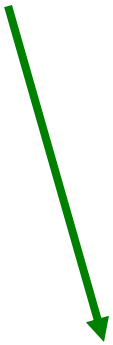
BIO 311C
Spring 2010

You will learn most from each lecture if your read the corresponding textbook assignment before the lecture.

Recall that all presentation slides with an asterisk in the lower-right corner are placed on the course web site.



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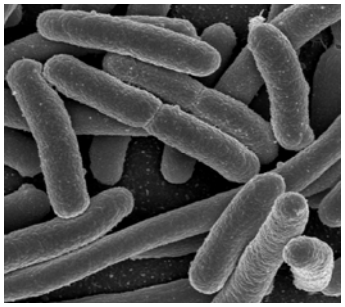
Lecture 4 – Wednesday 27 Jan. 2010

Five Major Model Organisms



E. coli
a prokaryote

Caenorhabditis elegans
a roundworm

Drosophila melanogaster
a fruit fly

Mus musculus
a mouse

Arabidopsis thaliana
a little weedy plant

A large portion of modern cell & molecular biology research uses these five model organisms.

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Some Ways that Prokaryotic Cells Differ from Eukaryotic Cells

- Prokaryotic cells are generally much smaller and less complex in shape than are typical eukaryotic cells.

- There is no communication among cells of prokaryotic organisms that contain more than one cell. Generally cells of multicellular eukaryotic organisms are in close communication with each other.

- The genetic content of prokaryotic cells most often occurs as a single circular molecule of DNA; some also contain plasmids. Most of the genetic content of eukaryotic cells occurs in a special compartment (the nucleus) and consists of two or more linear (noncircular) chromosomes. DNA also occurs in special compartments (e.g. mitochondria) of eukaryotic cells.

- Prokaryotic cells generally do not contain membrane-bounded organelles or a prominent cytoskeleton, while eukaryotic cells do contain these kinds of structures.

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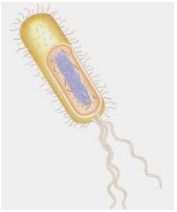
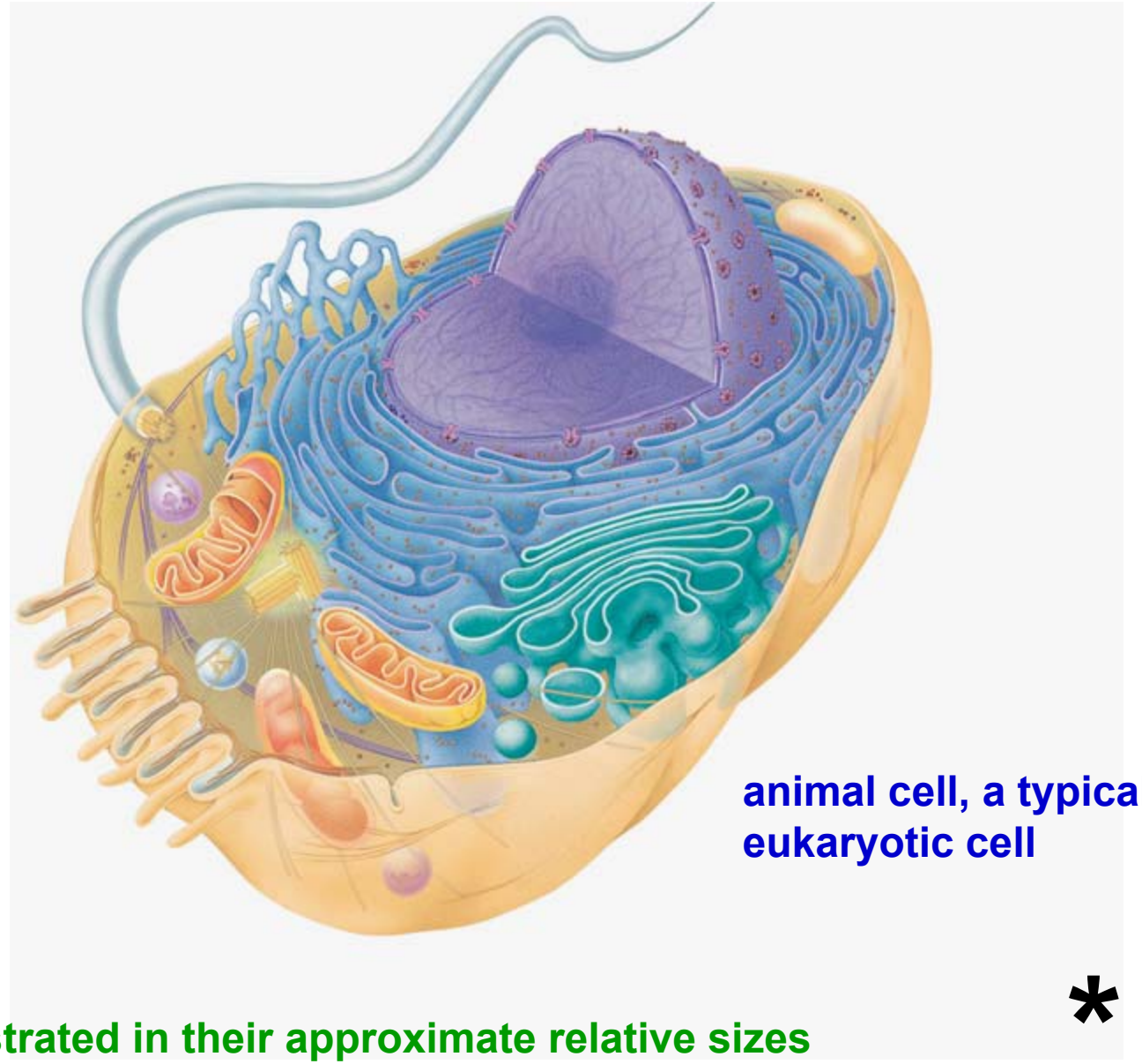
Most eukaryotic cells are much larger and much more complex than prokaryotic cells.



