

## Disease causation:

Cause in medical textbooks discussed under headings like: “**etiology**”, “**Pathogenesis**”, “**Mechanisms**”, “**Risk factors**”

Important to physician because it guides their approach to three clinical tasks: **Prevention, Diagnosis & Treatment**

**Theories of Disease Causation: (from eldest to newest)**

**1-Supernatural Theories:** curse, evil force of the demon

**2- Hippocratic Theory:** Hippocrates promoted the concept that **disease was the result of an imbalance among four vital "humors" within us: Yellow Bile, Black Bile, Phlegm, Blood** (if one of the humors became excessive or deficient, health would deteriorate and symptoms would develop)

Hippocrates tried to relate an individual's exposures (diet, exercise, occupation,..) to subsequent health outcomes.

**3- Miasma:** focused attention on environmental causes of disease and partly explained social disparities in health (poor people being more likely to live near foul odors (dirty street/environment))

**4- Theory of Contagion:** How contagious disease **transfer**

**5- Germ Theory:** (after invention of microscope)

**Henle-Koch postulates:** 1-The agent is present in every case of the disease 2- It does not occur in any other disease (one agent one disease) 3- It can be isolated from a person who's infected and if exposed to healthy subjects will cause the related disease

**6- Classic Epidemiologic Theory:** Epidemiologic Triad

<p><b>Agent:</b> referred to an <b>infectious microorganism</b> or pathogen: a virus, bacterium, parasite, or other microbe.</p> <p>The agent must be present for disease to occur; however, presence of that agent alone is not always sufficient to cause disease</p> <p><u>Factors will influence a disease:</u></p> <p><b>Infectivity</b> refers to the proportion of exposed persons who become infected.</p> <p><b>Pathogenicity</b> refers to the proportion of infected individuals who develop clinically apparent disease.</p> <p><b>Virulence</b> refers to the proportion of clinically apparent cases that are severe or fatal.</p> <p>Over time, the concept of agent has been broadened to include chemical (poison, smoke, alcohol) ,physical forces (such as repetitive mechanical forces associated with carpal tunnel syndrome, radiation), and nutritional (vitamin deficiency)</p>	<p><b>Host:</b> The human who can get the disease</p> <p>Risk factors: a variety of factors intrinsic to the host that can influence an individual's <u>exposure, susceptibility, or response</u> to a causative agent.</p> <p><b>Opportunities for exposure</b> are often influenced by → behaviors such as sexual practices, hygiene, etc</p> <p><b>Susceptibility and response</b> are influenced by → genetic composition, nutritional and immunologic status, anatomic structure, presence of disease or medications, and psychological makeup</p>	<p><b>Environment :</b>extrinsic factors that affect the agent and the opportunity for exposure</p> <p><b>Factors:</b></p> <p><u>Physical factors</u> such as geology and climate,</p> <p><u>Biologic factors</u> such as insects that transmit the agent,</p> <p><u>Socioeconomic factors</u> such as crowding, sanitation, and the availability of health services.</p>
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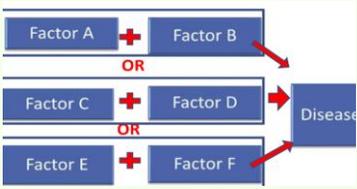
- These 3 factors interrelate in a variety of complex ways to produce disease.
- Different diseases require different balances and interactions of these three components.
- Development of appropriate, practical, and effective public health measures to control or prevent disease usually requires assessment of all three components and their interactions.
- it has proven inadequate for cardiovascular disease, cancer, and other diseases

Factors Associated with Increased Risk of Human Disease		
<b>HOST (Intrinsic)</b>	<b>AGENTS</b>	<b>ENVIRONMENT (Extrinsic)</b>
<ul style="list-style-type: none"> <li>■ Age</li> <li>■ Gender</li> <li>■ Ethnicity</li> <li>■ Religion</li> <li>■ Customs</li> <li>■ Occupation</li> <li>■ Heredity</li> <li>■ Marital status</li> <li>■ Family background</li> <li>■ Previous diseases</li> </ul>	<ul style="list-style-type: none"> <li>■ Biological (bacteria, etc.)</li> <li>■ Chemical (poison, alcohol, smoke)</li> <li>■ Physical (auto, radiation, fire)</li> <li>■ Nutritional (lack, excess)</li> </ul>	<ul style="list-style-type: none"> <li>■ Temperature</li> <li>■ Humidity</li> <li>■ Altitude <small>الارتفاع عن سطح البحر</small></li> <li>■ Crowding</li> <li>■ Housing</li> <li>■ Neighborhood</li> <li>■ Water</li> <li>■ Milk</li> <li>■ Food</li> <li>■ Radiation</li> <li>■ Air pollution</li> <li>■ Noise</li> </ul>

