Infectious process

(The Cycle Of Infection)

Chain of infection

Chain of event

Part III

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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**.

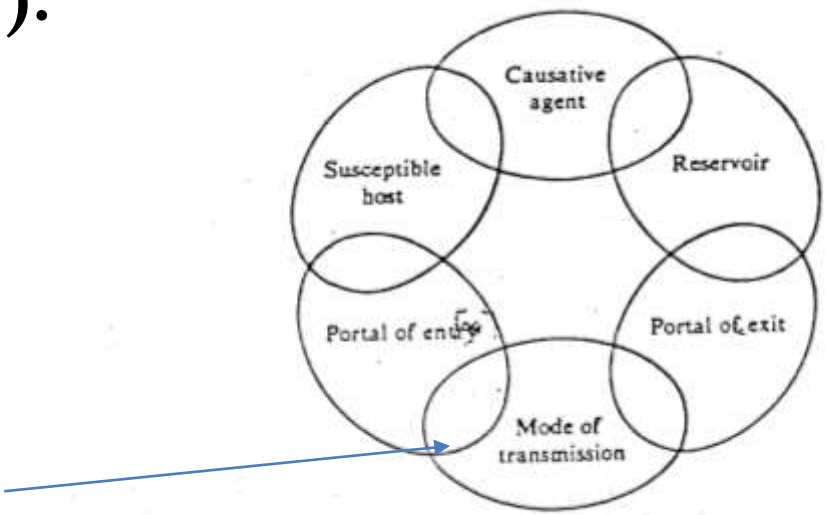


FIGURE 1.2 The chain of infection. Components of the infectious disease process.

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

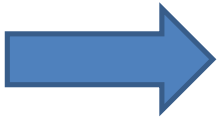
3. Air-borne
   - a. Droplet nuclei
   - b. Dust

4. Fomite-borne

5. Unclean hands and fingers

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 **biological**, the **disease agent passes** through a **developmental** cycle or **multiplication** **in the vector**
  - **Propagative,**
  - **Cyclo-propagative,**
  - **Cyclo-developmental**



(a)Mechanical transmission :

The infectious agent is mechanically transported

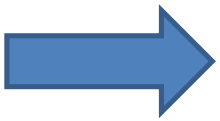
- by a crawling or flying arthropod
- through soiling of its feet or proboscis; or
- by passage of organisms through its gastrointestinal tract and passively excreted.
- There is no development or multiplication of the infectious agent on or within the vector.

Biological.
Propagative,
Cyclo-propagative,
Cyclo-developmental

(b) *Biological transmission* :

The infectious agent undergoing replication or development or both in vector and requires an incubation period before vector can transmit. (extrinsic incubation period)

Biological transmission is of three types :



(i) Propagative :

The agent merely multiplies in vector, but no change in form, e.g., plague bacilli in rat, fleas.

(ii) *Cyclo-propagative :*

The **agent changes in form and number**, e.g., **malaria parasites in mosquito**.

(iii) *Cyclo-developmental* :

The disease agent undergoes only development but no multiplication, e.g., microfilaria in mosquito.

Trans ovarian transmission

when the infectious agent is transmitted vertically from the infected female to her progeny(offspring**) in the vector, .**

Factors which influence the ability of vectors to transmit disease are :

(a) host feeding preferences

(b) infectivity, that is ability to transmit the disease agent

(c) Susceptibility, that is ability to become infected

(d) **Survival rate of vectors in the environment**

(e) domesticity, that is degree of association with man,

(f) suitable environmental factors.

Seasonal occurrence of some diseases (e.g., malaria) may be related to intense breeding and thereby greater density of the insect vector during certain periods of the year.

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

3. Airborne

Droplet nuclei *:*

- "Droplet nuclei" are a **type of particles** implicated (**related**) in the spread of airborne infection.
- They are tiny particles (**1-10 microns range**) that represent the dried residue of droplets .
- They may be formed by **evaporation of droplets** coughed or sneezed into the air or
- The droplet nuclei **may remain airborne** for **long periods** of time, **some retaining and others losing infectivity or virulence.**
- They **not only keep floating in the air but may be**
- **disseminated by air currents from the point of their** origin.
- Particles in **the 1-5 micron** range are **liable to be easily drawn** into the **alveoli of the lungs** and may be retained there.
- **Diseases spread by droplet nuclei** include TB, *influenza, measles, Q fever and many respiratory infections.*

B Indirect Transmission
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(2) Dust :

- Some of **the larger droplets** which are expelled during
- talking,coughing or sneezing, settle down by their sheer
- weight on the **floor, carpets**, furniture, clothes, bedding, linen and other objects in the immediate environment

❖ **and become part of the dust**.

