

# Pathogenesis



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# Terminology

We have 2 types of diseases: organic, infectious. (we're dealing with infectious diseases.)

- **Pathology:** the study of the structural and functional manifestation of disease. **Any change in the organ like: motility limitation, tenderness or swelling.**
- **Pathogenesis:** the steps involved in the development of a disease. **Every step has unique properties.**
- **Pathogenicity:** the ability to cause a disease.
  - \* This definition is interchangeable with **virulence**, **but** every one of them has its own definition.

# Pathogenesis



- Pathogen: a microorganism which causes disease when it encounters a susceptible host is called a pathogen. And a pathogen is genetically determined ( has a “ tox ” gene in it’s chromosome).
  - *Vibrio cholerae* Cholera
  - *Corynebacterium diphtheriae* Diphtheria
  - *Mycobacterium tuberculosis* Tuberculosis
- \*some organisms are not originally pathogens but they can overcome defence mechanisms and turn to pathogens (these are called Opportunistic Organisms).

## Notes from record:



Some organisms are not originally pathogens but they can overcome defence mechanism and turn to pathogen ( we call these organisms Opportunistic Organisms or Chancers ).



How can we determine if an organism is pathogen?

- From a patient with specific disease, if we isolated one microbial agent, then it is the only accused and source of infection.
- In some diseases we can isolate multiple microbes which give raise to: polymicrobial, mixed infections and super infections.

# Pathogenesis



- Potential pathogen: This is a term commonly used to refer to organisms which are often normal flora but under certain circumstances may overcome host defenses and cause disease e.g *Streptococcus pneumoniae*
- *Neisseria meningitidis* (URT) → Meningitis  
↳ Normal flora in oropharynx.
- *Haemophilus influenzae* (URT) → pneumonia, ear and eye infections, meningitis
- Non Pathogen: normal flora which rarely cause disease and are usually considered as non pathogen. **Exist as common sense.**

# Infection versus Infectious Disease

## Disease

- Any deviation from a condition of good health and well-being

**Infectious Disease** → Infection caused by infectious agent.

\*in order to cause infection, some organisms must enter inside the host and multiplies.

- A disease condition caused by the presence or growth of infectious microorganisms or parasites

- In general usage, the terms infection and infectious disease are synonyms
- Infection: this term is used to describe the process when an organism enters a host, invades and multiplies.  
\*If the organism hasn't entered host tissue, there is no infection.

# Why infection doesn't always occur



- Unsuitable landing site  
respiratory pathogen lands on the skin  
↳ when the organ is not suitable for the organism.
- Absence of receptors
- The presence of natural antibacterial at the site of landing \*competition for space, presence of antibacterial chemicals  
↳ occupied by normal flora ( no space).
- The indigeneous microflora may inhibit the pathogen (microbial antagonism) \*producing Bacteriocin.



- The individual's health status
- Immunized persons **Example: influenza shot even with infection, no symptoms will appear, or maybe minimized.**
- Phagocytic activity of WBC found in the blood or tissues **Major immune cells.**
- Immunization is preferred for: **elderly aged, children immunosuppressed, allergic people.**

# Periods in the course of disease



- The incubation period: The pathogen is preparing it self :
  1. Getting required nutrients.
  2. Multiplying to reach infection dose.

the time that elapses between arrival of the pathogen and the onset of symptoms. No signs or symptoms differ from organism to organism (days to years).

- The prodromal period:  
the time during which the patient feels “out of sorts” but does not yet experience actual symptoms of the disease

- The period of illness

the time during which the patient experiences the typical symptoms associated with that particular disease. Pathogen viability is the MAX.

- The convalescent period

the time during which the patient recovers.

\*The for stages are affected mainly by immune status if the patient (how it's competent).

# Localized versus systemic infections



- Localized infections

The disease remain in the same site of entry

Like: skin abscess, starts with an infection remains in it's place, ends after 2-3 days.

- Systemic infections

The disease spreads throughout the body

\*Spreads via Macrophages (it's way of transport). Usually called intracellular organisms, can live inside macrophages or phagocytes.

