

# Principles of Communicable Diseases Epidemiology-L-1/25-26



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## Objectives

- **Elucidate the importance of reviewing communicable diseases epidemiology**
- **Have knowledge of common terminology in communicable diseases epidemiology**
- **Define dynamics of disease transmission (chain of infection)**
- **List types of reservoir of infection**
- **Description of carriers and explain their public health importance in disease transmission**

**In history, communicable diseases had ever been the most serious threaten to human life and health until the end of World War II.**

**Then the situation improved accompanying with the advancement of biologic theory and techniques as well as the enhancement of human living conditions.**

**In recent decades, however, epidemics of communicable diseases have become fundamental public health problems once again. Certain newly identified infectious diseases and previously controlled communicable diseases have been emerging or recurring in part due to the variation of pathogens, changes in social and environmental conditions as well as human living modes.**

## **Communicable Diseases Epidemiology**

**Is the study of how and why communicable diseases emerge and spread among different populations, and what strategies can prevent or contain the spread of disease at the population level.**

# **Importance of Studying Communicable Diseases Epidemiology**

- ❑ Changes of the pattern of infectious diseases**
- ❑ Discovery of new infections**
- ❑ The possibility that some chronic diseases have an infective origin.**

## **Why Communicable Diseases are important to any health system?**

- 1- Continuous presence -Cholera**
- 2- Eradicated -Small pox**
- 3- Re-Emerging- TB, M pox**
- 4- Emerging ( New ) -Covid-19**

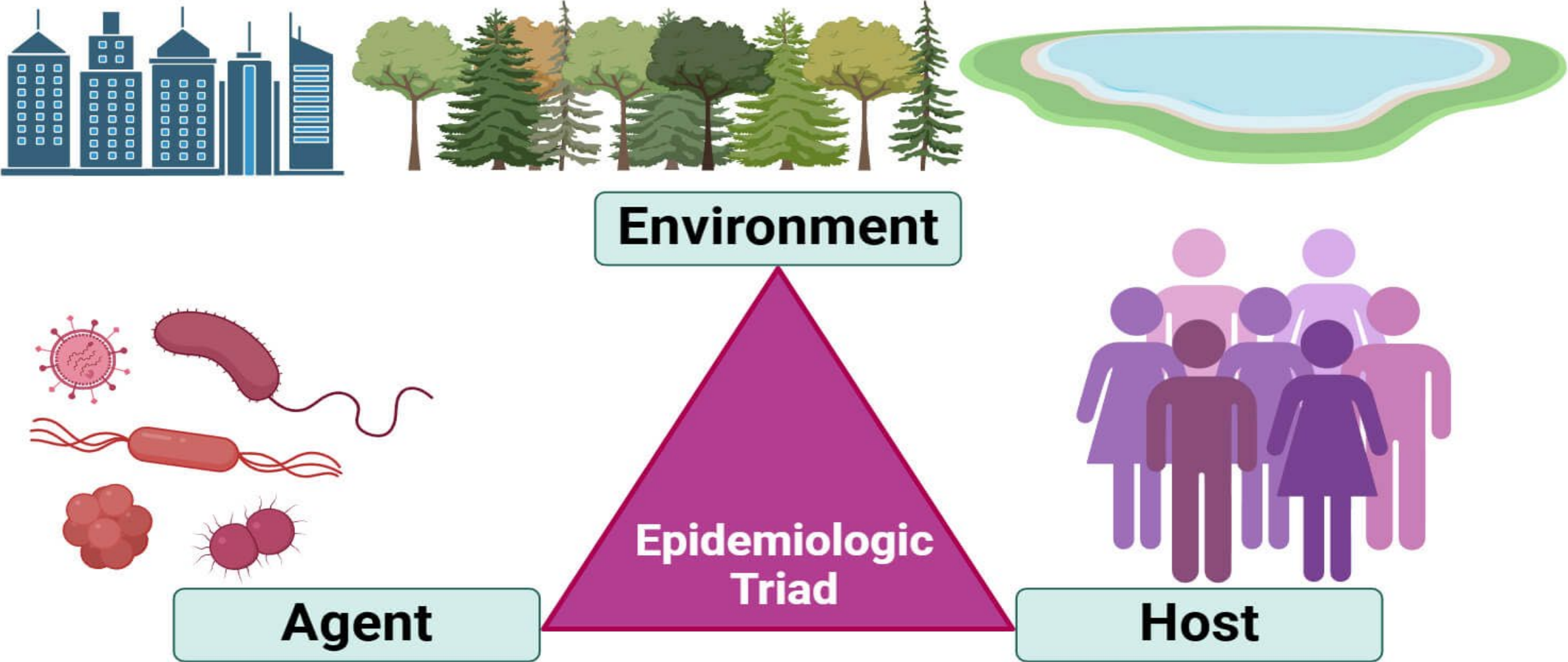
## **Reason for changes in pattern of infectious diseases?**

**1-This might be due to improvement in nutrition, better sanitation and housing, immunizations and antimicrobial chemotherapy.**

**2-Infections such as diphtheria, poliomyelitis and tetanus have decreased and, in some locations, have almost disappeared due to immunization.**

**3-Smallpox, has been eradicated from the world while another lethal infection, human immunodeficiency virus (HIV), H5N1 and Covid 19 had emerged in pandemic proportions.**

# Infectious Disease Model



# Infection

- **Complex process of interaction between pathogen and human body**
- **Infection is the entry and development or multiplication of an infectious agent in the body of man or animals.**
- **An infection does not always cause illness.**

## **Factors favoring occurrence of infection:**

**a- Unsanitary environment**

**b- Unsound health behavior of population**

## **There are several levels of infection (Grades of infection)**

- **Colonization** (S. aureus in skin and normal nasopharynx)
- **Subclinical or inapparent** infection (polio)
- **Latent** infection (virus of herpes simplex)
- **Manifest or clinical** infection

