

CHEM-342 Introduction to Biochemistry
Final Examination - Individual Part
7:00 - 9:00 PM Friday, 19 May 2000
H. B. White - Instructor

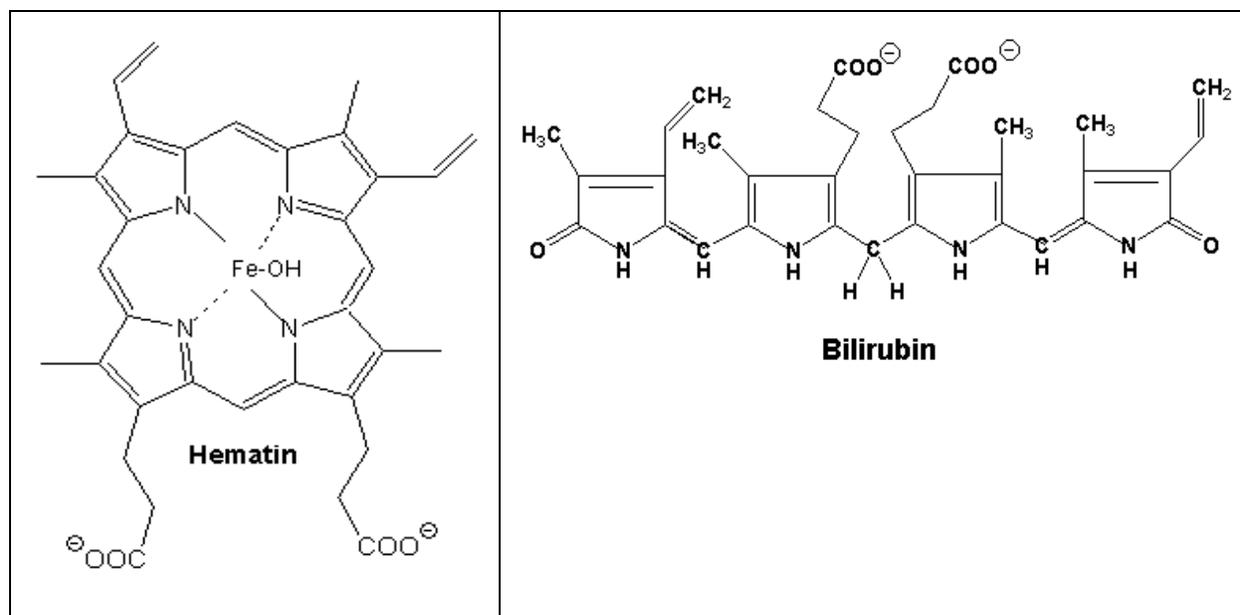
Name _____

Important - Please read this before you turn the page.

- 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. 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, and choose words with precision. Better quality answers will receive higher marks. Therefore organize your thoughts before you write. 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.
- Write your name on each page.
- Part I (75 points), the individual part of the examination, includes 6 problems and two essays
Part II (25 points), the group part of the examination, has two problems.
In addition, you can accumulate up to 9 individual bonus points in Part I of the examination.
- If you complete Part I early, you may leave the room for a break and return at 9:00 PM when Part II begins.
- You may refer to your notes, course reader, handouts, or graded homework assignments. Textbooks and the course book resources can be used for Part II only.
- Graded examinations may be picked up Tuesday morning, 23 May.
- Have a relaxing and safe Summer.

1. (10 Points) Describe in words and chemical structures the reaction catalyzed by trypsin.

2. (6 Points) Examine the structures of hematin and bilirubin, a breakdown product of hematin, below. Show on the structures where bond(s) in heme must be broken and indicate any atoms that are lost in forming bilirubin. Indicate the atoms, if any, that are added to bilirubin in the breakdown of hematin.



Bonus Point: What symptom indicates an accumulation of bilirubin in the human body?