\*2 types of macrophages: fixed and wandering.


# Acute, subacute and chronic



- Acute disease: disease has a rapid onset followed by a relatively rapid recovery (e.g., influenza)
- A chronic disease: a disease has slow onset and lasts for a long time (e.g., TB, syphilis)
- ↳ subclinical disease.
- Subacute disease: a disease comes more suddenly than chronic disease and less suddenly than the acute ones (e.g., endocarditis). **Caused by normal flora of oral cavity during tooth extraction.**

# Symptoms versus signs of a disease



- A symptom of a disease is defined as some evidence (subjective) of a disease that is experienced by the patient (e.g., nausea, pain, chills). **Vomiting, fever.**
- The disease may be either symptomatic (clinical disease) or asymptomatic (subclinical)
- Sign of disease is defined as some types of objective evidence of disease (e.g., hepatomegaly, blood pressure, abnormal laboratory results).
-  **Needs examination, lab test or radiograph.**



↳ Dormant form.

- Latent infections: symptomatic infectious disease may go to asymptomatic disease and then sometime later go back to being symptomatic disease (e.g., herpes virus infections). And TB spores are also an example.
- A latent disease is a disease that is lying dormant, not currently manifesting itself.

## Primary versus secondary infections

Infectious disease may follow another, the first disease is referred to as the primary infection and the second disease is referred to as the secondary infection

Usually, primary infections are viral and secondary infections are bacterial.

- Viruses prepare tissues for bacterial establishment by disabling CILIA, preventing cilia elevation.



# Steps in the pathogenesis of the infectious diseases



- Entry
- Attachment
- Multiplication
- Invasion/spread
- Evasion of host defense
- Damage to host tissues

**Number of  
Invading Microbes**

**Portals of Entry**

Mucous membranes  
Respiratory tract  
Gastrointestinal tract  
Genitourinary tract  
Conjunctiva  
Skin  
Parenteral route

**Penetration or Evasion  
of Host Defenses**

Capsules  
Cell wall components  
Enzymes

**Damage to Host Cells/  
Cytopathic Effects**

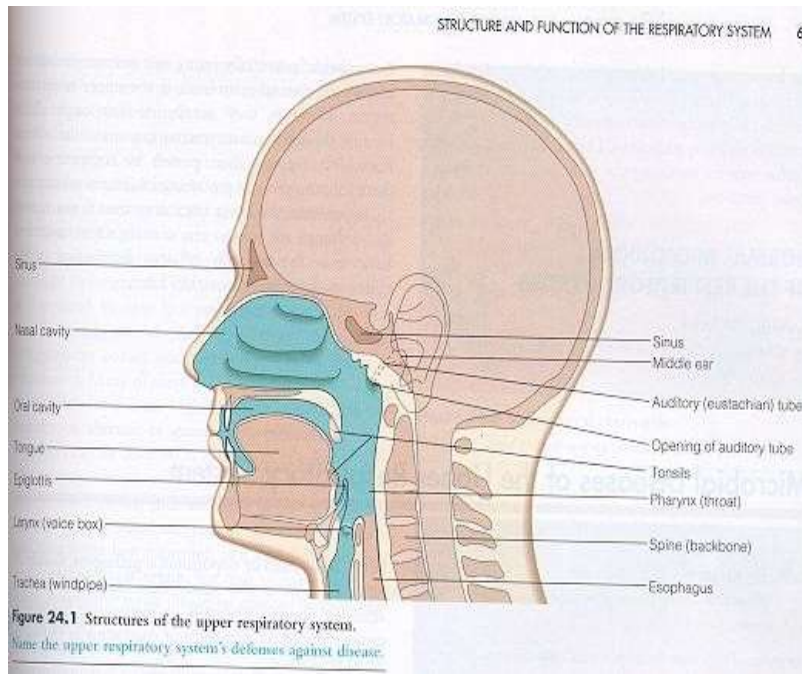
Direct damage  
Toxins  
Exotoxins  
Endotoxins  
Hypersensitivity

**Adherence**

# Portal of entry

## 1. Mucus Membranes →

The most important tissue used by bacteria to infect.



