Public Health

(L 4) EPIDEMIOLOGY

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History

- The Greek physician **Hippocrates** is sometimes said to be the **father of epidemiology**. He is the first person known to have examined the relationships between the occurrence of disease and environmental influences. He coined the terms *endemic* (for diseases usually found in some places but not in others) and *epidemic* (for disease that are seen at some times but not others).

- In the medieval Islamic world, physicians discovered the contagious nature of infectious disease. In particular, the physician **Avicenna**, considered a **"father of modern medicine,"** in *The Canon of Medicine* (1020s), discovered the contagious nature of tuberculosis and sexually transmitted disease, and the distribution of disease through water and soil.

- Avicenna stated that bodily secretion is contaminated by foul foreign earthly bodies before being infected. He introduced the **method of quarantine** as a means of limiting the spread of contagious disease.

- When the **Black Death** (bubonic plague) reached Al Andalus in the 14th century, **Ibn Khatima** hypothesized that infectious diseases are caused by small "minute bodies" which enter the human body and cause disease.

History

- The **miasmatic theory of disease** held that diseases such as cholera or the Black Death were caused by a *miasma* (Greek language: "pollution"), a noxious form of "bad air". In general, this concept has been supplanted by the more scientifically founded germ theory of disease.

- In the middle of the 16th century, a famous Italian doctor from Verona named **Girolamo Fracastoro** was the first to propose a theory that these very small, unseeable, particles that cause disease were alive.

- They were considered to be able to spread by air, multiply by themselves and to be destroyable by fire. In this way he refuted Galen's theory of miasms (poison gas in sick people).

- The development of a sufficiently powerful microscope by Anton van Leeuwenhoek in 1675 provided visual evidence of living particles consistent with a germ theory of disease.

- **Dr. John Snow** is famous for his investigations into the causes of the 19th Century Cholera epidemics.

- He began with a comparison between the death rates from areas supplied by two adjacent water companies in Southwark.

- His identification of the Broad Street pump as the cause of the SoHo epidemic is considered the classic example of epidemiology.

History

- He used chlorine in an attempt to clean the water, thus ending the outbreak.

- This has been perceived as a major event in the history of public health and can be regarded as the **founding event** of the **science of epidemiology.**

(Map of Cholera outbreaks in London)

Epidemiology

- Epi = upon (among)
- Demos = people
- Ology = science
- Epidemiology = the science which deals with what falls upon people…..

A Modern Definition :"The study of the distribution and determinants of health-related states in specified populations, and the application of this study to control health problems." So the **Objectives of Epidemiology**

1. To describe the **distribution** and magnitude of health and disease problems in the population.

2. To identify the **etiological factors** – risk factors in the population.

3. To provide the **data** essential to planning, implementation and evaluation of services for prevention, control and treatment of disease and to setting up of priorities for these services.

The ultimate aim of epidemiology is
- to **eliminate or reduce health problem** or its consequences

and

- to **promote health** and well-being of society as a whole.

The Epidemiology is the Backbone of Public Health, as it works to :

1. investigate nature / extent of health-related phenomena in the community / identify priorities
2. study natural history and prognosis of health-related problems
3. identify causes and risk factors
4. recommend / assist in application of / evaluate best interventions (preventive and therapeutic measures)
5. provide foundation for public policy

Terms to know

- **Disease** a pattern of response by a living organism to some form of invasion by a foreign substance or injury which causes an alteration of the organisms normal functioning
    - also – an abnormal state in which the body is not capable of responding to or carrying on its normally required functions

- **Pathogens** organisms or substances such as bacteria, viruses, or parasites that are capable of producing diseases

- **Pathogenesis** the development, production, or process of generating a disease

- **Pathogenic** means disease causing or producing

- **Pathogenicity** describes the potential ability and strength of a pathogenic substance to cause disease

Terms to know

- **<u>Infective diseases</u>** are those which the pathogen or agent has the capability to enter, survive, and multiply in the host

