STUDY ABOUT INFECTION

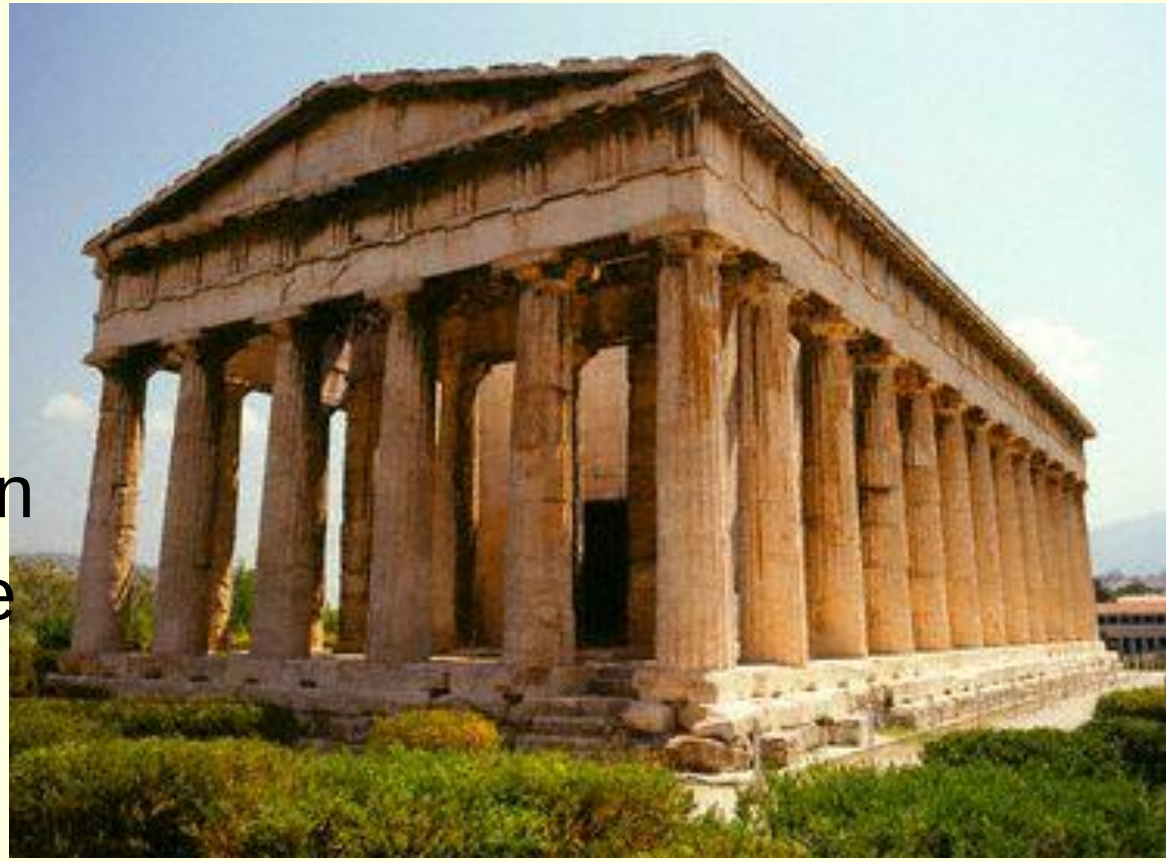
(Epidemiology)

Epidemiology

Epidemiology is derived from

three Greek root words

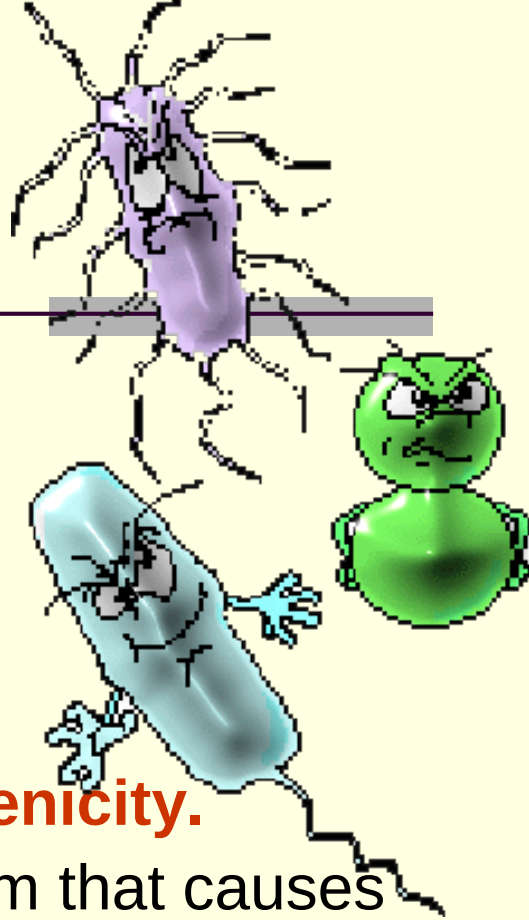
EPI on, upon
DEMOS people
LOGY study



Epidemiology is, thus, the study of what is upon the people. **In modern terms, it is the science of the distribution of disease and its determinants (causes).**

Epidemiological Terminology

- When a disease occurs occasionally, and at irregular intervals in a human population, it is a sporadic disease.
- When it maintains a steady, low-level frequency at a moderately regular interval, it is an endemic disease.
- An epidemic is a sudden increase in the occurrence of a disease above the expected level
- A pandemic is an increase in disease occurrence within a large population over a very wide region (usually the world).



An **infectious disease** is any change from a state of health in which part or all of the host body is not capable of carrying on its normal functions due to the presence of an organism or its products. Any organism or agent that produces such a disease is a **pathogen** [Greek *patho,* disease, and *gennan,* to produce].
Its ability to cause disease is called **pathogenicity.**
A **primary (frank) pathogen** is any organism that causes disease in a healthy host by a direct interaction. Conversely, an **opportunistic pathogen** is an organism that is either normally free-living, or a part of the host's normal microbiota, but which may adopt a pathogenic role under certain circumstances, such as when the immune system is compromised.

The outcome of most host-parasite relationships is dependent on three main factors:

(1) the number of organisms present in or on the host,

(2) the virulence of the organism,

(3) the host's defenses or degree of resistance.

The term **virulence** [Latin *virulentia,* from *virus,* poison] refers to the degree or intensity of pathogenicity. It is Determined by three characteristics of the pathogen: ***invasiveness, infectivity, and pathogenic potential.***

Invasiveness is the ability of the organism to spread to adjacent or other tissues. **Infectivity** is the ability of the organism to establish a focal point of infection.

Pathogenic potential refers to the degree that the pathogen causes damage. A major aspect of pathogenic potential is toxigenicity. **Toxigenicity** is the pathogen's ability to produce toxins, chemical substances that will damage the host and produce disease.

Virulence is often measured experimentally by determining the **lethal dose 50 (LD50)** or the **infectious dose 50 (ID50).** These values refer to the dose or number of pathogens that will either kill or infect, respectively, 50% of an experimental group of hosts within a specified period.

Infectious diseases:

- Are caused by microorganisms
- Are transmitted to humans from other humans, animals or the environment
- Usually follow recognizable patterns of symptoms, timing, etc.
- Evolve over time as new organisms emerge and human behavior and environments change

The course of an infectious disease usually has a characteristic pattern and can be divided into several phases.

1.The **incubation period** is the period between pathogen entry and the expression of signs and symptoms. The pathogen is spreading but has not reached a sufficient level to cause clinical manifestations. This period's length varies with disease.

2. The **prodromal stage** is the period in which there is an onset of signs and symptoms, but they are not yet specific enough to make a diagnosis. The patient often is contagious.

3. The **illness period** is the phase in which the disease is most severe and has characteristic signs and symptoms.

4. In the period of **decline**, the signs and symptoms begin to disappear. The recovery stage often is referred to as convalescence.

Often infectious diseases have characteristic **signs** and **symptoms.**

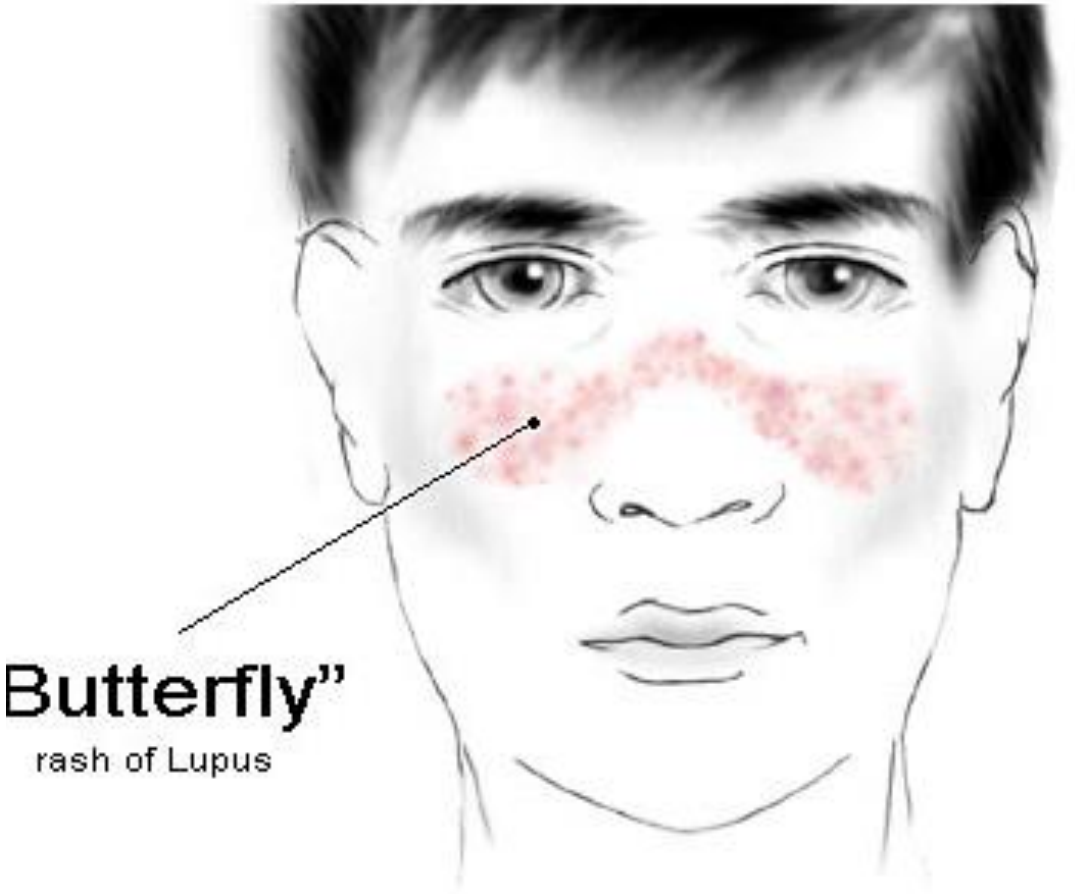
- **Signs** are objective changes in the body, such as a fever or rash, that can be directly observed.
- **Symptoms** are subjective changes, such as pain and loss of appetite, that are personally experienced by the patient.
- A **disease syndrome** is a set of signs and symptoms that are characteristic of the disease.

