Eukaryotic Cell Structure: Nuclear & Within the Cytoplasm

BIOL 101, Henry Kirk

Why should eukaryotic cell structure/interaction matter to anyone?

- For most people outside the medical field, the intricacies of how a cell's structure doesn't initially seem to matter. However...
- Understanding how cells take in nutrients can help a person improve their diet.
- Understanding genetic modification may have more relevance in the near future with an increase of cloning and genetic engineering
- Understanding cells can lead to a better understanding of how and why medical advances are happening
- Understanding DNA and inheritance could potentially lead to more parents having their DNA tested for inherited genetic disorders

What does a eukaryotic cell do?

- Genetic control using the nucleus & ribosomes
- Manufacture, distribution & breakdown of molecules using the endoplasmic reticulum, golgi apparatus, lysosomes, vacuoles and peroxisomes
- Energy processing using the mitochondria and chloroplasts
- Structural support, movement & communication using the cytoskeleton, plasma membrane & cell wall

("Chapter 4 - A Tour of the Cell", 5)

How does a eukaryotic cell compare to a prokaryotic?

- Unlike a prokaryotic cell, eukaryotic cells…
  - Have a nucleus
  - Have cytoplasm
  - Have more than one chromosome
  - Have a membrane bound nucleus
  - Have lysosomes and peroxisomes
  - Have an endoplasmic reticulum (ER)
  - Have mitochondria
  - Have a golgi apparatus
  - Is 10-100um (as opposed to 1-10um)

("Eukaryotic Cell vs Prokaryotic Cell")

Eukaryotic Cells: Structure

- "Eukaryotic cells are partitioned like a hard drive" - Lecture Chpt. 4
- Internal membranes a.ka. the “endomembrane system” divide it into sections.
- Cellular metabolism
  - Many chemical activities of cells occur within organelles
    - Lots of enzymes for driving biochemical reactions are built into the membranes of organelles.

("Chapter 4 - A Tour of the Cell", 5)

Eukaryotic Cells: Plant vs. Animal

- Animal cells
  - Have lysosomes and centrioles
- Plant cells
  - Have a rigid cell wall made of cellulose
  - Have cytoplasmic channels (plasmodesmata)
  - Have chloroplasts - for energy production through photosynthesis
  - Have a central vacuole - for storing materials and waste

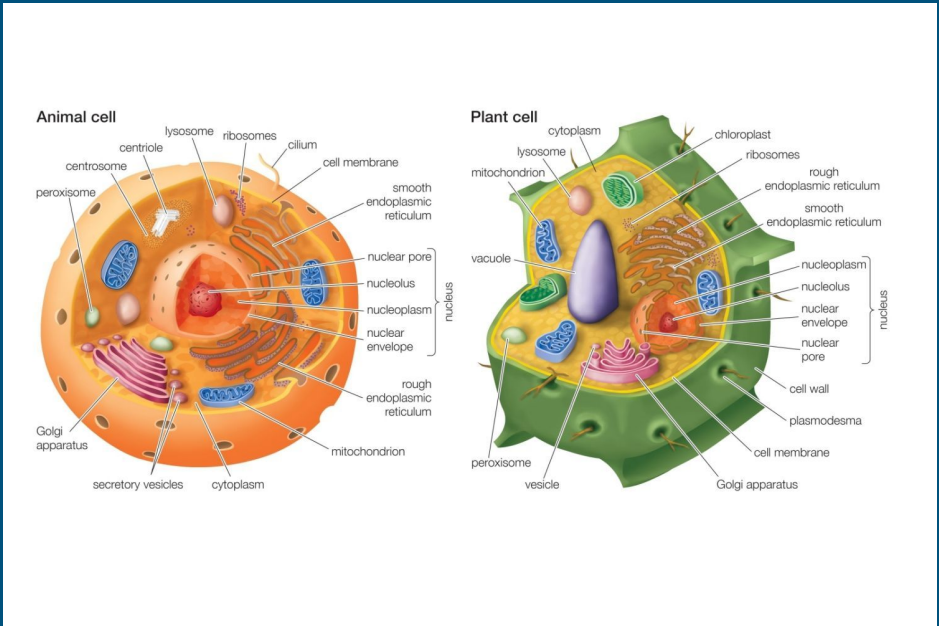


Figure 1

("15 Key Differences...")

