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MINISTRY OF EDUCATION & RELIGIOUS AFFAIRS
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ΠΡΟΓΡΑΜΜΑ ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗΣ ΑΕΙ ΓΙΑ ΤΗΝ ΕΠΙΚΑΙΡΟΠΟΙΗΣΗ ΓΝΩΣΕΩΝ ΑΠΟΦΟΙΤΩΝ ΑΕΙ (ΠΕΓΑ)

«Οι σύγχρονες τεχνικές βιο-ανάλυσης στην υγεία, τη γεωργία, το περιβάλλον και τη διατροφή»

APPLIED FOOD MICROBIOLOGY

- INTRODUCTION

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Athens, Hellas*





THE GOOD

THE BAD

THE UGLY

ART BY ZACH BELLSSIMO 2008



The Good



The Bad



The Ugly

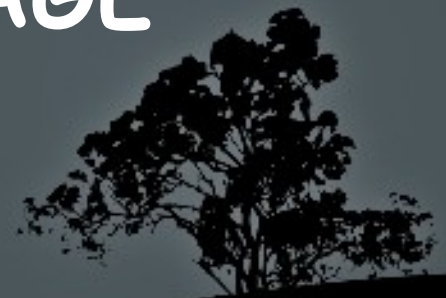
by ROB WORD

MICROORGANISMS ARE

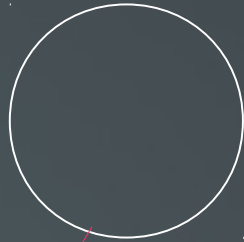
USEFUL

PATHOGENS

SPOILAGE



Big to small... to invisible



Microbial world



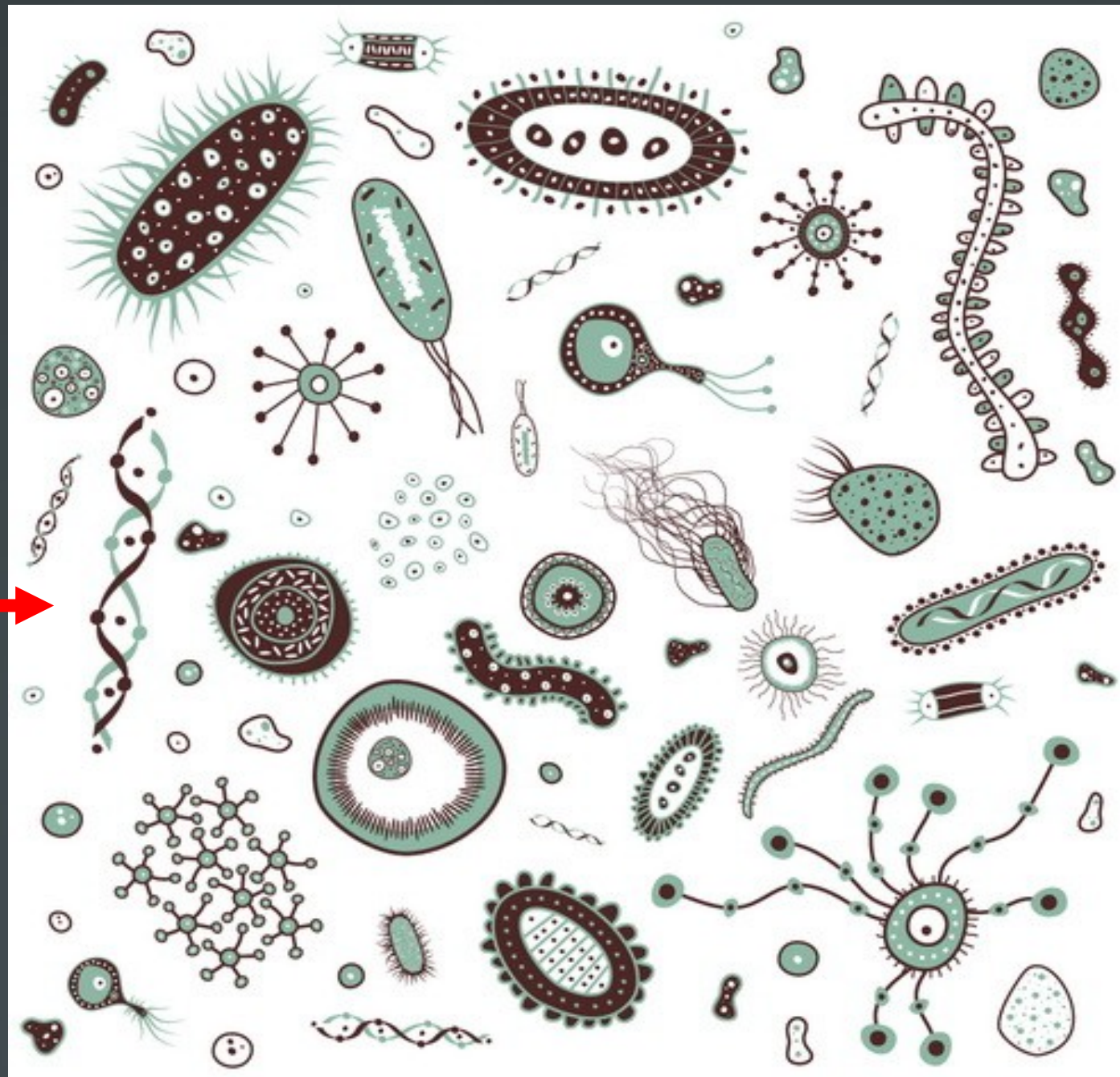
Microbial world is visible only with a magnifier (microscop)



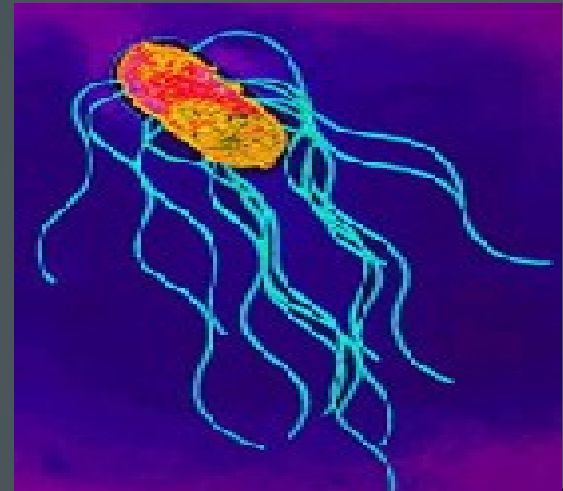
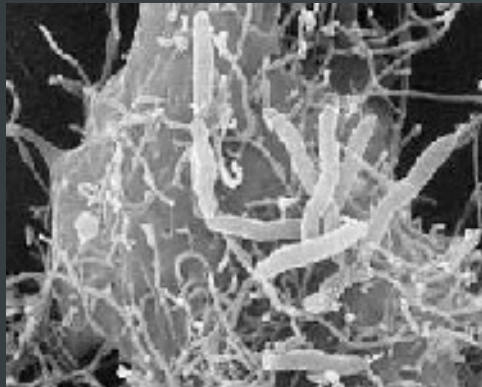
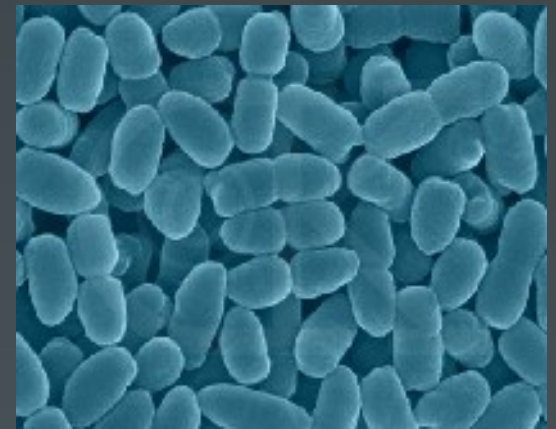
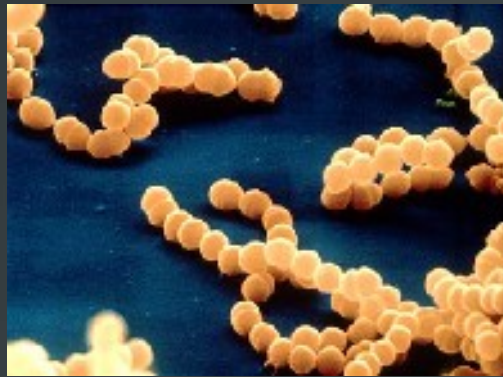
Amazing microworld



Amazing microworld



microbes

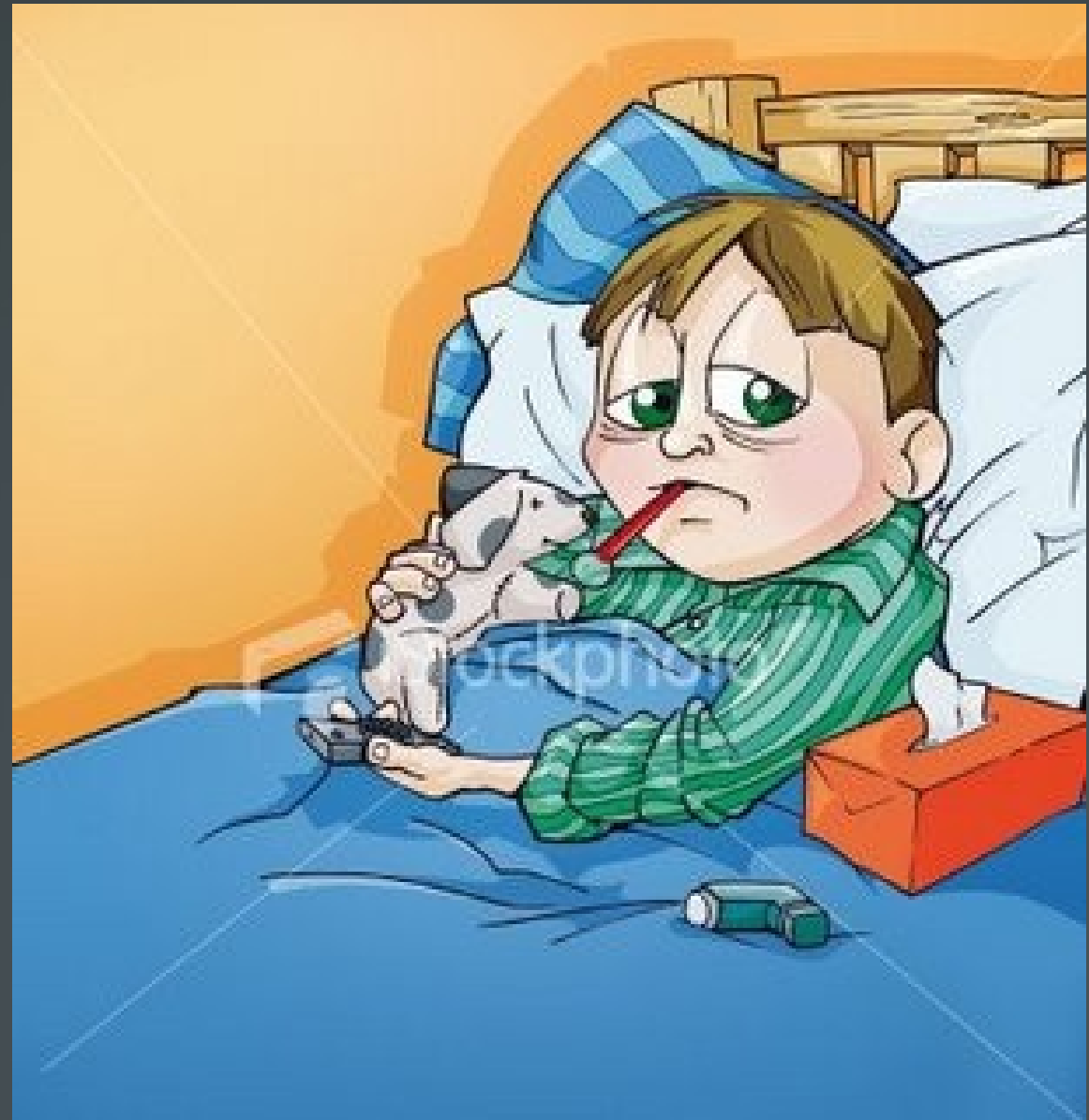


The bad

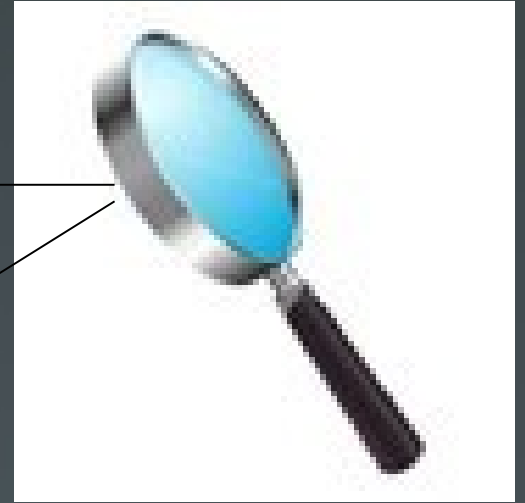


Illustration: Don Smith

The bad



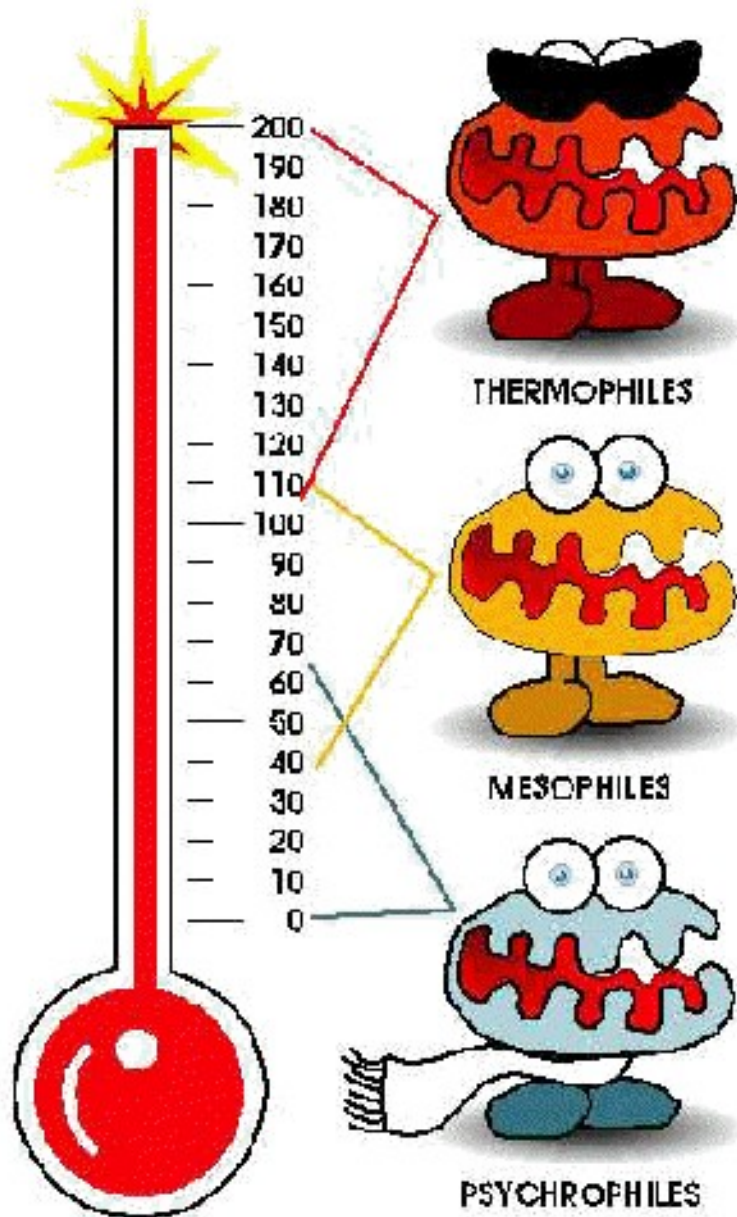
The bad are everywhere



The bad are everywhere



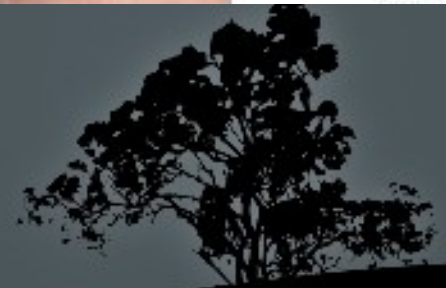
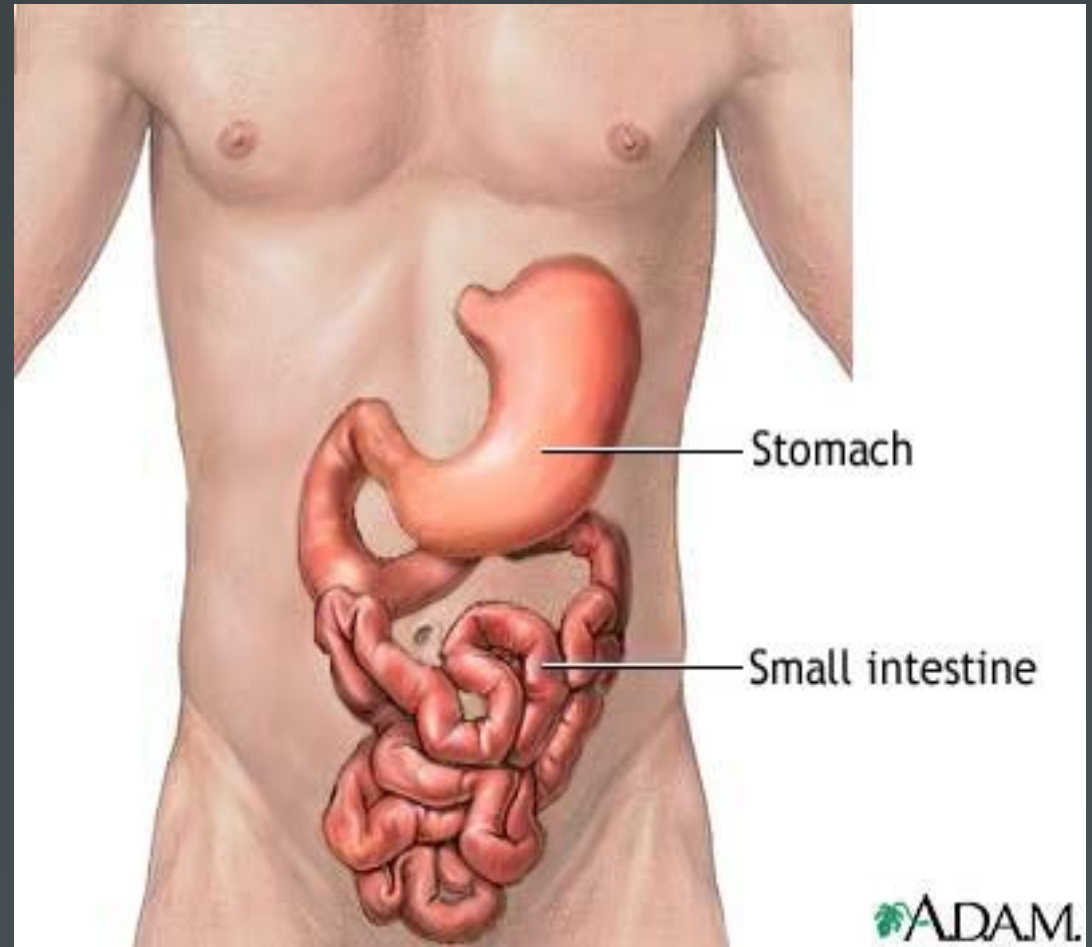
The bad are everywhere



