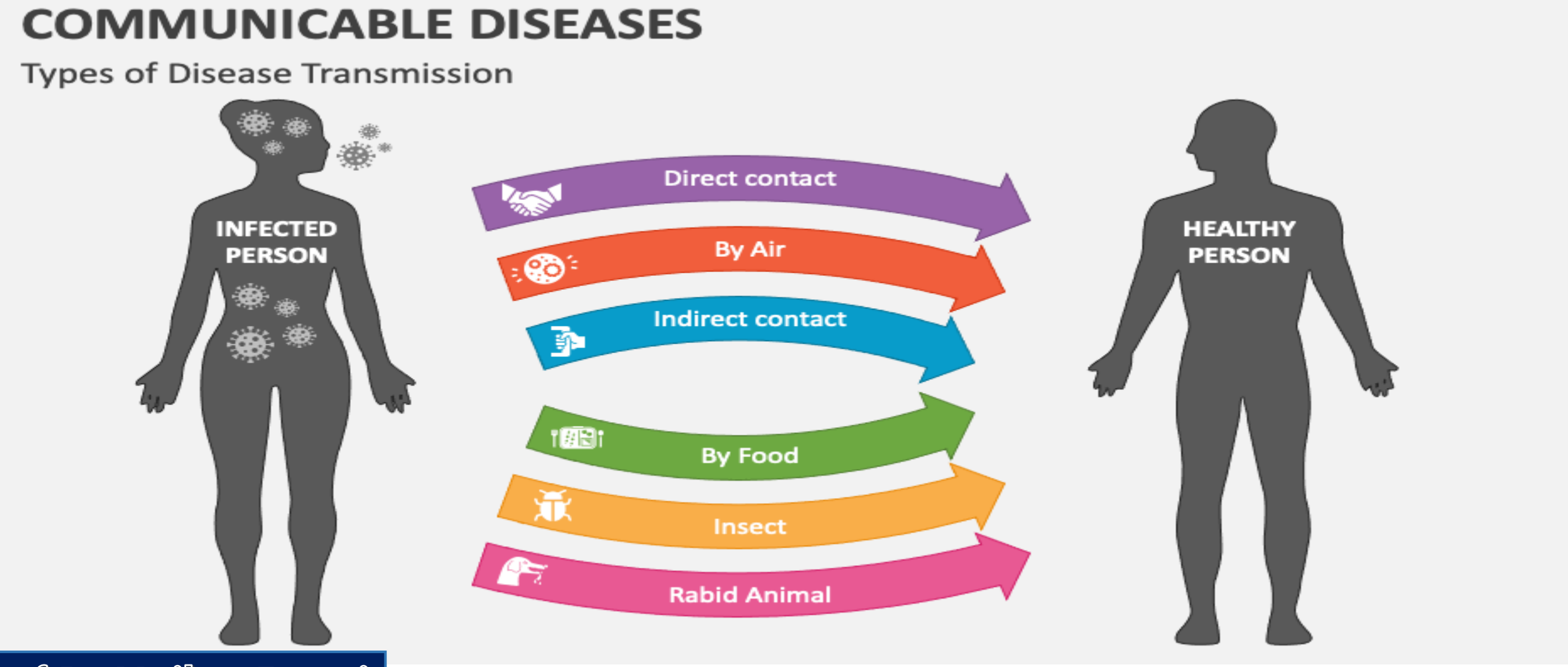
Principles of Communicable Diseases Epidemiology-L-2/25-26



Prof Dr Najlaa Fawzi

LEARNING OBJECTIVES

-Describe the different means of portal of exit and entry

-Illustrate with examples the different modes of transmission of communicable Diseases

-Identify important disease vectors

- Define host and types of resistance related to infection.
- Outline and state the application of herd immunity

Susceptible Host

- Elderly
- Infants
- Immunocompromised
- ANYONE!

Pathogen

- Bacteria
- Virus
- Fungi
- Parasite

Portal of Entry

- Mouth
- Nose
- Eyes
- Cuts in skin

Reservoir

- People
- Animals
- Soil
- Food
- Water

Mode of Transmission

- Direct Contact
- Indirect Contact
- Vectors

Portal of Exit

- Coughing/Sneezing
- Bodily Secretions
- Feces

Portal of exit

Portal of exit is the path by which a pathogen leaves its host. The portal of exit usually corresponds to the site where the pathogen is localized. For example, influenza viruses and Mycobacterium tuberculosis exit the respiratory tract, schistosomes through urine, cholera vibrios in feces

For a human reservoir, the portal of exit can include blood, respiratory secretions, and anything exiting from the gastrointestinal or urinary tracts.

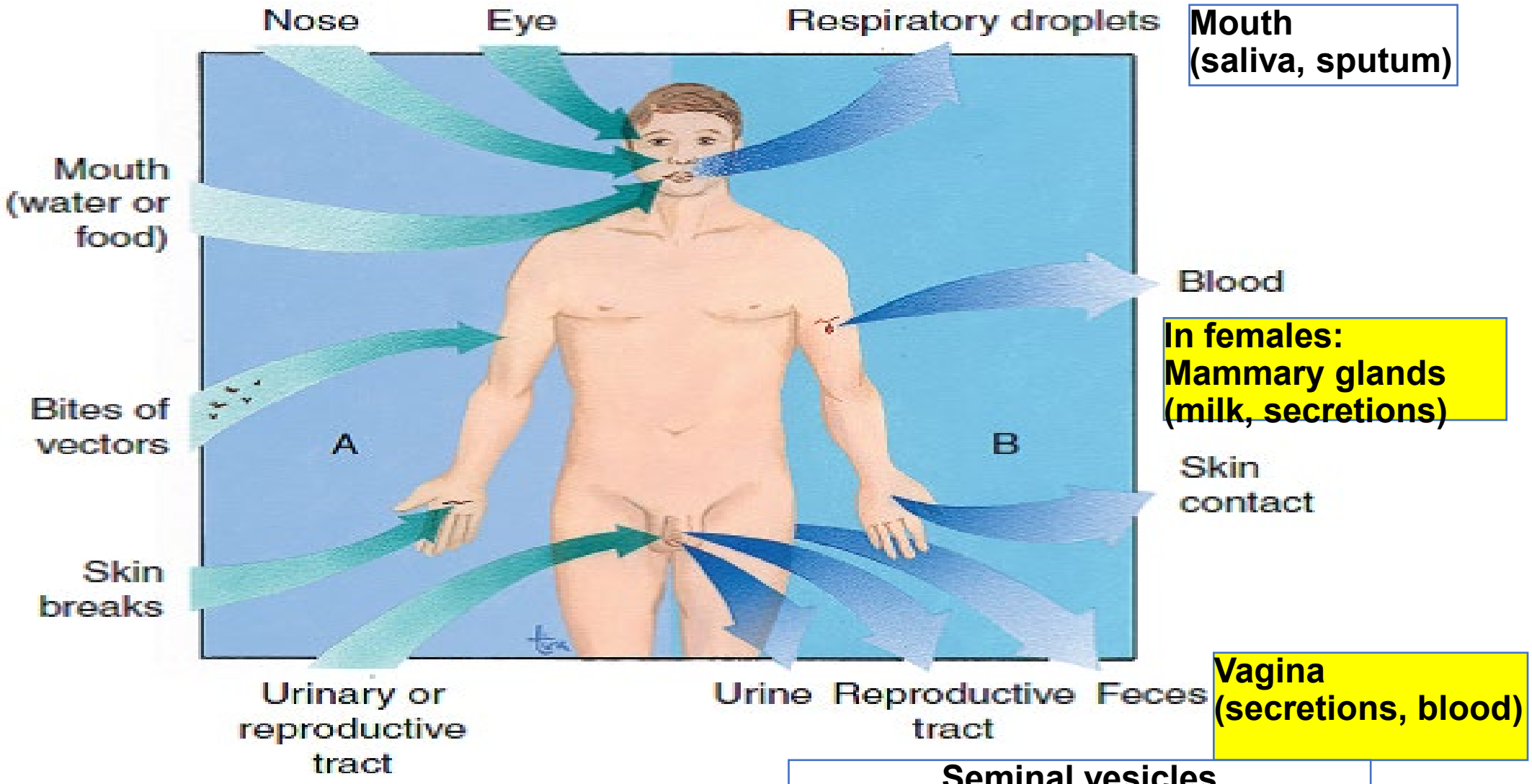


Figure 22–1 (A) Portals of entry. (B) Portals of exit.

