

CHEM-342 Introduction to Biochemistry
Final Examination - Individual Part
Thursday, 26 May 2005
3:30 – 5:15 PM
H. B. White - Instructor

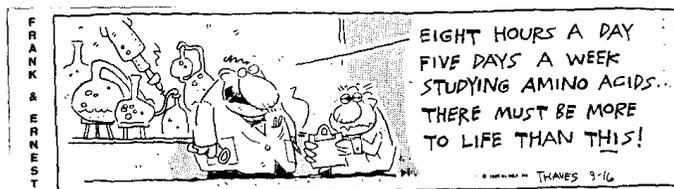
Name _____

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.
- There are 7 pages to this part of the examination (counting this cover page). Please write your name on each page. Feel free to use the backs of pages if you need more space.
- Part I (75 points) This individual part of the examination, includes 8 problems and short essay questions. Also, you can obtain up to 4 additional points from bonus questions.
Part II (25 points) The group part of the examination will require you to deal with new information collaboratively.
- If you complete Part I early, you may leave the room for a break and return at or before 5:15 PM when Part II begins.
- You may refer to your notes, course reader, handouts, or graded homework assignments.
- Attempt to draw a picture or diagram as part of your answer to every question.
- Graded examinations may be picked up Tuesday morning, 31 May.
- Have a relaxing and safe Summer.

The single-letter abbreviations for the 20 amino acids are:

A = Alanine	I = Isoleucine	R = Arginine
C = Cysteine	K = Lysine	S = Serine
D = Aspartic Acid	L = Leucine	T = Threonine
E = Glutamic Acid	M = Methionine	V = Valine
F = Phenylalanine	N = Asparagine	W = Tryptophan
G = Glycine	P = Proline	Y = Tyrosine
H = Histidine	Q = Glutamine	



3. (10 points) In parts of West Africa, the β -globin gene is polymorphic in the human populations. That means several alleles coexist at non-negligible frequencies. In a particular population they are β^A , β^S , and β^C at frequencies of 0.82, 0.13 and 0.05, respectively.
- a. (5 pts) Draw a geometric diagram in which areas represents the proportion of the children born in that population having the various possible genotypes for β -globin genes.
- b. (5 pts) On average out of every 10,000 births, how many infants would be born who possess **both** the S and C alleles for the β -globin gene?

1 Point Bonus: What is the human body temperature in °C?

4. (16 points) When Howard Dintzis wrote his first paper, the amino acid sequences of neither rabbit nor human globins were known. In his second paper, he used the sequence of the human globins to deduce the order of his rabbit tryptic peptides. The complete sequences of human and rabbit globins are now known. They are aligned and displayed below so direct comparisons can be made. (Notes: The sequences do not fit on a single line and thus wrap to subsequent lines. The single letter code for amino acids is on the cover page.)

