EPIDEMIOLOGY:

INTRODUCTION:

***General Definitions:**

-Public health: The science and art of Preventing disease, prolonging life and promoting health efficiency through organized community effort (Winslow 1920)

-Health: A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO 1948)

-Sickness: A state of social dysfunction; people notice that there's something wrong about you

-Disease: A physiological or psychological dysfunction (**Dis:** Not **+ ease:** comfort)

-Illness: A subjective (refers to the person who has the disease) state of not being well

***Different Definitions of Epidemiology:**

✓ A core science of public health

✓ The science of the mass phenomena of infectious diseases or the natural history of infectious diseases (Frost 1927)

✓ The science of infective diseases, their prime causes, propagation and prevention. (Stall brass 1931)

NOTE:

Prevention was added in stall brass' definition

✓ The study of the distribution and determinants of health-related states or events in specified populations, and the application of the study to the control (prevention) of health problem (J.M. Last 1988)

✓ Epi = upon, among | Demos = people | Ology = science, study of

Epidemiology = The *science* or the *study* (Systematic collection, analysis and interpretation of data) of diseases in populations

✓ The scientific method of disease investigation. Typically, it involves the disciplines of biostatistics and medicine

***Fields (Components of J.M. Last Definition) of Epidemiology:**

◊ **Distribution:**

→ **Includes:**

✓ Frequency:

-The core characteristic

-We first count the number → Then, we turn this number into a rate, ratio or a proportion

-This can be applied on diseases, disabilities or deaths in a specified population (Not merely diseases)

-This falls in the domain of biostatistics

-Frequency can be expressed as:

◆Prevalence: the total number of people in the population who have the disease at the moment or living with the disease

◆Incidence rate: the rate of new occurrence of new cases in the population

◆Death rate

◆…

[These rates are essential for comparing the disease frequency in different populations or sub groups of the same population]

✓ Pattern describing the occurrence of an event by person, place and time

NOTE:

Answering the question of: who, where and when? → leads us to **Descriptive Epidemiology**;

Who = Distribution of diseases among subgroups of the population in certain geographic areas

Where = Distribution of diseases in certain geographic areas depending on place

When = Any increase or decrease (of a health problem) over time

This will lead to the formulation of an **etiological hypothesis**; what might cause this disease

◆Person Distribution:

Persons who develop the disease by age, gender, ethnicity (العِرق), occupation, marital status, habits (smoking, physical exercise, dietary pattern), social class and other host factors (host is the person who got the disease) help us understand the natural history of disease

◆Place Distribution:

Study of the geography of the disease (geographical pathology), in which we learn the differences in disease patterns between two geographical areas (i.e. international [area in two different countries], national [same country] or urban/rural differences). **These variations may be due to** variations in population density, social class, deficiencies in health services, levels of sanitation, education and environmental factors.

◆ Time Distribution:

The occurrence of disease changes over time.
-Some of these changes occur regularly, while others are unpredictable.
-Two diseases that occur during the same season each year include seasonal influenza (winter) and West Nile virus infection (August-September). In contrast, diseases such as hepatitis B and salmonellosis can occur at any time. (don't depend on season)

NOTE:
Day of the week or time of the day may be important

✍ The 3 Types of **Time Trends or Fluctuations** in Disease Occurrence:

☞ Short term fluctuation:
a) Single (one incubation period and one peak) (i.e. food poisoning)
b) Multiple or continuous exposure (i.e. well of contaminated water-cholera; caused by the release of methylmercury in the industrial wastewater, Minamata disease in Japan)

☞ Periodic fluctuation:
a) Seasonal: i.e. GI infections in the Summer
b) Cyclic: i.e. Influenza every 7-10 years [due to antigenic variations]

☞ Long-term or Secular trend: that are chronic diseases that take years to develop (i.e. CVD, lung cancer)

◇ **Determinants:**

Factors in which their presence/absence affect the occurrence of the disease and the level of a health event.

NOTE:
Answering the question of: how and why?
→ leads us to **Analytical Epidemiology**

This allows us to test a hypothesis to prove right it's or wrong.

Analytical strategies help in developing scientifically sound health programs, interventions and policies.

