Just what are microbes made of?

Lecture

Chapter 4
Prokaryotic and eukaryotic cells
Prokaryotic cell features

Chapter 3 (next class)
Endosymbiotic theory
Light microscopy
Electron microscopy

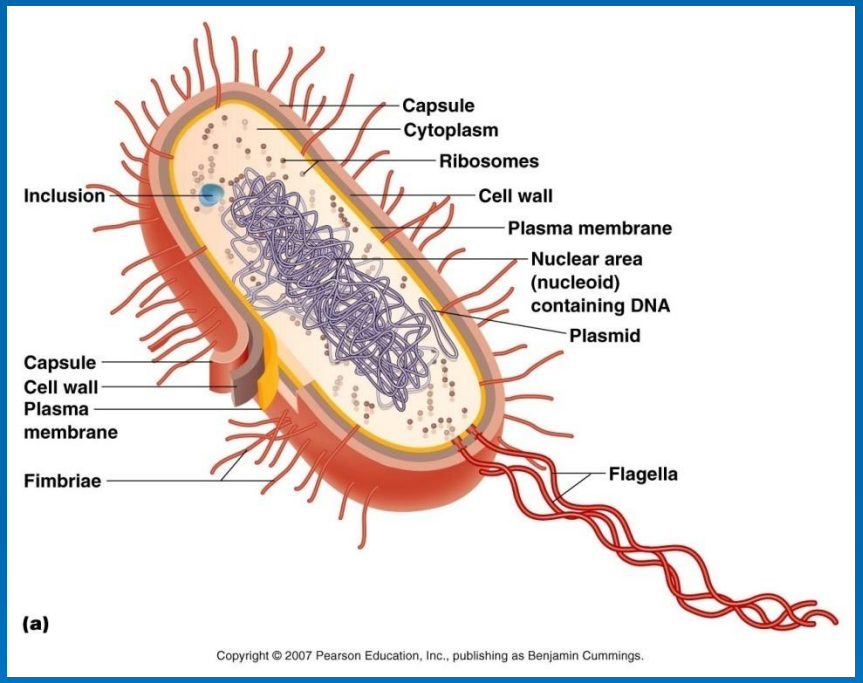
Microscopy techniques and staining

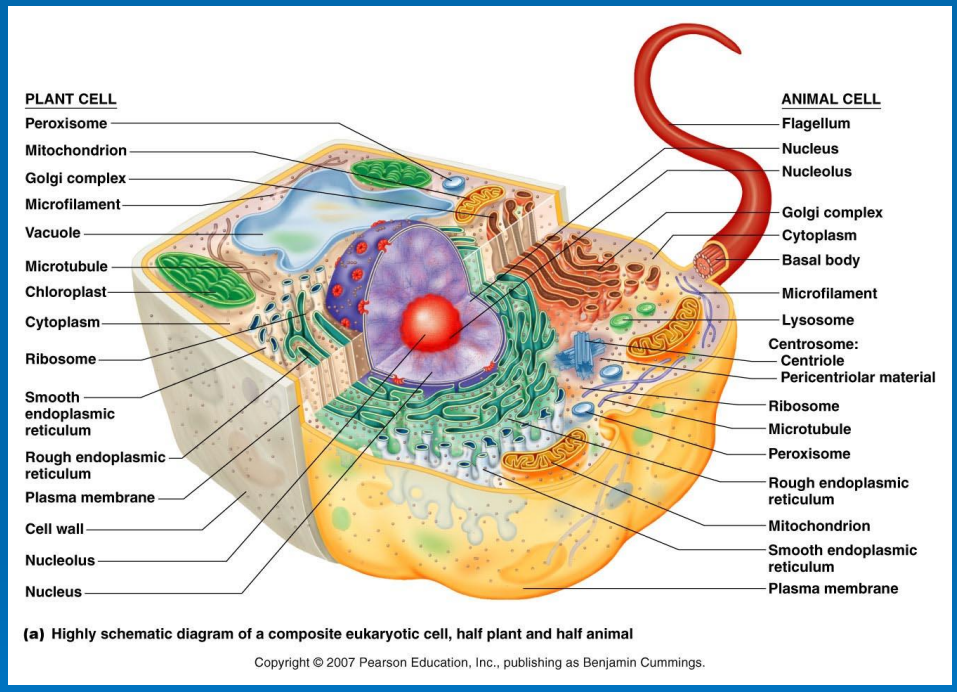
Lab

Aseptic technique
Microbes in the environment
Oil immersion microscopy

Pre-labs
Pure culture
Staining

CHAPTER 4
Prokaryotic vs. Eukaryotic cells





(a) Highly schematic diagram of a composite eukaryotic cell, half plant and half animal

Bacterial cell shapes

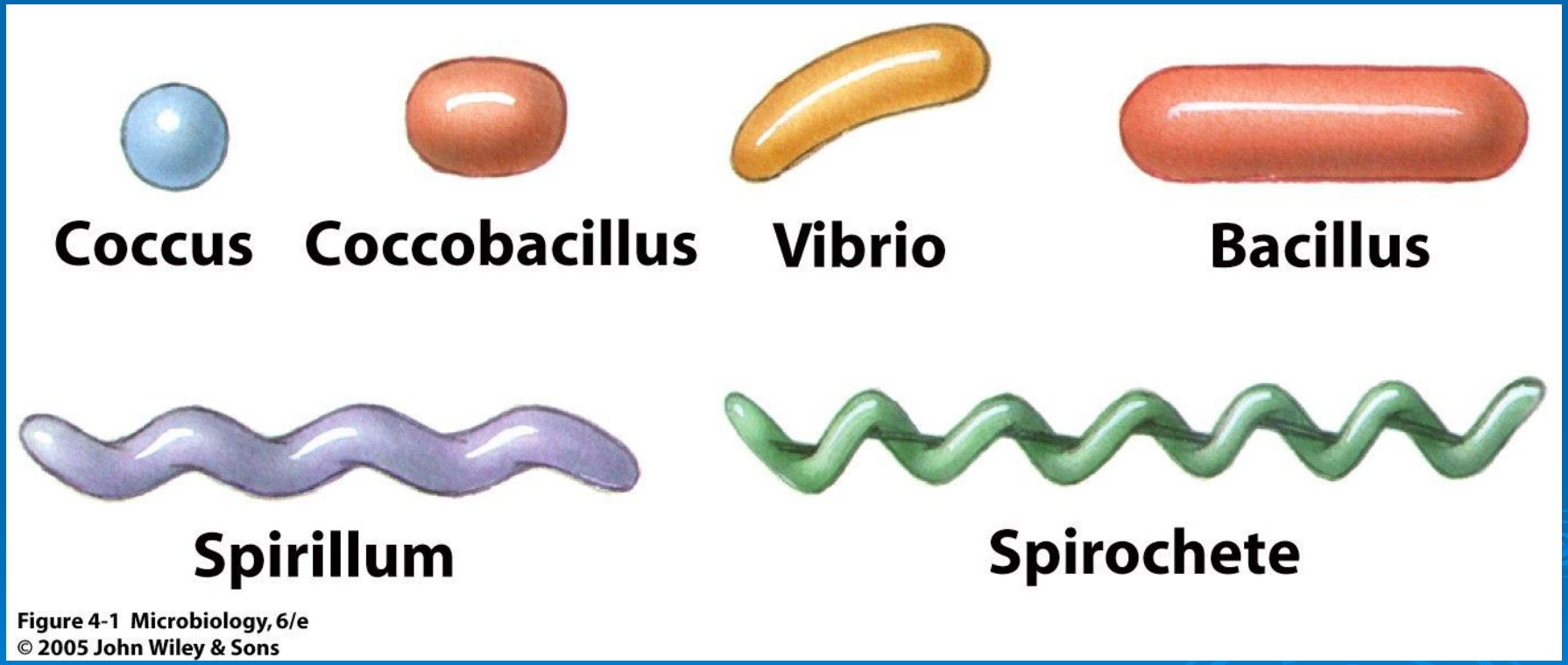
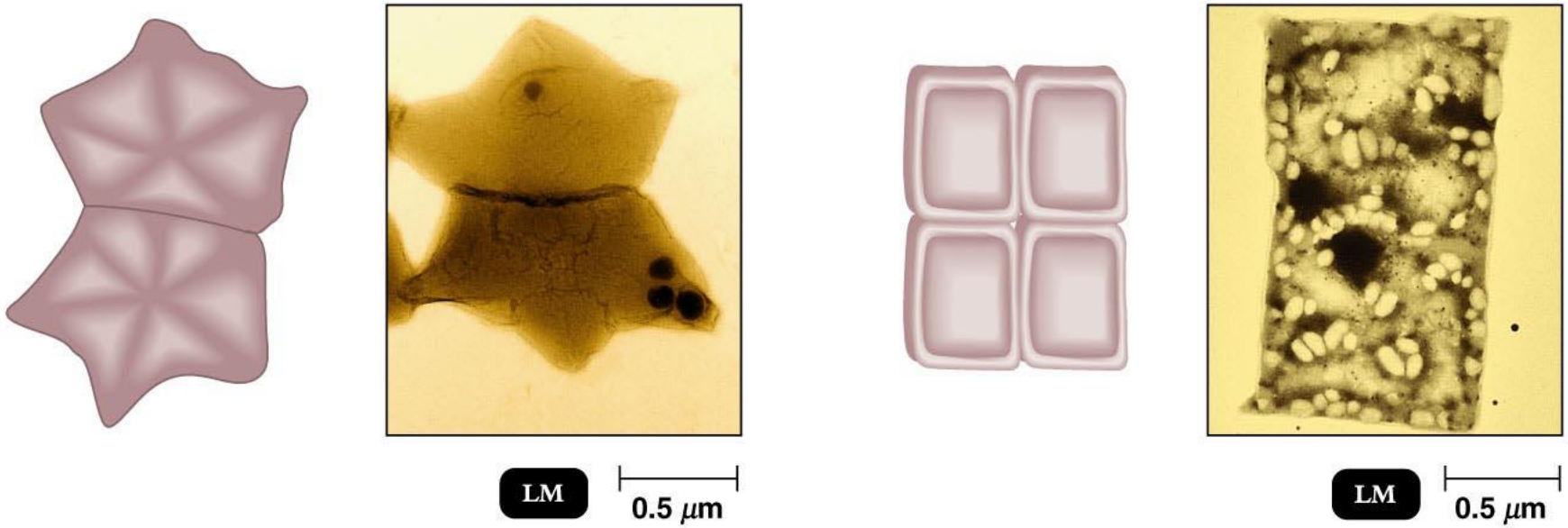


