Introduction to Communicable Disease

- **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**

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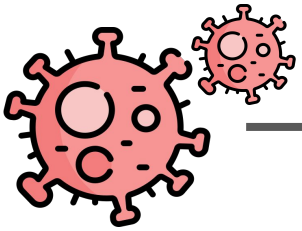
What is communicable disease?

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** (For a disease to be communicable it must meet all the criterias mentioned in **red**.)

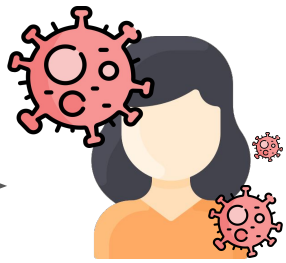
Control	Refers to the activities conducted to bring a disease or a health problem to a very low level till it becomes **no longer a public health problem.**[1](concerned with lowering the incidence but not to zero)
Elimination	Termination of all modes of transmission to a reduction of the **incidence 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.**[1] (Ex;measles in many countries.)
Eradication	Termination of all modes of transmission of infection by extermination of the infectious agent.[1] - The concept of eradication is a **global** one. (complete removal). - **Smallpox** is the only disease that has been eradicated to date.

Chain of Infection[2]

Susceptible Host
Portals of entry include (same as exit):
(1) Skin and mucous membranes,
(2) Respiratory tract,
(3) Genitourinary tract,
(4) Gastrointestinal tract



Infectious Agent
Agents include:
(1) Bacteria,
(2) Viruses,
(3) Fungi, (4) Parasites, (5) Protozoa



Reservoir
Reservoirs include:
(1) Humans (cases or carriers)
(2) Animals,
(3) Inanimate (e.g., soil) (microbes maximize their survival chances by choosing a susceptible reservoir)

Transmission

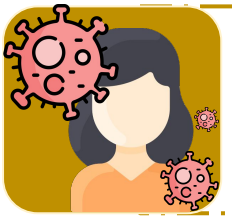
Transmission include:
(1) Contact
- Direct - Indirect - Droplets contact
(2) Common vehicle
(3) Vector transmission
(4) Airborn
- Droplet nuclei - Dust

Portal of Exit
Portals of exit include (same as entry):
(1) Skin and mucous membranes,
(2) Respiratory tract,
(3) Genitourinary tract,
(4) Gastrointestinal tract

1. Conceptually speaking, these three terms all refer to the process of controlling the spread of an infectious agent. The difference being that control is concerned with lowering the incidence but not to zero, only for it not be a public health problem. Meanwhile "elimination" and "eradication" refers to lowering the incidence to zero, either locally with the former or globally with the latter . An example of an eradicated agent is smallpox.

2.Microbes are self-replicating organisms that seek their own survival in different reservoirs, microbes maximize their survival chances by choosing a susceptible reservoir. A reservoir (defined in the next page) must have a portal of entry an exit.

Chain of infection



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.

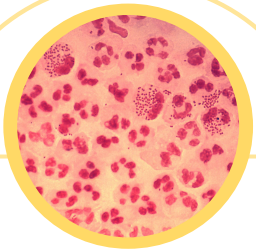
Portal of exit is the path by which a pathogen leaves its host.
For example, influenza viruses and Mycobacterium tuberculosis exit the respiratory tract, cholera vibrios in feces, and schistosomes through urine.

(Different microbes have different routes of transmission)

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.

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

Some of the Infectious agents that are associated with Diseases in Humans:

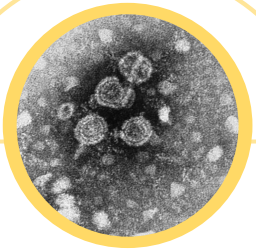


Neisseria Gonorrhoeae:
Source: Humans

Reservoir: Humans

Salmonella typhi:
Source: Food & water

Reservoir: Humans



Hepatitis C Virus:
Source: Transfusion and blood products
Reservoir: Humans

Rabies Virus
Source: Saliva of dogs

Reservoir: Dogs

Pre-requisites

(if any one of these prerequisites are missing the cycle will be broken)

1. The presence of a microbial **agent**.
2. The presence of a **reservoir** of infection.
3. **Portal of exit** through which the microbiological agent leaves the reservoir.
4. **Mode of transmission**.
5. **Portal of entry** or an inlet through which the microbiological enters the host.
6. The presence of a **susceptible host**.(Immunosuppressed individuals are more susceptible to infections)

Type of Reservoirs

- Human Reservoir
- Animal Reservoir
- Non-Living Reservoir

1 Human to Human

- ➔ Most **viral** and **bacterial respiratory tract infections**.
- ➔ Most infections caused by **Staphylococci** and Streptococci species.
- ➔ Sexually transmitted diseases **(STDs)**.