Nucleus: Overview

- Contains most of a cell’s DNA
- Controls the cell’s activities by directing protein synthesis by making messenger RNA (mRNA).
- The nucleus is comprised of and related to
  - Nuclear Envelope
  - Nucleolus
  - Ribosomes
  - Endoplasmic Reticulum

("Chapter 4 - A Tour of the Cell", 6)

Nucleus: Eukaryotic Cells

- Nuclear envelope
  - Surrounds the outermost portion of the nucleus.
  - Has pores that regulate the movement of molecules within a cell and connect with the cell’s network of membranes called the endoplasmic reticulum

Nucleolus

- Prominent structure in the nucleus and•the site of ribosomal RNA (rRNA) synthesis.
- Is the largest structure in the nucleus of eukaryotic cells.
- It is the site of ribosome creation

Nucleoplasm

- The liquid substance of the nucleus that fills the space around DNA and the nucleoli.

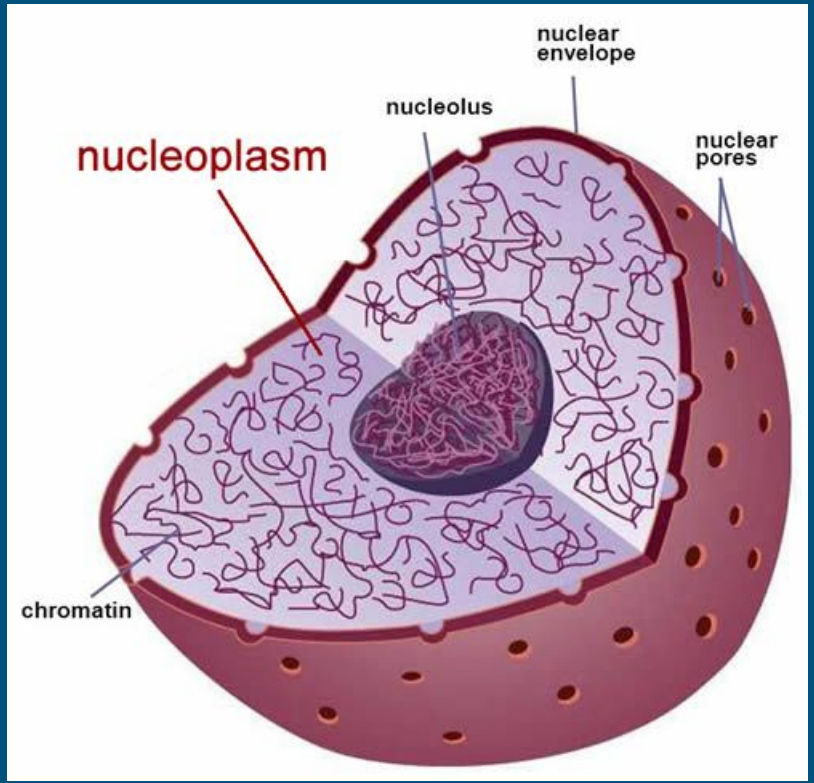


Figure 5

Endoplasmic Reticulum(ER): Function

- Smooth ER
  - Involved in diverse metabolic processes
  - Produces enzymes important in the production of lipids, oils, phospholipids, and steroids
  - Contains enzymes to process drugs, alcohol, and other potentially harmful substances
  - Also stores some calcium ions
- Rough ER
  - Is important in the synthesis and packaging of proteins
  - Has ribosomes are attached to its membrane
  - Makes additional membrane for its own use
  - Makes proteins for secretion