Figure 4-1 Microbiology, 6/e

Odd bacterial cell shapes



(a) Star-shaped bacteria

(b) Rectangular bacteria

Figure 4.5 - Overview

Bacterial cell arrangements

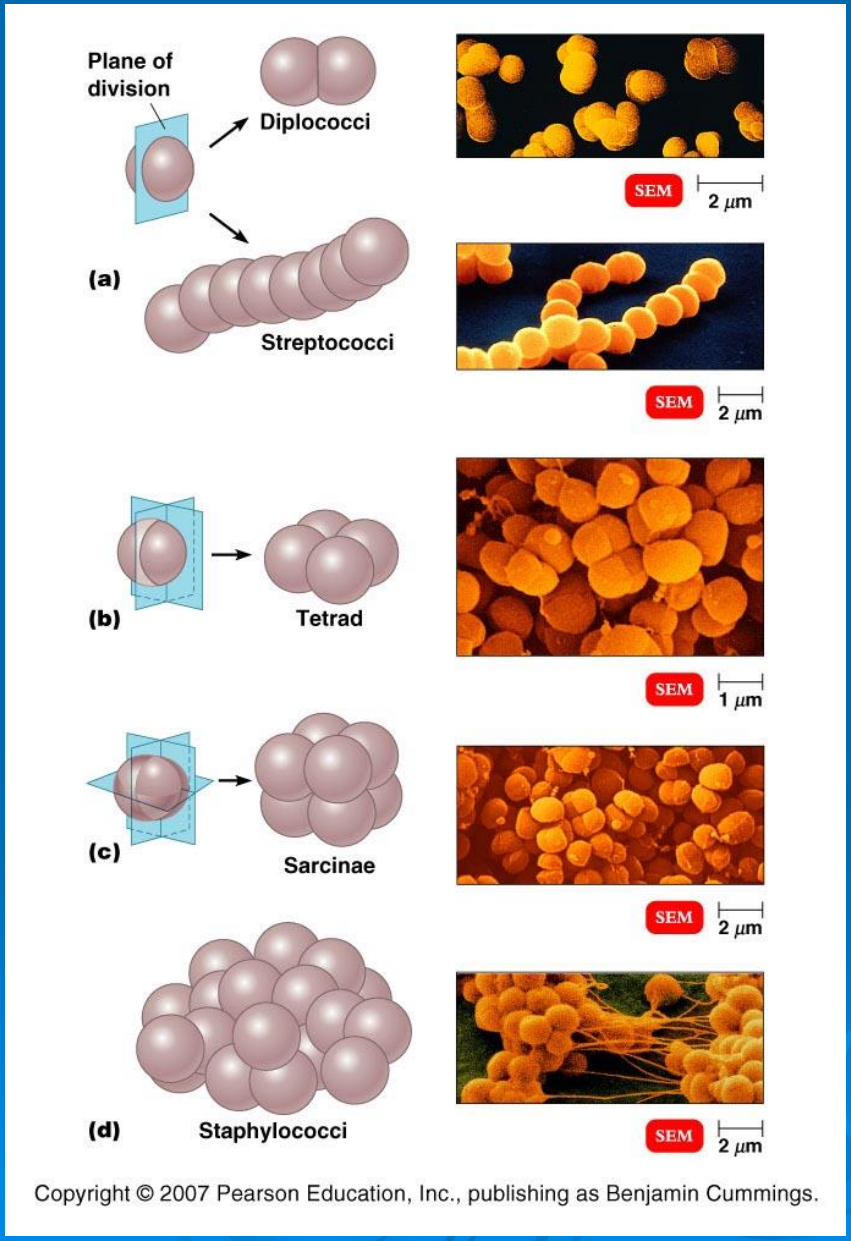


Figure 4.1 - Overview

Prokaryotic cell overview

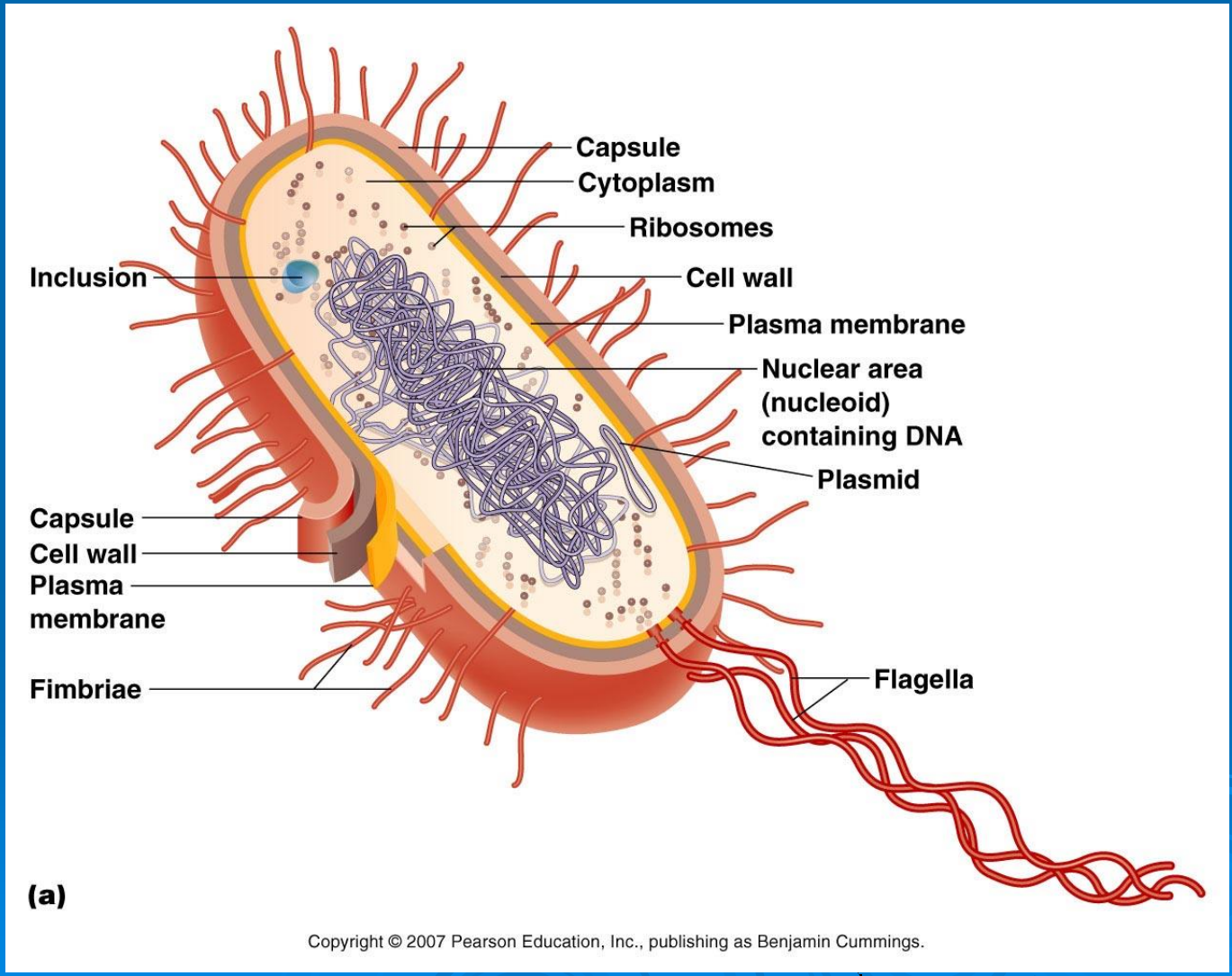


Figure 4.1 - Overview

Prokaryotic cell features

1. Glycocalyx

Prokaryotic cell features

1. Glycocalyx

2. Flagella

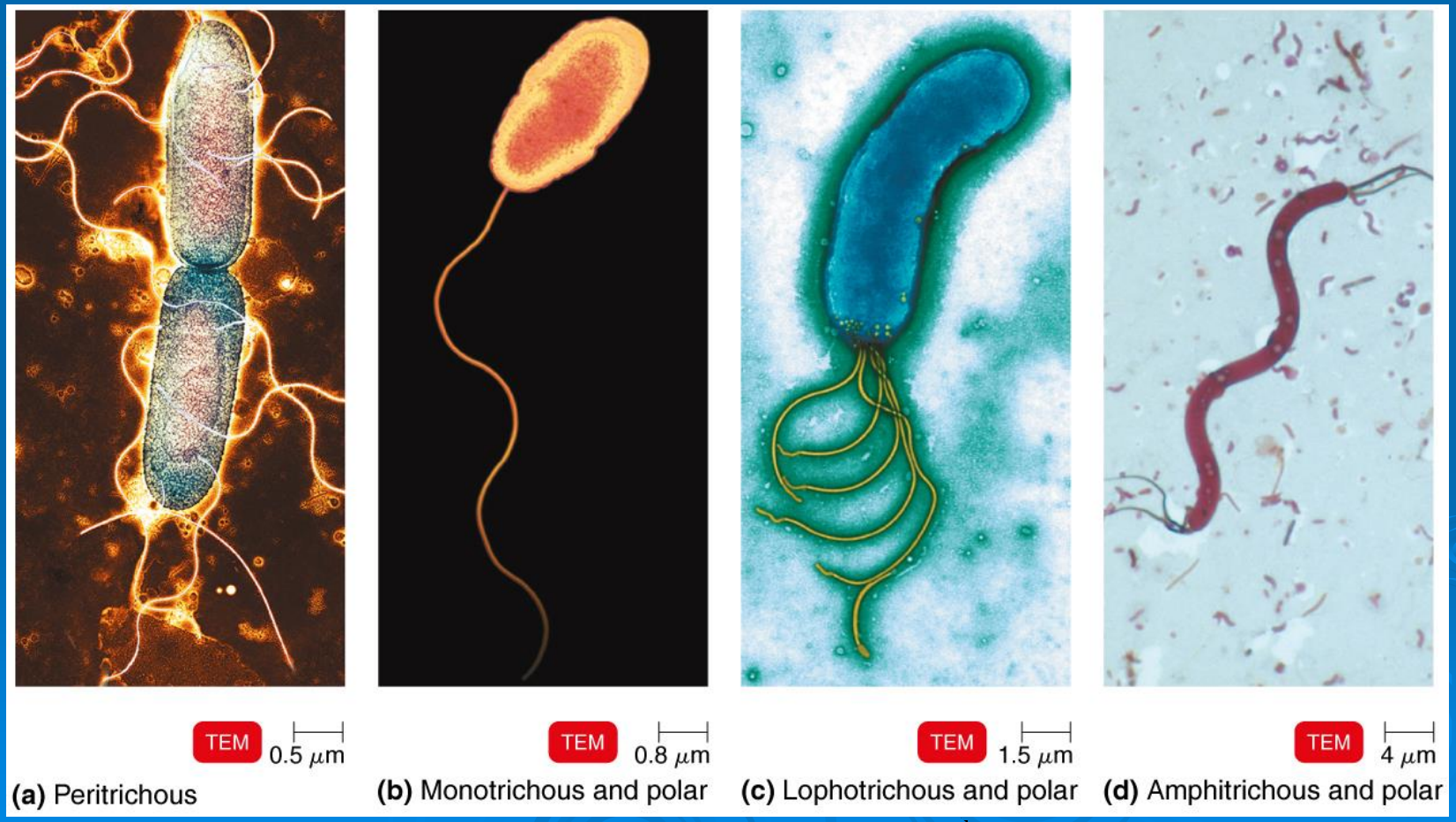
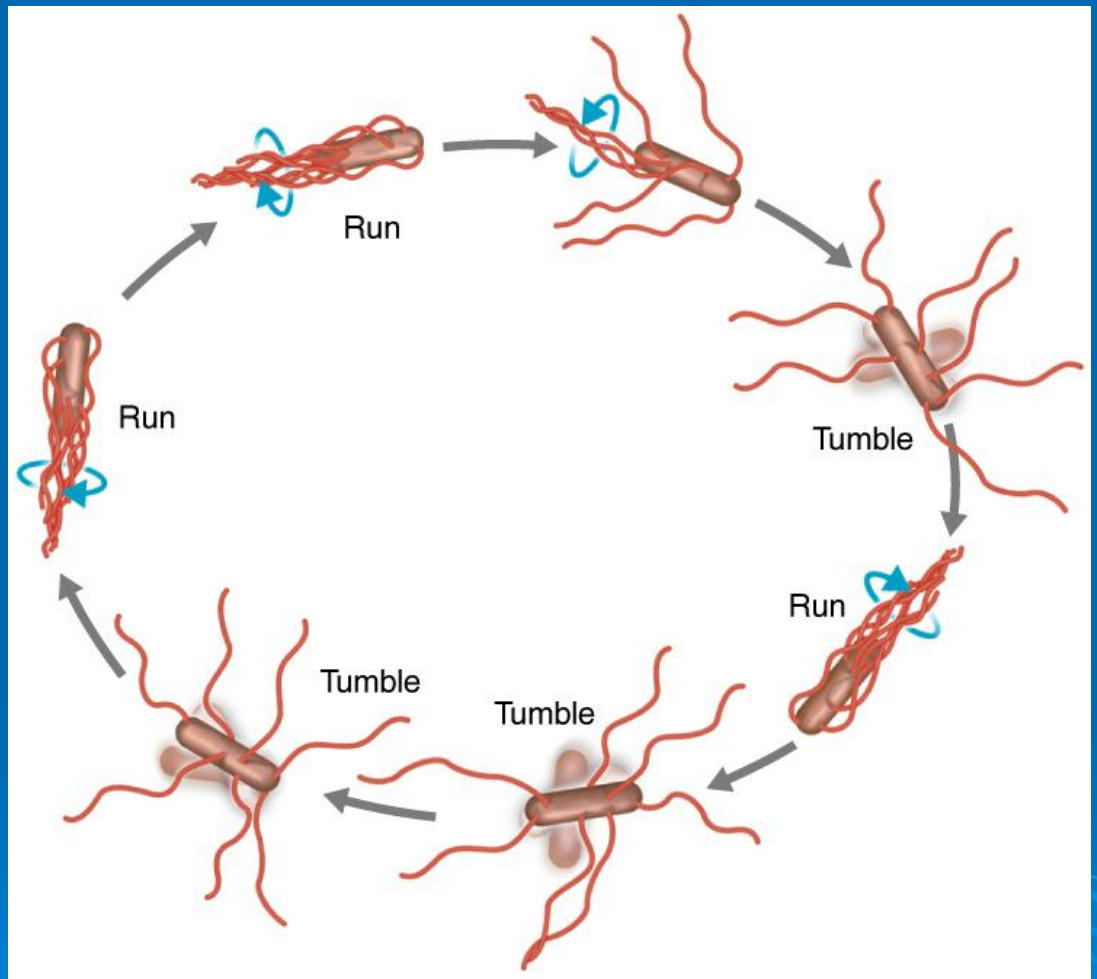


Figure 4.7 - Overview

Prokaryotic cell features

1. Glycocalyx
2. Flagella



(a) A bacterium running and tumbling. Notice that the direction of flagellar rotation (blue arrows) determines which of these movements occurs. Gray arrows indicate direction of movement of the microbe.