Table 2.2. Examples of infections with asymptomatic carriers

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

- These are very common here.

Human reservoir can be either:

- **Case:** possesses the infection and shows symptoms.
- **Carrier:** possesses the infection but doesn't show symptoms (Usually no one knows that they harbor the pathogen).

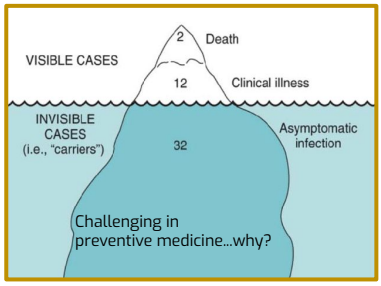
Public Health Importance

- **Carriers** are hosts without obvious illness
- They can 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.

Modes of transmission

Importance of carriers

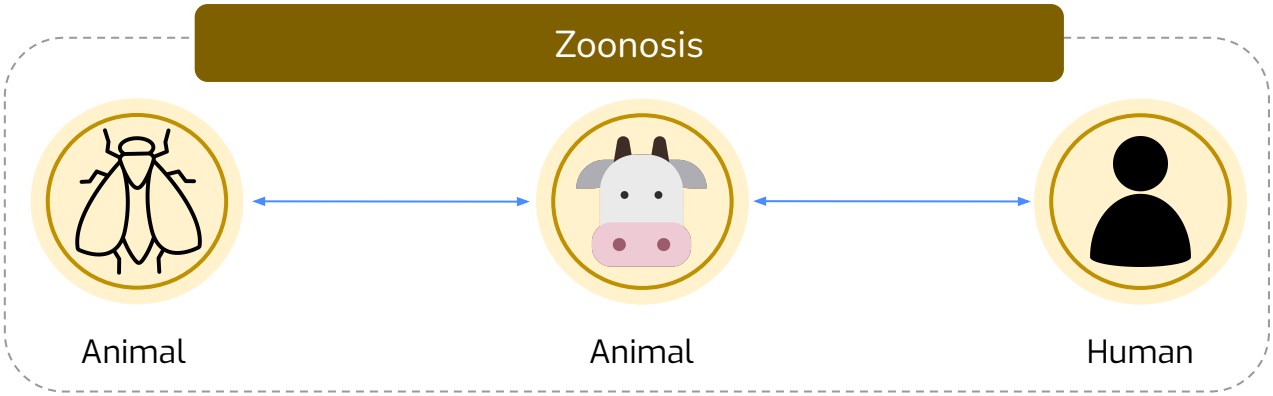
- **Number:** Carriers may outnumber cases.
- **Difficulty:** Carriers don't know that they are infected.
- **Mobility:** Carriers are mobile, cases are restricted.
- **Chronicity:** Carriers re-introduce infection and contribute to endemicity.



Effect of Carriers on Disease Transmission:

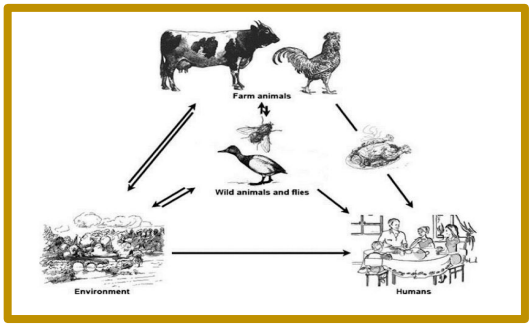
- Iceberg effect in temperate zone:
- These are the fact that carriers constitute a hidden reservoir of infection and that they may outnumber actual cases.

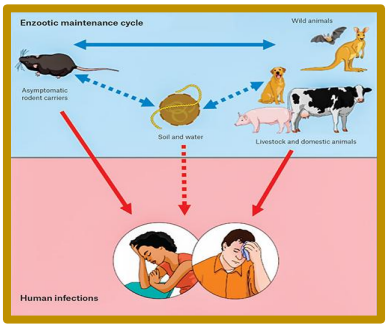
2 Animal to Human



Examples:

The Plague caused by the bacterium Yersinia pestis was transmitted from rodents to fleas and eventually to humans.
Other examples: Toxoplasmosis from cat feces, leptospirosis (rat urine), rabies.





3 Non-Living Reservoir

From places like soil and water. (Walking barefoot puts such people at risk of contracting the infectious agent from nonliving reservoirs)

Examples:

- 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 or a 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: The higher the dose of infection the higher probability of severe disease.

