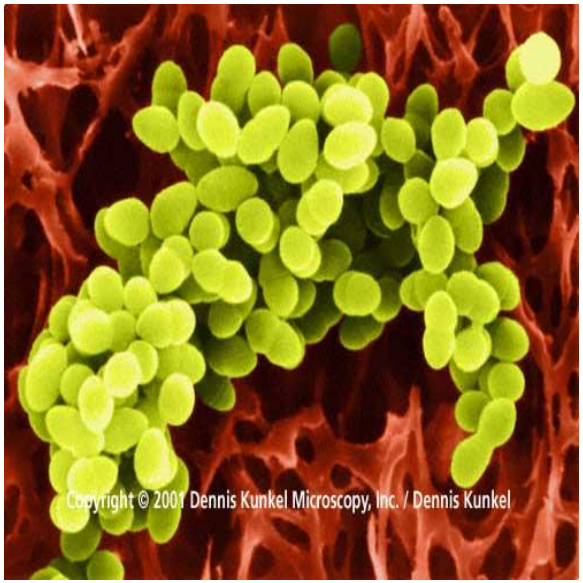
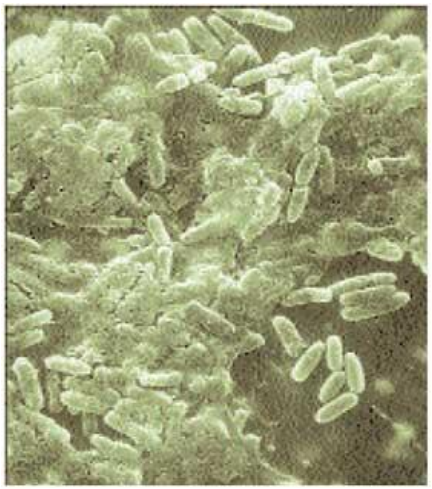
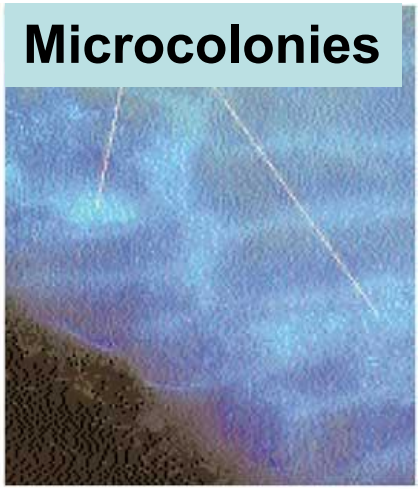
INFECTION AND INFECTIOUS PROCESS

1. Infection. Classification of infections
2. Sources of infection in Man
3. Methods of transmission of infection
4. Factors predisposing to microbial pathogenicity
5. Types of infectious diseases

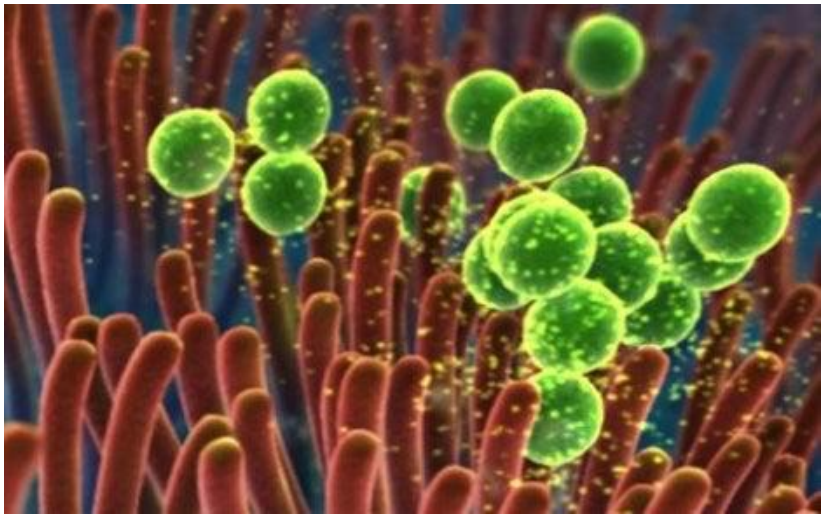






- *Biofilms of the different types of bacteria*

Infection is the lodgement and multiplication of organism in the tissue of host



Classification of infections

1. ***Primary infection:*** Initial infection with organism in host.
2. ***Reinfection:*** Subsequent infection by same organism in a host (after recovery).
3. ***Superinfection:*** Infection by same organism in a host before recovery.
4. ***Secondary infection:*** When in a host whose resistance is lowered by preexisting infectious disease, a new organism may set up in infection.

Classification of infections

5. ***Focal infection:*** It is a condition where due to infection at localized sites like appendix and tonsil, general effects are produced.
6. ***Cross infection:*** When a patient suffering from a disease and new infection it set up from another host or external source.
7. **Nosocomial infection**: Cross infection occurring in hospital.
8. ***Subclinical infection:*** It is one where clinical affects are not apparent.

Causative agents of infections

- ***Saprophytes:*** They are free living organisms which fail to multiply on living tissue and so are not important in infectious disease.
- ***Parasites:*** They are organisms that can establish themselves and multiply in hosts. They may be pathogens or commensal. Pathogens are those which are capable of producing disease in a host. On the contrary commensal microbes can live in a host without causing any disease.

Sources of infection in Man

Man: Man is himself a common source of infection from a patient or carrier. Healthy carrier is a person harboring pathogenic organism without causing any disease to him. A convalescent carrier is one who has recovered from disease but continues to harbor the pathogen in his body.

Anthroponosis

Sources of infection in Man

Animals: Infectious diseases transmitted from animals to man are called ***zoonosis***. Zoonosis may be bacterial, (e.g. *Plague* from rat), rickettsial, (e.g. *Murine typhus* from rodent), viral, (e.g. *Rabies* from dog), protozoal, (e.g. *Leishmaniasis* from dogs), helminthic, (e.g. Hydatid cyst from dogs) and fungal (zoophilic dermatophytes from cats and dogs).

Sources of infection in Man

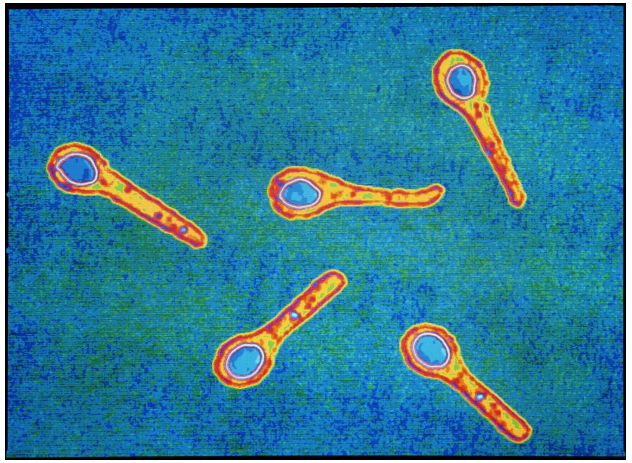
Insects: The diseases caused by insects are called ***arthropod borne disease***. Insects like mosquitoes, fleas, lice that transmit infection are called **vector**. Transmission may be mechanical (transmission of *Dysentery* or *typhoid bacilli* by housefly) and these are called **mechanical vector**. They are called **biological vector** if pathogen multiplies in the body of vector, e.g. *Anopheles mosquito* in *Malaria*.

Sources of infection in Man

Some vectors may acts as **reservoir** host, (e.g. *ticks* in *Relapsing fever* and *Spotted fever*).

Soil: Spores of tetanus bacilli, Gas-gangrene infection remain viable in soil for a long time.

Clostridium tetani →



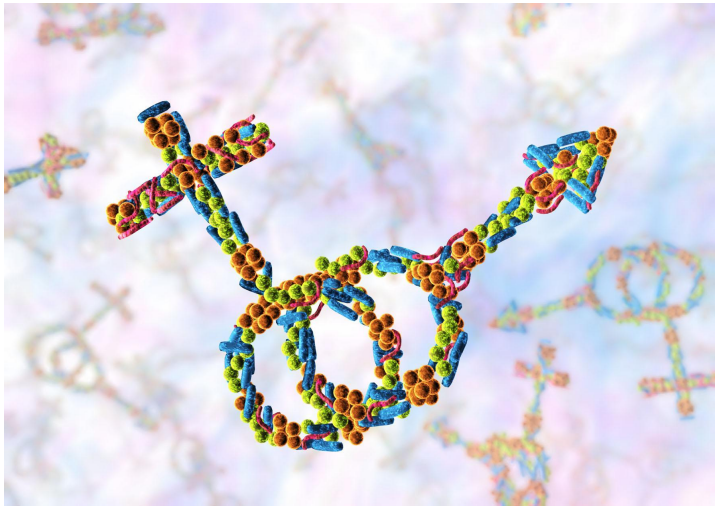
Sources of infection in Man

Water: *Vibrio cholerae*, infective hepatitis virus (*Hepatitis A and Hepatitis E)* may be found water.