Common **signs** and **symptoms** of infectious diseases

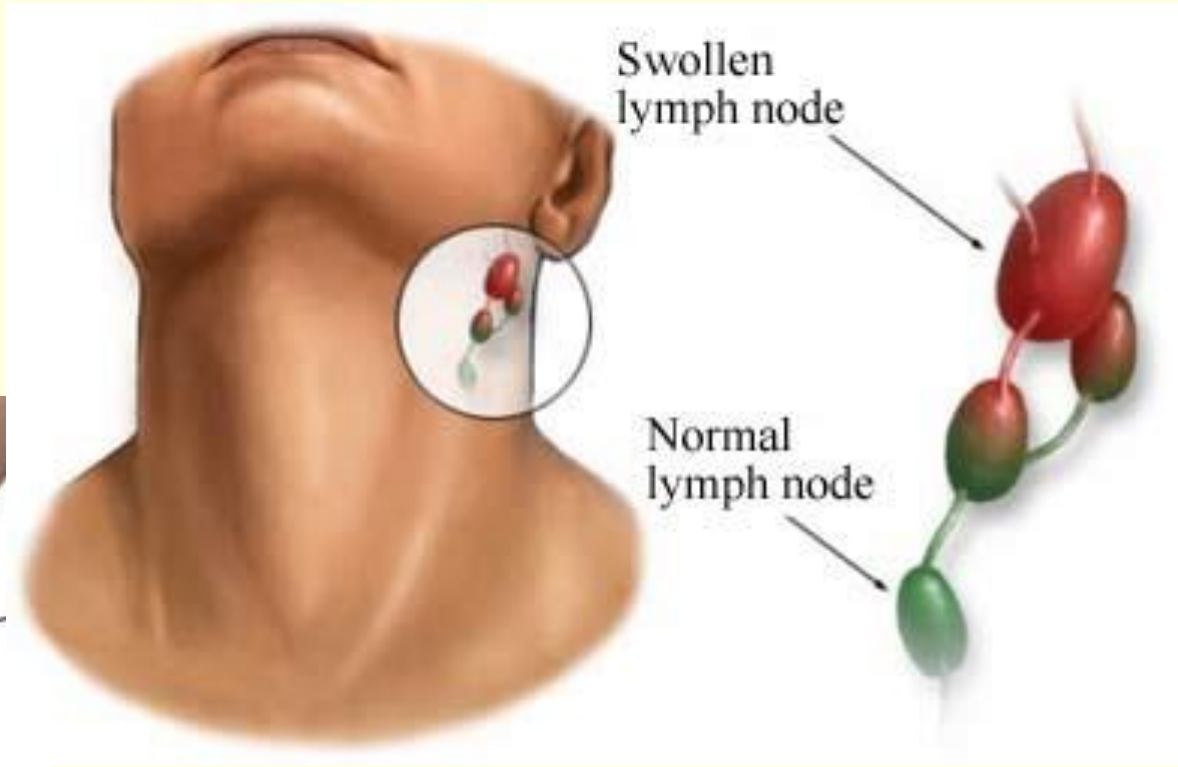
Sings	**Symptoms**
Fever	Chills
Septicemia	Pain, ache, soreness, irritation
Microbes in tissue fluids	Fatigue
Chest sounds	Malaise
Skin eruptions	Chest tightness
Leukocytosis	Itching
Leukopenia	Headache
Swollen lymph nodes	Nausea
Abscesses	Abdominal cramps
Tachycardia	Anorexia (lack of appetite)
Antibodies in serum	Sore throat

