INTRODUCTION USING THE METRIC SYSTEM TO EXPRESS THE SIZES OF MICROBES

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LEARNING OBJECTIVES

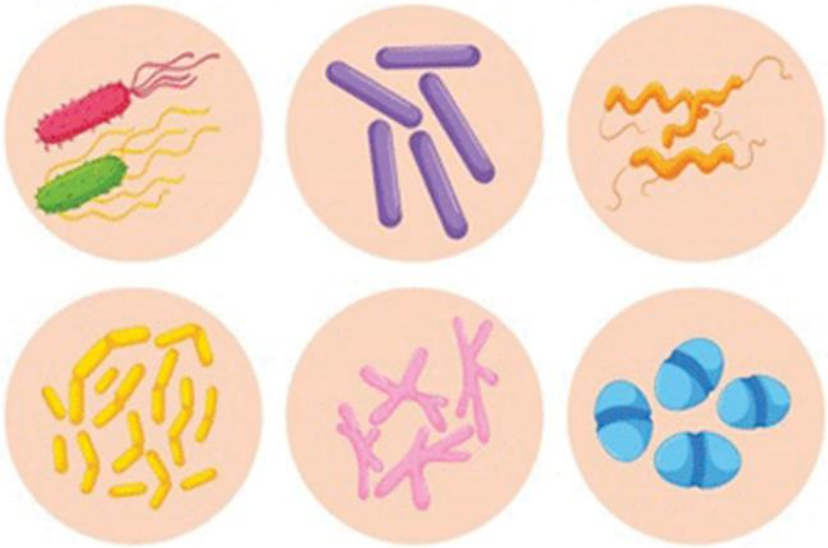
1. **Explain the interrelationships among the following metric system units of length: centimeters, millimeters, micrometers & nanometers**

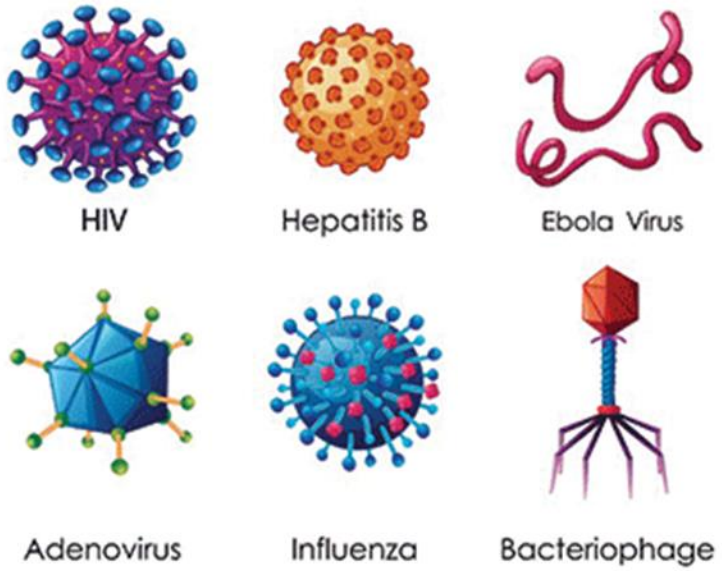
2. **State the metric units used to express the sizes of bacteria, protozoa & viruses**

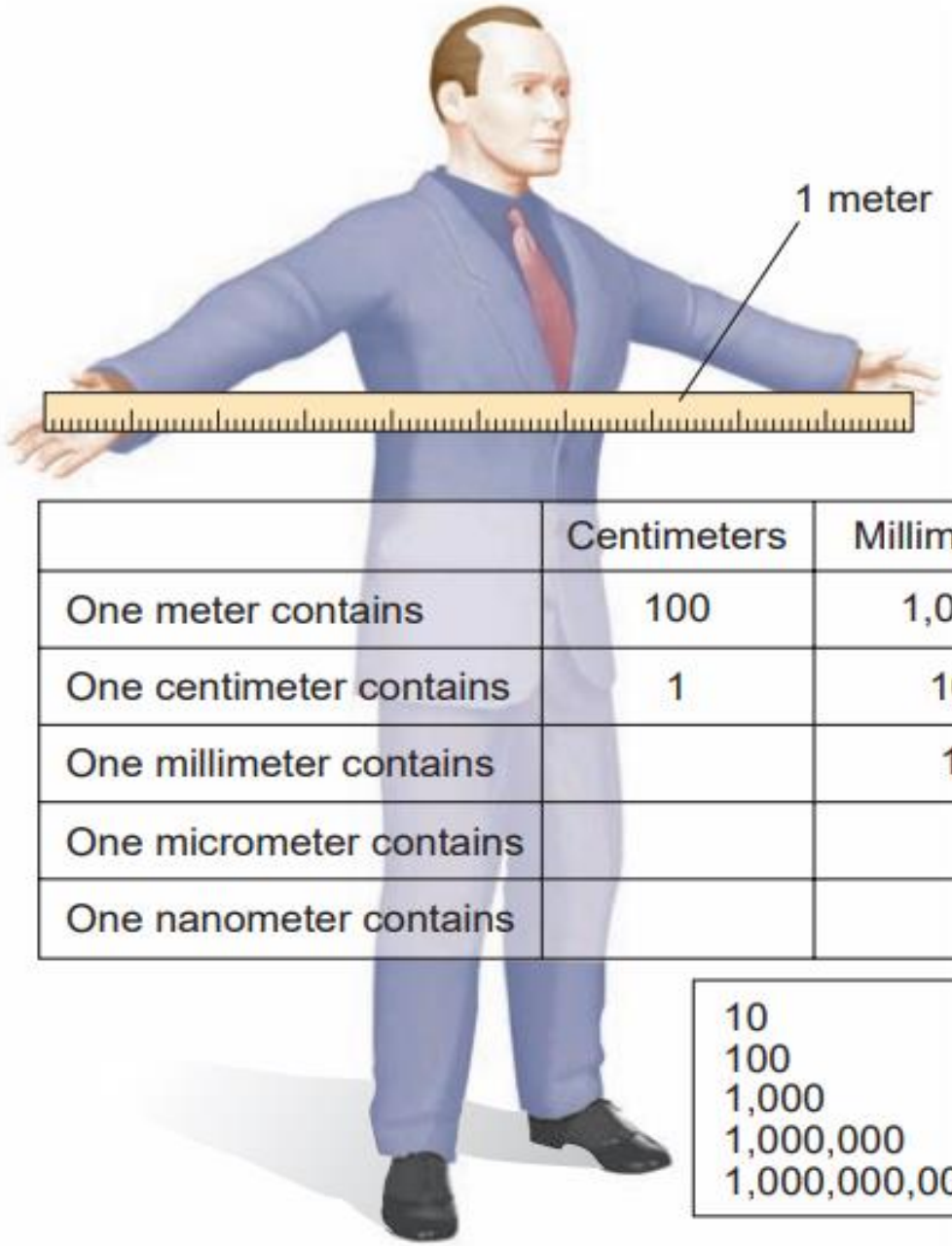
3. **Compare and contrast the various types of microscopes, to include simple microscopes, compound light microscopes, electron microscopes, and atomic force microscopes**

The sizes of bacteria are expressed in micrometers, whereas the sizes of viruses are expressed in nanometers.

Bacteria VS Virus



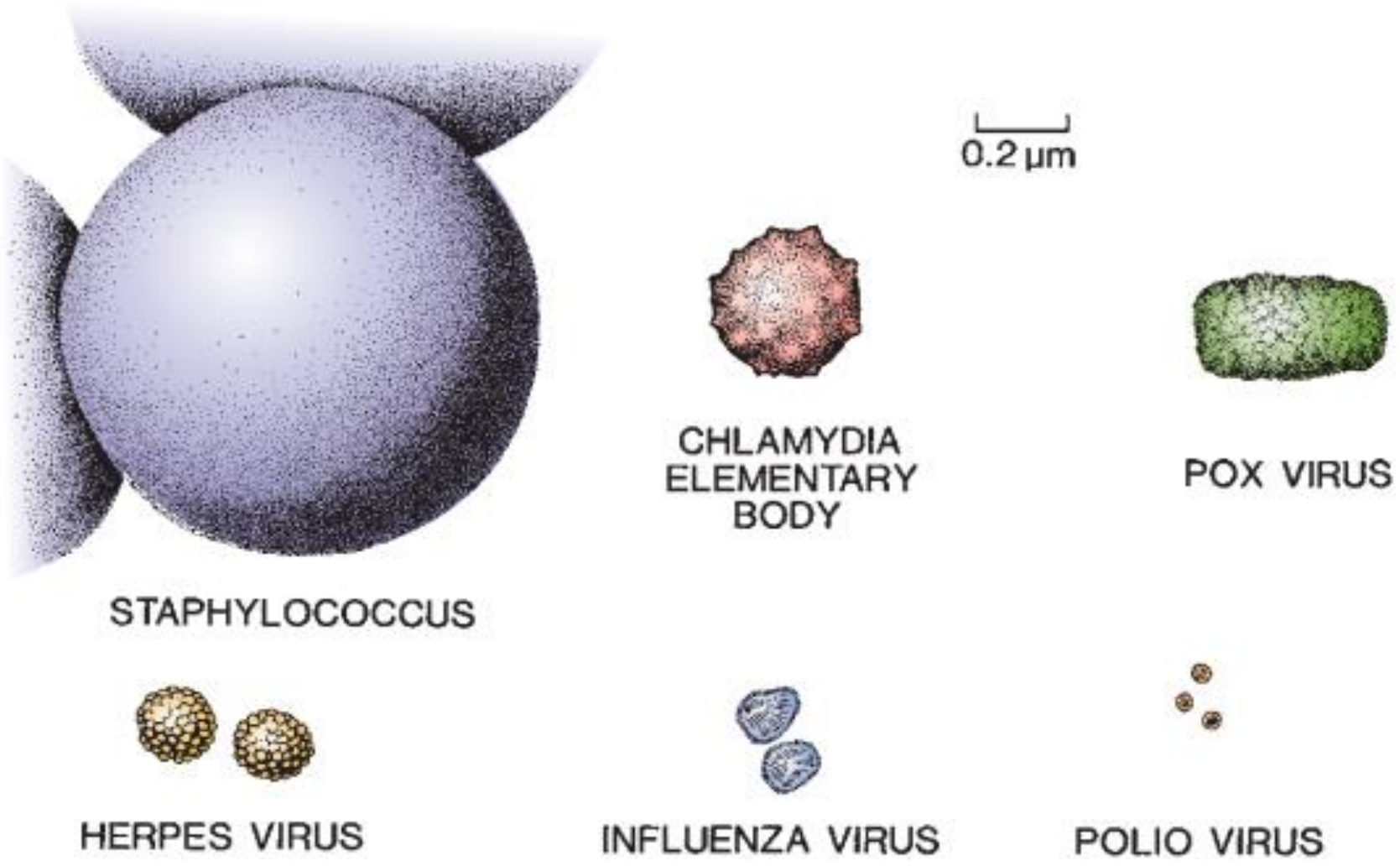




	Centimeters	Millimeters	Micrometers	Nanometers
One meter contains	100	1,000	1,000,000	1,000,000,000
One centimeter contains	1	10	10,000	10,000,000
One millimeter contains		1	1,000	1,000,000
One micrometer contains			1	1,000
One nanometer contains				1

$$
\begin{aligned}
10 &= 1 \times 10^{1} \\
100 &= 1 \times 10^{2} \\
1{,}000 &= 1 \times 10^{3} \\
1{,}000{,}000 &= 1 \times 10^{6} \\
1{,}000{,}000{,}000 &= 1 \times 10^{9}
\end{aligned}
$$

