

amino acids

threonine (thr)
 leucine (leu)
 histidine (his)
 tryptophan (trp)
 arginine (arg)

vitamins

biotin (bio)
 thiamine (thi)

nucleic acid bases

adenine (ade)
 cytosine (cyt)

sugars

glucose (glu)
 lactose (lac)
 maltose (mal)
 arabinose (ara)

antibiotics

streptomycin (sm)
 spectinomycin (sp)
 ampicillin (amp)
 tetracycline (tet)
 neomycin (neo)
 chloramphenicol
 (cm)

minimal medium without a carbon source**complex medium**

1. A. (8 points) You perform a conjugation between two *E. coli* strains with the following genotypes:

F-: thr⁺ leu⁻ arg⁻ thi⁺ bio⁻ lac⁺ mal⁺ ara⁻ sp^S amp^R

Hfr: thr⁻ leu⁻ arg⁺ thi⁻ bio⁺ lac⁻ mal⁻ ara⁺ sp^R amp^S

Using the reagent shelf above, what medium would you make to select transconjugants of each of the following genotypes? Be sure to list all ingredients.

arg⁺ _____

ara⁺ _____

bio⁺ _____

sp^R _____

B. (2 points) You wish to move a plasmid which carries the gene for tet^R from a bacterium which is trp⁺ his⁻ cm^R neo^S to a bacterium which is trp⁻ his⁻ cm^S neo^R. You perform the conjugation. What should you put in the medium to select for the desired transconjugates?

2. A. (6 points) A 12 year old patient presents with high fever, chest pains, and cough producing yellow sputum, you conclude the infection to be pneumonia. You review the patient's history and find that he has been diagnosed with the disease 4 years ago and the infection was cleared successfully with antibiotics. You also discover that he has had a series of infections almost his whole life. You take a throat swab. The culture comes back positive for the same serotype of pneumococcus as the earlier infection. Given what you know about adaptive immunity, please give a short explanation as to what genetic defect the patient may be carrying.

B. (4 points) What cell type recognizes major histocompatibility complex (MHC) class I proteins and what steps must follow complex recognition to ensure destruction of the infected cell. What type of infectious agent is this most effective against?

C. (2 points) What two cell types must be present for an immunization to be effective? (be specific)

1. _____

2. _____

You are a doctor in central North Carolina. It is a nice day in the early fall.

3. (10 points) Your first patient is a young lady who has a fever and acute abdominal pain. On examination you observe a discharge from her cervix which under the microscope is seen to contain gram negative cocci.

What disease is this likely to be? _____

What other diseases do you test her for?

Do you take any public health measures? _____

If so, what? _____

The test results come back and she is negative for the more serious diseases but is positive for the most common STD. How do you treat this disease? _____

Why?

4. (4 points) Your next patient is the child of a migrant farm worker. He has a fever and a rash. When you look in his mouth you observe white spots on his gums. He reports that several of the other children he plays with also have had a similar disease.

What disease is this likely to be? _____

Do you take any public health measures? _____

If so what? _____

5. (10 points) A young man comes in with elevated temperature, sweating, and increased blood pressure. You decide to check his throat using a tongue depressor and find that his mouth snaps shut instead of the expected gag reflex. The patient also complains of stiffness in the neck and problems with motor coordination. His movements seem rigid and he has some tremor. You obtain no organisms from a blood culture.

What is the disease? _____

Given the symptoms, describe the molecular mechanism of the toxin released by this pathogen and the specific site of action.

Based on what you know about this pathogen what is the most effective way to prevent symptoms and why?

6. (5 points) You and a friend decide to hike out in the woods of southwestern Carolina during mid-autumn. About 10 days after the trip your friend falls ill complaining of fatigue, fever, muscle pain, and a distinct bull's eye rash on his upper leg.

What is the pathogen and disease? _____

What is the vector for the pathogen? _____

How could have the infection been prevented?

7. (10 points) it is now winter and a 10 year old patient comes in with fever, joint pain, and inflammation of the heart. You talk to the parents and find out that about three weeks earlier the patient had a fever, red rash all over his body, and a sore and swollen throat. However, they did not bring the patient to a doctor because of a severe blizzard during that time.

