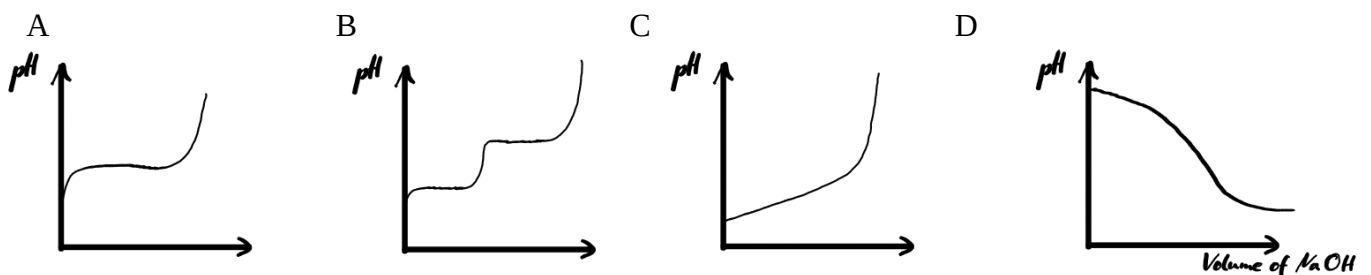


Klausur Einführung in die Biochemie SoSe 2022

1. In aqueous solutions, fatty acids assemble into micelles despite a reduction in entropy due to their clustering of fatty acid hydrophobic tails. What is the principal factor that drives micelle formation?

- A) Stronger hydrogen bonding of clustered polar fatty acid heads with water
- B) Disruption of the regular network of hydrogen bonds in water solvent
- C) Entropy of water molecules released from solvation shells of fatty acid tails
- D) Energy released upon association of hydrophobic tails

2. Which curve better depicts titration with NaOH of a diprotic acid such as H_2CO_3 , which can donate two protons:



3. 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_3COOH to CH_3COO^- in a series of acetic acid solutions with pH of 3.8, 4.8, 5.8, 6.8?

The pK_a of acetic acid is approximately 4.8.

- A) 10, 1, 0.1, 0.01
- B) 10, 20, 30, 40
- C) 0.1, 1, 10, 100

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

4. Conversion of malate to oxalacetate in the TCA circle, catalyzed by malate dehydrogenase in the mitochondrial matrix, is energetically unfavorable under standard conditions, but readily occurs in cells. This is possible because

- A) The previous reaction in the circle has a high positive ΔG
- B) The next reaction catalyzed by citrate synthase rapidly consumes oxalacetate
- C) TCA cycle produces sufficient amount of energy to power the reaction
- D) The malate can be exported to cytoplasm where conditions are favorable

5. Among 20 proteinogenic amino acids, which all have positively and negatively charged groups, three also have positively charged side chains and two have negatively charged side chains under physiological conditions. What would be the net charge of a peptide that includes each amino acid once?

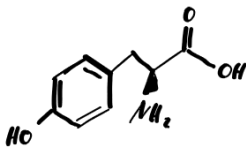
- A) +21
- B) -18
- C) +1
- D) -1

6. Peptide bond limits rotation of amino acid side chains relative to each other. Which properties of the peptide bond underlie this feature?

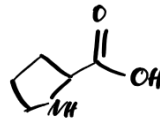
- A) The peptide bond has a partial double bond character due to resonance with the carbonyl group
- B) The peptide bond is an extremely strong linkage that limits
- C) Alpha amino and carbonyl groups electrostatically interact with charged side chains
- D) All of the above factors play a role

7. Identify proline among the amino acids shown below

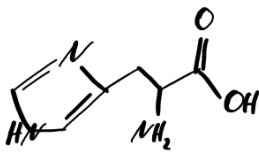
A



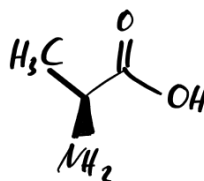
B



C



C



8. This amino acid can undergo oxidation and reduction reactions to form homotypic covalent bonds that stabilize tertiary and quaternary protein structure. It also participates in many enzymatic reactions as a nucleophile.

