

Epidemiology

Dr Eman Eltahlawy



Objectives

- **Define terms used in Epidemiology**
- **Identify components of infection cycle**
- **Role of public health epidemiologist in diseases prevention and control**



The Pontiac Story



Coming to human diseases...



- A lot of time what we experienced are similar to what happened in Pontiac story.
- Human disease has causal and preventive factors that can be identified through systematic investigation.
- Epidemiology offers means and ways for us to conduct systematic investigation.
- How?



Definition

- The origin of the word epidemiology is unknown but it is derived from the Greek words meaning study upon populations (epi = upon, demos = people, ology = study) 
- “The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control of health problems”. 

- **The science of epidemiology, therefore, combines elements of biology, social sciences and ecology - a bio-social-environmental science focusing on disease in populations.**
- **Epidemiology is concerned with disease in populations. Humans live in societies, where behavior and attitudes are shaped by interaction among people, which in turn are governed by the conventions and laws.**



Diseases

```
graph TD; A[Diseases] --> B[Communicable]; A --> C[Non Communicable];
```

Communicable

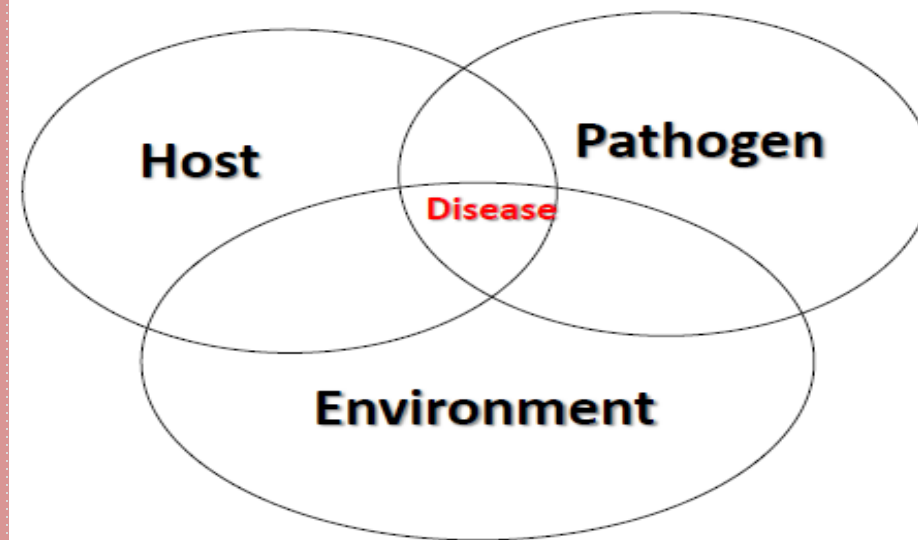
**Non
Communicable**



Host

Environment

Agent



- **Etiology** :it is study all factors that involved in development of diseases
- **Infection** :it is invasion of body by pathogenic organism
- **Source of infection** :the person, animal , objects ,or substances from which infection agent pass to the host



- **Virulence:** Severity of the disease produced by the organism.
- **Carrier:** Individual who harbors the organism but is not infected, as measured by serologic studies or evidence of clinical illness.



- **Infectivity** refers to the proportion of exposed persons who become infected.
- **Pathogenicity** refers to the proportion of infected individuals who develop clinically apparent disease.



- **Invasion of the body by pathogenic organism and to develop diseases depend on**

1. Agent factors:

- **dose of infection**
- **Pathogenicity or virulence which it is
Severity of the disease produced by the
organism.**



2.Host Factors :

- General Defense mechanism include natural barriers**
- Specific Immunity**



What happen to infected host

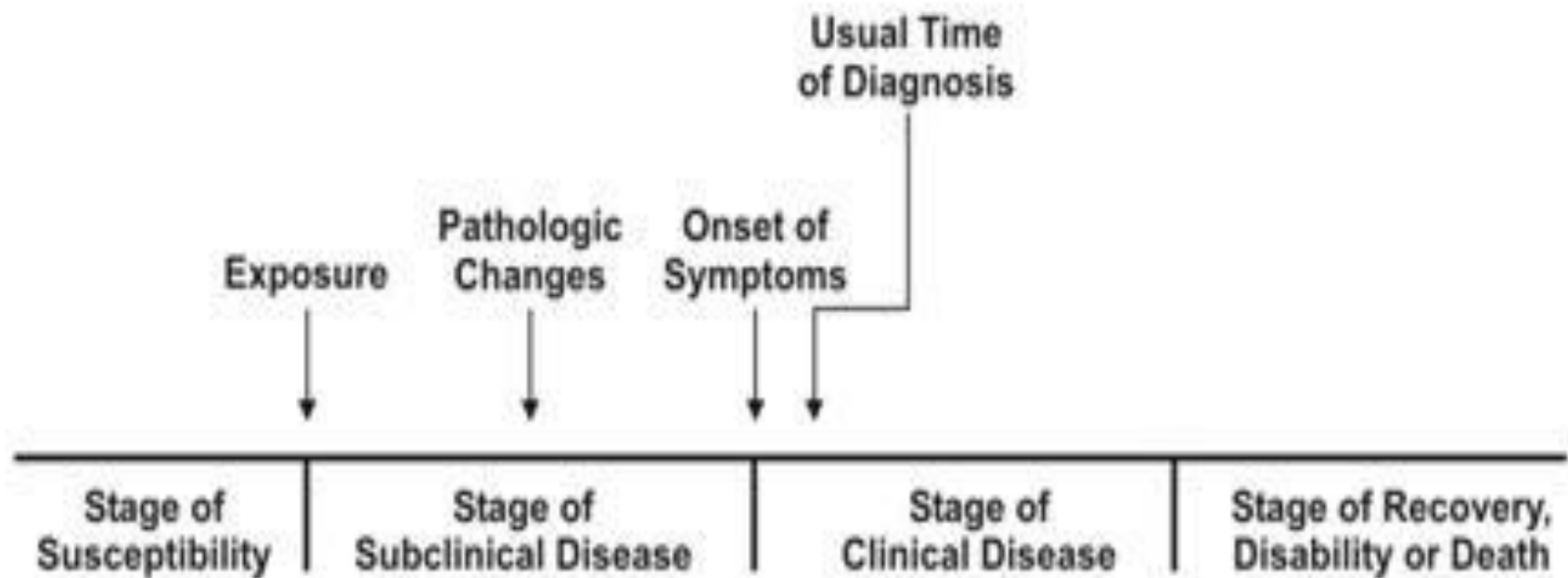


- **Natural history of disease** refers to the progression of a disease process in an individual over time, in the absence of treatment.
- The process begins with the appropriate exposure to or accumulation of factors sufficient for the disease process to begin in a **susceptible host**.



- After the disease process has been triggered, pathological changes then occur without the individual being aware of them. This stage of subclinical disease, extending from the time of exposure to onset of disease symptoms, is usually called the **incubation period for infectious diseases**





Timelines for Infection and Disease

Time of Infection

Dynamics of infectiousness

susceptible

latent period

Infectious period

Noninfectious

-- removed

-- dead

-- recovered

time

Dynamics of disease

susceptible

incubation period

Symptomatic period

Noninfectious

-- dead

-- recovered

-- immune

-- carrier

time



Timelines for Infection and Disease

Latent period: time interval from infection to development of infectious (note: this definition differs from that used for non-infectious diseases).

