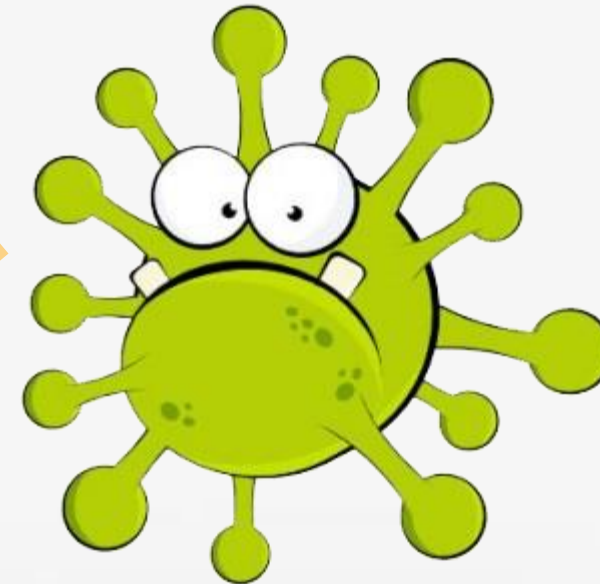


# HOST PATHOGEN INTERACTIONS



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# *Introduction:*

- Microbes are found everywhere.
- Every day we encounter with microbes (i.e., bacteria, fungi, viruses, protozoa and parasite).
- They enters inside body by different means.
- Most of the organism shows no harmful effect to humans due to protective mechanism.
- Humans and animals have “friendly” organisms throughout their bodies that survive as normal flora and colonize a host but do not cause disease.
- If these organisms begin to cause any obvious damage to a host by invading tissues and/or producing toxins, they then become pathogens.

# *What is the significance of host-pathogen interactions?*

Host-pathogen interactions provide information that can help scientists and researchers understand disease pathogenesis, the biology of one or many pathogens, as well as the biology of the host.

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# Koch's Postulates: Determine Disease Causation



Robert Koch

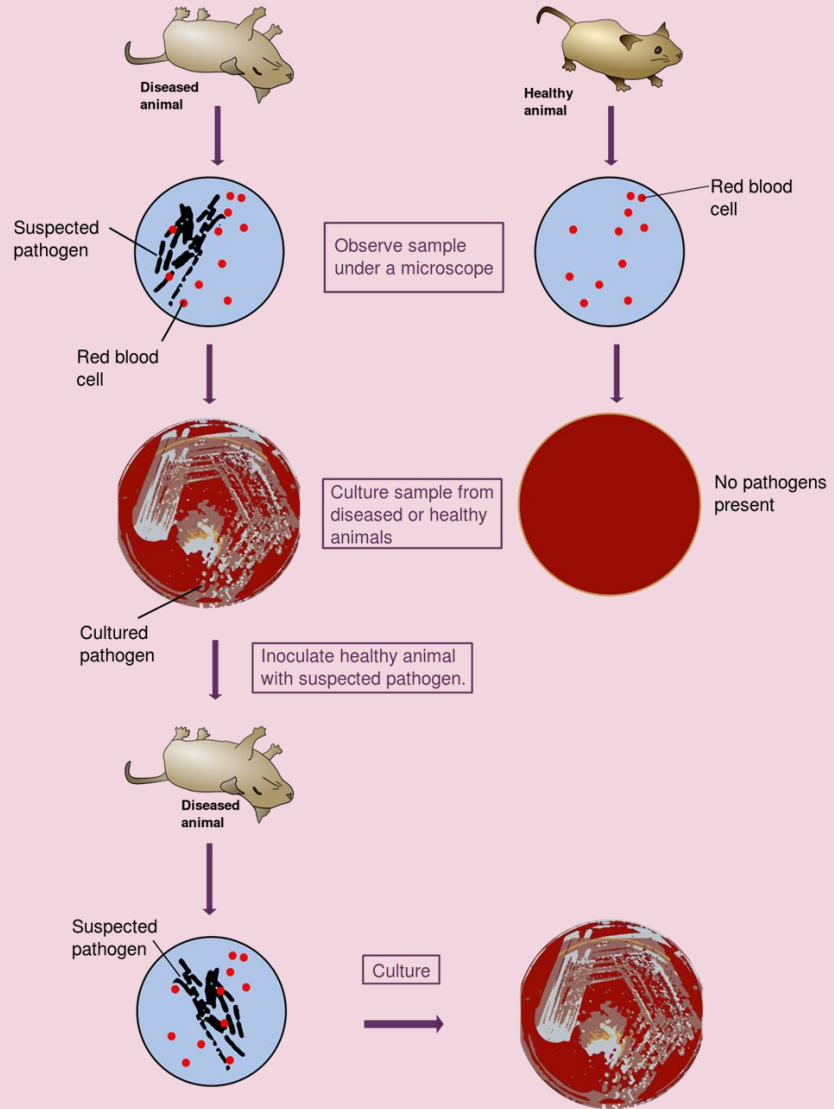
## Koch's Postulates:

① The microorganism must be found in abundance in all organisms suffering from the disease, but should not be found in healthy organisms.

