

# Infectious process

(The Cycle Of Infection)

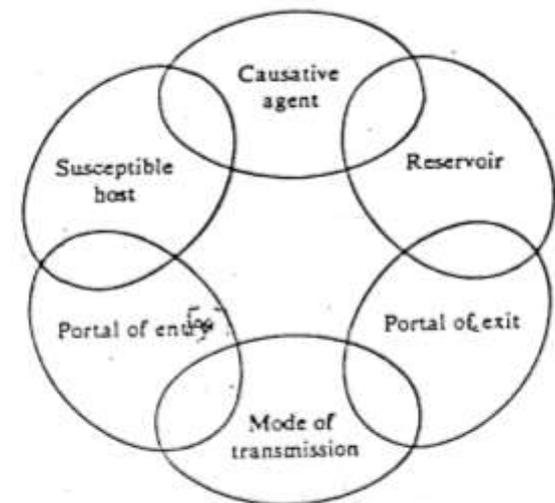
Chain of infection

Chain of event

## Part II

# Requisites for Perpetuation of Communicable Diseases (The Cycle Of Infection)

1. Presence of the **microbiologic agent**.
2. Presence of a **reservoir and source**.
3. An **outlet (portal of exit)** from reservoir.
4. A suitable **mode of transmission**.
5. An **inlet (portal of entry)**.
6. A **susceptible host**.



*Sources and reservoir*

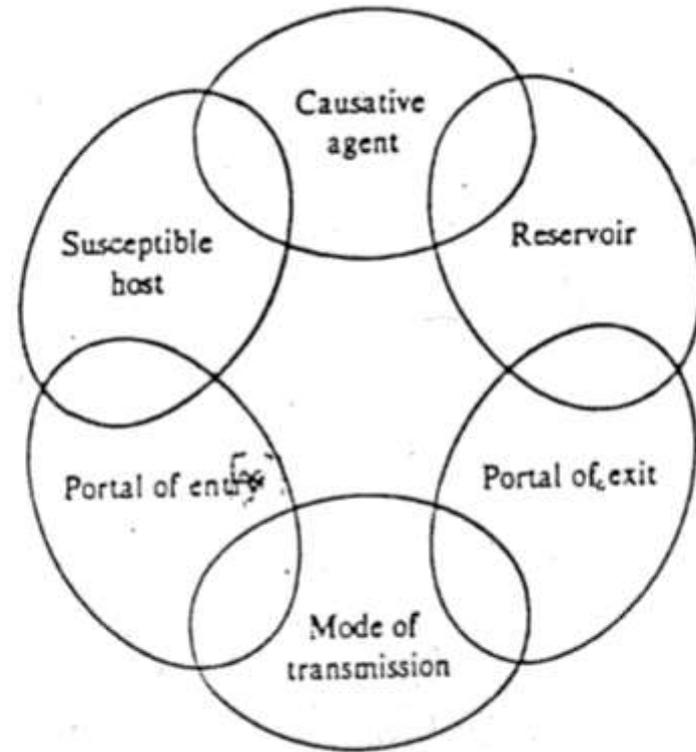


FIGURE 1.2 The chain of infection. Components of the infectious disease process.