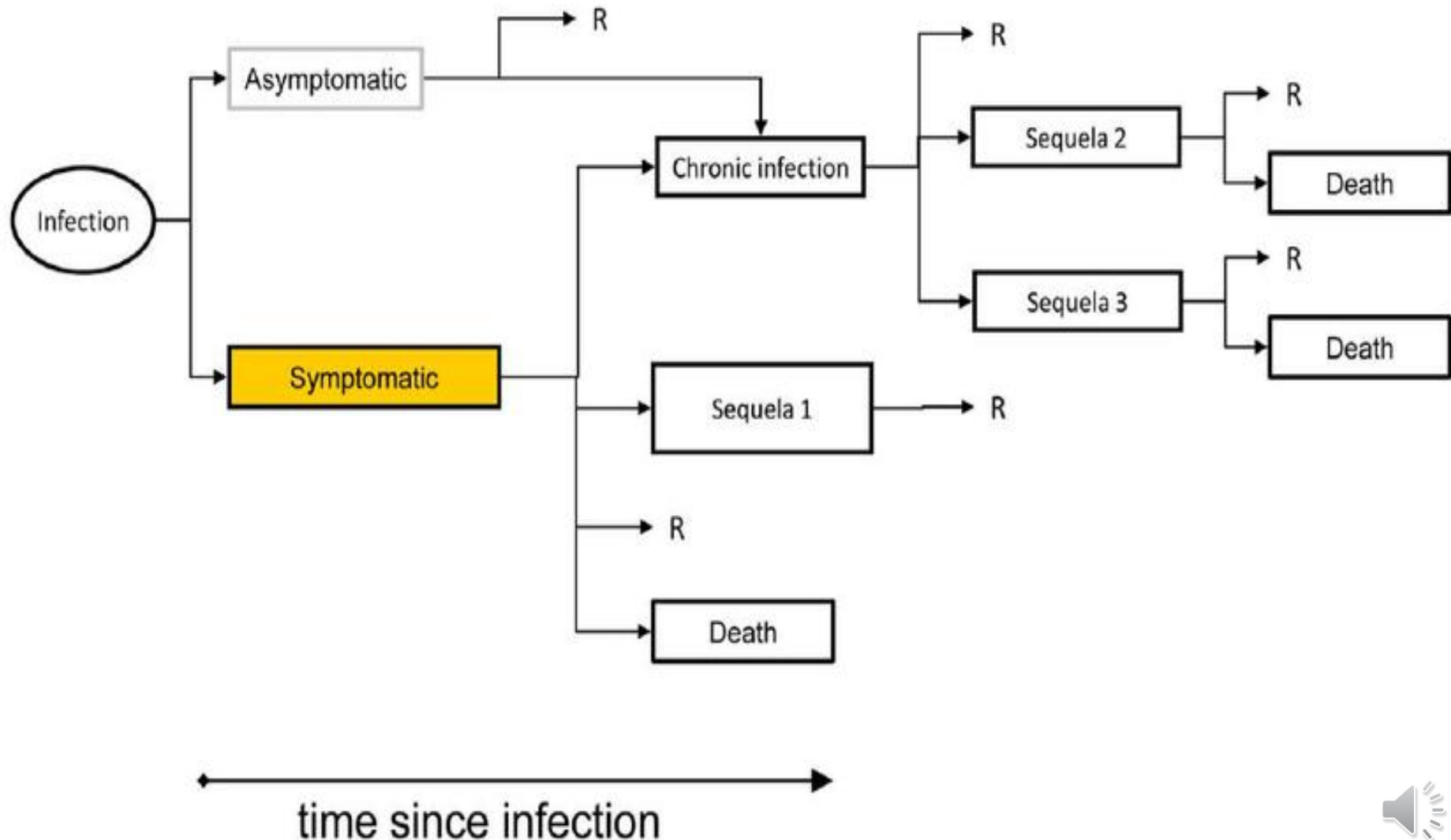
Infectious period: time during which the host can infect another host.

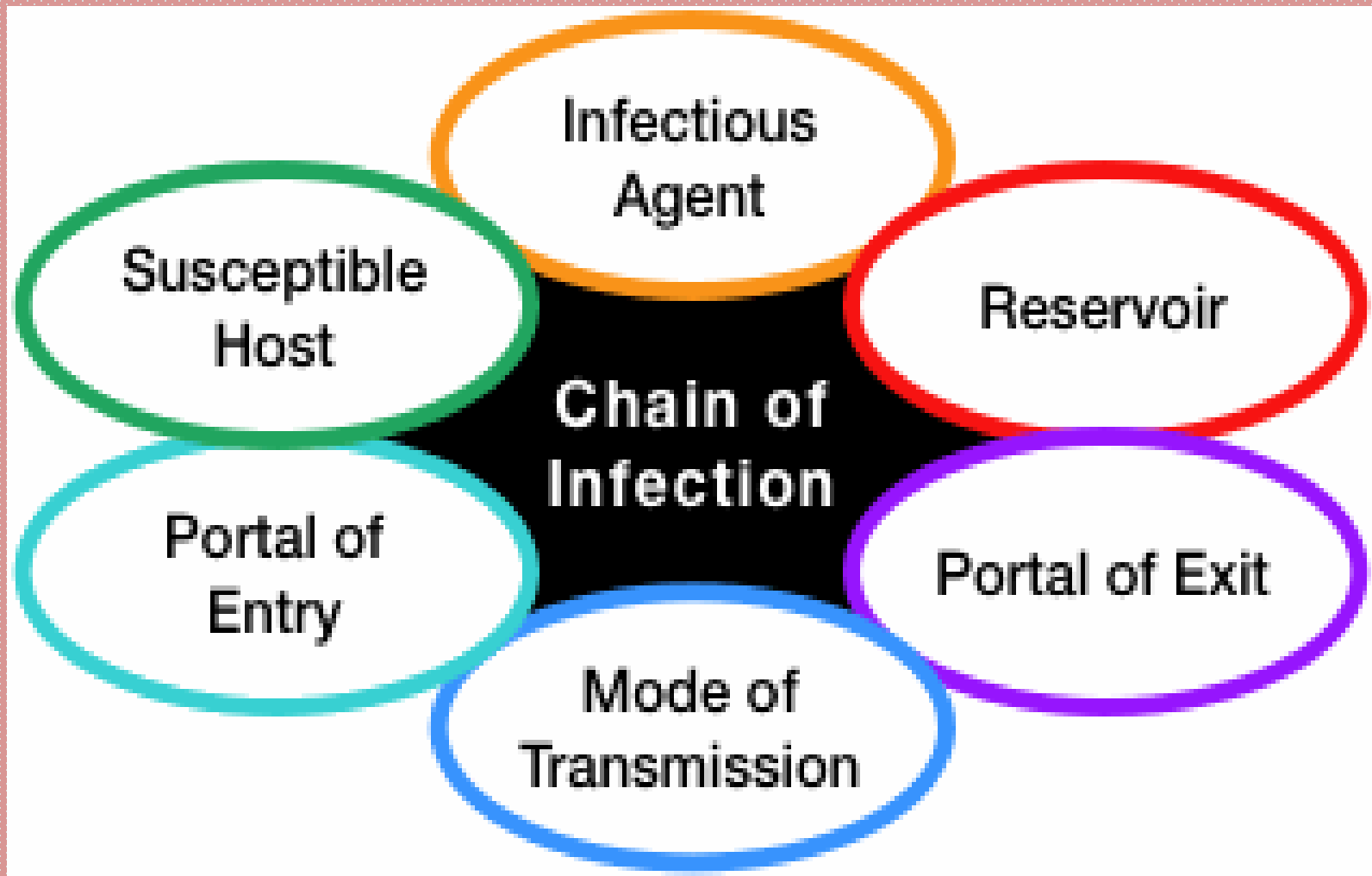
Incubation period: time from infection to development of symptomatic disease.

Symptomatic period: period in which symptoms of the disease are present.



