Dynamics Of Infectious Disease Transmission & Chain Of Infection

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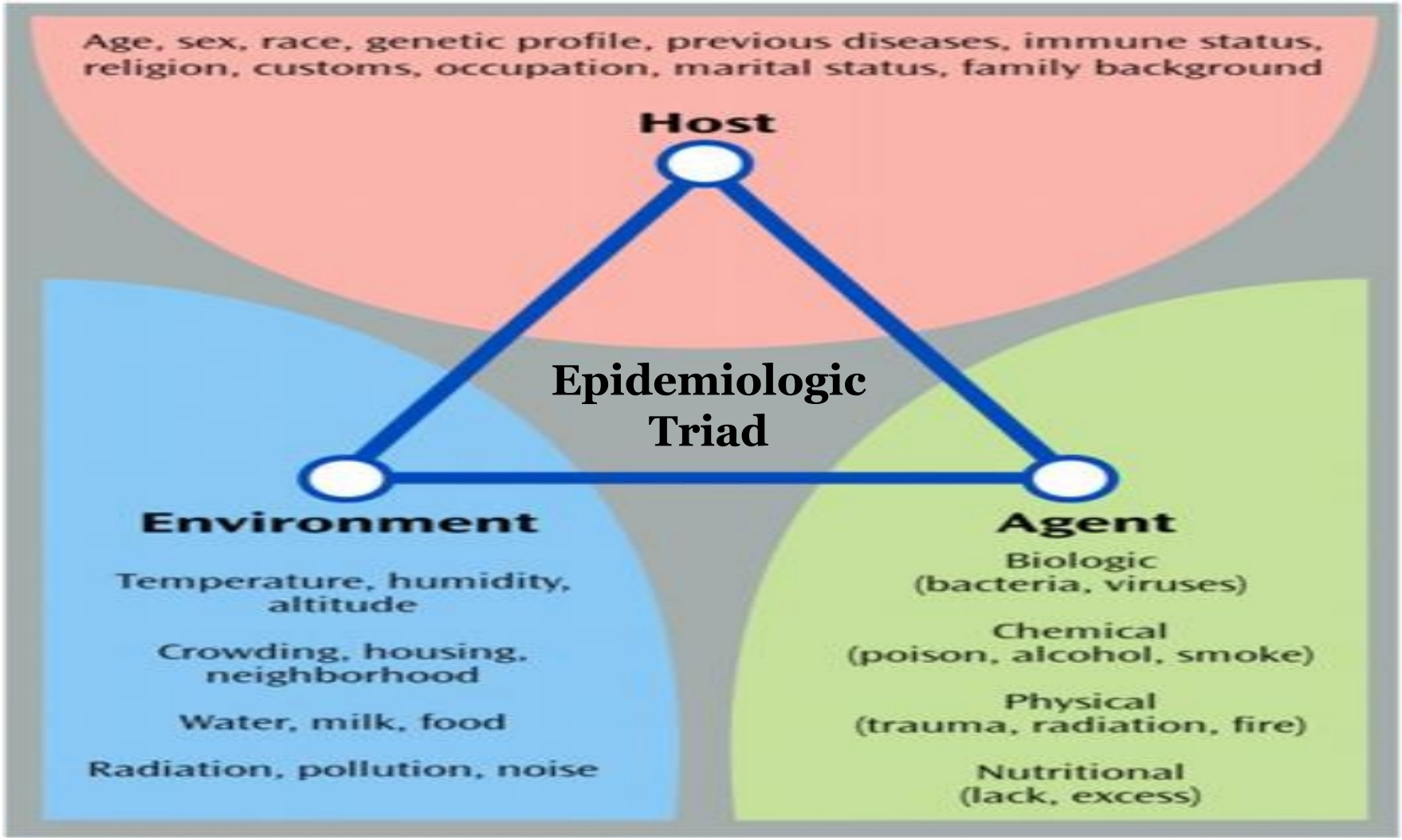
Lesson Plan