Fever

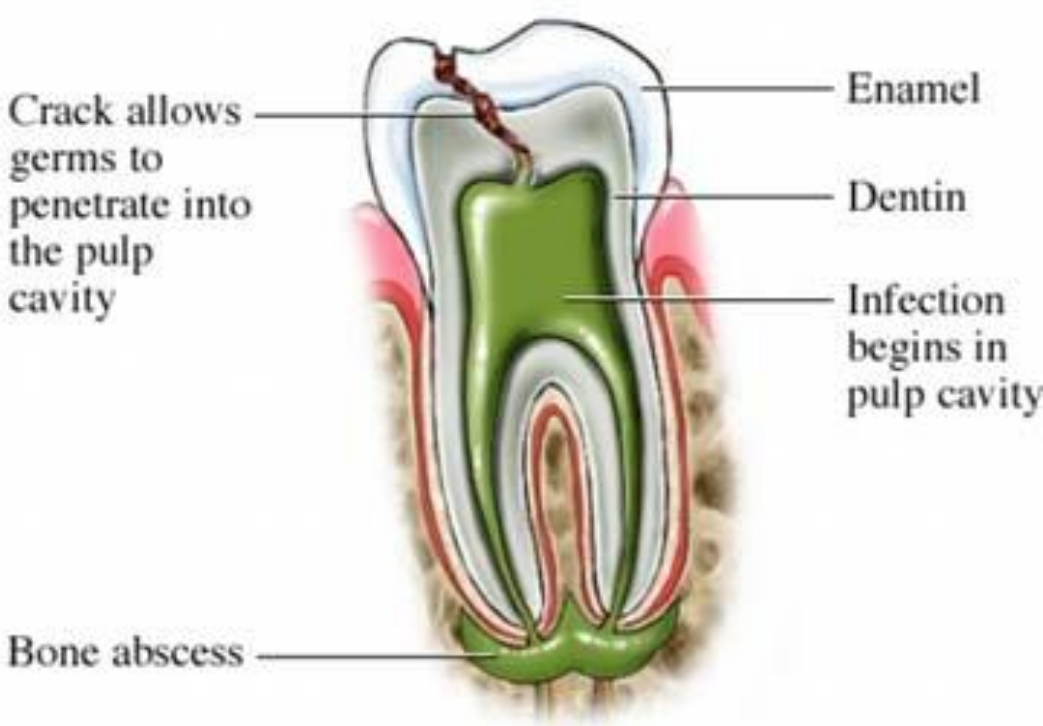
Rash

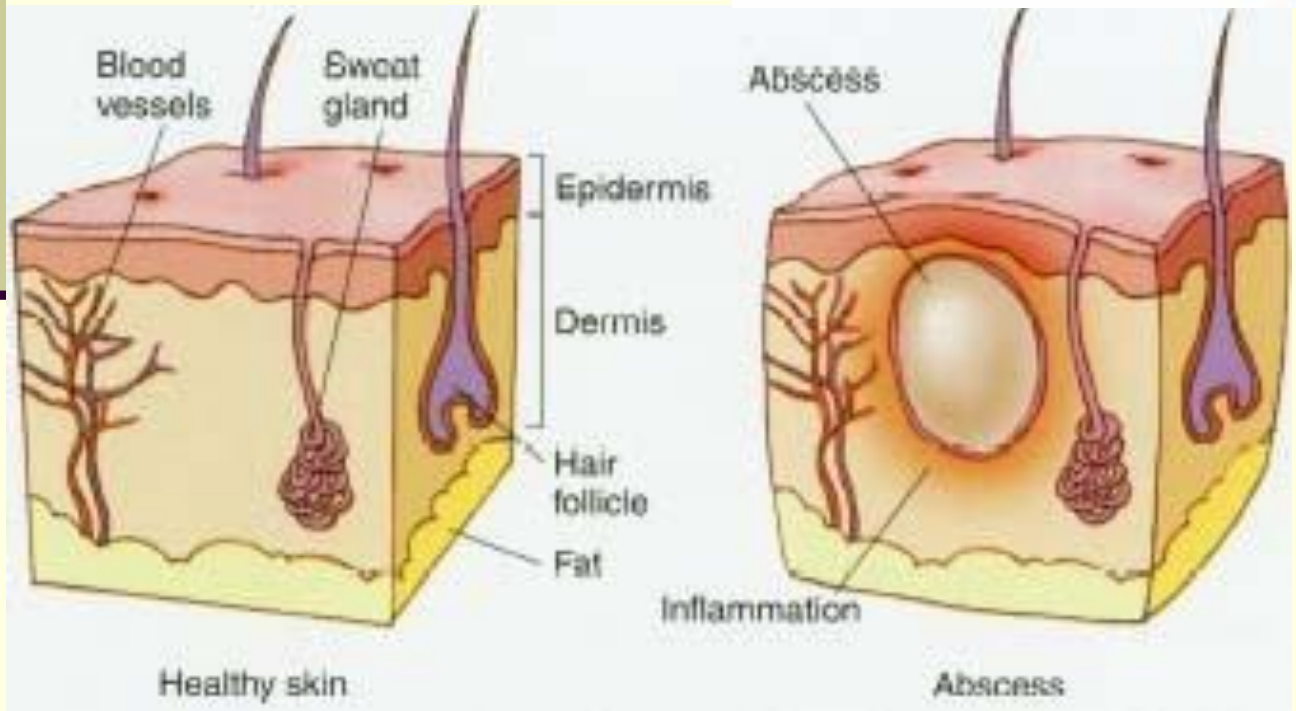


Swollen lymph nodes



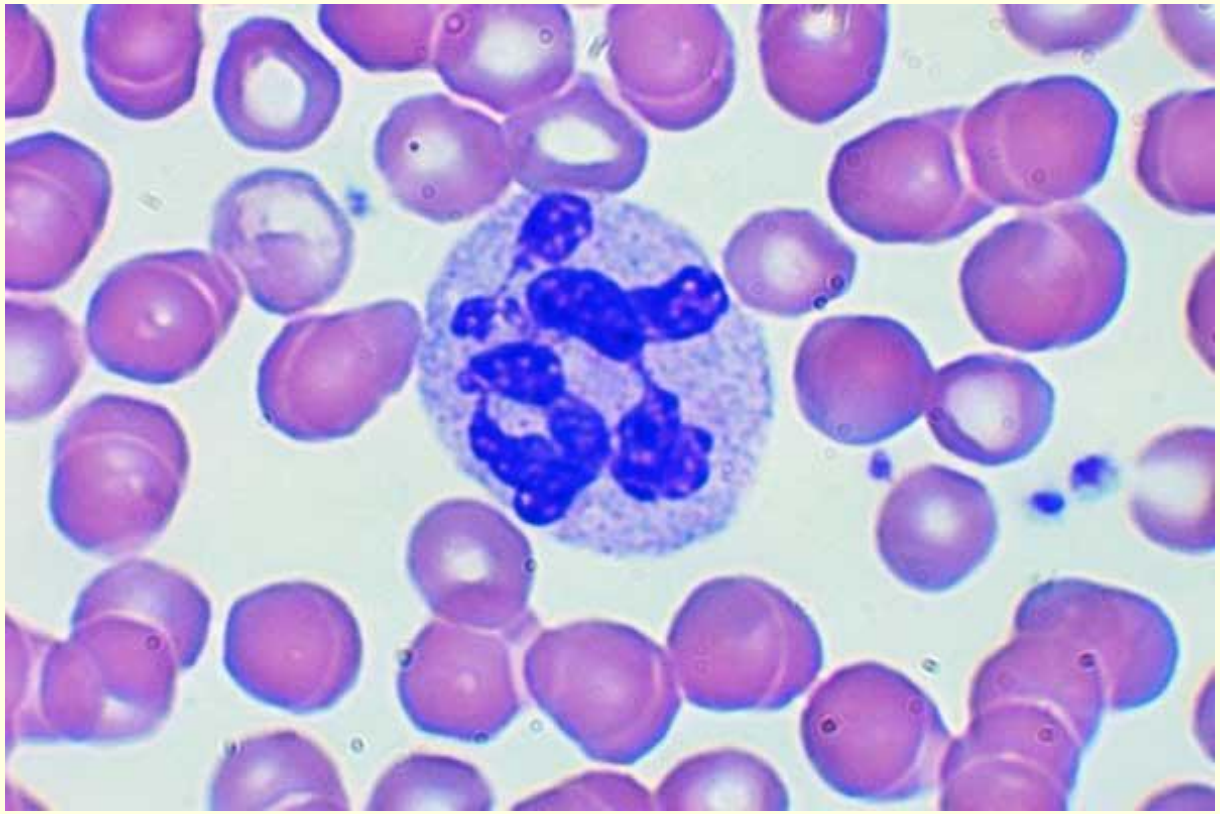
Abscesses


Crack allows germs to penetrate into the pulp cavity
Enamel
Dentin
Infection begins in pulp cavity
Bone abscess


Blood vessels
Sweat gland
Epidermis
Dermis
Hair follicle
Fat
Healthy skin
Abscess
Inflammation
Abscess

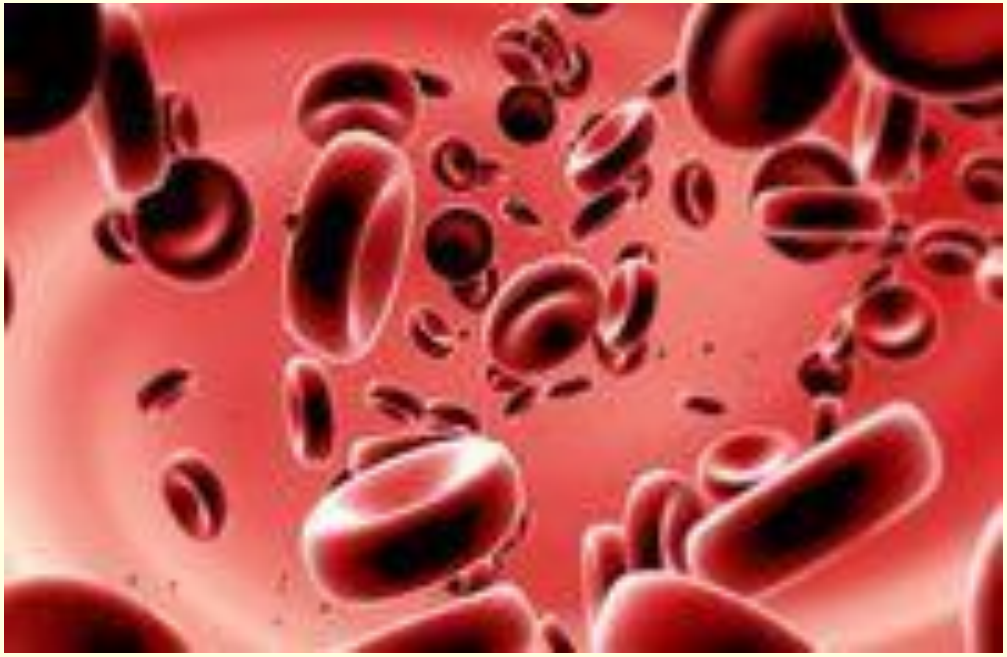
Leukocytosis

Leukocytosis is a raised white blood cell count (the leukocyte count) above the normal range.

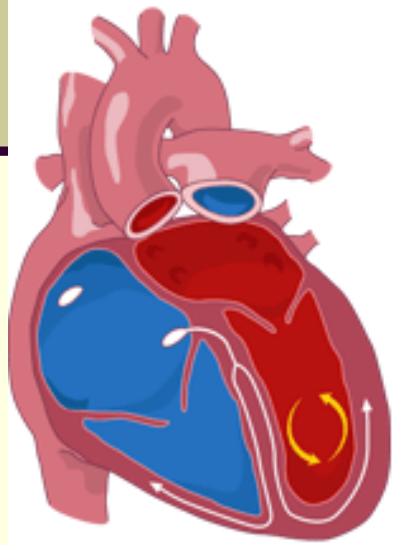


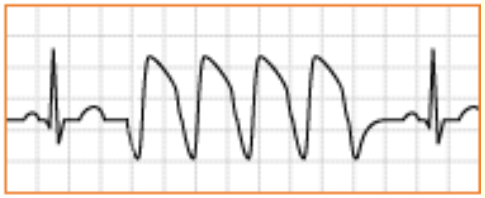
Leukopenia

Leukopenia is a decrease in the number of circulating white blood cells (leukocytes) in the blood. As the principal function of white cells is to combat infection, a decrease in the number of these cells can place patients at increased risk for infection.

