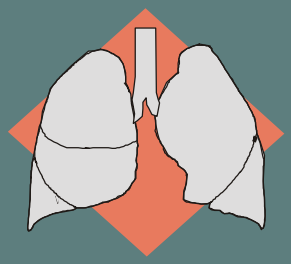

Self-Study Modules on Tuberculosis

1 Transmission and Pathogenesis of Tuberculosis

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Centers for Disease Control and Prevention

National Center for HIV, STD, and TB Prevention

Division of Tuberculosis Elimination

Public Health Practice Program Office

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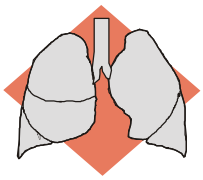

1 Transmission and Pathogenesis of Tuberculosis

CONTENTS

BACKGROUND

In this module, you will learn about the history of tuberculosis (TB). You will also learn how TB is spread from person to person (transmission) and how TB disease develops in the body (pathogenesis). Our understanding of the transmission and pathogenesis of TB has guided us in developing strategies for controlling the spread of TB and for treating TB infection and disease. As a public health worker, you should understand these concepts so that you can educate the patients you serve.

OBJECTIVES

After working through this module, you will be able to:

1. Briefly describe the history of TB.
2. Explain how TB is spread (transmission).
3. Explain the difference between TB infection and TB disease.
4. Explain how TB infection and TB disease develop (pathogenesis).
5. List risk factors for the development of TB disease.
6. Describe how human immunodeficiency virus (HIV) infection affects the pathogenesis of TB.
7. Describe the classification system for TB.

NEW TERMS

Look for the following new terms in this module and in the glossary.

AIDS – acquired immunodeficiency syndrome, a disease in which the immune system is weakened and therefore less able to fight certain infections and diseases; AIDS is caused by infection with the human immunodeficiency virus (HIV)

alveoli – the small air sacs of the lung that are at the end of the airway; when droplet nuclei reach these air sacs, TB infection begins

corticosteroid – a type of steroid, either natural or man-made, often used to treat arthritis or certain allergies

diabetes mellitus – a disease in which the body's ability to use sugar is weakened

droplet nuclei – very small droplets (1 to 5 microns in diameter) that may be expelled when a person who has infectious TB coughs or sneezes; they can remain suspended in the air for several hours, depending on the environment

drug injection – using a needle and syringe to inject drugs into the body

extrapulmonary TB – TB disease that occurs in places other than the lungs, such as the lymph nodes, the pleura, the brain, the kidneys, or the bones; most types of extrapulmonary TB are not infectious

HIV – human immunodeficiency virus, the virus that causes AIDS

immune system – cells and tissues in the body that protect the body from foreign substances

immunosuppressive therapy – therapy that suppresses, or weakens, the immune system

infectious – capable of spreading infection; a person who has infectious TB disease expels droplets containing *M. tuberculosis* into the air when he or she coughs or sneezes

miliary TB – TB disease that occurs when tubercle bacilli enter the bloodstream and are carried to all parts of the body, where they grow and cause disease in multiple sites; the chest x-ray of patients with miliary TB often looks like millet seeds scattered throughout the lung

mycobacteria – a kind of bacteria; mycobacteria can cause a variety of diseases

Mycobacterium africanum – a type of tuberculous mycobacteria, closely related to *M. tuberculosis*, that can cause a disease similar to TB in humans; it is very rare in the United States

***Mycobacterium avium* complex** – a common type of nontuberculous mycobacteria that can cause disease in humans

Mycobacterium bovis – a type of tuberculous mycobacteria that can cause a disease similar to TB in cows. Before the pasteurization of milk became common practice, these mycobacteria were often spread to humans through contaminated milk; in the United States today, *M. bovis* rarely affects humans

Mycobacterium tuberculosis – the organism that causes TB in humans and is sometimes called the tubercle bacillus; belongs to a group of bacteria called mycobacteria

nontuberculous mycobacteria – mycobacteria that do not cause TB disease and are not usually spread from person to person; one example is *M. avium* complex

pathogenesis – how an infection or disease develops in the body

pulmonary TB – TB disease that occurs in the lungs (about 85% of all U.S. cases), typically causing a cough and an abnormal chest x-ray; pulmonary TB is usually infectious if untreated

silicosis – a lung disease caused by inhaling silica dust, which is used in the production of glass and ceramics; occurs most often in mining and foundry workers

transmission – the spread of an organism, such as *M. tuberculosis*, from one person to another; depends on the contagiousness of the patient, the type of environment, and the length of exposure

tubercle bacilli – another name for *Mycobacterium tuberculosis* organisms, which cause TB disease

tuberculin skin test – a test used to detect TB infection (see **Mantoux tuberculin skin test** or **multiple-puncture test** in glossary)

tuberculous mycobacteria – mycobacteria that can cause TB disease or other diseases very similar to TB; the tuberculous mycobacteria are *M. tuberculosis*, *M. bovis*, and *M. africanum*

READING MATERIAL

History of TB

TB has affected humans for centuries. Until the 1940s and 1950s, there was no cure for TB.

Tuberculosis — a disease also known as consumption, wasting disease, and the white plague — has affected humans for centuries. Until the mid-1800s, people thought that tuberculosis, or TB, was hereditary. They did not realize that it could be spread from person to person through the air. Also, until the 1940s and 1950s, there was no cure for TB. For many people, a diagnosis of TB was a slow death sentence.

Until the 1950s, many people with TB were sent to sanatoriums, special rest homes where they followed a prescribed routine every day.

In 1865 a French surgeon, Jean-Antoine Villemin, proved that TB was contagious, and in 1882 a German scientist named Robert Koch discovered the bacteria that causes TB. Yet half a century passed before drugs were discovered that could cure TB. Until then, many people with TB were sent to sanatoriums, special rest homes where they followed a prescribed routine every day. No one knows whether sanatoriums really helped people with TB; even so, many people with TB could not afford to go to a sanatorium, and they died at home.