## **(2) RESERVOIR OF INFECTION**

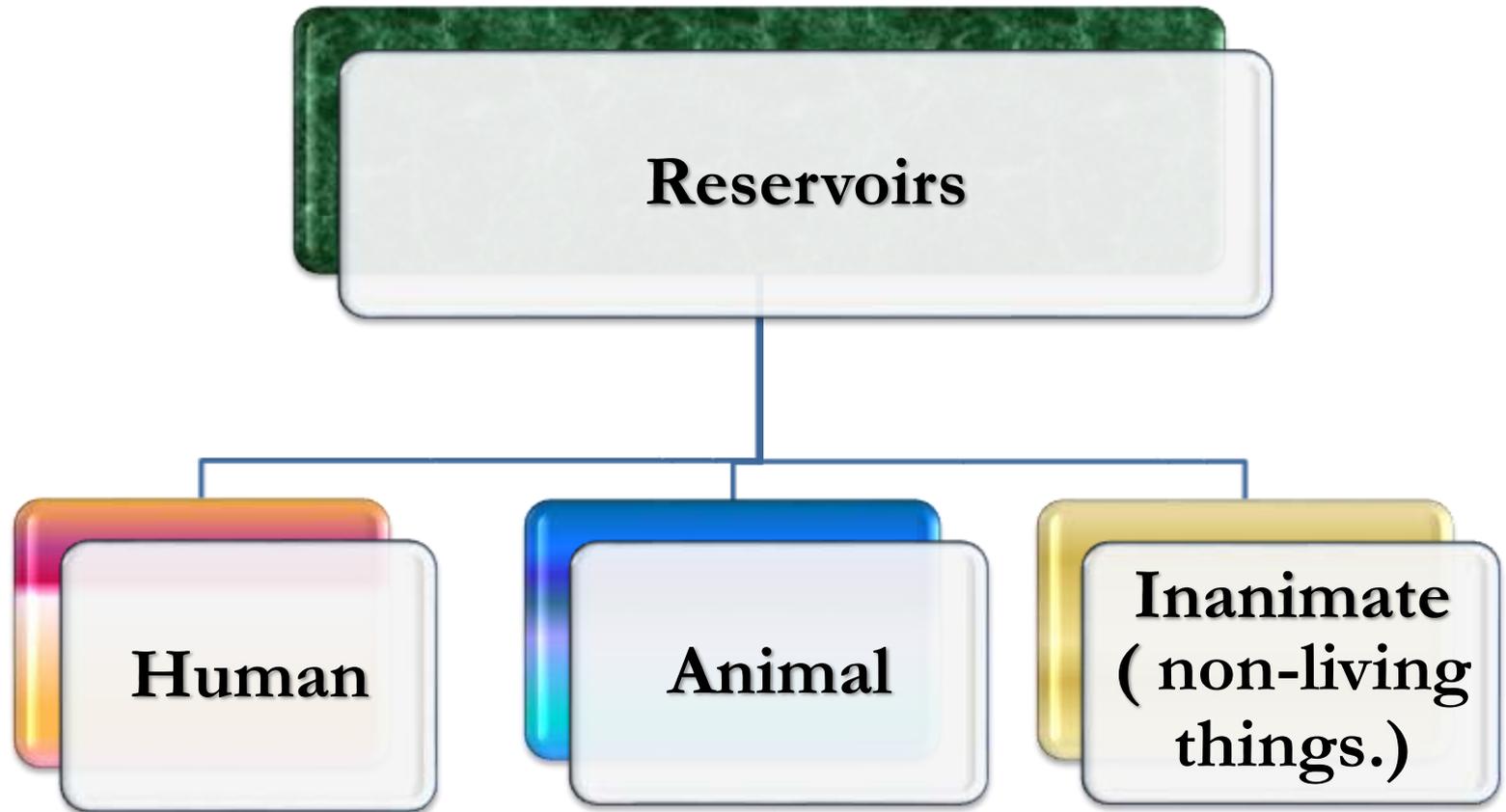
## Sources and reservoir

- ❖ **Existence of a reservoir or source** of infection is the **starting point for** the occurrence of a communicable disease
- ❖ source of infection is **defined as** “  
the **person, animal, object or substance** from which an infectious **agent passes** or is ***disseminated to the host***”
- ❖ A reservoir is defined as  
“ any **person, animal, arthropod, plant, soil or substance** {or combination of these) in which an **infectious agent**
  - **lives and multiplies,**
  - on which **it depends primarily for survival,** and
  - where it **reproduces itself** in such manner that **it can be transmitted to a susceptible host**”

In short, the **reservoir** is the **natural habitat** in which the **organism metabolizes and replicates.**

The reservoir may be of **three types** :

1. **Human reservoir**
2. **Animal reservoir, and**
3. **Reservoir in non-living things**

