CHEM-342 Introduction to Biochemistry Name _____
Midterm Examination - Individual Part
Wednesday, 22 March 2006
H. B. White - Instructor

Average 58.4/90, Range 30 – 88/90, N = 29

Important - Please read this before you turn the page.

Write your name on each page.

This individual part of the midterm examination is worth 90 points.

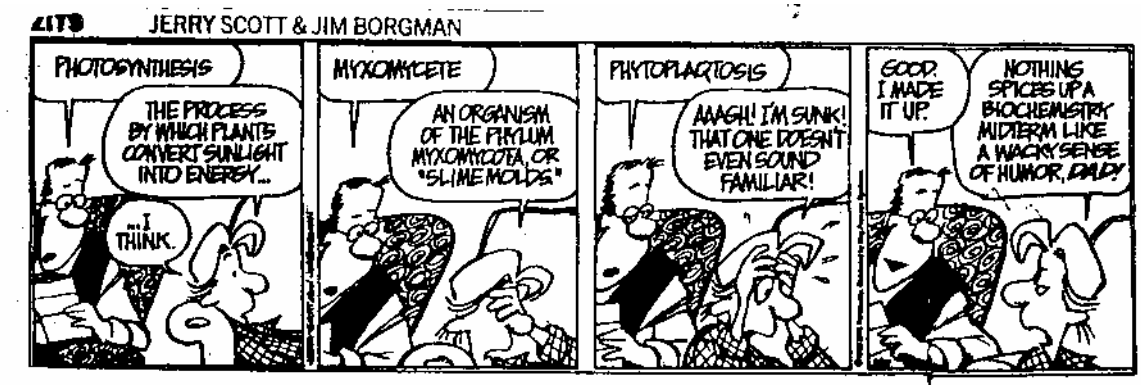
You may refer to your notes, course reader, handouts, or graded homework assignments Textbooks, reference books, and wireless laptop computers cannot be used.

This examination will assess your learning, problem-solving skills, and ability to communicate clearly. It is 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 for the following questions, some will be better than others because they

- show greater depth of understanding,
- avoid extraneous or inaccurate information,
- provide a more logical structure,
- use appropriate examples,
- include appropriate illustrations, 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.



1. (15 Points) Professor Essigsaure returned to his lab one night to prepare for a lecture demonstration based on the experiment presented in the second paragraph of Section 11 in Stokes' 1864 article. Within minutes he was looking high and low for the glacial acetic acid and mumbling angrily about associates who don't replace the things they use up. Frustrated, but undaunted, he figured any acid would do and substituted concentrated hydrochloric acid. After all, he reasoned, a stronger acid should work even better. — Not so. Sure enough the hemoglobin solution turned brown immediately upon addition of HCl but, much to his initial puzzlement, the resulting hematin did not extract into the ether layer.

   A. Please explain in chemical terms why HCl cannot be substituted for glacial acetic acid in this experiment.

   B. Draw chemical structures and diagrams to support your argument.

2. (15 Points) Buoyed by Zinoffsky's successes with horse hemoglobin, the iron content of proteins became of interest. The following experimental data were obtained.

   Dry weight of protein = 10.053 grams

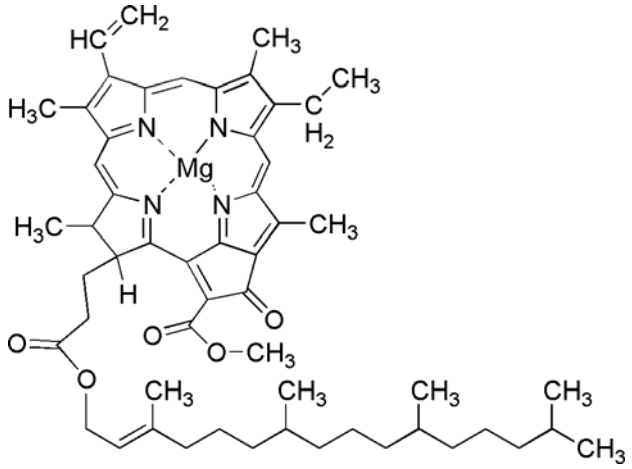
   $KMnO_4$ reagent = 13.53 ml (titer = 0.473 mgFe/ml)

   A. What is the percent iron in this protein?

   B. Estimate the minimum molecular weight of this protein.

   C. Is this protein hemoglobin? What is the basis for your answer?

3. (5 Points) Before most classes, I draw the structure of a mystery molecule on the board. The molecule usually is relevant to the article being discussed. While I don't expect students to identify the molecules, I do expect students to be able to analyze the structure and make some simple observations and predictions. The biomolecule below was not used this semester. In the space provided, predict *at least three* properties and/or features of this molecule based on its structure.

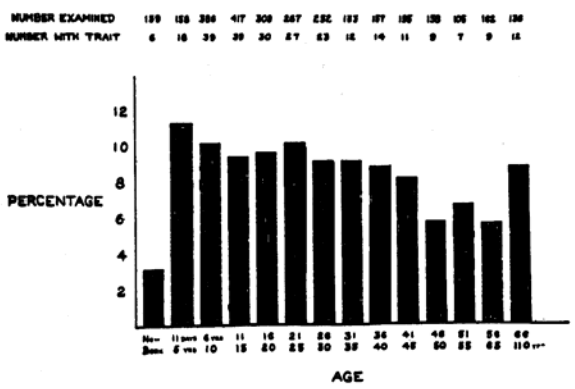


4. (10 Points) Construct an informative concept map using the following 10 words:

protein,	peptide bond,	heme,	iron,	histidine,
amino acid,	hemoglobin,	tetrapyrrole,	sulfur,	oxygen.

