NOTES ON:

PRINCIPLES OF VETERINARY EPIDEMIOLOGY

DISEASES IN POPULATION

- **A DISEASE** is a particular abnormal condition that negatively affects the structure or function of part or all of an organism, and that is not due to any external injury

- **POPULATION:** A complete collection of individuals that have some particular characteristic (s) in common. It could be of known size e.g. 50 fish in aquarium or of unknown size as tick populations in infested cows or number of stray dogs in certain district.

ETIOLOGY OF DISEASES "DETERMINANTS"

DETERMINANTS:

* Definition. Disease is caused by multiple factors. Those factors are determinants of disease, i.e. any characteristic that affects the health of a population.

- Epidemiologists assume that illness does not occur randomly in a population, but happens only when the right accumulation of risk factors or determinants exists in an individual.
- To search for these determinants, epidemiologists use analytic epidemiology or epidemiologic studies to provide the "Why" and "How" of such events.
- Ideally, the findings provide sufficient evidence to direct prompt and effective public health control and prevention measures.

❖ Classification of determinants

1. Primary and secondary
2. Intrinsic and Extrinsic
3. Determinants associated with host, agent or environment

1. **Primary and secondary**: For the initiation of most diseases;
   i. **Primary determinant:** Primary cause of a disease
   ii. **Secondary determinants.** Factors responsible of spread of a disease

1-Primary determinants = factors whose variations exert a major effect in inducing disease → necessary causes

- Examples for primary determinants: viruses, bacteria, parasites, trauma, climate, radiation, allergens, mineral deficiency (also all extrinsic); genetic constitution, metabolism, behaviour (also all intrinsic)

2-Secondary determinants = predisposing, enabling and reinforcing factors → component causes

- ❖ Examples for secondary determinants: age, sex, breed, hormonal status, immunological status (also all intrinsic); location, trauma, concurrent disease, vaccination status, husbandry (also all extrinsic)

1-PRIMARY DETERMINANTS (SPECIFIC FACTOR):

A) INTRINSIC: The causal agent is an integral part of the host.

1. **Hereditary**: Due to genetics different breeds have different risks for diseases, such as Cryptorchidism in horses, and umbilical hernia in calves.
2. **Metabolic and hormonal diseases** e.g. bloat in cattle, where clover at certain stage of growth gives rise to frothy bloat, but the exact cause of fermentation is unknown.
3. **Behavioral disorders**: e.g. weaving in horses, feather pecking and cannibalism in poultry.

B) EXTRINSIC: The causal agent is not integral part of the host. Includes:-

1. **Non- living agent:** Physical agents' e.g. trauma, bite of insects, fractures,etc
2. **Chemical agents** e.g. organic and inorganic poisons, poisonous plants, allergy,etc
3. **Living agents** e.g. bacteria, viruses, Mycoplasma, rickettsia, helminthes, fungi, etc.

2-SECONDARY DETERMINANTS (PREDISPOSING FACTORS).

A) INTRINSIC: - It includes:-

1. **Age:** is very important because the risk of many diseases changes widely over the animal's life due to underlying physiological changes that are associated with age, Neonates are highly susceptible to many enteric and respiratory infections but resistance increases as the animals mature.
2. **Sex.** This has a relative susceptibility of different sexual organs and tissues on invasion by pathogenic agents, as infection of pregnant uterus of the cows by B.abortus
3. **Species breed and strain**. There is a natural variation in the susceptibility of animals to diseases e.g. FMD can affect cattle and sheep while horses are resistant.
4. **Metabolism and hormonal balance**. There are effects of sex hormones, cortisone and metabolic state on the disease condition on the other hand, estrogen cause relative resistance of the uterus to vibrio and trichmonas infection during estrus.
5. **State of nutrition**.Well-nourished animals is more resistant to the disease than those which are underfed e.g. Helminthes and john's disease. Also, good

condition and highly fed animals are susceptible to some diseases than in poor condition e.g. enterotoxaemia diseases.

