Part 1.

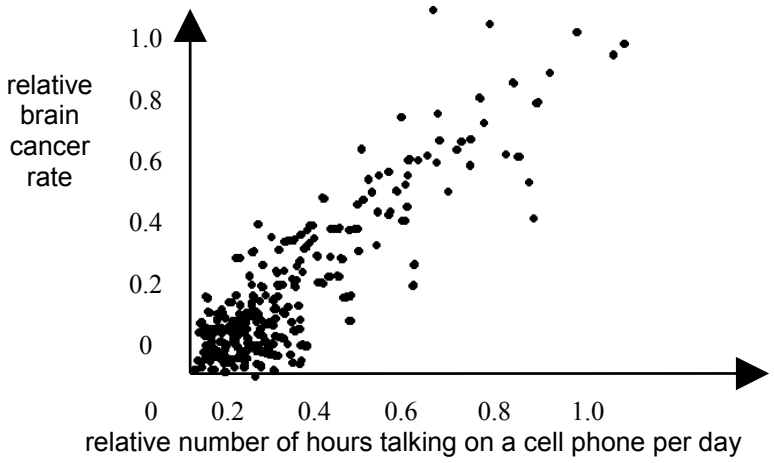
#1. Please state in a phrase what are the 2 major objectives of this course according to the syllabus? 2 pts.

objective #1 -

objective #2 -

#2. Although the use of cellular telephones has revolutionized the telecommunications industry, there is much concern that the strong electromagnetic fields that these phone generate pose a direct health risk to the brains of unsuspecting users.

In the figure at right appears a vague but statistically significant relationship between hours of cell phone use and the rate of brain cancer by cell phone users. What is your response to the newspaper reporter who said that this showed that cell phones cause brain cancer?



Is this conclusion ⟶ **VALID or NOT VALID** 2 pts.
{circle your choice}

#4. Currently, astronomers theorize that the Universe began with a "big bang" approximately how many years ago? _____ 1 pt.

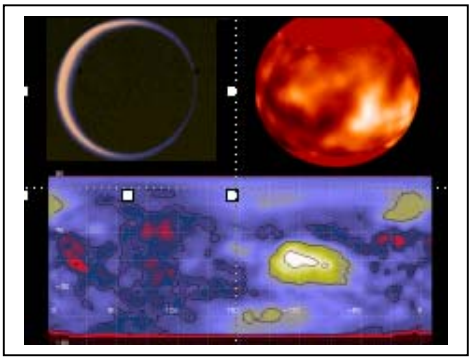
#5. **Where** were the atoms that make up most of our planet and most of our bodies originally formed? (hint: they were all formed starting with hydrogen) 1 pt.

#6. Please list four different gasses that were major components of the atmosphere of the early Earth.

1 – 2 – 3 – 4 – 2 pts.

#7. Evidence suggests that Saturn's moon Titan contains an atmosphere as well as aquatic and terrestrial habitats similar to the early Earth. Based upon your knowledge of why Europa has a liquid ocean beneath an ice veneer, what is the cause of the heating Titan's core, that accounts for its warm surface temperatures?

2 pts



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

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

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

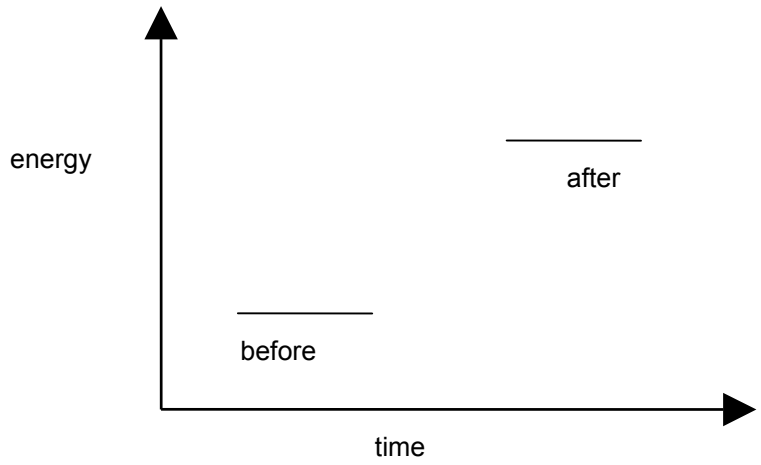
#11. Please briefly explain why are some covalent bonds are "polar" whereas others are "non-polar"? 2 pts.

