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BIOC3560 Midterm B
Please print name clearly

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NAME (please print clearly):	
STUDENT I.D. NUMBER:	
SIGNATURE:	

**University of Guelph
Department of Molecular and Cellular Biology**

**BIOC*3560
Midterm Examination B
13 Oct 2018**

Time: 90 minutes

Check your exam paper carefully; you should have 12 different pages, not including the cover sheet. Make sure your seven-digit student ID number is entered correctly in the space provided above and on the computer scoring sheet.

Answer Part I, questions 1-26, on the computer scoring sheet provided. Only one option is correct for each of these questions. Use **black lead pencil** to fill in the circles corresponding to your answer; erase cleanly if you make a mistake. **Do not use ink or white-out on the computer scoring sheet.**

Illegible and otherwise unreadable, incomprehensible or unclear answers & writing will be considered incorrect.

Answer Part II, questions 1-7, directly on the question paper. **Answer only in ink (NOT red!) and only in the space provided.** Answers in pencil will not be regraded.

Part I 25 marks	
Part II 25 marks	
Total 50 marks	

Part I: MULTIPLE CHOICE QUESTIONS 1- 25 (25 marks)

1. Which of the following is the Hill equation, as applied to an O₂-binding protein?

- (A) $Y = [S]/([S] + P_{50})$
- (B) $\log [Y/(1 - Y)] = n \log pO_2 - K_d$
- (C) $\log [Y/(1 - Y)] = n \log pO_2 - P_{50}$
- (D) $\log [Y/(1 - Y)] = n \log pO_2 - \log K_m$
- (E) None of the above****

2. Which of the following is true regarding sickle-cell hemoglobin (HbS)?

- (A) It cannot bind O₂, and clogs capillaries.
- (B) It has abnormal hydrophilic interactions.
- (C) Glutamate β6 is changed to valine. ***
- (D) Valine β6 is changed to glutamate.
- (E) Glutamate F8 is changed to valine.

3. Which statement is false with respect to enzyme phosphorylation?

- (A) The modification is irreversible. ***
- (B) The modification is covalent.
- (C) Addition and removal is mediated by different enzymes.
- (D) Phosphorylation can occur on His residues.
- (E) I was sleeping when you asked this Kahoot question.

4. During activation of aspartate transcarbamoylase, conversion from the T to R state involves the following:

- (A) movement of catalytic trimers away from each other
- (B) breaking a salt bridge between Asp236c and Lys143r
- (C) forming a salt bridge between D236c and K143r
- (D) A and B***
- (E) A and C

5. In oxygenated myoglobin, a co-ordination bond is formed with which residue?

- (A) His E7

- (B) Leu E7
- (C) His F8***
- (D) Leu F8
- (E) His HC3

6. Select the statement that accurately describes an O₂-binding curve of a globin.

- (A) The heme-O₂ binding curve is a sigmoidal curve.
- (B) Hemoglobin and myoglobin have reciprocal pO₂-binding curves.
- (C) Hemoglobin has a sigmoidal O₂-binding curve.***
- (D) Myoglobin has a sigmoidal O₂-binding curve.
- (E) All of the above.

7. Which statement is correct about the structure of aspartate transcarbamoylase?

- (A) The modulators bind to the regulatory (r) chains. ***
- (B) The catalytic subunits are dimers.
- (C) The heterotropic modulator binding sites are at the interfaces of catalytic chains.
- (D) The regulatory subunits are trimers.
- (E) It contains three trimers connected by two dimers.

8. Which of the following statements regarding heme is true?

- (A) It has a higher affinity for O₂ than for CO
- (B) It binds oxygen allosterically
- (C) It contains 4 pyrrole rings, linked by amino bridges
- (D) It contains 4 pyrrole rings and a system of conjugated C=C bonds***
- (E) It is encoded by several genes

9. Which statement accurately describes the Bohr effect in hemoglobin-O₂ binding?

- (A) H⁺ and CO₂ bind to Hb, contributing to salt bridges that stabilize the T state.***
- (B) H⁺ and CO₂ bind to Hb, blocking salt bridge formation that stabilizes the T state.
- (C) H⁺ only binds to amino termini.
- (D) CO₂ binds to the central cavity.
- (E) It explains why biochemistry is your most favourite course.

10. Which of the following is not involved in the regulation cyclin dependent kinases?
- (A) Phosphorylation of CDK
 - (B) Controlled degradation of cyclins
 - (C) Binding of CDK inhibitors
 - (D) Controlled synthesis of cyclins
 - (E) Binding the allosteric activator cAMP***
11. If O₂-binding by hemoglobin was consistent with a sequential model of ligand-binding, then which of the following is predicted to be correct?
- (A) O₂-bound subunits in the R state could be next to subunits in the T-state. ***
 - (B) O₂-bound subunits in the R state can never be adjacent to subunits in the T-state.
 - (C) O₂-bound subunits in the T state would block O₂-binding by subunits in the R-state.
 - (D) R₂T₂ Hb would contain no O₂.
 - (E) R₄ Hb would contain no O₂.

