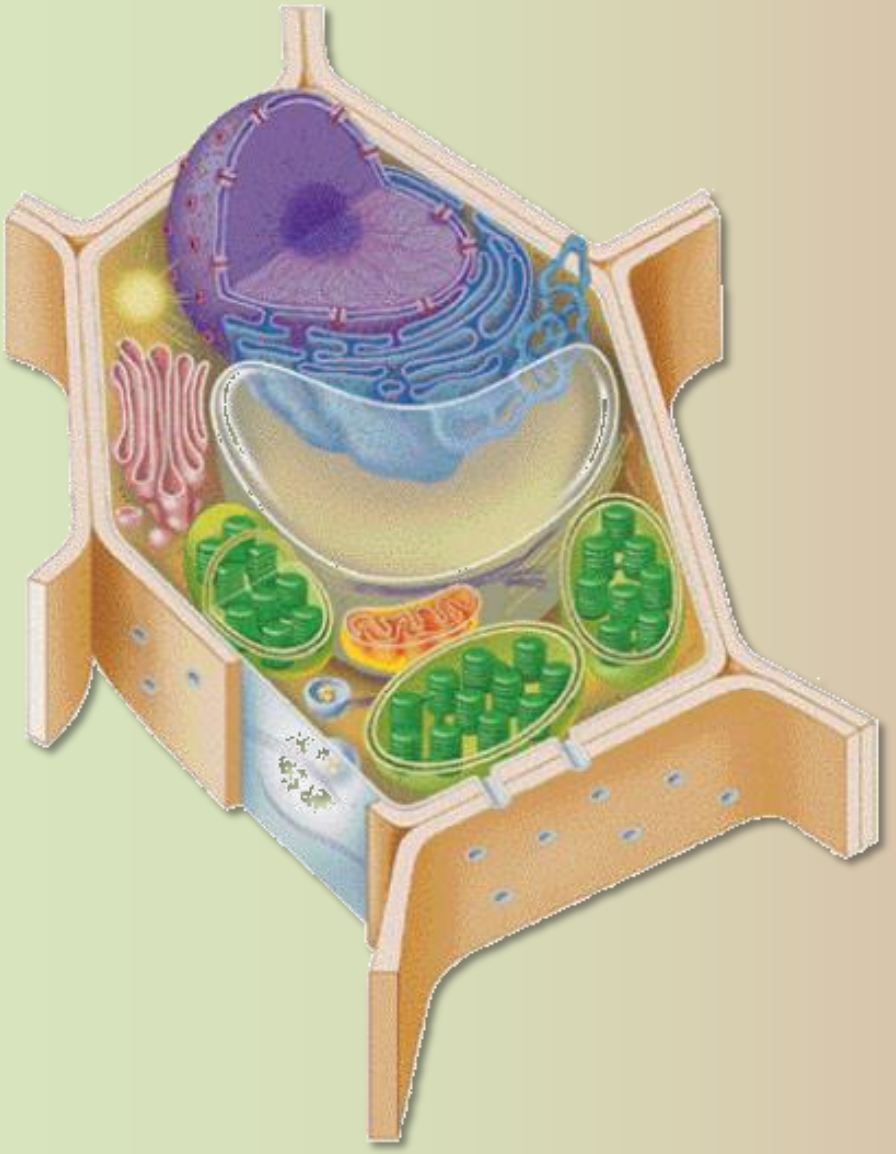
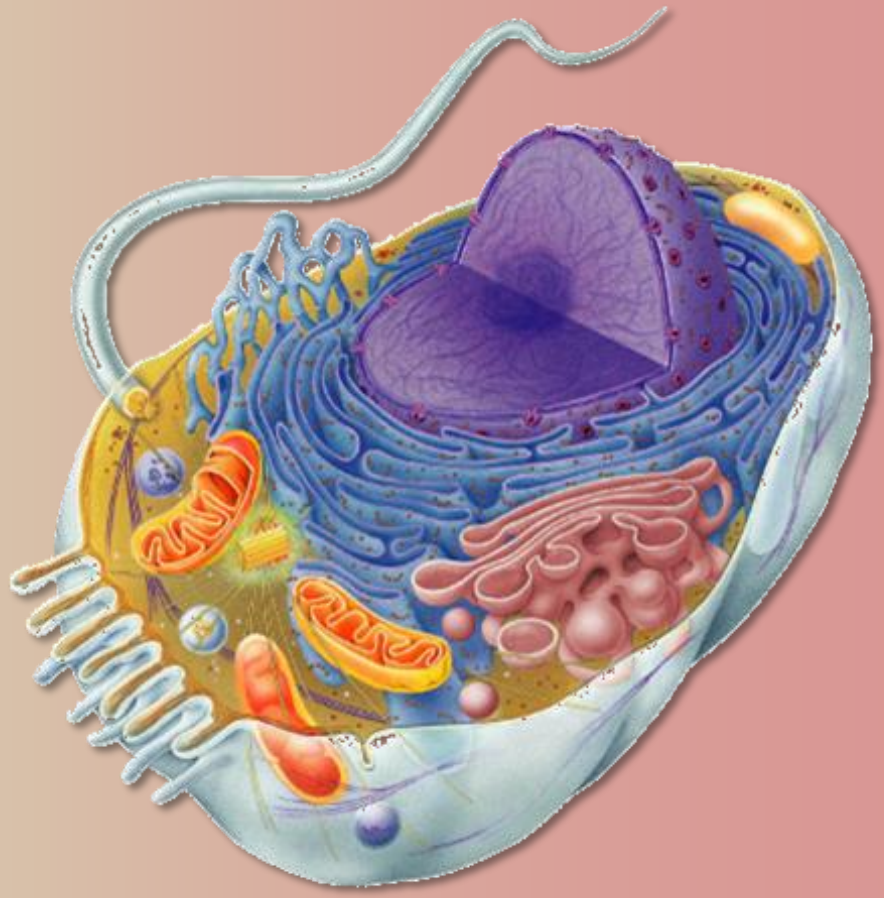
