimental animal that was kept on protein-free diet developed fatty liver infiltration, in particular as a result of deficiency of methylating agents. This is caused by disturbed generation of the following metabolite:

- A Choline \*
- B DOPA
- C Cholesterol
- D Acetoacetate
- E Linoleic acid

6. Carnitine including drug was recommended to the sportsman for improving results. What process is activated most of all with help of carnitine?

- A Transport of fatty acids to the mitochondria\*
- B Synthesis of steroid hormones
- C Synthesis of ketone bodies
- D Synthesis of lipids
- E Tissue respiration

7. After intake of rich food a patient feels nausea and sluggishness; with time there appeared signs of steatorrhea. Blood cholesterol concentration is 9,2 micromole/l. This condition was caused by lack of:

- A Bile acids \*
- B Triglycerides
- C Fatty acids
- D Phospholipids
- E Chylomicrons

8. Examination of a man who hadn't been consuming fats but had been getting enough carbohydrates and proteins for a long time revealed dermatitis, poor wound healing, vision impairment. What is the probable cause of metabolic disorder?

- A Lack of linoleic acid, vitamins A, D, E, K \*
- B Lack of palmitic acid
- C Lack of vitamins PP, H
- D Low caloric value of diet
- E Lack of butyric acid

9. An experimental animal has been given excessive amount of carbon-labeled glucose for a week. What compound can the label be found in?

- A Palmitic acid \*
- B Methionine
- C Vitamin A
- D Choline
- E Arachidonic acid

10. A sportsman was recommended to take a medication that contains carnitine in order to improve his results. What process is activated by carnitine the most?

- A Fatty acids transport to mitochondrions \*
- B Synthesis of steroid hormones
- C Synthesis of ketone bodies
- D Synthesis of lipids
- E Tissue respiration

11. Examination of a patient suffering from chronic hepatitis revealed a significant decrease in the synthesis and secretion of bile acids. What process will be mainly disturbed in the patient's bowels?

- A Fats emulsification \*
- B Protein digestion
- C Carbohydrate digestion
- D Glycerin absorption
- E Amino acid absorption

12. A 6 year old child was delivered to a hospital. Examination revealed that the child couldn't fix his eyes, didn't keep his eyes on toys, eye ground had the cherry-red spot sign. Laboratory analyses showed that brain, liver and spleen had high rate of ganglioside glycometide. What congenital disease is the child ill with?

- A Tay-Sachs disease \*
- B Wilson's syndrome
- C Turner's syndrome
- D Niemann-Pick disease
- E MacArdle disease

13. NSAID blockade the utilization of arachidonic acid via cyclooxygenase pathway, which results in formation of some bioactive substances. Name them:
- A Prostaglandins \*
  - B Thyroxine
  - C Biogenic amins
  - D Somatomedins
  - E Insulin-like growth factors
14. Arachidonic acid, an essential component of a human diet, acts as a precursor of the vitally important physiologically active biomolecules. Which substances are synthesized via cyclooxygenase pathway from arachidonic acid?
- A. Ethanolamine.
  - B. Choline.
  - C. Noradrenaline.
  - D. Prostaglandins \*
  - E. Triiodothyronine.
15. A 1-year-old child with symptoms of muscle involvement was admitted to the hospital. Examination revealed carnitine deficiency in his muscles. What process disturbance is the biochemical basis of this pathology?
- A Transporting of fatty acids to mitochondrions \*
  - B Regulation of  $Ca^{2+}$  level in mitochondrions
  - C Substrate phosphorylation
  - D Lactic acid utilization
  - E Actin and myosin synthesis
16. Laboratory investigation of the patient's blood plasma, which was performed 4 hours after a consumption of a fat diet, displayed a marked increase of plasma turbidity. The most credible cause of this phenomenon is the increase of ..... in the plasma.
- A. HDL.
  - B. Chylomicrons.\*
  - C. LDL.
  - D. Cholesterol.
  - E. Phospholipids.
17. Patients who suffer from severe diabetes and don't receive insulin have metabolic acidosis. This is caused by increased concentration of the following metabolites:
- A Ketone bodies \*
  - B Fatty acids
  - C Unsaturated fatty acids
  - D Triacylglycerols
  - E Cholesterol
18. In a human body the adipose tissue is the basic location of triacylglycerols (TAG) deposit. At the same time their synthesis takes place in hepatocytes. In the form of what molecular complex are TAG transported from the liver into the adipose tissue?
- A. Chylomicrons.
  - B. VLDL.\*
  - C. LDL.
  - D. HDL.
  - E. Complexes with albumin.

