Bachelor's Educational Programs

Exam questions in Medical Biochemistry

(2022-2023)

Water and Buffers

1. Water function and distribution in a body.

2. Specificity of water molecule structure.

3. Hydrogen bonds.

4. Water as a universal solvent.

5. Water and thermoregulation.

6. Strong and week electrolytes.

7. Dissociation of water.

8. The ion product of water.

9. Osmolarity and water movement between different compartments.

10. Electrolytes distribution between different compartments.

11. pH. Significance of pH.

12. Some of biological fluids' pH.

13. Definition of acids and basis.

14. Weak and strong acids.

15. Dissociation constant.

16. Definition and significance of pK.

17. Metabolic acids.

18. The Henderson-Hasselbalch equation.

19. Buffers.

20. Buffer capacity.

21. Acetic acid/acetate buffer couple.

22. Buffer systems in a human body.

23. Bicarbonate and hemoglobin buffer systems. Breathing rate dependence on pH.

24. Changing of pH in clinical practice.

25. Acidosis. The types of acidosis.

26. Alkalosis. The types of alkalosis.

27. Proteins.

28. Amino acid composition of proteins.

29. General description of amino acid's structure.

30. Side chain importance for amino acids characteristics and function.

31. Amino acids classification.

32. Hydrophobic amino acids.

33. Polar, not charged amino acids.

34. Amino acids containing aromatic rings.

35. Sulfur containing amino acids.

36. Positively charged amino acids.

37. Negatively charged amino acids.

38. 21th amino acid.

39. Derived amino acids. Examples.

40. Peptide bond. Formation of peptide bond.

41. Characteristics of peptide bond.

42. Peptides. Their example.

43. pH and proteins and amino acids groups that can be ionized and pH.

44. Titration of amino acids.

45. Determination of isoelectric point.

46. Definition of zwitter ion.

47. Primary structure of proteins.

48. Conservative and non-conservative changes in the primary structure of proteins.

49. Non-conservative mutation during sickle cell anemia.

50. Description of primary structure of pro-insulin and insulin.

51. Insulins that are used for the treatment of diabetes mellitus.

52. Secondary structure of proteins.

53. Importance of hydrogen bonds for secondary structure of proteins.

54. α–helical structure formation in proteins.

55. Regular structural unites of β–folds

56. Position of side chains in the secondary structure of proteins.

57. Structural motifs and folds of the proteins.

58. Tertiary structure. Importance of tertiary structure.

59. Folding process of proteins and conformation formation.

60. Bonds that participate in the formation of native conformation of proteins.

61. Destruction of native structure of proteins.

62. Quaternary structure of proteins.

63. Protein examples that have tertiary and quaternary structure.

64.Fibrous proteins. Their general description.

65. Collagen. Amino acid composition of collagen.

66. Derived amino acids in collagen.

67. Hydroxylated products function in collagen structure formation.

68. 5-hydroxylysine function for collagen.

