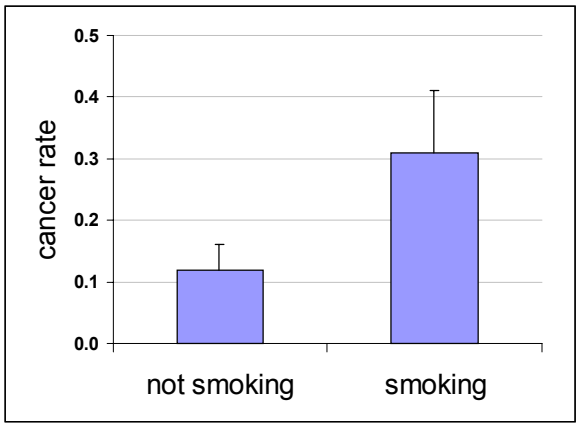
Part 1.

#1. Please state in a phrase what are the 3 major objectives of this course according to the syllabus?
objective #1 -
objective #2 -
objective #3 - 3 pts.

#2. The figure at right shows the data from an experimental study of smoking and lung cancer rate in rats. The control group ("not smoking") had a 0.12 rate of cancer and the experimental group ("smoking") had a cancer rate of 0.31, which is significantly higher.



(a). Is the conclusion that:

"smoking caused lung cancer in these rats"

VALID or NOT VALID

{circle your choice}

Please explain your choice: 2 pts.

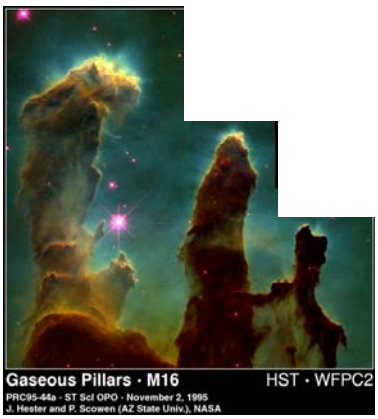
(b). In addition, briefly comment on the validity of the following extension of this conclusion:
"therefore, smoking causes lung cancer in humans"
2 pts.

#3. What kind of reasoning uses observations to create an hypothesis?
{circle your choice} ⟶ **deductive** or **inductive** 1 pt.

#4. Using what kind of reasoning does one predict the outcome of an experiment and thereby test an hypothesis?
{circle your choice} ⟶ **deductive** or **inductive** 1 pt.

#5. Briefly explain why life as we know it would most likely <u>never have evolved</u> on Earth if there had been an appreciable amount of oxygen in the atmosphere of the early earth?
2 pts

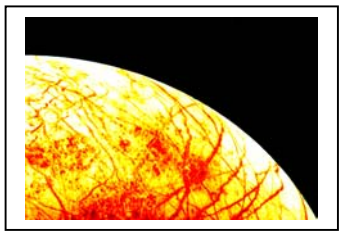
#6. Please briefly explain how these pillars of gas form and why new stars are "born" at the tops of these pillars?



2 pts.

#7. Please list four different gasses that were major components of the atmosphere of the early Earth.
1 – 2 – 3 – 4 – 2 pts.

#8. The figure at right depicts the surface of Jupiter's moon Europa. The moon has a veneer of ice beneath which is liquid water surrounding a geologically active rock and metal rich core.



Why is it the astronomers believe that life might be found on Europa? What conditions might be found there that are necessary for the evolution of life? Please list specific conditions.

2 pts

#9. What type of bond involves the sharing of valence electrons? _____ 1 pt.

#10. What type of bond involves the transfer of electrons among the reacting atoms or molecules? _____ 1 pt.

#11. What type of bond accounts for why wet surfaces cool as water evaporates? _____ 1 pt.

