

BSc. Biological Chemistry study programme
State exam Biochemistry (as compiled/collated 28. 07. 2022 – LG)
Students are randomly picking TWO questions.

- 1) **Prokaryotic and eucaryotic cells:** differences in cell body plan and infrastructure (bacteria; animal/plant cells), size differences
- 2) **Cytoskeleton:** structure and function:
- 3) Structure of **mitochondrion** and **chloroplast**, including membranes, inner organization:
- 4) **Bacterial cell walls** (Gram+/Gram- bacteria): Peptidoglycan; lipopolysaccharid,
Peptidoglycan
Bacterial endotoxin (**LPS**):
- 5) **Plasmatic membrane of the cell:** structure and composition
- 6) **Non-covalent ('weak) interactions** in living systems
- 7) **Amino acids (AAs)** (including chemical formulas)
AAs lacking a chiral centre:
AAs with 2x –COOH group
AAs with 2x –NH₂ groups
AAs containg S atom:
AAs with aromatic core
- 8) **AAs essential** for human: names and chemical formulas
- 9) **Alanine** ionic forms over pH course: **titration curve; pI; pK_A; pK_B**, equations of ionic changes over pH scale; equilibrium equations at pK_A and pK_B; how much soluble AA or peptide/protein are at pI?
- 10) **Peptide bond:** draw the formula and specify its structural and functional properties; write a sequence of atoms in the petid/protein **primary structure**:
- 11) **Secondary structure of proteins**
Differentiate between the two major periodic structures of proteins: **the α helix and β pleated sheet**.
Describe the patterns of hydrogen bonding:
- 12) **Tertiary structure** of polypeptides/proteins: give examples of the tertiary structure species; show all possible interactions (covalent and non-covalent) they hold tertiary structure of proteins
- 13) **Glutathion:** structure and function
- 14) **Enzymes:** function; nomenclature/classes; Michaelis-Menten equation; **K_M** – definition
- 15) **Competitive and non-competitive inhibition of an enzyme activity:** Lineveaver – Burk plots
- 16) **Electron transfers** in living systems: how electrons are delivered to an acceptor molecule? (co-factors of dehydrogenases; cytochromes, chinol/chinon system)
- 17) Co-factors of **decarboxylases** and **carboxylases**:
- 18) Co-factors/Co-enzymes: chemical name and formula:
ATP
Acetyl-CoA

19) Co-factors/Co-enzymes: name, chemical formula and enzyme having employed the given co-factor:

NAD⁺

Biotin

20) Carbohydrates:

21) Formation of the 2 cyclic forms of **D-glucopyranose**; **anomery**, what is the reason for making a cyclic forms at the carbohydrate molecule, how the cyclic form making reaction is called? **Carbohydrates:** hemiacetal/hemiketal bond; anomery; epimery

22) Draw the chemical formulas of:

1'-O-Methyl- β -D-glucopyranoside

2'-deoxy-2'-acetylamido-D-mannopyranose

23) Draw a common **N-linked oligosaccharide chain**/antennary branched glycan in glycoproteins.

24) Carbohydrates. Distinguish among **enantiomers**, **diastereoisomers** and **epimers** of monosaccharides, give examples including chemical formulas:

25) Draw the chemical formulas of:

D-Fructose (α anomeric form):

Glucose- α (1-6)-galactose (β anomeric form):

26) Glycosaminoglycans (GAGs) and proteoglycans: structure and function

27) DNA (deoxyribonucleic acid); **RNA** (ribonucleic acid)

Deoxynucleosides/Deoxynucleotides; Ribonucleosides/Ribonucleotides

Bases of nucleic acids (chemical formulas); Ribose; Deoxyribose

DNA/RNA: structure and function

28) Lipids: Fatty acids, Triacylglycerols, Phospholipids, Sphingolipids, Cholesterol: basic features, chemical formula of examples

29) Membrane transport: (mechanisms, examples – see table in Biochemistry 1 presentation)

Passive transports: simple diffusion; facilitated diffusion (permeases and translocases)

Active transport: primary; secondary (distinguished by energy source)

Ion Channels

30) Na⁺/K⁺ ATPase (function, scheme of the principle)

31) “Anion (Cl⁻/HCO₃⁻) exchange“: Figure/introduce its set-up, physiological role and functions; which types of transport mechanisms the „Anion Exchange“ is considered of?