Modes of transmission

Vector-borne & vertical transmission

Zika fever

Zika virus

Dengue fever

Dengue virus

Droplet transmission

Influenza

Influenza virus

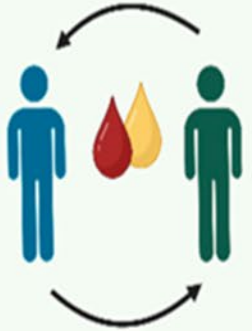
COVID-19 MERS

SARS-CoV
MERS-CoV

Direct contact transmission

Ebola disease

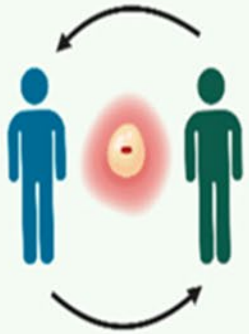
blood, body fluids



Ebola virus

Mpox

blisters, pustules



Monkeypox virus

Vector/ Reservoir

Hosts

Modes of transmission

Regardless of the reservoir, transmission must occur for an infection to spread.
First, transmission from the reservoir to the individual must occur.

Then, the individual must transmit the infectious agent to other susceptible individuals, either directly or indirectly.

Pathogenic microorganisms employ different transmission mechanisms.

There are three modes of pathogen transmission:

- ✓ **Contact transmission**
  - **Direct**
  - **indirect**
  - **Droplet**
- ✓ **Vehicle transmission**
  - **Airborne**
  - **waterborne**
  - **Foodborne**
  - **Blood borne**
- ✓ **Vector transmission**
  - **Biological**
  - **mechanical**

Single & multiple modes of transmission:

some infectious diseases spread by one means only :

- **Meningococcal meningitis – droplet infection**
- **Cholera, Typhoid – ingestion infection**
- **Malaria – arthropod borne infection**
- **Tetanus, rabies – contact infection**

❑ **Some infectious diseases spread by more than one means which maybe either is equally important, or one mean gets the upper hand, while the others are also important or rare.**

- **Poliomyelitis: respiratory &ingestion infection**
- **Brucellosis: ingestion infection (mainly), inhalation & contact (occasionally)**

Coronavirus infection (COVID-19)
Modes of transmission

1. Through **respiratory droplets**
2. Contact with **contaminated surfaces**
3. **Direct contact** with infected people

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Contact Transmission

Contact transmission includes direct contact or indirect contact. Person-to-person transmission is a form of direct contact transmission. Here the agent is transmitted by physical contact between two individuals through actions such as touching, kissing, sexual intercourse, or droplet sprays

There are three types of contact transmission:

- **Direct contact**
- **Indirect contact**
- **Droplet**

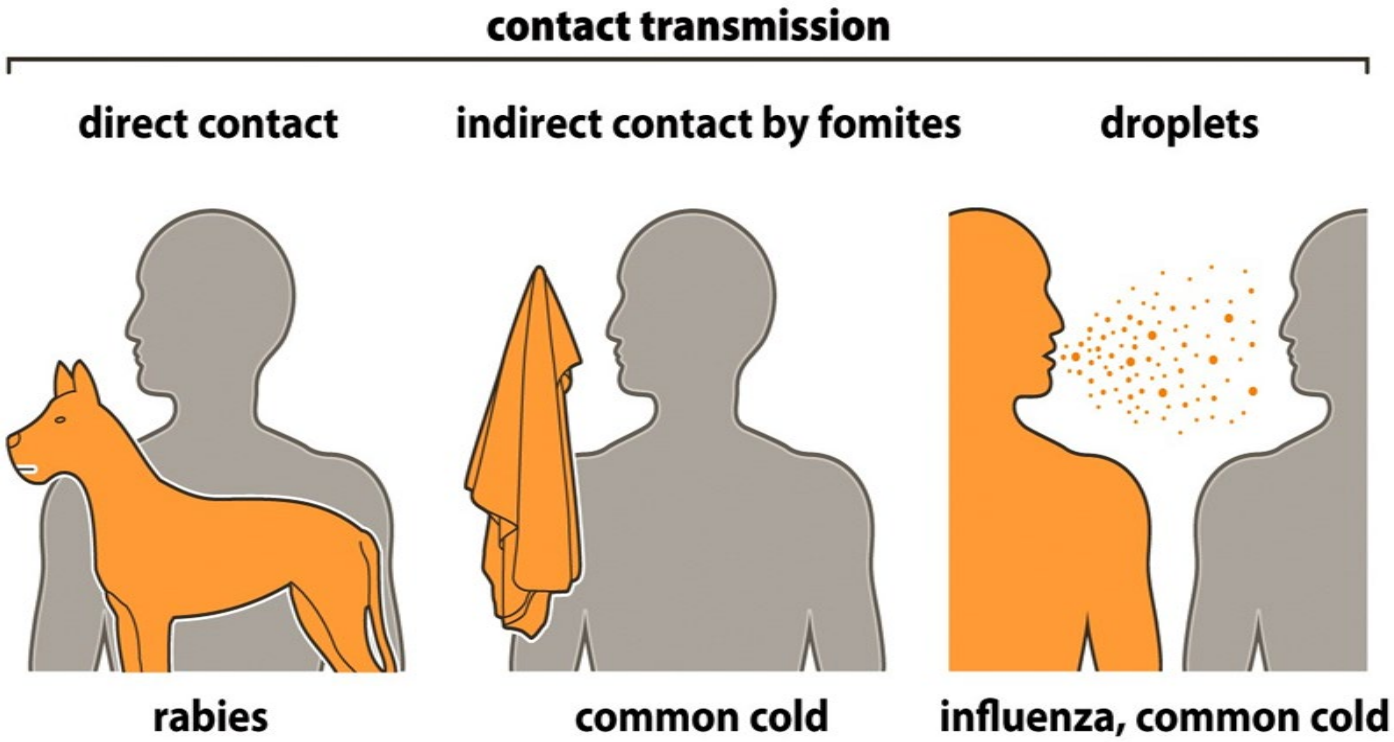


Figure 6.1 Microbiology: A Clinical Approach (© Garland Science)

Direct contact transmission requires physical contact between an infected person and a susceptible person and the transfer of pathogens via touching, sexual contact, or contact with bodily fluids or lesions.

Direct contact also refers to contact with soil or vegetation harboring infectious organisms. Thus, infectious mononucleosis ("kissing disease") and gonorrhea are spread from person to person by direct contact.

Diseases transmitted through direct contact include:

Hepatitis A

Smallpox

Staphylococcal infections

Mononucleosis

Sexually transmitted diseases.

Direct contact can be categorized as

- Vertical
- Horizontal
- Droplet transmission

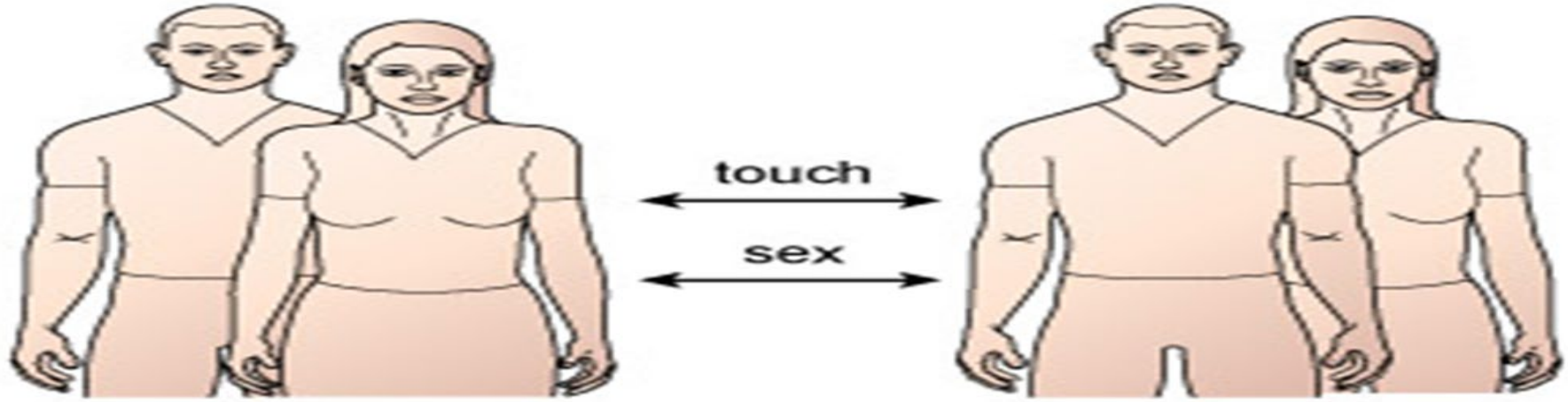
Vertical direct contact transmission occurs when pathogens are transmitted from mother to fetus or baby.