In the 1940s and 1950s, drugs were discovered to treat TB. After this, the death rate for TB in the United States dropped dramatically, and fewer and fewer people got TB.

A breakthrough came in 1943. An American scientist, Selman Waksman, discovered a drug that could kill TB bacteria. Between 1943 and 1952, two more drugs were found. After these discoveries, many people with TB were cured, and the death rate for TB in the United States dropped dramatically. Each year, fewer and fewer people got TB.

By the mid-1970s, most TB sanatoriums in the United States had closed. In the next two decades, people began to hope that TB could be eliminated from the United States, like polio and smallpox.

Since the mid-1980s, TB cases have started increasing again.

Even today, TB can be fatal if not treated.

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Since the mid-1980s, however, TB cases have started increasing again. This rise in cases is attributed to several factors, which are discussed further in Module 2, Epidemiology of Tuberculosis. Because of the increase in TB, health departments and other organizations are stepping up their efforts to prevent and control the disease. Even today, TB can be fatal if not treated. A timeline of major events in the history of TB is shown in Figure 1.1.

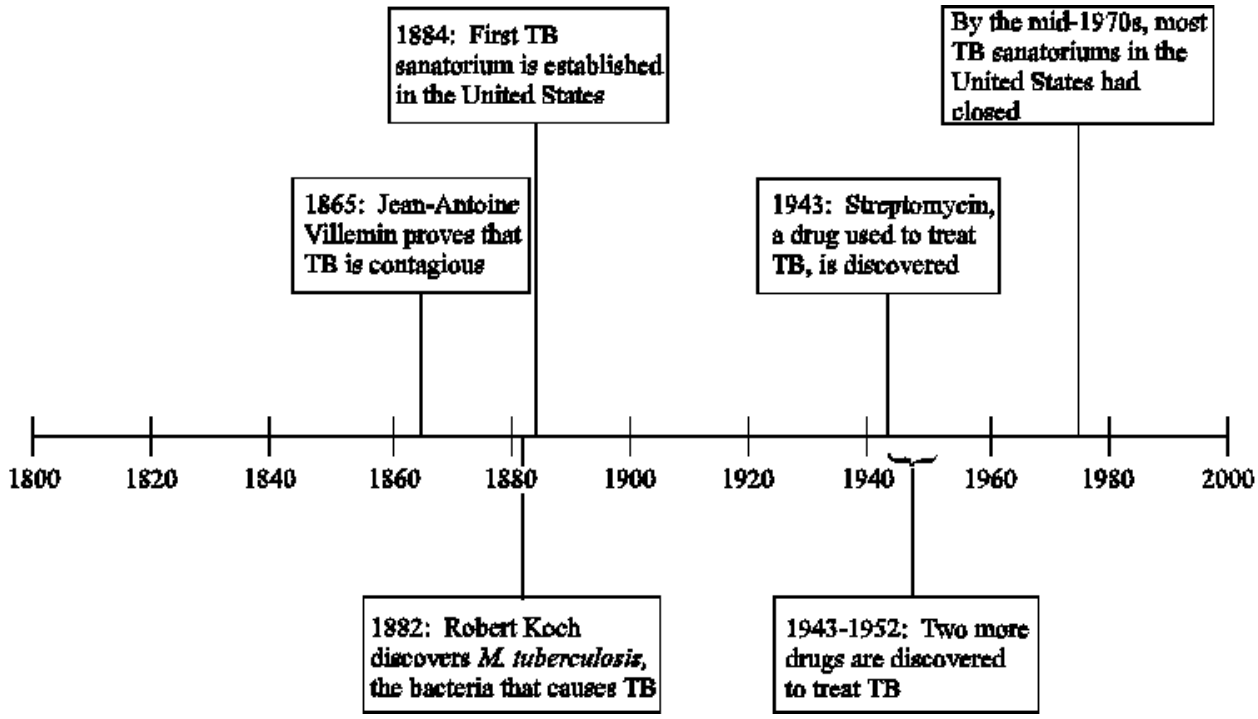

Figure 1.1 Timeline of major events in the history of TB.

Study Question 1.1

1.1. In what year was each of the following discoveries made?

a. TB was proven to be contagious _____

b. The bacteria that causes TB was discovered _____

c. The first drug that could kill TB bacteria was discovered _____

Answers on page 28.

Transmission

TB is caused by an organism called *Mycobacterium tuberculosis.*

TB is caused by an organism called ***Mycobacterium tuberculosis***. *M. tuberculosis* organisms are sometimes called **tubercle bacilli**.

M. tuberculosis is a type of **mycobacteria**. Mycobacteria can cause a variety of diseases. Some mycobacteria are called **tuberculous** mycobacteria because they cause TB or diseases similar to TB. These mycobacteria are *M. tuberculosis, M. bovis,* and *M. africanum*. Other mycobacteria are called **nontuberculous** mycobacteria because they do not cause TB. One common type of nontuberculous mycobacteria is *M. avium* complex. Nontuberculous mycobacteria are NOT usually spread from person to person.

TB is spread from person to person through the air.

TB is spread from **person to person** through the **air**. When a person with **infectious** TB disease (TB that can be spread) coughs or sneezes, 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.

Transmission is the spread of an organism, such as *M. tuberculosis,* from one person to another.

If another person inhales air that contains these droplet nuclei, **transmission** may occur. Transmission is the spread of an organism, such as *M. tuberculosis,* from one person to another (Figure 1.2).