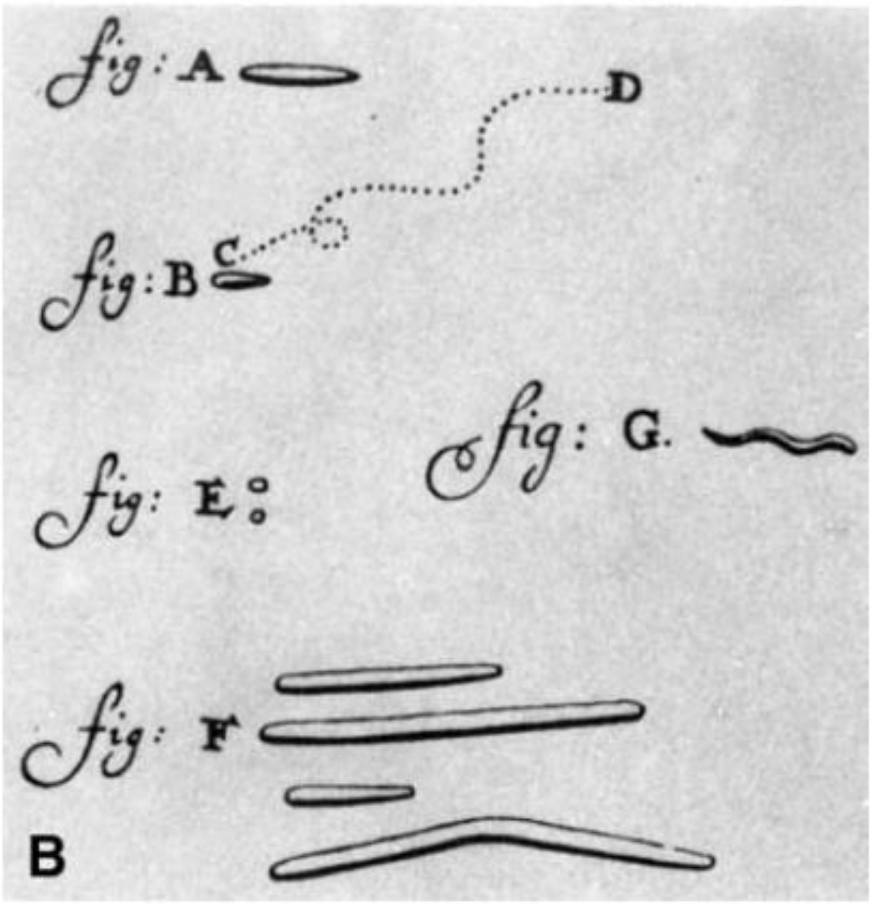
The relative sizes of Staphylococcus and Chlamydia bacteria and several viruses.



Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.

MICROBE OR MICROBIAL STRUCTURE	DIMENSION(S)	APPROXIMATE SIZE (μm)
Viruses (most)	Diameter	0.01–0.3
Bacteria		
Cocci (spherical bacteria)	Diameter	average = 1
Bacilli (rod-shaped bacteria)	Width × length	average = 1 × 3
	Filaments (width)	1
Fungi		
Yeasts	Diameter	3–5
Septate hyphae (hyphae containing cross-walls)	Width	2–15
Aseptate hyphae (hyphae without cross-walls)	Width	10–30
Pond water protozoa		
Chlamydomonas	Length	5–12
Euglena	Length	35–55
Vorticella	Length	50–145
Paramecium	Length	180–300
Volvox[a]	Diameter	350–500
Stentor[a]	Length (when extended)	1,000–2,000

[a]These organisms are visible with the unaided human eye.



(From Volk WA, et al. Essentials of Medical Microbiology, 5th ed. Philadelphia: Lippincott-Raven, 1996.)

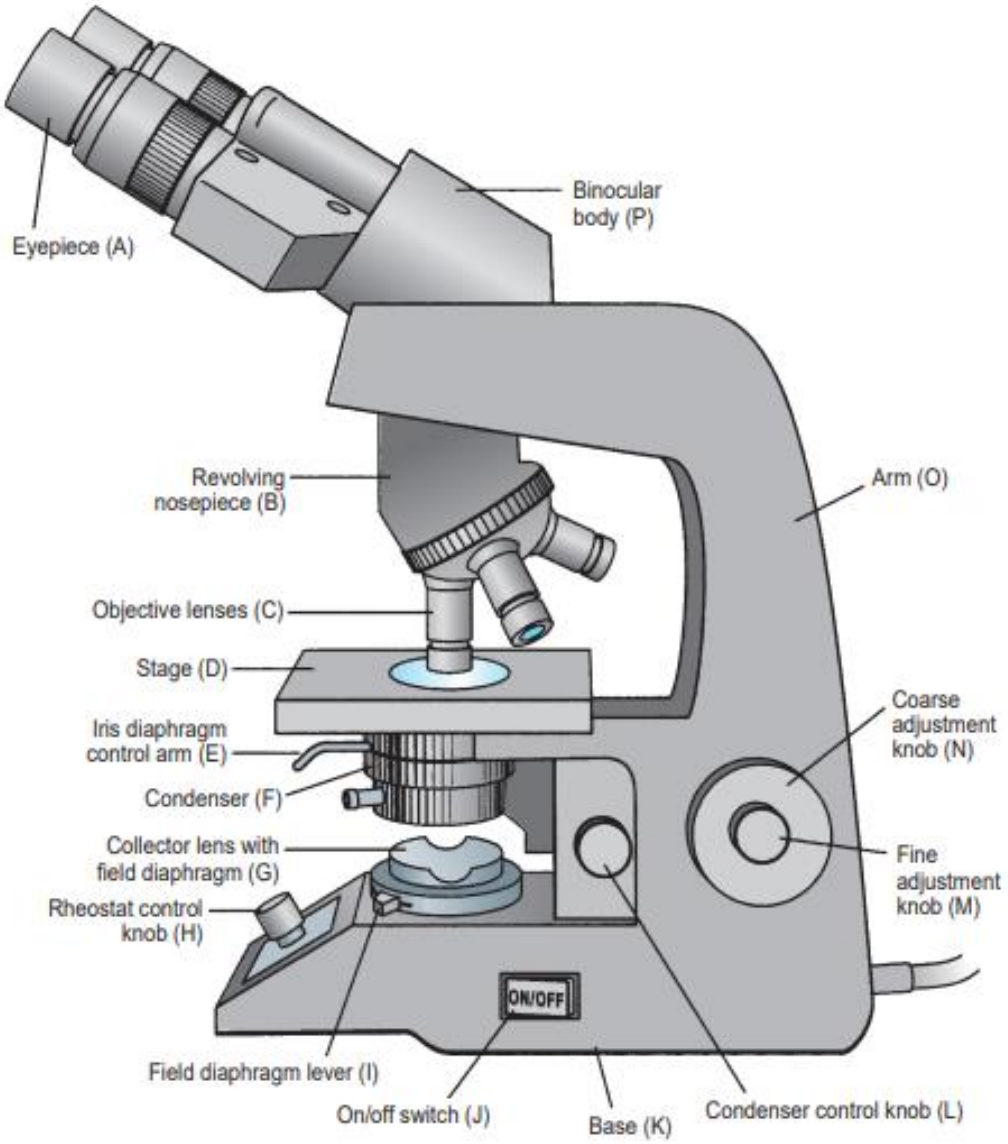
A Leeuwenhoek microscope (center), surrounded by examples of microscopes. (Not to scale.)

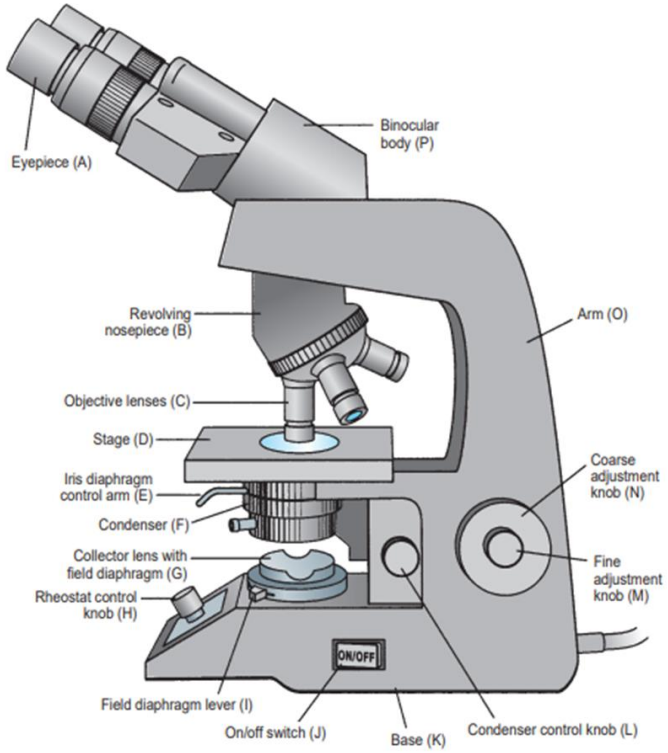






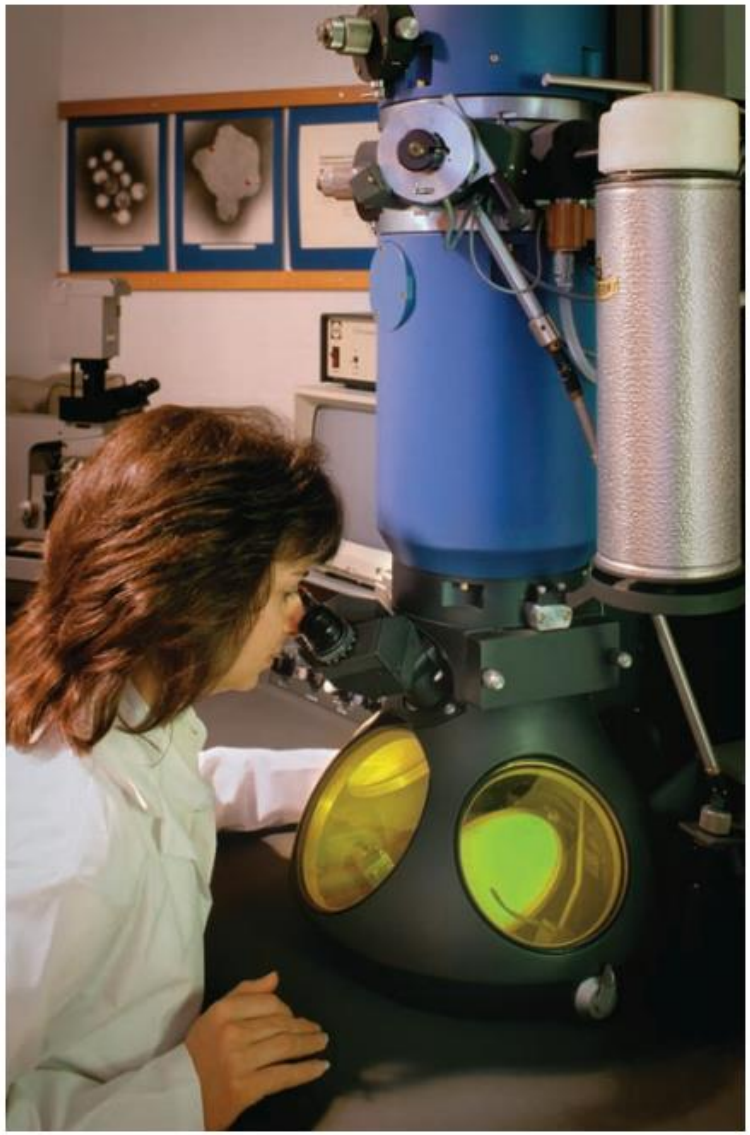

A modern compound light microscope.