The good



The good



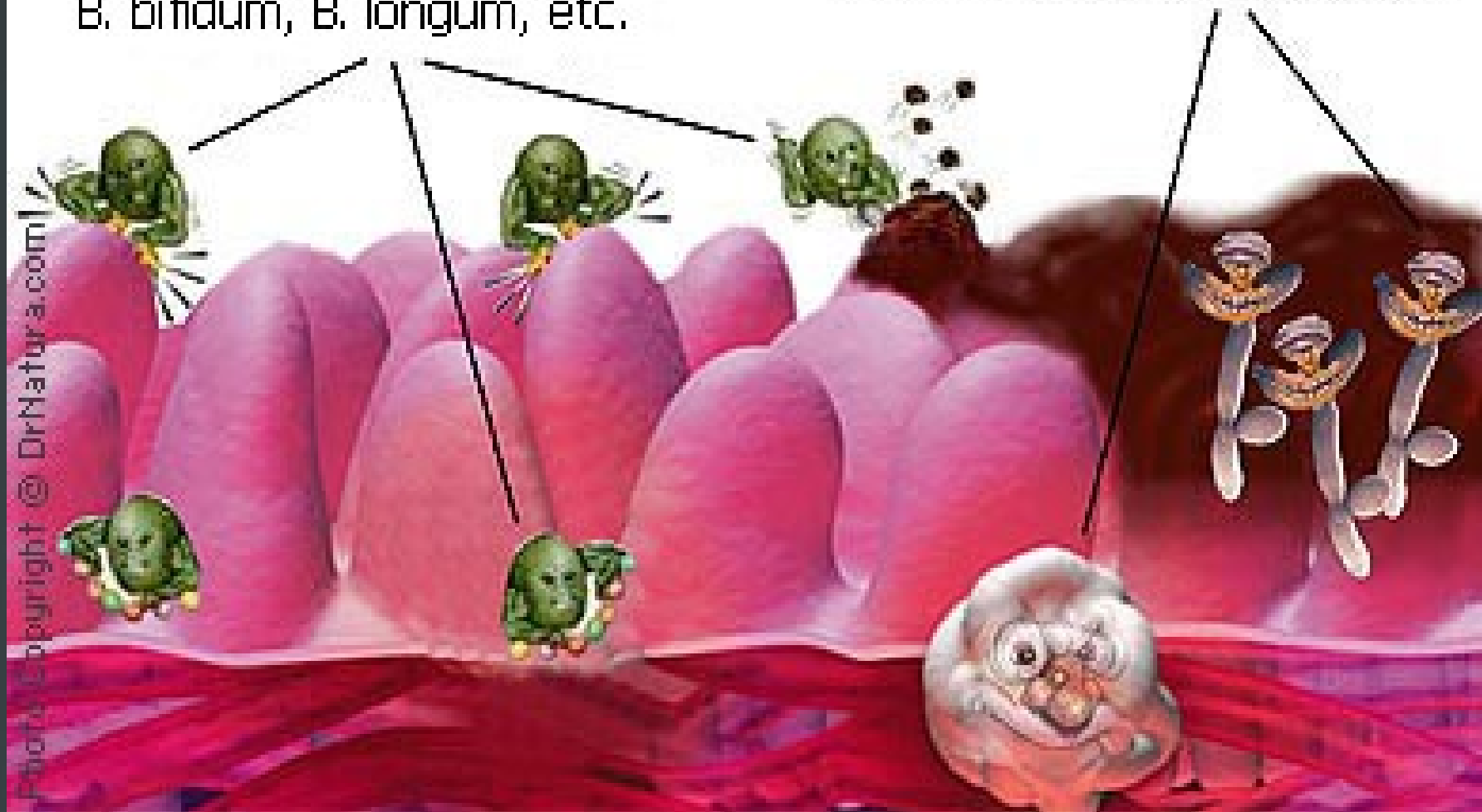
The good are together with the bad

Friendly Bacteria

L. acidophilus, *L. salivarius*,
L. casei, *L. thermophilus*,
B. bifidum, *B. longum*, etc.

Unfriendly Bacteria

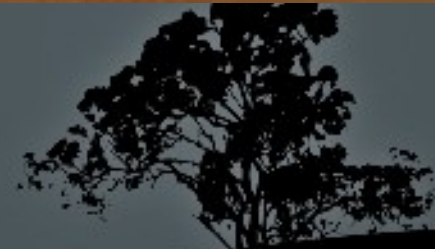
Pathogenic bacteria & fungi,
such as *Candida albicans*, etc.



The good may fight the bad



yogurt



yogurt



wine



beer

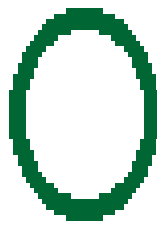


bread



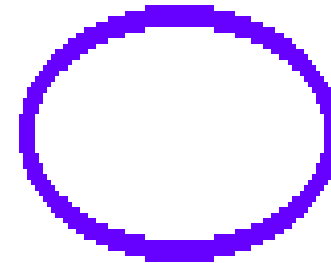
Microorganism approximate size

mould cell
10 x 40 μm



animal cell
10 μm

animal
nucleus
2.8 μm



yeast cell
5 to 8 μm

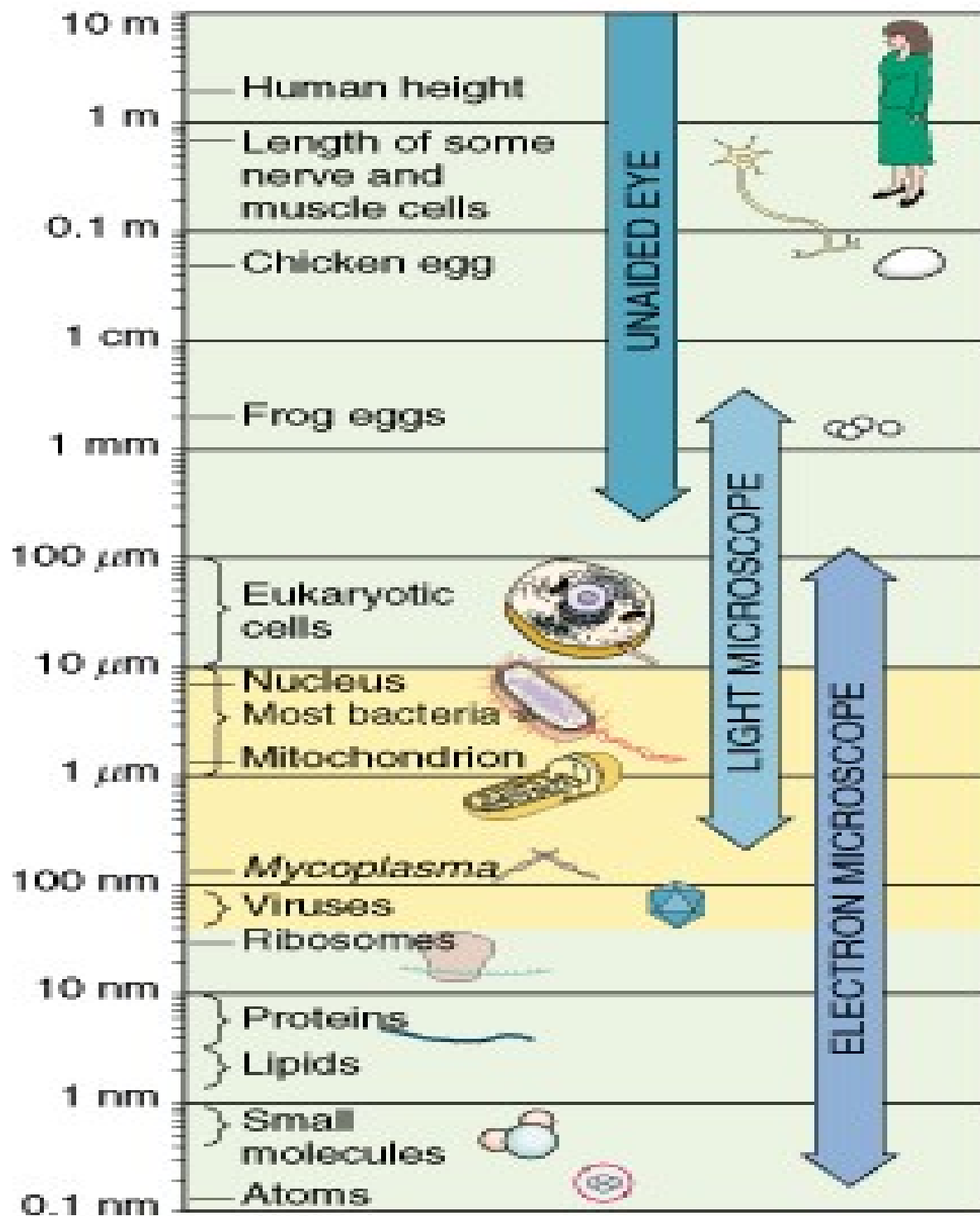
• virus
0.1 μm

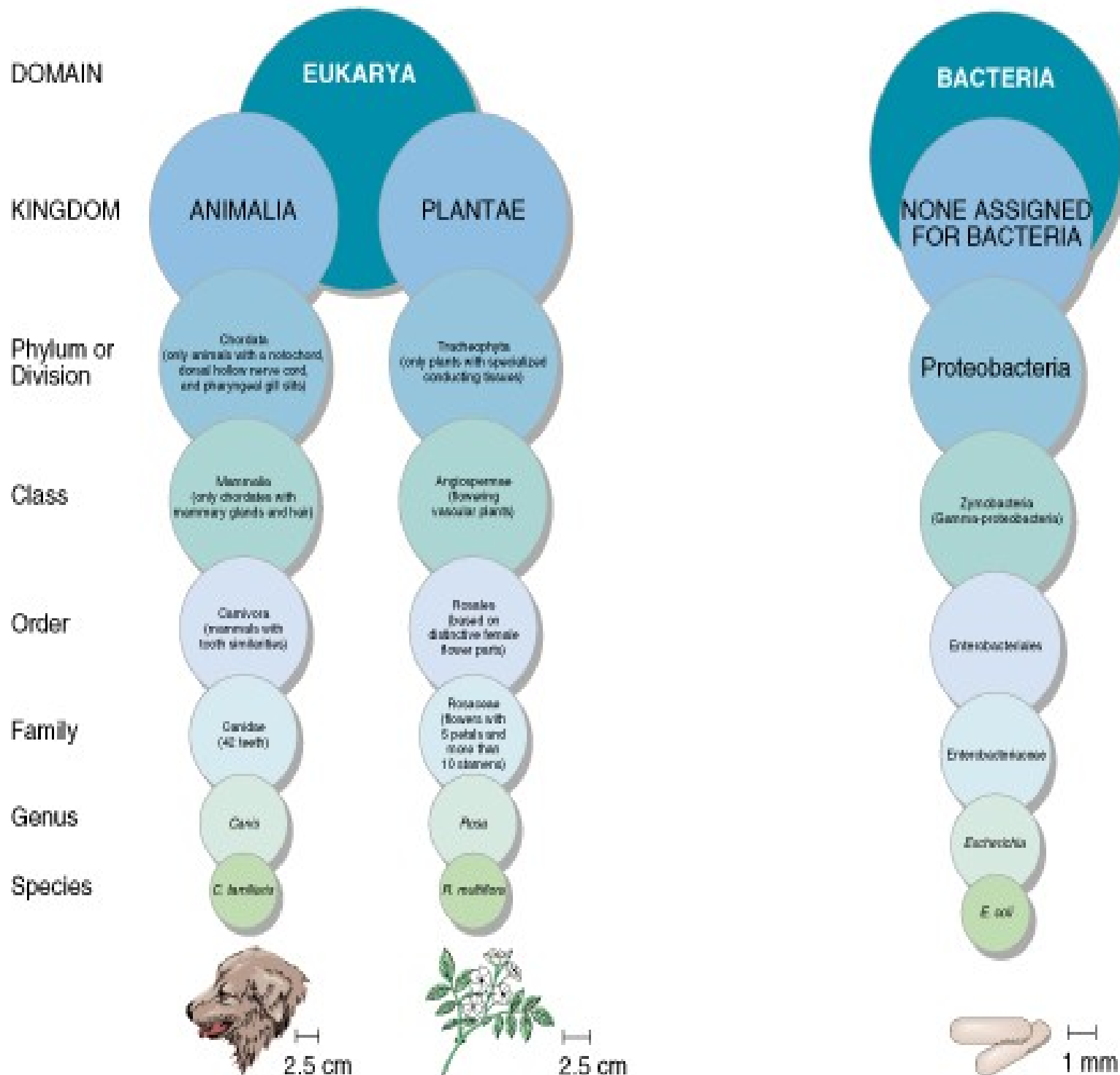


bacteria cell
(rod) 2-3 μm



bacteria cell
(coccus) 1 μm





SOURCES OF CONTAMINATION

Raw materials used in the food industry may be contaminated via soil, water, plants, equipment and utensils, humans, animals and air.

In the upper layer ($+30\text{cm}^2$) of fertile soil, 10^6 - 10^7 bacteria are present.

They mineralise organic material, which makes it possible for plants to absorb it.

Water is also microbially contaminated.

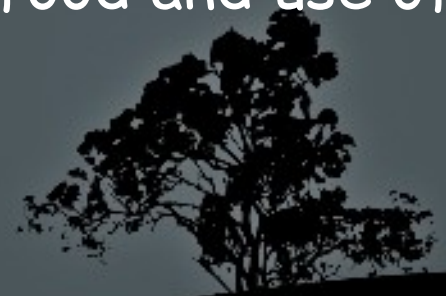
Potable water contains 10^2 bacteria/ml; waste water on the other hand contains 10^8 bacteria/ml.



SOURCES OF CONTAMINATION

Plants themselves are microbially contaminated and this is determined by the soil they are cultivated in and the water they come in contact with. By treatment of the soil with liquid manure, plants may be contaminated with faecal microorganisms, including pathogens.

Insufficiently cleaned and disinfected equipment and utensils are culture mediums for microorganisms. In addition to this they are important sources of cross-contamination. The qualitative and quantitative aspect of those sources of contamination is determined by the type of food and use of those equipment and utensils.



SOURCES OF CONTAMINATION

Human beings may be a source of contamination because of lack of personal hygiene. Via skin, hairs and respiratory tract of people employed in the food industry, numerous micro-organisms find their way into food products.

Animals are a source of contamination via intestines, skin, feathers, hooves and droppings, which are extremely microbially contaminated.

Finally, the microbial contamination of air will also influence the microbial quality of food.