Food: Contaminated food may be source of infection. Presence of pathogens in food may be due to external contamination, (e.g. food poisoning by *Staphylococcus*).

Methods of transmission of infection

- ***Contact (sexual intercourse):*** syphilis, gonorrhea.



- ***Inhalation:*** influenza, tuberculosis, smallpox, measles, mumps, etc.

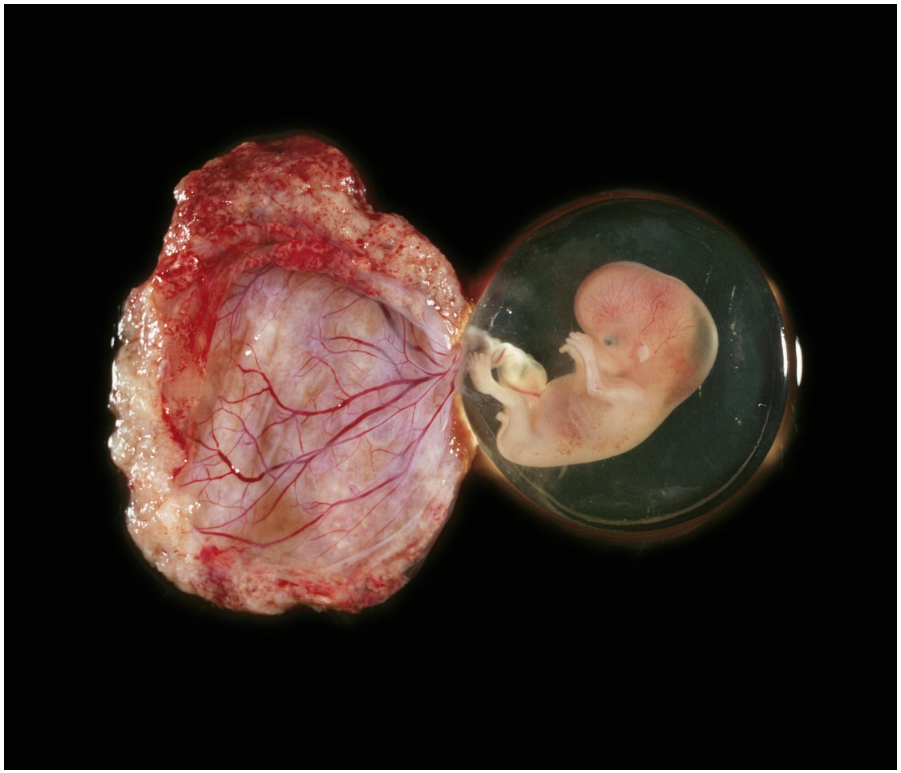
Methods of transmission of infection

- ***Ingestion:*** cholera (water), food poisoning (food) and dysentery (hand borne).
- ***Inoculation:*** tetanus (infection), rabies (dog), arbovirus (insect) and serum hepatitis, i.e. Hepatitis B (infection).

Human hand contaminated with colonies of bacteria (blue/pink patches)

Methods of transmission of infection

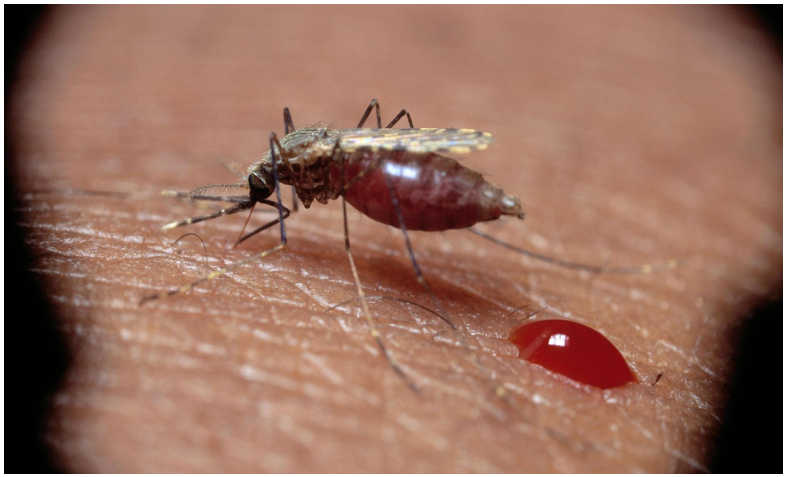
- ***Congenital:***
  syphilis,
  rubella,
  toxoplasmosis,
  cytomegaloviruses



Eight week old fetus attached to its placenta by the umbilical cord

Methods of transmission of infection

- ***Insects:*** **they act as mechanical vector (dysentery and typhoid by housefly) or biological vector (malaria) of infectious disease**
- ***Jatrogenic and laboratory infections:*** **infection may be transmitted during procedures**

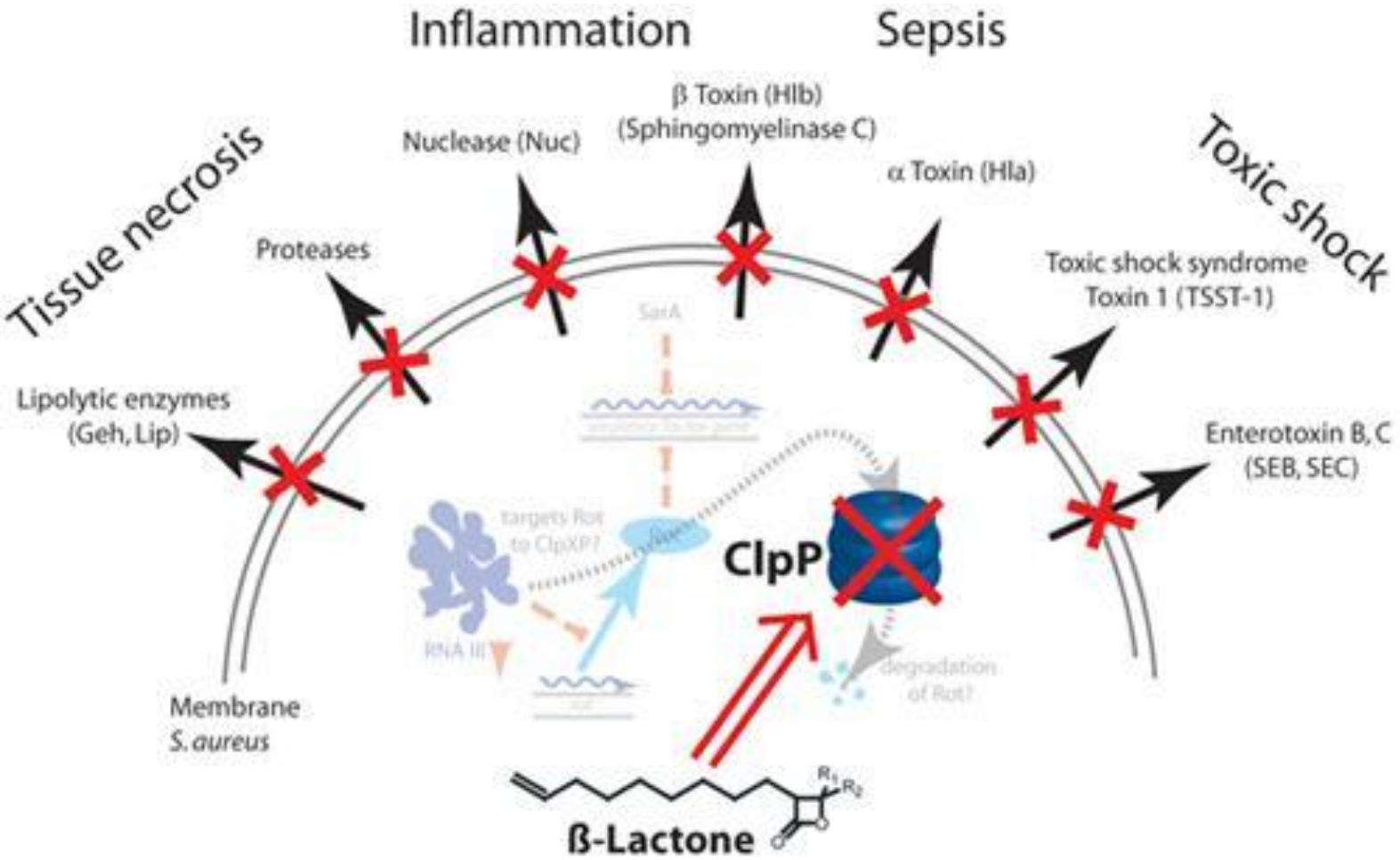


Characters of pathogens

- Bacteria should be able **to enter** the body.
- Organism should be able **to multiply** in the tissue.
- They should be able **to damage** the tissue.
- They must be capable **to resist** the host defense.

