

Mode of transmission

**Infectivity ,pathogenecity, Virulence,
immunogenecity and Herd Immunity**

By

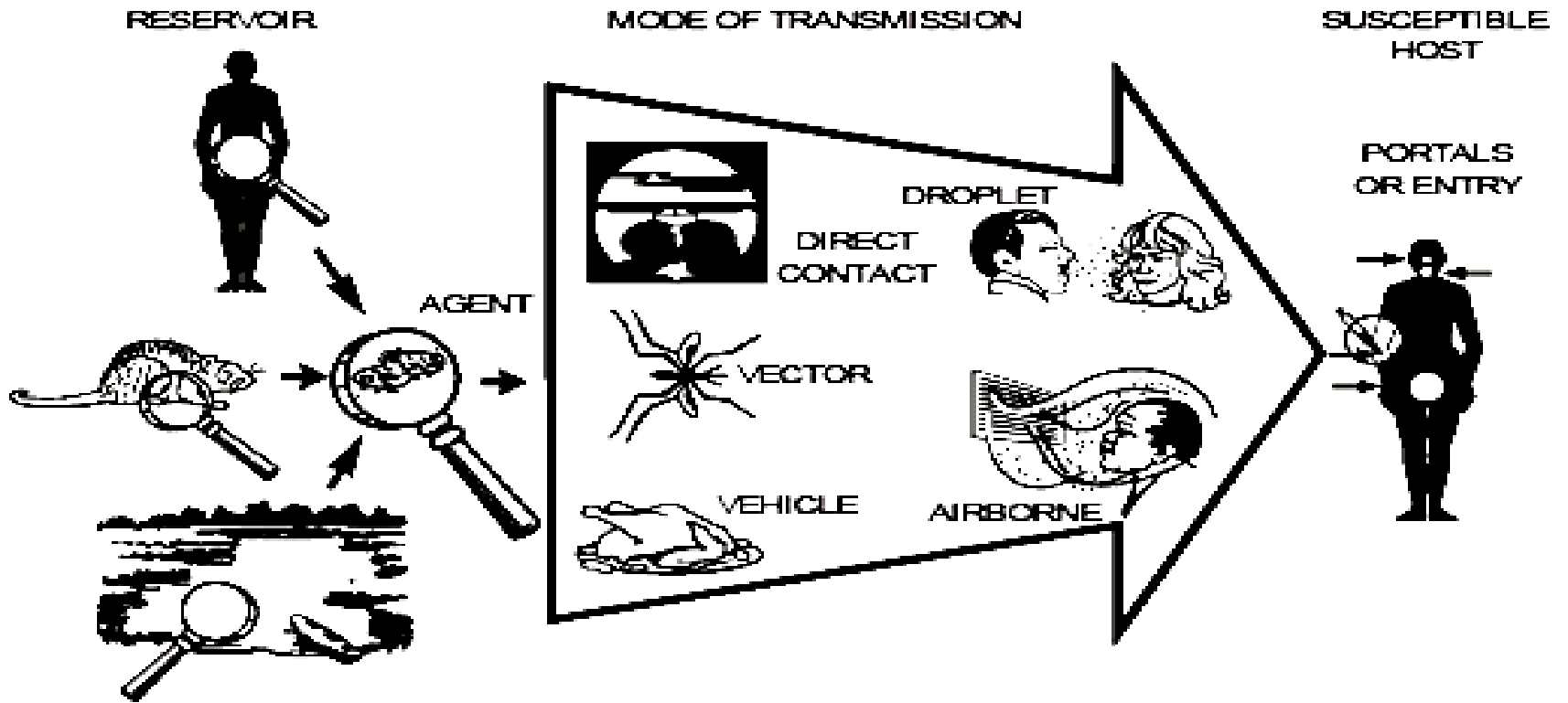
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Chain of infection *(Infectious cycle)*

Learning objectives:

- **Describe the infectious disease process (infectious cycle)**
- **List the types of reservoir of infectious diseases of man**
- **Define a carrier and list its types.**
- **Define zoonoses and list examples.**
- **Identify the different modes of transmission of the organisms from the reservoir to the new host.**

