



# Introduction to Communicable Disease Epidemiology

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# Objectives

- Define communicable disease, control, elimination and eradication
- Draw the cycle of infection
- Give examples of different types of infectious agents associated with diseases in humans
- List types of reservoir of infection
- Classify carriers and explain their public health importance in disease transmission
- Illustrate with examples the different modes of transmission of communicable diseases
- Define incubation period
- Classify and differentiate types of immunity
- Outline the measures for prevention and control of communicable diseases

# COMMUNICABLE DISEASES

An illness caused by an **infectious agent** or its toxic product which can be **transmitted** directly or indirectly or through vector from the **reservoir** to a susceptible **host**.

# Definition of Terms

- **Control:** Refers to the activities conducted to bring a disease or a health problem at a very low level till it becomes no longer a public health problem.
- **Elimination:** Termination of all modes of transmission to a reduction of the incidence of the disease to the zero in a confined or specific geographic locality as a result of deliberate efforts yet, continued intervention methods are required.

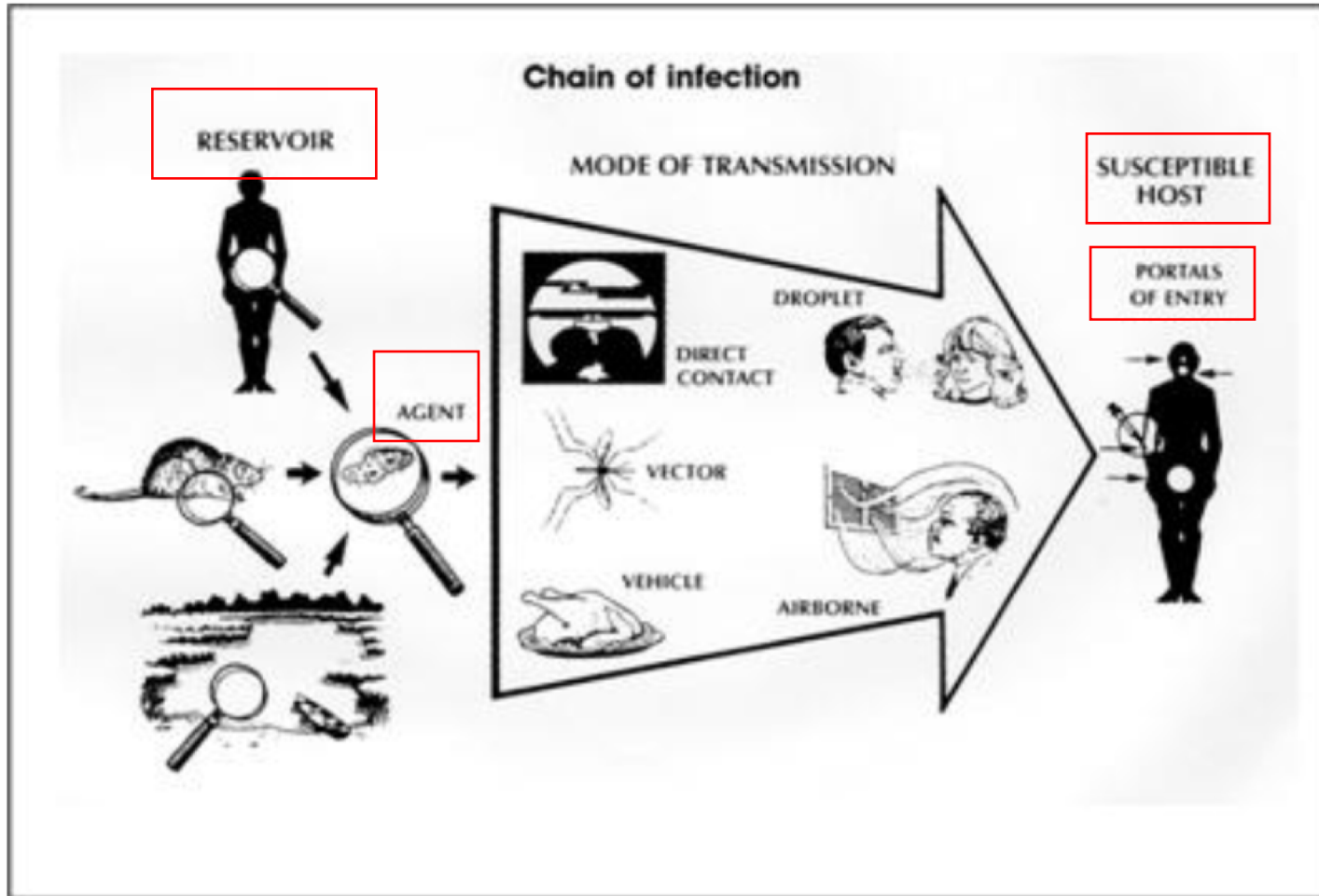


# Definition of Terms

- **Eradication:** Termination of all modes of transmission of infection by extermination of the infectious agent. The concept of eradication is a global one. Small pox is the only disease that has been eradicated to date is small pox.

