

574 / 4.1-1 - Einführung in die Biochemie (Prüfung) | Prüfer: Popov, Nikita | Datum: 12.10.2022

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1. The Henderson-Hasselbalch equation shown below establishes the relationship between the pH of the solution and concentration of the weak acid and its conjugate base. What are the ratios of CH_3COO^- to CH_3COOH in a series of acetic acid solutions with pH of 6.8, 5.8, 4.8, 3.8. The pK_a of acetic acid is approximately 4.8.

- A 10, 1, 0.1, 0.01
- B 100, 10, 0, 0.1
- C 0.1, 1, 10, 100
- D 100, 10, 1, 0.1

$$\text{pH} = \text{pK}_a + \log \frac{[\text{conjugate base}]}{[\text{weak acid}]}$$

2. How does the change in Gibbs free energy (ΔG) differ between the catalyzed versus uncatalyzed reaction?

- A ΔG is greater for the forward direction than for the reverse direction.
- B ΔG is greater for the uncatalyzed than the catalyzed reaction.
- C ΔG is greater for the catalyzed than the uncatalyzed reaction.
- D ΔG is the same for the catalyzed and uncatalyzed reactions.

3. The partial negative charge at one end of a water molecule is attracted to the partial positive charge of another water molecule. This attraction is called:

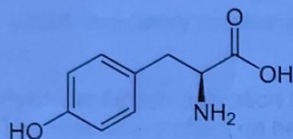
- A a covalent bond
- B a hydration shell
- C a hydrogen bond
- D an ionic bond
- E a hydrophobic bond

4. Some of the biological reactions are energetically unfavorable under standard conditions. Which strategy allows these reactions to readily occur readily in our cells:

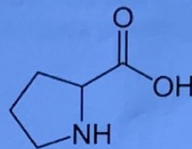
- A Rapid elimination of the reaction products
- B Acceleration of the previous reaction in the pathway
- C Changing the temperature of the cellular compartment where the reaction proceeds
- D Inhibiting the reverse reaction

5. Identify alanine among the amino acids shown below

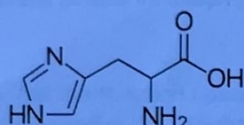
A



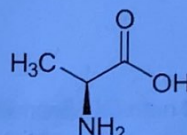
B



C



D

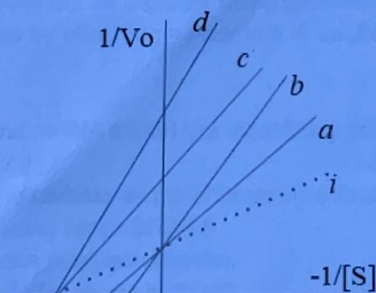


6. One of the 20 amino acids is frequently oxidized to form covalent bonds that stabilize quaternary structure by linking two peptide chains. Which of the following peptides can theoretically form a homo-polymer of more than two units using such bonds:

- A alanine-cysteine-glycine-proline-glycine
- B cysteine-alanine-glycine-alanine-cysteine
- C cysteine-alanine-proline-proline-alanine
- D alanine-proline-cysteine-lysine-glycine

7. Which line on the Lineweaver-Burk plot below corresponds to a reaction with a stronger noncompetitive inhibitor with the reaction in the absence of inhibitors shown as *i*.

- A *a*
- B *b*
- C *c*
- D *d*



8. Denatured ribonuclease A (RNase A) can rapidly refold and regain its activity in vitro in a buffer with some reducing agent without the need for any additional factors. What do you conclude from this experiment:

- A In vitro folding occurs faster than in cells
- B The primary protein structure contains all the information required for folding and activity
- C Cells use only reducing reactions to fold proteins
- D Most proteins fold very rapidly under any conditions

9. Fructose enters the glycolysis at the level of GAP and DHAP. Under excessive fructose consumption, this may lead to generation of pyruvate, stimulate fatty acid synthesis and cause obesity. Which regulatory mechanism is not available when fructose powers glycolysis instead of glucose:

- A Pyruvate kinase activation by AMP
- B The stimulatory effect on hexokinase
- C The feedback inhibition of phosphofructokinase by ATP and hexokinase
- D Pyruvate kinase inhibition of ATP

10. Assume that the reaction catalyzed by an enzyme follows Michaelis-Menten kinetics. The substrate concentration (K_m , Michaelis constant) needed to reach 50% of the maximum reaction velocity (V_{max}) is 25 μM . What substrate concentration is required to obtain at least 95% of the maximum reaction velocity?