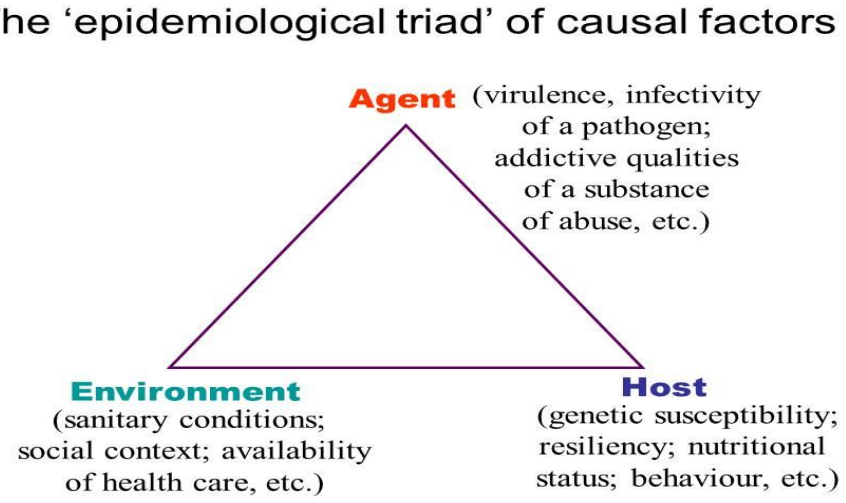
6. **Stress.** Stress factors have a great role in the spreading of diseases e.g., parasitic infestation, increases the incidence of hepatic necrosis (black disease) in lambs.
7. **Physiological state**. Brucellosis is established only after puberty causing abortion at the 6th months of pregnancy or later.
8. **Vaccination .**increases an individual's resistance to disease but the protection is not absolute for most biologics.

B-EXTRINSIC: It includes the factors in the environment

1) Animal stocking density, animal movement between groups; Housing (e.g. ventilation, sanitation):
2) Environmental conditions (e.g. temperature, humidity, wind velocity, precipitation).

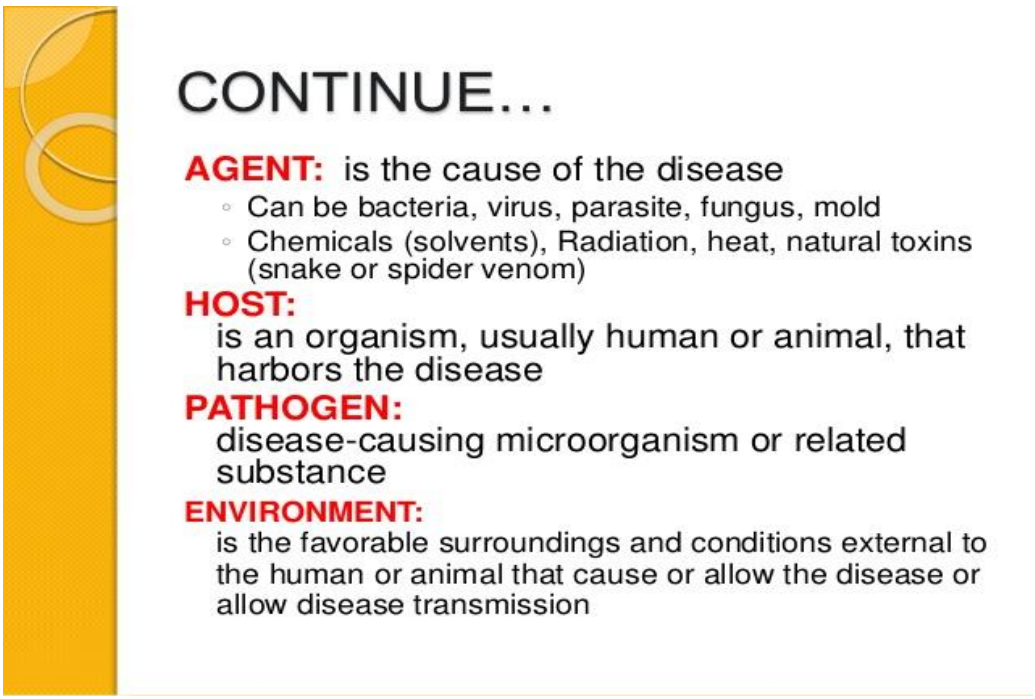
I) EPIDEMIOLOGICAL TRIAD "DETERMINANTS ASSOCIATED WITH HOST, AGENT OR ENVIRONMENT "