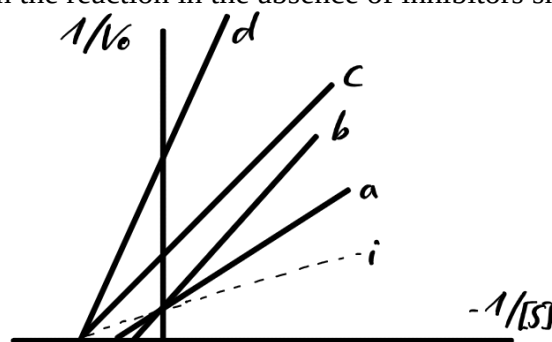
- A) alanine
- B) Lysine
- C) Cysteine
- D) Tyrosine

9. Two enzymes that catalyze the same reaction have different affinities for the substrate. What can be concluded about the maximum velocity of the reactions with the two enzymes?

- A) The V_{max} for both enzymes is the same
- B) The maximum velocity is higher for the enzyme with higher affinity
- C) The maximum velocity is higher for the enzyme with lower affinity
- D) The maximum velocity depends on enzyme concentration

10. Which line on the Lineweaver-Burk plot below corresponds to a reaction with a stronger competitive inhibitor with the reaction in the absence of inhibitors shown as I?

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



11. In the ping pong type of enzymatic reaction one of the products is released before some of the substrates bind to the enzyme. Which substrate binds first in the case of aspartate aminotransferase which includes pyridoxal phosphate cofactor in its aldehyde form:

- A) Glutamate
- B) Ketoglutarate
- C) Aspartate
- D) Either substrate can bind first

12. The function of the DNA sliding clamp is to

- A) load DNA polymerase 1 onto DNA
- B) maintain processive elongation phase of DNA synthesis
- C) separate DNA strands at the replication fork
- D) release DNA polymerase during synthesis of Okazaki fragments

13. Circular bacterial genome has one single origin of replication. If replication is initiated just once before its completed, how many DNA polymerase 3 molecules will simultaneously replicate this DNA molecule?

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

14. We've learned that replicative DNA polymerases require a template and have a very low error rate. It turns out that some DNA polymerases like terminal dNTP transferase (TDT) do not require a template. What error rate for non-templated DNA synthesis by TDT would you expect:

- A) Higher than template-directed DNA polymerases
- B) Much lower template-directed DNA polymerases
- C) Similar to the template-directed DNA polymerases
- D) The error rate in this case cannot be determined

15. In *E. coli*, genes with promoters which are less similar to consensus sequence for standard "housekeeping" sigma factor (σ_{70}) will be expressed

- A) At lower levels than those with the consensus sequence
- B) At higher levels than those with the consensus sequence
- C) Same as consensus
- D) May be expressed better under special conditions, such as high temperatures
- E) A and D

16. Which mRNA will be produced from the gene with the following sequence of the antisense strand: 5'-ACCGGGTTTTGGGCCA?

- A) 5'-UGGGGGAAAACCCGGT
- B) 5'-TGGCCCAAACCCGGT
- C) 5'-UGGCCCAAACCCGGU
- D) 5'-UGGCCCAAAGGGCCU

17. In eukaryotic cells, transcription is often regulated by distal regulatory elements called:

- A) Repressors
- B) Promoters
- C) Activators
- D) Enhancers

18. Translation termination factors RF promote the release of a polypeptide chain bound to the amino acid in the P site using this molecule:

- A) GTP
- B) Phosphate
- C) Water
- D) ATP

19. Imagine that some organism that uses Watson-Crick complementary 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) Methylcytosine
- B) Hypoxanthine (nucleobase in inosine)
- C) Dihydrouracil
- D) Pseudouracil

20. Protein synthesis machinery doesn't use actual proofreading in the same way as transcription and replication machinery. Why are cells most often able to tolerate the higher error rate of protein synthesis?

- A) Most proteins have relatively short half life
- B) Aminoacyl tRNA synthetases have synthesis and editing sites
- C) Wrong proteins are degraded by the proteasome

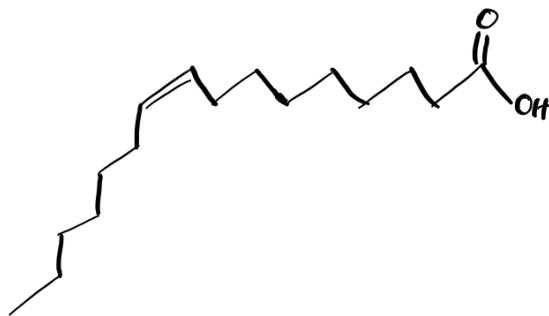
D) All of the above

21. Modification with ubiquitin regulates the abundance of most cellular proteins. This ubiquitin signal is recognized by a proteasome, which is:

- A) ER-associated ubiquitin ligase
- B) Transport complex in the plasma membrane
- C) Mitochondria-resident deubiquitinase
- D) A large ubiquitous proteolytic complex

22. Fatty acid on the image is:

- A) Oleate
- B) Palmitoleate
- C) Palmitate
- D) Linoleate



23. The enzyme responsible for splitting phosphatidylinositol into diacylglycerol and inositol-3-phosphate upon stimulation of a G protein-coupled receptor is:

- A) Fatty acid desaturase
- B) Phosphodiesterase
- C) Lysosomal acid lipase
- D) Phospholipase C

24. Good examples of integral membrane proteins are

- A) Porin and protein kinase B
- B) Insulin receptor substrate 1 (IRS-1) and small G protein Ras
- C) Adenylate cyclase and prostaglandin synthase
- D) Raf kinase and GLUT4 glucose channel

25. The stimulatory effect of coffee is in part due to the ability of caffeine to inhibit an enzyme that terminates cAMP-dependent activation of protein kinase A. This enzyme is

- A) Adenylate cyclase
- B) Phosphodiesterase

C) Phosphatase PP2A

D) Protein kinase A

26. Small G proteins that are activated by EGF receptor hydrolyse GTP and thereby terminate signaling. Mutations in such G protein called Ras cause chronic activation of the pathway by

A) Locking Ras in the GTP-bound state

B) Blocking binding to the Raf kinase

C) Limiting Ras association with the plasma membrane

D) Direct activation of downstream Erk kinase by Ras

27. One mechanism that prevents oncogenic cell transformation upon ectopic activation of oncogenes is programmed cell death apoptosis. This process is executed by proteolytic enzymes called caspases which belong to the class of

A) Lyases

B) Hydrolases

C) Isomerases

D) Ligases

28. During glycolysis cells transfer electrons on NAD^+ to produce NADH. In absence of adequate oxygen supply, muscle cells regenerate NAD^+ to sustain glycolysis by

A) alcoholic fermentation

B) production of lactate from pyruvate

C) activating the oxidative phosphorylation

D) importing NADH from mitochondrial

29. Fructose enters the glycolysis at the level of GAP and DHAP. Under excessive fructose consumption, this may lead to generate 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 inhibition of ATP

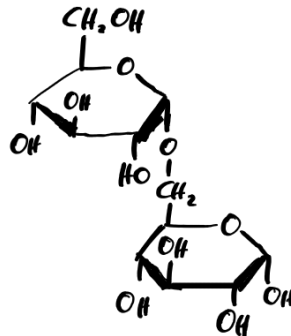
B) The stimulatory effect on hexokinase

C) The feedback inhibition of phosphofructokinase by ATP and hexokinase

D) Pyruvate kinase activation by AMP

30. The disaccharide isomaltose (please see the image) consists of the following monosaccharides

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



31. In mammals, fatty acids cannot be converted to glucose. The glyoxylate cycle in plants allows this because it

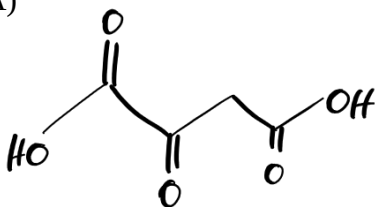
- A) bypasses decarboxylation reactions
- B) produces more ATP equivalents which power glucose synthesis
- C) generates less electron carriers than the citric acid cycle to spare energy
- D) proceeds much slower than the TCA cycle

32. 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:

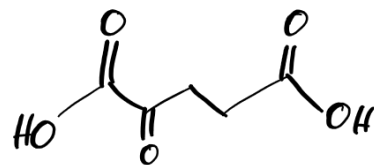
- A) Succinate
- B) Succinyl-CoA
- C) Isocitrate
- D) Fumarate

33. Identify oxaloacetate among the structures shown below.

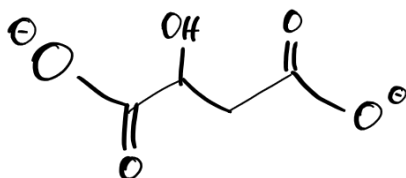
A)



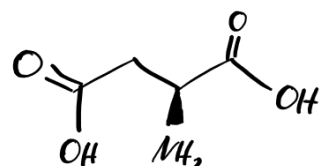
B)



C)



D)