69. Collagen amino acids sequence.

70. Glycine function in the formation of collagen superhelix.

71. Specificity of collagen structure.

72. Description of polyproline II helix.

73. Collagen cross-links formation.

74. Disorders in the process of synthesis in a collagen fiber.

75. Elastin. Specificity of elastin structure.

76. Allysine formation in fibrous proteins.

77. Heterocycle structures that are characteristic for elastin.

78. Keratin. Keratin specific structures.

79. Polar and apolar edges formation in the α- helixes of keratin.

80. Correlation between structure and function of the proteins.

81. General description of globular proteins.

82. Function and the types of hemoglobin.

83. Structure of hemoglobin.

84. Structure and function of heme group.

85. Function of myoglobin.

86. Structure of myoglobin.

87. Primary, secondary and tertial structures of myoglobin and hemoglobin.

88. Oxygen binding in myoglobin and hemoglobin

89. Oxygen saturation curves for myoglobin and hemoglobin

90. Hill coefficient and its interpretation

91. Molecular mechanism of cooperativity during oxygen binding in hemoglobin.

92. Conformation changes of heme and polypeptide bound to heme during changing deoxyhemoglobin into its oxygenated form.

93. His146 /Asp94 ionic couple and dissociation of hydrogen ions.

94. Bohr effect.

95. Biochemical mechanism of transportation H+CO2 and O2.

96. Transportation of CO2 using isohydric transport and in the form of carbaminohemoglobin.

97. Buffering function of hemoglobin.

98. Description of 2,3-bisphosphoglycerate.

99. Regulation of hemoglobin affinity by concentration of 2,3-bisphosphoglycerate.

100. Hypoxia and 2,3-bisphosphoglycerate.

Enzymes

101. Classification of enzymes.

102. Steps of the reactions catalyzed by enzymes.

103. Structure of enzymes.

104. Substrate binding center.

105. Catalytic site of an enzyme.

106. “Lock and key “model for enzyme-substrate complex formation.

107. ,,Induced fit” model for substrate binding.

108. Transition state for enzyme catalyzed reactions.

109. Activation energy.

110. Energy diagrams for reactions catalyzed by enzymes and without them. enzyme catalyzed

111. Catalytic Triade in the active center of serinoproteases.

112. General principles of enzymes kinetics.

113. Essence of Michael constant Km.

114. Significance of different Km of glucose binding for hexokinase isozymes.

115. Dependence of enzymatical reactions velocity on the substrate concentration.

116. Michael-Menten's equation and its interpretation.

117. Coenzymes in the process of catalyzes.

118. Classification of coenzymes.

119. Differences between coenzymes and prosthetic groups.

120. Oxidation-reduction coenzymes.

121. Coenzyme forms for niacin.

122. NAD^+ participation in oxidation-reduction process using lactate dehydrogenase example.

123. Coenzyme forms for riboflavin.

124. Activation-Transfer coenzymes.

125. Thiamine pyrophosphate (TPP), its structure and functional groups.

126.TPP participation in metabolic conversion processes.

127. Coenzyme A, its structure and functional groups.

128. Function of coenzyme A in transfer reactions.

129. Pyridoxal phosphate, its structure and functional groups.

130. Function of pyridoxal phosphate in the metabolism of amino acids.

1361 Biotin, its structure.

132. Participation of biotin in carboxylation reactions.

133. Common characteristics for activation-transfer coenzymes.

134. Metal ions as cofactors.

135. Factors acting on enzymes activity: optimal pH.

136. Optimum pH differences in the isoenzymes using the example of alcohol dehydrogenase.

137. Influence of the temperature on enzyme catalyzed reactions.

138. Importance of enzyme thermolability

139. Mechanism based inhibitors.

140. Covalent inhibitors.

141. Inhibition by heavy metals.

142. Regulation of enzyme activities by conformation changes.

143. Allosteric enzymes.

144. Allosteric activation.

145. Allosteric inhibition.

146. Dependence of allosteric enzyme velocity on the concentration of substrate.

147. Allosteric enzyme in metabolic pathways.

148. Conformation changes that are caused by covalent modification of enzymes.

149. Phosphorylation/dephosphorylation – covalent modification discussed with the example of muscle glycogen phosphorylase.