Some of them (e.g., TB bacilli) **may survive in the** dust for **considerable periods under** optimum conditions of temperature and moisture.

❖ . **Airborne dust is primarily inhaled, but may settle on**

❖ **uncovered food and milk.**

❑ ***This type of transmission is most common in hospital acquired (nosocomial) infection***

4. Fomite-borne

- Fomites (singular; fomes) **are inanimate articles or substances other than water or food, contaminated by the infectious discharges from a patient** and
- **Capable of harbouring and transferring the infectious agent to a healthy person.**

Fomites include

soiled clothes, towels, linen, handkerchiefs, cups, spoons, pencils, books, toys, drinking glasses, door handles, taps, lavatory chains, syringes, instruments and surgical dressings.

- **The fomites play an important role in indirect infection.**

Diseases transmitted by *fomites include diphtheria, typhoid fever, bacillary dysentery, hepatitis A, eye and skin infections*

.5. Unclean hands and fingers

- **Hands are the most common medium by which pathogenic agents are transferred to food from the skin, nose, bowel,** etc as well **as from other foods.**

- **The transmission takes place both**
- **directly (hand-to-mouth) and**
- **indirectly.**
- ***Examples include staphylococcal and streptococcal infections, typhoid fever, dysentery, hepatitis A and intestinal parasites*.**

- Unclean hands and fingers **imply lack of personal hygiene.**
- **Lack of personal** hygiene coupled **with poor sanitation**

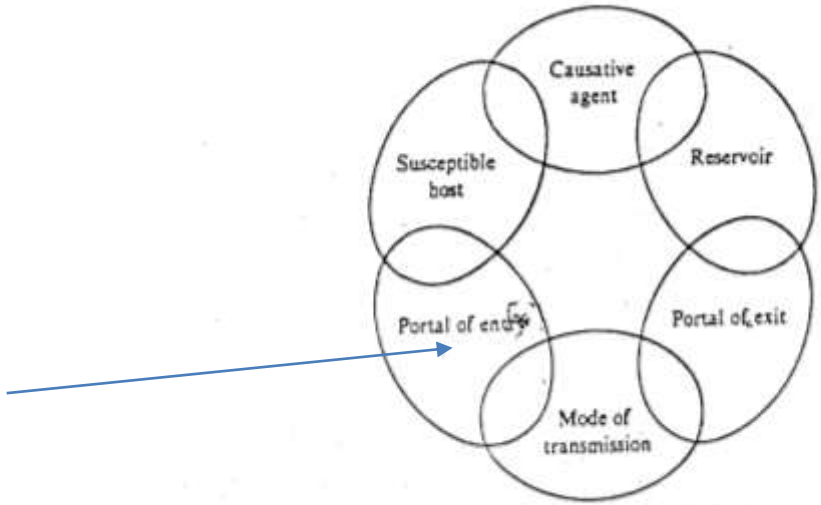

FIGURE 1.2 The chain of infection. Components of the infectious disease process.

(5) PORTALS OF ENTRY TO NEW HOST

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- Respiratory tract
- Gastro-intestinal tract
- Genito-urinary tract
- Skin and mucous membranes through:
  - Affecting its layers
  - Affecting its layers then passing to cause systemic infection
- Piercing skin through inoculation by:
  - Insects
  - During blood letting
- Trans-placental

Note

Some pathogens have:

- **One portal** of entry to new host.
- Two or more portals of exit from reservoir.

Examples:

Poliomyelitis viruses.
Salmonella typhi.

Time between entrance and start of manifestations is **called incubation period**

Definition of incubation period:

Interval between time of contact and entry of agent and onset of illness

❑ Intrinsic incubation period

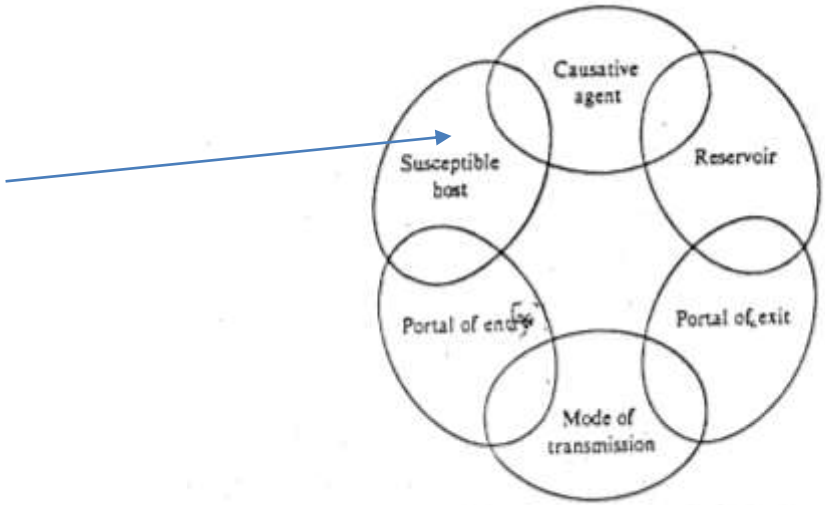
Interval between infection of a susceptible person or animal and appearance of symptoms or signs of disease caused by infecting pathogen