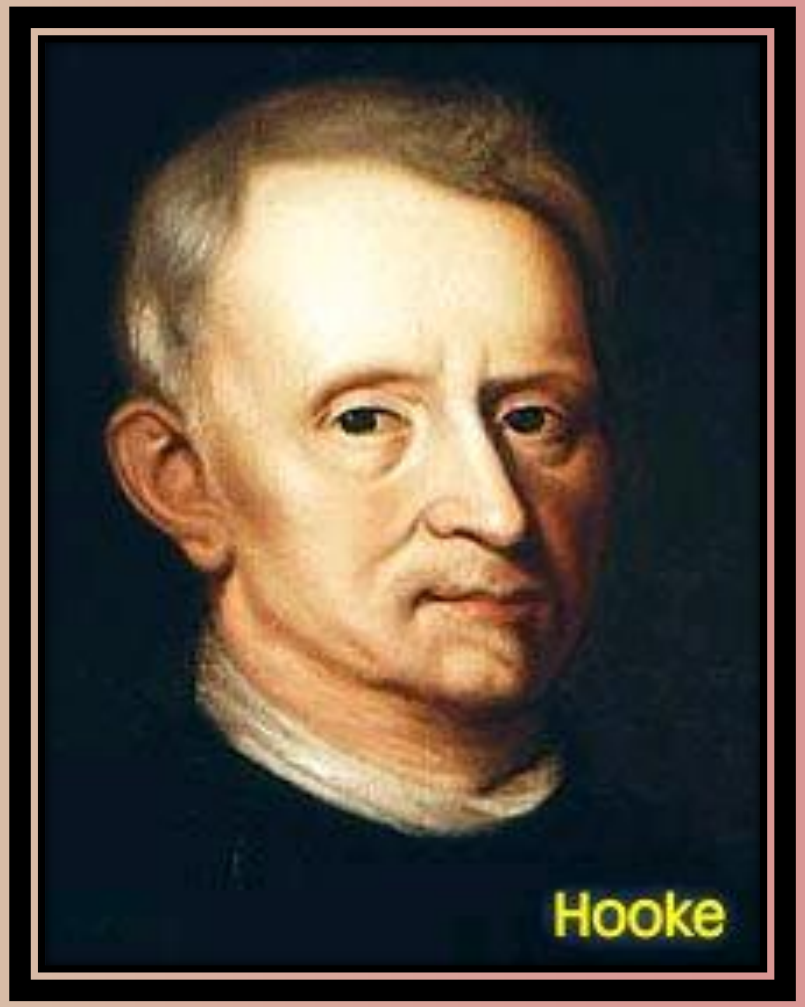