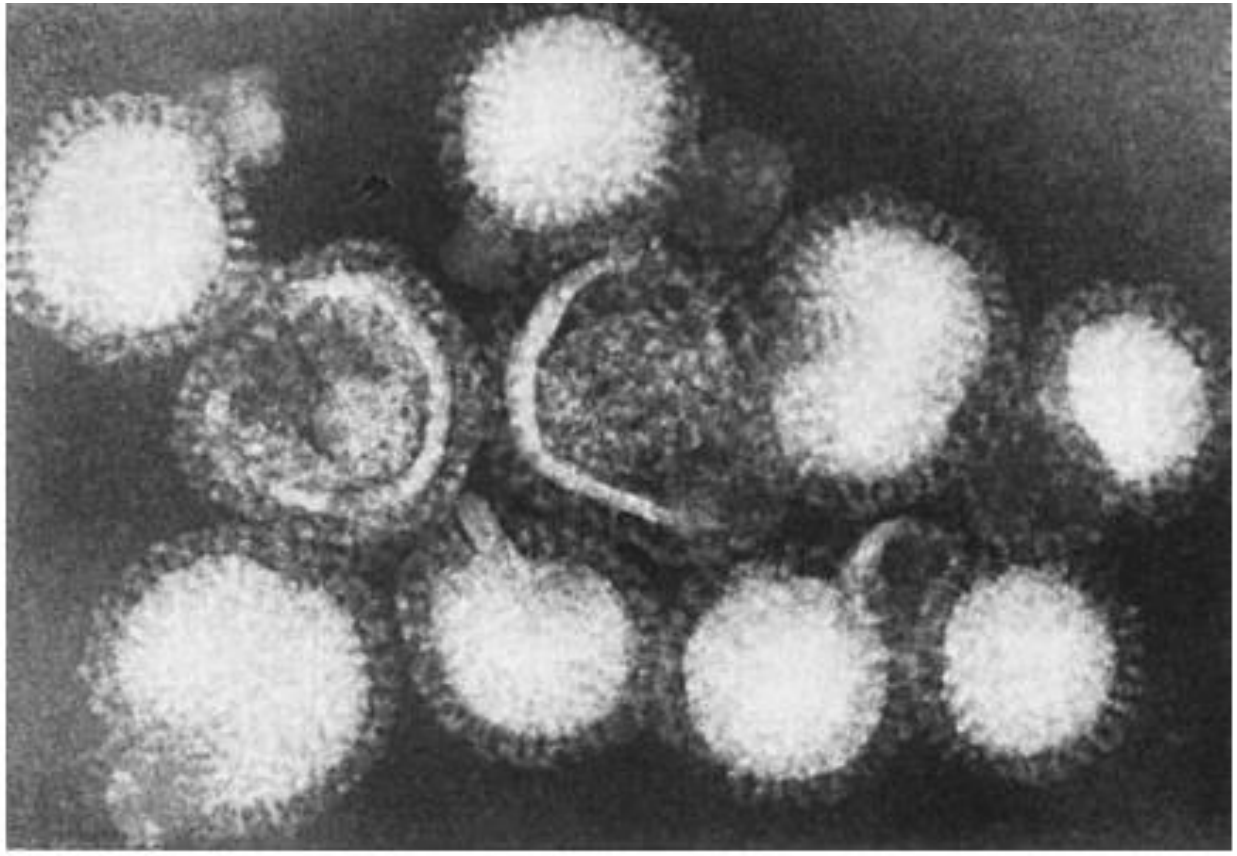
×4 (scanning objective)	×40
×10 (low-power objective)	×100
×40 (high-dry objective)	×400
×100 (oil-immersion objective)	×1,000

Electron Microscopes



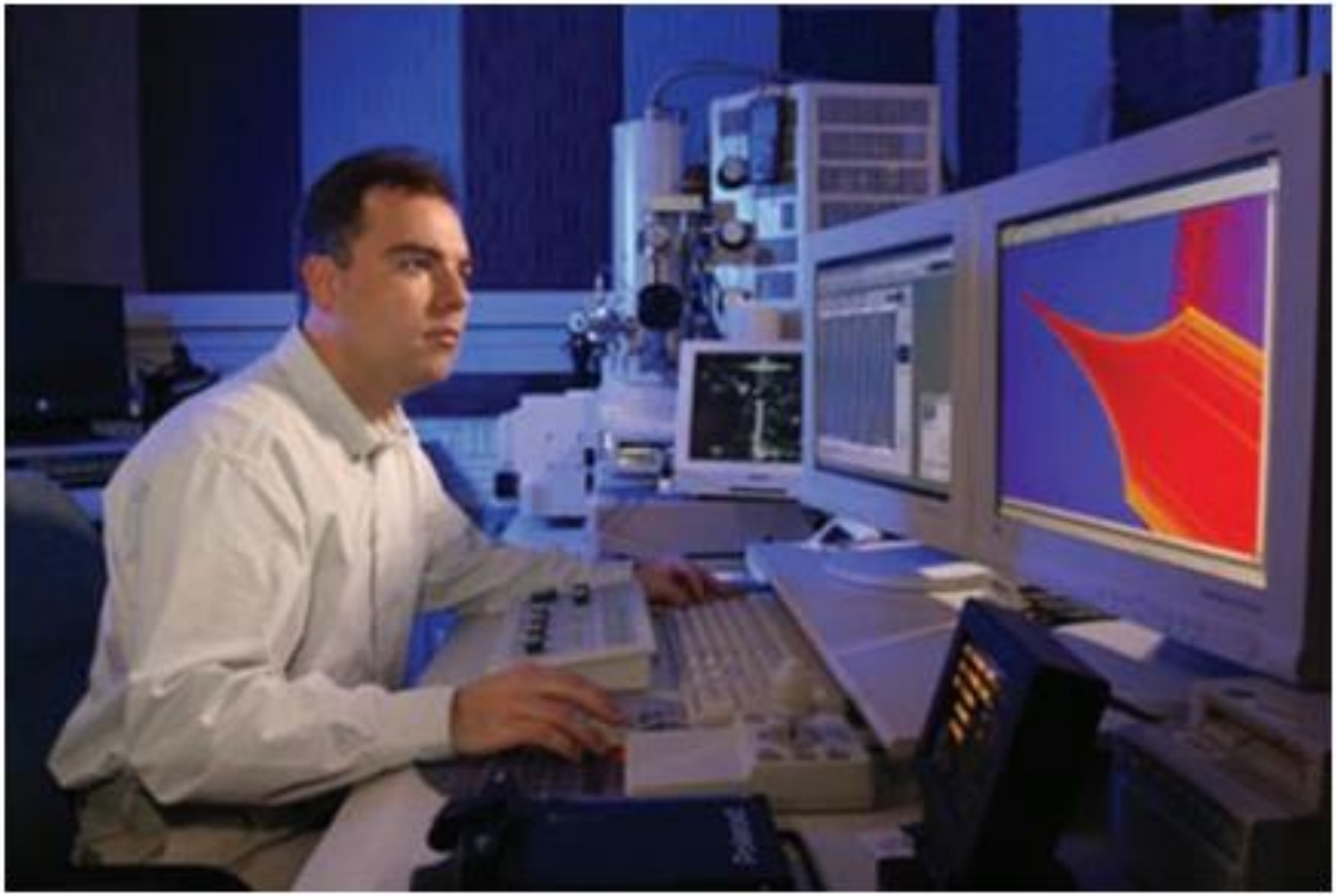
A CDC biologist using a transmission electron microscope.

(Courtesy of James Gathany and the Centers for Disease Control and Prevention.)



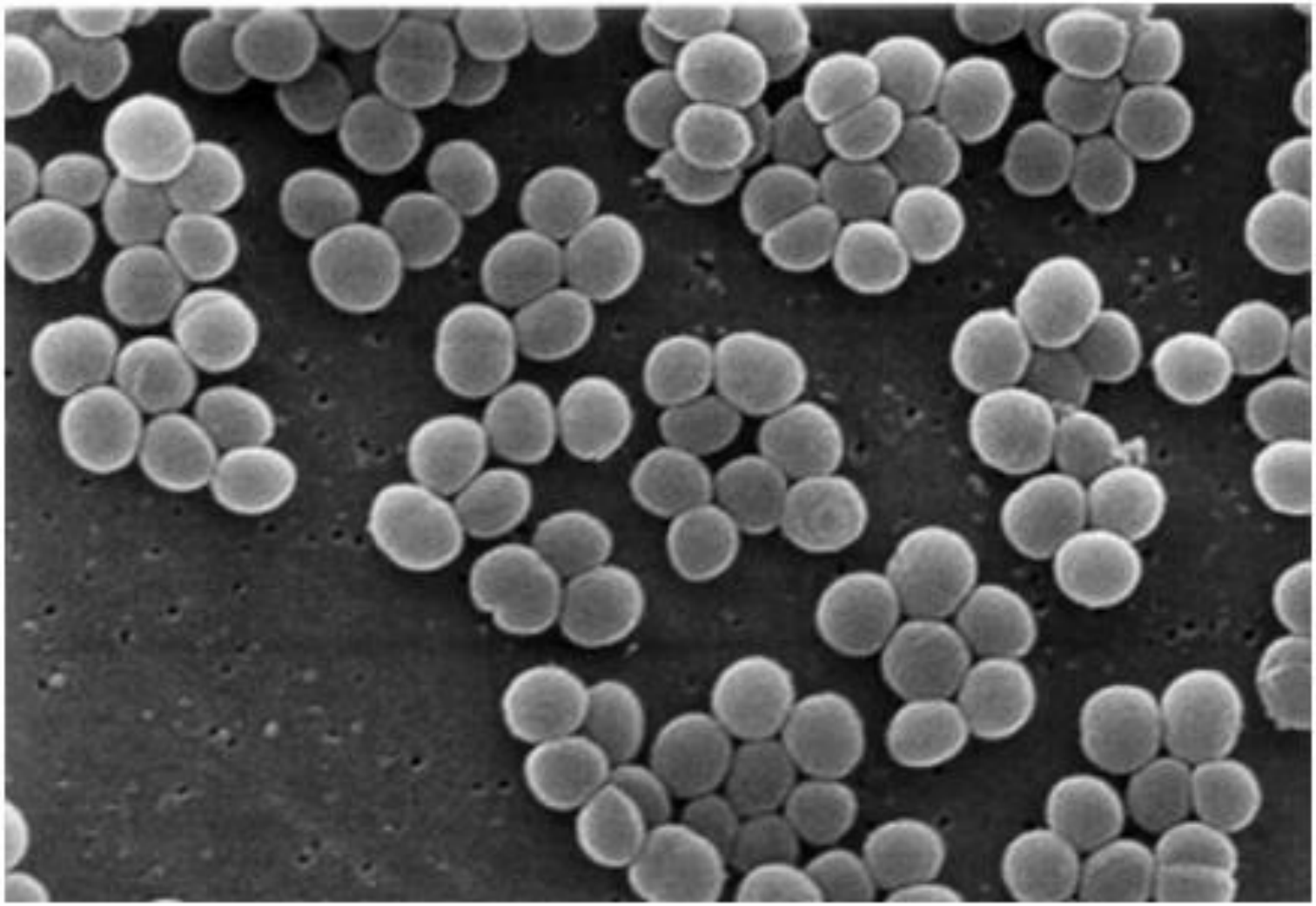
Transmission electron micrograph of influenza virus A.