# **What are the factors influencing the development of several levels of infection ?**

**1- Agent Factors**

**2- Host Factors**

# ➤ AGENT FACTORS: are related to

## Communicable Diseases & Causative agent



Anthrax

Zika

Arbovirus

Pertussis

Calciavirus

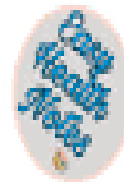
Rubella

Dengue

Paramyxo virus

Hepatitis

Ebola virus



## **1-Number (dose of infection) (ID)**

**Is the estimated number of organisms or virus particles required to produce infection in 50% of normal adult humans exposed by a given route.**

**Usually ,it varies according to the pathogenic agent and the individual age and overall health.**

Pathogen/disease	Infectious doses of microorganisms
<i>Histoplasma capsulatum</i>	10 (mice)
<i>Mycobacterium tuberculosis, Mycobacterium bovis</i>	10
Coxsackie A21 virus (Enterovirus)	18 or fewer
Influenza	>790
<i>Bacillus anthracis</i>	8,000-50,000
Q fever ( <i>Coxiella burnetii</i> )	10
Tularemia ( <i>Francisella tularensis</i> )	5-10
Adenovirus	>150
Respiratory syncytial virus	>100 -640

## **2-pathogeni city**

**is the property of an infectious agent that determines the extent to which obvious disease is produced in an infected population. Or the power of organism to produce disease.**

**The potential of a microorganism to cause disease in a susceptible host.**

**The ability to induce clinically apparent illness.**

## **Pathogenicity:**

**Measured by the ratio of infected individuals who develop clinical illness versus those exposed to the pathogen.**

### **3-VIRULENCE**

**Means the speed with which an Infectious agents kills the host.**

**This is a function of the severity of the infection and is heavily influenced by how many mild cases are not diagnosed.**

**The case fatality rate is one way of measuring the virulence.**

**Case fatality rate for infectious diseases is the proportion of infected individuals who die of the infection.**

**Virulence: Number of serious condition & mortality/ Number diseased**

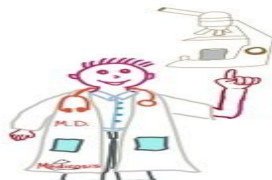
## 4-Invasiveness & Toxicity

**Invasiveness** is the power of the organism to penetrate into the body fluids and tissues of the host to live and multiply.

**Toxicity** Could be defined as measure of ability of organism to affect clinical reaction by chemical Substances which is produces.

Toxins produce by pathogens are either retained within their bodies and liberated after degeneration of the organisms, and are called **ENDOTOXIN**; or are released during the life of the organisms and are called **EXOTOXIN**.

Exotoxin



VS

Endotoxin



**The role of exotoxins in bacterial pathogenesis is unique to each exotoxin. *Corynebacterium diphtheria* produces diphtheria toxin, which is responsible for the systemic pathology associated with diphtheria. whereas *Vibrio cholera* produces cholera toxin, which is responsible for the diarrheal pathology associated with cholera.**

**Exotoxins vary in their cytotoxic potency, with the clostridia neurotoxins being the most potent exotoxins of humans.**

## **Endotoxin**

**is commonly found everywhere in our environment and it is the most significant pyrogen in parenteral drugs and medical devices. Endotoxins are also present in the digestive system.**

**Their presence in the blood stream may cause septic reactions with a variety of symptoms such as fever, hypotension, nausea, shivering and shock**

**High concentrations can lead to serious complications such as disseminated intravascular coagulation (DIC), endotoxin shock and adult respiratory distress syndrome (ARDS).**

## **5-Tissue Selectivity ( Tropism)**

**It is the inherent capability of pathogens to Invade some particular tissues  
This is the factor that give each disease its characteristics symptoms & signs.**

## **6-Antigenic Character &Antigenicity**

**Antigenicity is measure of ability of organism to stimulate an  
immunologic response in the host.**

## **7-Viability**

**The viability of pathogen is the ability to live and the period of living outside the  
body.**

## **8-Susceptibility to chemotherapy and antibiotics**

# Host Factors In Causation Of Disease

The **HOST** is defined as " Any susceptible man or animal potentially exposed to be parasitized by infective organisms".

**A person or other animal, including birds & arthropods, that affords subsistence or lodgement to an infectious agent under natural conditions**

- Primary (definitive) host**
- Secondary (intermediate) host**

**The host factors in causation of diseases are factors specific for the host , and important for :**

- **Occurrence**
- **Type**
- **Spread**
- **Severity of infection**

**They include :**

- Resistance & immunity**
- Genetic factors**
- Physiological factors**
- Age factors**
- Sex factors**

# Communicable diseases

**A communicable 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.**

## Contagious disease

**A contagious disease is the one that is transmitted through contact. Examples include scabies, trachoma, STD and leprosy.**

- **All contagious diseases are infectious, but not all infectious diseases are contagious. Contagious diseases are infectious diseases that are easily spread through contact with other people.**



## **Latent infection**

- **The host doesn't shed the infectious agent which lies dormant within the host without symptoms. Ex., latent infection occurs in Epstein-Barr virus (EBV), Varicella-Zoster virus (VZV), HIV, Herpesviruses, and Cytomegalovirus (CMV), flaring up when host defense breaks down**

## **In apparent Infection**

**The presence of infection in a host without recognizable clinical signs or symptoms. In apparent infections are identifiable only by laboratory means such as a blood test or development of positive reactivity to specific skin tests.**

## Contamination

**The presence of an infectious agent on a body surface, on or in clothes, beddings, toys, surgical instruments or dressings, or other articles or substances including water and food.**