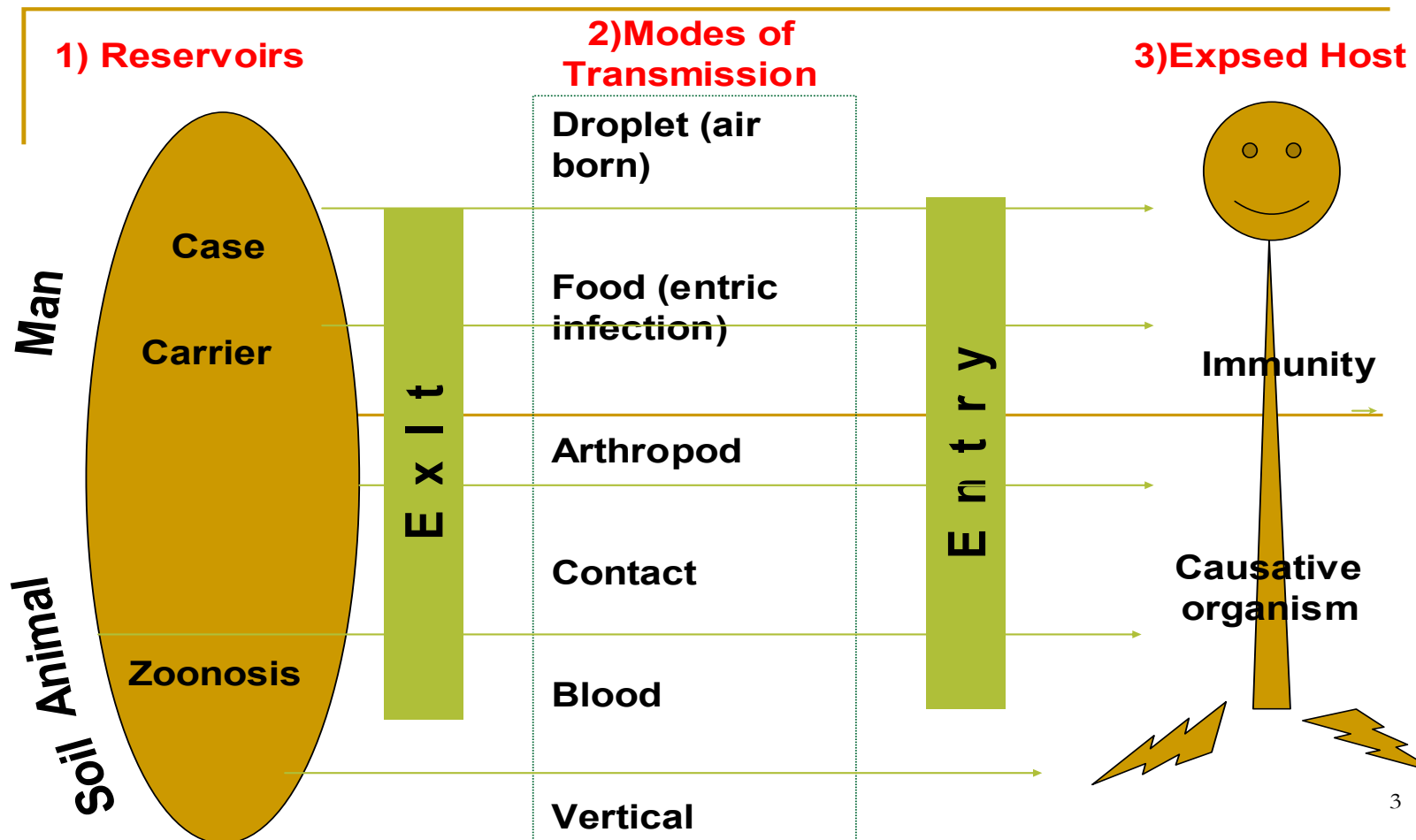
Sequae of infection





Epidemiologic Cycle

Epidemiological Cycle



Reservoirs of infections

- The reservoir of an infectious agent is the habitat in which the agent normally lives, grows, and multiplies.
- Reservoirs include:
 - ✓ Humans(case or carriers),
 - ✓ Animals or arthropods only no man to man infection
 - ✓ Both man and animal as reservoir
 - ✓ Environment include soil .



Human reservoir of infection

1. Carrier: Individual who harbors the organism but is not infected, as measured by serologic studies or evidence of clinical illness.



Types of Carriers

Asymptomatic or passive or healthy carriers are those who never experience symptoms despite being infected.

Incubatory carriers are those who can transmit the agent during the incubation period before clinical illness begins.



- **Convalescent carriers** are those who have recovered from their illness but remain capable of transmitting to others.
- **Chronic carriers** are those who continue to harbor a pathogen



- **Carriers commonly transmit disease because they do not realize they are infected, and consequently take no special precautions to prevent transmission.**



Infectivity Period of Carriers

- **Nature of disease.**
- **Type of carriers.**
- **Presence of pathological lesion in the body that favors persistence of infection.**
- **Chemotherapy or prophylaxis by antimicrobials**



Forms of Infectivity Period:

- *Transient Infectivity*: for some days only
- *Temporary Infectivity*: for few weeks or some months.
- *Chronic Infectivity*: for years, or lifelong



Classification of Carriers:

- Carriers by Period of Infectivity
 - Transient, for days.
 - Temporary, for weeks or months.
 - Chronic, for years or lifelong



Carriers by Foci of Infection

1. *Upper Respiratory Carriers*
2. *Gastrointestinal Carriers:*
3. *Urinary Tract Carriers*



Duration of carriers

- **Temporary:** Temporary carriers are those who shed the infectious agent for short periods of time. In this category may be included the incubatory, convalescent and healthy carriers.
- **Chronic:** A chronic carrier is one who excretes the infectious agent for indefinite periods.



Carriers by Flow of Organisms

- Carriers may not always show positive culture of taken sample, e.g. stools and urine for enterica, but may sometimes be negative, and so are called “intermittent carriers”.



Why we may need to do 1 -3 consecutive sample Laboratory examinations?

- To exclude intermittent carrier state.
- To exclude false negative results of sampling and examination errors



Importance of carriers

- Clinical Healthy
- Move Freely
- Large number
- Not known
- Dangerous group
- May remain infective for long period



II) FOCI OF COMMENSALS

- Commensals are nonpathogenic organisms that are normal inhabitants of some parts of the body, specially the upper respiratory tract, intestine, skin and vagina.
- They are potentially pathogenic under certain circumstances



Portal of Exit

(a) Urinary

(b) Intestinal

(c) Respiratory

(d) Others



EXIT OF INFECTION

- Exit in respiratory discharges
- Exit in saliva
- Exit in vomitus
- Exit in faeces (stools)
- Exit in urine
- Exit of skin or mucous membrane
- Exit of organisms in blood



2. A case :is defined as “a person in the population identified as having the particular disease, health disorder or condition under investigation”.

- Broadly, the presence of infection in a host may be **clinical, subclinical or latent**.
- **The clinical illness** may be mild or moderate, typical or atypical, severe or fatal depending upon the gradient of involvement.



Human reservoir

Cases

- Primary case
- Index case
- Secondary cases

According to spectrum of disease:

- Clinical cases
(mild/severe-typical/atypical)
- Sub-clinical cases
- Latent infection cases

Type:

- Incubatory
- Convalescent
- Healthy

Duration:

- Temporary
- Chronic

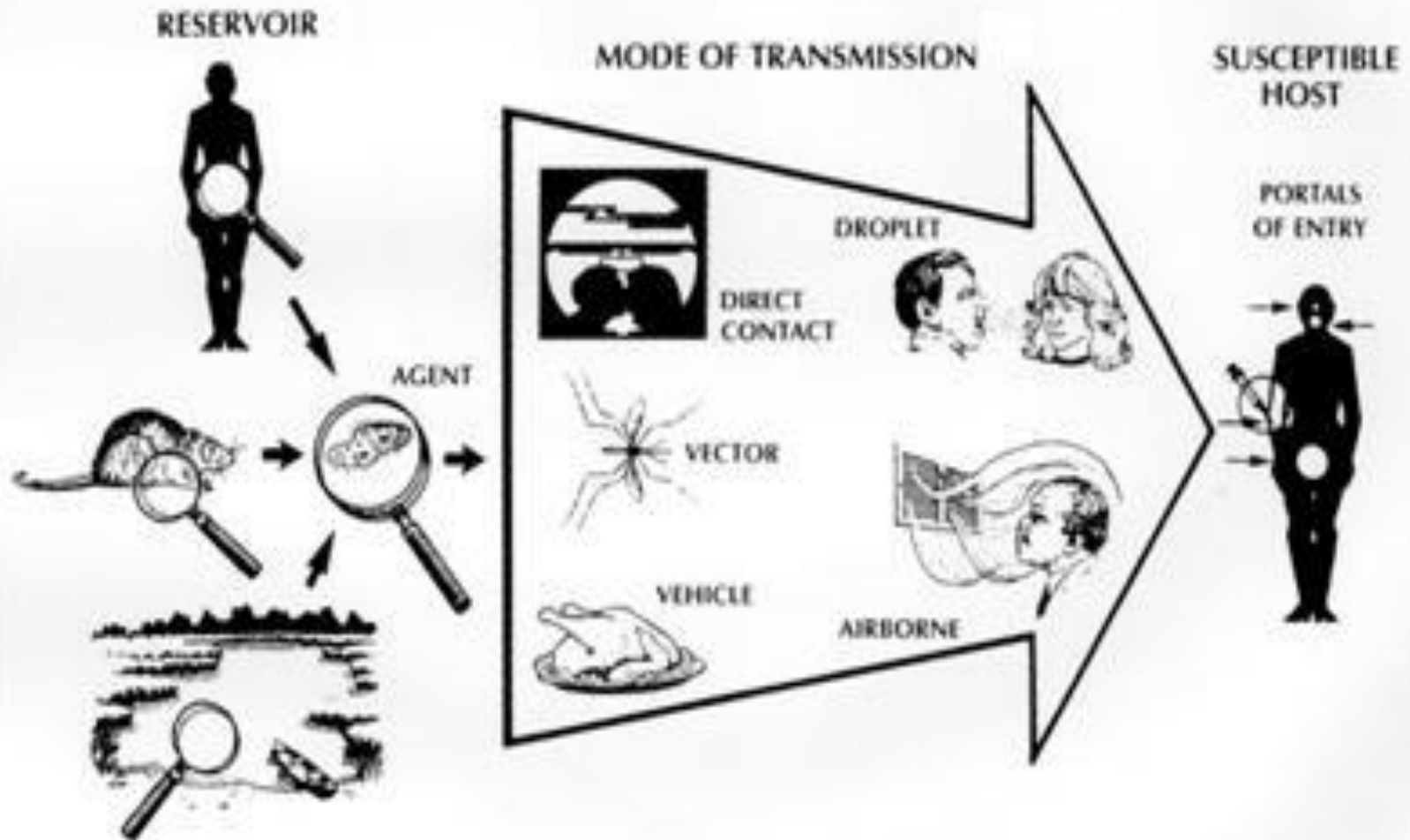
Carriers

Portal of exit:

- Urinary
- Intestinal
- Respiratory
- others



Chain of infection



Animal reservoir

- The diseases and infections which are transmissible to man from vertebrates are called **zoonosis**.
- The source of infection may sometimes be animals and birds.
- These, like the human sources of infection, maybe cases or carriers
- **Strictly zoonotic diseases** the disease transmitted from contact with animal only
- **Both animal and man**



Reservoir in non-living things

- Soil and inanimate matter can also act as reservoirs of infection.
- For example, the soil may harbour agents that cause tetanus, anthrax



Mode of Transmission



Modes of infectious disease transmission

A. General transmission

Abiotic environmental factors



Wind

Water

Inhalation of spores

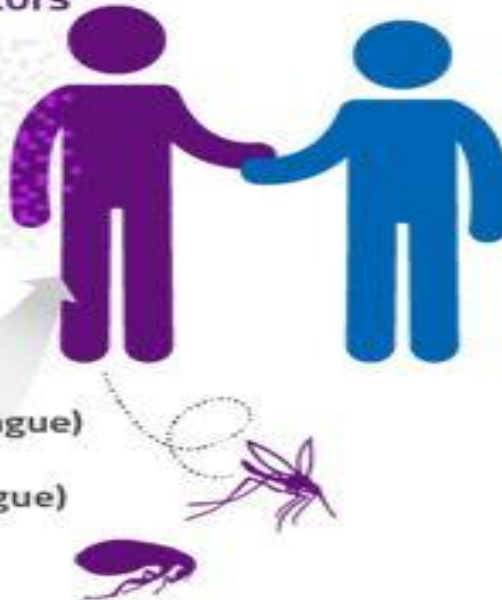
Entry into skin

Animal vectors



Mosquitoes (malaria, dengue)

Fleas (bubonic plague)



B. Human to human transmission



Direct contact

Pathogen survives best inside the body eg. HIV, Herpesviruses, Ebola



Indirect contact

Pathogen survives harsh environments

Pick up pathogen from surface or air eg. Influenza, norovirus



Droplets

Pathogens are in droplets, but do not survive long this way eg. Ebola, *Bordetella pertussis*



Airborne

Pathogens aerosolized and stay infective eg. influenza, Tuberculosis



Fecal - oral

Through contaminated water or food eg. Cholera, Norovirus, Shigella



Mode of transmission

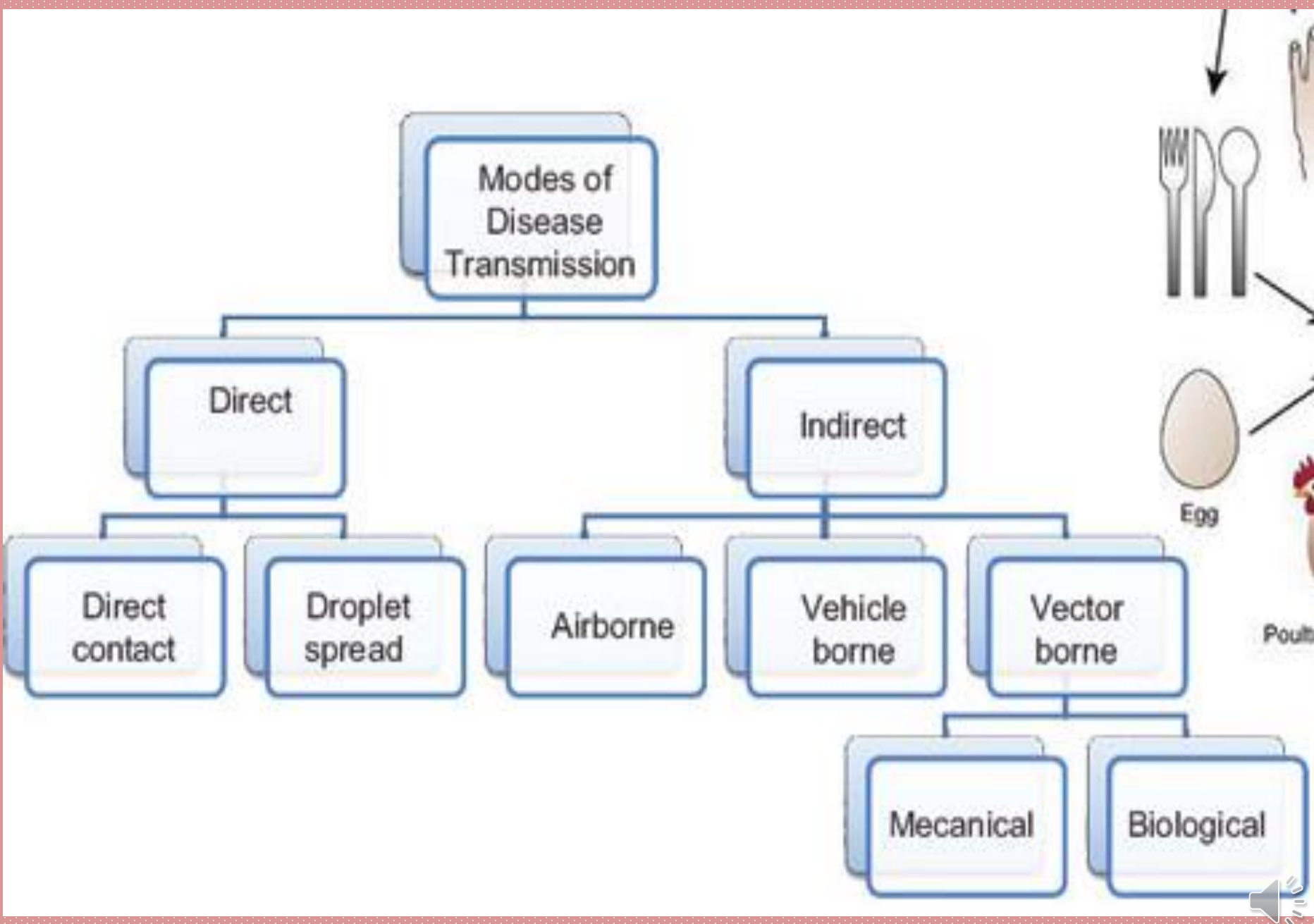
Direct transmission

- Direct contact
- Droplet infection
- Contact with soil
- Inoculation into skin or mucosa
- Trans-placental (vertical)

Indirect transmission

- Vehicle-borne
- Vector-borne:
 - ❖ Mechanical
 - ❖ Biological
 - Propagative
 - Cyclo-propagative
 - Cyclo-developmental
- Air-borne
- Fomite-borne
- Unclean hands & fingers





Single / Multiple Modes of Transmission

- Some infectious diseases are transmitted by one means only, while others spread by more than one means
- Multiple means may either be equally important, or one means gets the upper hand, and the others are also important or rare.



