

TEACHER KEY

Unit 2: Etiology
Activity 2: TB Transmission

Description:

Students will read the online exhibition section “Etiology” and complete an activity sheet that asks them to correctly order the steps in the progression of TB infection.

Time:

Exhibition review: 15 minutes

Activity Sheet: 10 minutes + 5 minutes review

Objectives:

- To demonstrate understanding of the steps of TB infection, including the role of immune response.

Curriculum Links:

Reading	1. Reading for Meaning	1.4 demonstrate understanding of a variety of texts by summarizing important ideas and citing supporting details
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Materials:

Online exhibition Fighting for Breath: Stopping the TB epidemic :

<http://museumofhealthcare.ca/explore/exhibits/breath/>

Handout

Procedure:

1. Ask students to read-through the exhibition pages Etiology – Introduction to TB and Etiology – A Perfect Breeding Ground.
2. Provide students with the worksheet and ask them to complete it. It is recommended that students have access to the exhibition while completing the work-sheet.
3. Review the work-sheet with the students and clarify any common misconceptions.

Background Info:

Tuberculosis is caused by an infection with *Mycobacterium tuberculosis*, rod-shaped bacteria that are spread mostly through air-born droplets or dust **microparticles** of dried **sputum**. Once inhaled, the body’s immune system typically reacts by **engulfing** the bacteria, forming a **tubercle** that contains the bacteria to help keep it from spreading. In most cases, the bacteria will die; in others, however, the bacteria can survive, become **dormant**, and the infected individual may develop active disease at a later date, sometimes soon after infection, sometimes years later.

Those who develop active pulmonary tuberculosis experience a range of signs and symptoms, including chest pain, cough, weight loss, pallor, fever, and night sweats.

TEACHER KEY

People with suppressed immune systems, such as persons with HIV and AIDS, are much more likely to develop active tuberculosis.

Only those with active TB are able to spread it, by coughing or sneezing. These actions release the bacteria from the lungs into the air, where it can be inhaled by others. The bacteria are able to survive in the air for several hours, but are weakened by direct sunlight.

Animals and humans are also affected by other related bacteria in the *Mycobacterium tuberculosis* complex, such as *Mycobacterium bovis*. The bacteria infect cows, buffalo, deer, and elk, among others. It can be transmitted to humans through **unpasteurized** milk and cheeses. The recognition of this led many governments to regulate dairy herds and the **pasteurization** of milk in the early twentieth century.

Process of Infection

Caption 1: Inhalation

The bacteria are inhaled. The majority of the bacteria will become lodged in the upper respiratory tract, namely the nose and throat, where their survival is difficult. Some of the smaller particles, though, will make it into the lungs and alveoli where infection sets in. Alternatively, the bacteria might be ingested, for example through infected milk products.

Caption 2: Bacteria multiplication

In the alveoli, the bacteria are **engulfed** by unactivated **macrophages** – white blood cells present within tissues - where they multiply until the macrophage bursts. The mycobacterium tuberculosis replicates very slowly, only once every twenty four hours, and takes up to one month to form a colony; in comparison, the *E. coli* bacteria form a colony in only eight hours.

Caption 3: T-cell activation

Dendritic cells are a key part of the mammalian immune system. They are present in our bodies where our tissues are in contact with the external environment, such as the skin and the lung alveolae. When dendritic cells detect foreign substances entering the body, they **engulf** them, process them into small molecular fragments (potential **antigens**) and bring them to the lymph nodes where they present the **antigens** to certain white blood cells called T-cells. If the T cell has a specific receptor for the presented **antigen** it will become activated to release potent molecules, such as **interferon-gamma** and **tumour necrosis factor**, which in turn stimulate **macrophages** and other T cells to produce a cell-mediated response against the bacteria carrying those **antigens**. Because it takes 48-72 hours to produce a cell-mediated response in the skin of an already sensitized individual, this reaction is called "delayed hypersensitivity."

Caption 4: Tubercle Formation

The T-cells return to the site of infection through the blood stream, where they contribute to the formation of a **tubercle**, or granuloma. The TB **tubercle** is made up of a core of

TEACHER KEY

infected **macrophages**, a surrounding ring of foamy **macrophages** (so named because the **macrophages** have ingested LDL cholesterol, causing them to appear foamy), and an outside ring of T-cells, all enveloped in a fibrous shell.

In some cases, an individual's immune system is unable to defend against the bacteria by creating a **tubercle** to isolate it. Primary progressive tuberculosis occurs as a result. This is mostly seen in young children or individuals with very suppressed immune systems.

When contained inside the granuloma the bacteria are inactive and the case of tuberculosis is considered to be **latent**. The bacteria are contained in the granuloma until the immune system is weakened, breaking down the outer ring of the **tubercle**, releasing the bacteria inside. In this situation, the case of tuberculosis has been reactivated and is known as secondary progressive tuberculosis. Only approximately 3-5% of immunocompetent individuals will develop secondary progressive tuberculosis within two years of the primary infection, and a further 3-5% will develop it after two years.

Caption 5: Cavitation and Tubercle break-down

In some cases, the damaged cells at the centre of the granuloma liquefy. The bacteria grow well in this liquid, multiplying outside of macrophages, their typical hosts. As they multiply, the **tubercle** enlarges. This can cause nearby tissue in the lungs to die and rupture, forming a cavity, or the **tubercle** to burst spreading bacteria further around the lungs or the body. This would also be considered a case of secondary progressive tuberculosis. The immune system will respond as per steps 3 & 4 when the bacteria are recognized in their new locations.

TEACHER KEY

Unit 2: Etiology

ANSWER SHEET: TB Transmission

1. Order the following list of steps involved in becoming infected with pulmonary tuberculosis.
- 5 TB bacteria are contained within the tubercle and infection is considered latent.
- 4 T-cells recognize the particles of TB bacteria as a threat. They help to form a tubercle around the bacteria to isolate them and protect the body.
- 2 The immune system responds to the foreign bacteria. Macrophages, white blood cells, engulf the TB bacteria but the bacteria are able to multiply and burst out of the macrophages.
- 1 The bacteria are inhaled and enter the lungs.
- 3 Dendritic cells engulf the TB bacteria, break them down into small particles, and transport the particles to the lymph nodes.
- 6 If the immune system is weakened the tubercle may break down, releasing bacteria back out into the body causing renewed active infection.

