Five-Kingdom Tree of Life

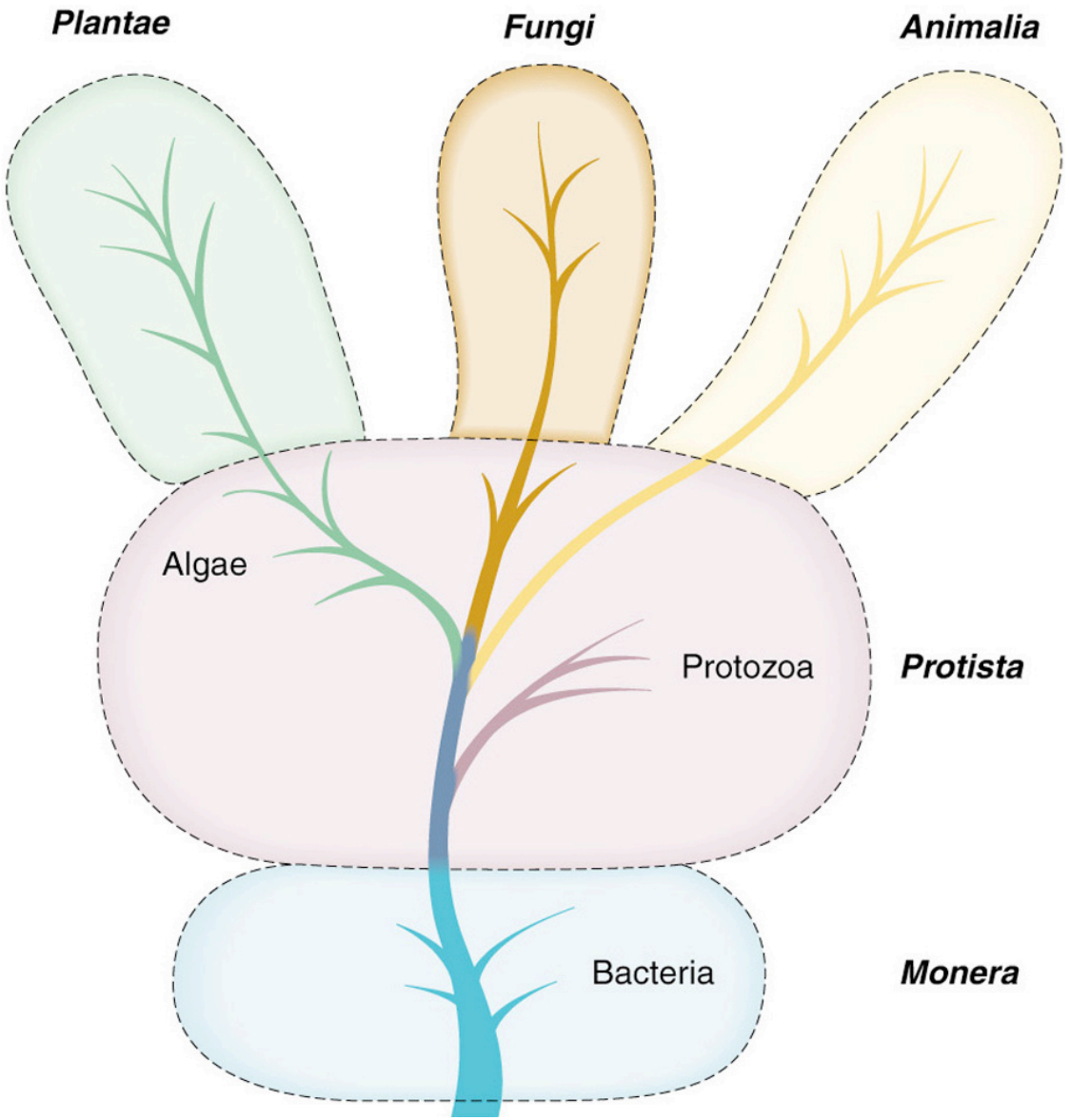


Fig. 19.12

Three Domain Tree of Life

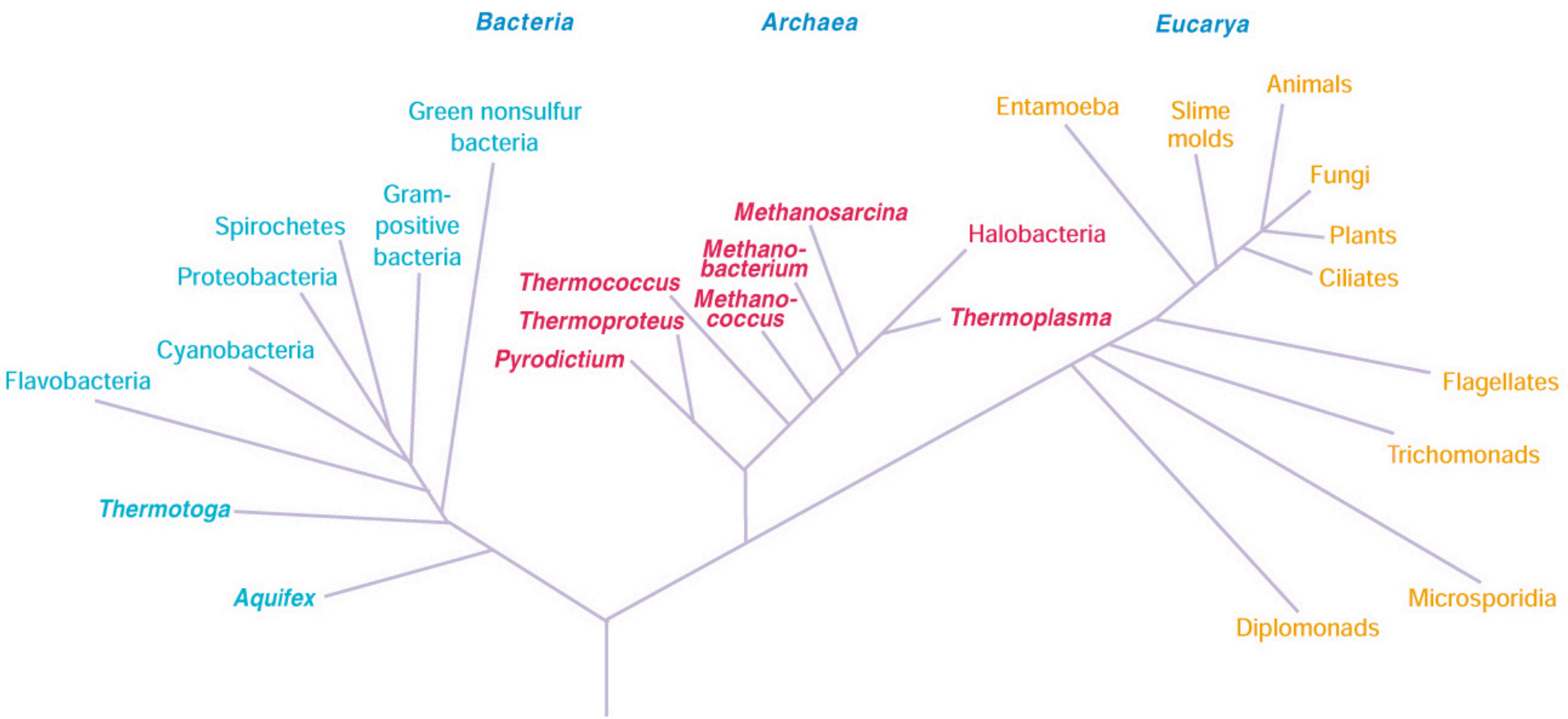


Fig. 19.3

16S rRNA

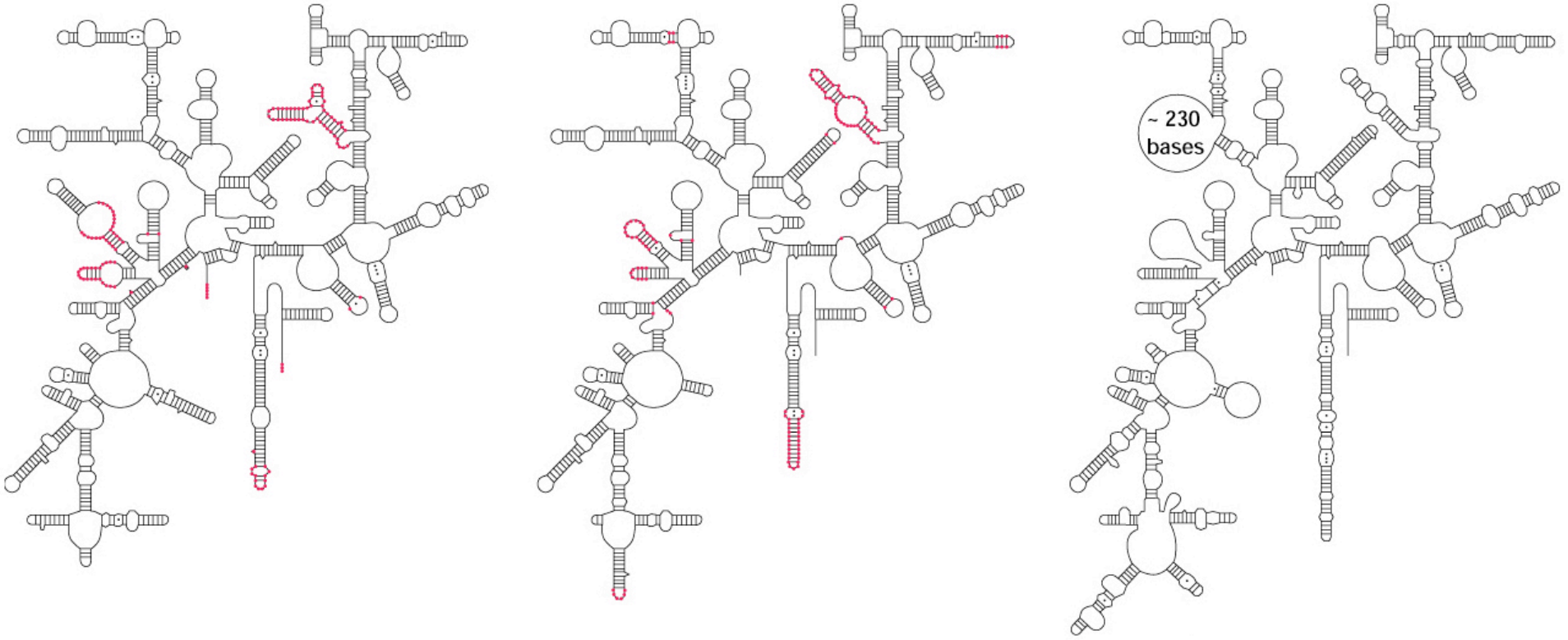


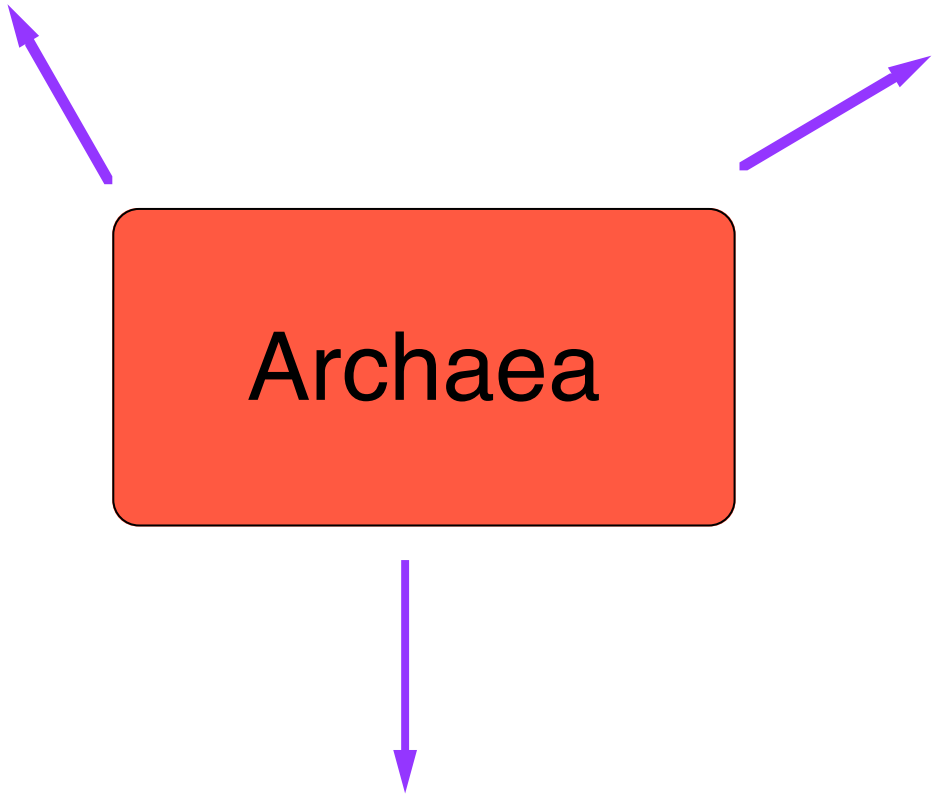
Fig. 19.9

Thermophiles

hot , acidic environments
Yellowstone geysers

Halophiles

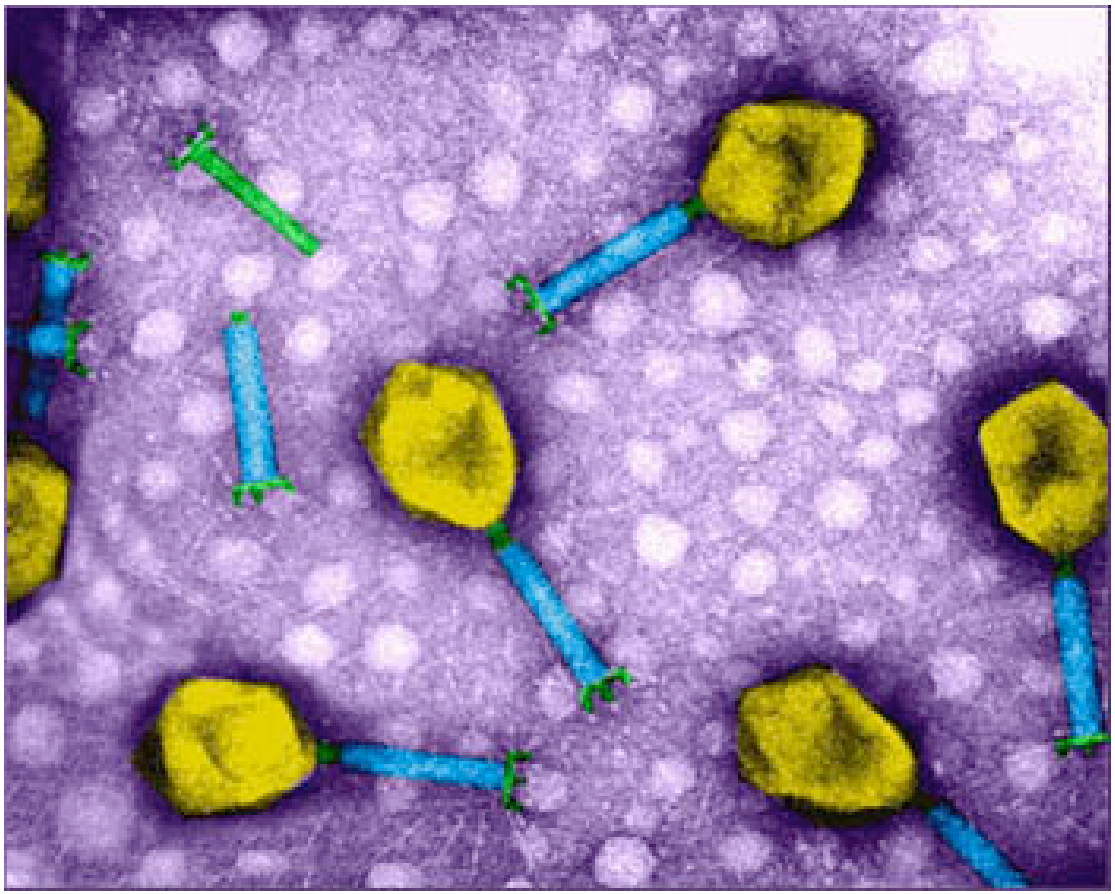
high salt concentrations
Great Sal Lake



Methanogens

swamps, sewage animal gut
produce methane
M. jannaschii from hydrothermal vent

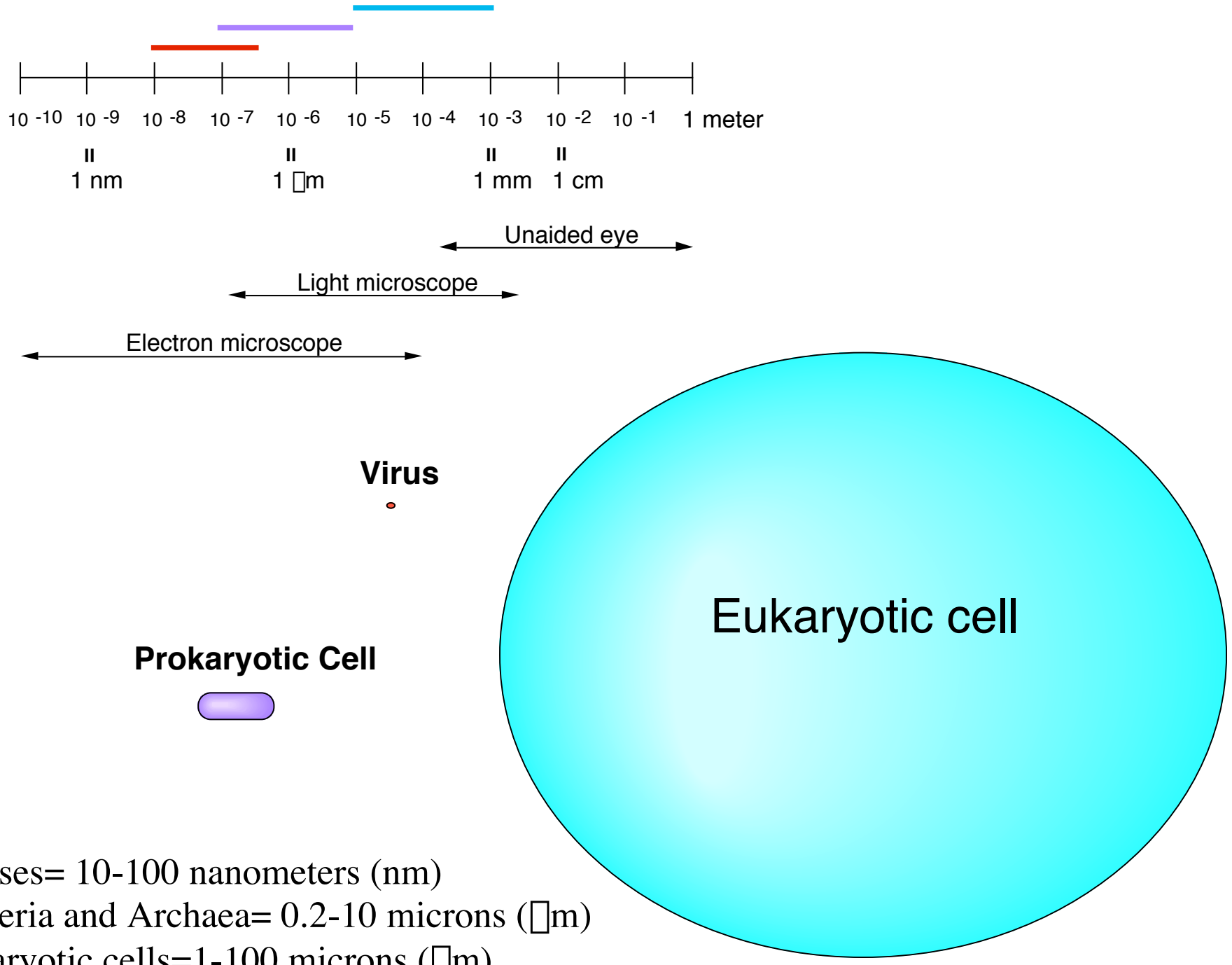
Where do viruses fit in?



Classification

Table 19.1 An Example of Taxonomic Ranks and Names

Rank	Example
Domain	*Bacteria*
Phylum	*Proteobacteria*
Class	γ-Proteobacteria
Order	*Enterobacteriales*
Family	*Enterobacteriaceae*
Genus	*Shigella*
Species	*S. dysenteriae*



Viruses= 10-100 nanometers (nm)
Bacteria and Archaea= 0.2-10 microns (μm)
Eukaryotic cells=1-100 microns (μm)

Table 2.1

Common Units of Measurement

Unit	Abbreviation	Value
1 centimeter	cm	10^{-2} meter or 0.394 inches
1 millimeter	mm	10^{-3} meter
1 micrometer	μm	10^{-6} meter
1 nanometer	nm	10^{-9} meter
1 Angstrom	Å	10^{-10} meter