19. Laboratory investigation of a patient revealed a high level of plasma LDL. What disease can be diagnosed?
- A. Gastritis.
  - B. Nephropathy.
  - C. Acute pancreatitis.
  - D. Atherosclerosis\*.
  - E. Pneumonia.
20. Aerobic oxidation of substrates is typical for cardiac myocytes. Which of the following is the major oxidation substrate of cardiac muscles?
- A. Fatty acids.\*
  - B. Triacylglycerols.
  - C. Glycerol.
  - D. Glucose.
  - E. Amino acids.
21. Which of the following enzymes accelerates the lipolysis under the action of epinephrine in stress situations?
- A. Triacylglycerol lipase. \*
  - B. Lypoprotein lipase.
  - C. Phospholipase A2
  - D. Phospholipase C.
  - E. Cholesterol esterase.
22. Clinical signs and laboratory testing of a patient allow make the assumption of gall-bladder inflammation, colloid properties of bile disorder and occurrence of gall-stones. Which substances can underlie the formation of gall-stones?
- A. Oxalates.
  - B. Urates.
  - C. Cholesterol. \*
  - D. Chlorides.
  - E. Phosphates.
23. Emotional stress causes activation of hormon-sensitive triglyceride lipase in the adipocytes. What secondary mediator takes part in this process?
- A Cyclic adenosine monophosphate \*
  - B Cyclic guanosine monophosphate
  - C Adenosine monophosphate
  - D Diacylglycerol
  - E Ions of  $\text{Ca}^{2+}$
24. The insufficient secretion of what enzyme is the cause of incomplete fats degradation in the digestive tract and appearance of great quantity of neutral fats in feces?
- A. Pepsin.
  - B. Phospholipase.
  - C. Enterokinase.
  - D. Amylase.
  - E. Pancreatic lipase \*

### **Metabolism of simple proteins**



1. Patient with encephalopathy was admitted to the neurological in-patient department. Correlation of increasing of encephalopathy and substances absorbed by the bloodstream from the intestines was revealed. What substances that are created in the intestines can cause endotoxemia?
- A Indole\*
  - B Butyrate
  - C Acetacetate
  - D Biotin
  - E Ornithine
2. Examination of a patient suffering from cancer of urinary bladder revealed high rate of serotonin and hydroxyanthranilic acid. It is caused by excess of the following amino acid in the organism:
- A Tryptophan\*
  - B Alanine
  - C Histidine
  - D Methionine
  - E Tyrosine
3. A 4 y.o. child with signs of durative protein starvation was admitted to the hospital. The signs were as follows: growth inhibition, anemia, edema, mental deficiency. Choose a cause of edema development:
- A Reduced synthesis of albumins \*
  - B Reduced synthesis of globulins
  - C Reduced synthesis of hemoglobin
  - D Reduced synthesis of lipoproteins
  - E Reduced synthesis of glycoproteins
4. The concentration of albumins in human blood sample is lower than normal. This leads to edema of tissues. What blood function is damaged?
- A Maintaining the oncotic blood pressure \*
  - B Maintaining the Ph level
  - C Maintaining the body temperature
  - D Maintaining the blood sedimentation system
  - E All answers are correct
5. Ammonia is a very toxic substance, especially for nervous system. What substance takesthe most active part in ammonia detoxication in brain tissues?
- A Glutamic acid \*
  - B Lysine
  - C Proline
  - D Histidine
  - E Alanine
6. A patient has pellagra. Interrogation revealed that he had lived mostly on maize for a long time and eaten little meat. This disease had been caused by the deficit of the following substance in the maize:
- A Tryptophan \*
  - B Tyrosine
  - C Proline
  - D Alanine
  - E Histidine

7. A patient with serious damage of muscular tissue was admitted to the traumatological department. What biochemical urine index will be increased in this case?

- A Creatinine \*
- B Common lipids
- C Glucose
- D Mineral salts
- E Uric acid

8. Nappies of a newborn have dark spots that witness of formation of homogentisic acid. Metabolic imbalance of which substance is it connected with?