- Domain Learning: Cognitive
- Allotted time in hours: 1 hour
- Teaching Faculty: Dr Noreen Shah
- Learning Sites: KGMC, Lecture Theatre
- Learning Strategies: Didactics/lectures, assignments with presentations
- Recommended Books and Websites: Saira Afzal
- Assessment Tools: MCQs, SAQ, OSPE

Learning Objectives:

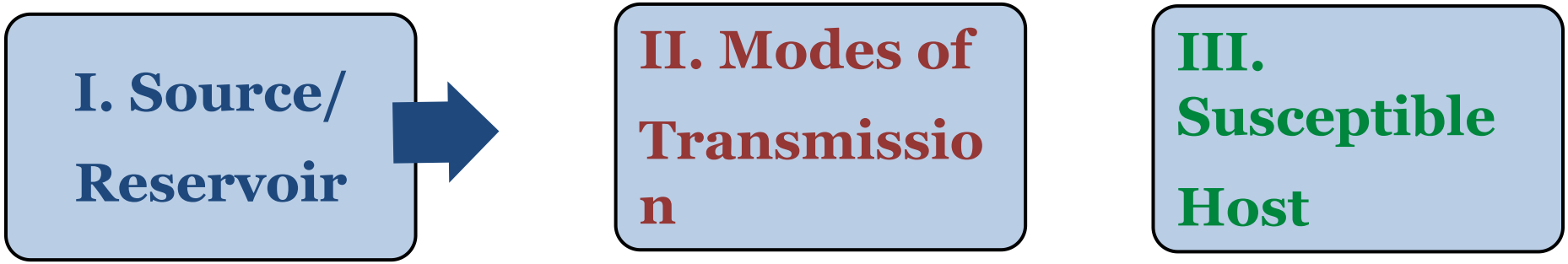
- At the end of this session the students will be able to;
- Define concepts of infectious disease epidemiology
- Describe different modes of transmission of infectious diseases
- Describe reservoirs of infection & chain of infection
- Describe the ways to break Chain of Infection

The standard model of infectious disease causation. It has 3 corners



Dynamics of transmission

Communicable diseases are transmitted from the reservoir/source of infection to susceptible host through .



I. Source/ Reservoir of infection

Any person, animal, plant, soil or substance in which an infectious agent normally lives and multiplies.

The reservoir harbours the infectious agent without injury to itself and serves as a source from which other individuals can be infected.

1. Human reservoirs

Cases

- Primary case
- Index case
- Secondary cases

According to spectrum of disease:

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

Carriers

Type:

- Incubatory
- Convalescent
- healthy

Duration

- Temporary
- Chronic

Portal of exit

- Urinary
- Intestinal
- Respiratory
- others

Cases may be classified as:

Primary case: The first case of an infectious disease introduced into the population.

Index case: The first case that come to attention of investigators.

Secondary case: Case that develops from the primary case.

According to spectrum of disease

***Clinical case*:** May be mild/severe/typical or atypical depending upon the gradient of involvement.

***Subclinical cases*:** Asymptomatic or mildly infected that does not alert the patients.

Latent cases: Asymptomatic infection capable of showing symptoms under some circumstances if activated.

Carriers:

- Carriers are infected persons that harbor specific infectious agent in the absence of visible clinical disease and serves as a potential source of infection to others.
- Carriers are less infectious than cases.
- Epidemiologically they are more dangerous as these escape recognition.

Carriers may be classified by type:

- ***Incubatory Carrier:*** Person capable of transmitting an infectious agent during incubation period.
- ***Convalescent Carrier:*** Person who continue to shed the disease agent during the period of convalescence, e.g. typhoid fever, cholera, whooping cough, in these clinical recovery does not coincide with bacteriological recovery.
- ***Healthy Carrier:*** Emerge from subclinical cases.

