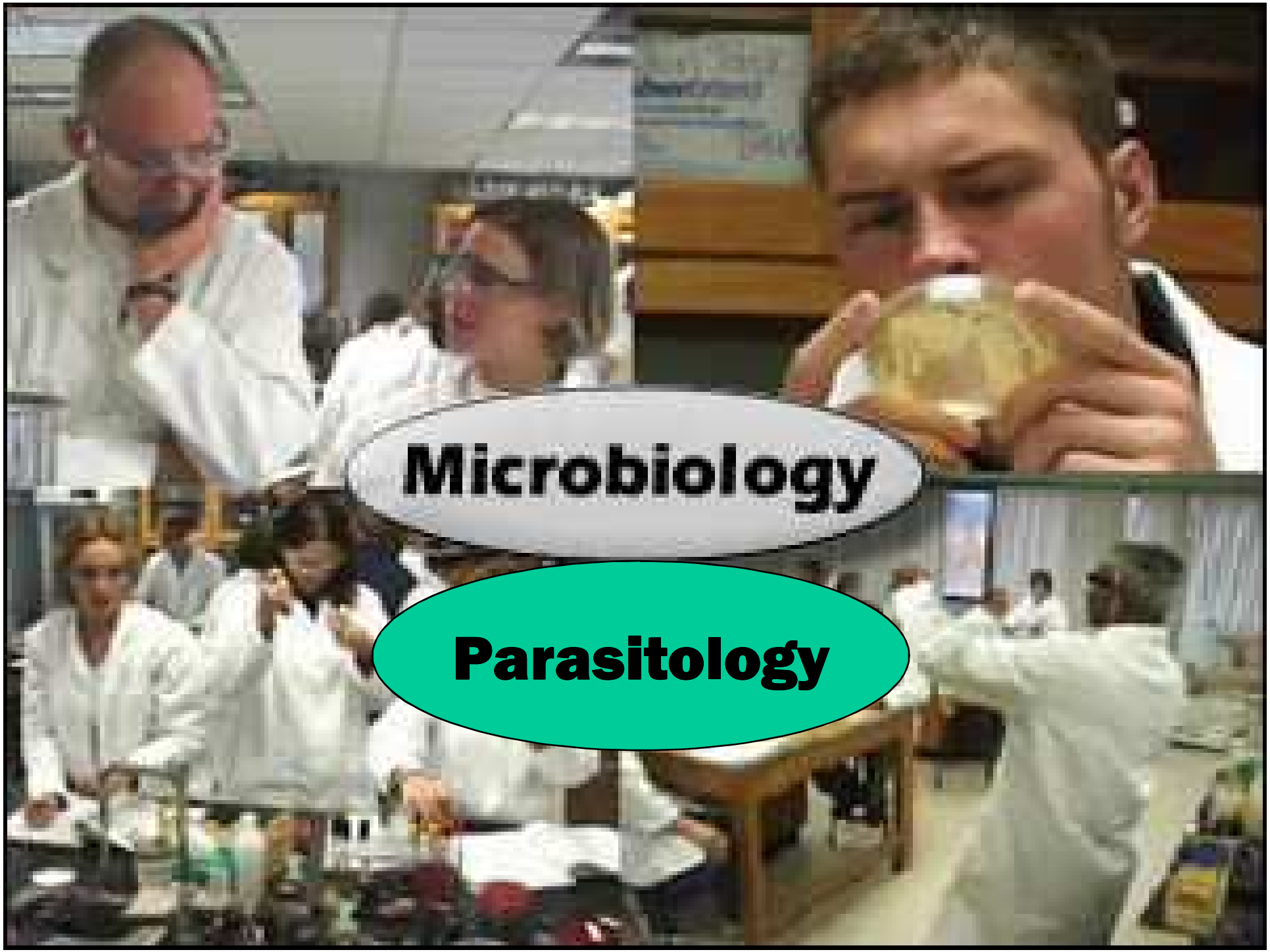


Bacterial classification

Naming of microorganism

All living things have two names :

- their generic name, e.g. : *Staphylococcus*
- their specific or species name : *aureus*

Either name may contain clues about the organism, the diseases it causes or even discoverer.

Names are usually derived from Latin or Greek and are either underline or in *italic*. Only in genus is CAPITALISED, and its first letter may be used in an abbreviated version.

In additional, a third name may be added to distinguish Varieties.

This often seen with medically important microorganism, e.g. Pneumococcus for *Streptococcus pneumoniae*.

So, one microorganism may be referred to in several ways :

- *Staphylococcus aureus* (proper name)
- *S. aureus* (proper abbreviated version)
- *Staph. aureus* (colloquial)
- Staphylococci (group name)
- *Staphylococcus sp.*

Bacterial Morphology and Cell Wall Structure

Bacteria are prokaryotes, fungi (yeast and Mold) ; parasites are eukaryotes.

There are many differences between the two major divisions – **prokaryotes** and **eukaryotes** – of cellular organisms.

These include the following.

A. In prokaryotes :

. No nuclear membrane, mitochondria, golgi bodies or endoplasmic reticulum – that produce by asexual division

. DNA is in the form of a single circular chromosome. Additional DNA is carried in plasmids.

. Transcription and translation can be carried out simultaneously.

B. In Eukaryotes :

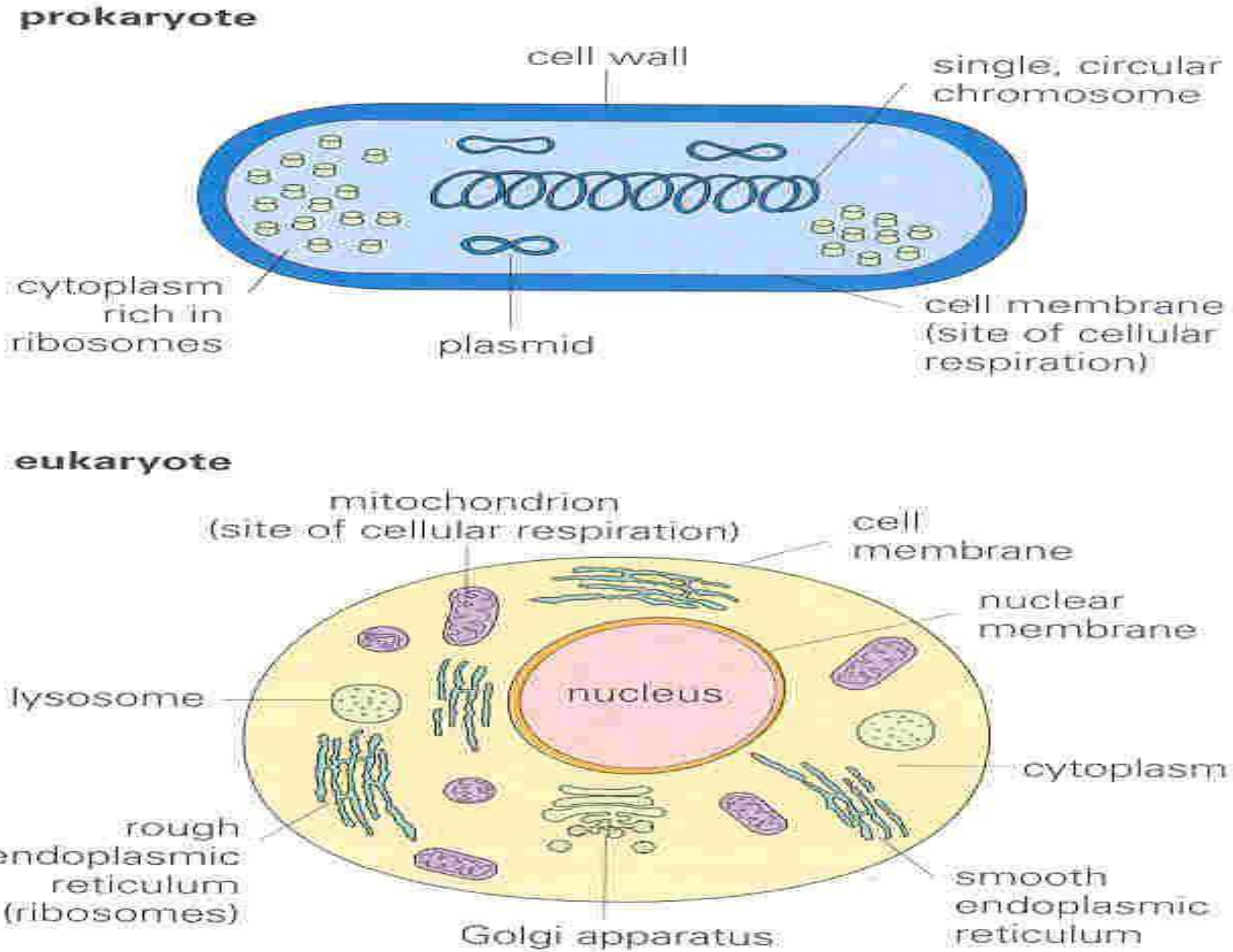
. DNA is carried on several chromosomes within a nucleus.