("Chapter 4 - A Tour of the Cell", 7)

Ribosomes

- Some ribosomes are *free ribosomes*; others are bound
- Free ribosomes float in the cytoplasm
- Make proteins that function in the cytoplasm

("A Tour of the Cell", 6)

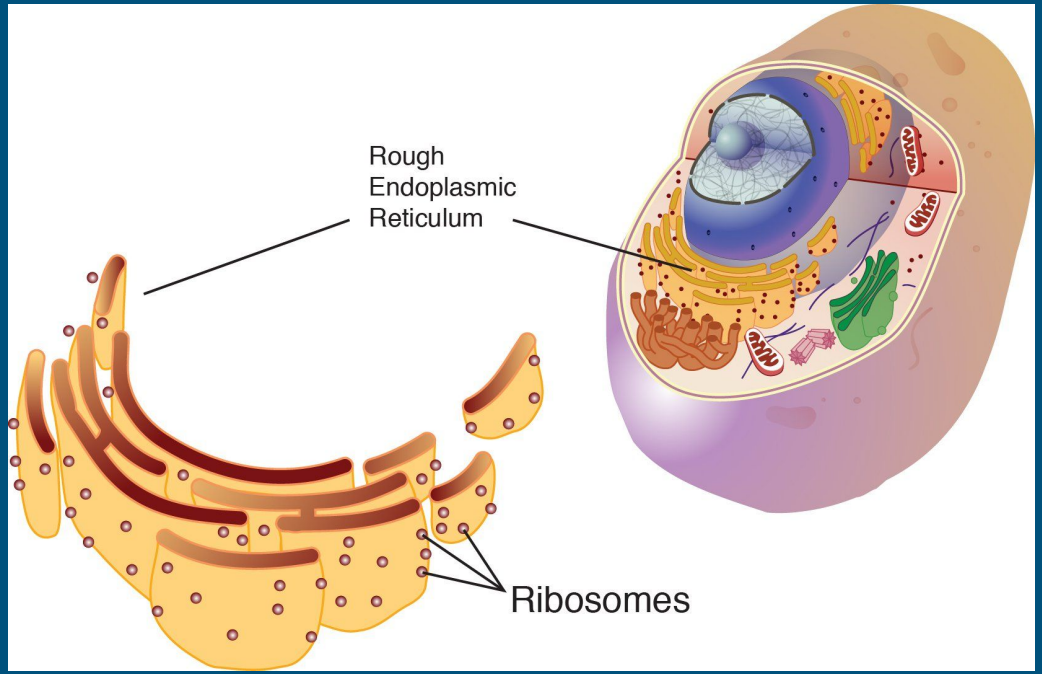


Figure 6

Golgi Apparatus

- Membrane-bound organelle of eukaryotic cells that is made up of flattened, stacked pouches called cisternae.
- Responsible for transporting, modifying, and packaging proteins & lipids into vesicles for delivery to targeted destinations