prokaryotic cell



animal cell, a typical eukaryotic cell

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These cells are illustrated in their approximate relative sizes

Summary

Some Characteristic Features of the Cells of Eukaryotes

- Most are greater than 5 μm in length.
- Practically every imaginable shape is represented by some eukaryotic cell.
- Some exist as unicellular organisms and others as a unit of a multicellular organism. Cells of most multicellular eukaryotes communicate extensively with each other.
- They contain relatively large and dense (80S) ribosomes in their cytoplasm and 70S ribosomes in their mitochondria and plastids.
- Most of their DNA is contained in an envelope-bounded nucleus. Nuclear DNA is organized by wrapping around specialized proteins to form two or more linear chromosomes.
- They contain a large array of various kinds of membrane-bounded organelles in an endomembrane system
- Most energy production occurs within mitochondria and (in green plants) within chloroplasts.
- They contain a cytoskeleton of tubular and filamentous structures.
- Most kinds contain a covering external to the plasma membrane.

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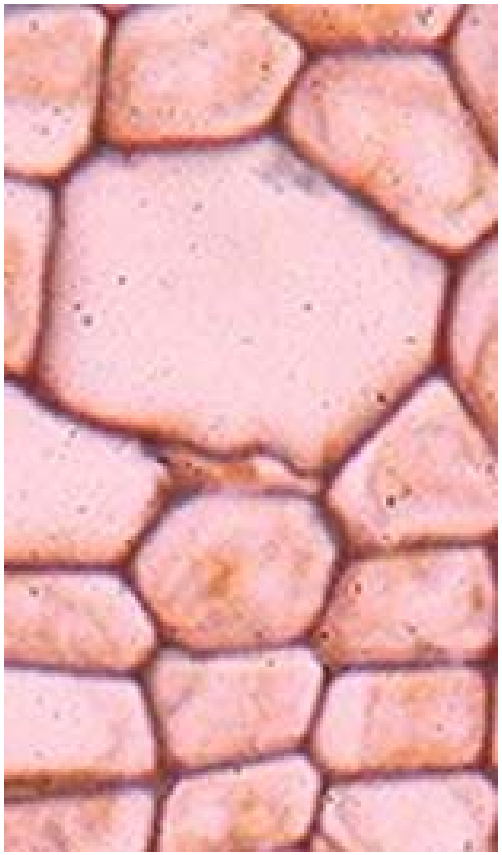
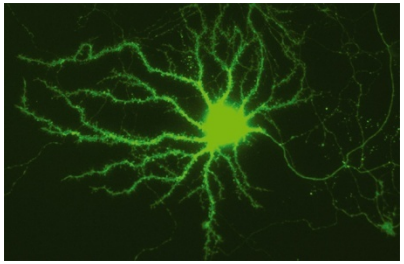
Most eukaryotic cells are greater than 5 µm in length.
Nearly every imaginable shape is represented by some eukaryotic cell.

