Introduction to Communicable Disease Epidemiology

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Most of the content of this presentation is courtesy of Dr. Hafsa Raheel

By the end of this session students should be able to

- 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 the types of reservoir of infection
- Classify carriers and to 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 between the types of immunity
- Outline the measures for the prevention and control of communicable diseases

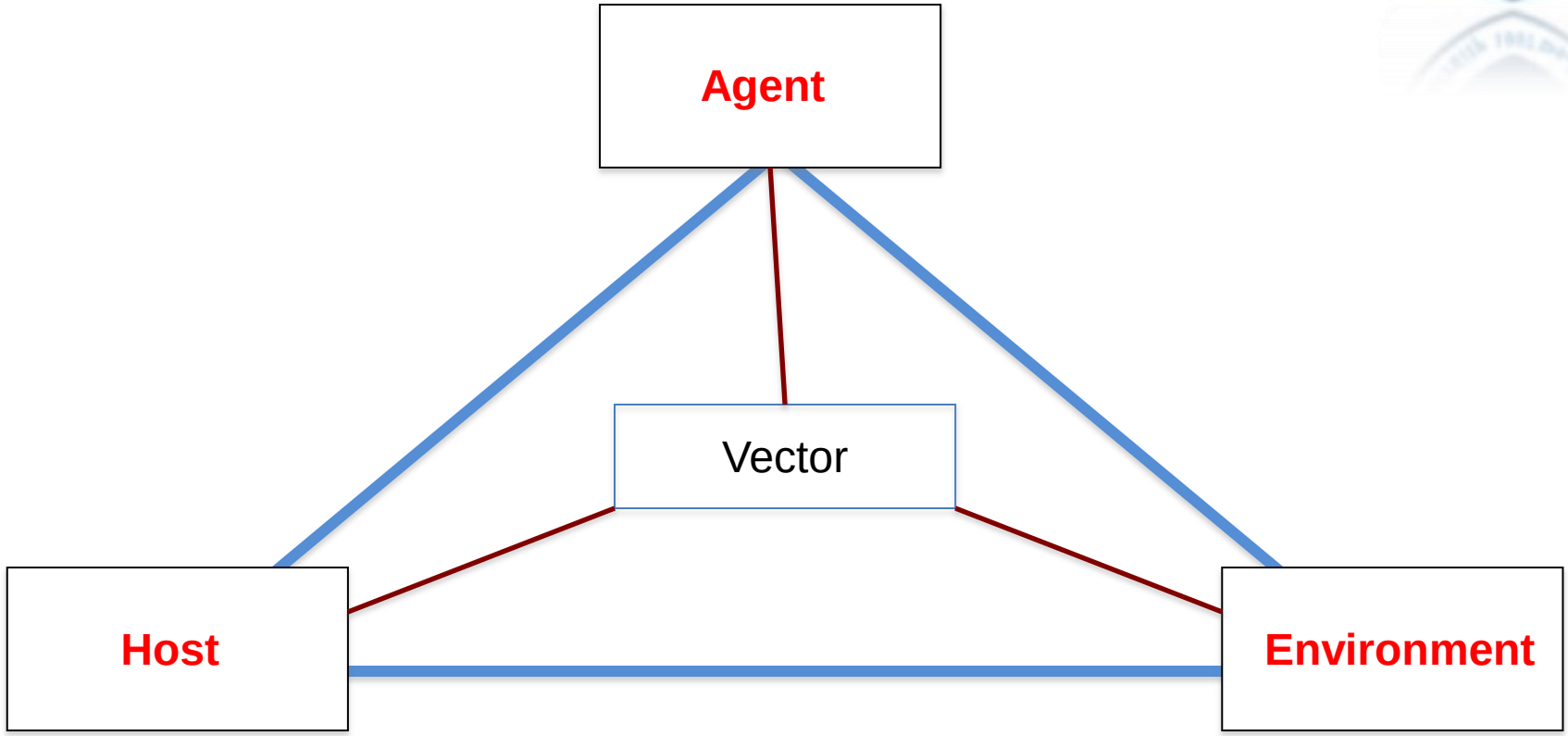
What is a Communicable Disease?

