Histopathology

Lecture 11 and last

General Pathology of Infectious Diseases

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OVERVIEW

Infectious diseases are diseases in which tissue damage or dysfunction is produced by microorganisms. Despite the availability and use of effective vaccines and antibiotics, and improvement in sanitation ,infectious diseases remain an important health problem worldwide.

Five of the ten leading causes of death are infectious diseases , most of these deaths occur in children, with respiratory infections, infectious diarrhea, in addition to them malaria and TB continue to affect millions of peoples.

Contiguous mean person to person transmission.

Non contiguous acquired from sources such as animals, insects , soil, air or originating from normal microbial flora of the body.

Infectious agents: Infectious agents belong to a wide range of classes, they include:

1. Prions: which are modified host proteins lacking genetic molecules (RNA or DNA), it is not virus, e.g. prion that cause mad cow disease.

2. Viruses: obligate intracellular agent which ,depend on host in their replication ,composed of nucleic acid core (DNA or RNA) surrounded by a protein coat.

3. Bacteriophage and plasmid: mobile genetic elements that infect bacteria & indirectly causing human diseases by encoding bacterial virulence factors including adhesion, toxins and enzymes so this will convert nonpathogenic bacteria into virulent ones it make the bacteria resistance to antibiotics.

4. Bacteria: prokaryotes lacking nucleic acid and endoplasmic reticulum. They have cell wall made of 2 phospholipid bilayer. Two types of bacteria identified by their Gram stain properties: Gram-positive and Gram-negative bacteria.

5. Mycoplasma, rickettsiae, Chlamydia: These infectious agents are grouped together because they are similar to bacteria (they divided by binary fusion and susceptible to antibiotics) but lack certain structures.

6. Fungi: a primitive microorganism having a rigid cell wall, they are larger and more complex than bacteria and are eukaryotes. Thus, they possess nuclear membranes and cytoplasmic organelles, such as mitochondria and endoplasmic reticulum. There are two basic morphologic types of fungi: yeasts and hyphae.

7. Parasites: include:

- **Protozoa** (one celled parasites)

- **Metazoa** (Helminths) multi-celled parasites or worms.

- **"Ecto-parasites**, i.e., Anthrapodes.

Host barriers to infection: Skin. Respiratory system, GIT, Urogenital tract.

1- Skin: normal defense in skin include:
   - Normal cutaneous flora like *Staphylococcus epidrmidis*.
   - Dense keratinized outer skin layer is constantly shed & renewed.
   - Low PH of skin (5.5) & presence of fatty acids within the layer of skin also inhibit microbial growth.

   Failure of local defense in skin occurs when there is;
   - Mechanical defects (puncture, burn, ulcer)
   - Needle sticks (e.g. may transmit hepatitis B or C).
   - Arthropods and animal bites.
   - Direct penetration

2- Respiratory system: Respiratory barriers to infections are:
   - Mucociliary blanket that lines the nose & upper respiratory tract, this secreted by goblet cells (trapped the larger microorganisms).
   - Alveolar macrophages & neutrophils recruited to the lung by cytokines, these cells phagocytosed smaller microorganisms (less than 5 micron).
   - Mucosal immunoglobulin (IgA).

The distance that infectious agents travel into the respiratory system is inversely proportional to their size, large particles are trapped in the mucociliary blanket that lines the upper respiratory tract , particles smaller than 5 microns are carried into the alveoli.

Failure of local defense in respiratory system occurs when there is:

- Smoking (damage the mucociliary action).

- Ciliary paralysis by infectious agents producing toxins (including *Mycoplasma pneumonia* and *Bordetella pertussis*) that enhance infection by impairing ciliary activity.

- Damage to epithelial cells of respiratory tract (like in viral infections which result in secondary bacterial infection).

- Damage to alveolar macrophages (tuberculosis).

- Lowering of cellular immunity (fungal infection this is called opportunistic infection).

3- GIT: Normal defenses against infected pathogens are:
- Acidic gastric PH.
- Viscous mucous secretion.
- Pancreatic enzymes & bile detergents.
- Immunoglobulin A (IgA) antibodies, secreted by B cells located in the mucosa associated lymphoid tissues.
- The normal gut flora.

Break down of these barriers is by followings:

- Low gastric acidity (by drugs).
- Killing the bacterial flora (by antibiotics).
- Damage of intestinal lining epithelium (Rotavirus, salmonella, shigella causing bloody diarrhea).
- Secretion of enterotoxins (like food poisoning by staph. bacteria) or secretion of exotoxins which result in severe diarrhea (*vibrio cholera*).
- Resist gastric acidity (cysts of intestinal amoeba).