Definition: A model used to explain the etiology "cause" of diseases.



Cf. Fireman's mantra: a fire requires air, fuel and heat

* **Animal disease results** from interaction between the host, agent and the environment. A vector may be involved in transmission.
* **A vector, an organism** which transmits infection by conveying the pathogen from one host to another without causing disease itself, may be part of the infectious process.



1-AGENT: Biological, physical, or chemical factors whose presence, absence are necessary for the disease to occur. Examples: bacteria, viruses, fungi, poison, drugs, trauma, radiation, fire.

AGENT FACTORS: A variety of factors influence whether exposure to an organism will result in disease, including the

1. **INFECTIVITY** .The capacity of an agent to produce infection or disease. Measured by the secondary attack rate.
2. **PATHOGENICITY** .The capacity of the agent to cause disease in the infected host. Measured by the proportion of individuals with clinically apparent disease.
3. **VIRULENCE** .Refers to the severity of the disease. Measured by the proportion of severe or fatal cases. If fatal, use case fatality rate.

2- HOST is an organism, usually human or animal, that harbors the disease

HOST FACTORS (INTRINSIC) A variety of factors intrinsic to the host, called risk factors, can influence an individual's exposure, susceptibility or response to a causative agent. It includes:-

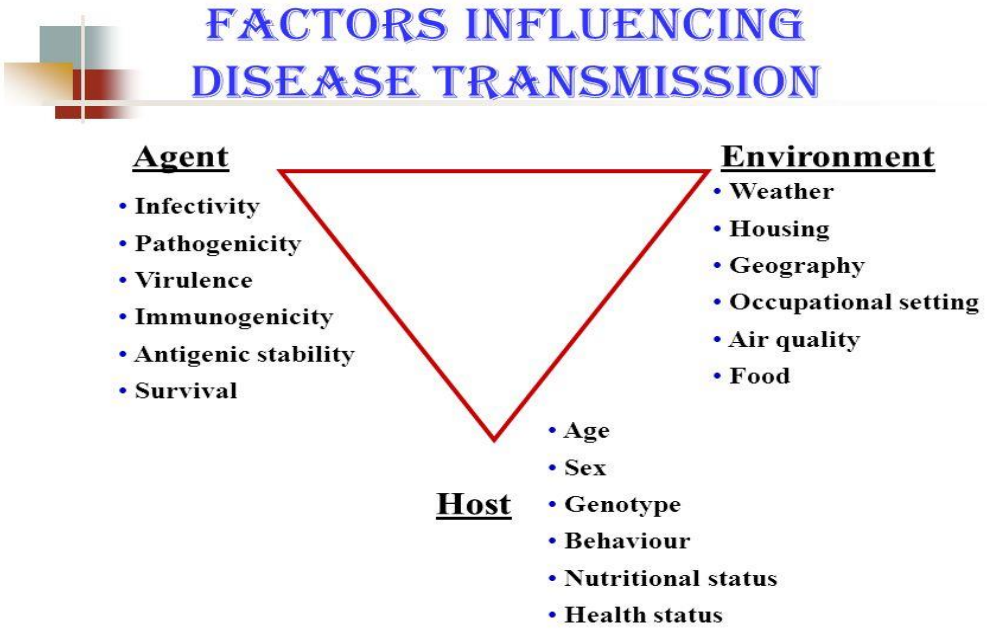
1. Genetics "Breed" 2- Innate resistance (e.g. gastric barrier)
2. Previous exposure 4- Vaccination status and response
3. Age , sex , bread ,etc
4. Behavior (e.g. mutual grooming, dominance, pica)
5. Production status (e.g., lactating vs. non-lactating)
6. Reproductive status (e.g., pregnant vs. non-pregnant)