It is an illness caused by an infectious agent or its toxic product that is transmitted from an infected person, animal or inanimate source to a susceptible host

Source: *Heymann DL. Control of communicable diseases manual. 19th Edition. Washington DC, USA: American Public Health Association; 2008. 746*

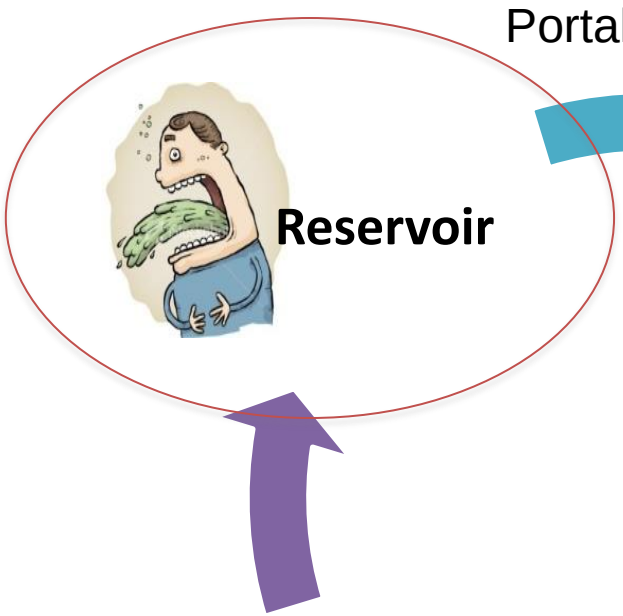
Chain of infection

Epidemiologic Triad



Source: *Gordis L. Epidemiology. Fourth Edition. Philadelphia, PA: Elsevier Saunders, 2009*

