INTRODUCTORY BIOLOGY AND MICROBIOLOGY

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Common Infectious Diseases and Modes of Transmission

Introduction

- Infectious diseases are those that are transmitted from one individual to another.
- These diseases, also known as contagious diseases, are caused by microorganisms, such as protozoa, fungi, viruses, and bacteria, that invades the body and causes a series of changes that leads to infection and damage to the body.
- Infectious diseases are one that can be transmitted by direct or indirect contact or through the air.

- While most infectious diseases last a short amount of time they can be quite serious, and sometimes fatal.
- Categories:
  - Foodborne Illnesses
    - Foodborne illness is any illness that may result from eating contaminated food or drinking contaminated beverages. Food may be contaminated with bacteria, viruses, parasites, toxins and chemicals.

- Typical symptoms include vomiting, diarrhea, and abdominal cramps. The elderly, very young, and those with a weakened immune system are more at risk of foodborne illness.
- List of Foodborne Illnesses/Gastrointestinal infections
  - **Bacteria**
    - Campylobacteriosis (*Campylobacter)*
    - *E. coli* infection (*E. coli*)
    - Listeriosis (*Listeria monocytogenes*)
    - Salmonellosis gastroenteritis (*Salmonella*)
    - Shigellosis gastroenteritis (*Shigella*)

- Typhoid Fever , Group D
- Vibrio cholerae (Cholera)
- Yersenia (Yersinia)

– Toxins

- Botulism - *C. botulinum*
- Paralytic Shellfish Poisoning (Paralytic Shellfish Poisoning, Ciguatera)
- Staphylococcal Food Poisoning , Enterotoxin - B Poisoning

- **Parasitic**
  - Cryptosporidiosis (Cryptosporidium parvum)
  - Cyclosporiasis
  - Giardiasis (*Giardia lamblia*)
  - Trichonosis Infection (Trichinosis)
- **Viral** foodborne illnesses/Gastrointestinal infections
  - **Viral Gastroenteritis –** rotavirus, norovirus, adenovirus, and astrovirus
  - **Hepatitis.**

- Diseases of the skin
  - Bacterial
    - Staphylococcus - Folliculitis; Boils and carbuncles; Impetigo.
    - Streptococcal skin infections - Erysipelas
    - Clostridium perfringens - Gas gangrene
    - *Mycobacterium leprae - Leprosy*
    - Corynebacterium and Propionobacterium
  - Viral infections
    - Warts – papillomas , many different viruses
    - Variola – smallpox

- Varicella – chickenpox
- Herpes simplex viruses – HSV-1 and HSV-2
- Rubella – measles

– Fungal infections of the skin (Dermatophytes)
  - Cutaneous infection - dermatophytes grow on moist skin using keratin in skin as substrate
  - Tineas or ringworms scalp – tinea capitis, tinea cruris – groin, tinea pedis- feet (athletes foot)
  - *Tricophyton spp., Microsporium spp., Epidermophyton spp.; Maduromycosis; Chromoblastomycosis*.

- Eye diseases
  - Conjunctivitis – Trachoma Chlamydia trachomatis
  - Neonatal conjunctivitis by Chlamydia and N. Gonnorrhea
  - Viral - adenoviruses
- Genitourinary Diseases
  - Gonorrhea - *Neisseria gonorrhea*
  - Syphilis – *Treponema pallidum*
  - Chlamydia – *C. trachomatis*
  - Herpes –herpes simplex 2 virus
  - Genital warts – Human Pappiloma Virus
  - *E. coli* – causes UTI infections

- Gardnerella - *G. vaginalis*
- Candida infections – *C. albicans*
- Trichomonas – *T. vaginalis*

- Diseases of the Respiratory system
  - Tb, tuberculosis - *Mycobacterium tuberculosis*
  - Pharyngitis, laryngitis, tonsilitis - *Streptpcoccus pyogenes*
  - Pnuemococcal pneumonia - *Streptococcus pneumoniae*
  - Ear infections - *Haemophilus influenza*
  - whooping cough - *Bordatella pertusis*
  - Corynebacterium diphtheria

- Flu - Influenza virus
- Common cold – rhino virus
- Chest cold – adeno virus

- Fungal infections of the respiratory system
  - Coccidiomycosis – causative agent ,*Coccidioides immitis.*
  - Histoplasmosis – *Histoplasma capsulatum*
  - Blastomycosis – *Blastomyces dermatitidis*
  - Pneumocystis pneumonia - *Pneumocystis carinii*
- Nervous System Diseases
  - Meningitis – *Neisseria meningitidis*
  - Listeriosis - *Listeria monocytogenes*

  - Botulism – *Clostridum botulinum*
  - Bacterial tetanus – *Clostridum tetani*
- Viral diseases of the nervous system
  - Rabies – Rhabdovirus
  - Polio viral infection – caused by small non-enveloped virus (naked) called a Picorna virus.
- Fungal infections of the nervous system
  - Meningitis - *Cryptococcus neofrormans*
- Arboviruses
  - West Nile encephalitis

Listeriosis

- Listeriosis is a bacterial infection caused by a Gram-positive, motile bacterium called *Listeria monocytogenes*.
- Listeriosis has a low incidence in humans and occurs in pregnant women, newborn infants, elderly patients, and patients who are immunocompromised.
- Pregnant women are the most susceptible and infection can lead to early delivery, infection of the newborn, and death of the baby.

