Dynamics
Of
Disease Transmission

Infection vs. Disease

- **Infection** is the invasion of the host by a pathogen

- **Disease** results only if the invading pathogen alters the normal functions of the body
- Disease is also referred to as morbidity

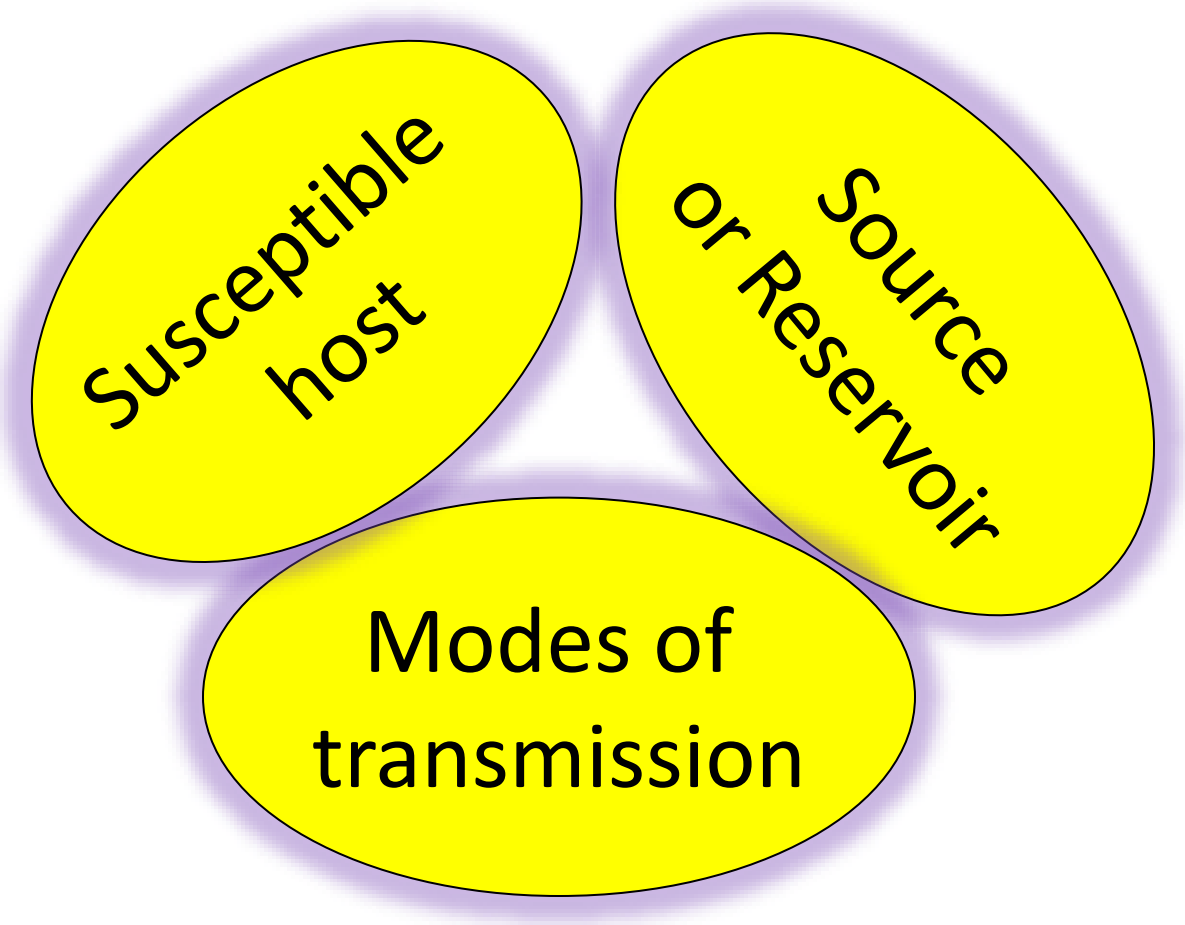
Definition of Infectious diseases

- An infectious disease is an illness due to a specific infectious (biological) agent or its toxic products capable of being directly or indirectly transmitted from man to man, from animal to man, from animal to animal, or from the environment (through air, water, food, etc..) to man.

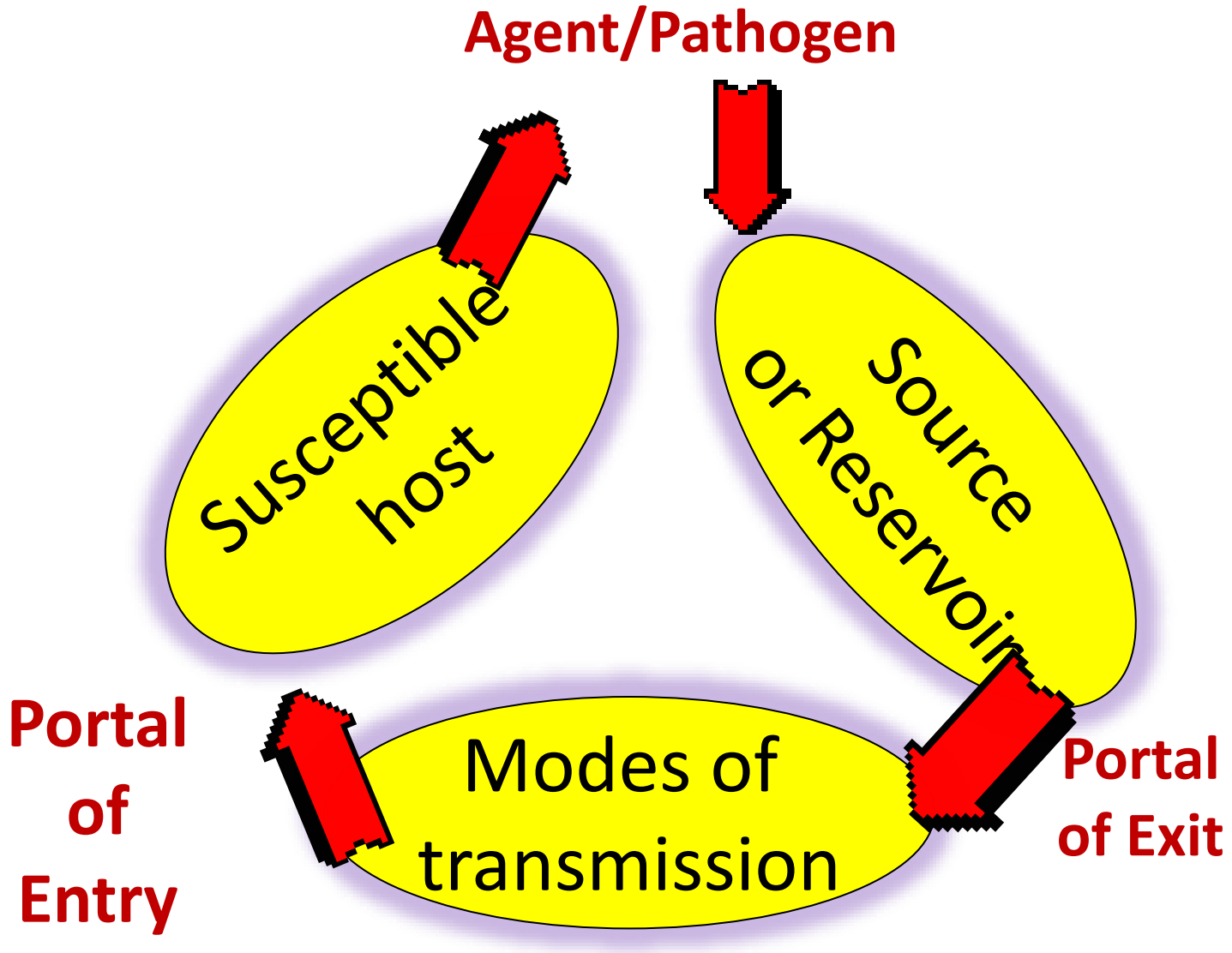
Dynamics of disease Transmission

(Chain of Infection)

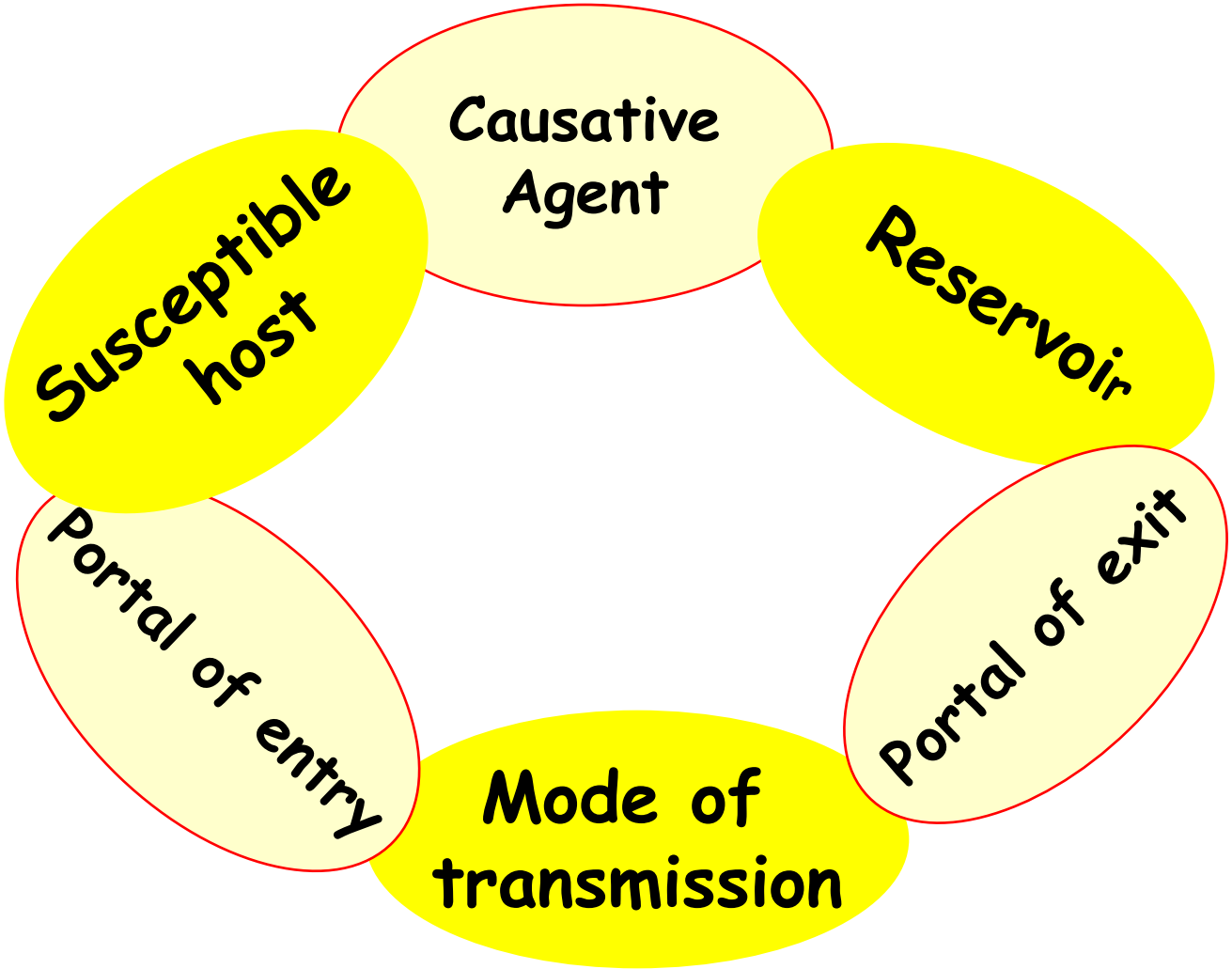
Chain of Infection



Chain of Infection



The chain of infection



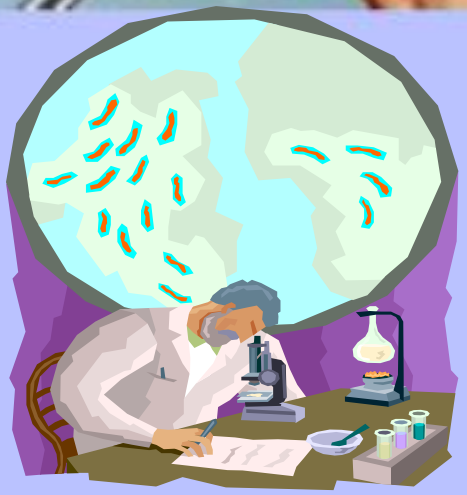
There are six links in the chain of infection :

Links of Infection

1. Infectious Agent
2. Source/ Reservoir of Infection
3. Portal Of Exit
4. Modes Of Transmission
5. Portal Of Entry
6. Susceptible host

1st - Infectious Agent

any disease-causing microorganism (bacteria, virus..)



Causative Agents

- Bacteria
- Viruses
- Fungi
- Protozoa
- Helminthes
- Parasites

Disease producing characteristics of infectious agents

- Invasiveness
- Infectivity
- Infectious dose & Virulence
- Viability in the free state
- Host specificity
- Antigenic variation
- Ability to develop resistance to antimicrobial agents

Links of Infection

1. Infectious Agent
2. **HOST-Source/ Reservoir of Infection**
3. Portal Of Exit
4. Modes Of Transmission
5. Portal Of Entry
6. Susceptible host

2nd – The Host

A living or non living things that affords subsistence or lodgment to an infectious agent under natural conditions.

SOURCE OF INFECTION

- **It is defined as the person, animal, object or substance from which an infectious agent passes or is disseminated to the host** (immediate source).

Common Sources

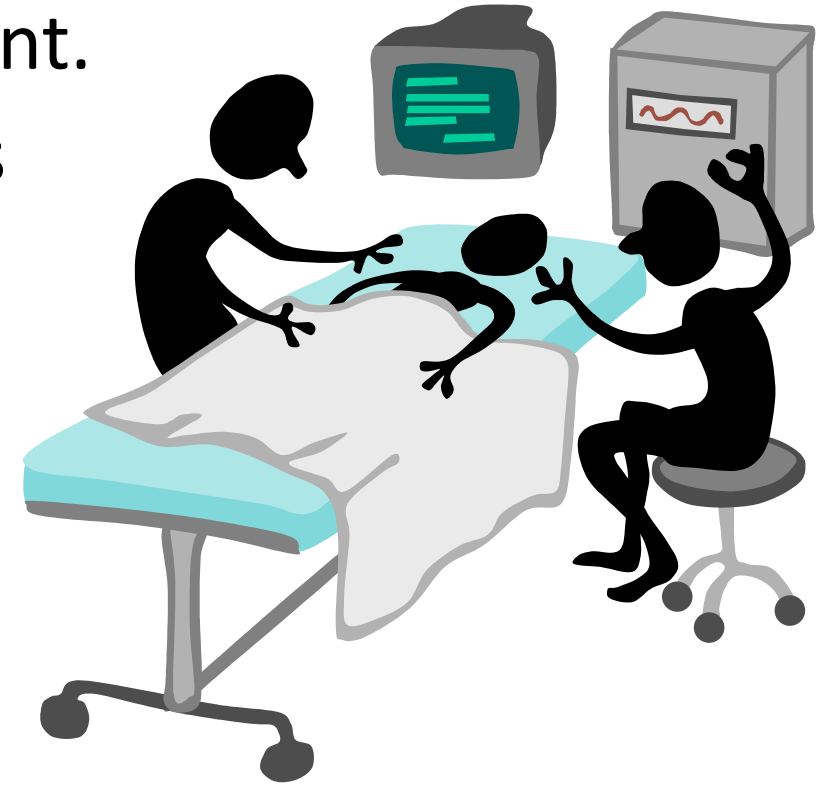
- Equipment
- Sand
- Toys
- Furniture
- Urine
- Fecal material
- Body secretion……