- **<u>Virulence</u>** the extent of pathogenicity or strength of different organisms
  - the ability of the pathogen to grow, thrive, and to develop all factor into virulence
  - the capacity and strength of the disease to produce severe and fatal cases of illness

- **<u>Invasiveness</u>** the ability to get into a susceptible host and cause a disease within the host
  - The capacity of a microorganism o enter into and grow in or upon tissues of a host

- **<u>Etiology</u>** the factors contributing to the source of or causation of a disease

- **<u>Toxins</u>** a poisonous substance that is a specific product of the metabolic activities of a living organism and is usually very unstable
  - notably toxic when introduced into the tissues, and typically capable of inducing antibody formation

- **<u>Antibiotics</u>** a substance produced by or a semisynthetic substance derived from a microorganism and able in dilute solution to inhibit or kill another microorganism

Determinants of Health

Social and Economic Factors

such as income, education, and employment status are important determinants of health. These factors can affect access to healthcare, housing, and healthy food options, among other things.

Environmental Factors

such as air and water quality, exposure to toxins, and access to green spaces can also impact health. Poor environmental conditions can increase the risk of respiratory and other health problems. Access to safe and clean environments is an important determinant of health.

Individual Behaviors

such as smoking, poor diet, and lack of physical activity are major determinants of health. These behaviors can increase the risk of chronic diseases such as heart disease, cancer, and diabetes.

Understanding Descriptive and Analytic Epidemiology

Epidemiology is the study of the distribution and determinants of health and disease in populations.

It is a cornerstone of public health, informing policy decisions at local, national, and global levels.

Epidemiologists use a range of study designs and statistical methods to investigate patterns of disease occurrence and to identify risk factors for specific health outcomes.

Accordingly, we have either:

Descriptive Epidemiology or Analytic Epidemiology

Descriptive Epidemiology

Measures of Disease Frequency: Measures such as incidence and prevalence are used to describe the occurrence of disease in a population. **Observational studies** are usually used in Descriptive Epidemiology.

Morbidity refers to the incidence or prevalence of a particular disease or health condition in a population. The following are common measures of morbidity:

•**Incidence rate:** The number of new cases of a disease that occur in a population over a specified period of time.

•**Prevalence rate:** Number of current case (old and new) of a specified disease at a point of time

Mortality

Mortality refers to the occurrence of death in a population.
The number of deaths in a population over a specified period of time, usually expressed per 1,000 or 100,000 population.

Incidence Rate Vs Prevalence Rate

$$prev\mathbf{AL}ence = \frac{\mathbf{ALL}\ cases}{Population\ @\ risk}$$

$$i\mathbf{N}cidence = \frac{\mathbf{N}ew\ cases}{Population\ @\ risk}$$

How full
(Prevalence)

Inflow
(Incidence)