Bacterial classification

Gram-positive

Aerobic Cocci, Aerobic Bacilli

Gram-negative

Aerobic Cocci, Enteric Bacteria, Pleomorphic Bacteria, Non-Fermenters

Anaerobes

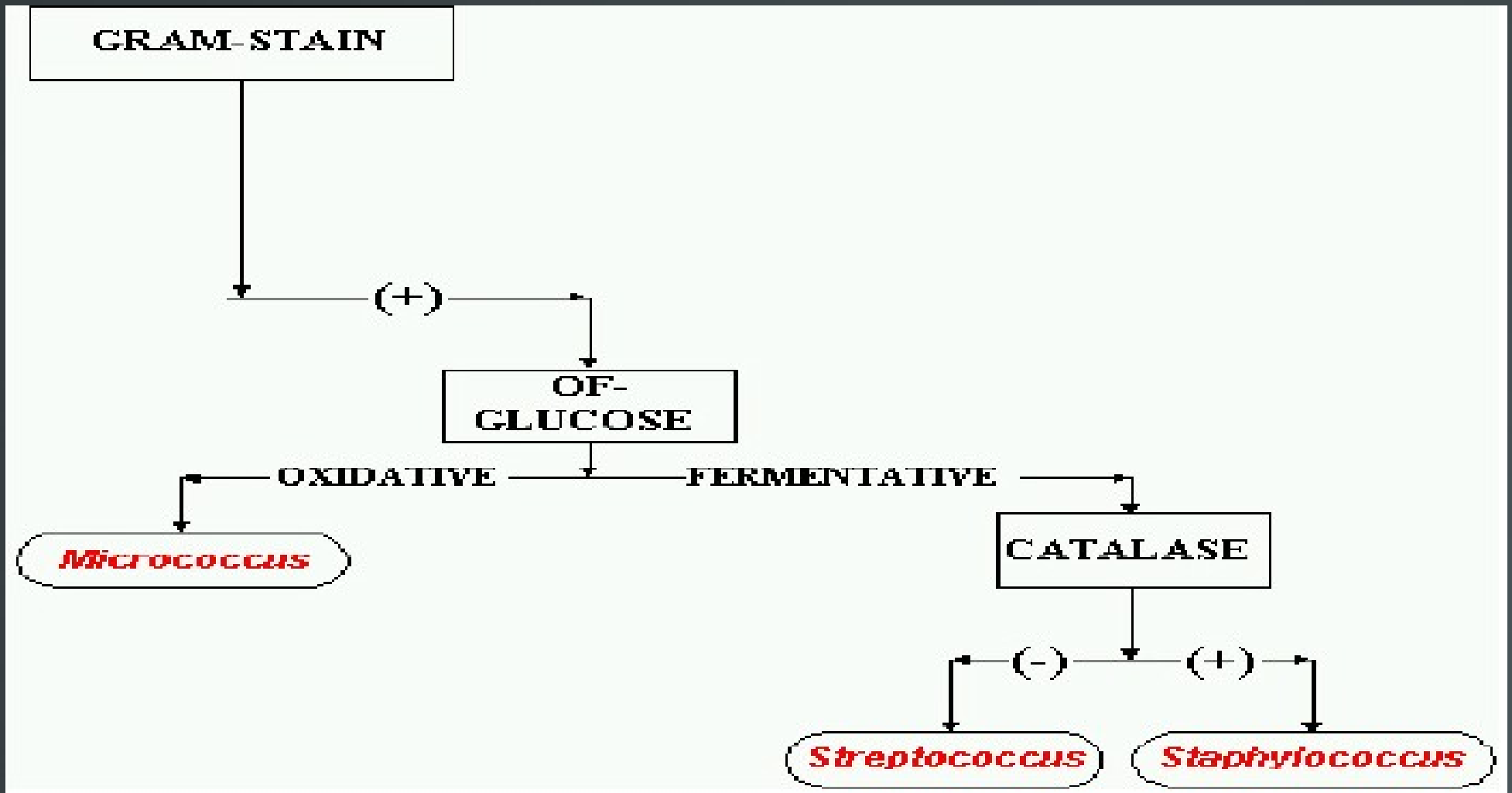
Gram-positive,

Gram-negative



Bacterial classification

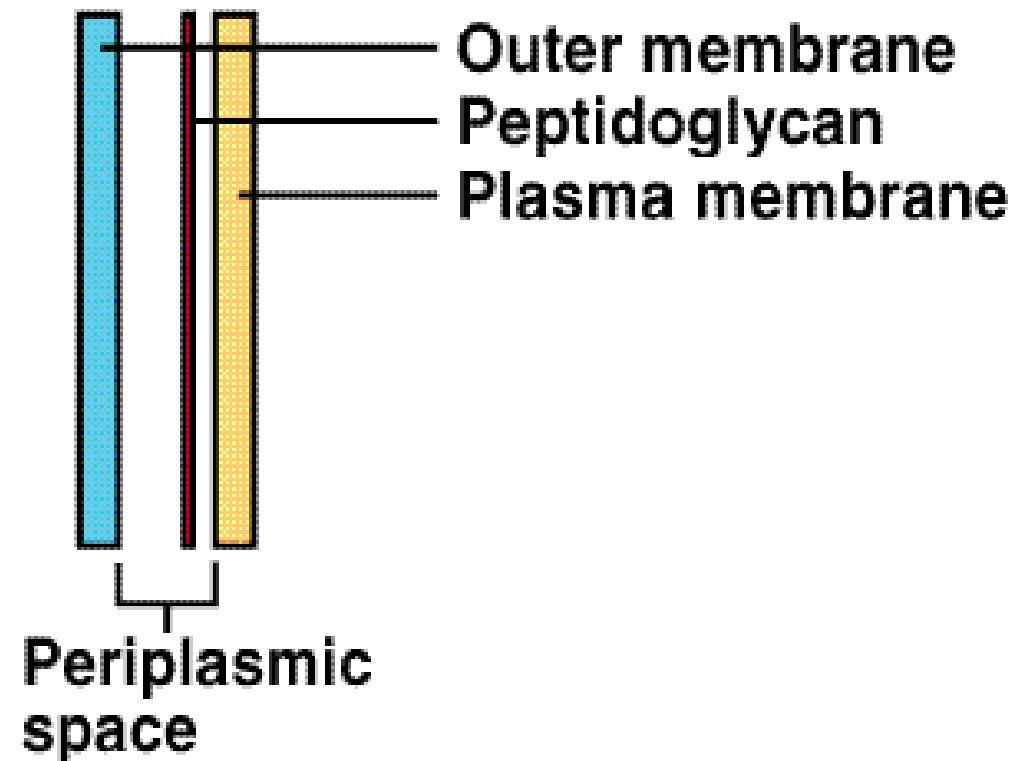
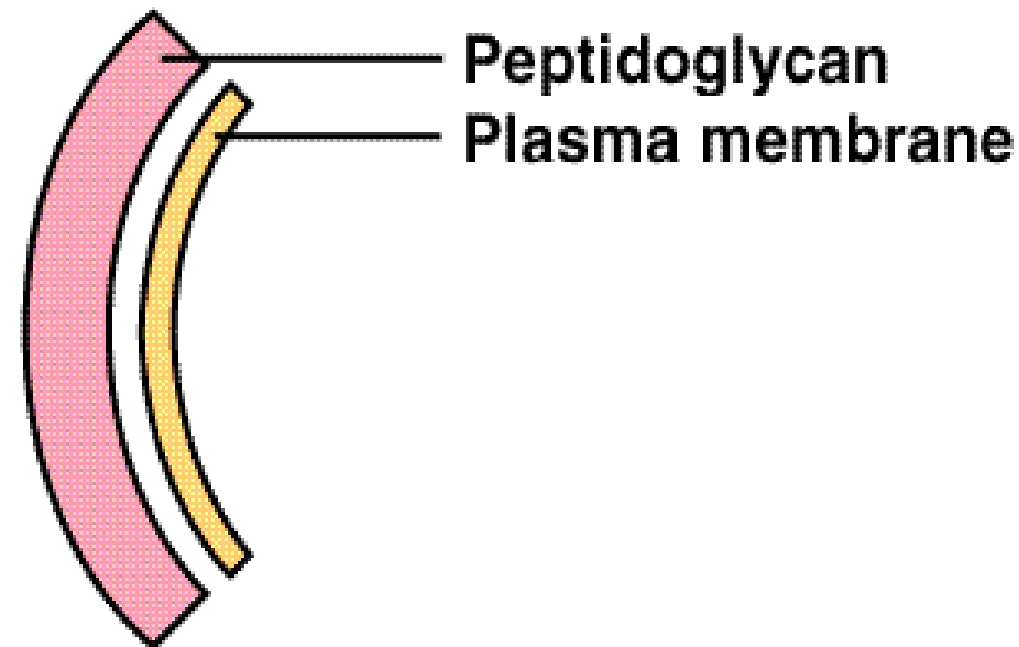
example



Bacterial Cell Wall

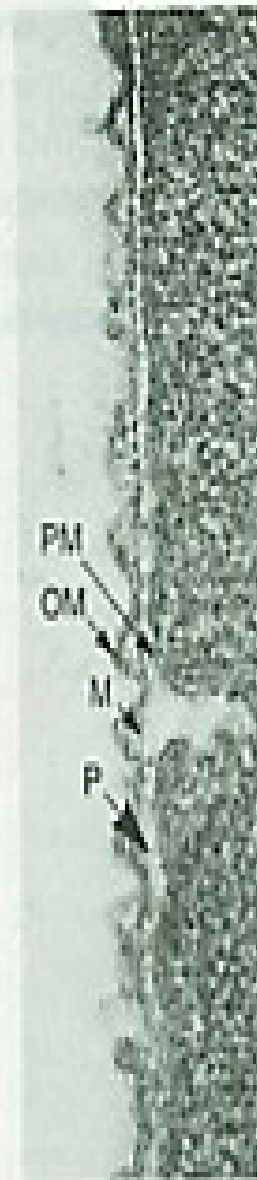
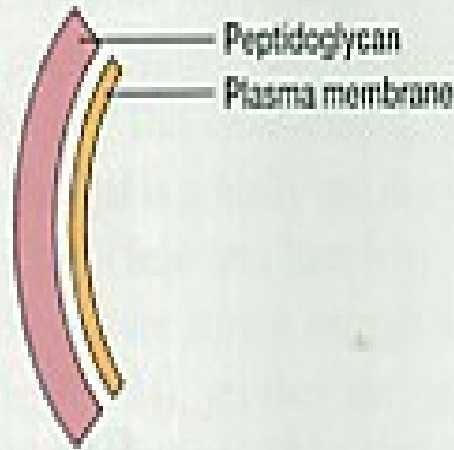
The gram-positive cell wall

The gram-negative cell wall





The gram-positive cell wall



The gram-negative cell wall

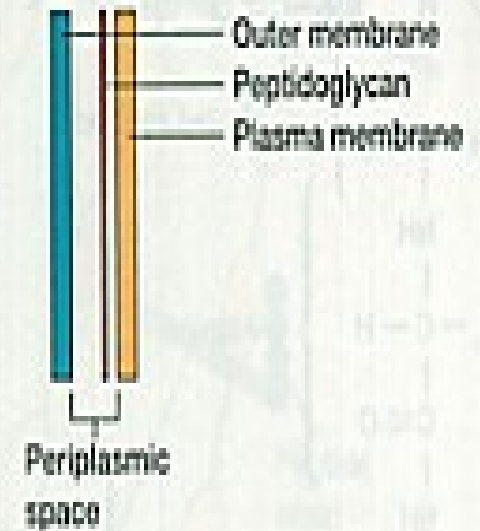
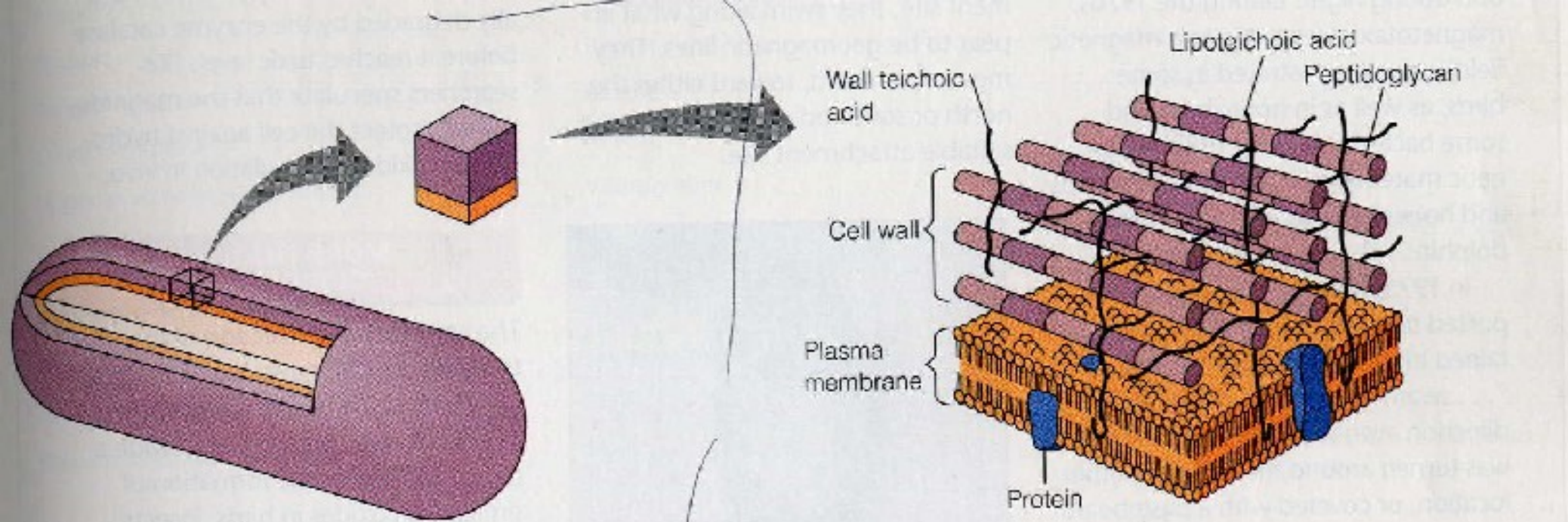
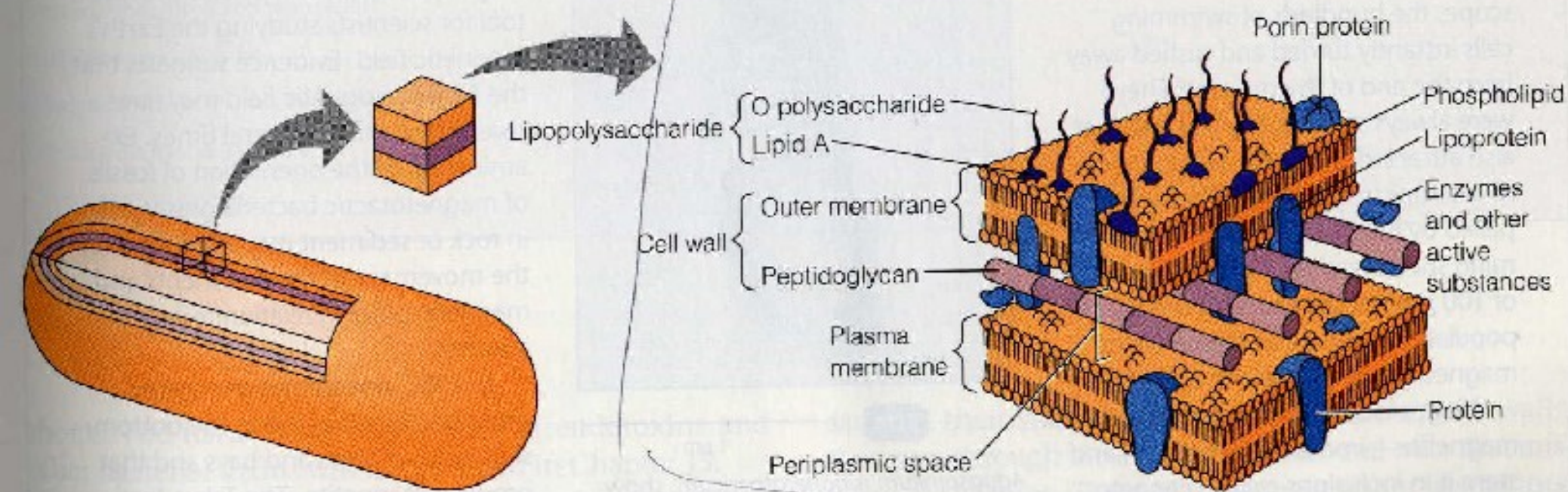


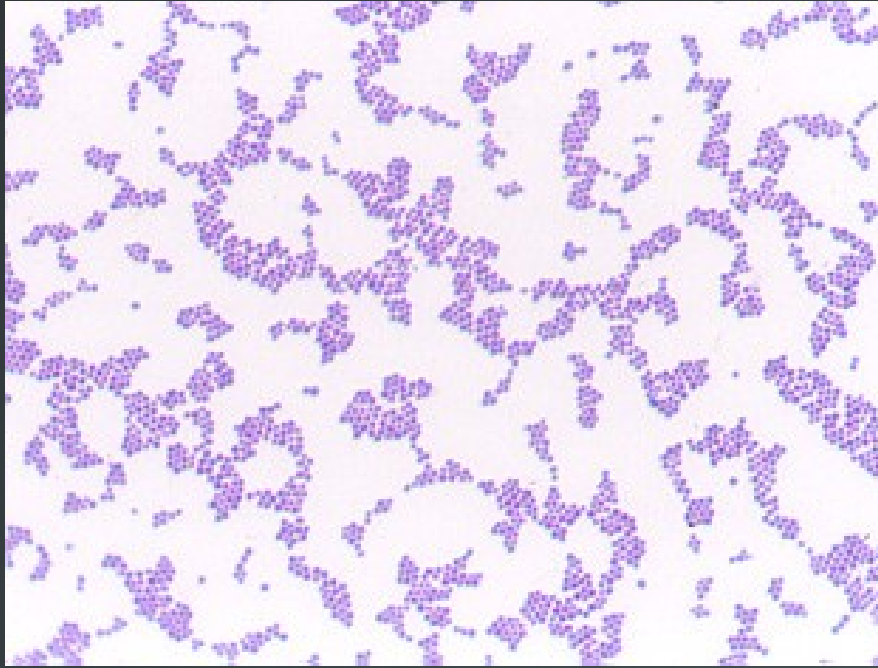
Figure 3.19 Gram-Positive and Gram-Negative Cell Walls. The gram-positive envelope is from *Bacillus licheniformis* (left), and the gram-negative micrograph is of *Aquaspirillum serpens* (right). M, peptidoglycan or murein layer; OM, outer membrane; PM, plasma membrane; P, periplasmic space; W, gram-positive peptidoglycan wall.



(b) Gram-positive cell wall



(c) Gram-negative cell wall



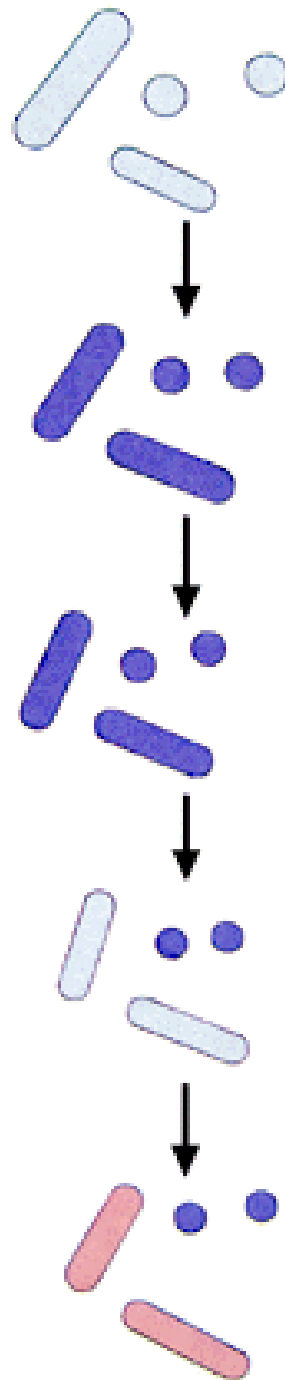
**Gram-positive
(blue)**



**Gram-negative
(purple)**



The Gram-Staining Procedure. Figure 2.13



Crystal violet for 30 seconds
Water rinse for 2 seconds

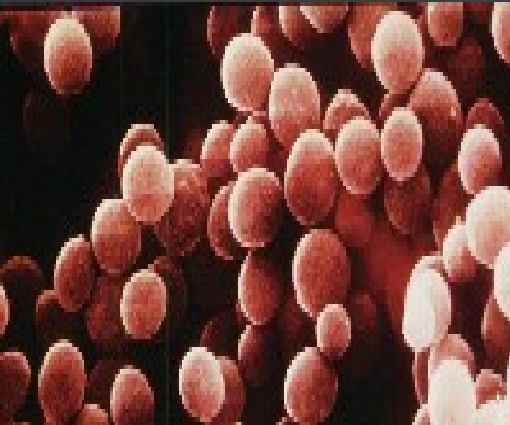
Gram's iodine for 1 minute
Water rinse

Wash with 95% ethanol or acetone for 10–30 seconds
Water rinse

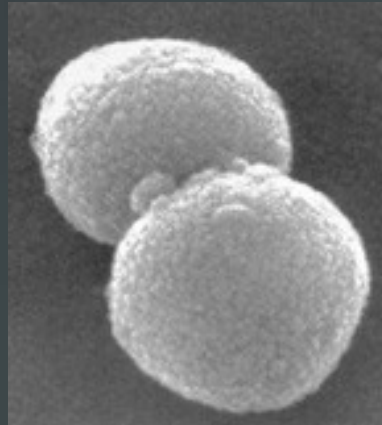
Safranin for 30–60 seconds
Water rinse and blot

Procaryotic microorganisms

cocci

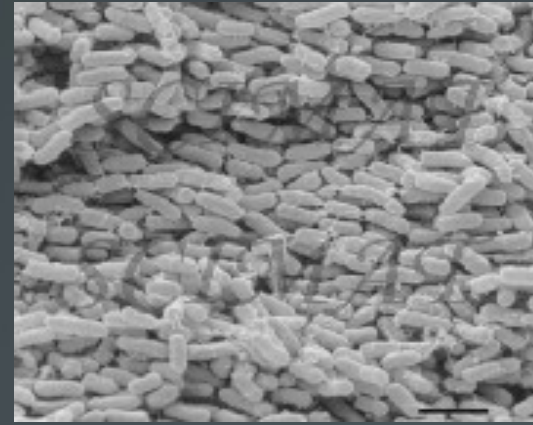


Staphylococcus aureus

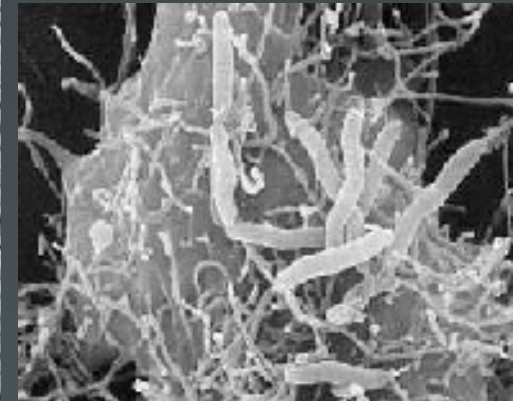


Streptococcus pneumoniae

bacilli



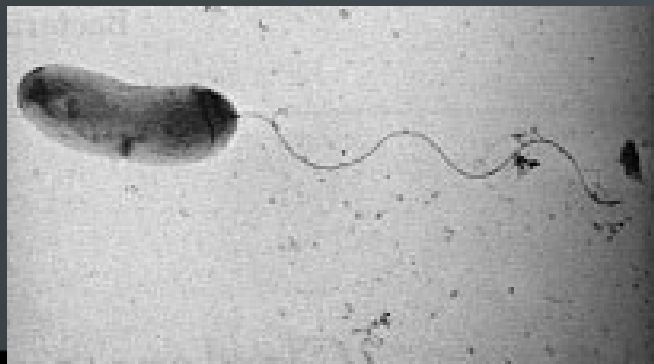
Enterobacter sp.