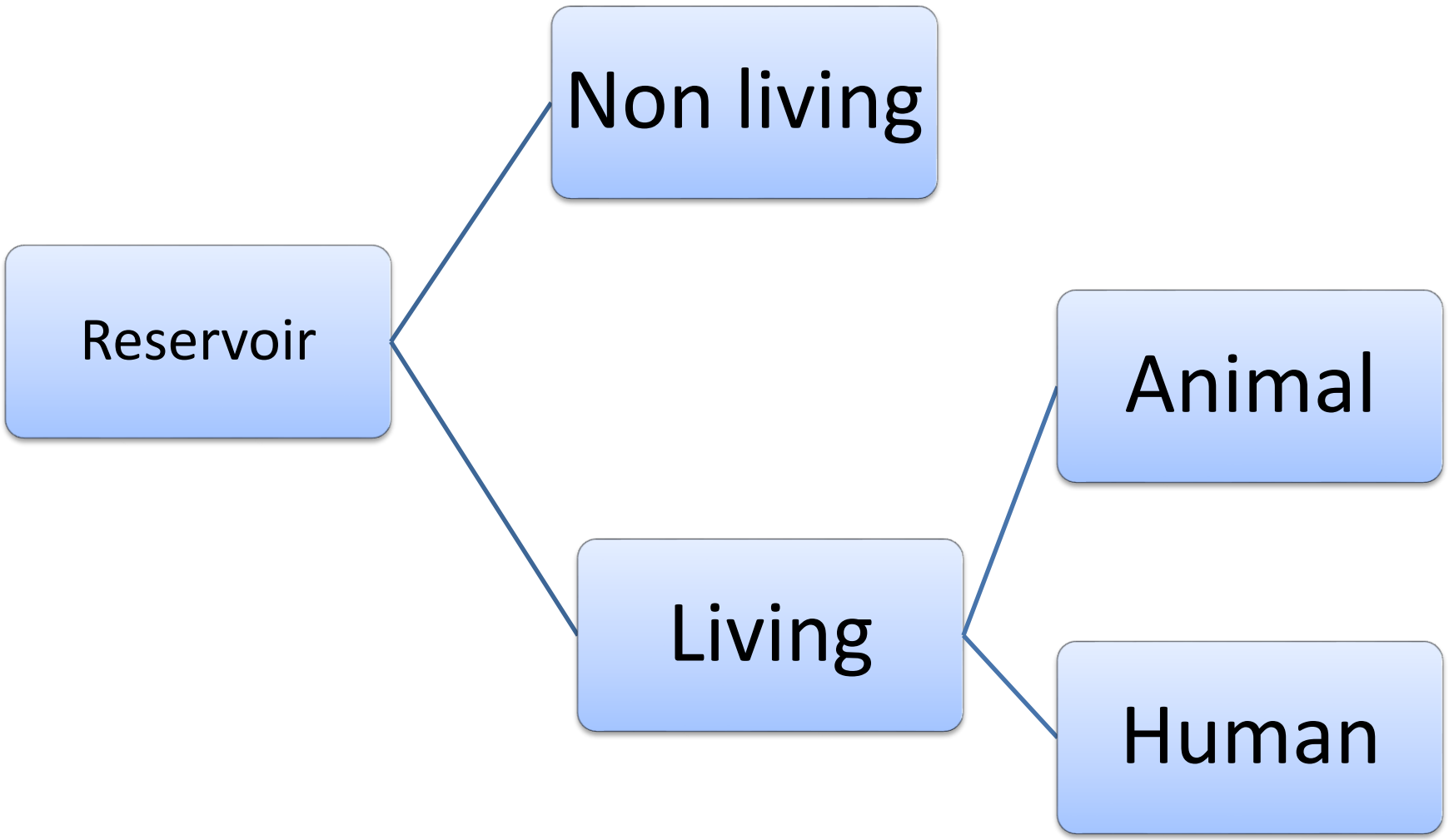
Reservoir

- Any person, animal, arthropod, plant, soil, or substance, or a combination of these, in which an infectious agent normally lives and multiplies, on which it depends **primarily for survival**, and where it **reproduces** itself in such a manner that it can be transmitted to a susceptible host.

Reservoir

- It is the natural habitat of the infectious agent.
  - Common reservoirs
    - humans
    - animals
    - Vector




Reservoir
Non living
Living
Animal
Human

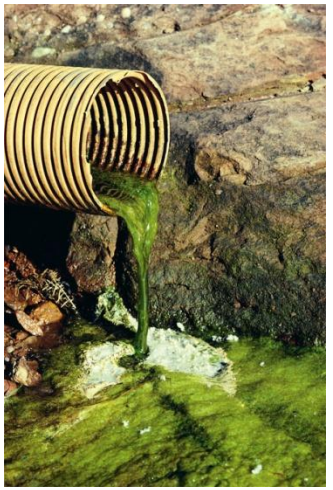
Reservoir in non-living things

- Soil and inanimate matter can also act as reservoir of infection.

- For example- soil -causes tetanus, anthrax and coccidiodomycosis.
  - –Cow dung- Tetanus

Nonliving Reservoirs

- Soil, water, and food can be reservoirs of infection
  - Presence of microorganisms is often due to contamination by feces or urine



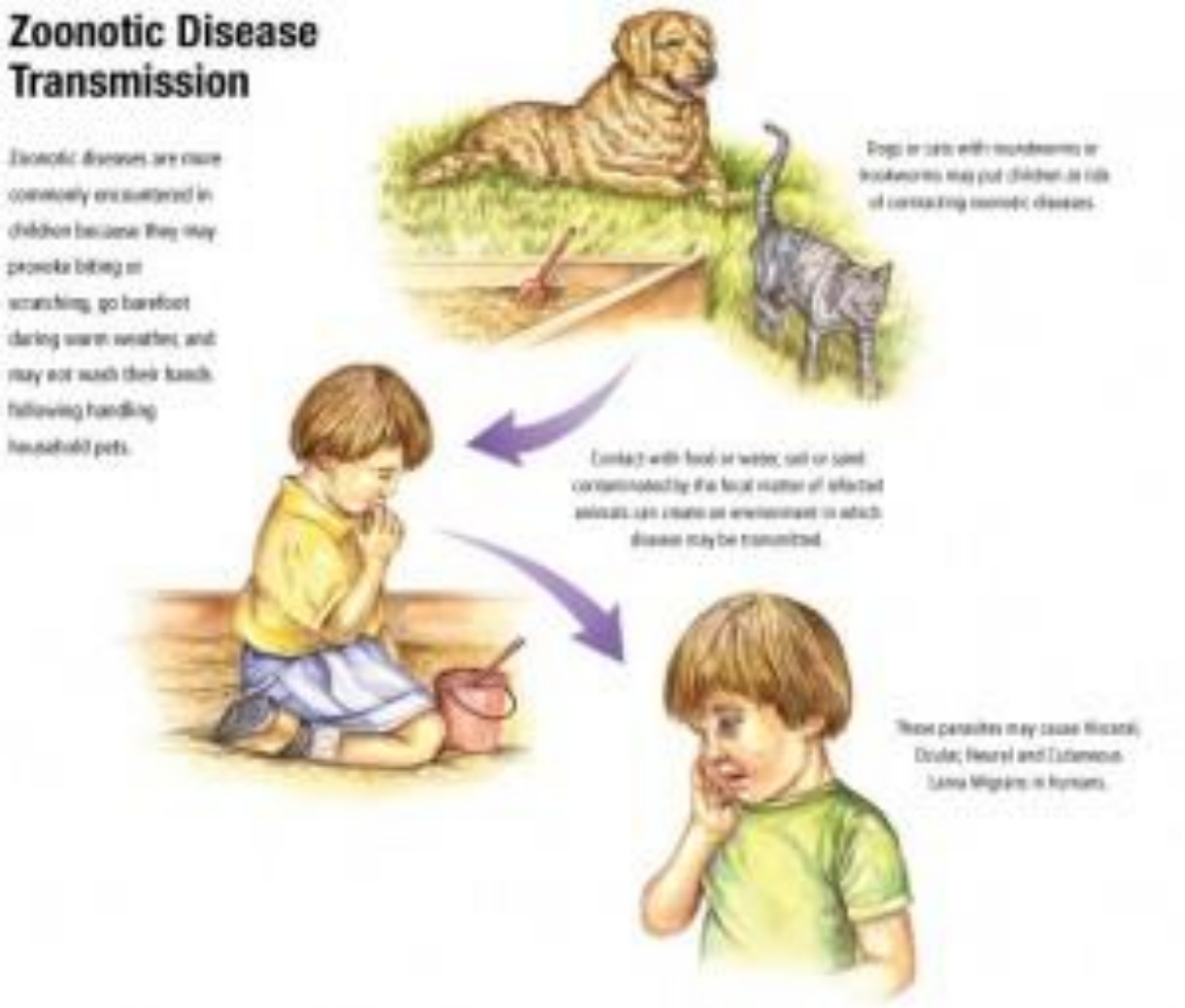
Animal reservoirs

- **Zoonoses** – diseases that are naturally spread from their usual animal host to humans
- e.g. Rabies- Dog, bat…,

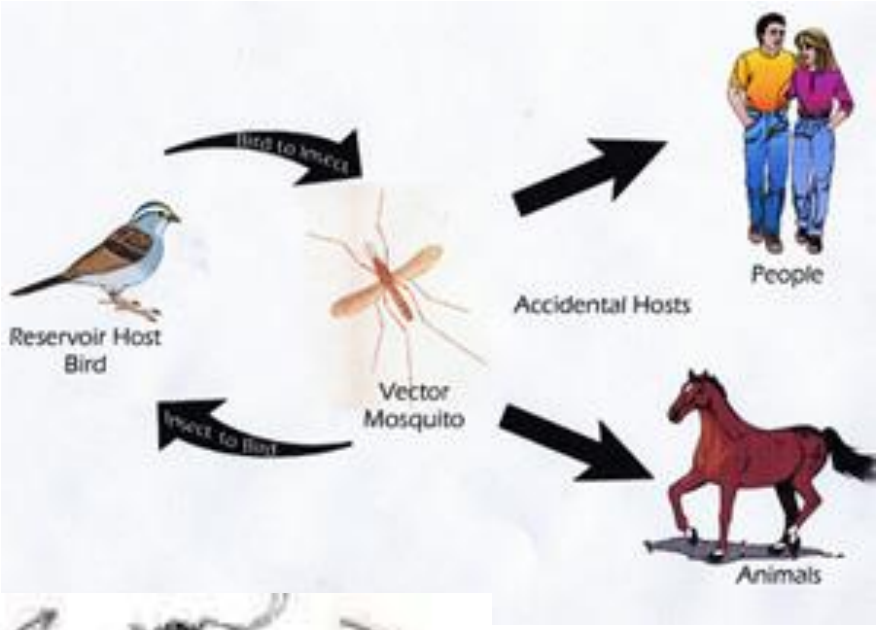
  Plague- Rat,

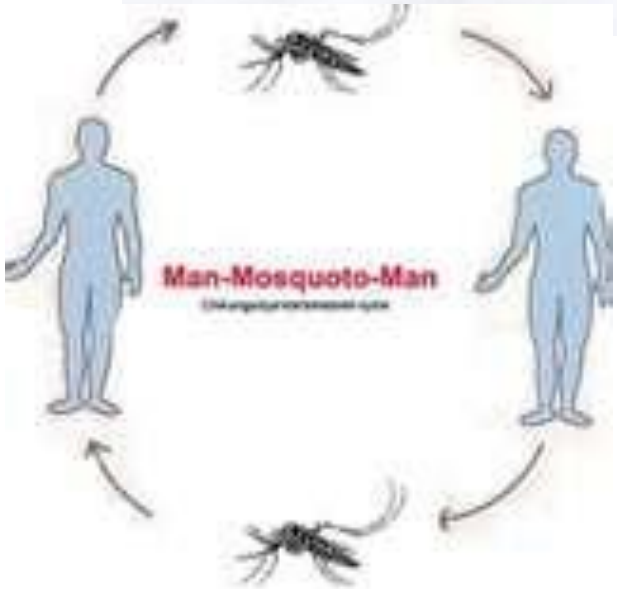
  bovine tuberculosis- Cow, dairy animal…..

Animal reservoir



- Biting by animal





Eating animal

Animal Reservoirs

- Acquire zoonoses through various routes
  - Direct contact with animal or its waste
  - Eating animals
  - Bloodsucking arthropods

  - There are over a 100 zoonotic diseases that can be conveyed from animal to man.

Human Reservoirs

NATURAL HISTORY OF DISEASE

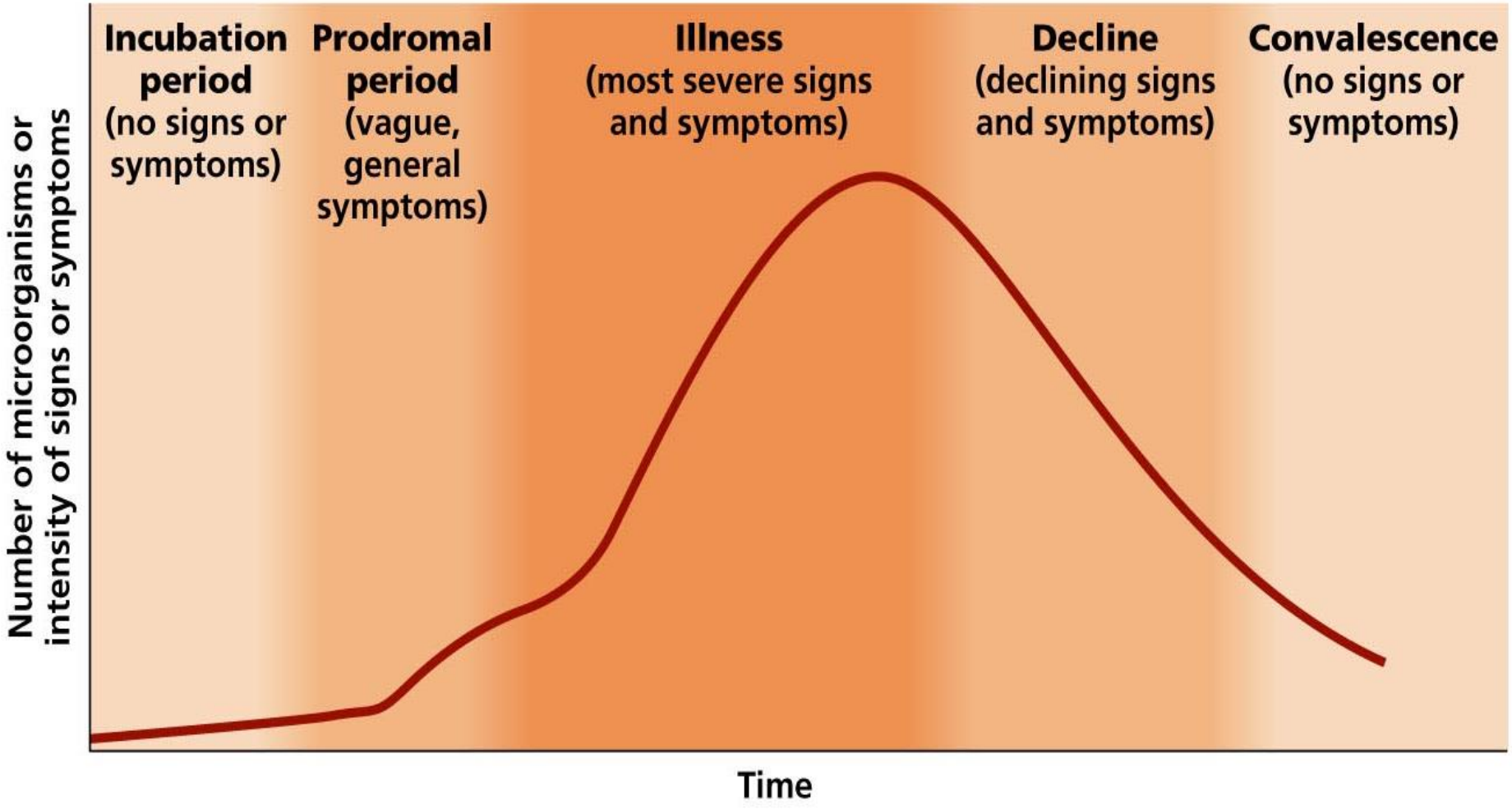
- **Pre-pathogenic phase /susceptibility stage**

- **Pathogenic phase**

1. **Incupation period**
2. **Prodromal stage**
3. **Stage of overt disease**
4. **Stage of defervescence**
5. **Stage of convalescence**

PATHOGENIC PHASE

5 Stages of Infectious Disease



Infectious Disease In Human

- Case
- Carriers

Cases

- Person showing s/s of illness.