150. Conformational changes caused by protein-protein interactions.

151. Proteolytic cleavage.

152. Inhibition of enzyme activity.

153. Competitive inhibition.

154. Non-competitive inhibition.

155 Mechanism of action of elective inhibitors using the example of aspirin.

156. Transition state inhibitors.

157. Penicillin, analog of transition state complex.

158. Suicide inhibitors.

159. Irreversible inhibitors.

160. Regulation of metabolic pathways.

161. Regulation of intracellular concentration of enzymes.

162. Regulated synthesis of enzymes.

163. Regulated degradation of enzymes.

164. Feedback inhibition.

165. Feed forward regulation.

166. Compartmentalization of enzymes.

Signal transduction, Bioenergetics

167. Main principles and pathways for signal transduction.

168. Contact dependent signal transduction.

169. Signal transduction using endocrine pathway.

170. Signal transduction using paracrine pathway.

171. Signal transduction using synaptic pathway.

172. Signal transduction using autocrine pathway.

173. Receptors for messenger molecules. Their types and general description.

174. Chemical messengers.

175. Water soluble and fat-soluble secondary messengers.

178. Plasma membrane receptors.

179. Protein phosphorylation in signal transduction pathways.

180. Energy producing and energy consuming processes.

181. Structure of acetyl CoA.

182. Sources of acetyl CoA.

183. Metabolic pathways of acetyl CoA.

184. Metabolic sources of pyruvate.

185. Pyruvate conversion pathways.

186. Composition of pyruvate dehydrogenase complex (PDH).

187. Krebs (TCA) cycle. Its essence and importance.

188. Substrates and products of Krebs cycle.

189. Reactions of Krebs cycle.

190. Description of the reaction catalyzed by citrate synthase.

191. First stage of NADH and CO2 production in TCA cycle.

192. α-ketoglutarate dehydrogenase complex and its similarity to PDH.

193. Second stage of NADH and CO2 production in TCA cycle.

194. Substrate level phosphorylation in TCA cycle.

195. Description of succinate dehydrogenase.

196. Production of L-malate in the Krebs cycle.

197. Regeneration of oxaloacetate in the last step of TCA cycle.

198. Coenzymes in TCA cycle.

199. Total energy production in the citric acid cycle.

200. Functioning of TCA cycle as open cycle.

201. Usage of TCA cycle intermediates in the processes of biosynthesis.

202. Anaplerotic reactions.

203. Regulation of TCA cycle.

204. Electron transport chain.

205. I complex of mitochondrial respiratory chain.

206. II complex of mitochondrial respiratory chain.

207. III complex of mitochondrial respiratory chain.

208. IV complex of mitochondrial respiratory chain.

209. Electron transfer by cytochromes.

210. V complex of mitochondrial respiratory chain – ATP synthase.

211. Inhibitors of electron transport chain.

212. Inhibition of respiratory chain by cyanide.

213. Oxidative phosphorylation.

214. Formation of ATP from NADH.

215. Formation of ATP from FADH2

Carbohydrate metabolism

216. ATP delivery from glucose.

217. Idea and importance of glycolysis.

218. Cells and tissues that are dependent on glucose.

219. Glucose transporters (GLUT).

220. Three stages of glycolysis.

221. Priming of glucose.

222. Production of glucose-6-phosphate and its importance in the glucose metabolism.

223. ATP,, investment" steps in glycolysis.

224. Phosphorylated intermediates cleavage in glycolysis.

225. Reaction products catalyzed byaldolase.

226. Importance of triose phosphate isomerase.

227. Getting 1,3-bisphosphoglycerate and reduction of NAD+ in the glycolysis.

228. Substrate level phosphorylation in the glycolysis.

229. Differences between oxidative and substrate level phosphorylation.

230. Shuttle of 2,3-bisphosphoglycerate.

231. 2,3-bisphosphoglycerate function in erythrocytes.

232. Production of phosphoenolpyruvate in the glycolysis.

233. Second step of ATP delivery in glycolysis.

234. Final step of anerobic glycolysis.

235. Energetical outcome of anerobic glycolysis.

236. Following conversions of NADHreceived from glycolysis.

237. Mechanism of malate-aspartate shuttle action.

238. Energetical outcome of malate-aspartate shuttle action.

239. Mechanism of glycerol phosphate shuttle action.

240. Energetical outcome of glycerol phosphate shuttle action.

241.Energetical outcome of glucose complete oxidation.

242. Lactic acidosis.

243. Definition and importance of gluconeogenesis.

244. Substrates of gluconeogenesis.

245. Four main reactions of gluconeogenesis

246. Cori cycle.

247. Glucose-Alanine cycle.

248. Produced and used ATP quantity inGlucose-Alanine cycle.

249. Comparing Cori and alanine cycle.

250. Glucose production from lactate.

251. Energy usage steps during conversion of pyruvate into phosphoenolpyruvate.

252. Hydrolyses of fructose-1,6-bisphosphate.

253. Producing free glucose in the last step of gluconeogenesis.

254. Usage of amino acids in the gluconeogenesis process.

255. Gluconeogenesis pathways starting from alanine and their correlation with urea cycle.

256. Compounds that can not enter in the gluconeogenesis.

257.Use of ATP in the process of gluconeogenesis.