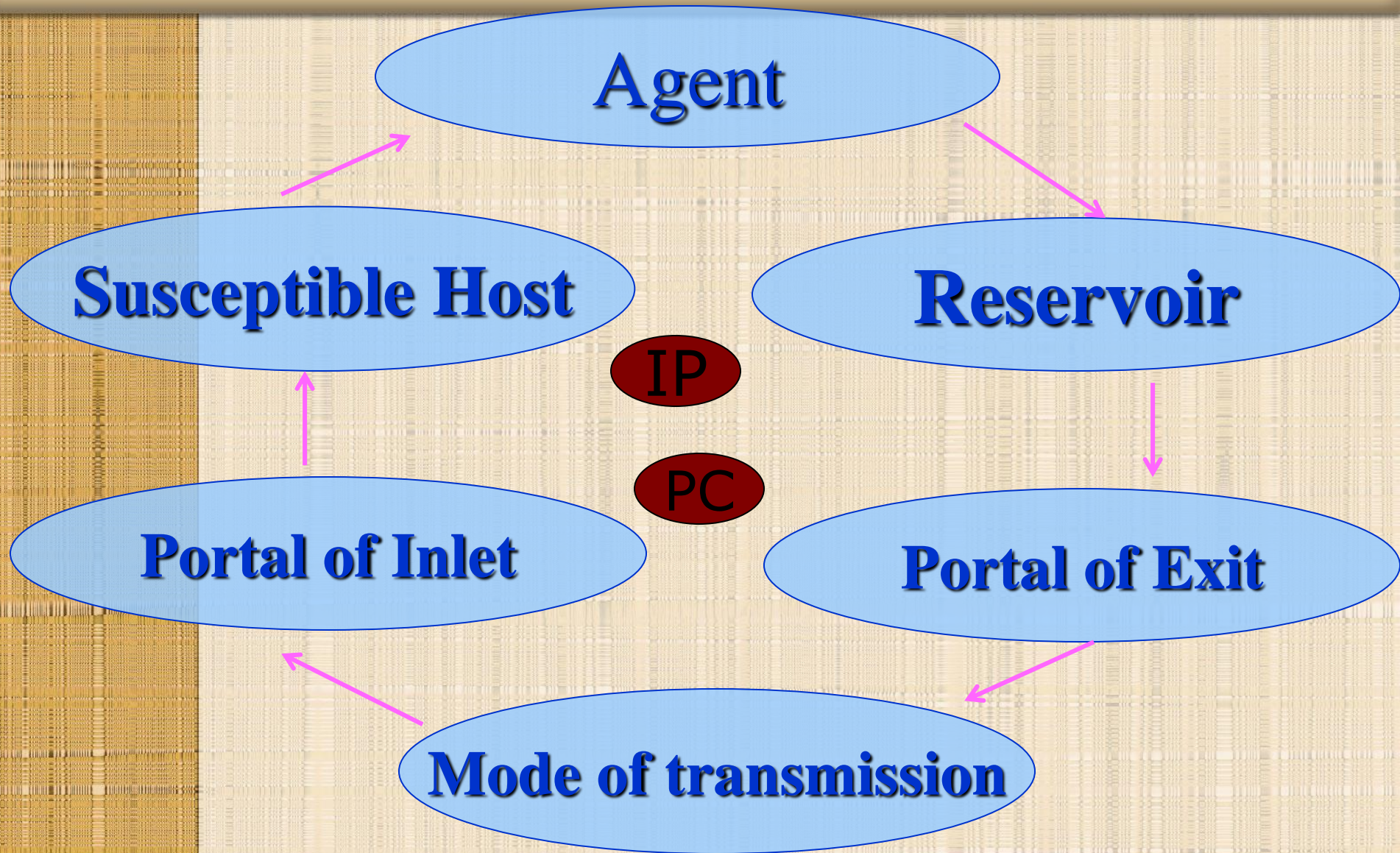
Chain of infection



Chain of infection

A process that begins when an agent leaves its reservoir or host through a portal of exit, and is conveyed by some mode of transmission, then enters through an appropriate portal of entry to infect a susceptible host.

Cycle of infection



The requisites (essentials) for the perpetuation of communicable diseases: The cycle of infection:

1. Presence of microbiological agent.
2. Presence of reservoir.
3. Portal of exit.
4. Mode of transmission.
5. Portal of entry (inlet).
6. Presence of susceptible host.

1. Agent:

- Microorganisms are responsible for disease production (viruses, bacteria, protozoa, parasites, fungi,..)
- Agent factors that affect disease transmission:
Infectivity, Pathogenicity, Virulence, Antigenicity, Resistance,....