Cell Structure and Function

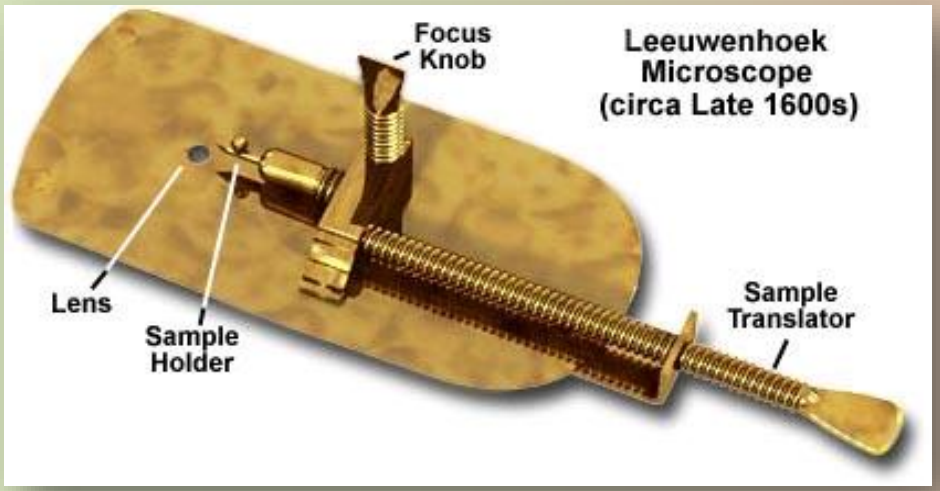
Dead White Men Who Discovered (and were made of) Cells:

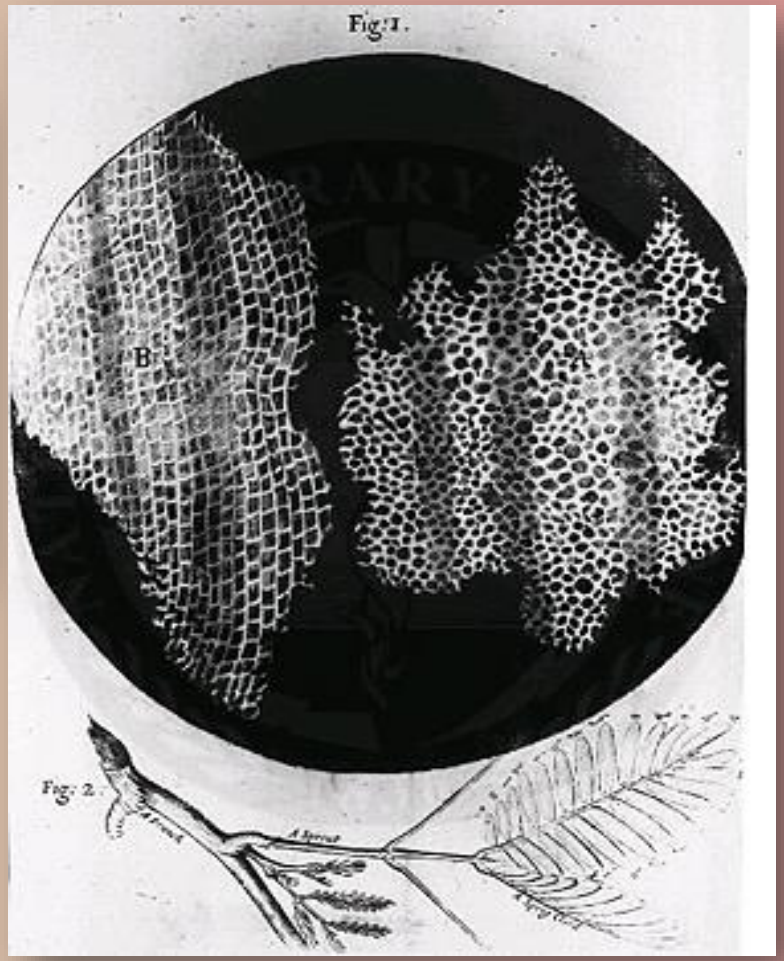
Anton Van Leeuwenhoek



Robert Hooke

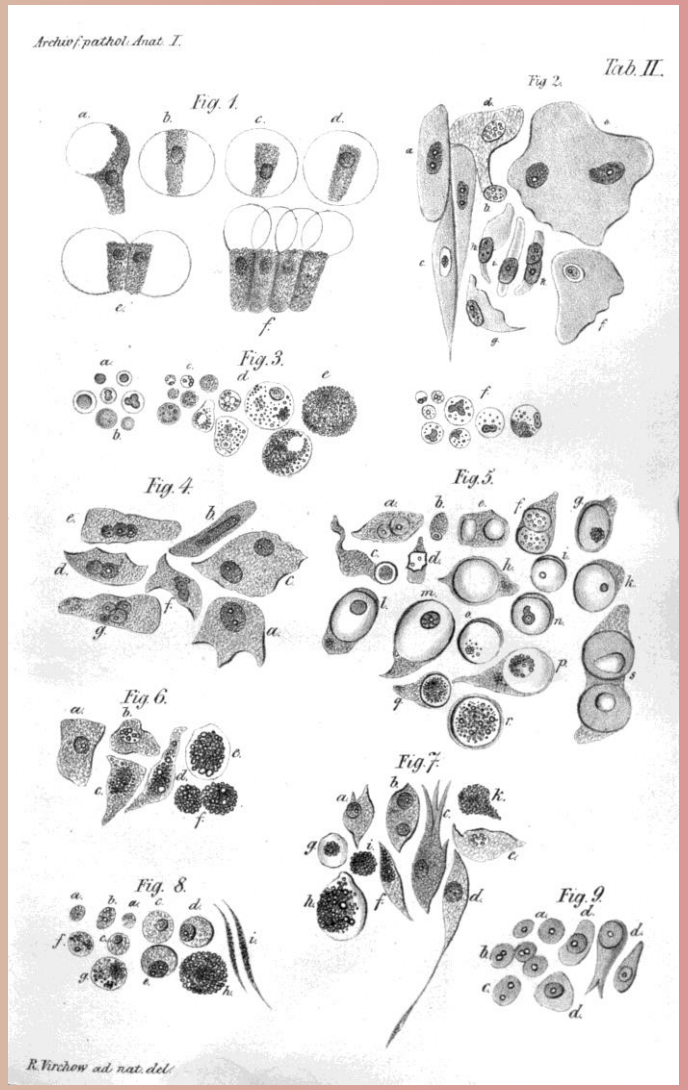
Where the Magic Happened





Cell Theory

- Schleiden
  - All plants are made of cells
- Schwann
  - All animals are made of cells
- Virchow
  - All cells come from other cells



Modern Cell Theory

- All living things are made of one or more cells
- All cells come from other pre-existing cells
- The cell is the basic unit of structure function

Light Microscopy

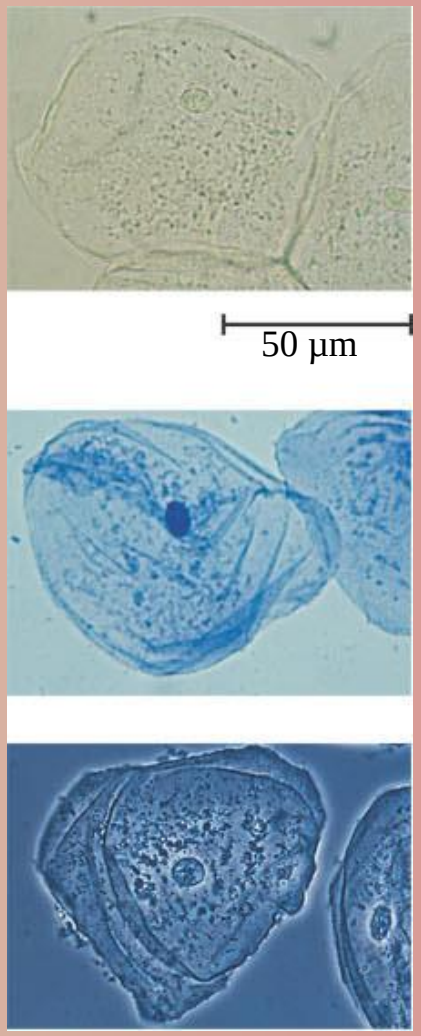
TECHNIQUE

(a) Brightfield (unstained specimen). Passes light directly through specimen. Unless cell is naturally pigmented or artificially stained, image has little contrast. [Parts (a)–(d) show a human cheek epithelial cell.]

(b) Brightfield (stained specimen). Staining with various dyes enhances contrast, but most staining procedures require that cells be fixed (preserved).

(c) Phase-contrast. Enhances contrast in unstained cells by amplifying variations in density within specimen; especially useful for examining living, unpigmented cells.