### • A. Respiratory Tract

- microbes inhaled into mouth or nose in droplets of moisture or dust particles

↳ And attach to the receptors existing on mucus membrane.

- Easiest and most frequently traveled portal of entry

# Common Diseases contracted via the Respiratory Tract



- Common cold
- Flu
- Tuberculosis
- Whooping cough
- Pneumonia
- Measles
- Diphtheria

Some are viral and other are bacterial.

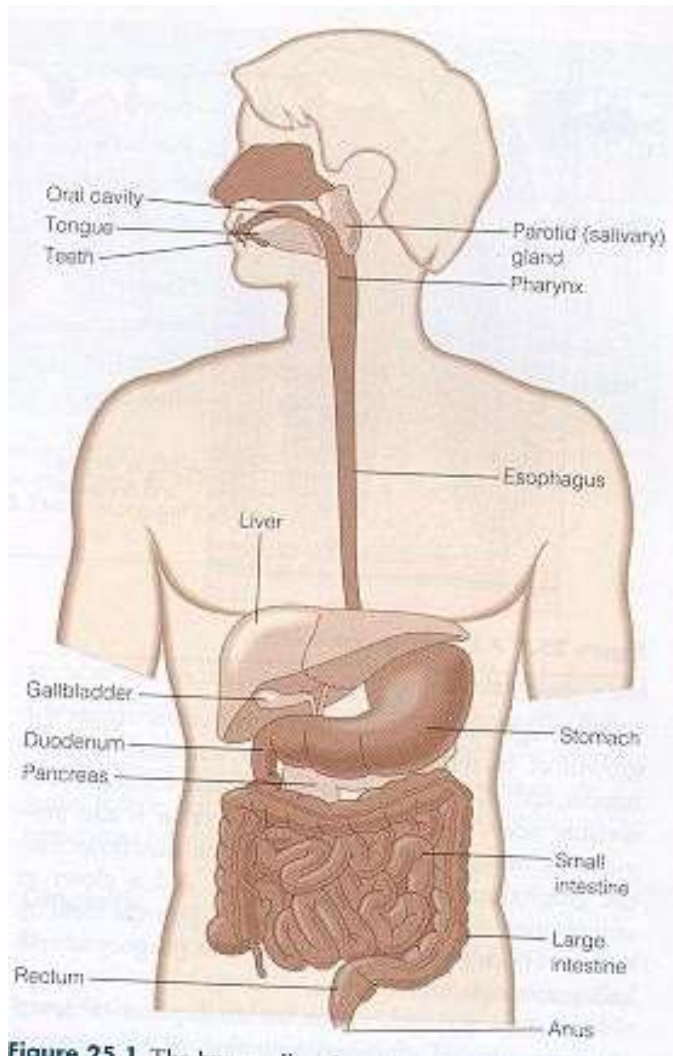
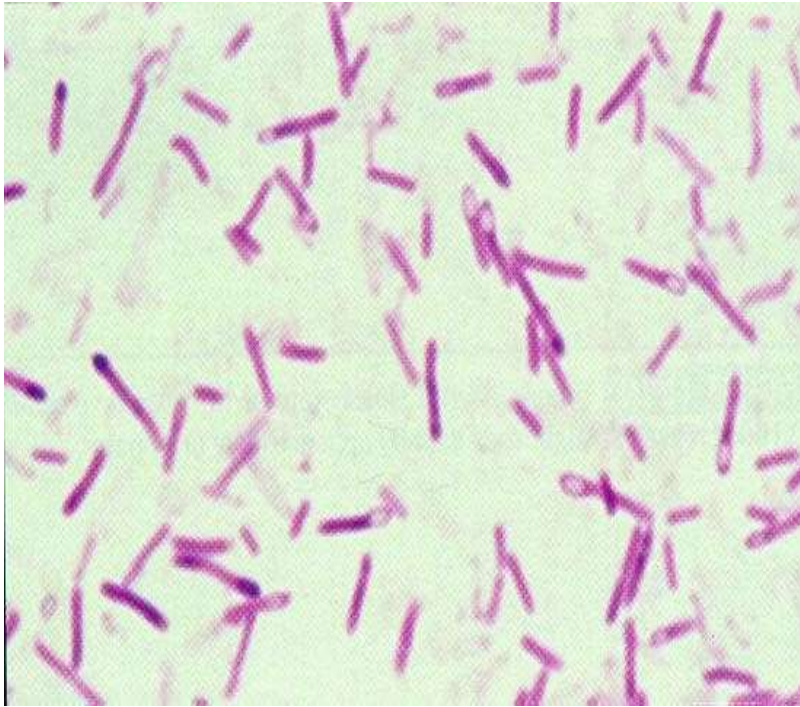


