

## Chapter 8 Homework

1. The immune system.
  - a. What is an antibody? Describe its structure and its function in the immune system.
  - b. Explain the term “immunologic memory.”
  - c. Describe the cellular-level processes that enable the adaptive immune system to have immunologic memory.
2. When you get a splinter in your toe, the area can become red, hot, swollen and ooze pus. Describe the specific causes of each of these symptoms.
3. Name the 3 general types of immunity and give an example of each.
4. Most common anti-HIV drugs work by inhibiting key steps in viral uptake and reproduction.
  - a. Make a drawing which shows the major steps that occur when HIV infects a CD4+ lymphocyte. Indicate on your figure where in the viral life cycle the following classes of drugs act: (1) fusion inhibitors, (2) reverse transcriptase inhibitors and (3) protease inhibitors.
  - b. Beginning in the mid-1990s, an increasing number of HIV-infected individuals began a drug regime called highly active antiretroviral therapy ([HAART](#)), a combination of three or more anti-HIV drugs taken at the same time. Why is taking a combination of drugs, each targeted against a different aspect of the viral life cycle, so much more effective than taking a single drug?
5. When a TB skin test is performed, a small amount of harmless TB antigen is injected under the skin. The patient monitors for redness and swelling at the site of injection. If a patient has been previously exposed to TB, but does not currently have an active TB infection will redness and swelling be observed? Why or why not?
6. Oh no! You return to Student Health two days after receiving a routine PPD skin test. You have a red bump on your forearm that measures 12 mm in diameter. Every year up until now, your test had been negative.
  - a. How does the PPD skin test work, and why does a red bump form for individuals infected with TB?
  - b. Assuming you have no significant health problems, what are the odds that the bacterium will remain in a latent, inactive state for the rest of your life?
  - c. The PPD skin test is imperfect. Describe one instance in which the PPD skin test fails by giving a false-negative result, and describe another instance in which the test fails by giving a false-positive result. Why does the test fail in each circumstance?
7. If you are exposed to the varicella virus as a child and have not been vaccinated, you will likely develop chicken pox. If you are exposed again as an adult, you probably will not develop the disease again.
  - a. At first exposure, what type of immunity fights off the varicella virus?
  - b. The varicella vaccine contains a live virus. Is this safe? Why or why not? What is the advantage of this type of vaccine over a vaccine made of a dead virus?
8. A 24-year-old HIV-positive man is hospitalized because he developed pneumonia. The

doctor starts the patient on antibiotics and measures the number of CD4 helper T cells in the patient's blood. The patient has a low CD4 count.

- a. What are two of the three major transmission routes by which this man might have become HIV-positive?
- b. The doctor then performs a test and finds that the man's serum is positive for antibodies to gp41 and gp120, the HIV envelope glycoproteins. Name and briefly describe this test the doctor ordered.

9. Answer the following questions about pathogens, the immune system, and vaccines.

- a. Check to indicate pathogen type(s) for which each statement applies.

Trait	Bacteria	Virus
Uses host cellular machinery to reproduce		
Can be killed or inhibited by antibiotics		
Short pathogen peptide sequences are displayed in MHC surface receptors.		
Living cells, usually having both a membrane and cell wall		
Protein capsid houses nucleic acid core		
Can reproduce without a host		
Tens of nanometers in size		

- b. How can T cells identify cells infected with viruses?
- c. Antigen binding to B-cell surface receptors and interaction with activated helper T cells activates B-cells to produce and secrete antibodies. Compare **the onset and magnitude** of the B-cell response for primary (initial) and secondary (subsequent) exposure to a particular antigen.
- d. Identify the following vaccine types from the descriptions provided. Which one is likely to confer life long immunity?

\_\_\_\_\_ : The pathogen is treated with chemicals or irradiated. The early version of the polio vaccine and the rabies vaccine are examples.

\_\_\_\_\_ : Mutations have been introduced to the pathogen. This form is used to prevent measles, mumps and rubella.

10. The incidence of many diseases has been reduced by widespread vaccination. However, vaccines are not available for some diseases.

- a. Name three diseases for which vaccines are most critically needed to improve world health.
- b. For one of the diseases you listed in part a, explain the major scientific and economic challenges associated with developing a vaccine.

11. Technologies for vaccine development and delivery are considered among the top ten biotechnologies that may improve health in developing countries. Imagine that you are a member of GAVI evaluating new vaccination strategies for adoption by the organization. You are asked to choose between an oral live attenuated (Sabin) and an injectable inactivated

(Salk) polio vaccine for use in Sub-Saharan Africa. Polio is a viral disease that can produce paralysis. It is passed through fecal-oral transmission. Assume that the two vaccines have equal efficacy in preventing polio infection.

- a. What does GAVI stand for?
- b. Place the following stages of viral infection and replication in the correct order:
  - \_\_\_ Synthesis of viral proteins
  - \_\_\_ Viral budding or cell lysis
  - \_\_\_ Endocytosis/injection or viral contents
  - \_\_\_ Binding to cell membrane
- c. How does a live attenuated vaccine differ from an inactivated vaccine?
- d. Which of the following components of the immune system must a vaccine stimulate?
  - i. macrophages
  - ii. B cells and T cells
  - iii. neutrophils
  - iv. innate immunity
  - v. complement

**12.** It has been shown that unvaccinated contacts of babies who receive the Sabin Polio vaccine will develop antibodies to the virus, while unvaccinated contacts of babies who receive the Salk Polio vaccine will not.