Compound Brightfield Microscope

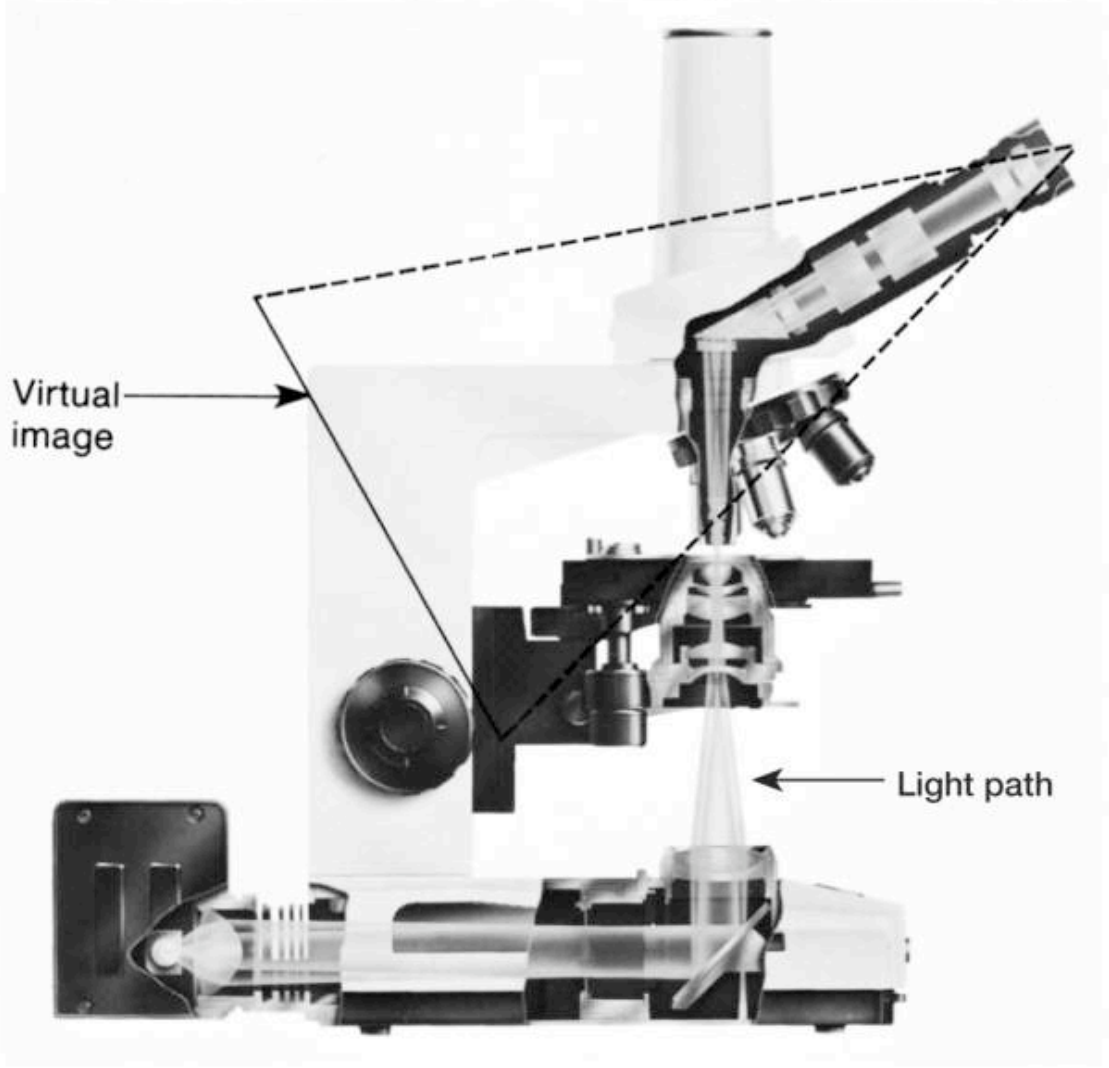


Fig. 2.4

Focal Length

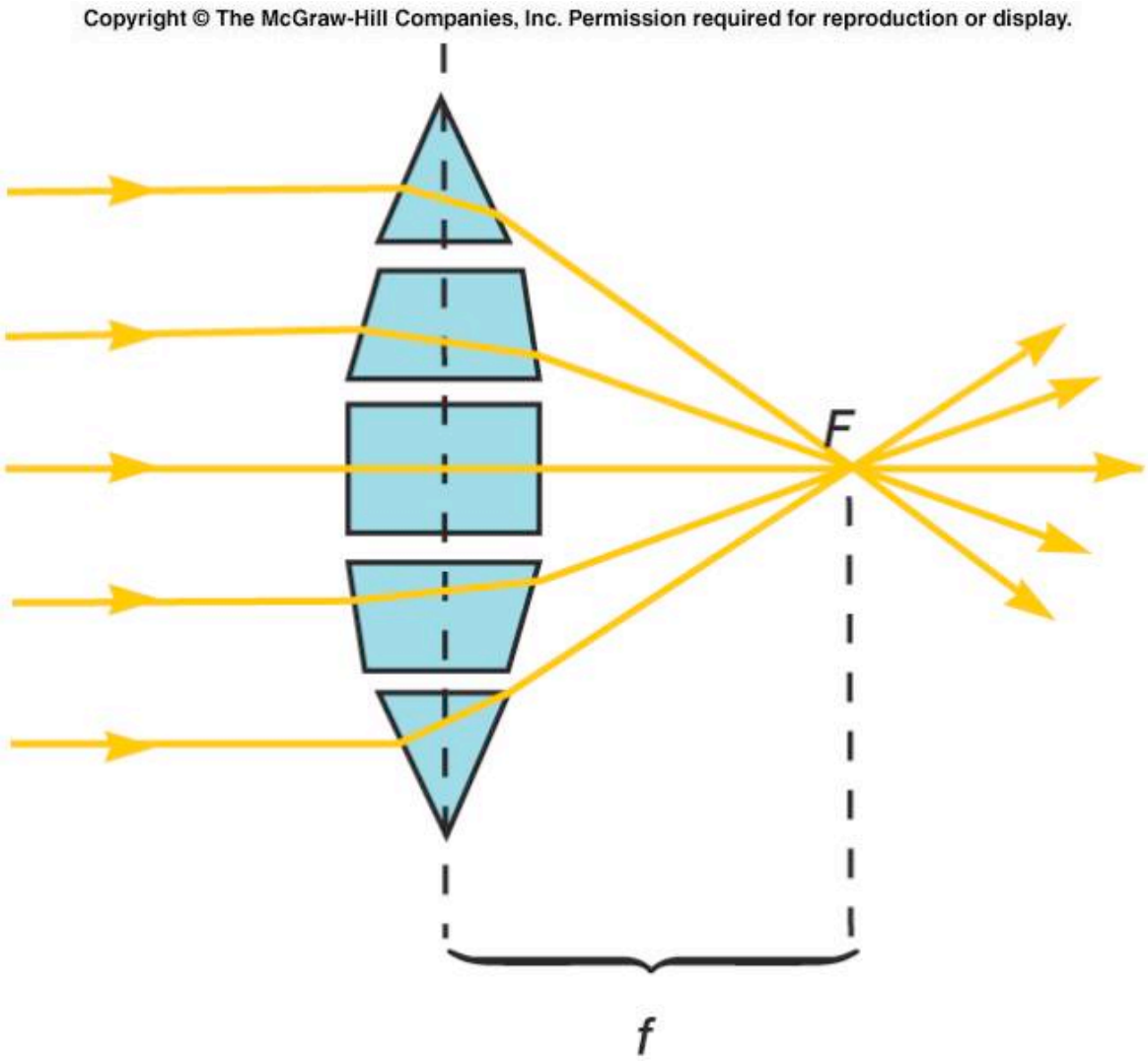


Fig. 2.2

Resolution

Table 2.2

The Properties of Microscope Objectives

	Objective			
Property	**Scanning**	**Low Power**	**High Power**	**Oil Immersion**
Magnification	4×	10×	40–45×	90–100×
Numerical aperture	0.10	0.25	0.55–0.65	1.25–1.4
Approximate focal length (*f*)	40 mm	16 mm	4 mm	1.8–2.0 mm
Working distance	17–20 mm	4–8 mm	0.5–0.7 mm	0.1 mm
Approximate resolving power with light of 450 nm (blue light)	2.3 µm	0.9 µm	0.35 µm	0.18 µm

