

Part 1.

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

objective #1 -

2 pts.

objective #2 -

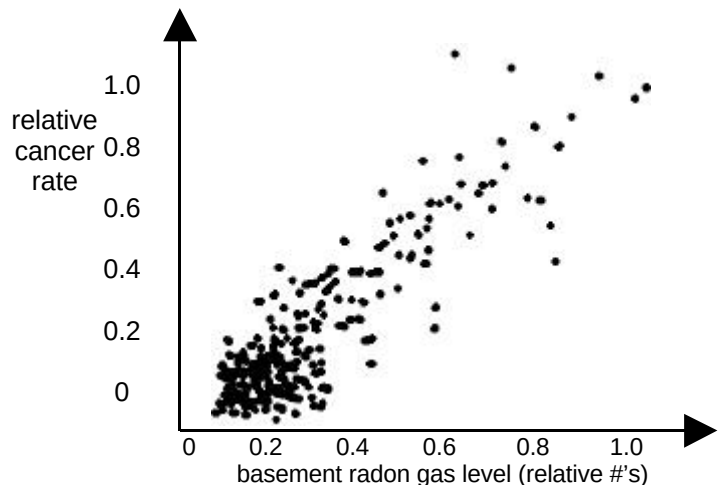
#2. List and briefly explain the principal steps of the “scientific method.”

3 pts.

#3. Radon gas is a radioactive natural byproduct of the decay of uranium oxide found in granitic rocks that often underlie, if not comprise, home foundations in Pennsylvania. Thus, as uranium decays, radon gas is released into the soil and then leaks into and accumulates in poorly ventialed basements. Since radon is also radioactive, it is by definition a potential carcinogen..

In the figure at right appears a typical relationship one might find between basement radon gas levels and the lung cancer rate of longtime homeowners in PA.

What is your response to the newspaper reporter who said that **“this graph shows that radon gas caused these cancers”**?



Is this conclusion $\longrightarrow$
{circle your choice}

VALID

or

NOT VALID

1 pt.

#4. What kind of reasoning uses observations to create an hypothesis?

{circle your choice} $\longrightarrow$

deductive

or

inductive

1 pt.

#5. Using what kind of reasoning does one predict the outcome of an experiment and thereby test an hypothesis?

{circle your choice} $\longrightarrow$

deductive

or

inductive

1 pt.

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

2 pts

#7. 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.

What is the cause of this heating of Europa's core, i.e. why is it geologically active? Please briefly explain. 2 pts



#8. 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 briefly explain.

2 pts

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

1 pt.

#10. What type of bond involves the sharing of valence electrons? _____

1 pt.

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

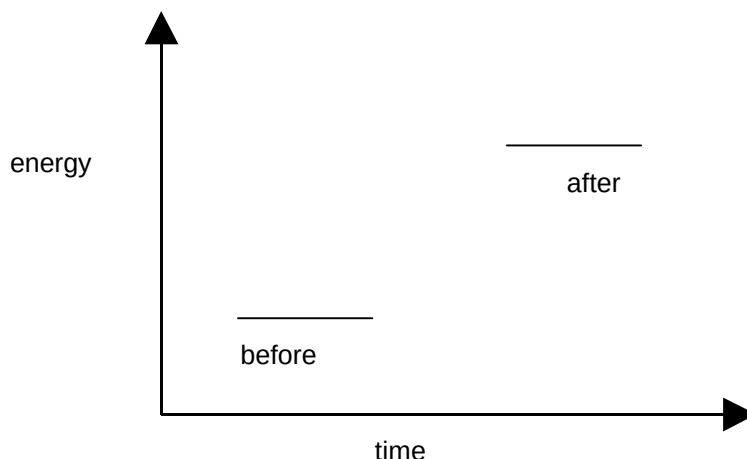
1 pt.

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

1 pt.

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

(1 pt)



#14. 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)

#15. What exactly do catalysts do? Briefly describe how it is that catalysis are able to cause reactions to occur with a much lower “energy of activation.” Please use a sketch of a catalyst catalyzing a reaction of compounds “A” + “B” in your explanation.

2 pts

#16. Please list one inorganic (mineral) and one organic means for synthesizing large complex organic polymers PRIOR to the evolution of life

inorganic source –

1 pt

organic source –

1 pt

#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.

#18. 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?

4 pts.

#19. Please list the four major categories of organic molecules used by all living organisms today and state what are the basic “monomers” of which each is comprised.

major categories of organic moleculesmonomers

4 pts.

1 -

comprised of:

2 -

comprised of:

3 -

comprised of:

4 -

comprised of:

#20. Please define the term “**gene**”:

1 pt

#21. Please diagram and briefly 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.