Figure 4.9

Prokaryotic cell features

1. Glycocalyx
2. Flagella
3. Axial filaments (endoflagella)

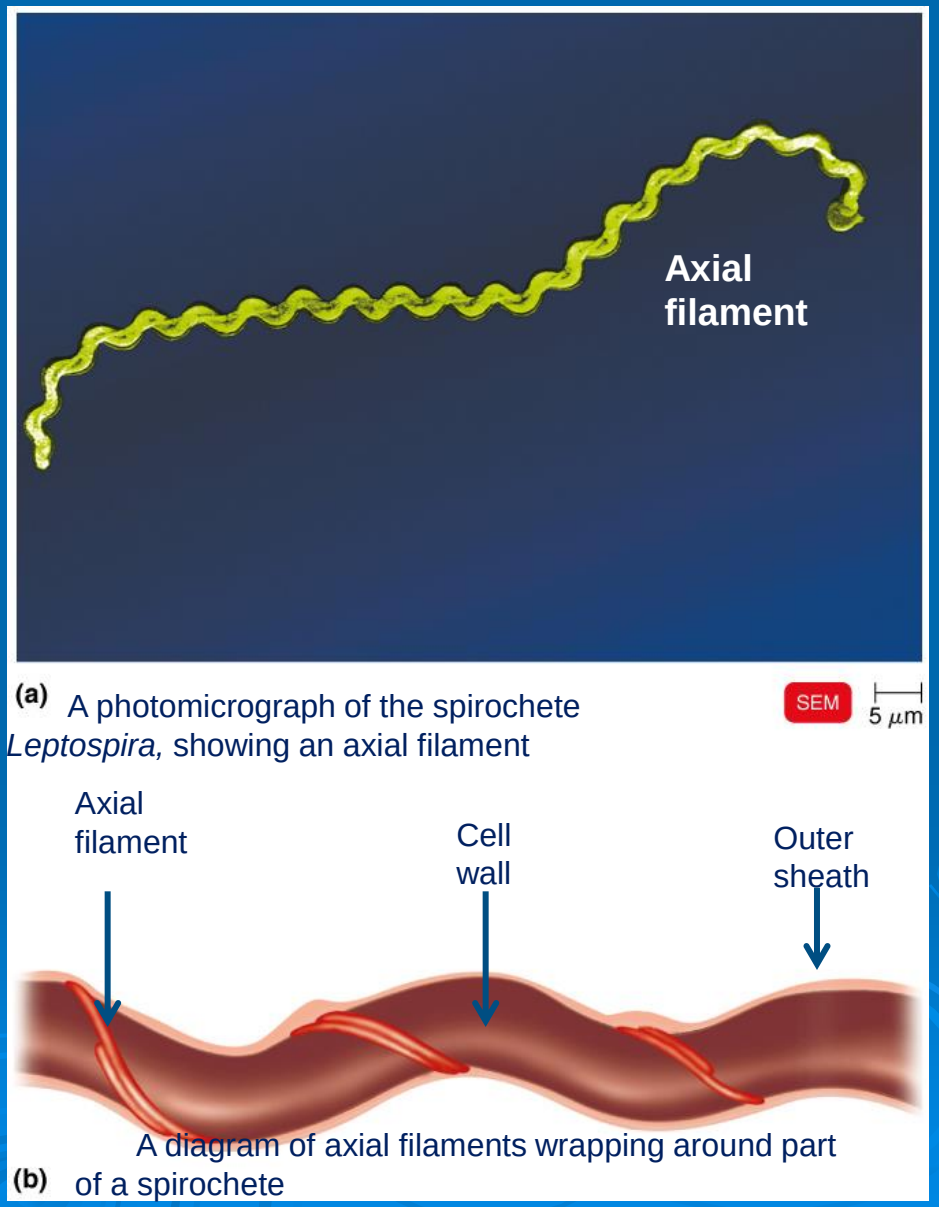


Figure 4.7 - Overview

Prokaryotic cell features

1. Glycocalyx
2. Flagella
3. Axial filaments (endoflagella)
4. Attachment pili (fimbriae)

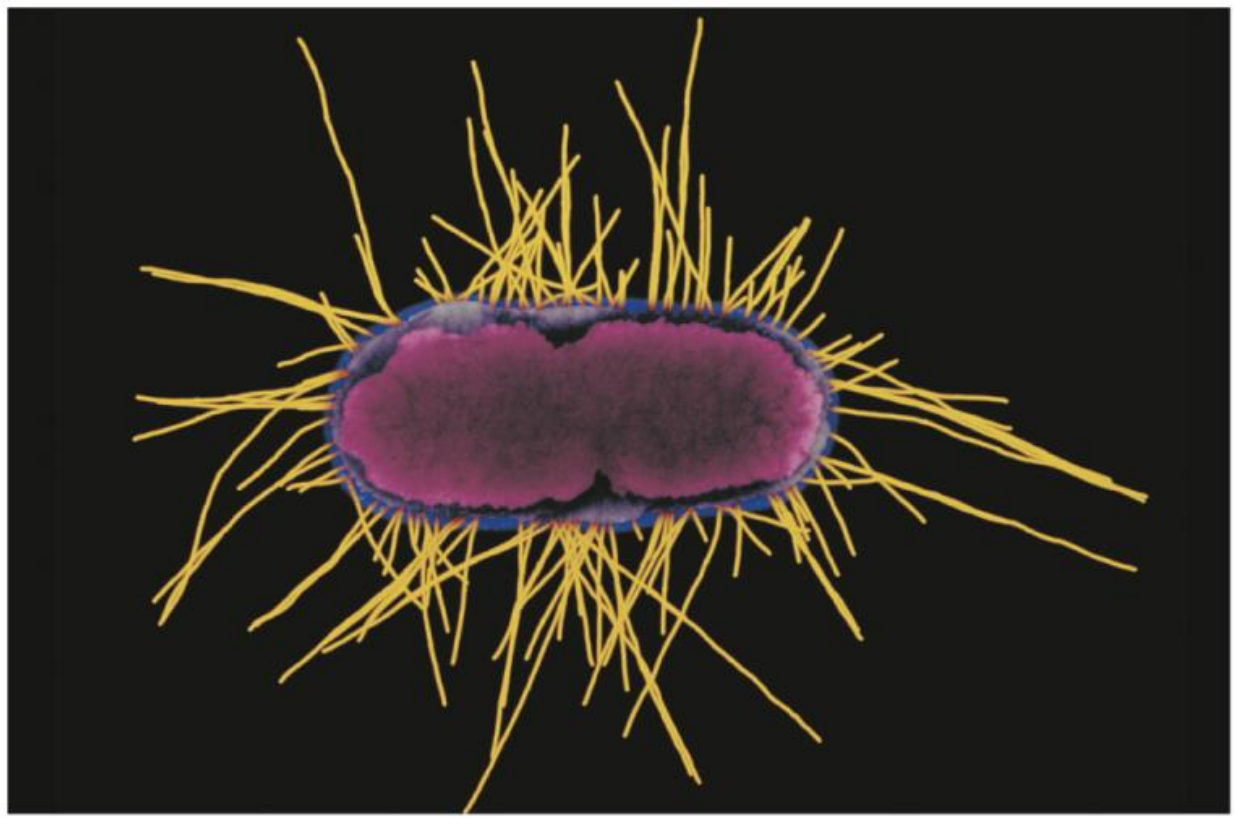


Figure 4.11

Prokaryotic cell features

1. Glycocalyx
2. Flagella
3. Axial filaments (endoflagella)
4. Attachment pili (fimbriae)
5. Conjugation pili (sex pili)

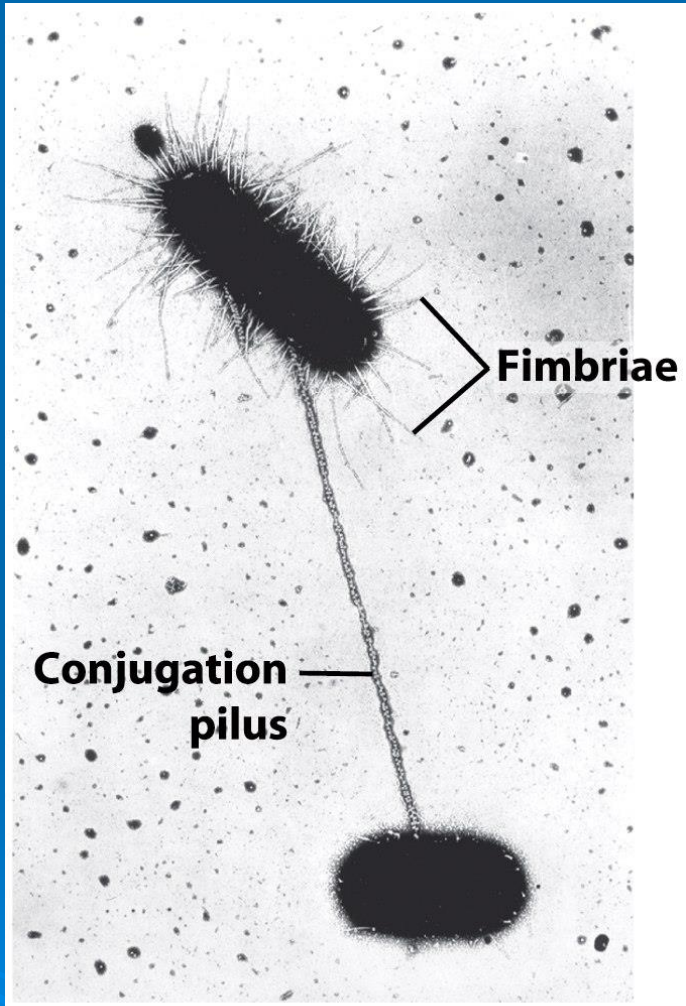


Figure 4-16 Microbiology, 6/e

Prokaryotic cell features

1. Glycocalyx
2. Flagella
3. Axial filaments (endoflagella)
4. Attachment pili (fimbriae)
5. Conjugation pili (sex pili)
6. Cell wall

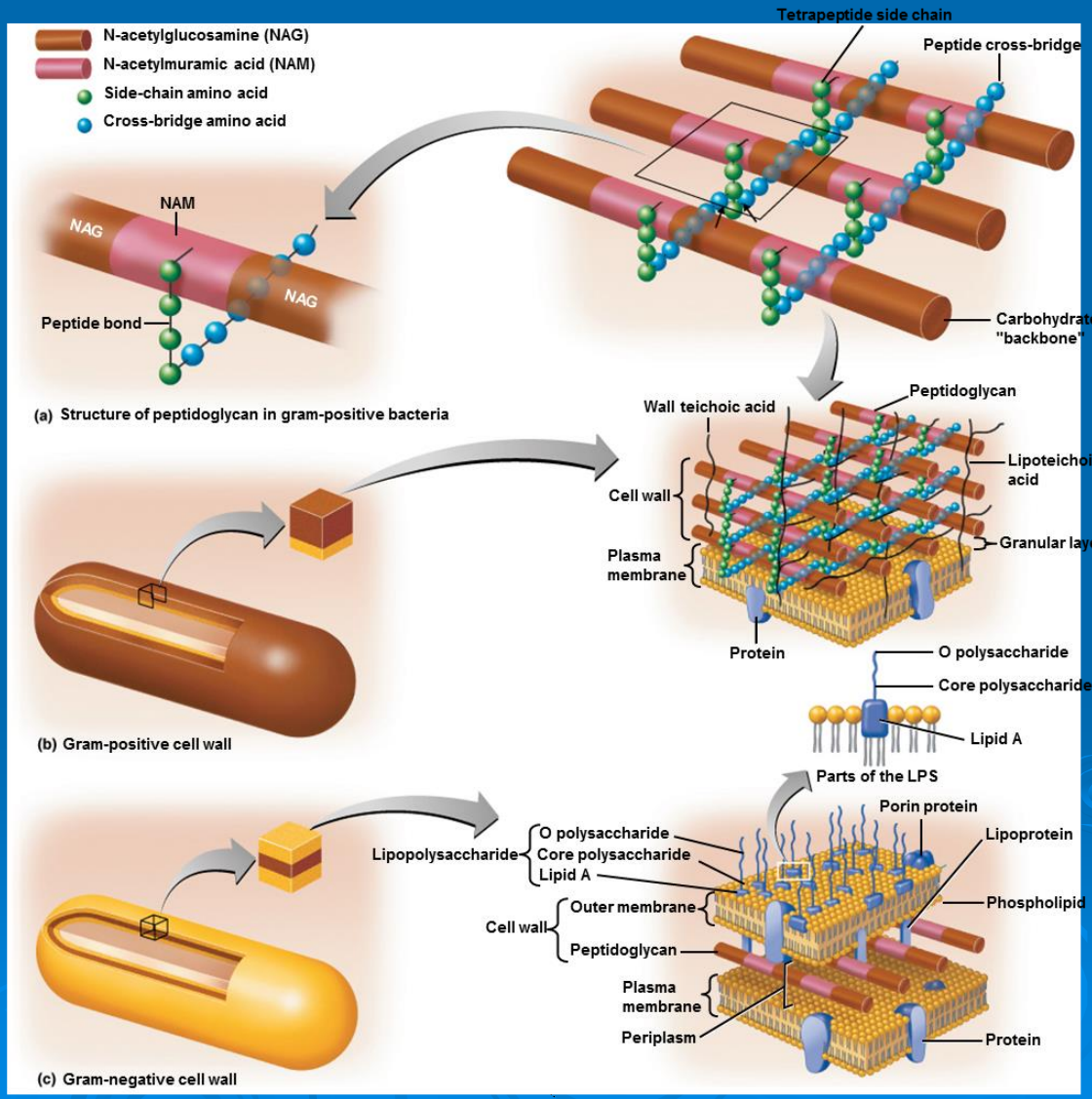


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Figure 4.13 - Overview

Peptidoglycan

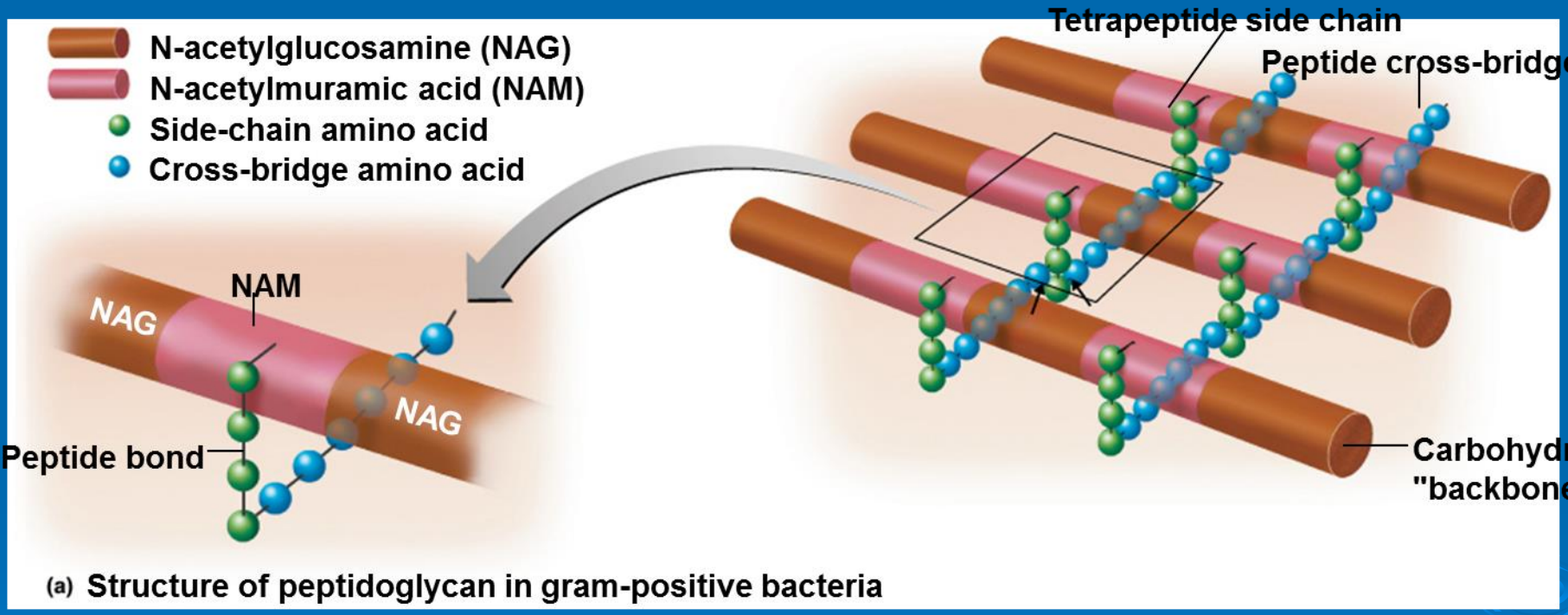


Figure 4.13a

Gram positive cell wall

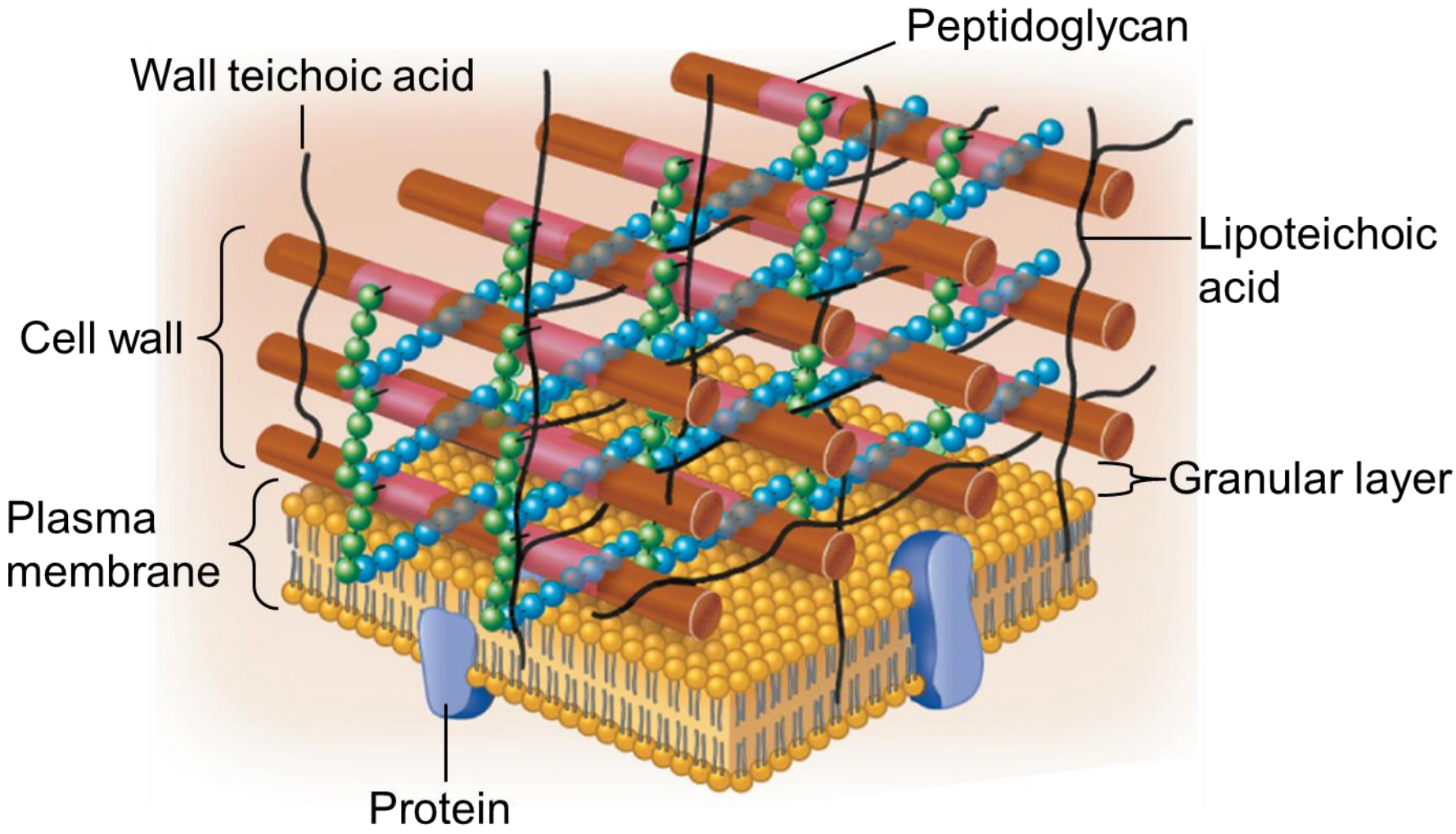


Figure 4.13b

Gram negative cell wall

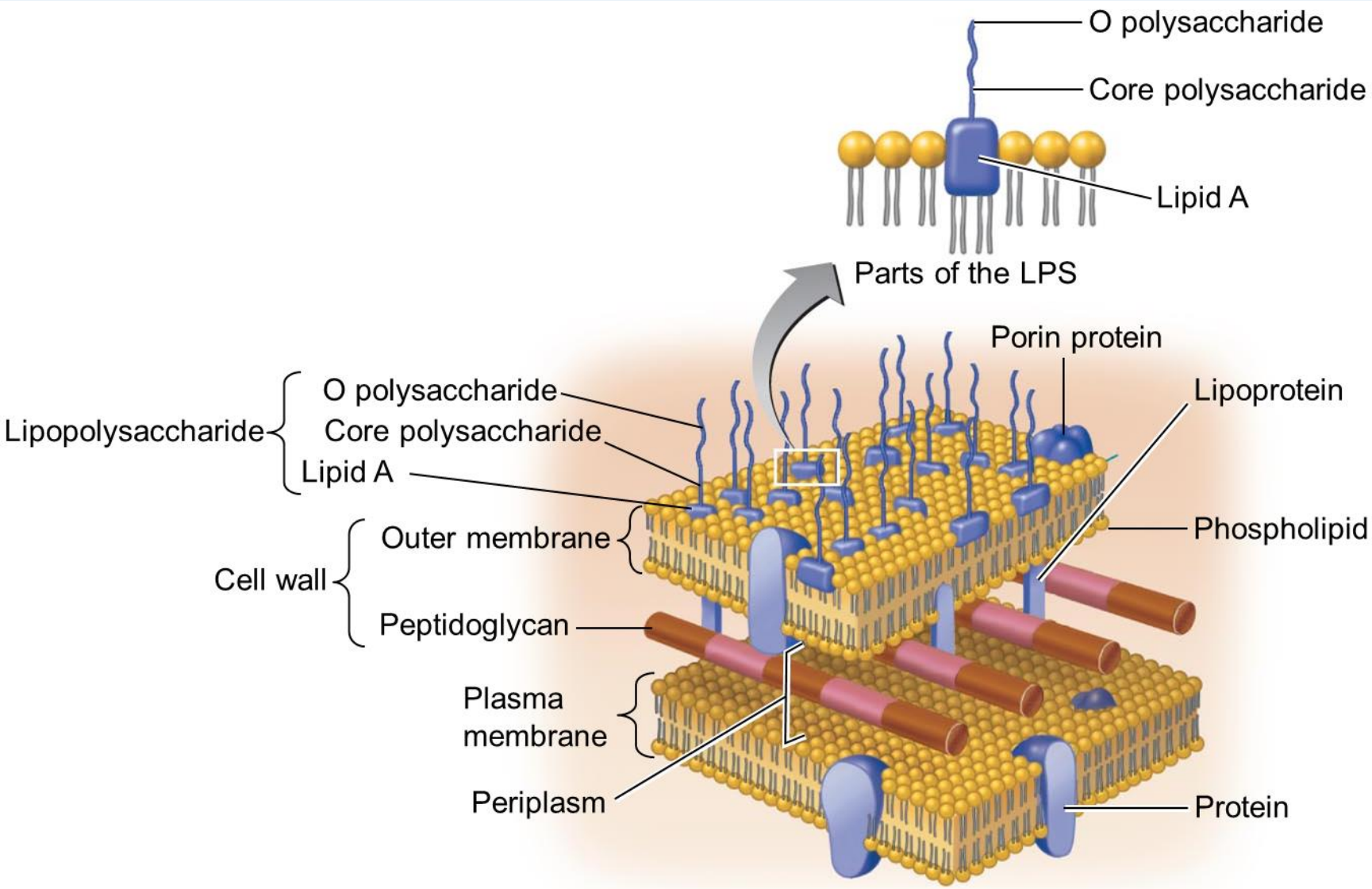


Figure 4.13c

Gram positive versus Gram negative cells

CHARACTERISTIC	POSITIVE	NEGATIVE
Cell wall thickness		
Composition of cell wall		
Porins		
Lipids in cell wall		
Lysis by lysozyme (enzyme that destroys murein)		
Sensitivity to penicillin		
Sensitivity to pressure		
Nutrient requirements		
Spore formers		

Independent Learning

1. Review cell wall structure in bacteria. You should know the structure inside and out. Literally.

Just what are microbes made of?

