Tuberculosis

Rationale
Tuberculosis (TB) remains a major global health problem. It causes ill-health among millions of people each year and ranks as the second leading cause of death from infectious disease worldwide, after the human immunodeficiency virus (HIV).

Objectives
Upon completion of this lesson, the student will be able to:
- Explain the history of tuberculosis
- Describe how tuberculosis is transmitted from person to person
- Distinguish between latent TB infection and TB disease
- Explain the treatment for tuberculosis

Engage
Maddy, a 16 year old girl, arrives at the hospital with her mom. She is complaining about frequent coughing and coughing up blood. It started about 7 days ago. Maddy is also experiencing weakness, weight loss, and night sweats.

Key Points
I. Tuberculosis is caused by a bacterium called *Mycobacterium tuberculosis*. The bacteria usually attack the lungs, but TB bacteria can attack any part of the body such as the kidney, spine, and brain. If not treated properly, TB disease can be fatal.

II. History of TB
   A. Historically known by a variety of names
      1. Consumption
      2. Wasting disease
      3. White plague
   
   B. Scientific Discoveries in the 1800s
      1. Until mid-1800s, many believed TB was hereditary
      2. 1865 Jean Antoine-Villemin proved TB was contagious
      3. 1882 Robert Koch discovered *M. tuberculosis*, the bacterium that causes TB

   C. Sanatoriums
      1. Before TB antibiotics, many patients were sent to sanatoriums
      2. Patients followed a regimen of bed rest, open air, and sunshine
3. TB patients who could not afford sanatoriums died at home

D. Breakthrough in the Fight Against TB
   1. Drugs that could kill TB bacteria were discovered in 1940s and 1950s
      a. Streptomycin (SM) discovered in 1943
      b. Isoniazid (INH) and p-aminosalicylic acid (PAS) discovered between 1943 and 1952
   2. TB death rates in U.S. began to drop dramatically
   3. Most TB sanatoriums in U.S. had closed by mid 1970s

E. Increase in TB in mid 1980s
   1. Inadequate funding for TB control programs
   2. HIV epidemic
   3. Increased immigration from countries where TB is common
   4. Spread in homeless shelters and correctional facilities
   5. Increase and spread of multidrug-resistant TB

III. Symptoms
   A. Bad cough that lasts 3 weeks or longer
   B. Pain in the chest
   C. Coughing up blood or sputum
   D. Weakness or fatigue
   E. Weight loss
   F. No appetite
   G. Chills
   H. Fever
   I. Sweating at night

IV. Mycobacterium tuberculosis
   A. Slow-growing, rod-shaped bacterium that can live only in people
   B. Unusual waxy coating on cell surface
   C. Over 60% of the mycobacterial cell wall is lipid. The lipid portion of the Mycobacterium tuberculosis cell wall consists of mycolic acids, cord factor, and wax-D
   D. Because of the thick and complex cell wall, Mycobacterium tuberculosis is resistant to many disinfectants and antibiotics
   E. Ziehl-Neelsen staining acid for fast detection used instead of gram staining for detection
   F. Divides every 15–20 hours, which is extremely slow compared to other bacteria
   G. Aerobic bacterium (needs oxygen to survive). For this reason, during active TB disease, Mycobacterium tuberculosis is found in the upper air sacs of the lungs
V. How is TB spread?
   A. TB germs are put into the air when a person with TB disease of the lungs or throat coughs, sneezes, speaks, or sings.
   B. These germs can stay in the air for several hours, depending on the environment.
   C. Persons who breathe in the air containing these TB germs can become infected; this is called latent TB infection.

VI. Latent TB Infection and TB Disease
   A. Latent TB Infection
      1. TB bacteria can live in the body without making you sick. This is called latent TB infection. In most people who breathe in TB bacteria and become infected, the body is able to fight the bacteria to stop them from growing. People with latent TB infection do not feel sick and do not have any symptoms.
      2. People with latent TB infection are not infectious and cannot spread TB bacteria to others. However, if TB bacteria become active in the body and multiply, the person will go from having latent TB infection to being sick with TB disease.
   B. TB Disease
      1. TB bacteria become active if the immune system can't stop them from growing. When TB bacteria are active (multiplying in your body), this is called TB disease. People with TB disease are sick. They may also be able to spread the bacteria to people they spend time with every day.
      2. Many people who have latent TB infection never develop TB disease. Some people develop TB disease soon after becoming infected (within weeks) before their immune system can fight the TB bacteria. Other people may get sick years later when their immune system becomes weak for another reason.
      3. For people whose immune systems are weak, especially those with HIV infection, the risk of developing TB disease is much higher than for people with normal immune systems.

VII. Testing for TB -- There are three tests that are used to detect TB bacteria in the body. These tests can be given by a health care provider or local health department.
   A. TB skin test (TST)
   B. TB blood tests
   C. Chest radiographs

VIII. Treatment
   A. Treatment for Latent TB Infection
      1. If you have latent TB infection but not TB disease, your health care
provider may want you be treated to keep you from developing TB disease. Treatment of latent TB infection reduces the risk that TB infection will progress to TB disease. Treatment of latent TB infection is essential to controlling and eliminating TB in the United States. The decision about taking treatment for latent TB infection will be based on your chances of developing TB disease.