# Chain of infection





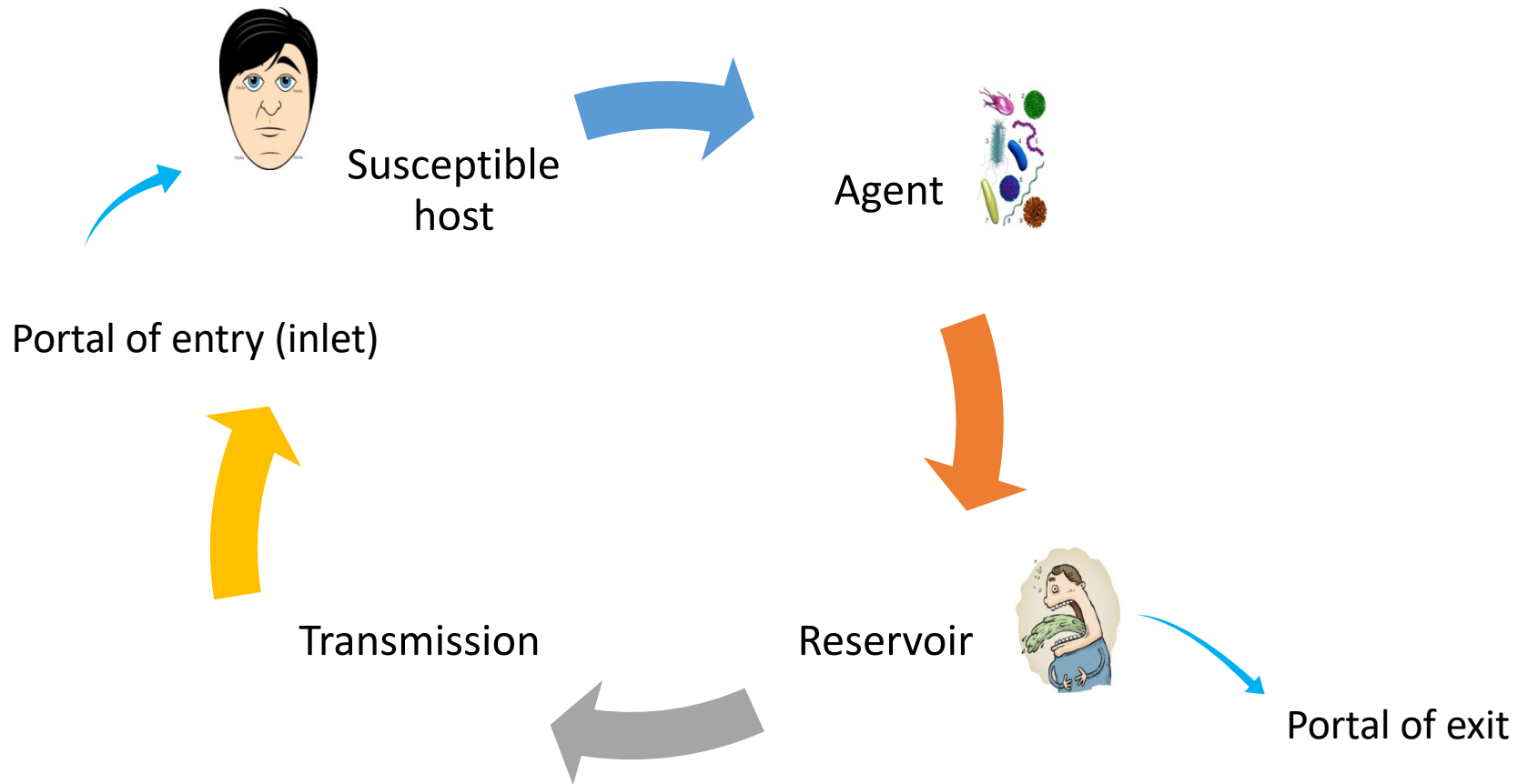
### Image Description

Source: Centers for Disease Control and Prevention. Principles of epidemiology, 2nd ed.

Atlanta: U.S. Department of Health and Human Services;1992.

- The **reservoir** of an infectious agent is the habitat in which the agent normally lives, grows, and multiplies. Reservoirs include humans, animals, and the environment.
- **Portal of exit** is the path by which a pathogen leaves its host. For example, influenza viruses and *Mycobacterium tuberculosis* exit the respiratory tract, schistosomes through urine, cholera vibrios in feces.
- An infectious agent may be **transmitted** from its natural reservoir to a susceptible host in different ways.
- The **portal of entry** refers to the manner in which a pathogen enters a susceptible host.
- The final link in the chain of infection is a susceptible **host**. Susceptibility of a host depends on genetic or constitutional factors, specific immunity, and nonspecific factors that affect an individual's ability to resist infection or to limit pathogenicity.

