Recitation Section 13
March 28-29, 2005

Biogeochemical Cycles—Carbon and Energy Metabolism

A. Carbon and Energy Options

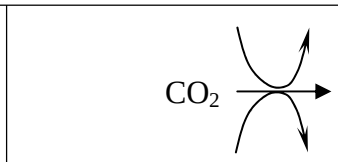
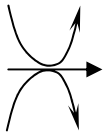
1. What two things are required by every organism for growth?

2. With respect to how organisms acquire organic carbon, we classify them into two groups. What are those groups?

3. What metabolic process is common to all organisms? What is the result of this process?

4. In addition to the process in 3, autotrophs also perform another function. What is it?

5. Fill in the table below with the various options for life we have encountered in 7.014. You need to indicate conditions and resulting processes, as well as the sources of carbon and electrons for each process.

B. Problem Solving

As an aspiring biogeochemist, you set out on an ambitious search for previously uncharacterized microorganisms. You go down to your local swamp and return with 3 different bacteria.

You're not sure what these bacteria need in order to grow, but since the swamp is pretty stinky you try growing them under anaerobic conditions in buffered water that has CO_2 and H_2S bubbled through it. You grow the three bacterial species in both the light and in the dark and observe the following.

	species #1	species #2	species #3
dark	grows	NO growth	NO growth
light	grows	grows	NO growth

1. From this data, you conclude that strain #1 is a chemosynthetic autotroph.

   i) What is the source of electrons for this metabolism?

   ii) What is the source of carbon for this metabolism?

2. What type of metabolism does strain #2 employ to make energy?

   i) What is the source of electrons for this metabolism?

   ii) What is the source of carbon for this metabolism?

3. You put strain #3 *together* with strain #1 under anaerobic conditions in water that has CO_2 and H_2S bubbled through it (the same conditions as above). Now both strain 1 and strain 3 grow in the light and in the dark.

   i) What type of metabolism used by strain #3?

   ii) In strain #3, what is the source of electrons for this metabolism?

   iii) In strain #3, what is the final electron acceptor for this metabolism?

4. Done with your experiment, you stop bubbling CO_2 and H_2S through the water after a day of growing species #1 and species #3 together. Surprisingly, both #1 and #3 continue growing indefinitely. Explain this observation.

In 1640 Jan Baptista van Helmont, a Flemish physician and chemist, carried out the following experiment about plant growth:

He took a pot of soil, and weighed the soil. He then took a willow sapling and weighed it. He planted the sapling and watered the plant for 5 years. After that time, he weighed the willow tree and he weighed the remaining soil. These were his observations:

	plant	**soil**
upon planting	5 lb	200 lb
5 years later	174 lb	
difference	**+169 lb**	

5. By how much do you suspect the weight of the soil decreased? Why?
   90% (180 lbs)
   85% (170 lbs)
   50% (100 lbs)
   10% (20 lbs)
   1% (2 lbs)
   0.1% (0.2 lbs)
   0.01% (0.02 lbs)

6. Bacteria that use O_2 as an electron acceptor in respiration produce more ATP per molecule of glucose than those that use NO_3^- as an electron acceptor. Explain why.