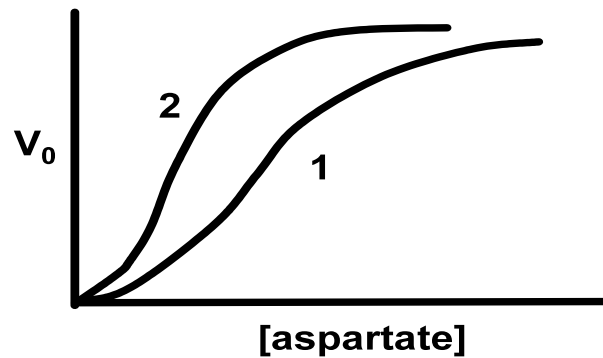
12. When studying ligand-binding by proteins, the Hill equation is useful because
- (A) n_H gives fractional occupancy of the binding sites
 - (B) n_H gives an indication of the degree of cooperativity in ligand-binding***
 - (C) n_H defines the number of ligand-binding sites in the native protein
 - (D) (A) and (B)
 - (E) (B) and (C)

13. Given the following statements regarding different types of globin proteins:
- (1) They have very similar primary structures
 - (2) They have very similar secondary structures
 - (3) They have very similar tertiary structures
 - (4) They have very similar quaternary structures

Which of the following statements is correct?

- (A) (1) & (2) are false
 - (B) (1) & (3) are false
 - (C) (1) & (4) are false***
 - (D) (2) & (3) are false
 - (E) (1) & (2) are true
14. While on a mountain climbing trip in Alberta (3700 m above sea level), you become faint and collapse. Two days later you feel better because the level of 2,3-bisphosphoglycerate (BPG) in your red blood cells has increased. How did BPG help?
- (A) BPG formed salt bridges in hemoglobin, significantly lowering its P_{50} .
 - (B) BPG formed salt bridges in hemoglobin, significantly increasing its P_{50} .
 - (C) BPG favoured the R state of hemoglobin, providing more O_2 to tissues.
 - (D) BPG favoured the T state of hemoglobin, providing more O_2 to tissues. ***
 - (E) BPG increased your metabolism of CO_2 .

Questions 15 and 16 refer to the following diagram, which shows reaction curves for aspartate transcarbamoylase (ATCase) with carbamoylphosphate and different concentrations of aspartate, in the absence of TTP (curve 2) and presence of TTP (curve 1).



15. What do the shapes of the curves tell us about the ATCase enzyme?
- (A) It obeys Michaelis-Menten kinetics.
 - (B) It binds substrate through a concerted mechanism.
 - (C) It binds substrate through a sequential mechanism.
 - (D) It binds substrate hyperbolically.
 - (E) It binds substrate cooperatively. ***
16. How has TTP affected catalysis by the ATCase enzyme?
- (A) TTP has increased the v_{max} .
 - (B) TTP has decreased the v_{max} .
 - (C) TTP has decreased $K_{0.5}$.
 - (D) TTP has increased $K_{0.5}$. ***
 - (E) TTP has competitively blocked substrate binding.
17. N-(phosphonacetyl)-L-aspartate (PALA) is useful in the study of aspartate transcarbamoylase because:
- (A) It is a bisubstrate analog that mimics the reaction substrates.
 - (B) It is a bisubstrate analog that mimics the reaction products.
 - (C) It is a bisubstrate analog that mimics the reaction intermediate. ***
 - (D) It locks the enzyme in the T state.
 - (E) It locks the enzyme in the R state** technically also true so you got the point but remember it is a potent competitive inhibitor of ATCase because it binds to and blocks the catalytic site.

18. Which set of terms best describes the relationship between carbamoyl phosphate and aspartate transcarbamoylase?

- (A) It is a substrate and a negative heterotropic modulator
- (B) It is a substrate and a positive heterotropic modulator
- (C) It is a substrate and a negative homotropic modulator
- (D) It is a substrate and a positive homotropic modulator
- (E) None of the above***

19. What do chymotrypsin and thrombin have in common?

- (A) They are both needed in digestion
- (B) They are both synthesized as active proteins
- (C) They are both made more active through a process dependent upon vitamin K
- (D) They both have a serine in the catalytic site ***
- (E) They are both activated by calcium

20. Which of the following is true regarding glycogen synthase?

- (A) It is phosphorylated by PKA.
- (B) It is phosphorylated by GSK3.
- (C) It has many phosphorylation sites.
- (D) Phosphorylation at different sites causes different levels of inactivation.
- (E) All of the above. ***

21. Which of the following kinases recognizes its substrates by a previously modified phosphoserine residue?

- (A) Glycogen synthase kinase 3 ***
- (B) Protein kinase A
- (C) Cyclin dependent kinase
- (D) Src kinase
- (E) Phosphorylase kinase

22. Protein-ligand binding is driven by favourable interactions involving:

- (A) Shape
- (B) Charge
- (C) Size
- (D) Hydrophobicity/hydrophilicity
- (E) All of the above***

23. With regards to ATCase, which of the following statements is false?

- (A) It can bind aspartate and malonate at the same time.***
- (B) The R-state is in a more open conformation than the T-state.
- (C) The binding of PALA causes the enzyme to shift into the R-state.
- (D) None of the above.
- (E) All of the above.

24. Which statement accurately describes the regulation of protein kinase A?
- (A) 2 regulatory subunits bind 2 catalytic subunits, forming an active tetramer
 - (B) cAMP blocks substrate binding to catalytic sites
 - (C) cAMP blocks substrate binding to regulatory subunits
 - (D) regulatory subunits bind to catalytic sites, becoming auto-phosphorylated
 - (E) regulatory subunits bind to catalytic sites, blocking access to the substrate***
25. An amino acid is conserved among proteins if:
- (A) every member of a set of proteins contains the same amino acid anywhere in the sequence.
 - (B) the same amino acid occurs at the same position in each of the aligned protein sequences. ***
 - (C) that amino acid has the same function in every member of a set of proteins.
 - (D) the same amino acid occurs at the N- and C-termini in every member of a set of proteins.
 - (E) the entire amino acid sequences of the proteins can be perfectly aligned.
26. What version of the Midterm is this?
- (A) A
 - (B) B***

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Answers written here will not be marked.