

I. (8 points) Fill in the following table regarding the growth of prokaryotes (if the answer is none, state none).

medium and organism	energy source	final electron acceptor
minimal medium, glucose, aerobic, <i>E. coli</i>		
minimal medium, glucose, anaerobic, <i>E. coli</i>		
minimal medium, CH ₃ OH, anaerobic, archaeal species		
minimal medium, NO ₃ ⁻ , H ₂ S ₂ O ₃ , aerobic, <i>Thiobacillus species</i>		

II. (8 points) Fill in the following with respect to the regulation of the levels of the amino acid tryptophan in cells.

TrpA is the first enzyme in the pathway for the biosynthesis of tryptophan.

Is *trpA* expressed when wild type cells are grown in medium containing tryptophan?

_____ Name four **different** mutations (at different sites in the DNA) which could result in the overproduction of tryptophan when cells are grown in the presence of excess tryptophan?

1. _____
2. _____
3. _____
4. _____

If the region upstream of the ATG for *trpE* (the first gene in the operon) is deleted and replaced by the maltose promoter under what conditions will tryptophan biosynthetic enzymes be made? _____

If it is replaced by lambda P_R under what conditions will tryptophan biosynthetic enzymes be made? _____

If the promoter is replaced by lambda P_R in *E. coli* K12 (λ) under what conditions will tryptophan biosynthetic enzymes be made? _____

III. (11 points) You wish to clone a gene for the synthesis of an antifungal antibiotic into *E. coli* from the actinomycete (a eubacterium) which makes it. In order to do this you have available the following:

wild type *E. coli*

the antibiotic-producing actinomycete (APA)

competent trp^- *E. coli*

the plasmid shown (mypal)

dogs

rabbits

fungus which is sensitive to the antibiotic (sf)

fungus which is resistant to the antibiotic (rf)

all necessary enzymes and biochemicals

all necessary media including fungal medium, minimal medium, Luria broth, and agar for growing *E. coli*,

streptomycin, ampicillin, neomycin, X-gal

Fill in the following protocol.

1. Isolate _____ from _____.
 2. Digest it with _____. Do a partial or complete (circle one) digestion.
 3. Digest _____ with _____. Do a complete digestion.
 4. Mix the products of 2 and 3 together and add _____.
 5. Introduce the product of 4 into _____ by _____.
 6. Plate the bacteria on _____ medium containing _____.
 7. Keep those colonies which are _____.
 8. Identify the clone you want by _____.
- _____.

You are unable to obtain the clone you want using this procedure. You know the cloning reactions worked as you are able to obtain trp^+ *E. coli* from the colonies obtained.

Give 2 possible reasons why the experiment might have failed.

1. _____

2. _____

IV. (8 points) You are studying gene regulation in human pathogenic *E. coli*. You find a large number of genes whose expression level is changed when the bacteria are grown in the presence of mammalian cells compared to the same medium without the mammalian cells. You suspect that the expression of some of these genes may be controlled by global regulators. Fill in the following for two **different types** of global regulators which might be involved.

Type of global regulator	Name a gene which encodes this type of regulator	Would you expect this regulator to have enzymatic activity? yes or no If yes, what?	Would you expect this type of regulator to bind to any macromolecules? yes or no If yes, which?

V. (12 points) You are a doctor in family practice. A patient comes in who is very ill with a cough and respiratory infection. When you listen to his lungs with your stethoscope you hear signs of congestion (fluid in the lungs). Name 3 different kinds of organisms which could be responsible for this illness.

1. _____

2. _____

3. _____

How would you treat each of these diseases?

1. _____

2. _____

3. _____

Your next patient has nausea and considerable diarrhea. Name 2 different kinds of organisms which could cause these symptoms.

1. _____

2. _____

List the principle virulence factor and its mechanism of action for each of these organisms.

1.

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2.

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VI.(5 points) Use the following list to answer the questions which follow:

Cell types

1. B cells
2. T cells
3. Plasma cells
4. Dendrites
5. Killer T cells
6. Mast cells
7. Helper T cells
8. Memory cells

Molecules

- A. IgA
- B. IgD
- C. IgE
- D. IgG
- E. IgM
- F. cytokines
- G. substances released by mast cells

When you respond to a primary immunization with tetanus toxoid which cells and molecules are involved? _____

When you respond to your booster shot some months later which cells and molecules are involved? _____

Which cells and molecules would you wish to stimulate to elevate resistance to an upper respiratory infection? _____

Which cells and molecules would you want to stimulate to increase resistance to TB?

Which cells and molecules would you wish to inhibit to inhibit an allergic reaction?

VII.(16 points) Fill in the following table regarding the transmission and possibility of eradicating various diseases

Disease	Route of transmission	Can this disease be eradicated? Yes or no	Major reasons why or why not
polio			1. 2. 3.
cholera			1. 2.
gonorrhoea			1. 2.
rabies			1.

VIII. (6 points) Why is it that we have been using the same immunization for polio for the last 50 years but must change the immunization for influenza drastically every several years (Be sure to state the reasons completely and succinctly)?

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IX. (6 points) Fill in the following table with regard to the interaction between rhizobia and legumes.

plant genotype	bacterial genotype	result of the interaction (production of nodules, color, N ₂ fixation, etc.)
wild type	wild type	
does not make flavanoids	wild type	
leg hemeglobin ⁻	wild type	
wild type	<i>nifHDK</i> ⁻	
wild type	nod factor minus	
wild type	can not form infection threads due to lack of proper capsule	

X. (6 points) You are studying a superfund site. Some of the toxic molecules believed to be present at this site are shown below.

What is the order (fastest to slowest) in which the molecules would be broken down aerobically? _____

Which molecule would break down fastest anaerobically? _____

You find that E is the most common molecule at the site. One of your colleagues suggests that it might be a good idea to try giving the site pulses of _____ to stimulate the anaerobic breakdown of E. What is the reasoning behind his suggestion?

XI. (9 points) Prokaryotes can live in a variety of extreme environments. Fill in the following table for three **different** extreme environments in which three **different free-living** prokaryotes can grow.

Extreme environment	Prokaryote which lives there	Major adaptation of prokaryote to the environment

XII. (7 points) Below is a diagram of the carbon cycle. Answer the following questions about this diagram.

1. Which of the reactions can only be carried out by prokaryotes? _____
2. Which of the reactions can only be carried out by archaea? _____
3. Which reactions do you expect to be found in the top layer of a microbial mat? _____
the middle layer? _____ the bottom layer? _____
4. What would be the changes in the earth today if organisms which can carry out reaction 1 had never evolved?

5. Name a group of prokaryotes which carries out reaction 6? _____

XIII. (18 points) Fill in the following table.

Property	Group of organisms		
	Eubacteria	Archaea	Eukaryotes (nucleus and cytoplasm)
structure of membrane lipids			
has operons (yes or no)			
has introns (yes or no)			
amino acid which initiates protein synthesis			
an inhibitor of protein synthesis for this group			
location of cytochromes in the cell			

I have enjoyed teaching you this semester. I wish you success in your future endeavors.