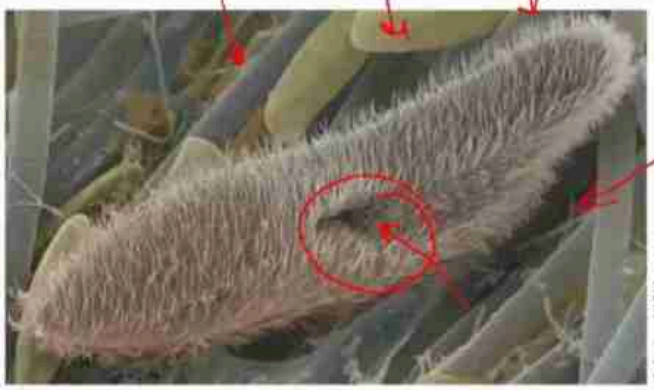
Electron microscope (EM) focuses a beam of electrons through a specimen or onto its surface.

- ❑ Can distinguish as small as about 2 nanometers (nm), a 100-fold improvement over the light microscope
- ❑ Enabled biologists to explore cell ultrastructure, the complex internal anatomy of a cell.

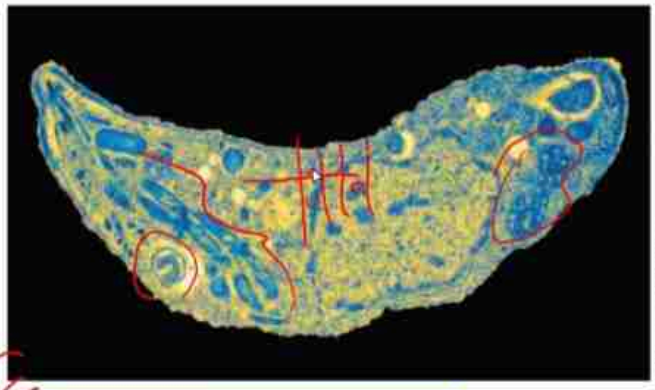


Colorized SEM 580×

Scanning electron micrograph of *Paramecium*

detailed architecture of cell surfaces indentation, called the oral groove, through which food enters the cell

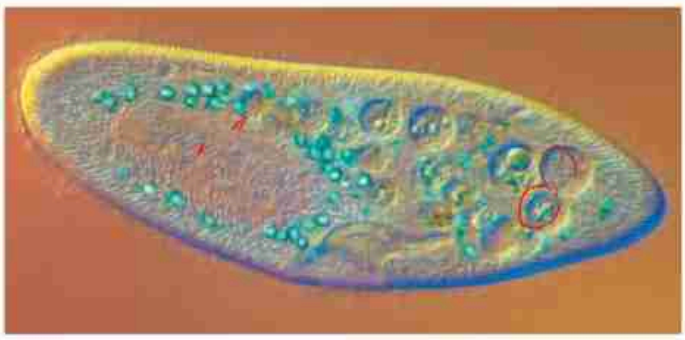
PIYEL



Colorized TEM 9,140×

Transmission electron micrograph of *Toxoplasma*

details of internal cell structure
stained with atoms of heavy metals, which attach to certain cellular structures more than others