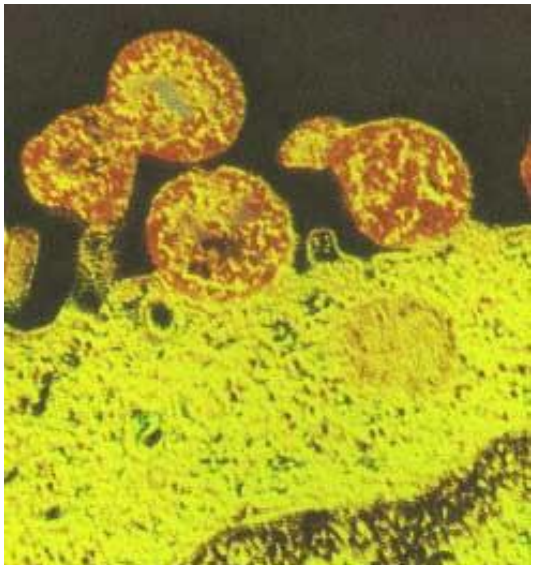
Pathogenecity **is referred to the ability of microbial species to produce disease.**

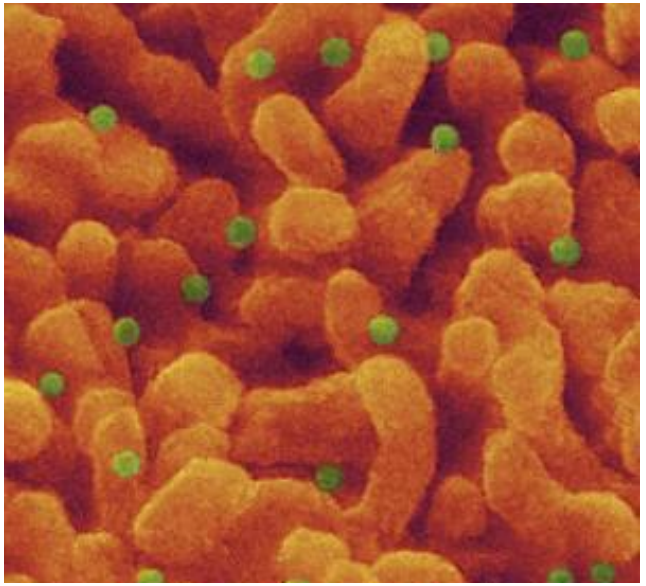
Virulence **is referred to the ability of microbial strains to produce disease.**



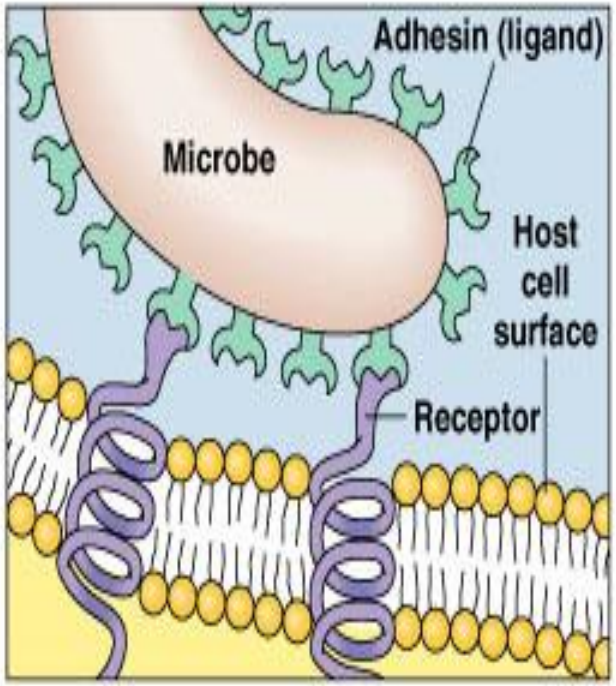
Factors of Virulence

- ***Adhesion:*** The initial event in the pathogenesis of many infections is the attachment of the bacteria to body surfaces. This attachment is specific reaction between surface receptors and adhesive structures on the surface of bacteria (adhesins).

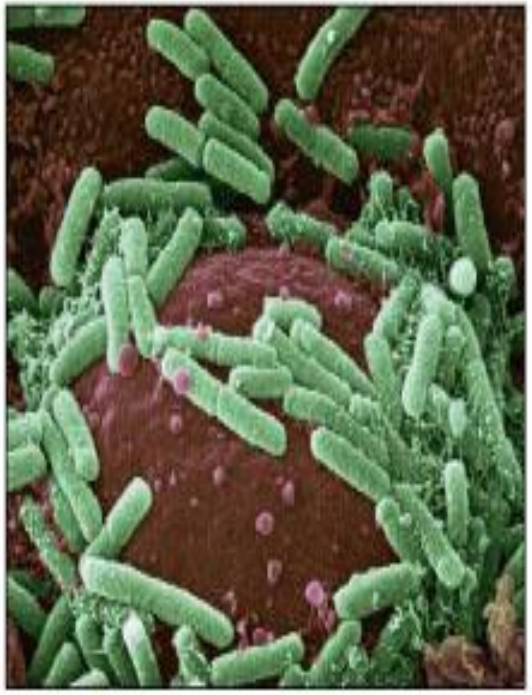




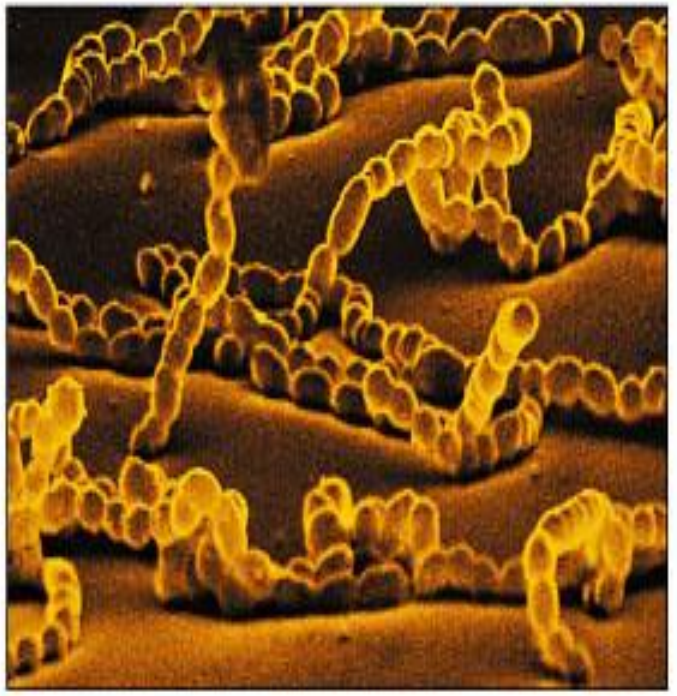
Adherence of bacteria



(a) Surface molecules on a pathogen, called adhesins or ligands, bind specifically to complementary surface receptors on cells of certain host tissues.



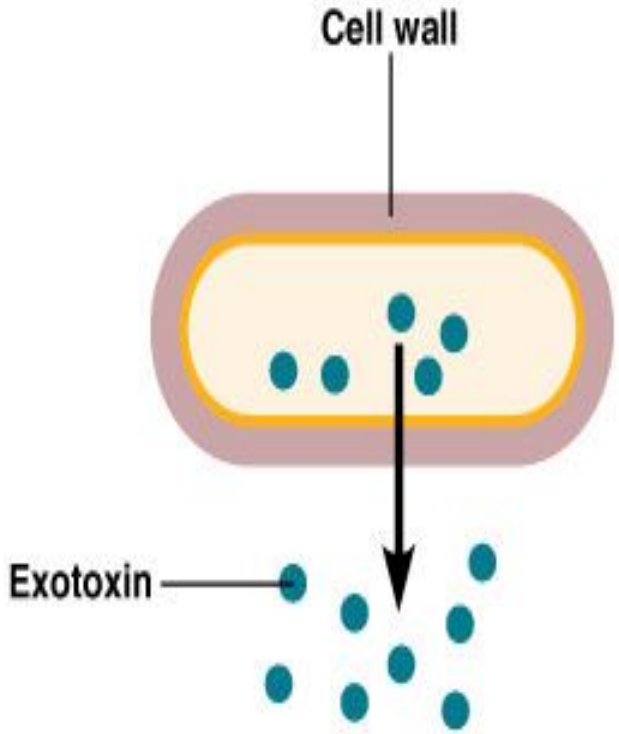
(b) *E. coli* bacteria (green) on human bladder cells.