CASE

According to spectrum of disease

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

- Primary case
- Index case
- Secondary cases

What are "Carrier Hosts"

Hosts that harbor infectious agent but do not show any outward signs or symptoms of a disease but are still capable of transmitting the disease are known as *carriers*.

CARRIERS

Serve as a potential source of infection to others

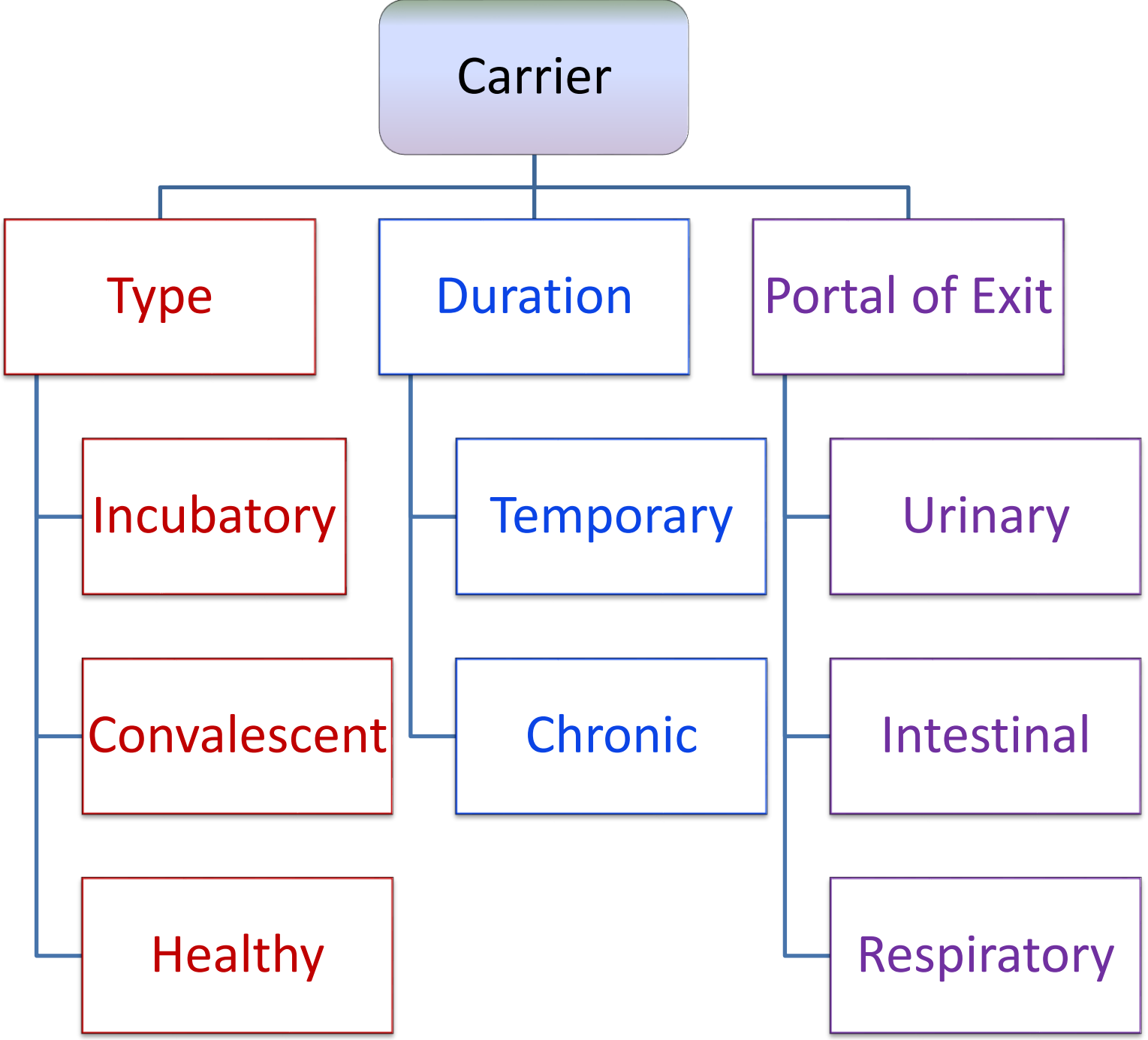
Carriers
WHY?

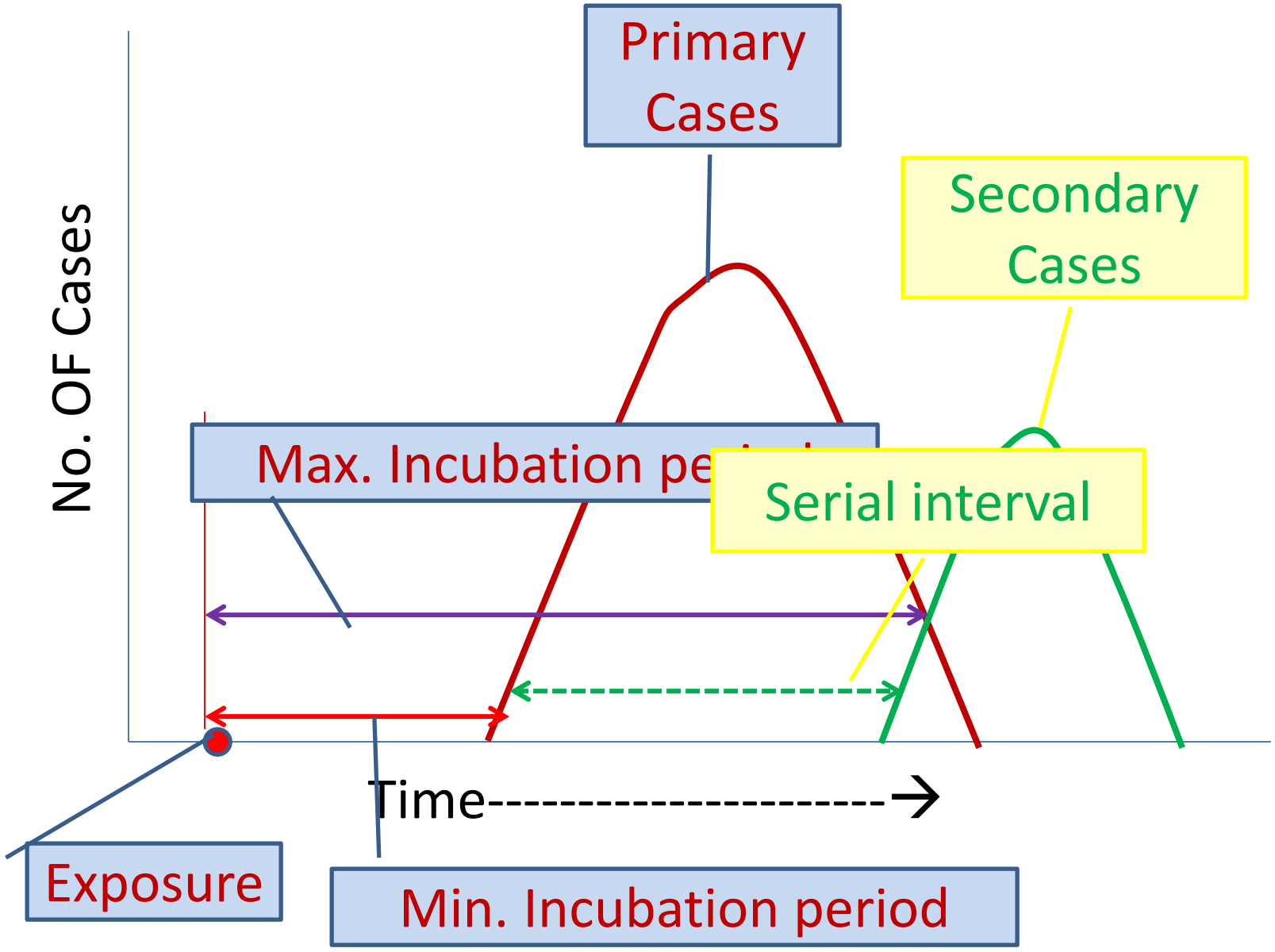
When the disease agent is not completely eliminated because of

- Inadequate treatment
- Inadequate immune response

- **Three elements have to occur to form a carrier state:**

1. The presence in the body of the disease agent.
2. The absence of recognizable symptoms and signs of disease.
3. The shedding of disease agent in the discharge or excretions.


Carrier
Type
Duration
Portal of Exit
Incubatory
Convalescent
Healthy
Temporary
Chronic
Urinary
Intestinal
Respiratory


Primary Cases
Secondary Cases
No. OF Cases
Max. Incubation pe
Serial interval
Time----------→
Exposure
Min. Incubation period

INCUBATION PERIOD

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

Serial interval

The gap in time between the onset of the primary and the secondary cases

GENERATION TIME

It is defined as the interval of time between receipt of infection by a host and maximal infectivity of that host

Infectious (communicable) period

Length of time a person can transmit disease (sheds the infectious agent).

3rd - The Portal of Exit

-Route of escape of the pathogen from the reservoir.

Examples: respiratory secretions,

blood exposure,

breaks in skin

3rd - The Portal of Exit

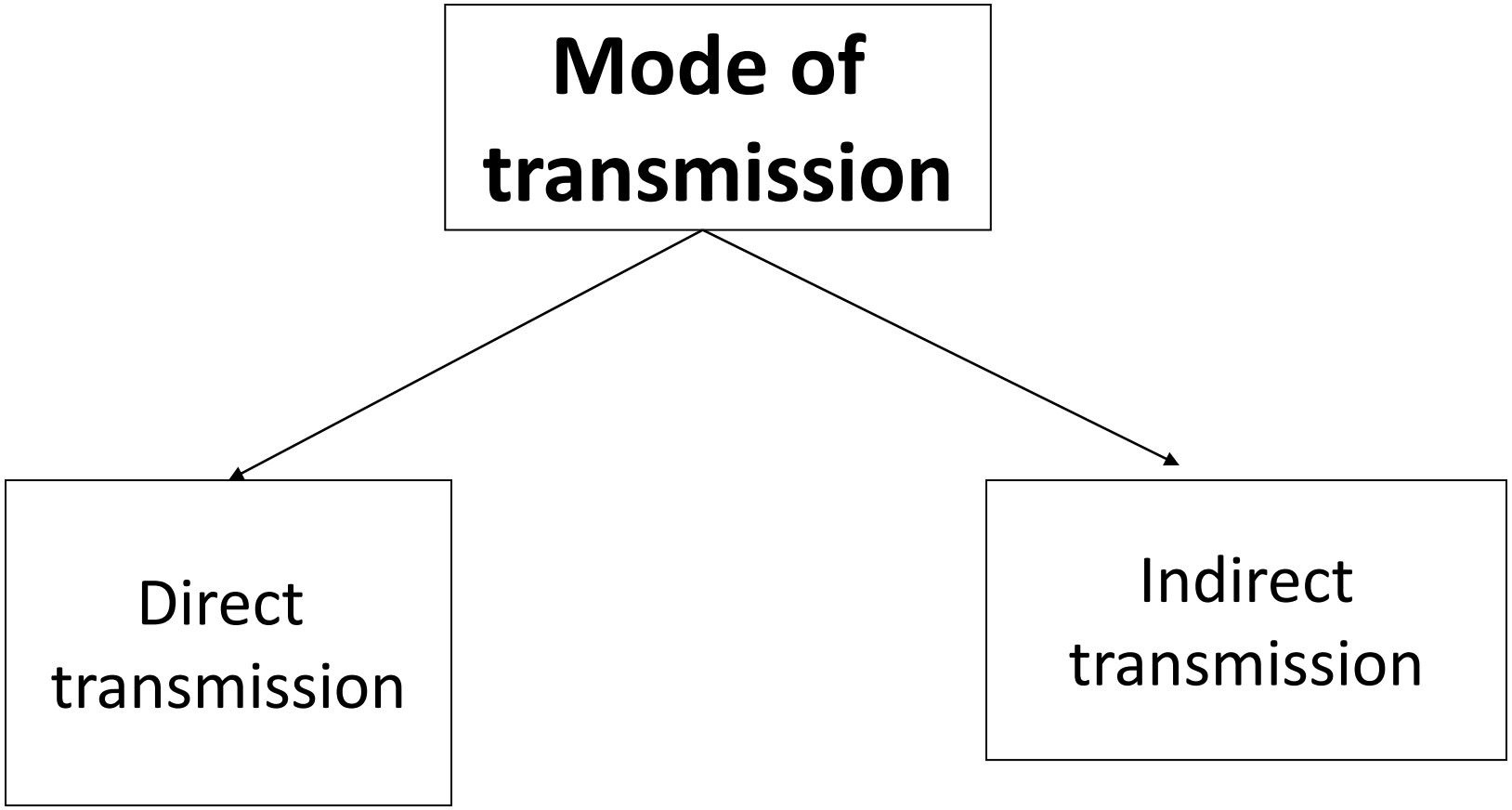
- respiratory tract
- GU tract
- GI tract
- skin/mucous membrane
- blood
- transplacental

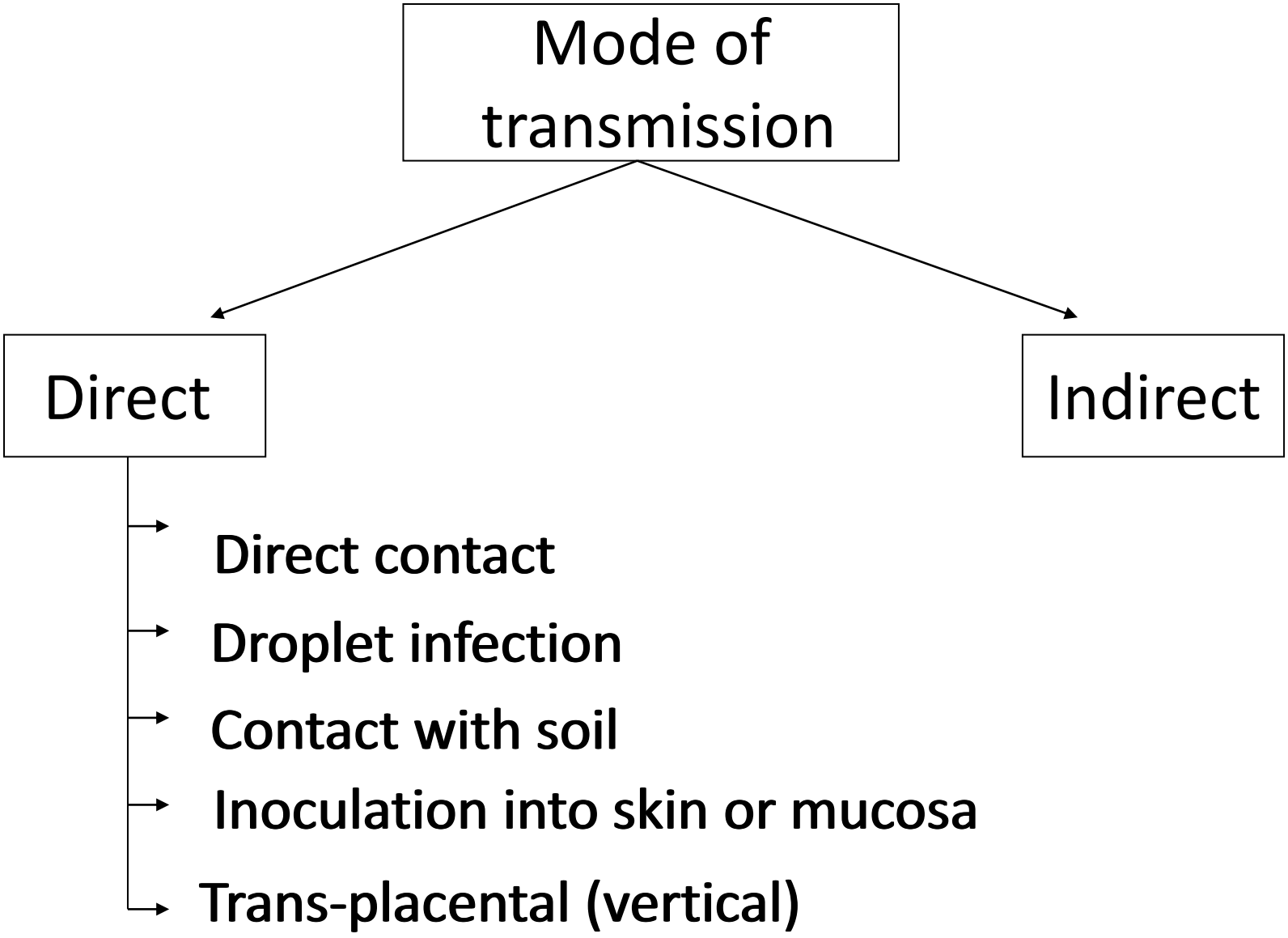
Links of Infection

1. Infectious Agent
2. Source/ Reservoir of Infection
3. Portal Of Exit
4. **Modes Of Transmission**
5. Portal Of Entry
6. Susceptible host