Refraction and Oil Immersion

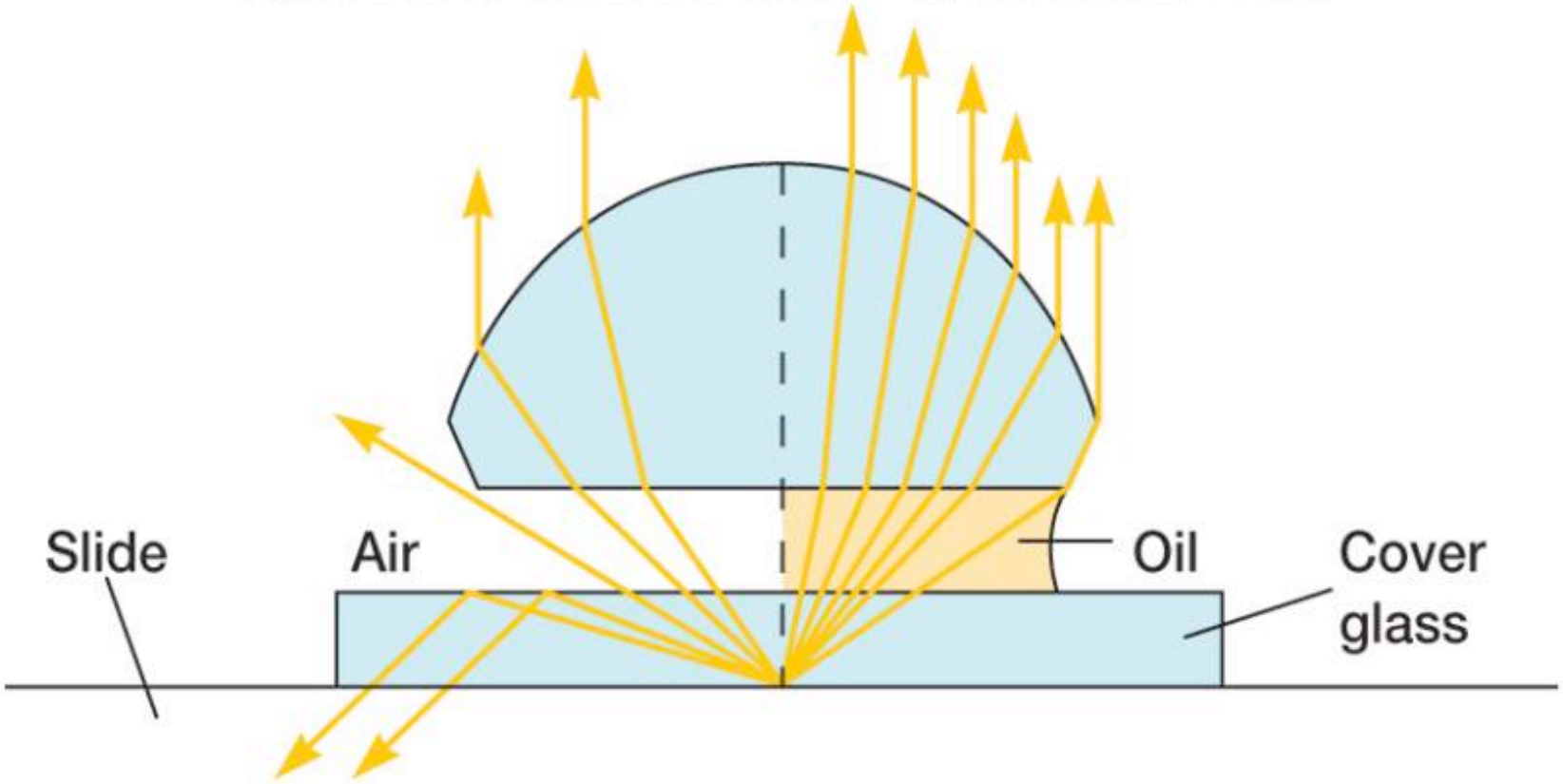


Fig. 2.6

Phase Contrast Microscopy

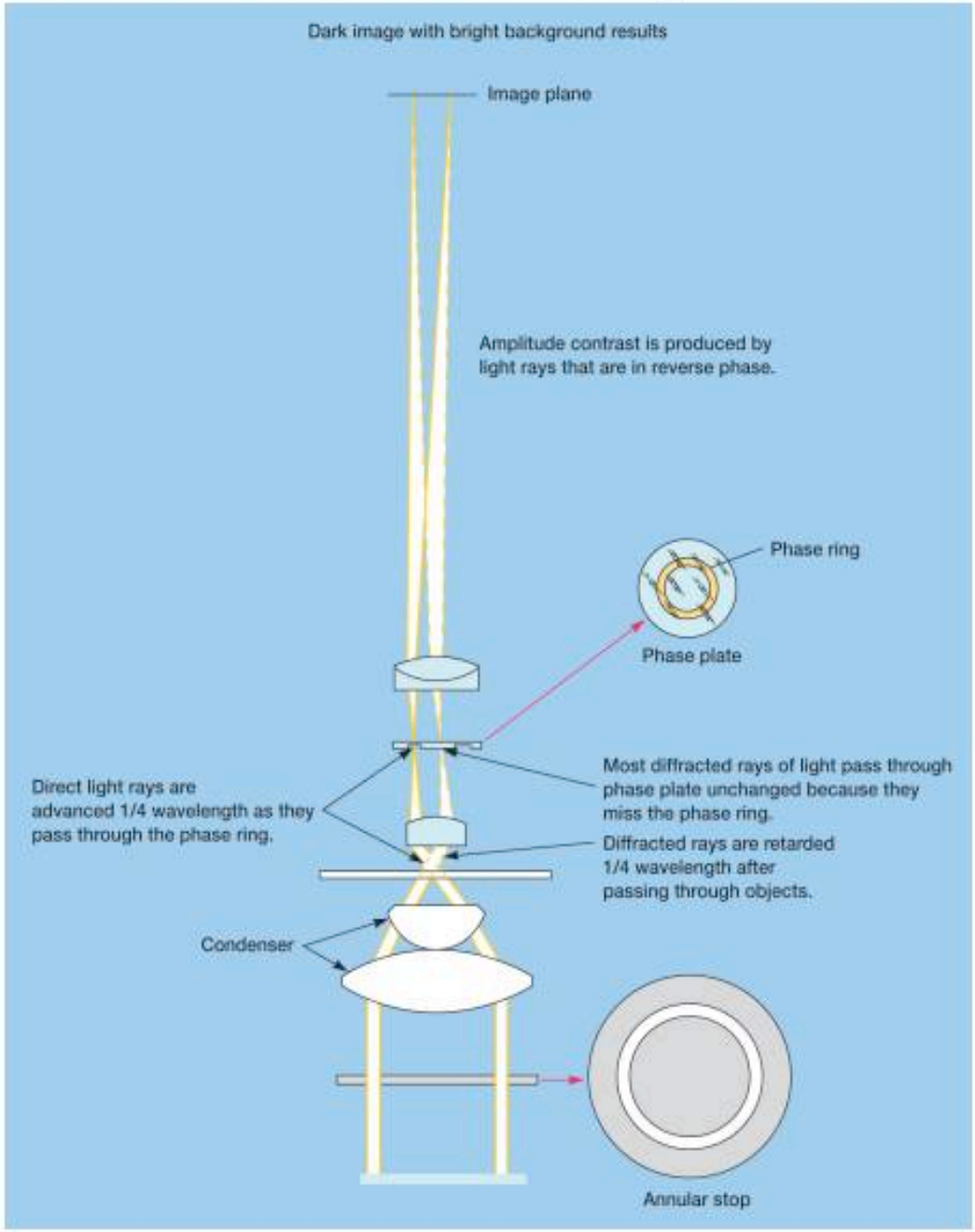


Fig. 2.9

Production of Contrast

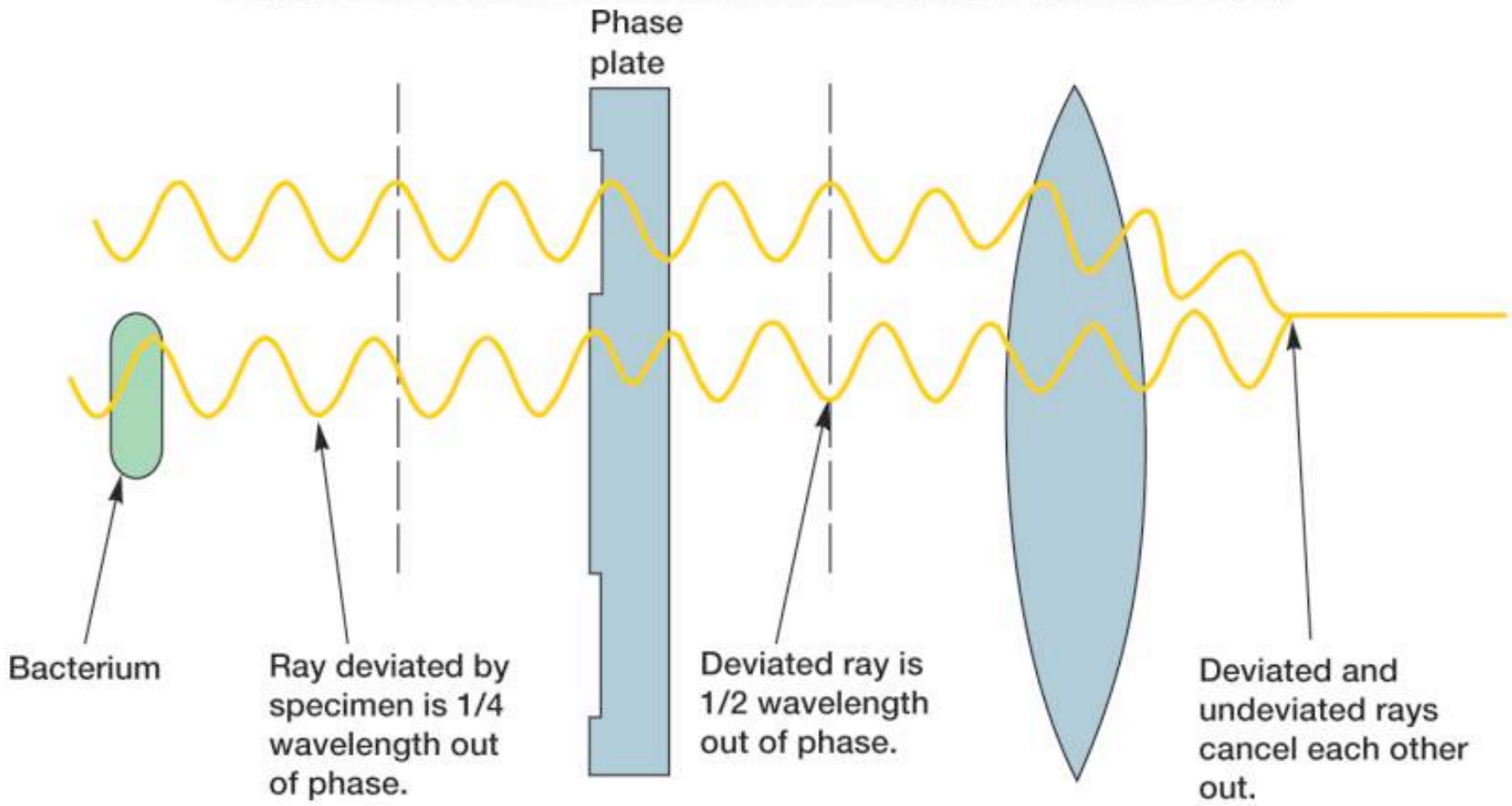
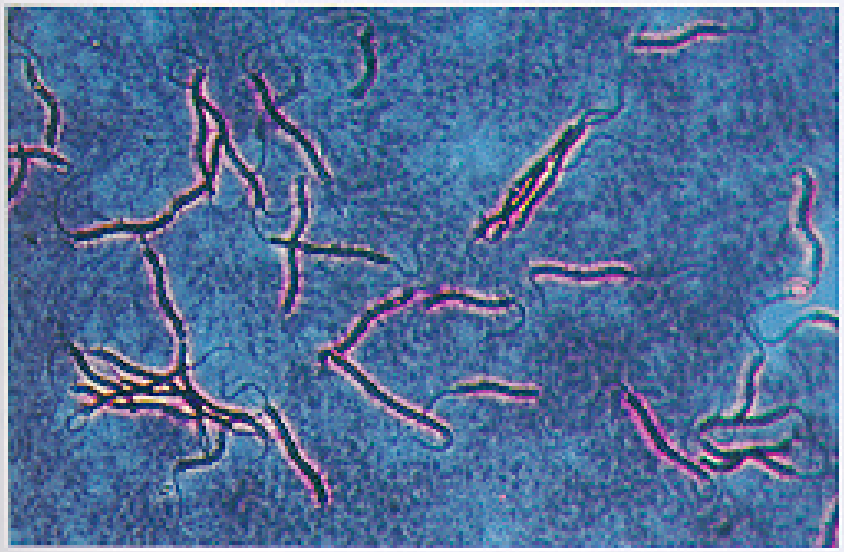
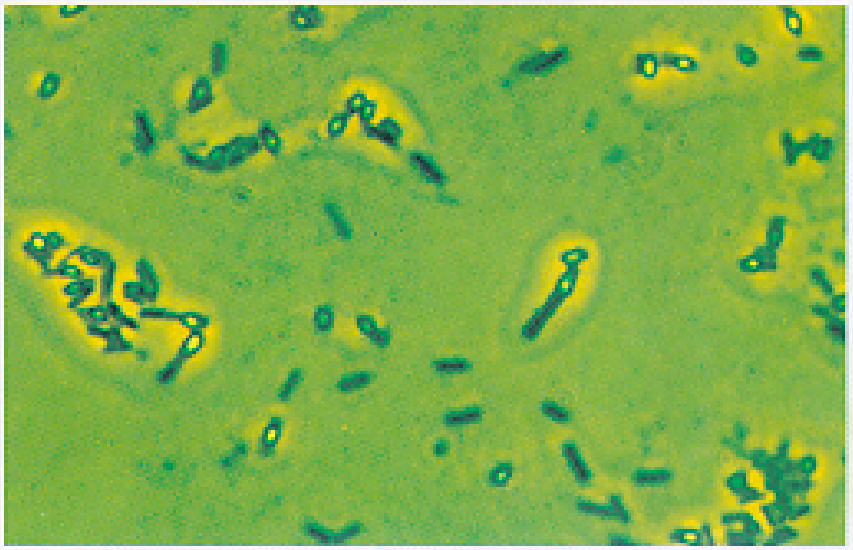