# The cycle of infection



# Examples of infectious agents associated with diseases in humans

## *Neisseria gonorrhoea*

- Source = humans
- Reservoir = humans

## *Salmonella typhi*

- Source = food/water
- Reservoir = humans

## *Hepatitis C*

- Source = transfusion,  
blood products
- Reservoir = humans

## *Rabies virus*

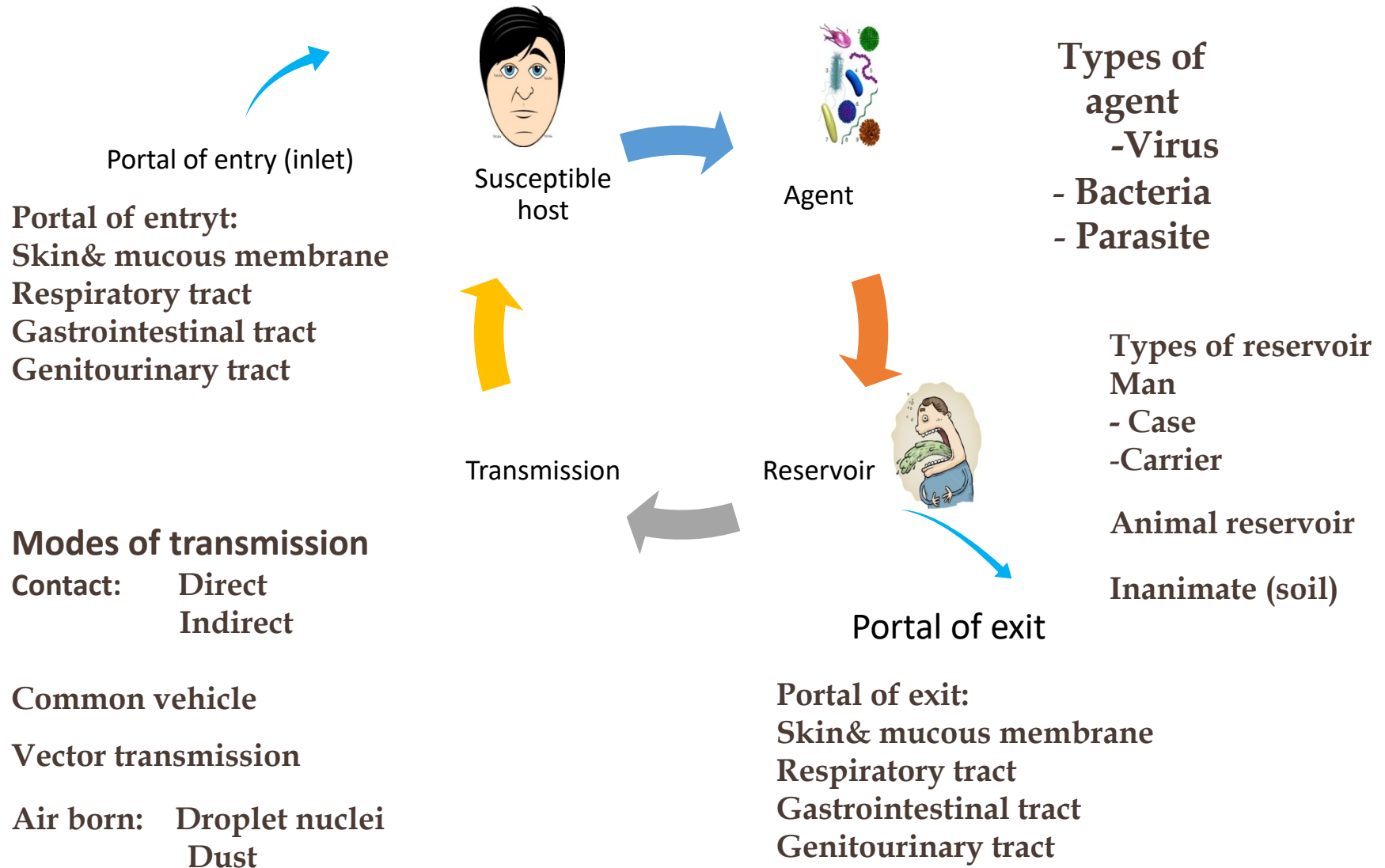
- Source = saliva of  
the dog
- Reservoir = the dog

# PRE-REQUISITES FOR THE TRANSMISSION OF COMMUNICABLE DISEASES

The six pre-requisites for the transmission of communicable diseases are

1. Presence of microbiological **agent**
2. Presence of **reservoir** of infection
3. **Portal of exit** through which the microbiological agent leaves the reservoir
4. **Mode of transmission**
5. **Portal of entry** (inlet) through which the microbiological enters the host
6. Presence of **susceptible host**