Answer ***only*** question 5 ***or*** 6. Credit will not be given for both.

5. (15 Points) Figure 2 (right) from the article by Diggs and coworkers displays the percentage of African Americans who displayed the sickle cell trait as a function of age.

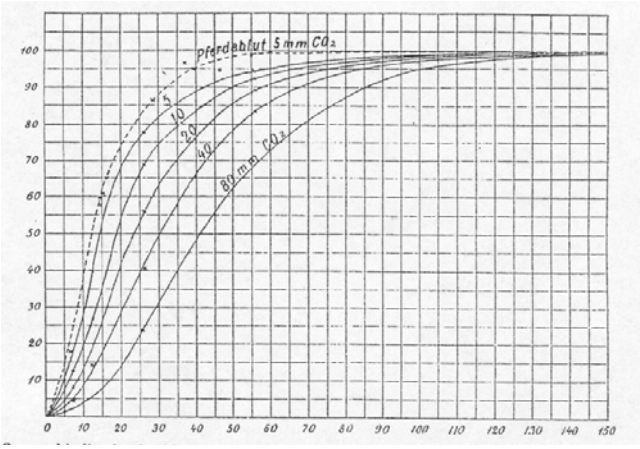


   A. What is the significance of the low frequency in newborns?

   B. Provide three possible explanations for the general decline in frequency in age after infancy.

Answer ***only*** question 5 ***or*** 6. Credit will not be given for both.

6. (15 Points) Bohr and coworker's data on the effect of carbon dioxide concentration on oxygen binding by hemoglobin are shown in their Fig 2 at the right.



   A. Describe the physiological significance of this curve.

   B. How is the sigmoid curve now interpreted in terms of hemoglobin structure?

Answer ***only*** question 7 ***or*** 8. Credit will not be given for both.

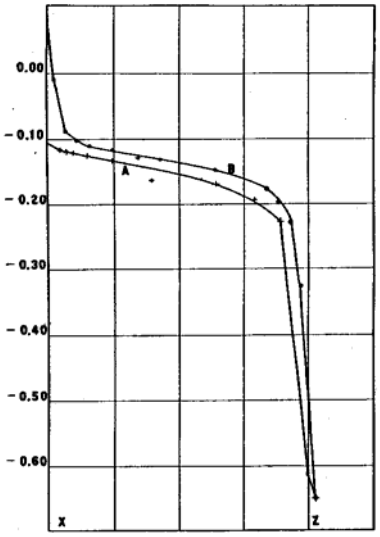


FIG. 1. Titration of hemoglobin and methemoglobin in pH 6.8. Potential against saturated calomel electrode plotted vertically; cc. of $Na_2S_2O_4$ plotted horizontally from x to z; cc. of $K_3Fe(CN)_6$ from z to x. Curve A titration of methemoglobin with $Na_2S_2O_4$; Curve B hemoglobin with $K_3Fe(CN)_6$.

7. (15 Points) Figure 1 from Conant's article shows the titration of methemoglobin with dithionite (A) and hemoglobin with ferricyanide (B).

   A. Write a balanced chemical equation for each reaction.

   B. Why does addition of reagent in the middle of the titration cause a small change in potential whereas it results in a much larger change at the beginning or end?

Answer ***only*** question 7 ***or*** 8. Credit will not be given for both.

8. (15 Points) Svedberg and Fåhareus did not provide figure captions for any of their figures, much to the consternation of CHEM-342 students.

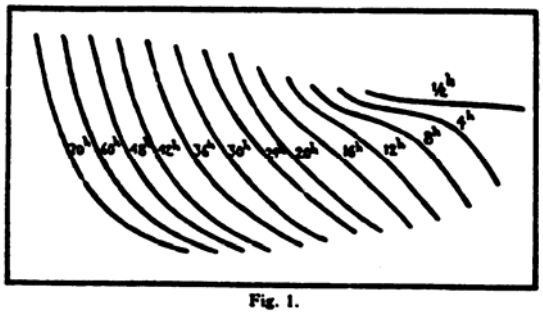


Fig. 1.

A. Now that you know what Fig. 1 means, provide in your own words an informative caption for it.

B. What does this figure show?

9. (15 Points) Before each class, I write a quotation on the board that I hope students will read and reflect on. Usually the quotation comes from some famous scientist, often a biochemist with direct relevance to this course. Three of those quotations are provided below. Select ***one*** and write a short essay on what it means using examples from this course.

Discovery commences with the awareness of anomaly, that is, with the recognition that nature somehow violated the preinduced expectation that governs normal science.

Thomas Kuhn (1970)

Progress in science depends on new techniques, new discoveries, and new ideas, probably in that order. **Sydney Brenner (1980)**

Scientists are often fascinated by questions that seem too trivial or uninteresting to the average person to think about. This is because the scientist sees implications in the questions that others cannot appreciate. **Stephen Tehudi (1990)**