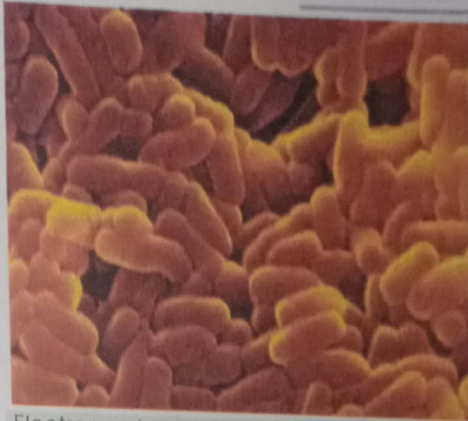


Bacterial pathogens cause diseases in respiratory tract and skin such as tuberculosis, whooping cough, pneumonia, diphtheria, etc. Generally these diseases spread in a densely crowded population and polluted environment.

## 1. Tuberculosis

For the first time Robert Koch identified *Mycobacterium tuberculosis* as the causal agent of TB (tuberculosis). During that period TB caused 1/7 of death in Europe. At present TB is the global health problem. About 20% of the world's population is suffering from TB and about 8 million people are victimised each year. Approximate annual death is 3 million.

Commonly tuberculosis occurs among the homeless, malnourished persons or alcoholic drinkers. This bacterium spreads through droplet nuclei and the respiratory route. Bovine tuberculosis is caused by *M. bovis* in cows and cattles. It is equally dangerous. *M. bovis* spreads to humans through contaminated milk.



Electron micrograph of *Mycobacterium tuberculosis*, the rod like bacteria that is the causative agent of tuberculosis in humans.

*Mycobacterium* is rod-shaped and acid fast (stained with acid fast technique by Ziehl-Neelsen Carbofuchsin stain). Therefore, the cells take red stain. The bacterium infects the respiratory tract and established in lung tissues. After being phagocytosed by macrophages the bacteria are enclosed into the small and hard tubercles which are the characteristic feature of the disease. Hence it gives the name of disease as tuberculosis. In X-rays tubercles can be observed. The symptoms include cough, pain in chest, fever and secretion called sputum. The sputum appears red or rust coloured if mixed with blood in lung cavity. Bacteria remain alive in macrophages. Sometimes the tubercle lesions liquefy and form air-filled cavities where from bacteria can spread new foci of infections throughout the body. This spreading is called miliary tuberculosis due to development of millet seed like many tubercles (Bloom, 1994).

(i) **Immunity:** Against infection by *M. tuberculosis* patients develops a cell mediated immunity which involves the sensitized T cells. It is the basis of **tuberculin skin test**. In this test a purified protein derivative of *M. tuberculosis* is injected into the patients (**Mantoux test**). If the pathogen is present in body of patient, sensitized T cells react with these proteins. Thereafter, a hypersensitivity reaction occurs with in 48 hours. Consequently around the injected site there appears hardening and reddening area.

(ii) **Diagnosis of Tuberculosis :** Laboratory diagnosis of tuberculosis includes isolation of the acid-fast bacterium, chest X-ray by commercially available DNA probe, HPLC test, the Mantoux or tuberculin skin test.

Chemotherapy is done by administering isonizid plus rifampin, ethambutol and pyrazinamide. These are administered simultaneously for 12 to 24 months. BCG (Bacillus-Calmette-Guerine) vaccine is used for treatment of tuberculosis.

## 2. Diphtheria

Diphtheria (Greek *diphthera* means membrane, and *ia* means conditions) is a serious air-borne contagious disease. It is caused by *Corynebacterium diphtheriae* which is a Gram-positive bacterium. Like tuberculosis, diphtheria also occurs in poor people living in crowded condition.

*C. diphtheriae* is club-shaped and contains many metachromatic granules in cytoplasm. It is associated with leathery membrane. In India, it has a major problem. It is inhaled through droplets and reaches to respiratory tract and infects it. Typical symptoms of diphtheria include a thick mucopurulent (containing mucus and pus) nasal discharge, vomiting, headache, fever, cough and stiffness in the neck and back.

