VIRUS TRANSMISSION

LEC-3-

This lecture takes a broader look at how viruses enter a host, spread throughout the body, and exit a host to infect other individuals within a population.

- **Viral pathogenesis** is how viruses cause disease within a host.
- However, for a virus to **initiate a successful infection**.
- **First**, sufficient numbers of virions must enter the host.
- **Second**, The host cells must be **accessible** to the virus, and those cells must be susceptible to infection. This affinity for susceptible tissues is known as **tropism**.

PORTALS OF VIRUS ENTRY

1. Respiratory Tract

Most common portal of entry.

- Viruses contained in larger droplets are deposited in the upper respiratory tract, while smaller aerosolized particles or liquids are able to travel into the lower respiratory tract.
- The **flow of mucus** in the upper and lower respiratory tract traps many viral particles.
- **Antibodies (IgA isotype)** bind to virus particles.
- **Alveolar macrophages**, another kind of immune system cell that is specialized in phagocytosis.
- **Cilia;**
- The ciliated epithelial cells of the respiratory tract display receptors for respiratory viruses, such as **influenza** or **rhinovirus.**

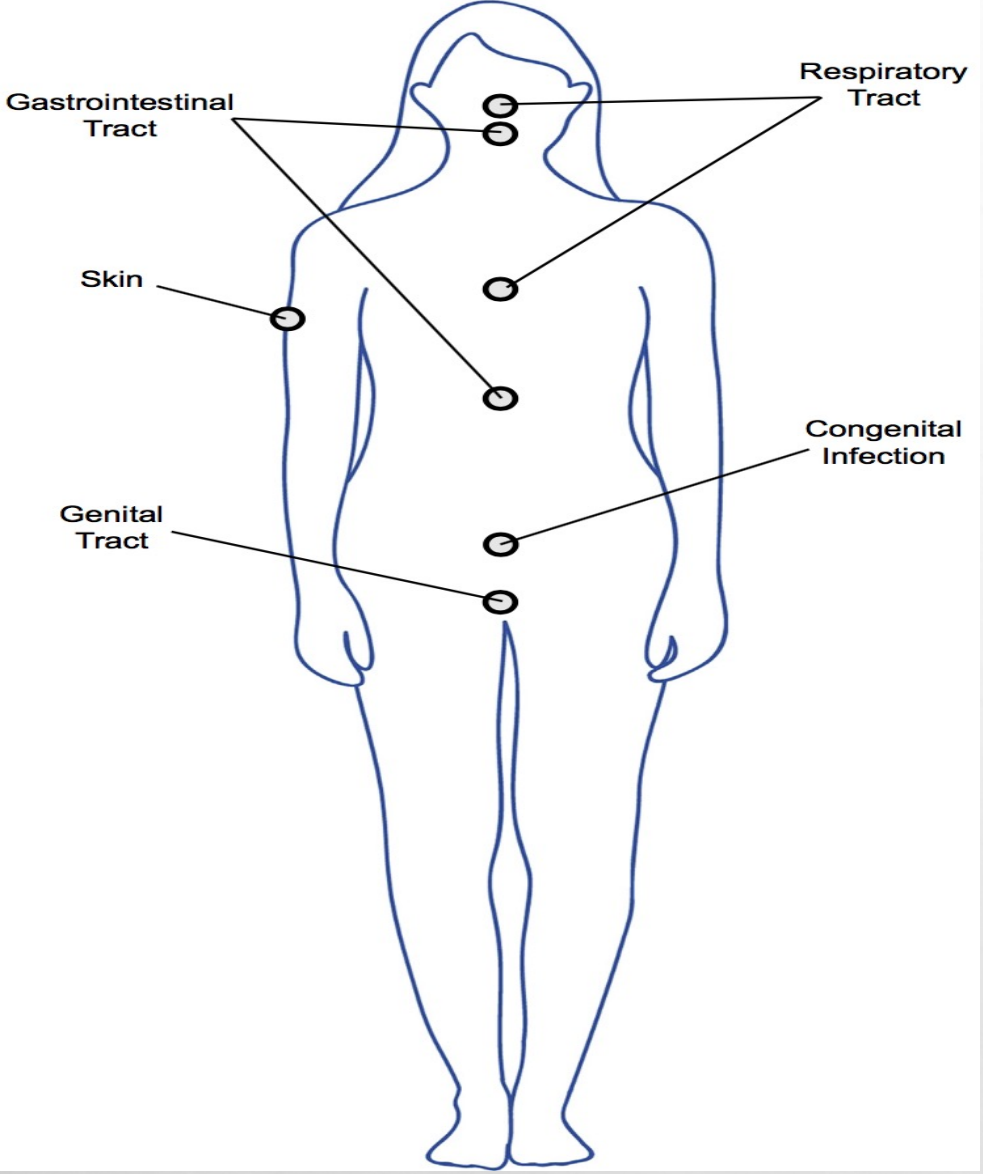


Figure 1 Common portals of virus entry. Viruses are able to gain entry into the body through a variety of different portals. These include the respiratory tract, gastrointestinal tract, or genital tract, as well as infection of the skin

2. Gastrointestinal Tract

- The small intestine; contains **M (microfold) cells, goblet cells** and **glands** that secrete mucus, which lines the epithelium
- Under the epithelium of the small intestine, lymph node–like masses called Peyer's patches contain millions of antibody-secreting lymphocytes (of the IgA antibody variety, as in the lungs), macrophages, and other immune system cells .

- Successful viruses must also be resistant to the **low pH** of stomach acid and the detergent qualities of bile.