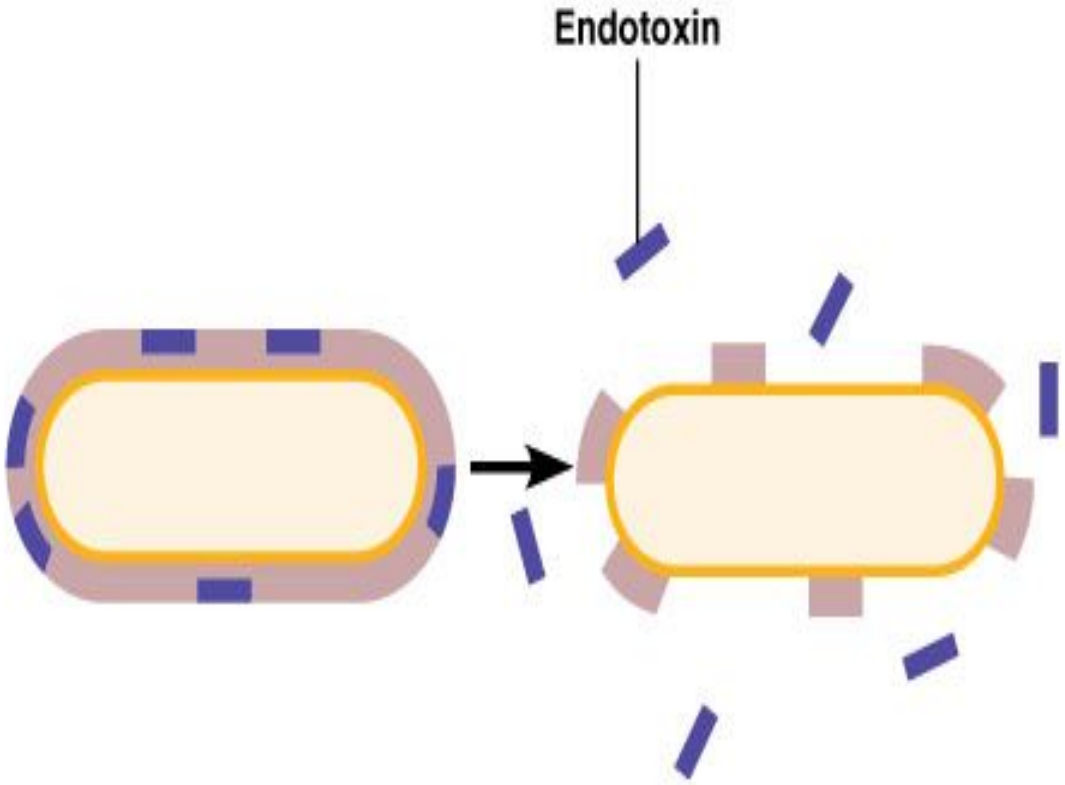
(c) Bacteria adhering to human skin.

Factors of Virulence

- ***Invasiveness*** is the ability of organism to spread in a host tissue after establishing infection. Less invasive organisms cause ***localized*** lesion. Highly invasive organisms cause ***generalized*** infection (septicemia).
- ***Toxigenicity.*** Bacteria produce two types of toxins – ***exotoxins*** & ***endotoxins***



(a) **Exotoxins** are produced inside mostly gram-positive bacteria as part of their growth and metabolism. They are then secreted or released following lysis into the surrounding medium.

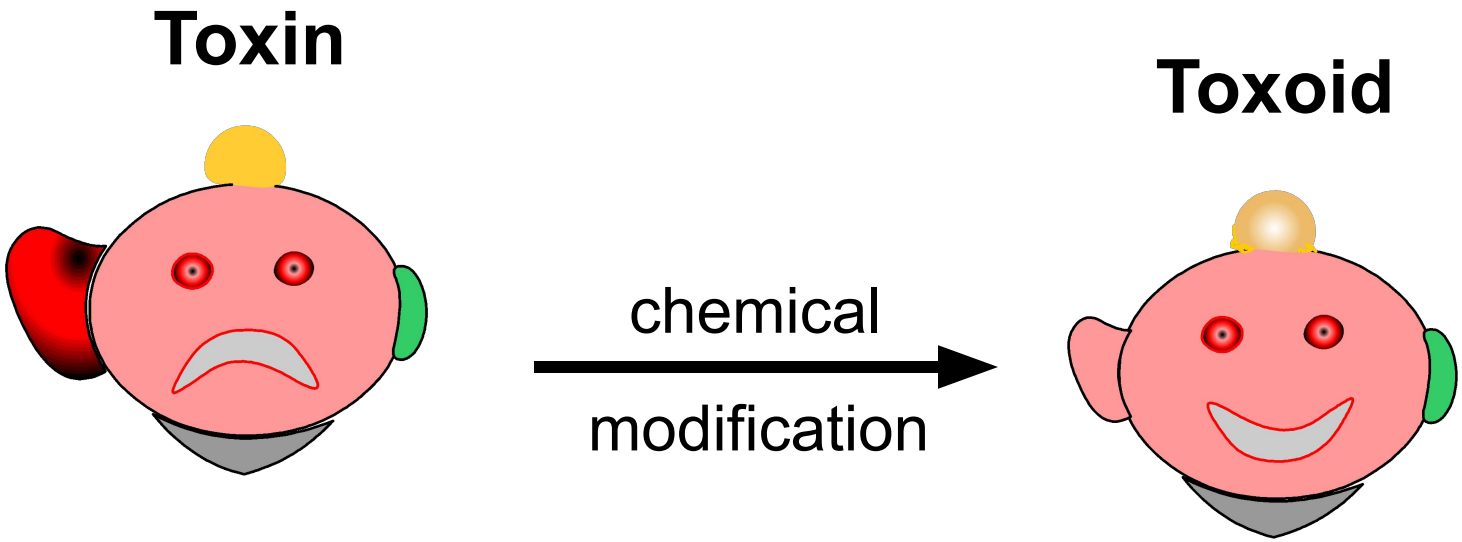


(b) **Endotoxins** are part of the outer portion of the cell wall (lipid A; see Figure 4.12c) of gram-negative bacteria. They are liberated when the bacteria die and the cell wall breaks apart.

Factors of Virulence - Exotoxins

- Heat labile **protein**.
- Diffuse readily into the surrounding medium.
- **Highly potent**, e.g. 3 kg botulinum can kill all the inhabitants of world.
- They are generally formed by Gr+ bacteria and also by Gr- organisms like **Shigella, V.cholerae, E.coli**.
- Exotoxin is specifically **neutralized antitoxin**.
- Can be separated from culture by filtration.
- Action is **enzymatic** and it has **specific** tissue affinity.
- **Specific pharmacological effects** for each exotoxin.
- Cannot cause pyrexia in a host.
- Can be **toxoided**.

Modification of Toxin to Toxoid



Factors of Virulence - Endotoxins

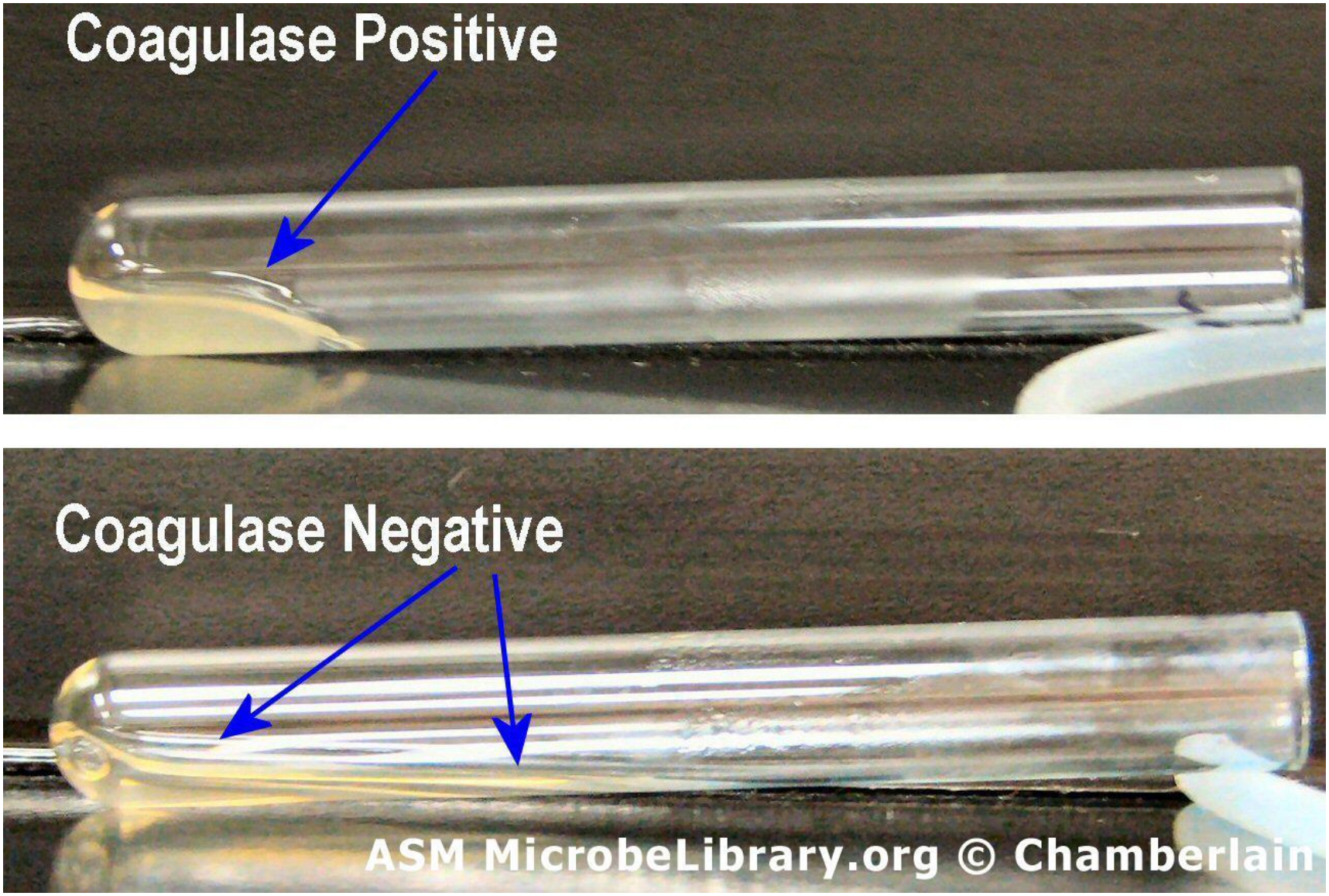
- Endotoxin (lipid a portion of lypopoly-saccharide) has biological activities causing *fever, muscle proteolysis, uncontrolled intravascular coagulation and shock.*
- These may be mediated by production from mononuclear cells of IL-1, probably IL-6.