Outflow
(Rate of Death + Cure)
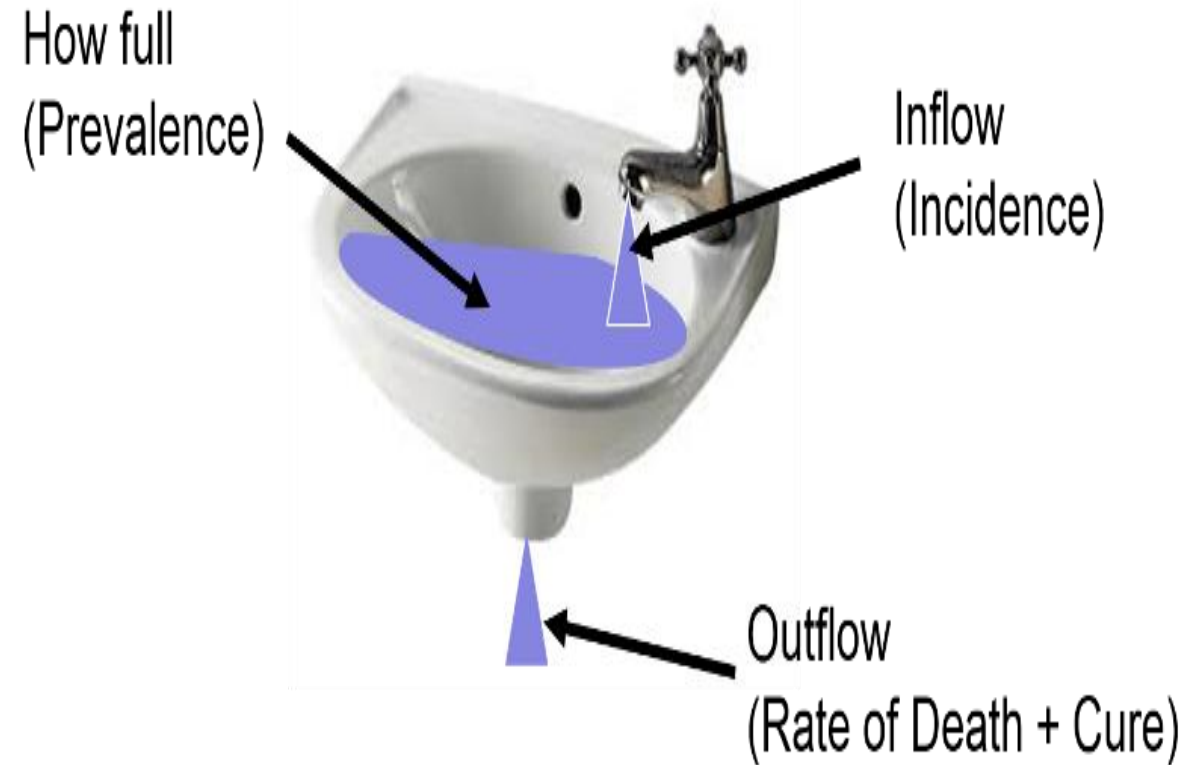
Analytic Epidemiology

Analytic epidemiology is concerned with identifying and quantifying associations between exposures and outcomes. This involves **testing hypotheses** and making causal inferences. Unlike **descriptive epidemiology**, which simply describes the distribution of disease in a population, **analytic epidemiology** aims to identify risk factors and determine the causes of disease.

Observational studies, such as cohort and case-control studies, are commonly used in analytic epidemiology to investigate the relationship between an exposure and an outcome.

Experimental Studies, like **Randomized controlled trials (RCTs)** are also used in analytic epidemiology to determine the efficacy of interventions or treatments.

Descriptive epidemiology pertain to the "**who, what, where and when** of health-related state occurrence". However, **analytical epidemiology** deal more with the **how and why** of a health-related event occur.

Epidemiological Study Designs
(**Measures of Association Between Exposure and Disease or outcome**)
Observational Studies
Cross-Sectional Studies: where data is collected from a sample of population at a single point in time to estimate the prevalence of a disease or condition.

Cohort Studies: that follow a group of individuals over time to identify risk factors and determine the incidence of disease.

Case-Control Studies: that compare individuals with a disease (cases) to those without the disease (controls) to identify potential risk factors.

Experimental Studies
involve the manipulation of an exposure or intervention to determine its effect on disease outcomes. **Randomized controlled trials (RCTs)** are the gold standard for experimental studies in epidemiology, where participants are randomly assigned to either a treatment or control group to determine the effectiveness of an intervention or treatment.