◇ **Health-related States and Events:**

The focus of Epidemiology is not only patients' health as individuals, but anything in the environment that may affect their health and well-being in any way. It studies all health-related conditions, i.e. road traffic accidents, abundance of firearms
→ Epidemiology is a broad science

◇ **Specified Population:**

[This is compared to *clinical medicine* that diagnoses and treats patients after they get sick and go seek physician's help]

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The sum of all these components = knowledge (data); in which can be applied for planning, implementation and evaluation of services for the prevention, control and treatment of disease.

→ Epidemiology is a science and practice
→ Epidemiology is an applied science

NOTE:
Epidemiological studies can help physicians in their advices and decisions

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→ **Wrap Up of What to Ask in Epidemiology:**

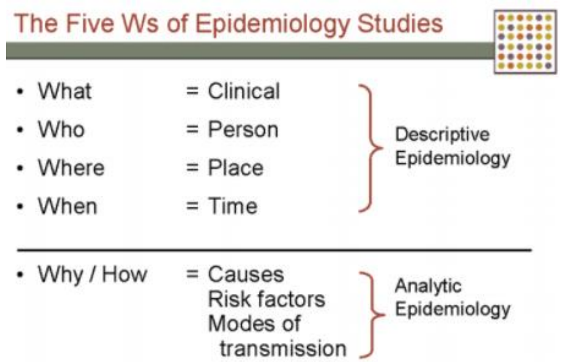
◇ **For the Health Event:**

What is the event?
What is the magnitude?
Who is affected?
Where did it happen?
When did it happen?
Why did it happen?
How did it happen?

◇ **For the Health Action:**

What can be done to reduce this problem and its consequences?
How can it be prevented in future?
What action should be taken by the community?
By whom should these activities be carried out?

◇ **For Epidemiological Studies:**



***Endemic, Epidemic and Pandemic:**

✍ **Endemic:**

-The habitual presence of a disease within a given geographic area

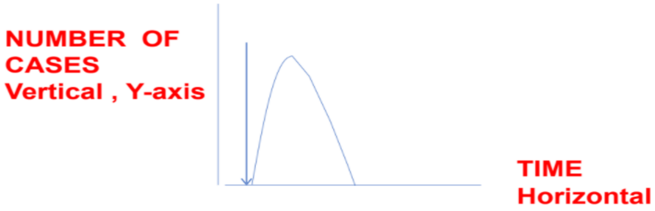
-May also refer to the usual prevalence of a given disease within such an area (APHA)

✍ **Epidemic:**

-The occurrence in a community or region of a group of illnesses of similar nature, clearly in excess of normal expectancy (APHA)

-Outbreak

-Epidemic Curve:



✍ **Pandemic:**

-A worldwide epidemic

◊ **Epidemic Example 1: Fatalities Associated with Farm Tractors (1982):**

(N = 166)

Who = highest among 60 – 69 year old persons

[more older age groups are at higher risk]

Where = highest in northern side of Georgia

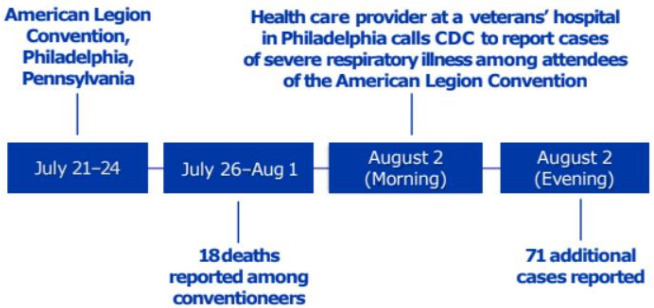
When = highest at 4pm – 5pm, then at 11am – 12pm

◊ **Epidemic Example 2: London Smog Disaster (1952):**

When fog and soot from coal burning created a dense smog in Winter, 1952, in London, the smog was around for five days from December 5–10. The death rate in London in the previous week was around 2,062. In the week of the smog, 4,703 died.

