1. (6 points) Jessica has worked for Wake Med Hospital in Raleigh for several years. Her primary duty is to be a 'runner', and help deliver lab results, x-rays, etc. to the doctors in a speedy fashion. One afternoon she was called by the attending physician to go and pick up a chest x-ray for a patient. She did just that and took the X-ray to the patient's room. The doctor had not arrived yet, but Jessica knew this patient, and he looked to be running a fever. She bent down to check is head with her hand. When she did, the young man uncontrollably coughed in her face. The sputum hit her cheek, but she didn't really think anything of it. She went and washed her face and hands and came back to the room. The doctor was there and looking at the x-ray. Jessica had experience looking at x-rays, and it was at this point she became really concerned. She noticed white spots on the lungs.

   A. Why is Jessica so concerned? What disease is this likely to be?

   B. What precautions do the health care workers now have to take when dealing with this patient?

   C. What is a therapy that can be very effective in controlling this disease?

For questions 2 and 3 you are a doctor in an HMO in North Carolina.. It is a warm summer morning.

2. (10 points)Your patient is 14 year-old male. He presents with painful, involuntary muscle spasms, resulting in rigid paralysis of the back and jaw. Several days ago, the patient was in an automobile accident and suffered a deep cut in one thigh. The cut was sewn up very tightly; the patient received no other treatment besides strong painkillers. It has been at least 10 years since he has received any kind of vaccination.

What microorganism is causing the patient's disease?

What is the principle virulence factor for this microorganism?

Please explain the mechanism of action of this microorganism's primary virulence factor.

If you had been the physician who treated the patient immediately following the car wreck, state two ways you would have handled his case differently to prevent this disease.

1.

2.

3.(6 points) Your next patient is a young girl who has diarrhea and vomiting. She went to a picnic last night and ate chicken salad and home canned three bean salad and banana cream pie. Name two different possible bacterial causes for this disease.

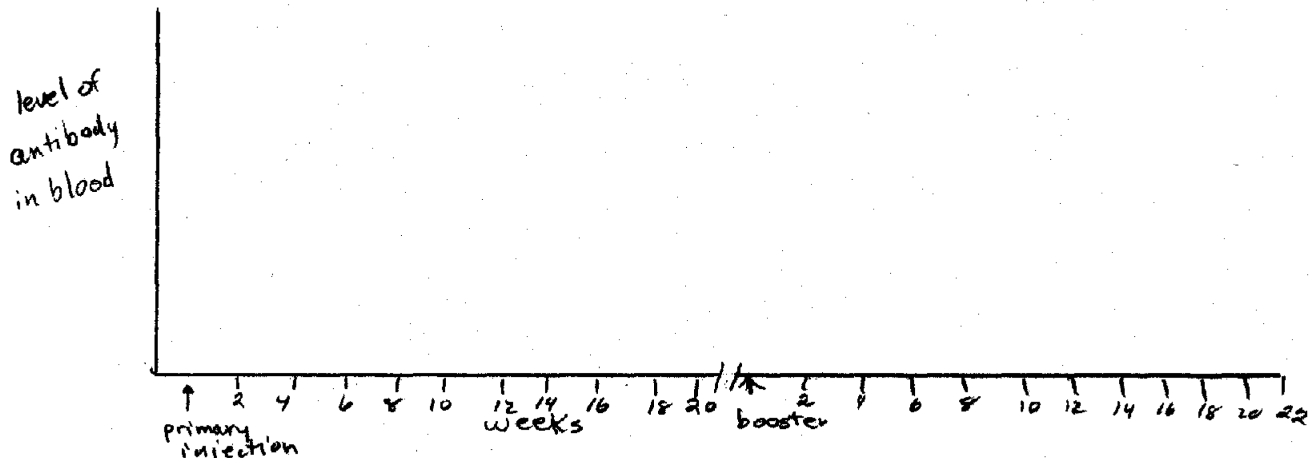
1.