3) **THE ENVIRONMENT** is the favorable surroundings and conditions external to the human or animal that cause or allow the disease or allow disease transmission
   - Environmental factors can include the biological aspects as well as the social, cultural, and physical aspects of the environment

Table (1): Factors associated with the increase risk of animal diseases.

Host Characteristics	Agent	Environmental Factors
Age	Infectivity	Stocking density/Herd size
Sex	Pathogenicity	Regions, , herds, Animal movement ,climatic changes, feeding etc
Production statuas	Virulence	Geographical distribution
Genetics		Environmental conditions/hygiene
Previous Disease		Housing
Immune Status		Climate/climatic changes
Vaccination status		Nutritional status
Body confirmation		Air, water , feed pollution

Factors associated with occurrence of diseases or outbreaks



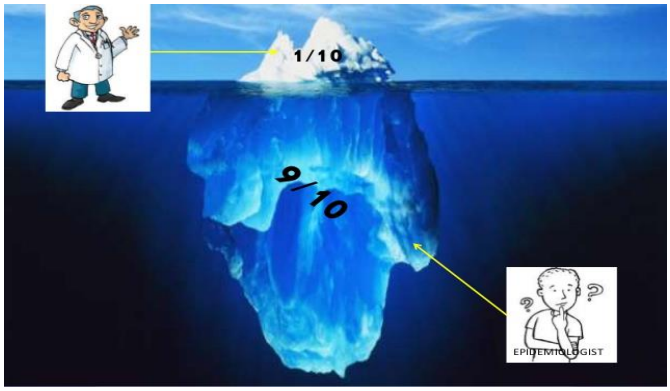
NATURAL HISTORY AND SPECTRUM OF DISEASE

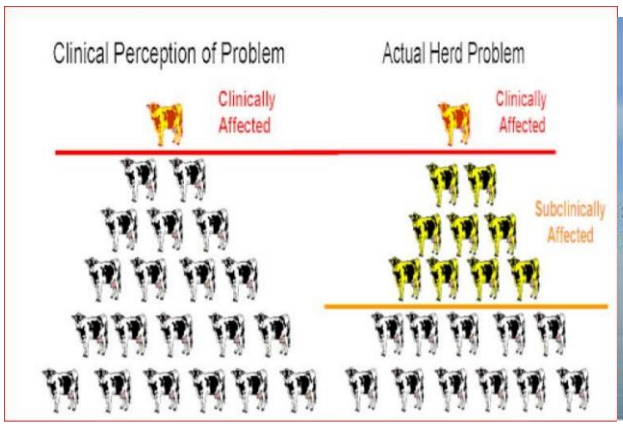
- The "natural history of disease" refers to the progression of disease process in an individual over time; in the absence of intervention.
- There are four stages in the natural history of a disease. These are:
  1. Stage of susceptibility
  2. Stage of pre-symptomatic (sub-clinical) disease
  3. Stage of clinical disease
  4. Stage of recovery, disability or death