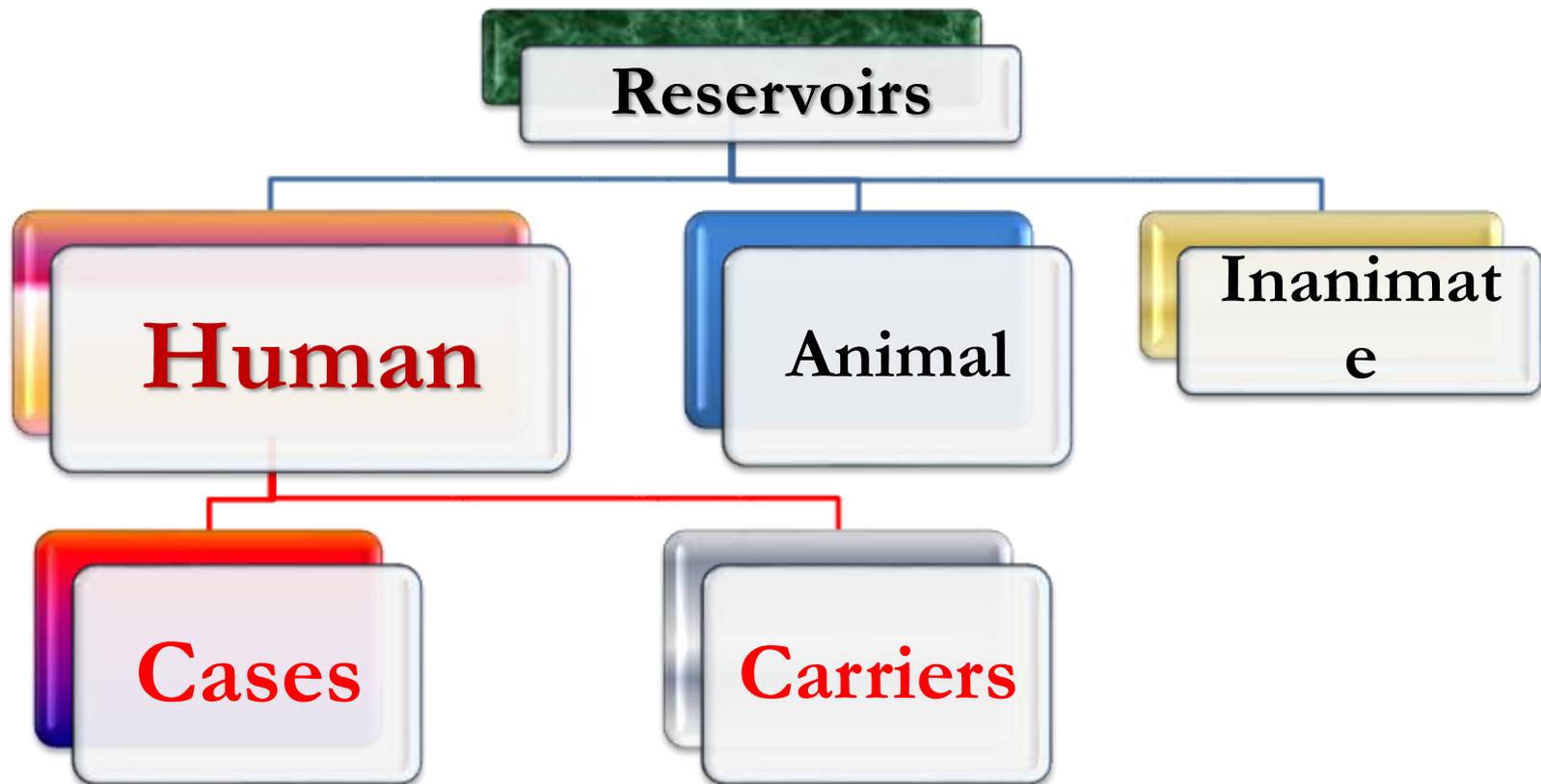


# 1. Human reservoir

Is the **most important source** or **reservoir** of infection for humans is man himself.

He may be a **case** or **carrier**.

**Man is often described as his own enemy**



# 1. Human reservoirs of infection:

## A. Cases:

- ❖ defined as "**a person in the population or study group**
- ❖ identified as having the **particular disease, health disorder or condition under investigation**"
- ❖ **A variety of criteria** (e.g., **clinical, biochemical, laboratory**) may be **used to identify cases**.

Broadly, the presence of infection in a host **may be**

- **Clinical,**
  - **Subclinical or**
  - **Latent.**
- are potential sources of infection,**

Whatever may be the "gradient of infection", all infected persons, whether clinical or subclinical, **are potential sources** of infection, because the disease agent is leaving the body through frequent stools, vomiting, coughing, sneezing or other means and is potentially available for transfer to a new host.