(From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006.)



Scanning electron microscope. (Courtesy of the National Institute of Standards and Technology, U.S. Commerce Department.)

***Staphylococcus aureus* and red blood cells, as seen by light microscopy.** (From Marler LM, et al. Direct Smear Atlas. Philadelphia: Lippincott Williams & Wilkins, 2001.)

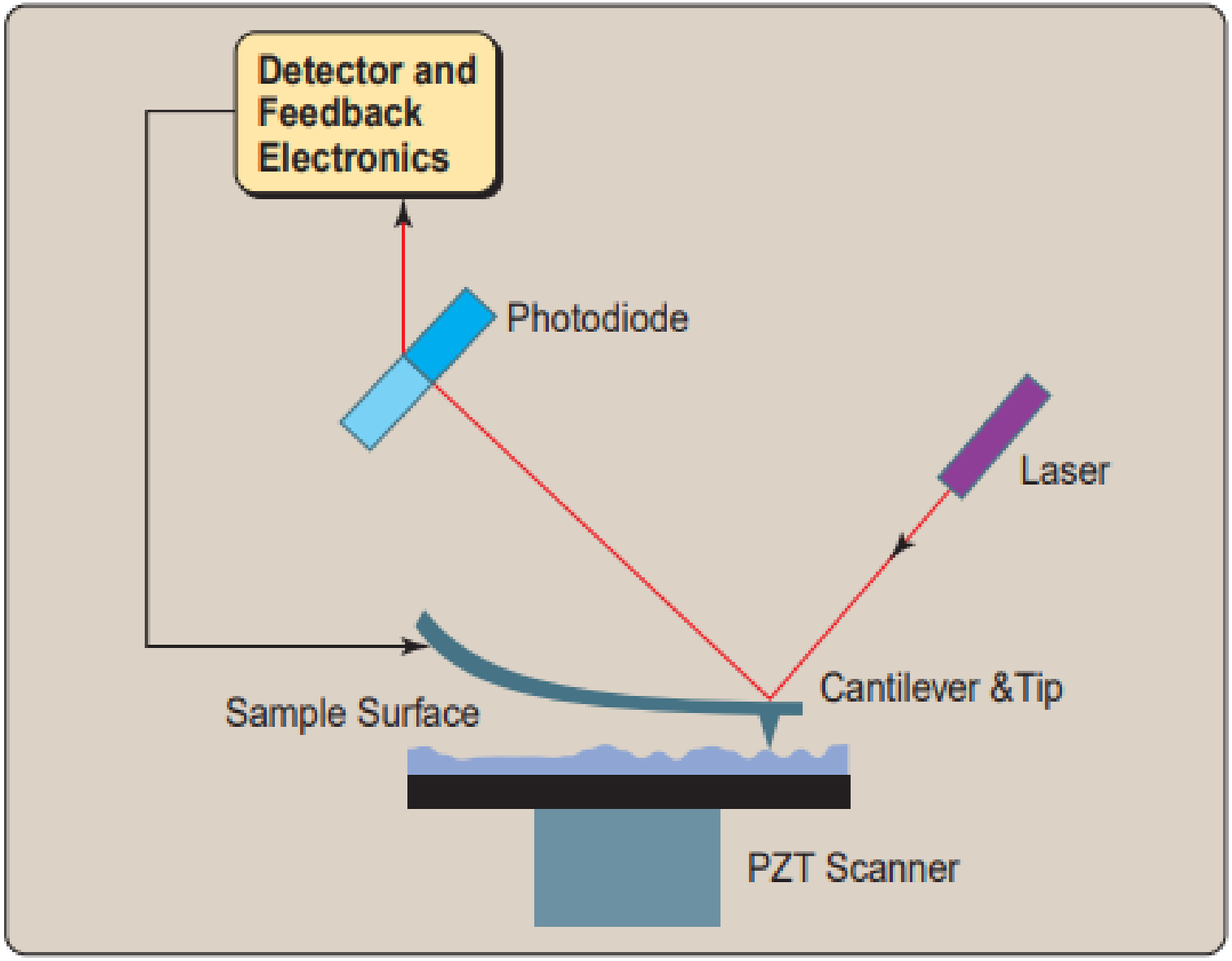


Scanning electron micrograph of *S. aureus*.

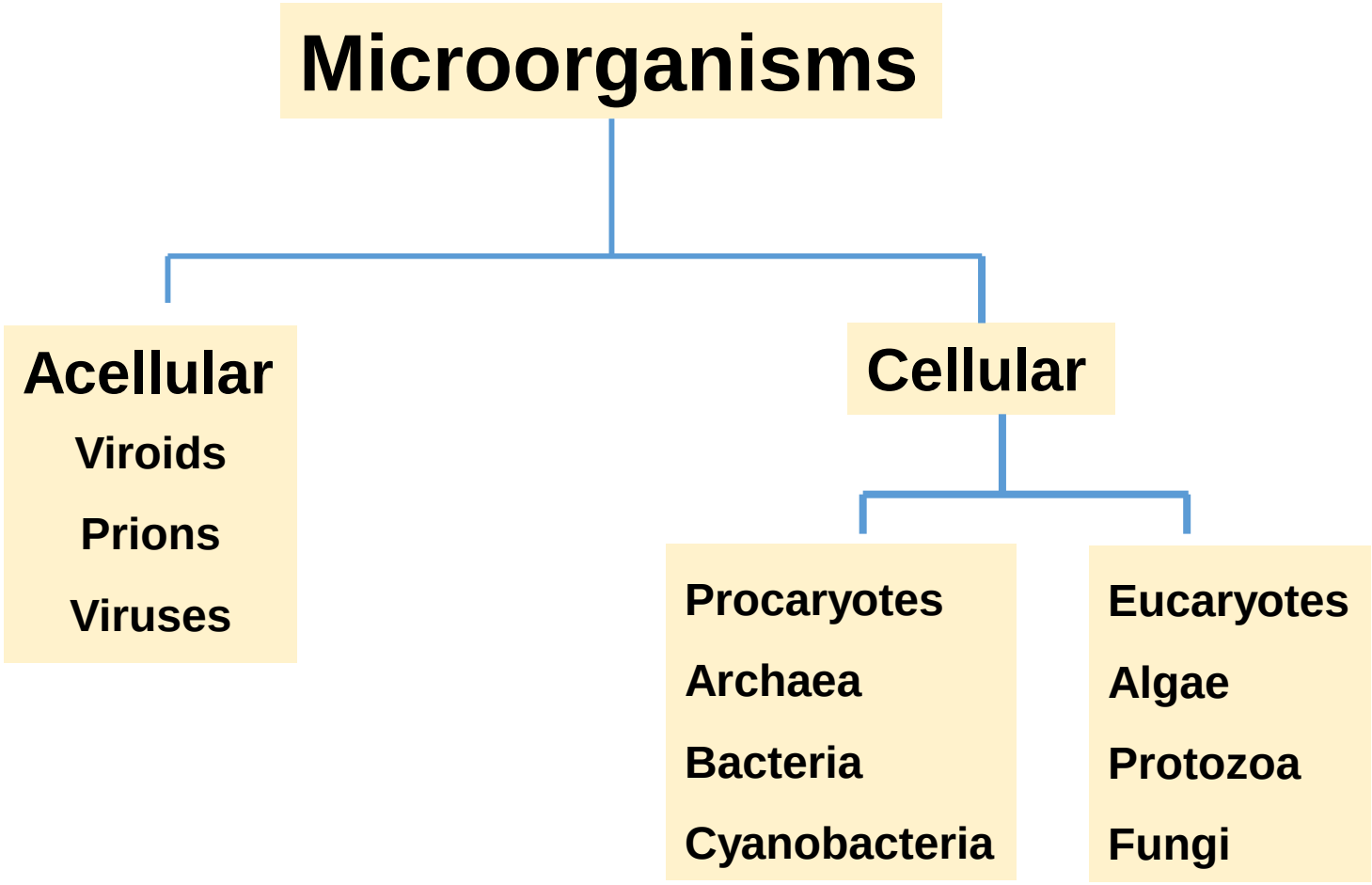
(Courtesy of Janice Carr, Matthew J. Arduino, and the Centers for Disease Control and Prevention.)

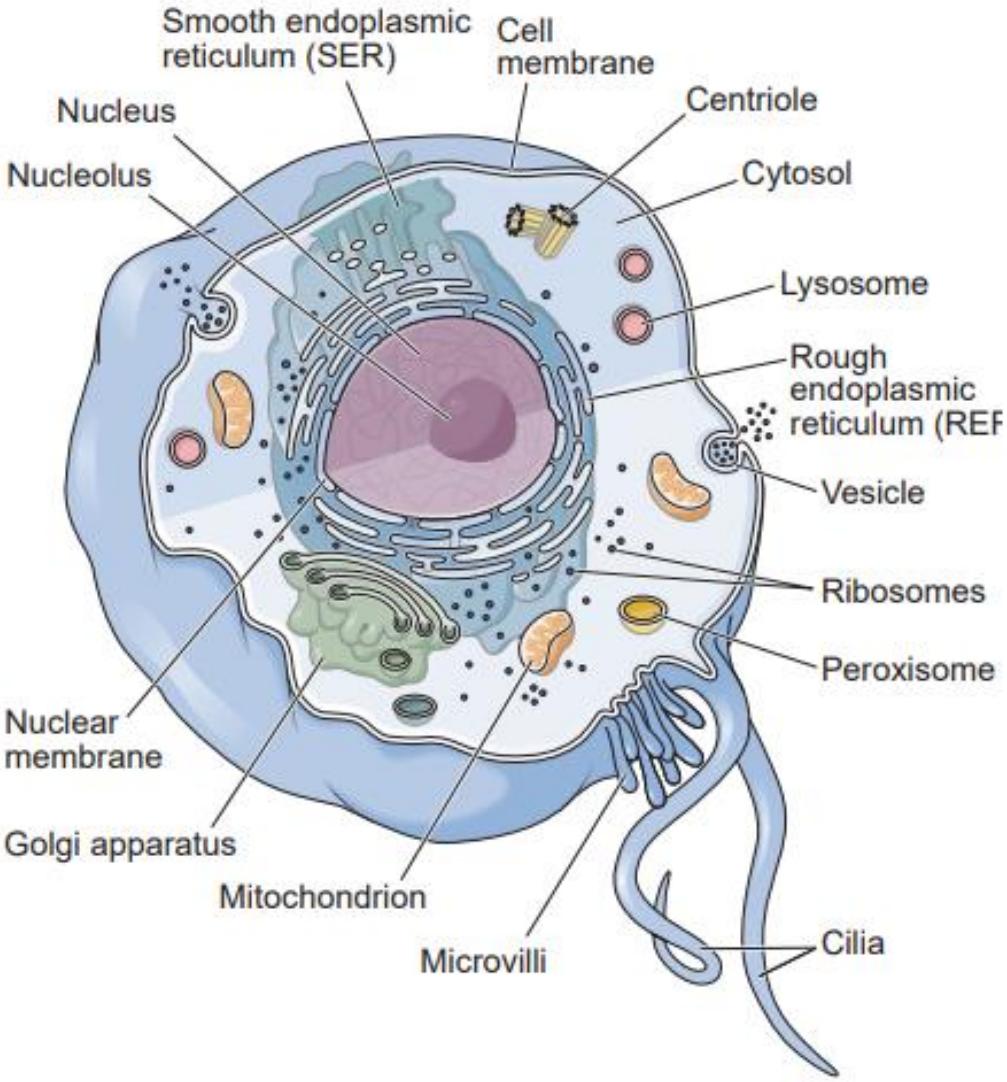
Transmission electron micrograph of *S. aureus*.
***S. aureus* cells in various stages of binary fission.**

(From Volk WA, et al. Essentials of Medical Microbiology, 5th ed. Philadelphia: Lippincott-Raven, 1996.)



