**Types of Human Disease by Source of the Infectious Agent**

Human infectious diseases can distinguish as :

1. **Sapronoses:** soil, water, decaying plants, animal excrement, carrion .
2. **Anthroponoses :** are diseases transmissible only from man to man. typhoid fever caused by *Salmonella typhi ,paratyphoid fever ,shigellosis.*
3. **Zoonoses :**  are infections which are naturally transmitted between vertebrate animals and people (WHO 1959) (the zoonoses include infections transmitted from humans to animals as well as from animals to humans).
* The number of known zoonoses is growing steadily.
* Approximately 1500 infectious diseases are recognized in humans.
* 20% (300) are due to zoonoses .
* 75% of recently emerging infectious diseases (EID) have been caused by zoonotic pathogens .
* **Classification of Zoonotic Diseases:**
1. **Based on Transmission:**
2. **Anthropozoonoses:** Zoonoses where the main reservoir of infection is non-human vertebrate animals. Most zoonoses are of this type e.g. bovine tuberculosis, rabies, leptospirosis.
3. **Zooanthroponoses:** Diseases that mainly affect people(A zoonotic disease maintained primarily in nature by human to human), which may be transmitted to animals, which then act as temporary reservoirs of infection Examples are *Mycobacterium tuberculosis* in dogs, infectious hepatitis in apes, H1N1 pandemic influenza in pigs.
4. **Amphixenosis**  : A zoonotic disease maintained in nature both by animal to animal and human to human transmission . Examples include staphylococcosis, streptococcosis, and influenza.
5. **Based on usual Reservoir :**
6. **Direct zoonotic diseases** : are transmitted and maintained in nature primarily between individuals of a single animal species. An example **is rabies** that may have a bat-bat or dog-dog or skunk-skunk cycle depending on the geographic area.
7. **Cyclozoonoses** : are transmitted and maintained in nature between two different animal species. An example is hydaditosis which has a sheep-dog cycle in some parts of the world.
8. **Metazoonoses** : are transmitted and maintained in nature between a vertebrate and an invertebrate animal species. One example is the arthropod-borne viral encephalitides which includes Eastern and Western equine encephalitis. Mosquitoes are the vector and wild birds are the usual animal reservoir.
9. **Saprozoonoses** : are maintained in both animate hosts and nonanimate environments. An example is visceral larva migrans in children caused by the dog roundworm. The adult worms live in the intestinal tract of dogs and lay eggs that are deposited in the soil through fecal contamination. The eggs must develop further in the soil environment before becoming infective for dogs or people.
10. **Based upon etiological agent:**

**1.Bacterial zoonoses:** Zoonoses caused by bacterial agents e.g. brucellosis, plague, salmonellosis, anthrax.

**2. Viral zoonoses:** Zoonoses caused by viruses e.g. rabies, influenza, yellow fever.

**3. Rickettsial zoonoses:** Zoonoses caused by rickettsia e.g. Qfever, tick typhus.

**4. Protozoan zoonoses:** Zoonoses caused by protozoans e.g. toxoplasmosis, trypanosomosis, leishmaniosis.

**5. Helminthic zoonoses:** Zoonoses caused by helminthes e.g. hydatidosis, taeniosis, schistosomosis, trichinellosis.

**6. Fungal zoonoses:** Zoonoses caused by fungal agents e.g. histoplasmosis, cryptococcosis.

**7. Ectoparasitic zoonoses:** Zoonoses caused by ectoparasites e.g. scabies, myiasis.

**Types of Zoonoses :**

**1-Reverse zoonoses** : are adapted to humans and have no natural reservoirs in animals, but can be transmitted to animals .The colonized animals can then re-transmit the infection to humans .

*S. Pyogenes*  infect the bovine udder (mastitis ) contaminated raw milk outbreaks of human disease.

*S. pyogenes* isolated from dog.

**2- Vector borne zoonoses:** living organisms that transmit infectious agents from an infected animal to a human or another animal.

Vectors are frequently arthropods, such as mosquitoes, ticks, flies, fleas and lice and can transmit diseases such as malaria .