## The clinical illness

- may be mild or moderate,
  - typical or atypical,
  - severe or fatal.
- ☐ Epidemiologically, **mild cases** may be **more important sources of infection** than **severe cases** because they are
- ambulant and spread the infection wherever they go,
  - ✓ whereas severe cases are usually confined(lie)to bed

## The subclinical cases

in apparent, covert, missed or abortive cases.

- ❖ The disease agent may multiply in the host **but does not manifest** itself by **signs and symptoms**.
- The **disease agent is, contaminates** the environment in the same way as clinical cases.
- ❖ **contribute more** than **symptomatic patients** to the **transmission** of infection to others
- The persons **unbeknown to themselves & others**
- ❖ **Subclinical cases play a dominant role in maintaining the chain of infection in the community (endemicity).**
- ❖ **detected only by laboratory tests**, e.g., **organism, antibody response, biochemical**



## *latent infection*

must be distinguished from subclinical infection.

- In **latent** infection, the **host does not shed** the infectious agent which lies **dormant** within the host
- **without symptoms** (and often **without** demonstrable **presence in blood, tissues or bodily secretions** of the host). *For example, latent infection occurs in herpes simplex,*
- **latent infection** play great role in the **perpetuation** of certain infectious

In epidemiological terminology,

❑ **Primary case**

is the **first case** of a **communicable disease introduced into the population unit** being studied.

❑ **index case**

Is the **first case** to **come to the attention of the investigator**; it is not always the primary case.

❑ **Secondary cases**

are those **developing from contact** with primary case.

❑ **A suspect case**

- is an **individual** (or a group of individuals) who **has** all of
- the **signs and symptoms** of a disease ,yet has
- **not been diagnosed** as having the disease or had the **cause of the symptoms connected to the suspected pathogen**

He may be a  
**case** or  
**carrier**

## b. Carriers

"an infected **person** or **animal** that **harbours** a specific infectious agent in the **absence** of discernible **clinical disease** and **serves as a potential source** of infection for others"

- ❖ As a rule carriers are **less infectious** than cases, but
- ❖ epidemiologically, they **are more dangerous** than cases
  - because they **escape recognition**, and
  - continuing as they do to live a normal life among the population or community, and **infect the susceptible** individuals over a **wider area** and **longer period** of time, under favourable conditions.



## The elements in a carrier state are :

- (a) the **presence** in the body of the **disease agent**
- {b) the **absence of** recognizable **symptoms** and signs of disease, and
- (c) the **shedding** of the disease **agent** in the discharges or excretions, **thus acting as a source of infection** for other

In some diseases, either **due to**  
**inadequate treatment** or  
**immune response,**



the disease agent is not completely eliminated, leading to a carrier state

## Carriers may be classified as below

### A. Type Chronologically

- (a) incubatory
- (b) Convalescent
- (c) Healthy

### B. Duration

- (a) Temporary
- (b) Chronic

### C. Portal of exit

- (a) Urinary
- (b) Intestinal
- (c) Respiratory
- (d) Others

### (a) Incubatory Carriers :

- those who **shed** the infectious **agent** during the
  - **incubation period** of disease.
  - infecting others before the onset of illness.
  - usually occurs during the **last few days** of the IP
- e.g., *measles, mumps, polio, pertussis, influenza, diphtheria and HBV*

## (b) Convalescent Carriers :

❖ those who continue to **shed the disease agent** during the period of convalescence, e.g., *typhoid fever, dysentery cholera, diphtheria and whooping cough.*

❖ In these diseases, **clinical recovery does not coincide** with bacteriological recovery.

*a serious threat to the unprotected household members and those in the immediate environment, as in the case of a typhoid fever patient who may excrete the bacilli for 6-8 weeks.*

*This highlights the importance of bacteriological surveillance of carriers, after clinical recovery*



### (c) **Healthy Carriers :**

Healthy carriers **emerge from subclinical cases.**

They are **victims of subclinical infection** who have developed carrier state **without suffering from overt disease,**

but are nevertheless **shedding** the disease agent, e.g., *poliomyelitis, cholera, meningococcal meningitis, salmonellosis, and diphtheria.*

□ **subclinical infected person may or may not be a carrier.**

❖ e. g in **polio the infection** may remain subclinical and the person may **act as a temporary carrier** by virtue of **shedding** the organism.

❖ On the other hand, in **tuberculosis,** most persons with **positive tuberculin test** do not actively disseminate tubercle bacilli and therefore are not labelled as carrier.