- A Tyrosine \*
- B Galactose
- C Methionine
- D Cholesterine
- E Tryptophane

9. A 1,5-year-old child presents with both mental and physical lag, decolorizing of skin and hair, decrease in catecholamine concentration in blood. When a few drops of 5% solution of trichloroacetic iron had been added to the child's urine it turned olive green. Such alteration are typical for the following pathology of the amino acid metabolism:

- A Phenylketonuria \*
- B Alkaptonuria
- C Tyrosinosis
- D Albinism
- E Xanthinuria

10. The greater amount of nitrogen is excreted from the organism in form of urea. Inhibition of urea synthesis and accumulation of ammonia in blood and tissues are induced by the decreased activity of the following liver enzyme:

- A Carbamoyl phosphate synthetase \*
- B Aspartate aminotransferase
- C Urease
- D Amylase
- E Pepsin

11. After a serious viral infection a 3-year-old child has repeated vomiting, loss of consciousness, convulsions. Examination revealed hyperammoniemia. What may have caused changes of biochemical blood indices of this child?

- A Disorder of ammonia neutralization in ornithinic cycle \*
- B Activated processes of aminoacids decarboxylation
- C Disorder of biogenic amines neutralization
- D Increased putrefaction of proteins in intestines
- E Inhibited activity of transamination enzymes

12. Albinos can't stand sun impact - they don't acquire sun-tan but get sunburns. Disturbed metabolism of what aminoacid underlies this phenomenon?

- A Phenilalanine \*
- B Methionine
- C Tryptophan
- D Glutamic acid
- E Histidine

13. Glutamate decarboxylation results in formation of inhibitory transmitter in CNS. Name it:

- A GABA \*
- B Glutathione
- C Histamine
- D Serotonin
- E Asparagine

14. In course of histidine catabolism a biogenic amine is formed that has powerful vasodilating effect. Name it:

- A Histamine \*
- B Serotonin
- C Dioxyphenylalanine
- D Noradrenalin
- E Dopamine

15. A patient diagnosed with carcinoid of bowels was admitted to the hospital. Analysis revealed high production of serotonin. It is known that this substance is formed of tryptophane amino acid. What biochemical mechanism underlies this process?

- A Decarboxylation \*
- B Desamination
- C Microsomal oxydation
- D Transamination
- E Formation of paired compounds

16. During hypersensitivity test a patient got subcutaneous injection of an antigen which caused reddening of skin, edema, pain as a result of histamine action. This biogenic amine is generated as a result of transformation of the following histidine amino acid:

- A Decarboxylation \*
- B Methylation
- C Phosphorylation
- D Isomerization
- E Deaminization

17. A patient complained about dizziness, memory impairment, periodical convulsions. It was revealed that these changes were caused by a product of decarboxylation of glutamic acid. Name this product:

- A GABA \*
- B Pyridoxal phosphate
- C TDP
- D ATP
- E THFA

18. Laboratory examination of a child revealed increased concentration of leucine, valine, isoleucine and their ketoderivatives in blood and urine. Urine smelt of maple syrup. This disease is characterized by the deficit of the following enzyme:

- A Dehydrogenase of branched amino acids \*
- B Aminotransferase
- C Glucose-6-phosphatase
- D Phosphofructokinase
- E Phosphofructomutase

19. A newborn child was found to have reduced intensity of sucking, frequent vomiting, hypotonia. In urine and blood exhibit increased concentration of citrulline. What metabolic process is disturbed?

- A Ornithinic cycle \*
- B Tricarboxylic acid cycle
- C Glycolysis
- D Glyconeogenesis
- E Cori cycle

20. Plasmic factors of blood coagulation are exposed to post-translational modification with the participation of vitamin K. It is necessary as a cofactor in the enzyme system of gamma-carboxylation of protein factors of blood coagulation due to the increased affinity of their molecules with calcium ions. What amino acid is carboxylated in these proteins?

- A Glutamate \*
- B Valine
- C Serine
- D Phenylalanine
- E Arginine

21. Pharmacological effects of antidepressants are connected with inhibition of an enzyme catalyzing biogenic amines noradrenaline and serotonin in the mitochondrions of cerebral neurons. What enzyme participates in this process?

- A Monoamine oxidase \*
- B Transaminase
- C Decarboxylase
- D Peptidase
- E Lyase

22. A child manifests epileptic seizures caused by vitamin B6 deficiency. This is conditioned by the decrease of the gamma-aminobutyrate level in the nervous tissue which acts as an inhibiting neurotransmitter. The activity of which enzyme is decreased in this case?

