Name:_____ Section :_____

7.014 Problem Set 1

Answers to this problem set are to be turned in. **Problem sets will not be accepted late. Solutions will be posted on the web.**

Please read the following two articles and use them to answer Question 1.

Article I

Please refer to article:
Fouad, Tamer. "Laptops can affect fertility in males, US researchers warn." (January 1, 2005).
(full text at http://www.thedoctorslounge.net/fertilounge/articles/fertility_laptops)

Article II

Please refer to article:
Moore, Charles. "Hot Laptops A Male Reproductive Health Hazard - And Something You Can Do About It." *Road Warrior*, January 4, 2005.
(full text with pictures at http://www.macopinion.com/columns/roadwarrior/05/01/04/)

Question 1

a) Do the articles above present the findings of the laptop study objectively? If yes, justify. If no, give examples of biased reporting and explain why you believe the reporting to be biased. (Feel free to underline or highlight passages in the text, as long as you clearly identify the meaning of your markings)

b) Look again at the second article. Does the Laptop Desk study answer the question of how likely is it that this device would help alleviate the problem of the elevated scrotum temperature associated with laptop use? Why or why not?

c) Based on the information in the two articles, do you think the Laptop Desk is likely to be a significant relief for the problem of the elevated scrotum temperature associated with laptop use? Why or why not?

d) Based on the information in the two articles, do you think it was appropriate to include the information about the Laptop Desk in the second article? Why or why not?

Question 2

Hemoglobin is the protein complex that carries oxygen around our bodies and distributes it to the organs and tissues. Sickle cell anemia is a disease that results from the presence of abnormal hemoglobin (HbS) in the red blood cells. In order to have the disease a person needs to have only HbS hemoglobin.

Wild-type hemoglobin (HbA) is composed of 2 α and 2 β polypeptides. The α and β polypeptides are approximately the same length, and are very similar in their primary structure.

a) If you run HbA on a denaturing gel, how many bands are you likely to see? Why?

When mutant HbS and wild-type HbA hemoglobin molecules are analyzed on a denaturing gel, they produce identical patterns.

b) What is the likely defect in the HbS? Why?

At low concentrations of O_2 HbS forms rigid rod-like complexes in the cell. These complexes deform the red blood cells from saucer shape to sickle-like shape. These rigid, sickle-like cells can get stuck in the small blood vessels and cause damage.

The β-subunit of HbS has the amino acid valine in position 6, where the wild-type molecule has a glutamic acid.

- At normal oxygen concentrations, the overall shape of the β-subunit and the entire hemoglobin molecule remains unaffected by the substitution.
- At low concentrations of O_2, the Val6 on one β-subunit interacts with two amino acids on a β-subunit of another hemoglobin molecule.

c) What level(s) of protein structure of the β-subunit is (are) affected by the substitution at normal oxygen concentrations? Why?

d) What level(s) of protein structure of the β-subunit is (are) affected by the substitution at low oxygen concentrations? Why?

At low concentrations of O_2 the Val6 on the mutant β-subunit interacts with a surface pocket made up of amino acids Phe85 and Leu88. This pocket is found on both wildtype and mutant β-subunits.

e) What is the strongest interaction involved in this binding event?

Question 2, continued

f) This pocket is found on both wild-type and mutant β-subunits. Explain why (at low concentrations of O_2) hemoglobin containing only mutant β-subunits forms long rods yet hemoglobin containing wild-type β-subunits does not.

g) The hemoglobin of a person who has both HbA and HbS does not form long rods and thus does not exhibit sickle-cell symptoms. Explain in terms of molecular interactions why the red blood cells of such a person are not deformed.

Question 3

In order for a substance to boil, the kinetic energy of the molecules must exceed the energy of the forces between the molecules. For each pair of compounds listed below, explain the difference in the boiling in terms of the intermolecular forces.

Compound	Boiling Point (°C)
methane (CH_4)	-161
methanol (H_3COH)	65
water (H_2O)	100
sodium chloride (NaCl)	1416
diamond*	decomposes without boiling (in vacuum)

*C_n: a covalently-bonded lattice

a) methane vs. methanol

b) methanol vs. water

c) water vs. sodium chloride

d) sodium chloride vs. diamond

Question 4

In the past thirteen months, NASA has successfully landed spacecraft on the planet Mars and on Titan, one of the moons of Saturn. One of the goals of each mission was to look for evidence of water. Different evidence of the past or present existence of water was found on both Mars and Titan. Neither Mars nor Titan has oxygen-containing atmosphere.

a) Scientists are not concerned with the absence of oxygen in the atmosphere, but instead view water as a sign of the possible existence of microbial life. Given what we know about the history of life on Earth, why is water regarded as a much more important sign of possible life than oxygen?

The evidence found on the surface of Mars is consistent with a number of scenarios. One is that the surface of the planet once contained oceans, rivers, and lakes. However, currently the atmosphere on Mars is too thin to allow these bodies of water to remain on the surface.

