CHEM-342 Introduction to Biochemistry Name _____
Midterm Examination - Individual Part (75%)
Wednesday, 25 March 2009
H. B. White – Instructor

Average = 66.0 ± 17.0, Range = 35-93/105 N=21

Important - Please read this before you turn the page.

There are 10 pages to this examination including this page.

Write your name on every page.

This individual part of the midterm examination is worth 105 points.

Answer questions 1-5. Then answer any four of the remaining questions 6 - 11.

The examination is closed book until 8:15 AM. Thereafter you may refer to your notes, course reader, handouts, or graded homework assignments. Textbooks and reference books 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, 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. Also, **USE YOUR OWN WORDS**, transcription of words from your notes does not show me that you understand.

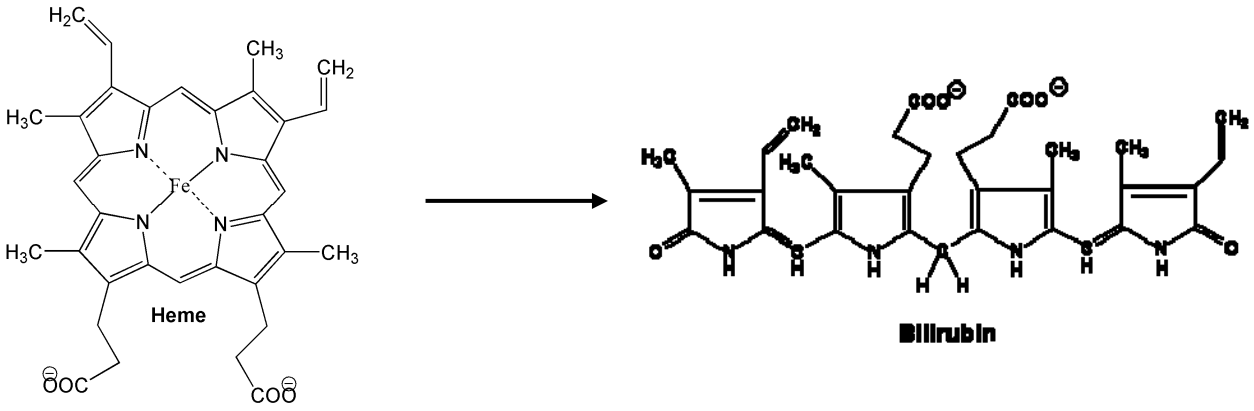
I don't have all of the answers, but I'm beginning to ask the right questions."

Answer Questions 1 – 5 and then four of the remaining questions 6-11.

1. (3 Points) What is the normal human body temperature in degrees Celsius? Show your work if you make a calculation.

2. (3 Points) Estimate the partial pressure of oxygen in this room? (Provide units with your number)

3. (9 Points) Herrick's patient had jaundice, a condition caused by the accumulation of bilirubin, a breakdown product of heme. The structures of bilirubin and heme are shown below. Circle all of the atoms in heme that are lost and all of the atoms in bilirubin that are gained in this metabolic transformation.



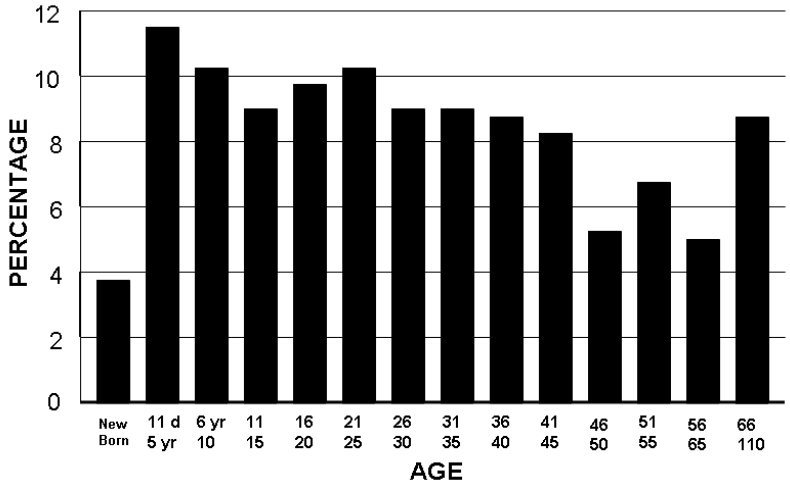
4. (15 Points) Zinoffsky was not the first to purify horse hemoglobin and determine its iron and sulfur content. In fact, Zinoffsky presents a table early in his paper that lists the results of three other researchers whose values seem pretty consistent but different from the values Zinoffsky himself reports. (See table below.) Assuming the earlier results were correct, *estimate* the corresponding empirical weight for horse hemoglobin. Show your work.