This can occur in three ways:
In utero: Through the placenta before birth.
Intrapartum: During the process of childbirth.
Postpartum: After birth, typically through breastfeeding.
Examples: HIV, syphilis, and toxoplasmosis.

Horizontal direct contact transmission

Often, contact between mucous membranes is required for entry of the pathogen into the new host, although skin-to-skin contact can lead to mucous membrane contact if the new host subsequently touches a mucous membrane.

- **Contact transmission may also be site-specific; for example, some diseases can be transmitted by sexual contact but not by other forms of contact.**
- **AIDS and gonorrhea are spread from person to person by direct contact.**
- **Direct contact also refers to contact with soil or vegetation harboring infectious organisms. Hookworm is spread by direct contact with contaminated soil.**



(a) contagious and sexually transmitted infections

(b) mother-to-child transmission

Direct droplet transmission

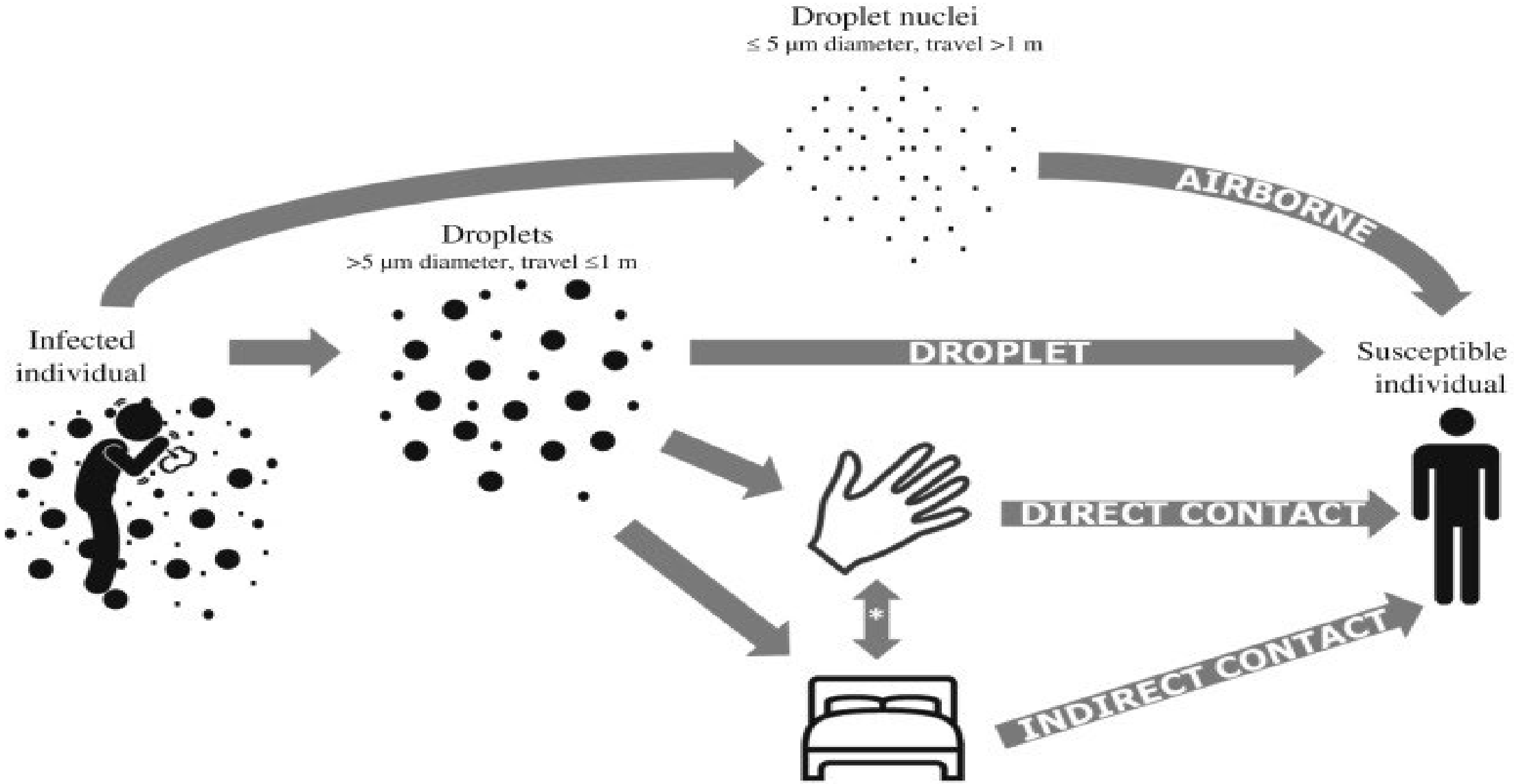
When an individual coughs or sneezes, small droplets of mucus that may contain pathogens are ejected.

- ✓ **Droplets traditionally defined as > 5 µm(microns) .**

- ✓ **This leads to direct droplet transmission, which refers to droplet transmission of a pathogen to a new host over distances of one meter or less.**
- ✓ **A wide variety of diseases are transmitted by droplets, including influenza and many forms of pneumonia.**

- ❑ **Pertussis ,meningococcal and Covid -19 infection are examples of diseases transmitted from an infectious patient to a susceptible host by droplet spread.**

- ❑ **Transmission over distances greater than one meter is called airborne transmission.**



* Transmission routes involving a combination of hand & surface = indirect contact.

Direct Transmission Occurs By:

- Touching
- Kissing
- Sexual intercourse
- Other contacts (e.g. childbirth, medical procedures, injection of drugs, breastfeeding)
- Airborne, short-distance (via droplets, coughing, sneezing)
- Transfusion (blood)
- Trans-placental