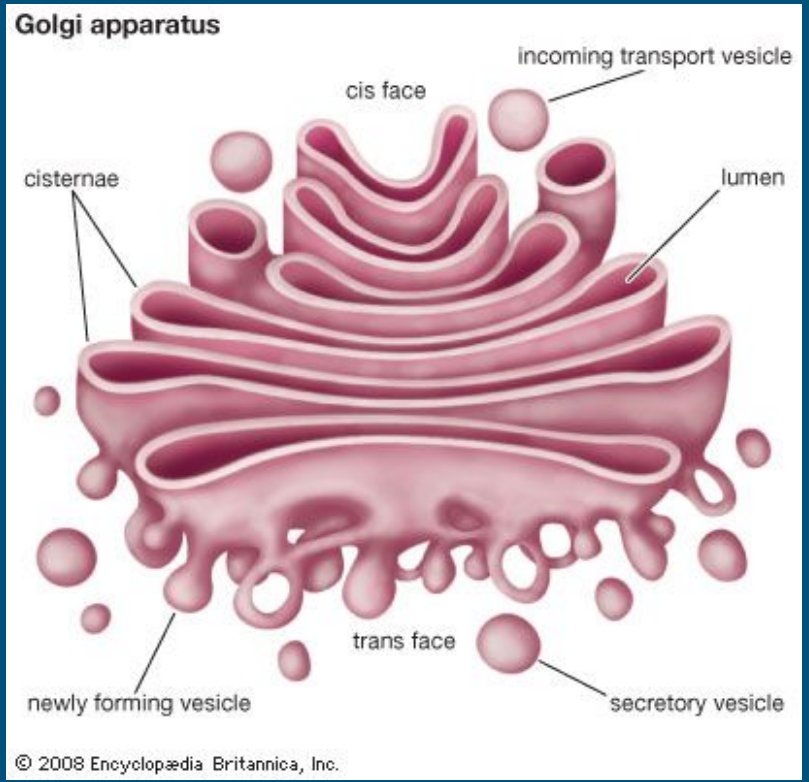


Figure 3

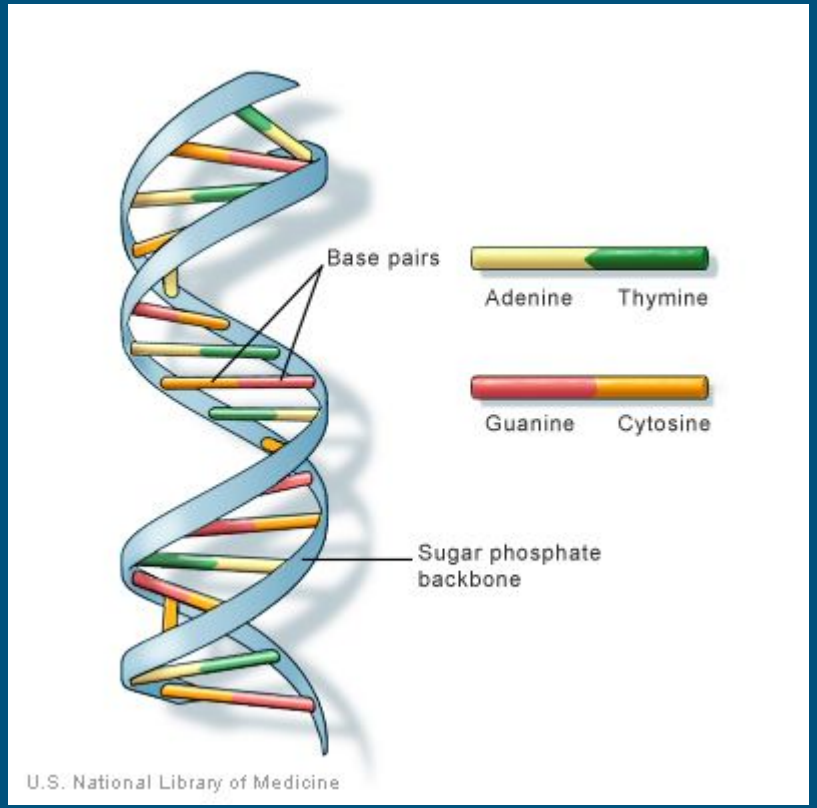
("Britannica")

DNA: Overview

- DNA is organized into structures called chromosomes.
- Chromosomes are divided into sections called genes.
- DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Human DNA consists of around 3 billion bases
- More than 99 percent of those bases are the same among humans.