Lecture

Chapter 4/ 3
Review cell wall
Remaining cell features
Endosymbiotic theory
Light microscopy
Electron microscopy

Microscopy techniques and staining

Lab

Review results
Pure culture
Smear and simple stain

Pre-labs
Motility
Gram stain

Gram positive versus Gram negative cells

CHARACTERISTIC	POSITIVE	NEGATIVE
Cell wall thickness		
Composition of cell wall		
Porins		
Lipids in cell wall		
Lysis by lysozyme (enzyme that destroys murein)		
Sensitivity to penicillin		
Sensitivity to pressure		
Nutrient requirements		
Spore formers		

Prokaryotic cell features

7. Plasma membrane

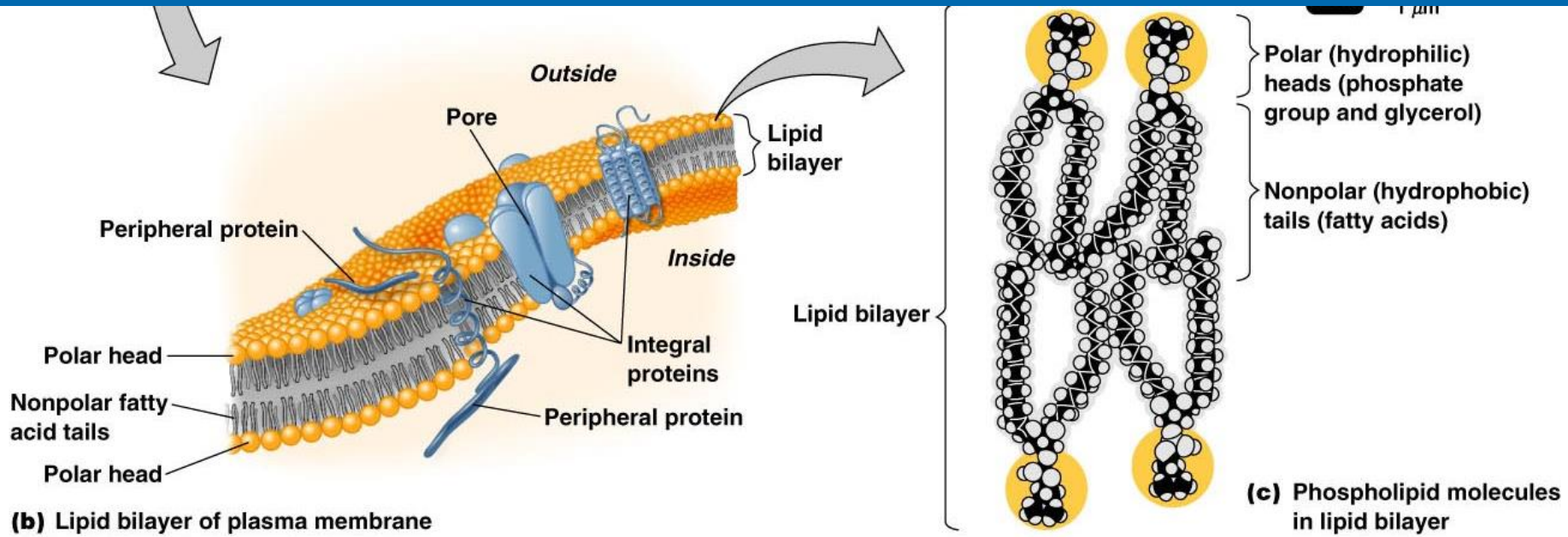


Figure 4.14 - Overview

Plasma membrane: osmosis and tonicity

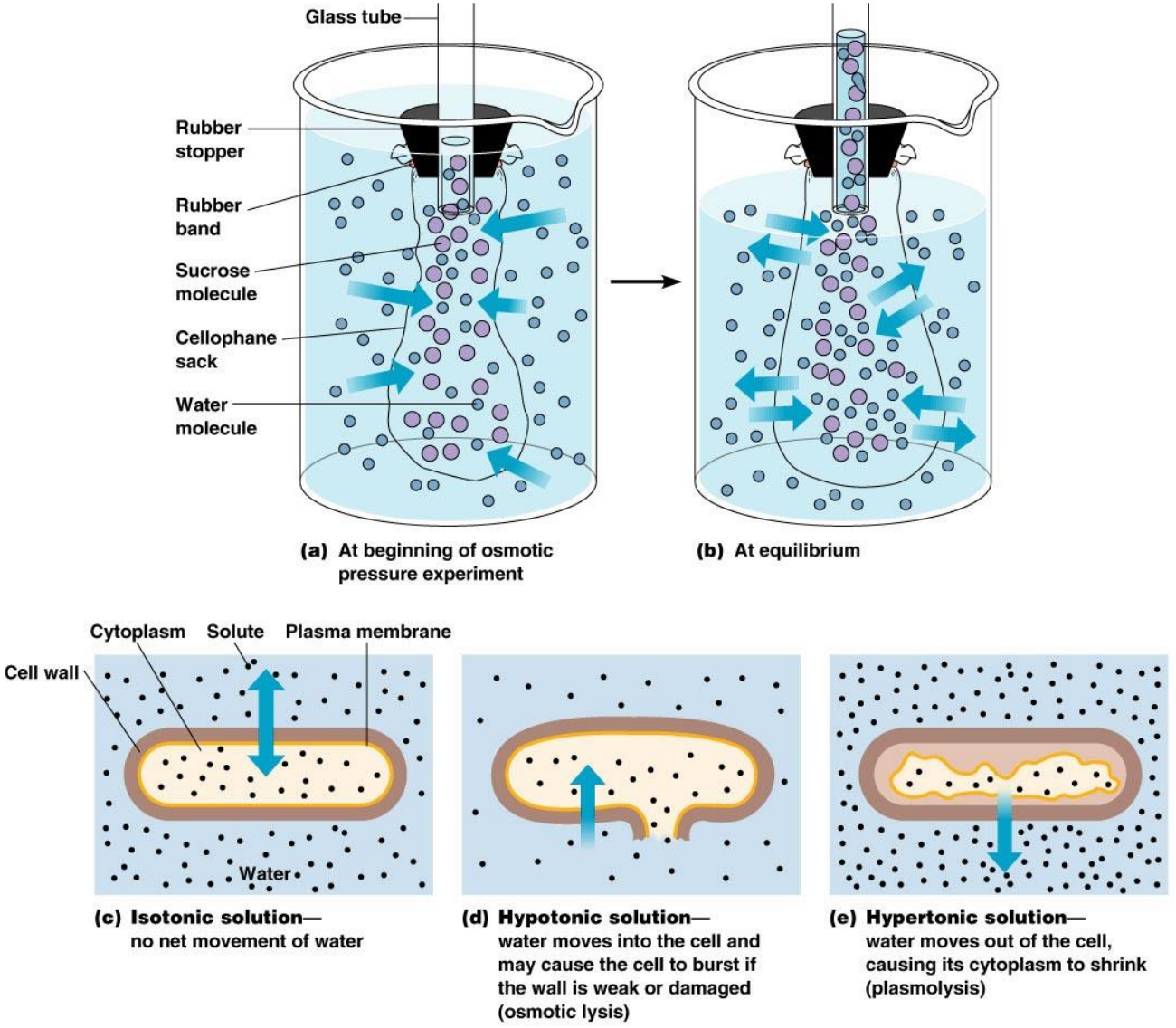


Figure 4.18 - Overview

Prokaryotic cell features

8. Ribosomes

Prokaryotic	Eukaryotic
3 RNAs (23s, 16s, 5s)	4 RNAs (28s, 15s, 5.8s, 5s)
53 proteins	70 proteins
30S/ 50S subunits	40S/ 60S subunits
70S ribosome	80S ribosome

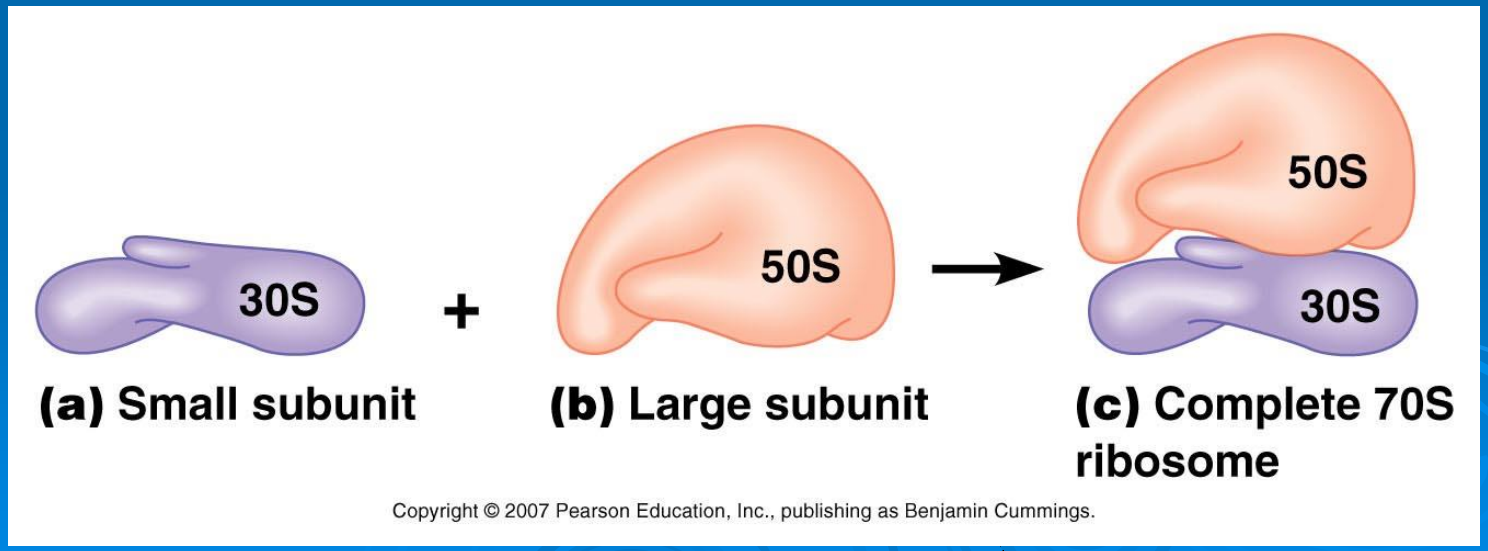


Figure 4.19

Prokaryotic cell features

9. Endospores

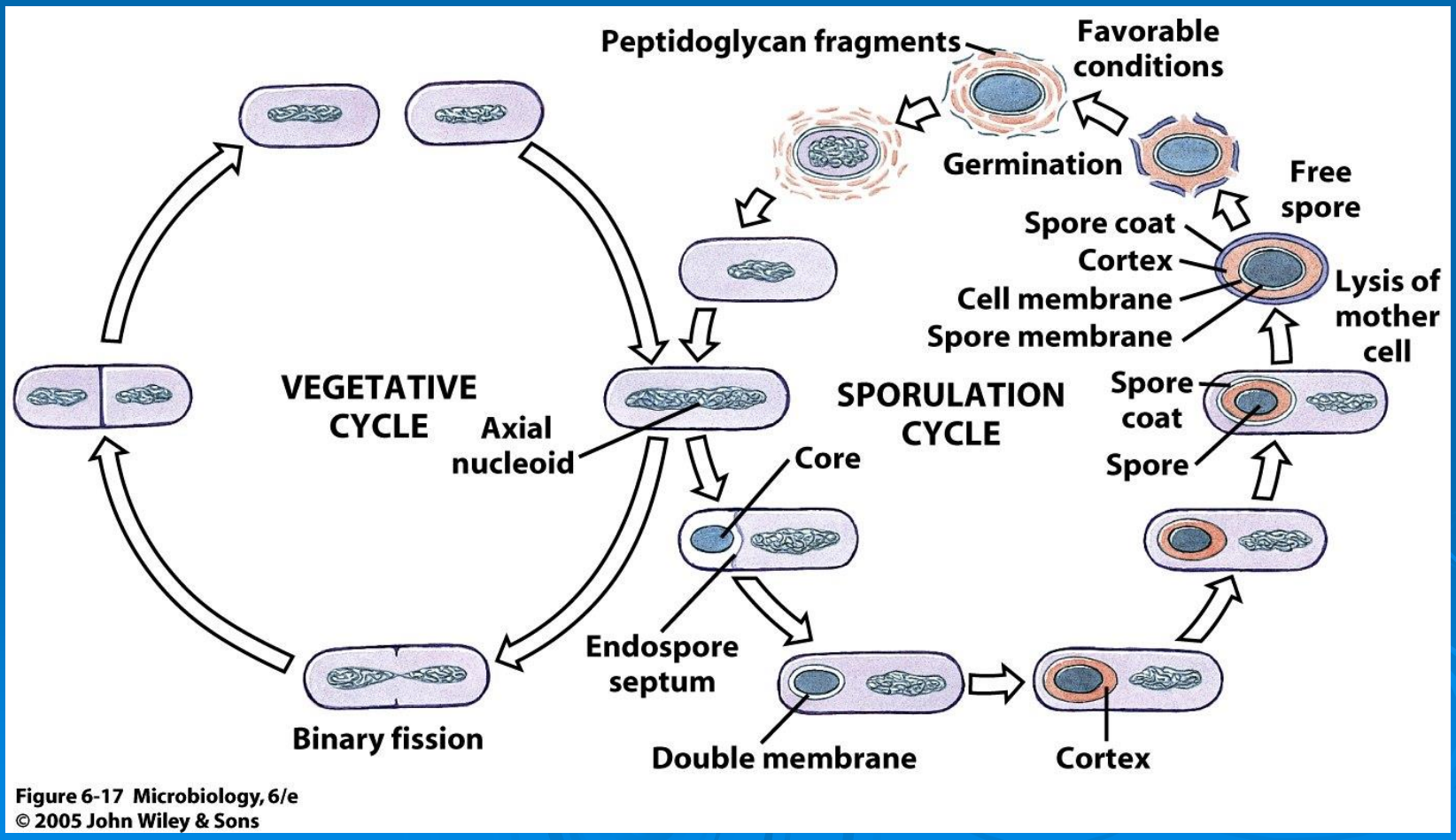
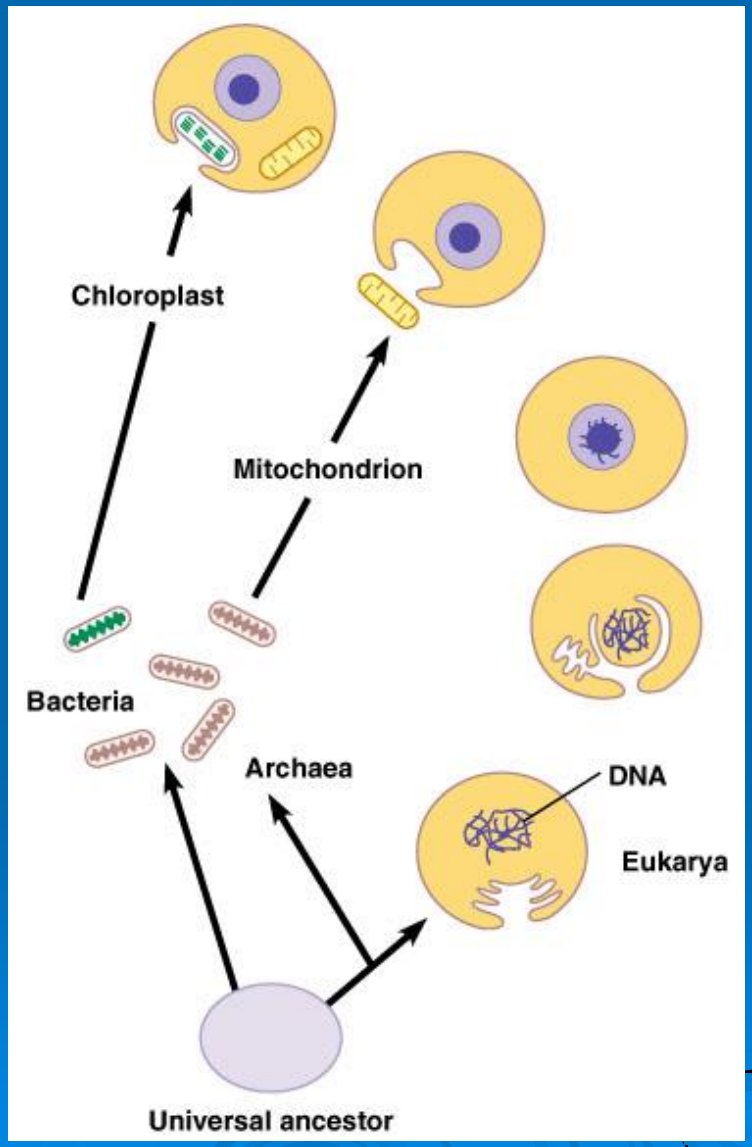