Cycle of Infection



Types of agent

-Virus

- Bacteria

- Parasite

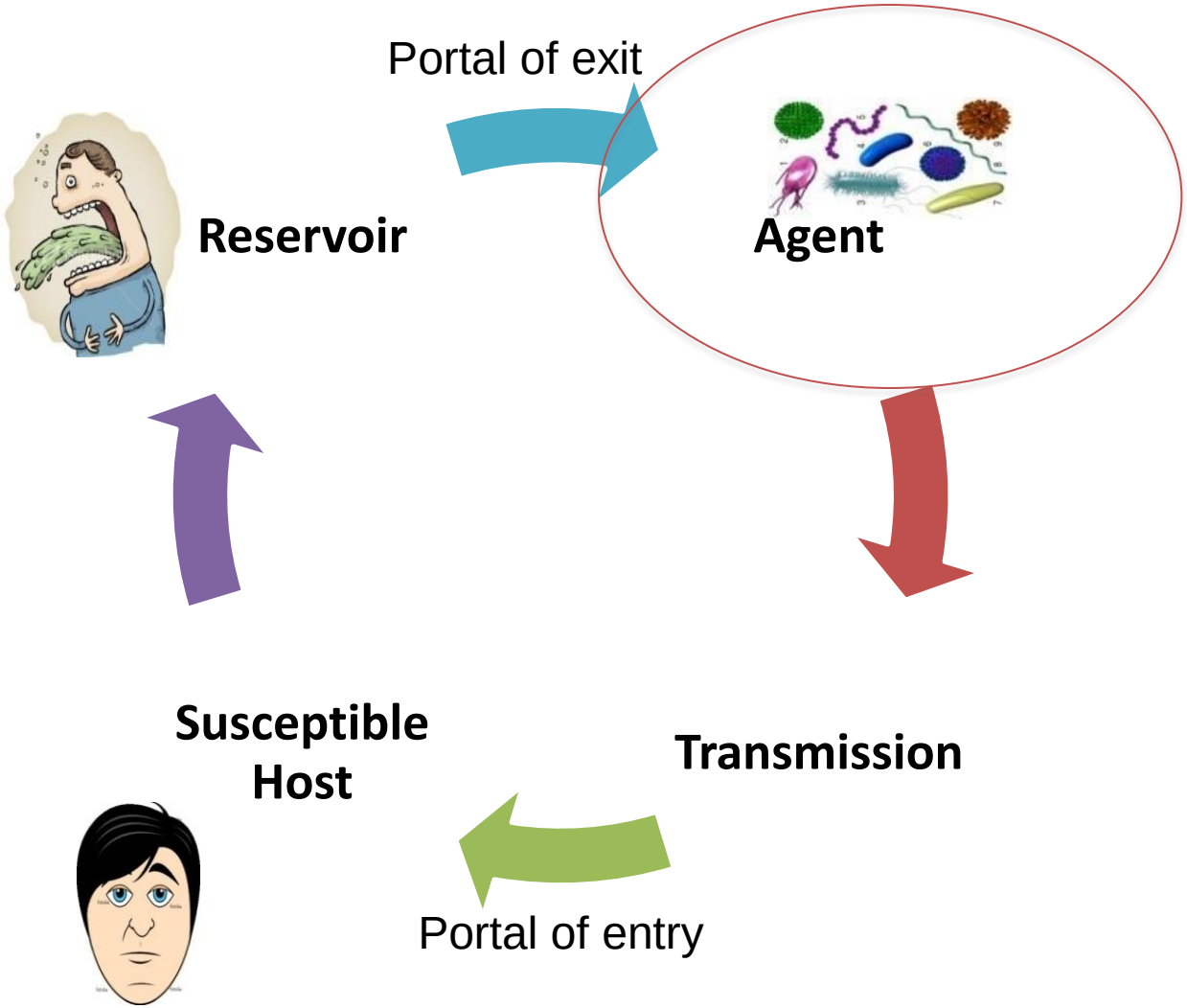
The Reservoir

- It is the habitat where the infective agent survives grows and multiplies in such a manner that it can be transmitted to a susceptible host.

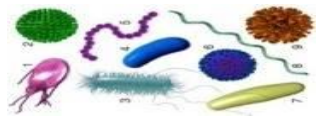
- Reservoir of infection can be:
  - ***Human*** *=> case or carrier*

    Carrier=person with unapparent infection that transmit the disease to others
  - ***Animal*** *=> case or carrier*
  - ***Environmental reservoir:***
    - *Water => e.g. legionnaire's disease*
    - *Soil => e.g. Botulism, Tetanus,*
    - *Plants*
  - ***Combination of these types***

Chain of Infection



The Agent



Mechanism of disease production (pathogenesis)

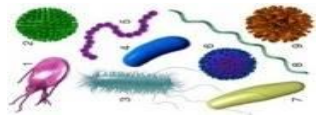
Invasiveness: ability of the organisms to invade the tissues and multiply

Toxigenicity: ability of the organism to produce toxins

1- Exotoxins: (released by living organisms): Heat labile; highly immunogenic and converted to antigen or toxoid by formalin, heat and acid.

2- Endotoxins: (released after disintegration of the organism): Heat stable, poorly immunogenic and not converted to toxoid.