Atomic force microscope. See text for details. PZT, lead zirconate titanate. (Courtesy of Askewmind at en.Wikipedia)


Microorganisms
Acellular
Viroids
Prions
Viruses
Cellular
Procaryotes
Archaea
Bacteria
Cyanobacteria
Eucaryotes
Algae
Protozoa
Fungi



A typical eucaryotic animal cell.

(From Cohen BJ. Memmler's The Human Body in Health and Disease, 11th ed. Philadelphia: Lippincott Williams & Wilkins, 2009.)

Cell Wall

☑ Present

Plants

Algae

Fungi

Most bacteria

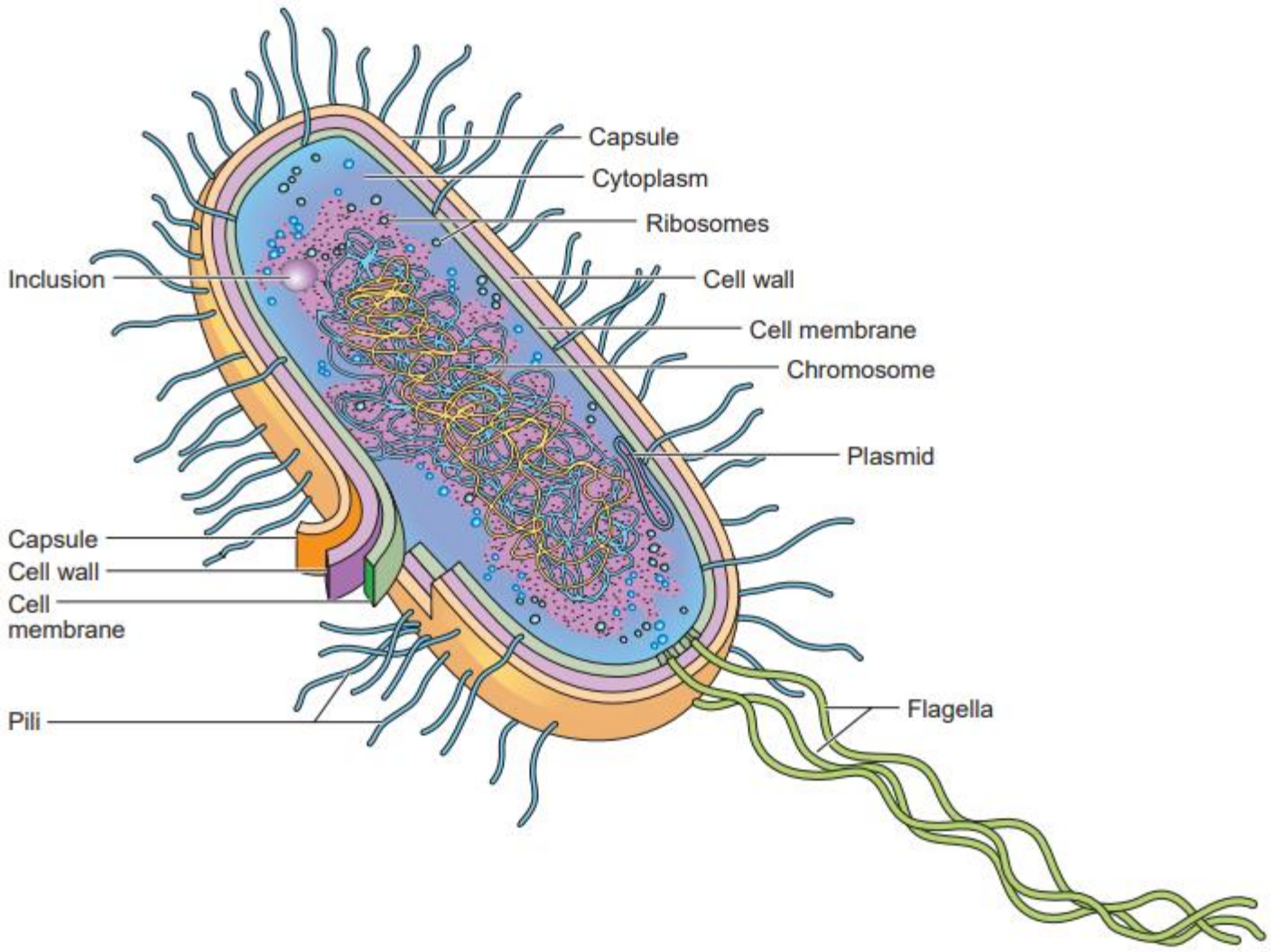
☒ Absent

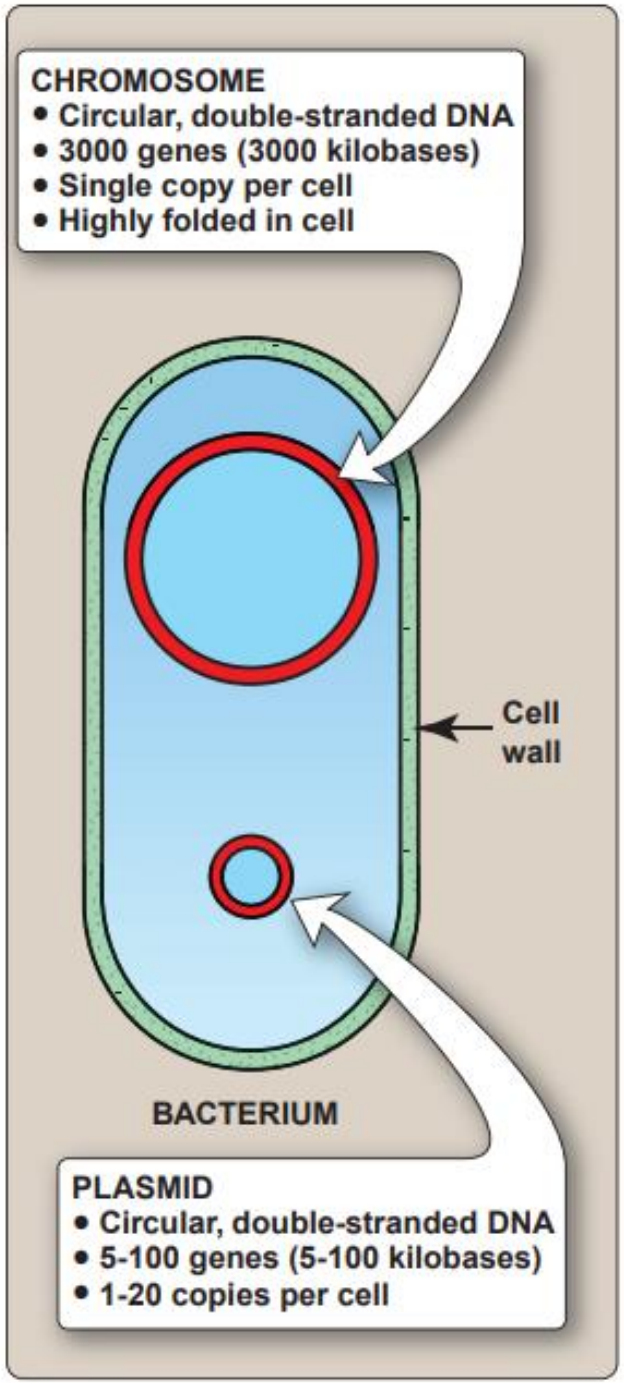
Animals

Protozoa

Mycoplasma species

A typical procaryotic cell



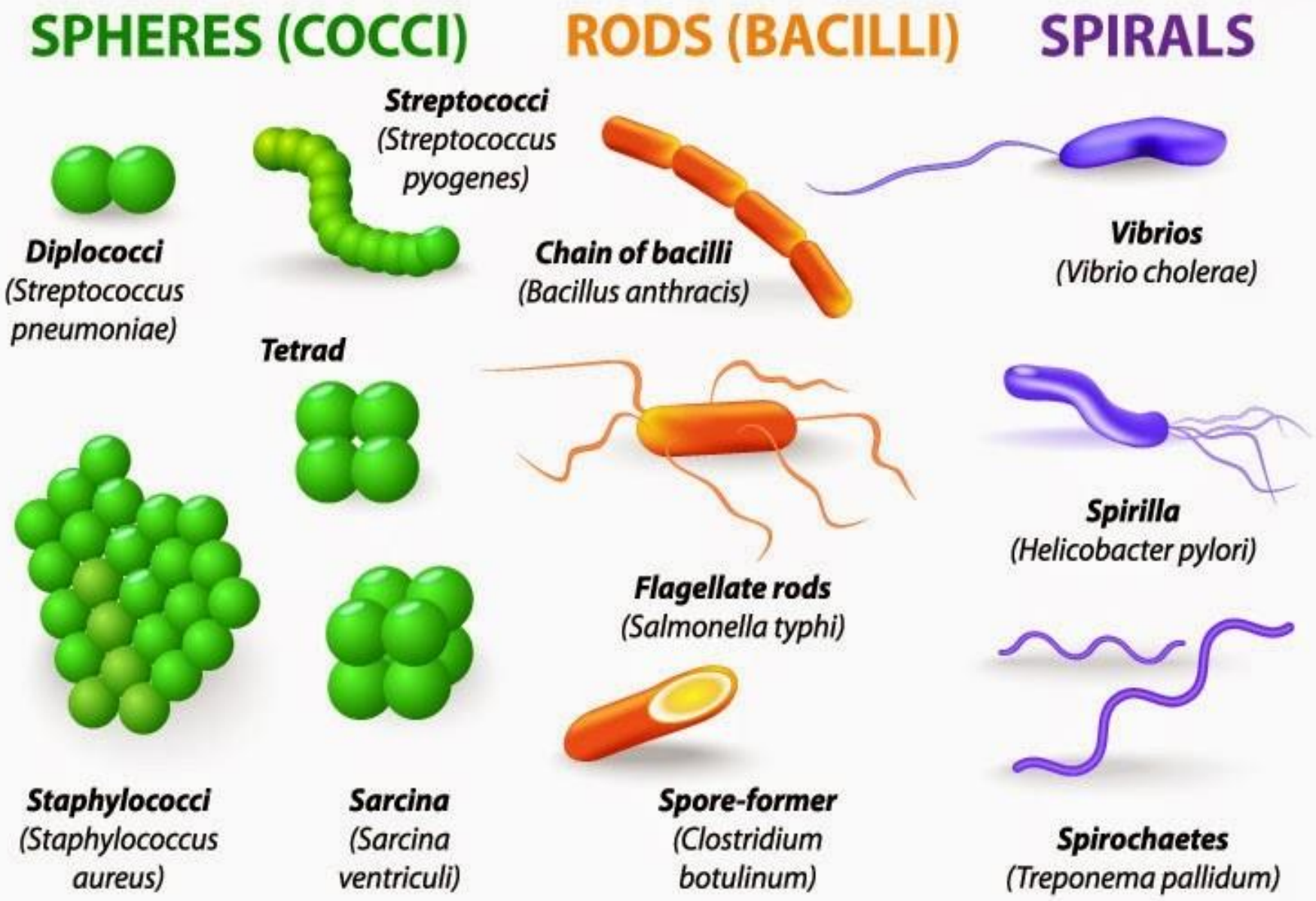


A typical bacterial genome. The hypothetical bacterial cell illustrated here possesses a chromosome containing 3,000 genes and a plasmid containing 5 to 100 genes.