Figure 6-17 Microbiology, 6/e

Endosymbiotic theory



Endosymbiotic evidence

	Prokaryotes	Eukaryotes	Mitochondria of Eukaryotic cells	Chloroplasts of Photosynthetic eukaryotes
DNA	1 single, circular chromosome	Multiple linear chromosomes compartmentalized in a nucleus	1 single, circular chromosome	1 single, circular chromosome
Replication	Binary Fission (1 cell splits into 2)	Mitosis	Binary Fission (1 cell splits into 2)	Binary Fission (1 cell splits into 2)
Ribosomes	"70 S"	"80 S"	"70 S"	"70 S"
Electron Transport Chain	Found in the plasma membrane around cell	Not found in the plasma membrane around cell (found only in the cell's mitochondria and chloroplasts)	Found in the plasma membrane around mitochondrion	Found in the plasma membrane around chloroplast
Size (approximate)	~1-10 microns	~50 - 500 microns	~1-10 microns	~1-10 microns
Appearance on Earth	Anaerobic bacteria: ~3.8 Billion years ago Photosynthetic bacteria: ~3.2 Billion years ago Aerobic bacteria: ~2.5 Billion years ago	~1.5 billion years ago	~1.5 billion years ago	~1.5 billion years ago

CHAPTER 3
Microscopy

TABLE 3.1 Metric Units of Length and U.S. Equivalents

Metric Unit	Meaning of prefix	Metric Equivalent	U.S. Equivalent
1 kilometer (km)	*kilo* = 1000	1000 m = 10^3 m	3280.84 ft or 0.62 mi; 1 mi = 1.61 km
1 meter (m)		Standard unit of length	39.37 in or 3.28 ft or 1.09 yd
1 decimeter (dm)	*deci* = 1/10	0.1 m = 10^{-1} m	3.94 in
1 centimeter (cm)	*centi* = 1/100	0.01 m = 10^{-2} m	0.394 in; 1 in = 2.54 cm
1 millimeter (mm)	*milli* = 1/1000	0.001 m = 10^{-3} m	
1 micrometer (μm)	*micro* = 1/1,000,000	0.000001 m = 10^{-6} m	
1 nanometer (nm)	*nano* = 1/1,000,000,000	0.000000001 m = 10^{-9} m	