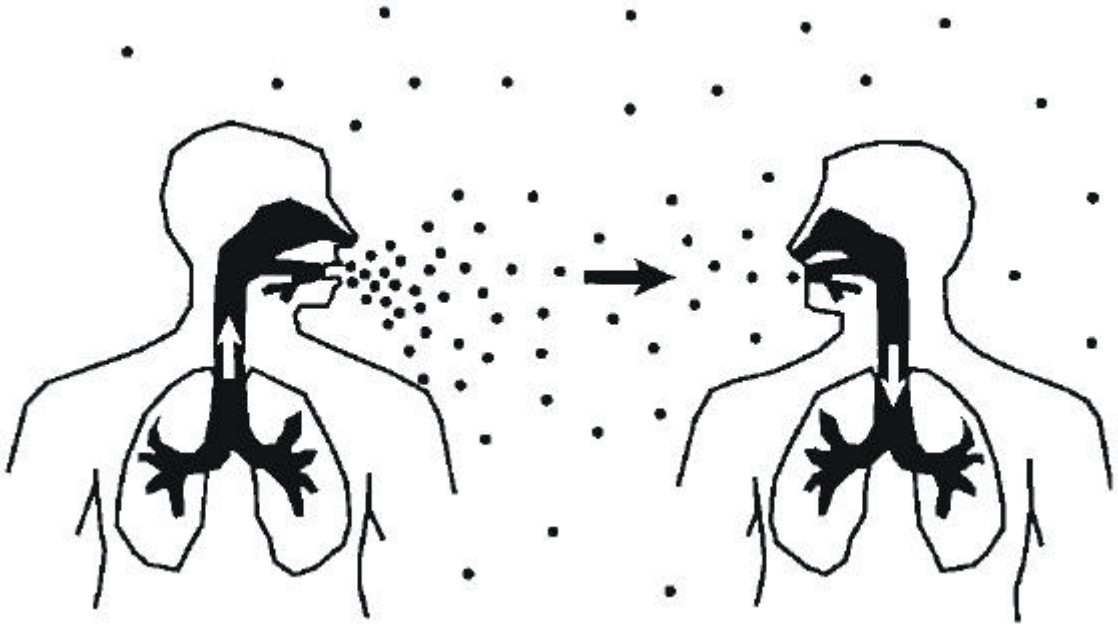

Figure 1.2 Transmission of TB. TB is spread from person to person through the air. The dots in the air represent droplet nuclei containing tubercle bacilli.

Not everyone who is exposed to an infectious TB patient becomes infected.

Not everyone who is exposed to an infectious TB patient becomes infected with *M. tuberculosis.* The probability that TB will be transmitted depends on three factors:

- How contagious is the TB patient?
- In what kind of environment did the exposure occur?
- How long did the exposure last?

The transmission of TB is discussed in more detail in Module 5, Infectiousness and Infection Control.

Study Questions 1.2-1.3

1.2. What organism causes TB? What are two other tuberculous mycobacteria?

1.3. How is TB spread?

Answers on page 28.

Pathogenesis

Infection begins when droplet nuclei reach the alveoli.

When a person inhales air that contains droplets, most of the larger droplets become lodged in the upper respiratory tract (the nose and throat), where infection is unlikely to develop. However, the droplet nuclei may reach the small air sacs of the lung (the **alveoli**), where infection begins (Figure 1.3). The following section describes the **pathogenesis** of TB (the way TB infection and disease develop in the body).

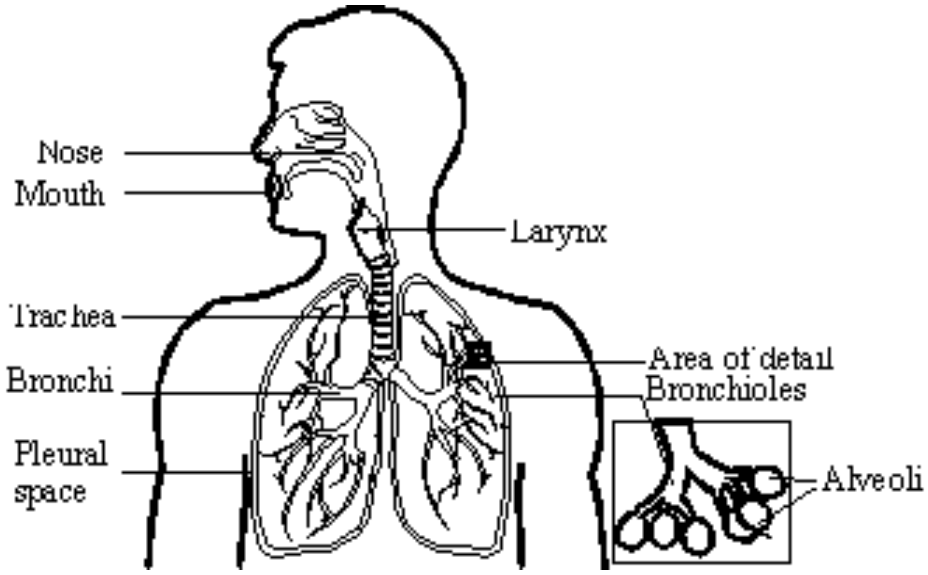

Figure 1.3 The lungs and the alveoli.

At first, the tubercle bacilli multiply in the alveoli and a small number enter the bloodstream and spread throughout the body. Bacilli may reach any part of the body, including areas where TB disease is more likely to develop. These areas include the upper portions of the lungs, as well as the kidneys, the brain, and bone. Within 2 to 10 weeks, however, the body's immune system usually intervenes, halting multiplication and preventing further spread. The **immune system** is the system of cells and tissues in the body that protect the body from foreign substances.

TB infection means that tubercle bacilli are in the body but the immune system is keeping them under control.

TB Infection

TB infection means that tubercle bacilli are in the body but the body's immune system is keeping the bacilli under control. The immune system does this by producing special immune cells that surround the tubercle bacilli. The cells form a hard shell that keeps the bacilli contained and under control.

TB infection is detected by the tuberculin skin test.

TB infection is detected by the **tuberculin skin test**. Most people with TB infection have a positive reaction to the tuberculin skin test. The tuberculin skin test is discussed in more detail in Module 3, Diagnosis of Tuberculosis Infection and Disease.