4- Urogenital tract: Normal defenses against infected pathogens are:
- Urination.
- Normal vaginal flora.
- Intact epidermal / epithelial barrier.

Failure of local defense in urogenital system occurs when there is;

- Obstruction, microbial attachment and local proliferation .
- Antibiotic use.
- Direct infection/local invasion.
- Local trauma (e.g. sexually transmitted diseases).

- Urinary tract is protected from infection by regular emptying during micturition.
- Urinary tract pathogens (e.g., E. coli) almost always gain access via the urethra (ascending infection) and must be able to adhere to urothelium to avoid being washed away.
- Women have more than 10 times as many urinary tract infections as men because the length of the urethra is 5 cm in women versus 20 cm in men, making women more susceptible to entry of bacteria from the rectum.

The transmission of microorganism can be:

In general, the source of infection is another human, or an animal, or the environment. (Figure 1)

1- Direct from person to person as by aerosols, direct contact as in chicken pox, measles, (contagious).
2- It may need prolonged intimate or mucosal contact e.g sexually transmitted diseases (Chlamydia , syphilis).

3- Some respiratory bacteria and fungi are transmitted only when the lesion is opened to the airways e.g in T.B.
4- Other may take the feco-oral route for transmission (ingestion of stool contaminated food or water) as in cholera , rotavirus.
5- Other microbes need a reservoir host and transmitted from animal to human.
6- Others may be transmitted by human blood and its products through vertical transmission (mother-to-child), sexual transmission, unsafe injections.