B. Treatment for TB Disease

1. TB disease can be treated by taking several drugs, usually for 6 to 9 months. It is very important to finish the medicine, and take the drugs exactly as prescribed. If you stop taking the drugs too soon, you can become sick again. If you do not take the drugs correctly, the germs that are still alive may become resistant to those drugs. TB that is resistant to drugs is harder and more expensive to treat.

IX. Drug resistant TB - is caused by *M. tuberculosis* organisms that are resistant to at least one first-line TB treatment drug. Drug-resistant TB can be difficult to treat.

A. Primary resistance is caused by person-to-person transmission of drug-resistant organisms.

B. Secondary resistance develops during TB treatment. Either the patient was not treated with the right TB drugs or the patient did not properly follow the prescribed treatment regimen.

Activity

I. Complete the Tuberculosis Terms
II. Complete the Tuberculosis Study

Assessment

Tuberculosis Quiz

Materials

Tuberculosis Terms Key

http://www.cdc.gov/tb/topic/basics/default.htm

Global TB Report 2012:
http://apps.who.int/iris/bitstream/10665/75938/1/9789241564502_eng.pdf

TB Reports:

Reported TB in United States 1953-2011
Accommodations for Learning Differences
For reinforcement, the student will develop a time line for tuberculosis. Include incubation, signs and symptoms, diagnosis, prognosis and treatment.

For enrichment, the student will research and report on an individual tuberculosis treatment and its history.

National and State Education Standards
National Health Science Cluster Standards
HLC02.01
Health care workers will know the various methods of giving and obtaining information. They will communicate effectively, both orally and in writing.

HLC06.02
Health care workers will understand the fundamentals of wellness and the prevention of disease processes. They will practice preventive health behaviors among their clients.

TEKS
130.204(c)(1)(F) explain the changes in structure and function due to trauma and disease;
130.204 (c)(12)(A) research wellness strategies for the prevention of disease;
130.204 (c)(12)(B) evaluate positive and negative effects of relationships on physical and emotional health such as peers, family, and friends; and
130.204 (c)(12)(C) explain the benefits of positive relationships among community health professionals in promoting a healthy community.

Texas College and Career Readiness Standards
English Language Arts
II. B. 1. Identify new words and concepts acquired through study of their relationships to other words and concepts.
III. A. 2. Adjust presentation (delivery, vocabulary, length) to particular audiences and purposes.
III. B. 1. Participate actively and effectively in one-on-one oral communication situations.
III. B. 2. Participate actively and effectively in-group discussions.
III. B. 3. Plan and deliver focused and coherent presentations that convey clear and distinct perspectives and demonstrate solid reasoning.
IV. B. 3. Listen actively and effectively in group discussions.
V. A. 3. Explore a research topic.
V. B. 1. Gather relevant sources.
V. B. 2. Evaluate the validity and reliability of sources.
V. B. 3. Synthesize and organize information effectively.
V. C. 1. Design and present an effective product.

Science
III. B. 3. Recognize scientific and technical vocabulary in the field of study and use this vocabulary to enhance clarity of communication.
III. C. 1. Prepare and present scientific/technical information in appropriate formats for various audiences.
III. D. 1. Use search engines, databases, and other digital electronic tools effectively to locate information.
IV. B. 1. Understand how scientific research and technology have an impact on ethical and legal practices.
X. E. 5. Understand how human practices affect air, water, and soil quality.

Social Studies
I. A. 2. Analyze the interaction between human communities and the environment.

Cross-Disciplinary
I. E. 2. Work collaboratively.
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<td>Multidrug-resistant TB (MDR TB)</td>
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<td><em>Mycobacterium tuberculosis</em></td>
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<td>TB skin test</td>
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Tuberculosis Terms

**BCG**– or Bacillus Calmette–Guérin is a vaccine for TB named after the French scientists who developed it, Calmette and Guerin. BCG is rarely used in the United States, but it is often given to infants and small children in other countries where TB is common.

**Chest x-ray** – a picture of the inside of the chest made by exposing a film to x-rays that pass through the chest. A doctor can look at this film to see whether TB bacteria have damaged the lungs.

**Culture** – a test to see whether there are TB bacteria in your phlegm or other body fluids. This test can take 2 to 4 weeks in most laboratories.

**Extrapulmonary TB** – TB disease located in any other part of the body besides the lungs (for example, the kidney, spine, brain, or lymph nodes)

**INH or isoniazid** – a medicine used to prevent TB disease in people who have latent TB infection; INH is also one of the four medicines often used to treat TB disease.

**Latent TB infection** – a condition in which TB bacteria are alive but inactive in the body; people with latent TB infection have no symptoms, don't feel sick, can't spread TB to others, and usually have a positive skin test reaction, but they may develop TB disease if they do not receive treatment for latent TB infection.

**Multidrug-resistant TB (MDR TB)** – TB disease caused by bacteria resistant to two or more of the most important medicines: INH and RIF.