- The symptoms of listeriosis usually last 7–10 days, with the most common symptoms being fever, muscle aches, and vomiting.
- Diarrhea is another symptom, but less common. If the infection spreads to the nervous system it can cause meningitis, an infection of the covering of the brain and spinal cord.
- Listeria originally evolved to invade membranes of the intestines, as an intracellular infection, and developed a chemical mechanism to do so. This involves a bacterial protein “internalin” which attaches to a protein on the intestinal cell membrane “cadherin. ”

- These adhesion molecules are also to be found in two other unusually tough barriers in humans – the blood-brain barrier and the feto-placental barrier, and this may explain the apparent affinity that Listeria has for causing meningitis and affecting babies in-utero.
- Particular strains of a food-borne bacteria are able to invade the heart, leading to serious and difficult-to-treat heart infections.
- Listeria monocytogenes is ubiquitous in the environment. The main route of acquisition is by the ingestion of contaminated food products.

- Listeria has been isolated from raw meat, dairy products, vegetables, fruit and seafood.
- Soft cheeses, unpasteurized milk and unpasteurised pâté are potential dangers too.
- The main prevention is through the promotion of safe handling, cooking and consumption of food.
- This includes washing raw vegetables and cooking raw food thoroughly, as well as reheating leftover or ready-to-eat foods, like hot dogs, until steaming hot.

- Another preventative measure is to advise high-risk groups such as pregnant women and immunocompromised patients to avoid unpasteurized pâtés and foods such as soft cheeses.
- In the advent of listeriosis, bacteremia should be treated for two weeks, meningitis for three weeks, and brain abscess for at least six weeks. Ampicillin generally is considered the antibiotic of choice and gentamicin is added frequently for its synergistic effects. About 10 percent of serious listeria infections involve cardiac infections that are difficult to treat, with more than one-third proving fatal.

Botulism

- Botulism is a rare, but sometimes fatal, paralytic illness caused by botulinum toxin.
- This toxin is a protein produced under anaerobic conditions by the bacterium Clostridium botulinum. The toxin enters the human body in one of three ways:
  - by colonization of the digestive tract by the bacterium in children (infant botulism) or adults (adult intestinal toxemia),
  - by ingestion of toxin from foods (foodborne botulism), or
  - by contamination of a wound by the bacterium (wound botulism).

- Person-to-person transmission of botulism does not occur. All forms lead to paralysis that typically starts with the muscles of the face and then spreads towards the limbs.
- In severe forms, it leads to paralysis of the breathing muscles and causes respiratory failure.
- In light of this life-threatening complication, all suspected cases of botulism are treated as medical emergencies, and public health officials are usually involved to prevent further cases from the same source.

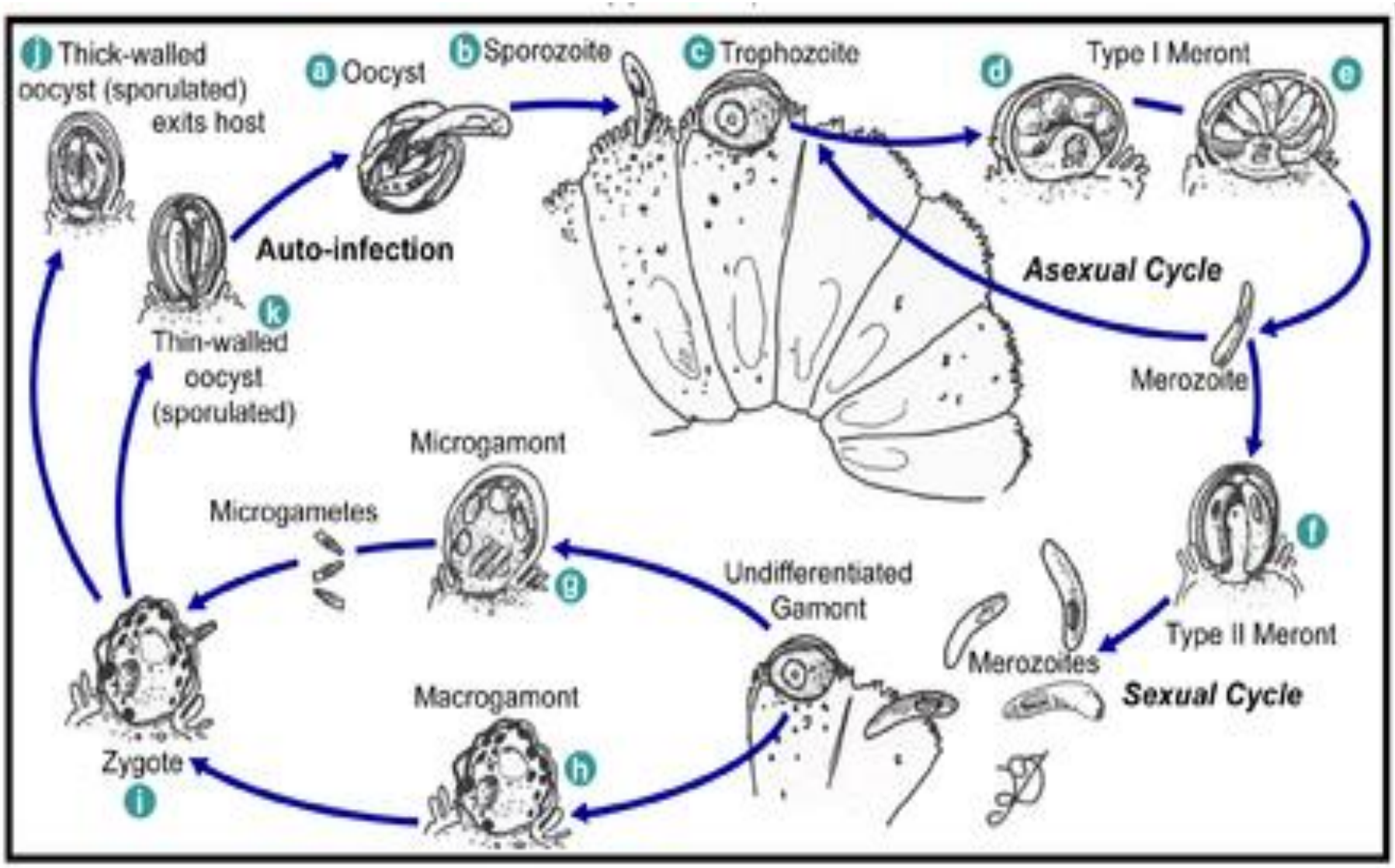
- Botulism can be prevented by killing the spores by pressure cooking or autoclaving at 121 °C (250 °F) for 30 minutes or providing conditions that prevent the spores from growing. Additional precautions for infants include not feeding them honey.
- C. botulinum is an anaerobic, Gram positive, spore-forming rod. Botulinium toxin is one of the most powerful known toxins: about one microgram is lethal to humans. It acts by blocking nerve function (neuromuscular blockade) through inhibition of the release of the excitatory neurotransmitter acetyl choline from the presynaptic membrane of neuromuscular junctions in the somatic nervous system. This causes paralysis.