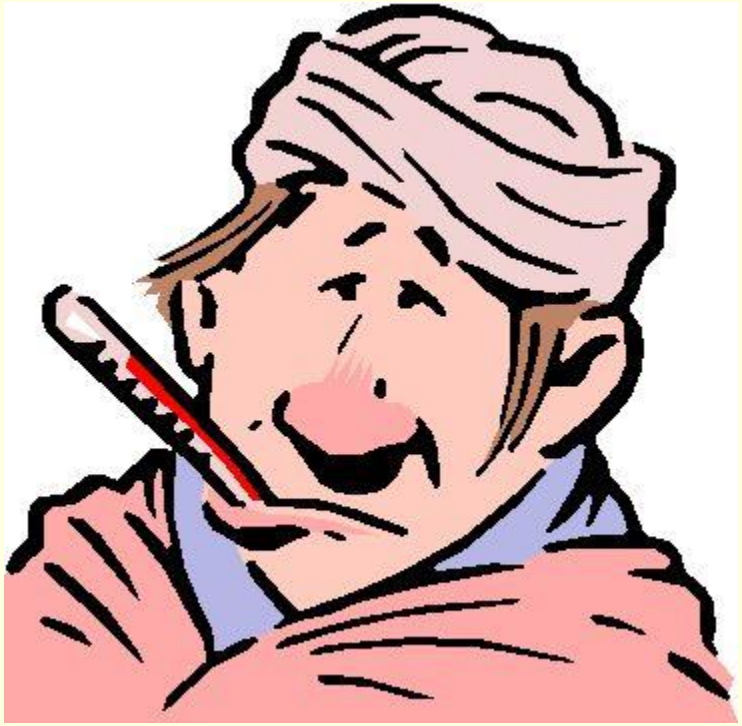


Tachycardia

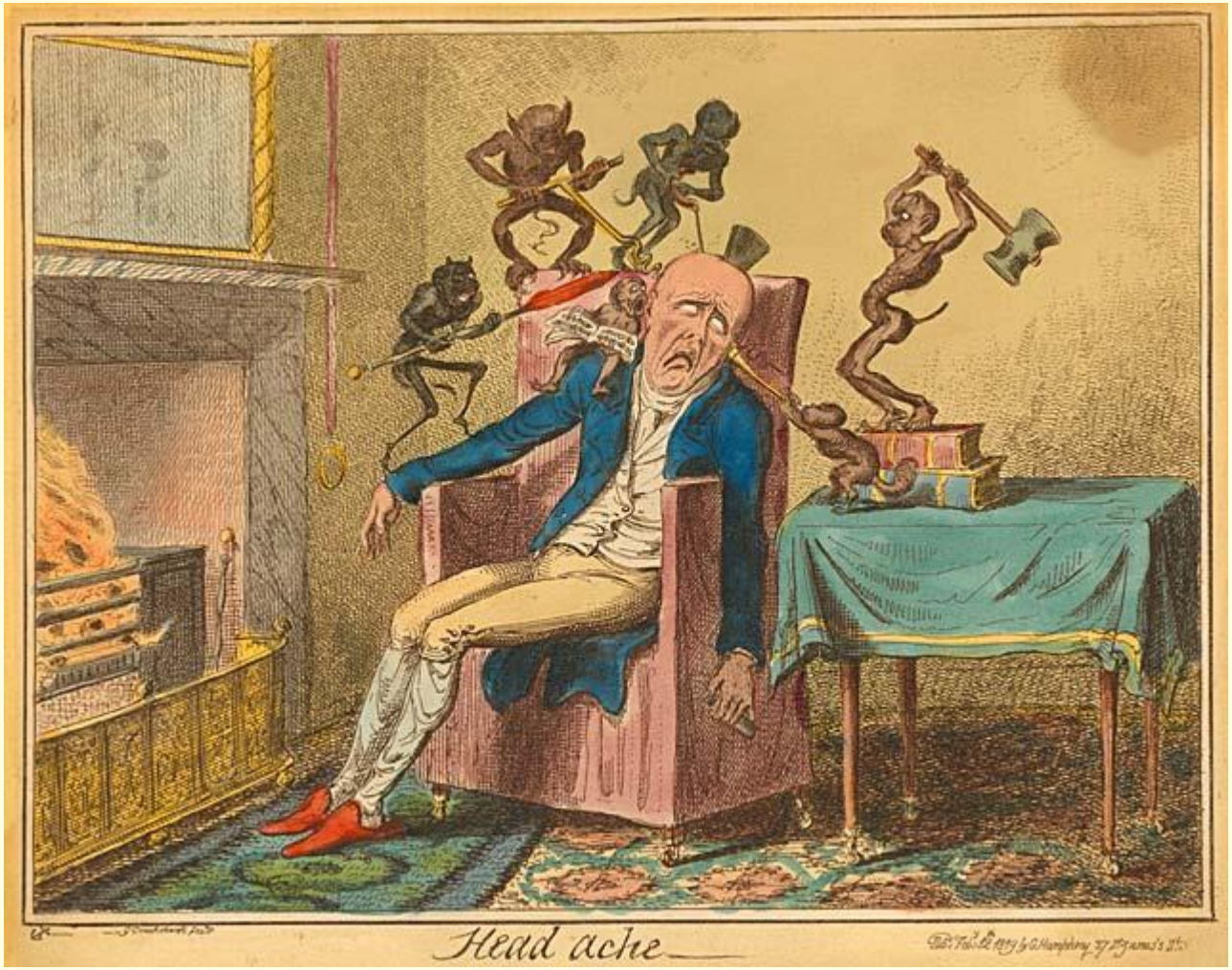




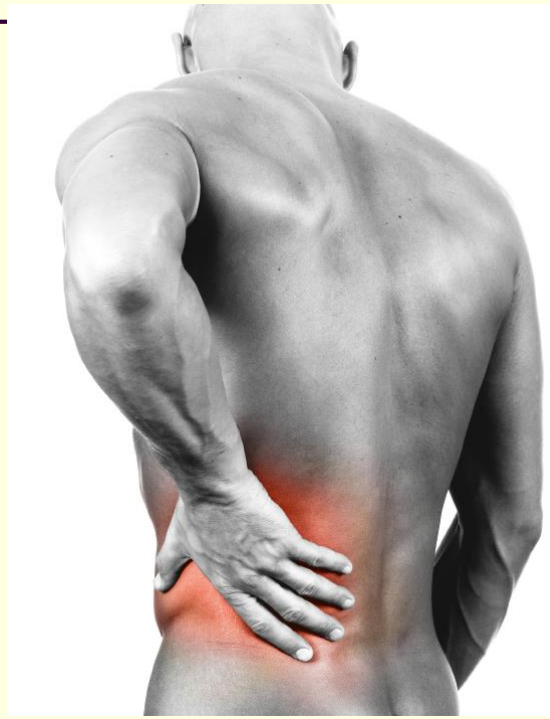
Chills



Headache

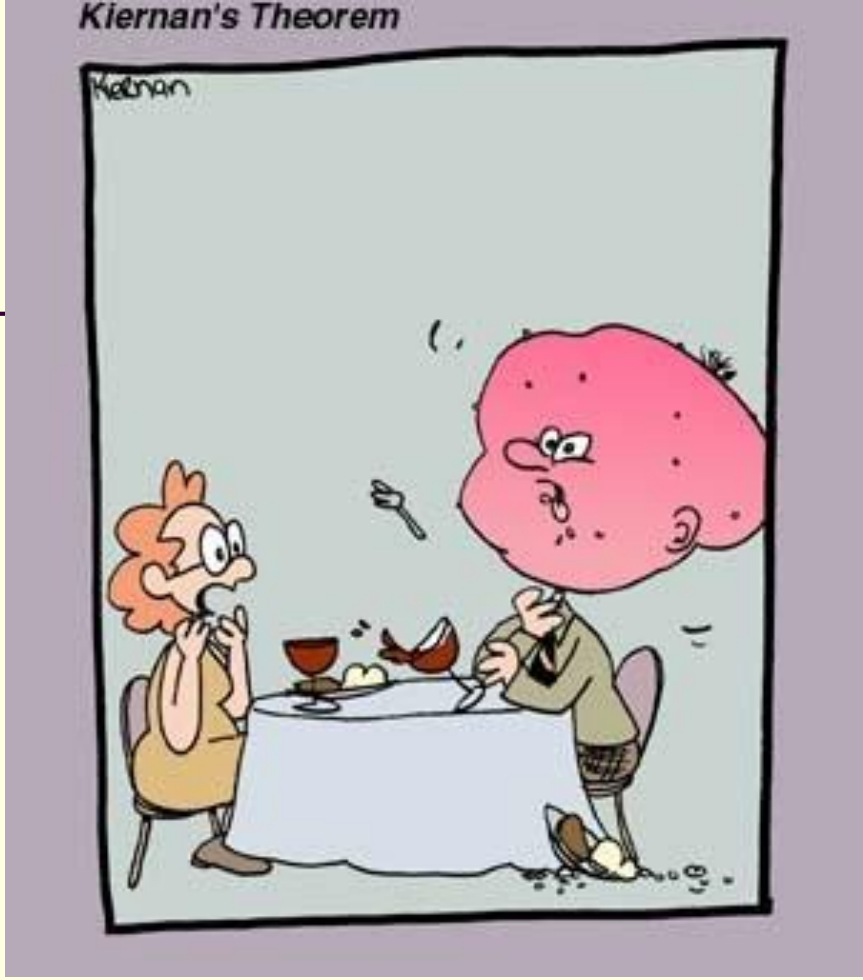


Pain, ache, soreness

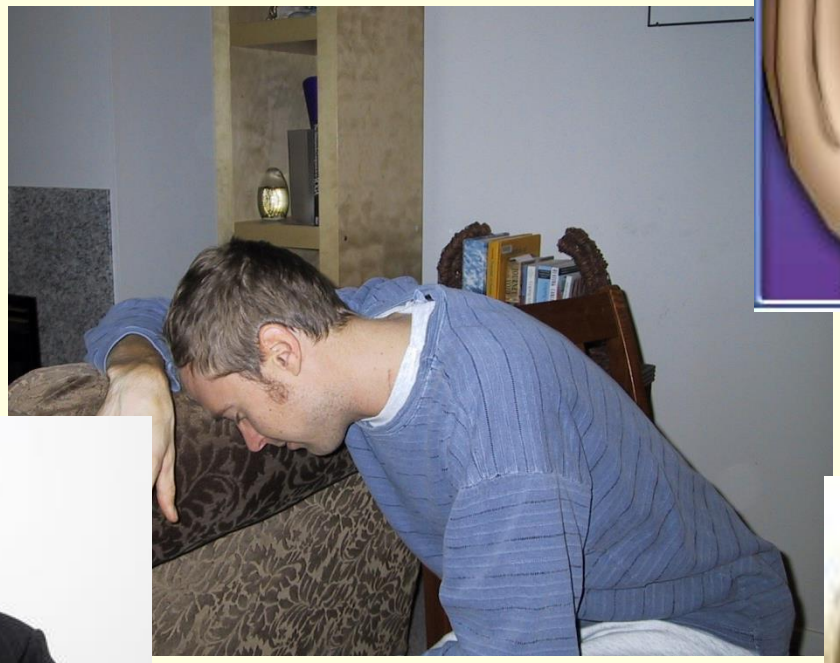


Nausea

Irritation



Malaise, fatigue

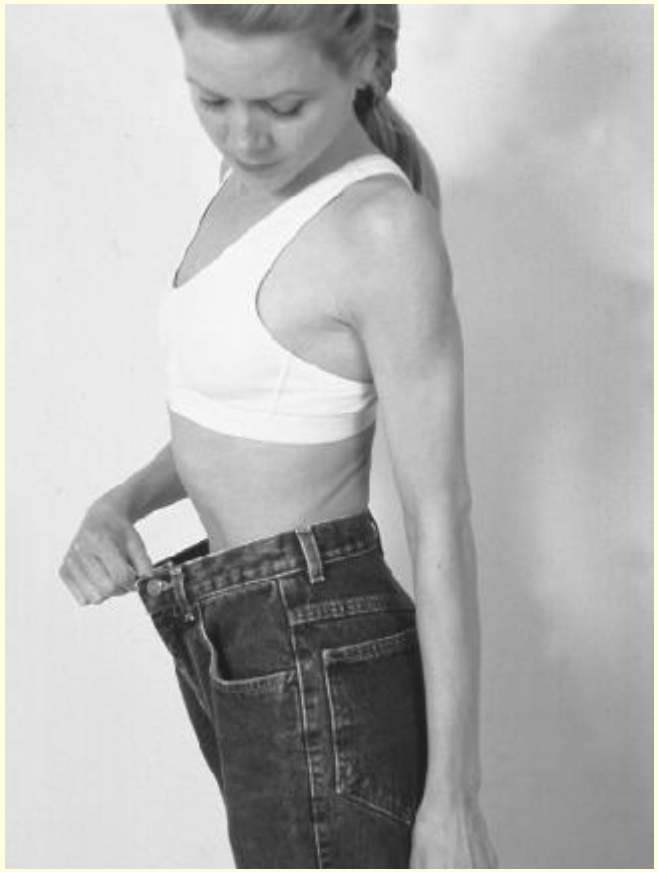


Chest tightness

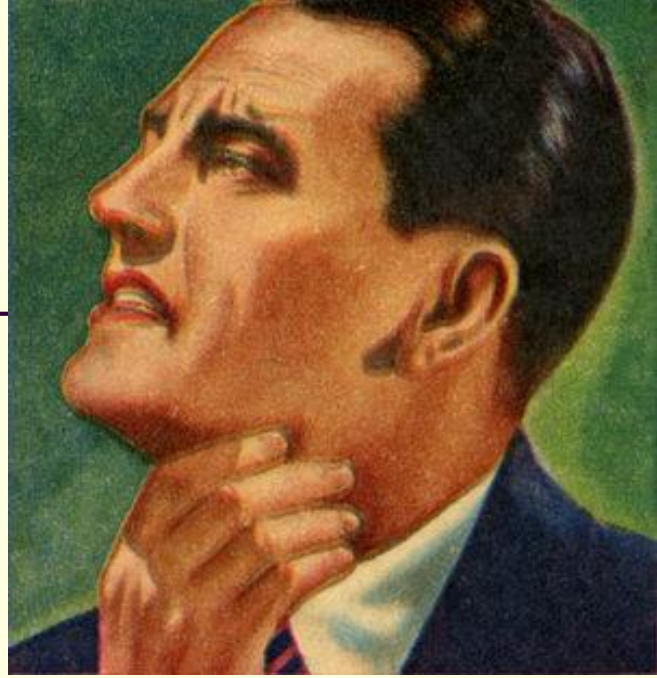
Itching

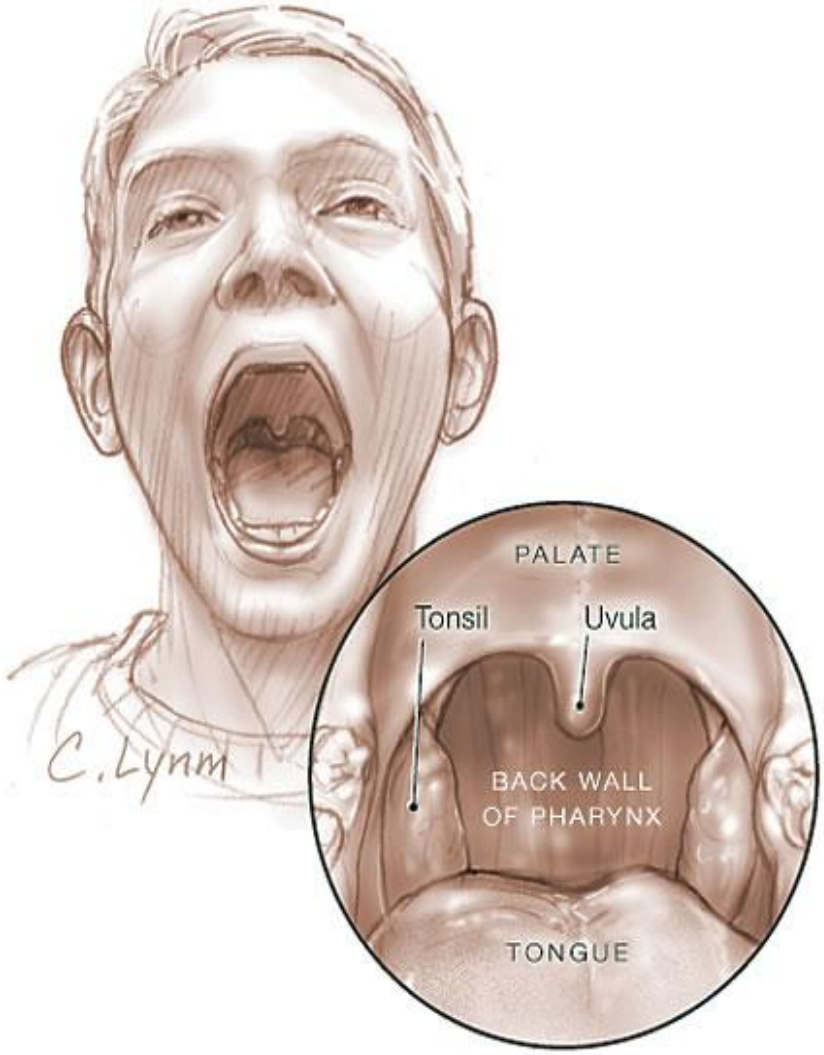
Abdominal cramps

Anorexia

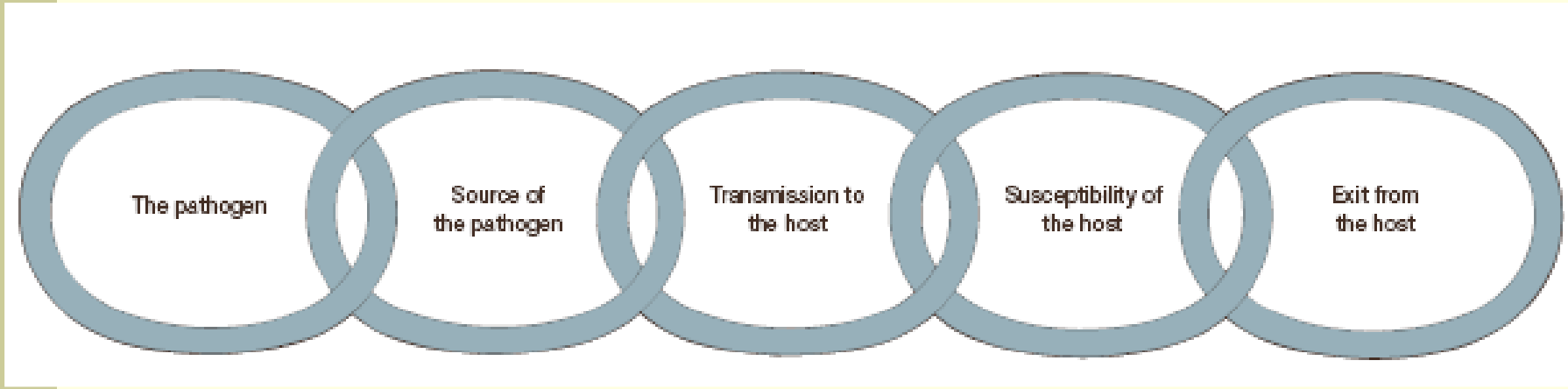


Sore throat





Infectious Disease Cycle or Chain of Infection.



The first link in the infectious disease cycle is the pathogen. A **communicable disease** is an illness caused by a pathogen or its products that has been transmitted from an infected person or a reservoir, either directly or indirectly. Pathogens have the potential to produce disease (pathogenicity); this potential is a function of such factors as the number of pathogens, their virulence, and the nature and magnitude of host defenses.

What Was the Source and/or Reservoir of the Pathogen?

The source and/or reservoir of a pathogen is the second link in the infectious disease cycle.

A **source** is the location from which the pathogen is immediately transmitted to the host, either directly through the environment or indirectly through an intermediate agent. The source can be either animate (e.g., humans or animals) or inanimate (e.g., water, soil, or food). The **period of infectivity** is the time during which the source is infectious or is disseminating the pathogen.

The **reservoir** is the site or natural environmental location in which the pathogen is normally found living and from which infection of the host can occur. Thus a reservoir sometimes functions as a source. Reservoirs also can be animate or inanimate.

Much of the time, human hosts are the most important Animate sources of the pathogen and are called carriers.