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.

#22. Exactly what happens if a code of UAA, UAG, or UGA is given? Please include necessary details.

2 pts.

#23. Consider the following DNA sequence:

TAC GCC GCT ATT

How many codons are present in this sequence? _____

0.5 pts

Which of the following is the transcribed mRNA sequence? {circle one}

1.5 pts

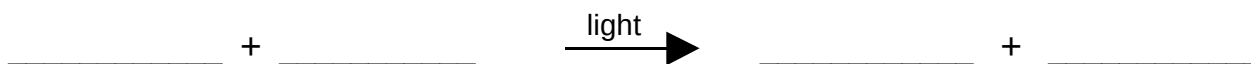
- (a). **TAC GCC GCT ATT**
- (b). **AUG CGG CGA UAA**
- (c). **ATG CGG CGA TAA**
- (d). **GAG CAT AAT ACN**

Please use the table above and write down what would be the corresponding amino acid sequence for the sequence of nucleic acids you selected above

2 pts

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

2 pts.



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

2 pts.



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

1 pt.

		SECOND BASE				
		U	C	A	G	
FIRST BASE (5' end)	U	UUU Phe	UUC Ser	UAU Tyr	UGU Cys	U
	C	UUC Phe	UCC Ser	UAC Tyr	UGC Cys	C
	A	UUA Leu	UCA Ser	UAA Stop	UGA Stop	A
	G	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	AUU Ile	AGU Ser	U	
	AUC Ile	ACC Thr	AUA Ile	AGC Ser	C	
	AUA Ile	ACA Thr	AAA Lys	AGA Arg	A	
	AUG Met 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	

OPTIONAL EXTRA CREDIT QUESTION:

EX#1. According to the seminar by Dr. Randy Morgan on the natural history, conservation ecology, and efforts to educate the public about ants,

(a). write down one specific and interesting thing you remember from the talk about “bullet ants”:

5 pts

(b). which is more dominant on Earth in terms of numbers of species, total biomass, and effects on global soil ecosystem processes: tiny eusocial insects or all other animals combined?

3 pts

Part 2.

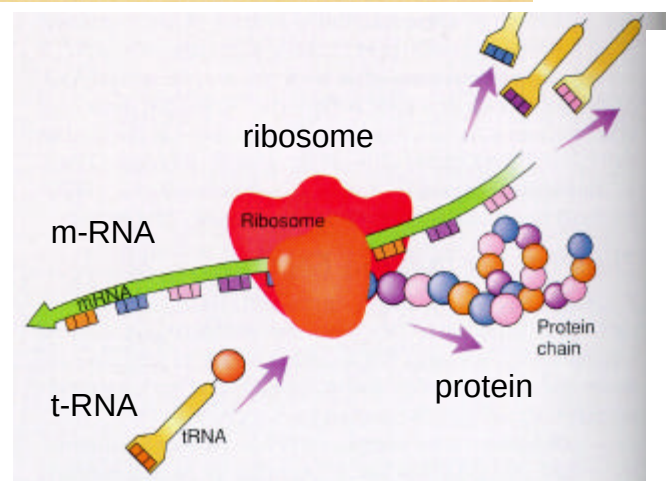
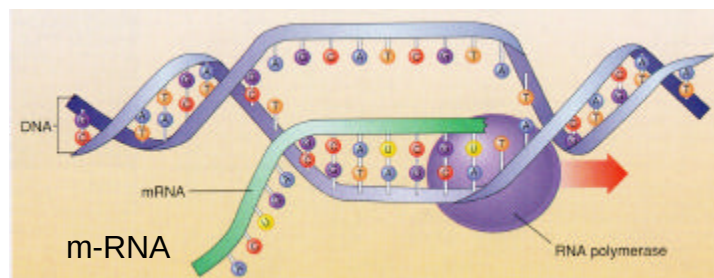
Question #1. This question will assess your understanding of the four challenges for the first life to evolve. (note: this entire page counts as one question)

- 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? (2.5 pts)
- 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? (2.5 pts)
- 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? (2.5 pts)
- 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? (2.5 pts)

Question #2. This question will assess your understanding of the Central Dogma of Molecular Biology, which is that genes on the DNA code for all of the proteins used to carry out cellular functions.

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.