**3-Food borne zoonoses :** caused by consuming food or drinking water contaminated by pathogenic micro-organisms such as Bacteria and their toxins viruses parasites.

They enter the body through the gastrointestinal tract where the first symptoms often occur.

**4- Neglected zoonoses :** that is commonly associated with poverty and impacts the lives and livelihoods of millions of poor livestock keepers or those living in periurban slums primarily in developing countries. such as anthrax, bovine tuberculosis, brucellosis, cysticercosis , echinococcosis ( hydatid disease) and rabies .are called neglected because they are not adequately addressed nationally and internationally.

**5- Emerging zoonoses :** newly recognized or newly evolved or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range is known as emerging zoonosis . Factors in Disease Emergence Ecological Factors Host related factors Pathogen related factors .

* **Zoonoses can further be divided according to the habitat or ecosystem where their agents circulate as:**

**(i) synanthropic**, with an urban (anthroponotic, domestic) cycle where the source of human infection are most often domestic animal or synanthropic vertebrates bound to human dwellings.

e.g.: vesicular stomatiitis, brucellosis, bovine tuberculosis, glanders, listeriosis, erysipeloid or ringworm causedby Trichophyton verrucosum and Microsporum canis.

These diseases are transmissible usually percutaneously, aerogenically, alimentarily or per conjunctiva, and often present typical occupational diseases in farmers, butchers and veterinary doctors.

**(ii) exoanthropic**, with a sylvatic(feral) cycle, and their reservoir is in the countryside outside human dwellings –in so-called natural foci. e .g. tick-borne encephalitis and other arboviroses, tularaemia, plague or scrub typhus, where man acquires the infectious agent after entering a natural focus, commonly by the attack of an haematophagous vector.

 **Transmission of zoonotic diseases:**

**Direct contact**: Coming into contact with the saliva, blood, urine, nasal secretions, feces or other body fluids of an infected animal. Examples include petting or touching animals, and bites or scratches.

**Indirect contact**: contact with areas where animals live and roam, or objects or surfaces that have been contaminated with germs. Examples include aquarium tank water, pet habitats, coops, plants, and soil, as well as food and water dishes.

 **Foodborne**: Eating or drinking something unsafe (such as unpasteurized milk, undercooked meat or eggs or unwashed fruits and vegetables that are contaminated with feces from an infected animal).

**Vectorborne**: Being bitten by a mosquito, tick, flea or other vector.

**The Infection Process in Zoonoses**

**Infection process:** is an interaction between the pathogenic microorganism and the host’s organism(macroorganism) which started by entry of the microbial agent in the host’s body.

**The infectious organism :** is the aetiological agent of a corresponding disease, and it belongs to one of the five large groups of organisms:

 (1) viruses (2) bacteria (Prokaryota) (3) fungi(4) protozoa(5) Metazoa (multicellular parasites –helminths and arthropods).

To be ascertained as the aetiological agent of a particular disease, the microor-ganism must fulfil **Koch’s Postulates**– i.e., it should:

**(1)** be detected in all cases of the disease;

**(2)** be isolated from the patient and cultured in a laboratory;

**(3)** the isolated and cultured agent should reproduce the disease after inoculation to another host of the same or related species;

**(4)** be recovered from this inoculated, sick host;

**(5)** produce a specific immune reaction (form antibodies) in the inoculated host.

The important characteristics of the aetiological agent include its **pathogenicity, virulence, invasivity and toxigenicity.**

**Pathogenicity:** is the ability of the agent to produce a specific pathological state in a susceptible host. Pathogenic microorganisms are characteristic by their specificity(affinity) against hosts:

usually only some species of host (vertebrates) are susceptible, while other species are refractory (resistant) to the microorganism. For instance, while most serovars of Salmonella are pathogenic to a broad range of vertebrates, typhoid caused by Salmonella typhiis only known in man (i.e.,

anthroponosis). The rate of susceptibility varies, however, even within a certain species and is influenced by genetic, physiological and other factors.