- The membrane envelopes of most enveloped viruses are disintegrated by bile.
- **Acid-labile** viruses are unable to withstand the low pH of the stomach, ex. rhinoviruses
- while **Acid-resistant** viruses contain capsid proteins that are not denatured by low pH, ex. (poliovirus).

Viruses can be transmitted via the gastrointestinal tract in several different ways.

- Viruses can be transmitted from mother to child in breast milk, either as free virions or within infected cells; HIV, cytomegalovirus.
- Other viruses enter via the **fecal– oral route; Norwalk virus**.

3. Genital Tract

- As a result of sexual activity; are sexually transmitted diseases
- Tropism of human papillomavirus (HPV) for the epithelium of the cervix or penis, entry into the body through breaks in the genital epithelium or by binding local cell receptors, as occurs with hepatitis B virus or HIV.
- Viruses infecting via the genital tract have to overcome local barriers to infection, such as mucus and the low pH of the vagina.

4. SKIN

- Two layers of tissue: the outermost **epidermis** and the underlying **dermis.**
- **Subcutaneous tissue** is found beneath the skin.
- The flow of fluid over the skin makes viral attachment difficult.
- Sebum (oil) produced by sebaceous glands creates an acidic environment.
- **HPV**, gain access through small cuts or abrasions in the skin
- Bites of insect vectors (mosquitoes, ticks, mites) can introduce viruses into the dermis,
- Subcutaneous tissue can be accessed by viruses through animal bites, needle punctures, or improperly sterilized tattooing equipment.

5. EYES

- The external layer of the eye is composed of the **sclera** and the **cornea**.
- Tears function: washing away any potential pathogens.
- Traumatic event (a puncture wound, for example) provide entry of virus into the eye.
- Infection of the cornea can occur with herpes simplex virus **(HSV)**
- Viral conjunctivitis, also known as **“pink eye**,” is usually caused by **adenoviruses.**