✓ It was found that sulfur dioxide and smoke interaction was the cause

◊ **Epidemic Example 3: Legionnaire's Disease Outbreak (1976):**



Who = highest among ≥ 70-year-old persons (20.4% in hotel A only)

[more older age groups are at higher risk]

Where = highest in hotel A (9.0%)

When = highest between 25th to 27th of July, just after the convention ended

✓ The **Legionella bacterium** was finally identified and isolated and was found to be breeding in the cooling tower of the hotel's air-conditioning system; the bacteria then spread through the building whenever the system was used

✓ Similar bacteria grew in warm waters in nature, such as hot springs, and also had been identified in air-conditioning cooling towers

✓ The finding from this outbreak investigation lead to development of new regulations worldwide for air conditioning systems

◊ **Epidemic Example 4: Epidemiology and Polio Vaccine:**

In April 1955, Dr. Thomas Francis, director of Poliomyelitis Vaccine Evaluation Center at the University of Michigan, announced that the two-year field trial of the **Salk vaccine** against polio was up to 90% effective

***Scope (نطاق) of Epidemiology:**

<u>Originally</u>, Epidemiology was investigation and management concerned with of epidemics of **communicable diseases (infectious diseases).**

<u>Lately</u>, Epidemiology was extended to endemic **communicable (infectious) diseases** and **non-communicable diseases (chronic diseases).**

<u>Recently</u>, Epidemiology can be applied to **all diseases and other health related events** that affect human health

***History of Epidemiology:**

<u>1) Hippocrates (460BC)</u>: Environment and human behaviors affects health

<u>2) John Graunt (1662)</u>: Quantified births, deaths and diseases

<u>3) Lind (1747)</u>: Scurvy could be treated with fresh fruit

<u>4) William Farr (1839)</u>: Established application of vital statistics (for birth and death and diseases) for the evaluation of health problems when he was in London, UK

<u>5) John Snow (1854)</u>: Tested a hypothesis on the origin of an epidemic of cholera in London

6) <u>Alexander Louis (1872)</u>: Systematized application of numerical thinking (quantitative reasoning)
7) <u>Bradford Hill (1937)</u>: Suggested criteria for establishing causation [the new era of epidemiology]

→ Epidemiology emerged in 460 BC
→ Epidemiology flourished as a scientific discipline in 1940s

→ Cholera: A Closer Look:

John Snow (1813–1858)

- An English physician and modern-day father of epidemiology
- He used scientific methods to identify the cause of the epidemic of cholera in London in 1854
- He believed that it was the water pump on Broad Street that was responsible for the disease
  - The removal of the pump handle ended the outbreak

During that time Farr and Snow had major disagreement about the cause of cholera.
Farr adhered to what was called the miasmatic theory of diseases, according to this theory, which was commonly held at that time, diseases were transmitted by a **miasma** or a cloud with bad smell that clung low on the earth surface.

Who =
Where = Soho district in London
When = highest between 1 – 5 Sep 1854

DISEASE CAUSATION:

***Cause (**Etiology = Pathogenesis = Mechanisms = Risk factors**):**
Anything producing an effect or a result (Webster)

NOTE:
Knowing the cause helps in Prevention, Diagnosis and Treatment

***Causal Relationships (Pathways):**

◊ Direct Causation:
A causes B *without* intermediate effects (very rare) almost never happens

◊ Indirect Causation:
A causes B, but with intermediate effects

***Theories of Disease Causation:**

◊ Supernatural Theories:
Curse, evil force of the demon

◊ Hippocratic Theory:
Human behavior and environment affect their health status
✓ Disease was the result of an imbalance among <u>four vital "humors"</u> within us:
Yellow Bile, Black Bile, Phlegm, Blood
✓ Hippocrates was a keen observer and tried to relate an individual's exposures (i.e. diet, exercise, occupation and other behaviors) to subsequent health outcomes

◊ Miasma:
Explains contagious or infectious diseases

◊ Theory of Contagion:
About how contagious diseases are transferred

◊ Germ Theory (cause shown via Henle-Koch postulates):
Appeared after the invention of the microscope, we could see the germs and it was hypothesized that microorganisms caused disease

Louis Pasteur introduced the germ theory in 1878, that was developed later into Henle-Koch postulates:
✓ The agent is present in every case of the disease
✓ It does not occur in any other disease (one agent one disease)
✓ It can be isolated and if exposed to healthy subjects will cause the related disease
• There are three conditions to prove that this agent causes this disease

NOTE:
Even though there was a "germ" of truth in miasmatic theory, in that it focused attention on environmental causes of disease and partly explained social disparities in health (poor people being more likely to live near foul odors), the theory began to fall into disfavor as the germ theory gained acceptance