Author	Percent Sulfur	Percent Iron	Mean Value Sulfur/Iron	Calculated Emp. Wt.
Bucheler	0.6532	0.4670	-	
"	0.6443	0.47238	2.427	
"	-	0.46720	-	
Kossel	0.65	0.47	2.42	
Otto	0.67	0.45	2.60	
Ave of above	**0.654**	**0.465**	**2.48**	**?**
Zinoffsky Ave	**0.391**	**0.334**	**2.03**	**16,800 Da**

5. (15 Points) No one has actually seen a molecule of hemoglobin, yet by now you should have a mental image (model) of hemoglobin that is strongly influenced by reading a biochemistry text, searching on-line, and perhaps other courses you have taken. This image, still under construction, comes from the research results of many scientists Compare your current image of hemoglobin to the image that people like Svedberg or Diggs would have had around 1935? (Please draw two diagrams.) Identify in words what aspects of your image must have come from research after 1935.

Answer *4* of the remaining 6 questions.

6. (15 points) A group of students were intrigued by the gradual, but distinct, decline in the percentage of patients who had the sickle cell trait as a function of age redrawn below.



Jake *This is just a chance occurrence. There is really no statistical significance to the trend."*

Betsy *Maybe so, but lack of statistical significance doesn't necessarily mean lack of biological significance. I think it shows that people with sickle cell trait have a shorter life expectancy and thus they represent a smaller percentage of older people.*

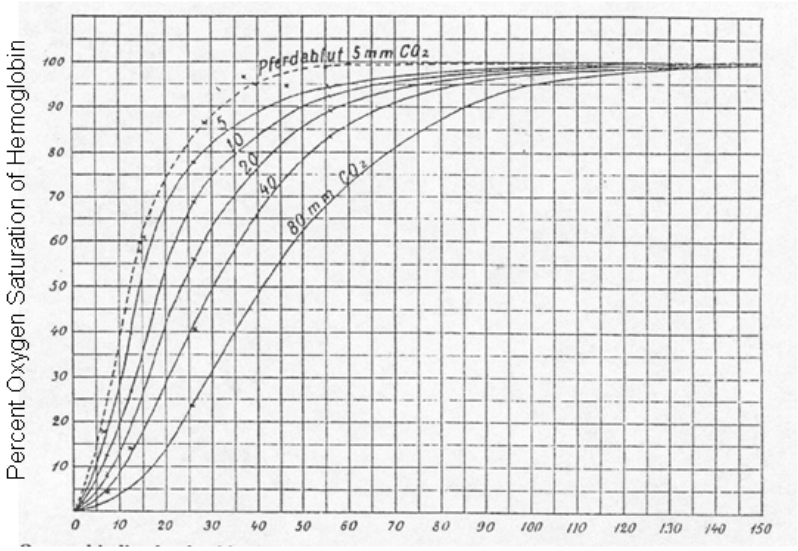
Greg *You're both wrong. It is simply an artifact or illusion generated by pooling data from two populations that have different frequencies of the sickle cell gene*.

Sue *Couldn't it just be that it is a little harder to detect sickle cell trait in the blood of older people?*

Evaluate these hypotheses. Which, if any, of the four is the most likely way to explain the trend? Explain your reasoning. Use the back of this page if you need more space.

7. (15 Points) In medicine, a clinical case study is a complete description of a patient with some illness. Not knowing the cause of the illness, a doctor will describe everything in the hopes that some subset of the symptoms will be diagnostic. Herrick's lengthy description of his patient includes 1) some symptoms that later turned out to be irrelevant, 2) some that were characteristic of disease, and 3) one or two that were diagnostic. For example, the presence of jaundice (see question 3) turns out to be directly related to the destruction of red blood cells, but jaundice can be caused by other conditions as well. Thus it is characteristic, but not diagnostic for sickle cell disease. Briefly describe one or more symptoms (in addition to the example provided) that fall into the three categories mentioned.

8. (15 Points) The figure below shows the results of Bohr, Hasselbalch, and Krogh (1904) that appear in many current textbooks.



Describe the physiological significance of hemoglobin's sigmoid oxygen-binding curve and the effect of carbon dioxide on it.

9. (15 Points) Zinoffsky was interested in the stoichiometry between Fe and S in hemoglobin. Peters was interested in the stoichiometry between Fe and O_2 bound to hemoglobin. Explain the significance of finding stoichiometry in each case.

10. (15 Points) Stokes treated oxyhemoglobin with a reducing agent ($SnCl_2$) while Peters treated oxyhemoglobin with and oxidizing agent [$K_3Fe(CN)_6$].

    A. What reactions were occurring in each case?

    B. In each case, the reaction enabled them to observe something of significance. Describe the observation and its significance.

11. (15 Points) Not only was Svedberg able to derive an important equation (a mathematical model) based on physical and chemical models, he was able to design an instrument (the ultracentrifuge) that could provide data to enable him to calculate the molecular weights of proteins. His equation follows:

$$\frac{dc}{c} = \frac{M(1-V\rho)\omega^2 x dx}{RT}$$

A. In your own words, describe the significance of the (1-$V\rho$) term.

B. In your own words, describe the significance of the $\omega^2 x$ term.