

I. (10 points, note that this question will be graded as number right -- number wrong) Which of the following processes could be carried out by a mutant bacterium which could not make heme groups? Circle them.

glycolysis
 fermentation
 aerobic respiration
 anaerobic respiration

aerobic photosynthesis
 cyclic photophosphorylation
 nitrogen fixation
 ATP production via bacteriorhodopsin

Which of the following processes yields energy? Circle them.

glycolysis
 fermentation
 aerobic respiration
 anaerobic respiration

aerobic photosynthesis
 cyclic photophosphorylation
 nitrogen fixation

II. (9 points) You isolate a mutant of your favorite bacterium which accumulates adenine in its cells. List 3 possible sites for this mutation and describe how to use the tests shown to distinguish between them.

site of mutation	synthesis of adenine by cell free extracts	accumulation of adenine in the mutant cell into which you introduce a plasmid carrying all of the wild type genes whose products are involved in adenine biosynthesis and its regulation

III. (10 points). You have available materials:

E. coli pAT1

E. coli pBR2

competent *E. coli*

competent *E. coli* pAT1

Erwinia carotovora

competent *E. carotovora*

E. carotovora pAT1

complex medium

minimal medium with glucose

Xgal

pectin

a stain for pectin

starch

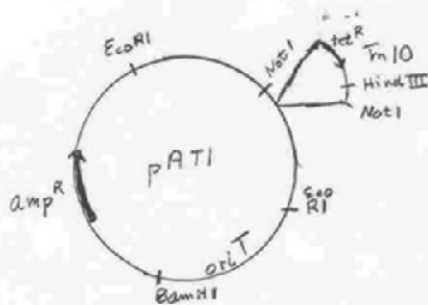
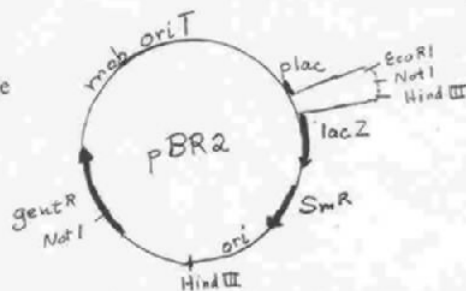
lignin

cellulose

a stain for cellulose

tetracycline, ampicillin, gentamycin, streptomycin

restriction enzymes and all other enzymes necessary to clone DNA



You wish to clone the gene which encodes the enzyme pectinase from *Erwinia* into *E. coli*. Fill in the steps in the protocol below:

1. Isolate plasmid DNA from _____ and digest it with _____.
 2. Isolate whole cell DNA from _____ and digest it with _____.
 3. Mix the products of #1 and #2 and add _____ (enzyme).
 4. Incubate overnight and _____ (process) the product into _____.
 5. Plate the resulting bacteria on _____.
 6. Identify those bacteria which contain the desired clone by _____
-
-
-

IV. (5 points) A colleague is carrying out experiments on the biochemistry of a marine alga and tells you that he knows that all of the activity that he is measuring is due to the alga and not to contaminating bacteria. He says that he knows that his algal cultures are bacteria-free since he took a sample of them and plated them on nutrient agar and nothing grew. Do you agree with him? Yes or no (circle one). If yes, why? If no, why not?

What different technique could he use to check for bacterial contamination in his cultures?

V. (6 points) You are a doctor practicing in North Carolina. It is a late summer afternoon. A patient comes in who has diarrhea and vomiting. The episode started about an hour ago. He has no fever and there is no blood in his stools. You ask him what he has eaten today and are told he skipped breakfast and went to a picnic for lunch where he ate tuna fish salad made with mayonnaise and home canned three bean salad. What is this disease likely to be? What organism caused it?

Do you treat this disease with antibiotics? yes or no (circle one)
Why or why not?

What is the most likely source of the disease?

VI. (15 points) Which of the following diseases could potentially be eradicated and what are the major reasons for your answer?

disease	Can this disease be eradicated? (yes or no)	List different major reasons for the ability or inability to eradicate the disease
rabies		1.
polio		1. 2. 3.
gonorrhoea		1. 2.
Lyme disease		1. 2.
plague		1. 2.

VII. (5 points) If *E. coli* K12(λ) is irradiated with UV light, phage λ is induced. In a *recA*⁻ mutant of *E. coli* K12(λ) UV light has no such effect. Why? (IE, describe the mechanism by which UV light causes the induction of λ phage).

VIII. (9 points) If you infected a cell with naked dsDNA from a virus, could the virus nucleic acid replicate?

Yes or no ? (circle one)

When intact dsDNA virus is used to infect cells what enzymes, if any, must this virus **encode** in order to multiply in the cell?

If you infected a cell with naked + strand RNA from a virus, could the virus nucleic acid replicate?

Yes or no ? (circle one)

When an intact + strand RNA virus is used to infect cells what enzymes, if any, must this virus **encode** in order to multiply in the cell?

If you infected a cell with naked - strand RNA from a virus, could the virus nucleic acid replicate?

Yes or no ? (circle one)

When an intact - strand RNA virus is used to infect cells what enzymes, if any, must this virus **encode** in order to multiply in the cell?

IX. (5 points) A friend who has a peach orchard in North Carolina says he read in the newspaper that the damage to his crop in the spring due to freezing is actually due to a bacterial infection. He is puzzled and asks if you can explain this to him.

What is your explanation?

X. (8 points) Fill in the following table with respect to the light reactions in bacterial oxygenic and anaerobic photosynthesis.

	oxygenic photosynthesis	anaerobic photosynthesis (noncyclic)
pigments used		
electron donor		
electron acceptor		
example of a prokaryote that carries out this reaction		

XI. (8 points) Fill in the table for the following reactions:

reaction	Is this reaction oxidation or reduction?	Why do organisms carry out this reaction?
$H_2S \rightarrow S$		
$NO_2 \rightarrow NO_3$		
$NO_3 \rightarrow NO_2$		
$N_2 \rightarrow NH_3$		

XII. (4 points) If you isolated an organism from a hot spring and wanted to tell if it was a eubacterium or an archaeobacterium what two **different** tests could you do (do not attempt to test for cell wall composition)?

1.

2.

XIII. (6 points) You are attempting to clean up an industrial waste site which contains chlorinated phenolic compounds. You wish to find bacteria to break down these xenobiotic compounds. A colleague suggests that you attempt to isolate pure cultures of bacteria which can grow on each of these compounds as a sole carbon and energy source.

Is this strategy likely to be effective? yes or no (circle one)

Why or why not?

--

XIV. (11 points) Fill in the following table with respect to the following symbiotic interactions.

symbiotic interaction	advantage to the bacteria	advantage to the eukaryote	modification of the biochemistry or physiology of the eukaryote involved in the symbiosis to accommodate the interaction	what organism is the primary producer in this ecosystem and what is the source of energy for the ecosystem
legume root nodules				
cow's rumen				XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX
tube worms in hydrothermal vents				

XV. (9 points) Fill in the following table showing some general characteristics of the three major groups of living organisms.

general characteristic	eubacteria	archaea	eukaryotes
presence of a nucleus			
cell wall structure			
some members can grow anaerobically			