Some microorganisms are potential pathogens that are able to cause disease only under condition of a host weakened by, for example, stress, malnutrition, cancer, immunosuppression (secondary zoonoses and sapronoses in HIV-infectedpatients), after transplantation or surgical operations. Such agents are some times also called as “opportune” (e.g. many mycoses caused by species of fungi in essence saprophytic).

**Virulence:** is the pathogenicity rate of individual strains of infectious agent; it is determined mainly by invasivity and toxigenicity.

**Invasivity** : is ability of the agent to penetrate a host’s tissues and replicate there.

**Toxigenicity :** is ability of the agent to damage the host by the produc-tion of poisons (exotoxins and endotoxins), sometimes even in the absence of replication.

Bacteria *Clostridium tetani, C. perfringens,, C. botulinum, Bacillus anthracis, B. cereus Staphylococcus aureus ,Streptococcus pyogenes ,Corynebacterium diphtheriae, Vibrio cholerae, Aspergillus spp.*) are examples of microorganisms forming diverse and extremely effective toxins which can cause or considerably aggravate the disease of a host .

 **Infection Entry :**

An infection starts with a penetration of the agent into the host’s body by one of the three great (skin, mucosae of respiratory and alimentary tracts) or two limited (conjunctiva, urogenital tract) epithelial surfaces. The obligately arthropod-borne diseases (i.e. transmitted exclusively by arthropods) involve arboviroses, Lyme borreliosis, tick-borne recurrent borrelioses, rickettsioses, trypanosomiases, leishmaniasis, babesiosis or malaria.

* **Mucosa of the respiratory tract:**

 entry per inhalatione. A number of zoonotic and sapronotic pathogens enter the respiratory tract (air passages, both higher and lower) by inhalation of contaminated dust particles (small solid particles in the air) or aerosol droplets, and the diseases are called “respiratory infections”.

Droplets with a diameter of <100μm can be stable and persist in the air for a long time and droplets with a diameter of 1–5μm can easily penetrate even into pulmonary alveoli.

* **Mucosa of the alimentary tract:** entry per os, perorally. In the peroral (alimentary) penetration of the agent in the host’s body (ingestion, swallowing), the most important role is played by contaminated foods (“food-borne diseases”) and water or drinks (“water-borne diseases”). This is a very often an entry gate in zoonoses where the vehiculum of the agent are contaminated foods of animalorigin, most commonly meat, milk or eggs:salmonellosis (eggs, meat), campylobacterosis (meat, especially poultry). pseudotuberculosis, yersiniosis, listeriosis (cheese, meat), pasteurellosis, botulism meat and salad patés), anthrax, tularaemia (water, musts, cider), brucellosis (milk).
* **Conjunctivae entry:** per conjunctiva. Human infection through conjunctivae has only been described in some zoonoses and sapronoses, e.g., vesicular stomatitis, psittacosis, arenaviroses, Q fever, brucellosis, tularaemia, glanders, fusarioses, and amoebic keratitis.

**How Bacterial Cells Damage Host Cells**

Three mechanisms:

* + **Direct Damage**
	+ **Toxins\***
	+ **Hypersensitivity Reactions**

**\* Most bacterial damage is carried out by toxins.**

**1. Direct Damage**

* **Some bacteria can induce cells to engulf them (*E. coli, Shigella, Salmonella,* and *Neisseria gonorrhoeae*).**
* **Microbial metabolism and multiplication kills host cells.**
* **Other microbes enter the cell by excreting enzymes or through their own motility.**

**2. Toxin Production**

* **Toxins:** Poisonous substances produced by microbes**.**
* Frequently toxins are the main pathogenic factor.
* **Toxigenicity:** Ability of a microbe to produce toxins.
* **Toxemia:** Presence of toxins in the blood.
* **Toxin effects:** May include fever, cardiovascular problems, diarrhea, shock, destruction of red blood cells and blood vessels, and nervous system disruptions.
* Of 220 known bacterial toxins, 40% damage eucaryotic cell membranes.
	+ **Two types of toxins:**
	+ **Exotoxins**
	+ **Endotoxins**

