<u>**Example Exam Questions**</u>

1. Bacteriophage use bacterial surface molecules as receptors in order to initiate lytic or lysogenic infection.
   a. What advantage would using an integral outer membrane protein or an O-linked sugar residue in lipopolysaccharide have over using flagellin or pilin as a receptor for a bacteriophage that infects gram-negative bacteria?
   b. What would be an appropriate surface molecule to use as a receptor for bacteriophage that infect gram-positive bacteria?

2. The movement of an object in a fluid depends in part on the physical properties of the fluid, and in part on the dimension of the object in question.
   a. Give the mathematical expression of the Reynolds number (R). What are the units of R, and what does the number signify?
   b. State the approximate magnitude of R for microorganisms. What consequences does R have for possible mechanisms of microbial motility?

3. Motility is a well-studied area of microbiology, particularly because of its importance in microbial survival.
   a. Describe the fundamental components of the bacterial motility apparatus, where its parts are located relative to the cell, and the order and manner in which its parts are synthesized.
   b. Discuss the phenomena of how bacteria find nutrients. Describe how bacteria find areas of higher nutrient concentration (or less 'repellant'). Describe the bacterial cell components involved in chemotactic signaling, and the overall mechanism.

4. Derek Lovley and colleagues recently discovered anaerobic microbes that can transfer the electrons from acetate oxidation directly to a graphite electrode, and finally to oxygen, according to the scheme shown in the cartoon below:
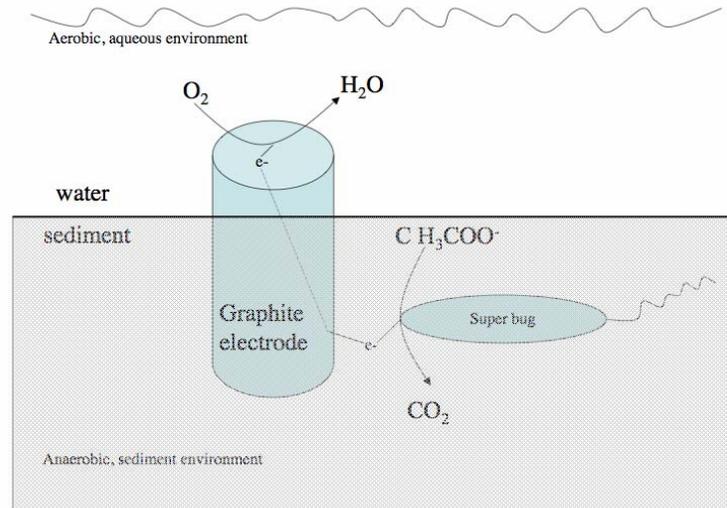
a. Calculate the ΔE_o' and ΔG_o' for the oxidation of acetate ($C H_3COO^-$) through the transfer to the electrode and finally to oxygen (assume there is no energy loss in the transfer through the electrode to O_2.). (Faraday constant, F = 96.5 kJ/Vmol)

b. Calculate ΔE_o' and ΔG_o' for the oxidation of acetate ($C H_3COO^-$), when it is coupled to the reduction of sulfate (SO_4^{2-}) to sulfide (HS-).

c. Assuming there is only a 5 % efficiency of electron transfer through the graphite electrode, what process yields more energy: Acetate oxidation coupled to sulfate reduction, or electron flow from acetate, through the graphite electrode to oxygen, as shown above ?

Table of standard reduction potentials E^o

			E_o' [Volts]
$CH_4 + 2 H_2O$	$\rightarrow$	$CO_2 + 8 H^+ + 8 e^-$	- 0.24
$C H_3COO^- + 2H_2O$	$\rightarrow$	$CO_2 + 7H^+ + 8e^-$	- 0.29
$CO + H_2O$	$\rightarrow$	$CO_2 + 2H^+ + 2e^-$	- 0.49
HS-	$\rightarrow$	$S^o + H^+ + 2e^-$	- 0.28
HS- $+ 4 H_2O$	$\rightarrow$	$SO_4^{2-} + 9H^+ + 8e^-$	- 0.22
HS- $+ 3 H_2O$	$\rightarrow$	$SO_3^{2-} + 7H^+ + 6e^-$	- 0.22
HS- $+ 3 H_2O$	$\rightarrow$	$SO_3 + 9H^+ + 8e^-$	- 0.12
$2 H_2O$	$\rightarrow$	$O_2 + 4H^+ + 4e^-$	+ 0.82