**Contact carrier:** with an infected persons like doctors or nurses, usually transient type (common in cholera, typhoid)

## According to duration of carriage:

### A. Transient carriers:

persons harbor and excrete the organisms **up to weeks**)

### B. Temporary carriers;

Shed the infectious agent for **short periods** of time. (<3 months),  
included the **incubatory, convalescent and healthy carriers**

### C. Chronic carriers:

A chronic carrier is one who **excretes** the infectious agent  
**for indefinite periods.**

(>3 months, .>one year )

□ The duration of the carrier state varies with the disease.

❖ *In typhoid fever and hepatitis B, the chronic carrier state may last for several years;*

❖ The longer the carrier state, the greater the risk to the community

Some carriers excrete the infectious agent

only **intermittently** and some **continuously**.

Chronic carriers are **far more important sources of infection** than cases

Therefore their early detection and treatment are essential to limit the spread of infection

**D. Permanent carriers:** (for life)

## C. Portal of exit

- (a) Urinary
- (b) Intestinal
- (c) Respiratory
- (d) Others

## C. Portal of exit :

- urinary carriers,
- intestinal carriers,
- respiratory carriers,
- nasal carriers, etc.
- Skin eruptions, open wounds and blood are also portals of exit.

## Carriers are dangerous because:

1. They do not show any clinical manifestation
2. The carrier and his contacts are not aware of their conditions
3. It is difficult to discover them
4. It is not always possible to deal with them
5. The long period of carriage in some diseases.

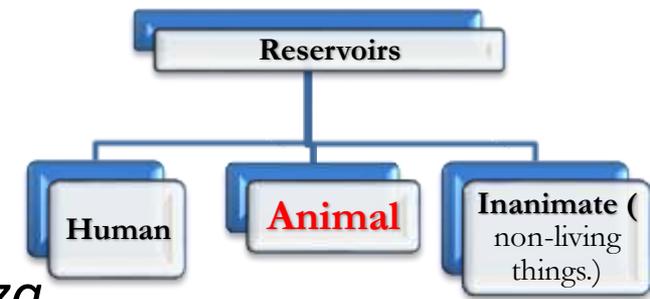
## 2. Animal reservoir

Animal can act as reservoirs whether as diseased or carriers.

*examples are rabies, yellow fever and influenza.*

*The role of pigs and ducks in the spread of epidemic and pandemic influenza both as reservoirs, carriers a*

**Zoonosis:** infectious disease transmissible under normal conditions from vertebrate animate to man.



### ***Examples:***

*Cattle in Bovine T.B.*

*Goats in Brucellosis.*

*Dogs in Rabies*

*Rats in plague*

*Mice, rodents, ducks and cows in Salmonella*

*Monkeys in :Yellow fever*

### **. Reservoir in non-living things**

**Soil and inanimate** matter can also act as reservoirs of infection.

*example, soil may harbour agents that cause tetanus, anthrax,*

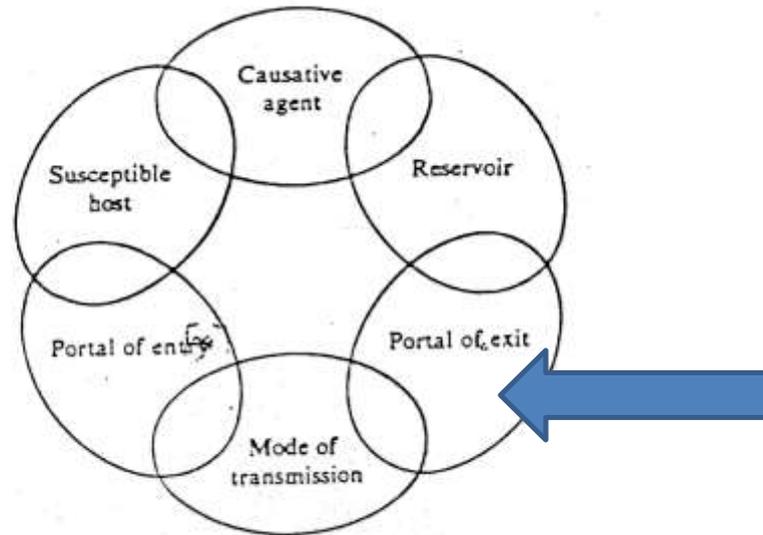


FIGURE 1.2 The chain of infection. Components of the infectious disease process.