The Agent



Pathogenicity: The power of an infectious agent to produce disease

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

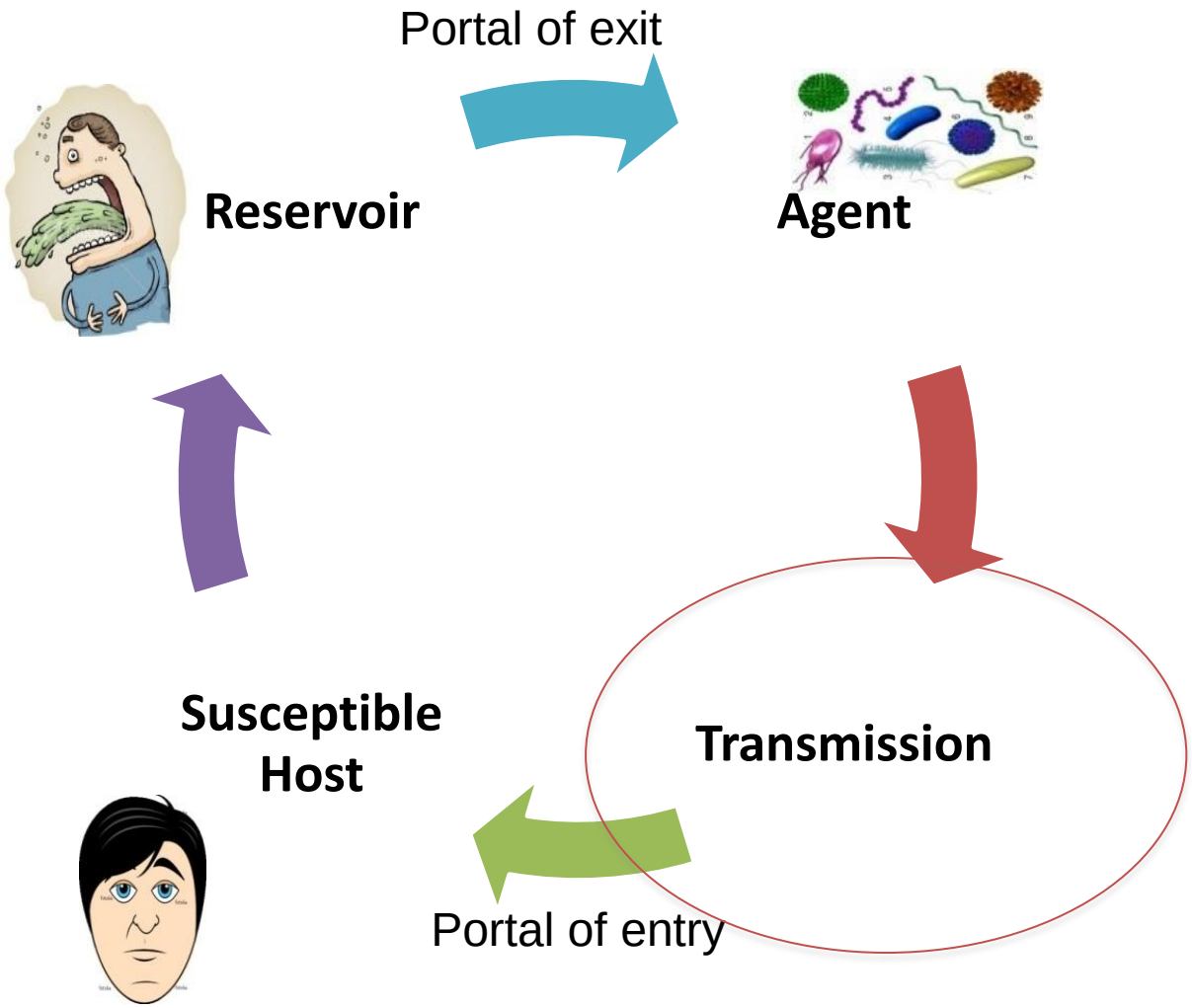
Viability of the organism (resistance): Ability of the organism to live outside the body

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

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.

Chain of Infection



The Mode of Transmission

1. Direct Transmission

- Direct contact
  - skin-to-skin
  - e.g. STDs
- Droplet spread
  - spray with droplet over a few feet
  - e.g. pertussis,

2. Indirect Transmission

- Airborne
  - droplet nuclei or dust suspended in air
- Vehicle
  - food, water, biological products, fomites
- Vector
  - insects
  - may support growth or change to the agent