People who have TB infection but not TB disease are NOT infectious.

People who have TB infection but not TB disease are **NOT infectious** — in other words, they cannot spread the infection to other people. These people usually have a normal chest x-ray. It is important to remember that TB infection is not considered a case of TB. Major similarities and differences between TB infection and TB disease are shown in Table 1.1.

Table 1.1
TB Infection vs. TB Disease

TB Infection	TB Disease (in the lungs)
Tubercle bacilli in the body	
Tuberculin skin test reaction usually positive	
Chest x-ray usually **normal**	Chest x-ray usually **abnormal**
Sputum smears and cultures **negative**	Sputum smears and cultures **positive**
No symptoms	**Symptoms** such as cough, fever, weight loss
Not infectious	**Often infectious** before treatment
Not a case of TB	**A case** of TB

Study Questions 1.4-1.6

1.4. When a person inhales air that contains droplets, where do the droplet nuclei go?

1.5. After the tubercle bacilli reach the small air sacs of the lung (the alveoli), where do they go?

1.6. In people with TB infection (but not TB disease), how does the immune system keep the tubercle bacilli under control?

Answers on pages 28-29.

Study Questions 1.7-1.8

1.7. How is TB infection detected?

1.8. What are the major similarities and differences between TB infection and TB disease? List characteristics of each.

Answers on pages 29-30.

Case Study 1.1

A 30-year-old man visits the health department for a tuberculin skin test because he is required to have one before starting his new job. He has a positive reaction to the tuberculin skin test. He has no symptoms of TB, and his chest x-ray findings are normal.

Should this be considered a case of TB?

Should this man be considered infectious?

Answers on page 33.

TB Disease

TB disease develops when the immune system cannot keep the tubercle bacilli under control and the bacilli begin to multiply rapidly.

Some people with TB infection develop TB disease. TB disease develops when the immune system cannot keep the tubercle bacilli under control and the bacilli begin to multiply rapidly. The risk that TB disease will develop is higher for some people than for others. The pathogenesis of TB infection and disease is shown in Figure 1.4.

TB disease can develop very soon after infection or many years after infection.

TB disease can develop very soon after infection or many years after infection. In the United States, about 5% of the people who have recently been infected with *M. tuberculosis* will develop TB disease in the first year or two after infection. Another 5% will develop disease later in their lives. In other words, **about 10% of all people who have TB infection will develop disease at some point**. The remaining 90% will stay infected, but free of disease, for the rest of their lives (Figure 1.5).

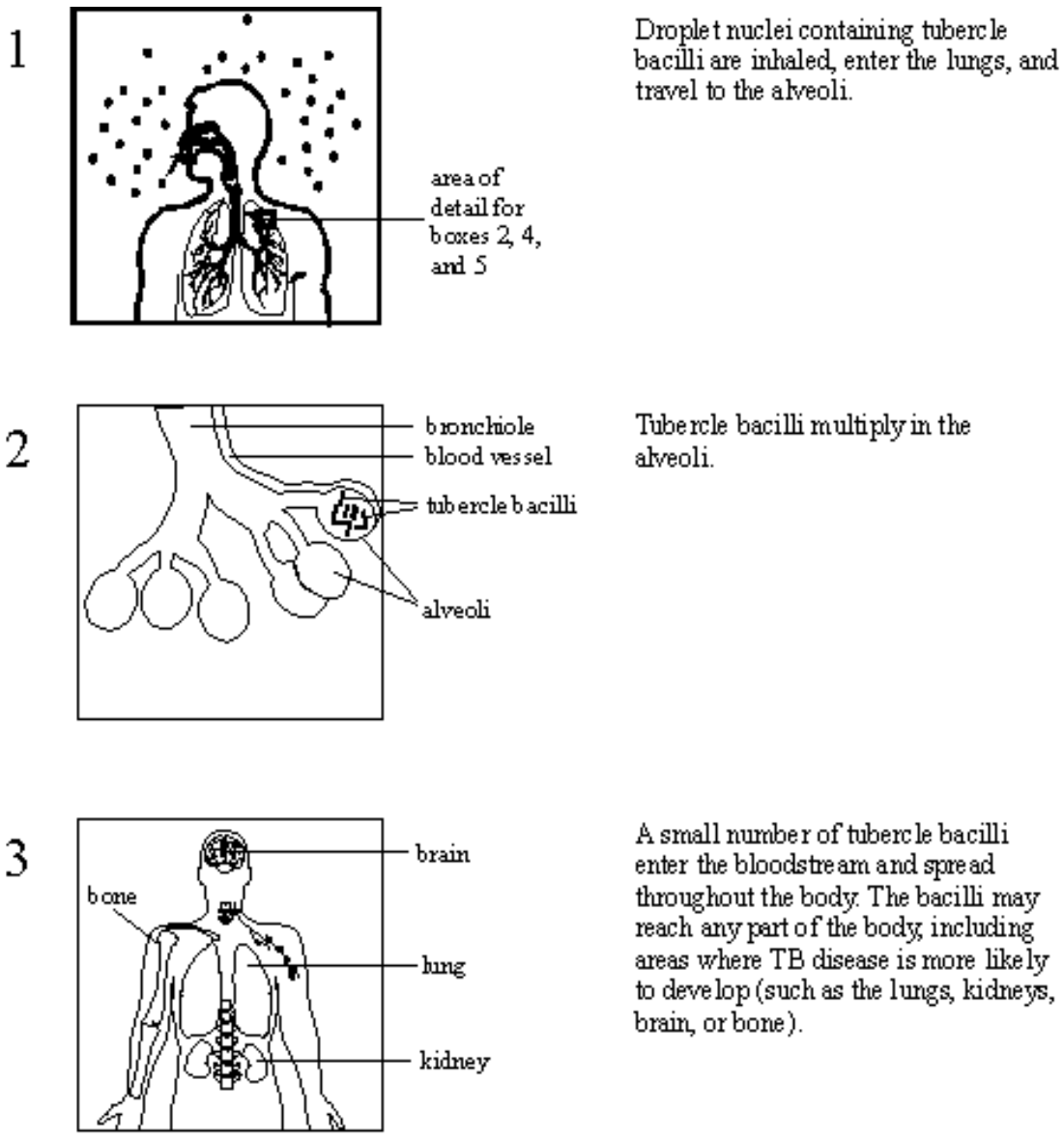

Figure 1.4 Pathogenesis of TB infection and disease.