Indirect contact transmission

Refers to the infection of a susceptible person via a contaminated surface

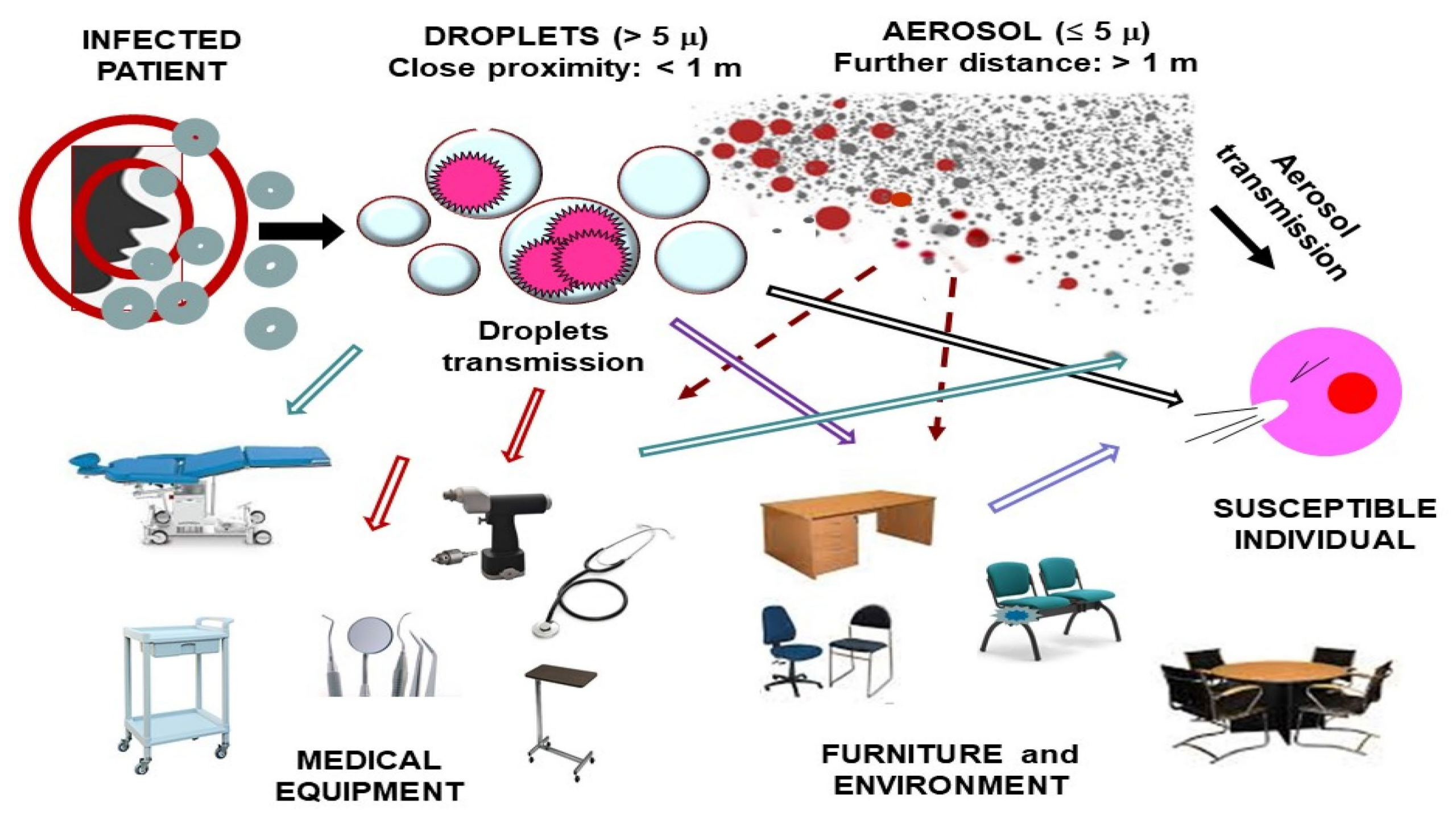
It involves non-living objects called fomites that become contaminated by pathogens from an infected individual or reservoir

Fomites:

Are nonliving objects that facilitate the indirect transmission of pathogens.

A fomite is an object or surface that is capable of transmitting disease and infectious agents. Fomites can also be referred to as passive vectors.

Fomites can include pens, phones, work surfaces, countertops, tabletops, toys , and doorknobs.


INFECTED PATIENT
DROPLETS (> 5 μ)
Close proximity: < 1 m
AEROSOL (≤ 5 μ)
Further distance: > 1 m
Aerosol transmission
Droplets transmission
SUSCEPTIBLE INDIVIDUAL
MEDICAL EQUIPMENT
FURNITURE and ENVIRONMENT

Transmission occurs indirectly when a new susceptible host later touches the fomite and transfers the contaminated material to a susceptible portal of entry.

Fomites can also include objects used in clinical settings that are not properly sterilized, such as syringes, needles, catheters, and surgical equipment.

Pathogens transmitted indirectly via such fomites are a major cause of healthcare-associated infections

Essential requirement for indirect contact transmission

The infectious agents must be capable of surviving outside the human host in the external environment and retain its basic properties of pathogenesis and virulence till it finds new host.

Factors determining external survivability of disease agent:

- ✓ **Characteristics of the agent**
- ✓ **Non-living object**
- ✓ **Influence of environmental factors like temp and humidity**

- ✓ **Drug resistance**

Vehicle- borne Transmission

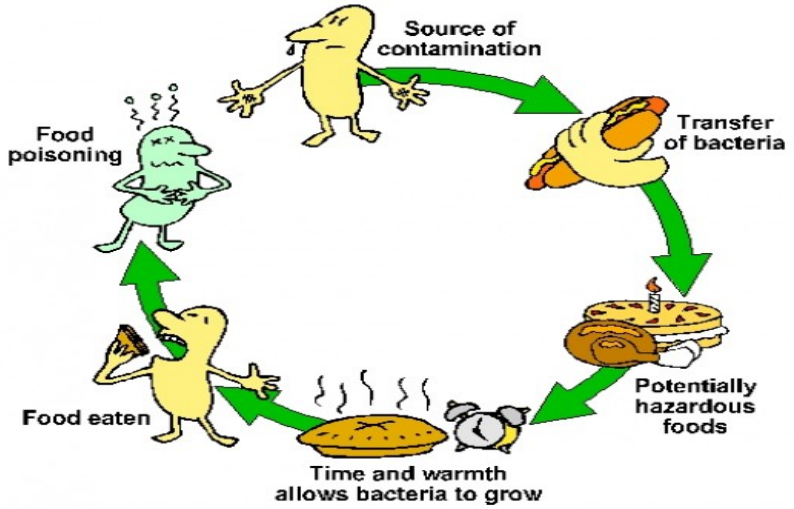
This occurs when a microorganism travels on a common vehicle or contaminated source to the susceptible host.

Vehicles that may indirectly transmit an infectious agent include food, water, biologic products (blood

Figure 6.3 Microbiology: A Clinical Approach (© Garland Science)

- **A vehicle** may passively carry a pathogen — as food or water may carry the hepatitis A virus.

Alternatively, the vehicle may provide an environment in which the agent grows, multiplies, or produces toxin — as improperly canned foods provide an environment that supports the production of botulinum toxin by Clostridium botulinum.



Epidemiological Features of Vehicle Transmission

1. If the dose of contamination is heavy, the outbreak may be explosive
2. Cases are initially confined to those who are exposed to the contaminated vehicle, in some infections
3. The distance travelled by the infectious agent may be great, e.g., outbreaks of food poisoning
4. It is not always possible to isolate the infectious agent in the incriminated vehicle, e.g., typhoid bacilli in contaminated water
5. When the vehicle is controlled or withdrawn, the epidemic subsides, e.g., epidemics of cholera
6. The common source of infection is often traceable

Waterborne disease remains a serious problem in many regions throughout the world. The World Health Organization (WHO) estimates that contaminated drinking water is responsible for more than 500,000 deaths each year.
Similarly, food contaminated through poor handling or storage can lead to foodborne transmission of disease

Examples :

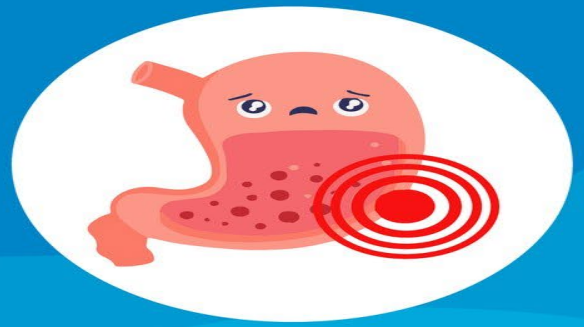
- **Diseases transmitted by water and food acute Diarrhea , typhoid fever, cholera, Hepatitis A , food Poisoning& intestinal parasites .**
- **Disease transmitted by blood : Hepatitis B, C**

World Health Organization
Philippines

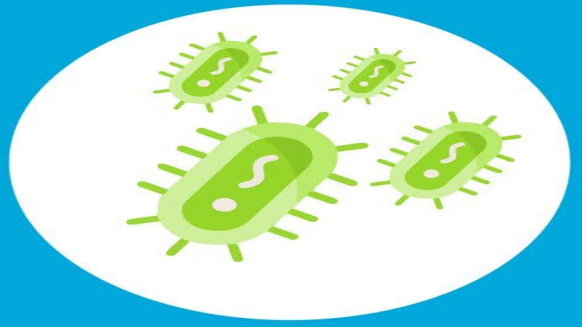
What are the most common waterborne diseases?