- A. Pyridoxal kinase.
- B. Alanine aminotransferase.
- C. Glutamate dehydrogenase.
- D. Glutamate decarboxylase.\*
- E. Glutamate synthetase.

### **Metabolism of complex proteins**

1. Methotrexate (competitive inhibitor of the dihydrofolatreductase) is prescribed for treatment of the tumour. On which level does methotrexate inhibit synthesis of the nucleic acids?

- A Mononucleotide synthesis \*
- B Replication
- C Transcription
- D Reparation
- E Processing

2. Blood of a 12 year old boy presents low concentration of uric acid and accumulation of xanthine and hypoxanthine. This child has genetic defect of the following enzyme:

- A Xanthine oxidase\*
- B Arginase
- C Urease
- D Ornithine carbamoyltransferase
- E Glycerylkinase

3. An experiment proved that UV-radiated cells of patients with xeroderma pigmentosum restore the native DNA structure slower than cells of healthy individuals as a result of reparation enzyme defect. What enzyme helps this process?

- A Endonuclease \*
- B RNA ligase
- C Primase
- D DNA polymerase III
- E DNA gyrase

4. A 20 year old patient complains of general weakness, dizziness, quick fatigability. Blood analysis results: Hb- 80 g/l. Microscopical examination results: erythrocytes are of modified form. This condition might be caused by:

- A Sickle-cell anemia \*
- B Hepatocellular jaundice
- C Acute intermittent porphyria
- D Obturative jaundice
- E Addison's disease

5. A 48 year old patient complained about intense pain, slight swelling and reddening of skin over the joints, temperature rise up to 38°C. Blood analysis revealed high concentration of urates. This condition might be caused by disturbed metabolism of:

- A Purines \*
- B Collagen
- C Cholesterol
- D Pyrimidines
- E Carbohydrates

6. A patient has yellow skin colour, dark urine, achromatic feces. What substance will have strengthened concentration in the blood serum?

- A Unconjugated bilirubin
- B Conjugated bilirubin \*
- C Mesobilirubin
- D Verdoglobulin
- E Biliverdin

7. A 46 year old woman suffering from cholelithiasis developed jaundice. Her urine became dark-yellow and feces became colourless. Blood serum will have the highest concentration of the following substance:

- A Conjugated bilirubin \*
- B Unconjugated bilirubin
- C Biliverdin
- D Mesobilirubin
- E Urobilinogen

8. A 46 year old patient applied to a doctor complaining about joint pain that becomes stronger the day before weather changes. Blood examination revealed strengthened concentration of uric acid. The most probable cause of the disease is the intensified disintegration of the following substance:

- A Adenosine monophosphate \*
- B Cytidine monophosphate
- C Uridine triphosphate
- D Uridine monophosphate

E Thymidine monophosphate

9. A 42-year man suffering from gout has increased level of urinary acid in the blood. Allopurinol was prescribed to decrease the level of urinary acid. Competitive inhibitor of what enzyme is allopurinol?

- A Xanthinoxidase \*
- B Adenosinedeaminase
- C Adeninephosphoribosiltransferase
- D Hypoxantinphosphoribosiltransferase
- E Guaninedeaminase

10. Patient experienced increased susceptibility of the skin to the sunlight. His urine after some time became dark-red. What is the most likely cause of this?

- A Porphyria \*
- B Hemolytic jaundice
- C Albinism
- D Pellagra
- E Alkaptonuria

11. A 65 year old man suffering from gout complains of kidney pain. Ultrasound examination revealed renal calculi. The most probable cause of calculi formation is the strengthened concentration of the following substance:

- A Uric acid \*
- B Cholesterol
- C Bilirubin
- D Urea
- E Cystine

12. It was found out that some compounds, for instance fungi toxins and some antibiotics can inhibit activity of RNA-polymerase. What process will be disturbed in a cell in case of inhibition of this enzyme?

- A Transcription \*
- B Processing
- C Replication
- D Translation
- E Reparation

13. An oncological patient was prescribed methotrexate. With the lapse of time target cells of the tumour lost susceptibility to this drug. There is change of gene expression of the following enzyme:

- A Dehydrofolate reductase \*
- B Thiaminase
- C Deaminase
- D Folate oxidase
- E Folate decarboxylase

### Functional biochemistry

1. An infant has apparent diarrhea resulting from improper feeding. One of the main diarrhea effects is plentiful excretion of sodium bicarbonate. What form of acid-base balance disorder is the case?