3. **(10 Points)** If 10% of the people in an African village of 200 are heterozygous for the sickle cell gene (have the “trait” but not anemia), estimate how likely is it that there is at least one person in the village who has sickle cell anemia? Show or describe your thinking.
4. **(10 Points)** HbC is a fairly common electrophoretic variant of hemoglobin found in the African American population. As shown by the handout in class, the migration of HbC in electrophoresis suggests that it has two more positive charges than HbS and four more positive charges than HbA. Consistent with this, HbC has a lysine in place of glutamic acid (HbA) at position 6 of the beta chain, the same position where valine is found in HbS. We can symbolically represent HbA as $\alpha_2\beta_2$, HbC as $\alpha_2\beta_2^{\text{Glu6Lys}}$ and HbS as $\alpha_2\beta_2^{\text{Glu6Val}}$.

Consider that you have discovered a new hemoglobin variant HbC-Udel which has the same electrophoretic mobility as HbC but it has glutamic acid at position 6 of the beta chain. *Discuss conceptually and categorize* the various possible ways that HbC-Udel might differ from HbA.

Bonus question I (2 Points) Draw a diagram that clearly shows how one should arrange three trapezoidal tables in 208 Gore Hall to form a table surface in the shape of an equilateral triangle.

Bonus question II (4 points) *Accurately* draw or describe where to find biochemical journals such as the Journal of Biological Chemistry in the Morris Library.

5. **(10 Points)** People who have sickle cell anemia often receive transfusions from a compatible donor. (Such blood transfusions were not practiced in 1933 when Diggs and coworkers did their study.) Assume that a transfusion has doubled the number of red blood cells per ml of blood in a patient. If a day after the transfusion, you placed a sample of the patient's blood under a sealed microscope slide, observed it immediately, and again 6 and 24 hours later, what would you expect to see? Draw pictures for 0, 6, and 24 hours with explanations below.

0 Hour	6 Hours	24 Hours

2 Bonus points: How would adding dithionite to the samples at time 0 affect the results?

6. **(5 Points)** You were asked to attend at least one research seminar during the last half of the semester. Describe one (or more) seminar(s) you attended. What did you learn? What were your reactions to the presentation?

- 7. Essay (15 Points)** Select **one** of the following three questions to answer thoughtfully.
- i. Neither Diggs et al. nor Allison indicate that their “volunteers” were truly informed about the studies in which they participated. This is no longer standard practice. In terms of informed consent, what would a researcher need to do today to replicate Allison’s experiments? Be specific and uninformative. Or,
 - ii. Though all the articles you have read this semester deal with hemoglobin and/or sickle cell anemia, authors come from many different backgrounds and lived at different times. Thus, they have must have had quite different mental pictures of hemoglobin. Select three authors and compare and contrast what they knew and didn’t know about hemoglobin. Or,
 - iii. Part of the purpose of CHEM-342 is to have you develop attitudes and strategies for inquiry—to rediscover your curiosity. Central to this is a keen awareness of what you know and don’t know and a sense of relative uncertainty. Based on the articles you have read this semester, identify two significant learning issues that you still have. State them concisely and describe why you think it would be important for you to learn more about these topics.

- 8. (10 Points)** Pauling and coworkers observed that heterozygous individuals for the sickle cell gene produce a 40:60 ratio of HbS to HbA, rather than a 50:50 ratio. The following describes an in vitro (cell-free in a test tube) experiment which gave a similar but much more striking result [Schreier et al., *European Journal of Biochemistry*, 34, 213 (1973)].

A cell-free protein-synthesizing system, reconstituted with various components (ribosomes, aminoacylated tRNAs, initiation factors, etc.) from mammalian sources, is strongly dependent on exogenous messenger RNA. 9 to 10S RNAs isolated from duck reticulocytes (A) are translated into duck hemoglobin chains by this system. Likewise, 9 to 10S RNAs from rabbit reticulocytes (B) are translated into rabbit hemoglobin chains. When the system is presented simultaneously with duck and rabbit mRNA (A+B) at equal and saturating concentrations, rabbit hemoglobin synthesis occurs almost exclusively even though the maximal rate of hemoglobin synthesis is relatively unaffected regardless of whether the mRNAs are employed separately or in combination.

A. Construct a table that displays the results described

B. Provide a simple pictorial model to explain what appears to be happening on the molecular level.