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

(1 pt)

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

(1 pt)



#14. 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 of a catalyst catalyzing a reaction in your explanation.

4 pts

#15a. Please list below what are the four major categories of organic **monomers** that were spontaneously synthesized by lightning etc. on Earth:

1 –

2 –

3 –

4 –

#15b. 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 –

2 –

3 –

4 –

(4 pts)

#16. 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?

5 pts.

#17. *{Fill in the blanks}* The earliest method of cellular energy generation (i.e., "metabolism") involved the splitting of the simple carbohydrate named _____ to generate the short term energy carrier named _____. This basic metabolic pathway is found in all life today and is called _____.

3 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.

First base (5' end)	Second base: U	Second base: C	Second base: A	Second base: G	Third base (3' end)
U	UUU Phe	UCU Ser	UAU Tyr	UGU Cys	U
	UUC Phe	UCC Ser	UAC Tyr	UGC Cys	C
	UUA Leu	UCA Ser	UAA Stop	UGA Stop	A
	UUG Leu	UCG Ser	UAG Stop	UGG Trp	G
C	CUU Leu	CCU Pro	CAU His	CGU Arg	U
	CUC Leu	CCC Pro	CAC His	CGC Arg	C
	CUA Leu	CCA Pro	CAA Gln	CGA Arg	A
	CUG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	AUU Ile	ACU Thr	AAU Asn	AGU Ser	U
	AUC Ile	ACC Thr	AAC Asn	AGC Ser	C
	AUA Ile	ACA Thr	AAA Lys	AGA Arg	A
	AUG Met or start	ACG Thr	AAG Lys	AGG Arg	G
G	GUU Val	GCU Ala	GAU Asp	GGU Gly	U
	GUC Val	GCC Ala	GAC Asp	GGC Gly	C
	GUA Val	GCA Ala	GAA Glu	GGA Gly	A
	GUG Val	GCG Ala	GAG Glu	GGG Gly	G

#18. Exactly what happens if a code of GGU, GGC, GGA, or GGG is given?

2 pts.

#19. Please explain what a "codon" is and how it differs from an "anticodon"

#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

CAU AGC GGG UGA

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

2 pts.

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

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

1 pt.

#23. 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.

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

2 pts.

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

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

1 pt.

Part 2.

Question #1. This question will assess your understanding of the four challenges for the first life to evolve.

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

(3 pts)

(b) Please explain what were the first energy and raw materials sources (monomers), how were these formed, and how did the earliest cells acquire these resources?

(3 pts)

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

(3 pts)

(d) Please explain how the earliest cells reproduced. Please also explain what was the "mechanism of inheritance" in these earliest of cells, i.e. what was the guarantee that the daughters resembled the parental cells?

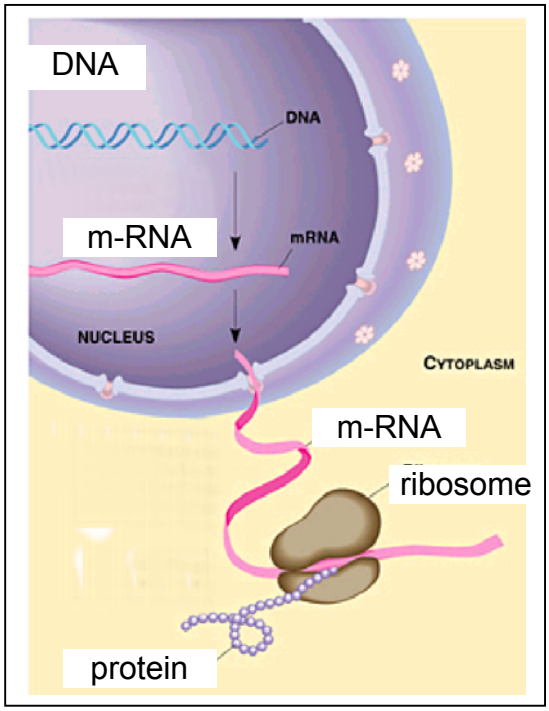
(3 pts)