Spore Formation: Maintain viability for a long period in unfavorable environmental conditions.

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

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

- STD organisms tend to survive poorly outside the body.

Ease of Communicability

Is measured by the secondary attack rate, which is the number of secondary cases, occurring within the range of incubation period following exposure to a primary case expressed as a percentage of susceptible.

Period of Communicability

Is the length of time, from acquiring the infection, during which the infection can be transmitted to another uninfected organism.

Incubation Period

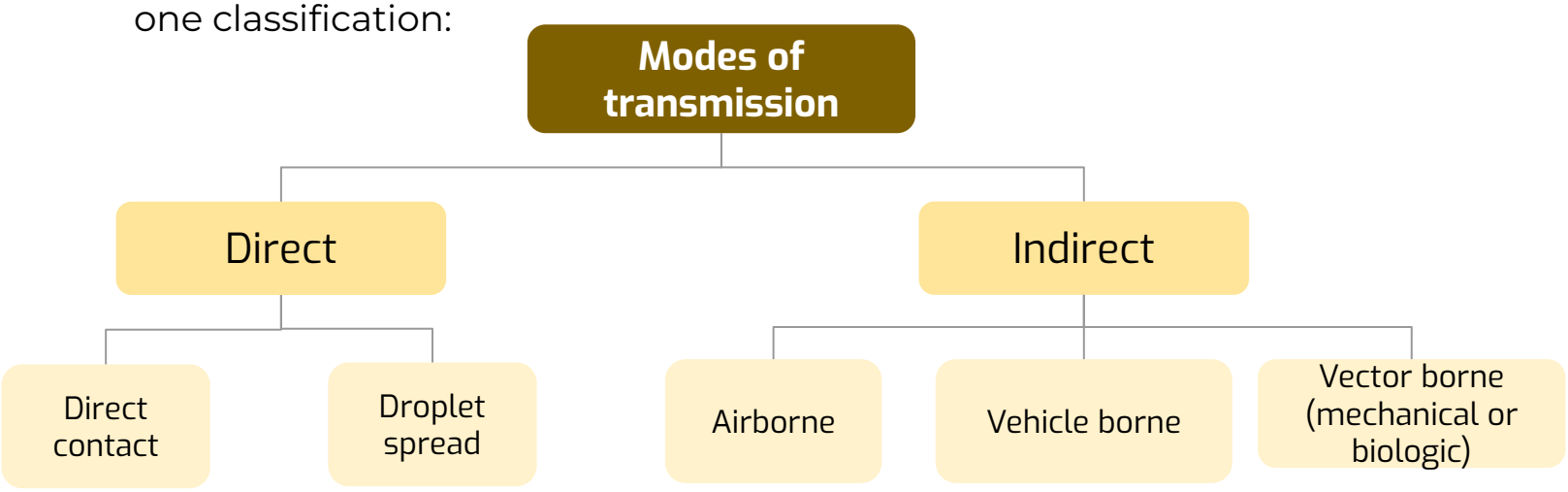
It is the period between the entry of the organism and the appearance of the first symptom of the disease.

Important for:

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

Modes of transmission

There are different classifications for modes of transmission. Here is one classification:



Direct transmission

In direct transmission, an infectious agent is transferred from a reservoir to a susceptible host by direct contact or droplet spread.
The lack of an intermediate medium to transmit the infection signifies direct from indirect transmission.

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.