Case-control studies
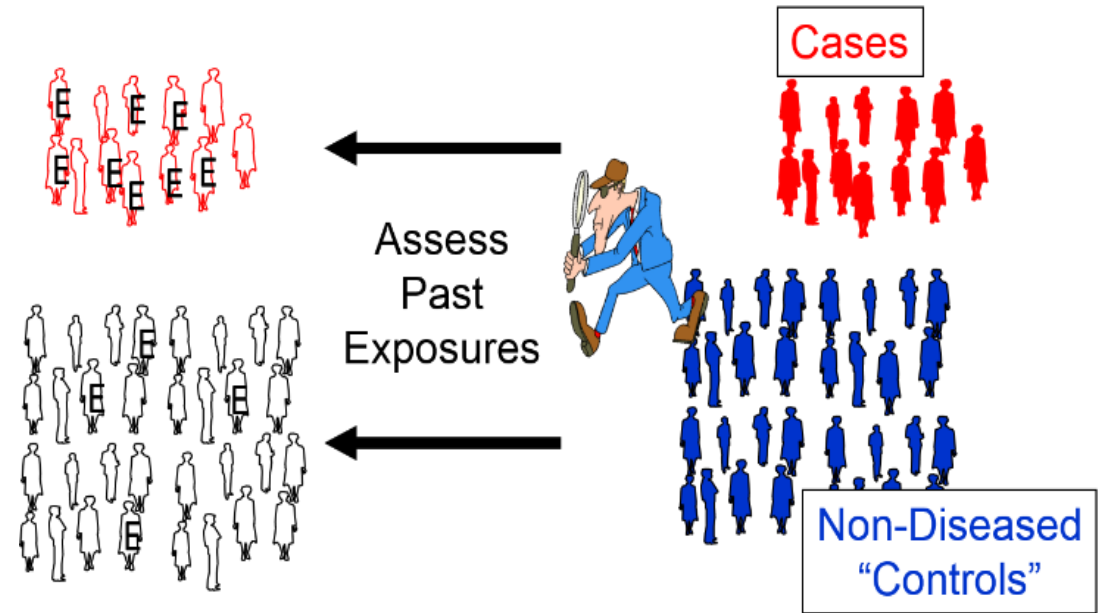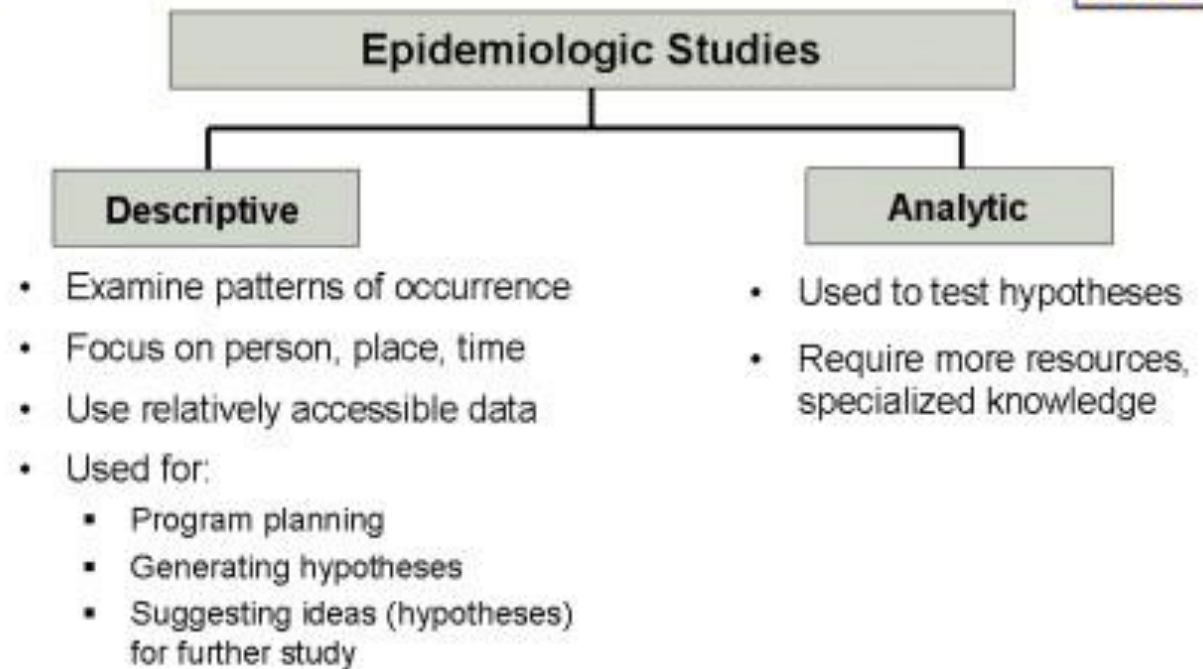