Mechanisms of disease production (pathogenesis):

- Invasiveness: (Pneumococcosis, measles).
- Toxicity: (Tetanus, Botulism).
- Hypersensitivity: (Tuberculosis).
- Others: (Immune suppression; AIDS).

Infectivity

The ability of an agent to invade and multiply (produce infection) in a susceptible host.

How to measure ease & spread of infection?

Secondary Attack Rate

The proportion of exposed susceptible persons who become infected.

$$\text{Secondary attack rate} = \frac{\text{Number of secondary cases}}{\text{Number of susceptibles}} \times 100$$

Examples; High infectivity; Measles, Polio

Low infectivity; Leprosy

Pathogenicity

Is the ability of the organisms to produce specific clinical reaction after infection

It refers to the proportion of infected persons who develop **clinical** disease.

It can be measured by:

Ratio of clinical to subclinical case =

$$\frac{\text{Clinical cases}}{\text{Subclinical cases}}$$

Virulence

It refers the ability of organisms to produce **severe** pathological reaction.

It is the proportion of persons with clinical disease who become severely ill or die.

It can be measured by: **Case fatality rate**

$$\text{Case fatality rate} = \frac{\text{Total number of deaths from a disease}}{\text{Total number of cases of that disease}} \times 100$$

Antigenicity (Immunogenicity)

The ability of the organism to produce specific immunity (antibodies or antitoxin).

It can be measured by:

Second attack frequency:

*Second attacks are rare in **measles, mumps and chicken pox.***

*Re-infection occurs as in case of **common cold, syphilis and gonorrhoea.***

Resistance:

The ability of an agent to survive adverse environmental conditions.

Example:

- Hepatitis agents are generally very resistant.**
- Influenza viruses are typically fragile.**

2. Reservoir of infection

The **reservoir** of an agent is the habitat in which an infectious agent normally lives, grows, and multiplies.

Reservoirs include:

Humans, animals, and the environment.

Human reservoirs

Two types of human reservoir exist:

- **Cases:** persons with symptomatic illness
- **Carriers**

Carrier

A person or animal without apparent disease who harbors a specific infectious agent and is capable of transmitting the agent to others.

Carriers are dangerous because:

1. They do not show any clinical manifestation so they carry normal life.
2. The carrier and his contacts are not aware of their condition so, they take no precautions.
3. It is difficult to discover them.
4. It is not always possible to deal with them.
5. Chronic carriers can remain infectious for a long time leading to repeated introduction of the disease to contacts.

Types of Carriers:

1. Asymptomatic (In-apparent) carrier:

The carrier state that may occur in an individual with an infection that is in-apparent throughout its course

Examples: Polio virus, meningococcus, hepatitis A virus

2. Incubatory, Convalescent, Post-Convalescent carriers:

The carrier state may occur during the incubation period, convalescence, and post convalescence of an individual with a clinically recognizable disease.

Examples of Incubatory carrier: Measles, chickenpox

Convalescent carriers:

Examples: Diphtheria, hepatitis B viruses and Salmonella species

**The carrier state may be of short or long duration (transient carrier or chronic carrier).

Chronic carriers:

who continue to harbour an agent for an extended time (months or years) following the initial infection.

Examples: Hepatitis B virus and Salmonella typhi

Animal reservoirs

Zoonoses: Infectious diseases that are transmissible under normal conditions from *vertebrate* animals to humans. (with humans as incidental hosts)

Zoonotic diseases include:

- brucellosis (cows and pigs),
- anthrax (sheep),
- plague (rodents),
- rabies (bats, dogs, and other mammals).

Environmental reservoirs:

Soil, and water

- **Soil:** Agents live and multiply in the **soil**.

Examples:

- **Tetanus** spores and
 - Fungal agents; (those causing **histoplasmosis**)
- **Pools of water** are the primary reservoir of Legionnaires' bacillus.

3. Portal of exit

Portal of exit is the path by which an agent leaves the source host.

Examples:

- Respiratory tract
- GIT
- Skin and mucous membrane

4. Modes of transmission

After an agent exits its natural reservoir, it may be transmitted to a susceptible host in numerous ways.

These modes of transmission are classified as:

- **Direct transmission**

- Direct contact
- Droplet spread

- **Indirect transmission**

- Airborne
- Vehicleborne
- Vectorborne:
 - Mechanical
 - Biologic

Direct transmission

There is essentially *immediate* transfer of the agent from a reservoir to a susceptible host by direct **contact** or **droplet** spread.