**A. Exotoxins**

* + Proteins: Enzymes that carry out specific reactions.
	+ Soluble in body fluids, rapidly transported throughout body in blood or lymph.
	+ Produced mainly by gram-positive bacteria.
	+ Most genes for toxins are carried on plasmids or phages.
	+ Produced inside bacteria and released into host tissue.
	+ Responsible for disease symptoms and/or death.
		- **Cytotoxins:** Kill or damage host cells.
		- **Neurotoxins:** Interfere with nerve impulses.
		- **Enterotoxins:** Affect lining of gastrointestinal tract.
	+ **Antibodies called antitoxins provide immunity.**

**Toxoids:** Toxins that have been altered by heat or chemicals. Used as vaccines for diphtheria and tetanus.

**B-Endotoxins**

* + Part of outer membrane surrounding gram-negative bacteria.
	+ Endotoxin is lipid portion of lipopolysaccharides (LPS), called lipid A.
	+ Effect exerted when gram-negative cells die and cell walls undergo lysis, liberating endotoxin.
	+ **All produce the same signs and symptoms:**
		- Chills, fever, weakness, general aches, blood clotting and tissue death, shock, and even death. Can also induce miscarriage.

**Fever:** Pyrogenic response is caused by endotoxins

* + **Endotoxins do not promote the formation of effective antibodies.**
		- **Organisms that produce endotoxins include: *Salmonella typhi , Proteus spp., Pseudomonas spp., Neisseria spp*.**

**Infection Course and Host Defence :**

**An infection**:is the entry of the pathogenic organism into the host’s body and mul-tiplication of the agent in the host’s tissues. The result of the infection is either aninapparent infection or a manifest disease of the host. Infection is thus a broader term than infectious disease.

An inapparent (asymptomatic) infection, sometimes also called a subclinical, does not present any symptoms of disease. It can be detected by the presence of specific antibodies after the infection or by delayed hypersensitivity.

A characteristic combination of certain clinical symptoms, occurring in some diseases, is called a **syndrome.**

**Contagiosity:** is the proportion of infected (not only diseased) individuals out of the total number of individuals exposed to the pathogenic agent.

**The incubation period:** is the time between the entry of the pathogen in the host’s body and the first clinical symptoms of the disease. This incubation period varies in zoonoses and sapronoses considerably, the range being from:

* several hours (salmonellosis, staphylococcal intoxication)
* a few days (tularaemia, plague, anthrax, yellow fever, sand fly fevers),
* 1–2 weeks (the most common case: e.g., leptospirosis, brucellosis, tick-borne encephalitis and a majority of other arbovi-roses, HFRS, Q fever, ornithosis, histoplasmosis, dermatomycoses,toxoplasmosis),

to 1 month or longer (rabies, bovine tuberculosis, emmonsio-sis, leishmaniasis, trypanosomiases, babesiosis) in some infectious diseases the incubation period can exceed 1 year (prion diseases, lepra)

A very significant factor for the “success” of an infection is the **dose** of the respective pathogen that penetrates into the host organism. In general, pathogenic agents as well as strains of one pathogenic species with varying virulence can be characterized in relation to different species of hosts using a number of dose Types:

**The infectious dose (ID):** is the number of particles (cells) of the pathogen causing an infection. It can be expressed in a variety of indices, most often as **MID**(minimum infectious dose) or, more precisely **ID50** amount of pathogenic microorganisms that will produce demonstrable infection in 50 per cent of exposed individuals) **.**(Some highly contagious diseases have very low infectious doses: e.g., for human tuberculosis the respiratory MID is 1–10 cells of *Mycobacterium tuberculosis* .

**The pathogenic dose :** (the dose causing disease) is nearly always higher than the infectious dose. For instance in salmonellosis it is 104–106 cells of Salmonella enterica at peroral application of various serovars to man, while in human tularaemia it is as low as 10 cells of Francisella tularensis at intradermal inoculation.

\*\*When a pathogen enters its host and multiplies inside of it, we term that process an **infection**

**\*\*** When the body's receptors, cells, tissues or organs are damaged, destroyed or inactivated, resulting in an abnormal state of function, health and overt clinical signs and symptoms, we term that process a **disease.**