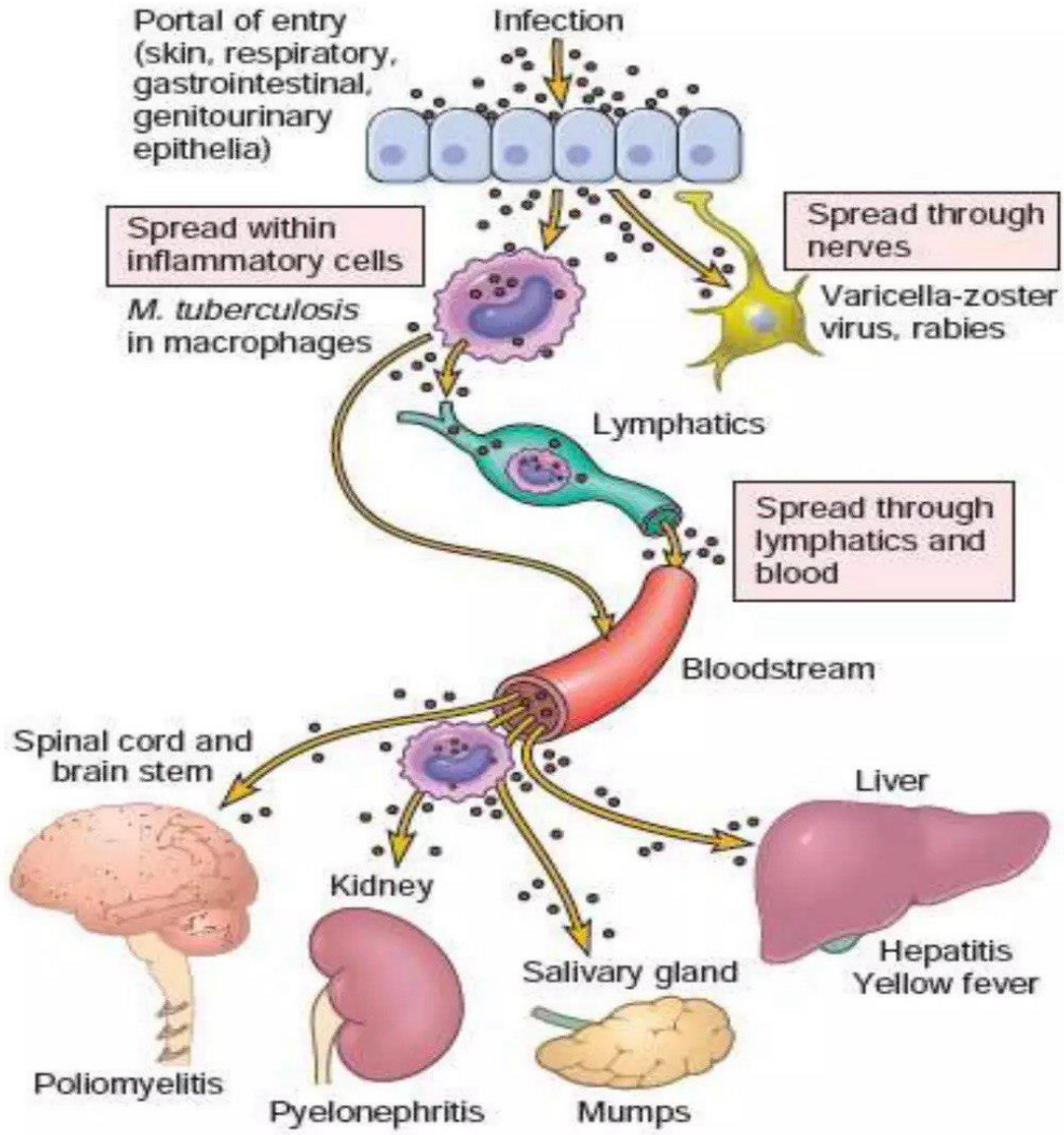


Figure 1.Routes of entry, dissemination, and release of microbes from the body.

How can the microorganism cause a disease?

Infectious diseases involve interplay between microbial virulence factors and host responses.

The infectious agents damage the tissue in 3 ways:

1- Enter the cell and cause death or dysfunction directly.
2- Injury may be due to local or systemic release of microbial products including endotoxin , exotoxins or super antigens.
3- Induce host cellular responses which may cause additional damage to the surrounding tissues e.g suppuration, scarring, hypersensitivity reactions.

Selected important infectious diseases:

Bacterial infection : **Staphylococcal infection, Streptococcal infections**

Staphylococcus aureus are gram-positive cocci that cause acute diseases due to direct infection or due to the production of toxins.

- It is pyogenic infection

Pyogenic infection = suppurative infections = pus forming

Types of staph infections:

Staph infections can be broadly classified into two groups:

1) Skin and soft tissue infections.

2) Invasive infections.

1) Skin and soft tissue infections:

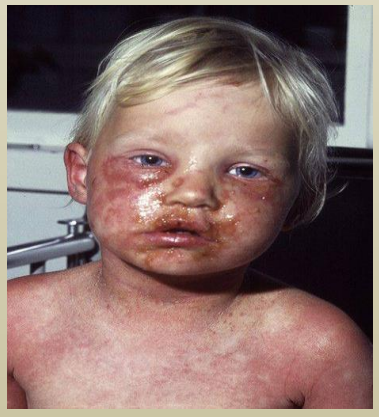
- **Furuncle and Carbuncles:**

Furuncle (boil): start at the hair follicles → small localized, painful abscess which may rupture → extrude pus to the outside and later on will healing.

Furuncle(boil)

carbuncle

Impetigo



Staphylococcal scalded skin syndrome

Carbuncle: it is a more extensive lesion &it is dangerous if it occur on the upper half of the face.

• **Impetigo** – a highly contagious skin infection that mainly affects children caused by staphylococcal or streptococcal infection.

• **a skin abscess** – a collection of pus that appears as a painful lump under the surface of the skin .

Note: Antibiotic resistance is a growing problem in treatment of S. aureus infections. ***Methicillin-resistant S. aureus (MRSA)*** *are resistant to nearly all penicillin and cephalosporin antibiotics.*

Figure 2. *Circumolar paler and sand paper rash in child with scarlet fever*

Figure 3. *White coating tongue that peel after few days leaving strawberry tongue*

2) Invasive infections:

In a small number of people, a staph skin infection can lead to a more serious, invasive infection deeper within the body. Examples include:

• Staphylococcal food poisoning is caused by preformed *S. aureus* toxin present in contaminated food.

• septic arthritis.

• osteomyelitis.

• pneumonia.

• endocarditis.

• sepsis.

• toxic shock syndrome – life threatening condition where bacteria release toxins into the blood, w hich can cause a sudden fever, vomiting, diarrhea, fainting, dizziness and a rash.

Streptococcal infections:

• Streptococci are gram-positive cocci that cause acute suppurative infections of the skin, oropharynx, lungs, and heart valves.

- It classify into α hemolytic and β-hemolytic . β-hemolytic are typed according to their surface carbohydrate antigens :

(Group A) It is one of the most frequent bacterial pathogens of humans,

- The diseases caused by ***S. pyogenes*** are in two categories:

1- **Suppurative diseases**, including pneumonia.
2- **Non Suppurative diseases** occur at sites remote from the site of bacterial invasion.

Scarlet fever: (Figure 2 and 3)

- Bacterial infection caused by group A β-hemolytic streptococcus

- It is most common in children between the ages of 3 and 15 years.