4th - The Route of Transmission

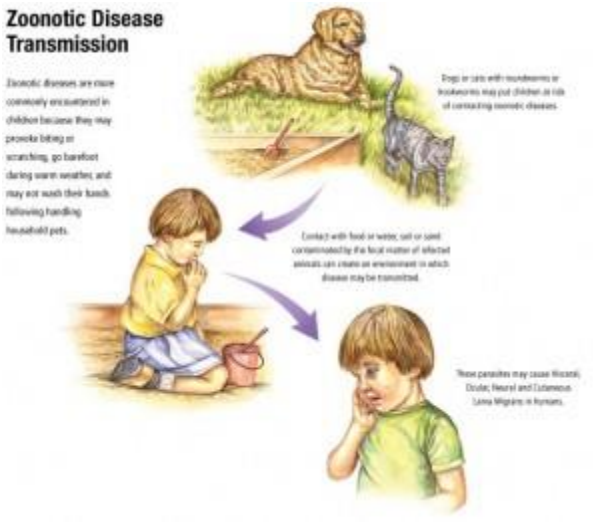
-Method by which the pathogen traverses from the reservoir to the new host


Mode of transmission
Direct transmission
Indirect transmission


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

Direct contact

Direct contact

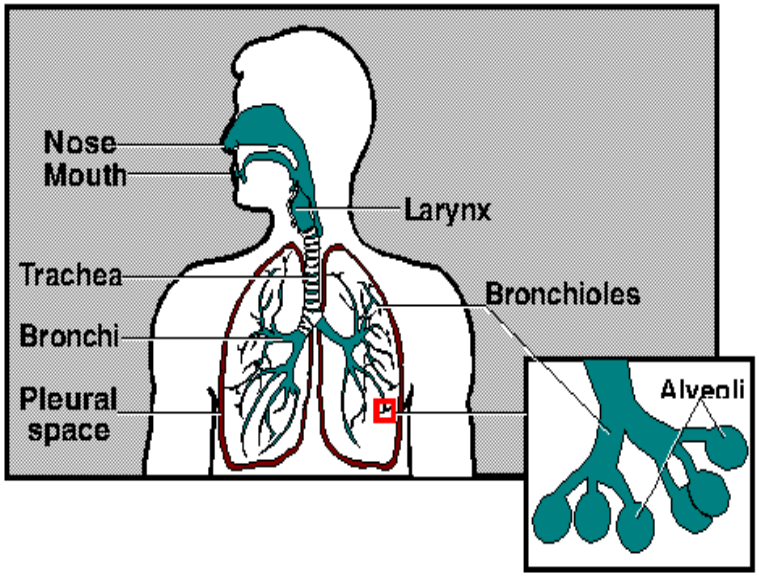


Droplets

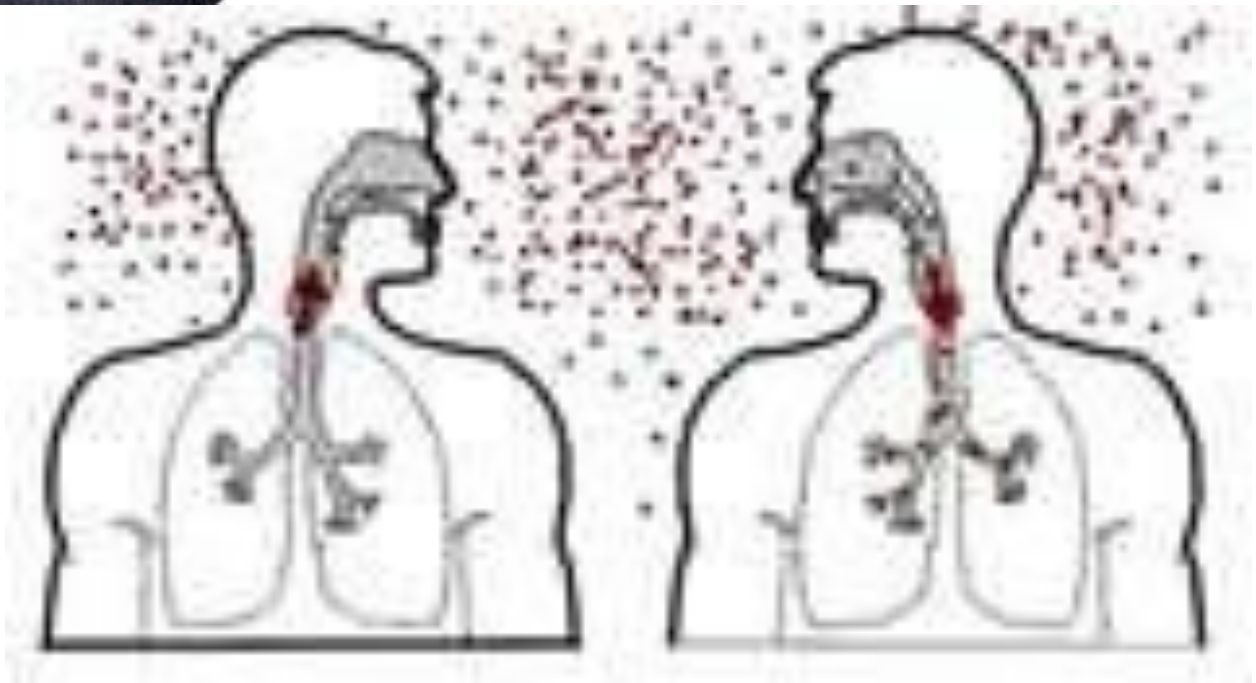
- These particles are about 1 to 5 microns in diameter. Droplet nuclei can remain suspended in the air for several hours, depending on the environment.
- Impinge directly on Conjunctiva, Skin or oro-respiratory mucosa of close contacts.

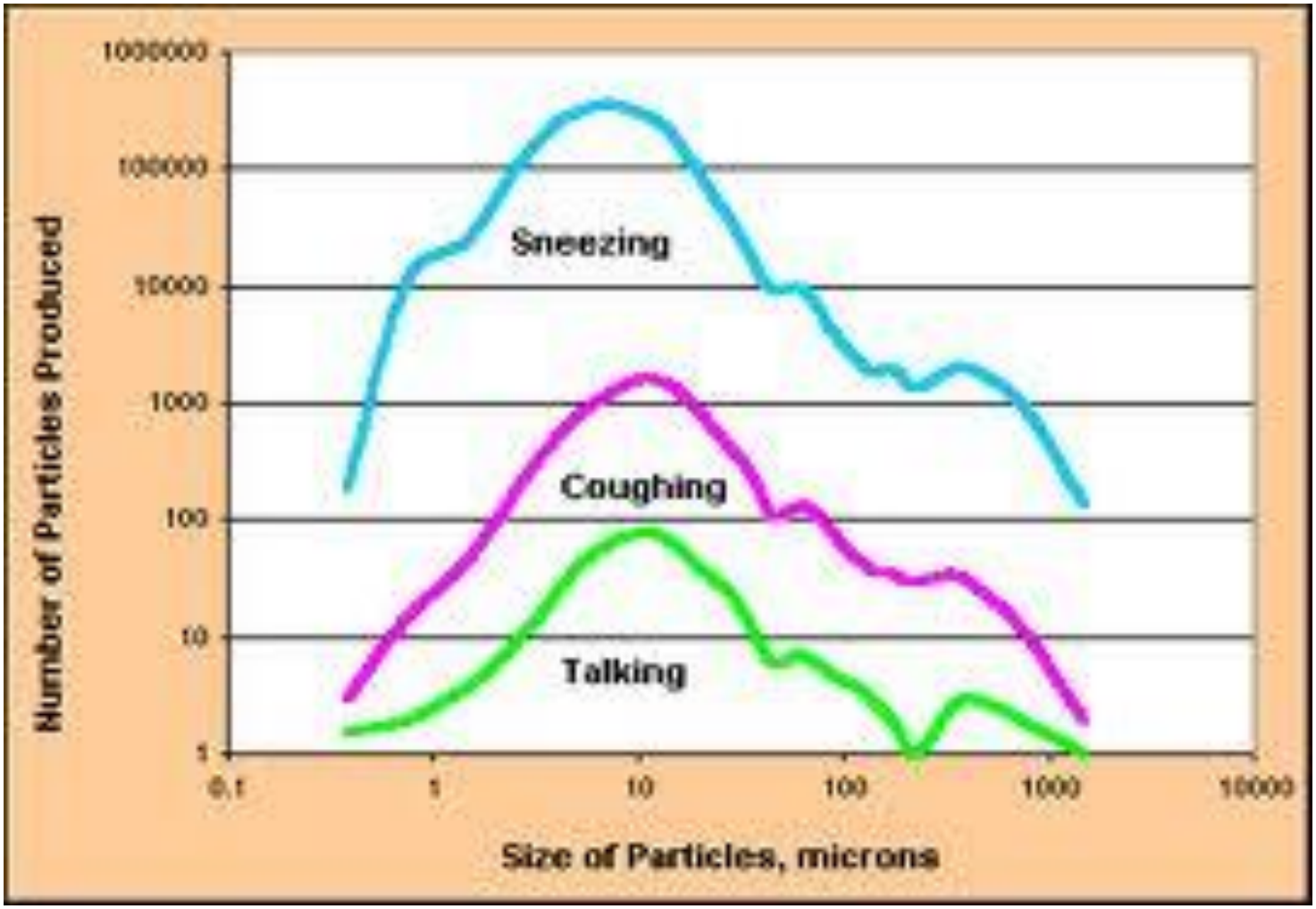
DROPLET INFECTION

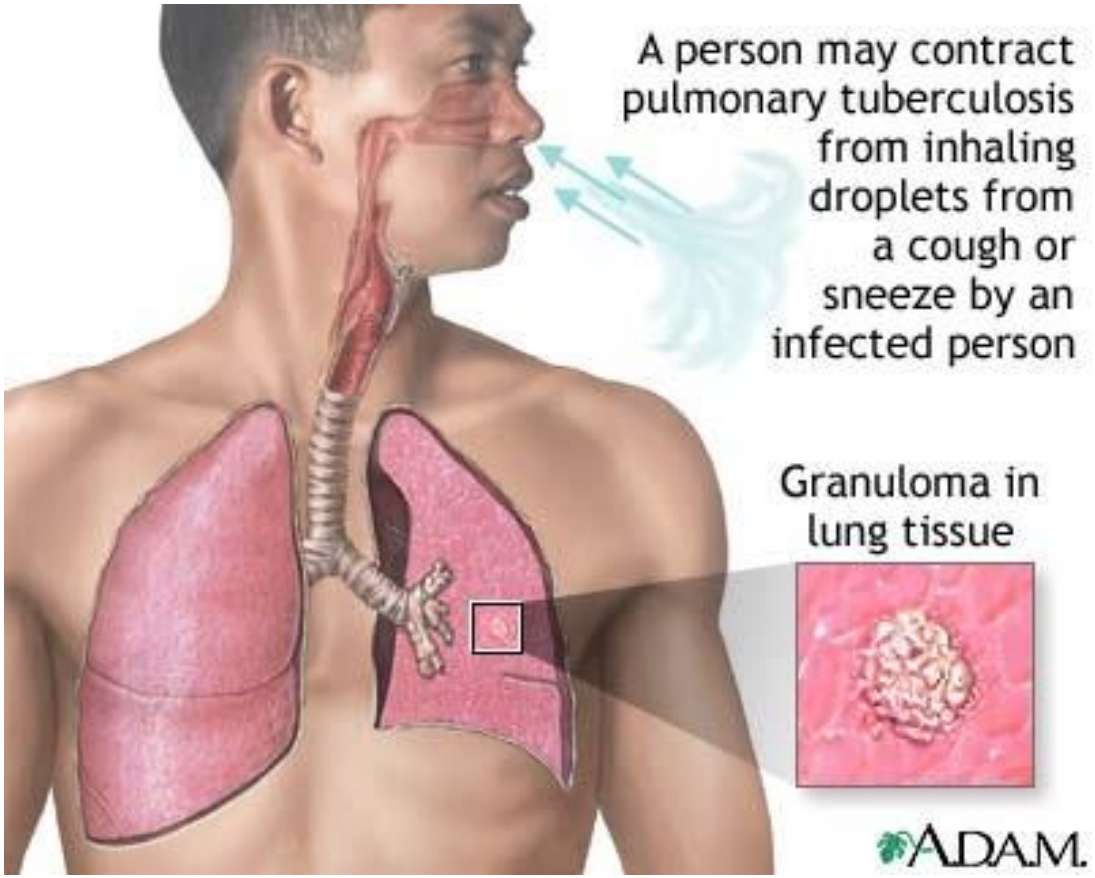
- >10 mm diameter – filtered by nose
- < 5 mm penetrate deeply & reach the alveoli.
- Distance of spread- 30-60 cms between the source & host



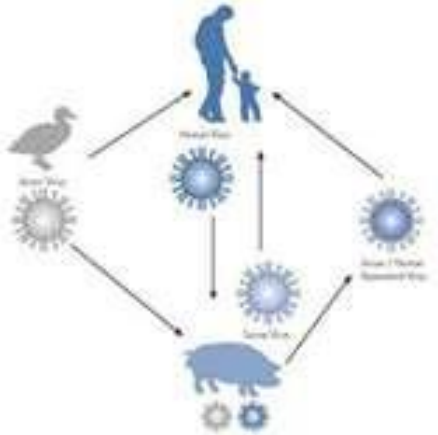
Droplet Of Infection




Number of Particles Produced
1000000
100000
10000
1000
100
10
1
Sneezing
Coughing
Talking
0.1
1
10
100
1000
10000
Size of Particles, microns


A person may contract pulmonary tuberculosis from inhaling droplets from a cough or sneeze by an infected person
Granuloma in lung tissue
A.D.A.M.