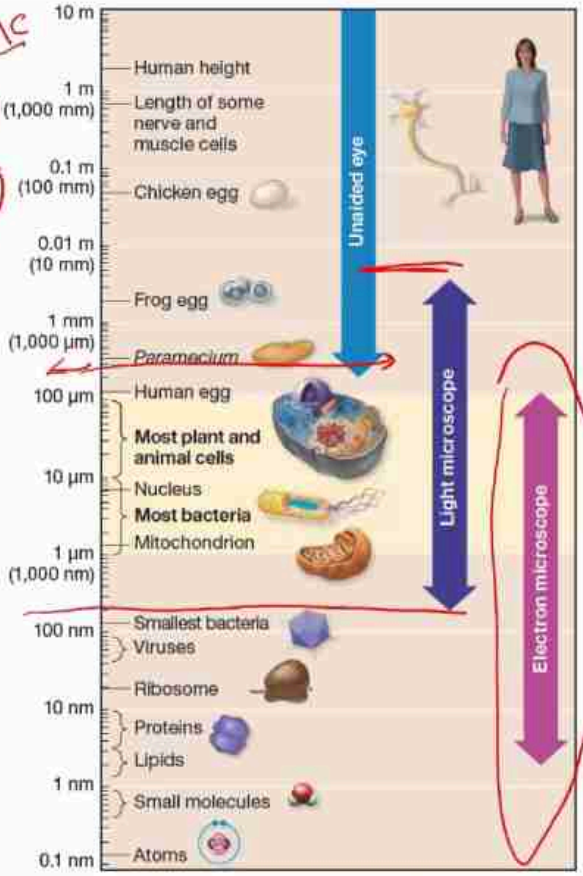
LM 380×

Paramecium as seen using differential interference contrast microscopy

- ❑ amplifies differences in density so that the structures in living cells appear almost three-dimensional
- ❑ fluorescent stains that selectively bind to various cellular molecules

Which type of microscope would you use to study
(a) The changes in shape of a living human white blood cell;
(b) The finest details of surface texture of a human hair;
(c) the detailed structure of an organelle in a liver cell?

(a) Light microscope; (b) scanning electron microscope; (c) transmission electron microscope



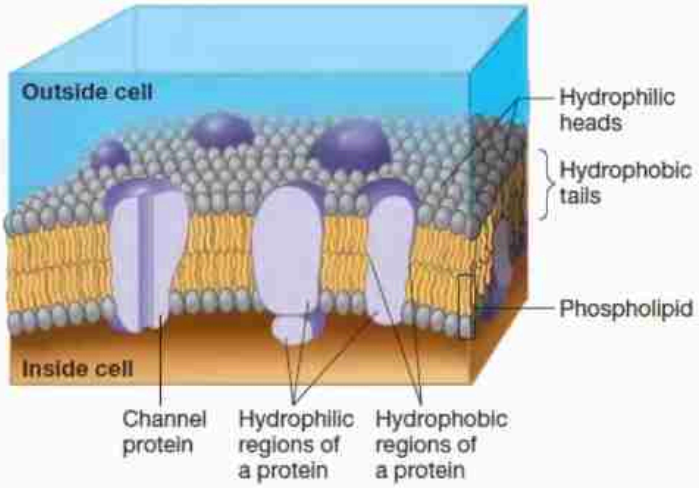
The small size of cells relates to the need to exchange materials across the plasma membrane

- ❑ Cell must be large enough to house enough DNA, protein molecules, and structures to survive and reproduce. But why aren't most cells as large as chicken eggs?
- ❑ The maximum size of a cell is influenced by geometry—the need to have a surface area large enough to service the volume of a cell.
- ✓ Active cells have a huge amount of traffic across their outer surface.
- ❑ A chicken egg cell isn't very active, but once a chick embryo starts to develop, the egg is divided into many microscopic cells, each bounded by a membrane that allows the essential flow of oxygen, nutrients, and wastes across its surface.

So what is a cell's surface like? And how does it control the traffic of molecules across it?

❖ **plasma membrane**, referred to as the cell membrane, forms a flexible boundary between the living cell and its surroundings.

❑ This membrane is amazingly thin.



❑ the phospholipids' hydrophilic (water-loving) heads face outward, exposed to the aqueous solutions on both sides of a membrane.

❑ Their hydrophobic (water-fearing) tails point inward, mingling together and shielded from water.