A **carrier** is an infected individual who is a potential source of infection for others. Four types of carriers are recognized:

1. An **active carrier** is an individual who has an overt clinical case of the disease.

2. A **convalescent carrier** is an individual who has recovered from the infectious disease but continues to harbor large numbers of the pathogen.

3. A **healthy carrier** is an individual who harbors the pathogen but is not ill.

4. An **incubatory carrier** is an individual who is incubating the pathogen in large numbers but is not yet ill.

Convalescent, healthy, and incubatory carriers may harbor the pathogen for only a brief period (hours, days, or weeks) and then are called **casual, acute,** or **transient carriers.** If they harbor the pathogen for long periods (months, years, or life), they are called **chronic carriers.**

In addition, being bitten by arthropod **vectors** (organisms that spread disease from one host to another) such as mosquitoes, ticks, fleas, mites, or biting flies.

Zoonoses

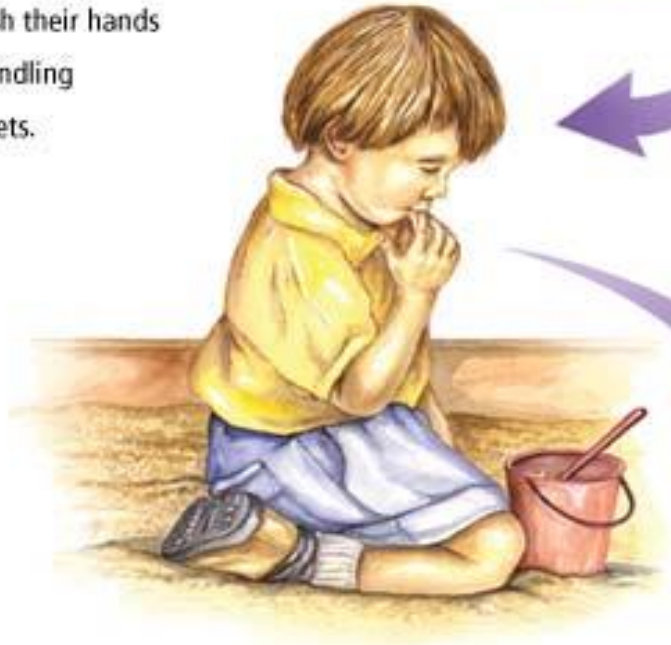
Infectious diseases called zoonoses occur in animals and are occasionally transmitted to humans; thus these animals also can serve as reservoirs. Humans contract the pathogen by several mechanisms: coming into direct contact with diseased animal flesh (tularemia); drinking contaminated cow's milk (tuberculosis and brucellosis); inhaling dust particles contaminated by animal excreta or products (Q fever, anthrax); or eating insufficiently cooked infected flesh (anthrax, trichinosis).

Zoonotic Disease Transmission

Zoonotic diseases are more commonly encountered in children because they may provoke biting or scratching, go barefoot during warm weather, and may not wash their hands following handling household pets.

Dogs or cats with roundworms or hookworms may put children at risk of contracting zoonotic diseases.

Contact with food or water, soil or sand contaminated by the fecal matter of infected animals can create an environment in which disease may be transmitted.



These parasites may cause Visceral, Ocular, Neural and Cutaneous Larva Migrans in humans.

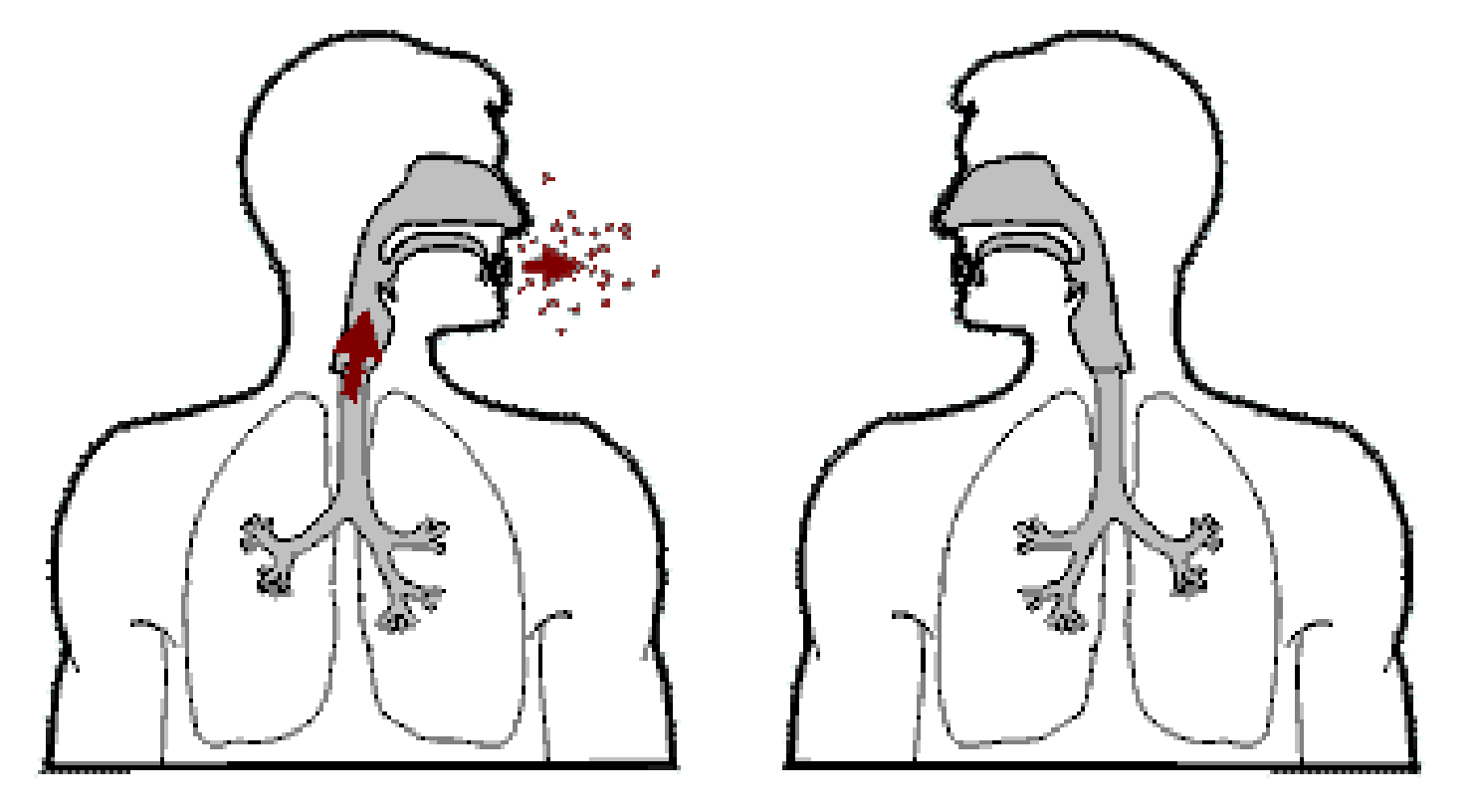
Some Examples of Zoonoses

Disease-causing Organism		Animal or Insect Carrier	Human Disease
Bartonella hensalae bacteria		Cats	Cat scratch disease
Chlamydia psittaci bacteria		Birds	Psittacosis
Mononegavirales virus		Mammals, including bats, raccoons, skunks, foxes, and coyotes	Rabies
Yersinia pestis bacteria		Fleas and rodents, including rats, chipmunks, prairie dogs, ground squirrels, and mice	Plague
Hantavirus		Rodents, including rats and mice	Hantavirus pulmonary syndrome
Borrelia burgdorferi bacteria		Ticks, deer, and mice	Lyme disease
Toxoplasma gondii bacteria		Cats and farm animals	Toxoplasmosis
Trichinella larvae		Bears, foxes, and other wild game; pigs and horses	Trichinosis

How Was the Pathogen Transmitted?

To maintain an active infectious disease in a human population, the pathogen must be transmitted from one host or source to another. Transmission is the third link in the infectious disease cycle and occurs by four main routes: airborne, contact, vehicle, and vector-borne.

Airborne Transmission



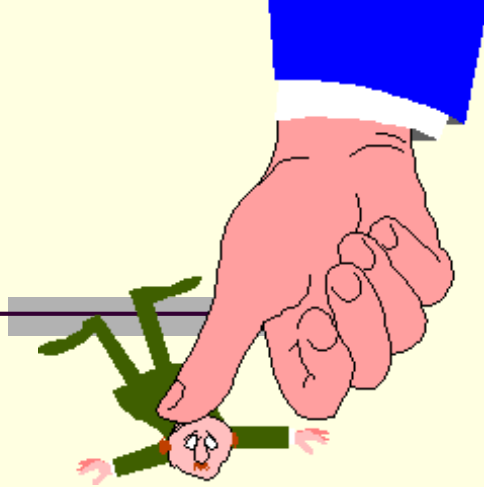
Airborne Transmission

Because air is not a suitable medium for the growth of a pathogen, any pathogen that is airborne must have originated from a source such as humans, other animals, plants, soil, food, or water. In **airborne transmission** the pathogen is truly suspended in the air and travels over a meter or more from the source to the host. The pathogen can be contained within droplet nuclei or dust. **Droplet nuclei** are small particles, 1 to 4 μm in diameter, that result from the evaporation of larger particles (10μm or more in diameter) called droplets. Droplet nuclei can remain airborne for hours or days and travel long distances. When animals or humans are the source of the airborne pathogen, it usually is propelled from the respiratory tract into the air by an individual's coughing, sneezing, or vocalization.

Dust also is an important route of airborne transmission.