Intervention studies (randomized clinical trials)
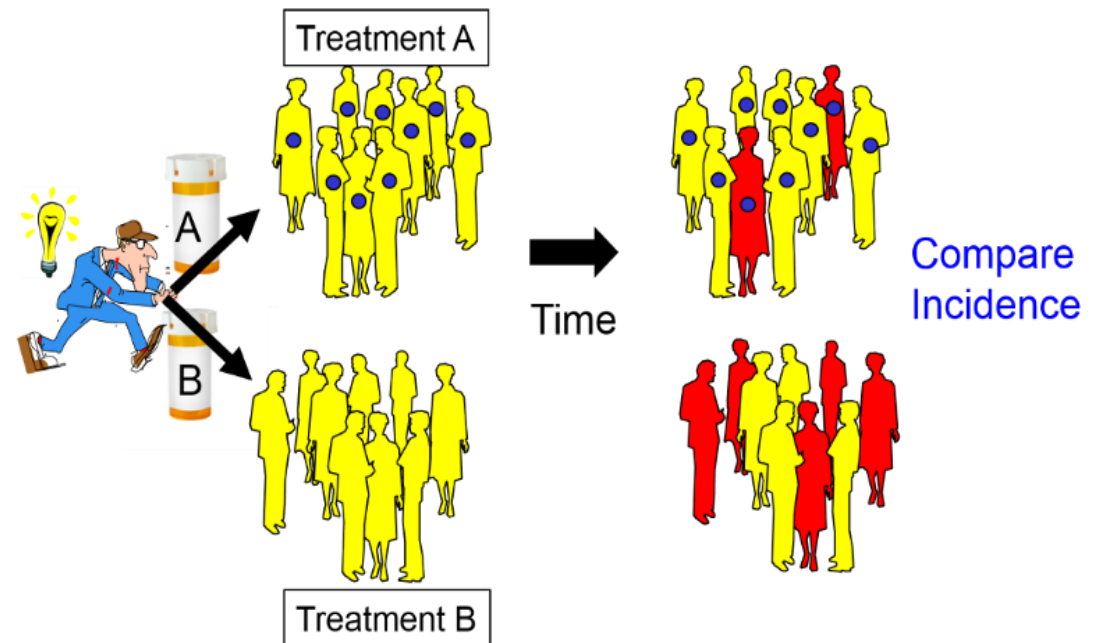
The Five Ws of Epidemiology Studies

- What   = Clinical ⎤
- Who   = Person   ⎥ Descriptive
- Where   = Place   ⎥ Epidemiology
- When   = Time   ⎦

- Why / How   = Causes   ⎤
              Risk factors   ⎥ Analytic
              Modes of   ⎥ Epidemiology
              transmission   ⎦

Epidemiologic Study Types

Epidemiologic Studies

Descriptive

- Examine patterns of occurrence
- Focus on person, place, time
- Use relatively accessible data
- Used for:
  - Program planning
  - Generating hypotheses
  - Suggesting ideas (hypotheses) for further study

Analytic

- Used to test hypotheses
- Require more resources, specialized knowledge

Descriptive or Analytic Studies?