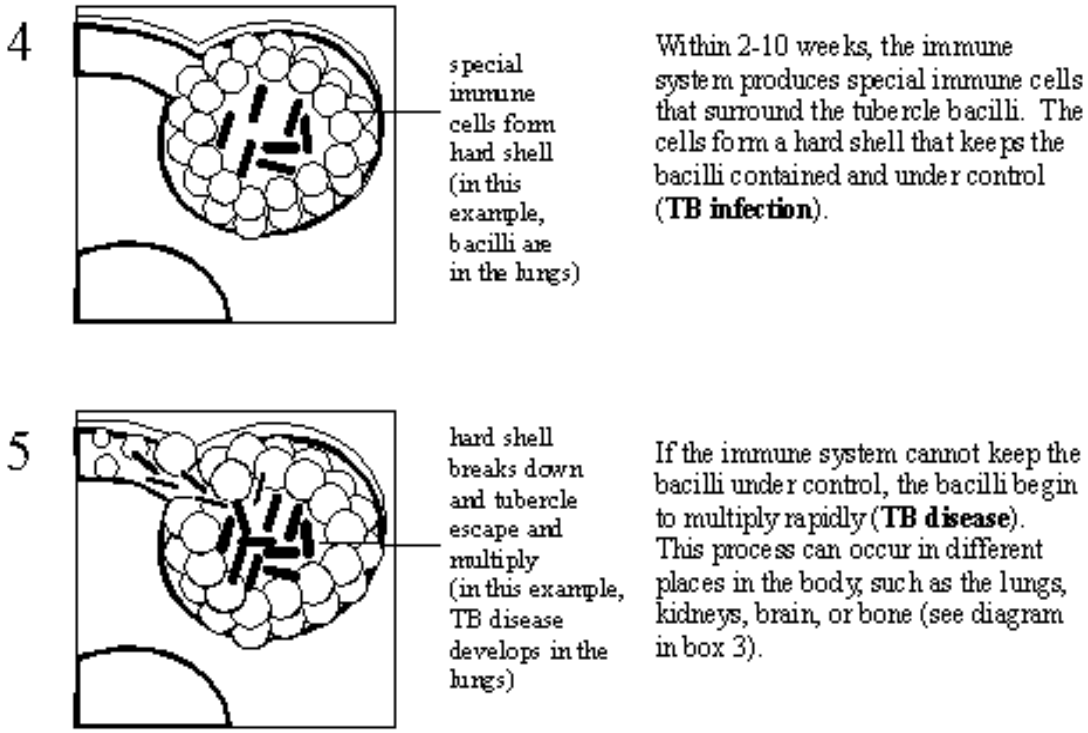

Figure 1.4 Pathogenesis of TB infection and disease (continued).

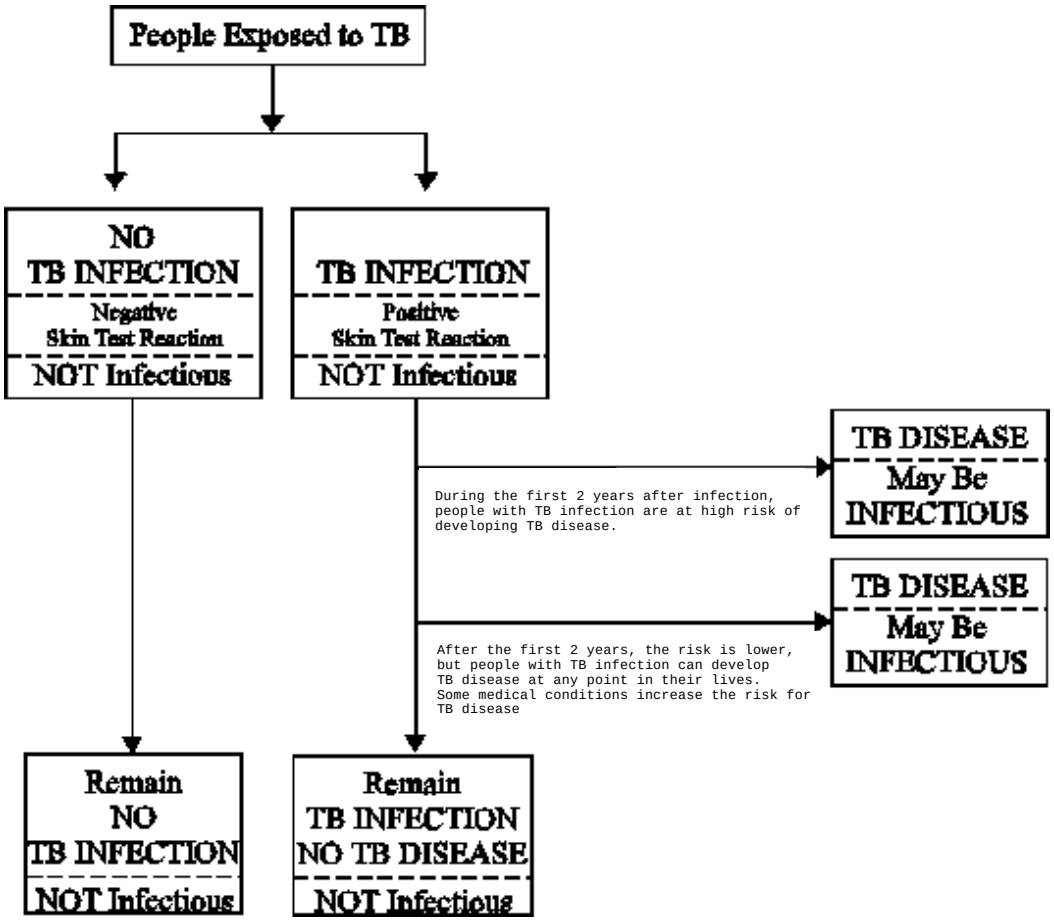

Figure 1.5 Progression of TB. People who are exposed to TB may or may not develop TB infection. People with TB infection may or may not develop TB disease. The risk of developing TB disease is highest in the first 2 years after infection.