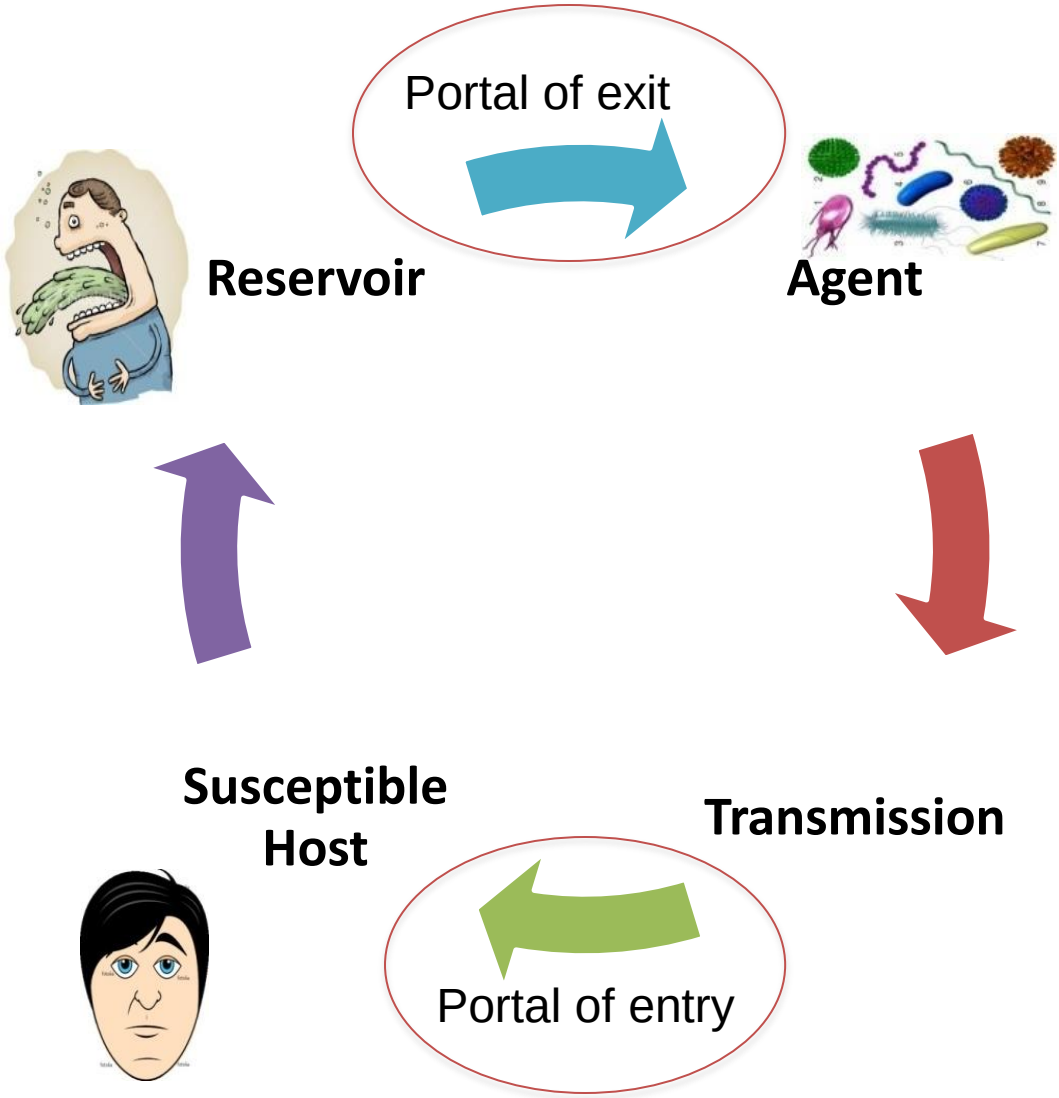
INCUBATION PERIOD

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

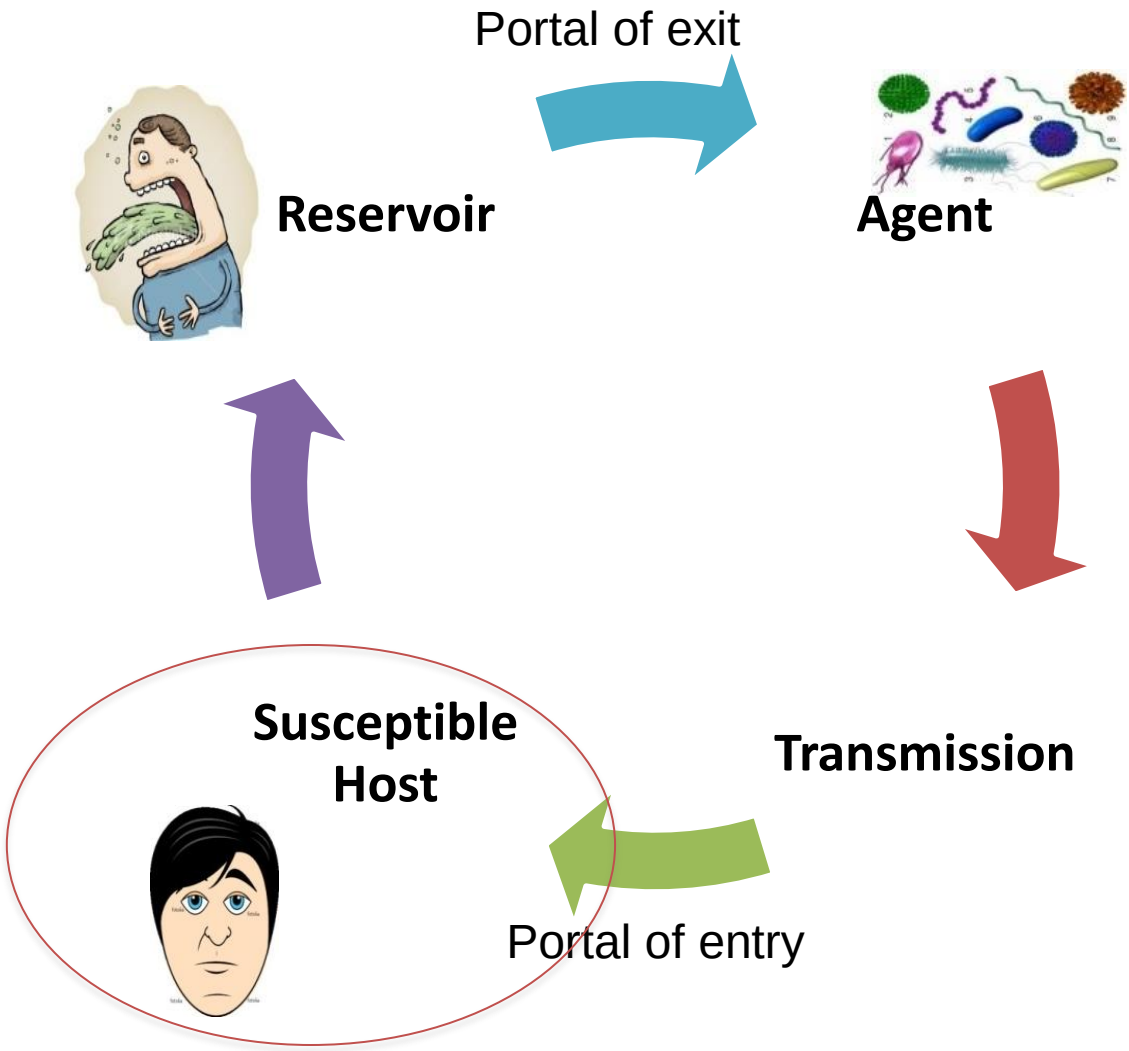
Chain of Infection



The Portal of Entry and Exit

- **Portal of entry**: it is the path by which the infectious agent enters that host
- **Portal of exit**: is the path by which the infectious agent exits the infected host
- These could be:
  - *Skin* => Direct contact; e.g. scabies, fungal, staph
  - *Mucous membrane* => e.g. HBV, STDs
  - *Respiratory tract* => rhinovirus, EBV
  - *GIT* => E-coli, enteric virus, HAV
  - *GUT* => gonorrhoea, syphilis…..