Figure 25.1 The human gastrointestinal tract.

- B. Gastrointestinal Tract
  - microbes gain entrance through contaminated food & water or fingers & hands
    - ↳ Depends on ingestion.
  - most microbes that enter the G.I. Tract are destroyed by HCL & enzymes of stomach or bile & enzymes of small intestine
- A factor of infection through this portal affected by lacking hygiene.
- Nail-biting is also a common way of infection through this portal as a result of huge number of microbes.

# Common diseases contracted via the G.I. Tract



*Clostridium botulinum*

- Salmonellosis
  - *Salmonella sp.*
- Shigellosis
  - *Shigella sp.*
- Cholera
  - *Vibrio cholorea*
- Ulcers
  - *Helicobacter pylori*
- Botulism
  - *Clostridium botulinum*

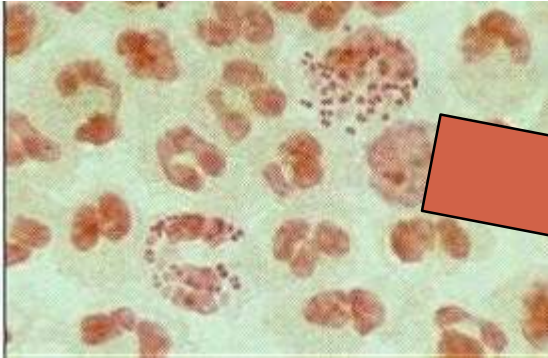
# Fecal - Oral Diseases

- The most dangerous in GI tract infections.

- These pathogens enter the G.I. Tract at one end and exit at the other end.
- Spread by contaminated hands & fingers or contaminated food & water
- Poor personal hygiene.

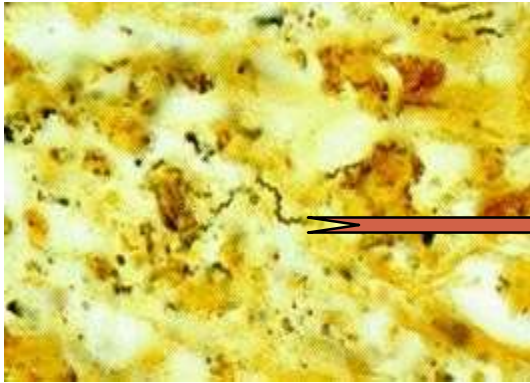
Example: Typhoid caused by salmonella typhi.

# Mucus Membranes of the Genitourinary System - STD's



Gonorrhoea

*Neisseria  
gonorrhoeae*



Syphilis

*Treponema  
pallidum*



## 2nd Portal of Entry: Skin

- Skin - the largest organ of the body. When unbroken is an effective barrier for most microorganisms.
  - The main defence mechanism in human body.
- Some microbes can gain entrance through openings in the skin: hair follicles and sweat glands, wound ...etc
  - The more skin is intact, the less probability of infection.
  - Any damage to hair follicle abscess could develop it to cellulitis, which is inflammation of subcutaneous connective tissue.