## Incubation and Latent periods

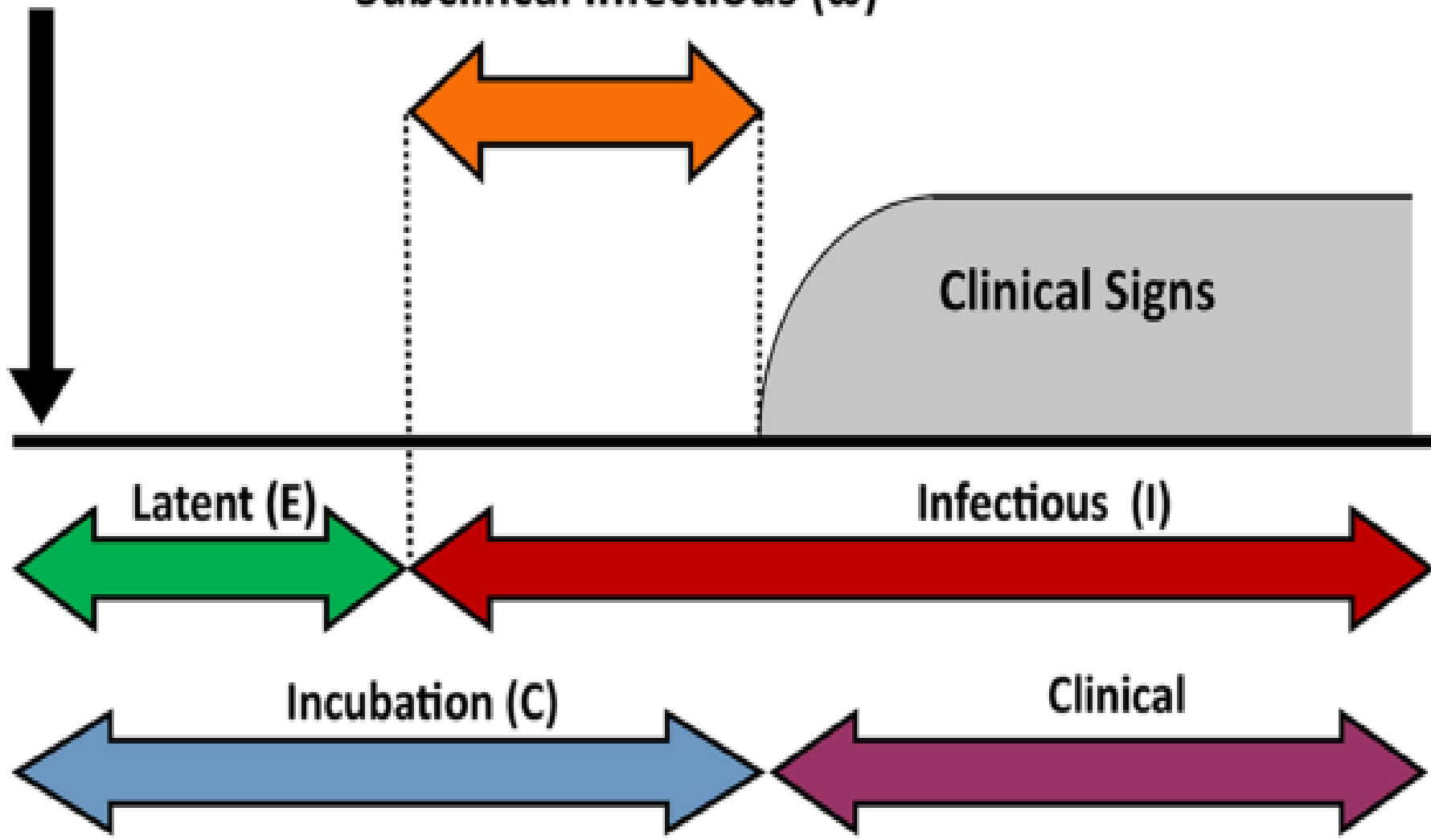
- ❑ **Incubation period:** time from exposure to development of disease. In other words, the time interval between invasion by an infectious agent and the appearance of the first sign or symptom of the disease in question.
- ❑ **Latent period:** the period between exposure and the onset of infectiousness (this may be shorter or longer than the incubation period).

Infection

Subclinical Infectious ( $\omega$ )

Clinical Signs

Time



Latent (E)

Infectious (I)

Incubation (C)

Clinical

➤ **Generation time:** is the time taken for a person from receiving of infection to develop maximum infectivity.

Is roughly equal to the incubation period of the disease.

➤ **Median incubation period:**

The time required for 50% of cases to occur following exposure.

## The factors which determine the incubation period

- The generation time of the pathogen
- Infective dose
- Portal of entry
- Individual susceptibility
- Intervention (e.g. pharmacologic prophylaxis and treatment)

### Incubation period

How long it takes an infected person to show symptoms



<b>Disease</b>	<b>Incubation period (days)<sup>a</sup></b>
Influenza	1–2
Common cold	1–3
Bronchiolitis, croup	3–5
Acute respiratory disease (adenoviruses)	5–7
Dengue	5–8
Herpes simplex	5–8
Enterovirus disease	6–12
Poliomyelitis	5–20
Measles	9–12
Smallpox	12–14
Chickenpox	13–17
Mumps	16–20
Rubella	17–20
Mononucleosis	30–50
Hepatitis A	15–40
Hepatitis B and C	50–150
Rabies	30–100
Papilloma (warts)	50–150
AIDS	1–10 yr

<sup>a</sup>Until first appearance of prodromal symptoms.

## **Incubation period of a disease is useful for:**

- Tracing the source of infection and contacts**
- Determining the period of surveillance**
- Applying immunization principles for prevention of diseases**
- Identification of point source or propagated epidemics**
- Estimating prognosis of a disease**

**The period of infectivity** is the time that the patient is infectious to others.

**Period of communicability** is the time during which an infectious agent may be transferred directly/indirectly from an infected person to another person, from infected animal to man or from an infected person to animal, including arthropods

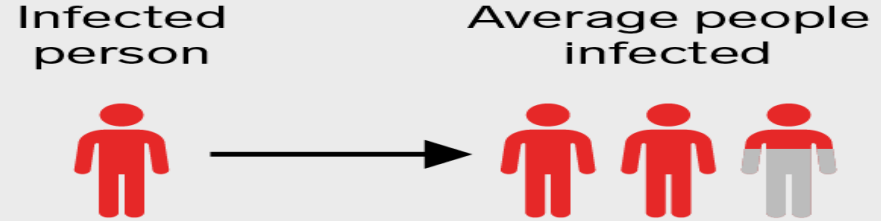
❖ **An important measure of communicability is secondary attack rate**

**An infection rate** : is the probability or risk of an infection in a population. It is used to measure the frequency of occurrence of new cases of infection within a population during a specific time period.