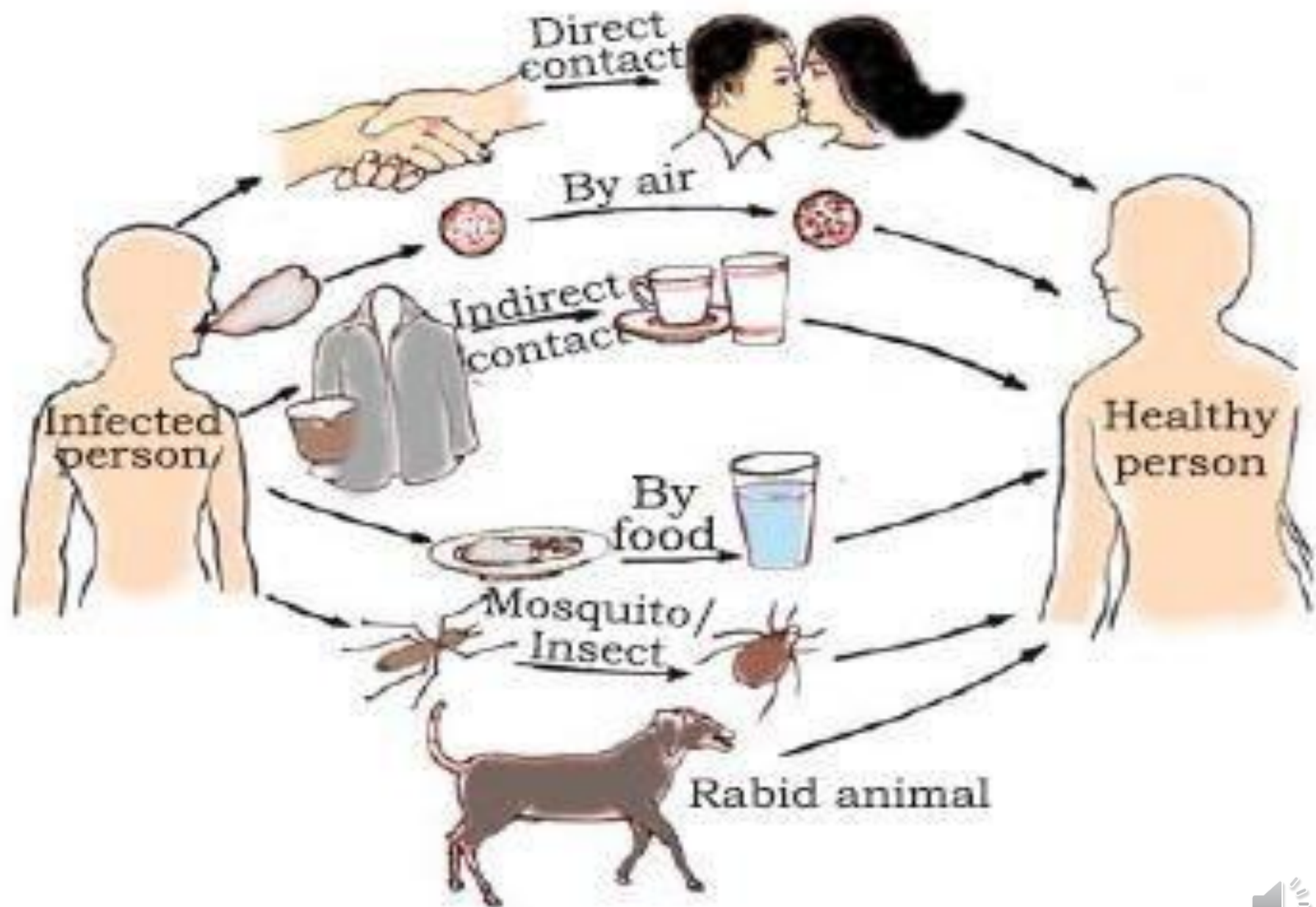
Entry of Infection

- **Respiratory tract,**
- **Gastrointestinal tract,**
- **Percutaneous route for :**
 - **Arthropod borne infection.**
 - **Wound infection.**
 - **Injection infection.**
- **Skin and mucous membranes, for other contact infections.**
- **Fetal circulation, for inutero infection.** 

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.
- Direct contact can be categorized as **vertical**, **horizontal**, or **droplet transmission** when pathogens are transmitted from mother to child during pregnancy, birth, or breastfeeding..





DROPLET INFECTION



- When an individual coughs or sneezes, small droplets of mucus that may contain pathogens are ejected. 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.
- **Indirect contact transmission** involves inanimate objects called fomites that become contaminated by pathogens from an infected individual or reservoir.



Direct droplet infection

- Both reservoir of infection and the new host are found together within the same place.
- The host gets infected through **direct inhalation of droplet spray** of the reservoir.
- Kissing is a potential method of direct infection.



Predisposing factors

- **Crowding, especially in confined places as classrooms of schools, and dormitories of camps.**
- **Association with the reservoir for long time.**
- **Ill ventilation of the place.**



Droplet Infection (Airborne)

- It occurs when infectious agents are carried by dust or droplet nuclei suspended in the air.
- Airborne dust includes material that has **settled on surfaces** and become re-suspended by air currents as well as infectious particles blown from the soil by the wind.
- Droplet nuclei are dried residue of fewer than 5 microns in size.
- Droplet nuclei may remain suspended in the air for long periods of time and maybe blown over great distances.



Airborne infection

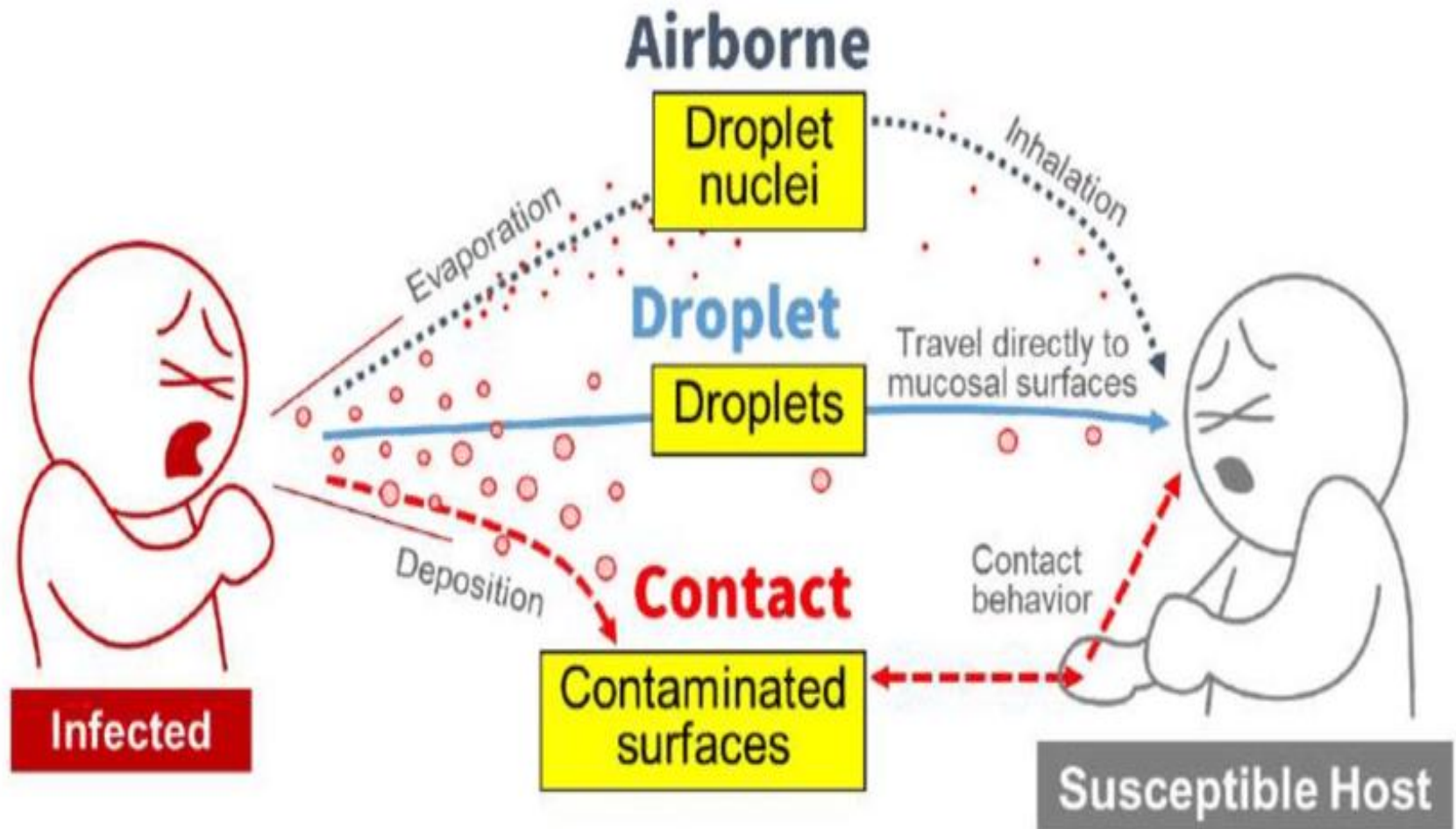
- **Droplet nuclei** are the minute residues of fine droplets after evaporation of water. They remain suspended in air for hours, and may be carried by air current for nearby places.
- **Dust:** big droplets and respiratory discharges may fall on the floor or any surface, and get dried.