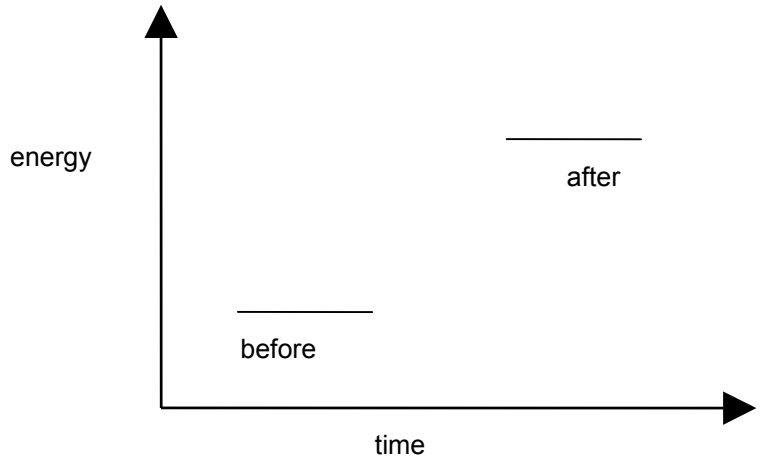
#12. What type of bond accounts for why polar molecules dissolve in water? _____ 1 pt.

#13. Please explain why do some molecules dissolve in water, whereas others do not?

3 pts

#14. Use the axes at right and sketch the reaction diagram for a typical synthesis reaction that has a high activation energy.

(1 pt)



#15. <u>Use a dotted line</u> and sketch on the same graph at right what the reaction diagram would look like if a catalyst were used.

(1 pt)

#16. How do catalysts work? Briefly describe how it is that catalysis (such as clay, metal surfaces, RNA or proteins) are able to cause chemical synthesis reactions (polymerizations) to occur. Please use a sketch to show a catalyst in action in your explanation.

3 pts

#17a. Please list below what are the four major categories of organic **monomers** that were spontaneously synthesized by lightning etc. on Earth:

#17b. Please list below what are the four major categories of organic **polymers** that were synthesized by catalysts (such as clay, iron pyrite, etc) from each of the four monomer types at left below (Note: each polymer below must correspond to its monomer at left)

1 – → 1 –

2 – → 2 –

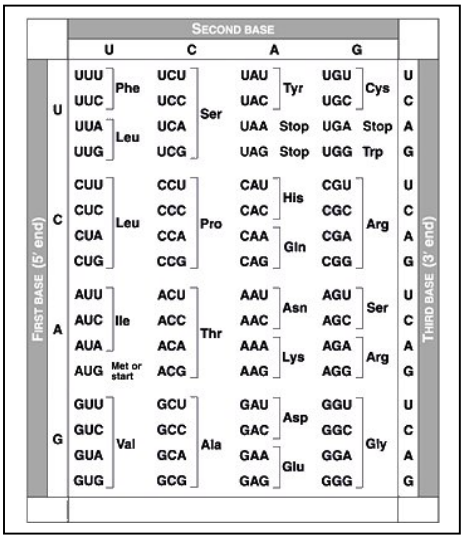
3 – → 3 –

4 – → 4 –

4 pts

The chart at right shows the abbreviated amino acid name corresponding to each of the possible combinations of nucleotide triplet codes used in protein synthesis.

Please refer this chart to answer the next several questions on protein synthesis.



#18. Exactly what happens if a code of UUA, UUG, CUU, or CUC is given?

2 pts.

#19. Exactly what happens if a code of UAA, UAG, or UGA is given?

2 pts.

#20. Please use the table above and write down what would be the corresponding amino acid sequence for the following sequence of nucleic acids:

2 pts

CUU UGG GGG UAA

#21. How many codons are present in this sequence? _____ 1 pt

#22. Please define the term "**gene**":

3 pts

#23. Please write down the basic chemical equation for photosynthesis:

2 pts.

_____ + _____ $\xrightarrow{\text{light}}$ _____ + _____

#24. Geologic evidence suggests that photosynthesis evolved approximately how many years ago? _____

1 pt.

#25. Please state what is the geologic evidence that suggests that photosynthesis evolved at the time that it did (hint: what is "banded iron")?

3 pts.

#26. Please write down the basic chemical equation for aerobic metabolism (anaerobic+aerobic):

2 pts.

_____ + _____ $\longrightarrow$ _____ + _____ + ATP

#27. Approximately how many ATP's are generated by the complete oxidation of one molecule of glucose? _____ 1 pt.