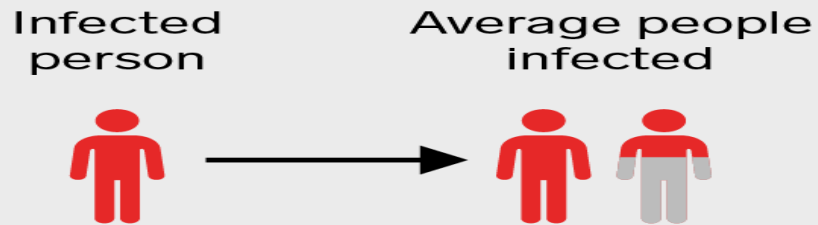
**The number of infections equals the cases identified in the study or observed.**

# The average number of people that one person with a virus infects, based on the R0 scale

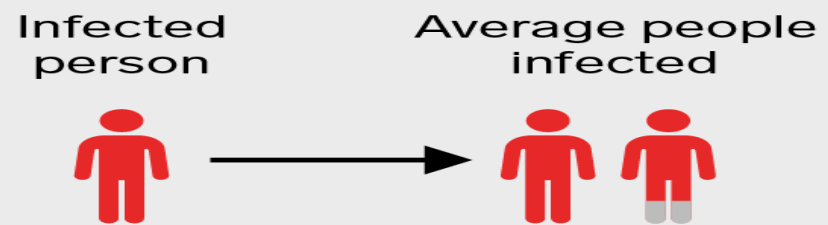
**COVID-19: 2–2.5\***



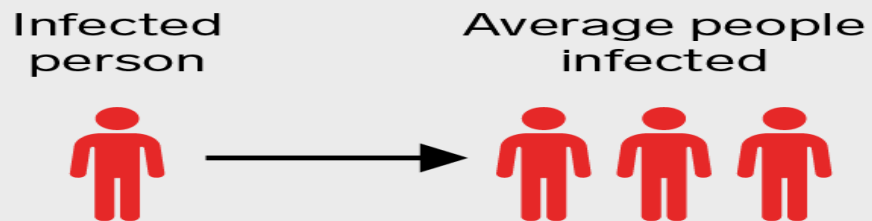
**H1N1: 1.2–1.6**



**Ebola: 1.6–2**



**SARS: 2–4**



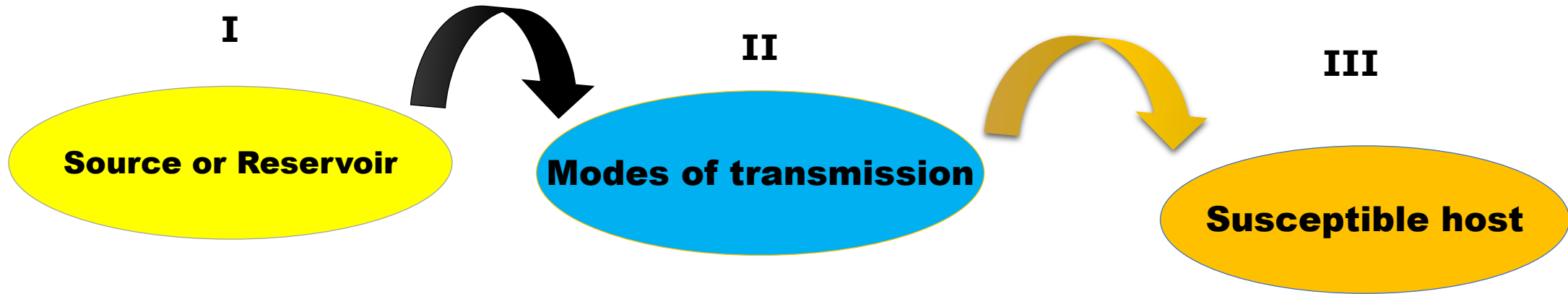
**MERS: 2.5–7.2\*\***

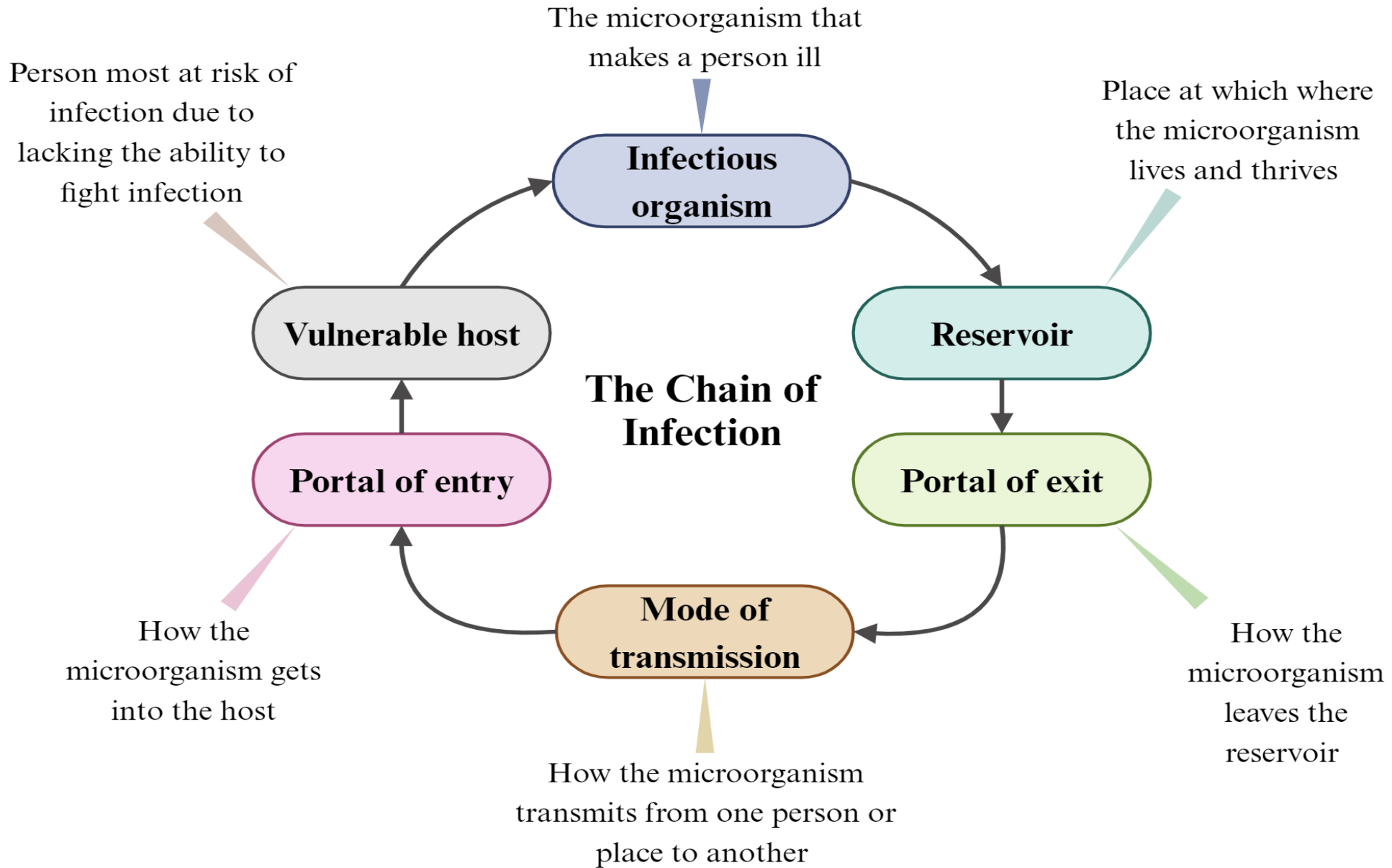


\*As of February 28, 2020

\*\*R0 calculated solely during the 2015 outbreak in South Korea

# Dynamics of disease Transmission (Chain of Infection)





# 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 ( source)**
- **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**

## SOURCE & RESERVOIR

**The starting point for the occurrence of a communicable disease is the existence of a reservoir or source of infection.