Compound light microscope

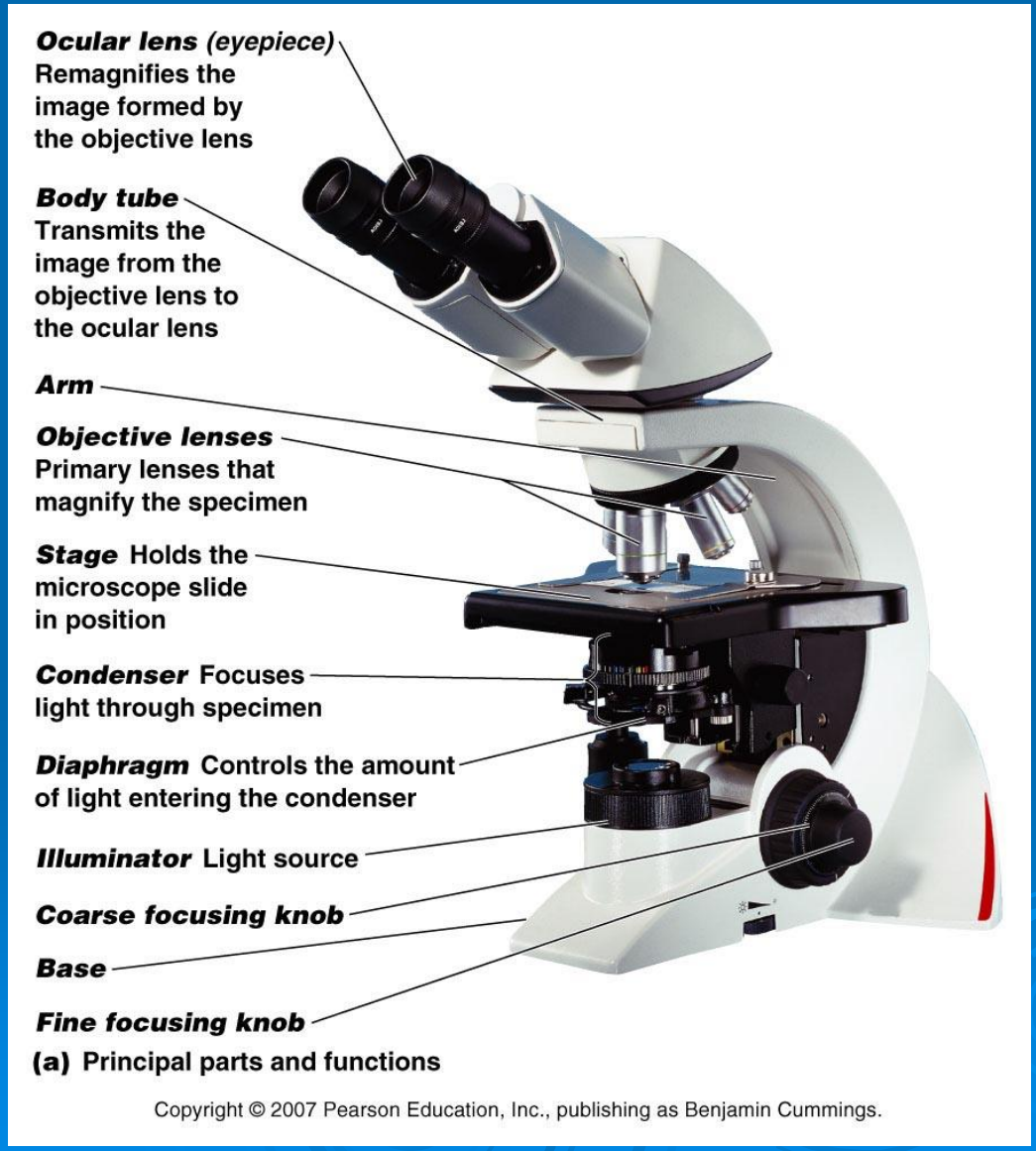


Figure 3.1a

Compound light microscope- pathway of light

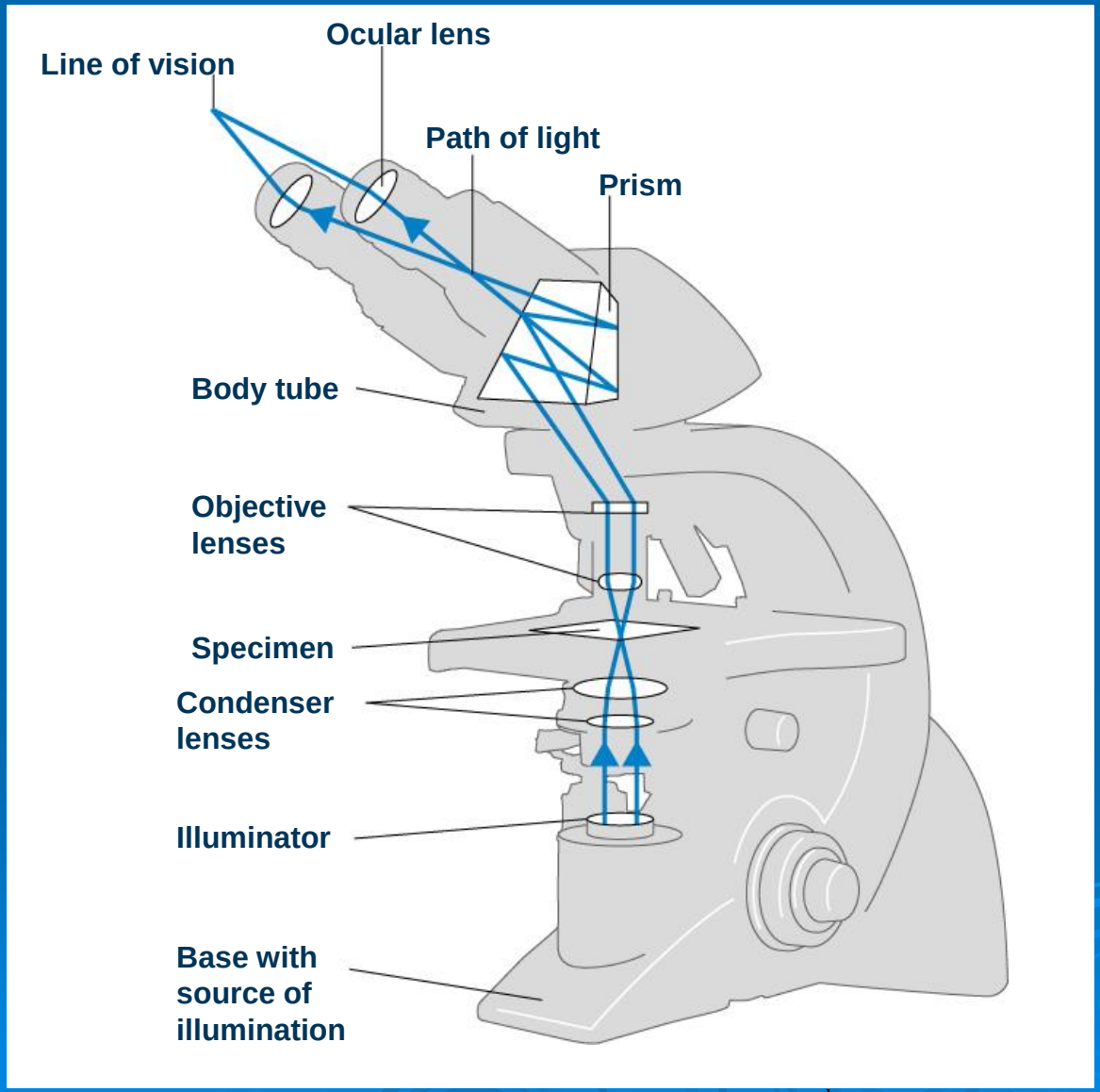


Figure 3.1a

Microscopy ranges

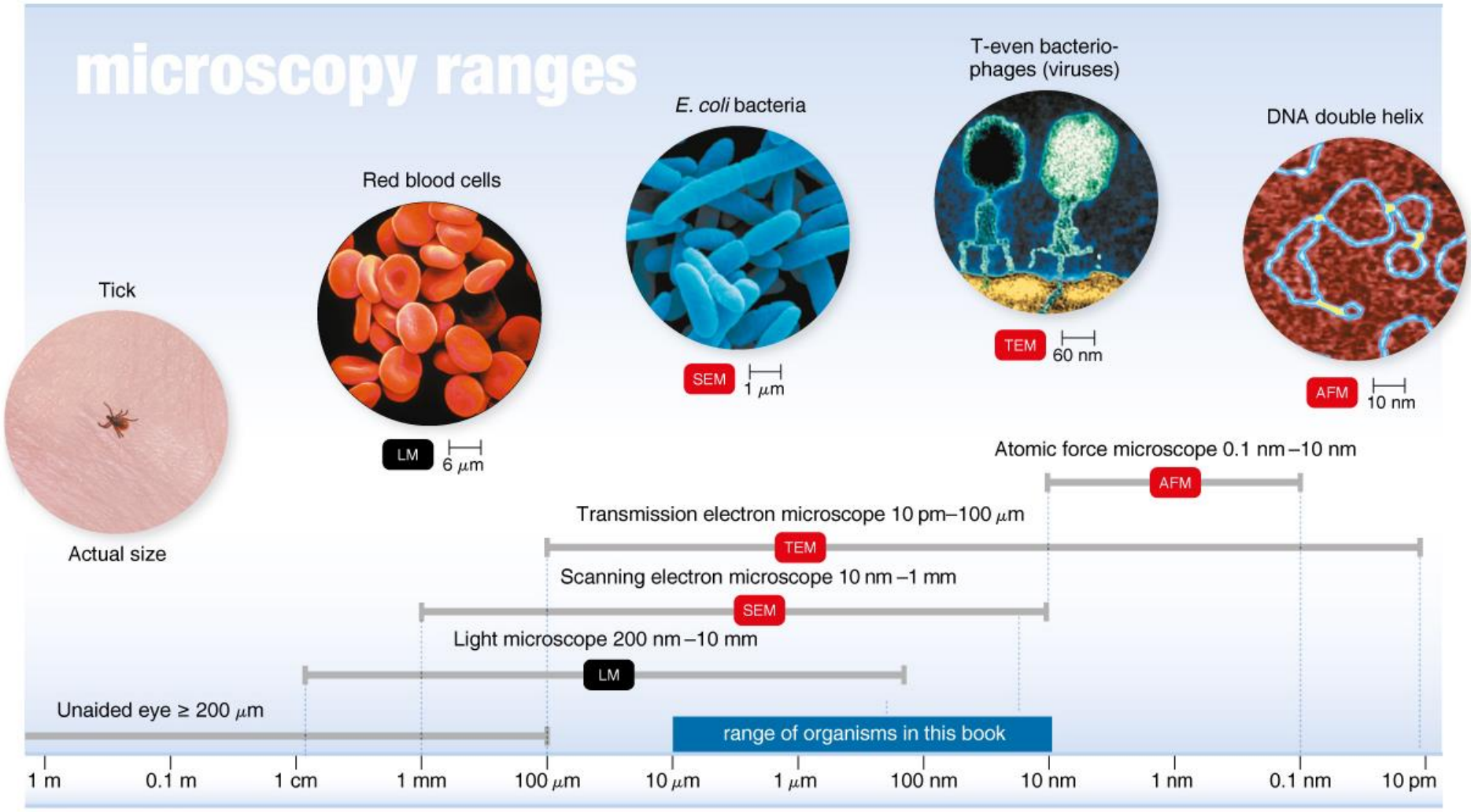


Figure 3.2

Properties of light

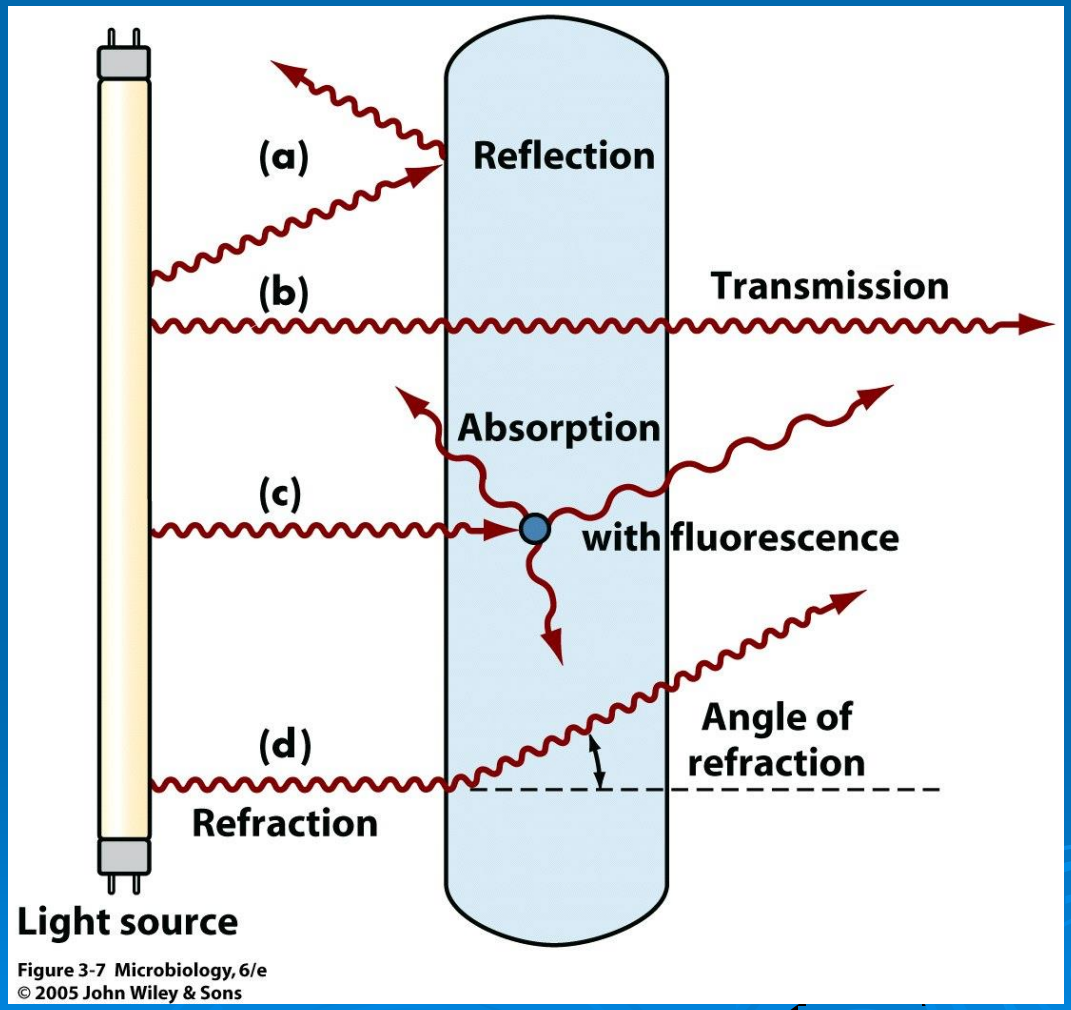


Figure 3-7 Microbiology, 6/e

Refraction and immersion oil

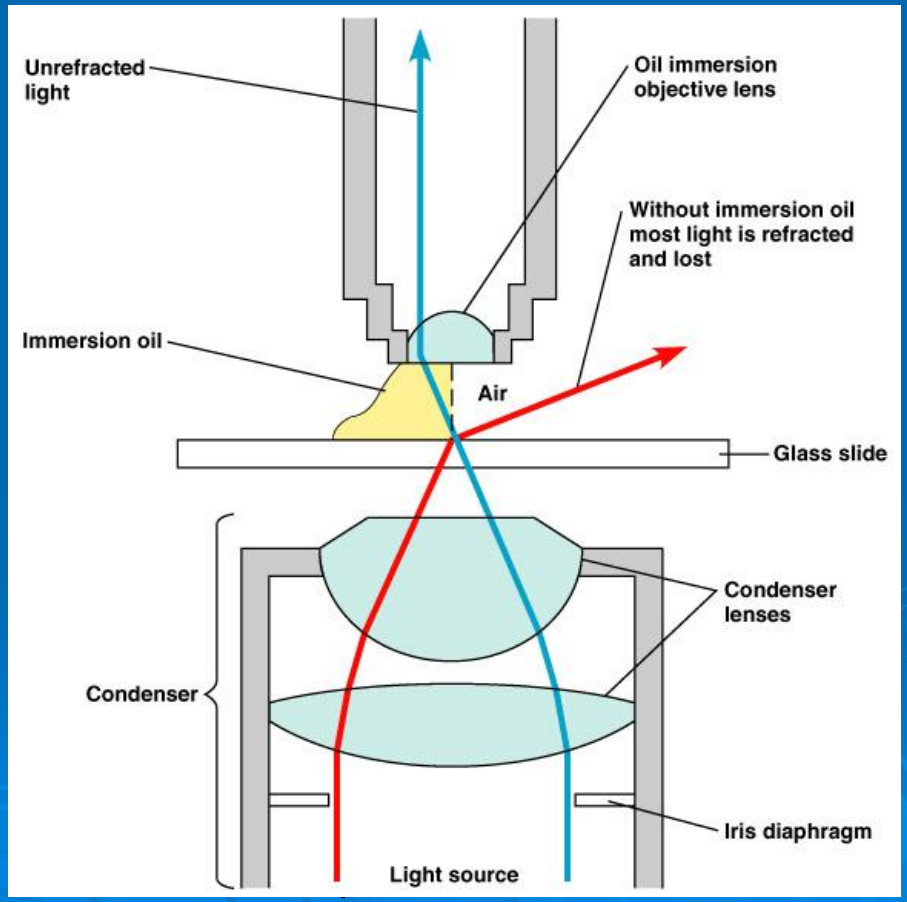


Figure 3.3

Brightfield and darkfield microscopy

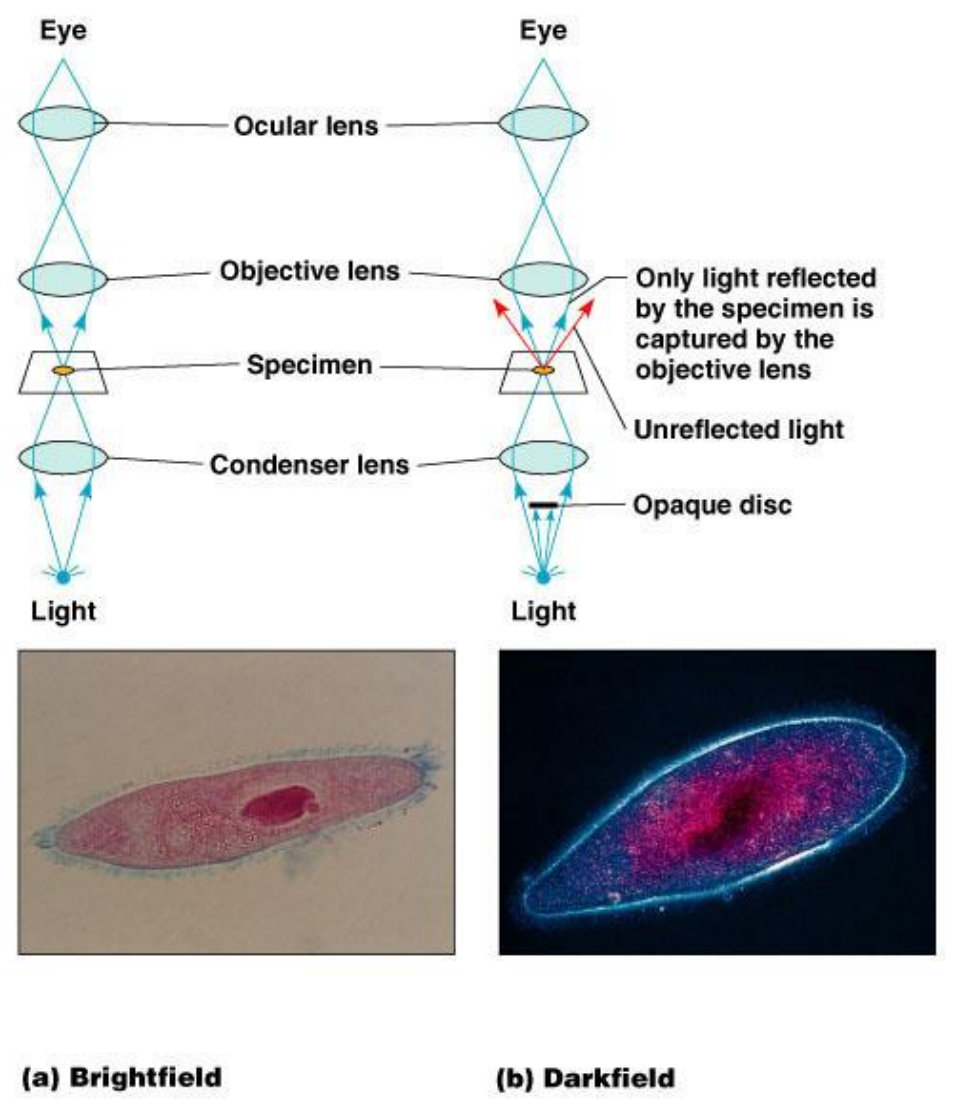


Figure 3.4 - Overview

Phase contrast and Nomarski optics (DIC)