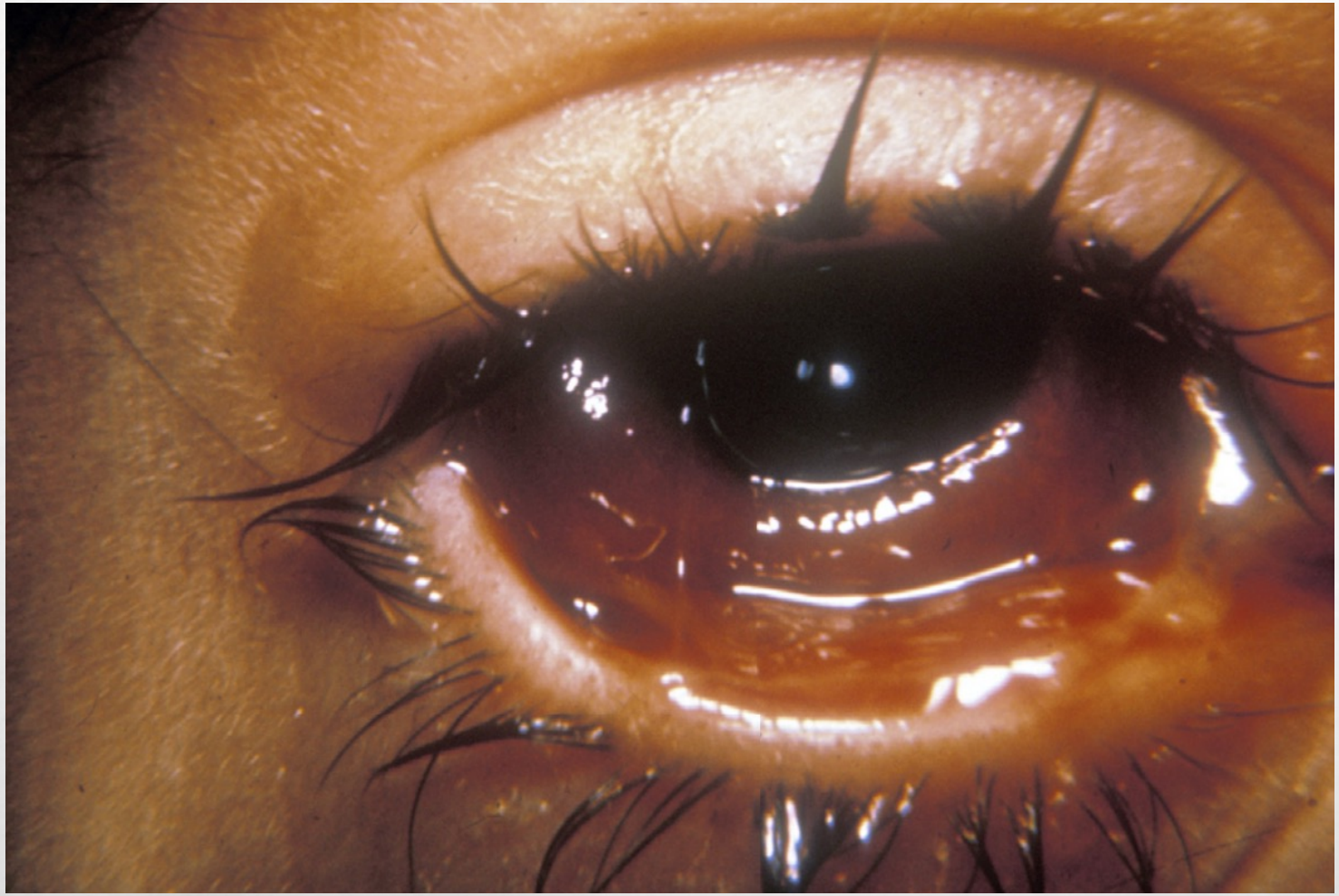


Figure 2: The eye.

shows conjunctivitis, the inflammation of the conjunctiva, caused by accidental infection with vaccinia.

5. PLACENTA

- **Congenital infections** occur when a mother infects a fetus before its birth.
- Ex. **cytomegalovirus**, **herpesvirus,** variola (small- pox), rubella, and measles.
- The effects can be severe, including miscarriage, low birth weight, intellectual deficiencies, hearing loss, and death of the infant.
- Congenital infections occur via **vertical transmission**, meaning that the virus is spread from one generation to the next generation leads to long-term persistence of the virus within the child.
- **Horizontal transmission**, meaning that direct host-to-host transmission occurs.