**7- Multicausal Theories:** to have multiple contributing causes without a single necessary one

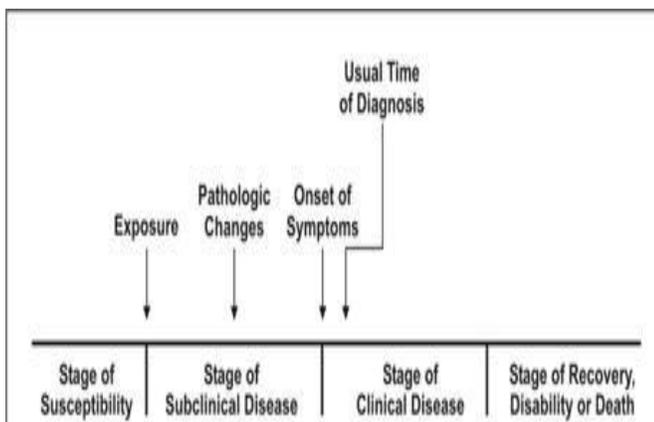
The sum of all factors that contribute to the occurrence of a disease; the **factor which can be modified**, interrupted or nullified is **most important**.

**\*\*A causal pathway may be direct** (without intermediate effects (very rare)) **or indirect** (with intermediate effects)

<p><b>Necessary &amp; Sufficient:</b> Without that factor, the disease never develops (necessary) and in presence of that factor, the disease always develops (sufficient). Rare situation</p>	<p><b>Necessary, but not Sufficient:</b> Multiple factors are required, often in specific temporal (time) sequence (cancer, initiator then promoter). Infectious diseases also (Infection with HIV is necessary but not sufficient to cause AIDS). If one is missed, the disease won't develop</p>	<p><b>Sufficient, but not Necessary:</b> Various factors independently can produce the disease.</p>	<p><b>Neither sufficient nor Necessary</b></p> <ul style="list-style-type: none"> <li>•More complex model.</li> <li>•Probably most accurately represents causal relationships that operate in most chronic diseases.</li> </ul> 
<p><b>Sufficient factors:</b> one that inevitably produces disease (the presence of the factor always result in disease). <b>Necessary factors:</b> 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)</p>			

**Natural history of disease:**

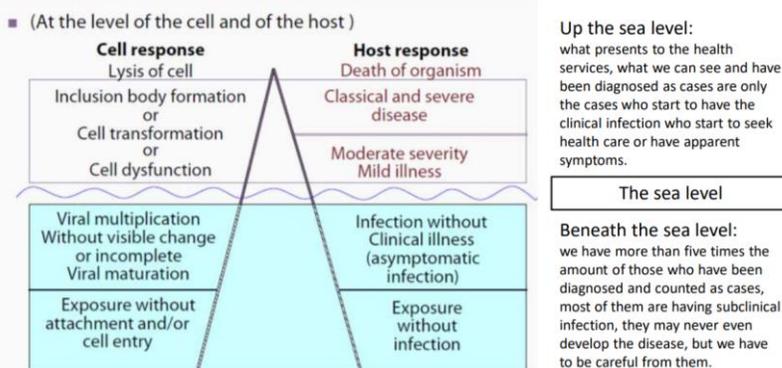
The progression of a disease process in an individual over time, in the absence of treatment.



Starts with the **stage of susceptibility**, followed by the **stage of subclinical disease** with pathologic changes occur with no symptoms, then onset of symptoms starts (the start of **clinical stage**), after a short while, it is the usual time of diagnosis, lately, the **stage of recover, disability or death**.

**\*\*Carriers:** persons who are infectious but have **subclinical disease**, or persons who appear to have **recovered** from their clinical illness but remain infectious, such as chronic carriers of hepatitis B virus, or persons who never exhibited symptoms. (Can transform the pathogen to others)

**The "Iceberg" Concept of Infectious Diseases**



**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.

### 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**.

#In general, control measures are usually directed against **the segment in the infection chain that is most susceptible to intervention** (any place in the chain that we can block or make a break, this can stop the infection sequence)

**Reservoir**, the habitat in which the agent normally lives, grows, and multiplies

The reservoir may or may not be the source from which an agent is transferred to a host

1- **Human Reservoir**: 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.)