2.

You get a stool sample and find no blood in the sample and no unusual bacteria. Which bacterium do you now favor as the causative agent?

Do you treat this disease with antibiotics? Why or why not?

4. (9 points) Fill in the graph below to show a primary immune response and a secondary immune response.



What cells are responsible for the primary immune response? ____________________

What cells are responsible for the secondary immune response? ____________________

If someone has a disease which destroys all of their T cells can they still make a primary immune response? yes or no (circle one)

5. (10 points) Several public health officials from California have asked you to use your knowledge of emerging infectious disease to determine if a particular bacterial disease they have witnessed in Los Angeles is related to a disease that has affected many people in Sydney, Australia. You have found a protocol in your lab to deal with such an experiment, but there are some important points missing.

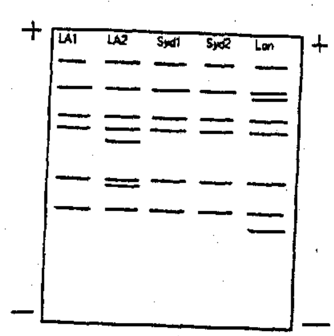
Assume the following:

You have two patients you are testing from Los Angeles
You have two patients you are testing from Sydney
You have a control patient from London
Patient #1 from LA (LA1) is showing very severe symptoms
Patient #2 from LA (LA2) is showing minor symptoms
Patient #1 and Patient #2 from Sydney (Syd1, Syd2) are showing severe symptoms
Patient from London (Lon) is showing no symptoms

A. Fill in the following protocol.

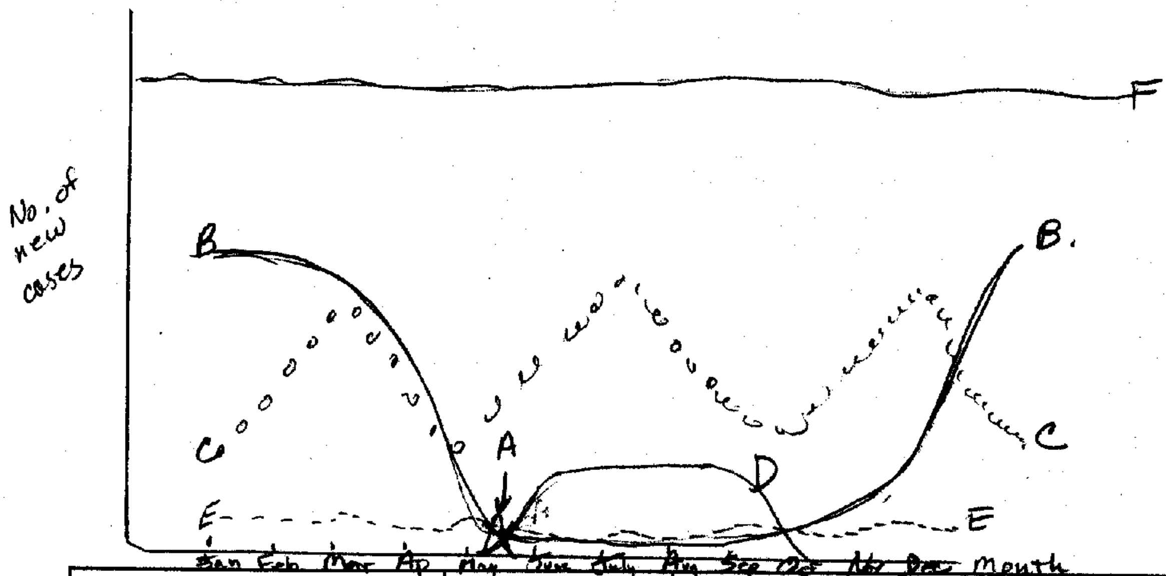
1) Obtain a _____________ from patients in ____________ and in ____________
2) Isolate and re-streak to obtain ____________ cultures.
3) Extract _________ from the isolated bacteria.
4) Prepare the DNA by cutting it with restriction enzymes which recognize 8-10 bp to create very few, rather large DNA fragments.
5) Take the DNA fragments and run the samples on a _________________________ (type of electrophoresis).