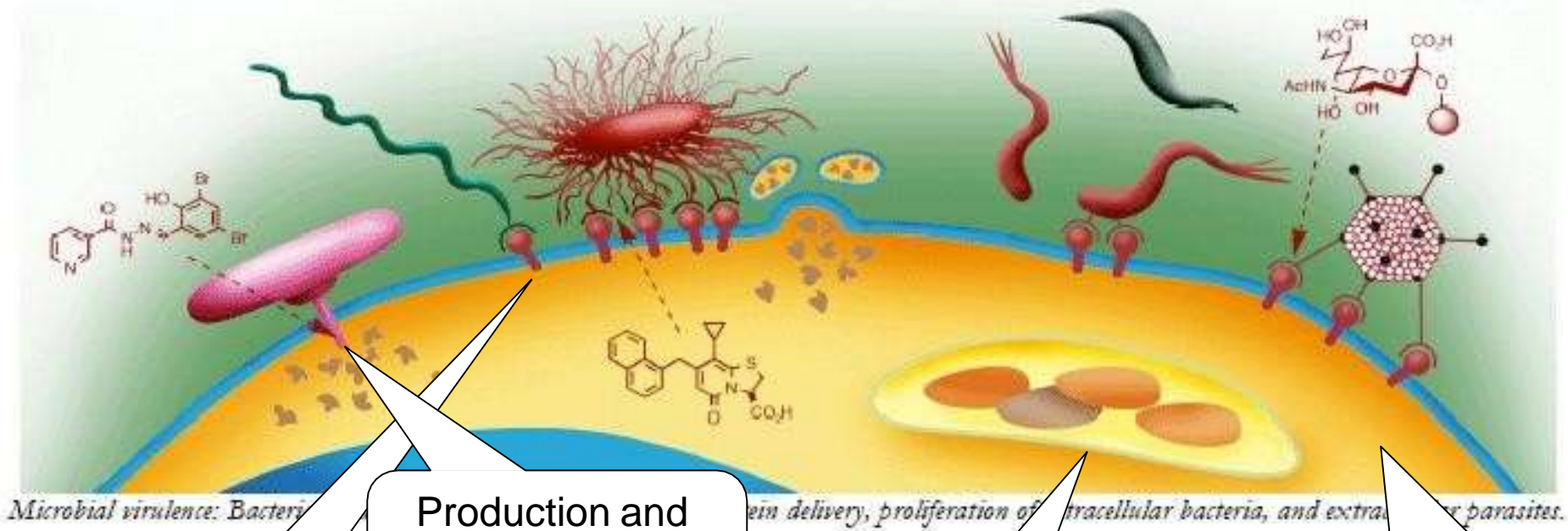
## 3rd Portal of Entry: Parenteral

- Microorganisms are **deposited** into the tissues below the skin or mucus membranes
- Punctures and scratches
- injections
- bites → From either animal or human.
- surgery → As in post surgical site infections.

# Organism/Host interaction

Many properties that determine a microbe's pathogenicity or virulence are unclear or unknown  
But, when a microbe overpowers the hosts defenses, infectious disease results!

- The only difference between pathogenicity and virulence that we can use is depletion of pathogenicity or severity of signs and symptoms.
- Virulence is much more severe than pathogenesis.



Microbial virulence: Bacteria... protein delivery, proliferation of intracellular bacteria, and extracellular parasites.

Attachment to host tissues  
**Receptors.**

Production and delivery of various factors

Replication and evasion of immunity

Damage to host tissues

Organisms should have adhesion structure or chemical as glue which usually exist on fimbriae, the main function for its attachment.  
 - The adhesive molecules are a protein, and high molecular weight.

# Virulence

1. Virulent is used as a synonym for pathogenic

The virulent strains are capable of causing disease, whereas the avirulent strains are not.