Characters of Endotoxins

- Proteins polysaccharide lipid complex heat stable.
- Forms part of cell wall (don't diffuse into the medium).
- Obtained only by cell lysis.
- They have **no enzymatic** action.
- Effect is **non-specific** action.
- No specific tissue affinity.
- Active only in **large doses** 5 to 25 mg.
- **Weakly antigenic**.
- Neutralization by antibody ineffective.
- Cannot be toxoided.
- Produce in **Gram negative bacteria**.

Factors of Virulence

- *Communicability* is the ability of parasite to spread from one host to another. It determines the survival and distribution of organism in a community.
- *Coagulase* (S.aureus) which prevents phagocytosis by forming fibrin barrier around bacteria.
- *Fibrinolysin* promotes the spread of infection by breaking down the fibrin barrier in tissues.

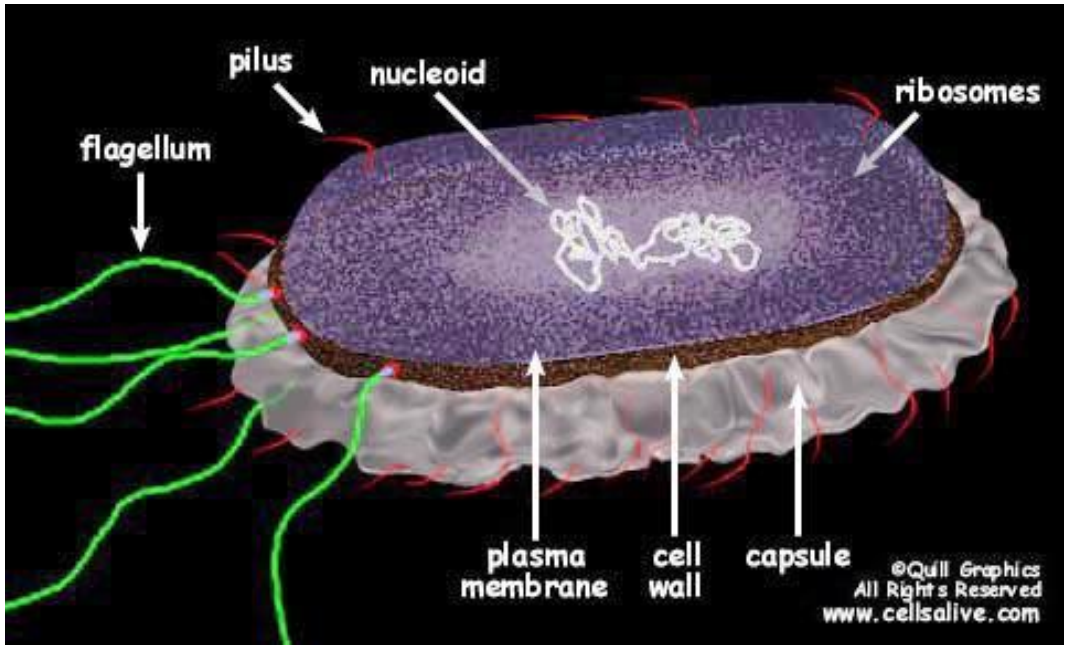

Coagulase Positive
Coagulase Negative
ASM MicrobeLibrary.org © Chamberlain

Factors of Virulence

- *Hyaluronidase* split hyaluronic acid (component of connective tissue).
- *Leucocidins* damage polymorphonuclear leucocytes.
- *Ig A1 proteases:* split IgA and inactivates its antibody activity.
- *Hemolysin* is produced by some organisms capable of destroying erythrocytes.

Factors of Virulence. Bacterial appendages

Capsulated bacteria like Pneumococcus, K.pneumoniae and H.influenzae stand phagocytosis



Surface antigen, e.g. Vi-antigen of S. typhi and K-antigen of E.coli resisted phagocytosis and lytic activity of complement.

Infecting dose

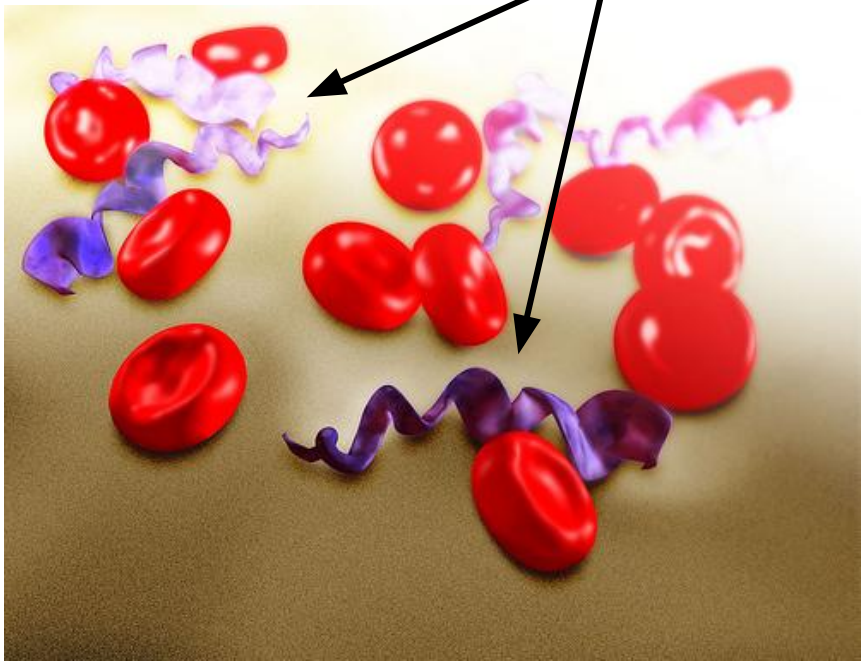
- The *minimum infection dose* (MID) or *minimum lethal dose* (MLD) is the minimum number of organism required to produce clinical evidence of infection or dearth of susceptible animal.

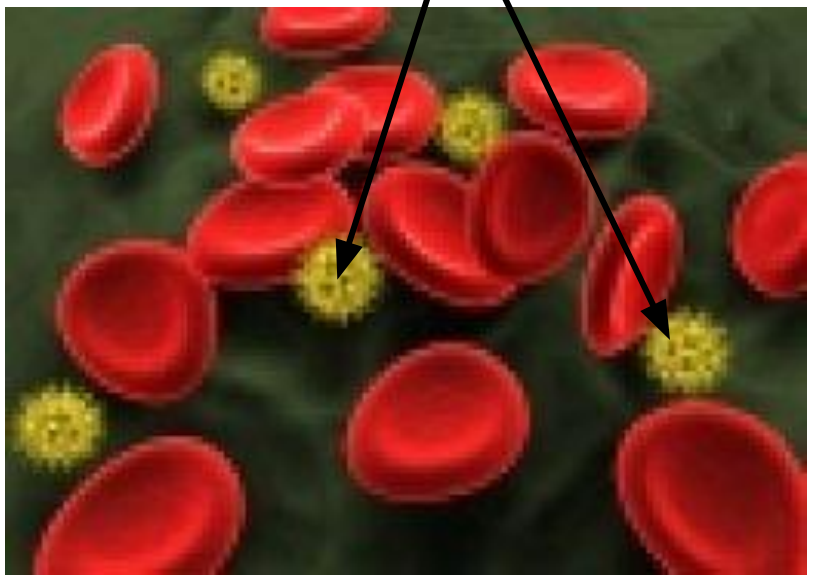
•*Route of infection*

- *Vibrio cholerae* is effective orally. No effect when it is introduced subcutaneously.
- Streptococci can initiate infection whatever be the mode of entry.