About half the risk of developing TB disease is concentrated in the first 2 years after infection.

Because about half the risk of developing TB disease is concentrated in the first 2 years after infection, it is important to detect new infection early. People with TB infection can be given treatment to prevent them from getting TB disease. (This is discussed in Module 4, Treatment of Tuberculosis Infection and Disease.) Thus, detecting new infection early helps prevent new cases of TB.

Table 1.2
Risk Factors for the Development of TB Disease

Risk Factor	How Many Times Higher Is the Risk of TB Disease?[1]
Acquired immunodeficiency syndrome (AIDS)	170
HIV infection	113
Recent TB infection (within past 2 years)	15
Certain medical conditions[2]	3-16

[1] Compared to the risk for people with no known risk factors
[2] For example, diabetes, certain types of cancer, or immunosuppressive therapy

Some conditions appear to increase the risk that TB infection will progress to disease.

Some conditions appear to increase the risk that TB infection will progress to disease (Table 1.2). The risk may be about 3 times higher (as with diabetes) to more than 100 times higher (as with HIV infection) for people who have these conditions than for those who do not. Some of these conditions are

- Infection with **HIV**, the virus that causes **AIDS**
- Injection of illicit drugs
- Recent TB infection (within the past 2 years)
- Chest x-ray findings suggestive of previous TB
- Diabetes mellitus
- Silicosis
- Prolonged therapy with corticosteroids
- Immunosuppressive therapy
- Certain types of cancer (e.g., leukemia, Hodgkin's disease, or cancer of the head and neck)
- Severe kidney disease
- Certain intestinal conditions
- Low body weight (10% or more below ideal)

For definitions of these terms, please see the glossary or the New Terms section at the beginning of this module.

People who are infected with both *M. tuberculosis* and HIV are much more likely to develop TB disease than people who are infected only with M. tuberculosis.

When the immune system is weakened, the body may not be able to control the multiplication and spread of tubercle bacilli. For this reason, people who are infected with both *M. tuberculosis* and HIV are much more likely to develop TB disease than people who are infected only with *M. tuberculosis.* Studies suggest that the risk of developing TB disease is 7% to 10% **each year** for people who are infected with both *M. tuberculosis* and HIV, whereas it is 10% **over a lifetime** for people infected only with *M. tuberculosis.*

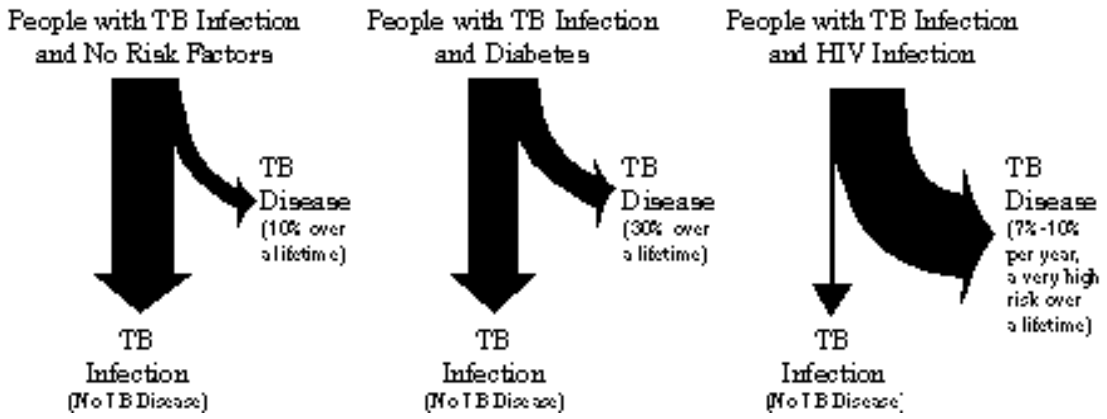

Figure 1.6 Risk of developing TB disease.

Figure 1.6 shows the risk of developing TB disease for three different groups of people. For people with TB infection and no risk factors, the risk is about 10% over a lifetime. For people with TB infection and diabetes, the risk is 3 times as high, or about 30% over a lifetime. For people with TB infection and HIV infection, the risk is about 7% to 10% PER YEAR, a very high risk over a lifetime.

In an HIV-infected person, TB disease can develop in either of two ways. First, a person who has TB infection can become infected with HIV and then develop TB disease as the immune system is weakened. Second, a person who has HIV infection can become infected with *M. tuberculosis* and then rapidly develop TB disease.

Study Questions 1.9-1.12

1.9. What happens if the immune system cannot keep the tubercle bacilli under control and the bacilli begin to multiply rapidly?

1.10. What percentage of people who have TB infection (but not HIV infection) develop TB disease?

1.11. What conditions appear to increase the risk that TB infection will progress to disease?

1.12. How does being infected with both *M. tuberculosis* and HIV affect the risk for TB disease?

Answers on pages 30-31.

Case Study 1.2

A 45-year-old woman is referred to the health department by her private physician because she was found to have TB infection. She is an obese woman who has high blood pressure and heart problems. Upon further questioning, she reports that she has injected illicit drugs in the past but has never been tested for HIV infection.

\# **What conditions does this woman have that increase the risk that she will develop TB disease?**

Answer on page 33.