- Treatment
  - The only drug currently available to treat infant botulism is Botulism Immune Globulin Intravenous-Human (BIG-IV or BabyBIG).
  - There are two primary Botulinum Antitoxins available for treatment of wound and foodborne botulism. Trivalent (A,B,E) Botulinum Antitoxin.
  - The second antitoxin is heptavalent (A,B,C,D,E,F,G) Botulinum Antitoxin.

Cryptosporidiosis

- Cryptosporidiosis is a type of parasitic disease caused by the parasite *Cryptosporidium*. Cryptosporidiosis is typically spread through the fecal-oral route and can be spread through contaminated water as well. Cryptosporiodiosis is one of most common waterborne diseases.
- The transmission of *Cryptosporidium* is based on successful ingestion of oocysts which are able to implant and infect the epithelial tissue of the intestine.

- *Cryptosporidium* is classified as a protozoan within the Phylum Apicomplexa. Other pathogens classified in this phylum include the malaria parasite and the parasite that causes toxoplasmosis. The life cycle of *Cryptosporidium* allows for growth in a single host.
- The spore phase of the life cycle, also referred to as the oocyst stage, is the stage that allows survival of the pathogen in numerous harsh environments. The oocyst allows for survival against harsh chemicals including harsh disinfectants such as chlorine.


j Thick-walled oocyst (sporulated) exits host
a Oocyst
b Sporozoite
c Trophozoite
d
Type I Meront
e
Auto-infection
Asexual Cycle
k Thin-walled oocyst (sporulated)
Merozoite
Microgamont
Microgametes
g
Undifferentiated Gamont
f
Type II Meront
Merozoites
Sexual Cycle
Macrogamont
h
Zygote
i

Viral Gastroenteritis

- Viruses that are known to cause gastroenteritis include rotavirus, norovirus, adenovirus, and astrovirus. Globally, Rotavirus is the most common cause of gastroenteritis in children.
- Rotavirus is a genus of double-stranded RNA virus in the family Reoviridae. Reoviruses are non-enveloped and have an icosahedral capsid composed of an outer and inner protein shell.