◊ Classic Epidemiologic Theory (Epidemiologic Triad):
Disease is the result of forces within a dynamic system consisting of:
• <u>Agent of disease</u>:
-An infectious microorganism or pathogen
-Generally, the agent must be present for disease to occur; however, presence of that agent alone is not always sufficient to cause disease.
-A variety of factors influence whether exposure to an organism will result in disease:
◆Infectivity: the proportion of exposed persons who become infected
◆Pathogenicity: the proportion of infected individuals who develop clinically apparent disease
◆Virulence: the proportion of clinically apparent cases that are severe or fatal

NOTE:

Agents include chemical (poison, smoke, alcohol), as well as physical forces (such as repetitive mechanical forces associated with carpal tunnel syndrome, radiation), and nutritional (vitamin deficiency)

- Susceptible Host:

-The human who can get the disease

-A variety of factors intrinsic to the host, sometimes called risk factors, can influence an individual's exposure, susceptibility, or response to a causative agent.

◆Exposure is influenced by: behaviors such as sexual practices, hygiene, smoking, physical exercise, dietary habits, and other personal choices as well as by age and sex

◆Susceptibility and response to an agent are influenced by: factors such as genetic composition, nutritional and immunologic status, anatomic structure, presence of disease or medications and psychological makeup

- External environment:

Extrinsic factors that affect the agent and the opportunity for exposure. Environmental factors include:

◆Physical factors such as geology and climate

◆Biologic factors such as insects that transmit the agent

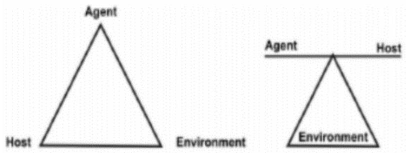
◆Socioeconomic factors such as crowding, sanitation and the availability of health services

NOTE:

✓ Agent + Host + Environmental factors = Etiology of a disease

✓ The factor which can be modified, interrupted or nullified is most important.

→ **Wrap Up:**



Factors Associated with Increased Risk of Human Disease

HOST (Intrinsic)	AGENTS	ENVIRONMENT (Extrinsic)
Age	Biological (bacteria, etc.)	Temperature
Gender	Chemical (poison, alcohol, smoke)	Humidity
Ethnicity	Physical (auto, radiation, fire)	Altitude
Religion	Nutritional (lack, excess)	Crowding
Customs		Housing
Occupation		Neighborhood
Heredity		Water
Marital status		Milk
Family background		Food
Previous diseases		Radiation
		Air pollution
		Noise

NOTE:

Development of appropriate, practical, and effective public health measures to control or prevent disease usually requires assessment of all three components and their interactions

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While the epidemiologic triad serves as a useful model for many diseases, it has proven inadequate for cardiovascular disease, cancer, and other diseases that appear to have multiple contributing causes without a single necessary one.

(i.e. chronic diseases)

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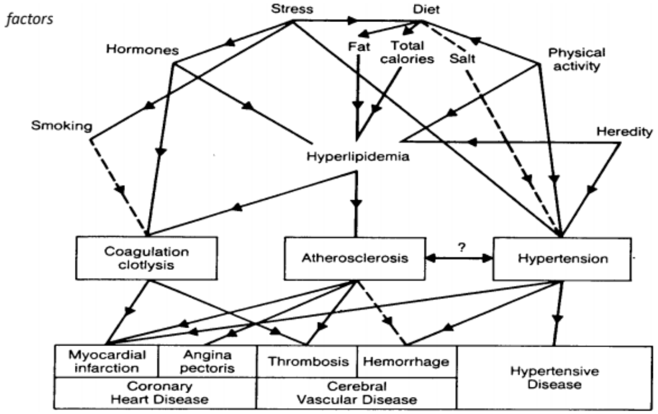
◇ **Multicausality and Webs of Causation (cause shown via Hill's criteria and discovering the causes of chronic diseases) [The most advanced theory]:**