. A nucleus is bounded by a nuclear membrane.

. Transcription requires formation of messenger RNA (mRNA) and movement of mRNA out of the nucleus into the cytoplasm.

. Translation takes place on ribosomes

. The cytoplasm is rich in membrane-bound organelles (Mitochondria, Endoplasmic reticulum, Golgi apparatus, lysosomes)



Bacteria Ultrastructure

Cytoplasmic membrane

The cytoplasmic (protoplasmic) membrane controls the movement of water, ions, nutrients, and excretory substances in and out of the cell also secretes extra cellular hydrolytic enzymes

Bacteria possess structures called **mesosomes** which appear as indentations in the cytoplasmic membrane.

They are thought to assist the membrane in its transport activities and to help with cell reproduction. Respiratory enzymes are found on the surface of the mesosomes

D N A

Bacterial DNA usually takes the form of a single, super-coiled chromosome. It may be accompanied by circular extra-chromosomal DNA fragment (**Plasmids**).

DNA can be transferred between bacteria by :

▲ **transformation :**
up take of naked bacterial DNA across the cell wall

▲ **transduction :**
DNA fragments transferred by viruses (bacteriophages)

▲ **conjugation :**
DNA transferred between bacteria along a specialised hollow tube (Sex-pilus)

Cell wall

- It contains a high concentration of inorganic ions and requires a strong cell wall to prevent fluid being drawn into it and lyses the cell

- The cell wall of bacterium is strengthened by a mucopeptide polymer (**peptidoglycan**)

- Differences in the composition of bacterial cell walls, lead to differences in the staining of bacteria

The main differences between the cell wall of Gram positive and Gram negative bacteria are as follow :

A. Gram positive bacteria

- the cell wall contains a large amount of peptidoglycan (20-80 nm) and teichoic acids which consist of polymers of ribitol phosphate and, or, glycerol phosphate

B. Gram negative bacteria

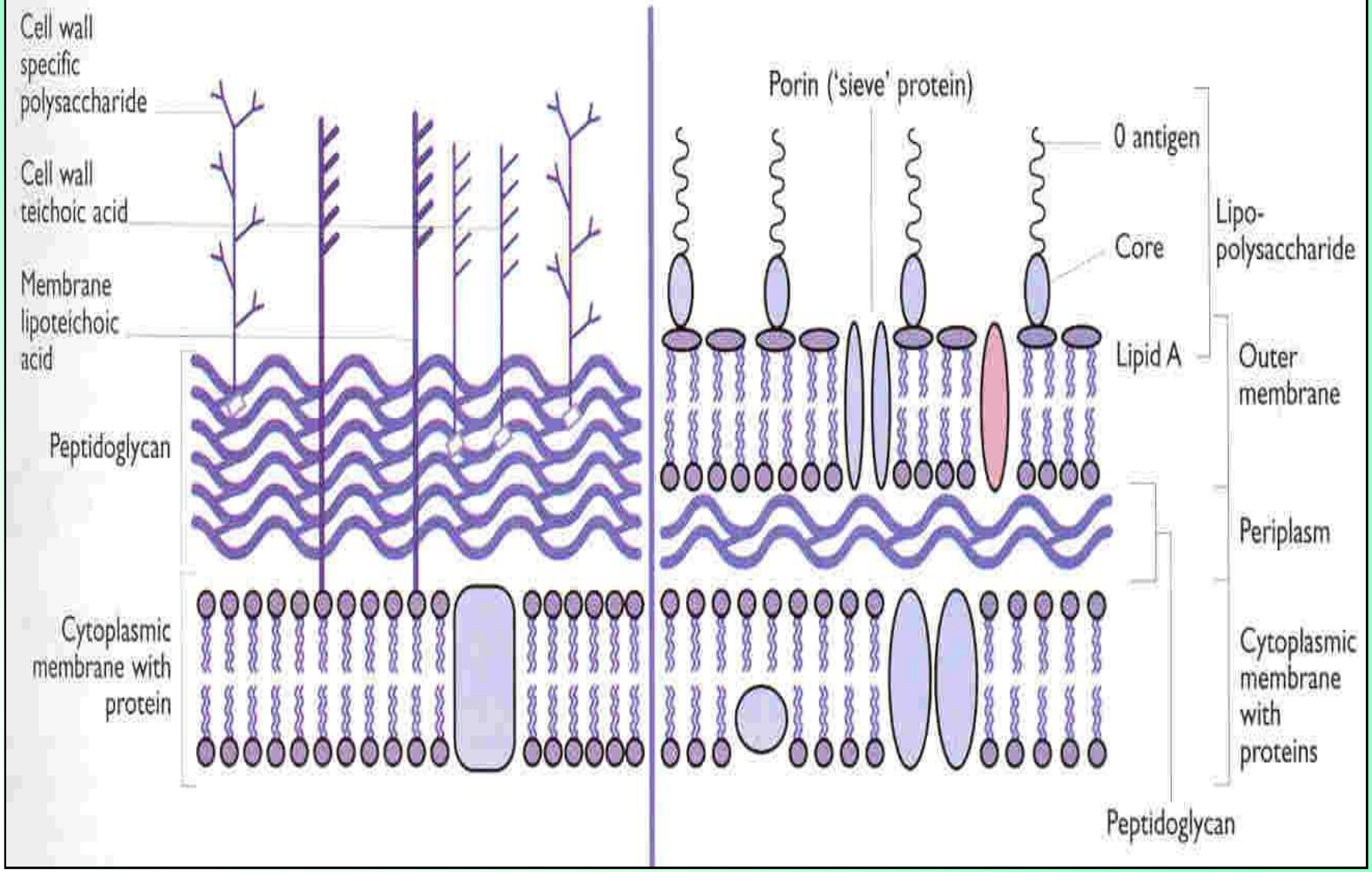
- the cell wall contains only a small amount of peptidoglycan (5-10 nm)

- The outer layer of the cell wall, however, contains toxic lipopolysaccharide molecules, referred to as **endotoxin.**

- The lipid A part of these molecules is highly toxic

Gram-positive cell wall

Gram-negative cell wall



External structure

1. Bacterial capsules

Some species have a capsules, often composed of **polysaccharide**, external to the cell wall.

Special techniques are required to demonstrate bacterial Capsules using **an india ink**.

By possessing a capsule *(Streptococcus pneumoniae)*, the pathogenicity of an organism is increased because capsulated bacteria are not as easily phagocytized and destroyed by host cells.

Some bacteria (***Pseudomonas aeruginosa***) will produce a polysaccharide **biofilm** under certain condition like antibiotics and host defenses