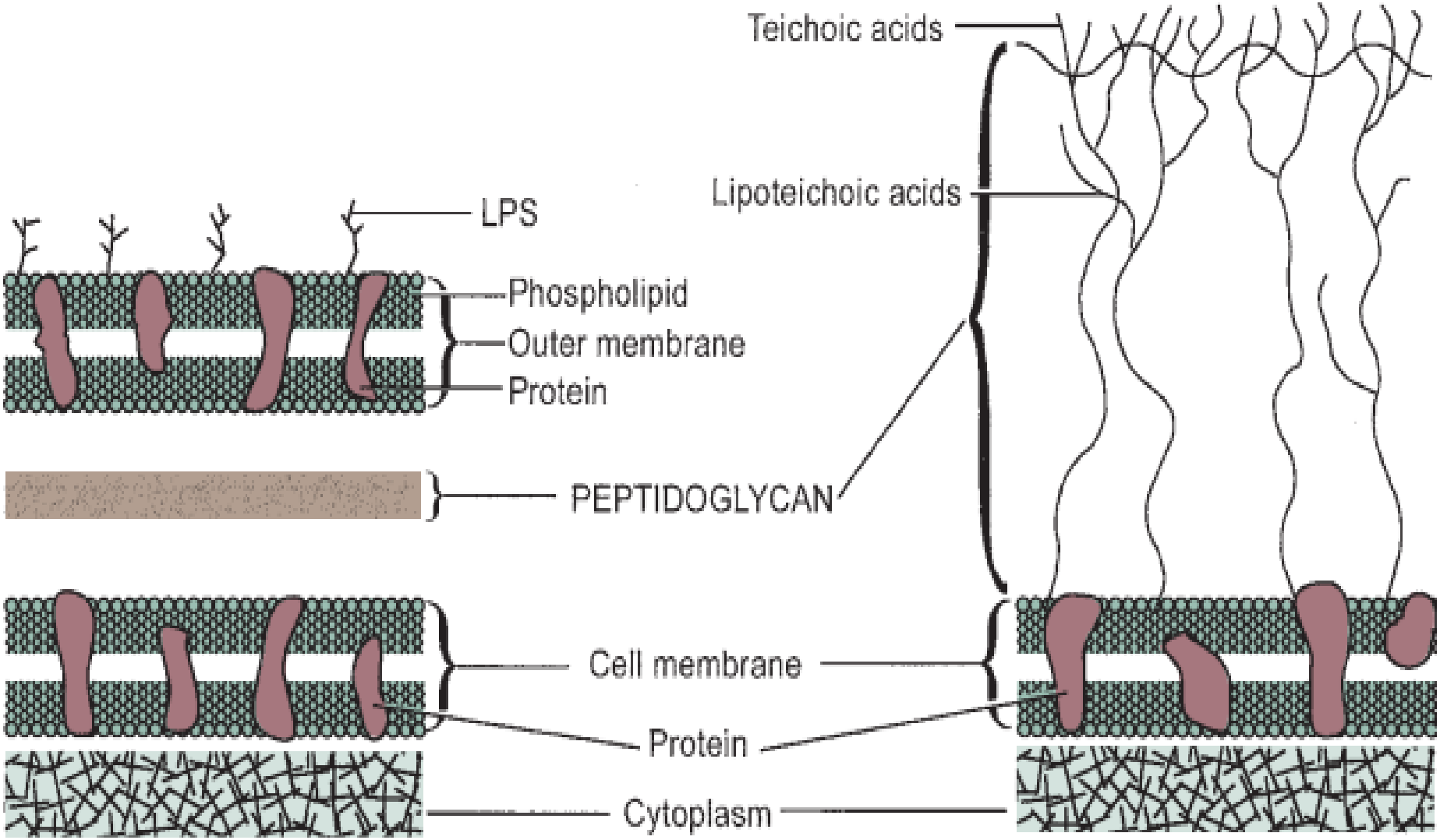
(From Harvey RA et al. Lippincott's Illustrated Reviews, Microbiology, 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2007.)

BACTERIA SHAPES

https://www.scimath.org/lesson-biology



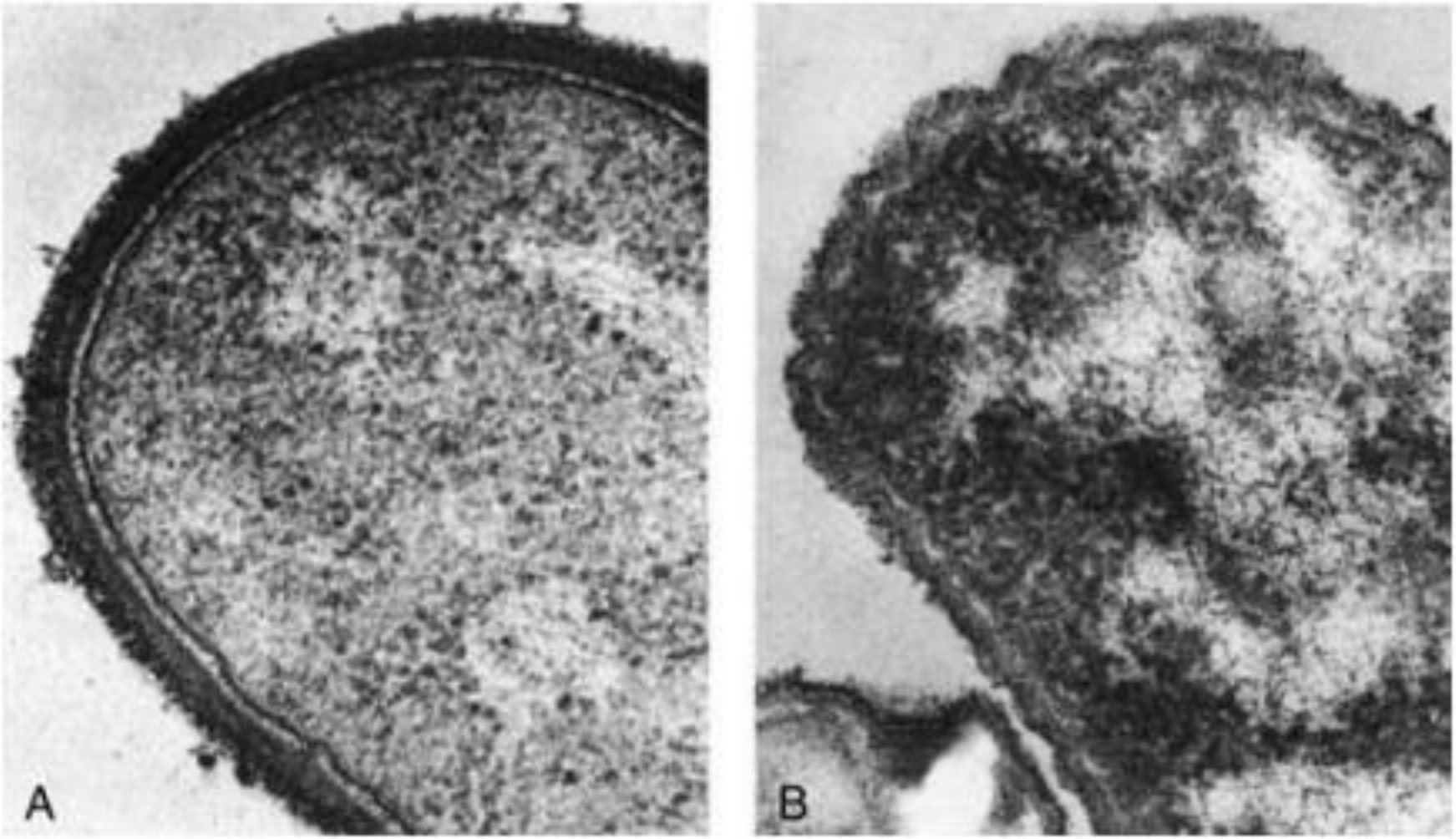
Differences between Gram-negative and Gram-positive cell walls.

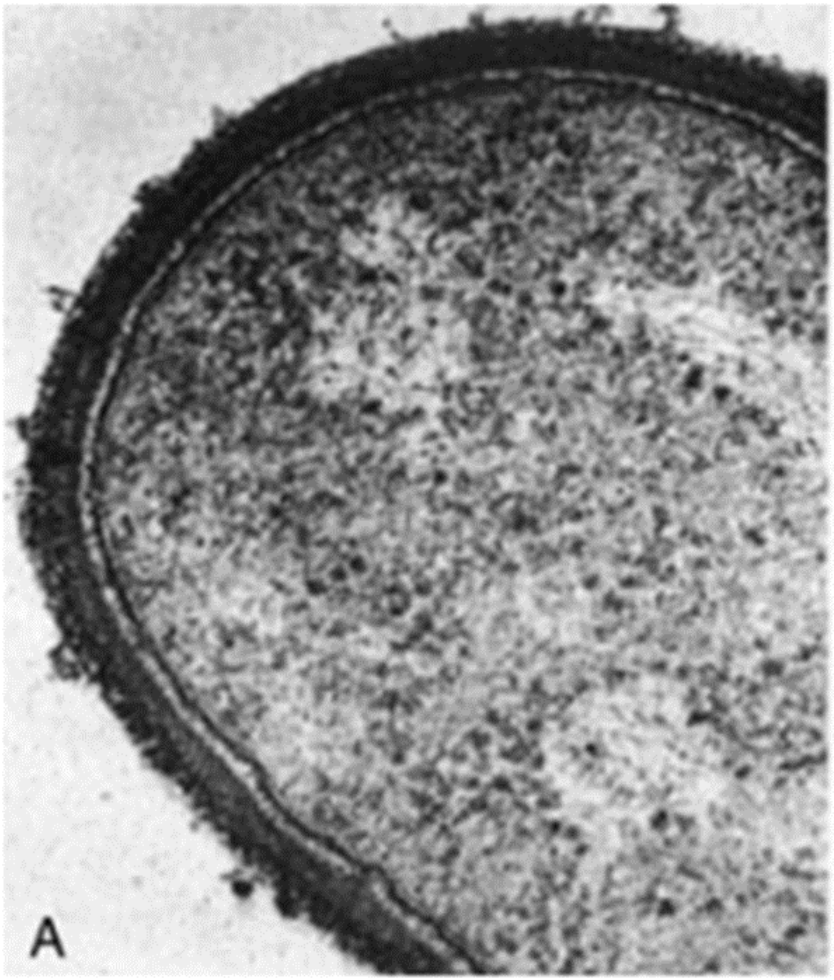


Gram-Negative Cell Wall

Gram-Positive Cell Wall

The relatively thin Gram-negative cell wall contains a thin layer of peptidoglycan, an outer membrane, and lipopolysaccharide (LPS). The thicker Gram-positive cell wall contains a thick layer of peptidoglycan and teichoic and lipoteichoic acids.

