Intro Bio Exam 1   Oct. 1, 2015   **ID code:________________________ __________**

NAME ____ Name, *on cover sheet only*

CLASS REGISTERED FOR (check one): *One point deducted if you do not check a class!*

_____ C2005-sect. 001 [morning]
_____ C2005-sect. 002 [afternoon]
_____ F2401   SEAT NO. ___________

PLEASE READ THIS PAGE!! There are 4 pages with questions. All information is the same in all exam copies, but the question order may differ.

Each page is worth approximately the 25%.
To receive proper credit for your answer, you must write your **name** on the **first** page only, and on **all** other pages write only an ID code consisting of **your birth date plus a 5-letter word of your choice** (e.g., 08/16/90, gauss). Pages will be separated for grading and later reassembled. It is essential that your ID code be on each question page and the cove page. Please do it **now**. Please do it legibly. One point will be deducted for each page without an ID code. The use of ID codes makes the grading anonymous. Please check the class for which you are registered; one point will be deducted for failure to do so.

Information you may find useful is provided on the last pages including your handout of amino acid structures not showing charges. The information pages can be torn off and used as scrap paper, and you may use the back of this cover page as scrap paper. But be sure to turn in this cover page.

No electronic devices other than simple (scientific) calculators (non-graphing) are allowed, either visible or on your person-- no cell phones, Blackberries, IPods, etc. All electronic devices must be stored in briefcases or backpacks, not on your person. Please keep these items under your seat. Students found to have a cell phone on their person (e.g., in a pocket) will receive a zero for the exam.

Use pen and no white-out. If you must change your answer, cross it out and use the back of the same page. If you use pencil a regrade is not possible. However, regrades are rare anyway.

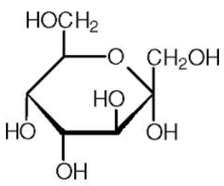
When choices are presented, ***unless instructed otherwise***, circle what you consider to be the best answer or answers **and** provide an explanation of your reasoning for choosing your answers. **Your explanation should show how you arrived at your answer**, not just repeat it or the question. Think of trying to explain your answer to a classmate. Try to list or explain all the critical steps in your reasoning that led you to your answer. If you present some correct reasoning, you may earn partial credit. But no partial credit can be given if you provide no explanation at all, so try to write something for every question requiring an explanation (which is almost all of them). Don't leave blank white spaces, write something.

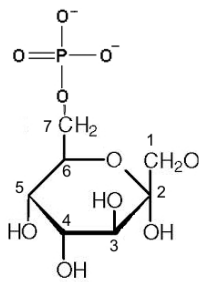
On the other hand: You should limit your answer to the space provided for each question. If you must cross out some writing, use additional space for your answer on the back of the **SAME** page on which the question appears, but limit your total writing to occupy the same amount of space as was originally provided. Use of more space for irrelevant information may result in the deduction of credit. Pages are separated for grading and the last page without questions will be discarded, so if you do need more space for your answer because of crossing out, be sure to use the back of the **SAME** page. Do not use the last information page for any answers, as these will be discarded.

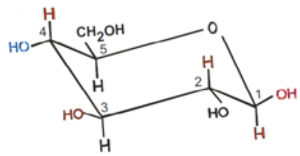
Note that academic dishonesty is dealt with severely at Columbia. The instructors give an F for the course and refer the matter to the Dean. Expulsion is a common outcome, with no second chances. Please complete the following pledge:
"I affirm that I will not plagiarize, use unauthorized materials, or give or receive illegitimate help on assignments, papers, or examinations. I will also uphold equity and honesty in the evaluation of my work and the work of others. I do so to sustain a community built around this Code of Honor."

Student signature____

1. Sedoheptulose is a 7 carbon sugar found in some plants. It is also present phosphorylated, as shown below.


D-sedoheptulose


D-sedoheptulose
-7-phosphate


Beta-D-glucose

1A. The anomeric carbon in D-sedoheptulose is carbon number: _**2**__. Write 0 if there is no anomeric carbon.

Ring closure produces a newly-formed hydroxyl and a bond from the anomeric carbon to a ring oxygen. Carbon 2satisfies these requirements.

1B. A more complete name for this D-sedoheptulose would include the prefix:

(alpha) (beta) (gamma) (something else) (none of these).