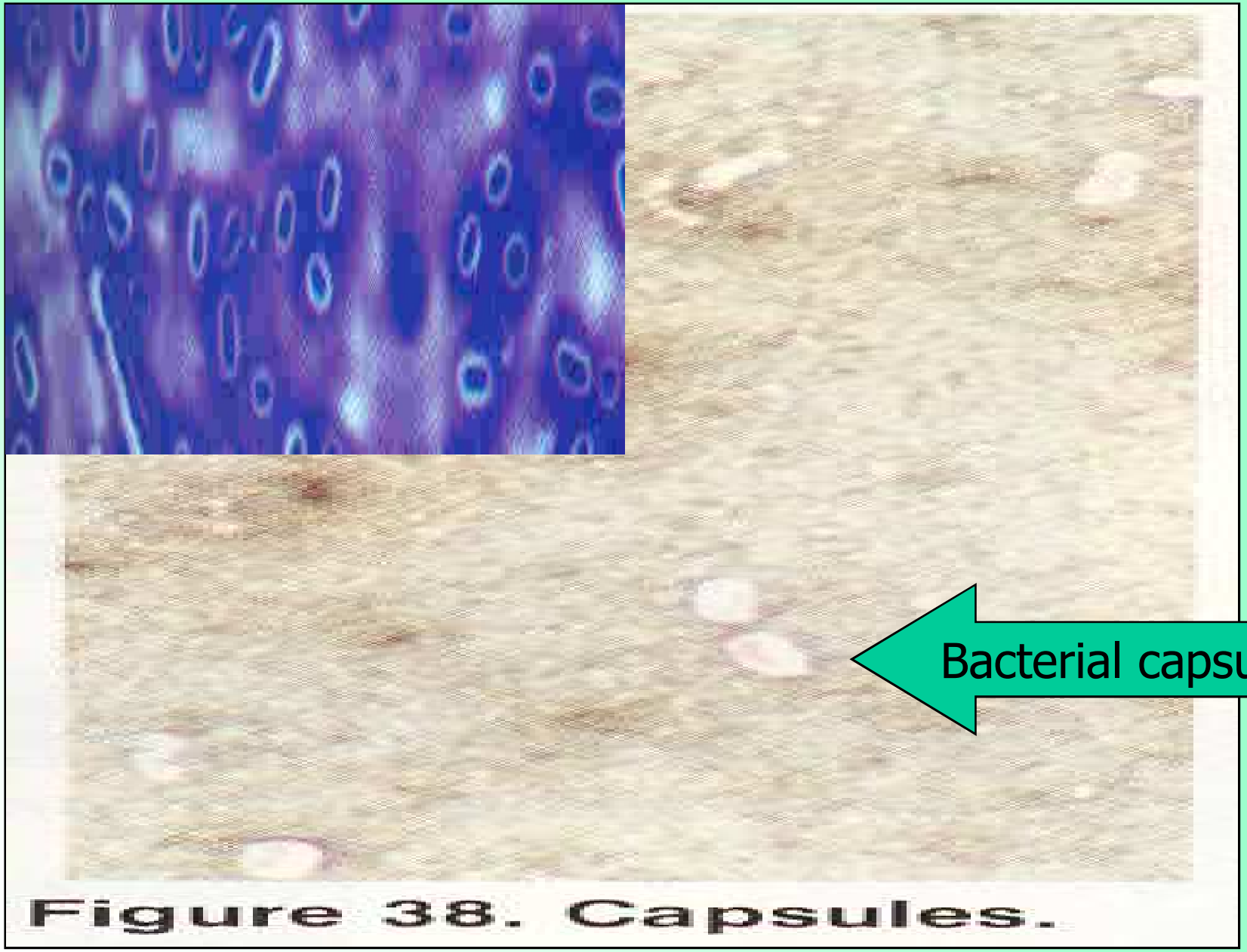
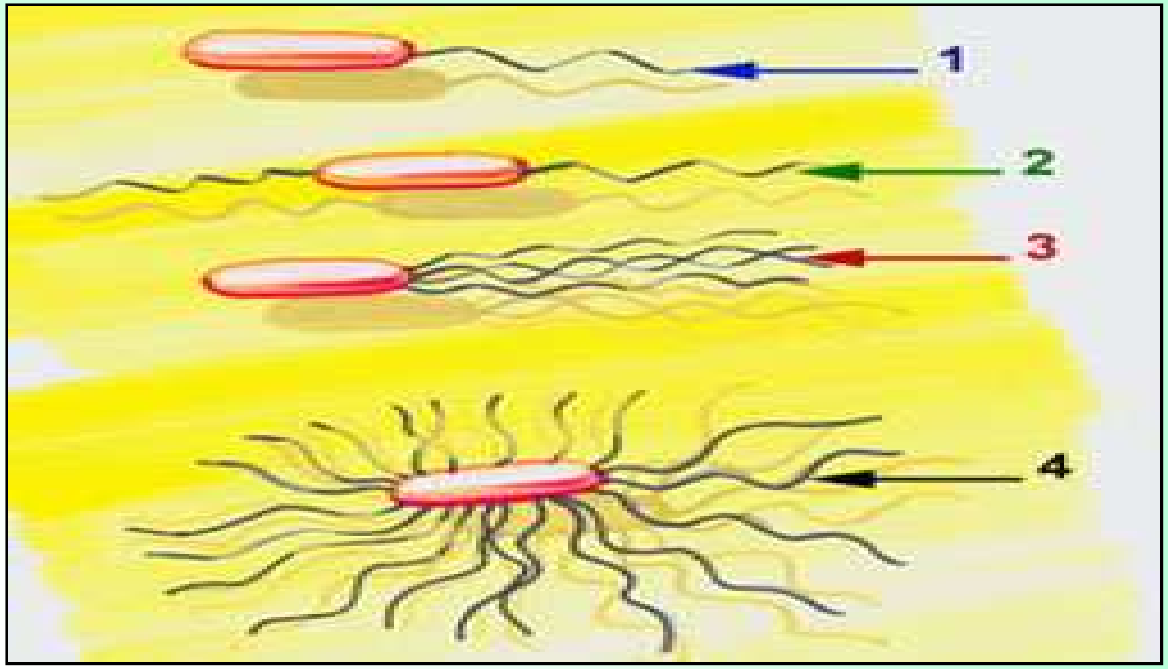


Figure 38. Capsules.

2. Flagella

Motile bacteria posses one or more thread-like flagella. Movement is brought about by the rotation of the flagella **(Chemotaxis)**

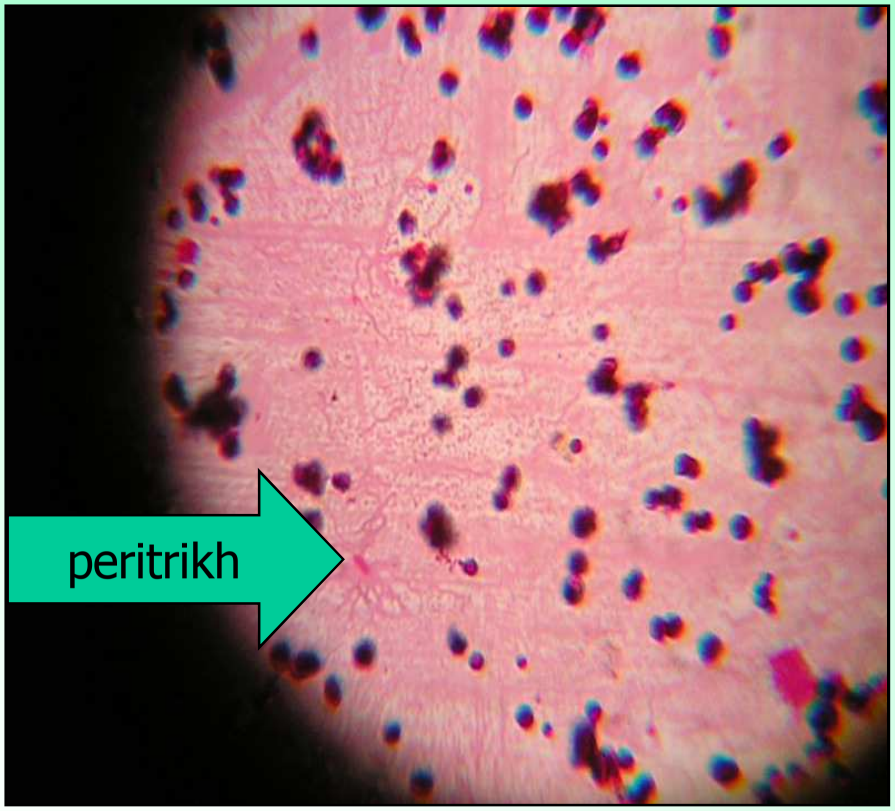
This movement, or motility, is used in laboratory identification of organism

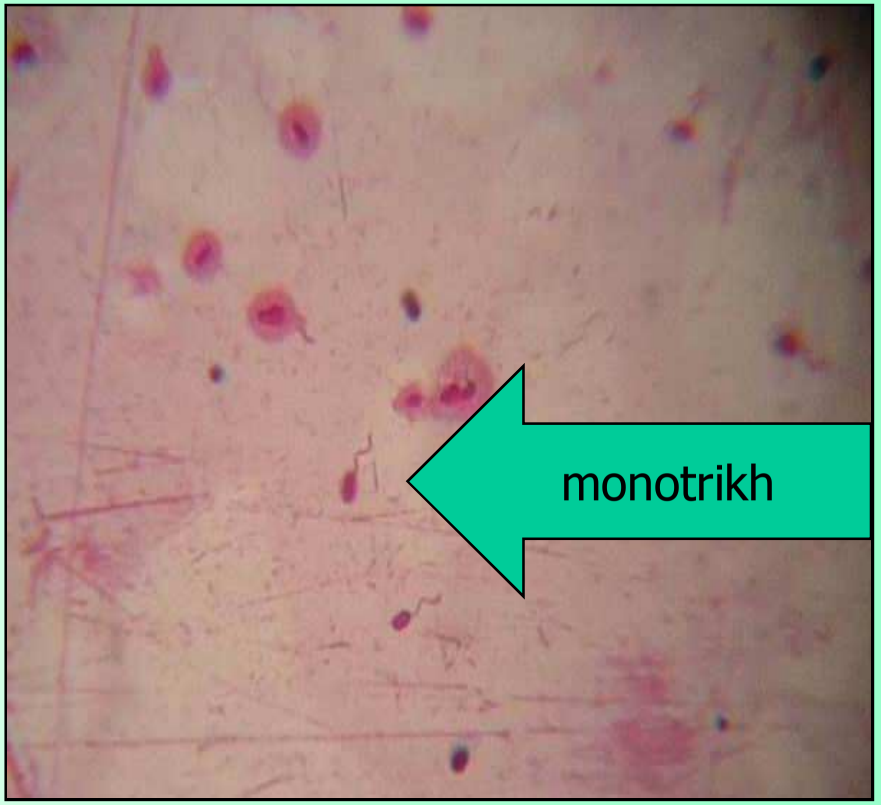


Flagella types :