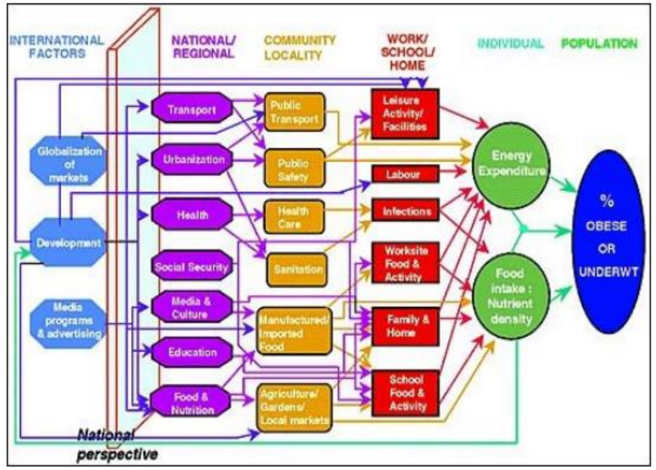
i.e. Cardiovascular Diseases

In diet we have salt we have total calorie intake we have fat from the diet, some of them lead to hypertension directly. If we look at hypertension it is a factor related to hypertensive disease and hypertension related to hemorrhage and cerebral vascular hypertension related to myocardial infarction.

factors



i.e. Obesity



***Factors for Disease Causation:**

◇ **Sufficient factors:**

Ones that inevitably produce disease (the presence of this type of factors always results in disease)

◇ **Necessary factors:**

Without which disease does not occur, but by itself, it is not sufficient to cause disease (the disease will not occur without the presence of the factor)

→ **In this respect, Causal Relationships could be classified into:**

I☞ Necessary and Sufficient:

-Without that factor, the disease never develops (factor is necessary). And in presence of that factor, the disease always develops (factor is sufficient)

-A certain factor whenever it's there by itself will result in occurrence of a disease

-Rare situation

II☞ Necessary, but not Sufficient:

Multiple factors are required, often in specific temporal sequence (cancer, initiator then promoter). Infectious diseases also (Infection with HIV is necessary but not sufficient to cause AIDS)

III☞ Sufficient, but not Necessary:

Various factors independently can produce the disease (Either radiation or benzene exposure can each produce leukemia without the presence of the other)

IV☞ Neither Sufficient nor Necessary:

-More complex model

-Probably most accurately represents causal relationships that operate in most chronic diseases

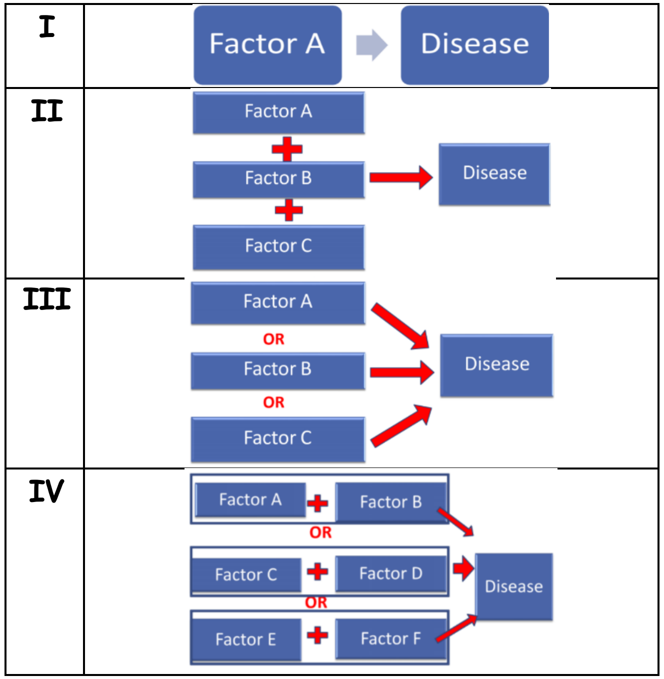
NOTE:

✓ Public health action does not depend on the identification of every cause of a disease

✓ Disease prevention can be accomplished by blocking any single factor from any combination of causes.

For example, elimination of smoking would prevent lung cancer, although some lung cancer would still occur to people who never smoked but have the right combination of other risk factors.

→ **Wrap Up:**

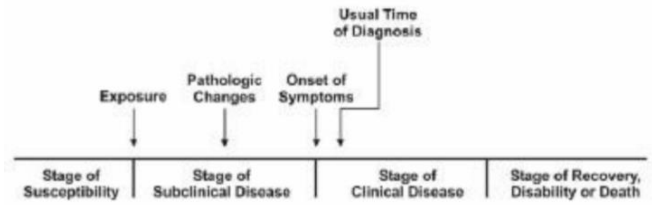


NATURAL HISTORY OF DISEASES:

***Natural History:**

The progression of a disease process in an individual over time, in the absence of treatment.