Droplet Of Infection



Droplet transmission

- examples
  - meningococcus
  - influenza
  - pertussis

- prevention strategy
  - wear a mask when close to patient (<1 meter)
  - hand hygiene

Inoculation In skin

Trans Placental

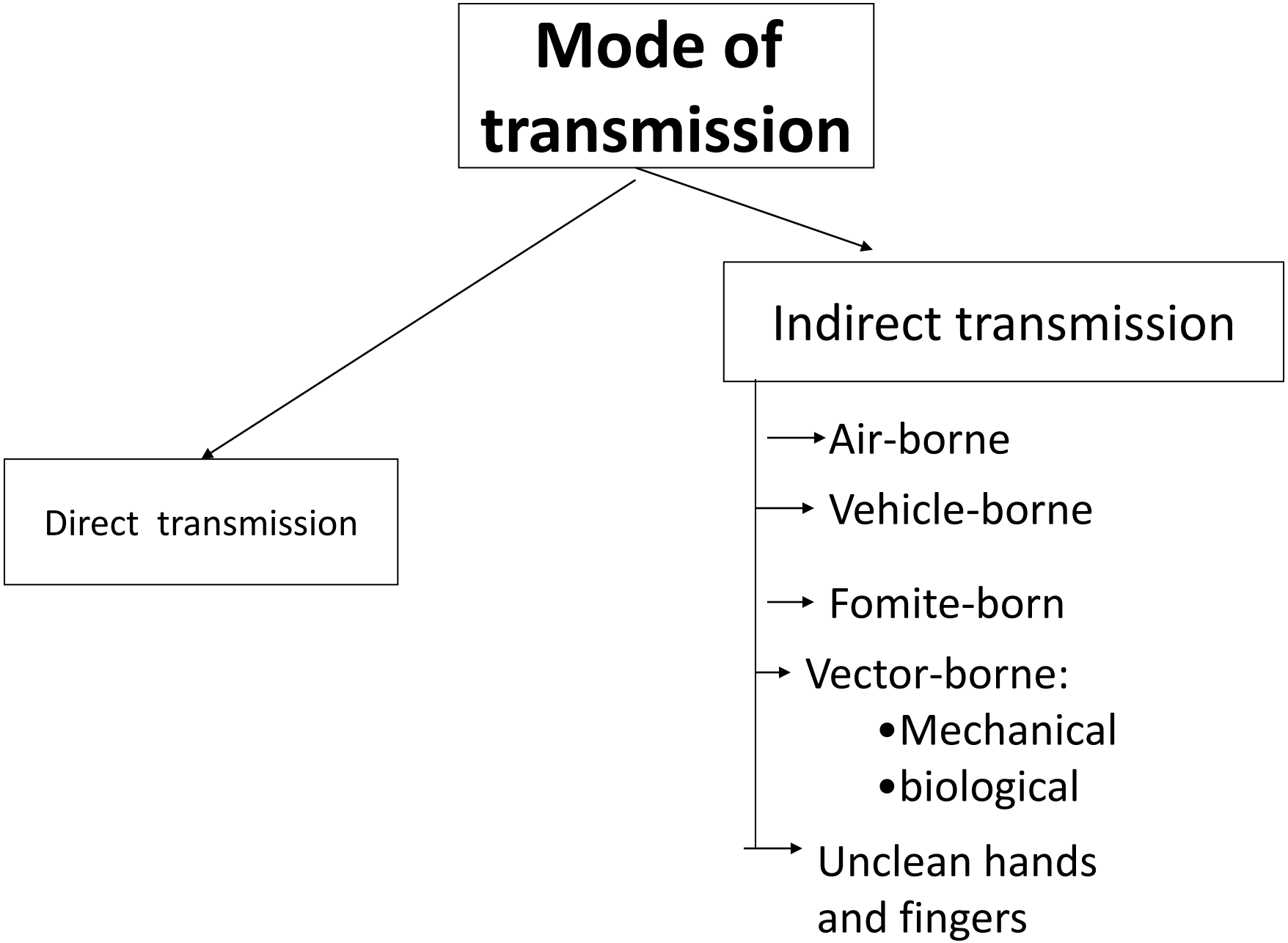
Vertical Transmission

Contact transmission

- most frequent mode of transmission within the healthcare environment
- Examples
  - touching open and draining wounds
  - touching blood
  - touching rashes or vesicles
  - touching equipment soiled with body fluids

Contact transmission

- prevention strategies include:
  - hand hygiene
  - cleaning and disinfection of medical devices and equipment


Mode of transmission
Direct transmission
Indirect transmission
Air-borne
Vehicle-borne
Fomite-born
Vector-borne:
Mechanical
biological
Unclean hands and fingers

INDIRECT TRANSMISSION

air

Airborne transmission

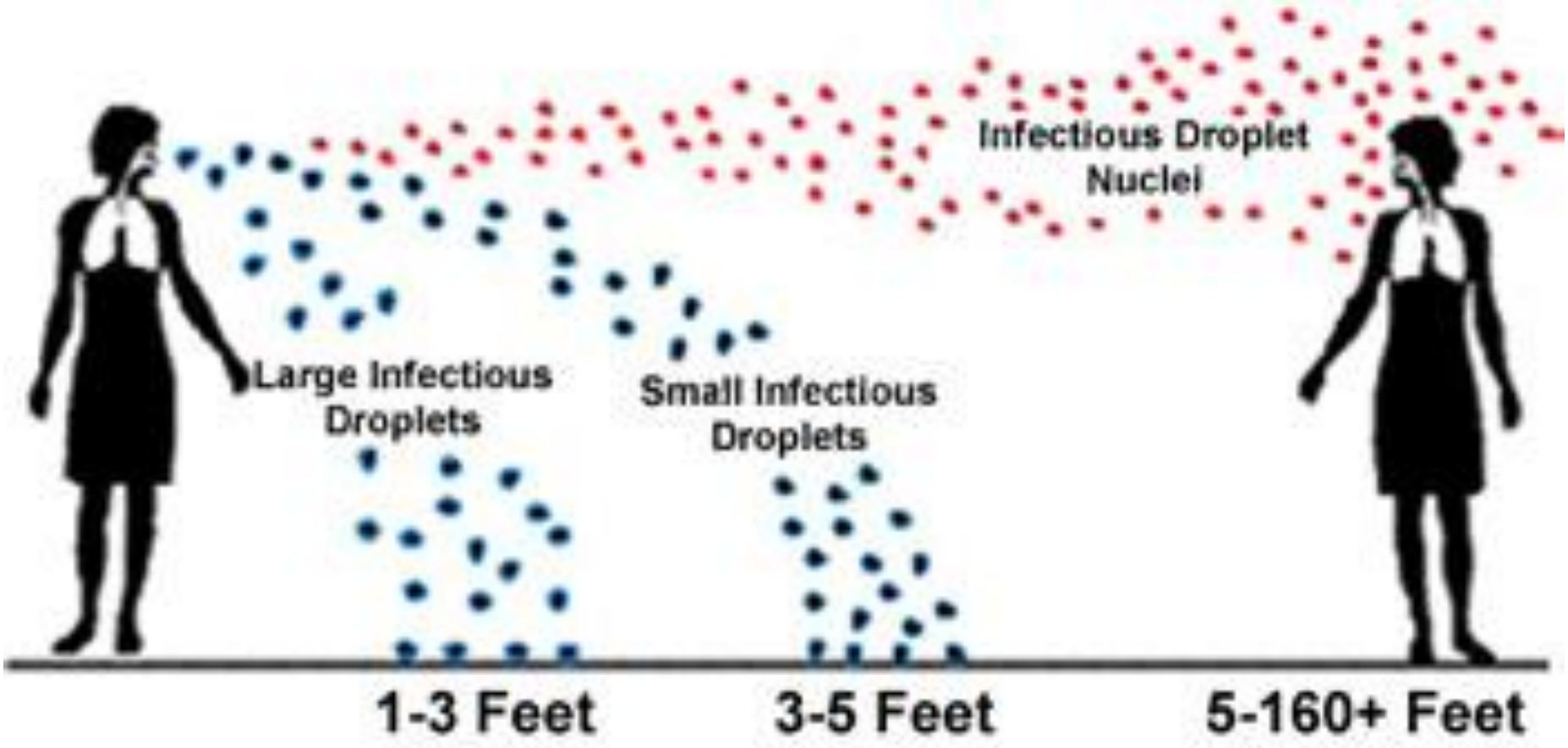
Dust

Droplet nuclei

Droplet nuclei

- Tiny particles- 1-10 micron size
- Dried residue of droplet
- Formed by-
  - Evaporation of material expelled during coughing/ sneezing
  - Atomizing devise

Droplet nuclei



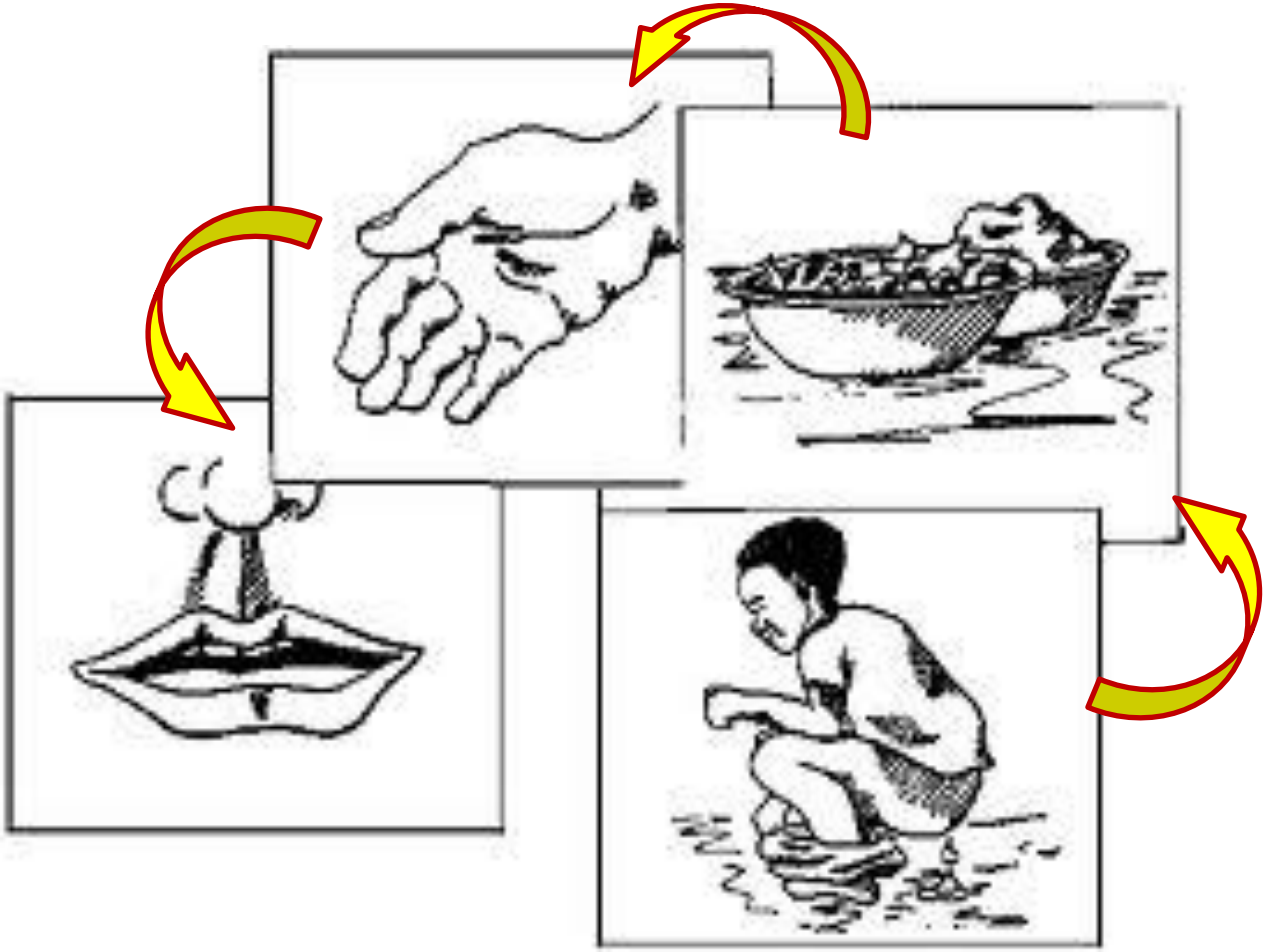
Droplet nuclei

- Remain suspended in the air for long duration
- Keep floating in the air
- Disseminated by air current.
- Reach to alveoli & retain there

Airborne transmission

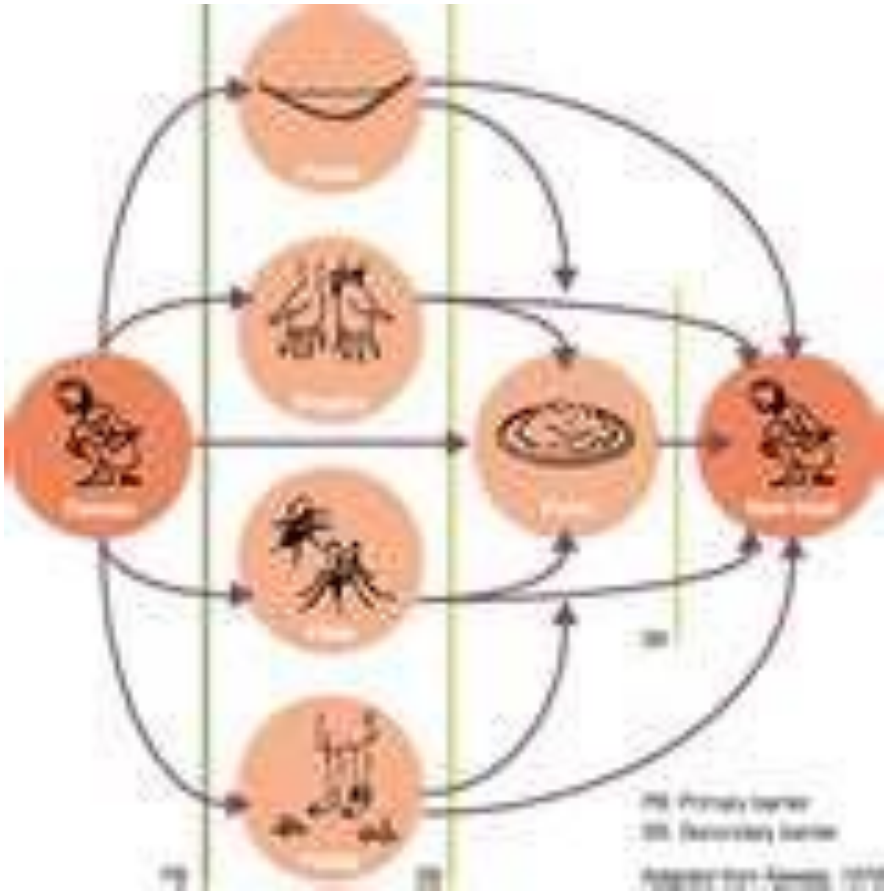
- Examples
  - chickenpox
  - measles
  - tuberculosis
- Prevention strategies
  - place patient in separate room with door closed
  - patient should wear mask when leaving room or facility
  - staff should be immune to measles and varicella
  - staff should wear a mask (respirator) if tuberculosis is a possibility

Indirect Transmission



Feco oral Rout of Diseases

Indirect Transmission



INDIRECT TRANSMISSION

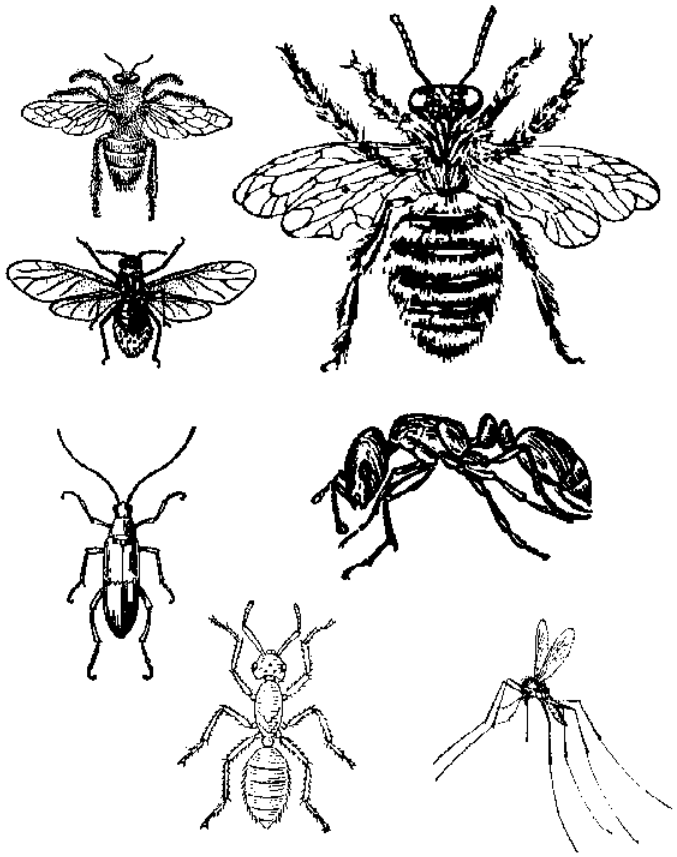
Common vehicle transmission

Common vehicle transmission

Microorganisms are transmitted to susceptible hosts from common items, e.g.