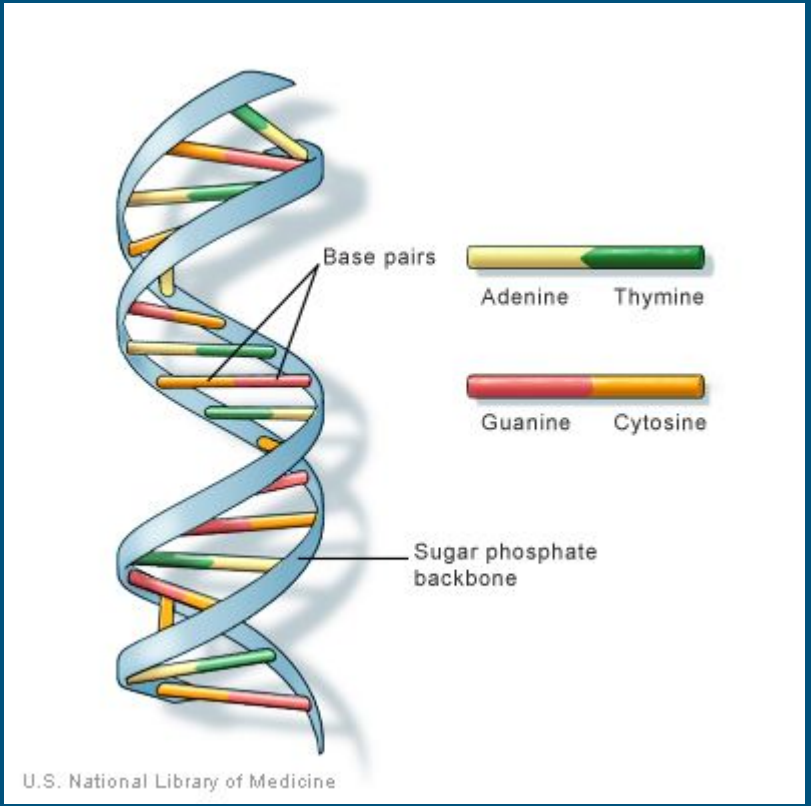
("Genetics Home Reference")

("What is DNA")



DNA: mRNA

- Transcription (which occurs in the nucleus) is the forms strands of mRNA.
  - mRNA is a copy of the genetic instructions to make a polypeptide chain.
- Translation
  - The bonding of amino acids into proteins by ribosomes
  - ("Thinking About Biology", 137)