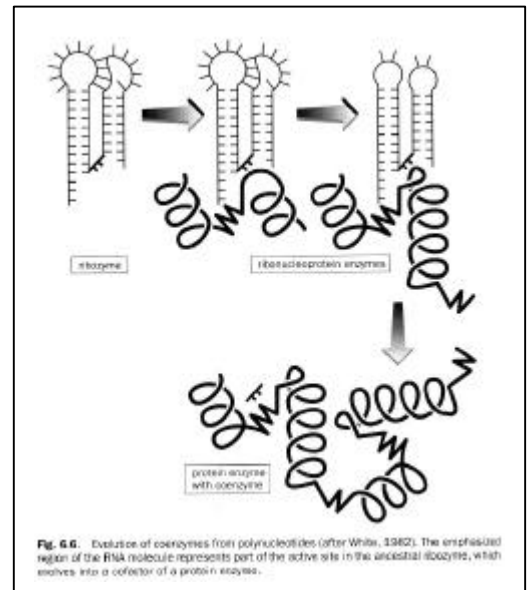
		SECOND BASE					
		U	C	A	G		
FIRST BASE (5' end)	U	UUU Phe	UCU Ser	UAU Tyr	UGU Cys	U	
	U	UUC Phe	UCC Ser	UAC Tyr	UGC Cys	C	
	U	UUA Leu	UCA Ser	UAA Stop	UGA Stop	A	
	U	UUG Leu	UCG Ser	UAG Stop	UGG Trp	G	
C	C	CUU Leu	CCU Pro	CAU His	CGU Arg	U	
	C	CUC Leu	CCC Pro	CAC His	CGC Arg	C	
	C	CUA Leu	CCA Pro	CAA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



10 pts.

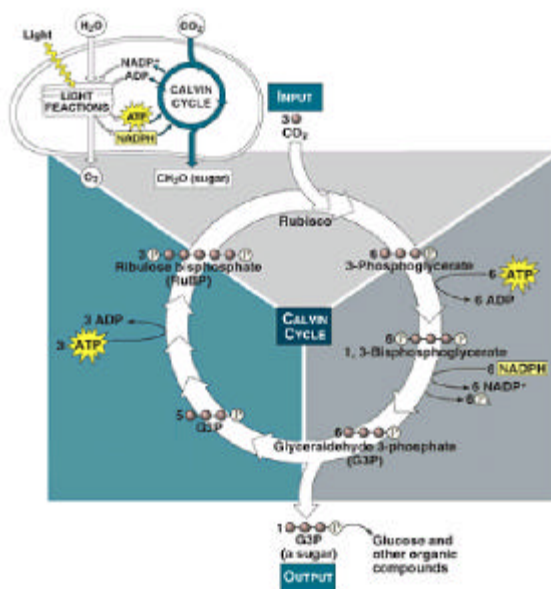
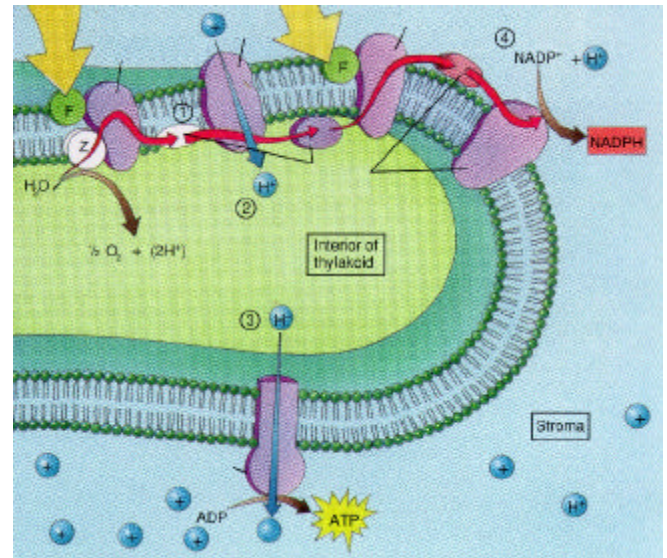
Question #3. One of the most important events in the origin of life is the origin of the scheme of using DNA as the genetic blueprint that codes for all proteins that carry out all cell functions. Most likely, the first enzymes were RNA, not protein, however, this "primitive" method of cell metabolism was replaced by a DNA encoded and protein-based metabolic apparatus. For this question, please refer closely to the figure at right and explain how this replacement of RNA enzymes occurred and how this led to the DNA based scheme that we see today.