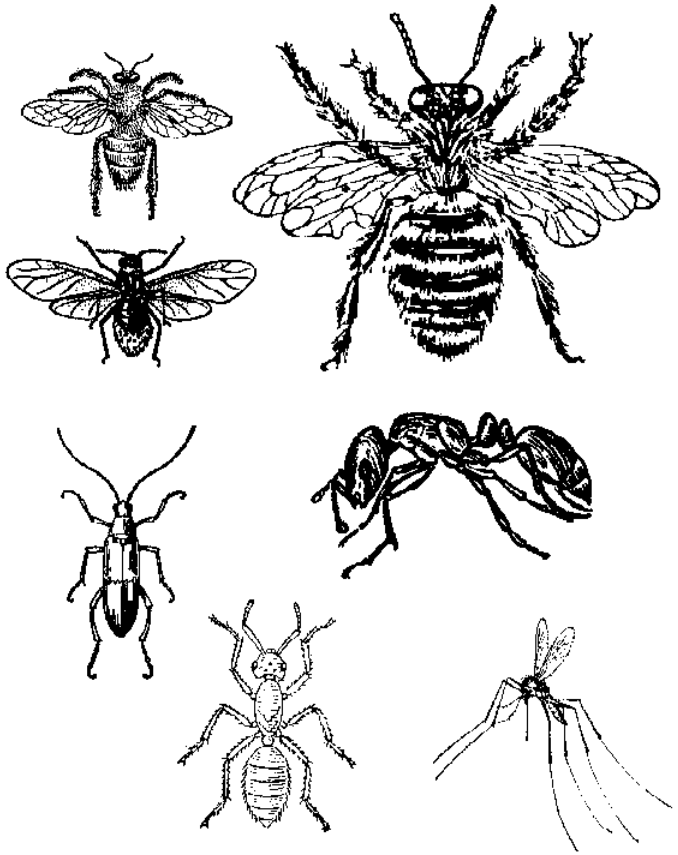
- food
- water
- medications
- devices/equipment

Vector of infection



- An insect or any living carrier that transports an infectious agent from an infected individual or its wastes to a susceptible individual or its food or immediate surroundings. Both biological and mechanical transmissions are encountered.

Vector-borne transmission

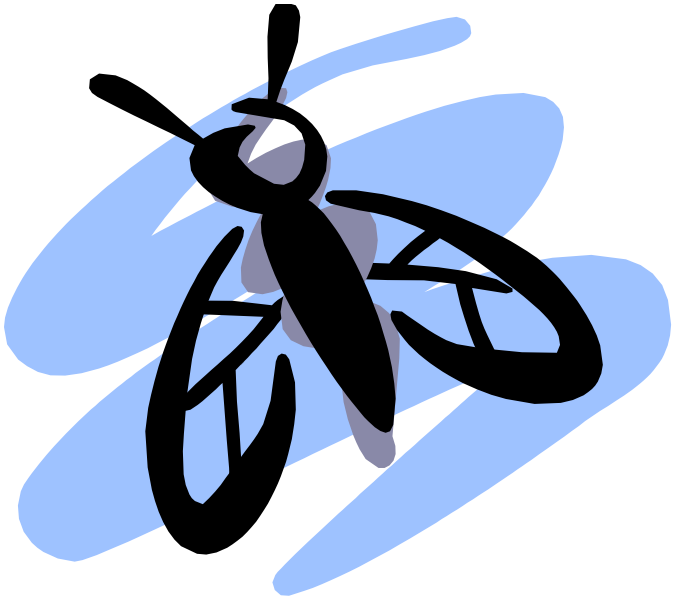


- Transfer of microorganisms by insects, flies, rats, or other vermin
- uncommon mode of transmission in healthcare facilities

INDIRECT TRANSMISSION

VECTOR BORNE

By 2 ways



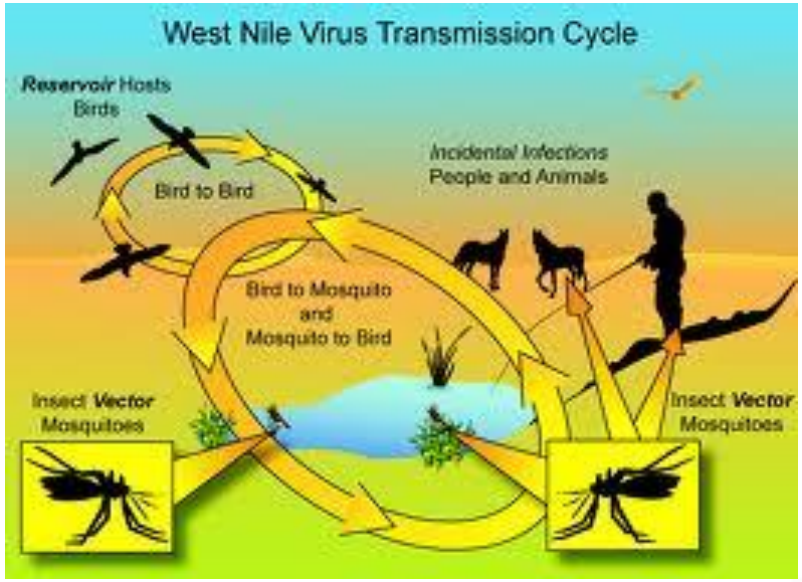
1. Mechanical
2. Biological

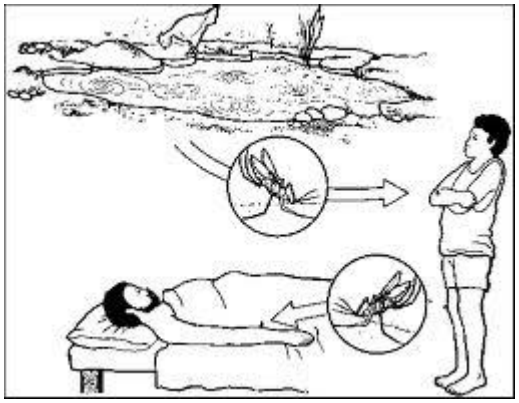
Mechanical Transmissiom

Biological Transmission

Inocculation of microorganism into skin by Biting

Biological Transmission

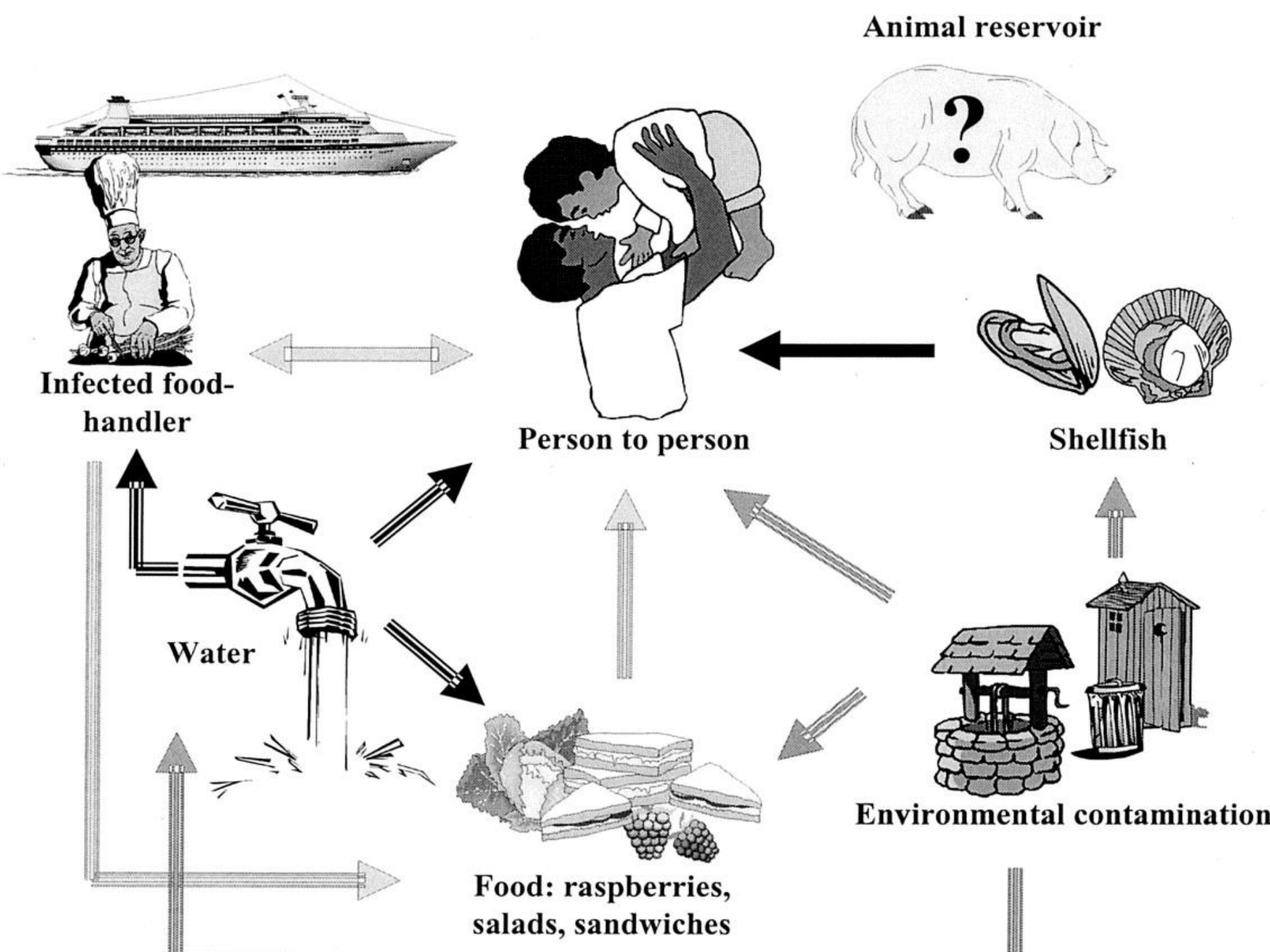




air…

direct contact

insects..

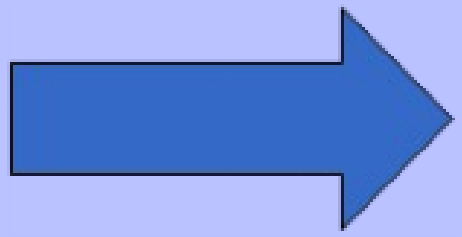

Animal reservoir
?
Infected food-handler
Person to person
Shellfish
Water
Environmental contamination
Food: raspberries, salads, sandwiches

Links of Infection

1. Infectious Agent
2. Source/ Reservoir of Infection
3. Portal Of Exit
4. Modes Of Transmission
5. **Portal Of Entry**
6. Susceptible host

5th - Portal of entry to the Host

- way through which the organism enters the new host…

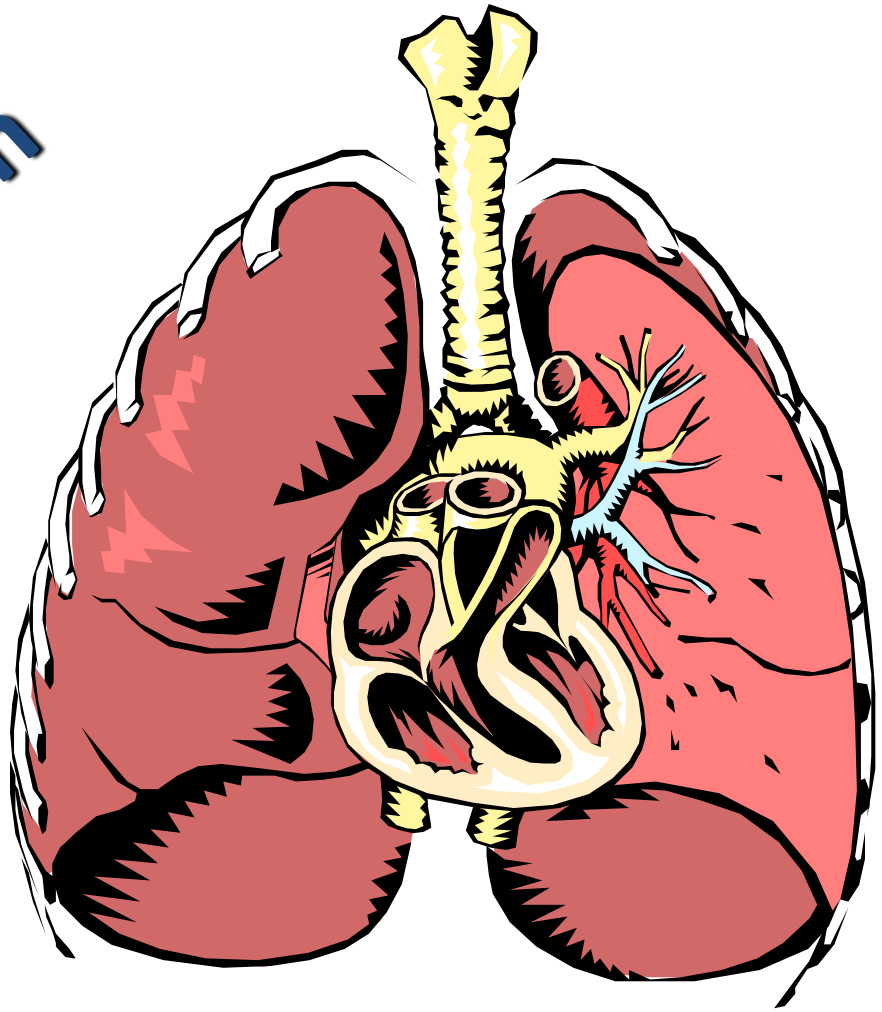


Portal of entry

- The path by which an infectious agent enters the susceptible host
  - respiratory tract
  - GU tract
  - GI tract
  - skin/mucous membrane
  - parenteral
  - transplacental