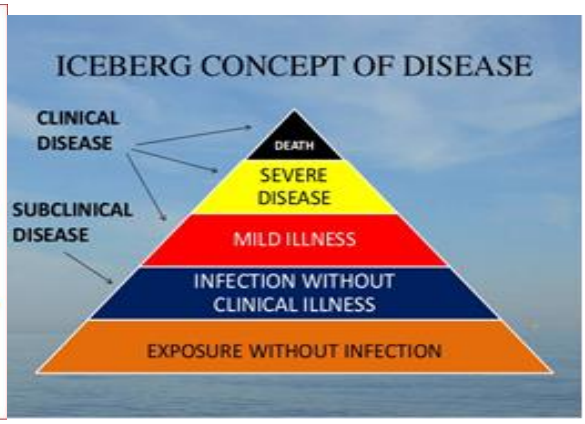
- The process begins with the appropriate exposure to or accumulation of factors sufficient for the disease process to begin in a susceptible host. For an infectious disease, the exposure is a microorganism.
- For cancer, the exposure may be a factor that initiates the process, such as asbestos fibers or components in tobacco smoke (for lung cancer)

ICEBERG PHENOMENON OF DISEASES

* **Iceberg phenomenon of disease** gives a picture of the spectrum of diseases in a community.
* **The visible part of the iceberg** denotes the clinically apparent cases of disease in the community. The part of the iceberg below the water level denoted the latent, subclinical, undiagnosed and carrier states in the community, which forms the major part.
* **The hidden part is** especially important in disease like hypertension, diabetes and malnutrition.
* **Some diseases exhibiting iceberg phenomenon:** diabetes , hypertension ,malnutrition, mastitis ,TB ,parasitic infestation





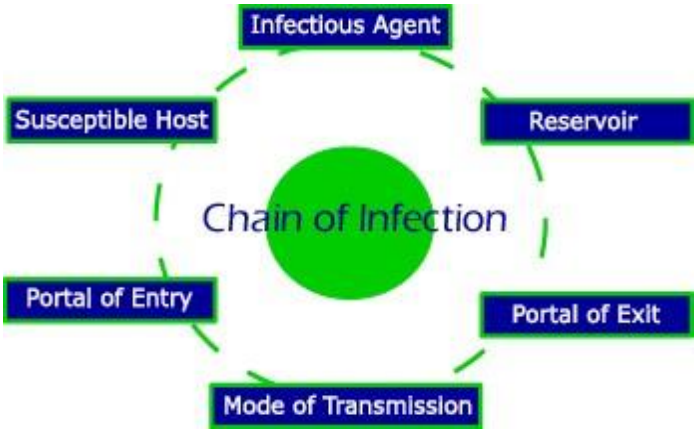


CHAIN OF INFECTION

DEFINITION. The six components involved in the transmission of microorganisms are illustrated and described as the chain of infection.

THE 6 ELEMENTS OF THE CHAIN ARE:

1. **Infectious Agent** - e.g. virus, bacteria, protozoa, fungi, animals (worms)
2. **Reservoir -** Where the agent normally resides
3. **Portal of Exit** - How the agent leaves the host
4. **Mode of transmission** - Direct or indirect contact
5. **Portal of Entry** - How the agent enters the susceptible host
6. **Susceptible Host** - Impacted by overall health, genetic factors, etc.



All these six components should be present to transmit an infectious disease from one human or animal to a susceptible host.

1. CAUSATIVE AGENT

- **The causative agent** for infection is any microorganism capable to producing disease.

- **Microorganisms** responsible for infectious diseases include bacteria, viruses, fungi, and protozoa. Sometimes, microorganisms are part of patient's own body flora and can cause infection in the immunocompromised host. These infections are called endogenous infections. Infections which are acquired from external sources are called exogenous infections

2. RESERVOIR OR SOURCE

a) **RESERVOIR** is the 2nd link in the chain of infection.
   - A reservoir is the place where the agent survives, grows, and/or multiplies: human, animal or environment. • e.g. Pseudomonas spp. survive and multiply . It is the natural habitat of the infectious agent."

b) **THE SOURCE** is defined as "the person, animal, object or substance from which an infectious agent passes or is disseminated to the host (immediate source).