② The microorganism must be isolated from a diseased organism and grown in pure culture.

③ The cultured microorganism should cause disease when introduced into a healthy organism.

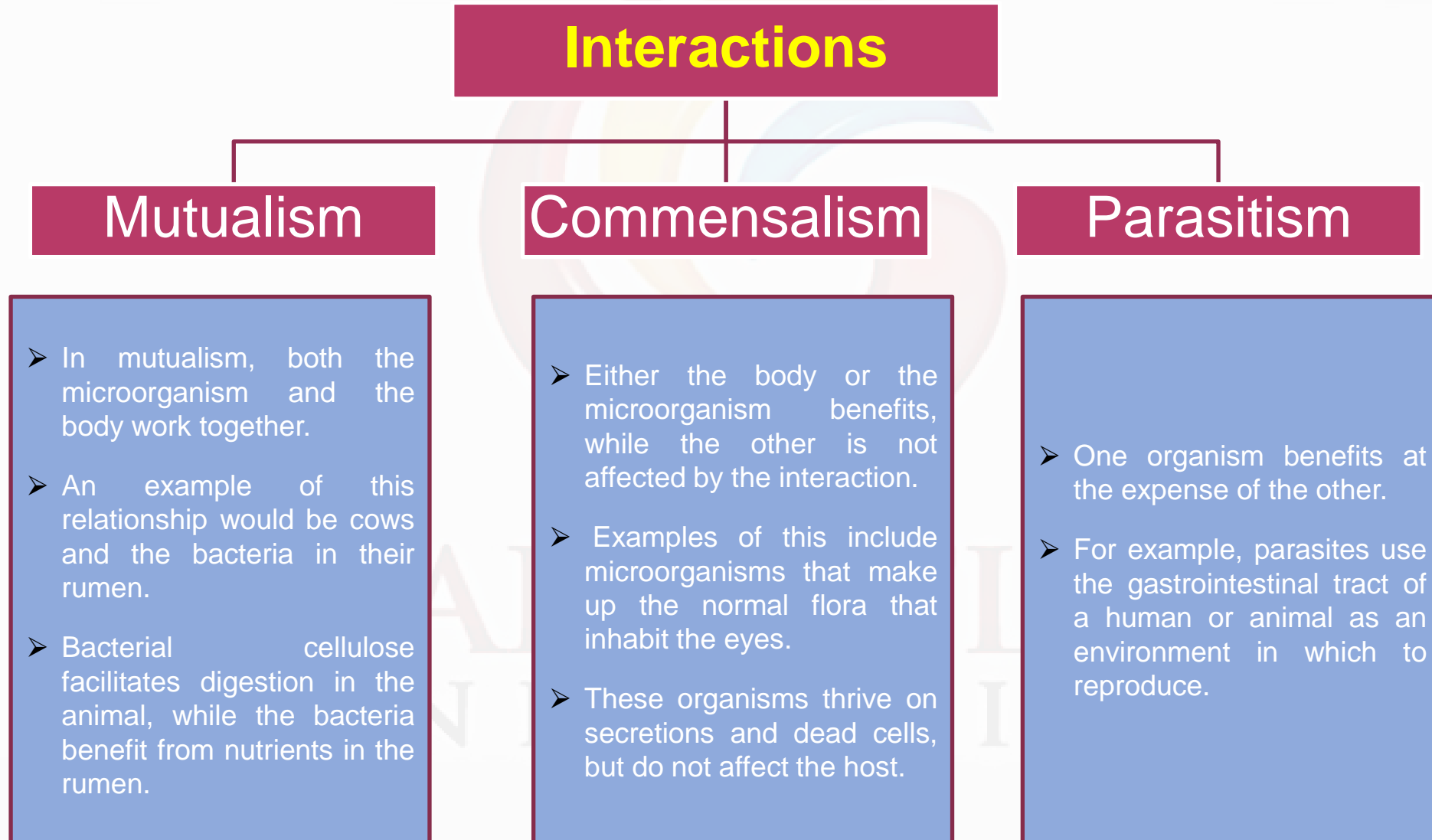
④ The microorganism must be reisolated from the inoculated, diseased experimental host and identified as being identical to the original specific causative agent.