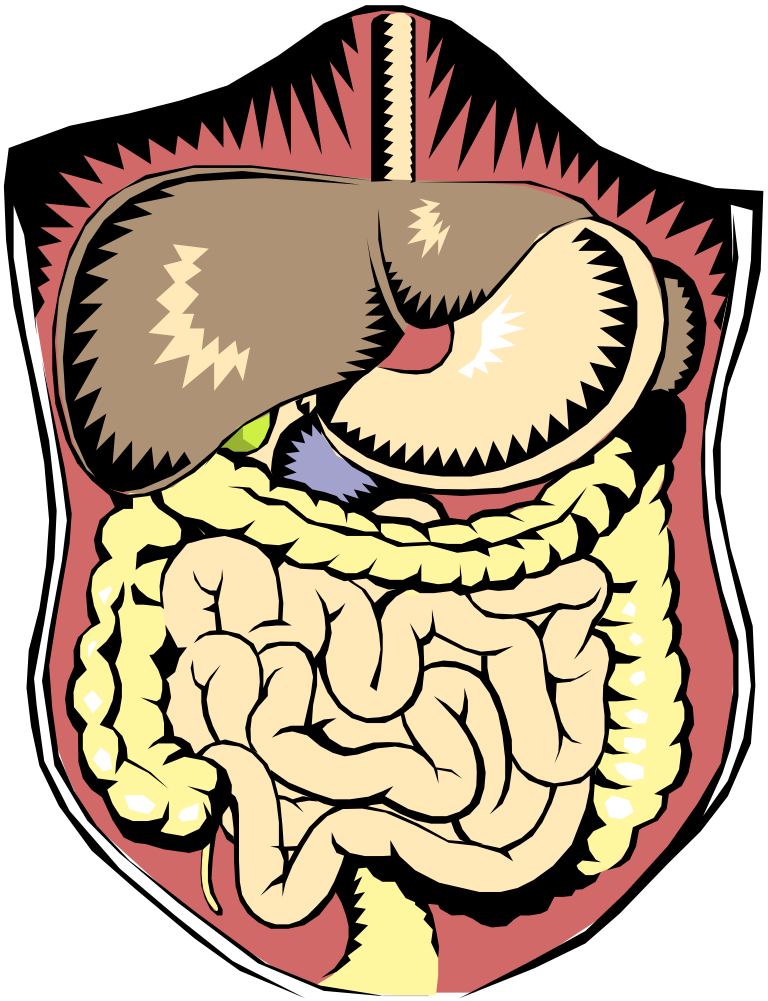
Respiratory System

inhalation



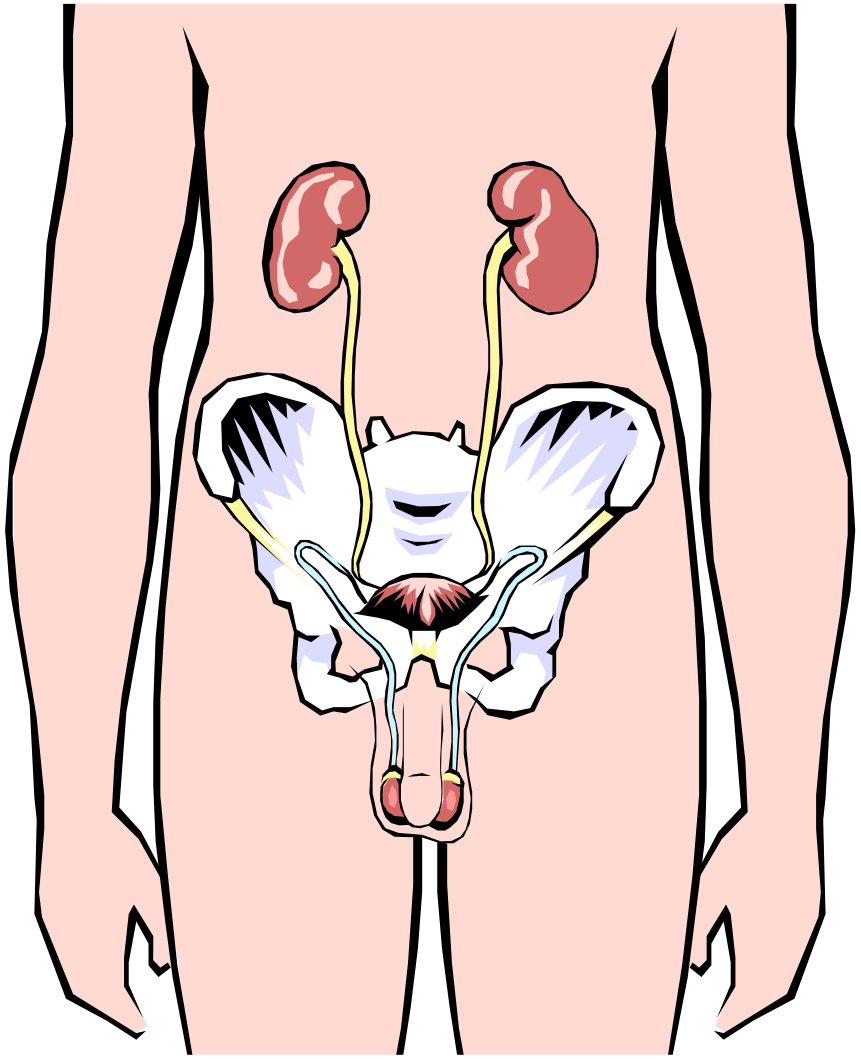
Gastrointestinal System

ingestion



Urinary & Reproductive Tracts

Sexual contact

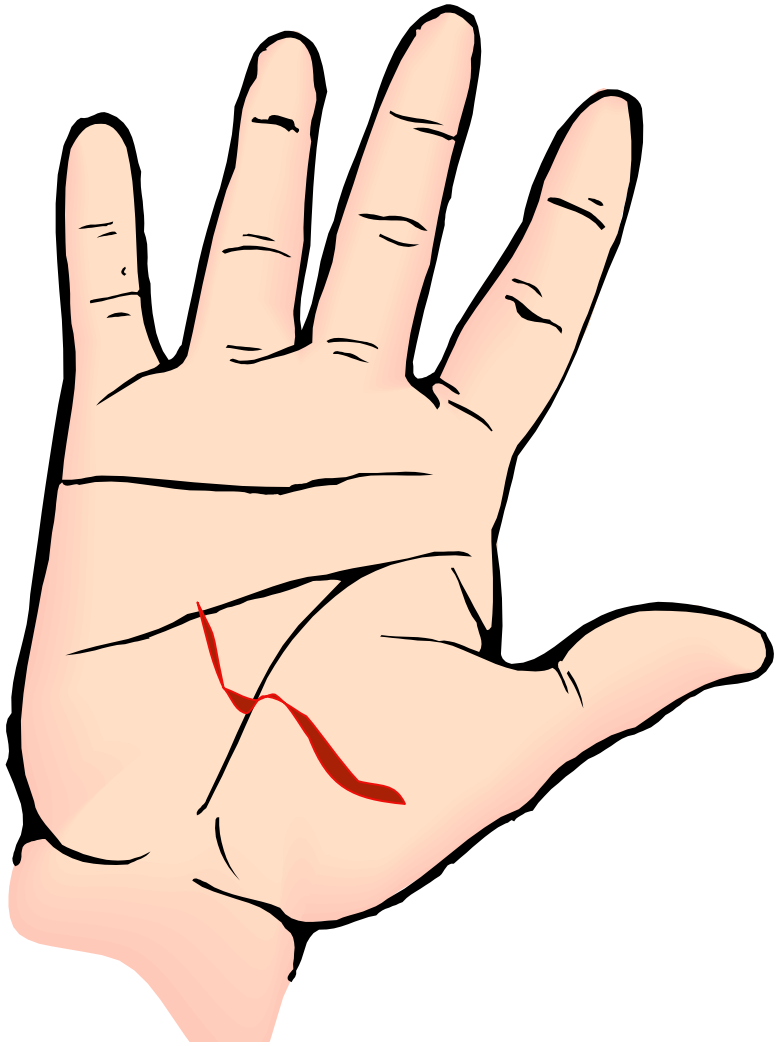


Skin

- Others enter by burrowing into or digesting the outer layers of skin

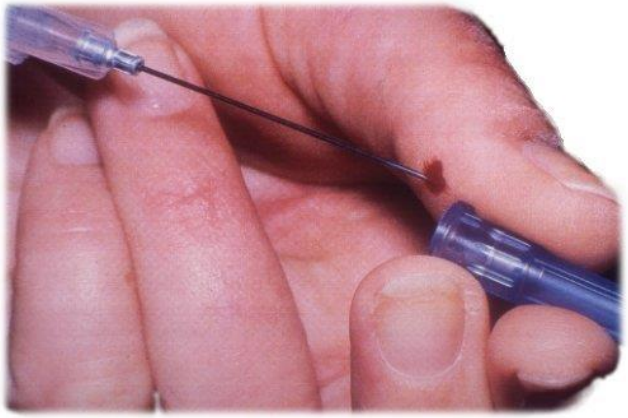
Breaks in Protective Skin Barrier

Some pathogens can enter through openings or cuts



Parenteral Route

- Not a true portal of entry but a means by which the usual portals can be circumvented



- Pathogens deposited directly into tissues beneath the skin or mucous membranes

Inoculation into skin

Scabies

5th - Portal of entry to the host

Inhalation…

Ingestion…

Sexual contact…

Broken skin

Links of Infection

1. Infectious Agent
2. Source/ Reservoir of Infection
3. Portal Of Exit
4. Modes Of Transmission
5. Portal Of Entry
6. **Susceptible host**

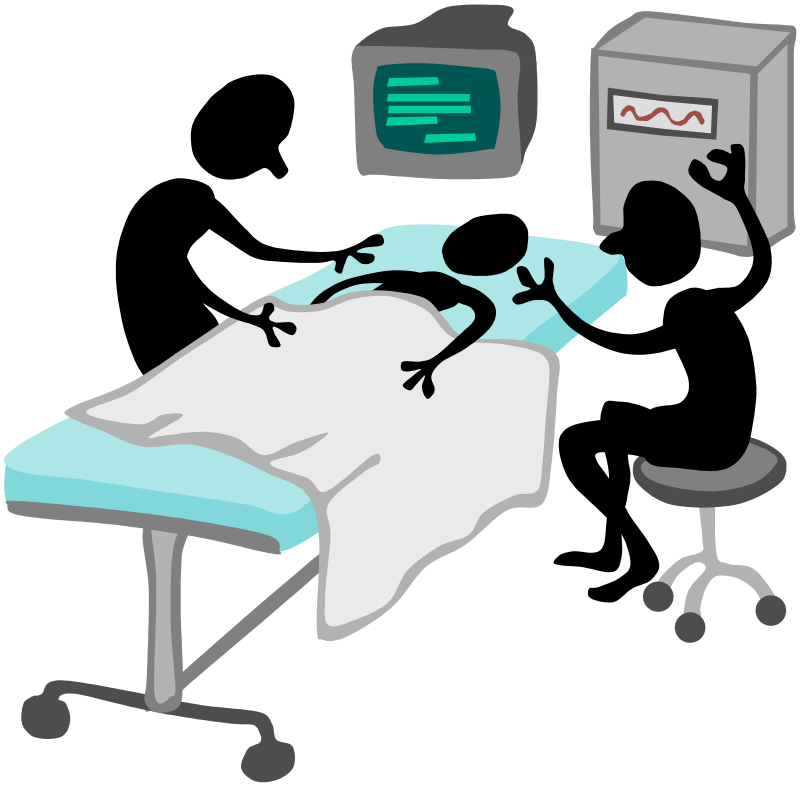
6th - The Susceptible Host

-The organism that accepts the pathogen

The support of pathogen life & its reproduction depend on the degree of the host's resistance.

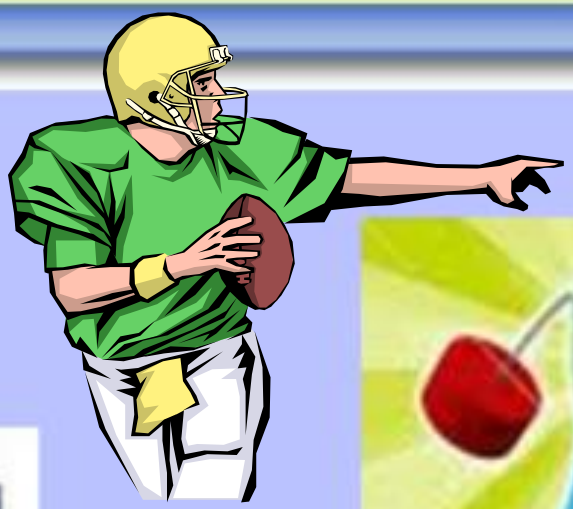
Susceptible Host

A person lacking effective resistance to a particular pathogenic organism

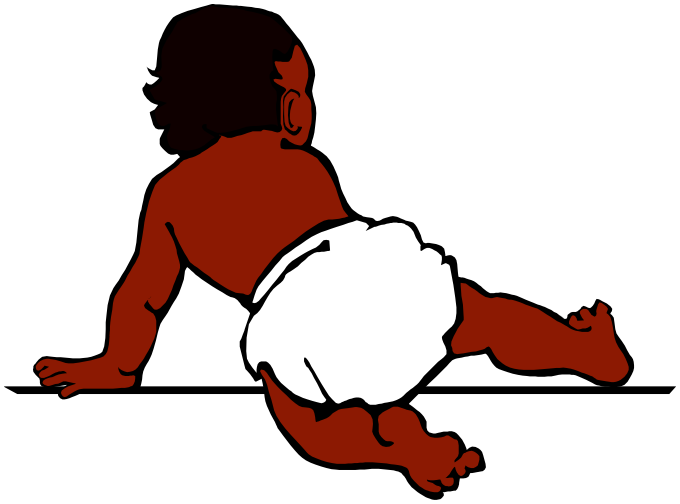


Strong immune system prevents infection

Vaccinations



Organisms with weakened immune systems are more vulnerable to the support & reproduction of pathogens.



Host characteristics that influence susceptibility to and severity of disease:

- Age
- Socioeconomic status
- Disease history
- Lifestyle
- Heredity
- Nutritional status
- Immunization status
- Diagnostic/therapeutic procedures
- Medications
- Pregnancy
- Trauma

Nonspecific Host Defense Mechanisms

- Normal (endogenous) flora
- Natural antibodies
- Natural barriers to entry of microorganisms
  - skin and mucous membranes
  - respiratory tract; cilia, cough mechanism
  - intestinal tract; gastric acid
  - GU tract; mechanical flushing
  - eye; tears
- Nutritional status

Factors For spread of infectious disease.

Factors for development or spread of infectious disease

- An etiological agent responsible for the disease should be present
- There should be a reservoir or carrier for the etiological agent to survive
- The infecting agent should be able to escape from the reservoir of infection through the portal of exit
- There should be a possible source of entry to transmit the agent to a new susceptible host
- The agent should be able to invade the new host
- The host should be susceptible

Infectiousness of disease

- The *infectiousness* of a disease indicates the comparative ease with which the disease is transmitted to other hosts

Factors – Infectiousness

- **Virulence/ Infectious dose**
- **Portal of exit-** No. of exit, conc. Of agent in exit
- **Transmission**- No. of mode
- **Portal of entry-** No. of entry point

How to interrupt the chain of infection:

-The essential part of patient care & self-protection.

Break the chain…how?

Remember!!! "breaking the chain of infection is our responsibility"

THANK YOU

Transmission Probability Ratio (TPR)

TPR is a measure of risk transmission from infected to susceptible individuals during a contact.

TPR of differing types of contacts, infectious agents, infection routes and strains can be calculated.

There are 4 types of transmission probabilities.

TPR (cont.)

Transmission probabilities:

- p00: tp from unvaccinated infective to unvaccinated susceptible
- p01: tp from vaccinated infective to unvaccinated susceptible
- p10: tp from unvaccinated infective to vaccinated susceptible
- p11: tp from vaccinated infective to vaccinated susceptible

TPR (cont.)

- To estimate the effect of a vaccine in reducing susceptibility, compare the ratio of p10 to p00.
- To estimate the effect of a vaccine in reducing infectiousness, compare the ratio of p01 to p00.
- To estimate the combined effect of a vaccine, compare the ratio of p11 to p00.