Types of infectious diseases

- **Infectious diseases may be *localized* or *generalized*. Localized infections may be *superficial* or deep-seated.**
- **Circulation of bacteria in the blood is known as *bacteremia* (*viruses – virusemia*).**





Types of infectious diseases

- ***Septicemia*** **is the condition where bacteria circulate and multiply in the blood, form toxic products and cause swinging type of fever.**
- ***Pyemia*** **is a condition where pyogenic bacteria produce septicemia with multiple abscesses in the internal organs such as the spleen, liver and kidney.**

Types of infectious diseases

- Depending on the spread of infectious disease in the community they may be classified into different types.
- *Endemic* diseases are ones that are constantly present in a particular area. Typhoid fever is endemic in most parts of India. An *epidemic* disease is one that spreads rapidly, involving many persons in an area at the same time. Influenza causes annual winter epidemics in the cold countries.

Types of infectious diseases

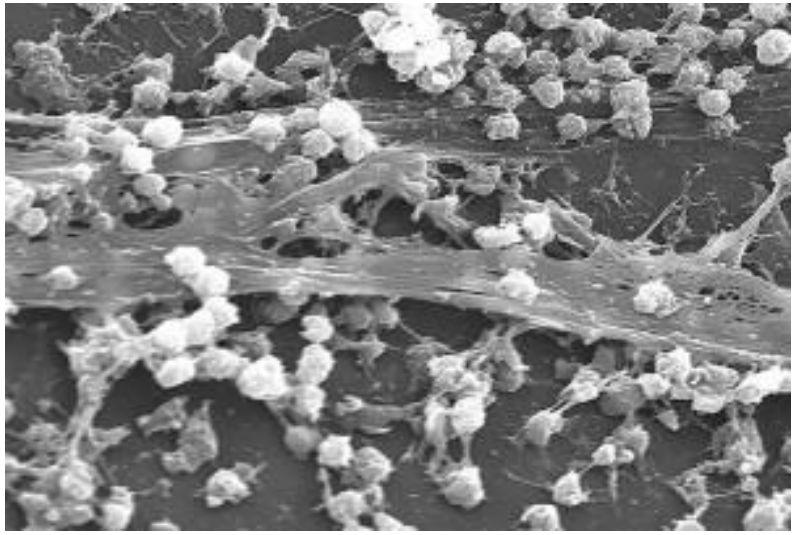
- A *pandemic* is an epidemic that spreads through many areas of the world involving very large numbers of persons within a short period (Influenza, cholera, plaque).
- Epidemics vary in the rapidity of spread. Waterborne disease such as cholera and hepatitis may cause explosive outbreaks, while disease, which spreads by person-to-person contact evolve more slowly.

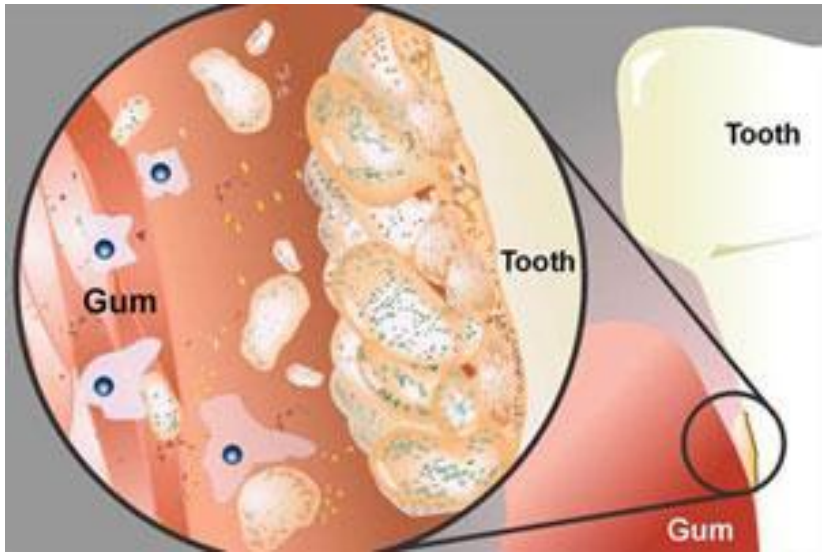
Stages of infectious disease

- ***Incubation period*** – no symptoms.
- ***Prodromal period*** – mild and generalized symptoms (fever, weakness, headache).
- ***Invasive stage*** – symptoms specific to the disease.
- ***Decline stage*** – symptoms subside.
- ***Convalescence*** – no symptoms, health returns to normal.

Biofilms

- Biofilms form when bacteria adhere to surfaces in aqueous environments and begin to excrete a slimy, glue-like substance that can anchor them to all kinds of material (metals, plastics, medical implant materials and, human or animal tissue).