  - *Blood* => HIV, HCV, HBV, malaria

Chain of Infection



The Host

A host is a person or other living animal, that affords living conditions suitable for the growth of an infectious agent

Susceptibility to infection is universal but susceptibility to disease depends on:

1-Immunity
2-Dietary and nutritional factors
3-Genetic factors

Immunity

Types of Immunity

Natural

- Natural resistance of the body offered by skin, mucous membranes, gastric acidity, respiratory cilia

Acquired

• 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)

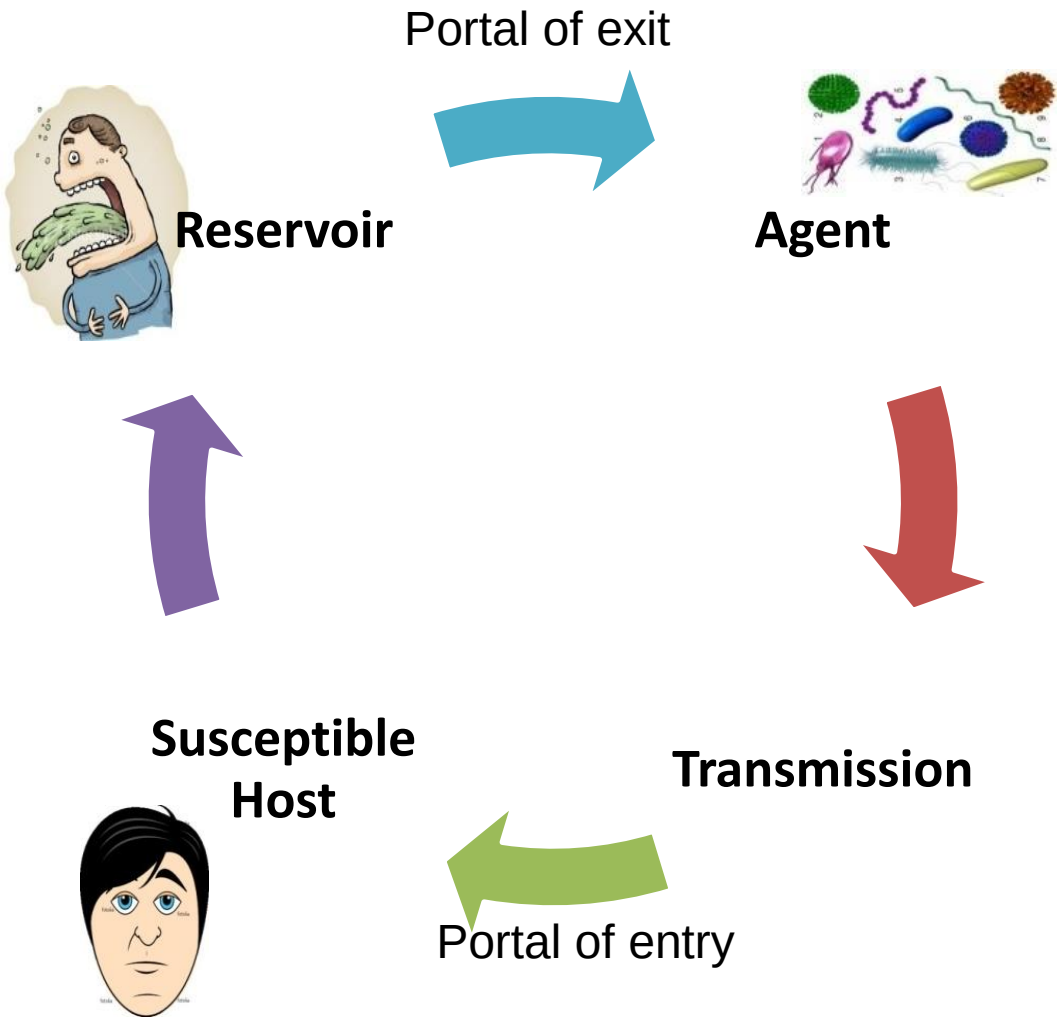
Pre-requisites for transmission of a communicable disease