**Mycobacterium tuberculosis** – bacteria that cause latent TB infection and TB disease

**Pulmonary TB** – TB disease that occurs in the lungs, usually producing a cough that lasts 3 weeks or longer; most TB disease is pulmonary.

**Resistant bacteria** – bacteria that can no longer be killed by a certain medicine

**Smear** – a test to see whether there are TB bacteria in your phlegm. To perform this test, lab workers smear the phlegm on a glass slide, stain the slide with a special stain, and look for any TB bacteria on the slide. This test usually takes 1 day to get the results.

**Sputum** – phlegm coughed up from deep inside the lungs. Sputum is examined for TB bacteria using a smear; part of the sputum can also be used to do a culture.

**TB blood test** – a new test that uses a blood sample to find out if you are infected with TB bacteria; the test measures the response to TB proteins when they are mixed with a small amount of blood.
**TB skin test** – a test that is often used to find out if you are infected with TB bacteria whereby a small amount of liquid called tuberculin is injected under the skin on the lower part of your arm. If you have a positive reaction to this test, you probably have a TB infection. Other tests will be needed to find out if you have latent TB infection or TB disease.

**Tuberculin or PPD** – a liquid that is injected under the skin on the lower part of your arm during a TB skin test; if you have latent TB infection, you will probably have a positive reaction to the tuberculin.
TUBERCULOSIS QUIZ

1. In what year was each of the following discoveries made?
   a. TB was proven to be contagious _____________
   b. The bacterium that causes TB was discovered _____________
   c. The first drug that could kill TB bacteria was discovered _____________

2. What organism causes TB?

3. How is TB spread?

4. How is TB detected?

5. What is the treatment for TB?

6. What is the treatment for latent TB?

7. What is drug-resistant TB?

8. What is the difference between primary and secondary drug-resistant TB?
TUBERCULOSIS QUIZ - KEY

1. In what year was each of the following discoveries made?
   a. TB was proven to be contagious 1865
   b. The bacterium that causes TB was discovered 1882
   c. The first drug that could kill TB bacteria was discovered 1943

2. What organism causes TB?
   TB is caused by an organism called *Mycobacterium tuberculosis*.

3. How is TB spread? TB is spread from person to person through the air. When a person with infectious TB disease coughs, sneezes, speaks, or sings, tiny particles containing *M. tuberculosis* may be expelled into the air. These particles, called droplet nuclei, are about 1 to 5 microns in diameter — less than 1/5000 of an inch. Droplet nuclei can remain suspended in the air for several hours, depending on the environment.

4. How is TB detected?
   - TB skin test (TST)
   - TB blood tests
   - Chest radiographs

5. What is the treatment for TB?
   TB disease can be treated by taking several drugs, usually for 6 to 9 months. It is very important to finish the medicine, and take the drugs exactly as prescribed. If you stop taking the drugs too soon, you can become sick again. If you do not take the drugs correctly, the germs that are still alive may become resistant to those drugs.

6. What is the treatment for latent TB?
   If you have latent TB infection but not TB disease, your health care provider may want you be treated to keep you from developing TB disease. Treatment of latent TB infection reduces the risk that TB infection will progress to TB disease. Treatment of latent TB infection is essential to controlling and eliminating TB in the United States. The decision about taking treatment for latent TB infection will be based on your chances of developing TB disease.

7. What is drug-resistant TB?
   Drug-resistant TB is caused by *M. tuberculosis* organisms that are resistant to at least one first-line TB treatment drug. Drug-resistant TB can be difficult to treat.

8. What is the difference between primary and secondary drug-resistant TB?
   Primary resistance is caused by person-to-person transmission of drug-resistant organisms. Secondary resistance develops during TB treatment. Either the patient was not treated with the right TB drugs or the patient did not properly follow the prescribed treatment regimen.
TUBERCULOSIS STUDY

Answer the following questions:

1. How is TB tested and diagnosed?

2. What methods of treatment exist for TB? How effective are these?

3. How does the CDC regulate and control the outbreaks of TB in the United States?

Reference data from the following websites to answer the questions:

World Health Organization (WHO):
http://apps.who.int/iris/bitstream/10665/75938/1/9789241564502_eng.pdf

Centers for Disease Control and Prevention (CDC):

Texas Department of State Health Services (DSHS):
http://www.dshs.state.tx.us/idcu/disease/tb/statistics/

Visit the WHO website.

1. Which 5 countries are most affected by TB?

2. Which five countries are least affected by TB?

3. What about these countries might lead to an increase/decrease in the bacterial infection? Do some web research looking at climate, daily salary, living conditions, food source, water source.
4. Over the past few decades have we seen an increase or a decrease in the total of
   a. Incidence of TB?
   b. Treatment of TB?
   c. Deaths caused by TB?

Visit the CDC website.

5. Which 5 states are most affected by TB?

6. Which 5 states are least affected by TB?

Visit the DSHS website.

7. Find your county how many cases were reported in 2011?

8. Which 5 counties in Texas were most affected by TB?

9. Which 5 counties in Texas were least affected by TB?

10. Who is more at risk for getting TB? Why?