- Monotrikh
- Amphitrikh
- Lopotrikh
- Peritrikh

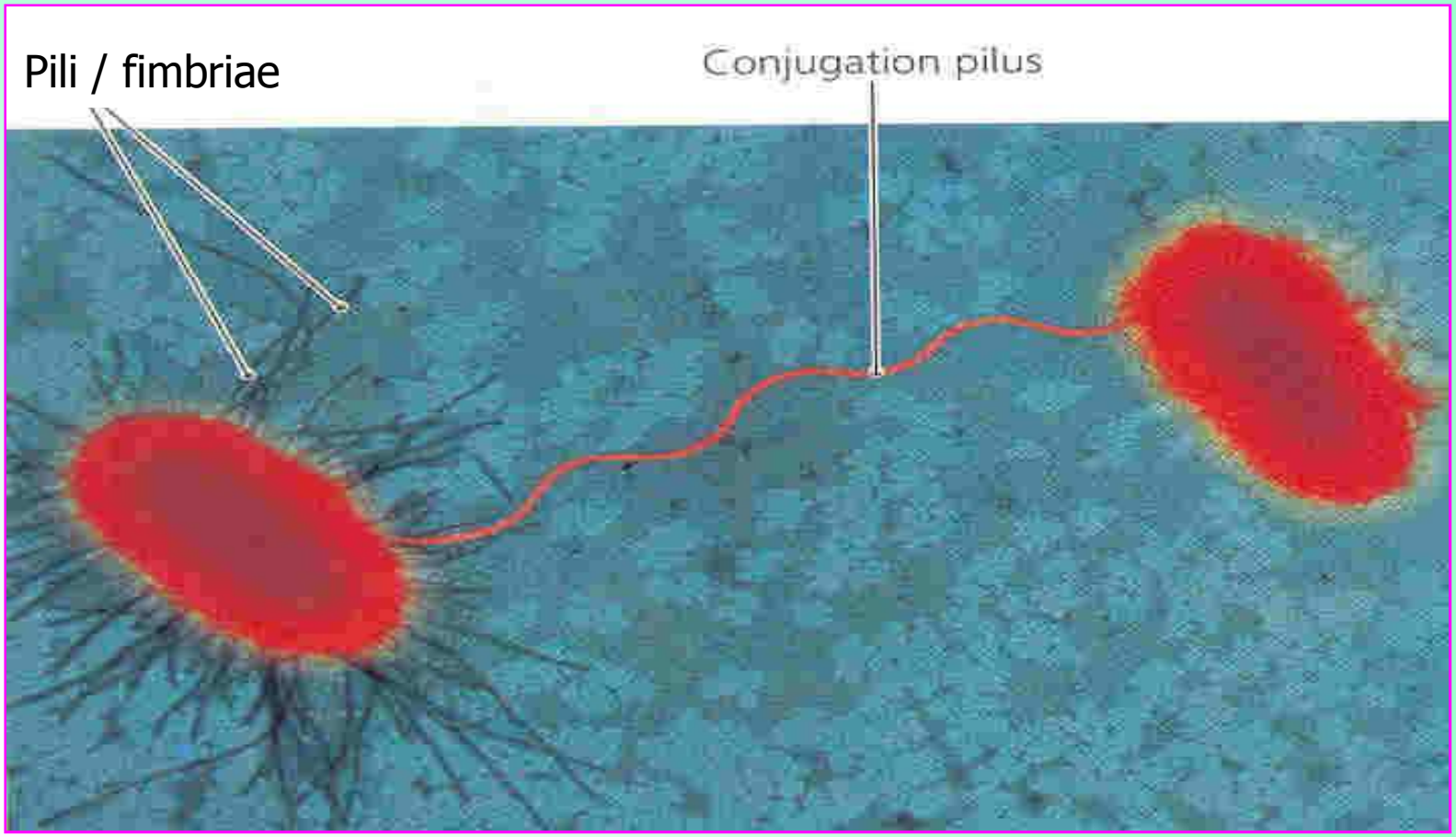
Flagella stain (Gray)



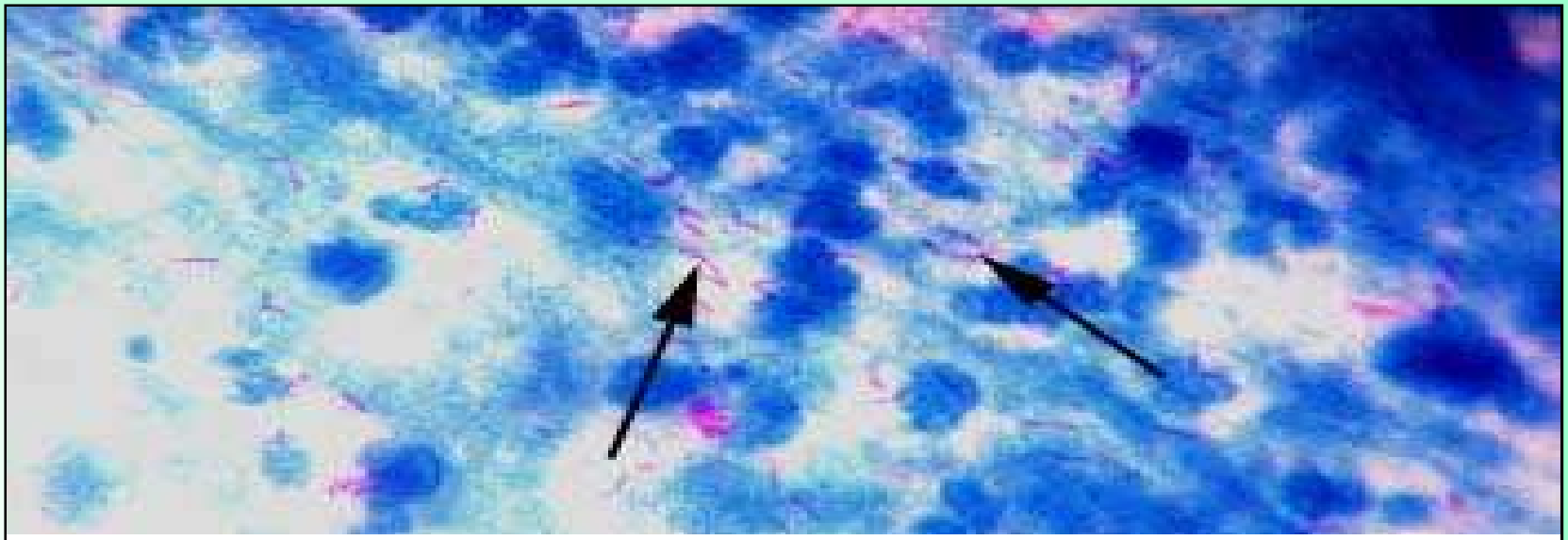


3. Pili (Fimbriae)

Short, stout hair-like processes, not concerned with motility, but with adhesion to host cells and the transfer of genetic material



Bacterial exceptions



1. Acid fast bacteria

are highly impermeable to dyes and organic solvents because of a waxy layer in the cell wall. The coat is responsible for virulence and antiphagocytic

2. Protoplast, spheroplast, and L – form (Mycoplasma)

- a bacterium referred to as **a protoplast** when **it is without a cell wall** the cell wall is lost due to the action of lysozyme enzymes which destroy peptidoglycan, make it is easyly lyzed