- a. Explain why this might be the case.
- b. List two reasons why the Sabin vaccine might be preferable to the Salk for use in Sub-Saharan Africa.
- c. What is the main risk of using the Sabin vaccine in an immunocompromised population?
- d. There has been much interest in eliminating poliovirus worldwide. What is the only infectious disease that has been eradicated to date?
- e. Discuss why the use of a vaccine led to the eradication of this disease while other diseases for which vaccines exist have not been eradicated.
- f. List two properties that are necessary in order for a disease to be eradicable.
- g. Which vaccine would you recommend that the GAVI adopt? Name two reasons why.
- h. Why has there been so much focus on and investment in vaccination as a strategy in world health?

**13.** Portions of the following article appeared in the Austin American Statesman on May 10, 2005. Please read the article and answer the following questions.

Questions about pertussis article:

- a. The article states that the pertussis vaccine does not protect 15-20% of children who receive it. Discuss how the concept of 'herd immunity' will protect these children. What fraction of the population must be vaccinated to achieve 'herd immunity'?
- b. The article describes a new booster vaccine called Boostrix. It states that the new vaccine may be available commercially next month. What process will the FDA use to ensure that the vaccine is safe after it is approved for general use? Why is this process necessary?
- c. Pertussis is generally a mild disease in adults and older children. What arguments would you make in support of widespread distribution of the booster vaccine?

## **Travis County investigating outbreak of whooping cough**

**County leads state in number of cases; State also could have another bad year for pertussis**

**By Mary Ann Roser**

AMERICAN-STATESMAN STAFF

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Local health officials are investigating an outbreak of whooping cough as Travis County copes with the bleak distinction of having the state's most reported infections of the highly contagious disease, also known as pertussis, so far this year.

The Austin/Travis County Health and Human Services Department reported 58 confirmed cases of pertussis since Jan. 1, an unusually high number. The county has not had a whooping cough death since 2003. That year, infant Serena King died of the illness, which causes a violent cough followed by a whooping sound.

King was younger than 2 months, the age at which babies get their first pertussis vaccination, when she died. State health officials are awaiting confirmation of a suspected pertussis death this year, but the patient was not from Central Texas, said Rita Espinoza, an epidemiologist at the Department of State Health Services.

Pertussis is on the upswing nationally, and if current trends continue in Texas, 2005 could be one of the worst years since vaccines have been available.

As of April 30, the state had a preliminary count of 269 pertussis cases, compared with 192 during the same period a year earlier, according to the state health department. The worst year for whooping cough since the introduction of vaccines in the 1940s was 2002, when the state reported 1,240 pertussis cases, Espinoza said.

Health officials are worried. In 2004, the preliminary count was 1,174 whooping cough cases statewide, compared with 670 in 2003. Travis County reported 97 cases in 2004 (the state's count for Travis County was higher, at 125; the two will reconcile the numbers later), and the county had 62 whooping cough cases in 2003, said Dr. Adolfo Valadez, the health authority for the Austin/Travis County department.

"It's a concern all over the state," Espinoza said. "I was just down in the Valley last week, and I was informed of 20 to 25 cases in an area where we usually don't hear of that many. We need to find a way to curb the cycle."

The outbreak is a warning to parents to keep their children's immunizations up-to-date, Valadez said. It has picked up steam in the past five to six weeks, and most of the cases are in babies younger than a year old and children from ages 10 to 15, Valadez said. Schools in Austin and Pflugerville are seeing sporadic cases, but "no schools have had to be closed," he said. "Quite, honestly, we're looking forward to school ending. That's how it spreads."

Espinoza and Valadez said other factors could be contributing to the uptick in cases in recent years: growing awareness of pertussis, a quicker test to diagnose the illness and waning immunity from the whooping cough vaccine.

The vaccine has been changed to reduce some side effects, which could cause immunity to wear off in less than five to 10 years, Espinoza said. Also, the vaccine is far from foolproof. It does not protect 15 percent to 20 percent of the children who get it, which means adolescents can get pertussis and spread it to young children and babies who are at greatest risk of serious illness. A week ago, the Food and Drug Administration approved the use of a pertussis booster vaccine, Boostrix, for children from ages of 10 and 18. Valadez said it is expected to be available commercially as early as next month, and he was encouraged that the tool was coming to the public health arsenal.

Now, children are vaccinated for pertussis at 2 months, 4 months, 6 months and between 15 months and 18 months, with a booster between ages 4 and 6, Espinoza said. Pertussis bacteria live in the nose, mouth and throat and escape into the air when people sneeze, cough and talk. The disease is usually mild in older children and adults but can cause breathing problems, pneumonia and swelling of the brain. It begins like a cold, with a mild fever and cough, which slowly worsens and leads to coughing fits that sometimes end in vomiting.

**14.** Google the terms:

- Vaccine and safety
- Vaccine and dangers

Do you think the sites that pop up on the two searches contain accurate health information? Why or why not? If you were a pediatrician, what would you tell the parents of your patients who had performed similar searches? A short paragraph is sufficient.

**15.** You have been asked to write a 500-525 word column on the Avian influenza situation for the BIOE Tribune. Your editor informs you that you must write a critique of the US plan in case of an Avian influenza pandemic. Your critique should include the scientific, economic, and public health aspects of this plan. Other topics, including potential vaccine strategies, may be addressed as well. The CDC website <http://www.cdc.gov/flu/avian/> may provide information which will be helpful in completing this assignment. REMEMBER this is for a newspaper so make it compelling and make it interesting, but also make it TRUE!

**16.** Who sings “**The Avian Flu...a three minute summary**”? (Hint: She also sings “King of the Rollerama” and “The Great Metric Threat of 79”.)