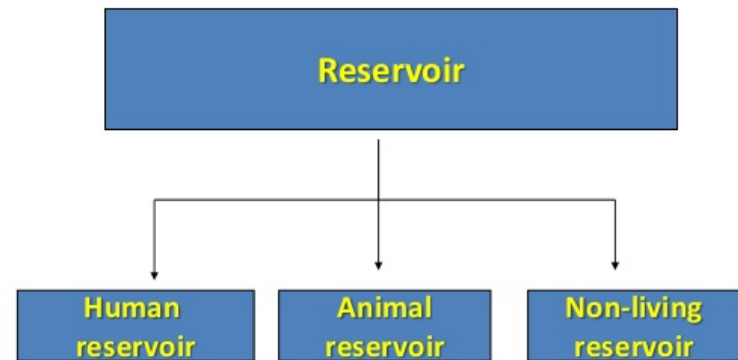
# PRE-REQUISITES FOR THE TRANSMISSION OF COMMUNICABLE DISEASES





# Types of reservoir of infection

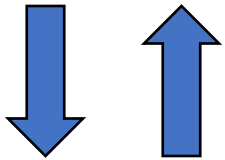
Types of reservoirs



# Reservoir of Infection

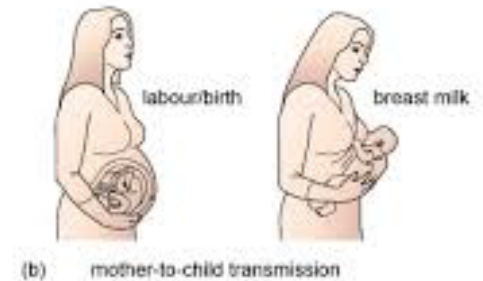
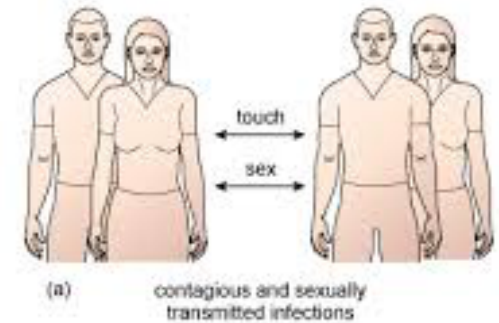
## 1. Human to Human

Human



Human

- Most viral and bact. RTIs
- Most staph and strept.
- STD
- Human reservoir could be cases or carriers



# Carriers and their public health importance in disease transmission

- Hosts without obvious illness
- Continue to spread the pathogen even though they have recovered from illness.
- Unless the family and other close contacts of the sick person or even the whole population can be treated, carriers will remain a threat to the health of those surrounding them.

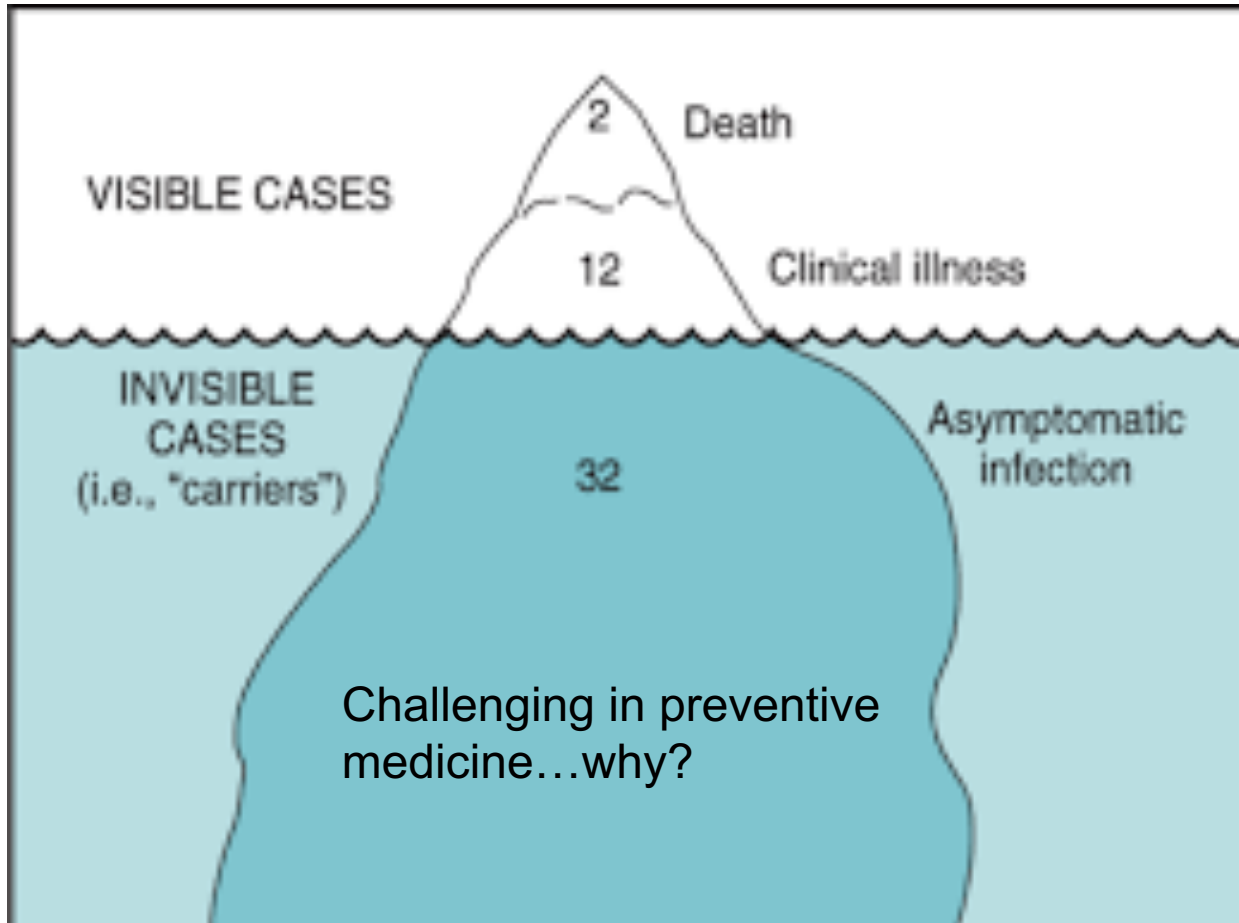
**Table 2.2. Examples of infections with asymptomatic carriers**