- A Metabolic acidosis\*

- B Metabolic alkalosis
- C Respiratory acidosis
- D Respiratory alkalosis
- E No disorders of acid-base balance will be observed

2. Buffer capacity of blood was decreased in the worker due to exhausting muscular work. Entry of what acid substance to the blood can this state be explained?

- A Lactate\*
- B Pyruvate
- C 1,3-bisphosphoglycerate
- D alpha-ketoglutarate
- E 3-phosphoglycerate

3. A 38 year old patient suffers from rheumatism in its active phase. What laboratory characteristic of blood serum is of diagnostic importance in case of this pathology?

- A C-reactive protein \*
- B Uric acid
- C Urea
- D Creatinine
- E Transferrin

4. A 30 y.o. woman had been ill for a year when she felt pain in the area of joints for the first time, they got swollen and skin above them became reddened. Provisional diagnosis is rheumatoid arthritis. One of the most probable causes of this disease is a structure alteration of a connective tissue protein:

- A Collagen \*
- B Mucin
- C Myosin
- D Ovoalbumin
- E Troponin

5. Examination of a 27-year-old patient revealed pathological changes in liver and brain. Blood plasma analysis revealed an abrupt decrease in the copper concentration, urine analysis revealed an increased copper concentration. The patient was diagnosed with Wilson's degeneration. To confirm the diagnosis it is necessary to study the activity of the following enzyme in blood serum:

- A Ceruloplasmin \*
- B Carbonic anhydrase
- C Xanthine oxidase
- D Leucine aminopeptidase
- E Alcohol dehydrogenase

6. A patient complains about dyspnea provoked by the physical activity. Clinical examination revealed anaemia and presence of the paraprotein in the zone of gamma-globulins. To confirm the myeloma diagnosis it is necessary to determine the following index in the patient's urine:

- A Bence Jones protein \*
- B Bilirubin
- C Haemoglobin
- D Ceruloplasmin
- E Antitrypsin

7. A 62 y.o. woman complains of frequent pains in the area of her chest and backbone, rib fractures. A doctor assumed myelomatosis (plasmocytoma). What of the following laboratory characteristics will be of the greatest diagnostical importance?

- A Paraproteinemia \*
- B Hyperalbuminemia
- C Proteinuria
- D Hypoglobulinemia
- E Hypoproteinemia

8. Pathological changes of the liver and brain were revealed in a 27-year-old patient. The copper concentration is abruptly decreased in blood plasma and increased in the urine. Wilson's disease was diagnosed. Activity of what enzyme in the blood serum should be examined to prove diagnosis?

- A Ceruloplasmin\*
- B Carboanhydrase
- C Xanthioxidase
- D Leucinamineopeptidaze
- E Alcoholdehydrogenaze

9. A 50-year-old patient complains about general weakness, appetite loss and cardiac arrhythmia. The patient presents with muscle hypotonia, flaccid paralyses, weakened peristaltic activity of the bowels. Such condition might be caused by:

- A Hypopotassemia \*
- B Hypoproteinemia
- C Hyperkaliemia
- D Hypophosphatemia
- E Hyponatremia

10. A 63-year-old woman developed signs of rheumatoid arthritis. Increase of which indicated blood values level could be helpful in proving diagnosis?

- A Additive glycosaminoglycans\*
- B Lipoproteids
- C Acid phosphatase
- D General cholesterol
- E R-glycosidase

11. A 35 y.o. patient who often consumes alcohol was treated with diuretics. There appeared serious muscle and heart weakness, vomiting, diarrhea, AP- 100/60 mm Hg, depression. This condition is caused by intensified excretion with urine of:

- A Potassium \*
- B Sodium
- C Chlorine
- D Calcium
- E Phosphates

12. A patient suffers from hepatic cirrhosis. Examination of which of the following substances excreted by urine can characterize the state of antitoxic function of liver?