# Exception of Koch's postulates

1. Some organisms cannot be cultured in a lab and grown on artificial media.
2. Some pathogens can cause several disease conditions such as *M. tuberculosis*, which can cause lung disease and other diseases of the skin, bone, and internal organs.
3. There may be ethical reasons that do not allow testing, (i.e., human diseases with no animal model - smallpox, rubella).

# Host-Pathogen Interactions



# *The Body's Normal Flora*

The body contains two types of normal flora:

- 1) resident flora (survive for extended periods)
- 2) transient flora (temporary)

Normal flora help to provide defenses against invading pathogens:

- a) Covering adherence sites
- b) Producing compounds toxic to other organisms
- c) Preventing pathogens from consuming available nutrients.

# Host Defenses

A microorganism will not be able to invade unless it overcomes an animal's or individual's host defenses. Specific host defenses may include:

- ❖ Skin and mucosal secretions
- ❖ Non-specific local responses (e.g., pH)
- ❖ Non-specific inflammatory responses
- ❖ Specific immune responses (e.g., lymphocytes)



***The ability for a pathogen to overcome host defenses can be accomplished by two distinct components:***

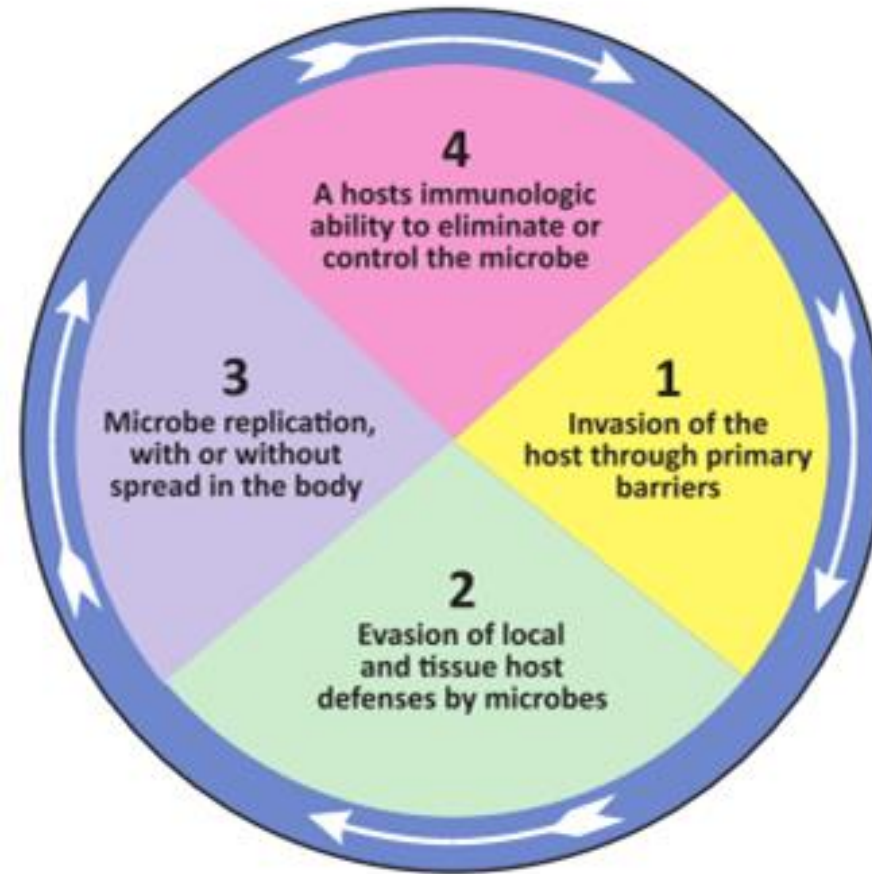
**A primary pathogen (causes disease in a healthy host)**

***or***

**Opportunistic pathogen (causes disease if host is immunocompromised).**

# Pathogen Defenses

- Pathogens contain virulence factors that promote disease formation and provide the opportunity for a microbe to infect and cause disease.
- The greater the virulence, the more likely disease will occur. Such factors include:
  - ❑ Ability of a pathogen to adhere to a host
  - ❑ Ability of a pathogen to colonize (overcome) a host
  - ❑ Ability of a pathogen to evade host defenses



**Components for the host pathogen interaction.**

# *Mechanisms of Pathogenesis*

- Pathogenesis is the method by which a disease can develop.
- This can occur through foodborne intoxication where the causative agent produces toxins in the body (e.g., botulism).
- Another route is the colonization of an invading pathogen on the host surface, which allows the pathogen to increase in numbers and produce toxins that are damaging to the host's cells (e.g., *Vibrio* and *Corynebacterium*).