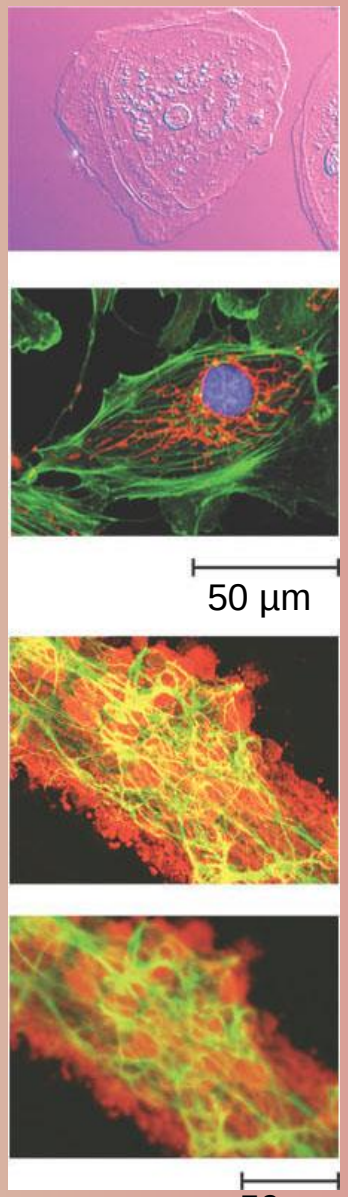
RESULTS



(d) Differential-interference-contrast (Nomarski). Like phase-contrast microscopy, it uses optical modifications to exaggerate differences in density, making the image appear almost 3D.

(e) Fluorescence. Shows the locations of specific molecules in the cell by tagging the molecules with fluorescent dyes or antibodies. These fluorescent substances absorb ultraviolet radiation and emit visible light, as shown here in a cell from an artery.

(f) Confocal. Uses lasers and special optics for "optical sectioning" of fluorescently-stained specimens. Only a single plane of focus is illuminated; out-of-focus fluorescence above and below the plane is subtracted by a computer. A sharp image results, as seen in stained nervous tissue (top), where nerve cells are green, support cells are red, and regions of overlap are yellow. A standard fluorescence micrograph (bottom) of this relatively thick tissue is blurry.



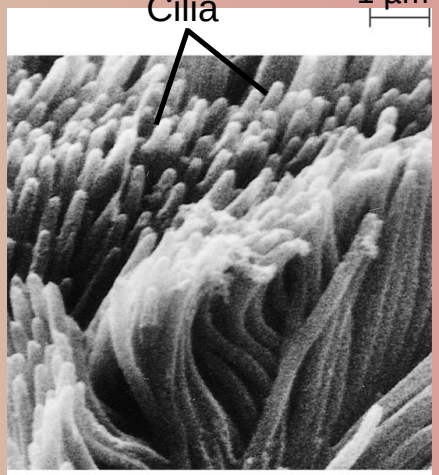
Electron Microscopy

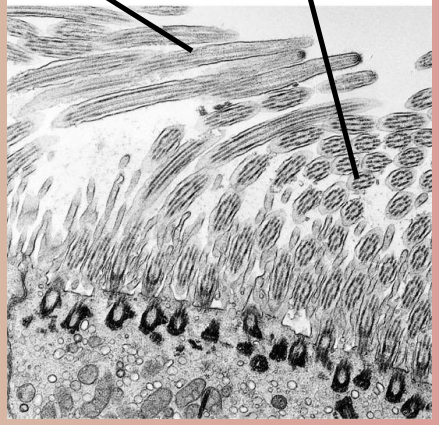
TECHNIQUE

(a) **Scanning electron microscopy (SEM).** Micrographs taken with a scanning electron microscope show a 3D image of the surface of a specimen. This SEM shows the surface of a cell from a rabbit trachea (windpipe) covered with motile organelles called cilia. Beating of the cilia helps move inhaled debris upward toward the throat.