Descriptive studies

- Generate hypotheses
- Answer what, who, where, and when

Analytic studies

- Test hypotheses
- Answer why and how

Descriptive Studies

Characterize who, where, or when in relation to what (outcome)

- **Person**: characteristics (age, sex, occupation) of the individuals affected by the outcome
- **Place**: geography (residence, work, hospital) of the affected individuals
- **Time**: when events (diagnosis, reporting; testing) occurred

Analytic Studies Definition

Analytic studies test hypotheses about exposure-outcome relationships

- Measure the association between exposure and outcome
- Include a comparison group

The Epidemiology Triangle

Epidemiologist have created a model to help explain the multifaceted phenomena of disease transmission: the **epidemiology triangle**.Three essential characteristics that are examined to study the cause(s) for disease in **analytic epidemiology** are: **Host, Agent, Environment.**
The mission of the epidemiologist is to break one of the legs of the triangle, which disrupts the connection between environment, host, and agent, stopping the continuation of an outbreak.

The agent is the cause of the disease. Can be bacteria, virus, parasite, fungus, mold Chemicals (solvents), Radiation, heat, natural toxins
 (snake or spider venom)

The host is an organism, usually human or animal,
that harbors the disease

The **environment** is the favorable surroundings and
 conditions external to the human or animal that cause
 or allow the disease or allow disease transmission
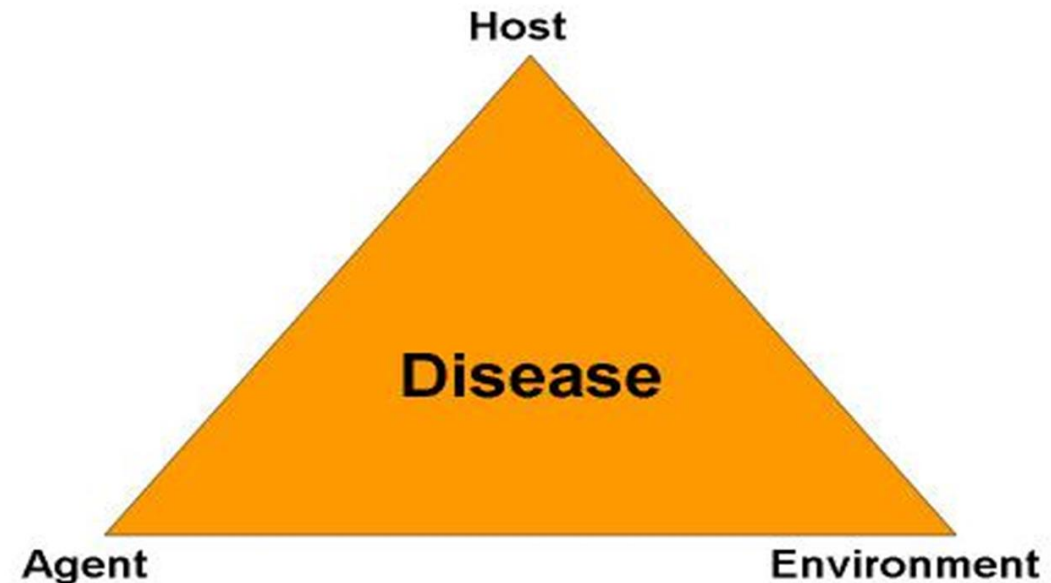
Disease Transmission

- **Fomites:** inanimate objects that serve as a role in disease transmission
  Pencils, pens, doorknobs, infected blankets

- **Vector:** any living non-human carrier of disease that transports and serves the process of disease transmission. Insects: fly, flea, mosquito; rodents; deer.

- **Reservoirs:** humans, animals, plants, soils or inanimate organic matter (feces or food) in which infectious organisms live and multiply
  - Humans often serve as reservoir and host

- **Zoonois:** when a animal transmits a disease to a human
- **Carrier:** one that spreads or harbors an infectious organism
  - Some carriers may be infected and not be sick. e.g. Typhoid Mary

  Mary Mallon (1869 – 1938) was the first person in the United States to be identified as a healthy carrier of typhoid fever. Over the course of her career as a cook, she infected 47 people, three of whom died from the disease. Her notoriety is in part due to her denial of her role in spreading the disease, together with her refusal to cease working as a cook. She was forcibly quarantined twice by public health authorities and died in quarantine. It is possible that she was born with the disease, as her mother had typhoid fever during her pregnancy.