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

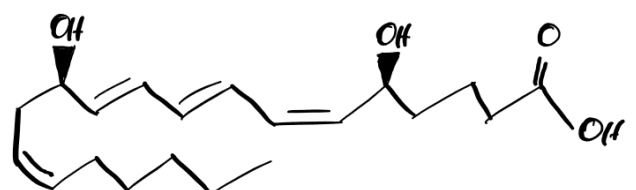
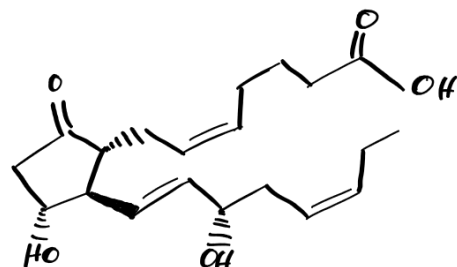
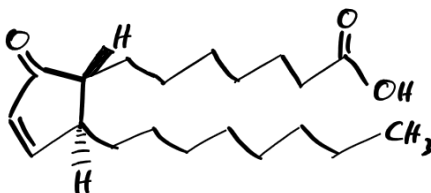
- A) Cytochrome c
- B) Molecular oxygen
- C) Ubiquinone
- D) NAD⁺

35. The rate limiting enzyme in fatty acid biosynthesis, Acetyl-CoA-carboxylase, is regulated by AMPK and citrate. In addition, similar to many other pathways, it is inhibited by the end product of the pathway. Based on this, which fatty acid produced by the fatty acid synthase allosterically inhibits acetyl coA carboxylase?

- A) Oleate
- B) Arachidonate
- C) Palmitate
- D) Palmitoleate

36. Leukotrienes and prostaglandins are different local hormones from arachidonate produced via alternative synthesis mechanisms. How many leukotrienes and how many prostaglandins are shown below

- A) One leukotriene and three prostaglandins
- B) Two leukotrienes and two prostaglandins
- C) Three prostaglandins and one leukotrienes
- D) All four are prostaglandins



37. Glutathione is derived from three amino acids: cysteine, glycine and glutamate. Side chain of which amino acid is critical in the oxidation-reduction reactions

- A) Glutamate
- B) Cysteine
- C) Glycine
- D) Both Cysteine and Glutamate

38. Serine and glycine are derived from this intermediate of the glycolysis

- A) 3-phosphoglycerate
- B) Glyceraldehyde 3-phosphate
- C) Pyruvate
- D) Phosphoenolpyruvate

39. This enzyme participates in both pyrimidine synthesis and the urea cycle but is localized in mitochondria in the latter pathway.

- A) Aspartate transcarbamoylase
- B) Ornithine transcarbamylase
- C) Carbamoyl phosphate synthetases
- D) Argininosuccinase

40. Ubiquitin ligases typically attach ubiquitin via its alpha carboxyl group to amino groups using isopeptide linkage. Which amino acid is the main target for ubiquitin conjugation.

- A) Arginine
- B) Glutamate
- C) Asparagine
- D) Lysine

41. Identify an option with all correct pairs of signalling molecules and their amino acid precursors

- A) Epinephrine – Tyrosine, GABA – Glutamine, Histamine – Histidine
- B) Adrenalin – Phenylalanine, GABA – Glutamate, Histamine – Histidine

- C) Thyroxine – Tyrosine, GABA – Aspartate, Serotonin – Tryptophan
- D) Histamine – Tyrosine, Triiodothyronine – Tryptophan, Epinephrine – Tyrosine

42. Carbamoyl phosphate synthetase uses this mechanism to guide intermediate products between catalytic sites, as well as to limit substrate dissociation and hydrolysis of unstable intermediates.

- A) Limited diffusion
- B) ATP hydrolysis
- C) Multicite substrate phosphorylation
- D) Substrate channeling

43. What is the molecular donor of amino groups most commonly used in the biosynthesis of nucleotides

- A) Glutamate
- B) Ammonia
- C) Glutamine
- D) Asparagine

44. Phosphoribosyl pyrophosphate (PRPP) is derived from the pentose phosphate pathway (PPP). Oxidative phase of PPP produces this ketose that is converted into PRPP in two steps.

- A) Ribose 5 phosphate
- B) Ribulose 5 phosphate
- C) Xylulose 5 phosphate
- D) Glyceraldehyde 3 phosphate

45. A common cytotoxic drug, 5'-Fluorouracil, is converted in cells into 5-fluorodeoxyuridine monophosphate that acts as a suicide inhibitor of this enzyme.

- A) Thymidylate synthase
- B) Ribonucleotide reductase
- C) Thymidine kinase
- D) Orotidylate decarboxylase