Sites of TB Disease

Pulmonary TB occurs in the lungs.

TB disease can occur in different places in the body (Figure 1.7). **Pulmonary TB** is TB that occurs in the lungs. About 85% of TB cases are pulmonary. Most patients with pulmonary TB have a cough and an abnormal chest x-ray, and they should be considered infectious until they meet certain criteria (see Module 5, Infectiousness and Infection Control).

Extrapulmonary TB occurs in places other than the lungs.

Extrapulmonary TB occurs in places other than the lungs, such as the larynx, the lymph nodes, the pleura (the membrane surrounding each lung), the brain, the kidneys, or the bones and joints. Extrapulmonary TB occurs more often in people who are infected with HIV than in people who are not infected with HIV. In HIV-infected people, extrapulmonary TB is often accompanied by pulmonary TB. Most types of extrapulmonary TB are not considered infectious (this will be discussed in Module 5, Infectiousness and Infection Control).

Miliary TB occurs when tubercle bacilli enter the bloodstream and are carried to all parts of the body, where they grow and cause disease in multiple sites.

Miliary TB occurs when tubercle bacilli enter the bloodstream and are carried to all parts of the body, where they grow and cause disease in multiple sites. This condition, which is rare but serious, is called miliary TB because the chest x-ray has the appearance of millet seeds scattered throughout the lung.

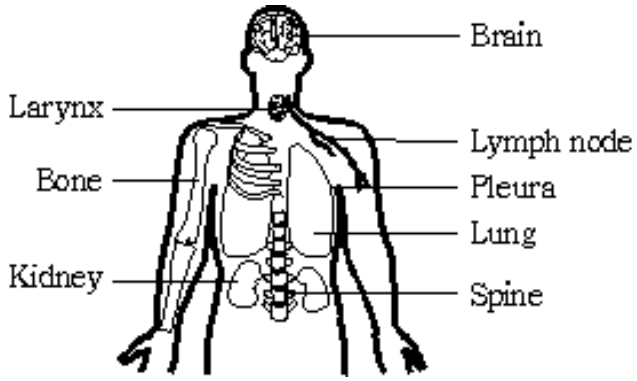

Figure 1.7 Common sites of TB disease.

The current classification system is based on the pathogenesis of TB.

Classification System

Many systems have been used to classify people who have TB. The current classification system (Table 1.3) is based on the pathogenesis of TB. Many health departments and private health care providers use this system when describing patients. Thus, it is important for public health workers to be familiar with this system. In particular, public health workers should be aware that any patient with a classification of 3 or 5 should be receiving treatment for TB, and the case or suspected case should be reported.

Table 1.3
Classification System for TB

Class	Type	Description
0	No exposure to TB Not infected	No history of exposure, negative reaction to the tuberculin skin test
1	Exposure to TB No evidence of infection	History of exposure, negative reaction to a tuberculin skin test given at least 10 weeks after exposure
2	TB infection No TB disease	Positive reaction to the tuberculin skin test, negative smears and cultures (if done), no clinical or x-ray evidence of TB disease
3	Current TB disease	Positive culture for *M. tuberculosis* (if done), **or** A positive reaction to the tuberculin skin test and clinical or x-ray evidence of current TB disease
4	Previous TB disease (not current)	Medical history of TB disease, **or** Abnormal but stable x-ray findings for a person who has a positive reaction to the tuberculin skin test, negative smears and cultures (if done), and no clinical or x-ray evidence of current TB disease
5	TB suspected	Signs and symptoms of TB disease, but evaluation not complete

Study Questions 1.13-1.14

1.13. What site of the body is the most common site for TB disease? What are some other common sites?

1.14. What is the classification system for TB based on? What is it used for?

Answers on page 32.

SUMMARY

TB has affected humans for centuries. Until the 1940s and 1950s, there was no cure for TB. Many people with TB were sent to sanatoriums, special rest homes where they followed a prescribed routine every day. After drugs were discovered to treat TB, many people with TB were cured, and the death rate for TB dropped dramatically.

TB is caused by an organism called *Mycobacterium tuberculosis* that is spread from person to person through the air. *M. tuberculosis* organisms are sometimes called tubercle bacilli. When a person with infectious TB disease coughs or sneezes, droplet nuclei containing tubercle bacilli may be expelled into the air. Other people may inhale the air containing these droplet nuclei and become infected.

TB infection begins when the tubercle bacilli multiply in the small air sacs of the lungs. A small number enter the bloodstream and spread throughout the body, but the body's immune system usually keeps the bacilli under control. People who have TB infection but not TB disease do not have symptoms of TB, and they cannot spread TB to others. They usually have a positive reaction to the tuberculin skin test.

In some people who have TB infection, the immune system cannot keep the tubercle bacilli under control and the bacilli begin to multiply rapidly, causing TB disease. This can happen very soon after infection or many years after infection. About 10% of people who have TB infection will develop disease at some point, but the risk is greatest in the first year or two after infection. Also, the risk is higher for people with certain medical conditions, such as HIV infection, than for other people.

TB disease usually occurs in the lungs (pulmonary TB), but it can also occur in other places in the body (extrapulmonary TB). Miliary TB occurs when tubercle bacilli enter the bloodstream and are carried to all parts of the body, where they grow and cause disease in multiple sites.

Additional Reading

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DuBos R, DuBos J. *The White Plague: Tuberculosis, Man, and Society.* New Brunswick, NJ: Rutgers University Press; 1987.

Ryan F. *The Forgotten Plague: How the Battle Against Tuberculosis Was Won — And Lost.* Boston: Little, Brown and Co; 1992.

ANSWERS TO STUDY QUESTIONS

1.1. In what year was each of the following discoveries made? (page 5)

a. TB was proven to be contagious 1865

b. The bacteria that causes TB was discovered 1882

c. The first drug that could kill TB bacteria was discovered 1943

1.2. What organism causes TB? What are two other tuberculous mycobacteria? (page 8)

TB is caused by an organism called *Mycobacterium tuberculosis. M. bovis* and *M. africanum* are two other tuberculous mycobacteria.