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

1. Presence of reservoir for infection
2. Presence of microbiological agent
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

Prevention and Control of Communicable Diseases

We need to break the cycle



Some Definitions

Control

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

Eradication

Termination of all modes of transmission of infection by extermination of the infectious agent

Prevention and Control Measures Applied to Break Different Stages of the Infection Chain

Measures That Directed to the Agent

- Sterilization
- Disinfection
- Proper treatment of infected individuals to kill the agent at its source

Measures Directed 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, surveillance for the longest incubation period.
- **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 of animals (if vaccine is available), treatment of infected animals and killing if treatment is not feasible.

Measures Directed towards Breaking Transmission

- Isolation if indicated => to interrupt direct transmission
- Decontaminating of fomites => vehicle transmission
- Promote handwashing => prevent feco-oral transmission
- Modify ventilation and air pressure => prevent airborne transmission
- Control vector population => control vector-borne transmission

- ***Environment:*** sanitation of water, food, proper sewage handling

Measures Directed towards Protecting Portal of Entry

- Using bed-nets
- Wearing masks and gowns to prevent entry of infected body secretions or droplets through skin or mucous membranes
- Covering skin and using insect repellents

Measures Directed to the Host

- Health education
- Adequate personal hygiene
- Sound nutrition
- Immunization
- Chemoprophylaxis

What is the Benefit of Complete Immunization in the Community?

- Complete immunization coverage can help prevent the agent from reaching a susceptible host

Herd immunity

- State of immunity within the community
- If a high proportion of individuals in the community are resistant to an agent, then susceptible people will also be protected by the resistant majority
- The level of susceptibility increases as new infants are born, an epidemic will develop after accumulation of susceptible
- It could be produced artificially by immunization, or naturally after infection

Exercise on MERS-Cov

- Middle Eastern Respiratory Syndrome Coronavirus (MERS-Cov) was first reported in Saudi Arabia in 2012
- In addition to humans, camels have also been infected
- People present with cough, fever and shortness of breath
- incubation period is from 2 to 14 days
- Although not fully understood, it has been reported to spread from person-to-person through respiratory secretions, through close contact by care-giving and also in the hospital setting and possibly by contact with infected camels
- There is currently no available antiviral treatment or vaccine for MERS-Cov, thus general health precautions are advised when dealing with sick people

Exercise on MERS-Cov

- Reservoir:
- Portal of Exit:
- Mode of transmission:
- Portal of entry:
- Incubation period:
- Prevention and control measures:
  - Factors in host -Factors related to agent
  - Factors in environment -Factors related to reservoir

References

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