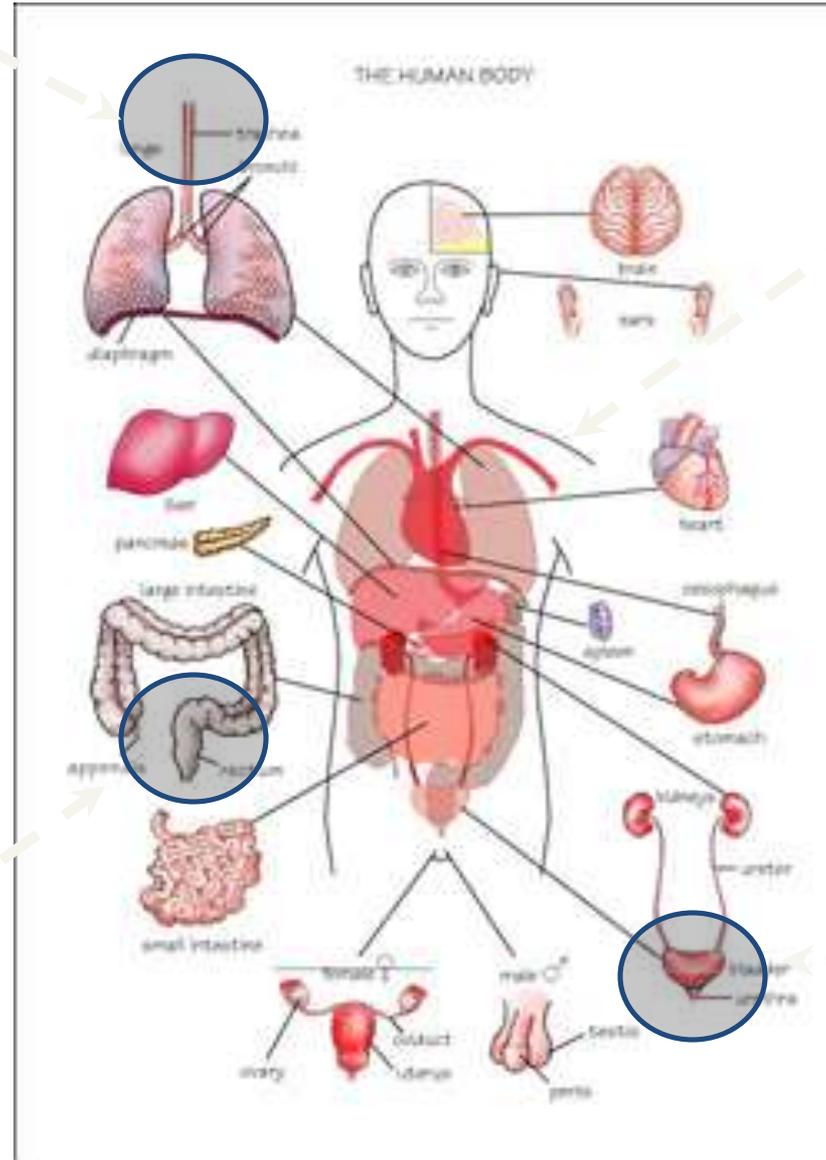
## **(3) PORTAL OF EXIT**

## Upper respiratory

- Diphtheria
- Streptococci
- Meningococci

## Skin & mucous membrane

- Staphylococci



## Feecal

- Typhoid
- Paratyphoid
- Cholera
- Hepatitis

## Urinary

- Typhoid
- Paratyphoid

# Portal Of Exit

The modes of exit from reservoirs are:

## 1. Alimentary canal:

In **feces** as typhoid, paratyphoid, cholera,

In **vomitus** as in cholera

*In certain diseases where the primary sites of infection is the bowel, the organisms will pass through the feces e.g.. polio (affects CNS) and hepatitis A.*

## 2. Respiratory tract:

organisms will leave the body **via the mouth and nose** in coughing, sneezing, laughing or even talking.

**Examples:** *in COVID-19, measles. Whooping cough, diphtheria, streptococcal sore throat, influenza, common cold, mumps, etc.*



## 3. Urinary tract:

This occurs in some diseases where **infection is general** and organisms **are found in blood**.

