

CHEM-527 Introductory Biochemistry
First Hourly Examination - Version B
Thursday, September 26, 2013
Dr. White Instructor

Name _____

If you feel any question is unclear or ambiguous, clearly explain your answer or interpretation.

Do not expose your answers to the scrutiny of your neighbors. Please fold under each page before you go on to the next.

- Write your name on every page.
- There are 9 pages to this examination including this page.
- A maximum score on this examination is 100 points.
- This examination will assess your learning, problem-solving skills, and ability to communicate clearly. Parts are intended to be challenging even to the best students in the class.
- Writing reflects how you think. Better quality answers will receive higher marks. Therefore organize your thoughts before you write and draw. Among the “right answers” I will read, some will be better than others because they:
 - show greater depth of understanding,
 - provide a more logical structure,
 - use appropriate examples,
 - include appropriate illustrations,
 - avoid extraneous or inaccurate information, and
 - choose words with precision.
- Strive to write not that you may be understood, but rather that you cannot possibly be misunderstood. Stream of consciousness answers are rarely well organized or clearly presented..

Breakdown of the Exam by sections:

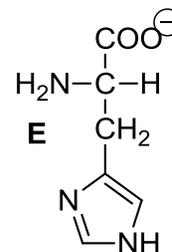
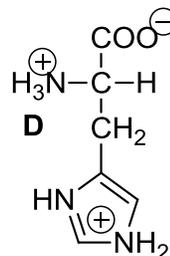
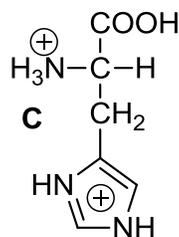
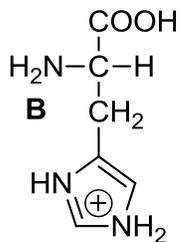
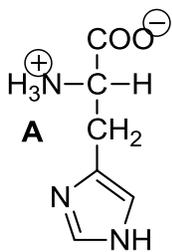
Short Answer	20 Points
Multiple Choice	35 Points
<u>Problems and Short Essay</u>	<u>45 Points</u>
Total	100 Points

Short Answer (20 points, 1 point each)

- _____ 1. Chemical bonds that stabilize the α -helix.
- _____ 2. Glutamate is to Aspartate as Leucine is to.
- _____ 3. Serine is to Threonine as Valine is to.
- _____ 4. Common abbreviation for adenylic acid.
- _____ 5. V_{\max} is not affected by this type of inhibitor.
- _____ 6. Type of inhibitor whose K_i is significantly lower than the K_m for the substrate.
- _____ 7. Colored, iron-containing prosthetic group covalently attached to hemoglobin.
- _____ 8. Nucleophilic amino acid residue involved covalently in the catalytic mechanism of acetylcholine esterase.
- _____ 9. General term for inactive enzyme precursors such as trypsinogen.
- _____ 10. Cholesterol belongs to this class of biological molecules.
- _____ 11. PCR stands for?
- _____ 12. Respiratory Quotient (RQ) is a ratio of what to what?
- _____ 13. The number of H-bonds per H_2O in ice.
- _____ 14. Metal ion involved in the urease active site.
- _____ 15. In organic chemistry, a peptide bond would be known as a:
- _____ 16. What effect does dissolving urea in water have on the temperature of the solution?
- _____ 17. Undergraduate from UD who later won a Nobel Prize for his work on restriction endonucleases.
- _____ 18. Protein purification method that exploits differences in charge on the protein.
- _____ 19. Protein that binds ATP and is involved in cell motility.
- _____ 20. Enzymes achieve high catalytic rates by lowering the:

Multiple Choice Questions (35 points, 3 points each correct answer, 2 points for a brief correct explanation of your answer for each.)

____ 1. Pick the predominant ionic form of histidine expected at pH 4. The pKa of the imidazole moiety is 6.0, the carboxyl group is 1.8, and the amino group is 9.2.



Explanation:

____ 2. Which of the following elements might be absent from a purified protein.

- A. Hydrogen B. Carbon C. Oxygen D. Nitrogen
- E. Sulfur F. All five atoms are always present.