Upon cyclization it is the hydroxyl that is newly formed on the anomeric carbon that distinguishes the alpha and beta stereoisomeric forms of the anomers. From the Haworth depiction, is can be seen that the C1 hydroxyl is below the other bond that's not part of the ring; below is called alpha, above is called beta.

1C. Circle the most polar compound: **(sedoheptulose-7-phosphate)** (sedohepulose) (glucose) (water) (can't predict)

A polar bond or polar molecule is characterized by a separation of charge. The ionized phosphate group on sedoheptulose-7-phosphate carries more than one full charge, whereas all the other compounds have only partial charges.

1D. The conformation of the phosphorous atom relative to the ring in the chair form of sedoheptulose-7-phosphate is:

(axial up) (axial down) (equatorial out) (equatorial in) (**none of these**)

The conformation of atoms in ring structures is limited to those attached to the ring. Beyond those joints the atoms are free to rotate relative to the ring; for intance, as does the -CH2OH at positon 6 in glucose.

1E. Which of the following polysaccharides is likely to form a compact starch-like structure? *(1-4 corrected to 2-5 in class)*

poly-beta-(2-5) D- sedoheptulose (yes) **(no)** (maybe) (can't predict)

poly-alpha(2-5)-D-sedoheptulose **(yes)** (no) (maybe) (can't predict)

poly-alpha-(2-5)-D-sedoheptulose-7-phosphate (yes) **(no)** (maybe) (can't predict)

Poly-beta-D- sedoheptulose is straight due to the equatorial conformation of the hydroxyl on the anomeric carbon 1 and the straight–through 1,4 connection and so will form straight bundles (cellulose–like) rather than form a helix. Poly-D-sedohetulose-7-phosphate will not allow a compact structure due to the many repulsive negative ionic charges throughout the molecule carried by the phosphate group. Poly-alpha(1-4)-D-sedoheptulose has neither of these problems and should be very similar to poly-alpha(1-4)-D-glucose, which is in starch.

2. Many polypeptides embedded in the cell membrane of a human cell that act as signal receptors need to diffuse within the membrane so as to form multimers in order to function. This diffusion & multimerization is aided or made possible by

2A. a low amount of cis-unsaturated bonds in membrane phospholipids) (yes) **(no)**

Low cis–unsaturated fatty acids will tend to make the interior of the membrane less fluidic (like solid fat) and so could impede diffusion of membrane proteins.

2B. a high amount of cis-unsaturated bonds in membrane phospholipids (**yes**) (no)

High cis unsaturated fatty acids will tend to make the interior of the membrane more fluidic (like liquid oil) and so facilitate the diffusion of membrane proteins.

2C. polar side chains on the exterior of the regions of the subunits embedded in the cell membrane **(yes)** (no)

Non-polar side chains on the exterior of the subunits would interact with the fatty acid tails in the membrane and so compete with protein-protein interact between non-polar side chains. But polar side chains or ionic side chains could form specific bonds between subunits in this non-aqueous environment (perhaps even more readily without competition from water).

(**2D**. Which levels of protein structure are probably required for the formation of a fully functional dimer?

(primary) (secondary) (tertiary) (quaternary) **(all of these)** (none of these)

The association of protein subunits into a multimeric protein is the formation of quaternary structure by definition. Quaternary depends on tertiary which depends on secondary and primary.

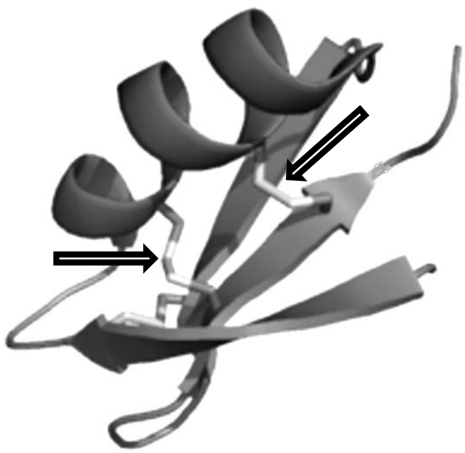
3A. Using paper electrophoresis, at what pH are you sure to separate from each other all 3 lipids shown on last page: triglyceride, phosphatidylethanolamine, and phosphatidylserine? Assume all are soluble in aqueous buffers. Circle one answer. (pH 1) (pH 7) **(pH 12)** (pH 1 and pH 7) (pH 7 and pH 12) (pH 1 and pH 12) (all 3) (none of these) Explain fully, marking the diagrams and/or making a table if you wish.