Transmission

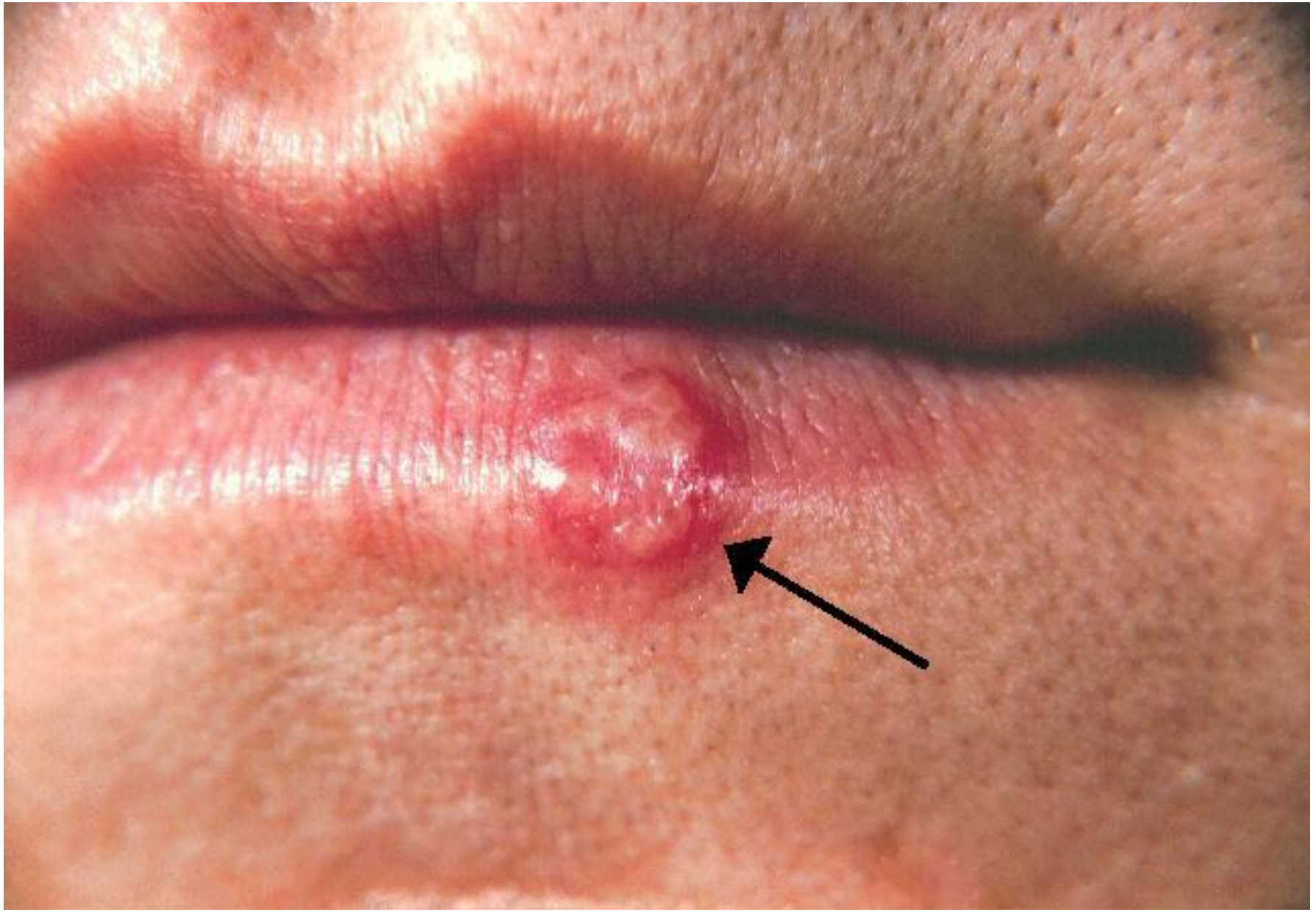
- Norovirus epidemics typically occur when groups of people spend time in close physical proximity to each other, such as on buses, in hospitals or in restaurants.
- People may remain infectious even after their diarrhea has ended. Norovirus is the cause of about 10% of cases in children.

Herpes simplex viruses

- Herpes simplex is a viral disease from the herpesviridae family caused by both Herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2).
- Infection with the herpes virus is categorized into one of several distinct disorders based on the site of infection. Oral herpes , the visible symptoms of which are colloquially called cold sores or fever blisters, is an infection of the face or mouth and is the most common form of infection.

- Genital herpes, known simply as herpes, is the second most common form of herpes. Herpes simplex is most easily transmitted by direct contact with a lesion or the body fluid of an infected individual. Transmission may also occur through skin-to-skin contact during periods of asymptomatic shedding.
- Oral herpes is easily diagnosed if the patient presents with visible sores or ulcers. Once infected, the virus remains in the body for life. Recurrent infections (outbreaks) may occur from time to time, especially in times of immune impairment such as HIV and cancer-related immune suppression.

- However, after several years, outbreaks become less severe and more sporadic, and some people will become perpetually asymptomatic and will no longer experience outbreaks, though they may still be contagious to others.
- Treatments with antivirals can reduce viral shedding and alleviate the severity of symptomatic episodes.



Dermatomycoses

- Conditions of the human integumentary system (the organ system that comprises the entire surface of the body, which includes the skin, hair, nails, and related muscle and glands) constitute a broad spectrum of diseases, also known as dermatoses.
- Common fungal skin and nail diseases include:
  - Ringworms caused by dermatophytes.
    - Ringworm of the body: *Microsporum canis, Trichophyton verrucosum, T. rubrum, T. violaceum* etc.

- Ringworm of the scalp: *Microsporum audouinii, M. canis, T. violaceum and T. schoenleinii*.
- Ringworm of the feet (athletes foot): *Trichophyton rubrum* and *T. mentagrophytes.*
- Ringworm of the nail: *T. rubrum* and *T. mentagrophytes.*

- The term “ringworm” is a misnomer, since the condition is caused by fungi of several different species and not by parasitic worms. The fungi that cause parasitic infection (dermatophytes) feed on keratin, the material found in the outer layer of skin, hair, and nails.
- Athlete’s foot is also known as tinea pedis is an infection of the skin that is caused by a fungi in the genus Trichophyton.

- While it is typically transmitted in moist communal areas where people walk barefoot, the disease requires a warm moist environment, such as the inside of a shoe, in order to incubate. Athlete's foot causes scaling, flaking, and itching of the affected skin.
- Blisters and cracked skin may also occur, leading to exposed raw tissue, pain, swelling, and inflammation. Secondary bacterial infection can accompany the fungal infection, sometimes requiring a course of oral antibiotics.

- Athlete’s foot can usually be diagnosed by visual inspection of the skin, but where the diagnosis is in doubt direct microscopy of a potassium hydroxide preparation (known as a KOH test) may help rule out other possible causes.
- Without medication athlete’s foot resolves in 30–40% of cases and topical antifungal medication consistently produce much higher percentages of a cure.
- Keeping feet dry and practicing good hygiene is crucial to preventing reinfection. Severe or prolonged fungal skin infections may require treatment with oral antifungal medication.