<b><i>Infection</i></b>	<b><i>Asymptomatic infections</i></b>
Bacillary dysentery	common <sup>(3)</sup>
Cholera (El Tor)	only 1 in 30-50 infections develops illness <sup>(16)</sup>
Giardiasis	1 in 2-4 infections develops illness <sup>(44)</sup>
Polio	very common
Typhoid fever	very common <sup>(73)</sup>
Schistosomiasis	very common <sup>(16)</sup>
Hookworm	very common
Yellow fever	common <sup>(3)</sup>
Japanese Encephalitis	only 1 in 1,000 infections develops illness <sup>(44)</sup>
Filariasis	very common
Malaria	common <sup>(3)</sup>
River blindness	common <sup>(2)</sup>
Plague	common during epidemics <sup>(73)</sup>

## Importance of carriers

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

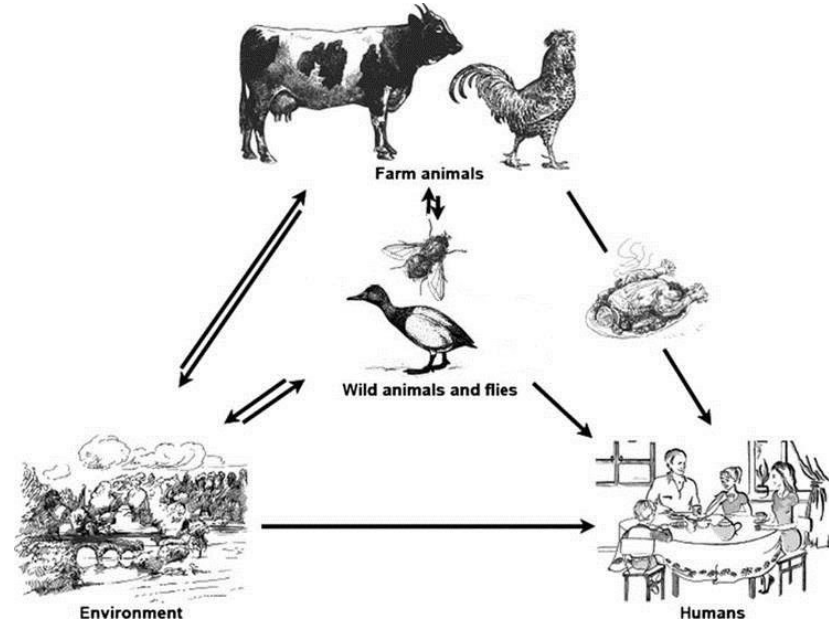
# Iceberg Phenomenon of Disease



# Reservoir of Infection

## 2. Animal to Human

Zoonosis



# Reservoir of Infection

## 3. Non-living reservoir

Soil, water...

- Tetanus
- Botulism
- Fungi (ringworm and hookworm)





# AGENT FACTORS RELATED TO DEVELOPMENT OF A DISEASE

**Pathogenicity:** Ability of the organism to produce disease or damage to the host/  
specific clinical picture

**Virulence:** Ability to produce severe pathological reaction. Measured by the ratio of  
clinical to subclinical disease and case fatality rate

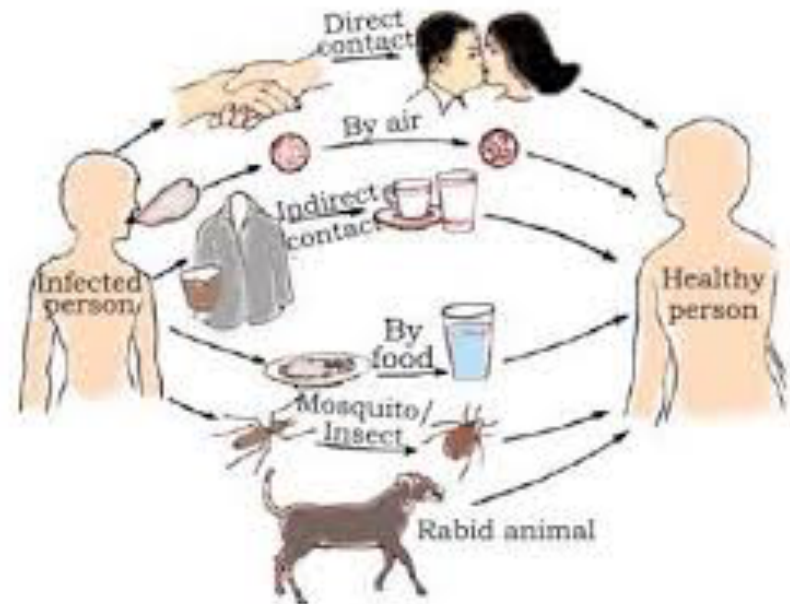
**Dose of infection (inoculum):** high probability of severe disease with higher dose  
of infection

**Viability of the organism (resistance):** Ability of the organism to live outside the  
body

**Antigenic power of the organism:** Ability to stimulate the immune system to  
produce antibodies or antitoxin with subsequent immunity. Measured by the  
second attack frequency

**Period of communicability** The length of time, from acquiring the infection, during  
which the infection can be communicated/ transmitted to another uninfected  
organism.