- **Direct contact** occurs through:
kissing, skin-to-skin contact, and sexual intercourse.

Direct contact refers also to contact with soil or vegetation harbouring infectious organisms.

Droplet spread

It refers to transmission by direct spray of relatively large, short-range aerosols over a few feet, before the droplets fall to the ground.

These aerosols may be produced by *sneezing, coughing,* or even *talking.*

Indirect transmission:

An agent is carried from a reservoir to a susceptible host

by:

Vehicleborne: inanimate vehicle

Vectorborne: animate vector

Airborne transmission: suspended air particles

Vehicleborne:

An infectious agent is carried from a reservoir to a susceptible host by an inanimate intermediary.

Vehicles include:

1. **Contaminated food and water**, *typhoid, paratyphoid, food poisoning, dysentery and cholera.*
2. **Biologic products (blood)**, *viral hepatitis, AIDS, syphilis and malaria.*
3. **Fomites** (inanimate objects such as toys, handkerchiefs, bedding, or surgical instruments).

Vectors are arthropods such as mosquitoes, fleas, and ticks

- **Mechanical transmission:**

the agent does not multiply or undergo physiologic changes in the vector.

For example, flies carry *Shigella* on appendages.

- **Biologic transmission:**

When the agent undergoes changes and /or multiplication within the vector before it is transmitted.

(Extrinsic incubation period). Example: Malaria, Filariasis

Airborne transmission occurs by particles that are suspended in air.

There are two types of these particles:

- **dust** and
- **droplet nuclei.**

1. Dust particles:

- result from re-suspension of particles that have settled on floor or bedding as well as,
- infectious particles blown from the soil by the wind.

Example: Fungal spores.

2. Droplet nuclei

They represent the dried residue of droplets that have been coughed or sneezed into the air.

They are very tiny particles less than 5 μ (microns) in size and may remain suspended in the air for long periods.

Examples:

Tuberculosis is transmitted more often indirectly, through **droplet nuclei**, than directly, through direct droplet spread.

Legionnaires' disease and **histoplasmosis** also spread through airborne transmission.

5. Portal of entry

An agent enters a susceptible host through a portal of entry.

- The portal of entry must provide access to tissues in which the agent can multiply or a toxin can act.
- Often, organisms use the same portal to enter a new host that they use to exit the source host.

6. Host

A susceptible host is the final link in the chain of infection.

The host is a person or other living organism that can be infected by an infectious agent under normal conditions.

Susceptibility of a host depends on:

1. Genetic factors
2. General factors
3. Specific acquired immunity

General factors which defend against infection:

- the skin,
- mucous membranes,
- gastric acidity,
- cilia in the respiratory tract,
- the cough reflex, and
- nonspecific immune response.

General factors that may increase susceptibility

are:

- malnutrition,
- alcoholism, and
- disease or therapy which impairs the immune response (Cortisone, cytotoxic drugs, ...)

Specific acquired immunity:

It refers to protective antibodies that are directed against a specific agent.

Specific acquired immunity: two types:

1. Active immunity: Resistance developed in response to stimulus by an antigen either;

- **Naturally** by **infecting agent** or
- **Artificially** by **vaccine** and usually

characterized by the presence of antibody produced by the host.

Specific acquired immunity:

2. Passive immunity:

Immunity conferred by an antibody produced in another host and may be acquired;

- **Naturally** by an infant from its mother or
- **Artificially** by administration of an antibody containing preparation (antiserum or immune globulin).

Specific Acquired immunity:

This depends on antibodies production.

Immunity may be:

1. Active immunity.

a) Natural (Post-Infection).

b) Artificial (Post-Vaccination).

2. Passive immunity.

a) Natural (Trans placental).

b) Artificial (Immune-Sera).

Herd immunity

It is the state of immunity of a group or a community.