- Tinea cruris, also known as ringworm of the groin is a dermatophyte fungal infection of the groin region in any sex, though more often seen in males.
- As the common name for this condition implies, it causes itching or a burning sensation in the groin area, thigh skin folds, or anus. It may involve the inner thighs and genital areas, as well as extending back to the perineum and perianal areas.
- Affected areas may appear flake, peel, or crack. Fungus from other parts of the body (commonly tinea pedis or ‘athlete’s foot’) can contribute to this itch. A warm, damp environment allowing the fungus to cultivate greatly contributes; especially with tight, sweaty, or rubbing clothing

- Keeping the groin area clean and dry by drying off thoroughly after bathing and putting on dry clothing right away after swimming or perspiring can prevent this infection.
- Other recommendations to prevent this infection are: not sharing clothing or towels with others, showering immediately after athletic activities, wearing loose cotton underwear, avoiding tight-fitting clothes, and using antifungal powders.
- Tinea cruris is best treated with topical antifungal medications of the allylamine or azole type.

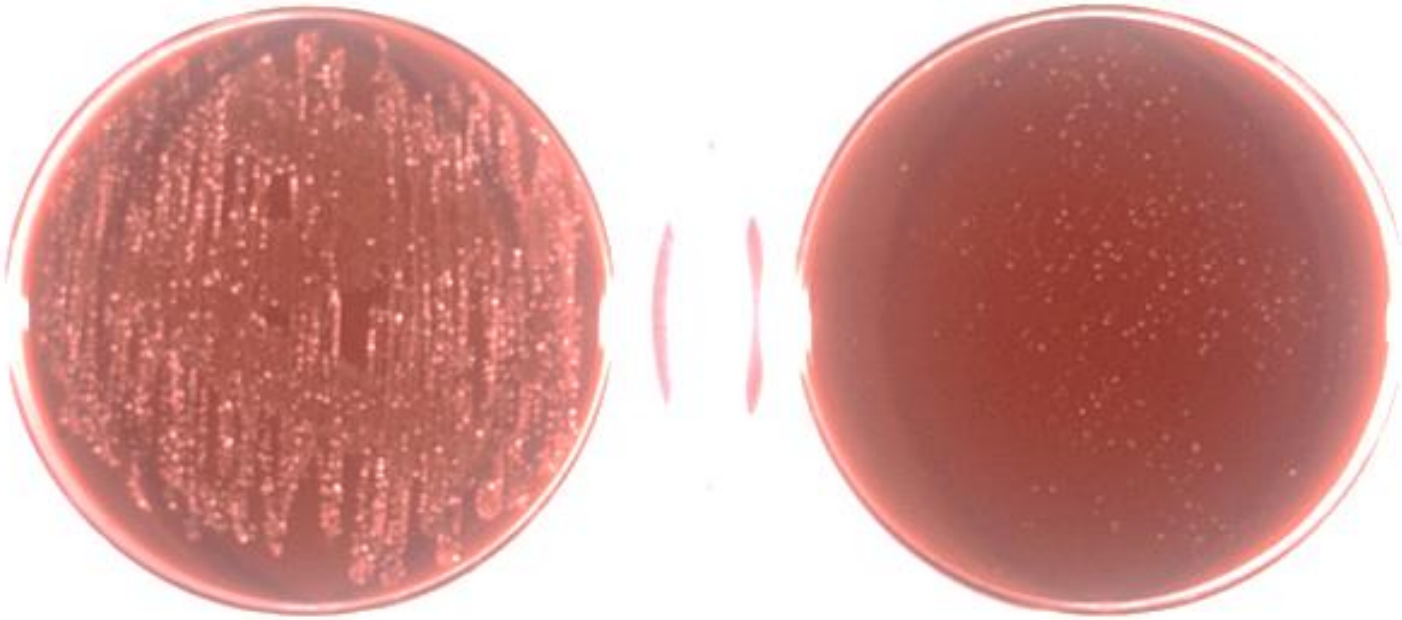
Gonorrhea

- Gonorrhea is a common human sexually transmitted infection.
- The usual symptoms in men are burning with urination and penile discharge. Women, on the other hand, are asymptomatic half the time or have vaginal discharge and pelvic pain.
- In both men and women if gonorrhea is left untreated, it may spread locally causing epididymitis or pelvic inflammatory disease or throughout the body.

- The incubation period is 2 to 14 days with most of these symptoms occurring between 4–6 days after being infected.
- Rarely, gonorrhea may cause skin lesions and joint infection (pain and swelling in the joints) after traveling through the blood stream.
- Very rarely it may settle in the heart causing endocarditis or in the spinal column causing meningitis.
- Gonorrhea is caused by the bacteria Neisseria gonorrhoeae. The infection is transmitted from one person to another through vaginal, oral, or anal sex.

- Men have a 20% risk of getting the infection from a single act of vaginal intercourse with an infected woman. The risk for men who have sex with men is higher.
- Women have a 60–80% risk of getting the infection from a single act of vaginal intercourse with an infected man.
- A mother may transmit gonorrhea to her newborn during childbirth; when affecting the infant's eyes, it is referred to as ophthalmia neonatorum. *It cannot be spread by toilets or bathrooms.*

(Testing for *Neisseria gonorrhoeae*)