Carriers classified as temporary or chronic:

- ***Temporary carriers:*** Are those who shed infectious agent for short periods of time. All the three incubatory, convalescent and healthy are included.
- ***Chronic carriers:*** A carrier who excretes the infectious agent for indefinite period. E.g. typhoid fever, hepatitis B, dysentery, malaria, etc.

Carriers classified by portal of exit:

- Carriers may be classified according to portal of exit of infectious disease.

i. Urinary

ii. Intestinal

iii. Respiratory

iv. Open wounds

v. Blood and body fluids

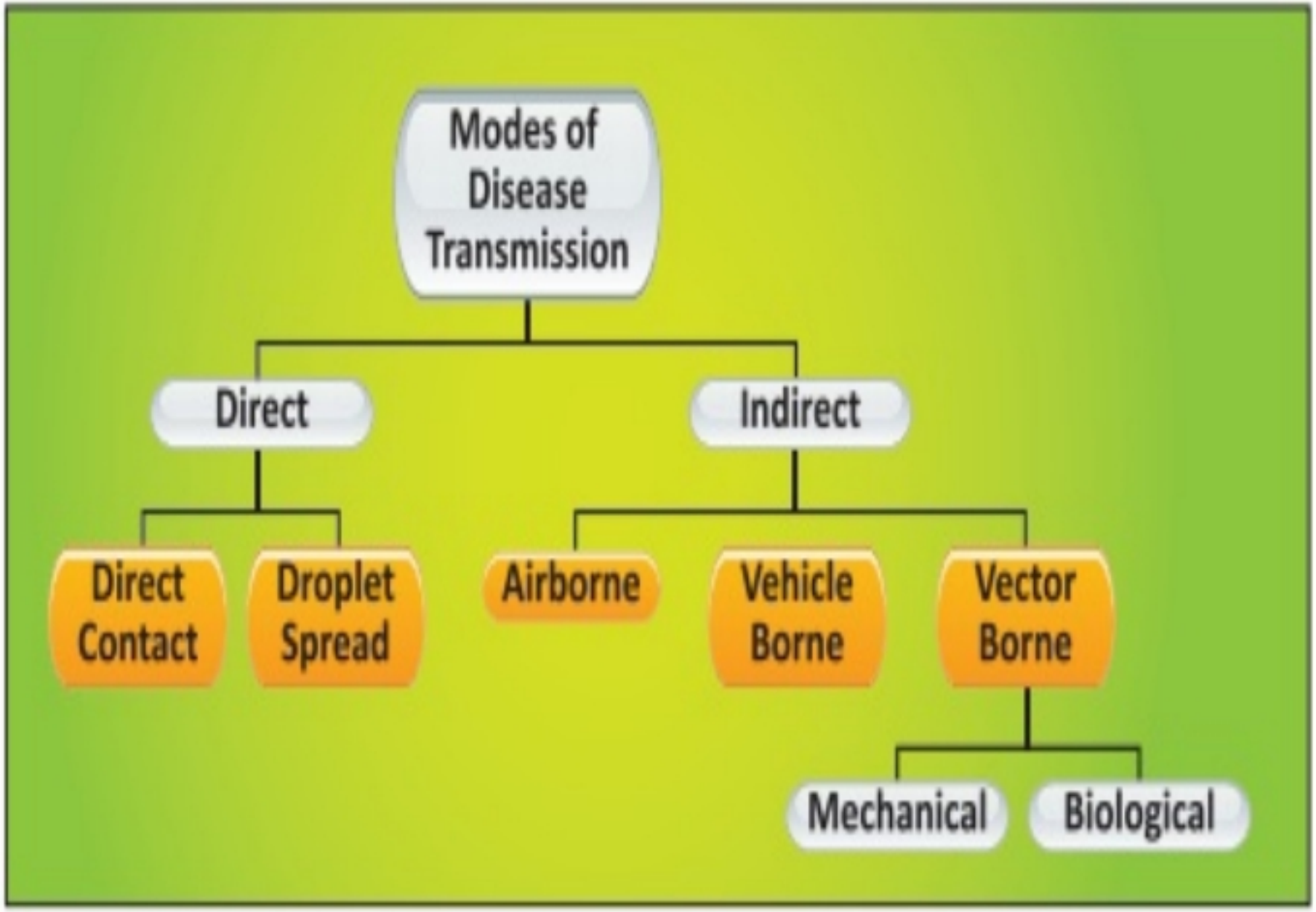
2.Animal Reservoirs (zoonotic diseases)