258. ,,Choice" of pyruvate conversion pathway.

259. Mechanism of developing hypoglycemia during alcohol consumption.

260. Tendency of hypoglycemia development in premature infants.

261. Glycogen, as the carbohydrate storage form in a human body.

262. Structure of glycogen molecule.

263. Functional differences for muscle and liver glycogen.

264. Description of glycogen degradation (glycogenolysis).

265. Key enzymes in the process of glycogenolyses.

266. Comparison of glycogen phosphorylase and α-amylase.

267. The product produced by the action of glycogen phosphorylase.

268. Mechanism of action of debranching enzyme (DB).

269. The product produced by the action of DB enzyme.

270. Glycogen storage diseases.

271. Description of glycogen biosynthesis (glycogenesis).

272. Enzymes involved in the process of glycogenesis.

273. Reversible reaction for glycogenolyses and glycogenesis.

274. Production of,, activated glucose" in the process of glycogenesis.

275. α–1,4 glyosidic linkage formation in the process of glycogen biosynthesis.

276.α–1,6glyosidic linkage formation in the process of glycogen biosynthesis.

277. Glycogenin and its function in the process of glycogen biosynthesis.

278. Advantages of glycogen as the storage form.

279. General aspects of glycogen metabolism regulation.

Lipid metabolism

280. General description of lipids.

281. Structure and chemical characteristics of triacylglycerols.

282. Importance of triacylglycerols as the storage form.

283. Classes of plasma lipoproteins.

284. Structure of plasma lipoproteins.

285. Hyperlipidemias.

286. Lipoprotein lipase. Its substrate, activator, product.

287. Lipases in adipocytes.

288. Perilipin.

289. Products of intracellular lipolysis and their use.

290. Ways of glycerol use.

291. Function of glycerol kinase and place of action.

292. Glucose as the precursor for fatty acids synthesis.

293. General description of fatty acid synthesis.

294. Steps of triacylglycerols synthesis.

295. Specificities of triacylglycerol synthesis in the brush border small intestine.

296. Fatty acid use for energy production.

297. Comparing fatty acid oxidation and synthesis.

298. Activation of fatty acids.

299. Carnitine as the transporter of CoA and its derivatives.

300. Carnitine palmitoyl transferase I(CPT I).

301. Carnitine acyl carnitine translocase.

302. Carnitine palmitoyl transferase II(CPT II).

303. Reactions of fatty acid βoxidation.

304. FADH2 delivery in the process of fatty acid βoxidation.

305. NADH delivery in the process of fatty acid βoxidation.

306. Reaction catalyzed by ketothiolase.

307. Energy production in the process of palmitic acid βoxidation.

308. Ketone bodies.

309. Localization of ketone bodiessynthesis process.

310. Starting compound in ketone bodies synthesis

311. Production of acetoacetyl-CoA- first step in the ketone bodiesbiosynthesis.

312. HMG-CoA synthase.

313. HMG-CoA lyase.

314. Importance of mitochondrial NADH/NAD+ ratio for defining direction of the reaction catalyzed by β–hydroxybutyrate dehydrogenase.

315. NADH/NAD+ changes in the fast state.

316. Producing acetone from acetoacetate.

317. Isozymes of HMG-CoA synthase.

318. Importance and location of ketone bodies usage.

319. Enzymes required for ketone body utilization.

320. Hyperketonemia and ketoacidosis.

321. General principles of lipid metabolism regulation in the fast state.

322.General description of cholesterol structure and function.