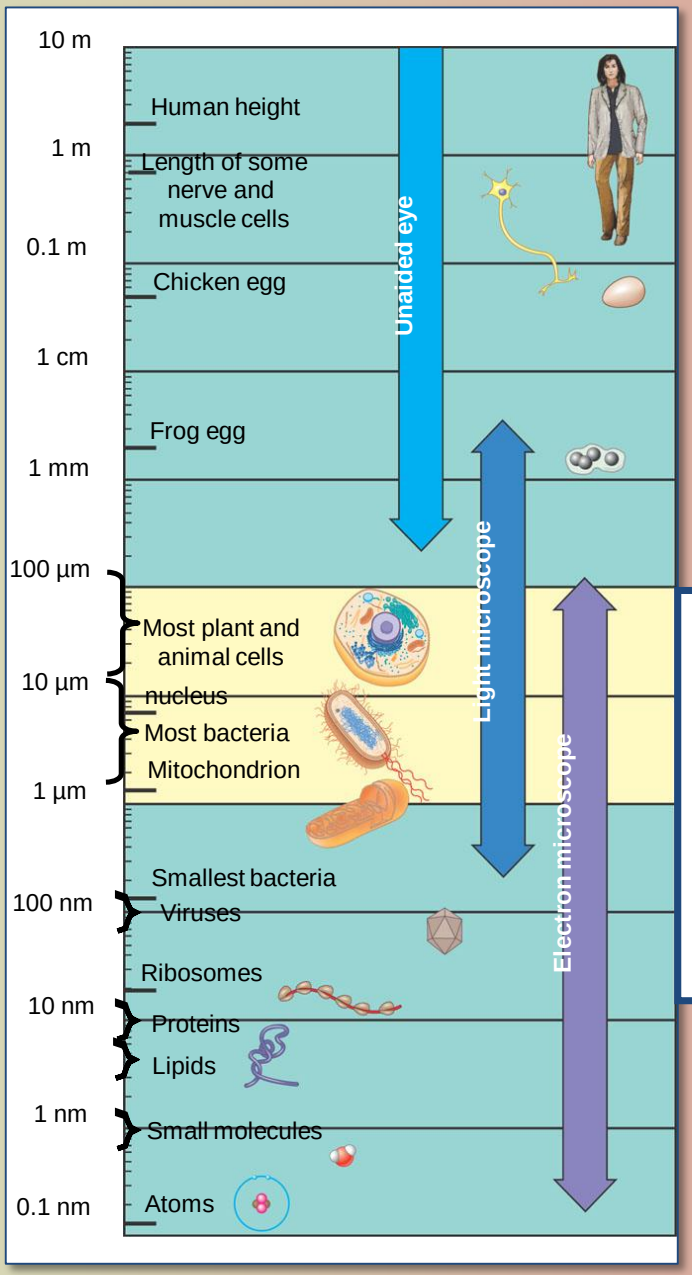
(b) **Transmission electron microscopy (TEM).** A transmission electron microscope profiles a thin section of a specimen. Here we see a section through a tracheal cell, revealing its ultrastructure. In preparing the TEM, some cilia were cut along their lengths, creating longitudinal sections, while other cilia were cut straight across, creating cross sections.

RESULTS





The size range of cells



Measurements

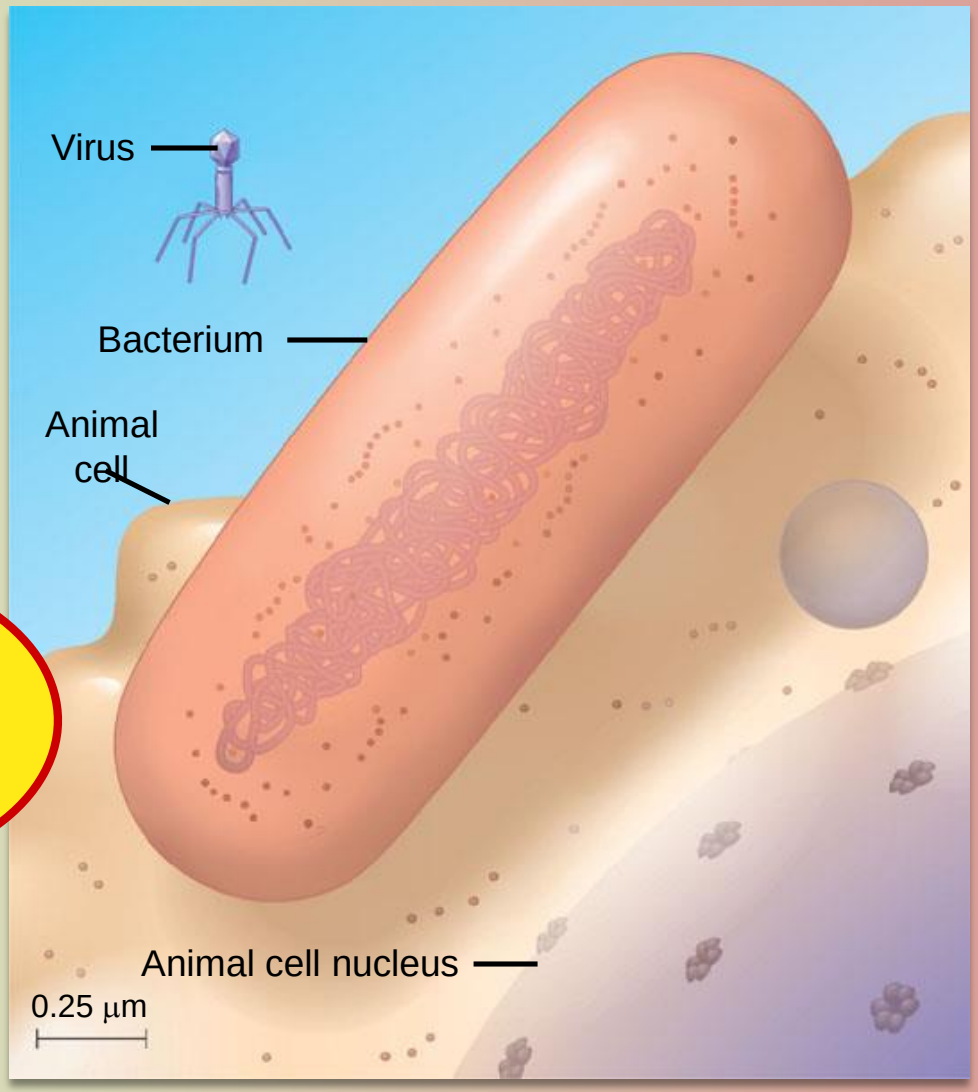
1 centimeter (cm) = 10^{-2} meter (m) = 0.4 inch