32) ATP:

a) Chemical formula; what role does it play?

b) Why free energy of hydrolysis of phosphoester/phosphodiester bonds is such large and how ATP hydrolysis is sustained enough stable and protected against spontaneous decay?

33) COENZYME A:

a) Chemical formula; what is the role of this coenzyme?

b) Why free energy of hydrolysis of thioesters is large relative to that of oxygen esters?

34) Draw the „free energy“ graph of the phosphate group flow from high-energy phosphate donors via ATP to acceptor molecules („substrate phosphorylation“); what is the name of enzymes being in charge of substrate phosphorylation?

35) Biochemical anatomy of mitochondrion:

Draw and figure structures and functional activities/pathways taken place in mitochondrion:

36) Figure all ways of pyruvate entry into the mitochondrion:

37) Figure all ways of glucose entry into the cell:

38) Malate-Aspartate shuttle (‘pendulum’): Draw its fundamental scheme and point its principal function:

39) Glycerol-3-phosphate shuttle (‘pendulum’): Draw its principal scheme and point out its function:

40) Energy metabolism strategy: Photolithotrophic organisms (Autotrophs):

- a) Source of carbon:
- b) Primary source of electrons:
- c) Terminal acceptor of electrons:
- d) Principal way of ATP formation:
- e) Examples of given organisms:

41) Chemoorganotrophic organisms (Heterotrophs):

- a) Source of carbon:
- b) Primary source of electrons:
- c) Terminal acceptor of electrons
- d) Principal way of ATP formation

42) Pyruvic acid/Pyruvate:

- a) What is the name of metabolic pathway providing pyruvate?
- b) Localization of pathway in the cell:
- c) Complete whole set of products/intermediates of pyruvate during its catabolic transformations (including chemical formulas):

43) Ethanol fermentation (equations with chemical formulas, indicate enzymes and their co-factors):

44) Acetic acid fermentation (equations with chemical formulas, indicate enzymes and their co-factors).

45) What does substrate level phosphorylation mean? Write respective chemical equations of glycolysis, (use chemical formulas; indicate names of enzymes and co-factors):

46) Pentose-phosphate cycle, answer questions as follow:

- a) Principal role in overall metabolism; which kind of metabolism does the cycle fall into?
- b) Localization of the cycle in the cell:
- c) Main pathway products:

47) Gluconeogenesis, answer the following questions:

- a) Metabolic significance:
- b) What does BYPASS #1 mean, and where takes place:
- c) write a sequence of reactions making BYPASS #1 (including chemical formulas, indicate enzymes and co-factors):

48) Which 2 metabolites/intermediates the tricarboxylic acid (Krebs) cycle needs to start up and keep the cycle ongoing? (Write respective equation including chemical formulas, name of the enzyme, co-enzyme):

49) Chemical equations of succinate transformations in Krebs cycle (including chemical formulas). Indicate names of enzymes, co-factors, and where enzymes/reactions take place?

50) Respiratory chain. Figure:

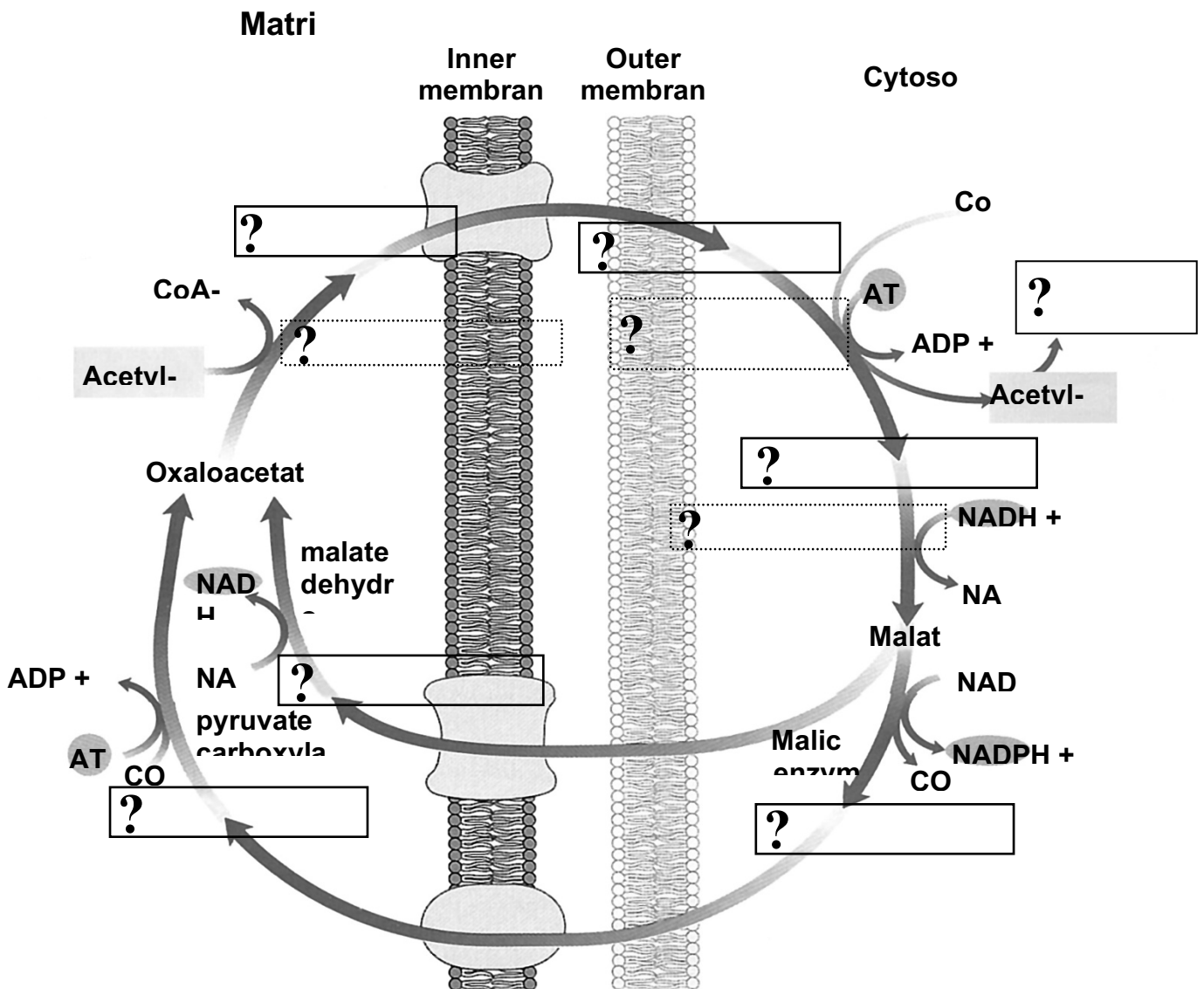
- a) Where does the chain take place?
- b) Structural units which the chain is consisted of, and a trend of the redox potential over the respiratory chain:
- c) Function/role of the respiratory chain:

51) Fatty acid (FA) synthesis. Figure:

- a) where does it take place?
- b) First reaction of the process is: $\text{Acetyl-CoA} + \text{X} \longrightarrow \text{Y}$
Replenish names of compounds X and Y, and indicate the name of enzyme and co-factor:
- c) Which organisms may synthesize carbohydrates from Acetyl-CoA, and what they need to be furnished with?

52) Indicate:

- a) Name of the cellular organelle in which the transport mechanism takes place?
- b) Replenish empty boxes in the blind map bellow with names of intermediates (full outlines) and respective enzymes (dashed outlines):
- c) What is the principal function/mission of the Acetyl-CoA transport?



53) Catabolism of fatty acids:

- a) What is the mechanism of catabolic degradation of fatty acids?
- b) Where does catabolic degradation of fatty acids take place, and how fatty acid molecules get to the place of ultimate degradation?
- c) What are ultimate products of fatty acid degradation?

54) Photosynthesis:

- a) Name of the cellular organelle in which photosynthesis takes place.
- b) Light-driven electron flow: structural units, and a trend of the redox potential over the electron flow (Draw the „Z“ scheme):
- c) What is the „cyclic“ photosynthesis, which PS is involved in and benefit is achieved?
- d) What is the terminal acceptor of electrons in “non-cyclic“ photosynthesis?
- e) Explain what RUBISCO means, and which functions covers?

55) Indicate:

- a) the membrane of which cellular organelle contains following membrane transport?
- b) Replenish empty boxes in the blind map bellow with names of intermediates (full outlines) and respective enzymes (dashed outlines)
- c) What is the principal function/mission of this membrane transport?