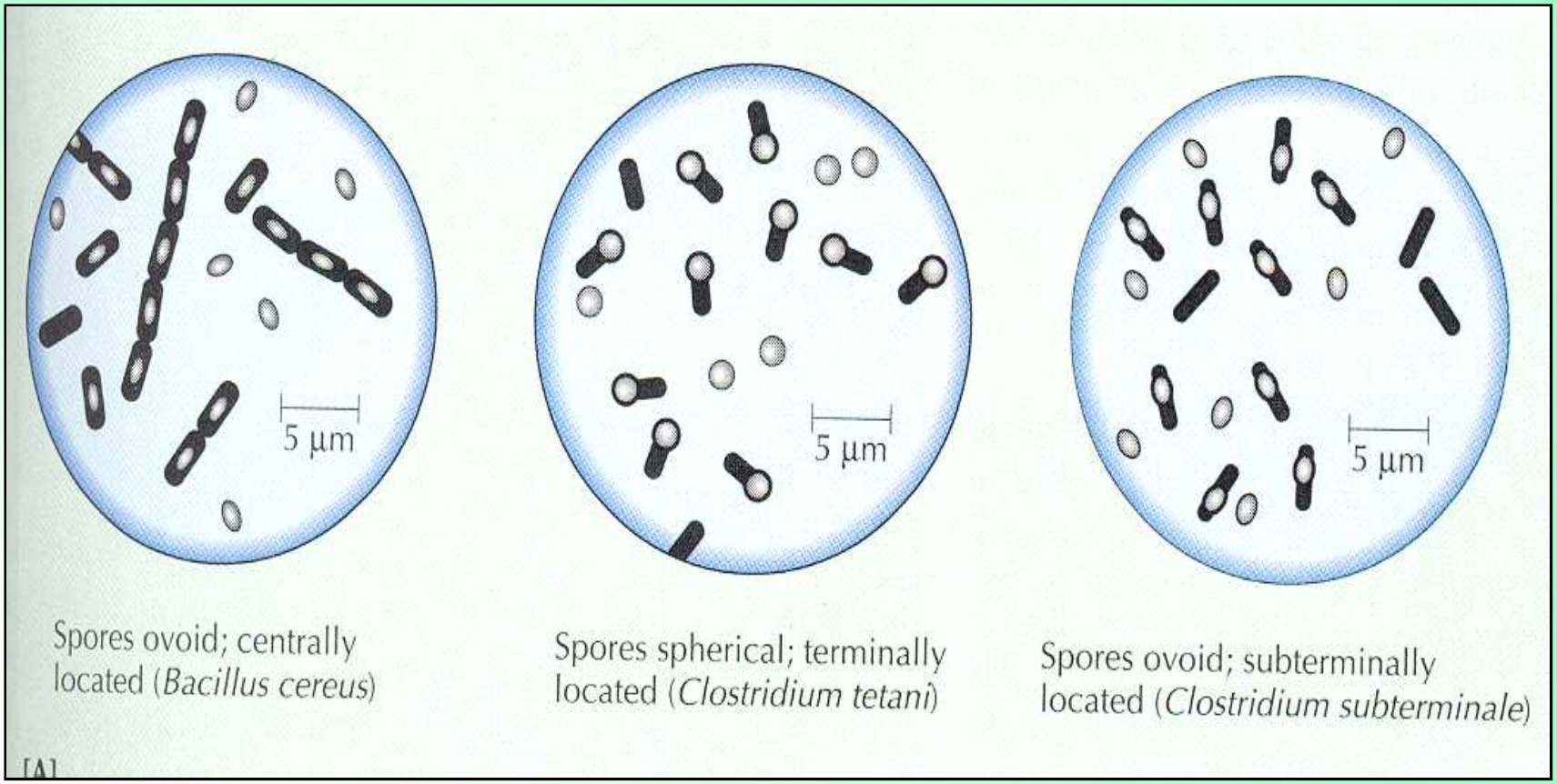
- **a Spheroplast** is a bacterium **with damaged cell wall.** the damage is caused by the action of a toxic chemical or an antibiotic such as penicillin.

- **L – form** are **mutant bacteria without cell wall.** they are produced when the surroundings become unfavorable

- They are able to reproduce and can be grown on special media with a high osmotic pressure

3. Spores

Some species surround the bacterial DNA with a tick protective Coat to form a spore that can survive extreme physical conditions



Bacterial Metabolism and Growth

Metabolic Requirements

A variety of nutrients is needed for growth and division.

In lab. they are provided either in liquid (broth) or solid (broth + agar) form.

Also importance for growth are :

1. Temperature
2. Gaseous atmosphere
3. pH

Most medically important species will grow at or around human body temperature, 35 ^{0}C, which is the temperature most commonly use to incubate bacteria from clinical specimen.

Depending on its atmospheric requirements, and organism can be described as :

1. **An obligatory (strict) aerobe :**
   require molecular oxygen as a terminal electron acceptor resulting information of water
   Example : *Pseudomonas aeruginosa*

2. **A microaerophilic organism :**
   needs about 2 – 8 % of oxygen for optimal growth .
   require oxygen as terminal electron receptor.
   Example : *Camphylobacter jejuni*

3. An obligatory (strict/moderate) anaerobe :

bacteria that grow in the absence of free oxygen but fail to multiply in the presence of oxygen on the surface of nutritionally adequate solid media incubated in room air or CO_2 incubators

Example : *Clostridium tetani*

4. A facultative anaerobe:

Can live with or without free oxygen.

Example : *Streptococcus pyogenes*

5. aerotolerant anaerobes

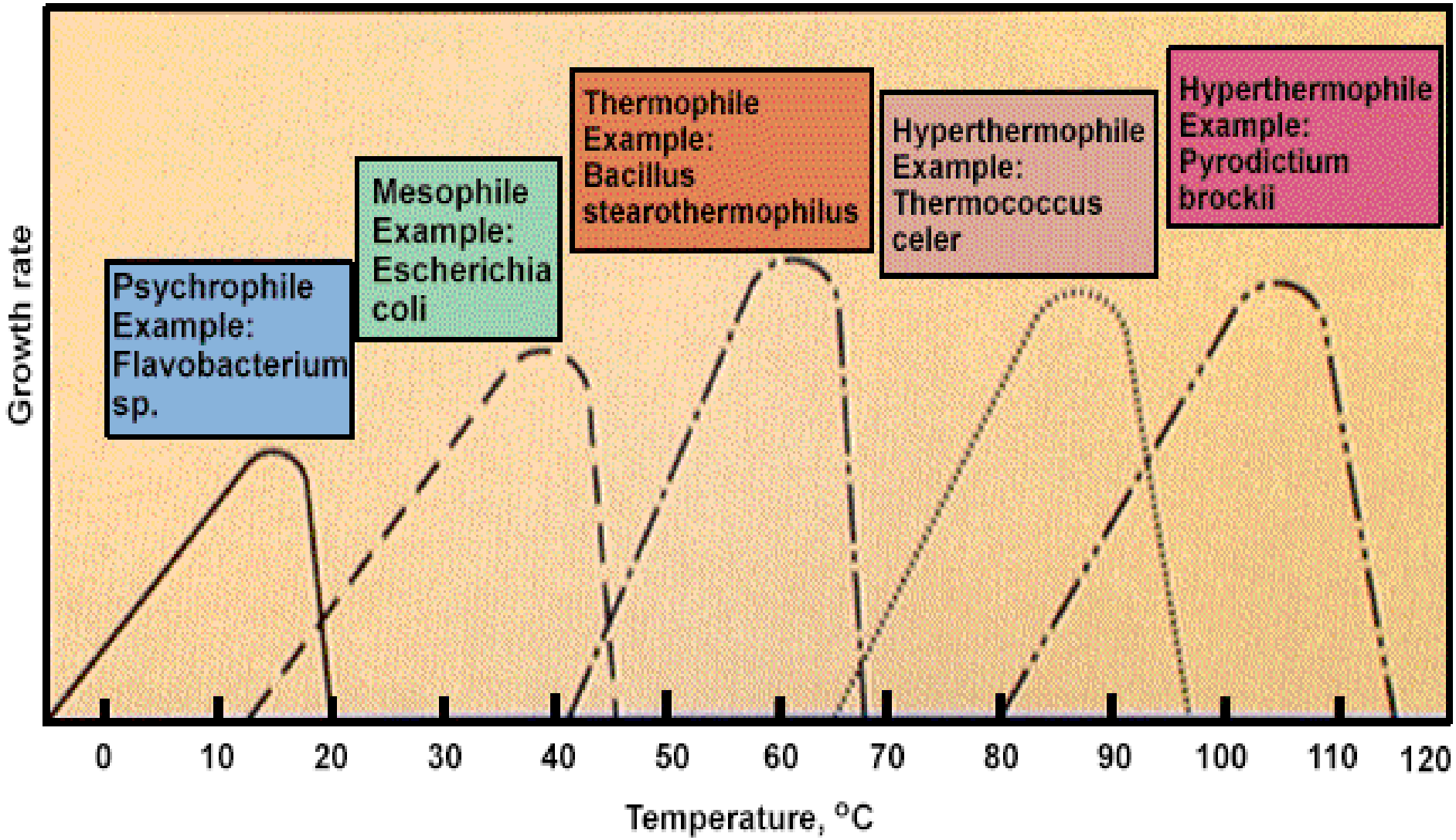
anaerobes that show limited or scanty growth on agar in room air or 5-10 % CO_2