Fig. 2.10





Fluorescence microscopy

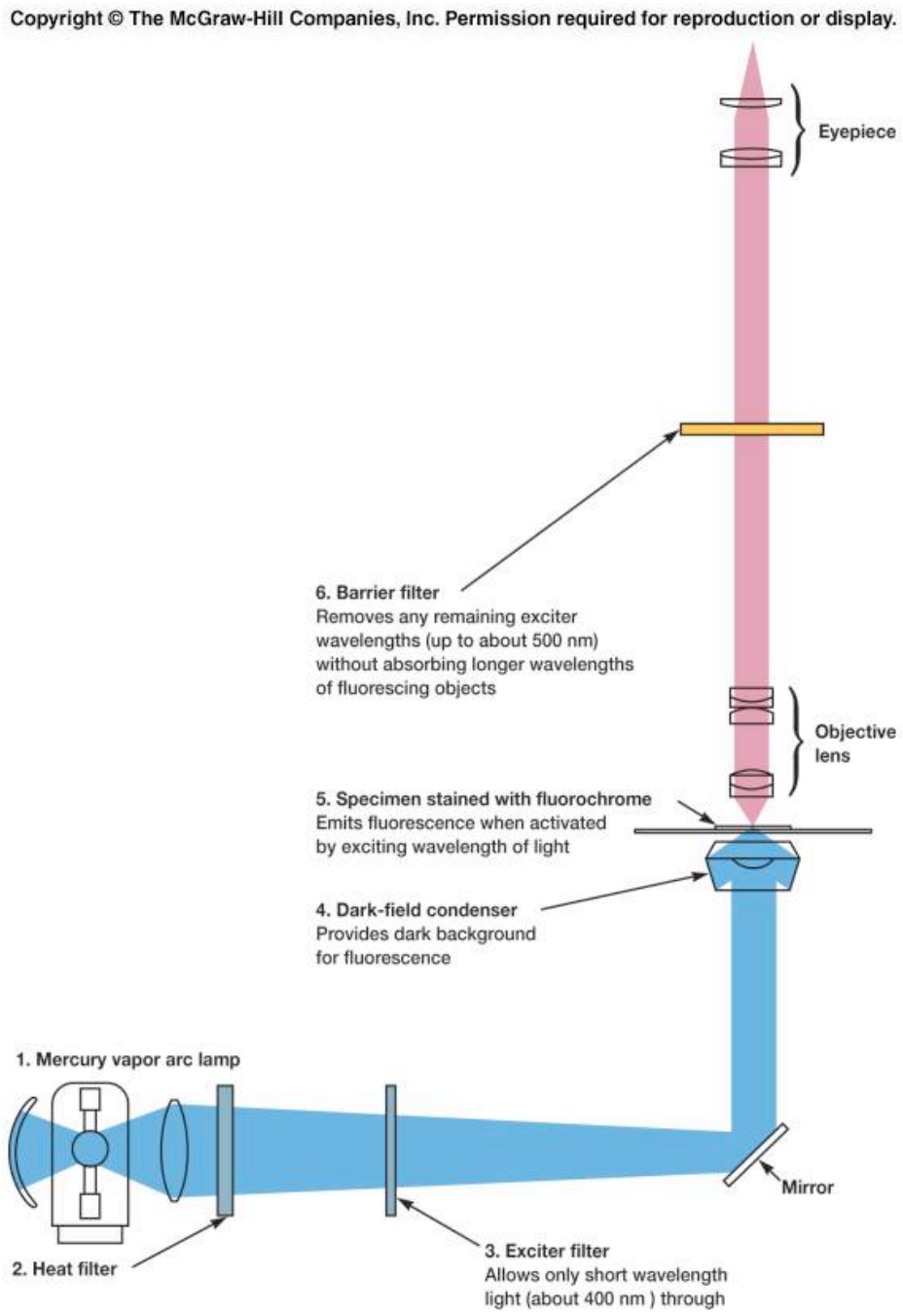
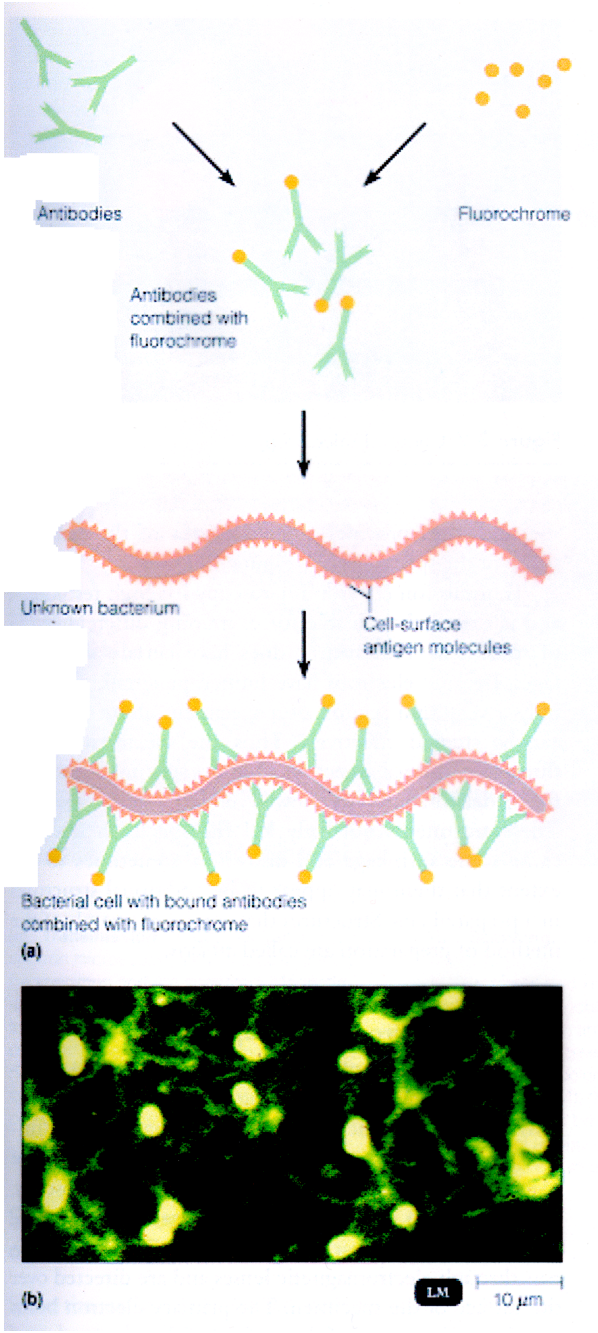
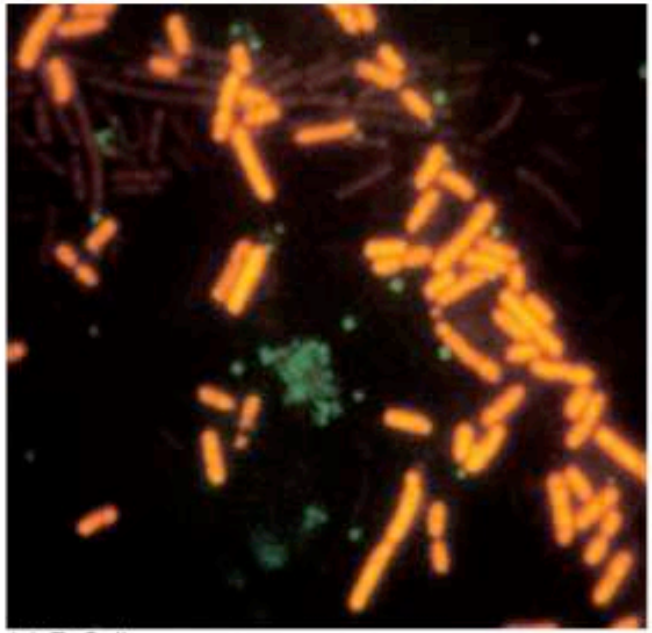
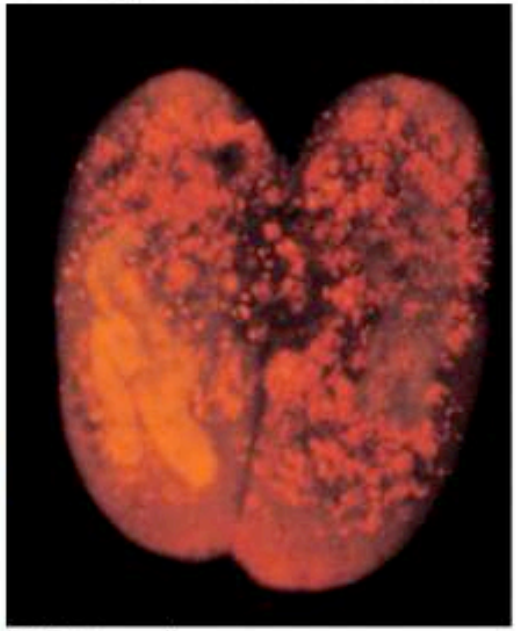


Fig. 2.12


Antibodies
Fluorochrome
Antibodies combined with fluorochrome
Unknown bacterium
Cell-surface antigen molecules
Bacterial cell with bound antibodies combined with fluorochrome
(a)
(b)
LM
10 μm