1.3. How is TB spread? (page 8)

TB is spread from person to person through the air. When a person with infectious TB disease coughs or sneezes, 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.

1.4. When a person inhales air that contains droplets, where do the droplet nuclei go? (page 10)

Most of the larger droplets become lodged in the upper respiratory tract, where infection is unlikely to develop. However, the droplet nuclei may reach the small air sacs of the lung (the alveoli), where infection begins.

1.5. After the tubercle bacilli reach the small air sacs of the lung (the alveoli), where do they go? (page 11)

At first, the tubercle bacilli multiply in the alveoli and a small number enter the bloodstream and spread throughout the body. Bacilli may reach any part of the body, including areas where TB disease is more likely to develop. These areas include the upper portions of the lungs, as well as the kidneys, the brain, and bone. Within 2 to 10 weeks, however, the body's immune system usually intervenes, halting multiplication and preventing further spread.

1.6. In people with TB infection (but not TB disease), how does the immune system keep the tubercle bacilli under control? (page 11)

The immune system produces special immune cells that surround the tubercle bacilli. The cells form a hard shell that keeps the bacilli contained and under control.

1.7. How is TB infection detected? (page 12)

TB infection is detected by the tuberculin skin test.

1.8. What are the major similarities and differences between TB infection and TB disease? List characteristics of each. (page 12)

TB infection

Tubercle bacilli are in the body.
The tuberculin skin test reaction is positive.
Usually the chest x-ray is normal.
Sputum smears (or smears from other specimens) and cultures are negative.
People with TB infection (but not TB disease)
    - Q Do not have symptoms (are not sick)
    - Q Are not infectious
    - Q Are not counted as having a case of TB

TB disease

Tubercle bacilli are in the body.

The tuberculin skin test reaction is positive.

Usually the chest x-ray is abnormal (if the disease is in the lungs).

Sputum smears (or smears from other specimens) and cultures are usually positive for *M. tuberculosis.*

People with TB disease

  Q Usually have symptoms (are sick)

  Q Are often infectious before treatment

  Q Are counted as having a case of TB

1.9. What happens if the immune system cannot keep the tubercle bacilli under control and the bacilli begin to multiply rapidly? (page 15)

When this happens, TB disease develops. The risk that TB disease will develop is higher for some people than for others.

1.10. What percentage of people who have TB infection (but not HIV infection) develop TB disease? (page 15)

In the United States, about 5% of the people who have recently been infected with *M. tuberculosis* will develop TB disease in the first year or two after infection. Another 5% will develop disease later in their lives. In other words, about 10% of all people who have TB infection will develop disease at some point. The remaining 90% will stay infected, but free of disease, for the rest of their lives.

1.11. What conditions appear to increase the risk that TB infection will progress to disease? (page 19)

HIV infection
Injection of illicit drugs
Recent TB infection (within the past 2 years)
Chest x-ray findings suggestive of previous TB
Diabetes mellitus
Silicosis
Prolonged therapy with corticosteroids
Immunosuppressive therapy
Certain types of cancer (e.g., leukemia, Hodgkin's disease, or cancer of the head and neck)
Severe kidney disease
Certain intestinal conditions
Low body weight (10% or more below ideal)

1.12. How does being infected with both *M. tuberculosis and* HIV affect the risk for TB disease? (pages 20-21)

Because their immune systems are weakened, people who are infected with both *M. tuberculosis* and HIV are much more likely to develop TB disease than people who are infected only with *M. tuberculosis.* Studies suggest that the risk of developing TB disease is 7% to 10% each year for people who are infected with both *M. tuberculosis* and HIV, whereas it is 10% over a lifetime for people infected only with *M. tuberculosis.*

In an HIV-infected person, TB disease can develop in either of two ways. First, a person who has TB infection can become infected with HIV and then develop TB disease as the immune system is weakened. Second, a person who has HIV infection can become infected with *M. tuberculosis* and then rapidly develop TB disease.

1.13. What site of the body is the most common site for TB disease? What are some other common sites? (page 23)

Lungs are the most common site.

Other common sites:

Larynx

Lymph nodes

Pleura (the membranes surrounding the lungs)

Brain

Kidneys

Bones and joints

1.14. What is the classification system for TB based on? What is it used for? (page 24)

The current classification system is based on the pathogenesis of TB. Many health departments and private health care providers use this system when describing patients.

ANSWERS TO CASE STUDIES

1.1. A 30-year-old man visits the health department for a tuberculin skin test because he is required to have one before starting his new job. He has a positive reaction to the tuberculin skin test. He has no symptoms of TB, and his chest x-ray findings are normal.

 # Should this be considered a case of TB?

The man described above has TB infection, and he has no evidence of TB disease. Therefore, this is not a case of TB.

 # Should this man be considered infectious?

No, he should not be considered infectious. This man has TB infection, not TB disease. People with TB infection and no evidence of TB disease are not infectious. (Note that sputum tests were not done. Sputum tests are not necessary when a person has no symptoms of TB and has normal chest x-ray findings. However, if they had been done, we would expect them to be negative.)

1.2. A 45-year-old woman is referred to the health department by her private physician because she was found to have TB infection. She is an obese woman who has high blood pressure and heart problems. Upon further questioning, she reports that she has injected illicit drugs in the past but has never been tested for HIV infection.

 # What conditions does this woman have that increase the risk that she will develop TB disease?

One condition is injection of illicit drugs. This condition increases the risk that TB infection will progress to TB disease. Another possible condition is HIV infection. This woman is at risk for HIV infection, which is the strongest known risk factor for developing TB disease. This woman should undergo HIV counseling and testing.

Obesity, high blood pressure, and heart problems are NOT risk factors for TB disease.