2- **Animal Reservoir**: **zoonosis** refers to an infectious disease that is transmissible under natural conditions from vertebrate animals to humans 1-Long recognized zoonotic diseases brucellosis (cows and pigs), anthrax (sheep), plague (rodents), trichinellosis/trichinosis (swine), and rabies (bats, raccoons, dogs, and other mammals) 2- newly recognized infectious diseases thought have emerged from animal hosts HIV/AIDS, Ebola infection and SARS

3- **Environmental Reservoir**: (Plants, soil, and water) Many fungal agents; histoplasmosis in the soil, Legionella pneumophila that causes severe pneumonia; water supplies in cooling towers and evaporative condensers

**Portal of Entry**: the manner in which a pathogen enters a susceptible host; 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. \*\* pathogens that cause gastroenteritis follow a so-called "fecal-oral" route →Skin (hookworm which penetrates the skin), mucous membranes (syphilis), and blood (hepatitis B, human immunodeficiency virus (HIV)) #To protect portals of entry are simple and effective (bed nets for mosquitoes, mask, gloves, and face shield)

**Susceptible Host**: depends on genetic factors, specific immunity, and nonspecific factors that affect an individual's ability to resist infection or to limit pathogenicity. 1-Specific immunity refers to protective antibodies 2- Nonspecific factors they are the physical barriers against the organism Persons with sickle cell trait seem are partially protected from a particular type of malaria (genetic factors). #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)

### **Modes of Transmission:**

**Direct transmission** (person-to-person); kin-to-skin contact, kissing (saliva), sexual contact, and soil. Droplet spread

**Indirect transmission:**

a- **Airborne**: infectious agents are carried by dust or droplet nuclei suspended in air (very small, very light weight) b- **Vehicleborne** (inanimate objects): food (Clostridium Botulinum), water (Hepatitis A virus), biologic products (blood), and fomites (such as handkerchiefs, bedding,..) c- **Vectorborne** (mechanical or biologic) through small insects (mosquitoes, fleas,..) like or may support growth or changes in the agent (E. coli infection, meningitis, rotavirus diarrhea,..)

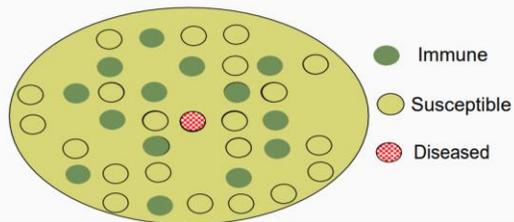
\***Vertical transmission** (inter-generation) is the transmission of disease-causing agents from mother directly to baby 1-Just before or just after birth 2-Via placenta or breast milk [e.g. HIV & Hepatitis C]

\***Horizontal transmission**: all other transmissions #Some interventions are directed at the mode of transmission (isolation of someone with infection,..)

**Portal of Exit**: the path by which a pathogen leaves its host; usually corresponds to the site where the pathogen is localized. influenza viruses and (Mycobacterium tuberculosis exit the respiratory tract, schistosomes through urine, cholera vibrios in feces, Sarcoptes scabiei in scabies skin lesions) bloodborne agents (rubella, syphilis, toxoplasmosis) can exit by crossing the placenta from mother to fetus, while hepatitis B exit through cuts or needles in the skin or malaria (with mosquitos) blood-sucking arthropods

### Herd Immunity and Disease Transmission

- In a population, disease transmission may stop before all susceptible individuals are infected
- **Herd immunity** is the resistance of a group to attack from a disease to which a large portion of members are immune, thus lessening the likelihood of a patient with a disease coming into contact with a susceptible individual



→ The disease agent is **restricted to a single-host species** within which transmission occurs

→ **Direct contact only**

→ **Infections must induce solid immunity**

→ **Herd immunity level:** a level for the proportion of the population that should be immunized or have got the infection for the herd immunity to start working

**Herd immunity level differs for various diseases** 94% measles can be controlled, mumps 90%, polio 80%

**The more infectious the disease is, the higher the herd immunity level**

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