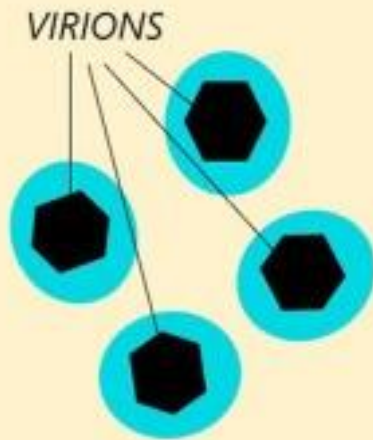
Airborne infection *Cont.*

- **Articles and fomites**
- **Milk:**
 - Haemolytic streptococci that cause pharyngitis (or scarlet fever).
 - Diphtheria bacilli, causing diphtheria.





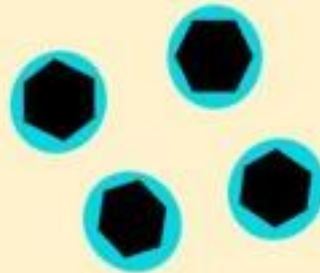
Stages Of Infectious Droplets And Droplet Nuclei



1

LARGE INFECTIOUS DROPLETS

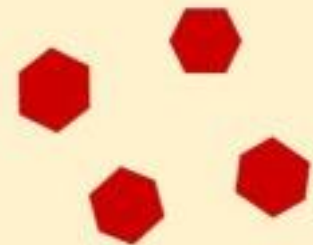
- Mucus/water **encased**.
- Viruses are **aerosolized** by the infector or by toilet water.
- Quickly fall to the ground after traveling up to **1 – 3 ft.**



2

SMALL INFECTIOUS DROPLETS

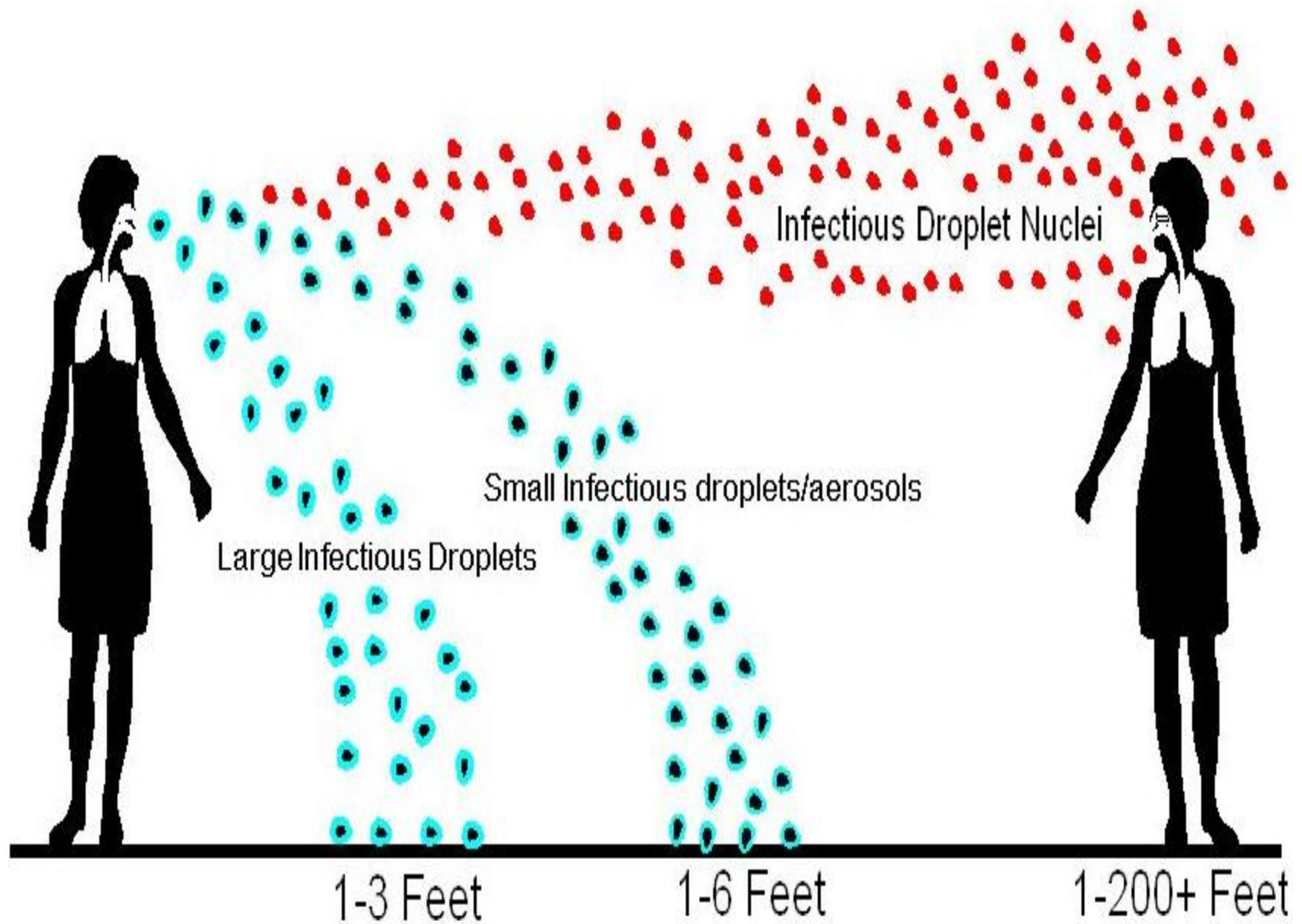
- Mucus/water coating **starts to evaporate**.
- Fall to ground after traveling **3 - 5 ft.**
- Can become droplet nuclei.



3

INFECTIOUS DROPLET NUCLEI

- Droplet size has decreased to **<5 microns**.
- Can float in the air for **prolonged periods** due to microscopic size.



Vehicle Transmission

- refers to the transmission of pathogens through vehicles such as water, food, and air.
- Water contamination through poor sanitation methods leads to **waterborne transmission** of disease.
- Dust and fine particles known as aerosols, which can float in the air, can carry pathogens and facilitate the **airborne transmission of disease**.