c) **A CARRIER** is a person who is colonized with a specific pathogenic microorganism but shows no signs or symptoms of infection, e.g. salmonella and Avian flu in water fowl

THE ELEMENTS IN A CARRIER STATE ARE:

1. The presence of the disease agent in the body.
2. The absence of recognizable signs and symptoms of disease.
3. The shedding of the disease agent in the discharges or excretions thus acting as source of infection for others

CARRIERS MAY BE CLASSIFIED AS BELOW:

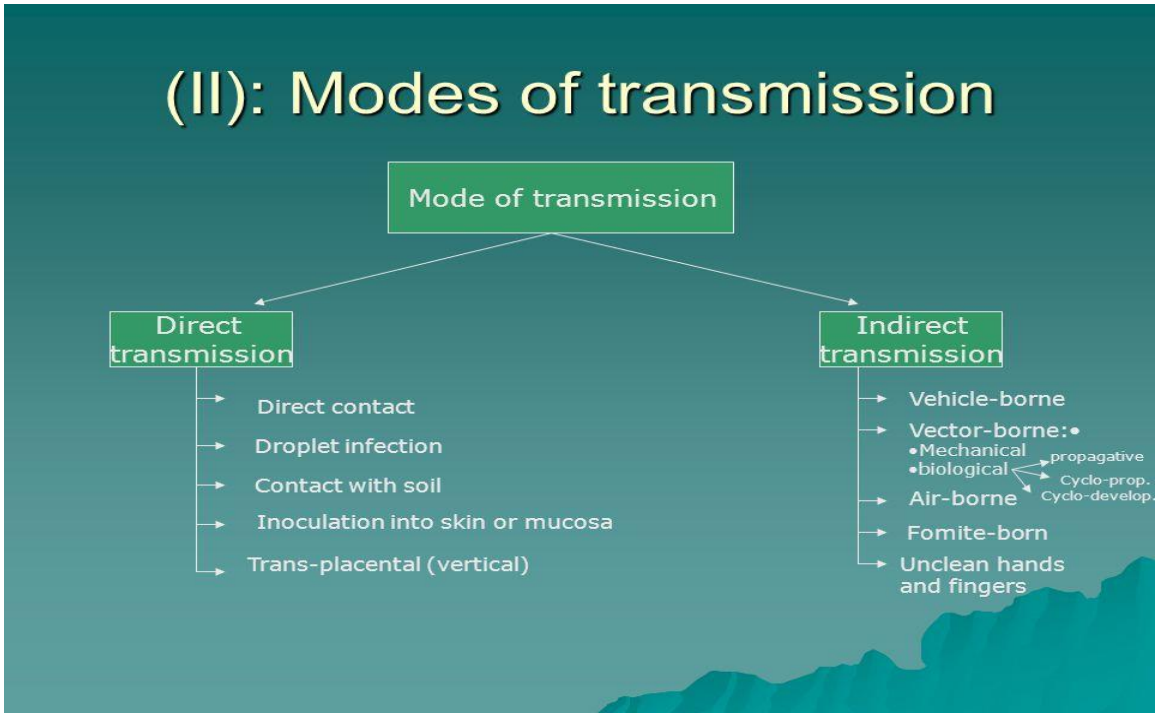
- **A. Type**
  1. **Incubatory** carriers are those who shed the infectious agent during the incubation period of the disease.
  2. **Convalescent** carriers are those who continue to shed the disease agent during the period of convalescence
  3. **Healthy** carriers emerge from the subclinical cases. They are the victim of subclinical infection who has developed carrier state without suffering overt disease.

- **B. Duration**
  3. **Temporary carriers**: Are those who shed infectious agent for short periods of time.
  4. **Chronic carriers**: A carrier who excretes the infectious agent for indefinite period.