Paramecium
A single-celled protist



plant cells

muscle cell



nerve cell

20 µm

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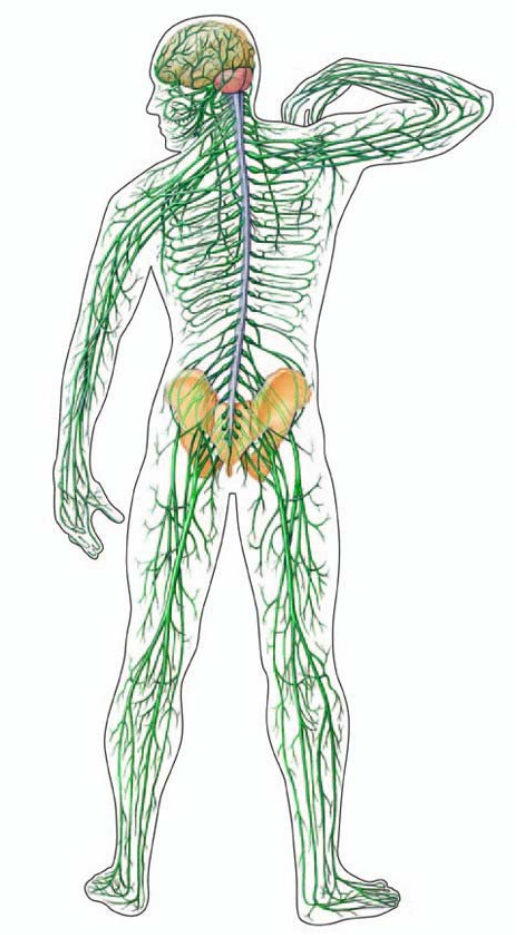
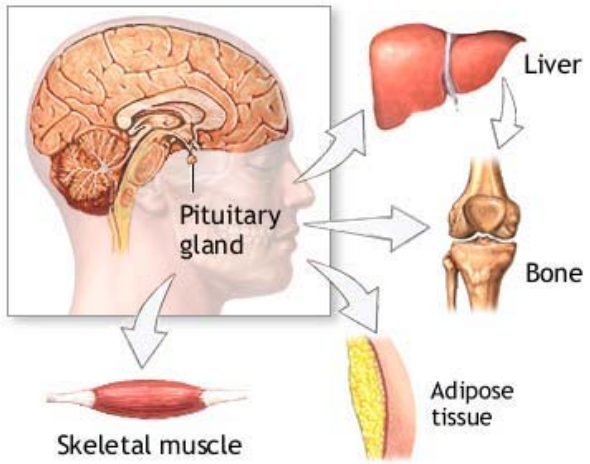
Cells of multicellular eukaryotes communicate extensively with each other.

Example: Nervous system communication (a kind of electrical communication)



Example: Hormonal communication (a kind of chemical communication)



Human Growth Hormone (GH) is transported throughout the body in the bloodstream

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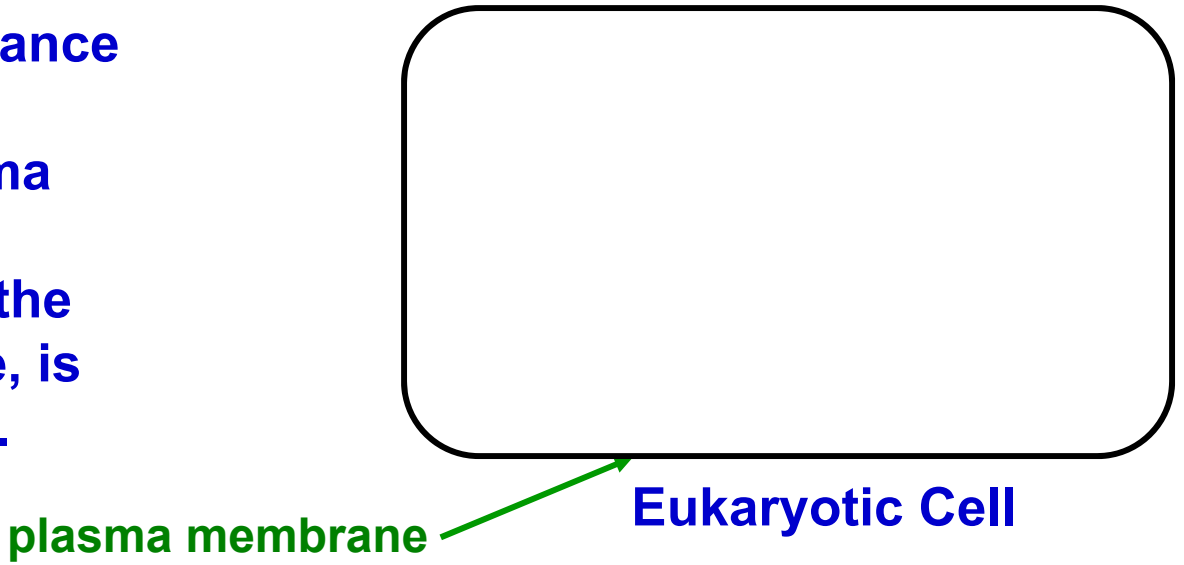
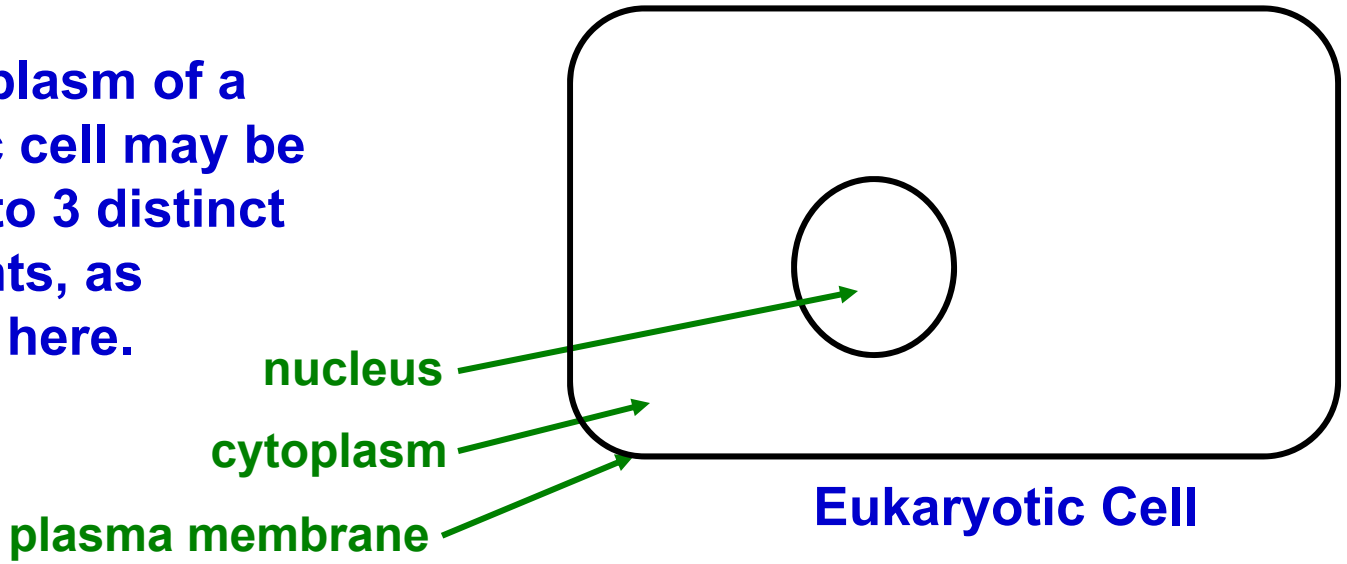
The "living" substance of any living cell, including its plasma membrane and everything within the plasma membrane, is called protoplasm.