At times a pathogen adheres to dust particles and contributes to the number of airborne pathogens when the dust is resuspended by some disturbance. A pathogen that can survive for relatively long periods in or on dust creates an epidemiological problem, Particularly in hospitals, where dust can be the source of hospital acquired infections.

Contact transmission



Contact transmission

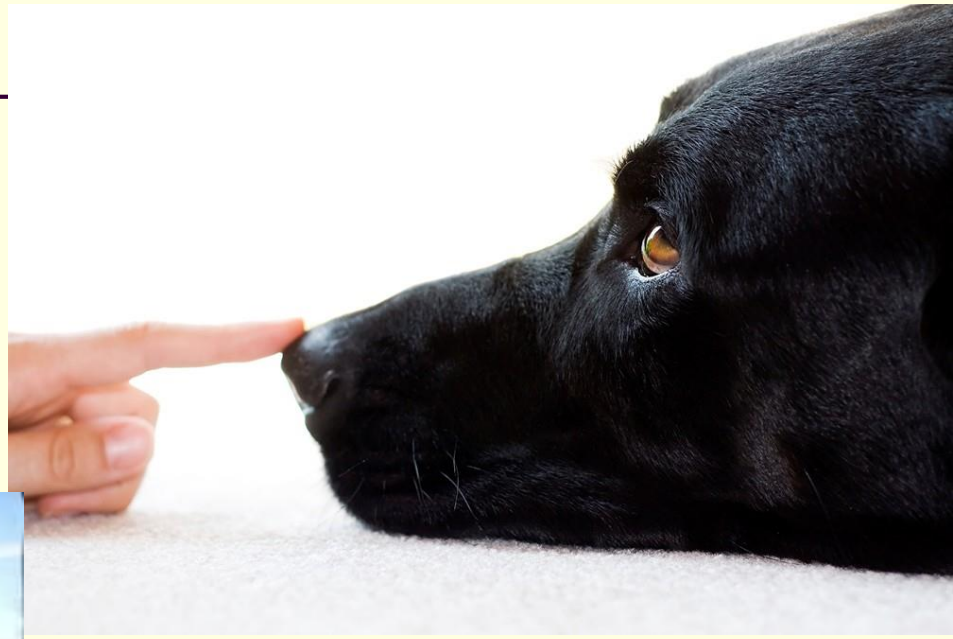
Contact transmission implies the coming together or touching of the source or reservoir of the pathogen and the host.

Contact can be direct, indirect, or by droplet spread.

Direct contact implies an actual physical interaction with the infectious source. This route is frequently called person-to-person contact.

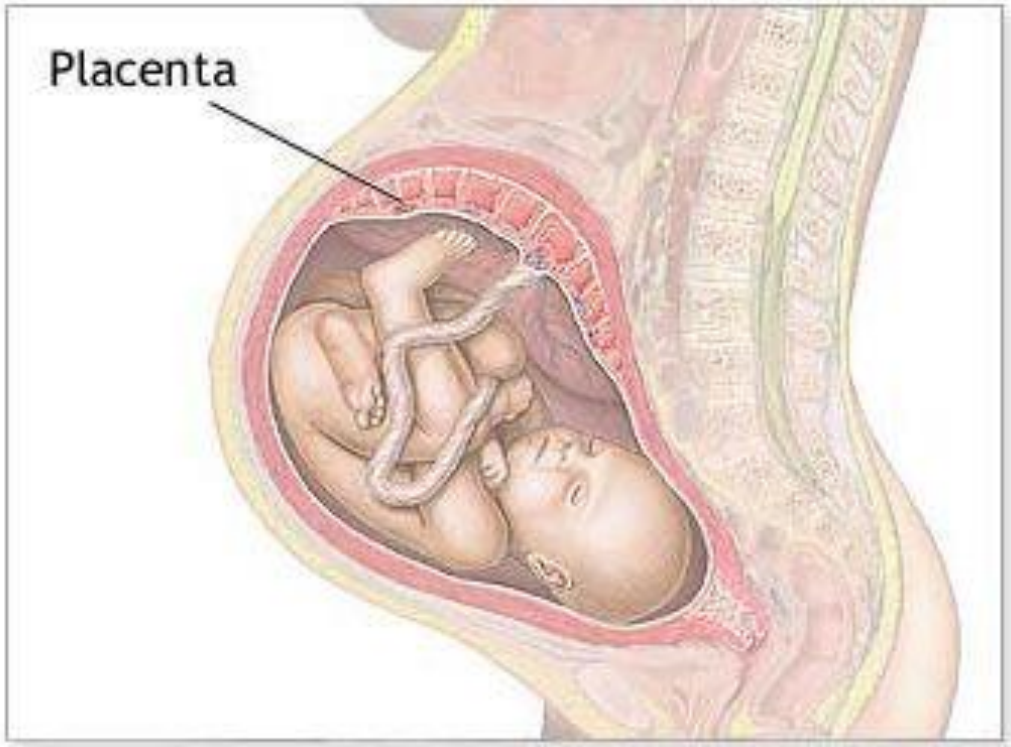
Person-to-person transmission occurs primarily by touching, kissing, or sexual contact (sexually transmitted diseases); by contact with oral secretions or body lesions (herpes and boils); by nursing mothers (staphylococcal infections).

Some infectious pathogens also can be transmitted by direct contact with animals or animal products.

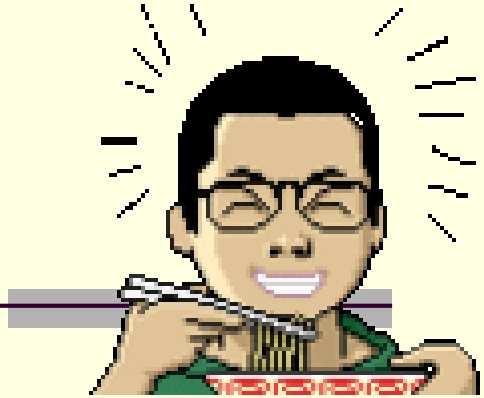


Indirect contact refers to the transmission of the pathogen from the source to the host through an intermediary—most often an inanimate object. The intermediary is usually contaminated by an animate source. Common examples of intermediary inanimate objects include thermometers, eating utensils, drinking cups, and bedding.

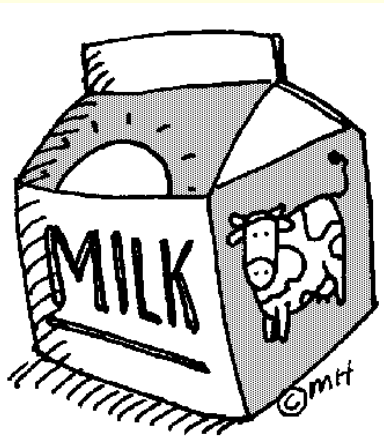
Transmission through the **placenta** (AIDS, syphilis).

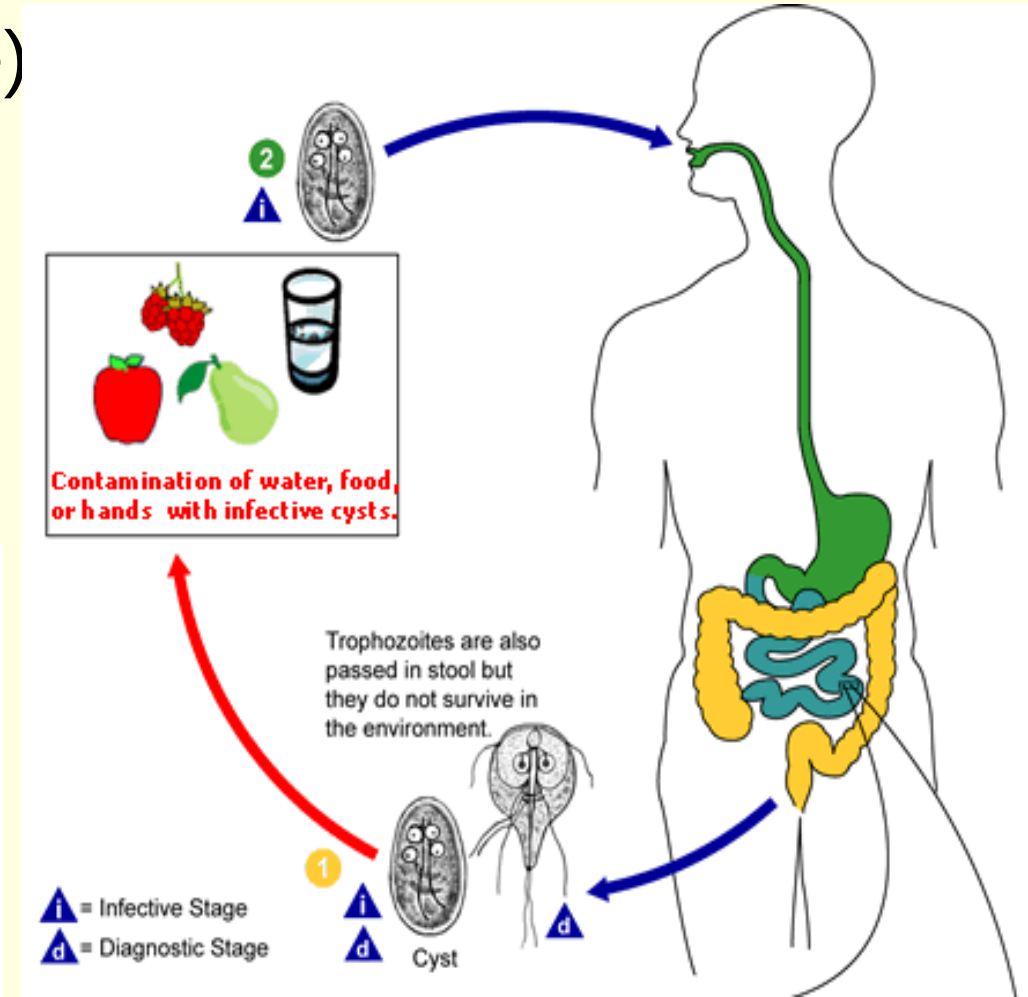


Ingestion transmission



Cholera (water), food poisoning (food), dysentery (hand borne)



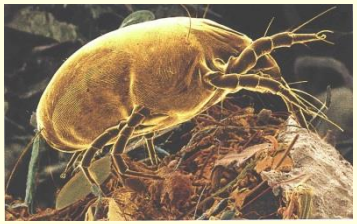


Inanimate materials or objects involved in pathogen transmission are called **vehicles.**

In **common vehicle transmission** a single inanimate vehicle or source serves to spread the pathogen to multiple hosts but does not support its reproduction. Examples include surgical instruments, bedding, and eating utensils. In epidemiology these common vehicles are called **fomites** [s., fomes or fomite]. A single source containing pathogens (blood, drugs, IV fluids) can contaminate a common vehicle that causes multiple infections. Food and water are important common vehicles for many human diseases.