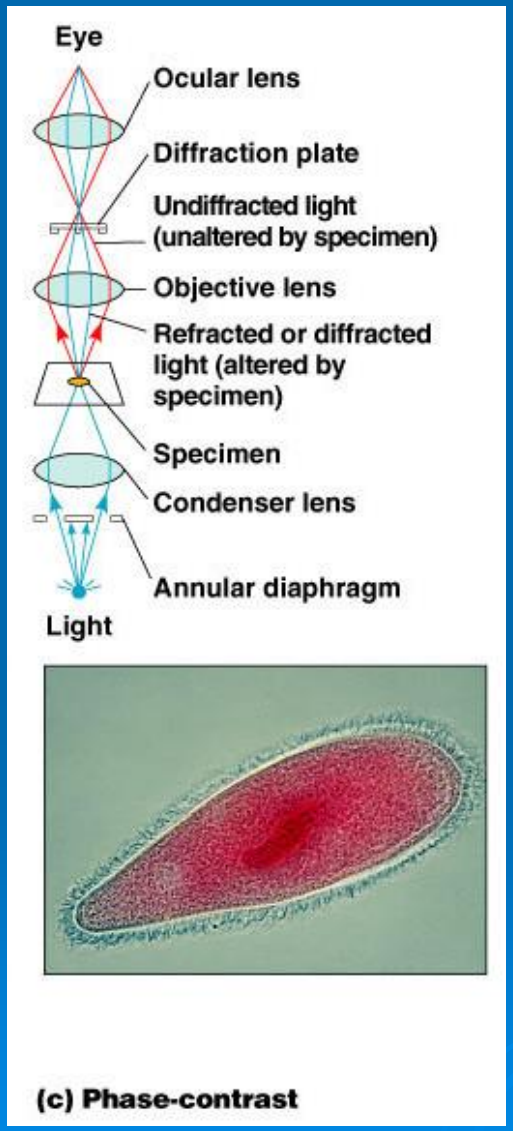


Figure 3.4 - Overview

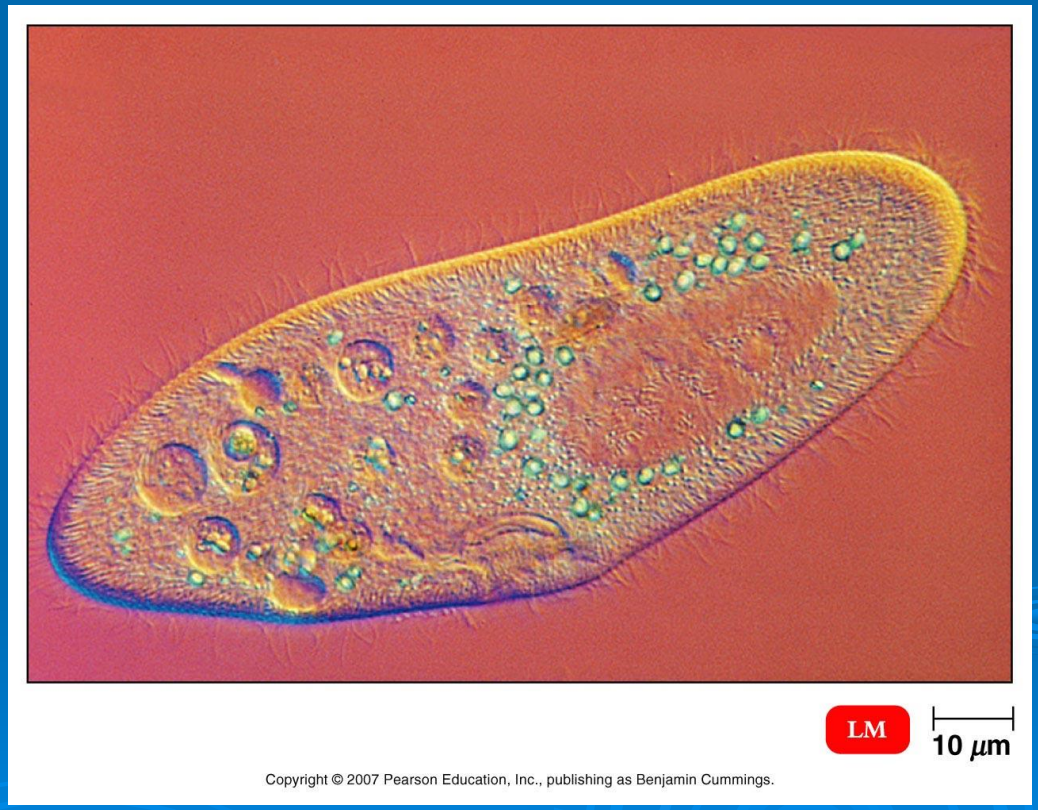


Figure 3.5

Fluorescence and confocal microscopy

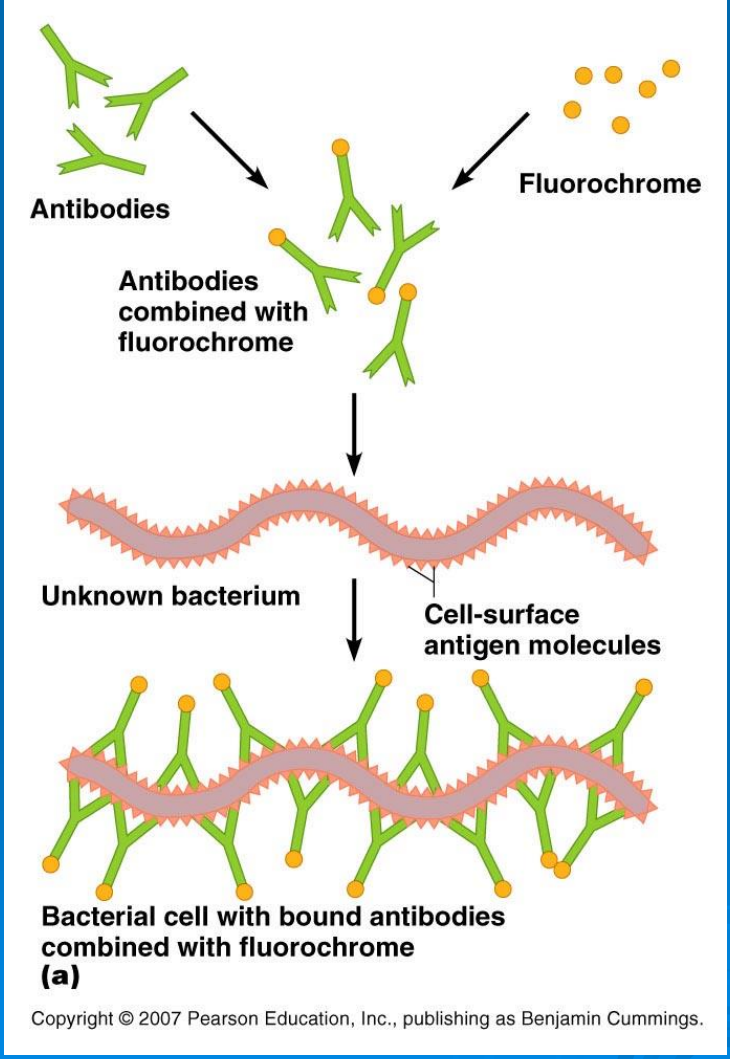


Figure 3.6

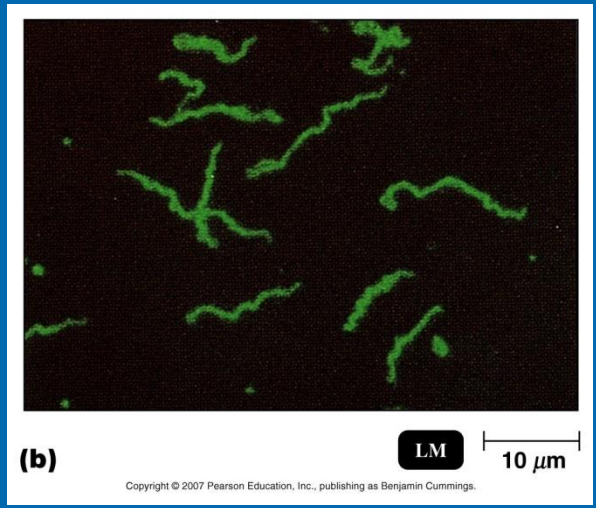


Figure 3.7

Resolving power

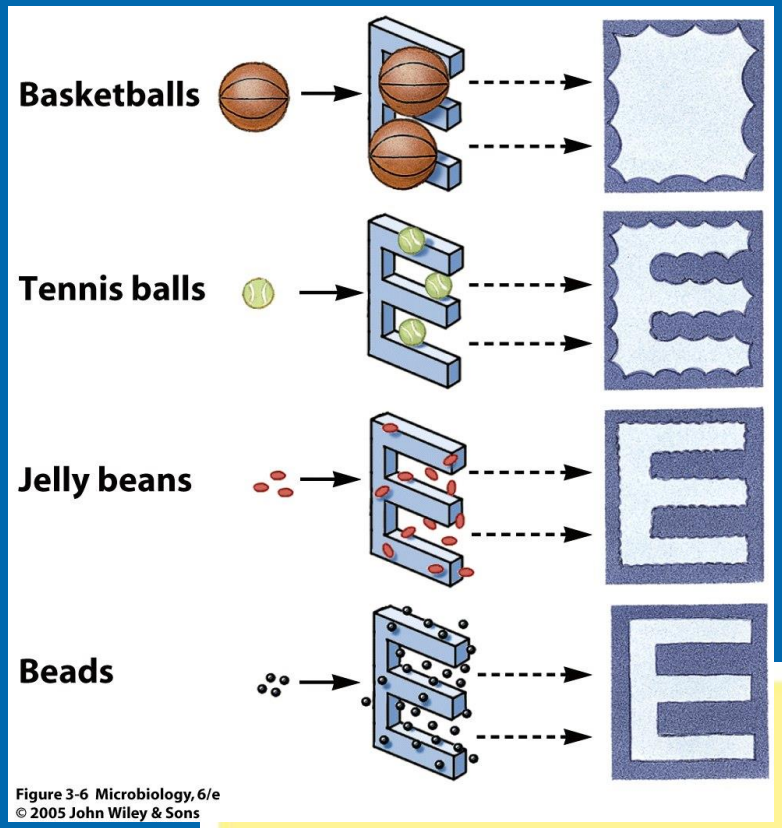
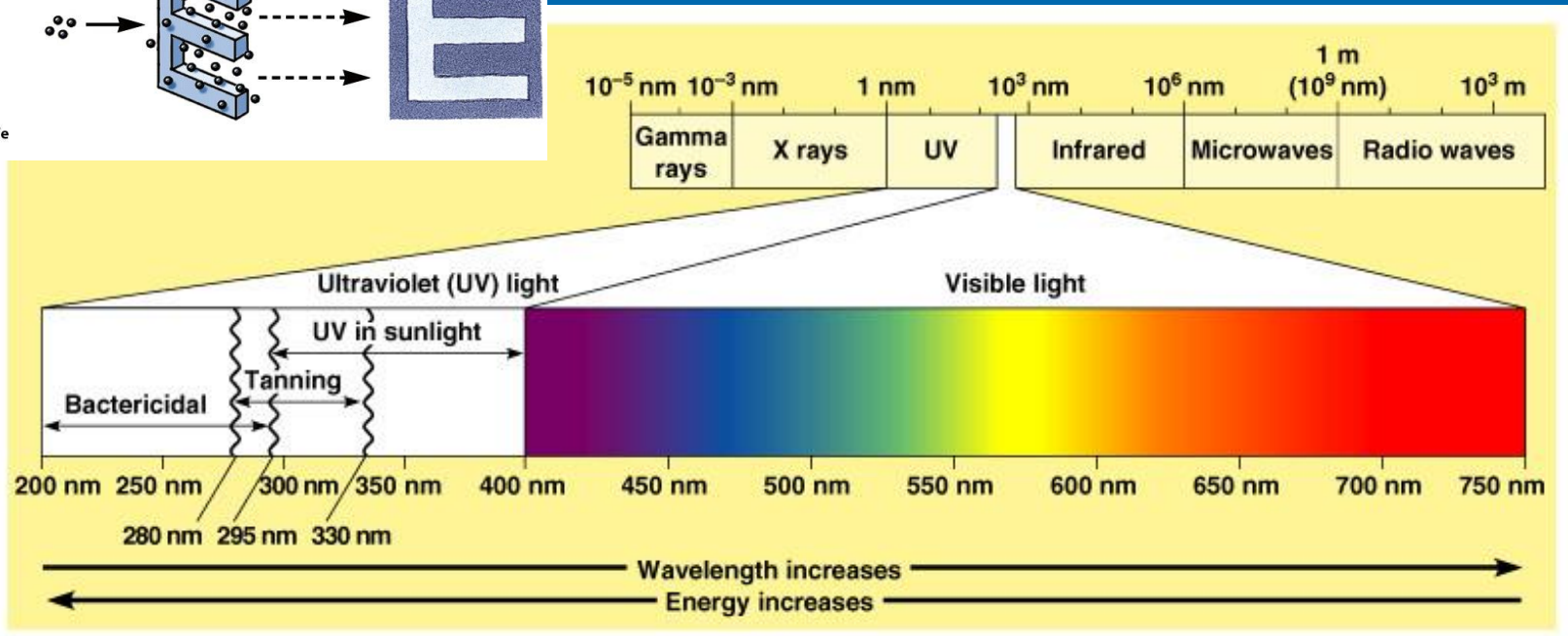
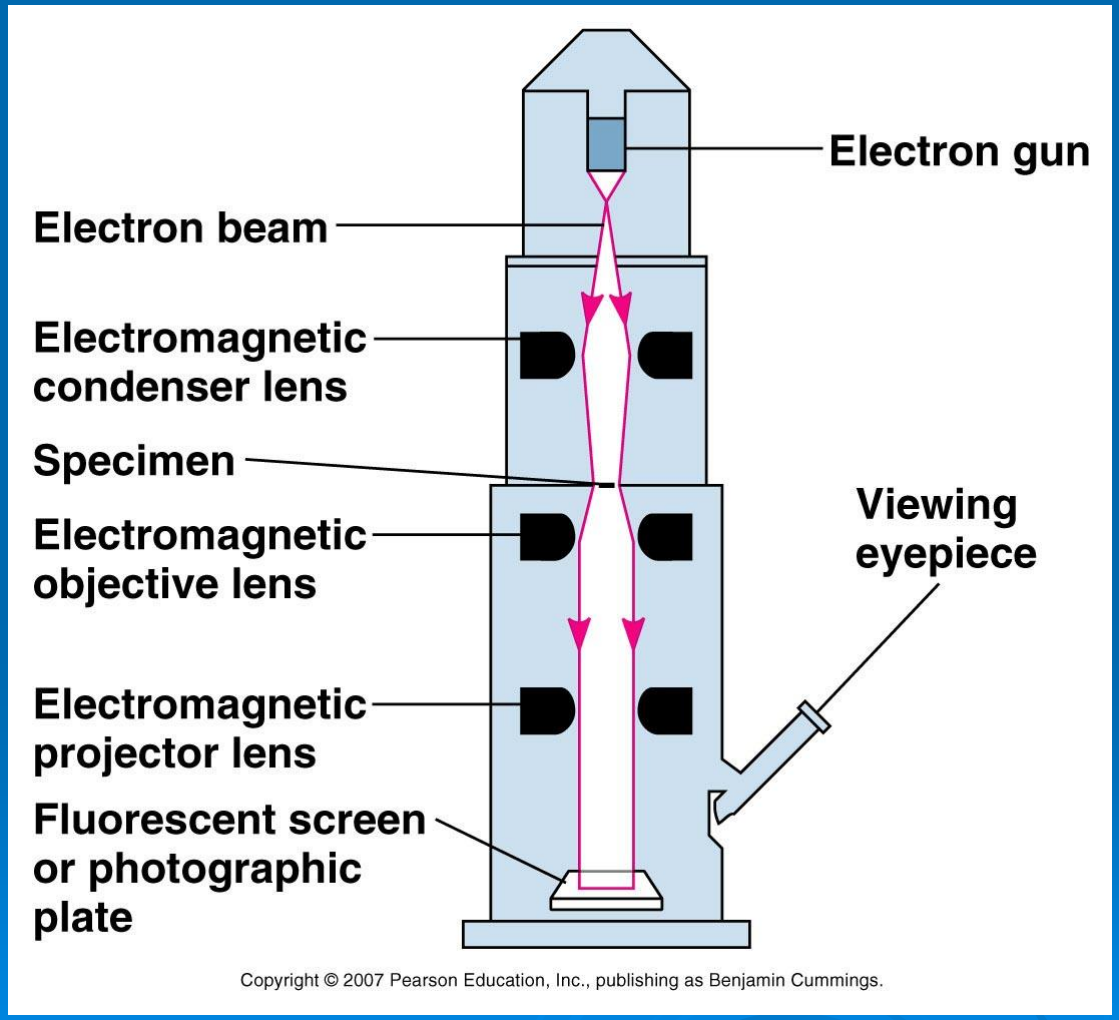


Figure 3-6 Microbiology, 6/e



Transmission Electron Microscopy (TEM)



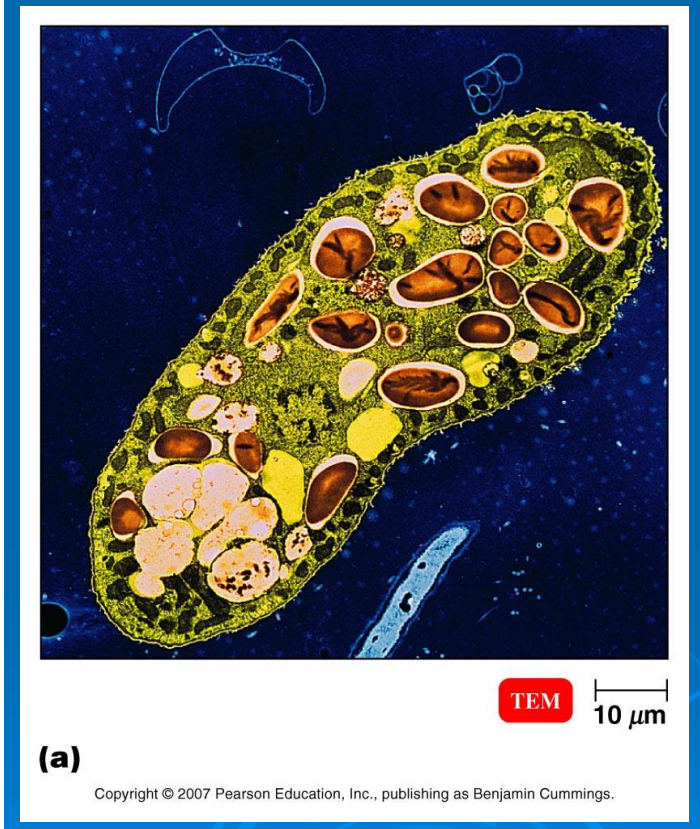


Figure 3.9a

Scanning Electron Microscopy (SEM)

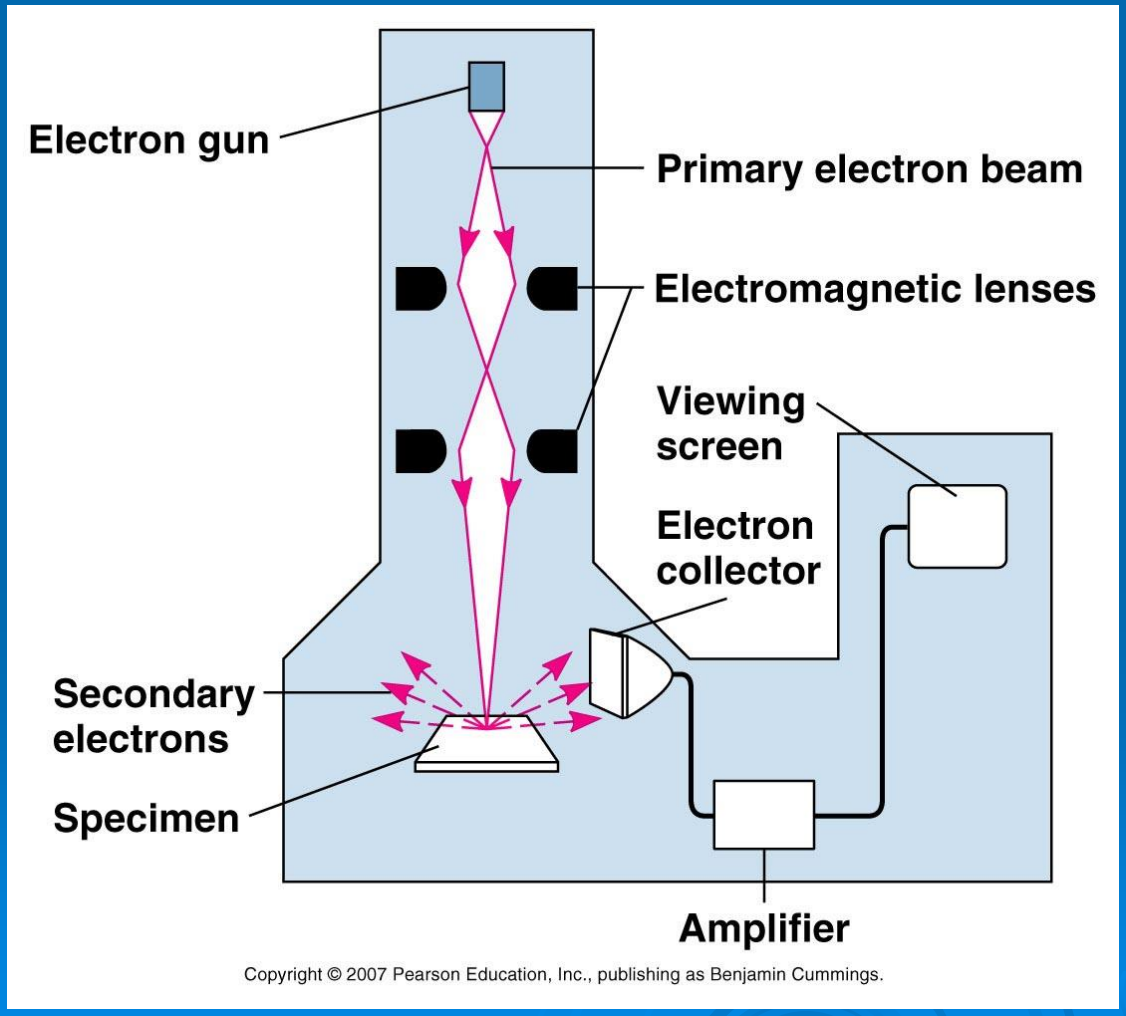
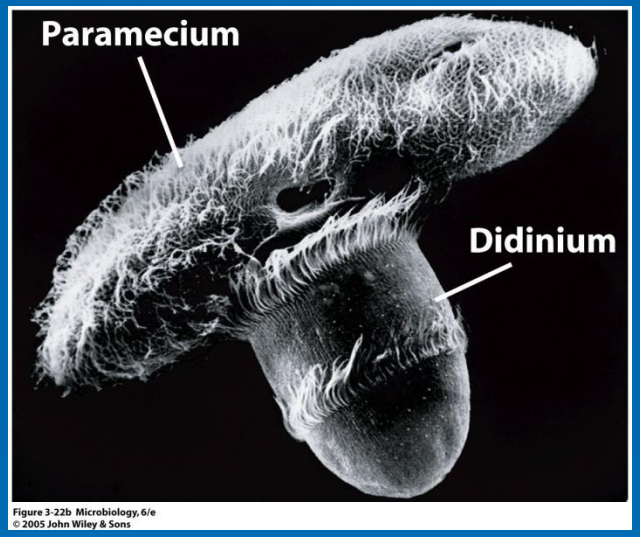
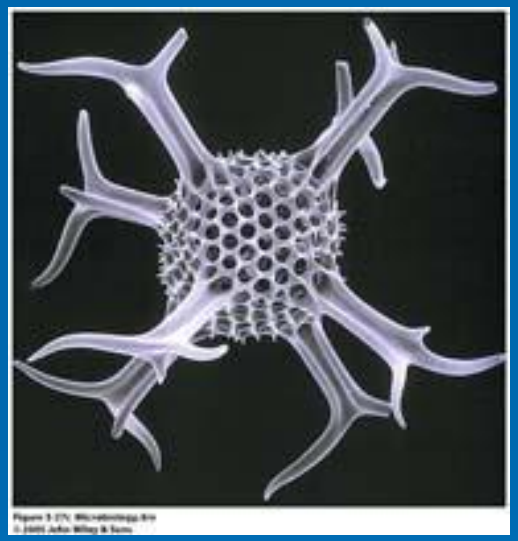