The protoplasm of a eukaryotic cell may be divided into 3 distinct components, as illustrated here.



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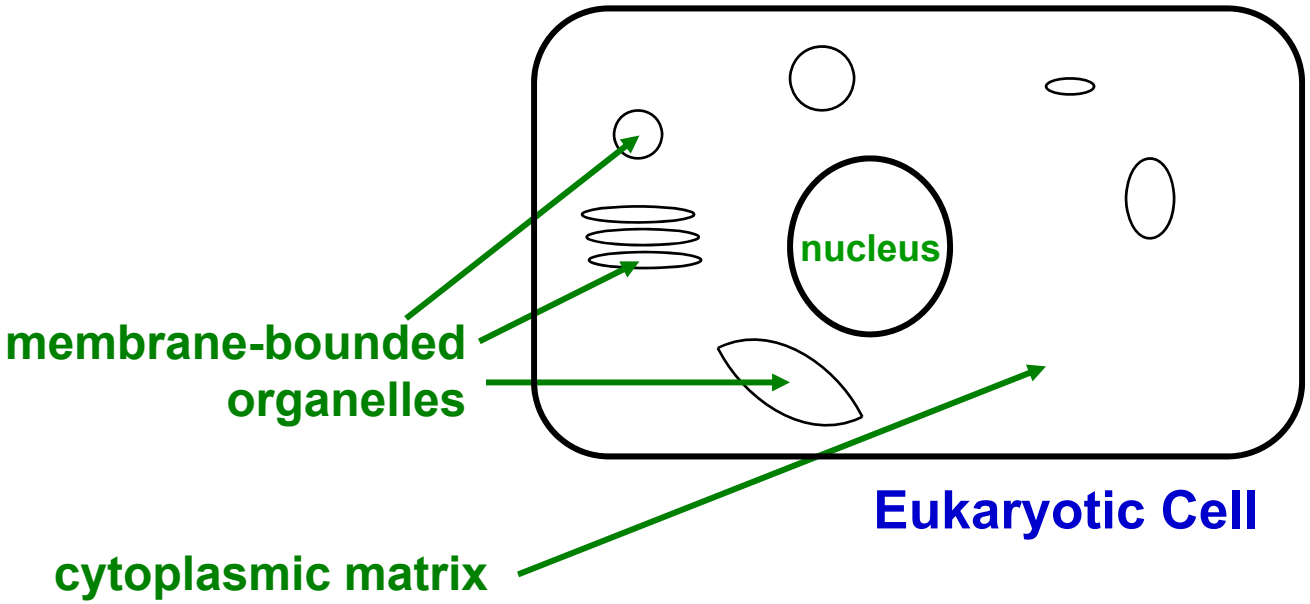
The cytoplasm of a eukaryotic cell may be divided into two kinds of components, a cytoplasmic matrix and membrane-bounded organelles. These membrane-bounded organelles compartmentalize the components of cytoplasm.