Chocolate Medium
Overgrowth

Thayer-Martin Medium
***Neisseria* Only**

Tuberculosis

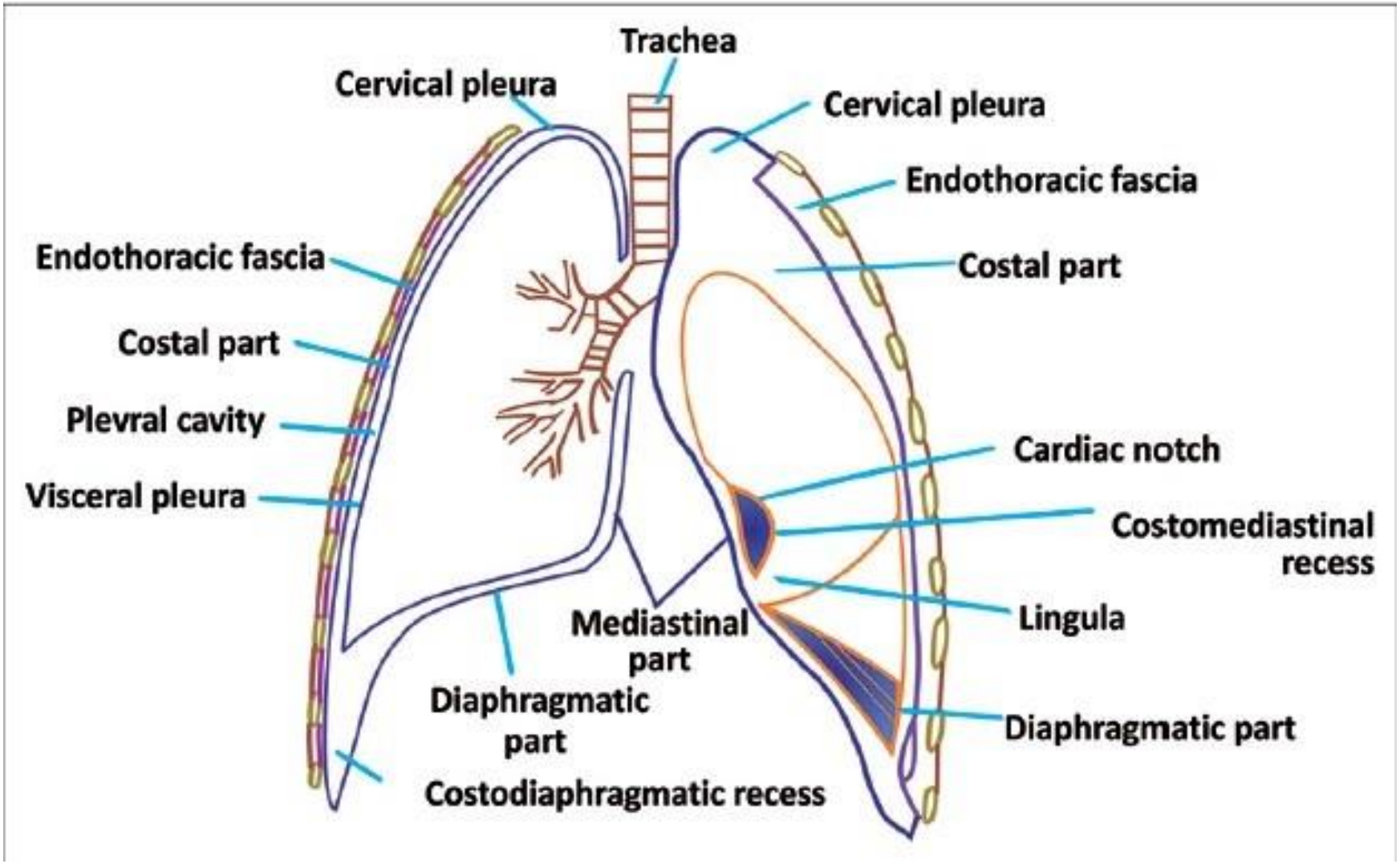
- Tuberculosis (TB; short for tubercle bacillus) is a common, and in many cases lethal, infectious disease caused by various strains of mycobacteria, usually Mycobacterium tuberculosis .
- Tuberculosis typically attacks the lungs, but can also affect other parts of the body. It is spread through the air when people who have an active TB infection cough, sneeze, or otherwise transmit their saliva through the air.
- Most infections are asymptomatic and latent, but about one in 10 latent infections eventually progresses to active disease which, if left untreated, kills more than 50% of those infected.

Symptoms

- The classic symptoms of active TB infection are a chronic cough with blood-tinged sputum, fever, chills; night sweats, and weight loss.
- Tuberculosis may infect any part of the body, but most commonly occurs in the lungs, known as pulmonary tuberculosis. Extrapulmonary TB occurs when tuberculosis develops outside of the lungs, but may co-exist with pulmonary TB as well.

- Extrapulmonary TB occurs more commonly in immunosuppressed persons and young children. In those with HIV this occurs in more than 50% of cases.
- Notable extrapulmonary infection sites include:
  - the pleura (in tuberculous pleurisy),
  - the central nervous system (in tuberculous meningitis),
  - the lymphatic system (in scrofula of the neck),
  - the genitourinary system (in urogenital tuberculosis), and the bones and joints (osseous tuberculosis).

- Tuberculosis may become a chronic illness and cause extensive scarring in the upper lobes of the lungs.



Diagnostics

- A diagnosis of TB should be considered in those with signs of lung disease or symptoms lasting longer than two weeks.
- A chest x-ray and multiple sputum cultures for acid-fast bacilli are typically part of the initial evaluation.
- A definitive diagnosis of TB is made by identifying *M. tuberculosis* in a clinical sample such as sputum, pus, or a tissue biopsy. However, the difficult culture process for this slow-growing organism can take two to six weeks for blood or sputum culture.