❑ Extrinsic incubation period:

Period between that time when vector gets infected and time vector becomes infective

❖ Variation in range and duration of incubation period depends on:

- ➢ Resistance of host
- ➢ Dosage and virulence of agent
- ➢ Type of agent with regard to toxin production
- ➢ Route of infection inside body



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SUSCEPTIBLE HOST

The Host

is a person or other living animal including birds and arthropods that **afford maintenance,** (survival) or **lodgment** to an infectious agent under natural conditions

Successful parasitism

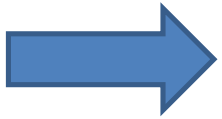
Four stages have been described in successful parasitism :

(a) First, the infectious agent must **find a PORTAL OF ENTRY**

many portals of entry, e.g., *respiratory tract, alimentary tract, genitourinary tract, skin, etc.*

Some organisms may have more than one portal of entry, *e.g., hepatitis B, Q fever, brucellosis.*

b) **On gaining entry into the host, the organisms must reach the appropriate tissue or "SITE OF ELECTION" in the body of the host where it may find optimum conditions for its multiplication and survival.**



Successful parasitism Cont. ..

(c) the disease agent must find **a way out** of the body **(PORTAL OF EXIT)** in order that it **may reach a new host** and propagate its species.

If there is no portal of exit, the infection becomes a dead-end infection as in *rabies, bubonic plague, tetanus and trichinosis*.

(d) **After leaving the human body, the organism must survive** in the **external environment for sufficient period till a new host is found.**

- **In** addition, a **successful disease agent should not cause the death of the host but produce only a low-grade immunity so that the host is vulnerable again and again** to the same infection.

The best example is common cold virus.

Incubation period

An infection becomes apparent only after a certain incubation period, which **is defined as**

"**the time interval between invasion by an infectious agent and appearance of the first sign or symptom of the disease in** question" .

- **During the incubation** period, the infectious agent undergoes
- **multiplication** in the host. When a **sufficient density of the** disease agent **is built up** in the host, **the health equilibrium is disturbed** and
- the **disease becomes overt.**

The factors which determine the incubation period include

- **the generation time of the particular pathogen,**
- **infective dose,**
- **portal of entry and**
- **individual susceptibility.**

- **In some**, the incubation period is of **median length** ranging from
- **10 days to 3 weeks**; in this category, *there are many examples* : ***typhoid infections***, *virus diseases such as chickenpox*, ***measles and mumps***.
- Then there are infections with **longer incubation** periods (ranging **from weeks to months or years**) and
- **incubation time is difficult to measure precisely**, e.g., hepatitis A and B, rabies, leprosy and slow virus diseases.

Serial interval

In actual practice we seldom know precisely the incubation period of a disease.

- But we know, **when an outbreak of disease occurs**, say in
- a **family which** is the smallest group and also a closed group, **there is an initial primary case**.
- **The primary case is followed by 2 or 3 secondary cases within a short time.**

❖ **The gap in time between the onset of the primary case and the secondary case is called the "serial interval".**

❖ **By collecting information about a whole series of such onsets, we get a distribution of secondary cases from**

❖ **which we can guess the incubation period of disease**

Communicable period

The communicable period **is defined as**

"the time during which an infectious agent may be transferred directly or indirectly from an infected person to another person, from an infected animal to man, or from an infected person to an animal, including arthropods"

- **Communicability varies in different diseases.**
- **Some diseases are more communicable during the incubation period than during actual illness.**
- **Communicability of some diseases can be reduced by early diagnosis and treatment.**

An important measure of communicability is

Secondary attack rate.