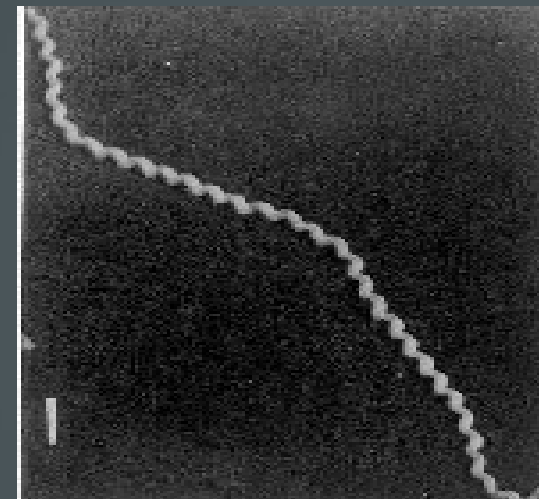
Aeromonas sp.

spirochetes

vibrios



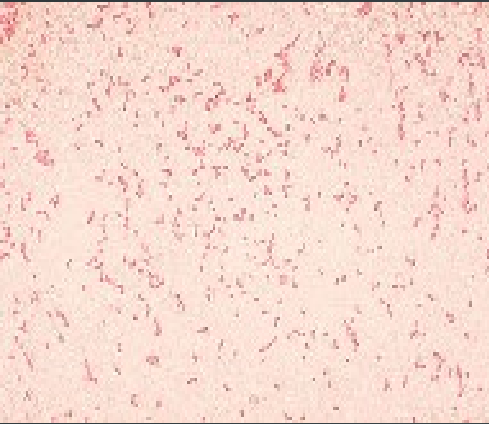
Vibrio cholerae



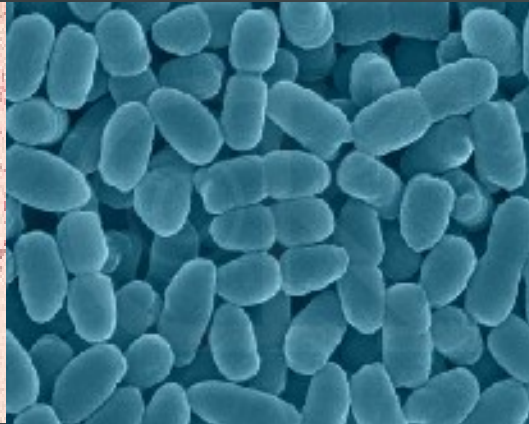
Leptospira interrogans

Gram-negative aerobic bacilli and cocci

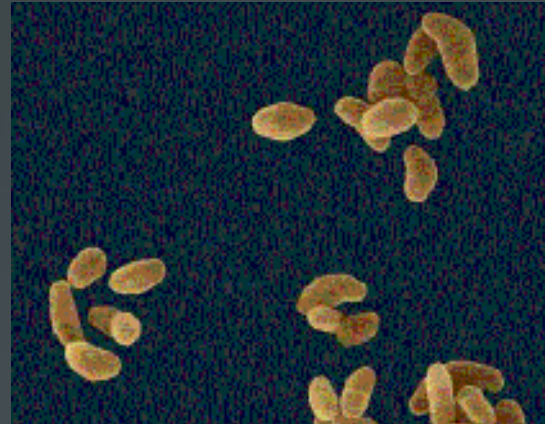
Acinetobacter baumannii



Bordetella pertussis



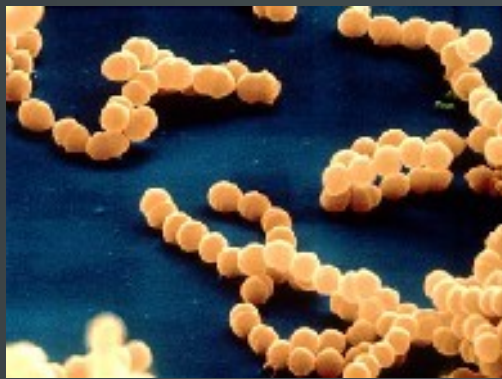
Francisella tularensis



Pseudomonas aeruginosa



Neisseria meningitidis

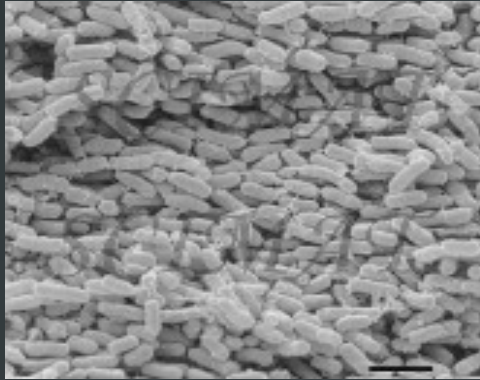


Neisseria gonorrhoeae

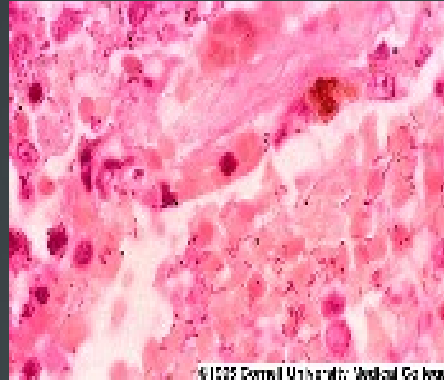


Gram-negative facultative anaerobic bacilli

Enterobacter sp.



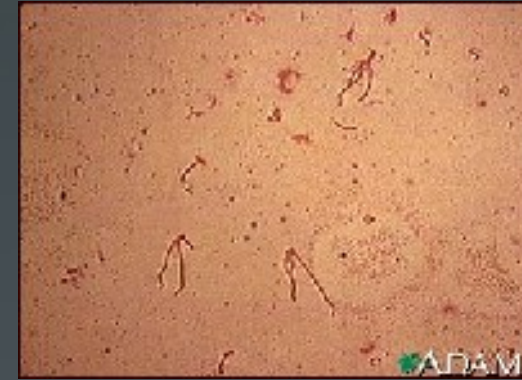
Klebsiella pneumoniae



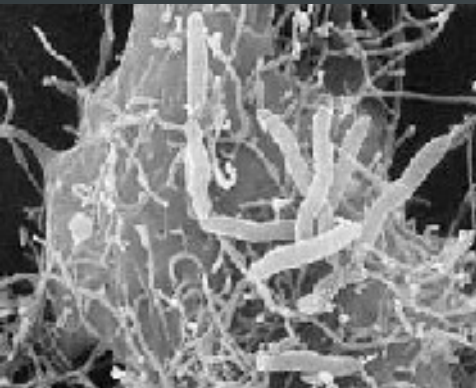
Proteus sp.



Yersinia enterocolitica



Aeromonas sp.



Vibrio vulnificus



Vibrio cholerae

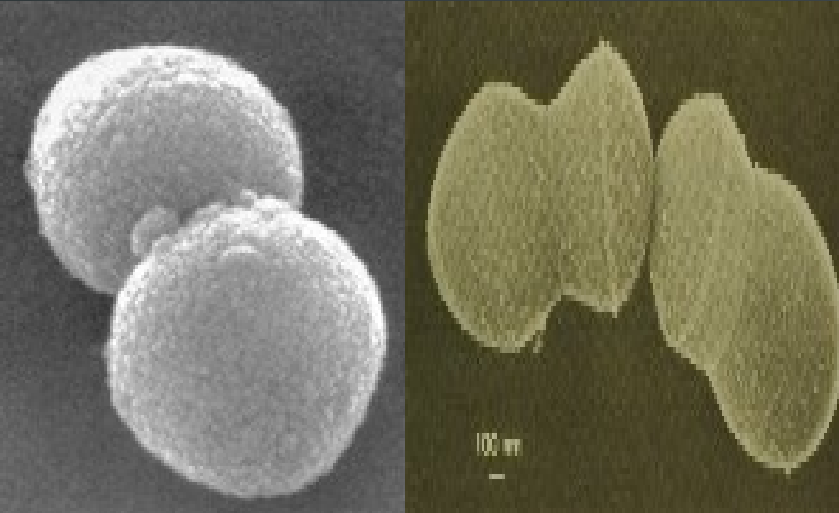


Salmonella typhi

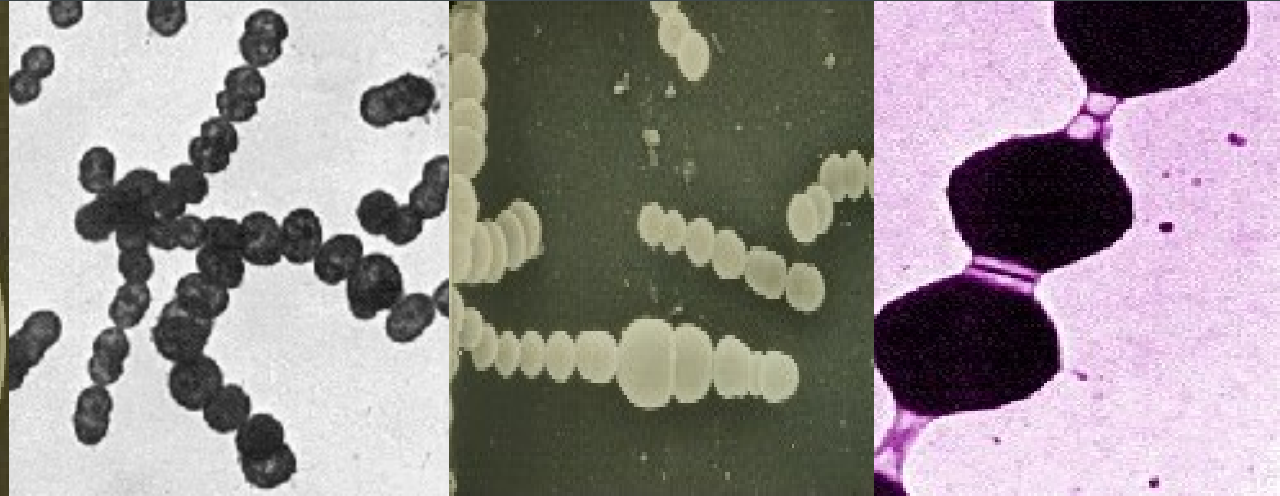


cocci

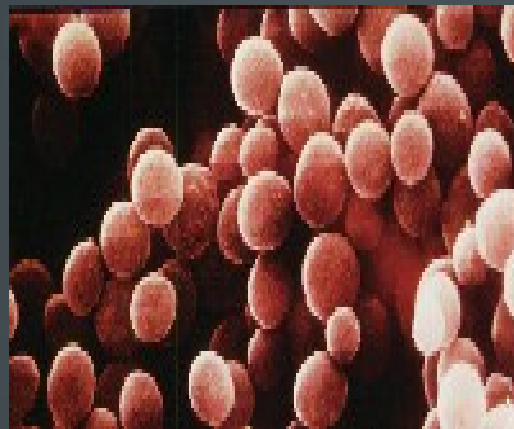
diplococcus

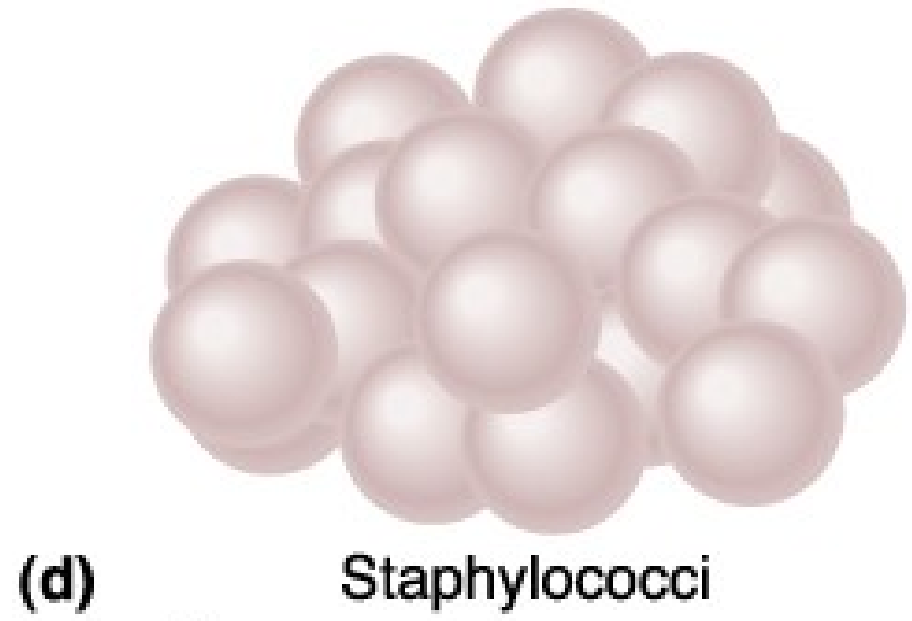
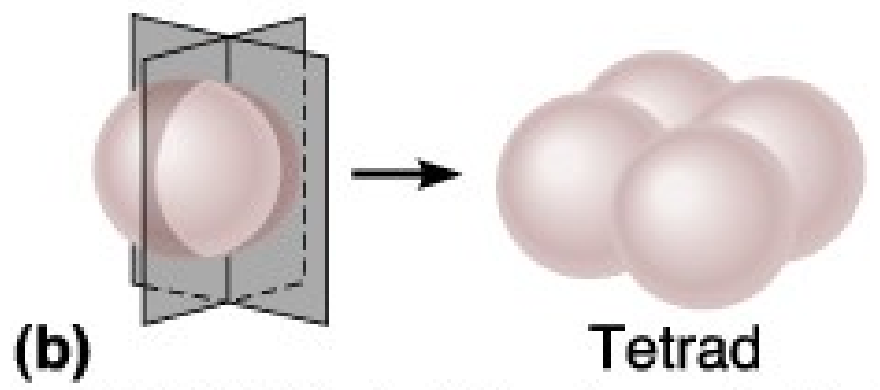
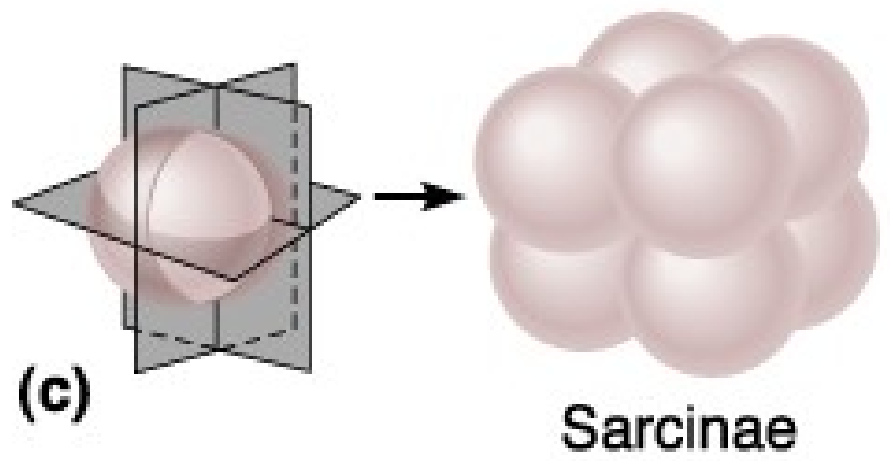
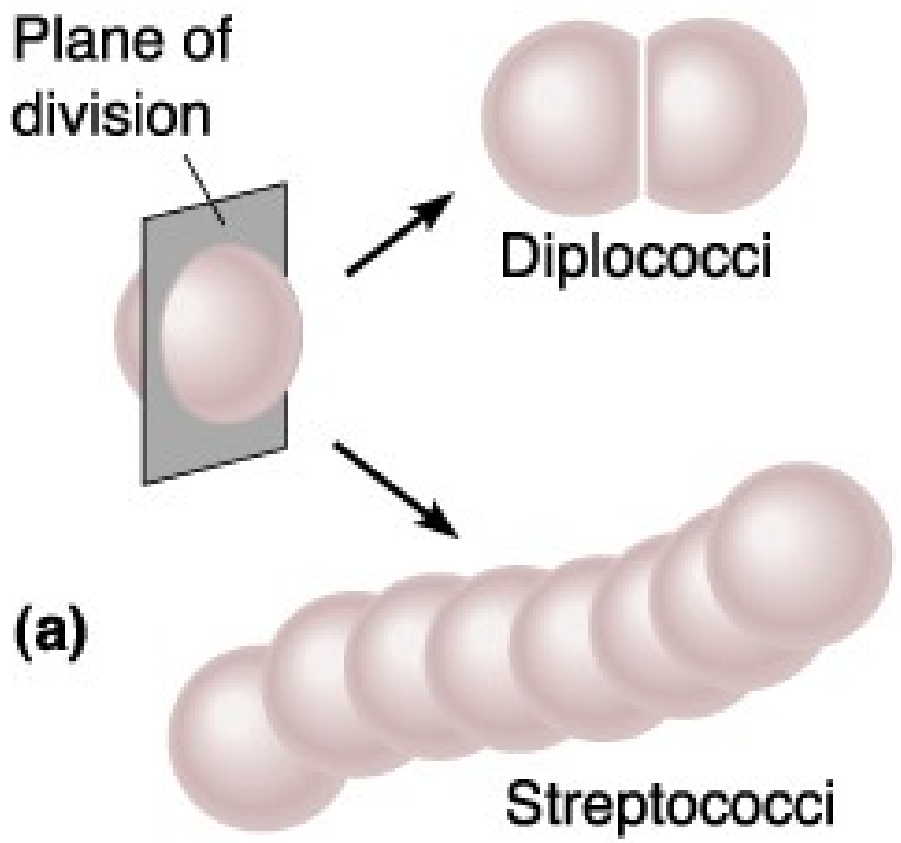


streptococcus



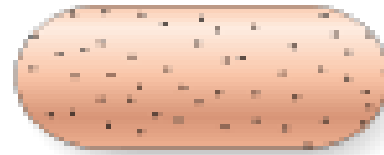
staphylococcus



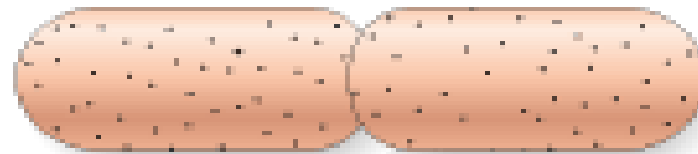


bacilli

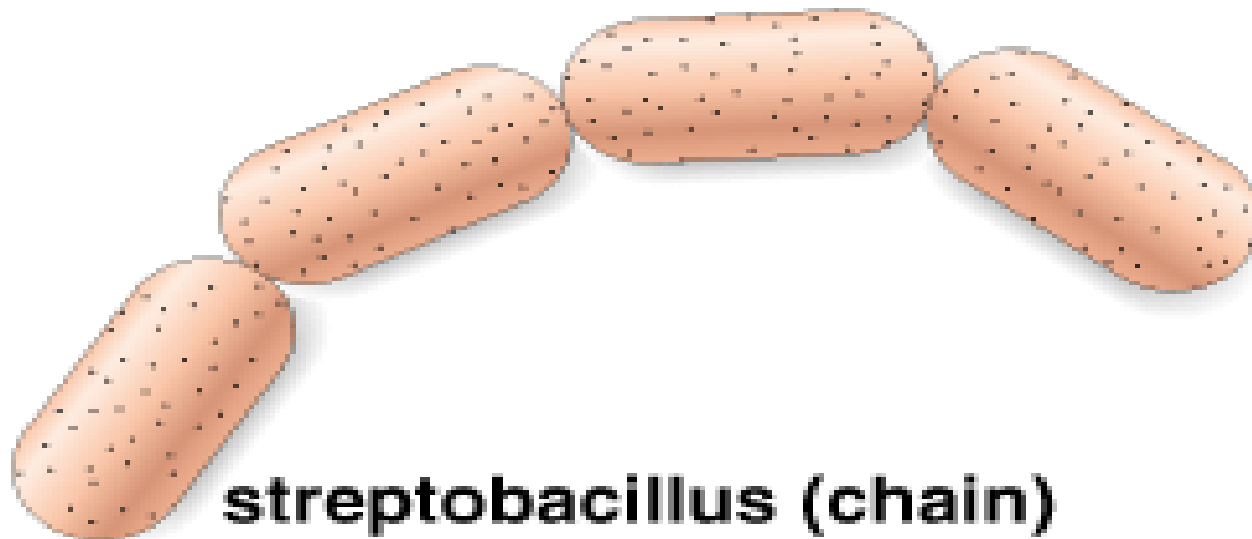
Rod



single



diplobacillus (pair)