**

**The source of infection is defined as “the person, animal, object or substance from which an infectious agent passes or is disseminated to the host (immediate source).”**

- **Reservoir is defined as “any person, animal, arthropod, plant, soil, or substance (or combination of these) in which an infectious agent lives and multiplies, on which it depends primarily for survival, and where it reproduces itself in such manner that it can be transmitted to a susceptible host”.**
- **In short, it is the natural habitat of the organism.**

# Types of reservoirs

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graph TD; A[Types of reservoirs] --> B[Human reservoir]; A --> C[Animal reservoir]; A --> D[Non-living reservoir];
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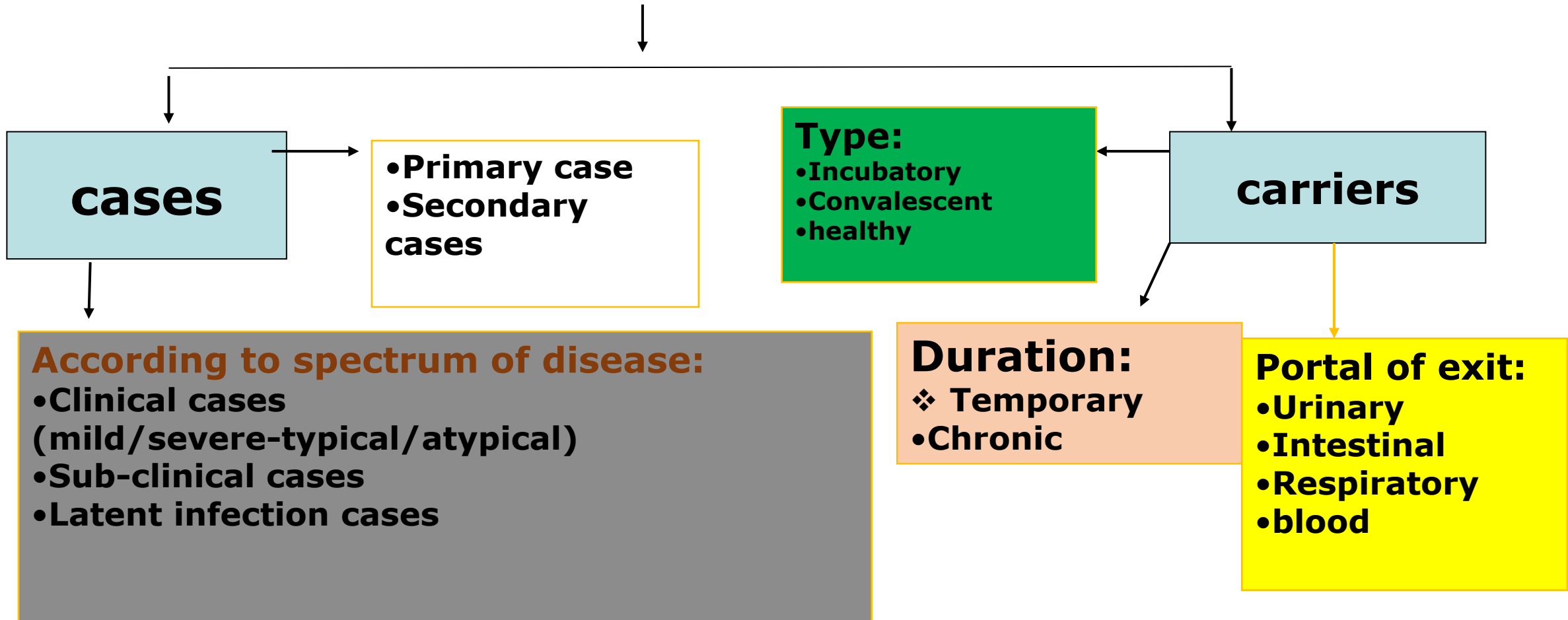
**Human  
reservoir**

**Animal  
reservoir**

**Non-living  
reservoir**

# Human reservoir

By far the most important source or reservoir of infection for humans is the man himself.



