

1. (8 points) You are given a sample of soil and wish to determine what bacteria are present in it.

A. What fraction of the bacterial species in nature would you expect to be able to grow in the lab? (Circle one)

- a. None b. Less than 10% c. About half d. Most of them

B. Describe how you could detect whether CO₂ fixation is occurring.

C. Describe how you could detect whether organisms are expressing genes for CO₂ fixation.

D. Describe how you could detect whether organisms that are capable of CO₂ fixation are present.

E. In an enrichment culture specific for *Thiobacillus*, Which of the following would you want to use for an electron donor? (Circle one)

- a. H₂ b. H₂S c. O₂ d. S₂O₃²⁻ e. NO₂⁻

2. (10 points) Fill in the following table using **yes** or **no** to indicate your answers.

compound	Can it be used as a source of energy?	Can it be used as an electron acceptor in anaerobic respiration?	Can it be used as a C source?
CH ₄			
CH ₃ OH			
Octane (C ₈ H ₁₈)			
SO ₄ ²⁻			XXXXX
H ₂ S			XXXXX
NO ₂ ⁻			XXXXX
Cellulose			
Nylon or dacron			
Benzoic acid			
hexachlorobenzene			

3. (4 points) You have been asked by a chemical company to study the breakdown of a new chemical, pollutane, in the environment. You add pollutane to a soil sample and after a few weeks determine that most of it has been broken down. You then attempt to isolate bacteria from the soil which will grow on pollutane as a carbon source. You are unsuccessful in this attempt. Suggest two different reasons why you might be able to find such an organism.

1.
2.

4. (6 points) For each of the following, enter “Yes” or “No” to indicate whether the process listed is a feature of nitrogen assimilation, nitrogen dissimilation, or both.

	nitrogen assimilation	nitrogen dissimilation
Reduction of NO ₃ ⁻		
Production of ammonia		
Production of nitrogen gas		
A form of anaerobic respiration		
Occurs in presence of oxygen		
Occurs in anoxic environments		

5. (12 points) Fill out the following for prokaryotes in the environments listed.

Environment	Metabolite provided to prokaryote by host	Metabolite provided to host by prokaryote	Environmental condition requiring adaptation in prokaryote	Alteration or specialization of host for prokaryote
Tubeworm at thermal vent				
Rumen of cow				1. Rumen 2.
Rhizosphere of legume				

6. (4 points) You are studying nitrogen fixation by root nodule bacteria. For each box below, indicate (by writing +, -, or n/c) whether N₂ fixation would increase, decrease, or be unchanged by the condition or mutation listed.

Condition	+, -, n/c
Mutation in legume reduces O ₂ affinity of hemoglobin	
Soil deficient in molybdenum	
Soil deficient in copper	
Grow in ammonia-enriched soil	

7. (8 points)

(A.) Name 2 light harvesting pigments that are used in bacterial photosynthesis:

(B.) Fill in the following table:

	Original electron donor	Final Acceptor
Aerobic conditions		
Anaerobic conditions (cyclic)		
Anaerobic conditions (non-cyclic)		

8. (7 points) One weekend you are visiting a friend whose family owns a peach orchard. You tell him that you learned in your microbiology class that freezing injury to the blossoms in the spring is often due to a bacterial disease. He asks you how this can be so. Give your reply below. Be succinct and straight forward, but be sure to include the important points. Include the type of bacteria which cause the disease, the disease mechanism, and the benefit to the bacteria.

How can this disease be prevented?

9. A. (2 points) List 2 major routes of transmission of plant diseases.

1.

2.

B. (4 points) Why is it true of many infectious diseases that the most severe forms of the disease and its complications are most common in the very young and the very old?

C. (4 points) What is the difference between polio and influenza which is responsible for the fact that the same vaccine used in 1960 is still effective against polio while we need a different vaccine for influenza each year?

10. (6 points) Binding of EHEC to alfalfa sprouts via a variety of adhesins is inducible by plant extracts. The method by which the synthesis of these adhesins is regulated is not known. Suppose that they are regulated by a two component system, *binD* and *binF* (where BinD is the sensor and BinF is a DNA binding protein) and that adhesins are only synthesized in response to the presence of plant extracts.

Fill out the following table indicating the expected phenotypes of the various mutants.

Bacterial mutant	Phenotype . Indicate no binding, no change, or increased binding.
EHEC <i>binD</i> ⁻	
EHEC BinD, change the histidine which is phosphorylated to alanine	
EHEC BinF, permanently in a configuration that looks like the shape of the phosphorylated form of BinF	

11. A. (3 points) You are a doctor in rural North Carolina. It is a warm day in mid-summer. Your first patient is a little girl who has just returned from a weekend camping trip with the Girl Scouts. She has a fever and red spots on her hands and feet. What disease do you suspect she has?

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How do you treat this disease? Be specific.

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B. (4 points) Your second patient is a young man who attended a picnic yesterday. He has diarrhea. He recalls eating chicken salad, three bean salad, barbeque, hamburger with lettuce and tomato (he likes his hamburgers rare), coleslaw, and banana pudding. List three **different (not the same species of organism)** possible causes of his illness.