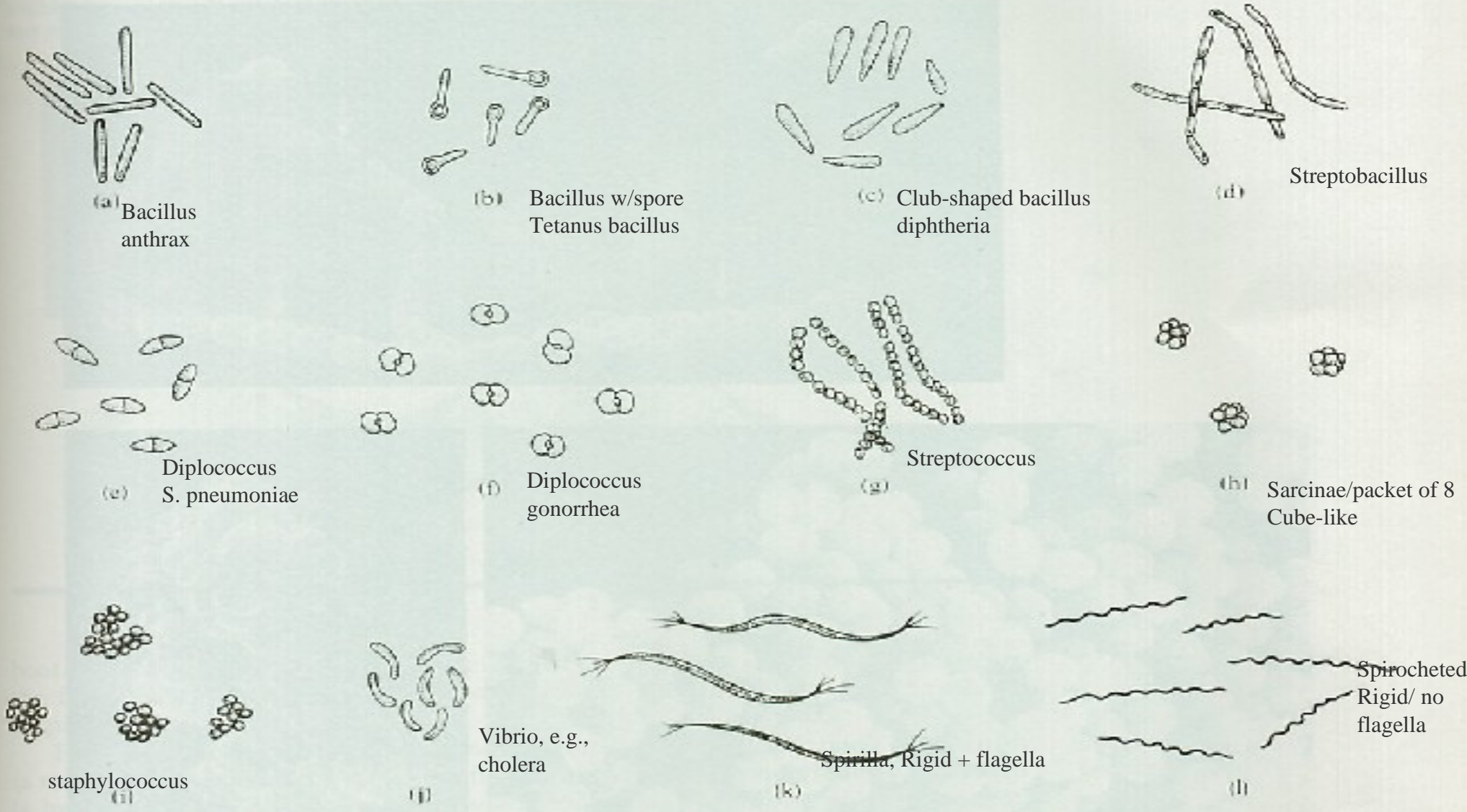


streptobacillus (chain)

FIGURE 4.1

Variations in Bacterial Anatomy

(a) Anthrax bacilli. (b) Tetanus bacillus swollen with spores. (c) Diphtheria bacilli displaying a club shape. (d) Streptobacilli. (e) Diplococci of bacterial pneumonia. (f) Diplococci of gonorrhea. (g) Streptococci such as those involved in strep throat. (h) Cube-like packets (sarcinae) of eight cocci. (i) Staphylococci in a grape-like cluster. (j) Vibrios such as the cholera organism. (k) Spirilla. (l) Spirochetes of syphilis.



(a) Bacillus anthrax

(b) Bacillus w/spore Tetanus bacillus

(c) Club-shaped bacillus diphtheria

(d) Streptobacillus

(e) Diplococcus S. pneumoniae

(f) Diplococcus gonorrhea

(g) Streptococcus

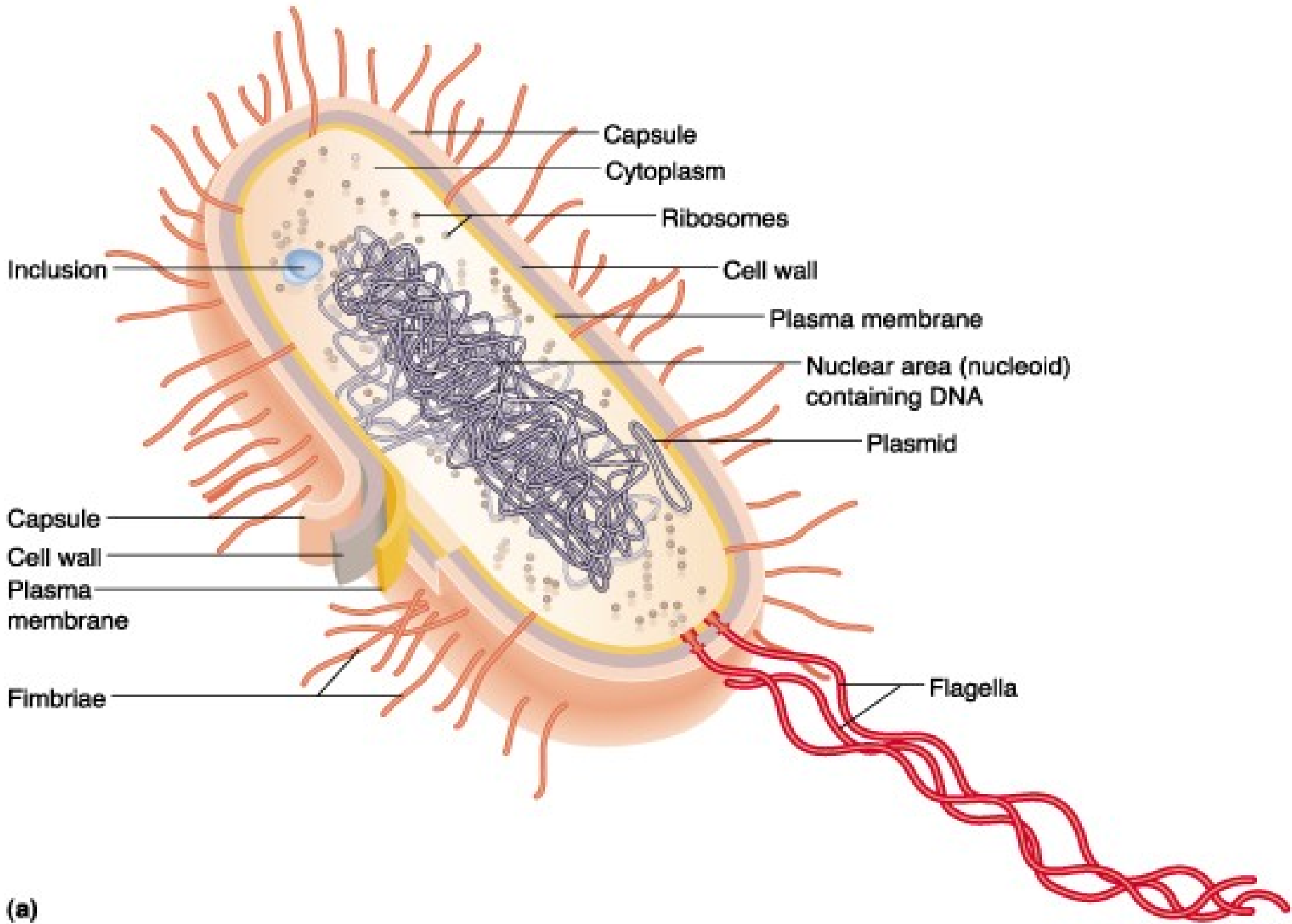
(h) Sarcinae/packet of 8 Cube-like

(i) staphylococcus

(j) Vibrio, e.g., cholera

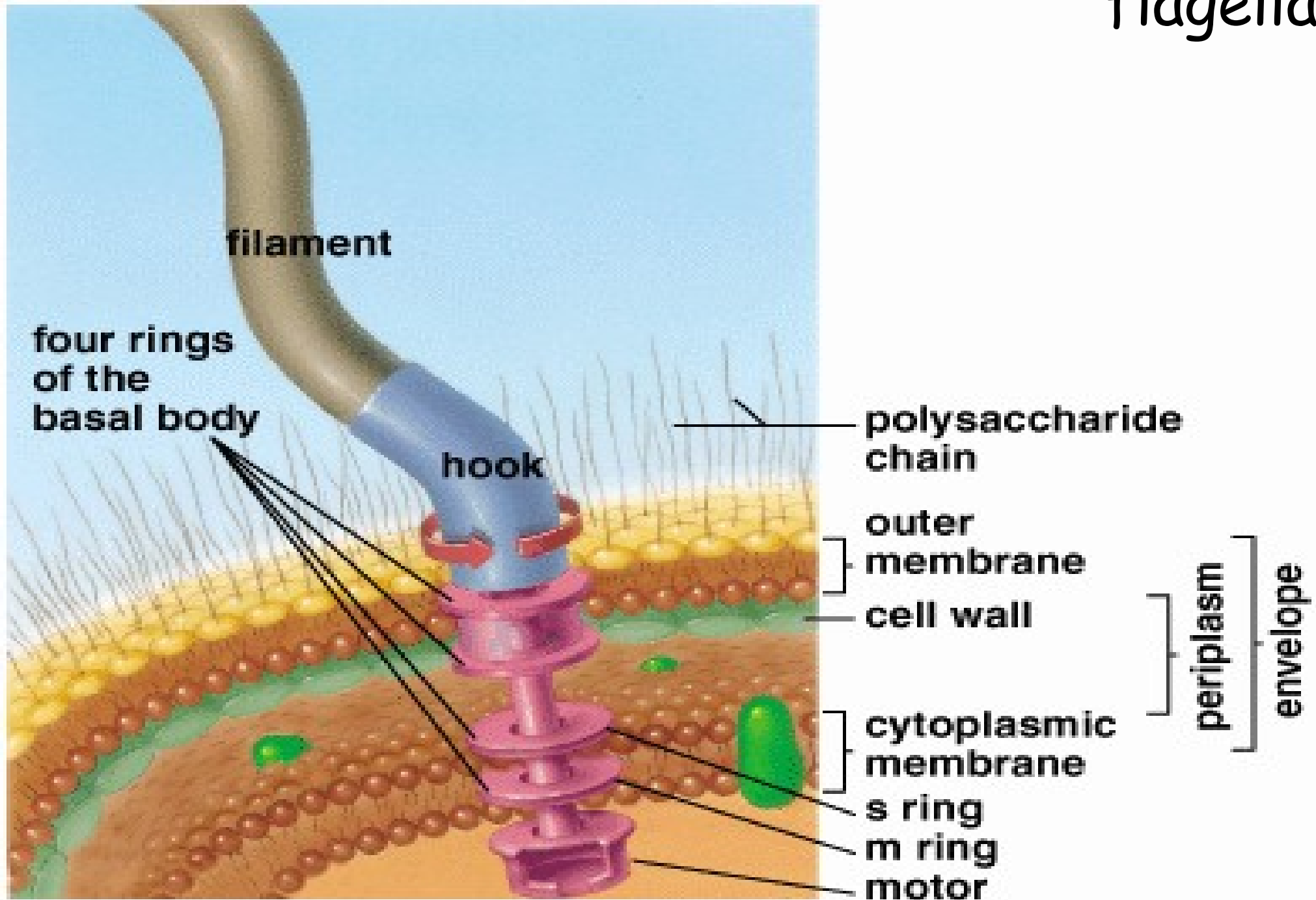
(k) Spirilla, Rigid + flagella

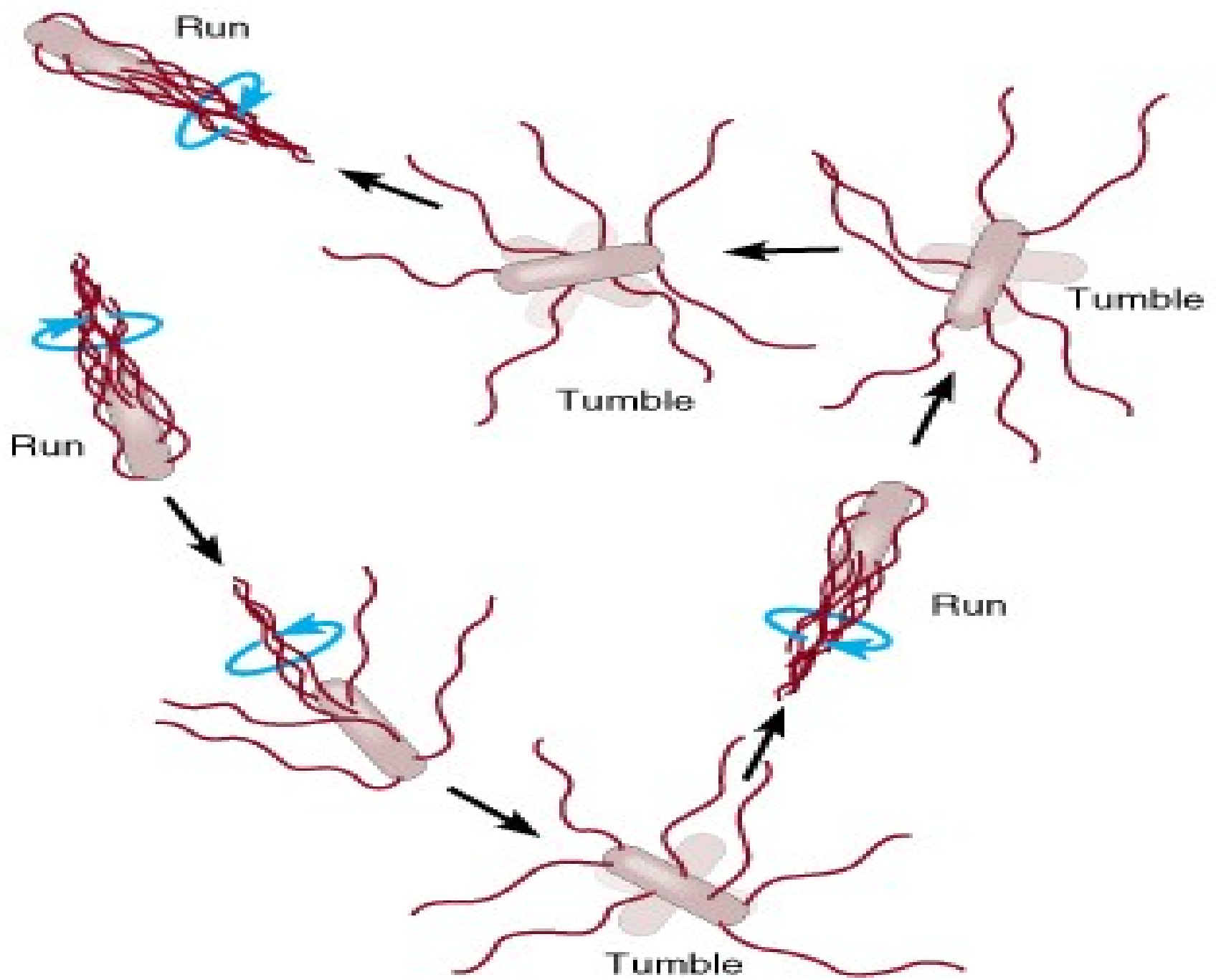
(l) Spirochetes of syphilis
Spirocheted Rigid/ no flagella



(a)