## **Cases**

- **A case is defined as “a person in the population or study group identified as having the particular disease, health disorder, or condition under investigation”. The case may be clinical, subclinical, or latent.**
- **Cases shows manifestation of disease, are infectious for varied period of time, according to the nature of disease, and whether specific therapy available and given or not.**

**Some days only – Influenza, common cold, measles.**

**Some weeks or few months – Pertussis, viral hepatitis (all types)**

**Long period of infectivity – chronic infectious diseases as syphilis, AIDS, TB, B, C hepatitis.**

## Index case

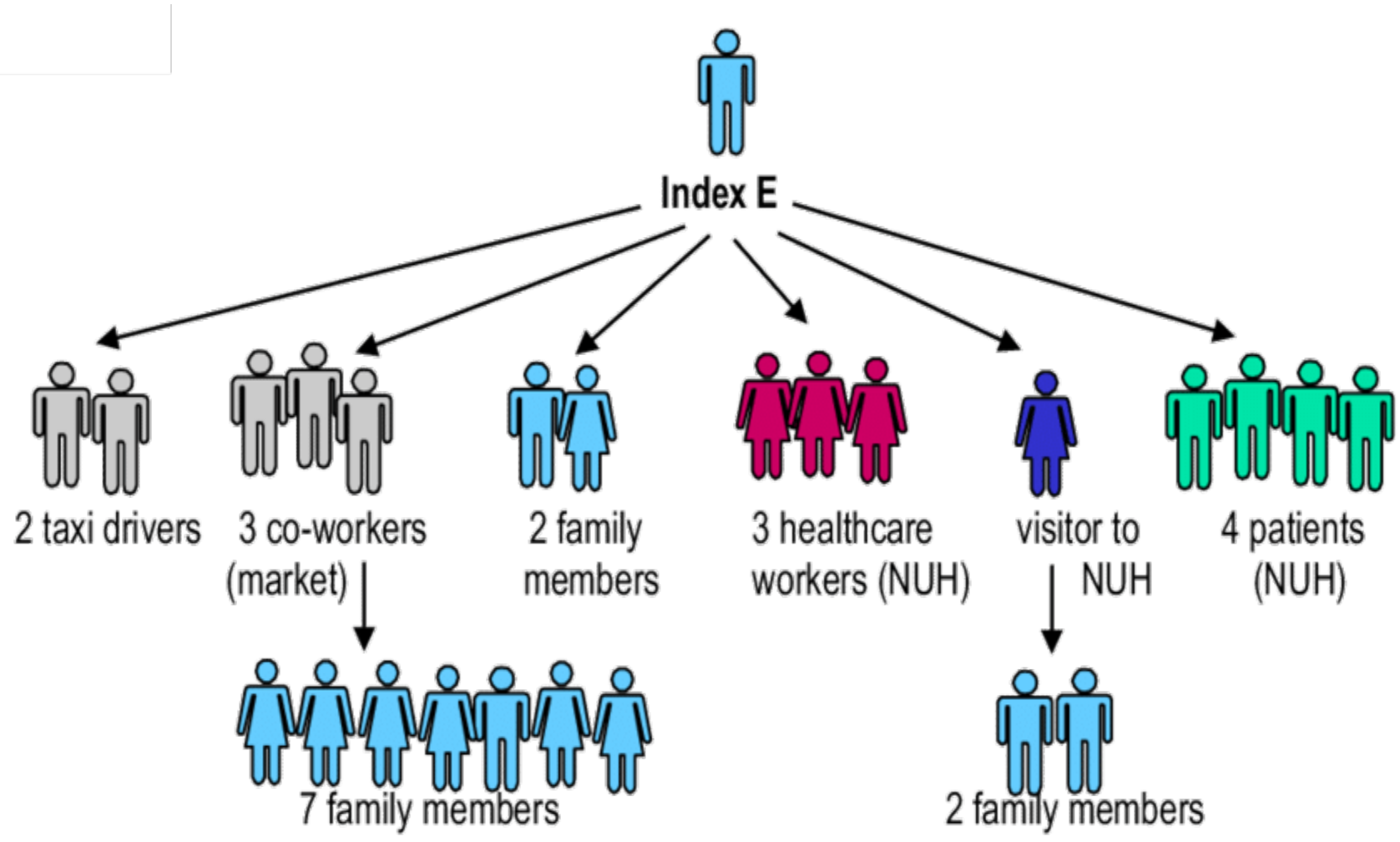
**is the patient in an outbreak who is first noticed by the health authorities, and who makes them aware that an outbreak might be emerging.**

## Primary case

- **Refers to the first case of a communicable disease introduced into the population, refers to the person who first brings a disease into a group of people—a school class, community, or country.**

- **Secondary cases**

- **Are those developing from contact with primary case.**



# Carrier

**Infected person or animal that harbors a specific agent in the absence of apparent clinical disease, & serves as a potential source of infection for others**

- A passive carrier is contaminated with the pathogen and can mechanically transmit it to another host; however, a passive carrier is not infected. For example, a health-care professional who fails to wash his hands after seeing a patient harboring an infectious agent could become a passive carrier, transmitting the pathogen to another patient who becomes infected.**
- An active carrier is an infected individual who can transmit the disease to others. An active carrier may or may not exhibit signs or symptoms of infection. For example, active carriers may transmit the disease during the incubation period (before they show signs and symptoms) or the period of convalescence (after symptoms have subsided). Pathogens such as hepatitis B virus, herpes simplex virus, and HIV are frequently transmitted by asymptomatic carriers.**

# **Classification of carriers:**

## **I. On the basis of Type:**

**❑ Incubatory Carriers:** are those who can transmit the agent during the incubation period before clinical illness begins.

**e.g. Measles, Mumps, Polio, Pertussis, Influenza, Diphtheria, Hepatitis-**

**❑ Convalescent Carriers:** are those who have recovered from their illness but remain capable of transmitting to others. , e.g. Typhoid, Bacillary Dysentery, Amoebic Dysentery, Cholera, Diphtheria & Pertussis.