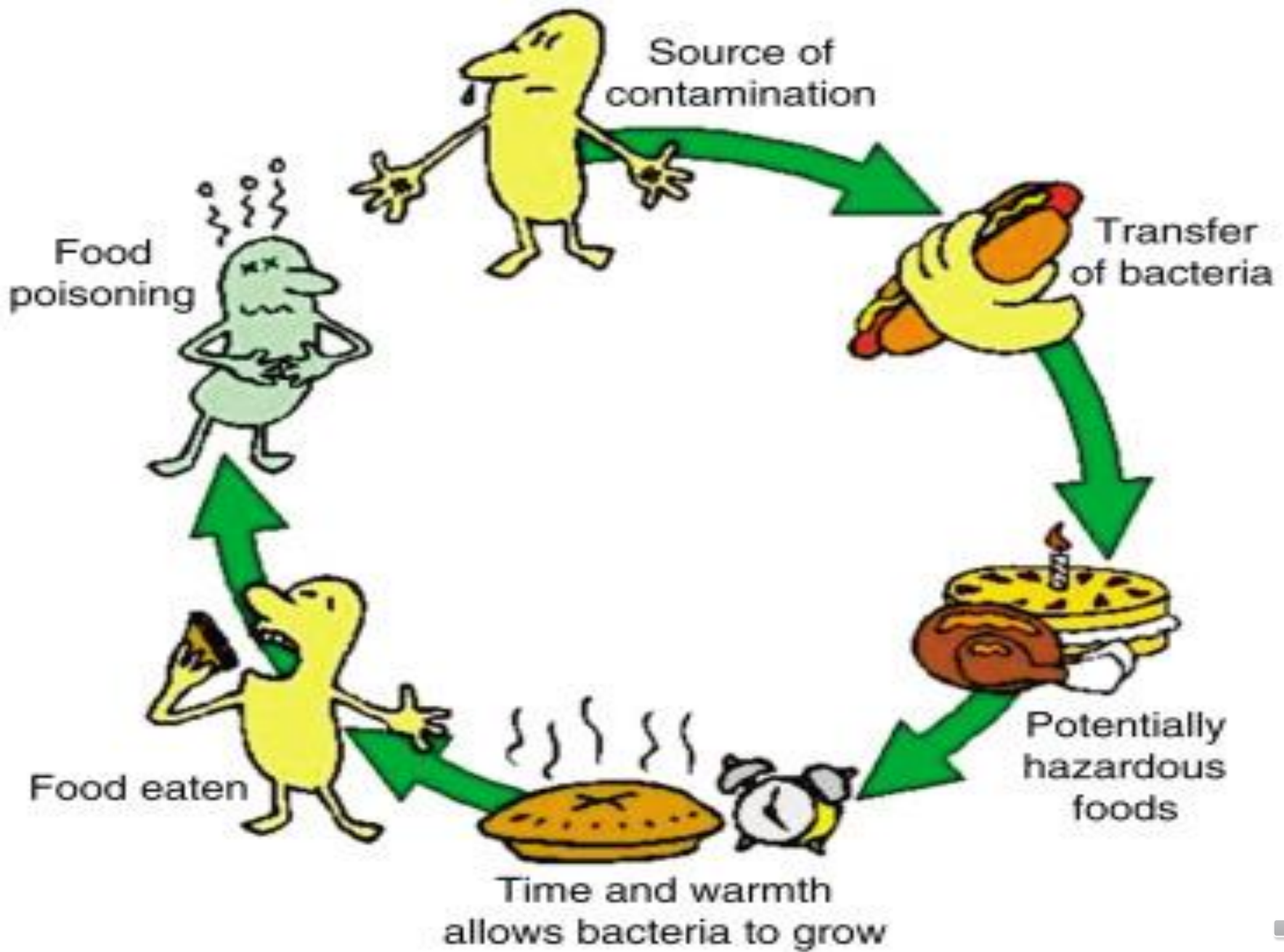


Food borne infection



- **Foodborne diseases are caused by contamination of food and occur at any stage of the food production, delivery and consumption chain.**
- **They can result from several forms of environmental contamination including pollution in water, soil or air, as well as unsafe food storage and processing.**





How organism find his way to food

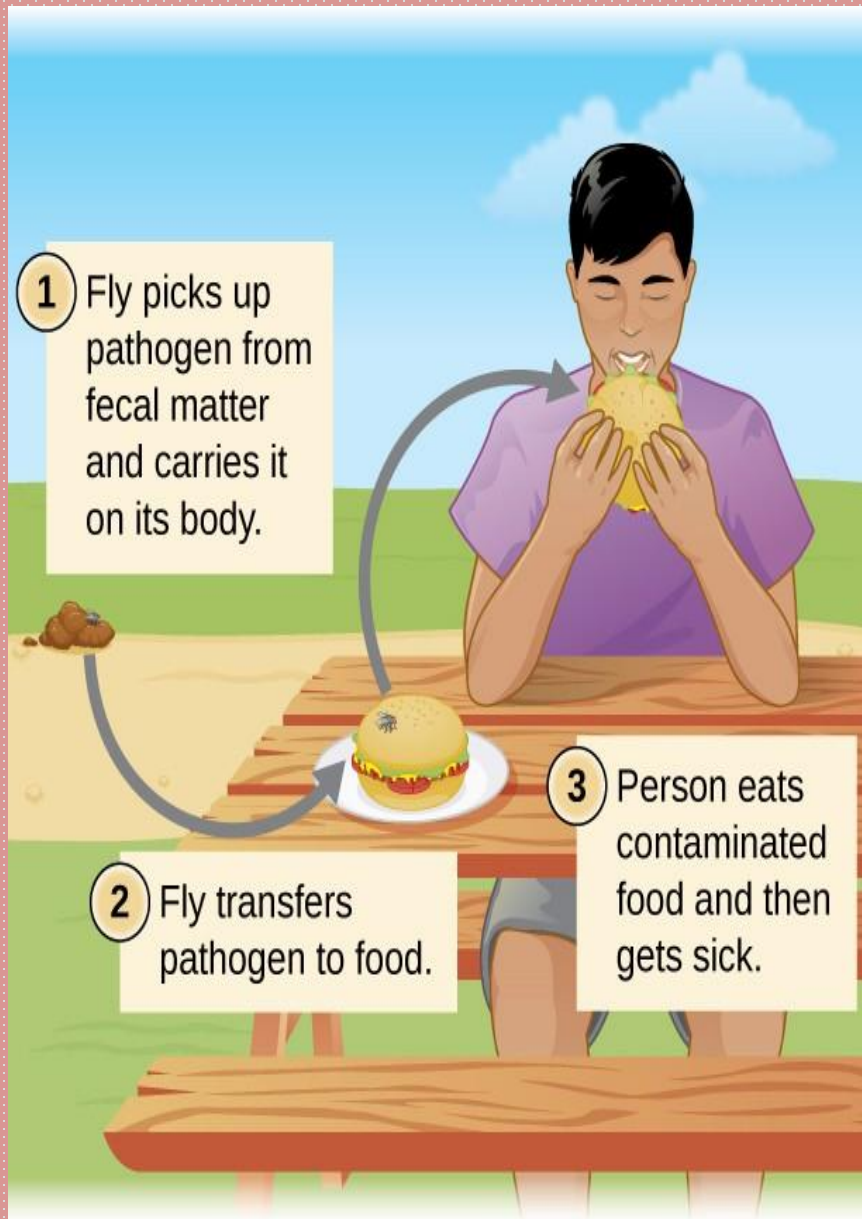
- Contaminated hands
- Houseflies and cockroaches
- Polluted water
- Human excreta contaminated dust
- Fertilization of vegetables with fresh human manure