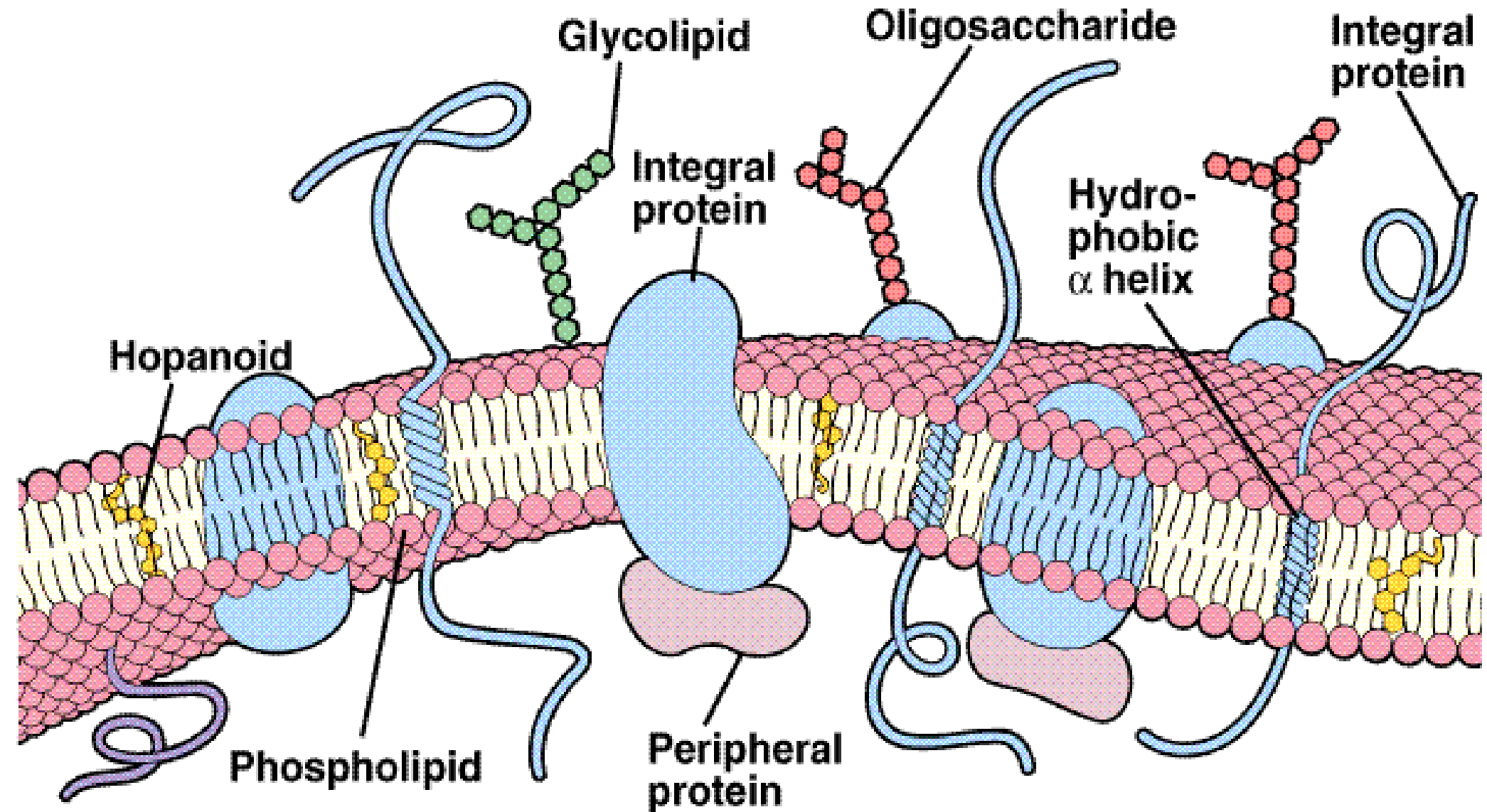
flagella

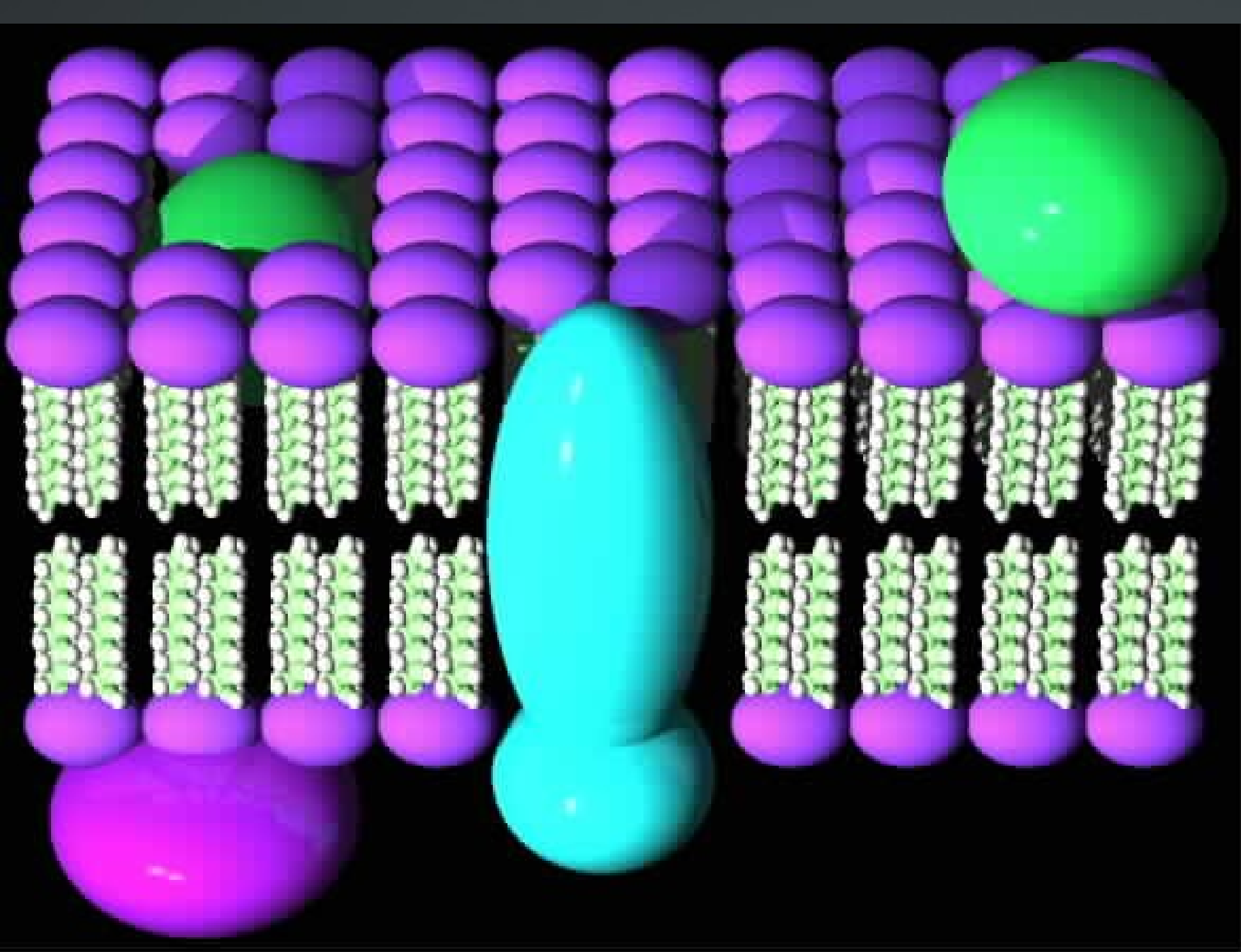




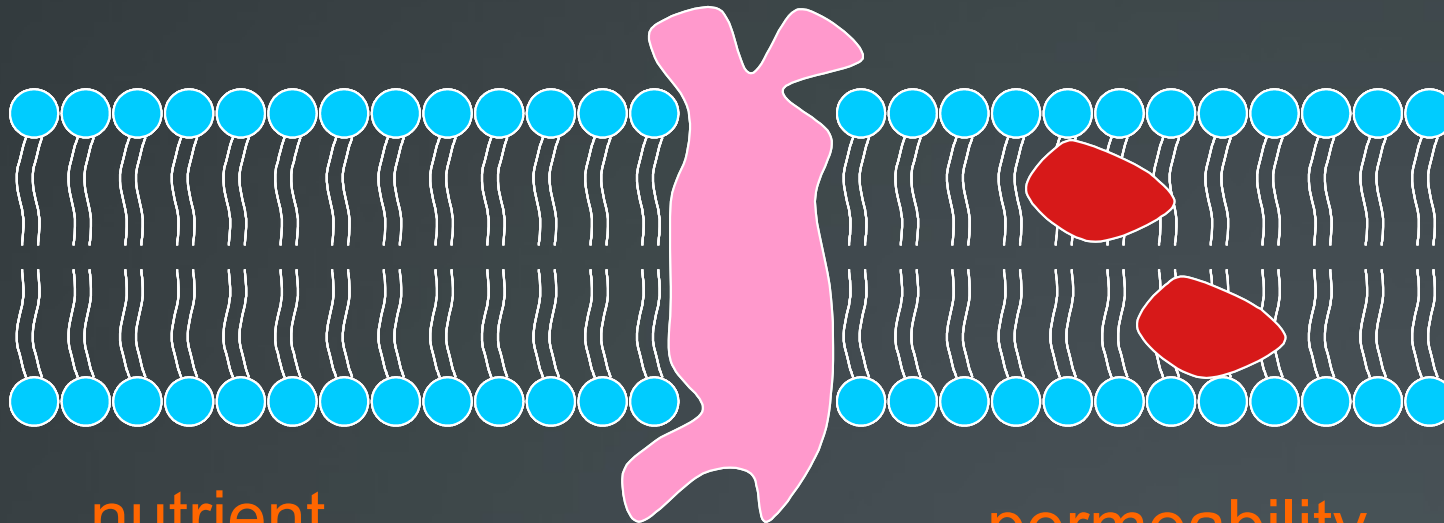
(a)