1 millimeter (mm) = 10^{-3} m

1 micrometer (µm) = 10^{-3} mm = 10^{-6} m

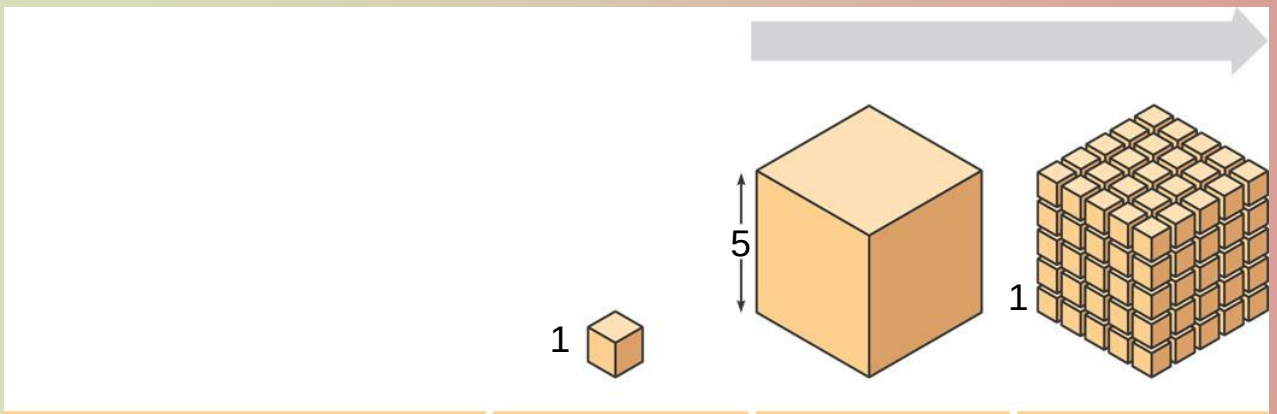
1 nanometer (nm) = 10^{-3} µm = 10^{-9} m

Comparing the size of a virus, a bacterium, and an animal cell



Why Cells Are So Small: The SA:V Ratio

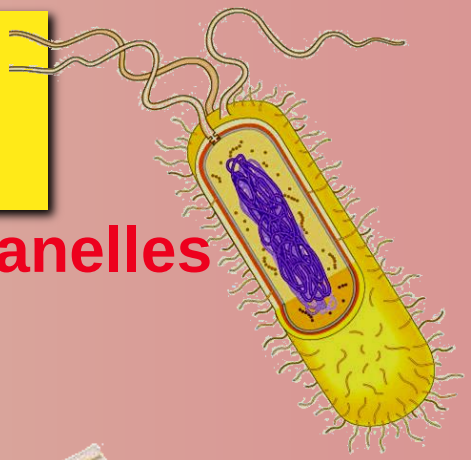
Surface area increases while total volume remains constant



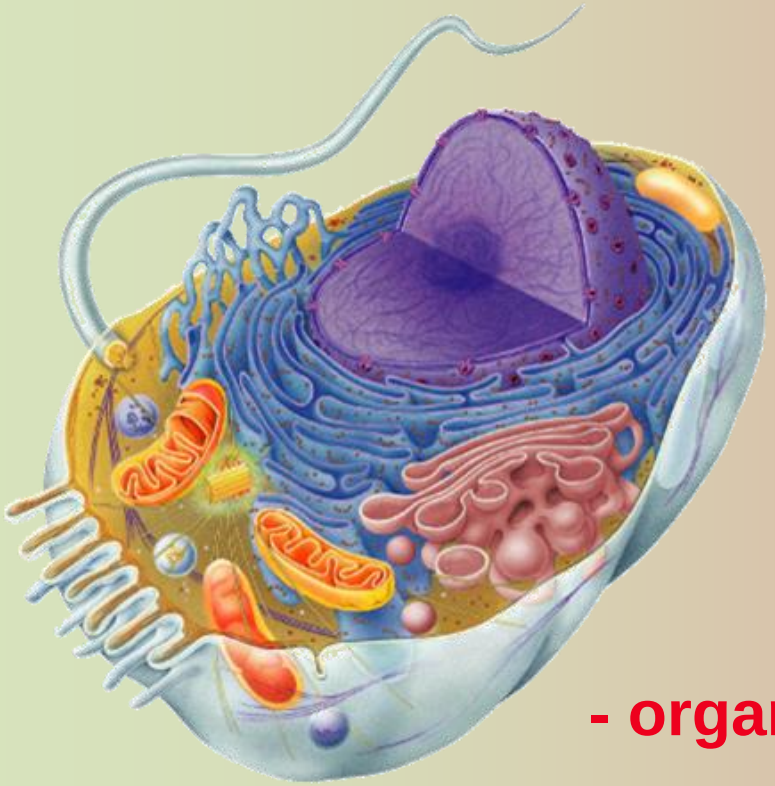
Total surface area (height × width × number of sides × number of boxes)	6	150	750
Total volume (height × width × length × number of boxes)	1	125	125
Surface-to-volume ratio (surface area ÷ volume)	6	12	6