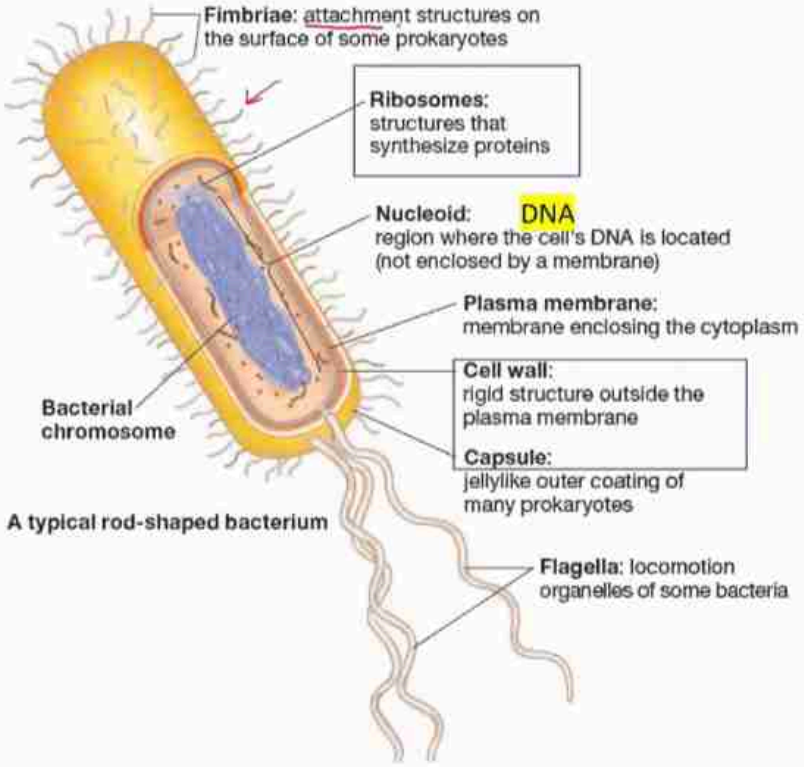
❑ Embedded in this lipid bilayer are diverse proteins. The regions of the proteins within the center of the membrane are hydrophobic; the exterior sections exposed to water are hydrophilic

Prokaryotic cells are structurally simpler than Eukaryotic cells

- ❑ Cells are of two distinct types: prokaryotic and eukaryotic.
- ❑ **Prokaryotic cells** were the first to evolve and were Earth's sole inhabitants for more than 1.5 billion years.
  - ❑ Eu**karyotic cells** evolved from some of these ancestral cells about 1.8 billion years ago.
- ❑ Biologists recognize three domains or major groups of organisms.
  - ❑ Domains Bacteria and Archaea consist of prokaryotic cells.
  - ❑ These organisms are known as prokaryotes.

hot/salty conditions

- ✓ All other forms of life are placed in domain Eukarya.
  - ✓ Composed of eukaryotic cells and are referred to as eukaryotes.
- ✓ Eukaryotic cells are distinguished by having a membrane enclosed nucleus, which houses most of their DNA, and many membrane-enclosed organelles that perform specific functions.
- ✓ Prokaryotic cells are smaller and simpler in structure.