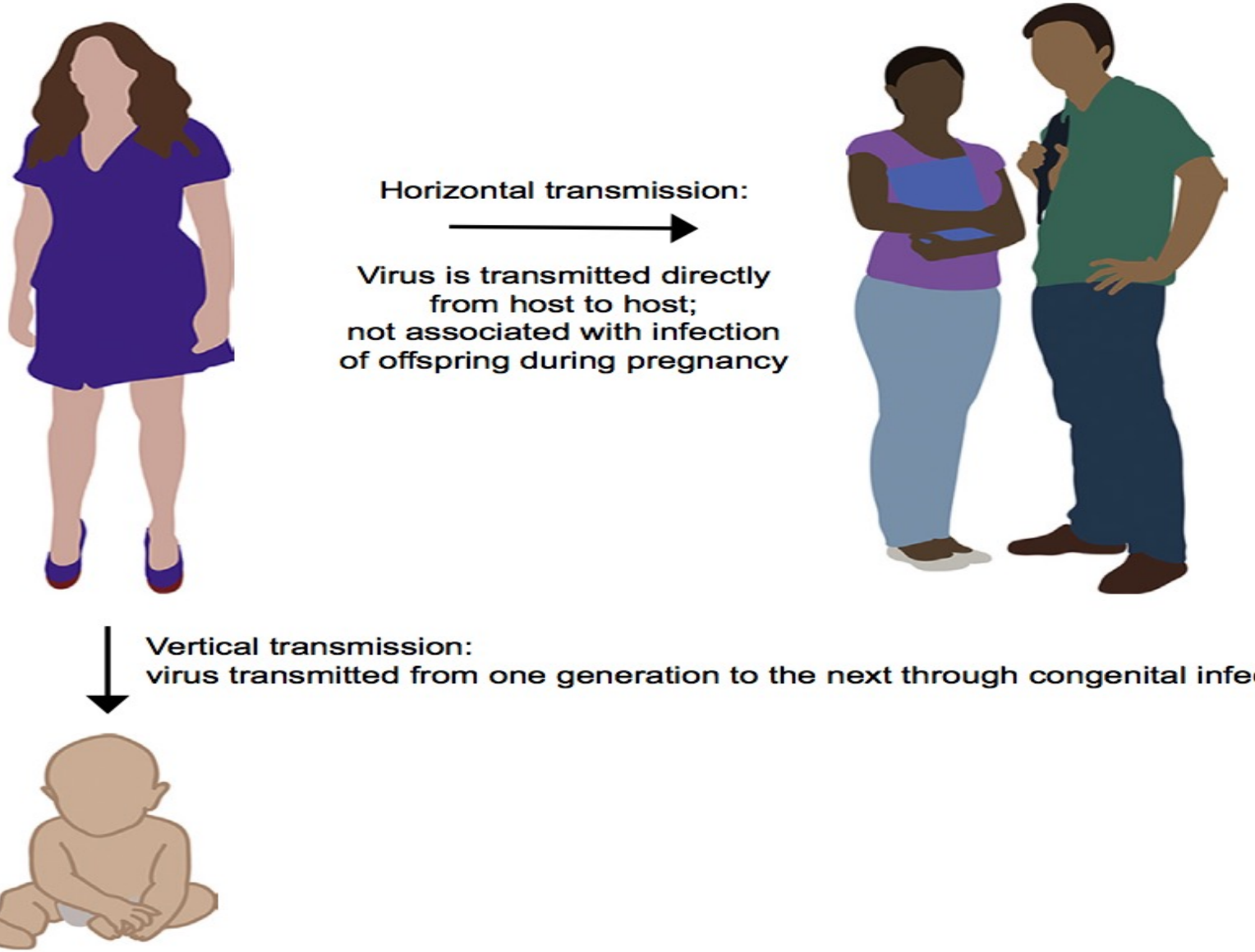


Figure 3: Horizontal transmission versus vertical transmission.

5. PLACENTA

- **Intrapartum transmission** occurs when the child is infected during the birthing process due to contact with the mother's infected blood, secretions, or biological fluids.
- **Vertical transmission of HIV** most often occurs by **intrapartum transmission**, although breastfeeding can also transmit the virus via the gastrointestinal tract.
- Pregnant mother may be encouraged to deliver the child by C-section if there are active signs of maternal infection.

6. TRANSPLANTS

- **Blood transfusion**
- Several viruses can be transmitted through **blood**, including **hepatitis A virus, hepatitis B virus, hepatitis C virus, HIV, West Nile virus,** and **dengue virus.**
- **Herpesviruses,** which remain in tissues or cells in a dormant state after infecting a healthy host, are common viral pathogens in transplants,
- A variety of other viruses have also been transmitted through **transplantation**, including **rabies**, **HIV**, and **hepatitis** viruses.

DISSEMINATION WITHIN A HOST

Localized infections

Systemic infections

Localized infections

- Viruses that infect and replicate only within cells at the site of infection cause **localized infections**.
- **Rhinovirus,** infects the epithelial cells of the upper respiratory tract and replicates there.
- **Papillomavirus** strains that infect the skin replicate locally in the epidermis.

Systemic infections

- Viruses initiate infection through one organ but then spread to other sites within the body cause **systemic infections**.