Types of cells

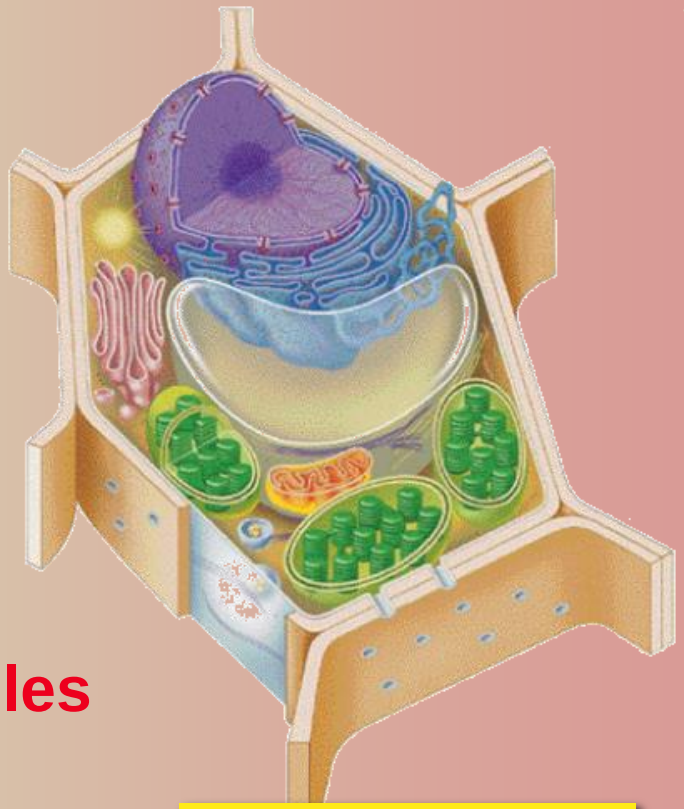
Prokaryote bacteria cells



- no organelles



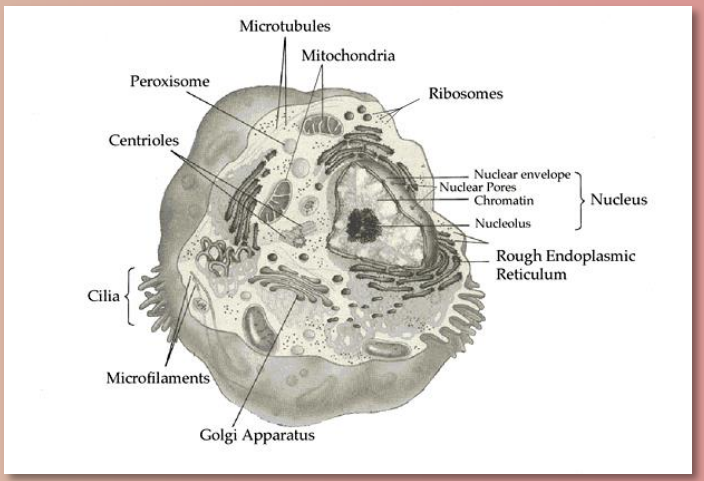
- organelles



Eukaryote animal cells

Eukaryote plant cells

Why organelles?



- Specialized structures
  - specialized functions
- Containers
  - Compartments = different local environments
    - pH, concentration differences
  - distinct & incompatible functions
    - lysosome & its digestive enzymes
- Membranes as sites for chemical reactions
  - Unique lipids & proteins
  - embedded enzymes & reaction centers
    - chloroplasts & mitochondria