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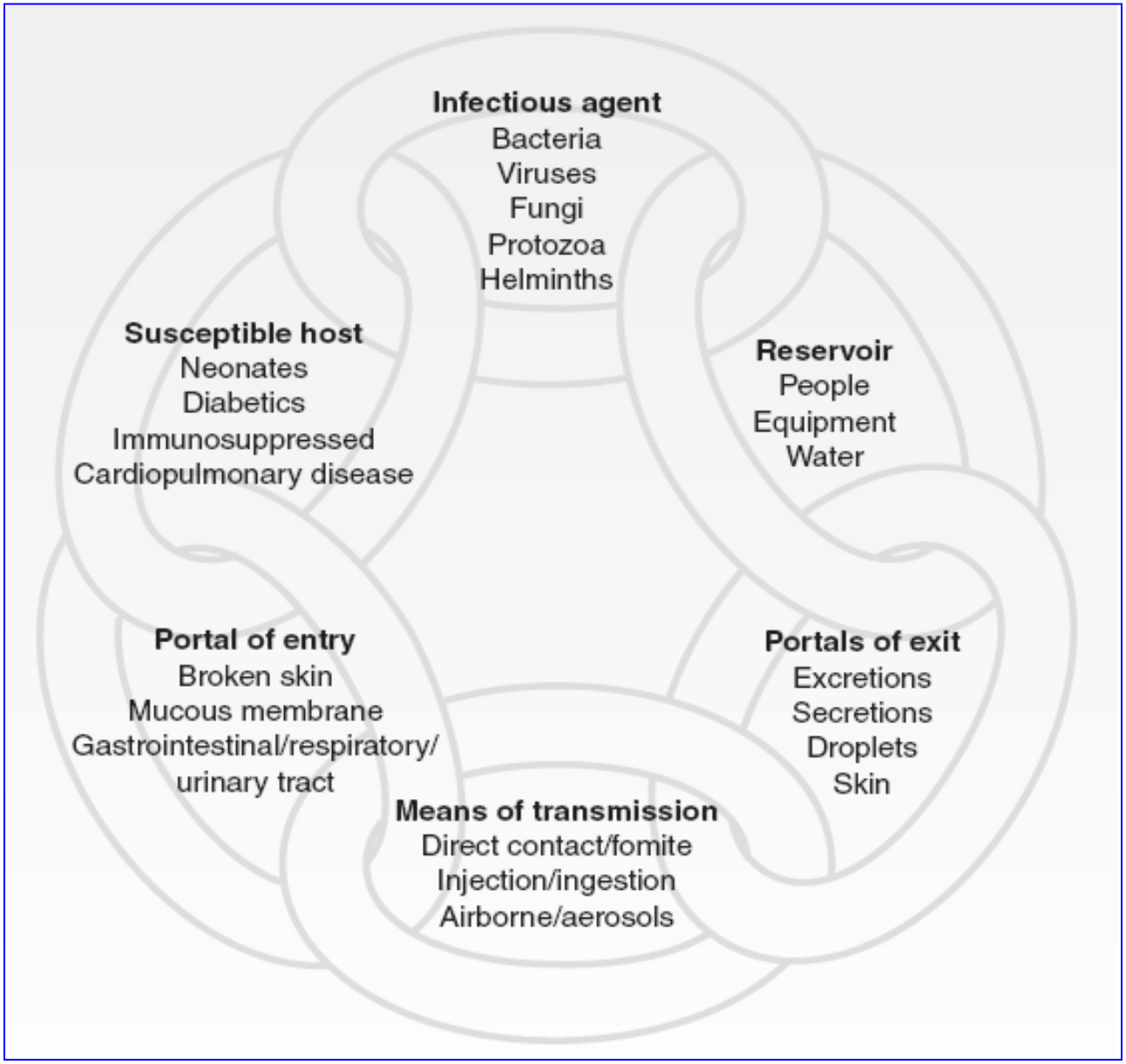
Chain of Infection



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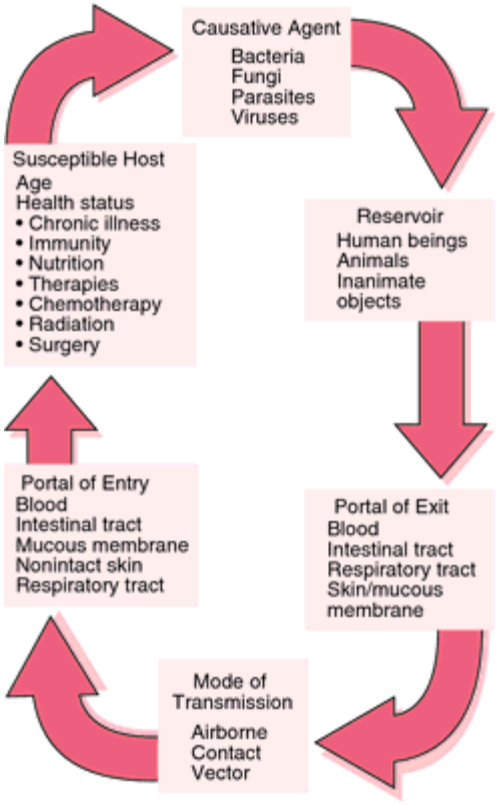

Causative Agent
Bacteria
Fungi
Parasites
Viruses
Reservoir
Human beings
Animals
Inanimate objects
Portal of Exit
Blood
Intestinal tract
Respiratory tract
Skin/mucous membrane
Mode of Transmission
Airborne
Contact
Vector
Portal of Entry
Blood
Intestinal tract
Mucous membrane
Nonintact skin
Respiratory tract
Susceptible Host
Age
Health status
• Chronic illness
• Immunity
• Nutrition
• Therapies
• Chemotherapy
• Radiation
• Surgery

Break the chain…how?

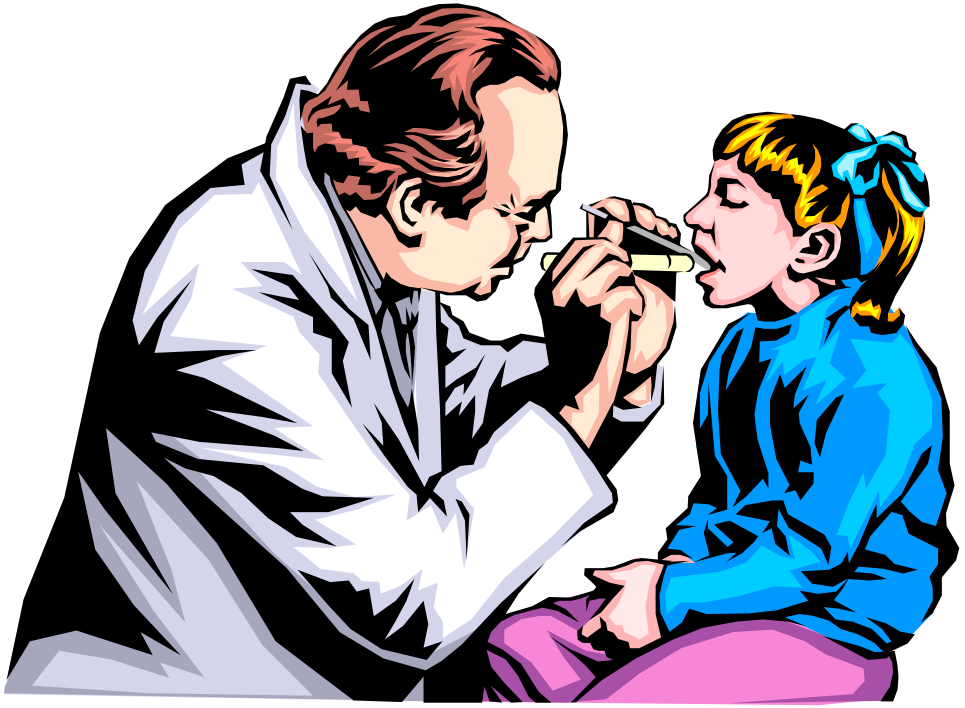
Remember!!! "breaking the chain of infection is our responsibility"

How to interrupt the chain of infection:

-The essential part of patient care & self-protection.

1. Pathogen Identification

-identification of infectious agent & appropriate treatment



2. Asepsis & Hygiene

-potential hosts & carriers must practice asepsis & maintain proper personal hygiene

3. Control Portals of Exit

-healthcare personnel must practice standard precautions:

(Control body secretions & wash hands according to protocol.)

4. Prevent a Route of Transmission

-prevent direct or indirect contact by:

1. Proper handwashing
2. Disinfection & sterilization techniques
3. Isolation of infected patients
4. Not working when contagious

5. Protect Portal of Entry

-Health professionals must make sure that ports of entry are not subjected to pathogens.

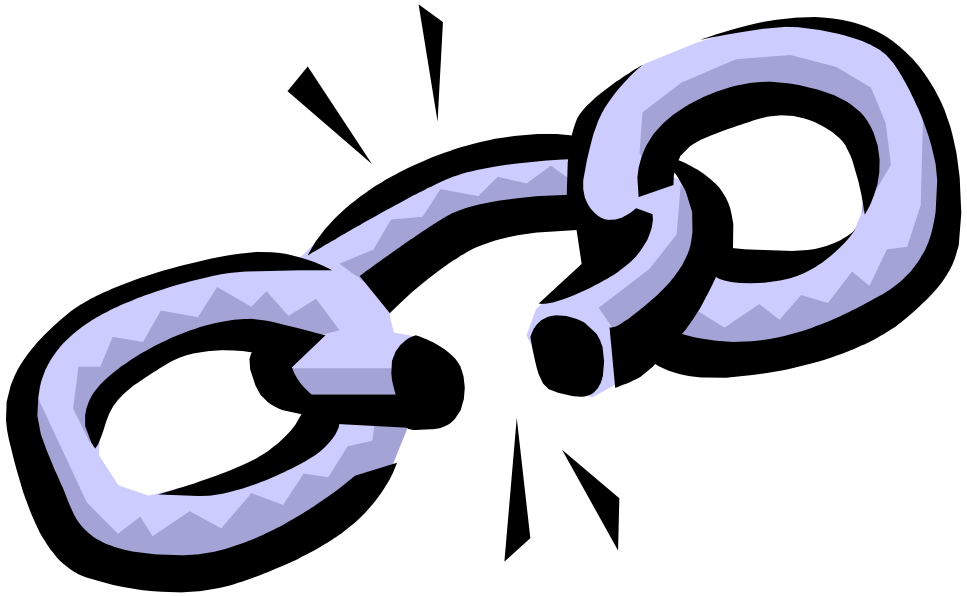
(nose, mouth, eyes, urinary tract, open wounds, etc.)

6. Recognition of Susceptible Host

-health professionals must recognize & protect high-risk patients

- Cancer Patients
- AIDS Patients
- Transplant Patients
- Infant & Elderly Patients

Remember--breaking the chain of infection is the responsibility of each health professional.



1. the various ways infection can be transmitted

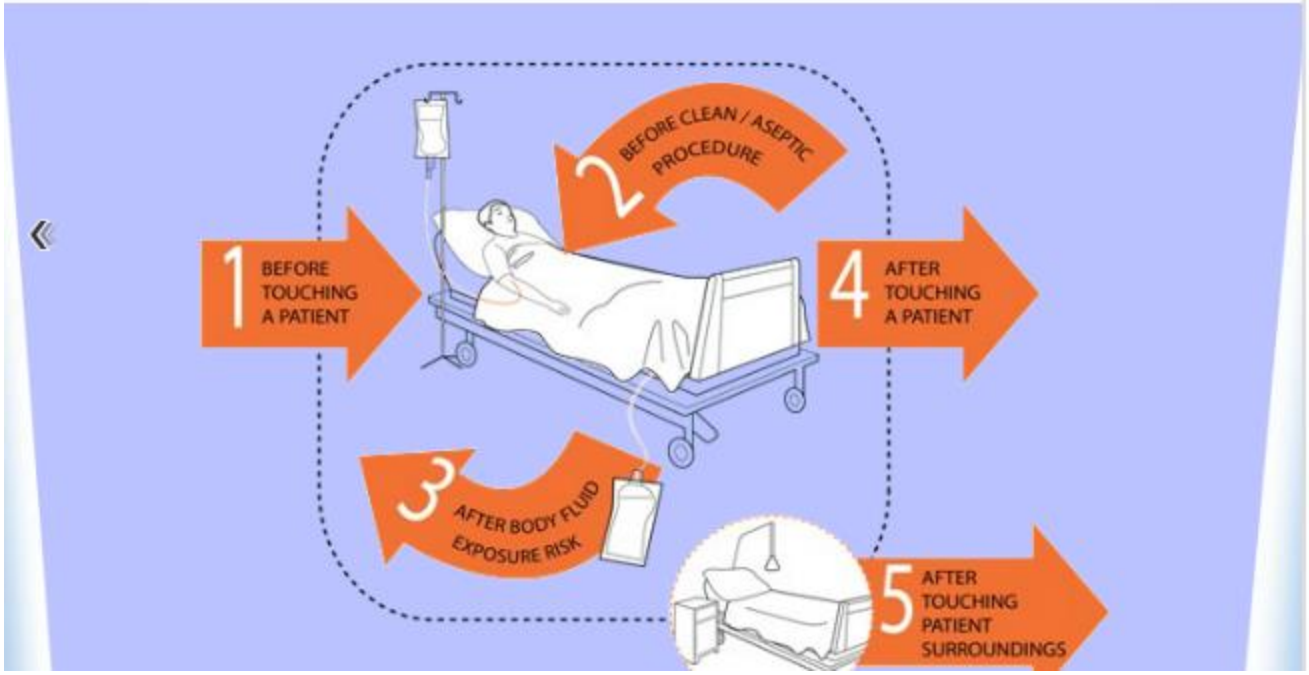
2. the ways the infection chain can be broken

Healthcare workers must practice…

Standard Precautions

- **Adequate handwashing with water and soap requires 40–60 seconds**
- **Alcohol-based handrubbing: 20–30 seconds**

Your 5 Moments for Hand Hygiene



“Prevent direct or indirect contact”

- Isolation
- Proper hand hygiene
- Disinfection & sterilization techniques

Protect high-risk patients

- Cancer patients
- AIDS patients
- Transplant patients
- Infants & elderly

The Chain of Infection

Remember!!! "breaking the chain of infection is our responsibility"


THANK
YOU!

MCQs & Exercises

1. Presence of an infectious agent in an inanimate article or on skin surface, particularly hands, is called

   (a) pollution (b) contamination (c) infection (d) infestation

2. Which mode of transmission is followed in transmission of microfilaria through female Culex mosquito

   (a) cyclo-propagative (b) propagative (c) cyclo-developmental (d) vehicle-borne

3. Malaria and Filariasis are mainly transmitted through vehicle - borne mode of transmission.
Yes/ No

4. All of the following are examples of direct modes of transmission except

(a) Fomites (b) inoculation into skin or mucus membranes (c) droplet infection (d) vertical transmission

5. Latent period + period of maximum communicability will give a crude estimate of the

(a) lead time (b) lag time (c) generation time (d) incubation period

6. The level of immunity that is present in a population against an infectious agent is known as

(a) innate immunity (b) acquired immunity (c) selective immunity (d) herd immunity

7. In calculation of secondary attack rate, exposure to which case is being taken into account

(a) primary case (b) index case (c) secondary case (d) subclinical case

8. Case Fatality Ratio (CFR) is a reasonably good measure of

(a) Pathogenicity (b) Infectivity (c) Virulence (d) Infectiousness

9. Epidemiologic chain of infection usually involves all of the following factors except

(a) Disinfectants (b) Infectious agent (c) Human host (d) Modes of transmission

10. The presence and development of insect vectors on the body or linen e.g. louse is known as

(a) Infection (b) Infestation (c) Infectiousness (d) Infectivity

11. A significantly large amount of subclinical infection occurs in all of the following diseases except

(a) Hepatitis A (b) Hepatitis B (c) Rubella (d) Measles

12. All of the following diseases are examples of Anthropozoonoses except

(a) *Tryponosoma cruzi* (b) Hydatid disease (c) Trichinosis (d) Plague

13. All of the following organisms are quite sturdy and can withstand adverse environment very well, except

(a) Clostridia spores (b) Cysts of intestinal protozoa (c) Ova of helminthes (d) Hepatitis A virus

14. The time in which half of the infected subjects will develop clinical manifestations, following entry of the organism into the body, is known as

(a) Lead time (b) Median Latent period (c) Median Incubation Period (d) Generation time

15. That subset of Endemic frequency, wherein exposure to infection generally occurs during early childhood so that by the time adulthood is achieved, the population becomes immune and a high level of herd immunity occurs, is known as

(a)Hyper-endemic (b) Holo-endemic (c) Meso-endemic (d) Hypo-endemic

Answers

(1)b

(2) c

(3) No

(4) a

(5)c

(6) d

(7) b

(8) c

(9) a

(10) b

(11) d

(12) a

(13) d

(14) c

(15) b