OPTIONAL EXTRA CREDIT Q. on the MARS WATER SEMINAR by David KLASSEN:
(note if you missed this seminar you may access David Klassen's web site {http://elvis.rowan.edu/~klassen/} and send me your answers to these questions via email – due Oct 20)

According to the seminar presentation by Dr. David Klassen:

(a) is there water on Mars? YES or NO

(b) in what form is most of the Martian water? LIQUID WATER or ICE

(c) has there ever been oceans of liquid water on Mars as there now is on Earth? YES or NO

(d) Please briefly speculate on the current thinking about life on Mars. If there is life on Mars, where would it most likely be found? {hint: where might there be any liquid water?}

Part 2.

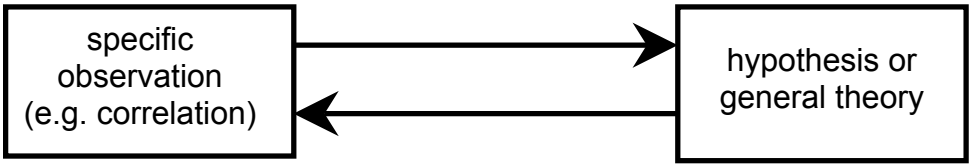
Question #1. This question will assess your understanding of the scientific method.

(a). List and briefly explain the principal steps of the "scientific method."

4 pts.

(b). Please **briefly** explain the key differences between Inductive and Deductive reasoning in the scientific method. In addition, please use the figure below to illustrate your explanation.

8 pts.



Question #2. This question will assess your understanding of the four challenges for the first life to evolve. (note: this entire page counts as one question)

(a) Please explain how the earliest cell membranes formed: (i) what were the principal molecules that comprised these membranes and (ii) how and where did these membranes most likely form?

3 pts

(b) Challenge #2. Please explain (i) what were the first energy and raw materials sources (monomers), (ii) how were these formed, and (iii) how did the earliest cells acquire these resources?

3 pts

(c) Challenge #3. Please explain (i) what was the basic metabolic process that arose in the earliest cells to generate energy for biosynthesis, (ii) what was the short term energy carrier, and (iii) how did the network of enzymes needed to start this metabolism originally get "into" this cell?

3 pts

(d) Challenge #4. Please explain (i) how the earliest cells reproduced, (ii) what was the "mechanism of inheritance" in these earliest of cells, and (iii) what was the guarantee that the daughters resembled the parental cells?

3 pts

Question #3. Please **briefly** explain the concept of natural selection. In general, how did natural selection lead to the evolution of improvements in cell function (e.g., metabolism, replication, etc.) of the earliest life forms? YOU MUST USE SOME SORT OF FIGURE or SKETCH in your answer.

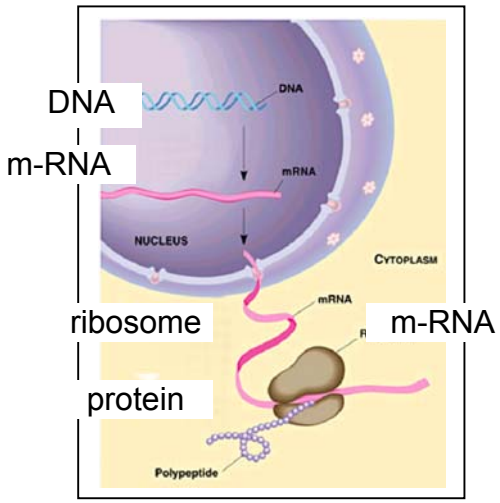
12 pts.

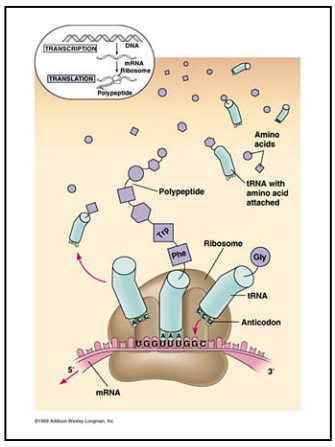
Question #4. This question will assess your understanding of the Central Dogma of Molecular Biology for protein synthesis.