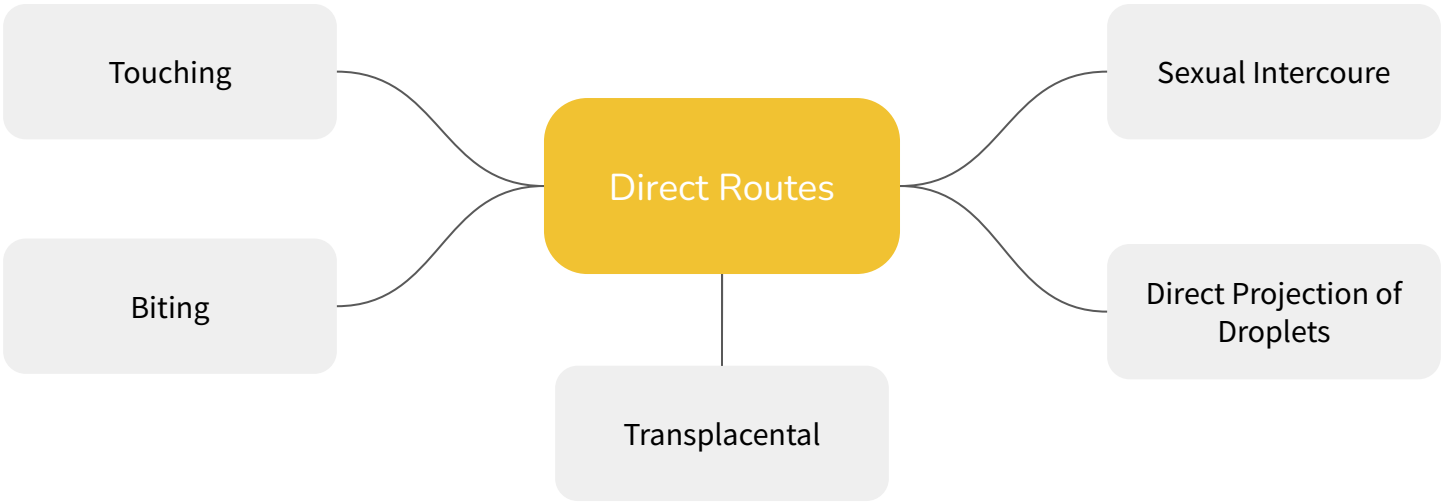
Thus, infectious **mononucleosis** ("kissing disease") and **gonorrhea** are spread from person to person by direct contact. **Hookworm** is spread by direct contact with contaminated soil.

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.

Modes of transmission



Direct transmission

Direct modes of transmission can occur in two main ways:

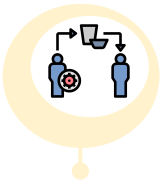
1. **<u>Person to person:</u>**
   - through touching, biting, kissing, sexual intercourse or direct projection of respiratory droplets[1] into another person's nose or mouth during coughing, sneezing or talking. A familiar example is the transmission of HIV from an infected person to others through sexual intercourse.
     Examples:
     - Transmission of HIV from an infected person to others through sexual intercourse, infectious mononucleosis ("kissing disease") and gonorrhea (direct contact)
     - Pertussis and meningococcal infection (droplet)

2. **<u>Transplacental transmission:</u>**
   - This refers to the transmission of an infectious agent from a pregnant woman to her fetus through the placenta.
     <u>Example</u>: Mother to Child Transmission (MTCT) of HIV TORCH infections (Toxoplasmosis, Others [Syphilis, Parvovirus, VZV], Rubella, CMV and hepatitis C and B.

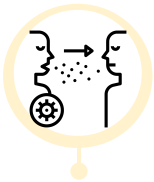
1-Humans produce droplets in various ways (e.g. sneezing, coughing, singing) and these droplets vary in size. Large droplets (> 5
μm) comprise most of the volume of expelled respiratory droplets and they tend to fall rapidly to the ground (only transmitted directly such as COVID-19). Droplets smaller than 5 μm are referred to as droplet nuclei and may remain suspended in the air for significant periods of time and move with air currents (transmitted indirectly as an airborne infection).

Modes of transmission

Indirect



Vehicle-Borne



Airborne

Vector-Borne

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

01

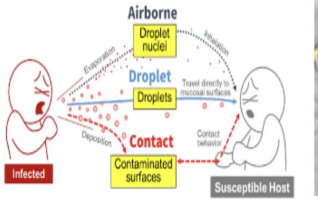
Airborne transmission:

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 secreted from the respiratory tract.

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.

Examples of air-borne:

- Droplet infection (**direct** spread): Whooping cough
- Droplet nuclei (**indirect** air-borne): TB ,Histoplasmosis.
  (TB droplets can remain suspended in air for several hours.
- Dust particles (**indirect** air-borne): Fungal spores



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Vehicle-borne transmission:

A **vehicle** is any **non-living substances** 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 indirect transmit an infectious agent include **food**, **water**, **biologic products** (blood), and **fomites** (inanimate objects such as handkerchiefs, bedding, or surgical scalpels).

- **Food and drink borne** illnesses are caused by the consumption of drinks that are contaminated with organism causing disease.
  - The most commonly recognized are: campylobacter, salmonella and E.coli bacteria(Campylobacter is associated with eating raw chicken, flies might carry Salmonella to different places.)
  - Transmitted by human hands or/and flies

Modes of transmission

03

Vector-borne transmission:

A vector is an organism, usually an arthropod such as houseflies, mosquitoes, lice, fleas and ticks that carries an infectious agent through purely mechanical means or may support growth or changes in the agent

(Vectors are different from your typical house flies, house flies usually take organisms and carry them around to different surfaces without puncturing the skin and injecting the organism.)

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- Examples of mechanical transmission are flies carrying shigella on their appendages and fleas carrying yersinia pestis, the causative agent of plaque, 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.