5. PORTAL OF EXIT

- The portal of exit is the path by which an infectious agent leaves its reservoir. Usually, • this portal is the site where the microorganism grows. Common portals of exit include the respiratory, genitourinary, and gastrointestinal tracts, the skin and mucous membranes and the placenta (transmission from mother to fetus).

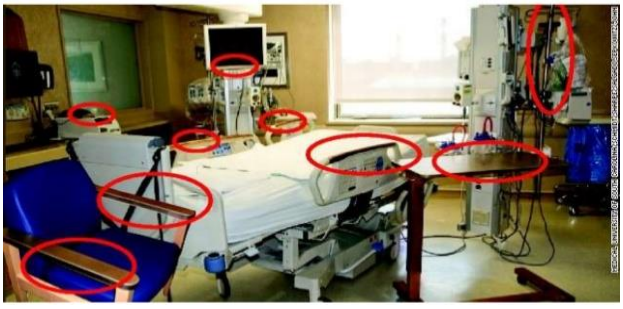
MODE OF DISEASE TRANSMISSION



4. Mode of transmission

- **Direct contact: it** refers to person-to-person spread of microorganisms through actual physical contact.

- **Indirect contact:** occurs when a susceptible person comes in contact with a contaminated object.
  - In health care settings, virtually any item could be contaminated with certain microorganisms, e.g. endoscopes, respiratory equipment, etc. Thorough cleaning, disinfection, and sterilization are essential in the health care.



1-DIRECT TRANSMISSION

* It is the transfer of an infectious agent directly into the body. It occurs through direct contact with the pathogen, but the pathogen can be delivered into the body in different ways.

There are four types of contact transmission.

* **Direct**—requires physical contact between hosts.
* **Indirect**—contact with body fluids or tissues of an infected individual.
* **Droplet**—large infectious particles sprayed into the air from the respiratory tract of an infected individual.
* **Droplet nuclei**—small infective particles that are suspended in the air, taken in by a host, and are capable of traveling to the lung.

Note: Pathogens delivered by droplet or droplet nuclei are usually limited to about one meter's distance away from the victim. Longer distances or a more indirect route to the victim is classified as an indirect transmission through airborne means.

Examples of diseases spread by contact are sexually transmitted diseases (STDs), pink eye, Ebola, ringworm, and respiratory diseases.

2-INDIRECT TRANSMISSION

Indirect transmission is the transfer of a pathogen by a vector, vehicle, or through the air

A) BY VECTORS. A vector is a living organism, such as an insect or arthropod that carries a disease-causing agent from one host to another in the life cycle of a pathogen.

B) VEHICLE-BORNE TRANSMISSION

- Vehicle-borne transmission occurs when a non-living object carries a disease-causing agent from one host to another in the life cycle of a pathogen. Inanimate objects that can carry disease include cooking utensils, bedding, clothing, toys, surgical instruments, medical supplies, water, blood, serum, plasma, and body tissues and organs.

- Examples of diseases spread through vehicle-borne transmission are food-borne diseases and waterborne diseases.

C) AIRBORNE TRANSMISSION

* In airborne transmission, pathogens are suspended in the air and enter a body through the respiratory tract.
* This may sound at first like the droplet or droplet nuclei of contact transmission mentioned above, but in airborne transmission, infectious agents may be suspended in the air for longer periods of time.
* Pathogens become airborne when they are shed from feces, sprayed from urine, or distributed by many different processes such as heating, cooling, or venting systems, or slaughterhouse environments.

5-PORTALS OF ENTRY.

- 1) Skin 2- Gastrointestinal Tract 3- Respiratory 4-Urogenital
- 5) Via Placenta 6)Parenteral (injection, bite)

6- SUSCEPTIBLE HOST

- The final link in the chain of infection is the susceptible host.
- A susceptible host is an animal who can become infected by the infectious agent.

THERE ARE SEVERAL LEVELS OF INFECTION

- Colonization - Subclinical or Inapparent - Latent infection
- Manifest or clinical infection.