

Introduction to Medical Microbiology

Medical microbiology is a broad and diverse field. It is a discipline that encompasses the study of infectious diseases in terms of virulence, epidemiology, host-pathogen interactions, and normal flora. It encompasses all pathogens, ranging from viruses and prions, to common human pathogenic bacteria and fungi responsible for mycoses, to macroscopic parasites such as eukaryotic protozoa and arthropods. Robert Koch's postulates have been of considerable importance in understanding the pathogenicity of these agents and thus opening a new chapter.

Medical microbiology is based on the study of microorganisms responsible for infections in humans. Specialties within microbiology include:

- Bacteriology, which studies bacteria (single-celled microorganisms belonging to a distinct kingdom, observed under a light microscope);
- Virology, which studies viruses;
- Mycology, which studies yeasts and fungi;
- Parasitology, which studies parasites such as tapeworms (endoparasites) and lice (ectoparasites).

Infectious diseases are the most common cause of death in developing countries, and their diagnosis and treatment pose significant challenges for healthcare systems in these regions. The World Health Organization has long been actively involved in the development and promotion of standardized techniques for laboratory testing of these diseases; an initial attempt to standardize the study of the susceptibility of pathogenic bacteria was made in 1950.

According to the health situation analysis included in the WHO's Eighth General Program of Work, communicable diseases continue to account for an excessively high proportion of health budgets in developing countries. There are still risks of epidemics and pandemics of viral or bacterial origin, particularly given that epidemiological surveillance and preventive measures are inadequate. To prevent and combat the major bacterial diseases, it is necessary to develop simple tools for epidemiological surveillance and disease control, as well as simple and reliable diagnostic techniques.

Thus, to effectively address the situation, public health laboratory services must rely on a network of laboratories that perform microbiological diagnostic tests for health centers, hospital physicians, and epidemiologists.

- Infectious Agents

Infectious agents affecting humans encompass a wide range of forms and levels of complexity. They include bacteria, viruses, certain fungi, and certain parasites. When one of these infectious agents comes into contact with a susceptible person, it can cause an infectious disease to develop. The signs of an infectious disease, its severity, and its treatment vary depending on the microbe involved and the host's state of health.

➤ Bacteria

Bacteria are living cells. Some are beneficial to the body (such as those in the digestive tract, for example, which aid in digestion), while others are pathogenic (such as Koch's bacillus, which causes tuberculosis). When a bacterium attacks the body, the body's natural defenses fight off the infection. Sometimes, antibiotics are necessary. These prevent bacteria from multiplying. Certain conditions (such as cancer and AIDS) and certain treatments (such as chemotherapy and corticosteroids) weaken the body's defenses and make it more susceptible to infections.

➤ Viruses

Viruses are microbes that are much smaller than bacteria. They can survive only inside a living cell. They can be aggressive, but most of the time, the body gets rid of them on its own. Some, however, are more aggressive and dangerous. Specific medications can effectively combat certain viruses (for example, herpes). Antibiotics, on the other hand, are ineffective.

➤ Fungi

Diseases caused by fungi are called fungal infections. Generally, fungi infect the skin and mucous membranes (in the mouth and genital area). Their occurrence is facilitated by a weakened skin barrier (for example, in cases of eczema or irritated, moist skin), but also when taking antibiotics or in the presence of certain conditions, such as diabetes.

In some rarer cases of debilitating illness, fungi can invade other parts of the body (such as the lungs).

➤ Parasites

Parasites are microorganisms that can be more or less aggressive. They invade all or part of the body. Others, such as tapeworms and pinworms, are less aggressive parasites that reside solely in the digestive tract.

Table 1 below lists some infectious diseases caused by various infectious agents:

Table1: Some Infectious Diseases by Infectious Agent.

Bacterial	Viral	Fungal	Parasitic
• Typhoid • Cholera • Tuberculosis • Leprosy • Tetanus • Diphtheria • Gonococcal • Chlamydia • Syphilis • Leptospirosis • Scrub typhus • UTI • Meningitis • Bacterial dysentery	• Hepatitis A,B,C,D,E • HIV • Chicken pox • Dengue • Chikungunya • Japanese encephalitis (JE) • H1N1 • SARS • Ebola • Nipah • HPV • Measles • Encephalitis	• Candidiasis • Cryptococcosis • Aspergillosis • Penicilliosis	• Malaria • Filaria • Amoebiasis • Leishmaniasis • Kala azar

Some infectious diseases by infectious agent.