- A 25 μM
- B 50 μM
- C 100 μM
- D 250 μM
- E 475 μM

$$V = \frac{V_{\max} [S]}{K_M + [S]}$$

11. Replication of linear chromosome ends (telomeres) involves a special enzyme called telomerase, which

- A extends one of the chromosome strands using its RNA component as a template
- B has primase and DNA polymerase activities
- C extends its RNA component as a primer using genomic DNA as a template
- D extends the telomeres by attaching a fragment of dsDNA using its ligase activity

12. Transcription, splicing and mRNA export are most likely coordinated by one of the following mechanisms

- A Phosphorylation of the carboxy-terminal domain of RNA Polymerase II
- B Acetylation of the splicing factor SRSF2
- C Farnesylation of histone acetyltransferase
- D Palmitoylation of the TBP subunit of TFIID

13. Circular bacterial DNA genome has one single origin of replication. If replication is initiated just once before its completed, how many DNA polymerase III molecules will simultaneously replicate this DNA molecule

- A 1
- B 2
- C 4
- D 8

14. The sequence of the template strand in the gene is: 5'-ATCTGTTGTCTA. The sequence of encoded mRNA will be:

- A 5'-UAGACUUAGACU
- B 5'-UAGACAACAGAU
- C 5'-UACAGUUGAGAU
- D 5'-TUGUCAAUGUAT

15. Amino acids are encoded by codons of a defined length; in addition, some codons signal initiation and termination of translation. What is the minimal number of nucleotides in the coding region of an mRNA that will be translated into a 20 amino acid polypeptide.

- A 60
- B 63
- C 66
- D 69

16. Translocation of ribosome along an mRNA molecule is driven by hydrolysis of

- A creatine phosphate
- B pyrophosphate
- C GTP
- D ATP

17. Imagine that some organism that uses Watson-Crick complementarity rules, has around 60 amino acids and about 60 tRNA encoded by triplets of A, C, G and U in its mRNA. Which modified base, common in human cells, would you not expect to find in the tRNAs of this organism?

- A Pseudouracil
- B Dihydrouracil
- C Methylcytosine
- D Hypoxanthine

18. One of the functions of signal recognition particle in protein translation is to

- A Escort the ribosome to a receptor on the ER membrane
- B Cleave the signal peptide from specialized proteins
- C Accelerate translation of mRNAs that encode for signal peptide
- E Activate calcium-dependent signaling pathways in the ER

19. Ubiquitin is usually attached via its C-terminal carboxyl group to the epsilon-amino group of the lysine residues but can also be attached to other amino acids when they are at this position in the peptide of n amino acids.

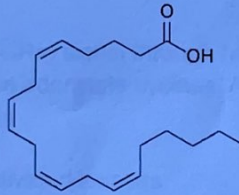
- A 1
- B 2
- C $n-1$
- D n

20. Which is a property of *E. coli* RNA polymerase?

- A It transcribes one DNA strand of a gene using an RNA primer for initiation.
- B It is a multimeric enzyme that catalyzes the formation of covalent phosphodiester bonds.
- C It has both a $3' \rightarrow 5'$ polymerase activity and a $3' \rightarrow 5'$ exonuclease activity.
- D It uses ribonucleoside triphosphates as substrates and removes supercoils.

21. Fatty acid on the image is

- A Oleate
- B Palmitoleate
- C Arachidonate
- D Linoleate



22. Phosphatidate (phosphatidic acid) is a major backbone of membrane lipids. It consists of the following building blocks:

- A Glycerol + fatty acid + phosphate
- B Sphingosine + fatty acid + phosphate
- C Glycerol + phosphate + monosaccharide
- D Monosaccharide + phosphate + fatty acid

23. Cholesterol is a key component of cell membranes and a precursor of several hormones.

The best understood function of cholesterol is

- A Controlling membrane fluidity
- B Attachment of sugar units for cell-cell recognition
- C Energy source under carbohydrate diet
- D Direct regulation of signaling pathways

24. Ras protein is subject to a range of posttranslational modifications. Which of the following modifications is primarily responsible for Ras anchoring to the plasma membrane:

- A Acetylation
- B GPI-lation
- C Myristoylation
- D Palmitoylation
- E Phosphorylation

25. Which of the following is not a common second messenger:

- A Ca^{2+}
- B Mg^{2+}
- C DAG
- D IP_3

26. G protein coupled receptors (GPCRs) signal through heterotrimeric G proteins, which can activate downstream proteins such as adenylate cyclase. A common intrinsic mechanism that terminates the activity of G proteins is

- A Slow GTP hydrolysis
- B Phosphorylation of GPCR-activated kinases
- C Export of the G protein via exocytosis
- D Sequestration of GPCRs to the nucleus

27. Activation of insulin receptor activates protein kinase B which, in turn, stimulates many downstream pathways. The key effect in terms of dealing with the extra blood glucose is

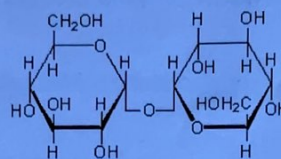
- A incorporation of the Glut4 channel in the membrane
- B phosphorylation and inhibition of glycogen synthase kinase
- C phosphorylation of the protein Ras which drives cell division
- D inhibition of the intrinsic apoptotic pathways
- E A and B
- F B and C

28. β -d-fructopyranose, β -d-fructofuranose, α -d-fructofuranose, α -d-fructopyranose are the tautomers of fructose that can readily interconvert. Which of the following statements is not true

- A These isomers are as reactive as the open chain form of fructose
- B These isomers are present in equimolar amounts in cells
- C These are different ring forms of the open chain keto-d fructose
- D These are reducing forms of fructose