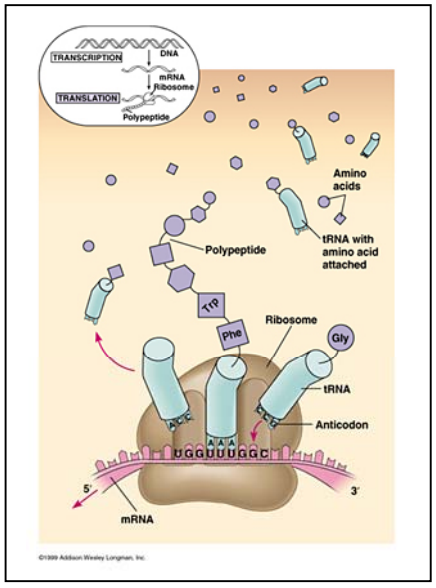
Question #2. Please briefly explain the key differences between Inductive and Deductive reasoning in the scientific method. Also, explain the relationships of these concepts to the concepts of correlation and causation. Lastly, you must use a figure to illustrate your explanation.

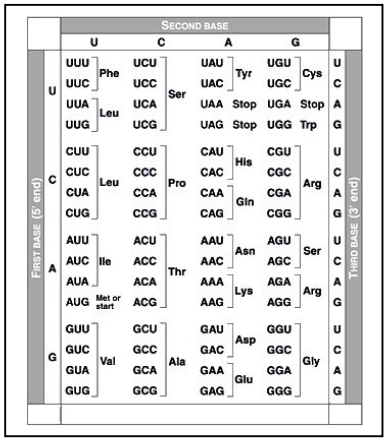
12 pts.

Question #3. This question will assess your understanding of the Central Dogma of Molecular Biology for protein synthesis.

Please use the figures below and explain the steps involved in "transcription" and "translation". Please use the terms DNA, m-RNA, t-RNA, ribosome, codon, anti-codon, gene, amino acid, protein, and other relevant terms in your response.

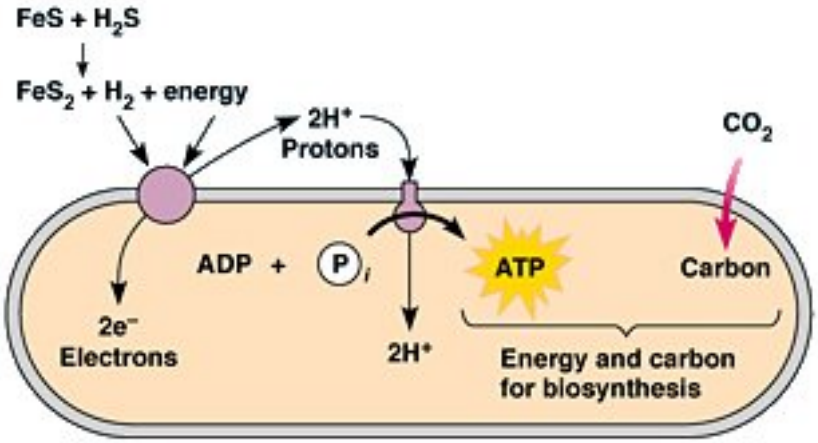






12 pts.

Question #4. One of the most important events in the origin of life is the origin of autotrophy. Most likely the first autotrophs were iron reducng 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?