# Mechanisms of Pathogenesis



# TRANSMISSION

- ❖ In order to begin infection and eventually cause disease, pathogens must find a transmission route.
- ❖ Transmission of an infectious agent can occur in many ways, but it is typically through exposed skin (e.g., a cut, abrasion, puncture, or wound) or mucous membranes (e.g., gastrointestinal tract, respiratory tract, or urogenital tract).

# ADHERENCE

- ❖ This attachment is called adherence.
- ❖ Microbes contain ligands, which are projections that attach host receptors or surface proteins.
- ❖ Pathogens may have specific adherence mechanisms to attach to cells or tissue surfaces.
  - a. Tissue tropism (i.e., pathogens that prefer specific tissues over others)
  - b. Species specificity (i.e., pathogens that only infect certain species)
  - c. Genetic specificity (i.e., surface mutations that occur so previous antibodies do not recognize the invading pathogen).

# INVASION

- ❖ At this point, microbes begin to invade the host and produce a bacteremia (i.e., presence of bacteria in the bloodstream) or viremia (presence of a virus in the bloodstream).
- ❖ Microorganisms are exposed to many barriers after introduction into the host.
- ❖ Some bacteria are able to cause disease while remaining on the epithelial barriers, while many need to penetrate that barrier.
- ❖ Once this barrier has been penetrated, these pathogens can multiply without competition.



# COLONIZATION

- ❖ Colonization is the multiplication of pathogenic organisms where toxins are produced, and the normal flora are overcome.
- ❖ During this stage, pathogens compete with normal flora for space and nutrients.
- ❖ Pathogens usually colonize host tissues that are in contact with the external environment.
- ❖ During colonization, the host begins to show signs of septicemia (i.e., blood infection where bacteria are reproducing).

# EVASION

- After colonization, pathogens circumvent the host's innate and adapted defenses by phagocytosis. Multiple mechanisms are used by pathogens to evade a host's immune system. For the innate system this includes:
- a) Intracellular pathogens that live inside a host cell
  - b) Avoid phagocyte recognition by producing capsules prevents phagocytosis
  - c) Producing membrane damaging toxins which can kill phagocytes (e.g., leukocidins)
  - d) Interfere with complement activation
  - e) Survive in the phagocyte

## EVASION

- Pathogens must also avoid adapted defenses.
- Pathogens can produce proteases (i.e., allow each pathogen to avoid antibodies) or catalases (i.e., prevents the digestion of an engulfed pathogen). They can also utilize antigenic variation to alter the antigen structure.
- In addition, pathogens can mimic host molecules,
- which can cause disease-related damage.

## DAMAGE TO HOST TISSUES

- ❖ Damage can occur through toxins, which are poisonous substances that produce toxemia within a host.
- ❖ Three types of toxins are produced to cause damage:
- ❖ Exotoxins: Proteins secreted by pathogens that cause damage to the host (botulinum toxin, tetanus toxin, hemolysin (ruptures red blood cells)).
- ❖ Endotoxins: Toxic substances that are released when a cell is killed (Lipolysaccharides).

# DAMAGE TO HOST TISSUES

- ❖ **Exoenzymes:** Enzymes that function outside the host cells or tissues.
  - ✓ **Coagulase** (forms a fibrin clot that “hides” the microbe from phagocytosis),
  - ✓ **Hyaluronidase** (breaks connective tissues down),
  - ✓ **Fibrinase** (breaks down blood clots to allow pathogens to continue spreading).

## EXIT FROM HOST

A pathogen must exit the body. This occurs through various routes.

Examples include sneezing, coughing, diarrhea, coitus, pus, blood, or insect bites.

## SURVIVAL IN ENVIRONMENT

- ❖ Finally, a pathogen must be able to survive in the environment long enough to be transmitted to another host.
- ❖ Some are hardy and can survive for several weeks before a new host is found. There are others that survive in animal reservoirs or require direct contact because they are fragile.

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