- Arthropod-borne is a group of infectious agents that are transmitted by bloodsucking arthopods from one vertebrare host to another

Pathogen	Reservoir	Vector	Disease
Chikungunya	Monkeys	Mosquito	Chikungunya fever
Dengue	Monkeys, Humans	Mosquito	Dengue hemorrhagic fever
Japanese B Encephalitis	Wild birds, Pigs	Mosquito	Encephalitis
Kyasanur Forest Disease	Forest birds, Animals	Tick	Hemorrhagic fever
Sindbis	Birds	Mosquito	Sindbis fever
Non-viral: Plasmodium	Mainly Humans	Mosquito	Malaria

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

1. **Natural immunity:** resistance of the body offered by skin, mucus membranes, gastric acidity ,respiratory cilia.
2. **Acquired immunity:** results when the body is exposed to the disease or organism

There are two types of Acquired immunity

Active

Post infection immunity **(natural)** or following vaccination **(artificial)**. 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

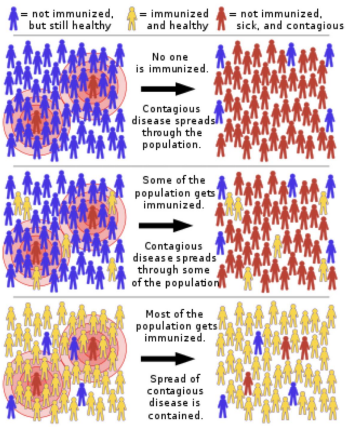
Passive immunity is provided when a person is **given antibodies** to a disease rather than producing them through his or her own immune system.
· A newborn **baby acquired passive immunity from its mother** through the placenta. A person can also get passive immunity through antibody-containing blood 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.

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.

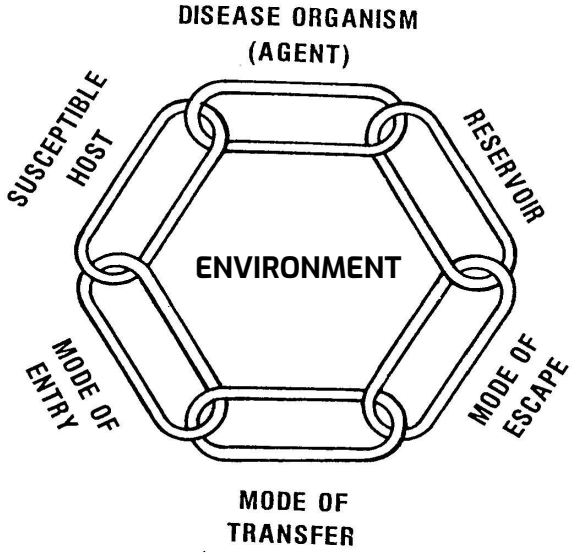
1. People without a fully-working immune system, including those without a working spleen.
2. People on chemotherapy treatment, whose immune system is weakened
3. Newborn babies who are too young to be vaccinated
4. Many of those who are very ill in hospitals
5. People with HIV
6. Elderly people



Prevention and control of communicable diseases

GOAL

Our goal in preventing communicable diseases is to break the cycle of infection at its weakest point!



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Measures applied to disease agent:

Sterilization and disinfection

2

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

3

Measures applied to the environment:

Sanitation (water/food/sewage)

4

Measures applied to the host:

Health education, adequate personal hygiene, sound nutrition, immunization and chemoprophylaxis.

5

Measures applied to the reservoir:

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.

Practice Questions

Q1: the only disease that has been eradicated to date is

A. Common Flu	B. Tetanus	C. STDs	D. Smallpox

Q2: Dogs are a reservoir in which of the following

A. Hepatitis C virus	B. Salmonella typhi	C. Rabies	D. Neisseria Gonorrhoeae

Q3: Which of the following is a type of direct transmission

A. Person to Person	B. Air-borne	C. Vector-borne	D. Vehicle-borne

Q4: Which of the following infectious agents is most to be likely transmitted by contaminated food & waters?

A. Malaria	B. Salmonella	C. Campylobacter	D. B&C

Q5: Getting vaccinated is an example of which type of acquired immunity?

A. Active (natural)	B. Active (artificial)	C. Passive (natural)	D. Passive (artificial)

Q6: Which of the following is a measures of preventing disease is NOT applied to the host?

A. Health Education	B. Immunization	C. Isolation	D. Personal Hygiene

Answer key:
1 (D) , 2 (C) , 3 (A) , 4 (D) , 5 (B) , 6 (C)

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