Figure 3.9b

SEM images



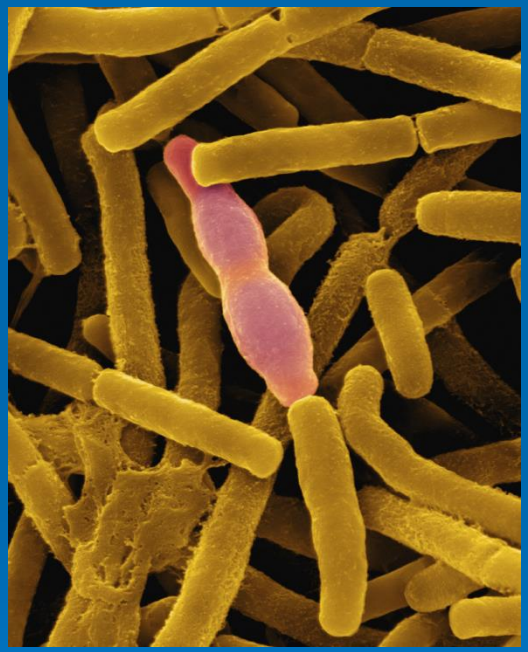
Didinium eating *Paramecium* (protozoa)



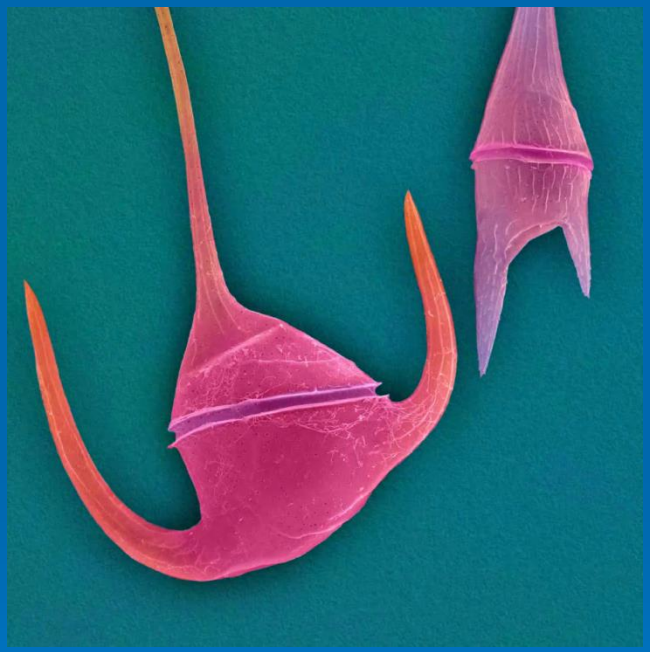
Radiolarian (protozoan)

Aspergillus (fungus)

SEM images



Bacillus anthracis
sporulation
(bacterium)



Alga *Ceratium*

Penicillium notatum
conidiophore
(fungus)

SEMs courtesy of Dennis Kunkel Inc.

Independent study

1. Look at the evidence for the endosymbiotic theory. Be prepared to present the evidence that mitochondria and chloroplasts arose from a symbiotic interaction between an early eukaryote and a prokaryote.

2. Review aerobic respiration (see Figure 5.17).

3. Review the light dependent and light independent reactions of photosynthesis (see Figure 5.24 and 5.25).

Microscopy Basics

-Living preparations

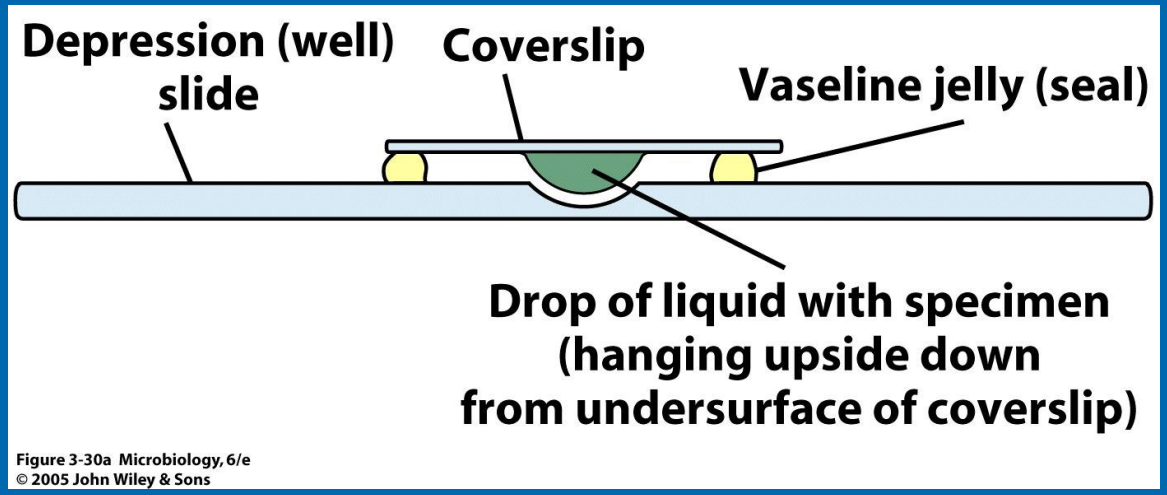


Figure 3-30a Microbiology, 6/e

Microscopy Basics

Living preparations

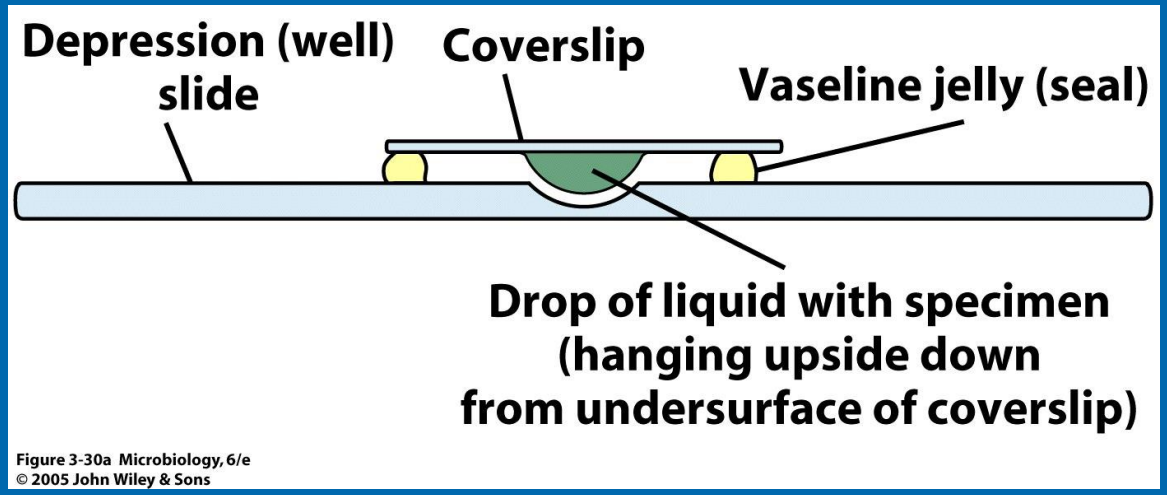
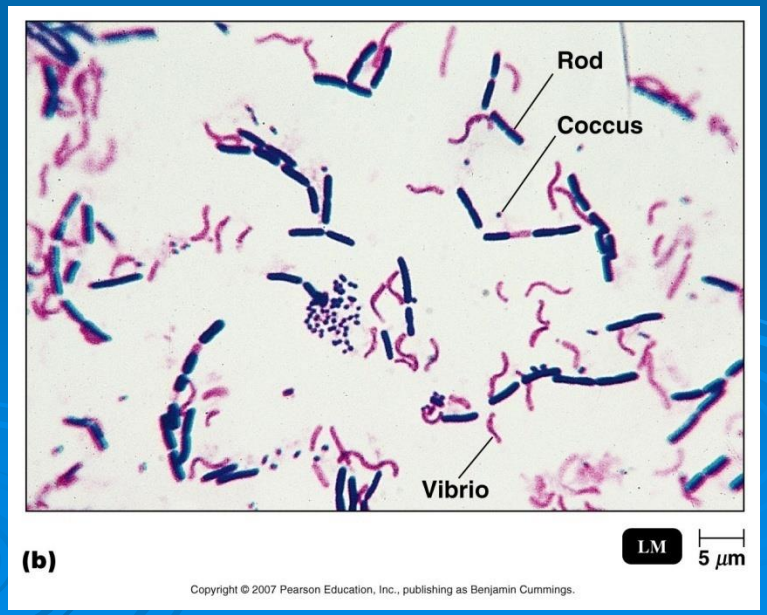
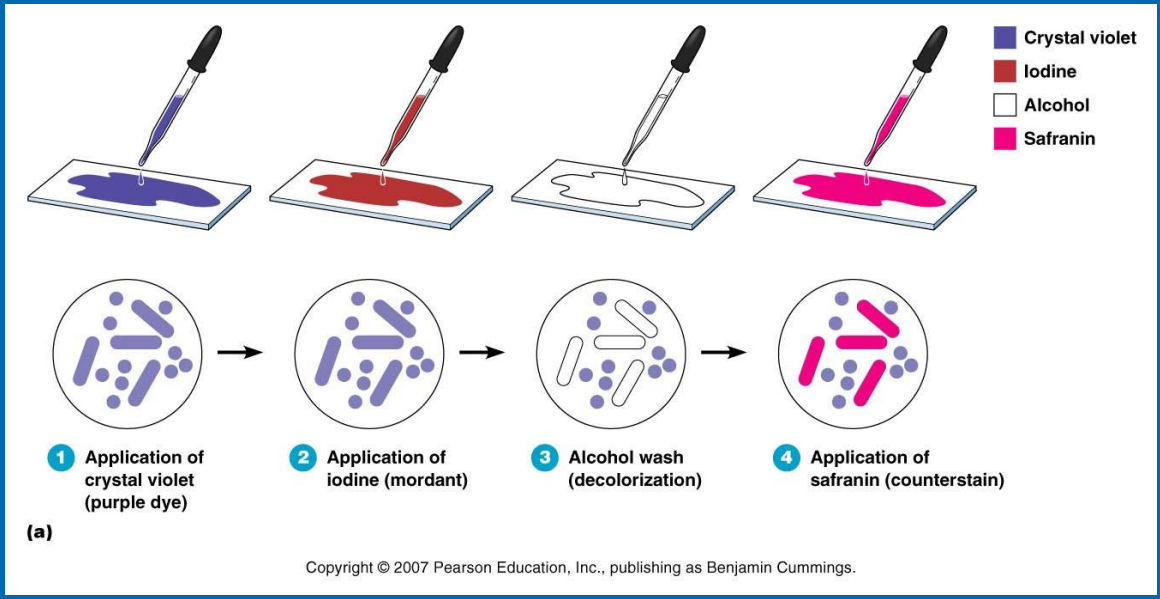


Figure 3-30a Microbiology, 6/e
© 2005 John Wiley & Sons

Stained preparations



Differential stains-
The Gram Stain



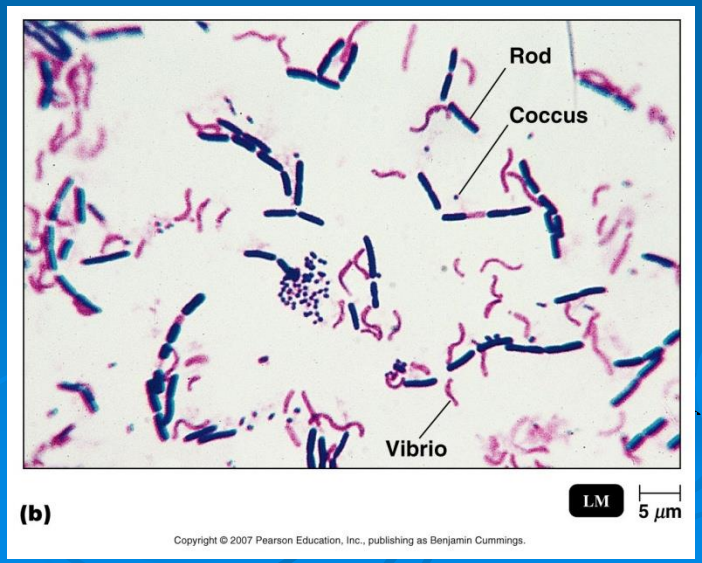
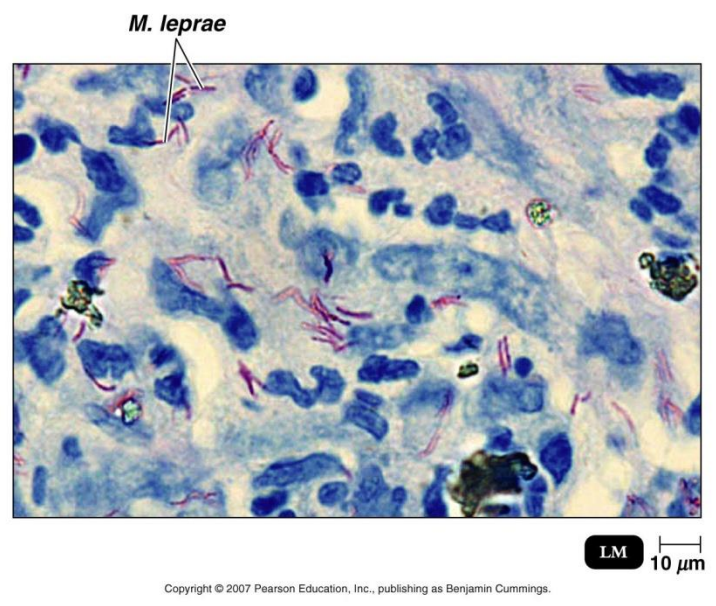
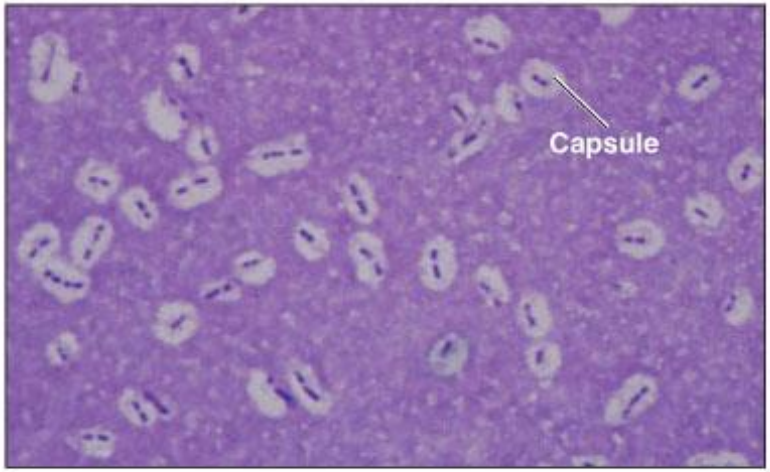


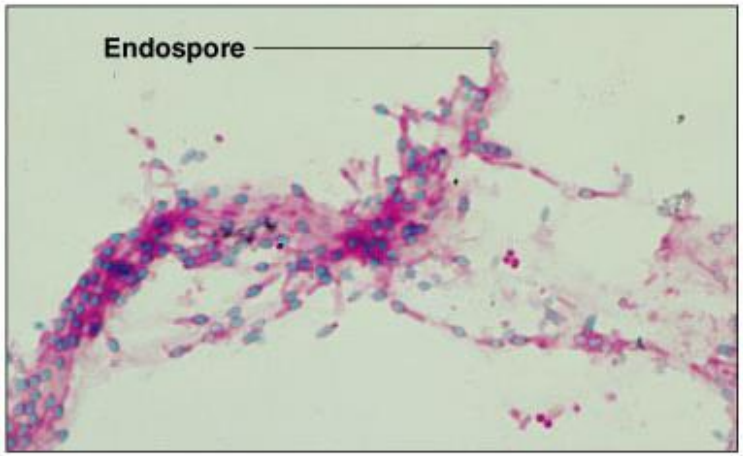
Figure 3.11a

Differential and special stains





(a) Negative staining.



(b) Endospore staining.

(c) Flagella staining.

Figure 3.12 and 3.13