- Virions spread to other organs through one of two ways:

hematogenous spread **neurotropic spread**

- In **hematogenous spread**, viruses spread to target organs using the bloodstream. This can occur through direct injection into the blood (animal or insect bites).

Viremia is the term used to describe the presence of virus within the bloodstream.

- In **neurotropic spread**, viruses spread through the body using neurons. Such as; **herpesviruses**

PORTALS OF VIRUS EXIT

- In order to persist within a population, a virus must spread from an infected host to a susceptible host.
- The **shedding** of virus refers to the release of infectious virions from the host.
- During **localized infections**, the virus is shed from the primary site of infection.
- Viruses that infect the skin are spread through skin-to-skin contact

- **Respiratory viruses** are shed within respiratory secretions, passed along through a cough or sneeze to a new, susceptible host.
- **Gastrointestinal viruses** are shed within aerosolized vomit or diarrhea, potentially contaminating food or water.
- Viruses that replicate in the **lungs**, nasal cavity, or salivary glands can be shed in saliva.
- Viruses such as **HIV** and herpesviruses can replicate within genital compartments and be shed in semen or vaginal secretions.

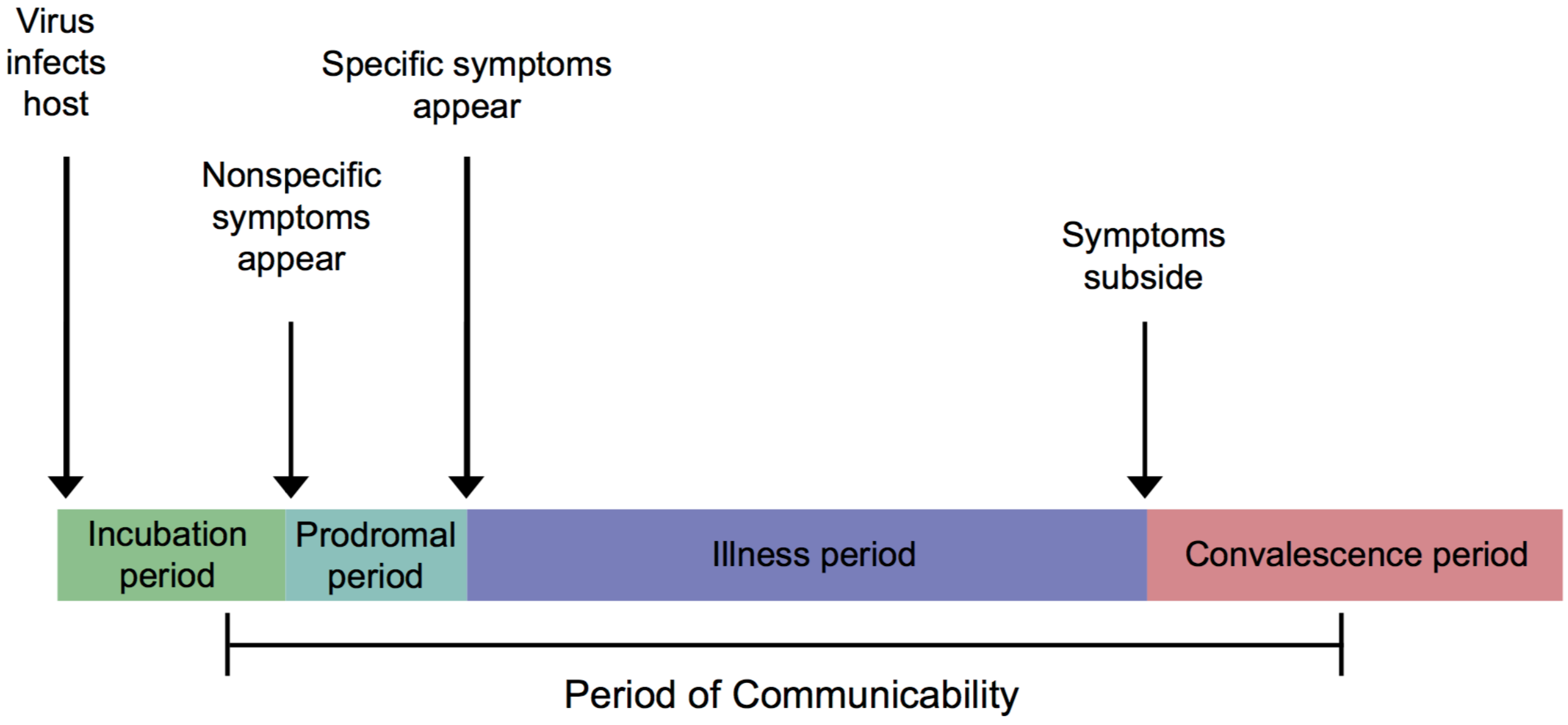
-Viremia is a common occurrence of infection with several viruses, including HIV and hepatitis. Consequently, these viruses can be transmitted through blood.