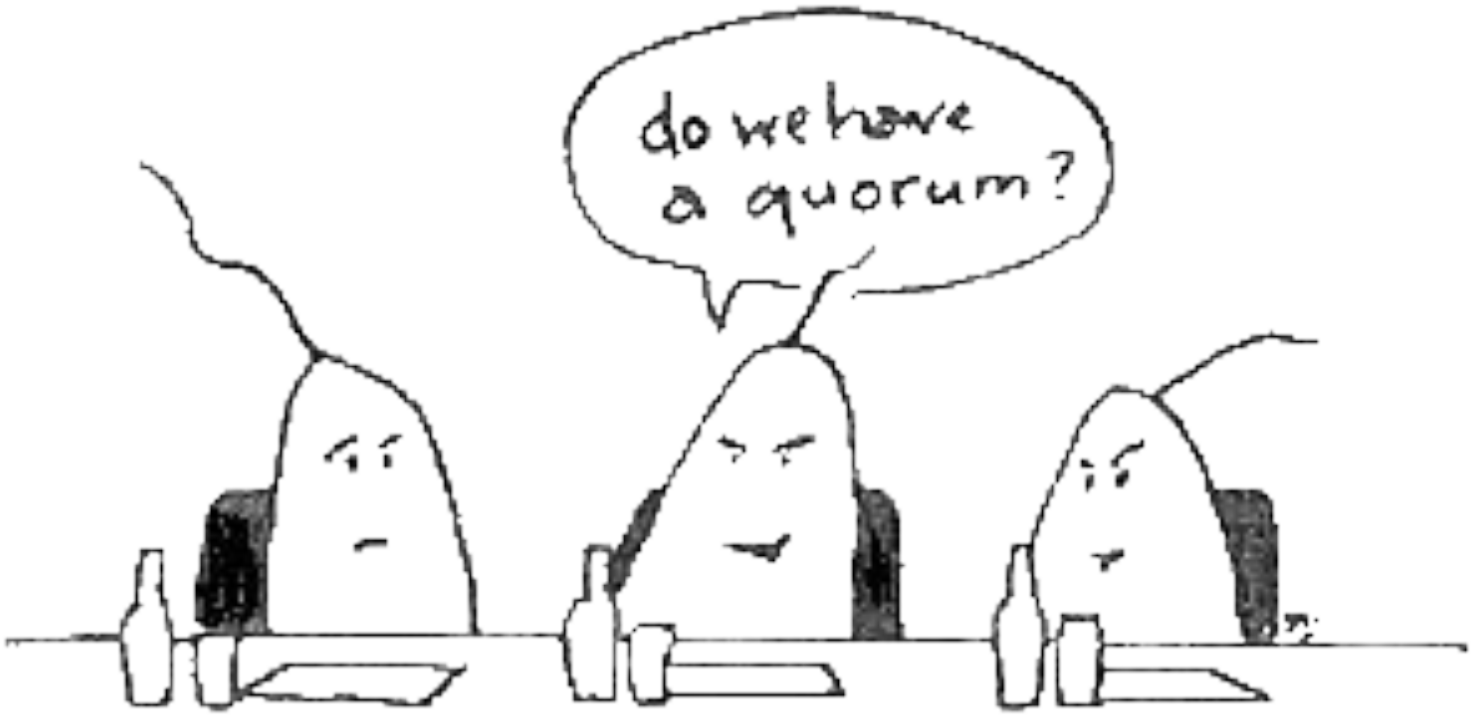




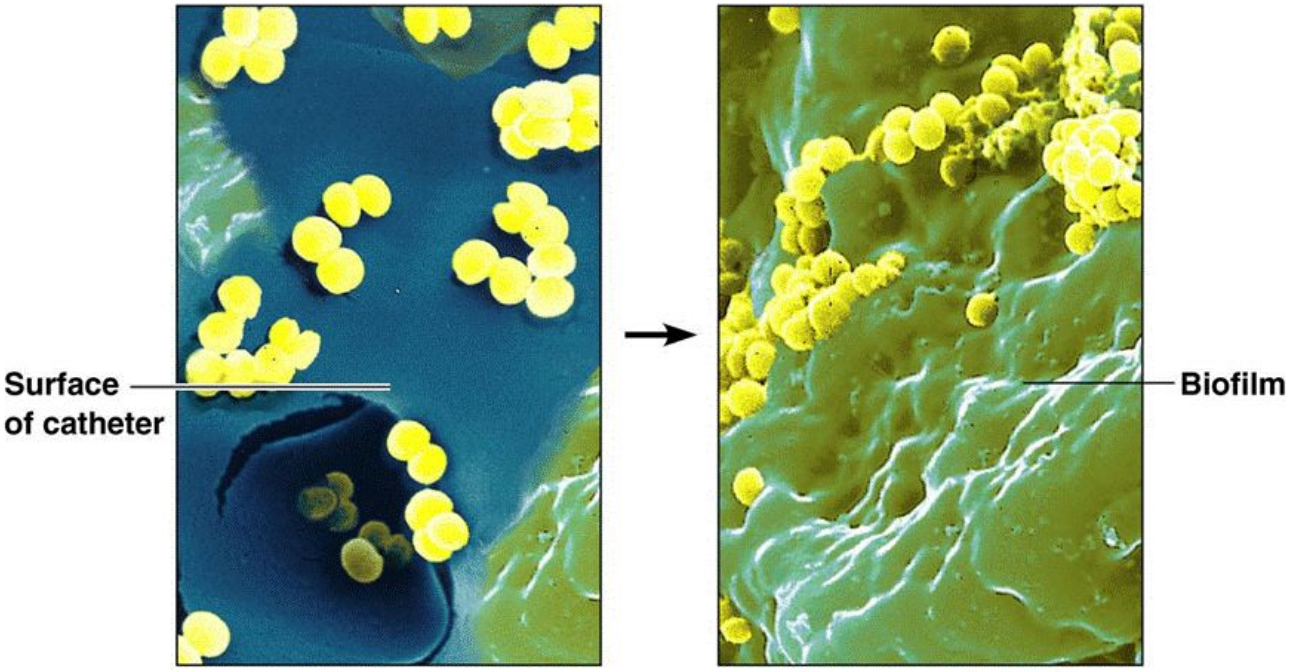
Hundreds of microbial biofilm colonize the human mouth, causing tooth decay and gum disease.

Quorum Sensing

Many groups of bacteria can communicate - by releasing and detecting chemical pheromones to gauge their population density - the molecular structure of a key protein in this interbacterial communication has been solved.



Quorum sensing provides an explanation for why some disease-causing virulence factors are not expressed during the early stages of encounter with the human host



(a) Catheter surface with adhering bacteria. Biofilm, light green, is beginning to appear.

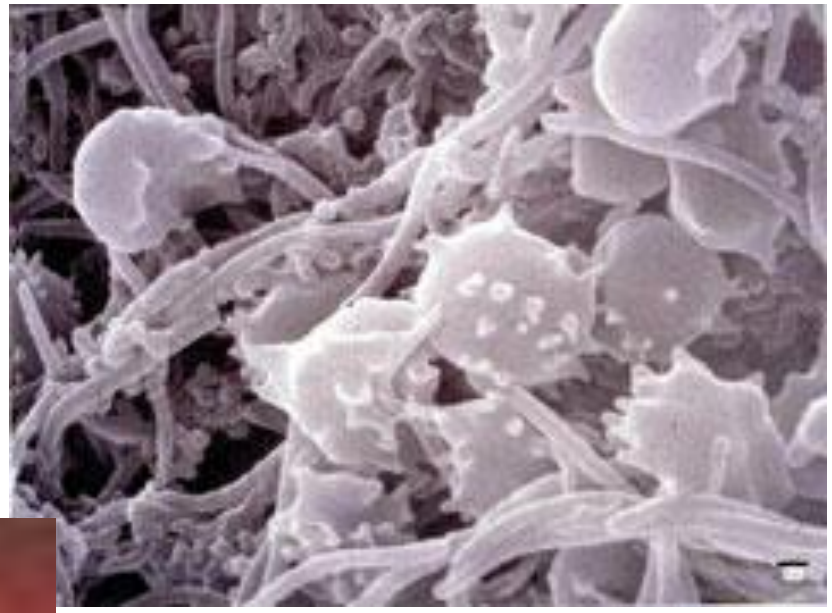
(b) Most of the bacteria producing the slime are not visible under the biofilm.

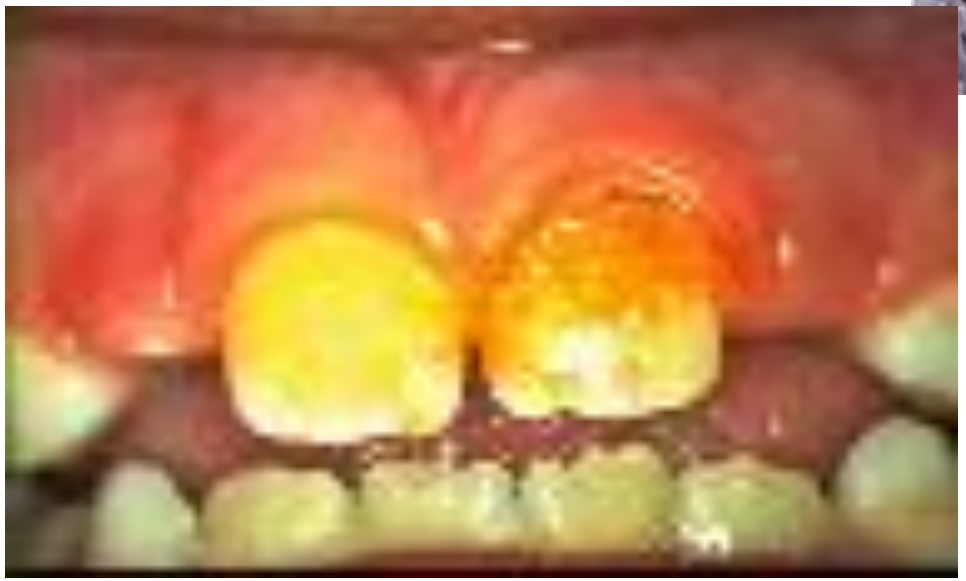
Figure 21.3 - Overview

Characteristics of biofilm

- A biofilm can contain a single species of bacteria or several species.
- Genetic studies confirm that bacteria switch on different genes, depending on whether they're living as free-floating microbes or clustering as biofilms.
- **Biofilm bacteria can be up to 1000 times more resistant to antimicrobial stress (e.g. antibiotics and disinfectants) than free-swimming bacteria of the same species.**

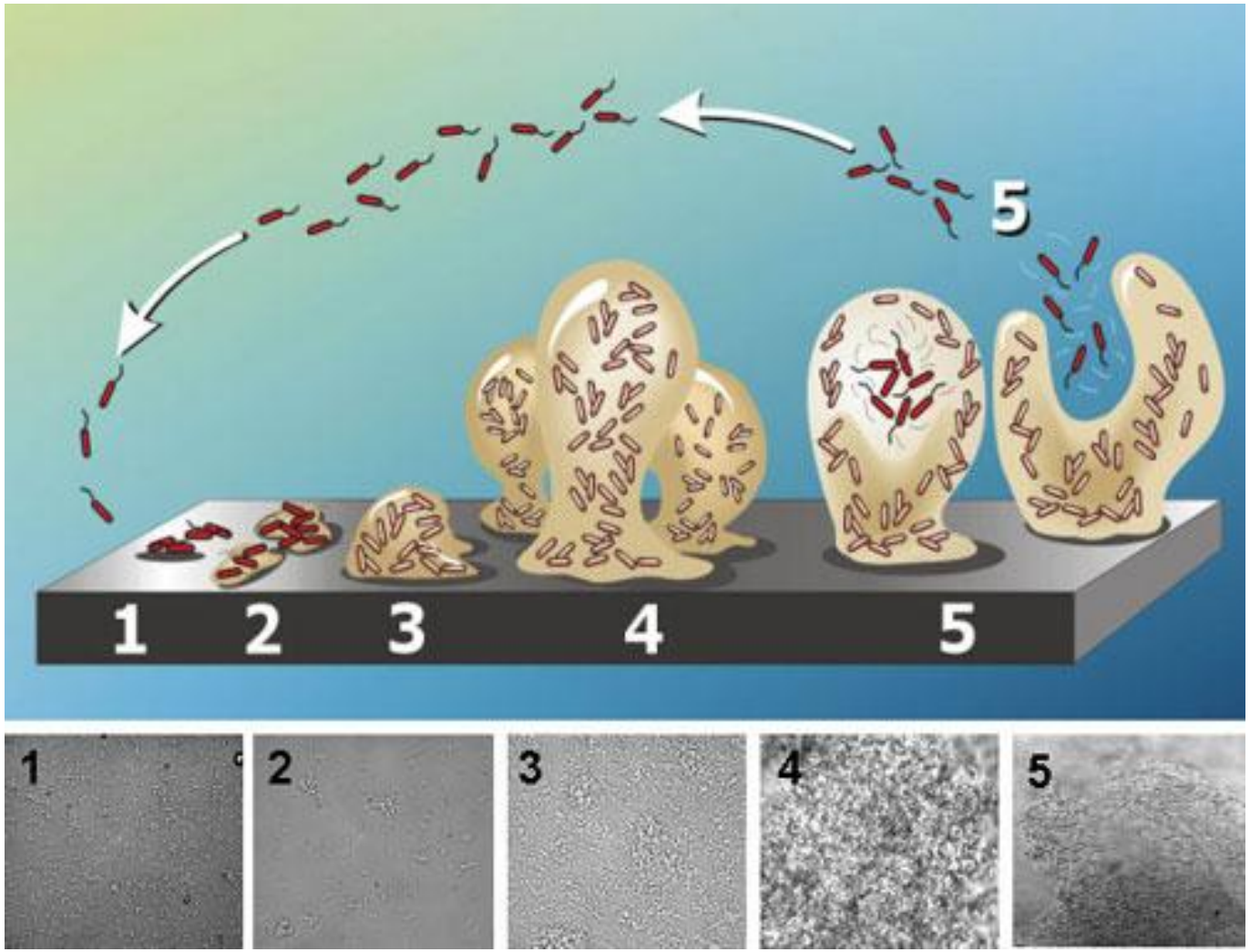
- **Plaque** is a biofilm on the surfaces of the teeth which secretes acids that destroy teeth and gums