**(Clinical recovery does not coincide with bacteriological recovery)**

**Convalescent carriers pose threat to the unprotected household member for example Typhoid fever in which patients may excrete the bacilli for 6-8 weeks.**

**□ Healthy (asymptomatic) carrier or sub-clinical cases:** Who remain well throughout the stage of infection and never develop clinical symptoms. Inhabitants of endemic areas of infectious diseases may get infected from polluted environment e.g. water supplies and food. If not become diseased, infection is eliminated in around two weeks, except for hepatitis B virus infection were healthy carriers are infectious for years.

## II -On the basis of Duration of infection:

- **Temporary Carriers:** shed infectious agent for short periods of time, this category may be included the **incubatory\*\*\***, convalescent, and healthy carriers.
- **Chronic Carriers:** are those who continue to harbor a pathogen for indefinite periods for months or even years after their initial infection. Such as hepatitis B virus or Salmonella Typhi, the causative agent of typhoid fever,
  - **Chronic carriers are far more important sources of infection than cases.**

One famous carrier is Mary Mallon, or Typhoid Mary, who was an asymptomatic chronic carrier of Salmonella Typhi. As a cook in New York City and New Jersey in the early 1900s, she unintentionally infected dozens of people until she was placed in isolation on an island in the East River, where she died 23 years later



### **III-On the basis of portal of exit:**

**Carriers are also classified according to the portal of exit to the infectious agents.**

**1- Respiratory carriers: diphtheria, meningitis.**

**2- Fecal: typhoid, dysentery.**

**3- Urinary: typhoid, paratyphoid. Chronic typhoid carriers may be urinary or fecal.**

### **Dangerous group of carriers:**

**1- Food handlers.**

**2- Hospital personnel (Nurses – physicians).**

**3- School personnel.**

## **Carriers are less infectious than cases but are more dangerous epidemiologically (WHY?)**

**It occurs either due to inadequate treatment or immune response, the disease agent is not eliminated, leading to a carrier state.**

### **Three elements must occur to form a carrier state:**

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

## **Importance of Carriers**

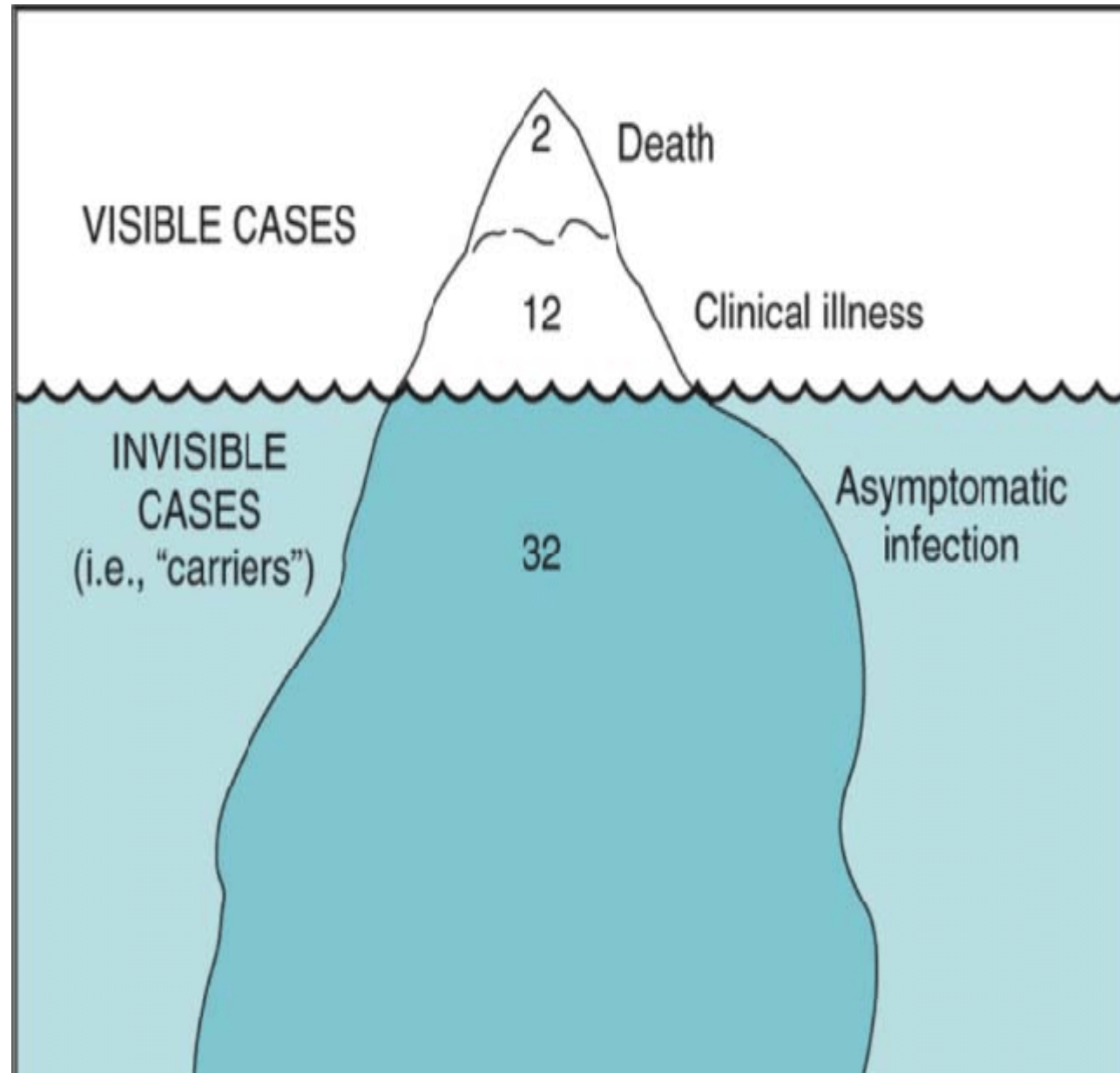
- **Number: Carriers may outnumber cases.**
- **Difficulty: Carriers don't know that they are infected.**
- **Mobility: Carriers are mobile, cases are restricted.**
- **Chronicity: Carriers re-introduce infection and contribute to endemicity.**

## **Effect of Carriers on Disease Transmission**

- **Iceberg effect**
- **These are the fact that carriers constitute a hidden reservoir of infection and that they may outnumber actual cases.**

## Iceberg Phenomenon

The iceberg phenomenon describes a situation in which a large percentage of a problem is subclinical, unreported, or otherwise hidden from view. Thus, only the "tip of the iceberg" is apparent to the epidemiologist.