- Infection disease that are transmissible under natural conditions from vertebrate animals to man, e.g. rabies, plague, bovine tuberculosis etc.

3. Reservoir in non-living things.

- Soil and inanimate matter can also act as reservoir of infection. E.g. soil may harbor agents that causes tetanus, anthrax etc.

Modes of transmission of disease


Modes of Disease Transmission
Direct
Indirect
Direct Contact
Droplet Spread
Airborne
Vehicle Borne
Vector Borne
Mechanical
Biological

1. Direct Transmission

i. ***Droplet infection:*** By coughing, sneezing and spitting e.g. pneumonia, diphtheria, influenza, tuberculosis

ii. ***Contact with soil:*** Bacterial cysts of tetanus.

iii. ***Animal bites:*** Rabies viruses.

iv. ***Tran placental transmission:*** **{TORCH** - Toxoplasmosis, (other syphilis, varicella-zoster, parvovirus B19), Rubella, Cytomegalovirus and Herpes infections**}** can be transmitted from the maternal blood into foetal blood through placenta

i. *Vehicle borne transmission:*

- The agents multiplies or develops in vehicle & transmits through agencies like water, vegetables, fruits, milk, milk products, ice, blood, serum, tissue etc. E.g. diarrhea, typhoid, cholera, polio, hepatitis A, brucellosis, etc.

2. Indirect transmission

i. ***Air borne:***

- Transmission is carried in air in form of droplets and dust e.g. tuberculosis, influenza, chicken pox, measles, viruses, spores of fungi etc.

ii. ***Vehicle borne:***

- These are inanimate substances other than water or food contaminated by the infectious discharge, e.g. diphtheria, typhoid bacillary dysentery, hepatitis A, eye and skin infections.

iii. ***Vector-borne transmission:***

Vectors are living organisms that can transmit infectious diseases between humans or from animals to humans. It may be:

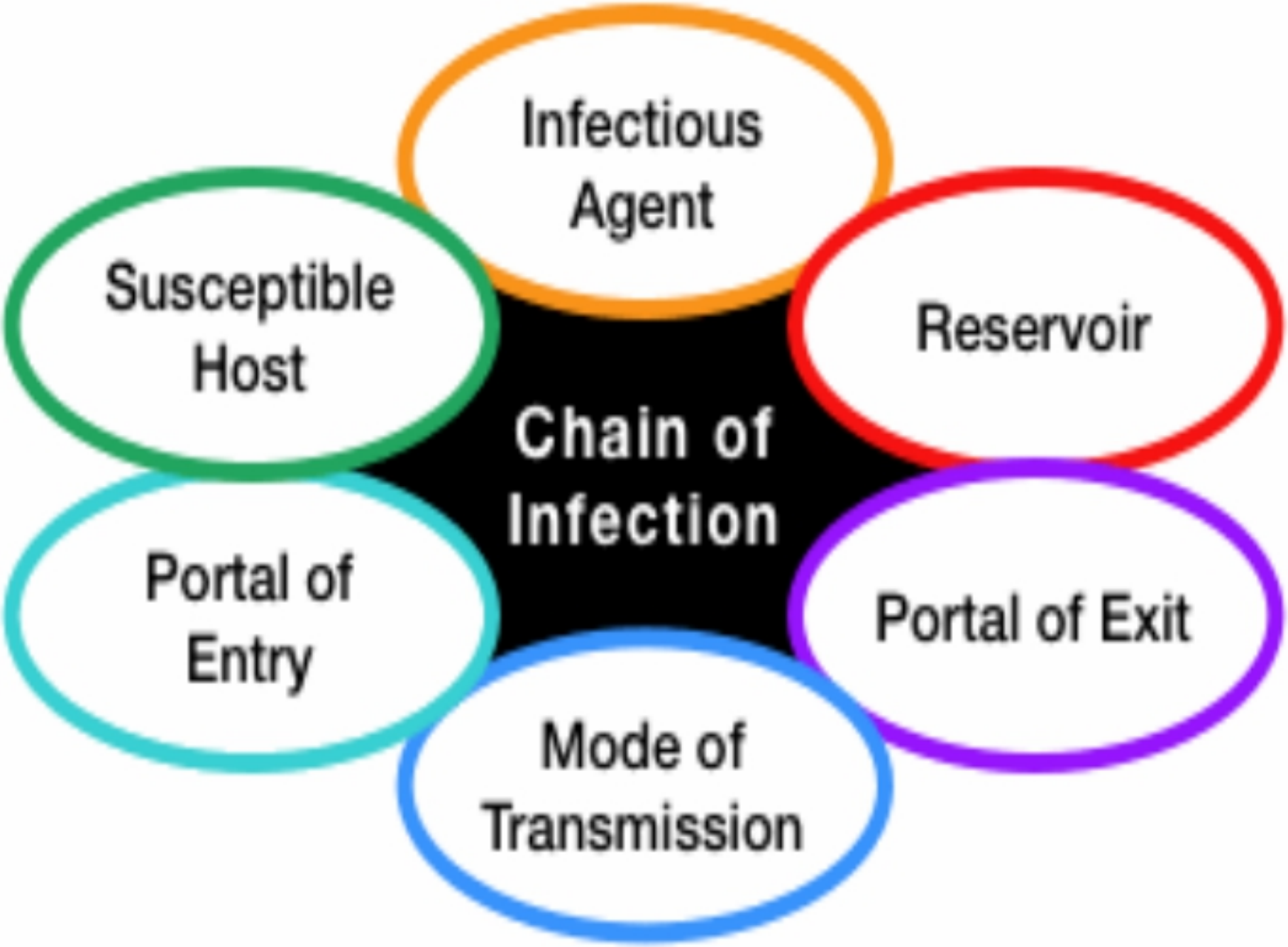
a. Mechanical transmission: When a vector simply carries pathogenic microorganisms on their body and transfers them to food. E.g. flies and cockroaches.

b. Biological transmission:

- Biological transmission occurs when the pathogen reproduces within a biological vector that transmits the pathogen from one host to another. E.g. mosquitoes, lice etc.

(a) Mechanical vector

(b) Biological vector


Infectious Agent
Susceptible Host
Reservoir
Chain of Infection
Portal of Entry
Portal of Exit
Mode of Transmission

Chain of Infection

Next Sick Person

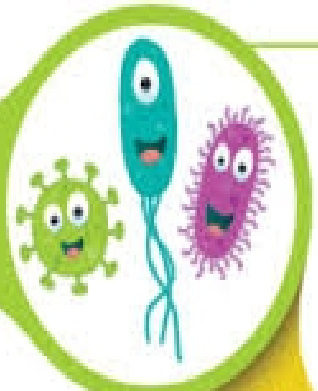
(Susceptible Host)

- Babies
- Children
- Elderly
- People with a weakened immune system
- Unimmunized people
- Anyone

Germs

(Agent)

- Bacteria
- Viruses
- Parasites



How Germs Get In

(Portal of Entry)

- Mouth
- Cuts in the skin
- Eyes

Where Germs Live

(Reservoir)

- People
- Animals/Pets (dogs, cats, reptiles)
- Wild animals
- Food
- Soil
- Water

Germs Get Around

(Mode of Transmission)

- Contact (hands, toys, sand)
- Droplets (when you speak, sneeze or cough)

How Germs Get Out

(Portal of Exit)

- Mouth (vomit, saliva)
- Cuts in the skin (blood)
- During diapering and toileting stool)

Definition:

- Chain of infection is a model (**a circle of links**) used to understand the infection process.
- Each circle represents a component in the cycle.
- Each link must be present and in the sequential order for an infection to occur.