**Examples:** *typhoid, bilharziasis, genito-urinary tract*

#### **4. Discharges from skin & mucous lesions**

Discharges from mucous membrane as in purulent conjunctivitis and venereal diseases.

#### **5. Insect bites**

- Mosquitoes: malaria.
- Lice; typhus
- Fleas: plague.

**6. Syringes and taking blood from donors;** viral hepatitis & AIDS.

**7. In-utero passage** (trans-placental): as in AIDS, Syphilis and German measles.

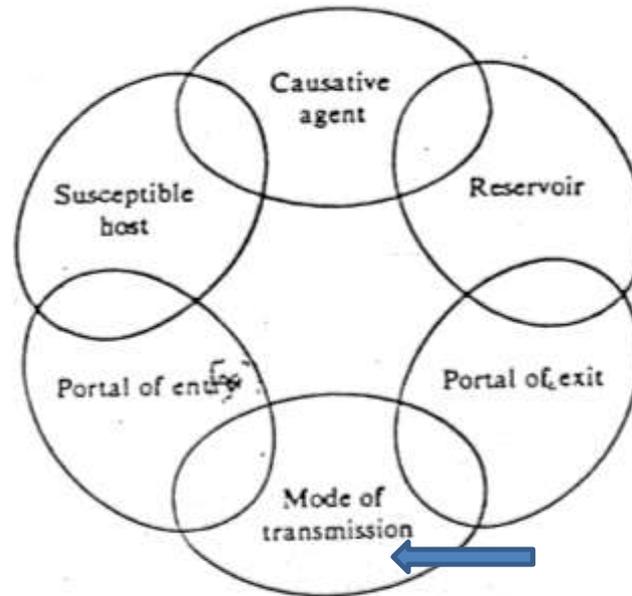


FIGURE 1.2 The chain of infection. Components of the infectious disease process.

## (4) MODES OF TRANSMISSION

# Modes Of Transmission

- different ways, the transmitted from the reservoir or source of infection to **a susceptible** individual is depending upon the
  - infectious agent,
  - portal of entry and
  - the local ecological conditions.
- ☐ infectious disease may transmitted
  - **by only one route**, *e.g., typhoid fever by vehicle transmission*
  - others which may be **transmitted by several routes** *e.g., AIDS, hepatitis B, brucellosis, Q fever*
- ❖ **The multiple transmission routes enhance the survival of the infectious agent.**

# The mode of transmission of infectious diseases may be classified as

## **A Direct Transmission**

1. Direct contact
2. Droplet infection
4. Inoculation into skin or mucosa
5. Transplacental (vertical.

## **B Indirect Transmission**

1. Vehicle-borne
2. Vector-borne
  - a. Mechanical
  - b. Biological
3. Air-borne
  - a. Droplet nuclei
  - b. Dust
4. Fomite-borne
5. Unclean hands and fingers

## ***(1) Direct contact:***

Infection may be transmitted by direct contact from

- ❖ **skin to skin, mucosa to mucosa, or mucosa to skin**
- ❖ **of the same or another person.**
- ❑ This implies **direct** and essentially **immediate transfer** of **infectious agents from the reservoir or source to a susceptible** individual, **without an intermediate** agency without a third object,  
e.g., *skin-to-skin contact as by touching, kissing or sexual intercourse*
- ❖ Direct contact not only **reduces the period** for which the organism will have to survive outside the human host **but**
- ❖ also **ensures a larger dose of infection.**
- ❑ Diseases transmitted by direct contact include **STI** and **AIDS, leprosy, skin and eye infections.**

## ***(2) Droplet infection :***

This is **direct projection** of a spray of droplets of **saliva** and **nasopharyngeal secretions** during **coughing, sneezing, or speaking** and **spitting, talking** into the surrounding atmosphere.

The expelled droplets may hit **directly** the **conjunctiva**, or **respiratory mucosa** or **skin** of a **close contact**.

Particles of **10  $\mu\text{m}$  or greater** in diameter are filtered off by nose.

Those **5  $\mu\text{m}$  or less** can penetrate deeply and reach the **alveoli**.

