

**CHEM-342 Introduction to Biochemistry**  
**Final Examination - Group (Part II)**  
**Monday, 24 May 2010**  
**9:00 – 10:00 PM**  
**H. B. White – Instructor**

**Group Members**

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**30 Points (Including bonus Question)**

**Important - Please read this before you turn the page.**

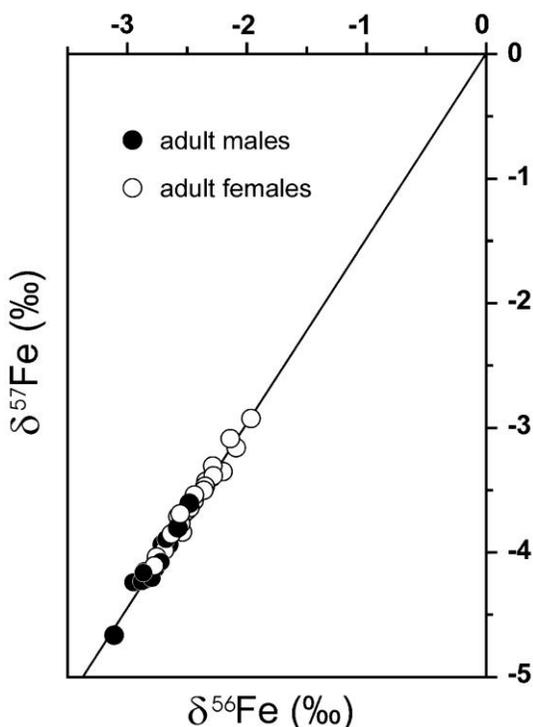
- You must sign your name on this page to receive the group grade.
- In CHEM-342, hemoglobin is a vehicle for learning how to learn by asking questions and pursuing answers to those questions. Undoubtedly you have learned a lot about hemoglobin in the process but you also should be developing habits of mind that will enable you to solve problems in other courses and throughout your life. This part of the final examination provides an opportunity for you and the other members of your group to display problem-solving skills as a team. It is extremely unlikely that anyone in your group or in the class has encountered the information on the following page. Your answers should display your collective:
  - breadth of knowledge (not limited to hemoglobin or biochemistry)
  - ability to analyze, make connections, and ask probing questions
  - sense of logic and organization
  - skill at generating models (testable hypotheses)
- This examination should be approached in phases
  - Phase 1** - Individual work for 10 to 15 minutes. Read the questions carefully and write down all of your learning issues and thoughts.
  - Phase 2** - Starting about 9 PM, as a group, generate as long a list of learning issues as you can. Organize your learning issues into five major categories and arrange them to display a probing series of connected questions.
  - Phase 3** - Generate a hypothesis provoked by the data and built around one of your learning issue categories. Make a prediction about the results of a test of your hypothesis.
- This examination will be evaluated on the richness of learning issues, the depth of analysis, the presentation of learning issues, and the quality of hypotheses and tests.

### Iron Deficiency Anemia???

The atomic mass of iron is the weighted average of the masses of its isotopes of which the four common non-radioactive ones are listed below from the 77<sup>th</sup> Edition of the CRC Handbook of Chemistry and Physics.

Isotope	% Natural Abundance	Mass
<sup>54</sup> Fe	5.845	53.939615
<sup>56</sup> Fe	91.754	55.934942
<sup>57</sup> Fe	2.119	56.935398
<sup>58</sup> Fe	0.282	57.933280

Mass spectrometry can measure the relative abundance of each isotope in various samples with great accuracy and precision. Thus, differences in isotope abundance among samples of as little as 0.01% can be detected. The figure below was published about eight years ago in *Science* [1]. In a single graph it depicts the relative abundance of the three most common iron isotopes in blood samples taken from 15 men and 29 women. For example, a  $\delta^{57}\text{Fe}$  (‰) value of -3 on the y-axis means that there is a 3 part per thousand (0.3%) deficit of <sup>57</sup>Fe in an iron sample relative to <sup>54</sup>Fe. A reference standard with the natural abundances listed above would be a point at the origin in the upper right hand corner.



$$\delta^{56}\text{Fe} (\text{‰}) = \left\{ \left[ \frac{(^{56}\text{Fe}/^{54}\text{Fe})_{\text{sample}}}{(^{56}\text{Fe}/^{54}\text{Fe})_{\text{std}}} \right] - 1 \right\} \times 1000$$

$$\delta^{57}\text{Fe} (\text{‰}) = \left\{ \left[ \frac{(^{57}\text{Fe}/^{54}\text{Fe})_{\text{sample}}}{(^{57}\text{Fe}/^{54}\text{Fe})_{\text{std}}} \right] - 1 \right\} \times 1000$$

- (15 points) After generating a significant list of group learning issues on a separate sheet, organize the list into five major categories and present them on the next page in a coherent way that displays logic and depth.
- (10 points) Generate a testable hypothesis built around **one** of your learning issues and, based on your knowledge and intuition, make a prediction of the outcome.

[1] Thomas Walczyk and Friedhelm von Blanckenburg, "Natural Iron Isotope Variations in Human Blood," 295, 2065-2066 (2002)

**Learning Issue Category 1**

**Learning Issue Category 2**

**Learning Issue Category 3**

**Learning Issue Category 4**

**Learning Issue Category 5**

Testable hypothesis generated by one category of learning issues.

Prediction of the results of a test of your hypothesis.

**Bonus Question:** (5 points) Iron is an essential dietary mineral. As a typical adult human, you have about 2 grams of iron in your body of which about 70% is associated with the heme group in hemoglobin (enough to make a small nail). Knowing what you do about the structure and biological lifetime of a hemoglobin molecule, estimate to within one order of magnitude (correct within a factor of plus or minus 10), how many molecules of tetrameric hemoglobin your body will make during this three hour exam?