323. Structural role of cholesterol.

324. Cholesterol as the precursor of important compounds.

325. Synthesis and the excretion of cholesterol.

326. Location of cholesterol synthesis process.

327. Starting compound of cholesterol synthesis and steps of the synthesis process.

328. Comparing starting steps of cholesterol and ketone bodies biosynthesis.

329. Description of HMG-CoA reductase.

330. Clinical use of HMG-CoA reductase inhibitors.

331. Transport of triacylglycerols, cholesterol and cholesterol esters.

332. Classes of apoproteins and their importance.

333. Very low-density lipoproteins (VLDL).

334. Structure and function of chylomicrons.

335. Function of low-density lipoproteins (LDL).

336. Function of high-density lipoproteins (HDL).

337. Cholesterol ester transferring protein (CETP).

338. “Reverse transport of cholesterol”.

339. Lecithin: cholesterol acyl transferase (LCAT).

340. “Bad” and “good” lipoproteins.

341. Correlation of LDL and HDL concentrations with the development of atherosclerosis and ischemic heart disease.

342. Biochemical aspects in the pathogenesis of atherosclerosis.

343. Excretion of cholesterol in the form of bile acids.

344. Enterohepatic circulation of bile acids.

345. Functions of bile acids and phospholipids.

346. Importance of cholesterol in the synthesis of Vitamin D.

Amino acids metabolism

347. Turnover of proteins and nitrogen balance.

348. Pathological conditions for which negative nitrogen balance is characteristic.

349. Reasons of developing positive nitrogen balance.

350. Synthesis of non-essential amino acids.

351. General description of amino transferases.

352. Examples of transamination reactions.

353. Importance of transamination reactions.

354. Amino acids that do not participate in transamination reactions.

355. Importance of the couple Glutamate/α-ketoglutarate in amino acids conversions.

356. Usage of α-ketoisovalerate for the treatment of hyperammonemia.

357. Role of pyridoxal phosphate in the transamination reactions.

358. Description of glutamate dehydrogenase.

359. Coenzymes of glutamate dehydrogenase.

360. Receiving ATP from glutamate.

361. Role of glutamine synthetase.

362. Substrates of glutamine synthetase.

363. Role of glutaminase.

364. Role of glutamate in the synthesis, degradation and interconversion of amino acids.

365. Essence and the importance of urea cycle in mammalian organisms.

366. Sources of urea nitrogens.

367. First and the last compound of urea cycle.

368. Differences according to the first and last compounds between two Krebs cycle.

369. Carbamoyl phosphate synthetase I.

370. Carbamoyl phosphate synthetase II.

371. ATP quantity required for carbamoyl phosphate formation.

372. Localization of urea cycle enzymes.

373. Receiving citrulline in the urea cycle.

374. Second step of ATP usage in urea cycle.

375. Receiving TCA cycle intermediates from urea cycle.

376. Last step of urea cycle.

377. Amino acid that can be converted into ornithine.

378. Factors that make arginine to be non-essential.

379. Following metabolism of urea cycle intermediate – fumarate.

380. Synthesis of N-acetyl glutamate.

381. Allosteric regulation of carbamoyl phosphate synthetase I.

382. Induction of urea cycle enzymes.

Vitamines

383. Classification of vitamins.

384. Fat soluble vitamins.

385. Active forms of vitamin A.

386. Precursor of vitamin A found in plants.

387. Getting retinol from carotenoids.

388. Retinol containing products from the diet.

389.Antioxidant properties of βcarotene and other carotenoids.