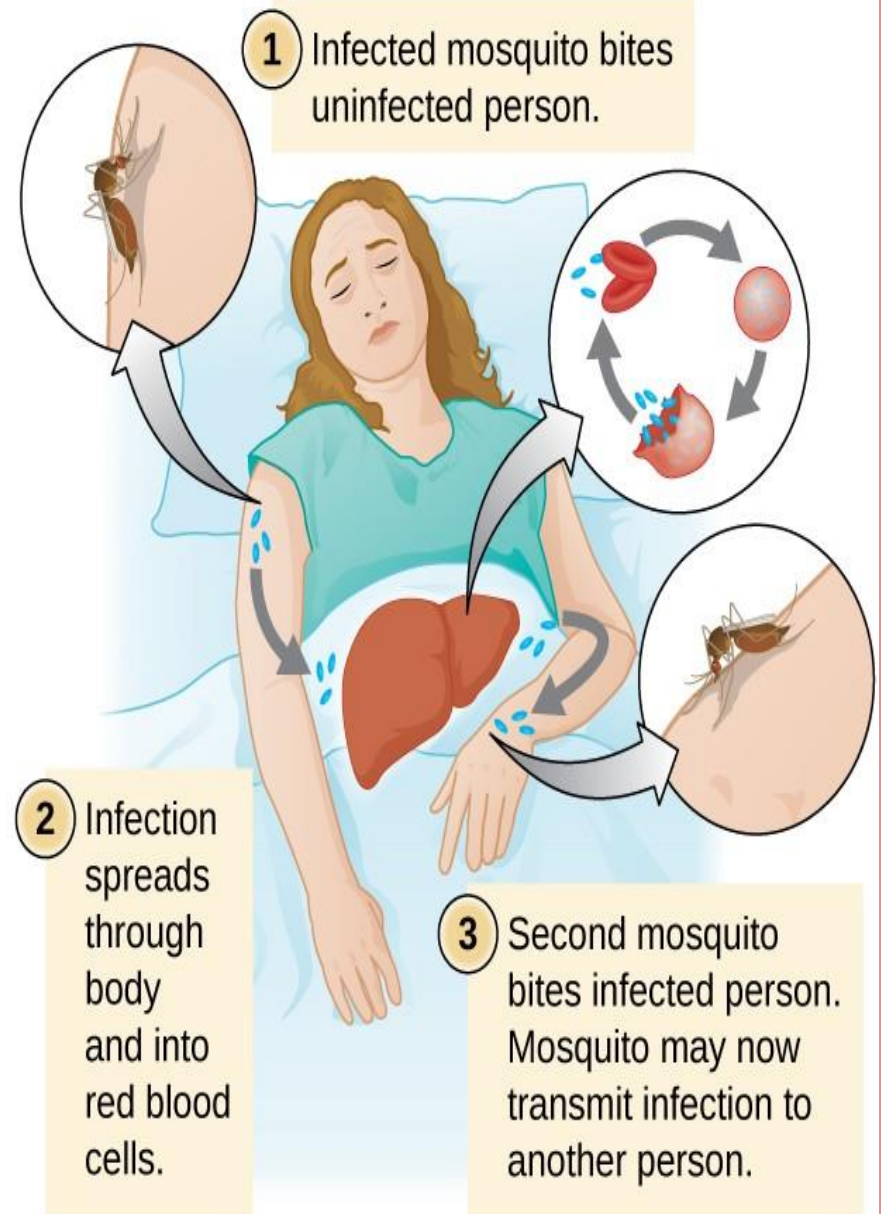
Vector Transmission

- Diseases can also be transmitted by a mechanical or biological vector, an animal (typically an arthropod) that carries the disease from one host to another.
Mechanical transmission is facilitated by a mechanical vector, an animal that carries a pathogen from one host to another without being infected itself.
- **Biological transmission** occurs when the pathogen reproduces within a biological vector that transmits the pathogen from one host to another





(a)



(b)



OTHER MODES OF TRANSMISSION

- **Injection Infection**
(Parenterally Infection)
- **Inutero Infection** (Congenital Infection)



1. Injection Infection

(Parenterally Transmitted Infection)

1. Blood-transmitted Infections:

- Viral hepatitis: B and C, and potentially A.
- Syphilis.
- AIDS.
- Malaria.
- Cytomegalovirus disease (CMV disease).

Infection is transmitted through:

- Using blood-contaminated syringes and needles, for injection by any route specially the intravenous.
- Blood transfusion without safety precautions.

2. **Pyogenic Infection:** usually staphylococcal, when using contaminated syringes and needles.



2. Inutero Infection

(Congenital Infection)

It is infection transmitted from the pregnant to either:

- **The embryo**, with early infection in the first trimester, before formation of placenta.
- **The foetus**, sometimes: with transplacental infection, after formation of placenta, e.g. syphilis.



Inutero infection may be viral, spirochetal or protozoal

- ***Viral Infection***, by: rubella virus, CMV, HBV, HCV, HIV, and potentially mumps, varicella and other viruses.
- ***Spirochetal Infection***: syphilis that has been largely controlled at present. Infection is transplacental, after the 4th month of pregnancy.
- ***Protozoal Infection***, by : Toxoplasma gondii.



Hazards of Inutero Infection

- Infection is etiologic factor of unfavorable outcome of pregnancy that may be either lethal or sublethal.
- ***Lethal:*** abortion, stillbirth, or neonatal mortality.
- ***Sublethal:*** congenital anomalies and malformations (deformities), congenital disability, or congenital disease (syphilis, rubella).



Vertical Infection

Viral diseases of human reservoir are transmitted through either:

- **Person to person infection** (respiratory, ingestion, percutaneous or injection infection) : considered as if **transverse infection**, but not termed so.
- **Mother to infant infection**, called “**vertical infection**”.



Vertical infection is transmitted in three ways:

- **Inutero infection,**
- **Perinatal Infection,**
- **Breast-feeding**



Perinatal Infection

- infection the infant acquires from infected birth canal during childbirth (Herpes simplex virus)

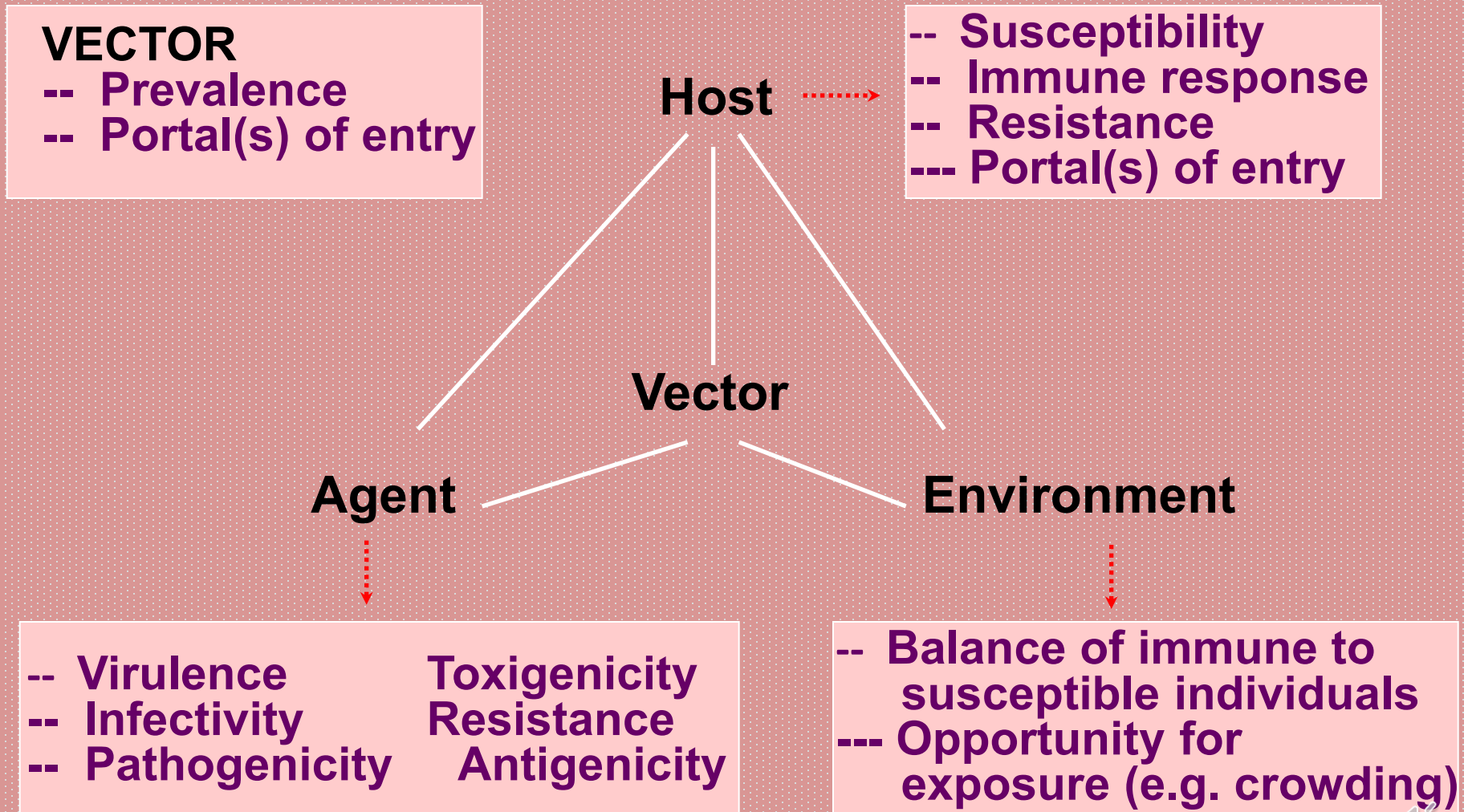


Breast-feeding

- Breast milk is free of infection, and is of anti-infection value as well.
- Some viral infections of mother, however, may pass in milk.
- CMV: particularly risky in preterm infants.
- HIV.
- HBV and HCV.



Factors Affecting Disease Transmission and Symptomatic Clinical Disease



Thank You