Explanation:

____ 3. Identify the treatment that would be inappropriate for the purification of a protein.

- A. $(\text{NH}_4)_2\text{SO}_4$ precipitation. B. Ion exchange chromatography .
- C. Gel-filtration chromatography. D. Trypsin hydrolysis E. Electrophoresis

Explanation:

_____ 4. Which one of the following ***does not*** involve the loss of water in its formation?

- A. Peptide bond B. Hydrogen bond C. Glycosidic bond D. Phosphoester bond
E. Ester bond

Explanation:

_____ 5. Pick the ***false*** statement:

- A. For many proteins, the primary amino acid sequence determines the tertiary structure.
B. In evolution, primary structure is more highly conserved than tertiary structure.
C. The tertiary structure of hemoglobin is dominated by α -helices.
D. The tertiary structure and mechanism of action of chymotrypsin and trypsin are noticeably similar.
E. The α/β barrel found in triose phosphate isomerase is an example of tertiary structure.

Explanation:

_____ 6. If doubling the substrate concentration results in more than a two-fold increase in reaction velocity of an enzyme, one could conclude that the:

- A. substrate is an allosteric modifier of enzyme activity.
B. enzyme probably is monomeric.
C. enzyme obeys Michaelis-Menten kinetics.
D. enzyme is saturated.
E. substrate is distorted during catalysis.

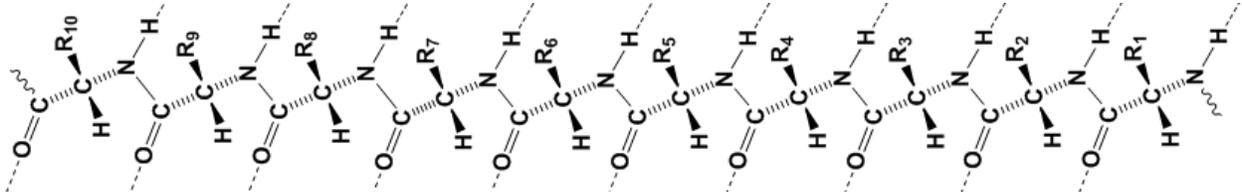
Explanation:

- ____ 7. A biochemist treated half of a sample of purified lactate dehydrogenase with succinic anhydride which derivatizes the ϵ -amino groups of lysine residues giving them negative charges. She mixed the derivatized sample with the native protein under conditions where the subunits could randomly dissociate and re-associate. Finally, she subjected the mixture to electrophoresis and observed five evenly spaced bands of protein only one of which corresponded to underivatized lactate dehydrogenase. Based on this information, what can be concluded about the quaternary structure of lactate dehydrogenase.
- A. It is a pentamer of identical subunits
 - B. It is normally monomeric but succinylation causes aggregation
 - C. Dimers and trimers associate to give pentamers
 - D. It is a tetramer of similar or identical subunits
 - E. There is insufficient information to deduce a structure

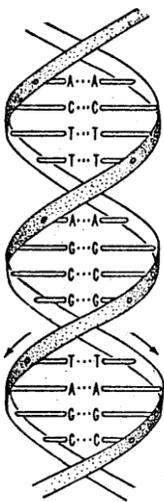
Explanation: (A diagram would help your explanation)

Thought Questions and Short Essays (45 points)

1. (6 points) The decapeptide below is the model used in class to illustrate the formation of an alpha helix as deduced by Linus Pauling. Assuming this peptide forms an alpha helix, show the connectivity of **all the hydrogen bonds** that would form in the helix, in other words, which hydrogen atoms connect to which oxygen atoms?



2. (4 points) Hemoglobin is a tetramer with an $\alpha_2\beta_2$ structure. Each subunit of hemoglobin is very similar to the tertiary structure of myoglobin. However, a number of hydrophilic amino acid residues in the myoglobin structure have been replaced with hydrophobic residues in the hemoglobin subunits. Provide a reasonable explanation for this observation.



3. (8 Points) The structure of DNA at the left appeared on a seminar announcement at DuPont many years ago. There are at least three significant errors in the structure. What are they? (2 points each for the first two and, 8 points for identifying all three)

4. (8 points) A group of CHEM-527 students were arguing in preparation for their first hour exam:

Alphie "I don't understand. How does hemoglobin 'know' when to release oxygen in the body?"

Betty "Oh that's easy. Whenever it gets to a capillary and encounters high carbon dioxide levels, it lets go."

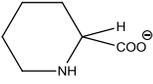
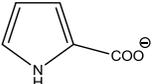
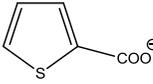
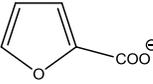
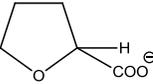
Gammy "It's not the carbon dioxide that does it. It's the lower pH that results from the carbon dioxide dissolved in the blood plasma."