-Viruria, the presence of virus within the urine, occurs with several systemic viral infections, including measles and mumps.

PATTERNS OF INFECTION

A host typically goes through four stages of disease development when it is infected with a virus.

Figure 4 Stages of disease development



Incubation period: Is the time between when the virus initially infects the host and when symptoms appear. example, rhinovirus, a cause of the common cold, the incubation period tends to be about 1–3 days.

Prodromal period: Occurs after the incubation period and is when symptoms first appear.

- Nonspecific, mild symptoms, such as malaise, muscle aches, or a low-grade fever.
- During this period, however, the virus is replicating quickly within the host.

Illness period: Occurs when specific symptoms of the disease occur.

- At this point, the virus is multiplying to high levels and the immune system has been activated, but the response takes time.

Convalescent period :

- The symptoms of the disease subside as the host begins feeling better, having entered into the **convalescent period**.
- This period may last for days or months, depending upon the severity of the infection.

TABLE 1 Incubation Period and Period of Communicability for Selected Human Viruses

Virus	Average incubation period (range)	Period of communicability
Rhinovirus	~24 h (1–3 days)	24 h before to 5 days after symptoms begin
Influenza A virus	2 days (1–4 days)	24 h before to 5–10 days after symptoms begin
Variola virus (smallpox)	7–17 days	24 h before fever begins until disappearance of all scabs
Ebola virus	8–10 days (2–21 days)	Infectious as long as blood or secretions contain the virus
Measles virus	10–12 days	5 days before to four days after onset of rash
Rubella virus	14 days (12–23 days)	1 week before until at least 4 days after rash appears

TABLE Incubation Period and Period of Communicability for Selected Human Viruses

Virus	Average incubation period (range)	Period of communicability
HIV	2–4 weeks	Early during infection and continues indefinitely
Mumps virus	16–18 days (12–25 days)	1–2 days before until 5 days after salivary gland swelling
Hepatitis A virus	28 days (15–50 days)	Last half of the incubation period to a week into jaundice (skin yellowing)
Hepatitis C virus	6–9 weeks (2 weeks–6 months)	1+ week before symptoms and continues indefinitely
Hepatitis B virus	~4 months (1.5–6 months)	Weeks before onset of symptoms and continues indefinitely

The replication and persistence of a virus within a host generally follow one of two different **patterns of disease**:

- **Acute infection**
- **Persistent infections**

ACUTE INFECTION

- The virus replicates rapidly within the host and is spread to other individuals, but the immune system clears the virus within 7–10 days
- Epidemics are most often caused by viruses that cause acute infection.
- Some acute infections are **inapparent** or **subclinical**, meaning that they produce no symptoms of disease
- Still replicates, activates the immune system and spread to other hosts.

PERSISTENT INFECTIONS

- Occur when the host immune system is unable to effectively clear the virus, but the virus does not replicate to levels that kill the host.
- Persistent infections often last for the lifetime.
- Example: **HIV** virus infect immune cells and interfere with their proper functioning.

PERSISTENT INFECTIONS

- **Persistent infections** can also result from **viral latency** or **slow infections.**
- **Viral latency**
- A state in which the virus becomes **dormant** within host cells.
- Example: all **herpesviruses** establish latency.

(For example, varicella zoster virus that causes chickenpox; Later in life, **reactivation** occur causes the painful skin rash known as shingles.)

- An unusual variation of persistent infection occurs with **slow infections**.
- These viruses can take years to reach a symptomatic phase.
- **HIV** establishes a slow infection: it takes around 8–10 years for an individual to progress to a stage of disease where symptoms are apparent.
- Due to immunosuppression.