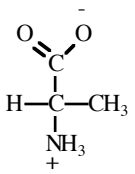
b) Assume that these bodies of water once contained living organisms. Provide two alternative hypotheses for how a planet might move from having a thick atmosphere over the surface with bodies of water containing living organisms to having a thin atmosphere over the dry surface with no detectable living organisms.

NASA scientists describe Titan as an extraordinary world where Earth-like geophysical processes operate on exotic materials in very alien conditions. Instead of liquid water, there is liquid methane (temperature on Titan is sub -170°C); instead of silicate rocks, there is frozen water ice; instead of dirt, there are hydrocarbon particles; and instead of lava, Titan's volcanoes spew very cold ice.

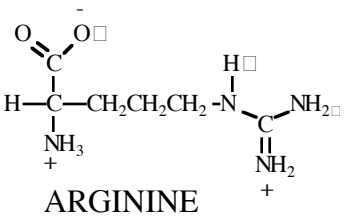
c) We have no idea what life on Titan might look like. However, if we are to find a living organism on Titan, it will have the following three properties:

d) Assume that life is found on Titan and that these organisms live in an environment where energy is freely available from abiotic sources. If in the future, the energy from abiotic sources becomes limiting, what feature would be common in the organisms that would survive and thrive during such a transition? Why?

STRUCTURES OF AMINO ACIDS
at pH 7.0



ALANINE
(ala)



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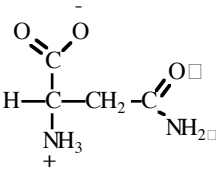
(arg)



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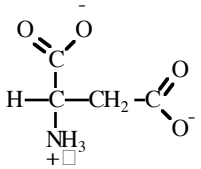
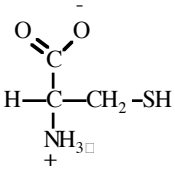
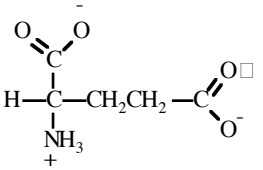
(asN)



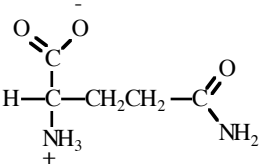
ASPARTIC ACID
(asp)



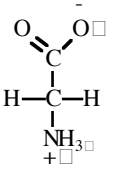
CYSTEINE
(cys)



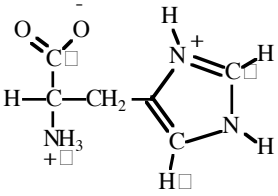
GLUTAMIC ACID
(glu)



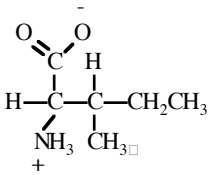
GLUTAMINE
(glN)



GLYCINE
(gly)



HISTIDINE
(his)



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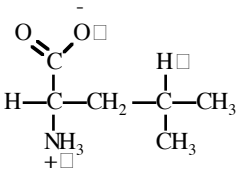
(ile)



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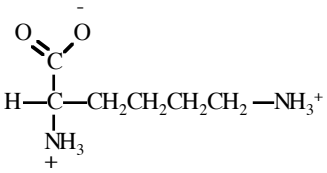
(leu)



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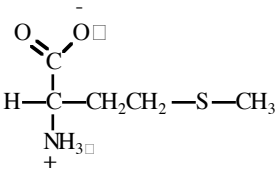
(lys)



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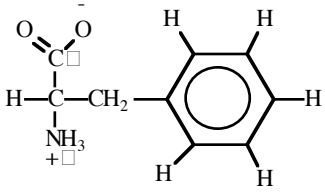
(met)



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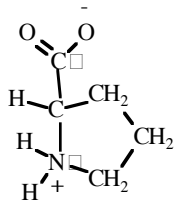
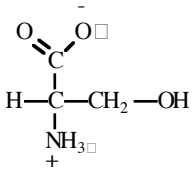


PROLINE
(pro)



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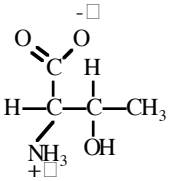
(ser)



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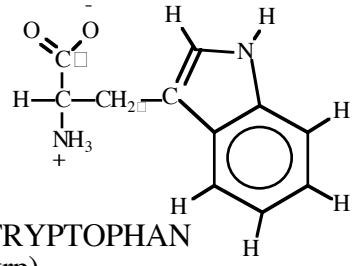
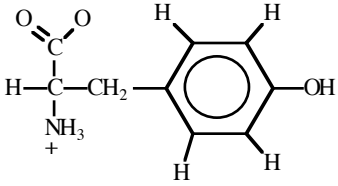


TRYPTOPHAN
(trp)



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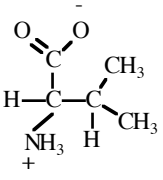
(tyr)



VALINE
(val)