## **Animal reservoirs**

**Humans are also subject to diseases that have animal reservoirs. Many of these diseases are transmitted from animal to animal, with humans as incidental hosts.**

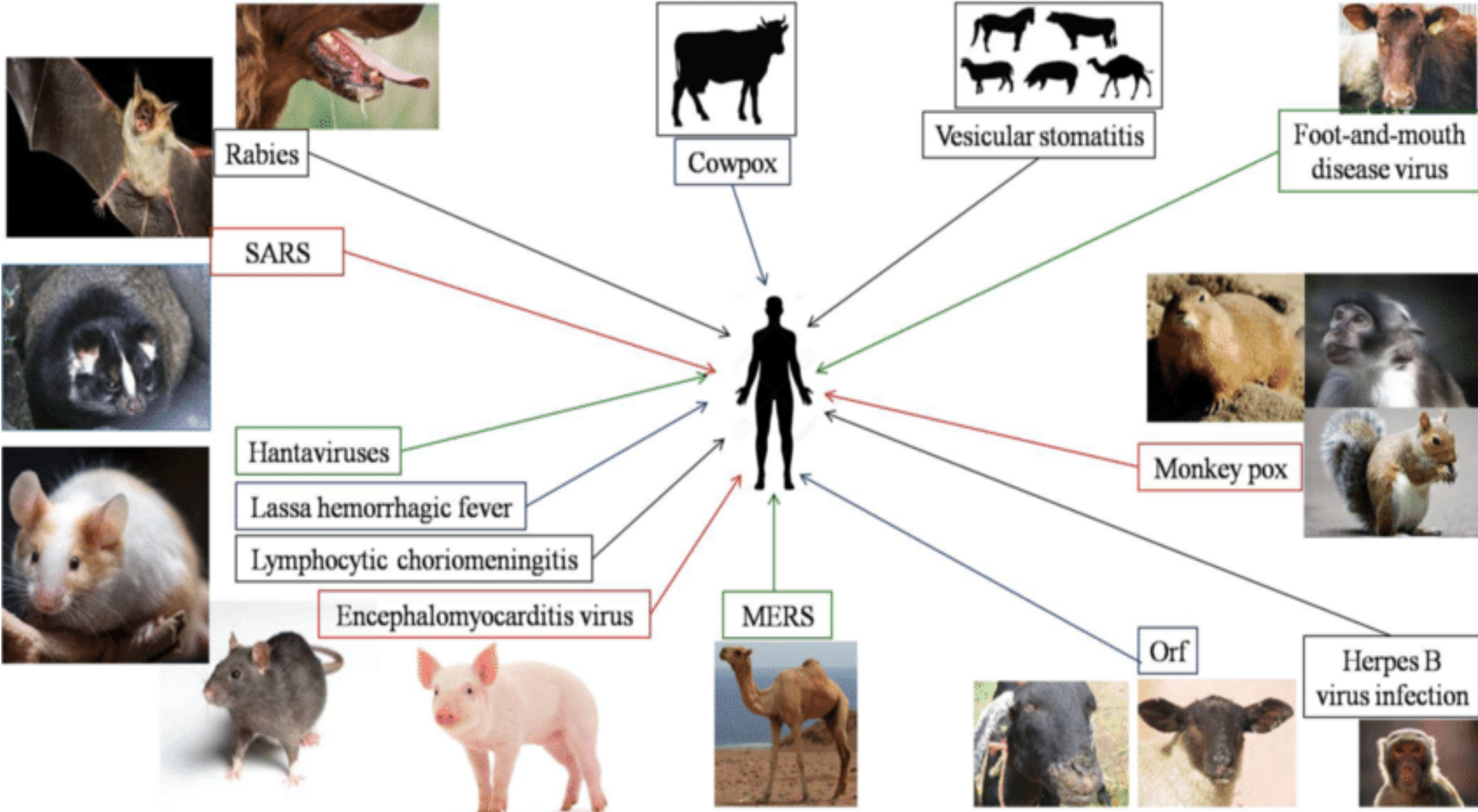
**The term zoonosis refers to an infectious disease that is transmissible under natural conditions from vertebrate animals to humans.**

**There are over a 100 zoonotic diseases that can be carried from animal to man. e.g. rabies, plague, bovine tuberculosis.....**

**Many newly recognized infectious diseases in humans, including HIV/AIDS, Ebola infection and SARS, are thought to have emerged from animal hosts, although those hosts have not yet been identified.**

- There is evidence that genetic recombination between animal and human viruses might produce “new” strains of viruses (e.g., influenza viruses).**

**Mammalian zoonotic viruses along with their reservoir hosts**



## **Reservoir in non-living things(Environmental reservoirs)**

- ❑ **Nonliving reservoirs of infection include water, food, and soil.**
- **Water is the most dangerous.**
- **Pathogens found in soil generally require the skin to be broken for entry into the body.**

**Many of the agents are basically saprophytes living in soil and fully adapted to live freely in nature.**

**Biologically, they are usually equipped to withstand marked environmental changes in temperature and humidity.**

- **Clostridium botulinum etiologic agent of Botulism.**
- **Clostridium tetani etiologic agent of Tetanus.**
- **Clostridium welchi etiologic agent of gas gangrene.**

# ANY QUESTION



## References

**1-Park K. Principles Of Epidemiology and Epidemiologic Methods In: Textbook of Preventive and Social Medicine. 25th ed. Jabalpur; M/s Banarasidas Bhanot Publishers; 2019. p 100- 108**

**2-Kadri AM. General Epidemiology of Infectious Diseases and its Prevention and Control In: IAPSM's Textbook of Community Medicine. 2nd ed. New Delhi; Jaypee Brothers Medical Publishers; 2021.p 223-234**