10 pts



Question #4. 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:

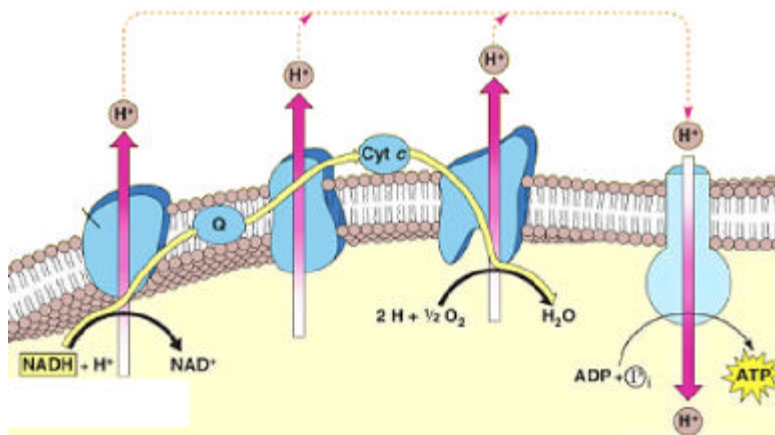
ATP synthase, Calvin cycle, carbon fixation, chlorophyll, chloroplast, CO_2 , cytochrome, electron transport chain, glucose, hydrolysis of water, light reactions, oxygen O_2 , photosystems 1 and 2, proton pump, reaction center



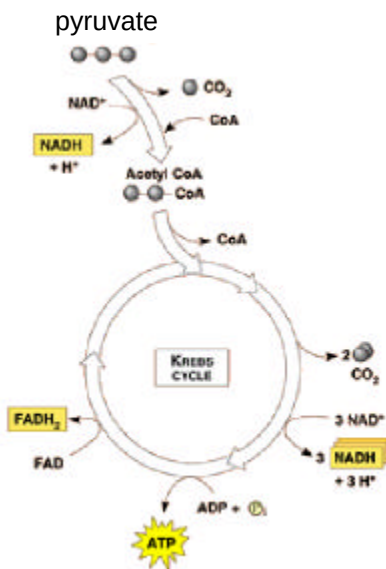
10 pts

Question #5. 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),

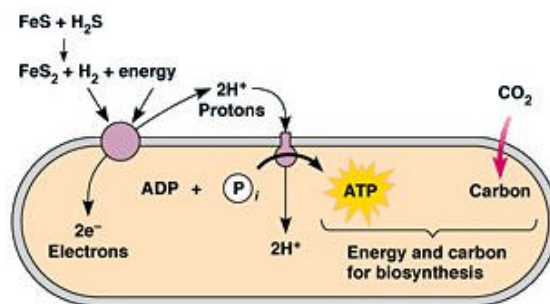


10 pts



Question #6. 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 explain what were the principal structures, molecules, and functions of these organisms that were retained in the organisms in whom photoautotrophy (photosynthesis) first evolved? Please refer to the figure above.

4 pts

Question #7. Please explain how adaptations to resist ultraviolet to radiation by ancient chemoautotrophic 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.

10 pts

Question #8. Please explain the endosymbiotic hypothesis for the origin of higher (eukaryotic) cells leading to animals, plants, and fungi from the available groups of prokaryotic bacteria. Please specifically identify the role of predation in the evolution of the earliest eukaryotes. You must use diagrams in your explanation.

6 pts

Please briefly explain at least one of the principal lines of evidence to support this hypothesis.

4 pts

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 all life on Earth shares a common ancestry.

1 –

4 pts

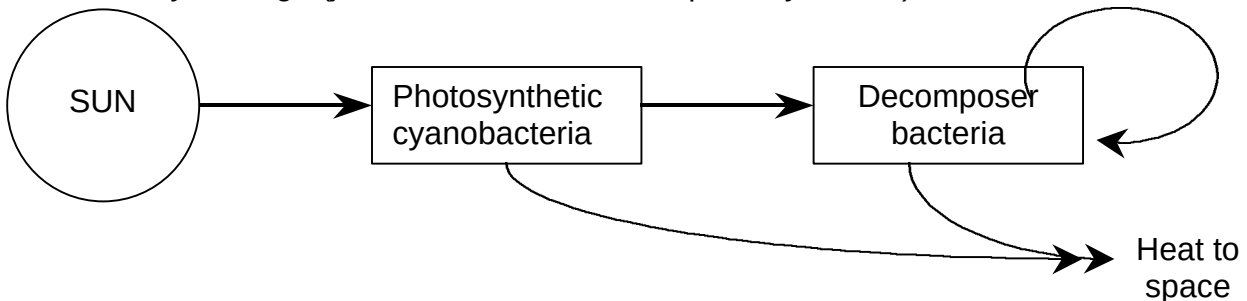
2 –

3 pts

3 –

3 pts

Question #10. Below is a basic ecosystem diagram for energy flow of the early earth at about 3.5 billion years ago (just after the evolution of photosynthesis).



(a). Please diagram the basic ecosystem diagram for energy flow of the present day.

6 pts

(b). Please briefly explain the role of “predation” in the evolution of biological and ecological diversity. How did the evolution of predation occur, and how did it lead to this increase in ecosystem complexity?

4pts

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