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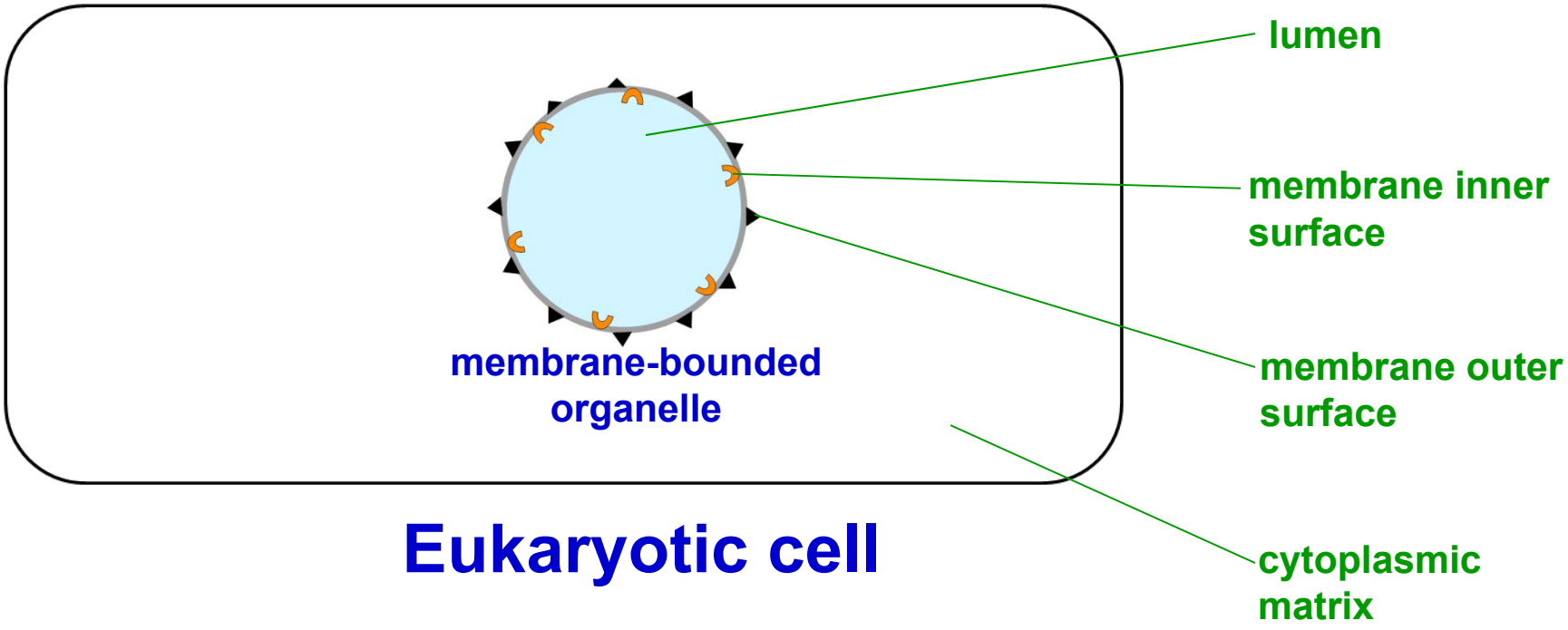
Compartmentalization of Eukaryotic Cells by Membrane-bounded Organelles



- The surrounding membrane of a membrane-bounded organelle separates the contents of the organelle from the cytoplasmic matrix.
- The space within a membrane- bounded organelle is called the lumen.
- The membrane of an organelle provides two functionally distinct surfaces, the cytoplasmic-facing surface and the lumen-facing surface.

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Definition:

A membrane-bounded organelle is a structure within a eukaryotic cell organelle that includes a surrounding membrane.

Note: In this course we will use the words “membrane-bounded organelle” and “organelle” interchangeably.