Della "I don't see it that way at all. Oxygen and carbon dioxide are competing for binding. When carbon dioxide concentrations are high, it displaces oxygen where it is needed."

How would you answer Alphie's question? Diagrams welcome.

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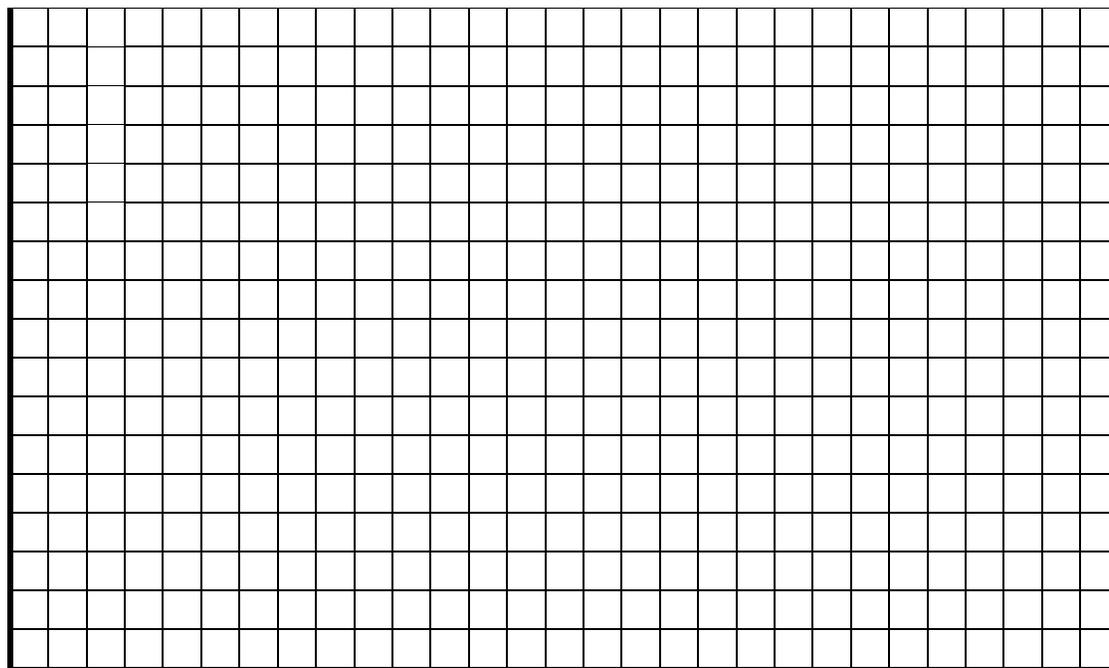
5. (19 total Points) Proline racemase, a bacterial enzyme, catalyzes the interconversion of D and L-proline. The K_m values for D and L-proline are 2.3 mM and 3.8 mM respectively. The maximal velocity is 8×10^{-3} mol/mg per min for L-proline. Various compounds have been tested as inhibitors of the enzymes. Their structure and extent of inhibition are indicated below.

					
Inhibitor	Pipicolate	Pyrrole-2-carboxylate		2-furoate	Tetrahydro-furoate
Concentration [M]	1.1×10^{-1}	5.7×10^{-2}	3.6×10^{-4}	5.7×10^{-2}	1.1×10^{-1}
Percent Inhibition*	18	98	50	73	11

Based on Cardinale & Abeles, *Biochemistry* 7:3970 (1968)

* Proline concentration was 5.7×10^{-2} M

- A. (8 Points) Using the grid below and the information above,
- (1) Sketch a graph of V vs. [S] for the uninhibited enzyme.
 - (2) Label the axes appropriately and provide numerical scales.
 - (3) On the same graph, place a mark corresponding to 3.6×10^{-4} M pyrrole 2-carboxylate and label it.



- B. (4 Points) Write the reaction catalyzed by proline racemase showing the structures of substrate and product.
- C. (3 Points) What is the equilibrium constant for the proline racemase reaction? Explain the reasoning for your prediction.
- D. (3 Points) What would be a reasonable structure for the transition state for the proline racemase reaction?
- E. (3 Points) Explain why the best inhibitor has a K_i approximately 160 times lower than the K_m values for L-proline?