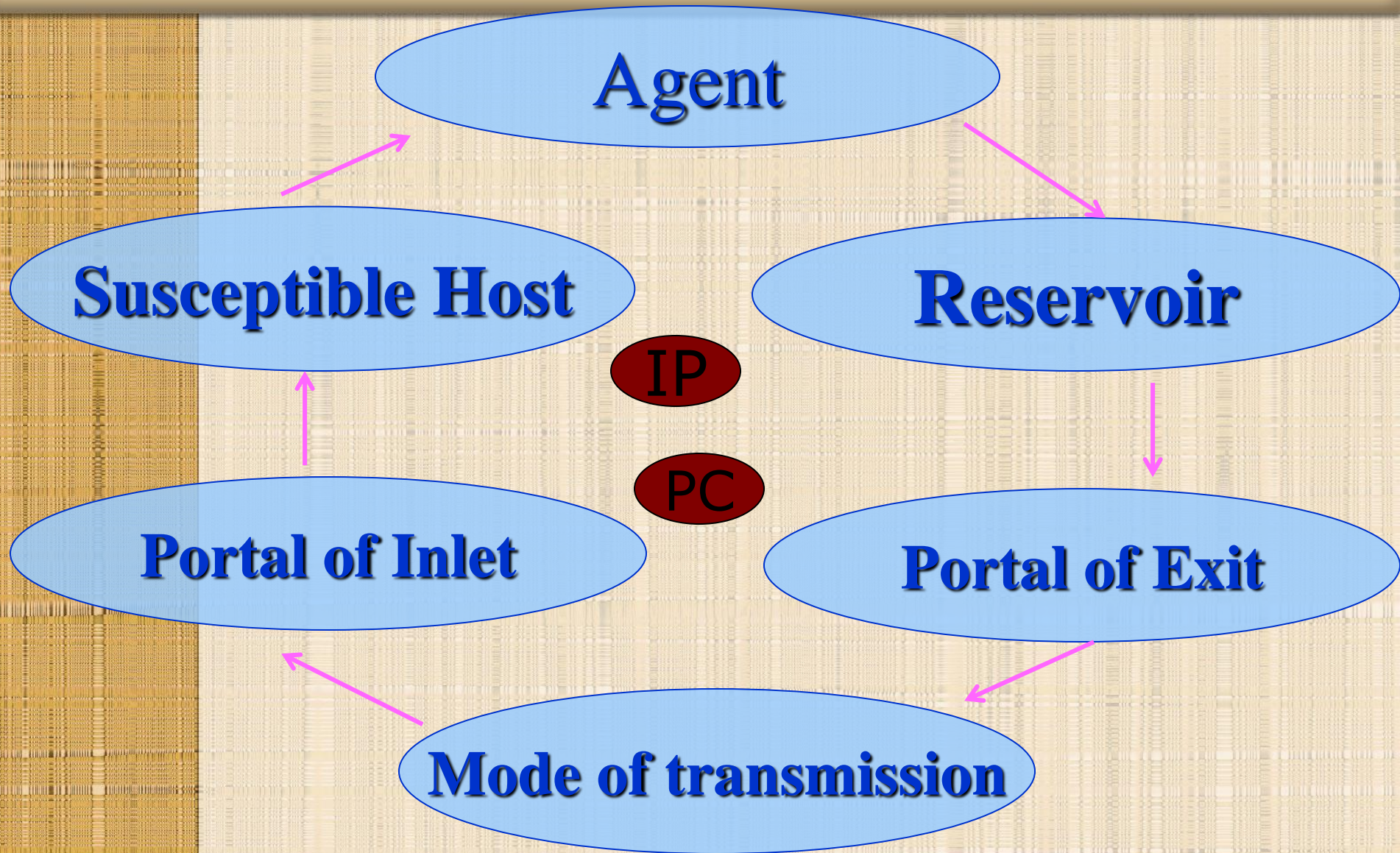
Also it is;

“The resistance of a group to invasion and spread of an infectious agent, based on the immunity of a high proportion of individual members of the group”.

Characteristics of Herd Immunity

- If a large percent of the population is immune, the entire population is likely to be protected.
- Once a high proportion of all people in the community are immune, the likelihood is small that an infected person will encounter a susceptible person.
- Herd immunity operates optimally when there is random mixing of the population. (No clustering of susceptible persons).

Cycle of infection



Communicable period

The time during which an infectious agent may be transmitted directly or indirectly from an infected person to a susceptible person or animal.

Its length varies from one disease to another.

Incubation period (IP)

- The period from exposure to infection to the onset of symptoms or signs of infectious disease.

The length of incubation period depends on:

- The portal of entry.
- The rate of growth of the organism in the host.
- The dosage of the infectious agent.
- The host resistance.

Extrinsic incubation period:

This is the period taken by the infectious agent outside the human body until it becomes infective again to a new individual.

e.g. *Rickettsia* takes five days in the intestinal villi of louse

The End



Thank You

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