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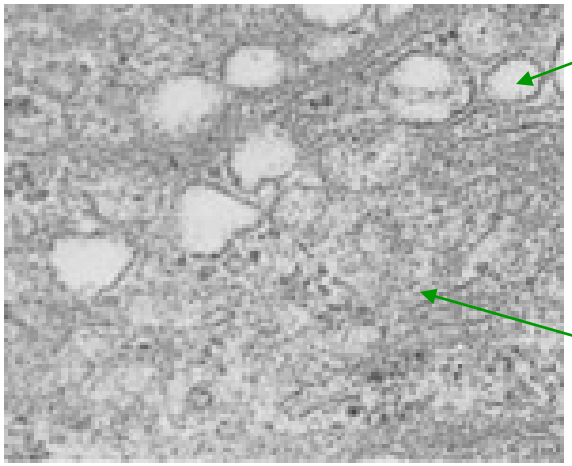
An occlusion may be defined as any structure in a cell that is not membrane-bounded and is large enough to be seen by some kind of microscopy. Electron microscopes can visualize occlusions smaller than 5 nm in diameter. Ribosomes are occlusions that occur in the cytoplasm of all cells. Occlusions may also include:

- packets of stored food and energy,
- packets of enzymes,
- waste substances,
- viruses.



Electron microscope image showing occlusions and a kind of membrane-bounded organelle of a eukaryotic cell.

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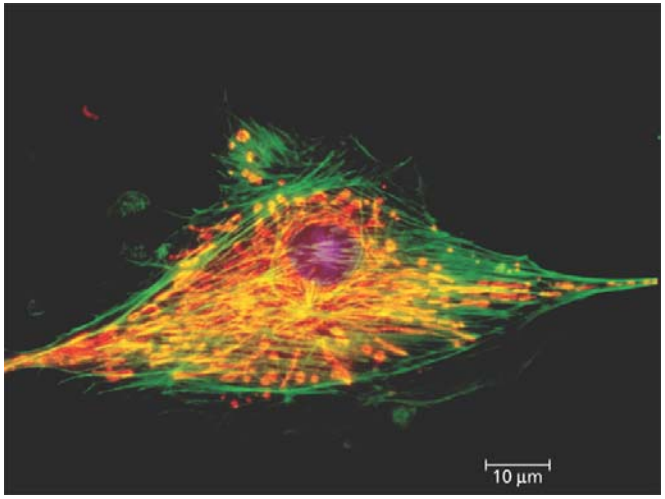
The cytoskeleton of eukaryotic cells consists of several kinds of cytoskeletal elements.

Cytoskeletal elements include filamentous and tubular structures, and various kinds of molecules bound to them.

Different colors in this color-enhanced image show different kinds of cytoskeletal elements that occur in the cytoplasmic matrix of an animal cell.



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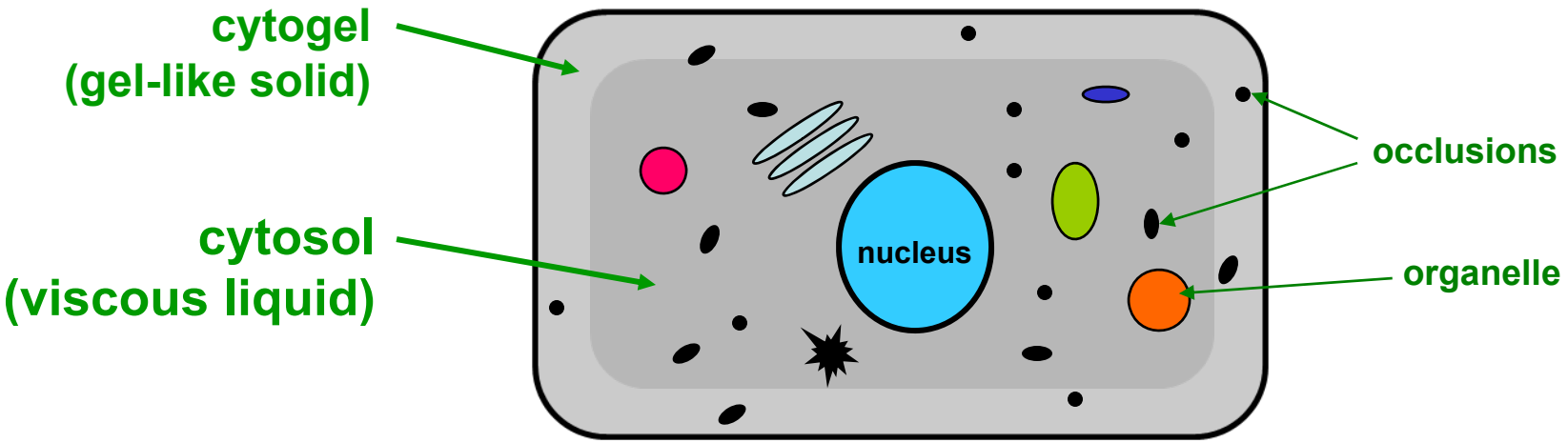
Cytosol and Cytogel

The cytosol and cytogel of a (prokaryotic or eukaryotic) cell consist of water in the cytoplasmic matrix along with ions and molecules dissolved in it.