- The Mantoux tuberculin skin test is often used to screen people at high risk for TB. It involves injecting a protein extraction of the tuberculosis bacteria under the skin, and then examining the site 36-48 hours later.
- A person who has been exposed to the bacteria and has previously formed antibodies is expected to mount an immune response, displaying a raised, red area of skin at the site of injection. The test does have limited accuracy, especially in immunosuppressed people, and is typically used in combination with clinical findings and x-rays to reach a diagnosis.

- The tuberculosis skin test is also known as the ***tuberculin test or purified protein derivative*** (PPD) test.
- The tuberculin skin test is based on the fact that infection with *M. tuberculosis* bacterium produces a ***delayed-type hypersensitivity skin reaction*** to certain components of the bacterium.
- The components of the organism are contained in *extracts of culture filtrates* and are the core elements of the classic tuberculin ***purified protein derivative*** **(**PPD).

- **This PPD material is used for skin testing for tuberculosis.** Reaction in the skin to tuberculin PPD begins when specialized immune cells i.e. *T - cells,* which have been sensitized by prior infection, are recruited by the immune system to the skin site where they release chemical messengers called *lymphokines.*
- These lymphokines induce induration (a hard, raised area with clearly defined margins at and around the injection site) through local vasodilation (***expansion of the diameter of blood vessels***) leading to fluid deposition known as ***edema***, ***fibrin deposition***, and ***recruitment of other types of inflammatory cells to the area***.

Administration of *Mantoux* Test

- The standard recommended tuberculin test is administered by injecting a ***0.1 mL*** volume containing ***5 TU (tuberculin units)*** PPD into the top layers of skin (***intradermally, immediately under the surface of the skin***) of the forearm.
- The injection is typically made using a ¼-inch to ½-inch, **27-gauge needle** and a **tuberculin syringe**.
- A discrete, pale elevation of the skin (i.e. a wheal or "bleb) 6 - 10 mm in diameter should be produced when the injection is done correctly.

- This wheal or "bleb" is generally quickly absorbed.
- If it is recognized that the first test was improperly administered, another test can be given at once, selecting a site several centimeters away from the original injection.

Reading the Tuberculosis Skin Test

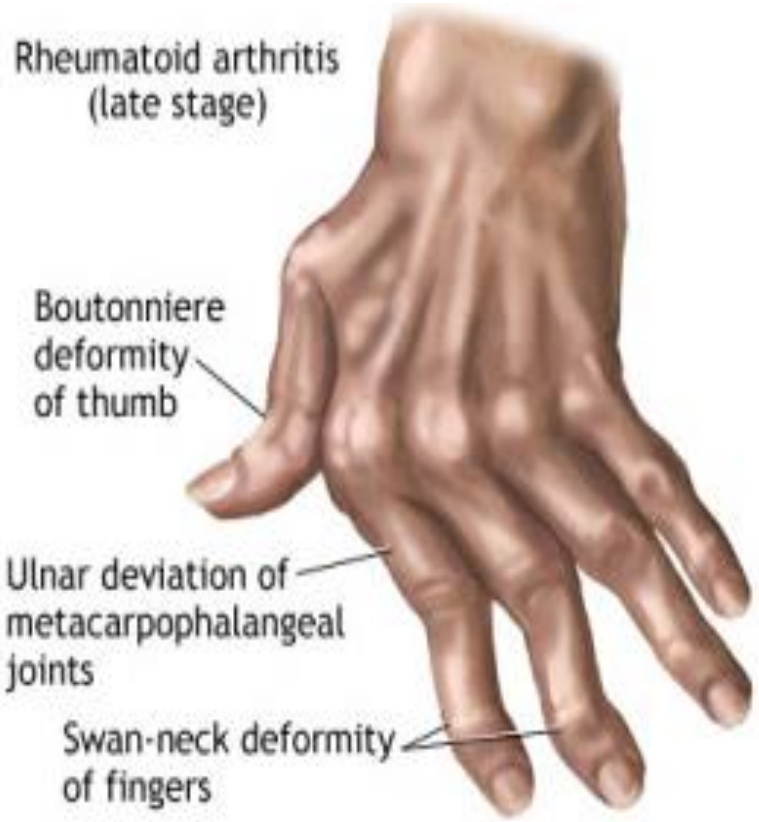
- "Reading" the skin test means detecting a raised, thickened local area of skin reaction, referred to as induration or wheal or bleb.
- Induration is the key item to detect, ***not redness or bruising.***
- Skin tests should be read ***48-72 hours*** after the injection when the size of the induration is maximal. Tests read after 72 hours tend to underestimate the size of the induration.
- The diameter of the induration should be measured transversely perpendicularly to the long axis of the forearm and recorded in millimeters. The area of induration around the site of injection is due to the reaction to the tuberculin.

Interpreting Tuberculosis Skin Test

- A tuberculin reaction is classified as positive based on the diameter of the induration ***in conjunction with certain patient-specific risk factors.***
  - In a healthy person whose immune system is normal, induration greater than or equal to 15 mm is considered a positive skin test.
  - If blisters are present (vesiculation), the test is also considered positive.

- In a person with has an underlying *kidney disease*, *diabetes*, or is a health-care worker or a personal previously in contact with someone with active TB, 10 mm of induration is considered a positive skin test result. In patients who are immunocompromised, such as people with *rheumatoid arthritis* or *Crohn's disease*, HIV/AIDs, 5 mm of induration is considered a positive skin test result. An autoimmune disorder, rheumatoid arthritis occurs when your immune system mistakenly attacks your own body's tissues. rheumatoid arthritis affects the lining of your joints, causing a painful swelling that can eventually result in bone erosion and joint deformity. Crohn's disease is an inflammation and scaring of the intestine.