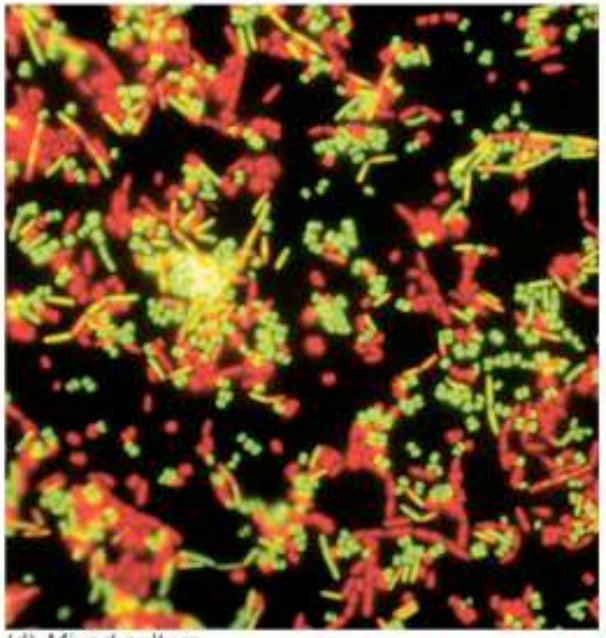


(a) *E. Coli*



(b) *P. tetraurelia*

(c) *C. lucilae*



(d) *Mixed culture*

Confocal Microscopy

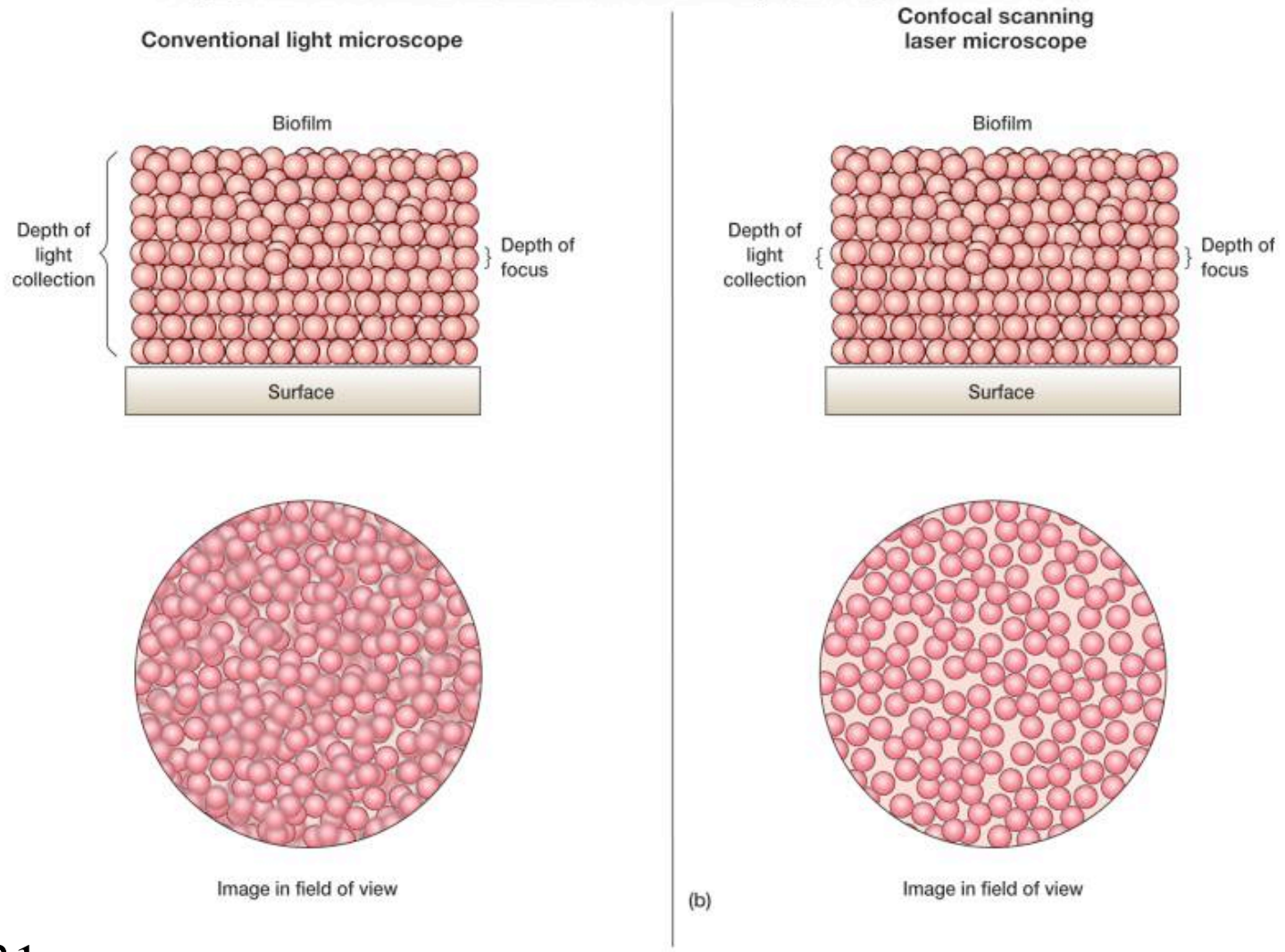
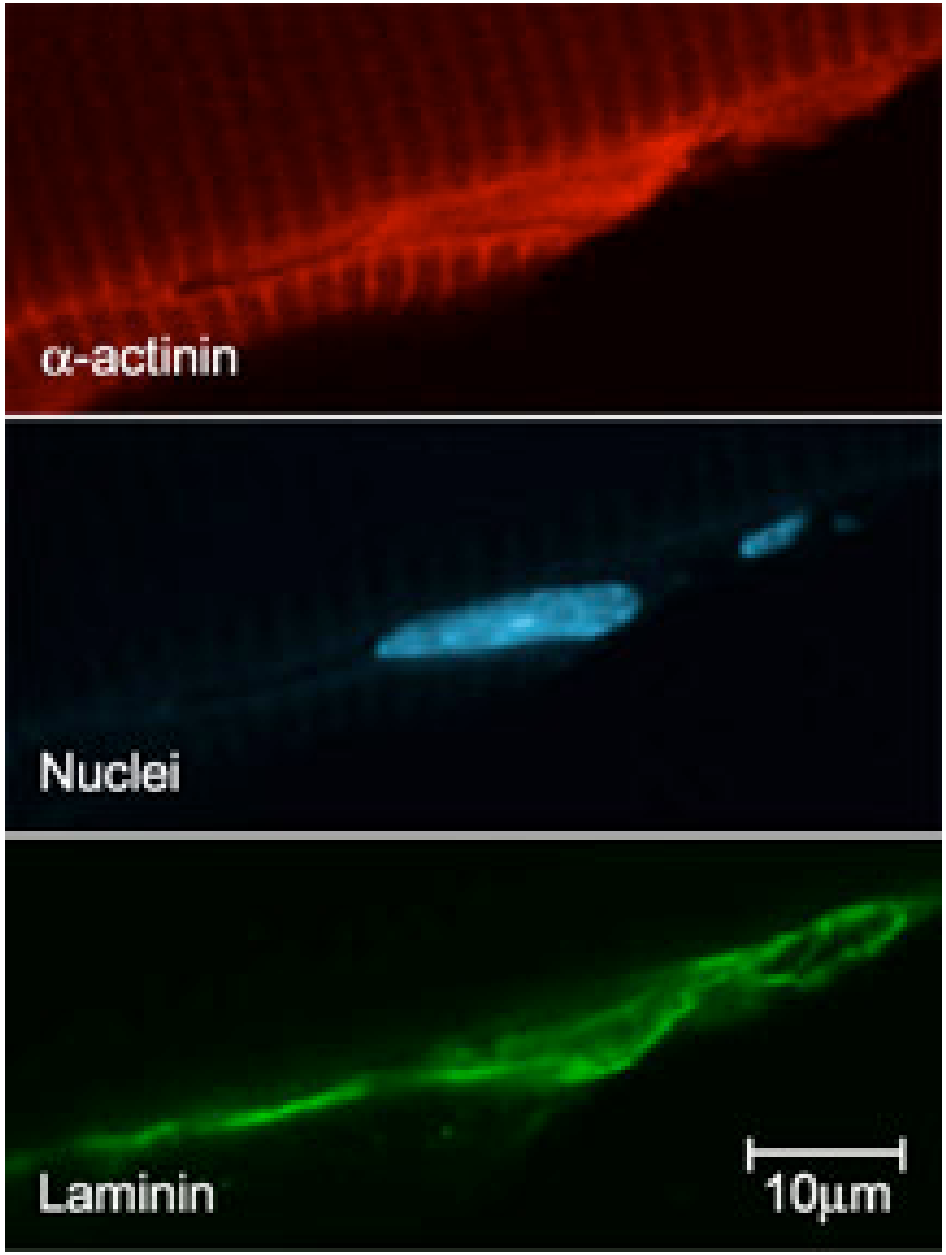