The cytosol is in a liquid state. The outer portion (just inside of the plasma membrane) of many eukaryotic cells occur in a rigid gel-like form and is called the cytogel.

All components of the cell except the cytosol and cytogel are large enough to be visible by some kind of microscopy.



Eukaryotic Cell

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Components and Compartments of Eukaryotic Cells

I. Non-living surface components
II. Living part of the cell (protoplasm)
    A. Plasma membrane
    B. Nucleus
    C. Cytoplasm
        1. Membrane-bounded organelles
        2. Cytoplasmic matrix
            a. occlusions
            b. cytoskeleton
            c. cytosol/cytogel

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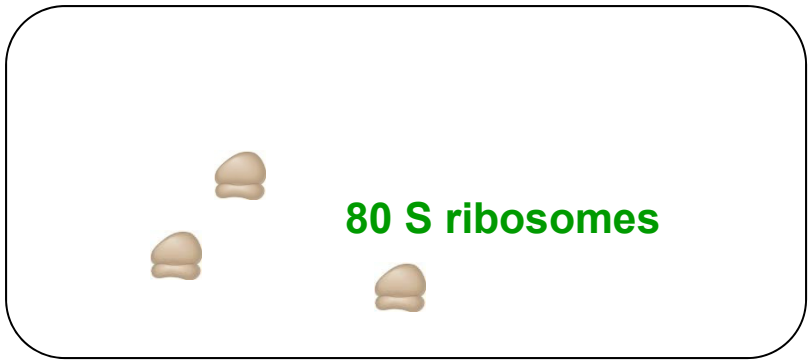
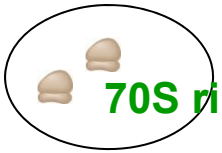
All living cells, both prokaryotic and eukaryotic, contain ribosomes.

Ribosomes contain the machinery for synthesis of proteins and are the sites where all proteins are synthesized.

Ribosomes in the cytoplasmic matrix of eukaryotic cells are slightly larger (80S ribosomes, ~24 nm diameter) and denser than are the ribosomes in prokaryotic cells (70S ribosomes, ~20 nm diameter).



eukaryotic cell



prokaryotic cell

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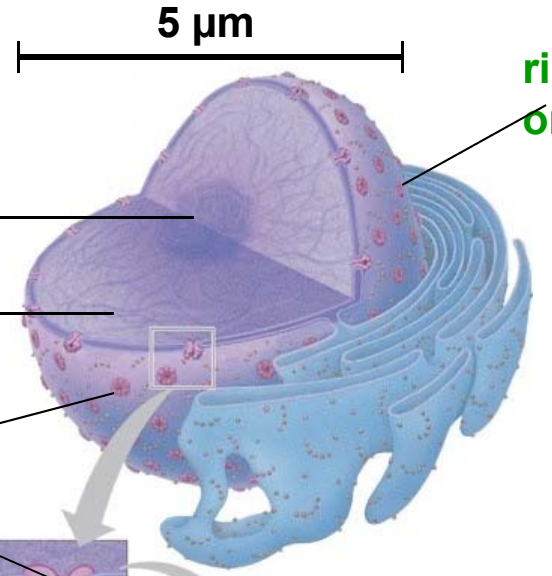
The nucleus is the largest structure within many kinds of eukaryotic cells.
Very little structure is visible within a nucleus of a living cell.



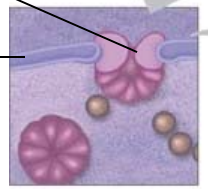
ribosomes (shown as tiny dots on the outer surface)

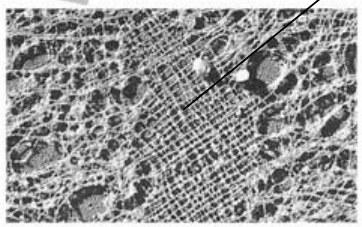
nucleolus

nucleoplasm (containing chromatin)

nuclear pores

nuclear envelope (containing 2 membranes) that enclose an intermembrane space)