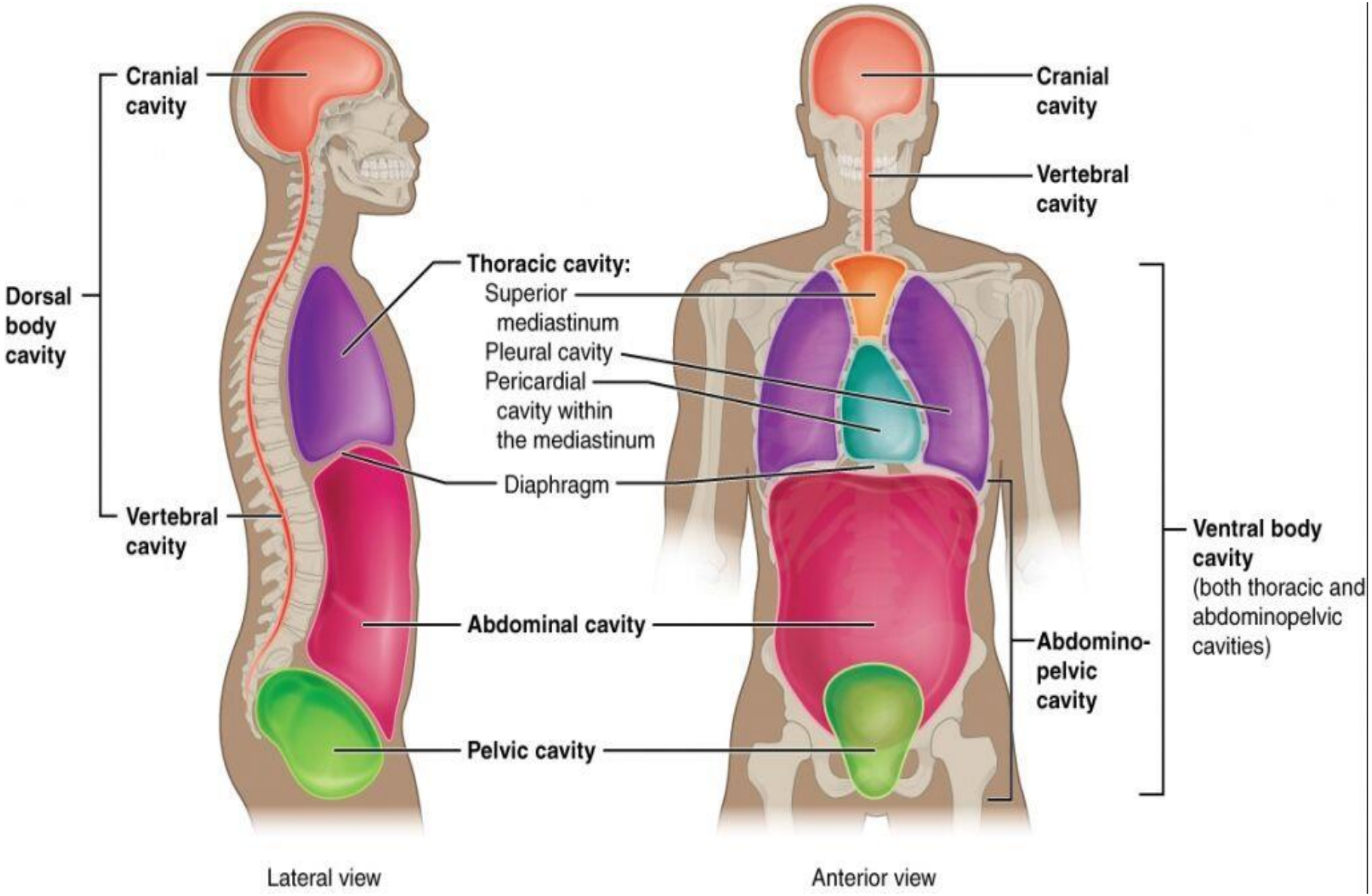
- Induration of less than 2 mm, without blistering, is considered a negative skin test.



Rheumatoid arthritis

Crohn's disease

- X-ray
  - Two views are usually taken:
    - one in which the x-rays pass through the chest from the back (posterior-anterior view), and
    - one in which the x-rays pass through the chest from one side to the other (lateral view).
  - You stand in front of the machine and must hold your breath when the x-ray is taken.
- Inform the health care provider if you are pregnant.
- Chest x-rays are generally avoided during the first six months of pregnancy.


Cranial cavity
Dorsal body cavity
Vertebral cavity
Thoracic cavity:
Superior mediastinum
Pleural cavity
Pericardial cavity within the mediastinum
Diaphragm
Abdominal cavity
Pelvic cavity
Lateral view
Cranial cavity
Vertebral cavity
Abdomino-pelvic cavity
Ventral body cavity (both thoracic and abdominopelvic cavities)
Anterior view

- You must wear a hospital gown and remove all jewelry.
- In adults, a multi-nodular infiltrate above or behind the clavicle (the most characteristic location, most visible in an apical-lordotic view) suggests reactivation of TB.
- Middle and lower lung infiltrates are nonspecific but should prompt suspicion of primary TB in patients (usually young) whose symptoms or exposure history suggests recent infection, particularly if there is pleural effusion. Calcified hilar nodes (*diffuse lung parenchymal calcified nodules*) may be present; they may result from primary TB infection.

-END-