Vector-Borne Transmission

As noted earlier, living transmitters of a pathogen are called vectors. Most vectors are arthropods (insects, ticks, mites, fleas)



or vertebrates (dogs, cats, skunks, bats).

Vector-borne transmission can be either external or internal.

In external (mechanical) transmission the pathogen is carried on the body surface of a vector.

Carriage is passive, with no growth of the pathogen during transmission. An example would be flies carrying *Shigella* organisms on their feet from a fecal source to a plate of food that a person is eating.

In internal transmission the pathogen is carried within the vector. Here it can go into either a harborage or biologic transmission phase. In **harborage transmission** the pathogen does not undergo morphological or physiological changes within the vector. An example would be the transmission of *Yersinia pestis* (the etiologic agent of plague) by the rat flea from rat to human.

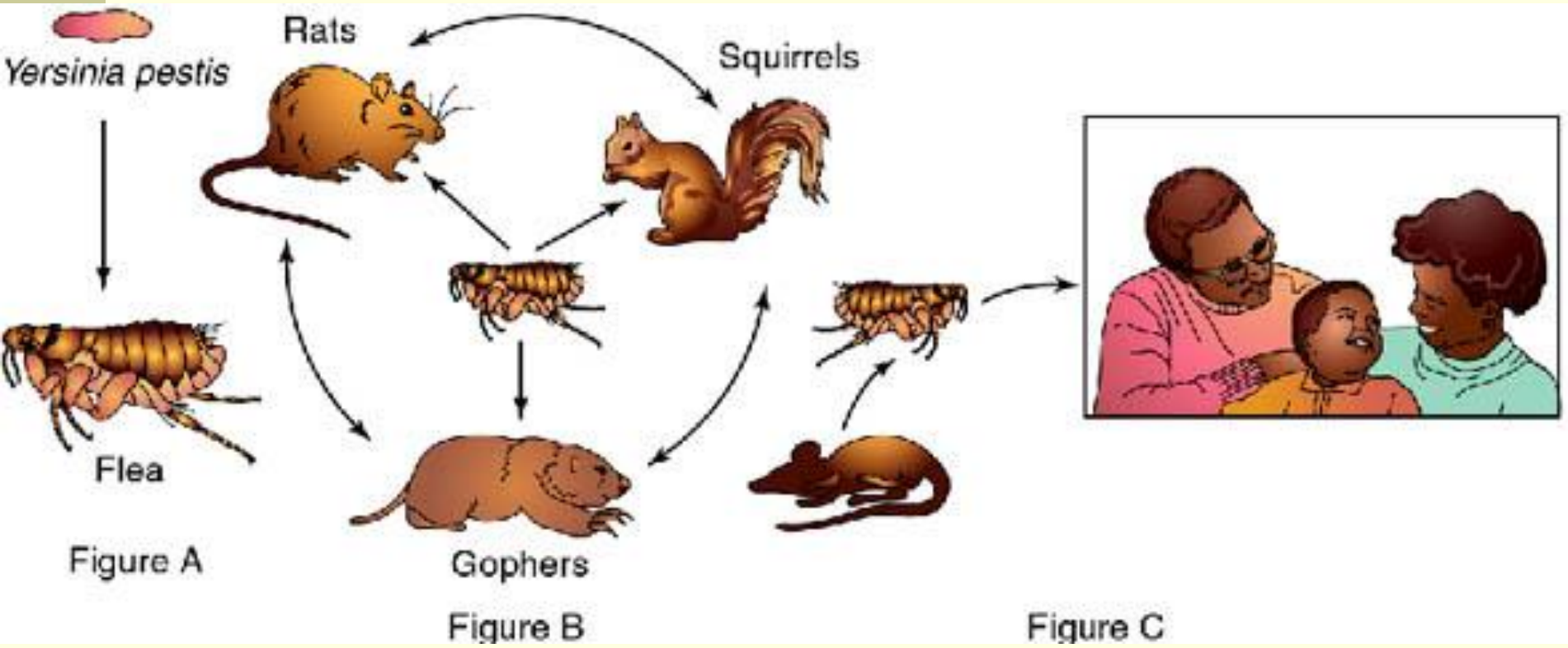


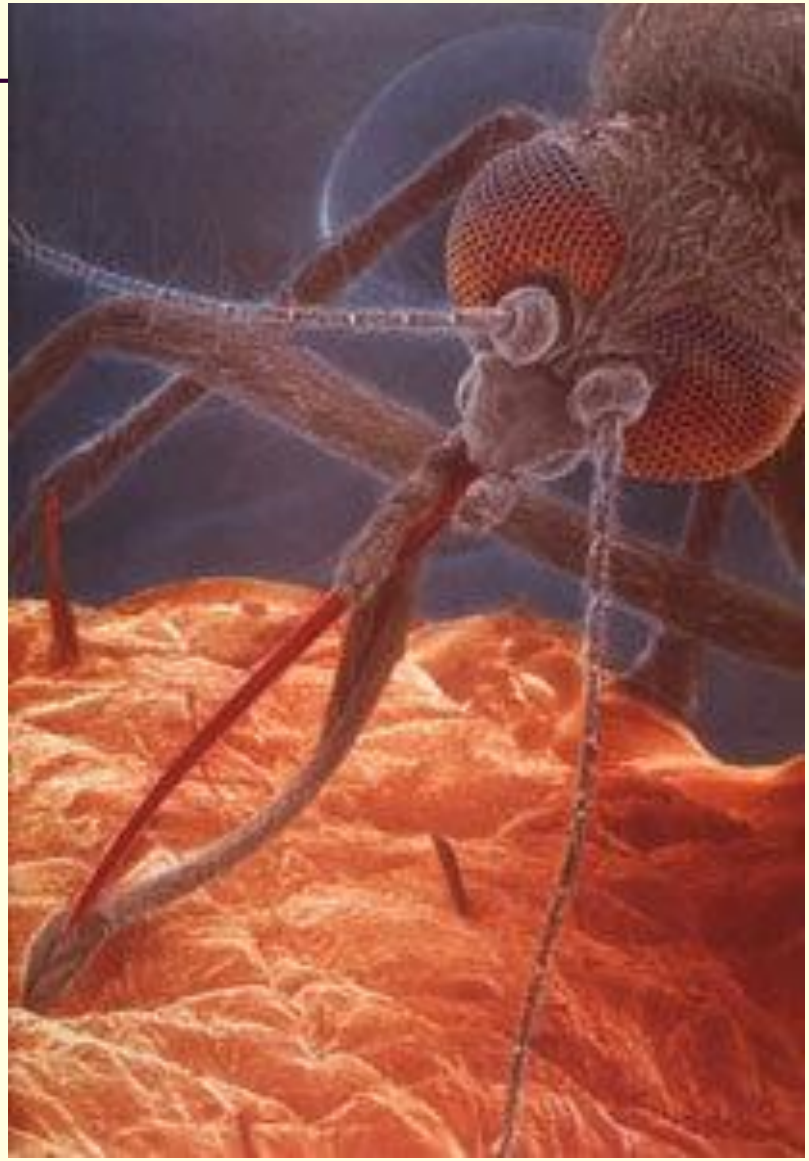
Figure A

Figure B

Figure C

Biologic transmission

implies that the pathogen Does go through a morphological or physiological change within the vector. An example would be the developmental sequence of the malarial parasite inside its mosquito vector. Malaria



Jatrogenic and laboratory infections

Infection may be transmitted during procedures like, injection, lumbar puncture, catheterization, etc. if proper care is not taken.

Why Was the Host Susceptible to the Pathogen?

The fourth link in the infectious disease cycle is the host. The susceptibility of the host to a pathogen depends on both the pathogenicity of the organism and the nonspecific and specific defense mechanisms of the host.

How Did the Pathogen Leave the Host?

The fifth and last link in the infectious disease cycle is release or exit of the pathogen from the host. It is equally important that the pathogen escapes from its host as it is that the pathogen originally contacts and enters the host. Unless a successful escape occurs, the disease cycle will be interrupted and the pathogenic species will not be perpetuated. Escape can be active or passive, although often a combination of the two occurs. Active escape takes place when a pathogen actively moves to a portal of exit and leaves the host. Examples include the many parasitic helminths that migrate through the body of their host, eventually reaching the surface and exiting. Passive escape occurs when a pathogen or its progeny leaves the host in feces, urine, droplets, saliva, or desquamated cells. Microorganisms usually employ passive escape mechanisms.