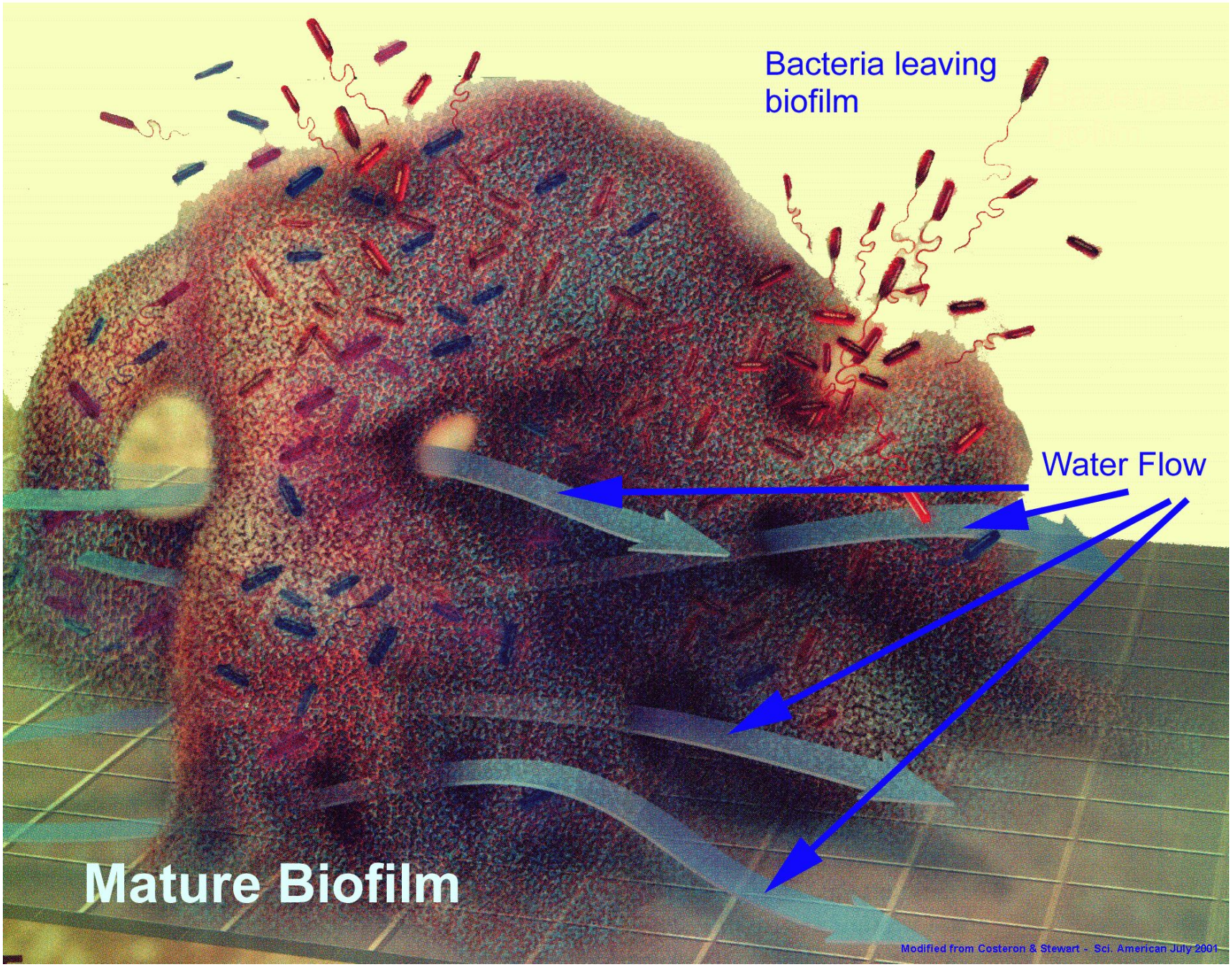


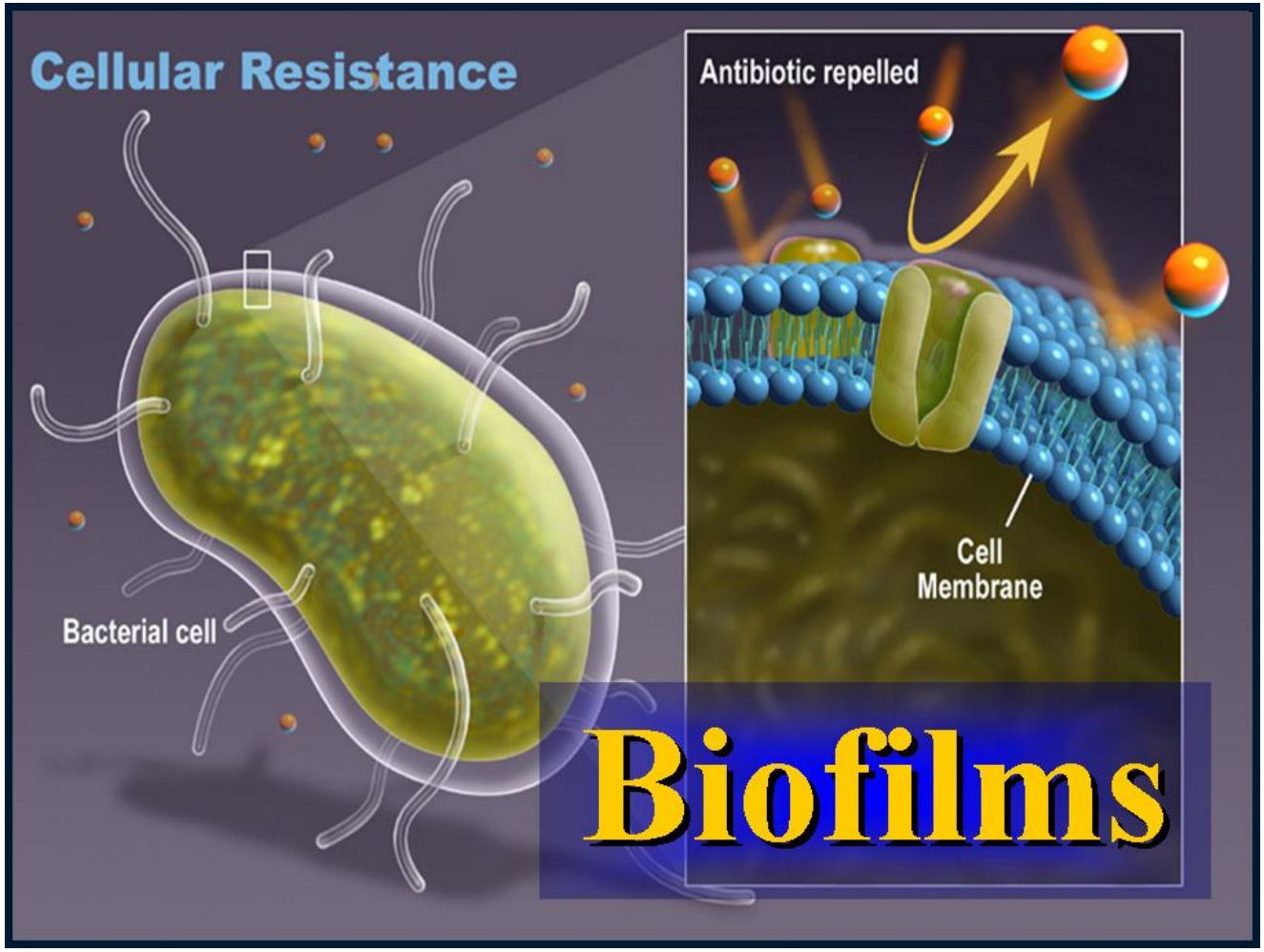


Dental plaque as seen under a scanning electron microcroscope

5 stages of P.aeruginosa biofilm development 1, initial attachment; 2, irreversible attachment; 3, 4 - maturation ; 5, dispersion.




Bacteria leaving biofilm
Water Flow
Mature Biofilm
Modified from Costeron & Stewart - Sci. American July 2001



These communities represent a higher order of structure and function than is found when bacteria are grown in broth culture

Biofilm communities are responsible for much of the biological activity attributed to bacteria in the wide range of habitats occupied by these biochemically complex microorganisms