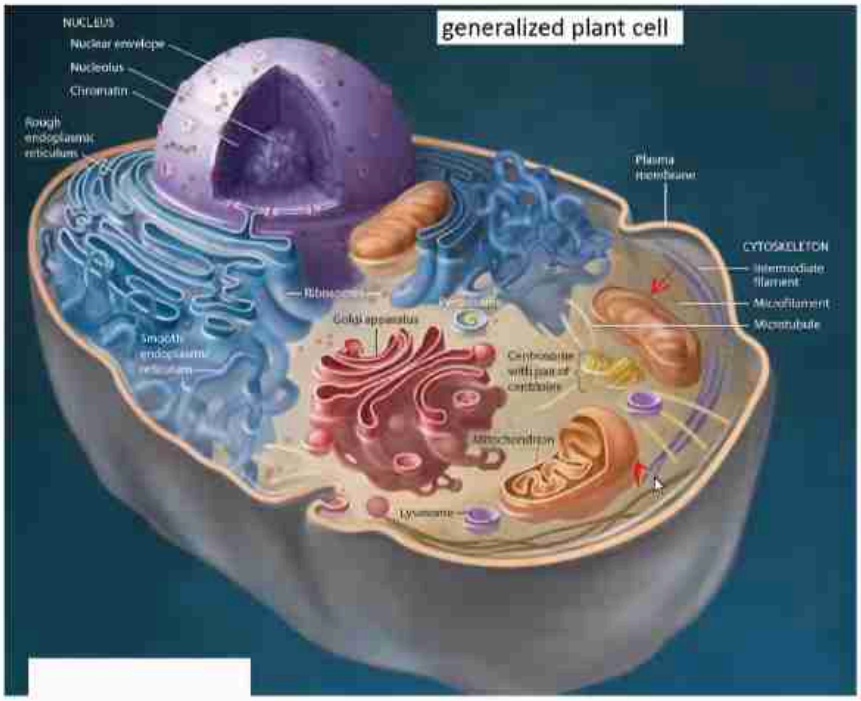
- Smaller and differ somewhat from those of eukaryotes
- the basis for the action of some antibiotics, which specifically target prokaryotic ribosomes

Protects the cell and helps maintain its shape. Some antibiotics, such as penicillin, prevent the formation of these protective walls

- Our cells don't have such walls, these antibiotics can kill invading bacteria without harming your cells

- **flagella** propel a cell through its liquid environment.

Eukaryotic cells are partitioned into functional compartments



- ❑ cells have multiple copies of all of these structures (except for the nucleus).
- ✓ Our cells have hundreds of mitochondria and millions of ribosomes.
- ❑ A plant cell may have 30 chloroplasts packed inside.
- ✓ Cells also have different shapes and relative proportions of cell parts, depending on their specialized functions.

❑ The organelles and other structures of eukaryotic cells can be organized into four basic functional groups:

(1) The nucleus and ribosomes: genetic control of the cell. DNA Protein

(2) endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles, and peroxisomes:
Organelles involved in the manufacture, distribution, and breakdown of molecules

(3) Mitochondria: energy processing.

(4) cytoskeleton, plasma membrane, and plant cell wall: Structural support, movement, and communication between cells

1. Genetic Control

Nucleus		DNA replication, RNA synthesis; assembly of ribosomal subunits (in nucleolus)
Ribosomes		Polypeptide (protein) synthesis

2. Manufacturing, Distribution, and Breakdown

Rough ER		Synthesis of membrane lipids and proteins, secretory proteins, and hydrolytic enzymes; formation of transport vesicles
Smooth ER		Lipid synthesis; detoxification in liver cells; calcium ion storage in muscle cells
Golgi apparatus		Modification and sorting of ER products; formation of lysosomes and transport vesicles
Lysosomes (in animal cells and some protists)		Digestion of ingested food or bacteria and recycling of a cell's damaged organelles and macromolecules
Vacuoles		Digestion (food vacuole); water balance (contractile vacuole); storage of chemicals and cell enlargement (central vacuole in plant cells)
Peroxisomes (not part of endomembrane system)		Diverse metabolic processes, with breakdown of toxic hydrogen peroxide by-product

3. Energy Processing

Mitochondria		Cellular respiration: conversion of chemical energy in food to chemical energy of ATP
Chloroplasts (in plants and algae)		Photosynthesis: conversion of light energy to chemical energy of sugars