Given the patients **current** symptoms what **is** the disease now? _____

Given the patients **previous** symptoms what **was** the **earlier** disease?

What pathogen is responsible for the current symptoms? _____

Are the two episodes linked? YES or NO

If so what could have been done to prevent the second infection?

8. You are a doctor at a local clinic. It is a cold January day. A patient walks in and boldly announces that he has Salmonellosis. You ask why he believes he has that disease. His response: "Well, I was working at Subway, eating a bag of chips and started sneezing and coughing real bad after a half hour. Later, I also got a fever, felt very tired, and have a bad headache. A lot of us at work have the same thing. I think you should prescribe some drug since I know that I won't get better without them." You think for a moment and respond, "You do not have Salmonellosis."

A. (6 points) Identify 3 facts in the boy's statement that are inconsistent with salmonellosis and state what the information would be if he did have Salmonellosis.

Error	Correct information if it were Salmonellosis

B. (1 point) What is the boy likely to have?

C. (1 point) Would an antibiotic be effective against this disease (the one you listed in part B)?

YES or NO

9. A child comes in to your clinic with fever and a sore throat. The parents are members of a group which does not believe in immunizations and only brought the child to the doctor reluctantly because she seemed very ill. During your examination of the child, you see a gray membrane covering the back of the child's throat.

A. (1 point) What disease is this most likely to be?

B. (5 points) What is the molecular mechanism of action of the disease's toxin?

D. (2 points) How should the child be treated?

10. A. (2 points) What is the most common first sign/symptom of an MRSA infection?

B. (1 point) Is it likely that your grandparents were exposed to or had this disease?

YES or NO

C. (2 points) What are the two main ways of treating a MRSA infection?

1. _____

2. _____

D. (4 points) If hospital spread of MRSA is prevented by testing all patients and staff, would this solve the problem with MRSA infections in North Carolina?

YES or NO

Why?

11. (16 points) Fill in the following table with respect to nitrogen-fixing bacteria.

Plant and genotype	Bacteria and genotype	Other conditions	Do they form nodules? Yes or no	Do they fix nitrogen? Yes or no
rice	Wild-type cyanobacteria	normal		
rice	Cyanobacteria <i>nifHDK</i> ⁻	Soil lacks Mo ⁺²		
Hemoglobin-minus rice	Wild-type cyanobacteria	normal		
Corn	Azospirillum species	Soil lacks W ⁺²		
Corn	Azospirillum species	Soil recently fertilized		
Wild-type pea	<i>R. leguminosarum</i> (pea species)	normal		
Wild-type alfalfa	Wild-type <i>R. leguminosarum</i>	normal		
Wild-type pea	<i>R. leguminosarum</i>	Soil lacks Mn ⁺²		
Wild-type pea	<i>R. leguminosarum</i> which can only make the cytochromes needed for growth in soil	normal		
Wild-type pea	<i>R. leguminosarum nifHDK</i> ⁻ and <i>R. leguminosarum nod</i> ⁻	normal		

12. (8 points) Fill in the following table with respect to bacterial diseases of plants

Plant	Bacteria	What will the result of the interaction be?
Wild-type wounded tomato	<i>A. tumefaciens</i> wild-type	
Wild-type wounded tomato	<i>A. tumefaciens</i> with the genes inside the T DNA borders replaced by the human insulin gene	
Wild-type wounded bean	<i>A. tumefaciens virG</i> ⁻	
Wild-type strawberry	<i>Pseudomonas ice</i> ⁺ +4°C	
Wild-type strawberry	<i>Pseudomonas ice</i> ⁺ -4°C	
Wild-type strawberry	<i>Pseudomonas ice</i> ⁺ with a mutation which disrupts the organization of the outer membrane but leaves the cells viable -4°C	
Wild-type bean	Soft rot <i>Erwinia</i>	
NodA ⁻ bean	Soft rot <i>Erwinia</i>	