Requirement of growth

Physical requirement : pH, Temperature

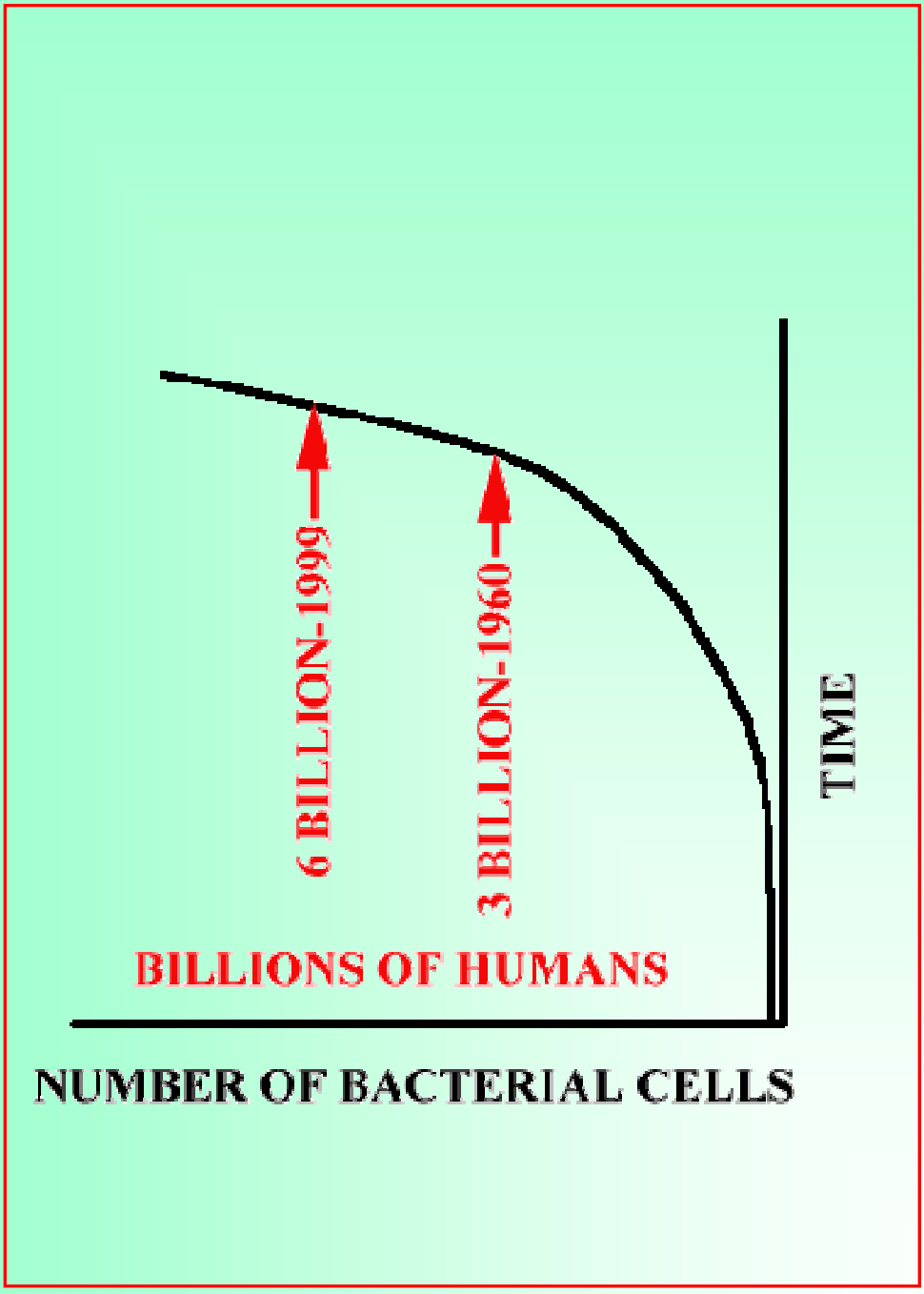
- psychrophilic, -10 to 20 ^{o}C, *Flavobacterium*
- mesophilic, -25 to 40 ^{o}C, *E. coli*
- thermophilic, 50-60 ^{o}C, *Thermus*
- extream thermophilic, 70-100 ^{o}C, *Thermococcus*

- pH
  - most bacteria grow at pH 6.5 and 7.5, halophiles



Bacteria

- A major advantage the bacteria are capable of rapid growth rates.
- bacteria can produce a NEW GENERATION, every 20 to 30 minutes under optimal environmental and nutrient conditions. Whereas, the human generation time is ~25 years.
- Bacteria has exponential or logarithmic growth in which the numbers of a species double



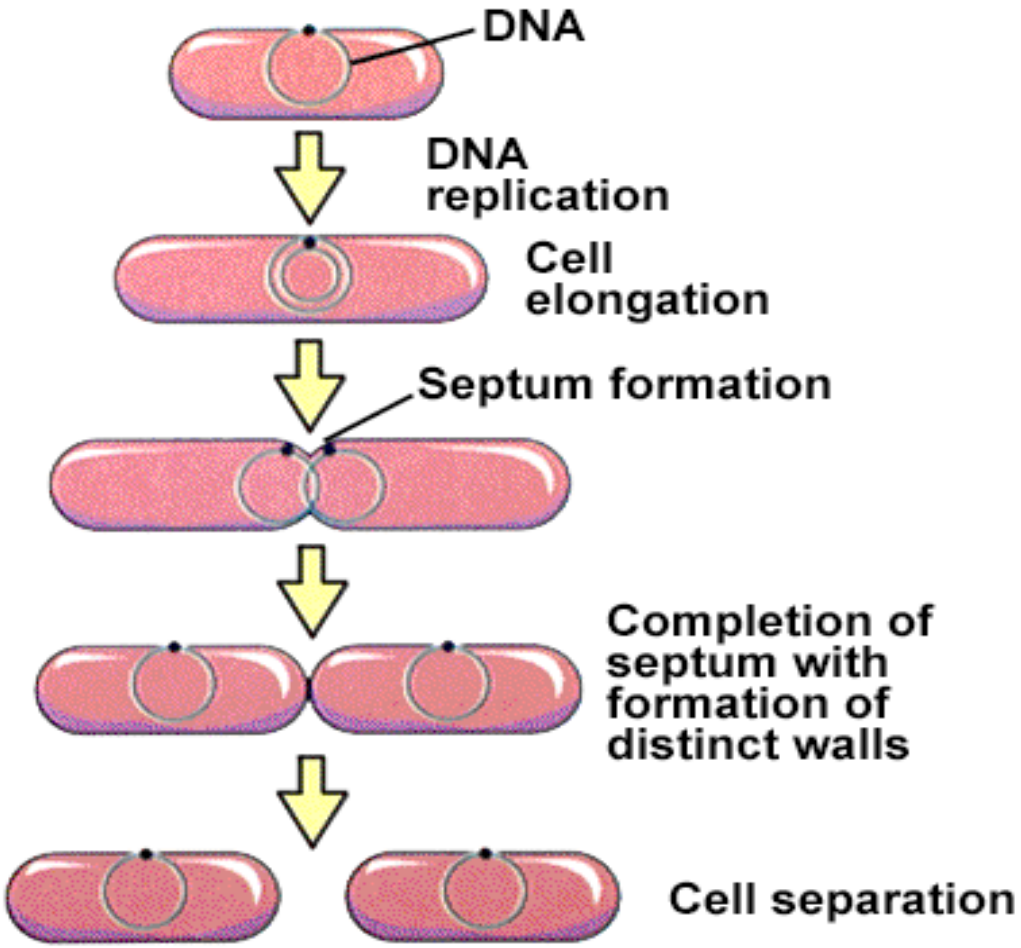
- A major advantage of the rapid reproduction time, and one that makes the bacteria so successful, is that they are able to evolve so much faster.

- Those organisms with the advantageous mutations tend to survive and live on. Because of their faster generation times bacteria can test billions of mutations for survival while a single human may take 25 or more years to test a given mutation.

BINARY FISSION

- Bacterial cells grow and then replicate using the process known as Binary Fission. This occurs in a number of stages.
    - The parent cell grows and enlarges.
    - The genetic material unwinds and replicates.
    - The copies of the genetic material go to opposite ends of the cell.
    - A cross wall forms and divides the enlarged cell into two cells.
    - Two new identical daughter cells are formed.