390. Biological function of retinol.

391. Receptors of retinoic acid.

392. A vitamin participation in visual cycle.

393. Biochemical mechanism of dry skin and skin keratinization during vitamin A deficiency.

394. Symptoms of vitamin A deficiency.

395. Vitamin A toxicity.

396. Vitamin D as a prohormone.

397. Synthesis of cholecalciferol in the skin.

398. Food reach in vitamin D.

399. Metabolism of cholecalciferol and ergocalciferol in liver.

400. Production of 1,25-dihydroxy cholecalciferol (calcitriol) in kidneys.

401. Synergic action of calcitriol and parathyroid hormone (PTH).

402. Regulation of calcium concentration by vitamin D and parathyroid hormone.

403. Influence of PTH levels on the production of 1,25(OH)2D and 24,25(OH)2D.

404. Synthesis of a protein calbindin induced by 1,25(OH)2D.

405. Importance of bone resorption in the maintenance of calcium homeostasis.

406. Regulation of calcium excretion by kidneys.

407. Function of calcitonin in the regulation of plasma calcium concentration.

408. Renal osteodystrophy.

409. Bone as the reservoir of calcium and phosphate.

410. Vitamin D deficiency in kids.

411. Vitamin D deficiency in adults.

412. Osteomalacia and osteoporosis.

413. Target cells of 1,25(OH)2D.

414. Risk groups in which vitamin D deficiency can be developed.

415. Reasons for vitamin D metabolism disorders.

416. Hypercalcemia and metastatic calcification.

417. Vitamin E forms in food.

418. Antioxidant characteristics of tocopherols and tocotrienols.

419. Localization of tocopherols and tocotrienols.

420. α–tocopherol action.

421. γ–tocopherol action.

422. Role of tocopherols and tocotrienols in the prevention of cardio-vascular diseases.

423. Function of vitamin E in heme biosynthesis.

424. Positive influence of vitamin E on immune system.

425. Natural forms of vitamin K.

426. Function of vitamin K in γ–carboxylation reactions.

427. Vitamin K dependent activation of proteins participating in the blood coagulation.

428. Influence of vitamin K on osteocalcin.

430. Reasons of developing vitamin K deficiency.

431. Clinical symptoms of vitamin K deficiency.

432. Anticonvulsants and vitamin requirement.

433. General description of water soluble vitamins.

434. General signs of hypovitaminosis for water soluble vitamins.

435. Vitamin thiamine as a coenzyme.

436. Participation of coenzyme derived from thiamine in metabolic processes.

437. Symptoms of mild thiamine deficiency.

438. Severe deficiency of thiamine – Beri-beri.

439. Nutritional problems in alcoholics.

440. Riboflavin and coenzymes derived from riboflavin.

441. Clinical symptoms of riboflavin deficiency.

442. Food reach in riboflavin.

443. Niacin derived from food, as the precursor of oxidation-reduction coenzymes.

444. Synthesis of niacin in the body.

445. Function of NAD+ and NADP+ in metabolic pathways.

446. Pellagra, risk groups for its development.

447. Pyridoxine, pyridoxamine and pyridoxal.

448. Coenzyme function of pyridoxal phosphate.

449. Vitamin B6 and synthesis of neurotransmitters and sphingolipids.

450. Function of vitamin B6 in heme biosynthesis.

451. Correlation of vitamin B6 deficiency with cardio-vascular diseases.

452. Requirement for vitamin B6.

453. Test of tryptophan loading.

454. General description of ascorbic acid.

455. Vitamin C as a cofactor for mixed function oxidases.

456. Vitamin C in the reactions of amino acids hydroxylation.

457. Function of ascorbic acid in the synthesis of carnitine.

458. Function of ascorbic acid in the synthesis of norepinephrine.

459. Reason of developing capillary cell wall fragility during vitamin C deficiency.

460. Mechanism of overall weakness development during carnitine deficiency.

461. Function of vitamin C in corticosteroids biosynthesis.

462. Role of ascorbic acid in the absorption of iron.

463. Symptoms of mild vitamin C deficiency.

464. Symptoms of scurvy and their biochemical reasons.

465. Reasons causing vitamin C deficiencies.

466. Daily requirement for vitamin C in smoking and non-smoking populations.

467. Usage of vitamin C for preventive and for therapeutic reasons.

468. Negative outcomes of hyper dosage of ascorbic acid.

469. Calcium as one of the main minerals for the body.

470. Importance of calcium homeostasis.

471. Reservoirs of calcium.

472. Multifunctional action of calcium.

473. Calcium requirement in the diet.

474. Symptoms of calcium deficiency.

475. Diet recommendations for the risk groups of osteoporosis.