Modes of Disease Transmission

- **Direct transmission** or person to person
    - Immediate transfer of the pathogen or agent from a host/reservoir to a susceptible host occur through direct personal contact such as touching contaminated hands, kissing or sex

- **Indirect transmission**
    - **Airborne:** Droplets or dust particles carry the pathogen to the host and infect it. Sneezing, coughing, talking all spray microscopic droplets in the air.
    - **Waterborne:** Carried in drinking water, swimming pool, streams or lakes used for swimming. Examples: cholera
    - **Vehicleborne**: Related to fomites
    - **Vectorborne**: A pathogen uses a host (fly, flea, louse, or rat) as a mechanism for a ride or nourishment this is **mechanical transmission**

    biological transmission when the pathogen undergoes changes as part of its life cycle, while within the host/vector and before being transmitted to the new host

Chain of Transmission

- Close association between the triangle of epidemiology and the **chain of transmission**

- Disease transmission occurs when the **pathogen** or agent leaves the **reservoir** through a **portal or exit** and is spread by one of several **modes of transmission.**

- Breaks in the chain of transmission will stop the spread of disease

Etiological agent/pathway — Source / Reservoir — Mode of transmission — Host
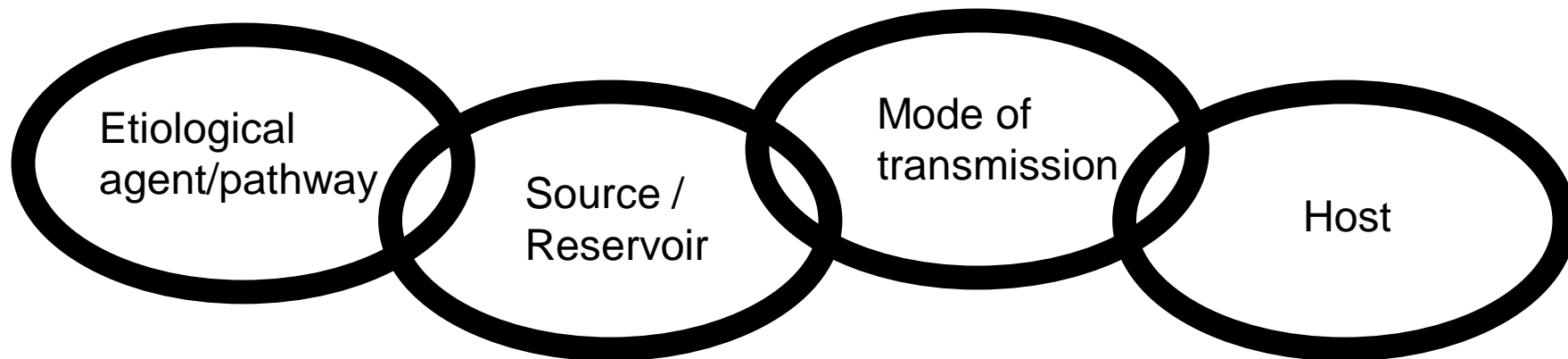
Levels of Disease

Diseases have a range of seriousness, effect, duration, severity, and extent

Classified into 3 levels

- **<u>Acute</u>** relatively severe, of short duration and often treatable
  - usually the patient either recovers or dies

- **<u>Subacute</u>** intermediate in severity and duration, having some acute aspects to the disease but of longer duration and with a degree of severity that detracts from a complete state of health
  - Patient expected to eventually heal

- **<u>Chronic</u>** less severe but of long and continuous duration, lasting over a long time periods, if not a lifetime
  - Patient may not fully recover and the disease can get worse overtime
  - Life not immediately threatened, but may be over long term

THANK YOU!