Typhoid fever

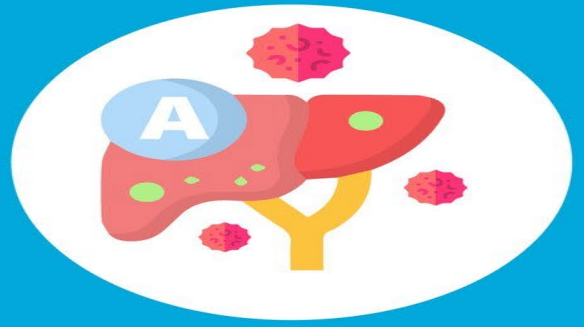
Acute diarrheal infection



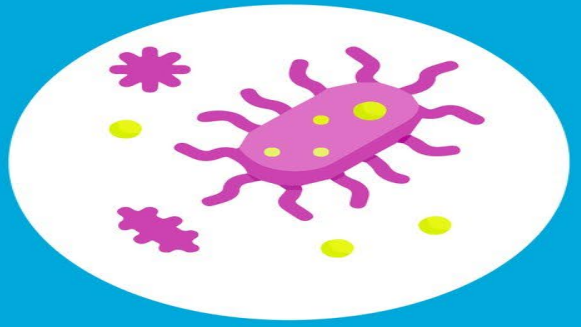
Dysentery



Escherichia Coli (E. coli) infection



Hepatitis A



Salmonella

Airborne transmission occurs when infectious agents are carried by dust or droplet nuclei suspended in air.

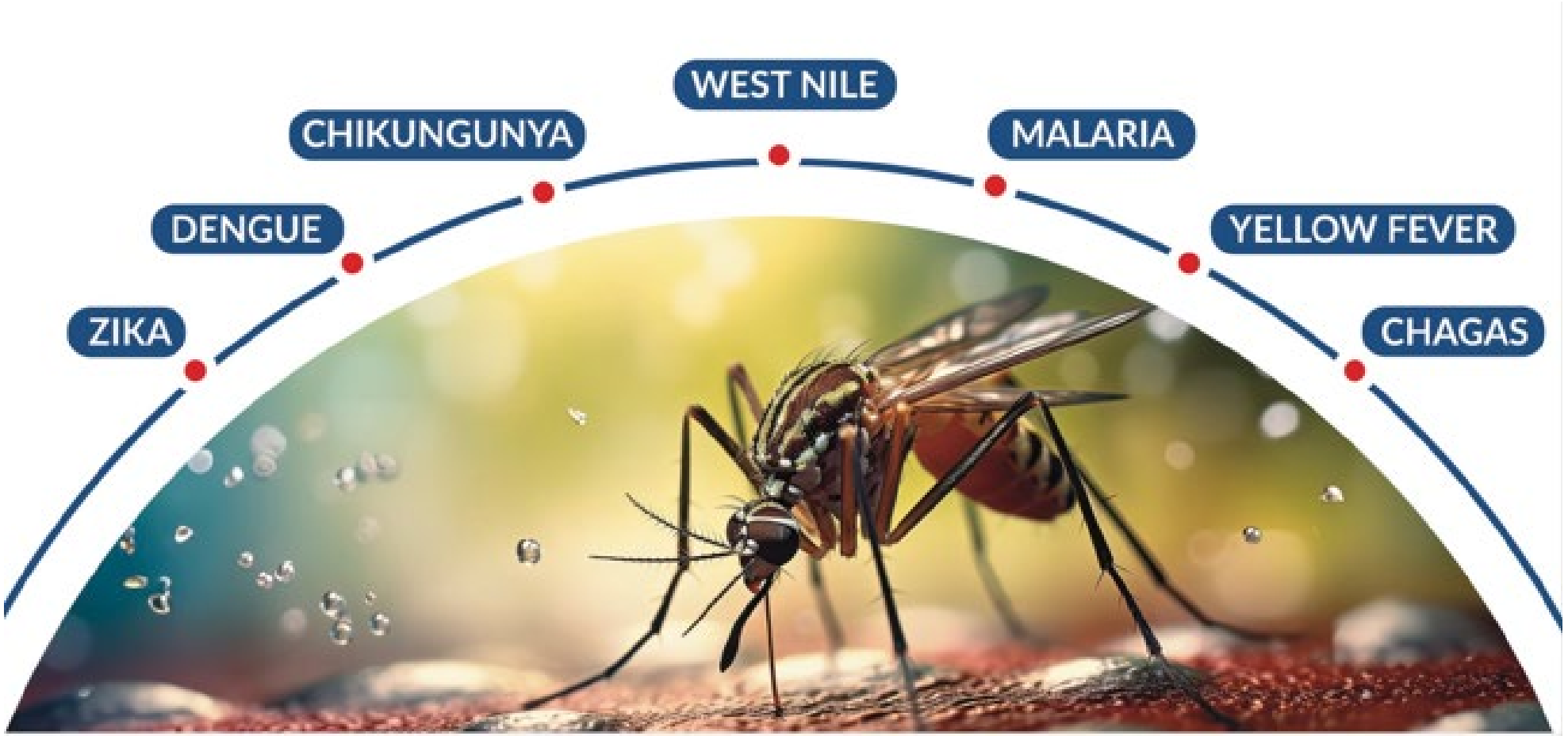
- Airborne dust includes material that has settled on surfaces and become resuspended by air currents as well as infectious particles blown from the soil by the wind.

- Airborne Transmission via aerosols (airborne particles <5μm) that contain organisms in droplet nuclei or in dusts.

- In contrast to droplets that fall to the ground within a few feet, droplet nuclei may remain suspended in the air for long periods of time and may be blown over great distances.

- **Measles, for example, has occurred in children who came into a physician's office after a child with measles had left, because the measles virus remained suspended in the air.**

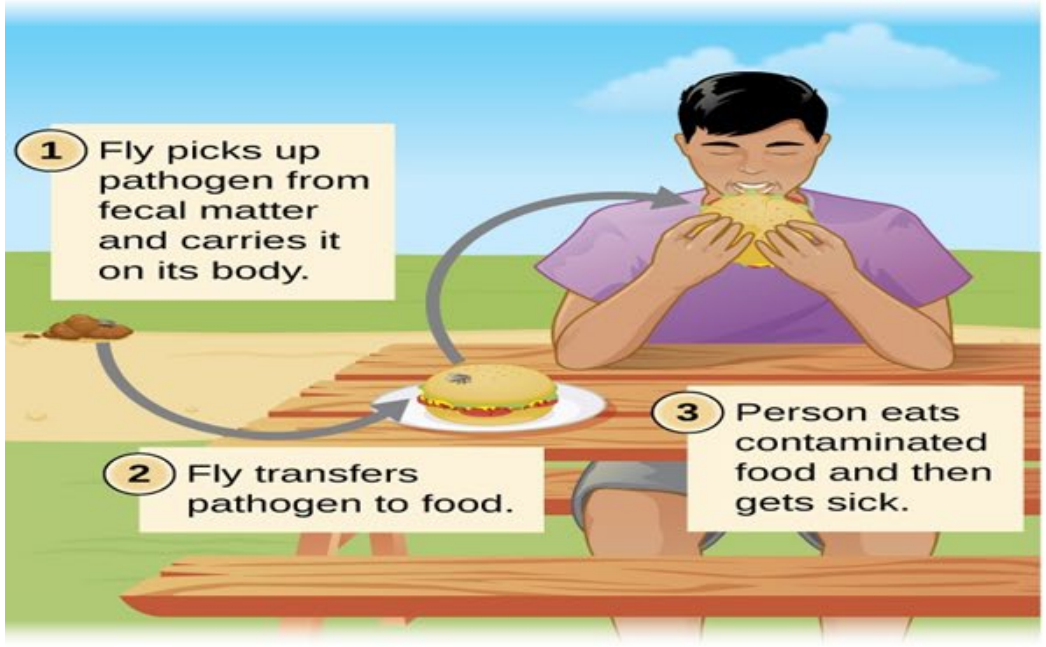
Special ventilation systems are required to prevent airborne transmission