2. Sometimes virulence is used to express a measure or degree of pathogenicity

# Organism/Host interaction



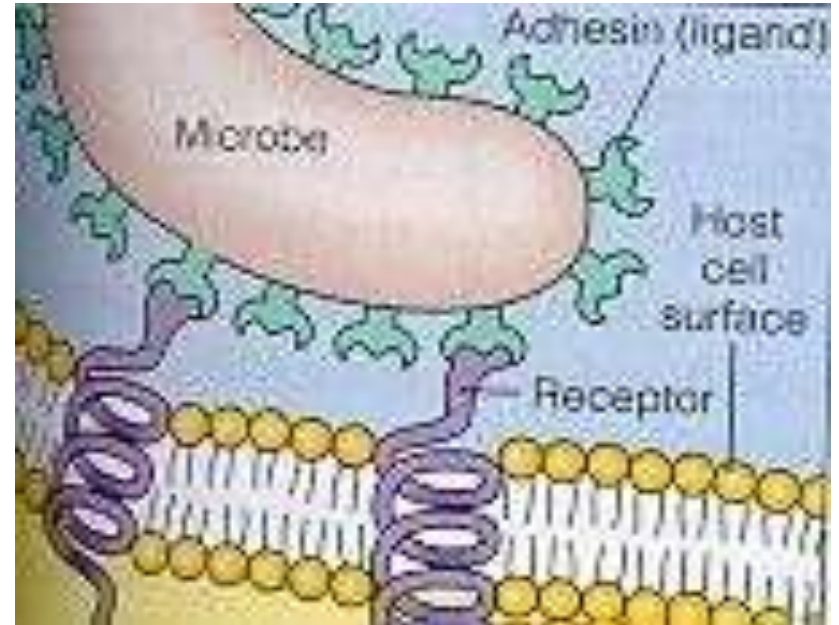
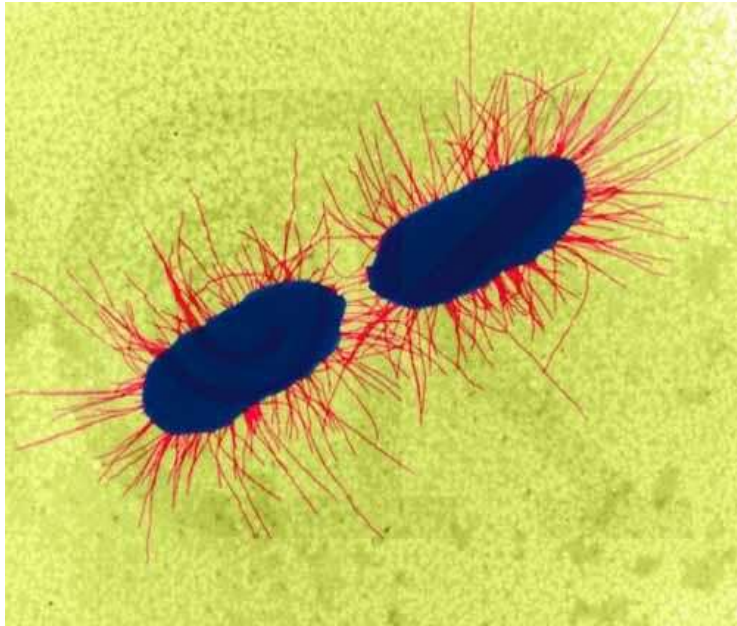
- Virulence factors: this term is used to describe those factors which contribute to the pathogenic potential of an organism

# Virulence factors



- I. Attachment (Microbial adherence to host tissues)  
Organism/host interaction depends on two primary factors
1. The organism must have adherence structure (adhesion)
  2. The host cell must have complementary receptors for binding the organism

# Adhesins and ligands are usually on Fimbriae



*ETEC* (*Enterotoxigenic E. coli*)



# Flagella

are considered to be virulence factors because they enable flagellated bacteria to invade areas of the body that nonflagellated bacteria cannot reach.

Without flagella bacteria won't be able to reach the site of infection.