The bacteria produces diphtheria toxin which is an exotoxin that causes an inflammation and greyish pseudomembrane on respiratory mucosa. The exotoxin is absorbed by the body into the circulatory system and transported through out the body.

Hence, it may destroy kidney, nervous tissues and even heart by producing toxic proteins which is called diphtheria toxin.

Diphtheria is diagnosed by culturing the bacterium and observation of pseudomembrane in throat. To neutralize the effect of endotoxin, generally antitoxin is given. Penicillin and erythromycin are prescribed for the treatment of infection.

Sometimes cutaneous diphtheria also develops when *C. diphtheriae* infects skin, skin lesions or wounds causing slow healing ulceration. This disease occurs when people of over 30 years age have a weakened immunity, particularly living in tropical regions. Worldwide immunization programme is being launched with the DPT (diphtheria-pertussis-tetanus) vaccine.



*Corynebacterium diphtheriae*, a Gram-positive bacterium causes diphtheria.

## 3. Meningitis

Meningitis (Greek *meninx* means membrane and *itis* means inflammation) is an inflammation of meninges (membranes) of brain or spinal cord. This disease is caused by bacteria, fungi or viruses and, therefore, divided into two: bacterial meningitis or septic meningitis and the aseptic meningitis syndrome (Table 25.1).

Due to a large number of causes of meningitis, accurate identification of causative agents must be done before the treatment of disease. The respiratory secretion of carriers acts as a source of meningitis. The bacteria colonize the nasopharynx and cross the mucosal barrier. Thereafter, these enter the blood stream and cerebrospinal fluid. Consequently, they cause inflammation of the meninges.

## Typhoid Fever

Typhoid (Greek *typhoides* means smoke) fever is caused by *Salmonella typhi* which is a Gram-negative, rod-shaped bacterium resistant to environmental conditions. Fresh water and food act as reservoir of the bacterium. However, it spreads through contaminated water.

**Typhoid Mary** : During 1900s thousands of typhoid fever cases and a few deaths were reported in the U.S.A. Most of these cases arose due to drinking of contaminated water or eating foods handled by persons suffering from typhoid fever and shedding *S. typhi*. One of the most famous carriers of this disease was Mary Mallon. Mary Mallon worked as cook in seven houses in New York City between 1896 and 1906. During the time of her work in these homes, 28 cases of typhoid fever occurred. The New York City Health Department arrested Mary and admitted to the hospital. Mary's stool was examined. She was found to carry typhoid fever bacteria but she did not show external symptoms of the disease. In 1908, an article was published in the *J. Amer. Med. Ass.* as "Typhoid Mary". After being released she pledged not to act as cook. But she changed her name and began to work as cook again. For five years she spread typhoid by shedding bacteria. She was again arrested and held in custody for 23 years until she died in 1938. During her life time, she was linked with 10 outbreaks of typhoid fever, 53 cases and 3 deaths. Thus, Mary was one of the most famous typhoid carriers.

*S. typhi*, after ingestion/drinking of water, colonize the small intestine, penetrate the epithelium and spread to lymphoid tissues, blood, liver and gall bladder. Symptoms include fever, headache, abdominal pain and malaise. This remains as such for several weeks. After 3 months most of the patients do not shed bacteria, whereas a few of them do for prolonged time without external symptoms. In these patients bacteria grow in gall bladder, and reach to intestine.

Laboratory diagnosis is made by demonstrating the bacteria in stool, urine and blood, and also through serological test (Widal test). The preventive and control measures include (i) purification of drinking water, milk pasteurization, and prevention of handling of food by carriers, (ii) complete isolation of the carriers, (iii) use of antibiotics such as ceftizoxime, trimethoprim-sulfamethoxazole or ampicillin, and (iv) use of vaccine for high risk individuals.

### III. Soil-Borne Diseases

#### 1. Tetanus

Tetanus (Greek *tetanos* means to stretch) is caused by *Clostridium tetani*. *C. tetani* is a Gram-positive, anaerobic and spore-forming bacterium, the endospores of