After completing the protocol and looking at your samples, you obtained the following results.



Based on the results, You feel that health officials in both cities, especially Los Angeles, should be concerned. What particular set of data from above, led you to that conclusion?

6. (12 points) Please match the following diseases to an appropriate epidemic curve. All curves may not be used. Provide a rationale for your choice.



Disease	Incidence curve	Reason for choice of curve
Strep Throat (tonsillar β-hemolytic streptococcal infection)		
Syphilis		
E. coli H5:O157 (food borne outbreak)		
Chlamydia trachomatis (genital infection)		
Chicken Pox		
Lyme disease		

7. (7 points) The damage to flower and fruit production on peach trees often seen due to early spring freezes in North Carolina is actually caused by bacteria. Explain how this can be so.

What can you do o prevent this damage?

An environmentally conscious friend of yours is afraid that the method of protecting the peach crop you have described above will cause permanent changes in the environment. Is this likely? Why or why not?

8. (12 points) Where an organism lives, many times determines what type of photosynthesis will take place. Organisms that live in the upper layers of soil would most likely undergo normal oxygenic photosynthesis, while those that live much deeper may perform anaerobic photosynthesis, since the amount of oxygen present decreases as you move down. Look at the following chart and compare both types of photosynthesis with respect to those characteristics listed.

Type of photosynthesis	ATP produced (yes/no)	Reaction center(s)	External e^- donor (if none, state none)	Final e^- acceptor
cyclic anaerobic				
non-cyclic anaerobic				
noncyclic aerobic				

9. (12 points)You are a Ph.D. student studying *E. coli*'s nitrate reductase enzyme. You wish to isolate and characterize mutants in this enzyme. You have identified several possible mutants and wish to sort them into three groups (note that you have already checked that no strain has more than one mutation).

- Group A - nitrate reductase uncoupled from the electron transport system
- Group B - nitrate reductase simply does not work.
- Group C - control, mutation is elsewhere, has wild-type growth requirements

All your mutants grow aerobically on complex media. Design media to differentiate between the groups of mutants. Be sure to specify media composition and culture conditions for each.

Materials available (not all will be used):

anaerobe jar (creates anaerobic conditions for culture)
NO gas source, compatible with anaerobe jar
substance which complexes with NO_2^- and removes it from solution
minimal medium contains glucose, $MgSO_4$, K_2HPO_4, NaCl, $FeCl_3$, and $MoSO_4$ only, no N
biotin
$(NH_4)_2SO_4$
KNO_3
lactose
X-Gal

Fill out the table below to indicate media and conditions you would choose to sort these mutants.

medium composition and culture conditions	growth of mutant group		
	A	B	C
complex medium, aerobic	good	good	good

10. (16 points) Fill in the following table indicating the probable results of the interaction of an alfalfa plant and its Rhizobium partner of the indicated genotypes. Indicate whether nodules would be formed, and whether N_2 fixation would occur (use yes or no in your answers).

plant genotype	bacterial genotype	result of the interaction	
		nodules	N_2 fixation
wild type	*nifHDK*$^-$		
doesn't make flavanoids	wild type		
wild type	*nod*$^-$		
legume globin minus	wild type		
wild type	1 bacterium *nifHDK*$^-$, *nod*$^-$		
wild type	a mixture of 2 bacteria 1. *nifHDK*$^-$ and 2. *nod*$^-$		

Now fill in the following table:

plant	bacterium	result of the interaction	
		nodules	N_2 fixation
corn which makes flavanoids	wild type Rhizobium		
wild type corn	*Azosprillum* (corn root colonizer) with constitutively over-expressed *nif* genes		