29. Trehalose, a disaccharide shown on the image, consists of the following monosaccharides:

- A Glucose and mannose
- B Glucose and galactose
- C Glucose and glucose
- D Mannose and mannose



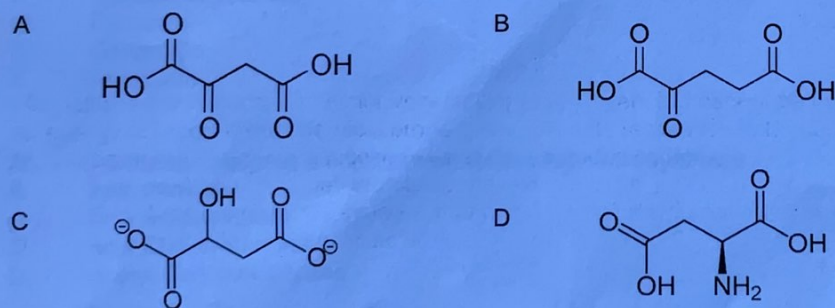
30. Cellulose is a glucose polymer very similar to glycogen, but cannot be used by humans as an energy source. What chemical property underlies its resistance to human enzymes:

- A beta(1-4) linkage of glucose units at the anomeric carbon
- B Frequent branches between linear cellulose chains
- C Cellulose consists of L-glucose that human enzymes do not recognize
- D Strong alpha(1-4) glycosidic bonds

31. alpha-ketoglutarate dehydrogenase has a very similar mechanism to pyruvate dehydrogenase, which produces acetyl-coA from pyruvate. Which of the following molecules is produced by the alpha-ketoglutarate dehydrogenase in the TCA cycle:

- A Succinate
- B Succinyl-CoA
- C Isocitrate
- D Fumarate

32. Identify alpha ketoglutarate among the structures shown below.



33. The last proton pump in the mitochondrial electron transport chain, cytochrome c oxidase, transfers electrons on this acceptor molecule to generate water

- A Cytochrome c
- B Molecular oxygen
- C Ubiquinone
- D NAD+

34. Fatty acid desaturase performs this important step in fatty acid metabolism
- A Attachment of a fatty acid to coenzyme A
 - B Chain elongation of fatty acids synthesized by the FAS enzyme, which are limited to 16 carbons
 - C Introduction of a double bond in a fatty acid
 - D Reduction of carbon-carbon double bonds during beta-oxidation
35. FADH₂ is said to have less energy potential than NADH because
- A it carries fewer electrons
 - B it doesn't readily give up protons to complexes in the electron transport chain
 - C complex II of the ETC that takes electrons from FADH₂ does not pump protons in the intermembrane space
 - D it is much less abundant than NADH in mitochondria
36. Ammonia is essential for amino acid and nucleotide biosynthesis but is toxic and is primarily transported around the body in the form of
- A Alanine
 - B Glutamine
 - C Serine
 - D Glutamate
 - E A and B
 - F C and D
37. Which of the following is not a typical substrate in transaminase reactions
- A Alanine
 - B alpha-ketoglutarate
 - C Pyruvate
 - D Glutamate
 - E Succinate
38. This enzyme catalyzes a commitment step in fatty acid synthesis
- A keto thiolase
 - B fatty acid synthase
 - C acyl-CoA synthetase
 - D acetyl-CoA carboxylase
39. Which molecules provide the most efficient way for long term energy storage in humans:
- A Glycogen
 - B Triacylglycerides
 - C Ketone bodies
 - D Polypeptides

40. The primary significance of pentose phosphate pathway for biosynthetic reactions is to
- A generate large amounts of ATP
 - B provide electron carriers and phosphorylated ribose units
 - C regenerate NAD^+ to enable glycolysis under anaerobic conditions
 - D serve as a backup pathway for glycolysis under glucose starvation
41. Which of the following molecules do not directly contribute nitrogen atoms to the purine ring:
- A Glycine
 - B Aspartate
 - C Glutamine
 - D Glutamate
42. What is the molecular donor of amino groups most commonly used in the biosynthesis of nucleotides
- A Glutamate
 - B Ammonia
 - C Glutamine
 - D Asparagine
43. Methotrexate is used in cancer therapy because it inhibits this enzyme which is critical for DNA synthesis in all actively growing cells
- A Dihydrofolate reductase
 - B Thymidine synthase
 - C Ribonucleotide reductase
 - D Deoxyribonucleotide polymerase
44. Amination of PRPP is stringently regulated by several nucleotides. It provides an efficient control point because
- A it is a precursor for all nucleotides
 - B since is catalyzed by a large enzyme which can be readily inhibited
 - C it is a committed step in purine biosynthesis
 - D the other enzymes in this pathway cannot be controlled
45. Which enzyme directly links the citric acid cycle and electron transport chain
- A Malate dehydrogenase
 - B Succinate dehydrogenase
 - C Alpha-ketoglutarate dehydrogenase
 - D Isocitrate dehydrogenase