# Organism/Host interaction



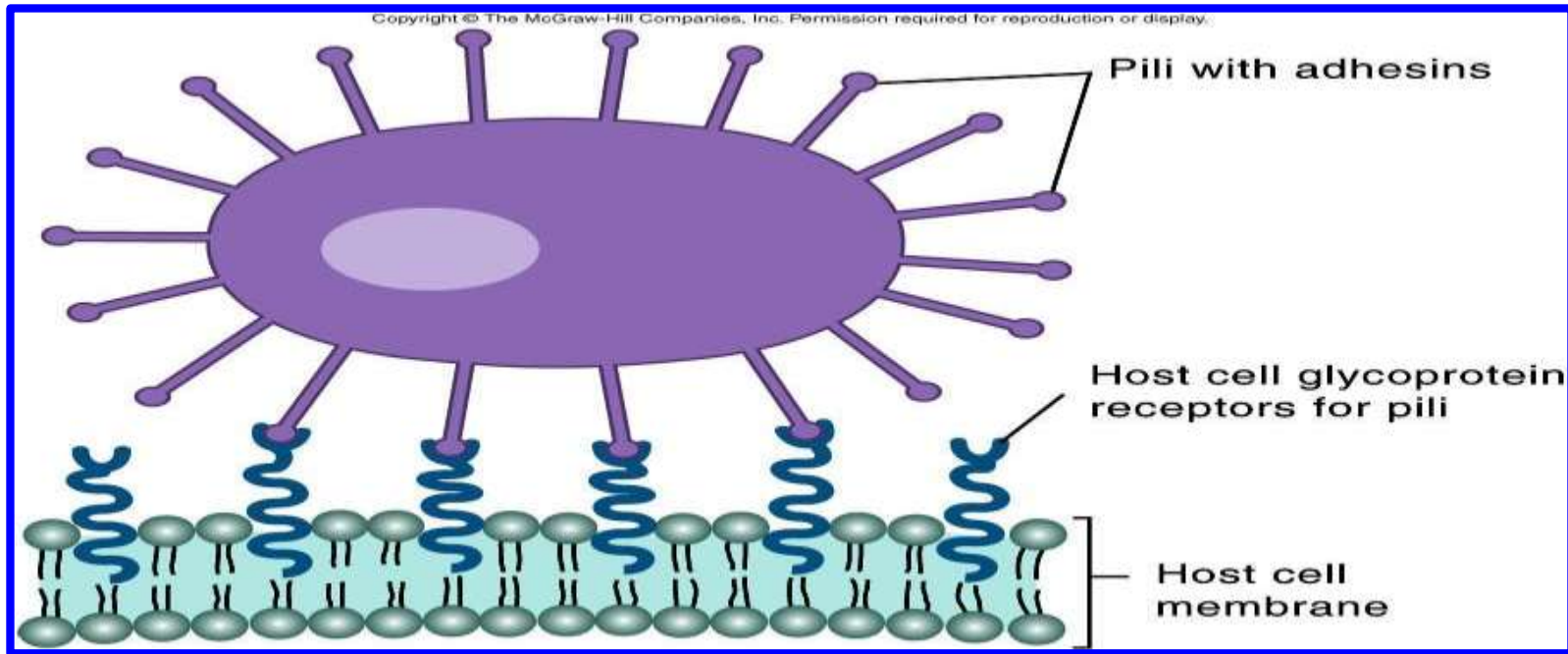
## Receptors

- Host cell receptors play an important role in determining where the organism can reside and multiply

Existence of normal flora is related to the existence of some chemicals that can attach to it.

### 1. Normal flora sites

- Gram positive organisms are normal flora of the oropharynx, fibronectin is a substance acts as a receptor for Gram positive organisms, if the amount of fibronectin has been decreased for any reason the oropharynx will be colonized by Gram negative organisms **And causes a disease.**



Bacteria typically employ proteins known as Adhesins to attach to host tissues, which usually are located on ends of fimbriae. Alternatively, adhesins can consist of glycocalyx.

# Organism/Host interaction

## 2. Tissue specificity

- The location of receptors helps to determine tissue specificity or sites of infection e.g: Influenza virus has specificity for cells of the respiratory tract; E. coli has specificity for cells of the urethra

Under rare circumstances E.Coli could cause:

- Brain abscess.
- Meningitis.
- Pneumonia.

→ Like: high number &

## 3. Host specificity frequent contact.

Many of the members of the dog's oral flora are unable to adhere to human cells because of a lack of receptors in the human

Rabies is an exceptional case.

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