4. Structural Support, Movement, and Communication Between Cells

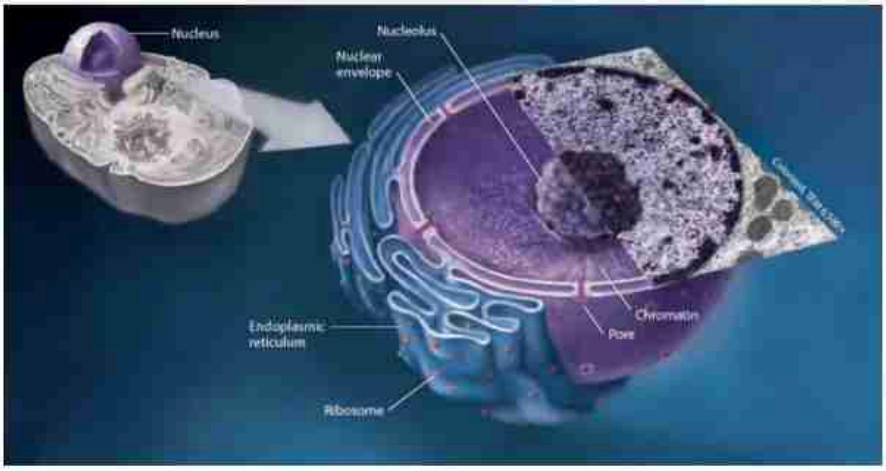
Cytoskeleton (microfilaments, intermediate filaments, and microtubules)		Maintenance of cell shape; anchorage for organelles; movement of organelles within cells; cell movement (crawling, muscle contraction, bending of cilia and flagella)
Plasma membrane		Regulate traffic in and out of cell
Extracellular matrix (in animals)		Support; regulation of cellular activities
Cell junctions		Communication between cells; binding of cells in tissues
Cell walls (in plants)		Support and protection; binding of cells in tissues

the internal membranes of a eukaryotic cell partition it into functional compartments in which many of its chemical activities—collectively called **cellular metabolism**—take place

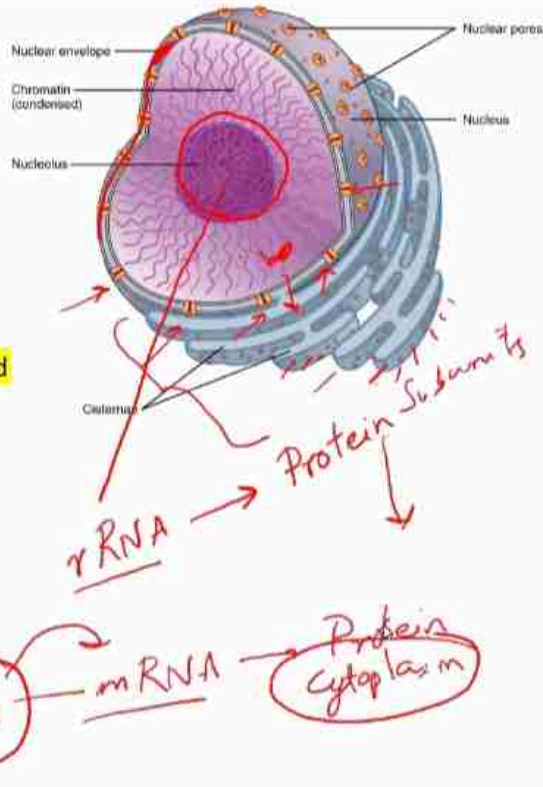
The Nucleus and Ribosomes

The nucleus contains the cell's genetic instructions

- Control the cell's activities by directing protein synthesis.
- The DNA is associated with many proteins and organized into structures called chromosomes. The proteins help coil these long DNA molecules.
- When a cell is not dividing, this complex of proteins and DNA, called **chromatin**, appears as a diffuse mass within the nucleus.



- a double membrane encloses the **nuclear envelope**.
  - Controls the flow of materials into and out of the nucleus
  - perforated with protein-lined pores:
  - regulate the entry and exit of large molecules and also connect with the cell's network of membranes called the endoplasmic reticulum



- The **nucleolus:** a special type of RNA called ribosomal RNA (rRNA) is synthesized with instructions in the DNA.
- rRNA helps in assembling the Protein sub units: These subunits then exit to the cytoplasm, where they will join to form functional ribosomes.
- messenger RNA (mRNA) directs protein synthesis: The mRNA moves into the cytoplasm, where ribosomes translate it into the amino acid sequences of proteins.
- What are the processes that occur in the nucleus?