1. Diseases Caused by Bacteria

- Whooping cough** is a respiratory disease caused by the bacterium *Bordetella pertussis*. It is highly contagious and spreads through the air. It causes frequent and prolonged coughing fits. It is a serious illness when it occurs in infants and frail individuals.
- Diphtheria** is a disease caused by several species of corynebacteria in the *diphtheriae* complex. Typical diphtheria is a respiratory infection that affects the central nervous system, the throat, or other organs, leading to death by asphyxiation.
- Tetanus** is an infectious disease caused by the environmental bacterium *Clostridium tetani*, which is found primarily in soil, dust, and plants. It is a toxic infection affecting humans and other animals, targeting the central nervous system.
- Typhoid fever** is a potentially fatal infection caused by the bacterium *Salmonella Typhi*. It is usually spread through contaminated water or food. Once the bacterium is ingested, it multiplies and enters the bloodstream.
- Gastroenteritis**, also known as “gastro,” is an inflammation of the lining of the stomach and intestines that causes diarrhea and vomiting. It can be caused by a virus, bacteria, or a parasite.
- Impetigo** is a bacterial skin infection caused by staphylococci or streptococci. It can take the form of crusted lesions the most common type or blistering lesions. These bacteria are transmitted, generally through direct contact with the lesions, and can cause small outbreaks in groups of children.
- Acute **meningitis** is an inflammation of the meninges, the protective membranes surrounding the brain and spinal cord. It is usually infectious, most often caused by a virus, more rarely by a bacterium, and sometimes by a fungus or a parasite.
- Tuberculosis (TB)** is an infectious disease, usually affecting the lungs, caused by the bacterium *Mycobacterium tuberculosis*. It is highly contagious and spreads through the air when infected people cough or sneeze. Although tuberculosis can be fatal, it is often curable and can be prevented with proper diagnosis and treatment.
- Scarlet fever** is an infectious disease caused by a bacterium: Group A β -hemolytic streptococci. It presents with a high fever, sore throat, and a rash. It primarily affects children aged 5 to 10 during the winter.
- Lyme disease** is a tick-borne infection caused by the spirochete *Borrelia spp.* Early symptoms include a migratory erythema, which may be followed, a few weeks or months later, by neurological, cardiac, or joint problems.

2. Diseases Caused by Viruses

- Hepatitis** is an inflammation of the liver that can cause a wide range of health problems and can be fatal. There are five main strains of the hepatitis virus, known as types A, B, C, D, and E.
- Molluscum contagiosum** is a contagious skin lesion caused by a virus of the poxvirus family. The lesion is characterized by a rounded, umbilicated papule a few millimeters in diameter, usually not itchy, from which a whitish substance may sometimes ooze when pressed.
- Polio** is a highly contagious disease caused by a virus (the poliovirus) that invades the nervous system and can lead to irreversible paralysis within a few hours. This disease primarily affects children under the age of five.
- Measles** is a highly contagious disease caused by a virus that spreads easily when an infected person breathes, coughs, or sneezes, and can lead to severe illness, complications, or death. Measles can affect anyone, but it is more common in children.
- Rubella** is a contagious infection caused by an RNA virus, the rubivirus. It causes fever and a rash, but often goes unnoticed. When it occurs in children, it is usually mild.
- The human immunodeficiency virus (**HIV**) is a virus that attacks the body's immune system. HIV infection is a chronic condition that can be managed. With treatment, people living with HIV can live long, healthy lives.

- Chickenpox** is a highly contagious viral infection that most commonly affects infants and young children. It causes a rash of blisters on the skin and mucous membranes.
- Fifth disease** is a common infection of the skin, upper respiratory tract, and joints. It is caused by a virus called parvovirus B19 and tends to spread between late winter and early summer.
- Warts** appear as small, benign skin growths that develop after infection with a virus that enters through damaged skin. There are different types of warts, which can appear on the skin of the hands, face, or soles of the feet.
- Shingles** is a disease caused by the reactivation of the varicella-zoster virus in a person who has previously had chickenpox. The rash often appears on the chest but can spread to other parts of the body. Shingles generally heals within 2 to 3 weeks.
- Infectious **mononucleosis**, a viral illness, is transmitted through saliva. Its symptoms include severe fatigue, a sore throat, high fever, and swollen lymph nodes in the neck. However, this infection may go unnoticed.
- Mumps** is a viral illness that may go unnoticed or present as painful swelling of the salivary glands (most commonly the parotid glands), accompanied by fever.

3. Diseases Caused by Fungi

- Athlete's foot** is a dermatophyte (fungal) infection of the skin on the feet. Symptoms of athlete's foot include flaking skin on the feet and, sometimes, redness and itching.
- Ringworm** is a generic term for diseases of the body (skin, scalp hair, body hair, nails: onychomycosis) characterized by rounded patches that grow from the center outward, with changes in the appearance and color of the skin, and, in some cases, hair loss. Most cases of ringworm are caused by various microscopic parasitic fungi from the group of dermatophytes, which attack keratin.

4. Diseases Caused by Parasites

- Scabies** is a **parasitic skin disease** caused by a tiny mite, the **sarcoptic mite**. After coming into contact with an infected person, the mites feed by burrowing into the skin.
- Pediculosis** is a parasitic infestation of the scalp caused by the head louse (*Pediculus humanus capitis*). The head louse is a wingless, blood-feeding insect that measures between 2 and 4 mm as an adult.
- A tapeworm, or tenia**, refers to an intestinal infestation caused by the presence of a parasitic worm (*Taenia solium*) in the human small intestine, which absorbs part of the ingested food.
- Pinworm infection**, which affects only humans, is one of the most common intestinal parasitic infections in children. It is caused by an intestinal worm—the pinworm—which is transmitted through the digestive tract. Although often asymptomatic, it can cause anal itching, diarrhea, and some irritability.