Binary fission



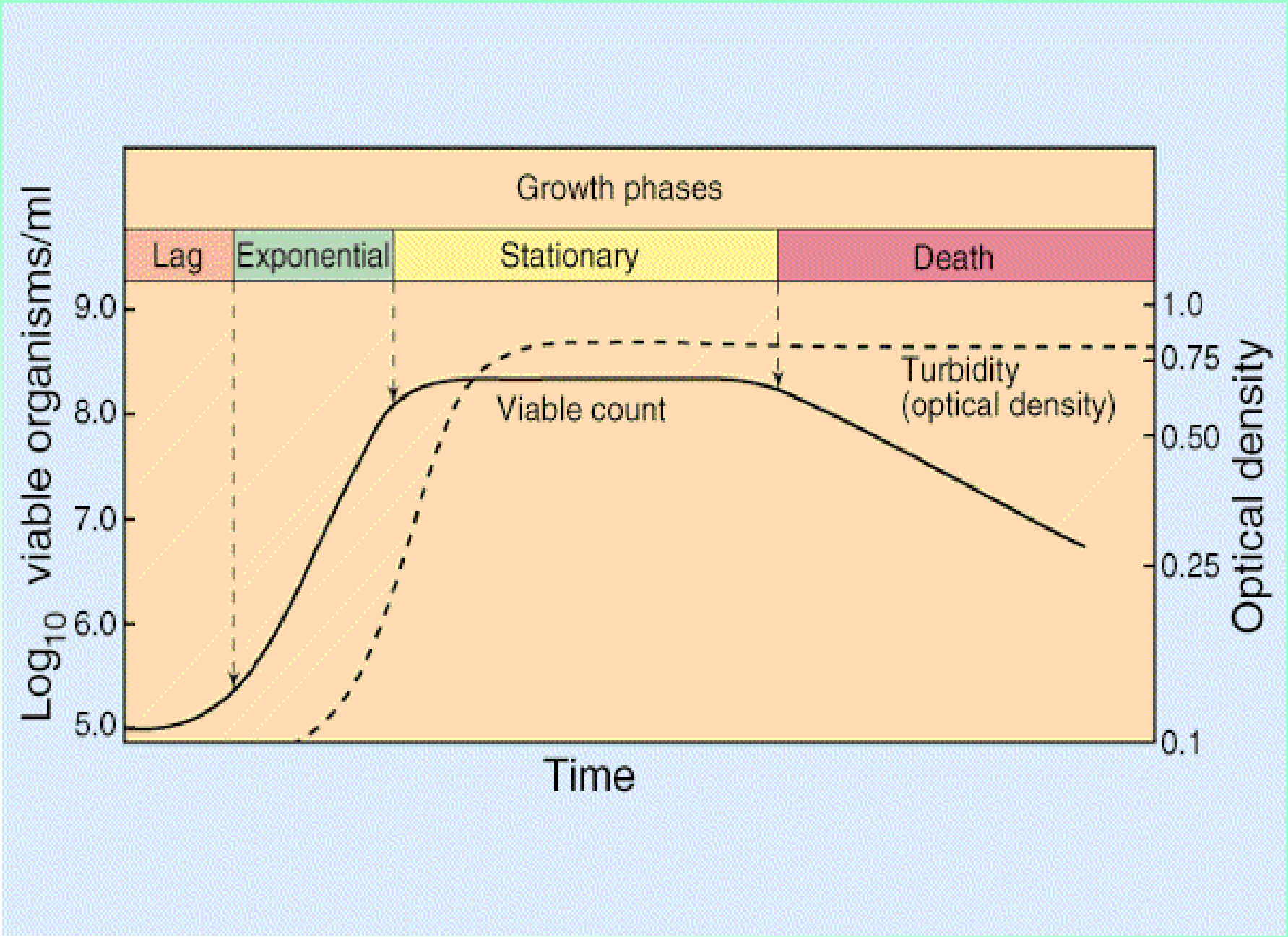
- The two new daughter cells can then divide and assuming that the correct environmental and nutritional conditions are present this division process will continue.

- The time required for one cell to divide to two cells is the Doubling Time or Mean Generation Time.

- The Doubling Time can vary depending on the type of cell and the nutritional (nutrient supply and mineral requirements) and environmental conditions (O_2, temperature, pH, osmotic pressure) present.

- Thus a single cell undergoing binary fission in optimum nutritional and environmental conditions with a doubling time of 10 minutes can become millions of cells within 12 hours.

- This doubling growth will continue as long as there are adequate nutrients. This doubling growth is often referred to as EXPONENTIAL GROWTH or LOG GROWTH.



PARASITOLOGI

Ilmu yang mempelajari jasad-jasad yang hidup untuk sementara atau tetap, di dalam atau pada permukaan jasad lain, dengan maksud untuk mengambil sebagian atau seluruh makanannya dari jasad lain tersebut.

Parasit : Jasad yang mengambil makanan dari jasad lain

Hospes : Jasad yang mengandung parasit

Binatang yang membunuh dulu mangsanya sebelum dimakan → Disebut predator (Pemangsa)

SIFAT PARASIT

1. Ekto Parasit : Parasit yang hidup pada permukaan tubuh hospes

→ infestasi

Mis : *Pediculus humanus capitis*

(Tuma Kepala)

Endo Parasit : Parasit yang hidup di dalam tubuh hospes → Infeksi

Mis : *Ascaris lumbricoides*

(cacing gelang)

SIFAT PARASIT

2. OBLIGAT : Parasit yang hanya dapat hidup bila tetap pada hospes

Mis : cacing *Ascaris lumbricoides*

FAKULTATIF : Parasit yang bisa tetap hidup, Walaupun diluar tubuh hospes

Mis : - cacing*Strongyloides stercoralis*
Stadium bentuk bebas
- Nyamuk
- Sengkenit

SIFAT PARASIT

3. MONOKSEN : Parasit yang hanya dapat hidup pada satu jenis hospes

Mis : cacing *Ascaris lumbricoides* →
Hanya menghinggapi manusia

POLIKSEN : Parasit yang dapat meng-hinggapi beberapa jenis hospes.

Mis : cacing *Trichinella spiralis* →
Babi, Tikus, Manusia

cacing *Brugia malayi* →
Manusia, kucing, Kera, Anjing

SIFAT PARASIT

4. PERMANEN : Parasit yang seluruh hidupnya tetap saja pada satu hospes.

Mis : cacing *Ascaris lumbricoides*

SEMENTARA : Parasit yang berada pada hospes, hanya untuk sementara

Mis: - Nyamuk *Aedes aegypti*

- Kutu busuk (*Cimex hemipterus*)

Istilah-istilah di Parasitologi

1. Hospes Definitif : Hospes yang mengandung parasit stadium seksual (Perkembangan seksual parasit +)

Mis : *A. lumbricoides* → H.D : Manusia

Plasmodium (malaria) → H. D : Nyamuk

2. Hospes Perantara : Hospes yang mengandung parasit stadium A seksual (Perkembangan Seksual Parasit –)

Mis : Plasmodium (Malaria) → H.D : Nyamuk → Sporogoni

H.P : Manusia → schizogoni

Filaria (Peny.Kaki Gajah) → H.D : Manusia

H.P : Nyamuk

Hospes Perantara

1. Manusia : H.P. Plasmodium (Malaria)

2. Binatang : - Nyamuk : H.P. Filaria

- Ikan Mas, Lele / Gabus : H.P. *Gnathostoma spinigerum*

- Keong Air : H.P. *Schistosoma japonicum*

- Ketam : H.P. Trematoda Paru

3. Tumbuh-tumbuhan : Slada Air / Lengkak : H.P. Trematoda

Istilah-istilah di Parasitologi

3. Hospes Reservoir / Cadangan :

Hospes yang mengandung parasit, yang dapat menjadi sumber infeksi bagi manusia.

Mis : - *Trichinella spiralis* → H.R : Babi, Tikus, Beruang dll.

- *Brugia malayi* → H.R : Kera, Kucing, Anjing

Istilah-istilah di Parasitologi

5. Hospes Aksidental :

Hospes yang tidak biasanya mendapat parasit tersebut, kemudian secara kebe-tulan mendapat parasit tersebut, yang kadang-kadang dapat menjadi dewasa.

Mis : - *Toxocara cati*

- *Ancylostoma ceylanicum*

→ Parasit anjing / kucing → kadang-kadang dapat menghinggapi manusia

→ Manusia = Hospes Aksidental

6. Vektor :

Suatu jasad (biasanya serangga) yang dapat menularkan penyakit / memindahkan parasit pada manusia atau binatang.