Plasma Membrane Structure





Membrane permeability



nutrient

permeability

water

100

glycerol

0.1

tryptophan

0.001

glucose

0.001

Cl⁻

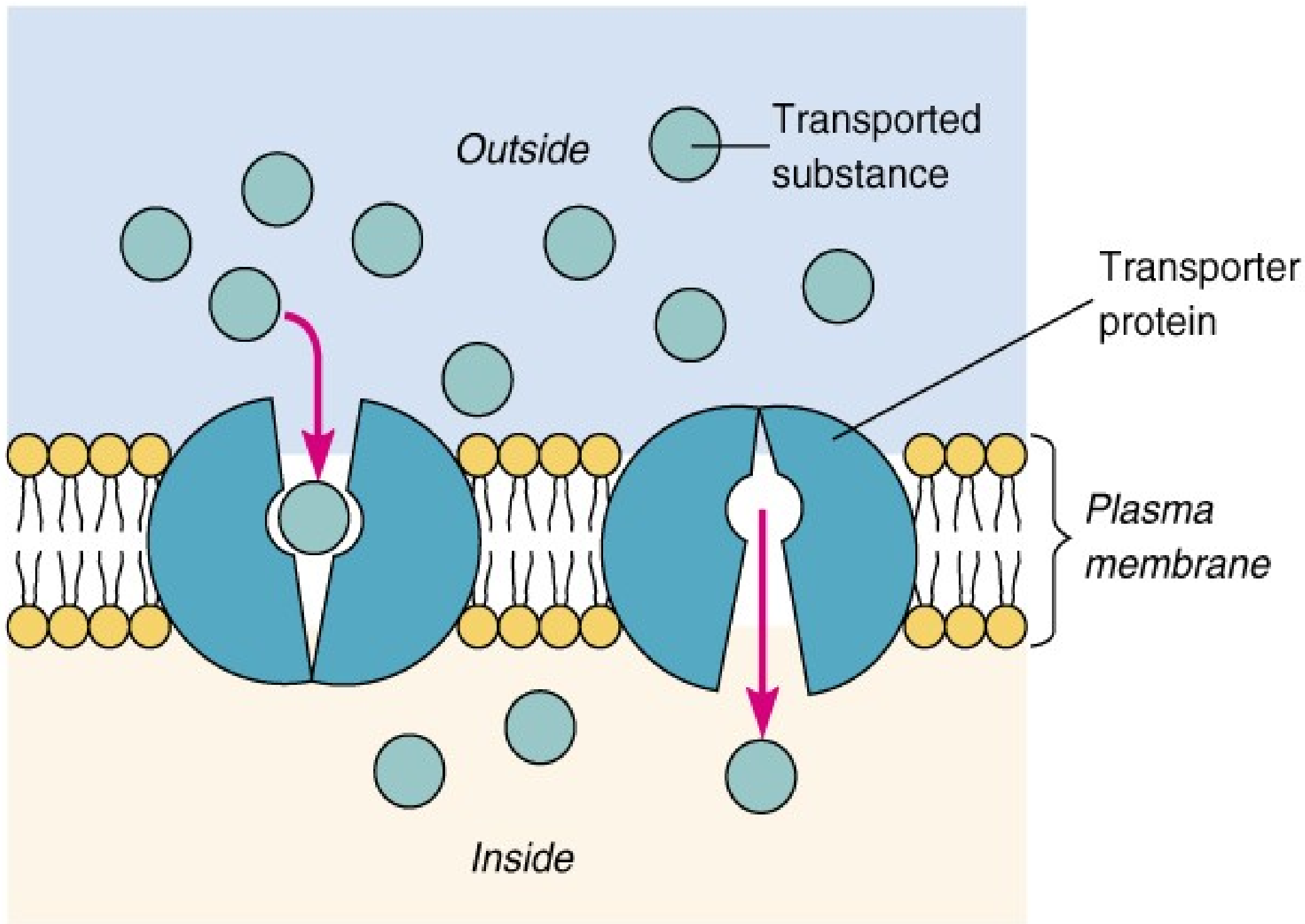
10⁻⁶

K⁺

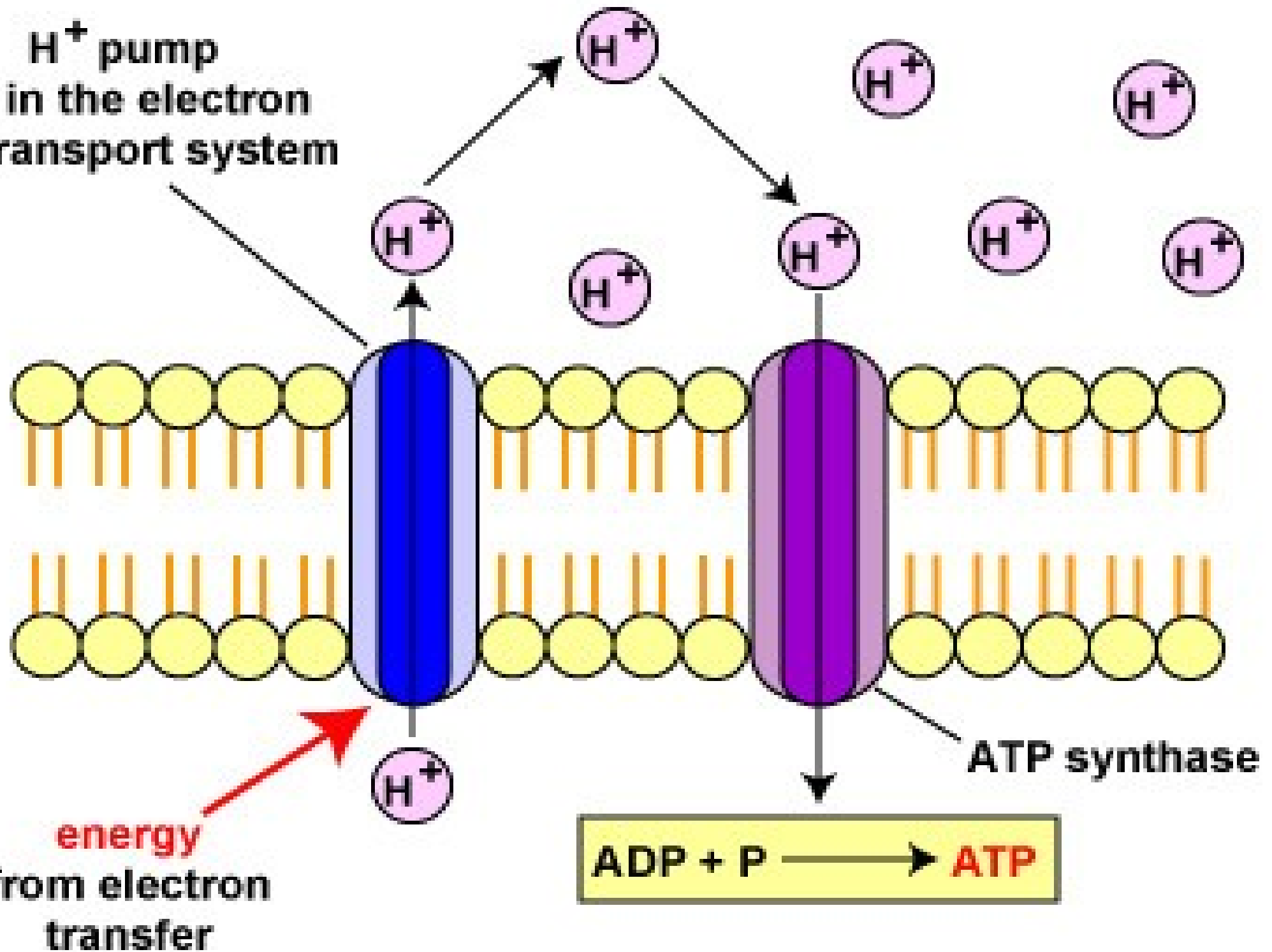
10⁻⁷

Na⁺

10⁻⁸



**H⁺ pump
in the electron
transport system**



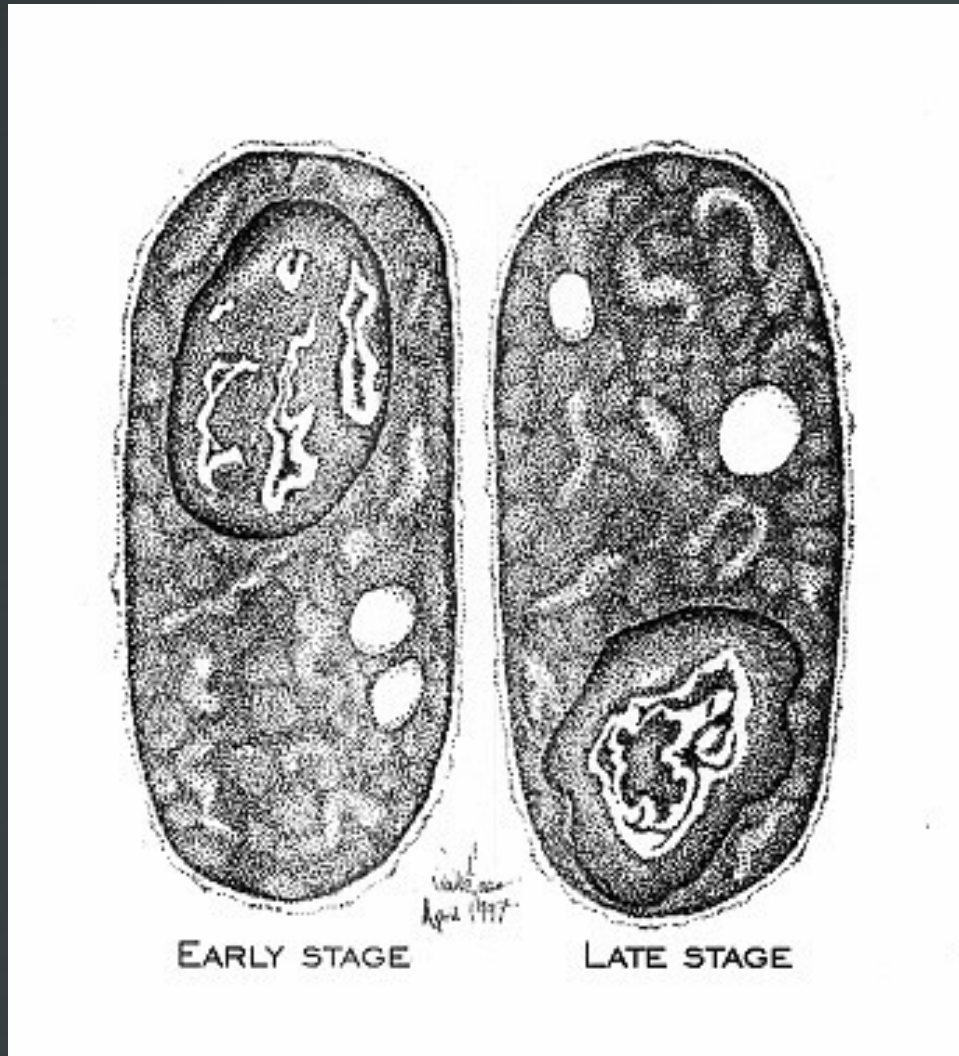
energy

**from electron
transfer**

ATP synthase



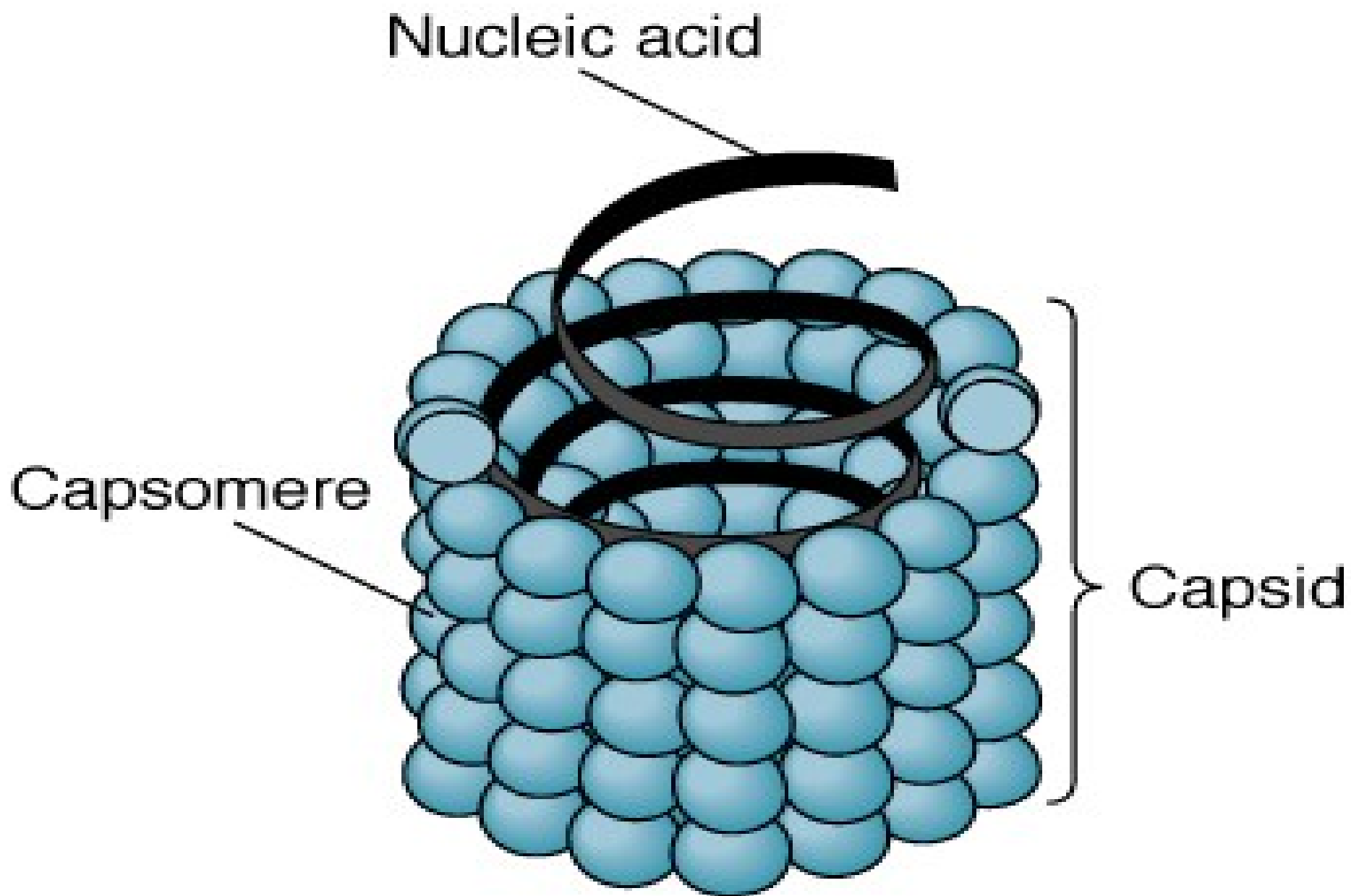
Endospores



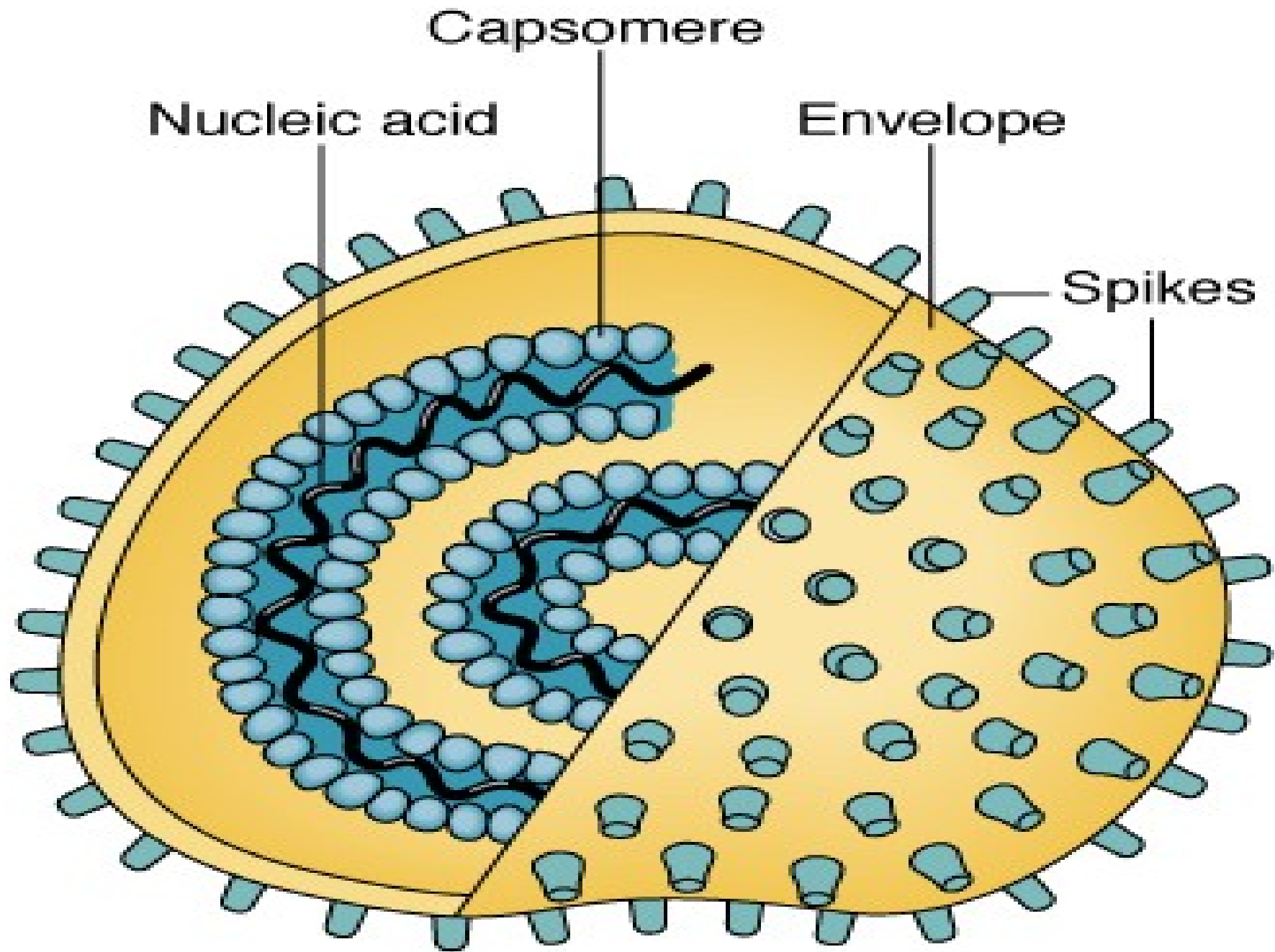
Clostridium tetani (σπόρια)



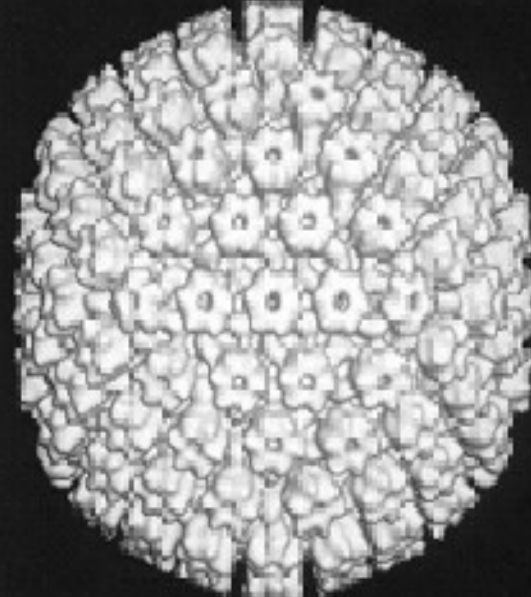
C. difficile (σπόρια)



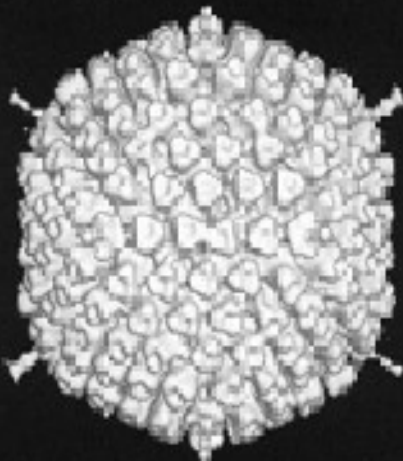
(a) A helical virus



(a) An enveloped helical virus

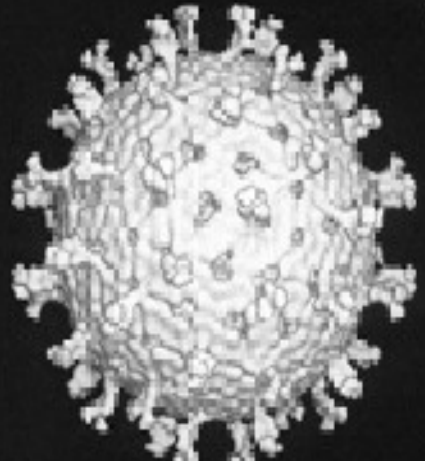


Herpes Simplex (1250Å)

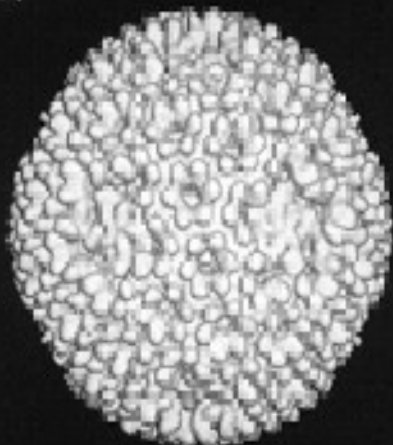


Adenovirus (1100Å)

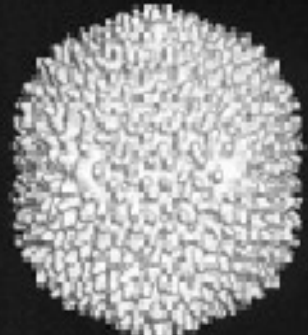
500Å



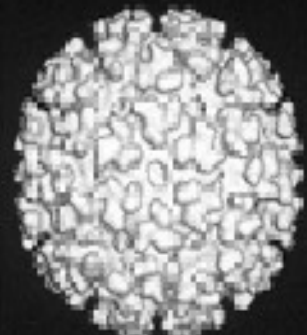
Rotavirus (1000Å)



Reovirus (Lang) (850Å)



Bacteriophage PRD1 (740Å)



Semliki Forest (700Å)



Bacteriophage lambda (650Å)



Human papilloma (620Å)



Bacteriophage T2 (500Å)



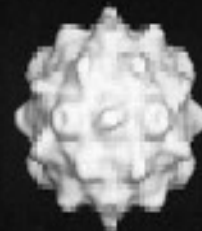
phi nucleocapsid (500Å)



Cauliflower mosaic (520Å)



Poliovirus (495Å)



Bacteriophage P5 (450Å)



T4 (430Å)



N1V (410Å)



N9V (397Å)



T=4 Ty Petro (392Å)



SpV-4 (380Å)



T=4 DHBs (380Å)



T=3 Ty Petro (330Å)



Bacteriophage phiX174 (335Å)



Flockhouse (300Å)



Human rhino (320Å)



Polio (320Å)



Cowpea mosaic (312Å)



TBE-RSP (318Å)



Cowpea rhinocyt mosaic (284Å)

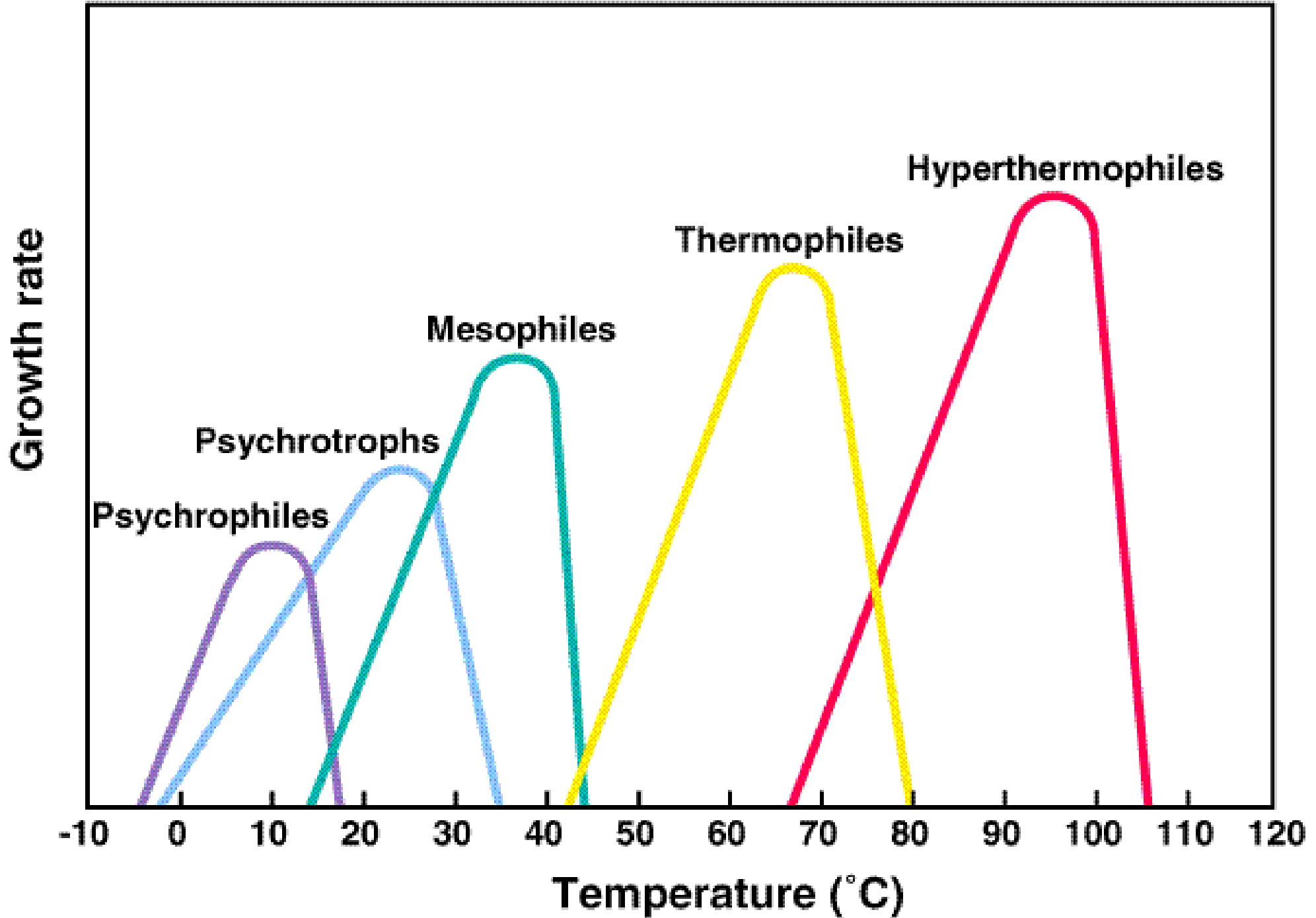


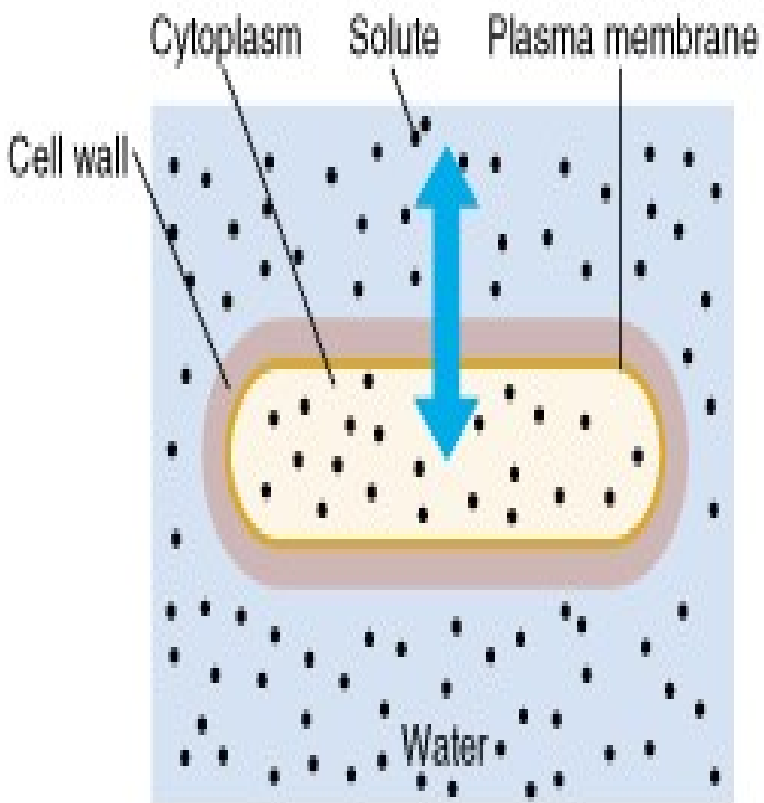
B19 parvovirus (200Å)