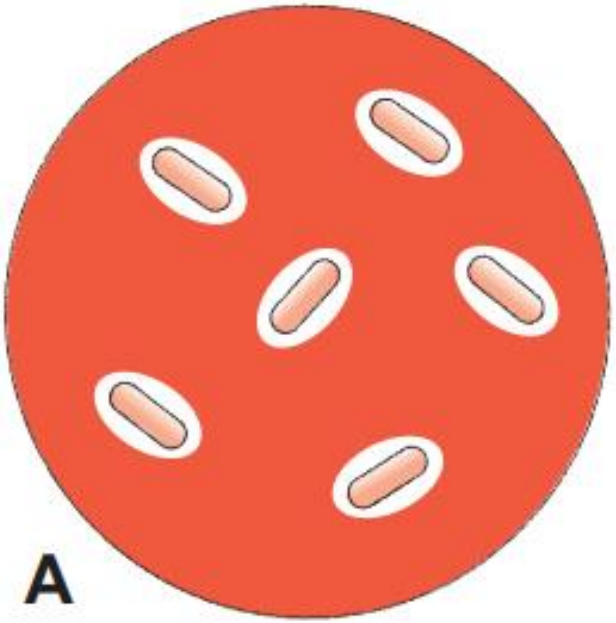

A
B

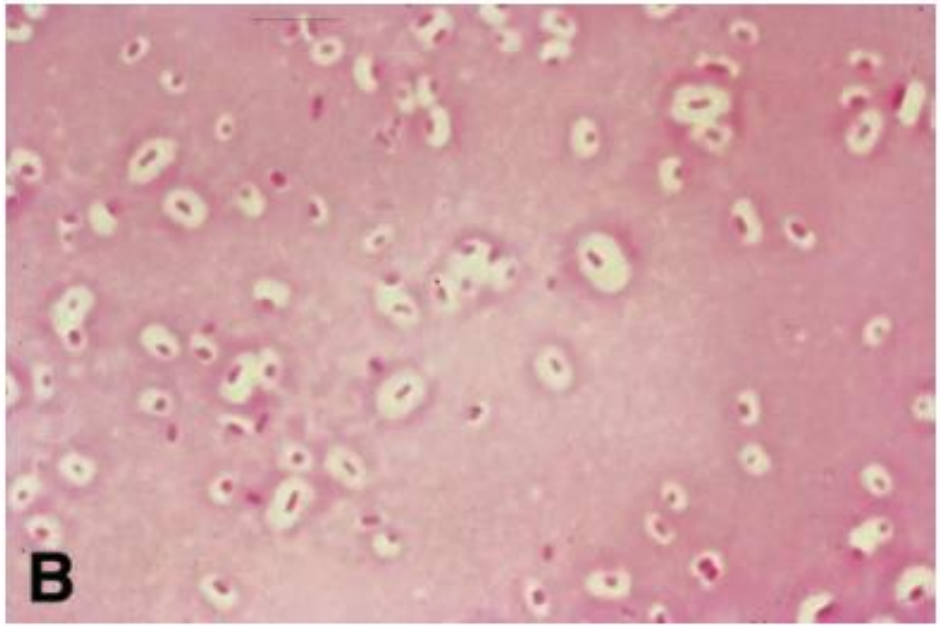


Bacterial cell walls. (A) A portion of the Gram-positive bacterium, *Bacillus fastidious*; note the cell wall's thick peptidoglycan layer, beneath which can be seen the cell membrane.

(B) The Gram-negative bacterium, *Enterobacter aerogenes*; both the cell membrane and the outer membrane are visible along some sections of the cell wall.

(From Volk WA, et al. Essentials of Medical Microbiology, 5th ed. Philadelphia: Lippincott Raven, 1996.


A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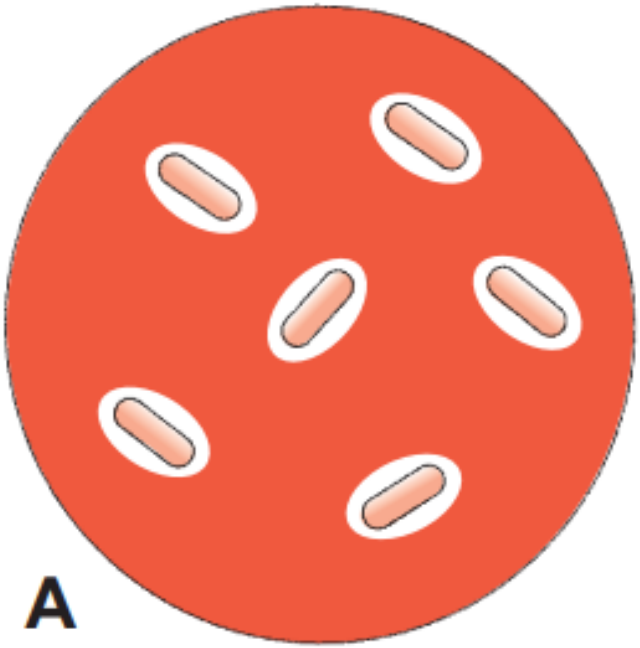
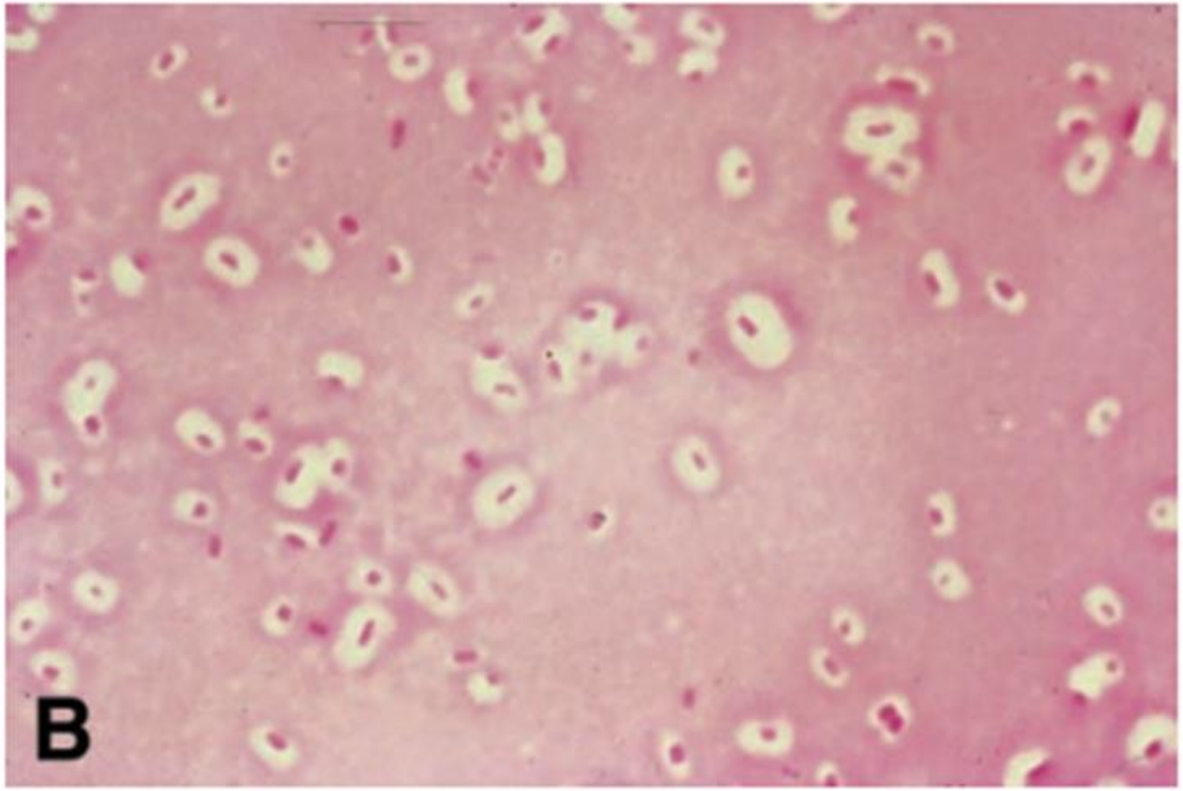
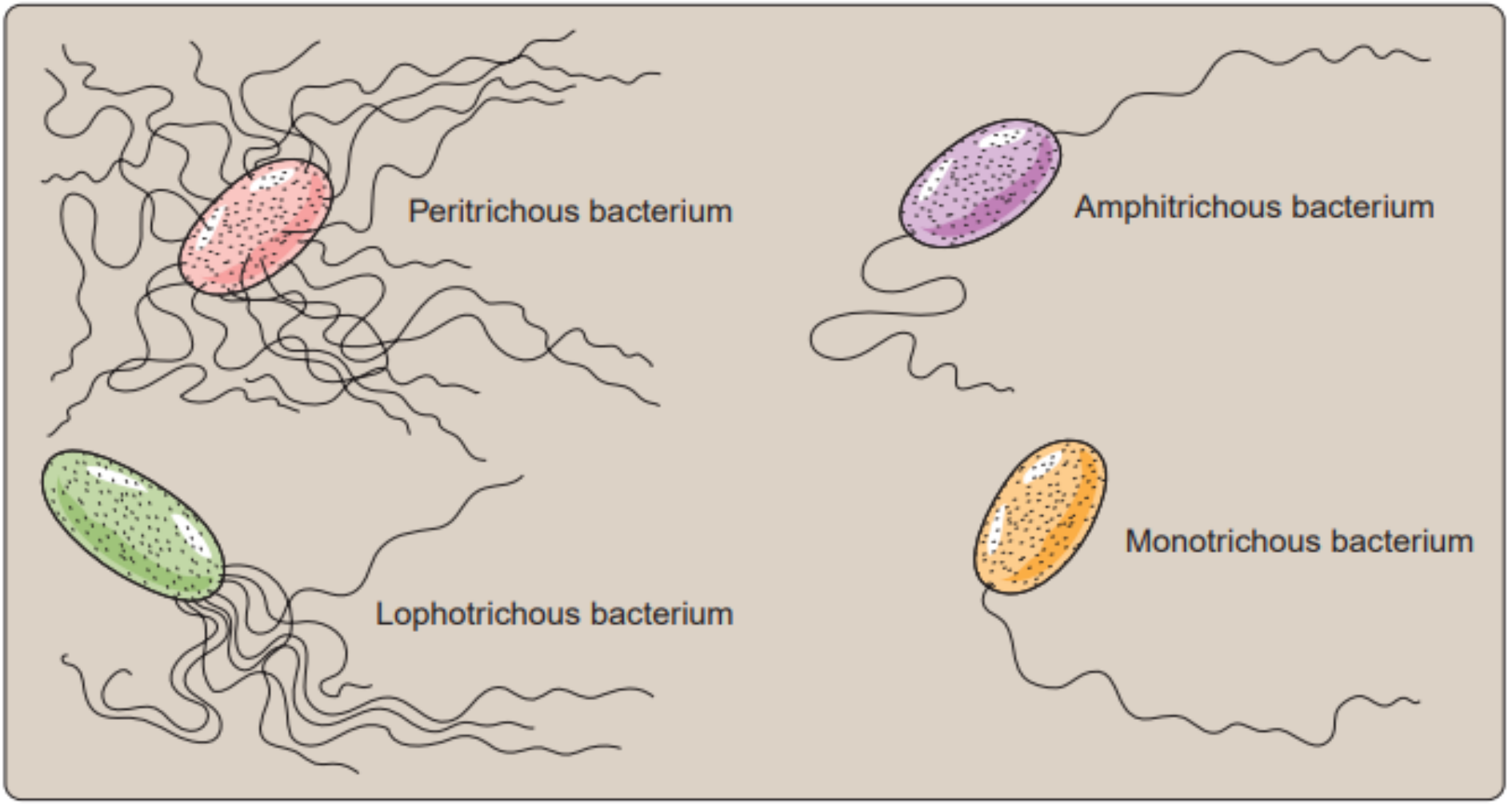