α Globin Sequence

HUMAN VLSPADKTNVKAAWGKVGAGHAGEYGAEALERMFLSFPTTKTYFPH
RABBIT VLSPADKTNIKTAWEKIGSHGGEYGAEAVERMFLGFPTTKTYFPH

FDSLHGSAQVKGHGKKVADALTNAVAHVDDMPNALSALSDLHAHKL RVPVNFK
FDFTHGSEQIKAHGKKVSEALTKAVGHLDLPGALSTLSDLHAHKL RVPVNFK

LLSHCLLVTLAAHLPAEFTPAVHASLDKFLASVSTVLT SKYR
LLSHCLLVTLANHHPSEFTPAVHASLDKFLANVSTVLT SKYR

β Globin Sequence

HUMAN VHLTPEEKSAVTALWGKVNVEVGGGEALGRLLVVYPWTQRFFESF
RABBIT VHLSSEEKSAVTALWGKVNVEVGGGEALGRLLVVYPWTQRFFESF

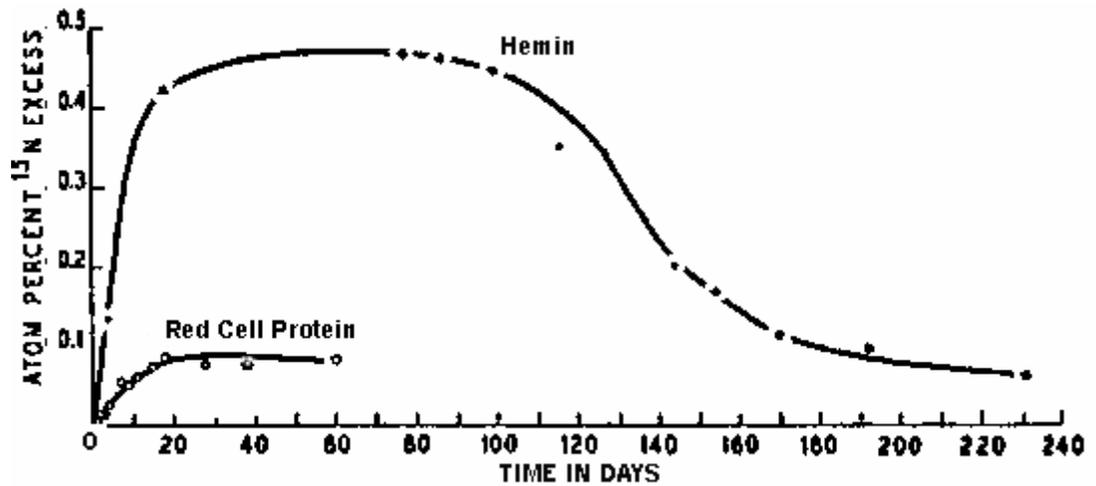
GDLSTPDAVMGNPKVKAHGKKVLGAFSDGLAHL DNLKGTFFATLSELHCDKLHVD
GDLSSANAVMNNPKVKAHGKKVLA AFSEGLSHLDNLKGTFAKLSELHCDKLHVD

PENFRLLG NVLVCVLAH HFGKEFTPPVQAAYQKVVAGVANALAHKYH
PENFRLLG NVLVIVLSH HFGKEFTPPVQAAYQKVVAGVANALAHKYH

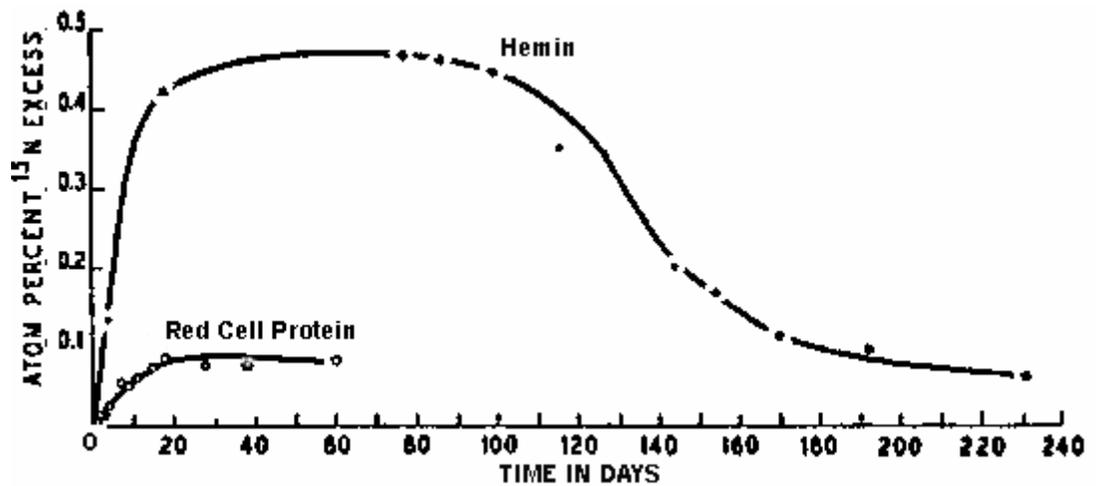
- (1 pt) Identify the N-terminal amino acid in each sequence by putting a circle around it.
- (3 pts) Indicate with a forward slash, “/”, every peptide bond trypsin would hydrolyze.
- (3 pts) Identify those tryptic peptides that have identical sequences in both species by underlining them in the human globin sequences?
- (4 pts) Put boxes around those rabbit tryptic peptides that would not have any ^{14}C in them in Dintzis’ experiment.
- (5 pts) Identify the tryptic peptide or peptides that you think would have been the most difficult for Dintzis to match up by underlining them in the rabbit sequence(s). How did you make your selection(s)?