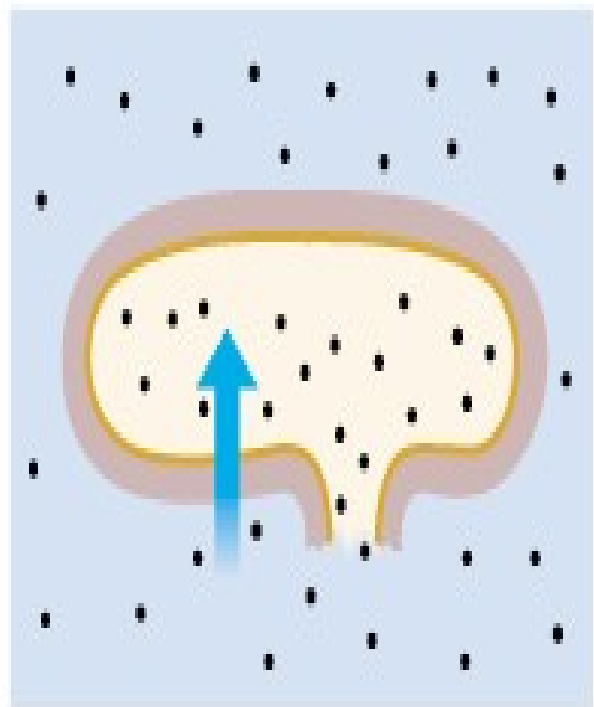
Bacteriophage phi29

Temperature and Growth

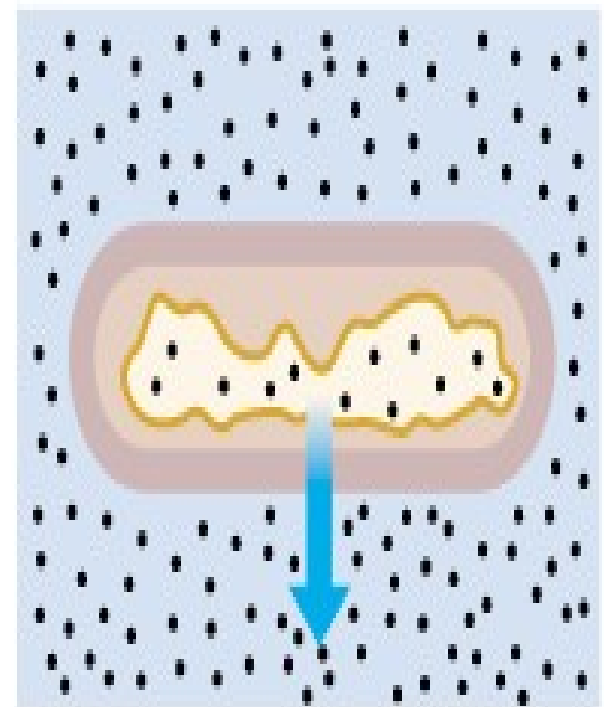




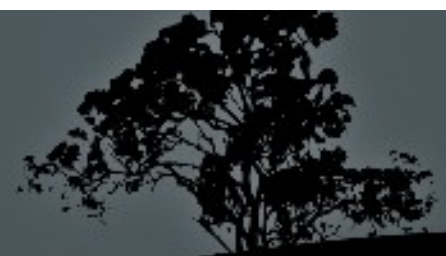
(c) Isotonic (isosmotic) solution
no net movement of water



(d) Hypotonic (hypoosmotic) solution
water moves into the cell and may cause the cell to burst if the wall is weak or damaged (osmotic lysis)

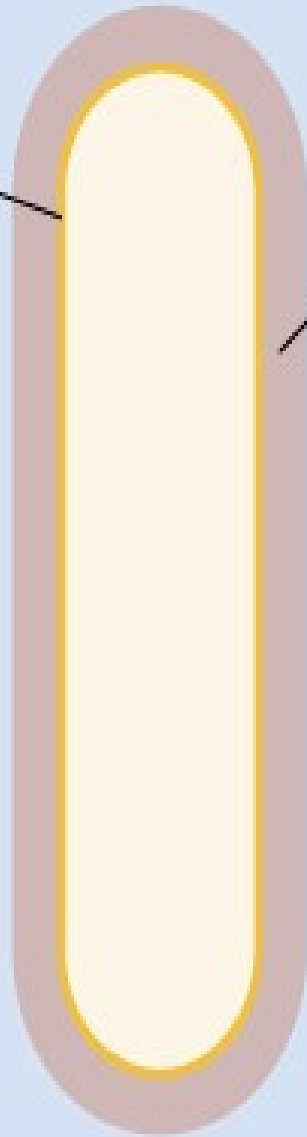


(e) Hypertonic (hyperosmotic) solution
water moves out of the cell, causing its plasma membrane to shrink (plasmolysis)



Plasma
membrane

Cell wall



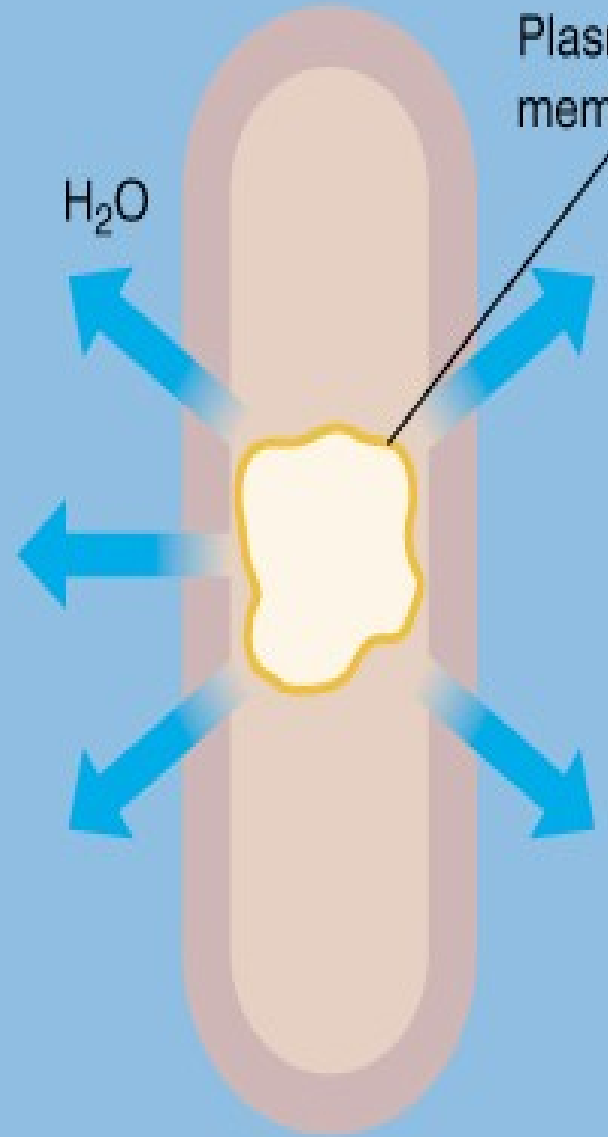
NaCl 0.85%

Normal cell in isotonic solution



Plasma
membrane

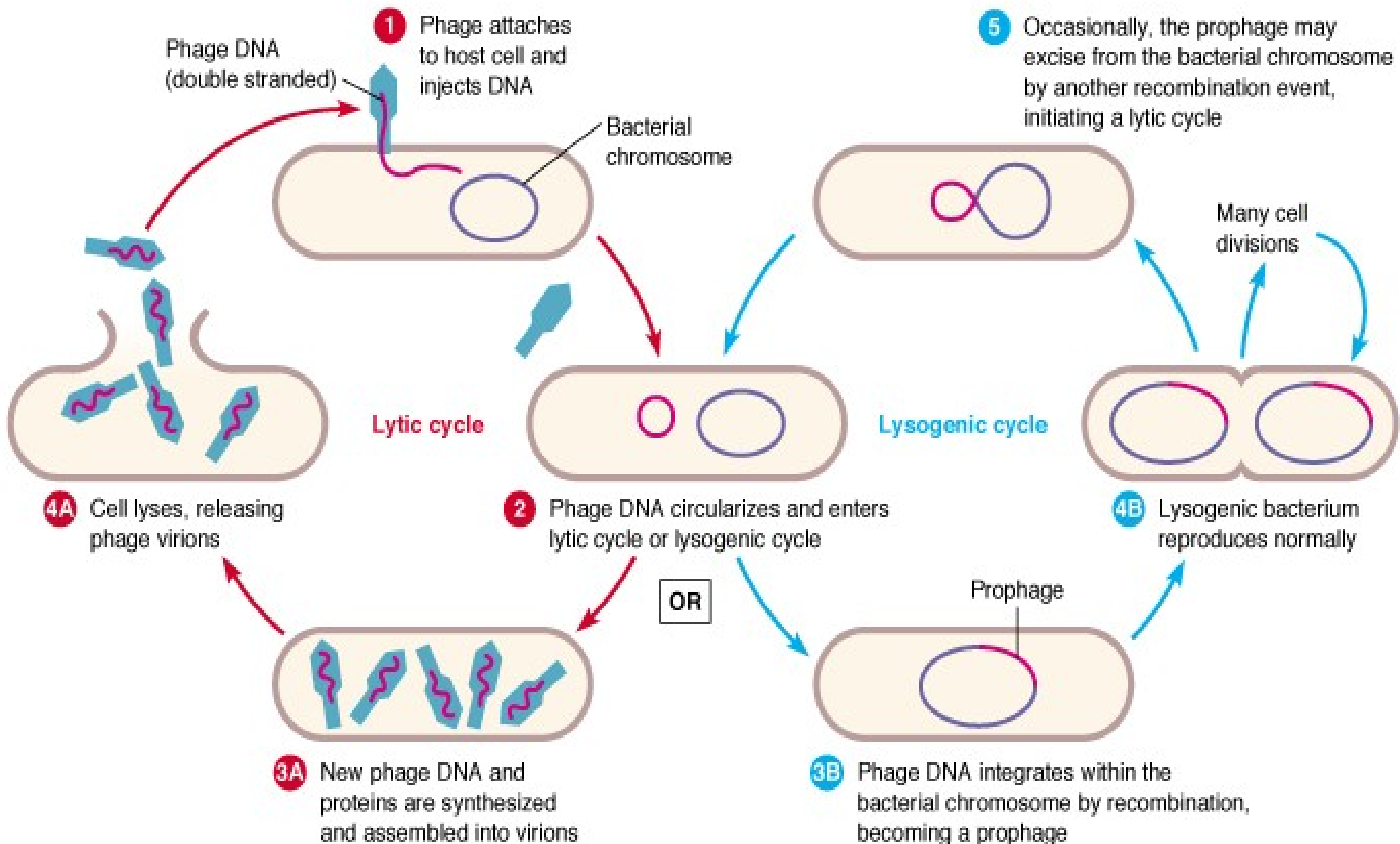
H₂O



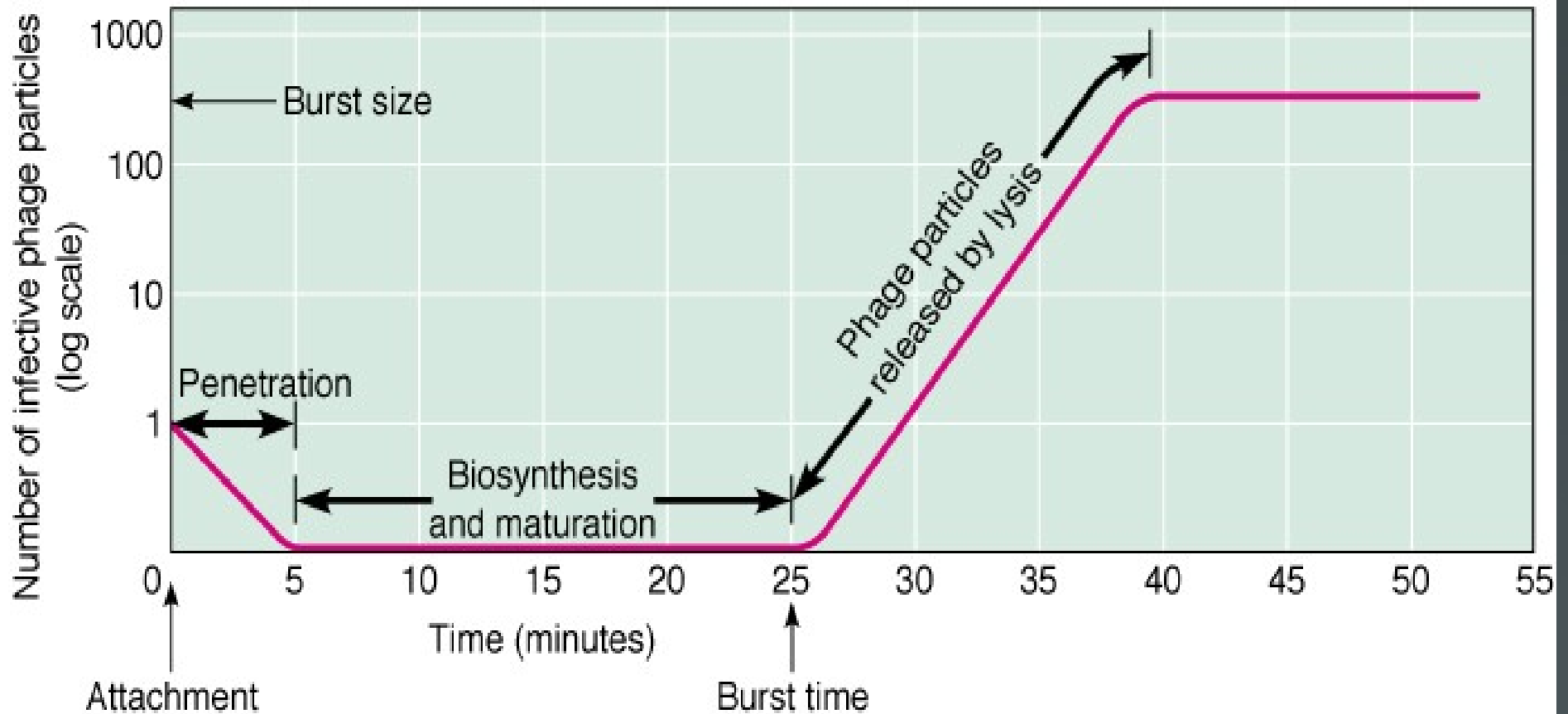
NaCl 10%

Plasmolyzed cell in hypertonic solution

Viral contamination

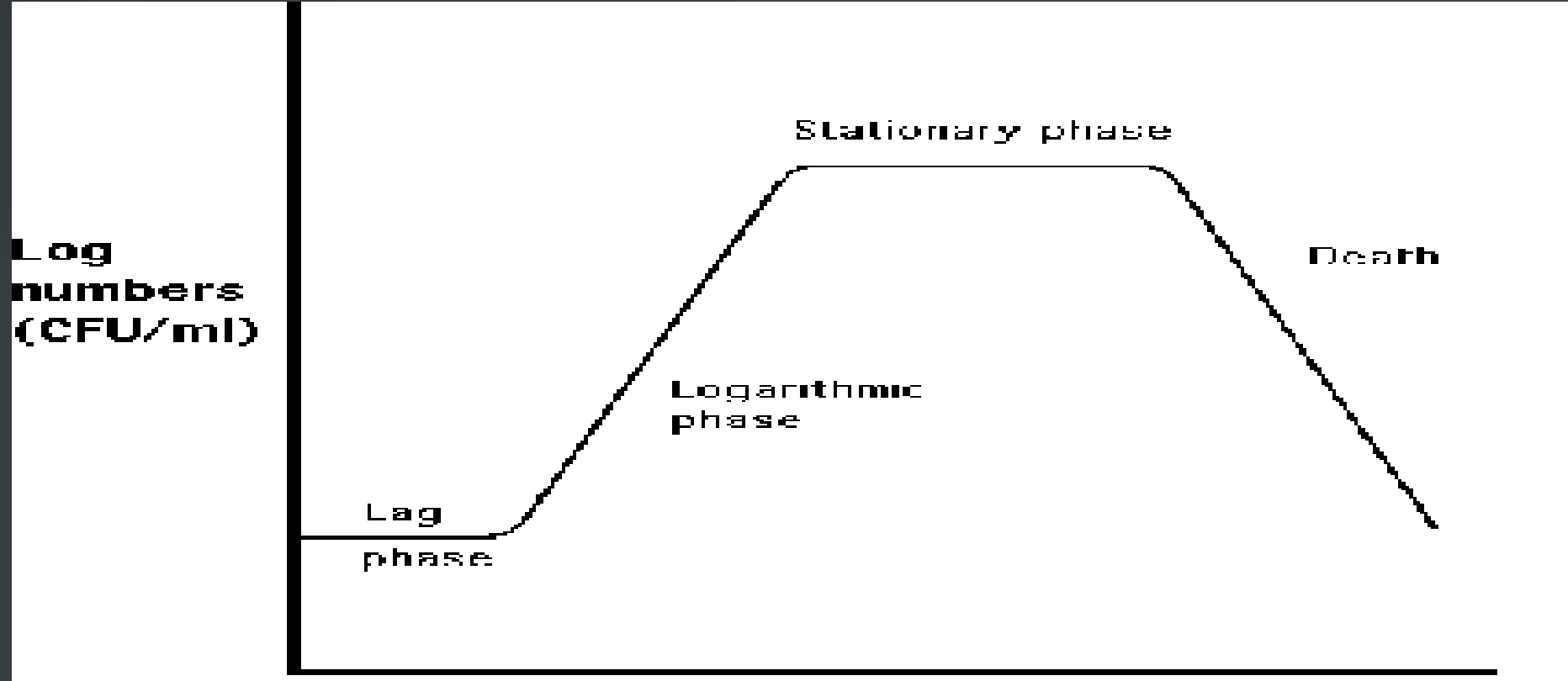


Viral contamination



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Bacterial growth



Hypothetical bacterial growth curve.