❖ The droplet spread is usually, limited to

- a distance of **30-60 cm** between source and host.
- these droplets, which may **contain millions of bacteria and viruses**
- **can be a source** of infection to others.
- The potential for **droplet spread** is increased in conditions of
- **close proximity, overcrowding** and **lack of ventilation**
- Diseases transmitted by droplet spread include many respiratory infections **common cold, diphtheria, whooping cough, TB, meningococcal meningitis, etc.**

### ***(3) Inoculation into skin or mucosa :***

The disease agent may be **inoculated directly** into the **skin** or **mucosa** e.g., **rabies virus by dog bite**, **hepatitis B,C virus** through contaminated needles and syringes etc.

### **4) *Transplacental (or vertical) transmission* In-utero passage :**

Disease agents can be transmitted transplacentally .

This is another form of direct transmission.

Examples include the so-called TORCH agents (Toxoplasma gondii, rubella virus, cytomegalo virus and herpes virus), varicella virus, syphilis, hepatitis B,C, and AIDS.

**In these cases, the disease agent produces malformations of the embryo by disturbing its development.**

<b>B Indirect Transmissi</b>
Vehicle-borne
Vector-borne
a. Mechanical
b. Biological
Air-borne
a. Droplet nuclei
b. Dust
Fomite-borne
5. Unclean hands and

## **B Indirect transmission**

- ❖ This include a variety of mechanisms including the traditional 5 F's - "flies, fingers, fomites, food and fluid".
- ❖ **An essential requirement** for indirect transmission is that
- ❖ The **infectious agent 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 a new host.**
- ❖ This depends upon
  - ❖ the characteristics of the agent,
  - ❖ the inanimate object and
  - ❖ the influence of environmental factors such as temperature and humidity.
- If the disease agent **acquires drug resistance**, it will further facilitate its spread.

**Indirect transmission can occur in a variety of settings :**



1. Vehicle-borne
2. Vector-borne
a. Mechanical
b. Biological
3. Air-borne
a. Droplet nuclei
b. Dust
4. Fomite-borne
5. Unclean hands

# 1 Vehicle-borne

- ❖ It implies transmission of the infectious agent
- ❖ through the agency of **water, food** (including raw vegetables, fruits, milk
- ❖ and milk products), ice, **blood, serum, plasma** or other
- ❖ biological products such as tissues and **organs**.

□ Of these **water and food are the most frequent** vehicles of transmission, because they are used by everyone.

□ The infectious agent

- ❖ **may have multiplied or developed** in the vehicle (e.g., *S. aureus* in food) before being transmitted; or
- ❖ **only passively transmitted** in the vehicle (e.g., HAV in water}.



## Cont. ..Vehicle-borne

- ❖ Diseases **transmitted by water and food** include chiefly infections of the alimentary tract, e.g., acute diarrhoeas, typhoid fever, cholera, polio, hepatitis A, food poisoning and intestinal parasites.
- ❖ Those transmitted **by blood include** *hepatitis B,C, malaria, syphilis, brucellosis, infectious mononucleosis and cytomegalovirus infection* .
- ❖ **Organ transplantation** may result in the introduction of the disease agent such as cytomegalovirus in association with kidney transplants.



## **The epidemiological features of vehicle transmission are :**

- (a) if the dose of contamination is heavy, the outbreak may be explosive as in the case of cholera and hepatitis A epidemics**
- (b) cases are initially confined to those who are exposed to the contaminated vehicle, in some infections**
- (c) when secondary cases occur, the primary case may be obscured**
- (d) the distance travelled by the infectious agent may be great, e.g., outbreaks of food poisoning**
- (e) it is not always possible to isolate the infectious agent in the incriminated vehicle, e.g., typhoid bacilli in contaminated water**
- (f) when the vehicle is controlled or withdrawn, the epidemic subsides, e.g., epidemics of cholera, and**
- (g) the common source of infection is often traceable.**

<b>B Indirect Transmission</b>
1. Vehicle-borne
2. Vector-borne
a. Mechanical
b. Biological
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## 2. Vector-borne

- In infectious disease epidemiology, **vector is defined** as
  - ❖ an **arthropod** or **any living carrier** (e.g., snail) that
  - ❖ transports an infectious agent to a susceptible individual.
- Transmission by a vector may be
  - ❖ **mechanical or**
  - ❖ **biological.**
  - ❖ In the latter case, the disease agent passes through a **developmental** cycle or **multiplication** in the vector.