	Net charge at: pH1	pH7	pH12
Triglyceride:	0	0	0
P-ethanolamine:	+1	0	-1
P-serine:	+1	-1	-2

ALL 3 molecules have different net charges only at pH12.

3B. If you used paper chromatography at pH7 to separate the molecules, how would they rank in mobility; 1 means fastest (migrated furthest), 3 means slowest. Fill in each rank (1, 2 or 3 or use the same number for a tie); remember to explain. Triglyceride__**1**_ Phosphatidylethanolamine__**2**__ Phosphatidylserine__**3**__

The more polar the molecule, the longer it will reside in the relatively stationary aqueous phase bound to the paper (cellulose) and thus the slower its mobility. At pH7, P-serine has 3 charged groups, P-ethanolamine has 2, and the triglyceride has only partial charges.



4. Scorpion toxin (see ribbon structure at left) is a 66-amino acid single polypeptide protein that contains an alpha-helix interacting with a beta sheet. After fully folding, 3 disulfide bonds are formed, two of which are indicated by arrows. Before folding, there were 9 cysteine residues in this protein.

4A. The number of sulfhydryl groups in the fully folded protein is _**3**__

To form 3 disulfides requires 3 pairs (i.e., 6) of cysteine sulfhydryl groups. 9-6 = 3 cysteines remain.

4B. In the alpha helix, the number of amino acid residues between the two cysteines pointed to by the arrows is approximately __**3**____

It can been seen that one turn of the alpha helix separates the two cysteines in question. The number of amino acids between two hydrogen-bonded amino acids in an alpha helix is 3. It is this spacing that allows the formation of a near linear O-H—O conformation required for the formation of an H-bond between the alpha NH of one amino acid the alpha C=O of another.

4C. In the beta sheet, the number of amino acid residues between the two cysteines pointed to by the arrows could be: (0) (2) **(3)** (4) (16) (any of these). Circle all possibilities.

Since every other amino acid side chain in a beta sheet protrudes on the opposite side, there would have to be an odd number of amino acids in between the 2 cysteines so that they were located on the same (here the upper) side of the sheet.

4D. Indicate the C-terminus by writing the letter C on it. Remember to explain how you know.

The carboxyl end is at top right because the arrow on the strand of the beta sheet near that end points N to C, following the convention.