✓ DNA is copied and passed on to daughter cells in cell division; rRNA is made and ribosomal subunits assembled; protein-making instructions in DNA are transcribed into mRNA.

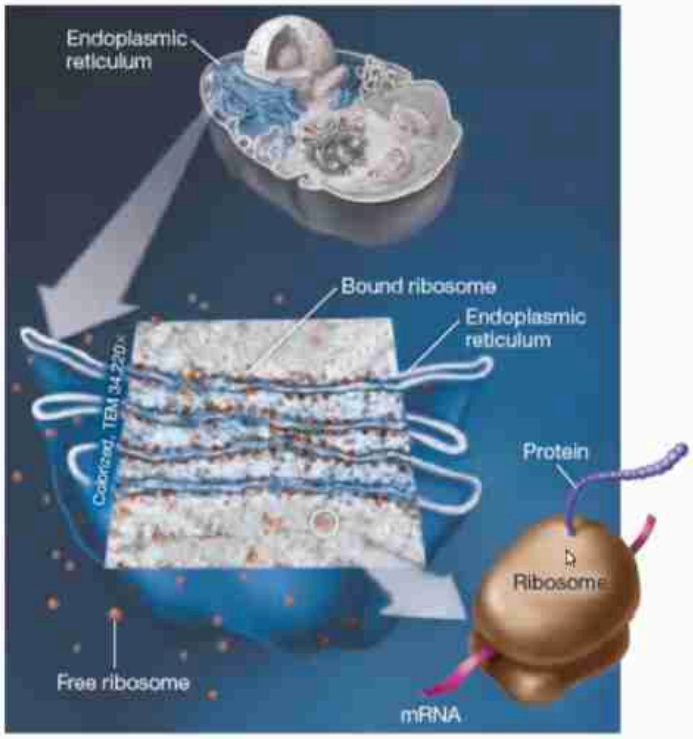
Ribosomes make proteins for use in the cell and for export

- ❑ Ribosomes are cellular components that use instructions from the nucleus, written in mRNA, to build proteins.
- ❑ Cells that make a lot of proteins have a large number of ribosomes.

- ❑ Present in two locations:

- ❑ Free ribosomes are suspended in the cytosol,
- ❑ Bound ribosomes are attached to the outside of the endoplasmic reticulum or nuclear envelope.

What role do ribosomes play?

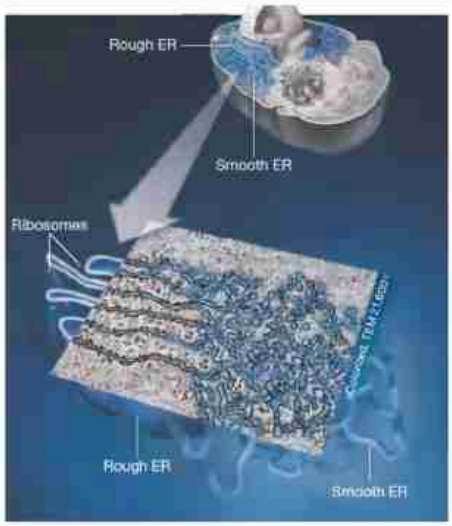


The Endomembrane System

Many organelles are connected in the endomembrane system

- Nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosomes, vesicles and vacuoles, and the plasma membrane
- Many of these organelles interact in the synthesis, distribution, storage, and export of molecules.

- The largest component of the endomembrane system is the **endoplasmic reticulum (ER)**, an extensive network of flattened sacs and tubules.
  - (The word *endoplasmic* means "within the cytoplasm," and *reticulum* is Latin for "little net.")



- membranes of the ER are continuous with the nuclear envelope.
- And when vesicles bud from the ER, they travel to many other components of the endomembrane system.

https://www.youtube.com/watch?v=Fcxc8Gv7NiU