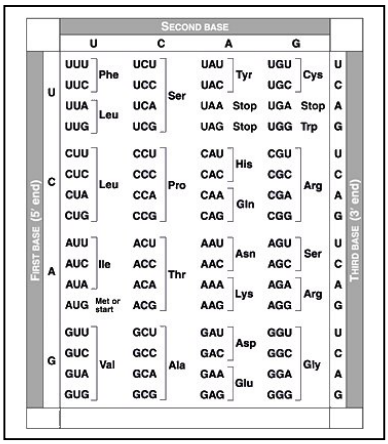
Please use the figures below and explain exactly how a single change in the sequence of nucleic acids on the DNA can affect the function of the protein for which that DNA encodes.

Note that you will have to use the following terms in your response:

amino acid, anti-codon, codon, DNA, gene, ribosome, protein, transcription, translation, m-RNA, t-RNA,

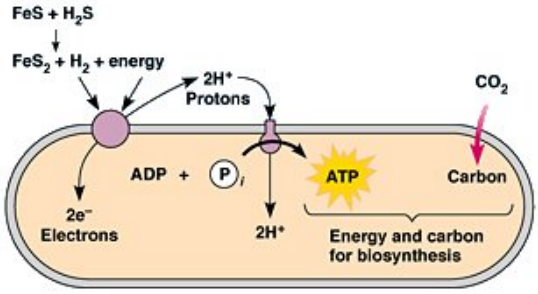






12 pts.

Question #5. One of the most important events in the origin of life is the origin of autotrophy. Most likely the first autotrophs were iron reducing bacteria near hydrothermal vents. For this question, please refer closely to the figure below and explain how the first chemoautotrophs functioned. What were the key structures, molecules, and functions of their metabolism that enabled them to synthesize their own food?



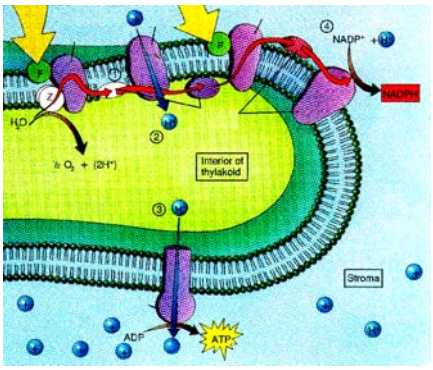
6 pts

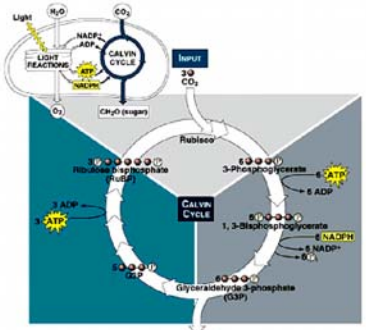
Please briefly explain how adaptations to resist ultraviolet to radiation by ancient chemoatuotrophic bacteria could have led to the evolution of photosynthesis around 2.5 billion years ago. Please note that you must use sketches in your explanation.

6 pts

Question #6. Please explain the key steps involved in photosynthesis. Your explanation should be brief and concise, should refer to the figures, and should use the following key words correctly:

ATP synthase, Calvin cycle, carbon fixation, chlorophyll, CO_2, cytochrome, electron transport chain, glucose, hydrolysis of water, light reactions, oxygen O_2, photosystems 1 and 2, proton pump, reaction center

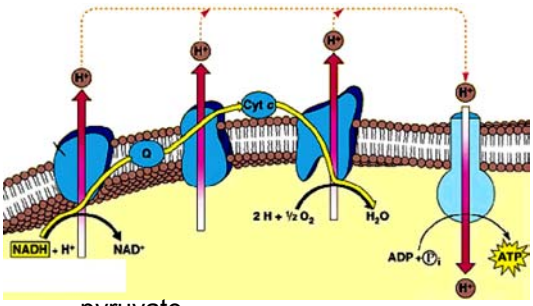




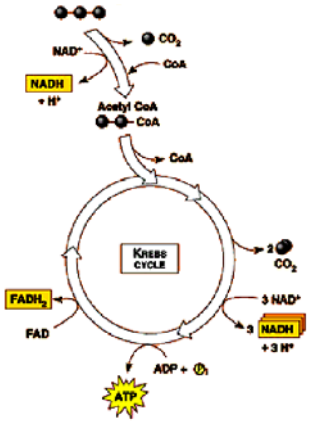
12 pts

Question #7. Please explain the key steps involved in aerobic respiration. Your explanation should be brief and concise, should refer to the figures, and should use the following key words correctly:

ATP synthase, CO_2, cytochrome, electron transport chain, glucose, glycolysis, Krebs cycle, formation of water, oxygen O_2, proton pump, pyruvate (see figures),



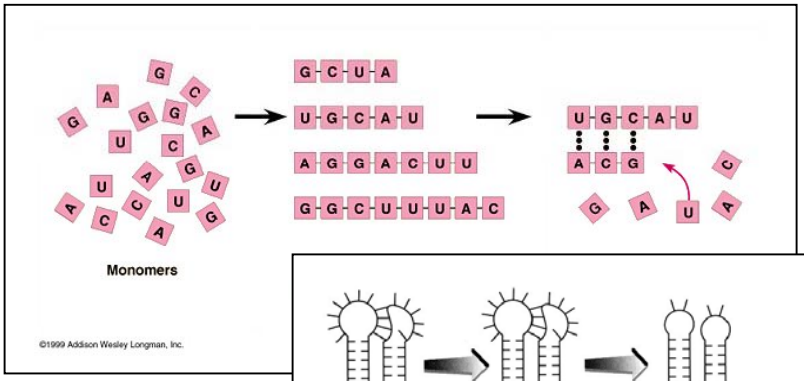
pyruvate



12 pts

Question #8. One of the most important events in the origin of life is the origin of the scheme of using DNA as the genetic blueprint that codes for all proteins that carry out all cell functions. Most likely, the first enzymes were RNA, not protein, however, this "primitive" method of cell metabolism was replaced by a DNA encoded and protein-based metabolic apparatus.

For this question, please refer closely to the figures at right and explain how this replacement of RNA enzymes occurred and how this led to the DNA based scheme that we see today.



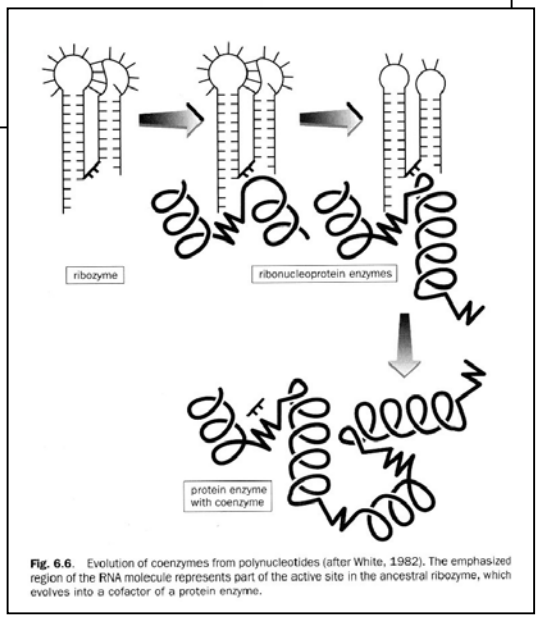
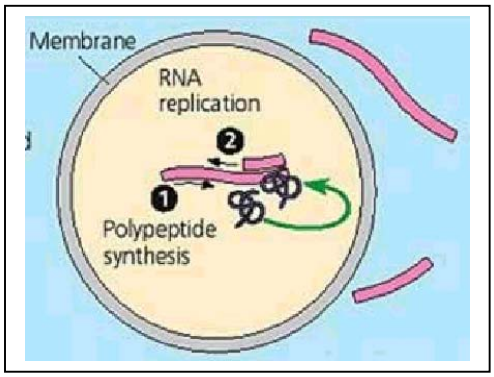
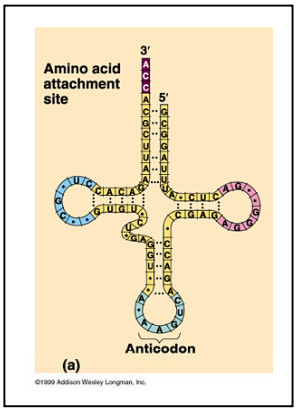


Fig. 6.6. Evolution of coenzymes from polynucleotides (after White, 1982). The emphasized region of the RNA molecule represents part of the active site in the ancestral ribozyme, which evolves into a cofactor of a protein enzyme.





12 pts