# Modes of transmission of communicable diseases



# Modes of transmission

An infectious agent may be transmitted from its natural reservoir to a susceptible host in different ways. There are different classifications for modes of transmission. Here is one classification:

- Direct
  - Direct contact
  - Droplet spread
- Indirect
  - Airborne
  - Vehicle borne
  - Vector borne (mechanical or biologic)

## Direct transmission



In direct transmission, an infectious agent is transferred from a reservoir to a susceptible host by direct contact or droplet spread.



# Direct contact

Occurs through skin-to-skin contact, kissing, and sexual intercourse.

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

Thus, infectious mononucleosis (“kissing disease”) and gonorrhoea are spread from person to person by direct contact. Hookworm is spread by direct contact with contaminated soil.

# Droplet spread

Refers to spray with relatively large, short-range aerosols produced by sneezing, coughing, or even talking. Droplet spread is classified as direct because transmission is by direct spray over a few feet, before the droplets fall to the ground.

Pertussis and meningococcal infection are examples of diseases transmitted from an infectious patient to a susceptible host by droplet spread.

## Direct transmission

**Person to person:** through touching, biting, kissing, sexual intercourse or direct projection of respiratory droplets into another person's nose or mouth during coughing, sneezing or talking. A familiar example is the transmission of HIV from an infected person to others through sexual intercourse.

**Transplacental transmission:** This refers to the transmission of an infectious agent from a pregnant woman to her fetus through the placenta.

An example is MTCT of HIV.

## Indirect modes of transmission

Indirect transmission refers to the transfer of an infectious agent from a reservoir to a host by suspended air particles, inanimate objects (vehicles), or animate intermediaries (vectors).



## Indirect transmission

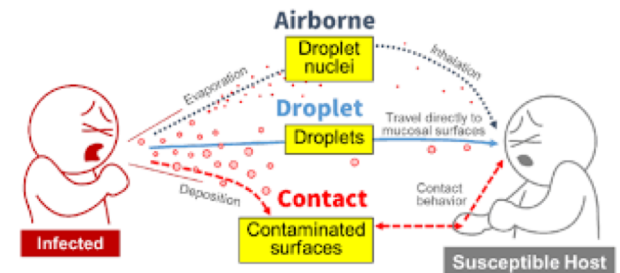
### **Airborne transmission:**

occurs when infectious agents are carried by dust or droplet nuclei suspended in air. Airborne dust includes material that has settled on surfaces and become resuspended by air currents as well as infectious particles blown from the soil by the wind. Droplet nuclei are dried residue of less than 5 microns in size.

Measles, for example, has occurred in children who came into a physician's office after a child with measles had left, because the measles virus remained suspended in the air

# Air-borne

- Droplet infection (direct spread):  
Whooping cough
- Droplet nuclei (indirect air-borne):  
TB, histoplasmosis
- Dust particles (indirect air-borne):  
Fungal spores



## Indirect transmission

### **Vehicle-borne transmission:**

A **vehicle** is any non-living substance or object that can be contaminated by an infectious agent, which then transmits it to a new host.

**Contamination** refers to the presence of an infectious agent in or on the vehicle.

Vehicles that may indirectly transmit an infectious agent include food, water, biologic products (blood), and fomites (inanimate objects such as handkerchiefs, bedding, or surgical scalpels).

## Indirect transmission

**Vector-borne transmission:** Vectors such as mosquitoes, fleas, and ticks may carry an infectious agent through purely mechanical means or may support growth or changes in the agent.

Examples of mechanical transmission are flies carrying *Shigella* on their appendages and fleas carrying *Yersinia pestis*, the causative agent of plague, in their gut.

Biologic transmission, the causative agent of malaria or guinea worm disease undergoes maturation in an intermediate host before it can be transmitted to humans

# Examples

Virus	Reservior	Vector	Disease
Chikungunya	Monkeys	Mosquito	Chikungunya fever
Dengue	Monkeys, Man	Mosquito	Dengue hemorrhagic fever
Japanese B Encephalitis	Wild birds, Pigs	Mosquito	Encephalitis
Kyasunur Forest Disease	Forest birds, animals	Tick	Hemorrhagic fever
Sindbis	birds	Mosquito	Sindbis fever

# INCUBATION PERIOD

what are other  
words for  
incubation period?



incubation, latent period,  
delitescence, hatching, latency,  
period, period of time,  
time period






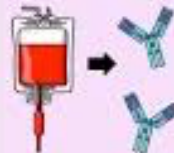
# INCUBATION PERIOD

It is the period between the entry of the organism and the appearance of the first symptom of the disease

Knowledge of the incubation period is important for

- Surveillance and quarantine in some diseases
- Application of preventive measures to abort or modify the attack.
- Identification of the source of infection

# Types of immunity

ACTIVE IMMUNITY		PASSIVE IMMUNITY	
Natural	Artificial	Natural	Artificial
			
Infection	Vaccination	Maternal antibodies	Monoclonal antibodies



# SUSCEPTIBLE HOST AND IMMUNITY

A person or other living animal, that afford subsistence or lodgment to an infectious agent under natural condition. Susceptibility to infection is universal but susceptibility to disease depends immunity and resistance.