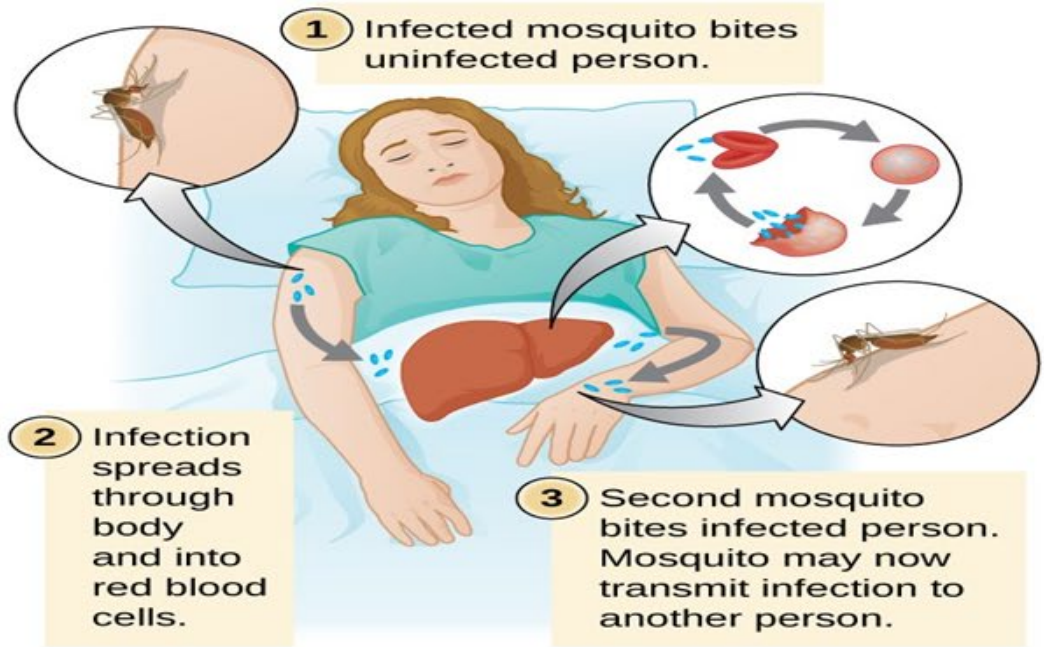
Vector Transmission

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors. Every year there are more than 700 000 deaths from diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis

VECTOR : is defined as an arthropod or any living carrier (e.g., snail) that transports an infectious agent to a susceptible individual.



(a)



(b)

The factors which influence the ability of vectors to transmit disease are:

1-Host feeding preferences

2-Infectivity, that is ability to transmit the disease agent

3-Susceptibility, that is ability to become infected

4-Survival rate of vectors in the environment

5-Domesticity, that is degree of association with man

6-Suitable environmental factors.

Based on the methods in which vectors are involved in the transmission and propagation of parasites involves

Diseases can be transmitted by a mechanical or biological vector, an animal (typically an arthropod) that carries the disease from one host to another.

- **Fleas**
- **Ticks**
- **Flies**
- **Lice**
- **Mosquitoes**

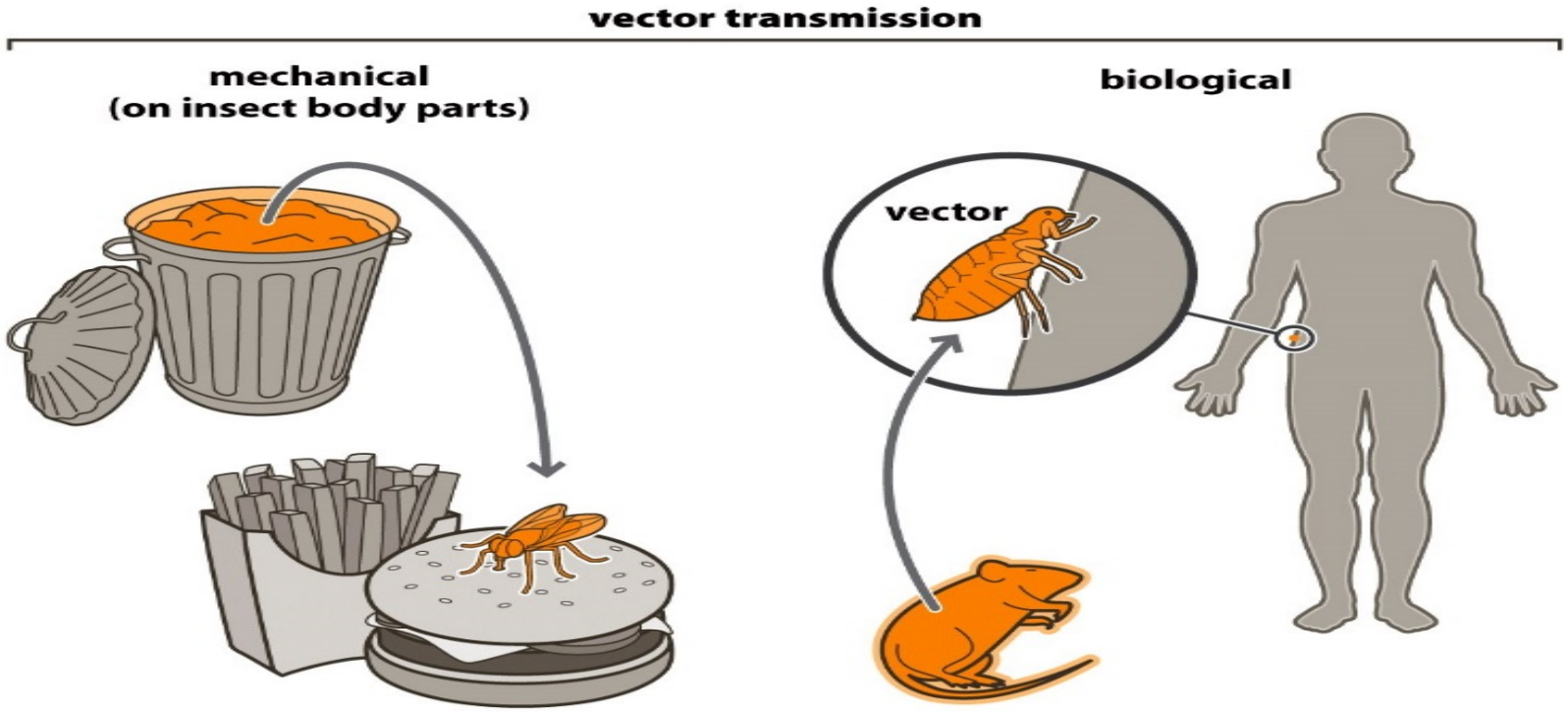


Figure 6.4 Microbiology: A Clinical Approach (© Garland Science)

Mechanical transmission

Is facilitated by a mechanical vector, an animal that carries a pathogen from one host to another without being infected itself. For example, a fly may land on fecal matter and later transmit bacteria from the feces to food that it lands on; a human eating the food may then become infected by the bacteria, resulting in a case of diarrhea or dysentery.

Biological transmission

Occurs when the pathogen reproduces within a biological vector that transmits the pathogen from one host to another.

Arthropods are the main vectors responsible for biological transmission

Biological insect vectors include mosquitoes, which transmit malaria and other diseases, and lice, which transmit typhus.

There are also important non-arthropod vectors of disease, including mammals and birds.

Various species of mammals can transmit rabies to humans, usually by means of a bite that transmits the rabies virus.

Chickens and other domestic poultry can transmit avian influenza to humans through direct or indirect contact with avian influenza virus A shed in the birds' saliva, mucous, and feces.

Importance of Mode of Transmission of Disease

- Breaking the chain at the ‘mode of transmission’ is one of the most important ways to interrupt the spread of infection. This is where infection prevention and control strategies can be most successful.
- It is important to distinguish between types of transmission when selecting control methods.
- Direct transmission can be interrupted by preventing contact with the source.
- Indirect transmission requires different approaches, such as the provision of mosquito nets, adequate ventilation, cold storage for foods or sterile syringes and needles.