1 Point Bonus: Howard Dintzis currently is an emeritus professor at what university?

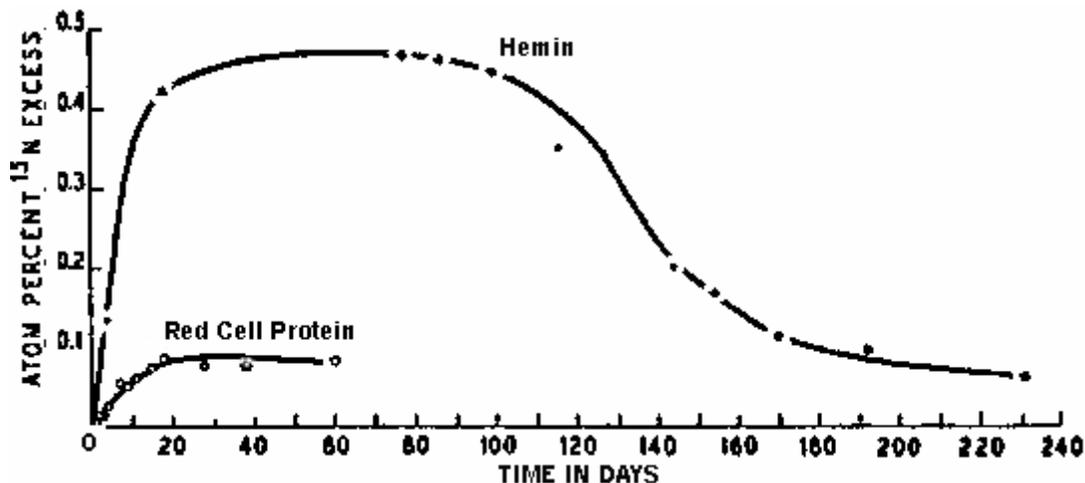
5. (16 Points) David Shemin determined ^{15}N content of the heme and globin portions of his own hemoglobin as a function of time after he consumed a large amount of ^{15}N glycine. All things being equal, on the graph of the data from his experiment, draw your prediction of the distribution of ^{15}N label for the following situations:
- a. (8 pts) The distribution of ^{15}N in hemin **and** globin, if ^{15}N Lysine were used instead of ^{15}N Glycine? Explain your prediction.



- b. (4 pts) What would the globin curve look like if Shemin had hydrolysed his hemoglobin and isolated the glycine from it and analyzed the glycine separately for ^{15}N ?



- c. (4 pts) What if Shemin had been able to isolate bilirubin, a breakdown product of heme, and measured its ^{15}N over time, what would its profile look like?



6. (5 Points) Allison (1954) mixed sodium metabisulfite ($\text{Na}_2\text{S}_2\text{O}_5$) with blood samples to determine which of his volunteers had sickle cell trait. Describe in words and chemical reactions, how this assay works.

7. (3 Points) Draw the structure of the dipeptide GE.

8. (10 Points) Essay. Answer **one** of the following two questions.
- a. Anthony Allison (1954) designed and conducted his experiments without formal approval by an independent human subjects review board. If you were to serve on such a board, specifically what would you like to know, that was not addressed in Allison's article, before considering whether or not to approve such an experiment today? How would this information help you make a better decision?
Or
 - b. David Shemin (1946) designed and conducted his experiments without formal approval by an independent human subjects review board. If you were to serve on such a board, specifically what would you like to know, that was not addressed in Shemin's article, before considering whether or not to approve such an experiment today? Does it make a difference whether the experimenter and the subject are the same?

1 Point Bonus: The spin state of iron in deoxyhemoglobin.