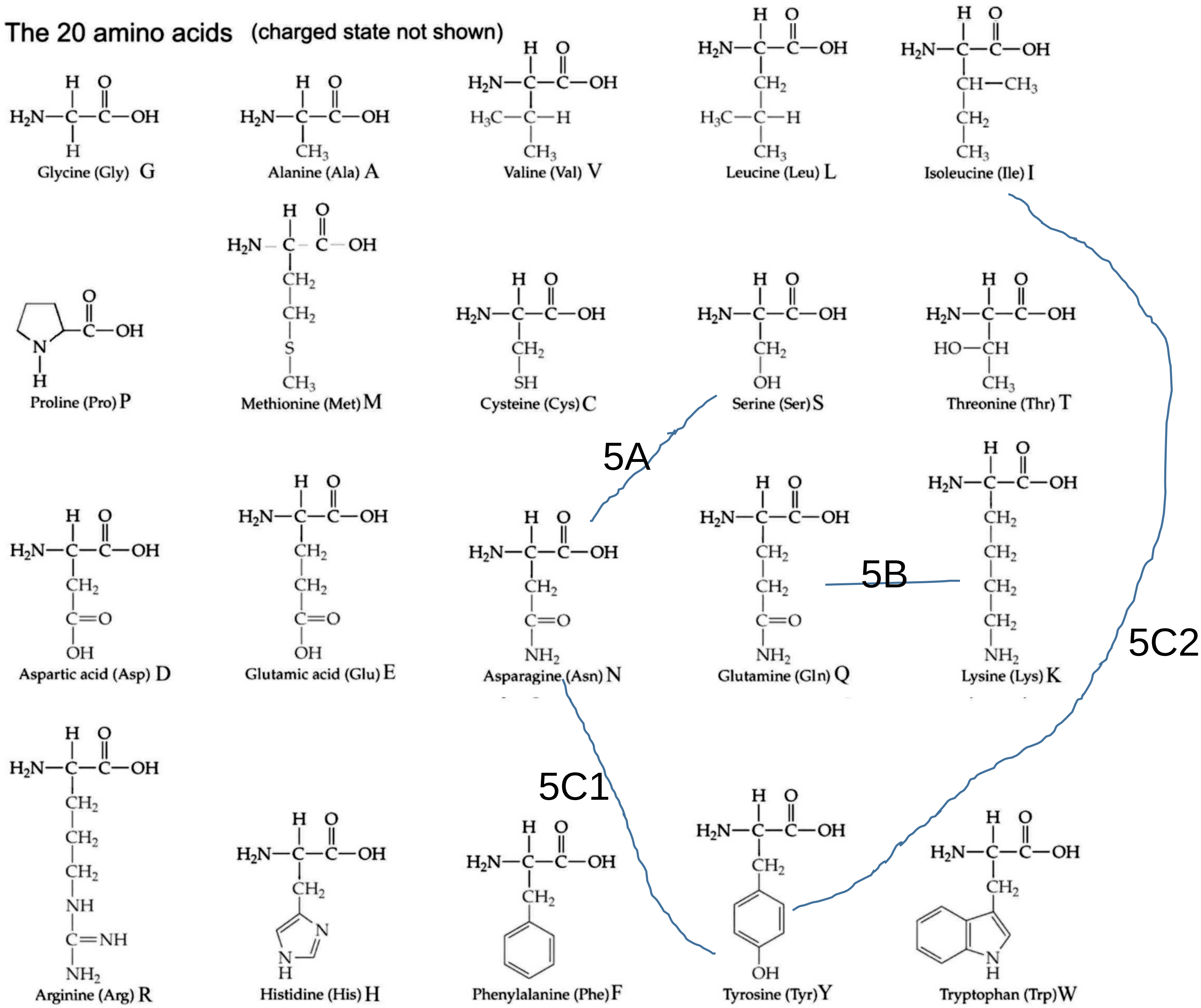
*This page contains **QUESTION 5**; it is NOT an information page.*

5. In the picture of the 20 amino acids **shown immediately below** connect pairs of amino acid with lines according to the properties of their side chains as indicated below. There will be multiple correct answers; just choose one. Amino acids may be re-used for more than question. Label each connection line with the letter of the question. Do *not* use histidine.

5A. Two amino acids that could form hydrogen bonds
5B. Two amino acids that could form ion-dipole interactions

5C. A single amino acid that could form either (5C1) a hydrogen bond or (5C2) a hydrophobic interaction with another amino acid (draw 2 lines and label them **5C1** and **5C2**).
No explanations are required, but you may provide one if you think your answer could use it, using the back of this page)

One of many correct answers:



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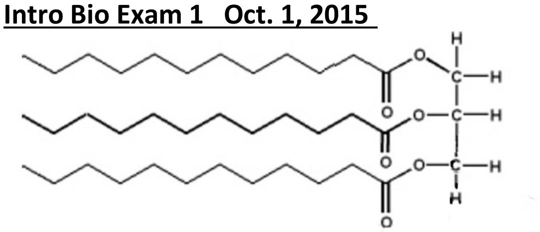
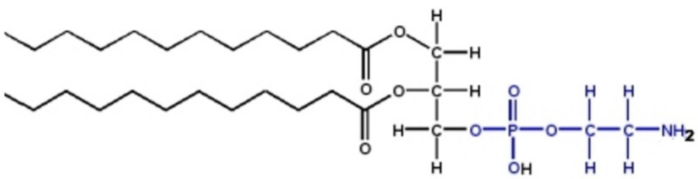
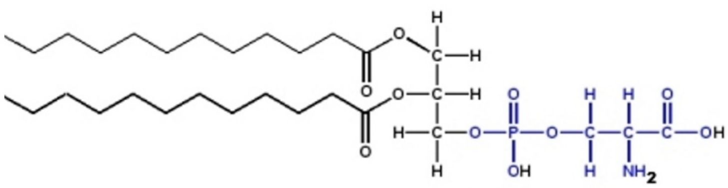


A triglyceride



Phosphatidylethanolamine



Phosphatidylserine