Portal of entry

The portal of entry refers to the manner in which a pathogen enters a susceptible host.

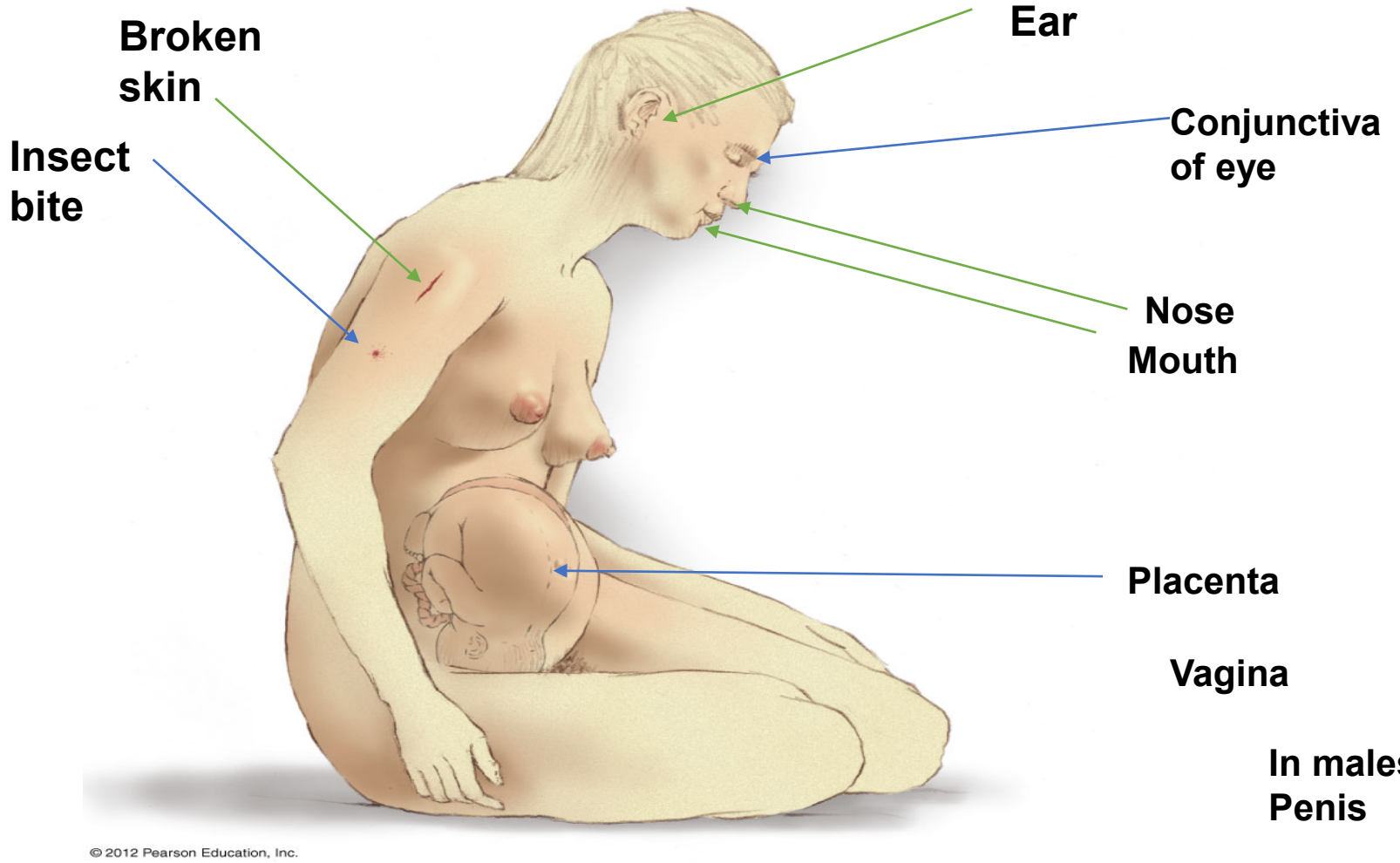
The portal of entry must provide access to tissues in which the pathogen can multiply or a toxin can act.

Often, infectious agents use the same portal to enter a new host that they used to exit the source host.

For example, influenza virus exits the respiratory tract of the source host and enters the respiratory tract of the new host.
In contrast, many pathogens that cause gastroenteritis follow a so-called "fecal-oral" route because they exit the source host in feces, are carried on inadequately washed hands to a vehicle such as food, water, or utensil, and enter a new host through the mouth.

Other portals of entry include the skin (hookworm), mucous membranes (syphilis), and blood (hepatitis B&C, human immunodeficiency virus).

Routes of entry for invading pathogens



Susceptible Host

The final link in the chain of infection is a susceptible host.

The host is the person or animal infected by the pathogen.

A person or animal lacking sufficient resistance to a particular pathogenic agent to prevent disease if or when exposed.

Occurrence of infection and its outcome are in part determined by host factors.

The importance of the host in the transmission cycle is its roles as both reservoir and source of pathogens.

Why an individual may have more than one attack of a particular infectious disease?

True second attack due to agent or host factors

❖ Agent Factors

1-Causative agent has several antigenic Sero - types, streptococcus haemolyticus.

2-With organisms characterized by antigenic changes, shift and drift of influenza virus.

❖ Host factors

1-in pulmonary TB and other diseases , where treated cases , (by specific chemotherapy) is not cured, but becomes inactive & may be exposed to reactivation under adverse predisposing conditions

2-cases having impaired or deficient immune response :

*** acquired by sever malnutrition, or under immune suppression therapy.**

***genetic agammaglobulinemia, or hypo gamma globulinemia**

HERD IMMUNITY

Herd immunity', also known as 'population immunity', is the indirect protection from an infectious disease that happens when a population is immune either through vaccination or immunity developed through previous infection.

WHO supports achieving 'herd immunity' through vaccination, not by allowing a disease to spread through any segment of the population, as this would result in unnecessary cases and deaths.

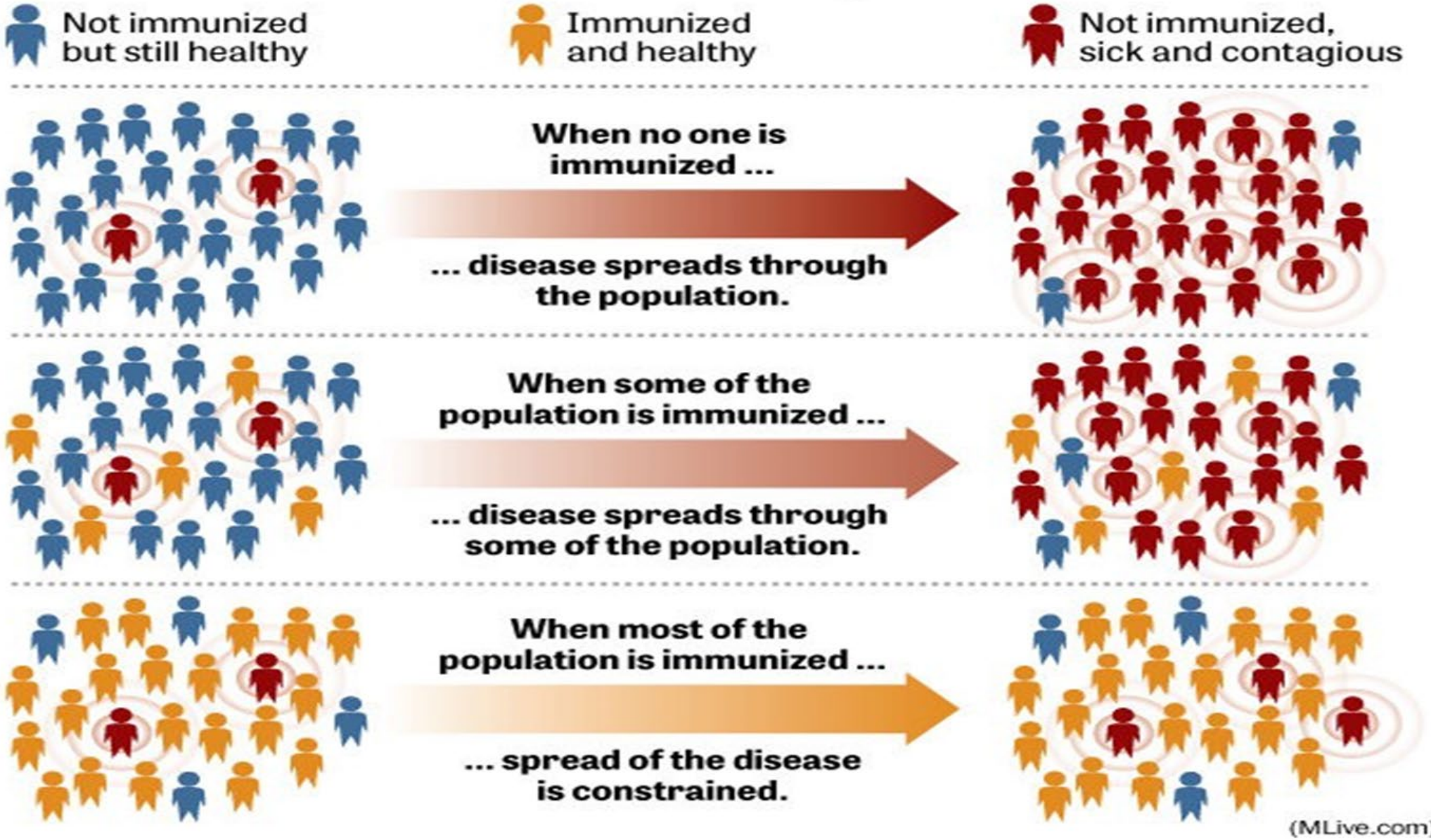
Herd immunity (or community immunity) describes a form of immunity that occurs when the vaccination of a significant portion of a population (or herd) provides a measure of protection for individuals who have not developed immunity.