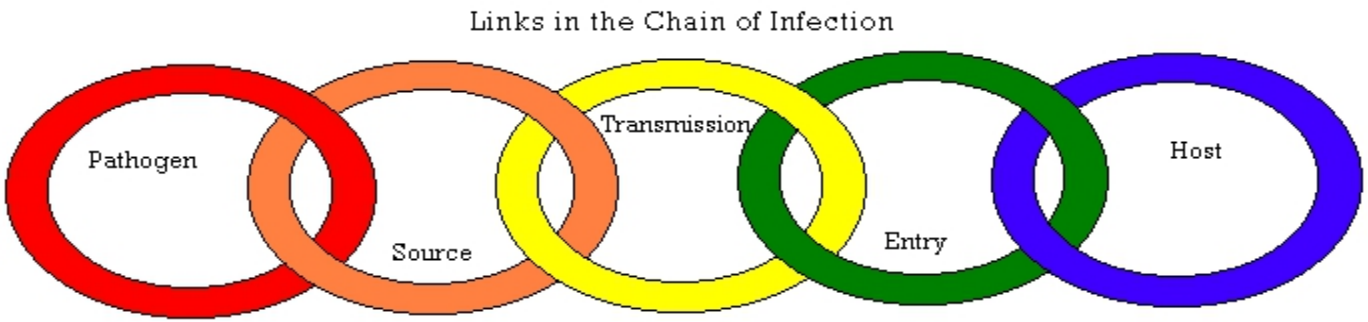
Chain of Infection:

- ***It is the process that begins when:***

1. ***An infectious agent leaves its***
2. ***Reservoir or host through a***
3. ***Portal of exit and then***
4. ***Is conveyed by some mode of transmission to***
5. ***Enter through an appropriate portal of entry to***
6. ***Infect a susceptible host***