Causative agent
1.
2.
3.

What public health measures should you take, if any?

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C. (4 points) Next you receive a call from a patient on extended camping vacation in Connecticut. Your patient is concerned over developing a skin rash. Prior to receiving any other information about symptoms you think of two possible diseases, list them below: (the patient has assured you that it is NOT poison ivy)

1. _____
2. _____

You inquire about the rash further. Your patient seems to think he has had an allergic reaction to a tick bite as the rash presented as a circular lesion on his leg surrounding the place from which he removed a small tick. At this point you think it likely that he has

Tests confirm that your suspicion was true. Should you treat him with antibiotics (circle one): Yes / No

12. (5 points) Fill out the following indicating the type of plaques (clear, cloudy, or none) which would be formed if λ of the indicated genotype infected the strains of *E. coli* shown. The genetic map of λ is given below.

P_R *cro* t_{R1} CII t_{R2} Q t_{R3} P_{Rlate} SR...A...

xis att int CIII t_{L1} N P_L CI P_{RM} P_{RE}

λ genotype	bacterial host	
	<i>E. coli</i> K12 (-)	<i>E. coli</i> K12 (λ)
wild type		
P_R no longer binds CI		
CII mutant		
P_{RM} replaced with P_{arg} and the cells are grown on minimal medium		XXXXXX
P_R replaced with P_{arg} and the cells are grown on minimal medium		

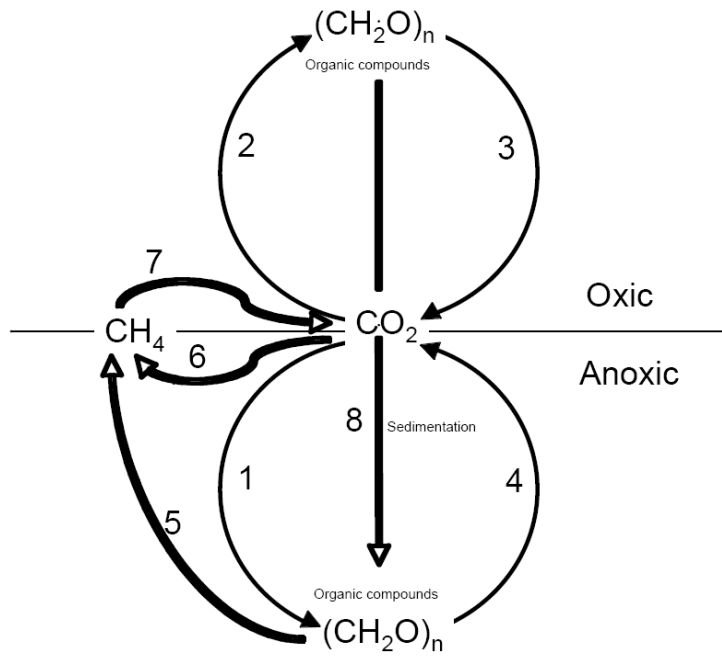
13. (8 points) You find that you can only detect active enzymes for the breakdown of the unusual carbon source nopaline in cell-free extracts of *Agrobacterium* when the bacterium has been grown on nopaline. Suggest two possible mechanisms for this regulation of the enzymes.

1.

2.

Pick one of your possible mechanisms (state clearly which 1 or 2) and describe how you would test to see if it was correct. Note you may assume that *Agrobacterium* has a sequenced genome but the functions of about 25% of the genes are unknown. The genes for nopaline catabolism have been identified.

14. (11 points) Below is a diagram of the carbon cycle.



For each of the questions below, list (by numbers 1-8 shown above) all the paths which fit the description.

- A. Includes anaerobic respiration _____
- B. Performed by methanotrophs _____
- C. Performed by some eukaryotes _____
- D. Requires some type of chlorophyll _____
- E. Can be performed by archaea _____
- F. Performed only by archaea _____
- G. Includes the dark reaction of photosynthesis _____
- H. Carried out by organisms in the top layer of a microbial mat _____
- I. Carried out by organisms in the middle layer of a microbial mat _____
- J. Carried out by organisms in the bottom layer of a microbial mat _____
- K. Which came earlier in geological time, 1 or 2? _____

15. (10 points) Fill out the table below, with **yes or no**, **specific naming** (as indicated) or denoting that it is not applicable (**n/a**).

	Eubacteria	Archaeobacteria	Eukaryote chloroplast and mitochondria	Eukaryote nucleus and cytoplasm
Genes can be arranged into operons (y/n)				
Composition of the plasma membrane (name)				
Has introns in many genes (y/n)				
May be susceptible to penicillin (y/n)				
This group contains anaerobic organisms (y/n)				
Vulnerable to streptomycin (y/n)				
Has a nucleus (y/n)				
Presence of histones? (y/n)				
Some members can obtain energy from converting N ₂ to NH ₃ (y/n)				
Some members can use energy from light (y/n)				

We have enjoyed teaching you this semester. We hope you have a good holiday and wish you success in your future endeavors.