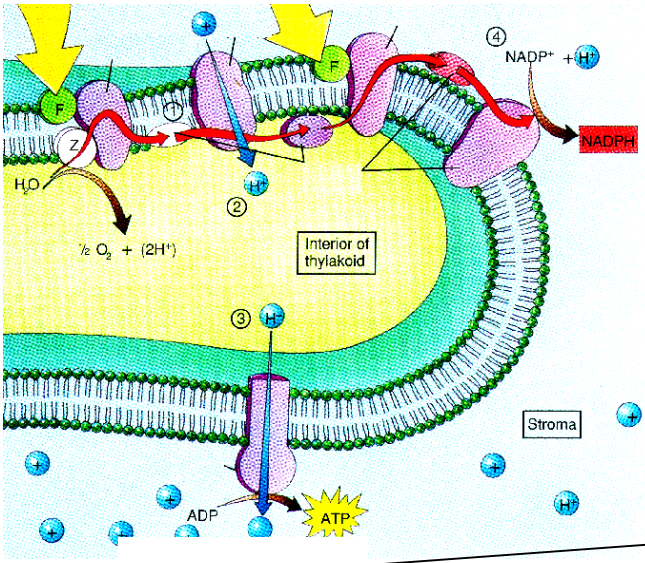


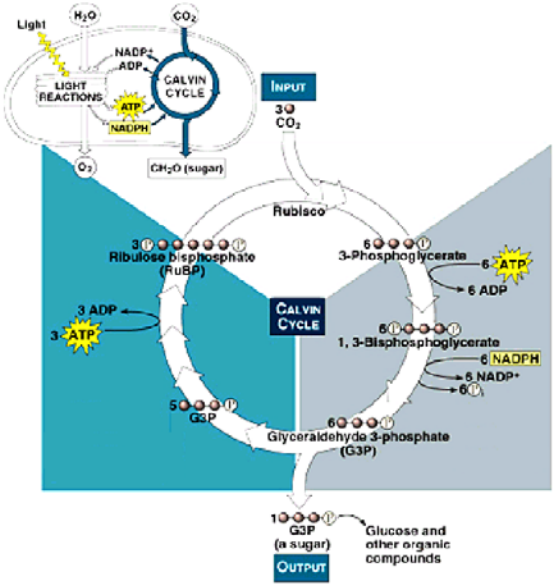
6 pts

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.

Question #5. 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, chloroplast, CO_2, cytochrome, electron transport chain, glucose, hydrolysis of water, light reactions, oxygen O_2, photosystems 1 and 2, proton pump, reaction center

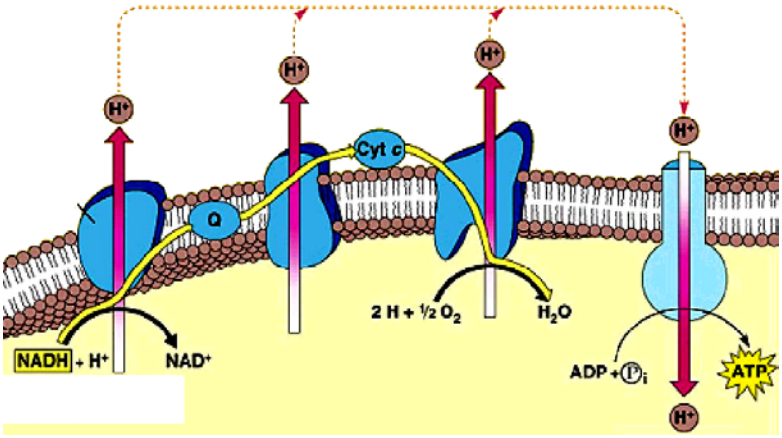




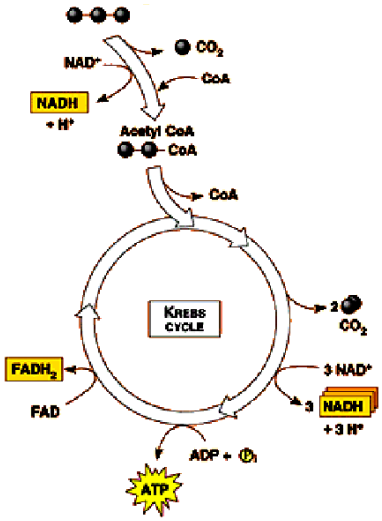
12 pts

Question #6. 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, mitochondria, oxygen O_2, proton pump, pyruvate (see figures),