- A Hippuric acid \*
- B Ammonium salts
- C Kreatinine
- D Uric acid
- E Aminoacids



13. Products of some proteins hydrolysis and modification are the biologically active substances called hormones. Lipotropin, corticotropin, melanotropin and endorphins are synthesized in the hypophysis of the following protein:

- A Proopiomelanocortin (POMC) \*
- B Neuroalbumin
- C Neurostromin
- D Neuroglobulin
- E Thyreoglobulin

14. During examination of an 11-month-old infant a pediatrician revealed osteoectasia of the lower extremities and delayed mineralization of cranial bones. Such pathology is usually provoked by the deficit of the following vitamin:

- A Cholecalciferol \*
- B Thiamin
- C Pantothenic acid
- D Bioflavonoids
- E Riboflavin

15. Desulfiram is widely used in medical practice to prevent alcoholism. It inhibits aldehyde dehydrogenase. Increased level of what metabolite causes aversion to alcohol?

- A Acetaldehyde \*
- B Ethanol
- C Malonyl aldehyde
- D Propionic aldehyde
- E Methanol

16. Index of pH of the blood changed and became 7,3 in the patient with diabetes mellitus. Detecting of the components of what buffer system is used while diagnosing disorder of the acid-base equilibrium?

- A Bicarbonate\*
- B Phosphate
- C Hemoglobin
- D Oxyhemoglobin
- E Protein

17. Diabetes mellitus causes ketosis as a result of activated oxidation of fatty acids. What disorders of acid-base equilibrium may be caused by excessive accumulation of ketone bodies in blood?

- A Metabolic acidosis \*
- B Metabolic alkalosis
- C Any changes won't happen
- D Respiratory acidosis
- E Respiratory alkalosis

18. Depressions and emotional insanities result from the deficit of noradrenalin, serotonin and other biogenic amines in the brain. Their concentration in the synapses can be increased by means of the antidepressants that inhibit the following enzyme:

- A Monoamine oxidase \*
- B Diamine oxidase
- C L-amino-acid oxidase
- D D-amino-acid oxidase
- E Phenylalanine-4-monooxygenase

19. A patient with suspected diagnosis "progressing muscular dystrophy" got his urine tested. What compound will confirm this diagnosis if found in urine?

- A Kreatine \*
- B Collagen
- C Porphyrin
- D Myoglobin
- E Calmodulin

20. Dietary intake of a 30 year old nursing woman contains 1000 mg of calcium, 1300 mg of phosphorus and 20 mg of iron per day. It is necessary to change content of these mineral substances in the following way:

- A To increase phosphorus content \*
- B To increase calcium content
- C To reduce fluorine content
- D To increase iron content
- E To reduce iron content

21. Cardinal symptoms of primary hyperparathyroidism are osteoporosis and renal lesion along with development of urolithiasis. What substance makes up the basis of these calculi in this disease?

- A Calcium phosphate \*
- B Uric acid
- C Cystine
- D Bilirubin
- E Cholesterol

22. Study of conversion of a food colouring agent revealed that neutralization of this xenobiotic takes place only in one phase - microsomal oxydation. Name a component of this phase:

- A Cytochrome P-450 \*
- B Cytochrome B
- C Cytochrome C
- D Cytochrome A
- E Cytochrome oxidase

23. A patient had hemorrhagic stroke. Blood examination revealed strengthened kinin concentration. The patient was prescribed contrical. It was administered in order to inhibit the following proteinase:

- A Kallikrein \*
- B Pepsin
- C Trypsin
- D Chemotrypsin
- E Collagenase

24. A 42-year-old man was hospitalized to a cardiologic department with the diagnosis of stenocardia. The inhibitor of phosphodiesterase was included in the medicinal treatment of the patient. The concentration of what substance will be increased in the cardiac muscle?

- A. ADP.
- B. GMP.
- C. AMP
- D. cAMP.\*
- E. ATP.

25. Under different pathological states the level of active forms of oxygen rises, which results in the destruction of cellular membranes. In order to prevent the damage of membranes, antioxidants are used. The most powerful natural antioxidant is:

- A.  $\alpha$ -Tocopherol.\*
- B. Glucose.
- C. Vitamin A.
- D. Fatty acids.
- E. Glycerol.

26. A 4 year old child with hereditary renal lesion has signs of rickets, vitamin D concentration in blood is normal. What is the most probable cause of rickets development?

- A Impaired synthesis of calcitriol \*
- B Increased excretion of calcium
- C Hyperfunction of parathyroid glands
- D Hypofunction of parathyroid glands
- E Lack of calcium in food

27. A doctor examined a child and revealed symptoms of rachitis. Development of this disease was caused by deficiency of the following compound:

- A 1,25 [OH]-dihydroxycholecalciferol \*
- B Biotin
- C Tocopherol
- D Naphthaquinone
- E Retinol