## Immunity

Natural resistance of the body offered by skin, gastric acidity

## Acquired immunity

**Passive:** acquired through transferred antibodies from mother to infant (**natural**) or by administration of immunoglobulin or anti-sera (**artificial**)

**Active:** post infection immunity (**natural**) or following vaccination (**artificial**)

# Active immunity




- **Active immunity** results when exposure to a disease organism triggers the immune system to produce antibodies to that disease. Exposure to the disease organism can occur through infection with the actual disease (resulting in **natural immunity**), or introduction of a killed or weakened form of the disease organism through vaccination (**vaccine-induced immunity**). Either way, if an immune person comes into contact with that disease in the future, their immune system will recognize it and immediately produce the antibodies needed to fight it.
- Active immunity is long-lasting, and sometimes life-long.

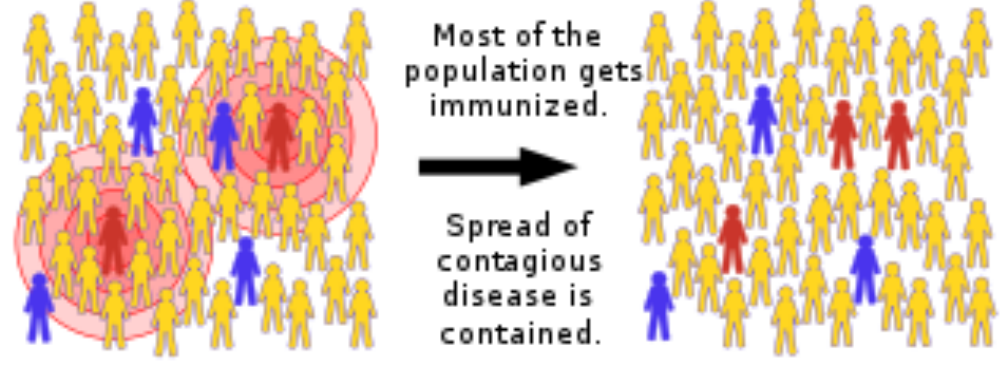
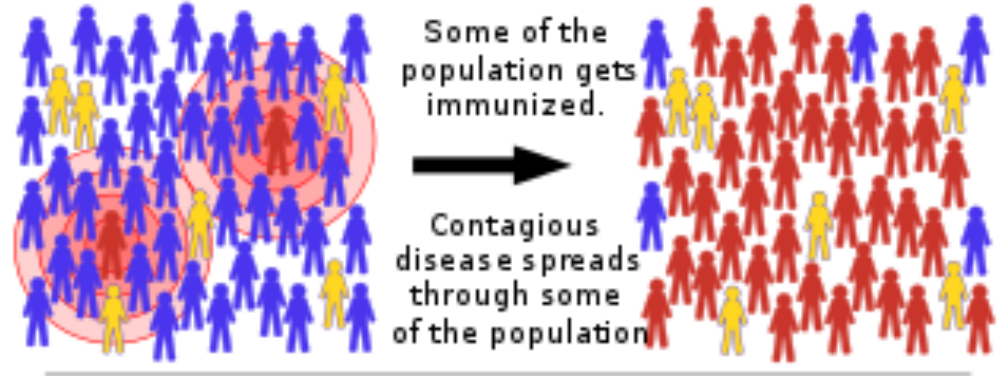
# Passive immunity

- **Passive immunity** is provided when a person is *given* antibodies to a disease rather than producing them through his or her own immune system.
- A newborn baby acquires passive immunity from its mother through the placenta. A person can also get passive immunity through antibody-containing blood products such as **immune globulin**, which may be given when immediate protection from a specific disease is needed. This is the major advantage to passive immunity; protection is immediate, whereas active immunity takes time (usually several weeks) to develop. However, passive immunity lasts only for a few weeks or months. Only active immunity is long-lasting.

## Herd immunity

- Herd immunity, also known as community immunity, refers to the protection offered to everyone in a community by high vaccination rates. With enough people immunized against a given disease, it's difficult for the disease to gain a foothold in the community. This offers some protection to those who are unable to receive vaccinations

 = not immunized, but still healthy     = immunized and healthy     = not immunized, sick, and contagious



- <http://vk.ovg.ox.ac.uk/vk/herd-immunity>
- <https://www.youtube.com/watch?v=P6ioHol-VZ4>

# People who depend on herd immunity

Some people in the community rely on herd immunity to protect them. These groups are particularly vulnerable to disease, but often cannot safely receive vaccines:

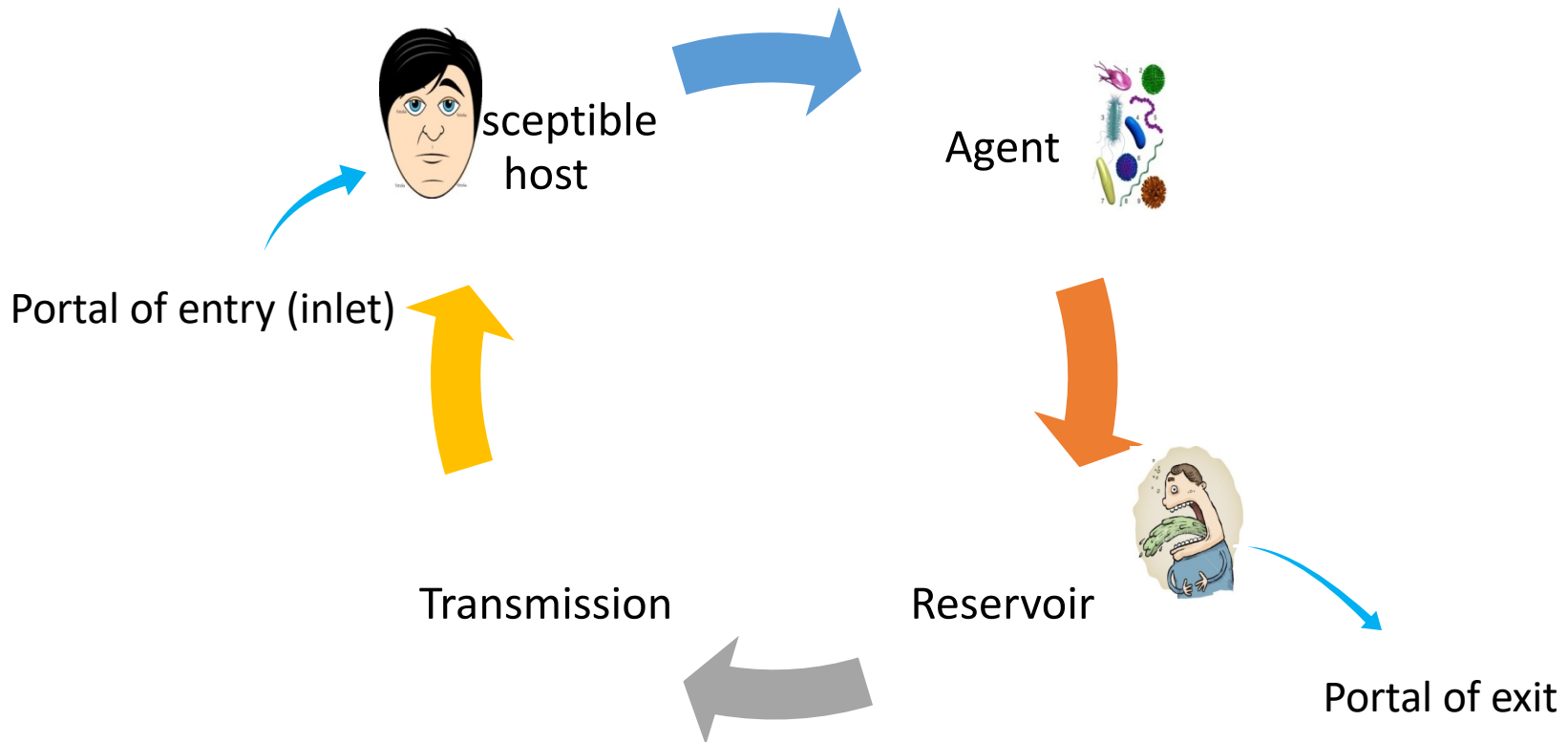
- People without a fully-working immune system, including those without a working spleen
- People on chemotherapy treatment whose immune system is weakened
- People with HIV
- Newborn babies who are too young to be vaccinated
- Elderly people
- Many of those who are very ill in hospital

# Prevention and control of communicable diseases





# PREVENTION AND CONTROL OF COMMUNICABLE DISEASES



**BREAKING THE CYCLE AT ITS WEAKEST POINT**

# MEASURES FOR THE PREVENTION OF COMUNICABLE DISEASES

**Measures applied to disease agents: Sterilization and disinfection**



# MEASURES FOR THE PREVENTION OF COMUNICABLE DISEASES

## **Measures applied to reservoir of infection**

- Cases: Case finding, reporting to the local health authority in order to apply the appropriate control measures for contact and the environment, isolation (strict isolation or discharge/body fluid isolation) for the whole period of communicability and treatment.
- Carriers: Identification of carriers in the community, treatment and exclusion from work till the organism is eliminated especially if food handlers or working with children. Its cost effectiveness depends on the proportion of carrier in the community as well as the sensitivity of their occupation.
- Animal reservoir: Adequate animal husbandry, immunization (if vaccine is available), treatment of infected animals and killing if treatment is not feasible.

# MEASURES FOR THE PREVENTION OF COMUNICABLE DISEASES

**Measures applied to contact:** Enlistment, surveillance for the longest incubation period of the disease, isolation (if indicated) as well as increase resistance by immunization or chemoprophylaxis.

**Measures applied to the host:** Health education, adequate personal hygiene, sound nutrition, immunization and chemoprophylaxis.

**Measures applied to the environment:** sanitation (water/food/sewage)

# References

- Park K. Nutrition and health. In: Preventive and social Medicine. Editor. 21th edition. 2011 pages 561-617 Park K. Nutrition and health. In: Preventive and social Medicine. Editor. 21th edition. 2011 pages 561-617
- <https://www.cdc.gov/mmwr/preview/mmwrhtml/su48a7.htm>

Thank you