pyruvate



12 pts

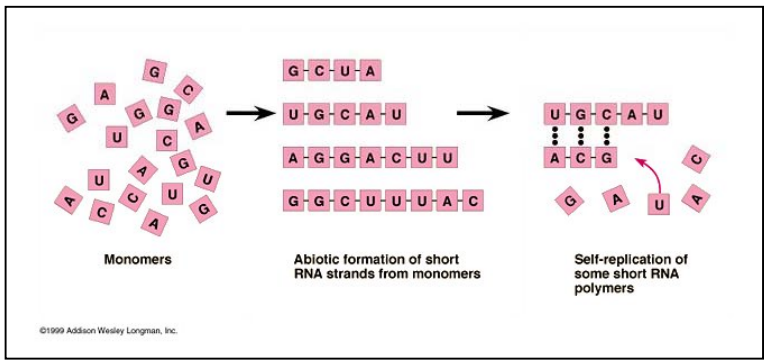
Question #7. After the first photosynthetic cells began to crank out oxygen from photosynthesis, oxygen began to accumulate in the atmosphere – much to the peril of all surface life. Please explain how adaptations to resist the toxic oxidizing effects of oxygen by living cells could have led to the evolution of aerobic respiration around 2 billion years ago. Please note that you must use sketches in your explanation.

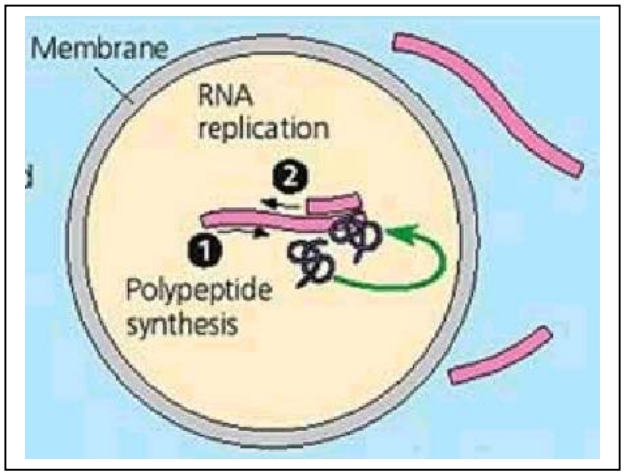
6 pts

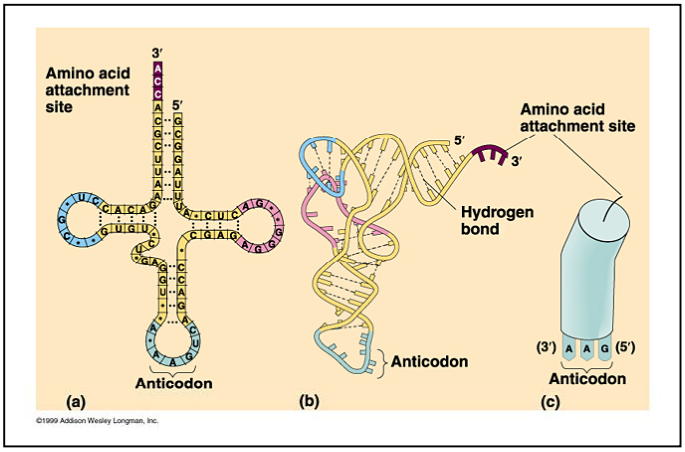
Please explain what were the principal structures, molecules, and functions of the first photosynthetic organisms that were retained and modified in the first organisms in whom aerobic respiration first evolved? Please refer to specific evidence depicted in the previous figures.

6 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.







Question #9. The fact that phospholipids form the cell membranes of all living organisms on Earth today is powerful evidence that all life presently inhabiting Earth derived from the same bacterial cell line that originated and evolved between 4.5 and 3.5 billion years ago.

Please describe important details of at least 3 other major lines of evidence (i.e. specific features of cell structure or function that solve the challenges to the origin of life) that indicate that <u>all life on Earth</u> shares a common ancestry. (Major hint: what are the specific solutions from Question #1)

1 – 4 pts
2 – 4 pts
3 – 4 pts