Fig. 2.31


α-actinin
Nuclei
Laminin
10μm

Electron Microscopy

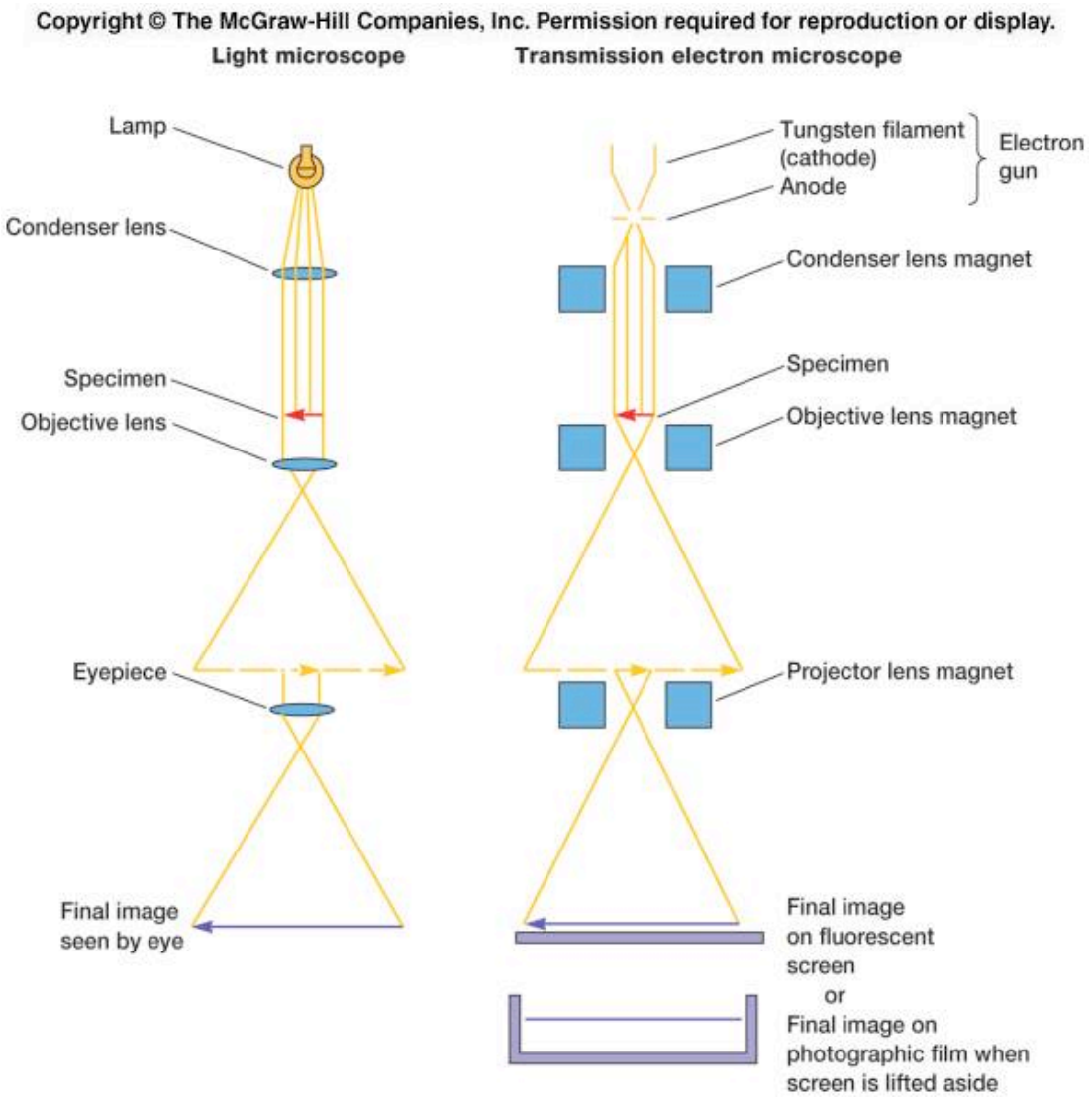


Fig. 2.23

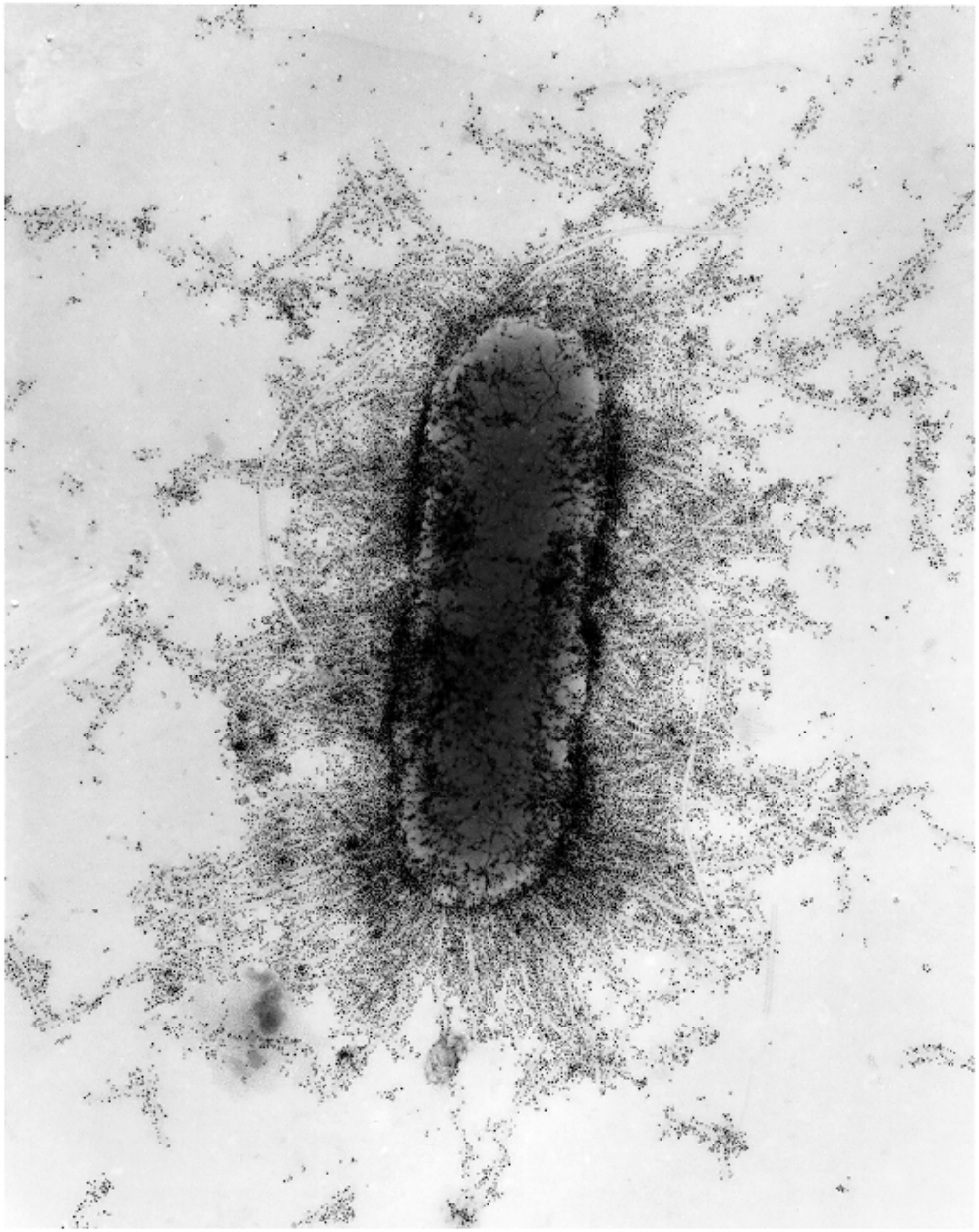
Table 2.3
Characteristics of Light and Transmission Electron Microscopes

Feature	Light Microscope	Electron Microscope
Highest practical magnification	About 1,000–1,500	Over 100,000
Best resolution[a]	0.2 µm	0.5 nm
Radiation source	Visible light	Electron beam
Medium of travel	Air	High vacuum
Type of lens	Glass	Electromagnet
Source of contrast	Differential light absorption	Scattering of electrons
Focusing mechanism	Adjust lens position mechanically	Adjust current to the magnetic lens
Method of changing magnification	Switch the objective lens or eyepiece	Adjust current to the magnetic lens
Specimen mount	Glass slide	Metal grid (usually copper)

[a]The resolution limit of a human eye is about 0.2 mm.

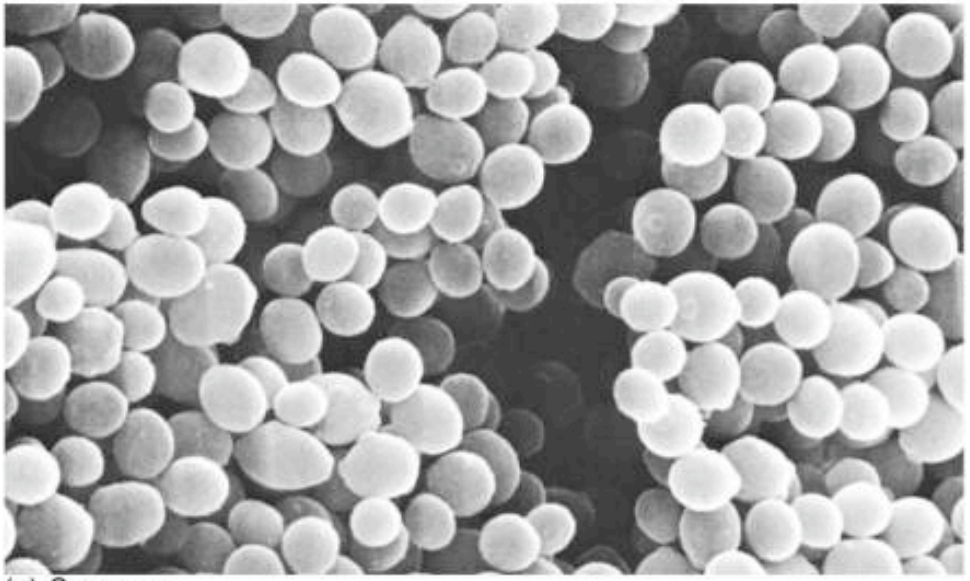
TEM

- 10,000-100,000 X



SEM

- 1,000-10,000X



(a) *S. aureus*

(b) *Cristispira*

Fig. 2.28

Which microscope do you use?

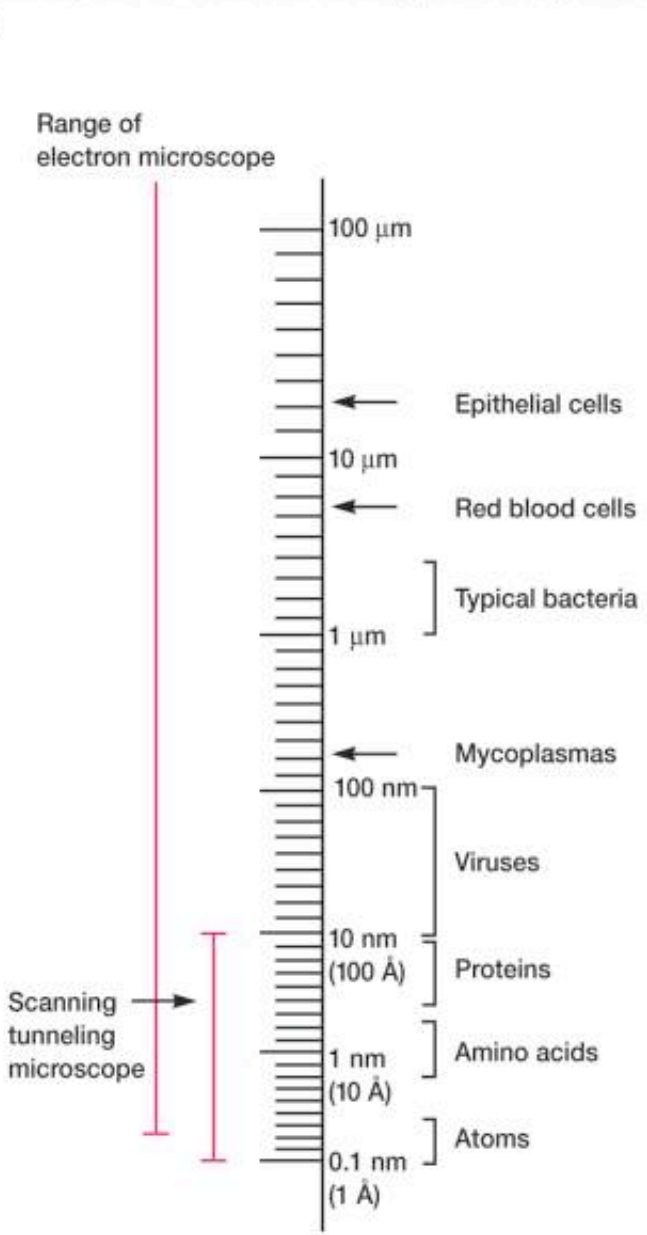
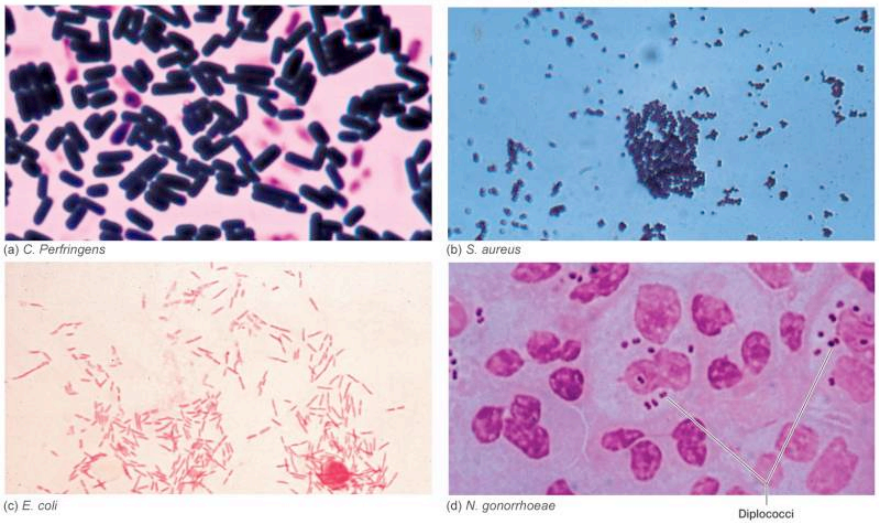


Fig. 2.20

Staining organisms

- Fixation
  - Heat
  - Chemical
- Dyes= contain chromophores
  - Basic (e.g. crystal violet, methylene blue)
  - Acidic (e.g nigrosin, eosin)
- Mordant