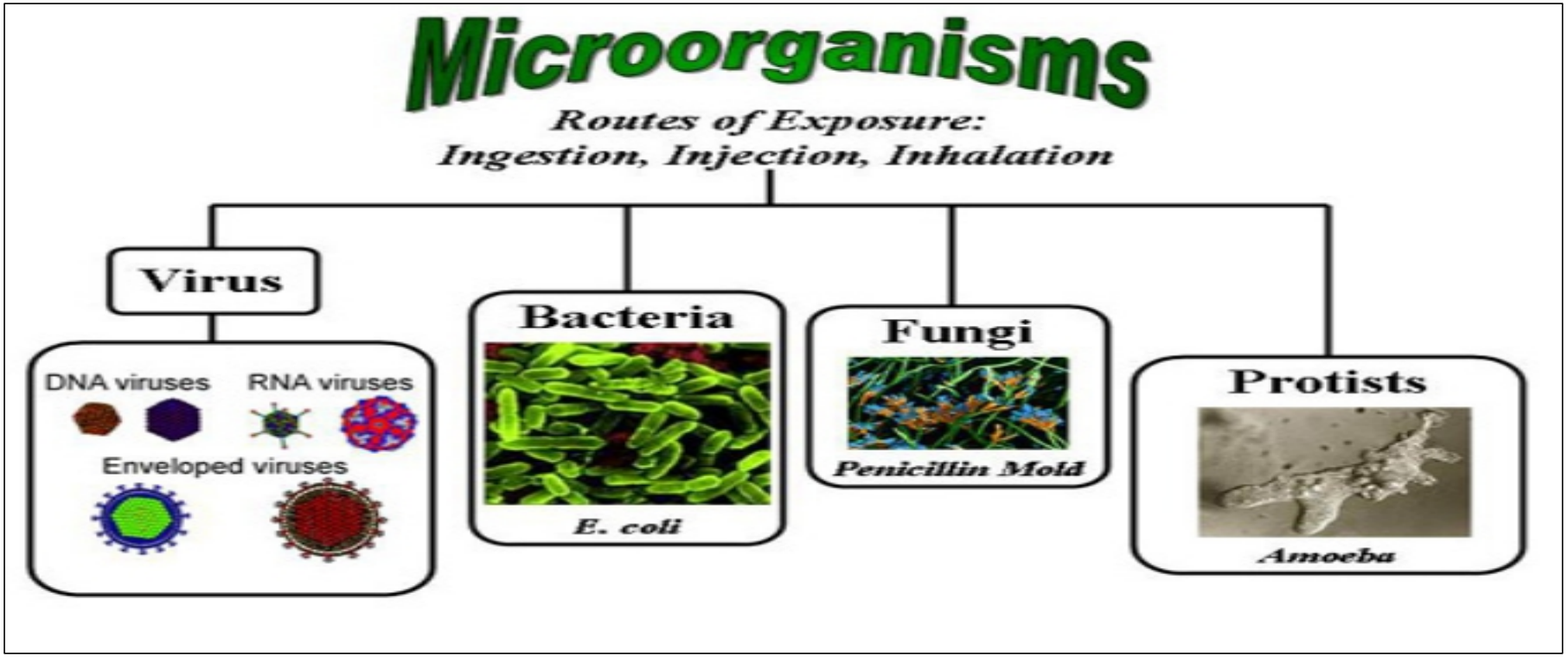
Different Ways to break Chain

- Diseases have certain weak points
- The basic approach in controlling the disease is to
- Identify these weak points and
- Break the weakest links in chain of transmission



1. Infectious agent

- These are the pathogens that cause communicable diseases. Most commonly these are:



- Micro-organisms are all around us, on our body, in our food and in the environment.
- Our body's immune system, allows us to be protected against these organisms.
- ***Breaking the Chain (Infectious agent)***
- Early diagnoses and treatment
- Cleaning, disinfection and sterilization
- Infection prevention policies
- Pest control

2. Reservoir or host

- The reservoir (source) is a host which allows the pathogen to live, and possibly grow, and multiply under right conditions of:
- Warmth
- Moisture
- A food source.
- E.g. Dirty surfaces and equipment, people, water, animals/ insects, soil

2: Reservoir of infection: Breaking the Chain

- Cleaning, Disinfection, Sterilization
- Infection Prevention Policies
- Pest Control

3. Portal of exit:

- It is the site from where micro-organisms leave the host to enter another host to cause infection. E.g.
- **Upper respiratory tract:** saliva, sneeze, cough
- **Gastrointestinal tract:** feces, vomit
- **Blood:** infected blood
- **Uro - genital tract:** semen, vaginal secretions, urine
- **Skin and mucous membranes:** discharges

3. Portal of exit: Breaking the Chain

- Hand hygiene
- Personal protective equipment
- Control of aerosols and splatter (aerosols can transmit respiratory infections like tuberculosis, splashing of mucosa is also a potential risk)
- Respiratory etiquette
- Proper waste disposal

4. Modes of transmission

- To move from the reservoir, a microorganism needs a Mode of Transmission to a susceptible host.
- These transmission routes include:

i. Direct contact (hands)
ii. Indirect contact (via equipment)
iii. Inhalation (airborne / droplet)
iv. Inoculation (deliberate or accidental puncture of the skin)
v. Ingestion (food)
vi. Intercourse
vii. Mother to Infant transmission.

