

CHEM-342 Introduction to Biochemistry  
Mid-term Examination - Group Part  
Friday, 28 March 2008  
H. B. White - Instructor  
25 Points +10 Bonus points

Group Members \_\_\_\_\_  
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**Important - Please read this before you turn the page.**

1. Write your names or group number on each page of the exam you turn in.
2. This part of the examination is closed book and closed notes.
3. Please read the question carefully and make sure that you have thought it through with **everyone's** input before converging on a solution.
4. If you do not agree with your group, you may submit the examination under your own name for separate grading.

1. (25 points) Although the reactions of hemoglobin reported by various researchers in the articles you have studied were performed outside the body, most of the work has physiological relevance. Your task is to integrate the following information into your growing understanding of the structure, function, and chemistry of hemoglobin.

Some enzyme reactions in the body produce **hydrogen peroxide**, which can react with **hemoglobin** to form **methemoglobin**. Methemoglobin cannot bind and transport **oxygen**; consequently, natural selection has favored processes that either decrease the formation or reduce the accumulation of methemoglobin. For example, red blood cells contain an abundance of **catalase**, an enzyme that destroys hydrogen peroxide by converting it to **water** and oxygen. (This enzyme causes the bubbles of oxygen to form when hydrogen peroxide is put on a wound.) Despite the protective presence of catalase, methemoglobin forms naturally and constitutes about 0.5-1.0% of the total hemoglobin in your body. There is another enzyme in red blood cells, **methemoglobin reductase** also known as **cytochrome b<sub>5</sub> reductase**, that converts methemoglobin back to hemoglobin coupled to **NADH** as reductant. Humans genetically deficient in this enzyme can have 30% methemoglobin in their red blood cells. Treatment of these patients with reducing agents like **ascorbic acid** (Vitamin C) or **methylene blue** considerably lowers the amount of methemoglobin in their blood.

Using chemical formulas, abbreviations, and equations, construct a diagram or concept map that includes the interconnection of the various underlined molecules in the reactions described above. You may add additional terms as you feel are needed.

**Bonus (5 points)** Several decades ago the first patient lacking catalase was discovered by accident by a Japanese surgeon. How was the discovery made?

**Bonus (5 points)** The arterial blood of a typical college student contains about 16g of HbO<sub>2</sub> per 100ml. **Estimate** how many ml of gaseous O<sub>2</sub> per 100ml of blood that represents at standard temperature and pressure? (Note: Estimation does not require a calculator. Any answer within a factor of 2 is correct. Show work for credit.)