Gram Stain Technique a differential stain



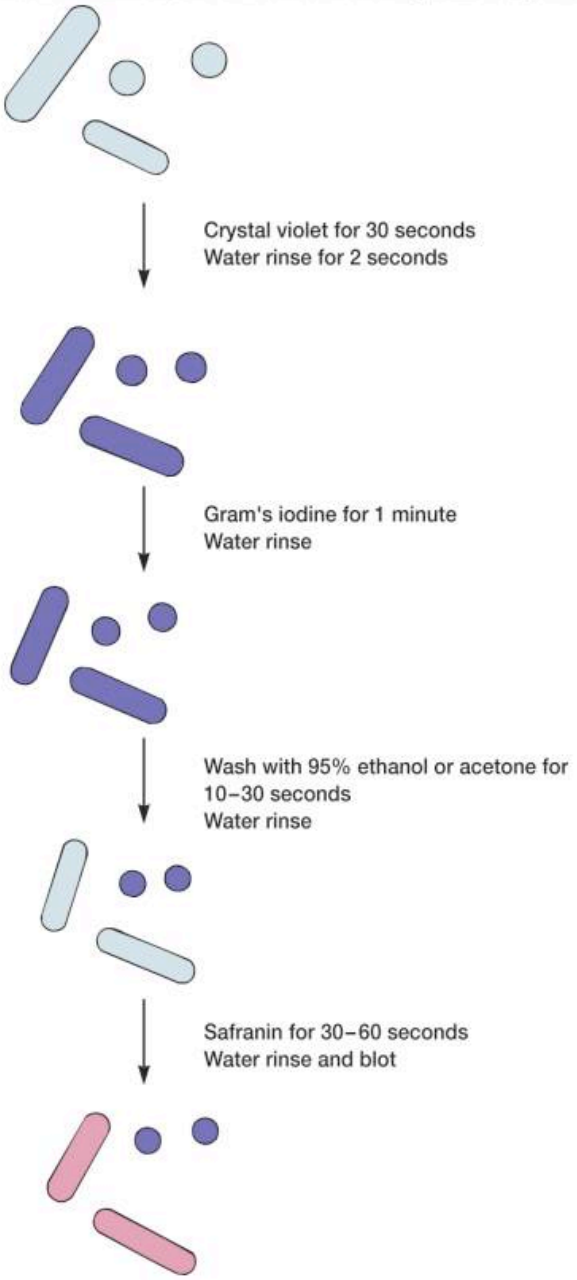


Fig. 2.14

Endospore Stain

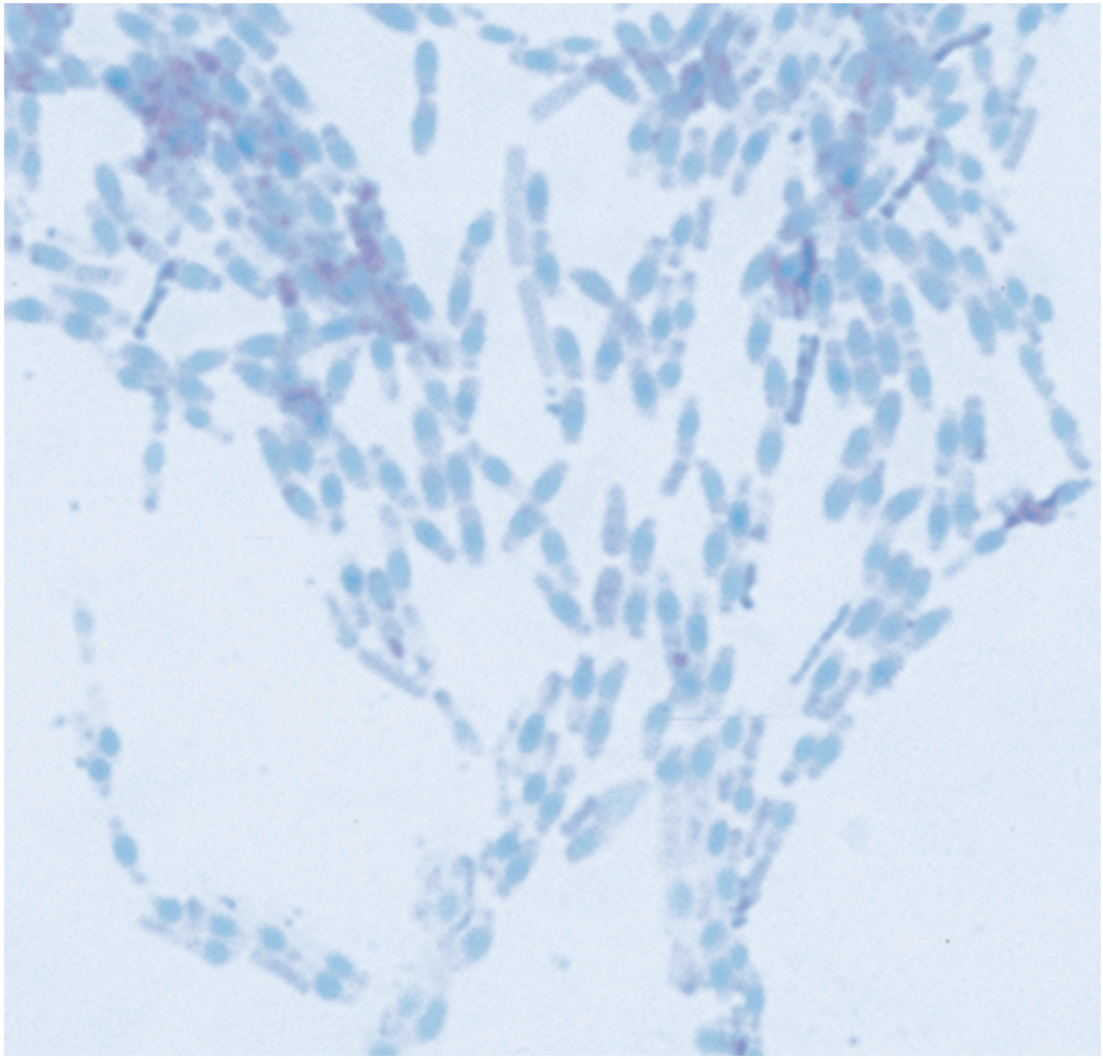


Fig. 2.18

Flagella Stain

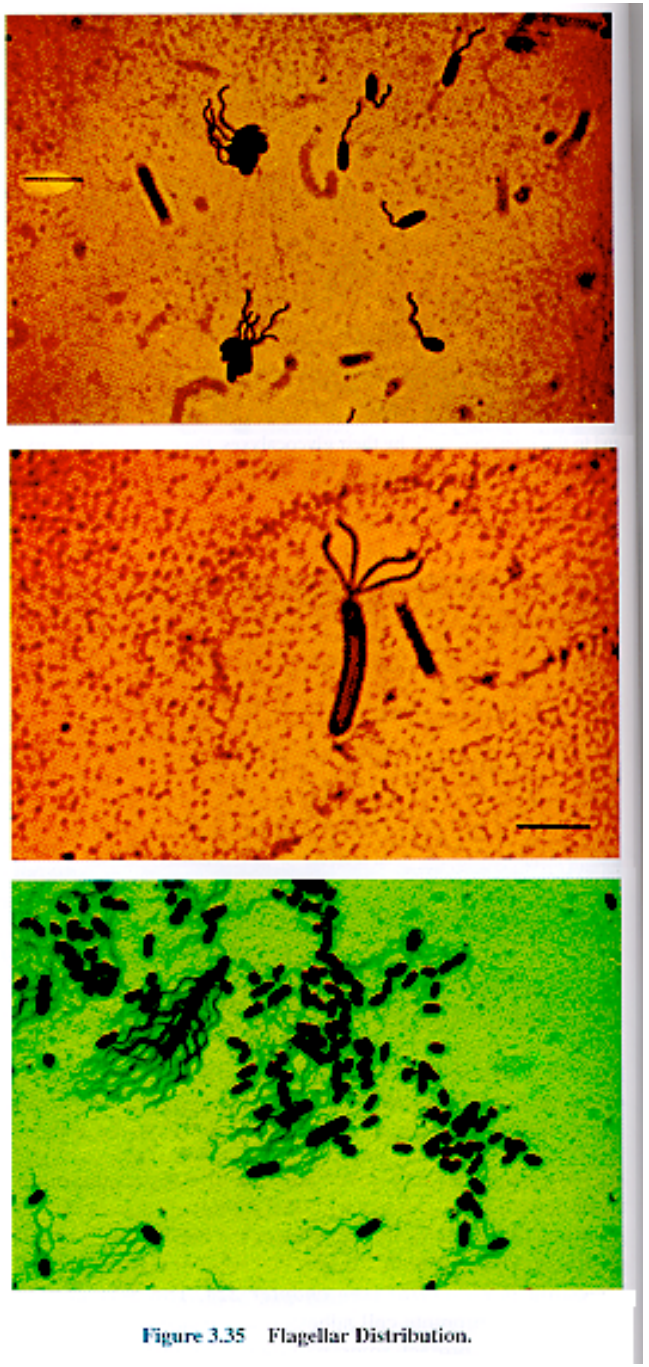


Figure 3.35 Flagellar Distribution.

Fig. 2.19

Capsule Stain

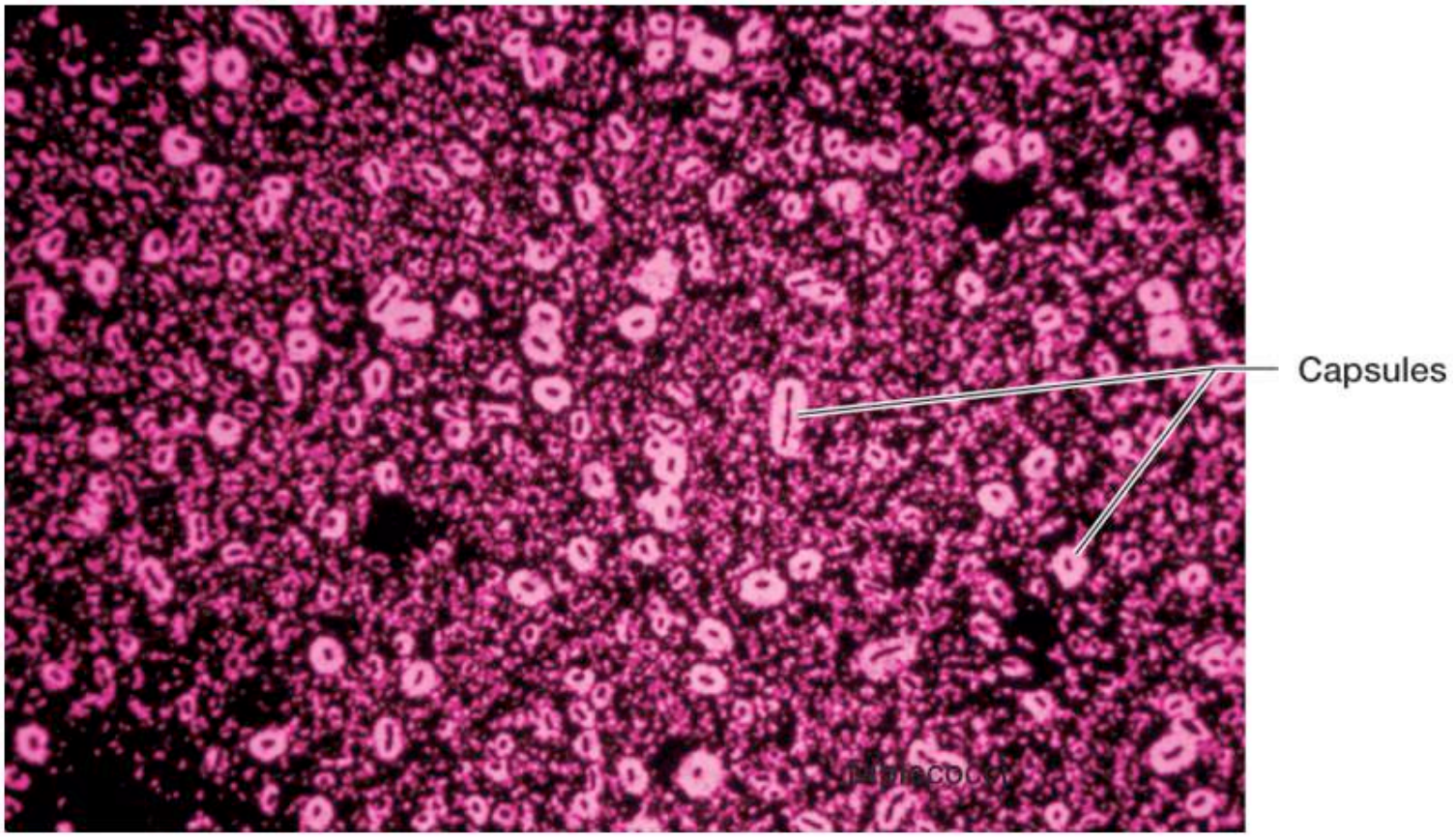


Fig. 2.17