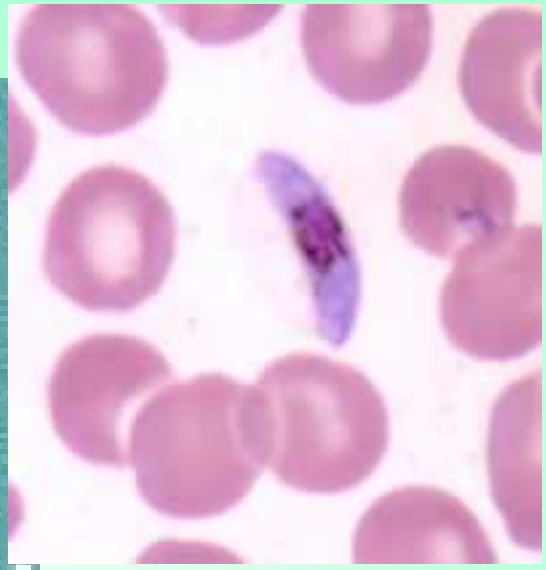
Mis : Nyamuk → Malaria, Filaria

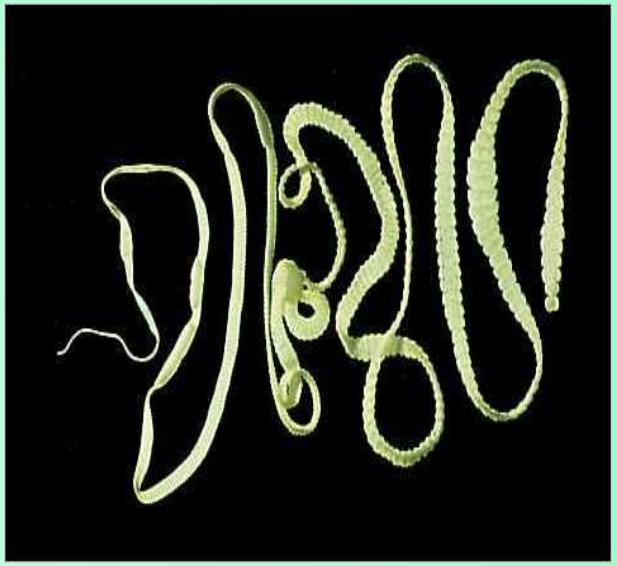
Lalat Glossina → Penyakit Tidur Afrika

Istilah-istilah di Parasitologi

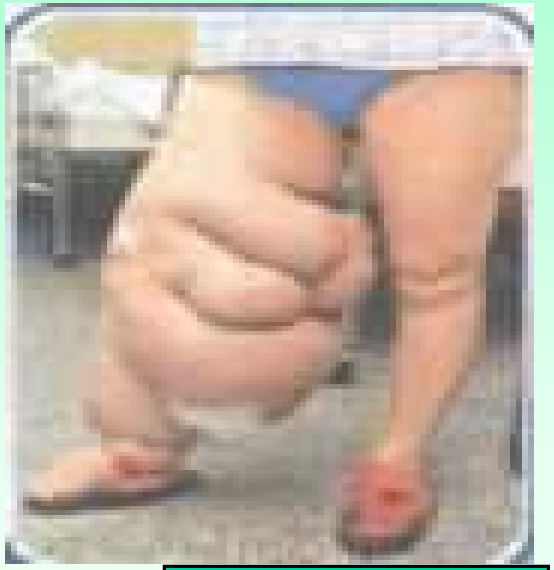
7. Zoonosis : Penyakit binatang yang dapat ditularkan pada manusia, atau sebaliknya

Morfologi parasit



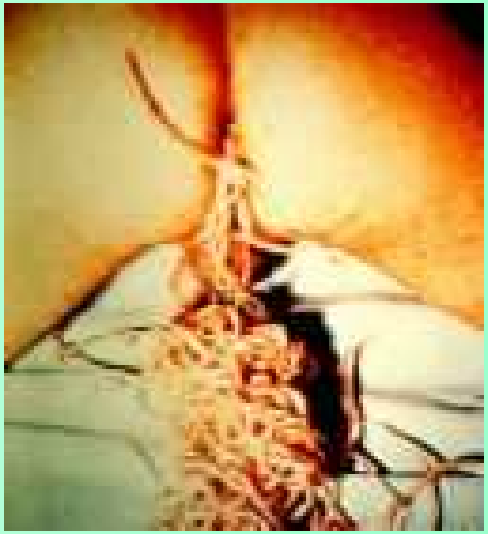


Gejala klinis penyakit parasitik



elefantiasis

skabies



askariasis

PENDAHULUAN PARASITOLOGI

- **Penyakit parasitik** : masalah kesehatan masyarakat negara tropis & sub tropis, termasuk Indonesia
- Program pemberantasan & pencegahannya → tujuannya untuk memutus mata rantai siklus parasit ↓

  Perlu pemahaman tentang siklus hidup parasit & patogenesis penyakitnya pada manusia
- Parasit yang dalam siklus hidupnya penularanya terjadi antara manusia ke manusia tanpa hospes reservoar lebih mudah diberantas

PENDAHULUAN PARASITOLOGI

- Dalam mempelajari siklus hidup parasit dapat diketahui stadium stadium dalam siklus hidup tsb

  ⟶ dapat dipakai untuk diagnosis (stadium diagnosis), stadium yang memulai infeksi (stadium infektif) & stadium yang menyebabkan patogenesis/gejala klinis penyakit tsb

PATOGENITAS
PENYAKIT PARASITIK

PENDAHULUAN PARASITOLOGI

- **PATOGENITAS PENYAKIT → PARASIT**

  - Patogenitasnya bervariasi tergantung jenis parasit (mis : protozoa, cacing atau serangga)

  - Faktor2 yang berhubungan dengan patogenitas parasit :

  - cara paparan & masuk ke dalam hospes
  - jumlah parasit yang menginfeksi
  - virulensi
  - penempelan pada jaringan hospes
  - replikasi
  - penghancuran sel & jaringan
  - gangguan, penghindaran & inaktifasi sistim kekebelan

PENDAHULUAN PARASITOLOGI

- **Paparan & cara masuk ke dalam hospes** :

  - Cara umum: melalui mulut (*oral ingestion*) & penetrasi melalui kulit /permukaan

  - Transmisi penyakit parasitik :

    a. melalui kontaminasi lingkungan yaitu dengan kotoran manusia & hewan sebagian besar terjadi secara *fecal-oral* (untuk infeksi cacing) & *penetrasi* larva melalui kulit (mis : infeksi cacing tambang & strongyloidiasis).

    b. melalui gigitan serangga (vektor), mis : malaria & filariasis

PENDAHULUAN PARASITOLOGI

- **Beberapa cara masuk parasit** :

Cara masuk	contoh parasit
- tertelan	*Giardia sp*, *E. histolytica*, Cestoda, Nematoda, *Cryptosporidium sp*,
- Penetrasi langsung	
a. gigitan serangga	malaria, filariasis, trypanosomiasis, leishmaniasis
b. plasental	*Toxoplasma gondii*
c. parasit langsung menembus kulit	cacing tambang, *S. stercoralis*, *Schistosoma sp*

PENDAHULUAN PARASITOLOGI

- **Penempelan & Replikasi parasit**

  - sebagian infeksi diawali dengan penempelan parasit pada jaringan hospes ⟶ diikuti dengan replikasi
  - penempelan parasit pada sel atau jaringan hospes bersifat non-spesifik, dapat terjadi secara :

  a. mekanik (mis : antigen Duffy untuk *P. vivax*)

  b. gigitan bagian mulut (mis: cac. tambang)

  c. interaksi antara struktur permukaan parasit (adhesins) & reseptor2 sel spesifik hospes (glycoprotein) (mis; *Giardia lamblia*)

PENDAHULUAN PARASITOLOGI

- Setelah menempel pada sel spesifik & berbagai jaringan selanjutnya parasit memperbanyak diri (bereplikasi) .
- Replikasi dapat terjadi secara intraseluler & ekstraseluler hospes

PENDAHULUAN PARASITOLOGI

- **Pengrusakan sel & jaringan hospes**

- Umumnya parasit mengawali proses penyakit dengan invasi sel/jaringan ⟶ diikuti replikasi & pengrusakan.
- Mekanisme patologik penyakit parasit dapat terjadi melalui :

a. penghasilan produk toksin oleh parasit
(mis: endotoksin, amoebic ionophore)

b. pengrusakan jaringan secara mekanik (mis : tekanan atrofi, pembendungan organ internal, migrasi jaringan)

c. Imunopatology
(mis: hypersensitivitas, autoimun, perubahan2 metaplastik)

PENDAHULUAN PARASITOLOGI

- Beberapa mekanisme patologik dalam penyakit parasitik :

Mekanisme	Contoh
1. produk parasit/racun	
- endotoksin	*P. falciparum*
- proteinase, kolagenase	*E, histolytica*, *Schistosoma sp*
2. Pengrusakan jaringan secara mekanik	
- pembebndungan organ2 internal	*A. lumbricoides*, cacing pita, filaria
- tekanan atropi	*Echinococcus sp*, sistiserkus
- migrasi jaringan	larva cacing
3. Imunopatology	
- hypersensitivitas	infeksi cacing