Secondary attack rate (SAR) is defined as "the number of exposed persons developing the disease within the range of the incubation period, following exposure to the primary case"

HOST DEFENCES

Host defences against infection are at once

- **local and systemic,**
- **non-specific and specific, and**
- **humeral and cellular.**

It is difficult to identify any infectious agent that fails to stimulate multiple host defence mechanisms

Resistance:

It is the total body mechanisms which act as barriers to invasion or multiplication of infectious agents or their damaging effects of their toxins

1) **Natural barriers** (Inherent resistance or innate immunity).
2) **Acquired resistance** (immunity).

1)Natural barriers (Inherent innate immunity
2) Acquired resistance (immunity).

1) Natural barriers (Inherent resistance innate immunity):

- **Non-specific resistance of the body against the invading organisms which**
  - **doesn't depend** on the presence of **specific antibodies or**
  - **antitoxin** for protection, but
- **depends on the anatomical or physiological characteristics** of the host.

1) Natural barriers Inherent resistance (innate immunity):

Natural defensive mechanisms:

- **The body surface**
- **Phagocytic cells lying in tissues**
- **Blood**

2) Acquired resistance (immunity).

1)**Natural barriers** (Inherent innate immunity
2) **Acquired resistance** (immunity).

i. **Passive immunity:**
- **Natural**
- **Artificial**

ii. **Active immunity**
- **Natural**
- **Artificial**

i. Passive immunity:

Type of resistance in which ready made antibodies are gained

1. **Natural passive: antibodies from the mother.**
2. **Artificial passive: by injecting immune serum or immunoglobulin**

Acquired resistance (immunity).
Passive immunity:
Natural
Artificial
Active immunity
Natural
Artificial

i. Passive immunity cont. .. :

1. Natural passive immunity: (Infant immunity)

- Infant resistance due to antibodies passed to the fetus through the placenta.
- **The mother should have acquired the infection and/or vaccine & developed specific antibodies against the disease.**
- **They are at highest level at birth** and decline gradually till **disappearance by the 6th month.**
- **Can be induced by immunizing the mother during pregnancy by *tetanus toxoid to protect the infant against tetanus neonatorum*.**

Breast milk, specially the **colostrums** contains

- plenty of antibodies (about 95% of colostrums' proteins)
- Antibodies are continuously secreted in breast milk but at lower levels than the colostrums.

Acquired resistance (immunity
Passive immunity:
Natural
Artificial
Active immunity
Natural
Artificial

i. Passive immunity Cont. .. :

- **2. Artificial passive immunity: (passive immunization or Immuno-prophylaxis)**
  - Immunity induced by injecting
  - immune serum ; used either for prophylaxis or treatment as *anti-tetanic or antidiphtheritic sera.*

    or
  - Immunoglobulin; as prophylaxis as in hepatitis A.

- **Characterized by short duration (for about 3 weeks)** during which the antibodies are gradually eliminated

Acquired(immunity).
Passive immunity:
Natural
Artificial
Active immunity
Natural
Artificial

ii. Active immunity:

- Type of resistance in which the person makes or develops his own antibodies.

❖ Natural active:

- post infection immunity.

may be solid, long [mumps or measles],
moderate [meningitis] or
short duration [common cold])

❖ 2.Artificial active:

- post vaccination immunity,

where the specific antigen when introduced in the body provoke the formation of antibodies

IDEAL IMMUNIZING AGENT:

- ✓ Minimal side effects
- ✓ Antigenic stability
- ✓ Durable immunity
- ✓ Easy administration
- ✓ Few injections
- ✓ Reasonable cost
- ✓ Availability
- ✓ Good keeping quality (long shelf life)
- ✓ Easy storage

Herd immunity

- It's the state of immunity within the community.
  - It's the factor that decides the epidemiological pattern of any infectious disease among that community.
- Herd immunity theory proposes that in diseases passed from individual to individual, it is difficult *to* maintain a chain of infection when large numbers of a population are immune.
- The higher the number of immune individuals, the lower the
- likelihood that a susceptible person will come in contact with an infectious agent
- Herd immunity provides an immunological barrier to the spread of disease in the human herd
- population with a very low or no immunity, the attack and case fatality rates tend to be very high involving practically all susceptible

The epidemic wave declined with a build-up of herd immunity following natural infection.

Herd immunity Cont. ..

The disease incidence rises at times when the number of susceptible in the population is highest and the herd immunity is lowest.

Herd immunity results from

either an epidemic or

after obligatory immunization schedules

Herd immunity may be determined by serological surveys (serological epidemiology).

1. **Community protection is governed by:**
2. The extent of coverage of the immunization program.
3. The degree of resistance to infection afforded by the vaccine.
4. Duration and degree of infectivity of the organism.
5. Past experience with different infections.
6. Overcrowding and environmental sanitation