Capsule stain. (A) Drawing illustrating the results of the capsule staining technique

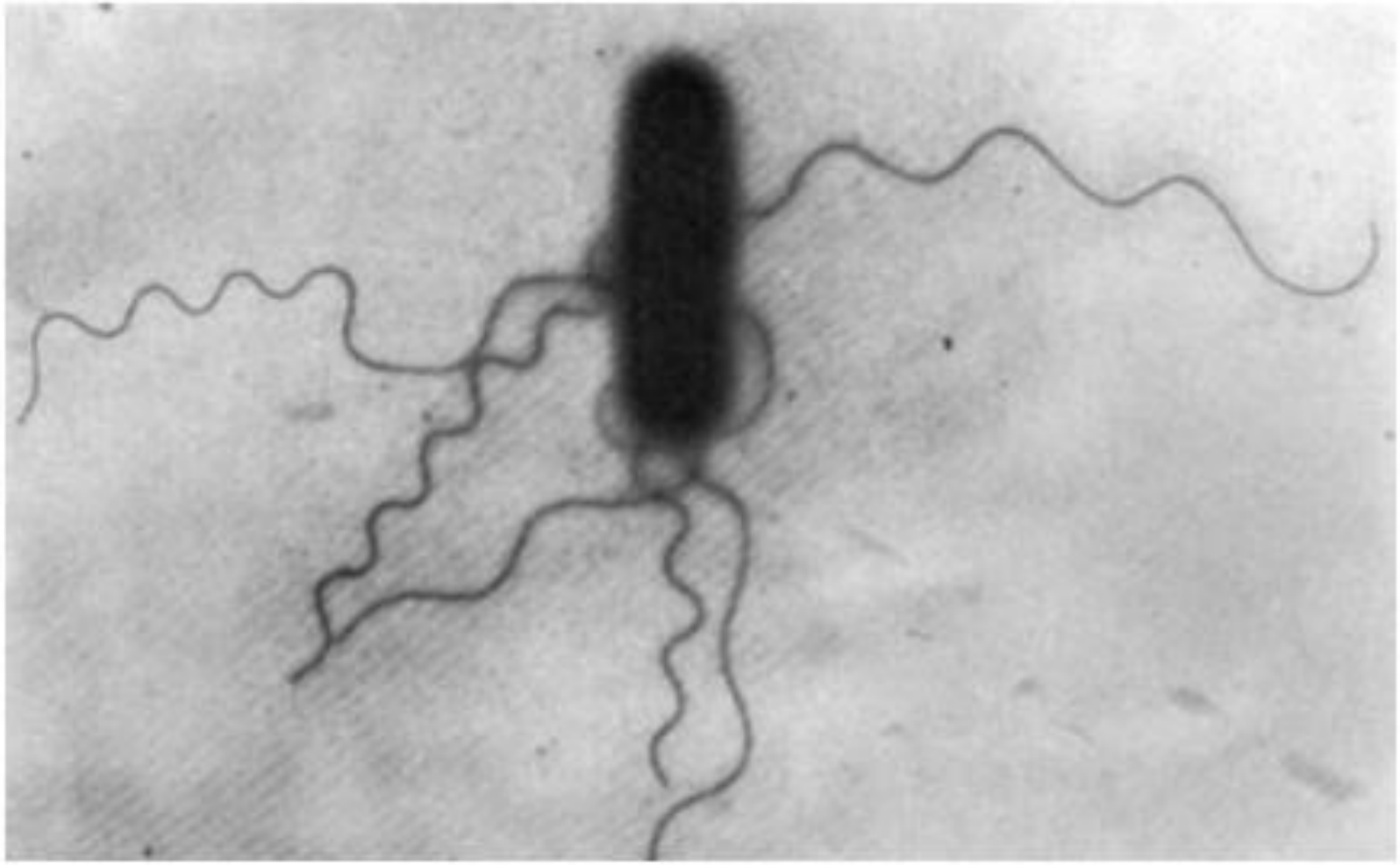


(B) Photomicrograph of encapsulated bacteria that have been stained using the capsule staining technique. The capsule stain is an example of a negative staining technique.

From Winn WC Jr, et al. Koneman's Color Atlas and Textbook of Diagnostic Microbiology, 6th ed. Philadelphia: Lippincott Williams & Wilkins, 2006



Flagellar arrangement. The four basic types of flagellar arrangement on bacteria: peritrichous, flagella all over the surface; lophotrichous, a tuft of flagella at one end; amphitrichous, one or more flagella at each end; monotrichous, one flagellum



A Salmonella cell, showing peritrichous flagella.

Salmonella is a bacterial genus.

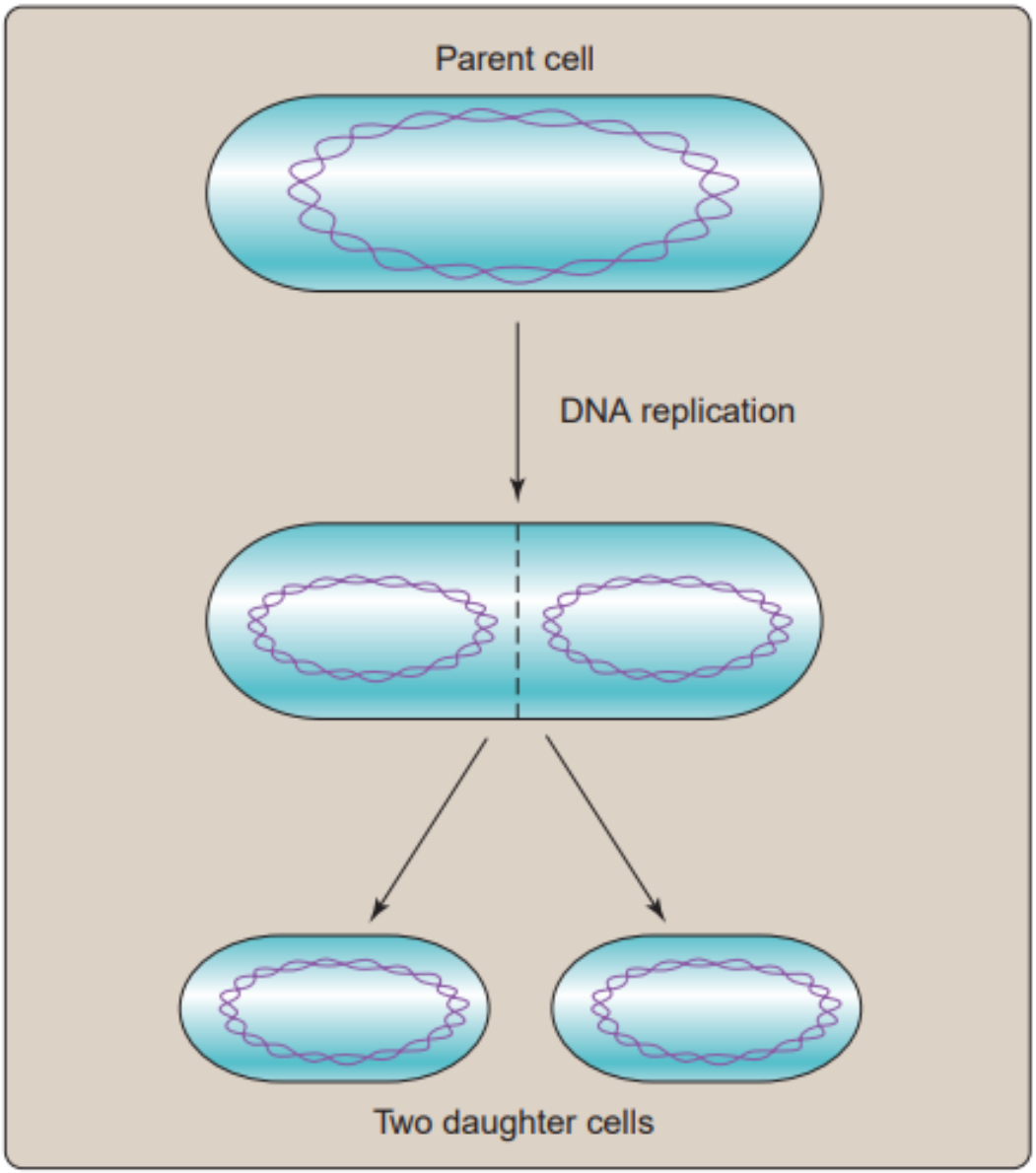
(From Volk WA, et al. Essentials of Medical Microbiology, 5th ed. Philadelphia: Lippincott-Raven, 1996.)

Cr.หมอแล็บแพนด้า

Diarrhea and a fever/ Diarrhea for more than 3 days that is not improving

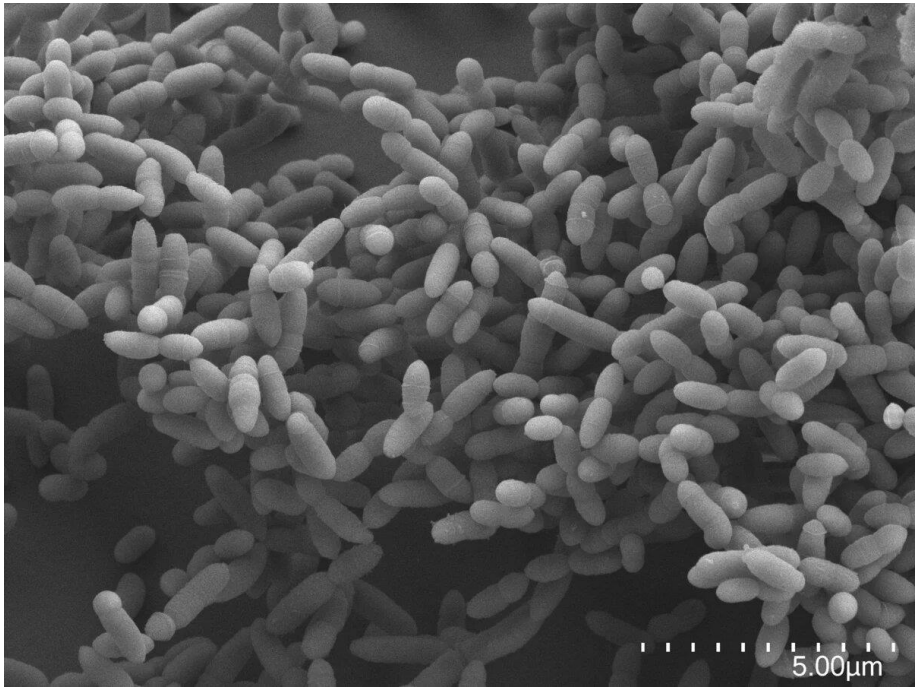
Cr: Erik Kramer, DO, MPH

Binary fission



First microorganism on earth

Archaea



https://phys.org/news/2021

Cyanobacteria

https://www.labroots.com/microbiology