For example, untreated infection with HIV causes a *spectrum* of clinical problems beginning at the time of seroconversion (primary HIV) and terminating with AIDS and usually death. It is now recognized that it may take 10 years or more for AIDS to develop after seroconversion.



***Spectrum of Disease:**

Because the spectrum of disease can include asymptomatic and mild cases, the cases of illness diagnosed by clinicians in the community often represent only the tip of the iceberg. Such persons, who are infectious but have subclinical disease, are called **carriers**.

→ **Carriers:**

Frequently, carriers are persons with incubating disease or inapparent infection. Persons with measles, hepatitis A, influenza and several other diseases become infectious a few days before the onset of symptoms.

However, carriers may also be persons who appear to have recovered from their clinical illness but remain infectious, or persons who never exhibited symptoms.

NOTE:

Carriers are the most dangerous group in the population

→ Unapparent Infection:

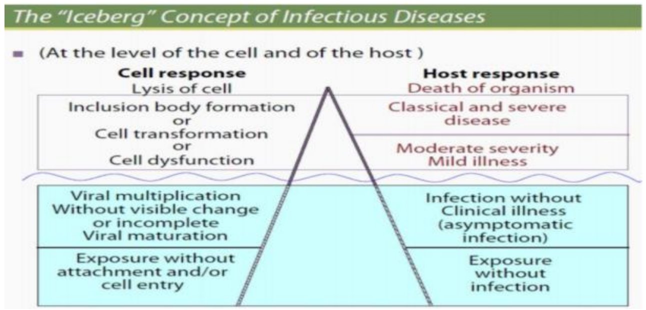
◆Preclinical disease: in the early stage of disease progression, disease is not clinically detected but is destined to become clinical disease

◆Subclinical disease: disease is not detected but the host carries the organism or has antibody response

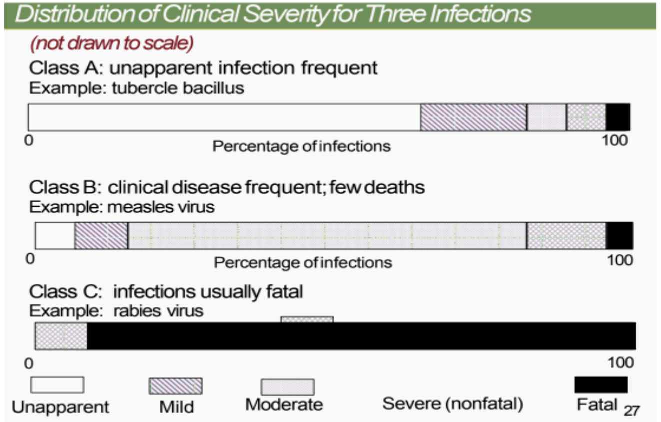
◆Chronic carriers are those who continue to harbor a pathogen such as hepatitis B virus or Salmonella Typhi, the causative agent of typhoid fever, for months or even years after their initial infection

One notorious carrier is Mary Mallon, or Typhoid Mary, who was an asymptomatic chronic carrier of Salmonella Typhi. As a cook in New York City and New Jersey in the early 1900s, she unintentionally infected dozens of people until she was placed in isolation on an island in the East River, where she died 23 years later.

→ The "Iceberg" Concept of Infectious Diseases:



→ Distribution of Clinical Severity for Three Different Infections:

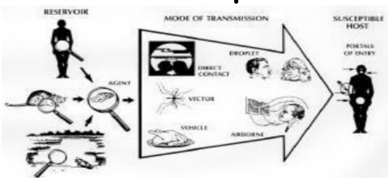


→ Incubation Periods for a Selected Number of Exposures and Diseases:

Exposure	Clinical Effect	Incubation/Latency Period
Saxitoxin and similar toxins from shellfish	Paralytic shellfish poisoning (tingling, numbness around lips and fingertips, giddiness, incoherent speech, respiratory paralysis, sometimes death)	few minutes-30 minutes
Organophosphorus ingestion	Nausea, vomiting, cramps, headache, nervousness, blurred vision, chest pain, confusion, twitching, convulsions	few minutes-few hours
Salmonella	Diarrhea, often with fever and cramps	usually 6–48 hours
SARS-associated corona virus	Severe Acute Respiratory Syndrome (SARS)	3–10 days, usually 4–6 days
Varicella-zoster virus	Chickenpox	10–21 days, usually 14–16 days
Treponema pallidum	Syphilis	10–90 days, usually 3 weeks
Hepatitis A virus	Hepatitis	14–50 days, average 4 weeks
Hepatitis B virus	Hepatitis	50–180 days, usually 2–3 months
Human immunodeficiency virus	AIDS	<1 to 15+ years
Atomic bomb radiation (Japan)	Leukemia	2–12 years
Radiation (Japan, Chernobyl)	Thyroid cancer	3–20+ years
Radium (watch dial painters)	Bone cancer	8–40 years

*Chain of Infection:

Transmission occurs when the **agent** leaves its **reservoir** or host through a **portal of exit**, is conveyed by some **mode of transmission**, and enters through an appropriate **portal of entry** to infect a **susceptible host**.



→ Reservoir:

The habitat in which the agent normally lives, grows, and multiplies.

NOTE:

The reservoir may or may not be the source from which an agent is transferred to a host. For example, the reservoir of Clostridium botulinum is soil, but the source of most botulism infections is improperly canned food containing C. botulinum spores.

◆Human Reservoir:

-Diseases that are transmitted from person to person without intermediaries include the sexually transmitted diseases, measles, mumps, streptococcal infection, and many respiratory pathogens

-Because humans were the only reservoir for the smallpox virus, naturally occurring smallpox was eradicated after the last human case was identified and isolated

◆Animal Reservoir:

-Many of these diseases are transmitted from animal to animal, with humans as incidental hosts

-The term **zoonosis** refers to an infectious disease that is transmissible under natural conditions from vertebrate animals to humans. Long recognized zoonotic diseases include brucellosis (cows and pigs), anthrax (sheep), plague (rodents), trichinellosis/trichinosis (swine), and rabies (bats, raccoons, dogs, and other mammals)

-Many newly recognized infectious diseases in humans, including HIV/AIDS, Ebola infection and SARS, are thought to have emerged from animal hosts, although those hosts have not yet been identified

◆Environmental Reservoir:

- Plants, soil, and water in the environment are also reservoirs for some infectious agents
-Many fungal agents, such as those that cause histoplasmosis, live and multiply in the soil
-Outbreaks of Legionnaires disease are often traced to water supplies in cooling towers and evaporative condensers, which are the reservoirs for the causative organism Legionella pneumophila

→ Portal of Exit:

The path by which a pathogen leaves its host. The portal of exit usually corresponds to the site where the pathogen is localized in the body. For example:

Pathogen	Portal of Exit
Influenza viruses and Mycobacterium tuberculosis	Respiratory tract
Schistosomes	Urine
Cholera vibrio	Feces
Sarcoptes scabies	Skin lesions
[Some Bloodborne Pathogens]	
Rubella, syphilis, toxoplasmosis	By crossing the placenta from mother to fetus
Hepatitis B	Cuts or needles in the skin
Malaria	Blood-sucking arthropods

→ Modes of Transmission:

◆Direct transmission (person-to-person):

-Direct contact: skin-to-skin contact, kissing (saliva), sexual contact and soil
-Droplet spread: spray with relatively large, short-range aerosols produced by sneezing, coughing, or even talking (Polio, hepatitis B, HIV, influenza)

NOTE:

Vertical transmission (inter-generation) is the transmission of disease-causing agents from mother directly to baby

- Just before or just after birth
- Via placenta or breast milk

Horizontal transmission: all other transmissions

Diseases that can be transmitted from mother to baby include:

- HIV
- Hepatitis C

◆Indirect transmission:

-Airborne: infectious agents are carried by dust or droplet nuclei suspended in air (<5 microns) (measles in a doctor's office)
-Vehicle-borne (inanimate objects): food (Closterium Botulinum), water (Hepatitis A virus), biologic products (blood), and fomites (such as handkerchiefs, bedding, surgical scalpels, tooth brush, toys, cutting board)
-Vector-borne (mechanical or biologic): mosquitoes, fleas, and ticks may carry an infectious agent through purely mechanical means, or may support growth or changes in the agent (E. coli infection, coxsackievirus (hand-foot-mouth disease), lice, meningitis, rotavirus diarrhea)

→ Portal of Entry:

The manner in which a pathogen enters a susceptible host.
The portal of entry must provide access to tissues in which the pathogen can multiply, or a toxin can act.