nuclear lamina

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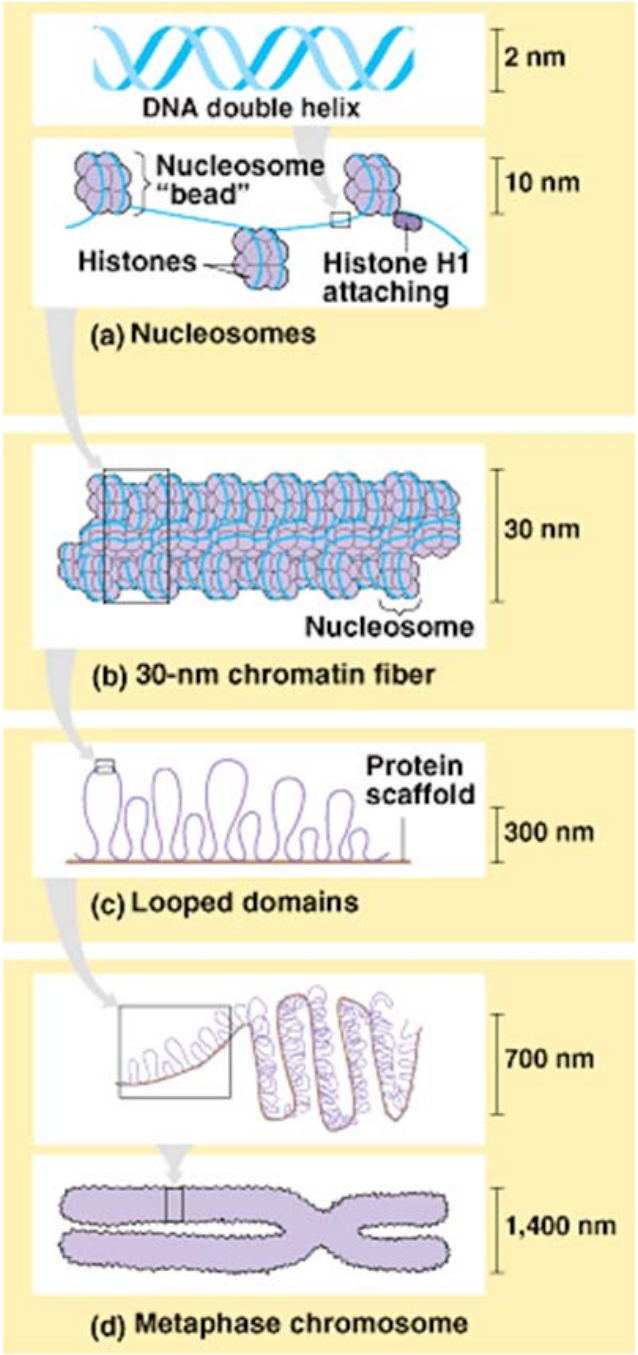
Levels of Chromatin Packing in the Nucleus



Also see textbook Fig. 16.21, p. 321

The DNA molecule of a single chromosome within the nucleus may be hundreds of times as long as the diameter of the entire cell. Eukaryotic cells contain linear (not circular) chromosomes packaged into the nucleus. the great length of DNA requires elaborate packaging in order to keep it from tangling, yet it must be accessible for its replication and for expression of the information it contains.

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Functions of the Cell Nucleus

Storage of information (DNA)

Transcription of information into a form (RNA) that is processed (chemically modified) and moved to the cytoplasm

Center of coordination of cellular activities

Construction of ribosomes (in the nucleolus)

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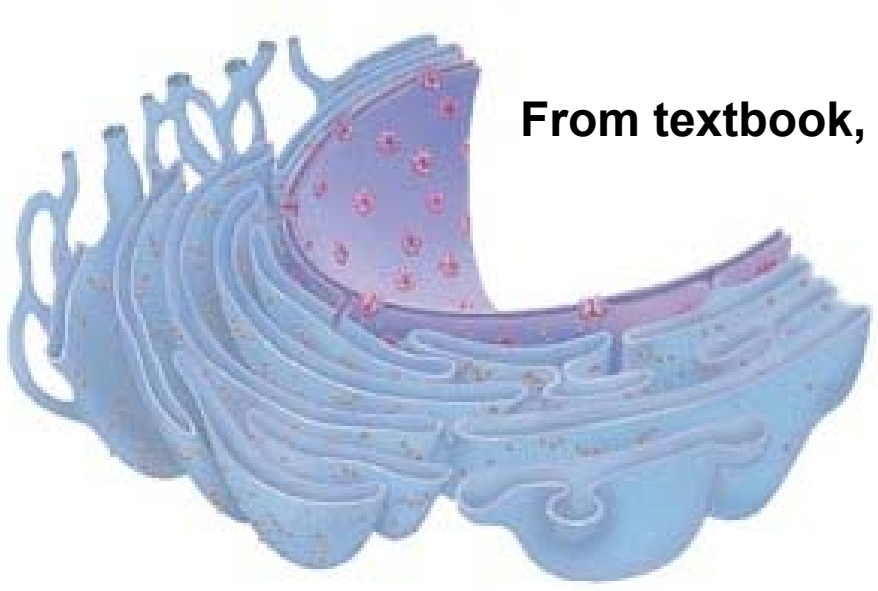
The outer membrane of the nuclear envelope is continuous with membrane that extends into the cytoplasm of the cell.

The intermembrane space of the nuclear envelope is continuous with the space enclosed by the extending membrane.



From textbook, Fig. 6.12, p. 105

The membrane connected to the nuclear envelope that extends into the cytoplasm of the cell is called endoplasmic reticulum.

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