The greater the proportion of individuals who are resistant, the smaller the probability that a susceptible individual will come into contact with an infectious individual

Herd immunity can effectively stop the spread of disease in the community. It is particularly crucial for protecting people who cannot be vaccinated.
These include children who are too young to be vaccinated, people with immune system problems, and those who are too ill to receive vaccines (such as some cancer patients).

WHY DOES MY CHOICE MATTER TO OTHERS?

It matters because of the concept of "herd immunity." Here's how it works:



Herd immunity generally applies only to diseases that are contagious.
It does not apply to diseases such as tetanus (which is infectious, but is not contagious), where the vaccine protects only the vaccinated person from disease.

People who depend on herd immunity

Some people in the community rely on herd immunity to protect them. These groups are particularly vulnerable to disease, but often cannot safely receive vaccines:

- **People without a fully-working immune system, including those without a working spleen**
- **People on chemotherapy treatment whose immune system is weakened**
- **People with HIV**
- **Newborn babies who are too young to be vaccinated**
- **Elderly people**
- **Many of those who are very ill in hospital**

The herd immunity threshold : The proportion of a population that needs to be immune to stop a disease's spread is called the herd immunity threshold (HIT).

This percentage varies for each disease and depends on factors such as contagiousness. Highly contagious diseases: Have a higher HIT.

For example, measles has a high basic reproduction number (R0) and requires about 95% immunity to achieve herd protection.

Less contagious diseases: Have a lower HIT. Polio, for instance, has a lower (R0) and a herd immunity threshold of about 80%.

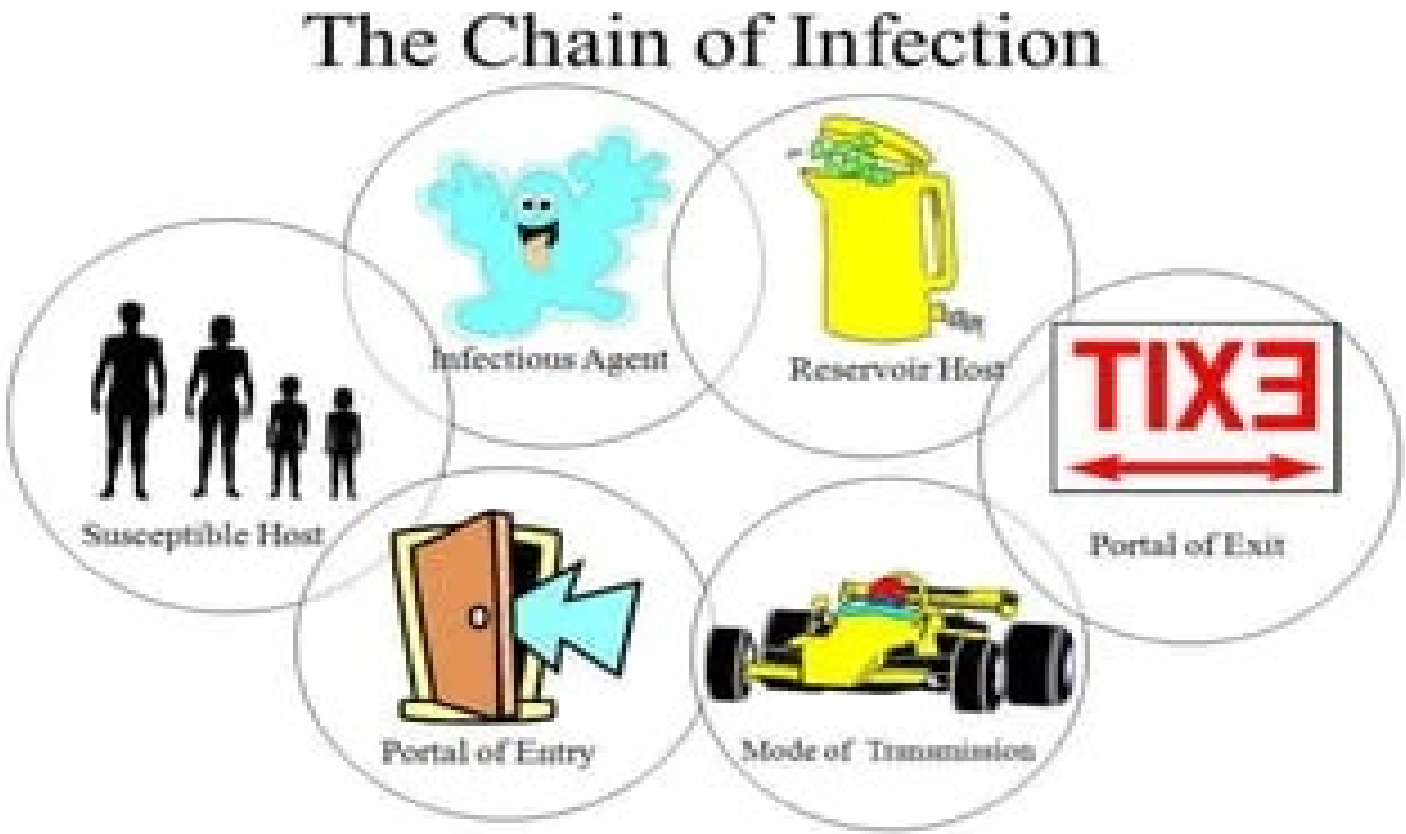
Factors that limit herd immunity

The concept of herd immunity has limits and is more complex for some diseases than others.

Several factors can prevent the establishment of lasting herd immunity:

- **Viral mutations:** Viruses that mutate rapidly, such as influenza and SARS-CoV-2 (COVID-19), can evade immunity acquired from previous infections or earlier vaccines.
- **Asymptomatic transmission:** If a disease can be spread by people who show no symptoms, it becomes much harder to control its transmission.
- **Waning immunity:** Immunity from either vaccination or infection may fade over time, requiring periodic booster shots to maintain protection.
- **Uneven vaccination rates:** Herd immunity may not apply evenly across a population if some communities have lower vaccination rates. Localized outbreaks can still occur in these under-vaccinated groups.

ANY QUESTION ?



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