Difference between droplet and Air borne transmission

- ***By droplet transmission:*** SARS, Covid - 19
- Droplets > 5 microns generated from the respiratory tract during coughing, sneezing or talking.
- If these come into contact with the mucous membranes (mouth, nose or eyes) of a recipient individual, they can cause infection.
- These droplets do not remain in the air for long and do not travel more than one metre of distance, so closeness is required for transmission.
- ***By the airborne route:*** flu, whooping cough, chickenpox, mumps, TB
- Infectious particles in air size range (≤5μm) remain infectious for longer time and travel long distance so are able to enter the respiratory tracts of individuals without having necessarily close contact.

4. Mode of transmission: Breaking the chain

i. Appropriate patient placement

ii. Proper hand hygiene, respiratory hygiene and cough etiquette

iii. Using appropriate Personal Protective Equipment

iv. Safely managing of blood/body fluids

v. Ensuring safe use and disposal of sharps

vi. Maintaining a clean healthcare environment and patient care

vii. Safely handling linen

viii. Safe disposal of waste

ix. Ensuring appropriate food hygiene and pest control

5. Portal of entry:

- The site through which micro-organisms enter the susceptible host by penetration, inhalation, or ingestion.

i. Inhalation: influenza
ii. Ingestion: gastro enteritis
iii. Needle prick: hepatitis B
iv. Sexual contact: HIV/AIDS,
v. Open wound or punctures: tetanus

5. Portal of entry: Breaking the Chain

- Wear a mask
- Maintain good ventilation
- Hand hygiene
- Personal protective equipment
- Personal hygiene plus isolation of infected
- Careful food handling
- First aid
- Safe sex

6. Susceptible Host:

- The future host is the person who is next exposed to the pathogen. The microorganism may spread to another person but does not develop into an infection if the person's immune system can fight it off.
- They may however become a 'carrier' without symptoms, able to then be the next 'mode of transmission' to another 'susceptible host'.
- Once the host is infected, he/she may become a reservoir for future transmission of the disease.

- **Vulnerable Populations like**:

i. Very young children

ii. Older adults

iii. Immunocompromised people

iv. People who are ill

v. People with a long-term health condition

vi. People who are physically weak (e.g. due to malnutrition or dehydration).

6. Susceptible Host:Breaking the Chain

- Separate high risk individuals from persons with known or potential infections
- Provide nutritional supplements to persons on inadequate diets
- Vaccinate against vaccine preventable diseases
- Maintain proper sanitation of air and environment
- Diagnose and treat underlying disease
- Health insurance
- Patient education

https://www.osha.gov/sites/default/files/2018-11/fy10_sh-20849-10_BP_Part_1_Quiz_w_Answers.pdf
https://www.proprofs.com/quiz-school/story.php?title=chain-infection

1. The chain of infection is a visual representation of:

a. The types of microbes that can cause an infection

b. The events that have to occur for an infection to develop

c. A chain of job functions that increase a infection. Person's risk of developing an infection

d. The two primary blood borne pathogens. Infection to develop.

3. Identify the part(s) of chain of infection that has been eliminated by the following action. Hand washing.

a. Susceptible host

b. Mode of transmission

c. Portal of entry

4. Identify the part (s) of chain of infection that has been eliminated by the following action. Identification of organism.

a. Portal of exit

b. Infectious agent

c. Portal of entry

5. Identify the part (s) of chain of infection that has been eliminated by the following action. Personal protective equipment

a. Source/ Reservoir

b. Portal of exit

c. Portal of entry

6. Identify the part (s) of chain of infection that has been eliminated by the following action. Sterilization

- Source or reservoir/mode of transmission
- Portal of entry/Portal of exit
- Mode of transmission / Infectious agent

Answers:

1. **c**
2. **c**
3. **b**
4. **b**
5. **b**
6. **a**

- https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section10.html
- https://professionals.site.apic.org/protect-your-patients/break-the-chain-of-infection/

Thankyou