✓ Often, infectious agents use the same portal to enter a new host that they used to exit the source host. For example, influenza virus exits the respiratory tract of the source host and enters the respiratory tract of the new susceptible host.

✓ In contrast, many pathogens that cause gastroenteritis follow a so-called "fecal-oral" route because they exit the source host in feces, are carried on inadequately washed hands to a vehicle such as food, water, or utensil, and enter a new host through the mouth.

✓ Other portals of entry include the skin (hookworm), mucous membranes (syphilis), and blood (hepatitis B, human immunodeficiency virus).

→ Susceptible Host:

-Susceptibility of a host depends on genetic factors, specific immunity [protective antibodies that are directed against a specific agent. Such antibodies may develop in response to infection, vaccine, or toxoid], and nonspecific factors (skin, mucous membranes, gastric acidity, cilia in the respiratory tract, the cough reflex) that affect an individual's ability to resist infection or to limit pathogenicity.

For example, persons with sickle cell trait seem are partially protected from a particular type of malaria.

-Factors that may increase susceptibility to infection by disrupting host defenses include malnutrition, alcoholism, and disease or therapy that impairs the nonspecific immune response (chemotherapy).

***Chain of Infection: Implications for Public Health:**

Knowledge of the portals of exit and entry and modes of transmission provides a basis for determining appropriate control measures. In general, control measures are usually directed against the segment in the infection chain that is most susceptible to intervention.

✓ Some interventions are directed at the **mode of transmission** (isolation of someone with infection, or counseling persons to avoid the specific type of contact associated with transmission), i.e. personal hygiene and social distancing to prevent Covid-19.

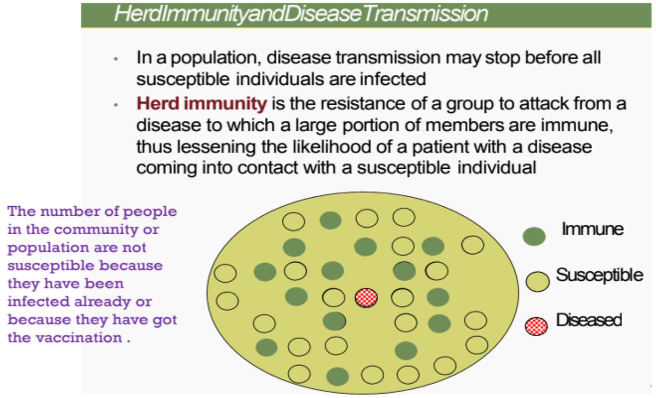
✓ Some strategies that protect **portals of entry** are simple and effective (bed nets for mosquitoes, mask, gloves, and face shield).

✓ Some interventions aim to increase a host's defenses (Vaccinations).

✓ Some interventions attempt to prevent a pathogen from encountering a susceptible host (The concept of **herd immunity** in childhood vaccines).

→ Herd Immunity:

The higher the proportion of immune people the lower is the likelihood that people without immunity will get infected, because the lower the probability that a person with a disease will come into contact with someone in the population who is susceptible.



✍ Requirements for Herd Immunity:

☞ The disease agent is restricted to a single-host species within which transmission occurs (For example, smallpox in human; no reservoir in the environment)

☞ There is relatively direct transmission from one member of the host species to another (direct contact only)

☞ Infections must induce solid immunity (also from immunization)

[A person becomes immune after being infected if this these three conditions are present]

✍ Herd Immunity and Disease Control:

The success of herd immunity in controlling the disease depends on the proportion of subjects with immunity in a population (Immunity can be from infection or immunization [natural or unnatural immunity]).

So, when the population is immunized at or above the herd immunity level (**critical immunization threshold level**), the infectious disease will be rarer, will spread less and will be eliminated.

NOTE:

Herd immunity level differs for various diseases. For example:

-It is estimated that 94% of the population must be immune before measles can be controlled

-For mumps, it is around 90%

-For polio, it is 80%

[The more infectious the disease is, the higher the herd immunity level]