DNA: Replication Summary Diagram

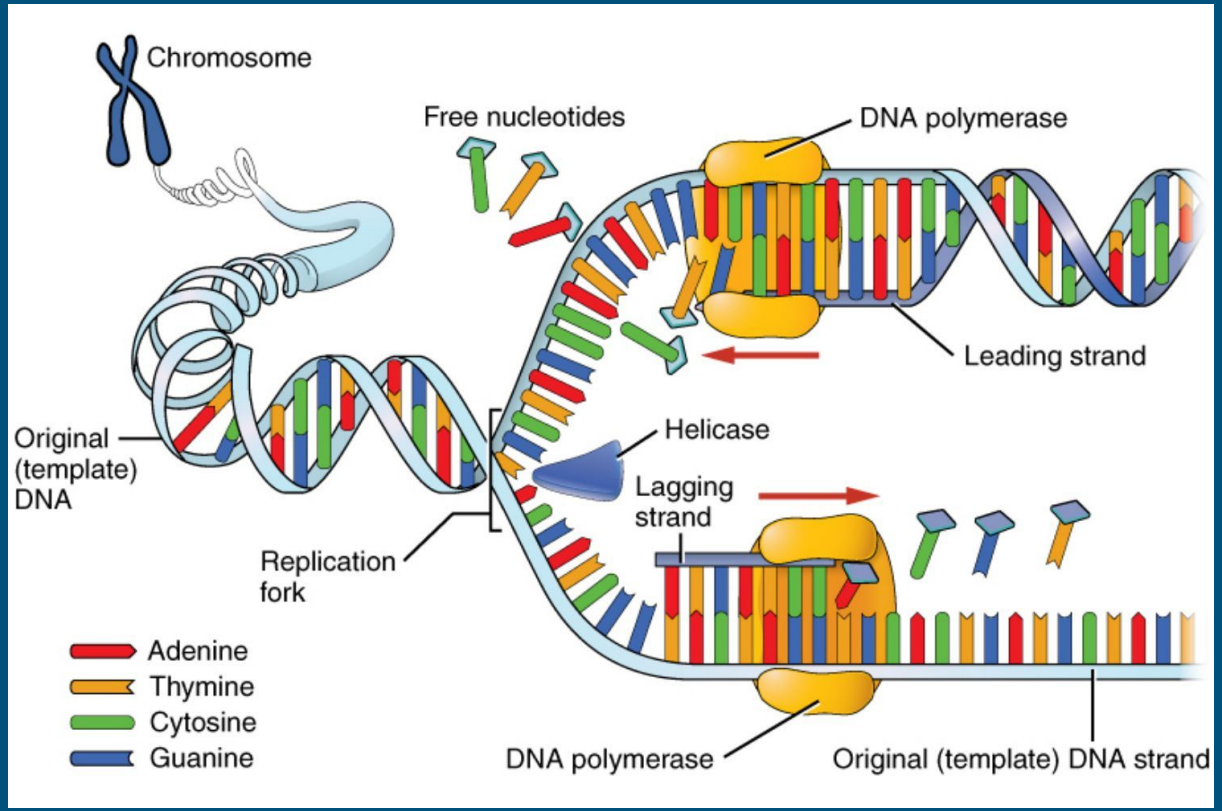


Figure 8

Mitochondria

- Power generators of a cell
- Convert oxygen and nutrients into adenosine triphosphate (ATP) in a process called cellular respiration
- Have two internal compartments
  - The intermembrane space
  - The mitochondrial matrix

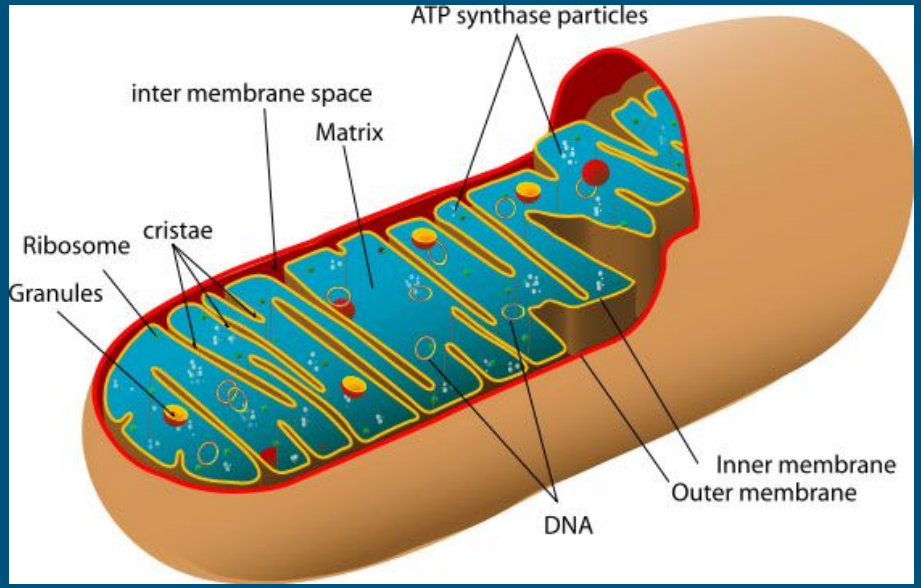


Figure 7

("Chapter 4 - A Tour of the Cell", 9)

("Molecular Expressions...")

DNA: CRISPR

- CRISPR is a new genome editing tool which could transform the field of biology.
- Why is CRISPR suddenly such a big deal?
- CRISPR allows scientists to edit genomes with unprecedented precision, efficiency, and flexibility.
- One example of it in use is when scientists used it to create monkeys with targeted mutations to preventing HIV infection in human cells.

("Everything You Need to Know About CRISPR...")

Cytoplasm: Overview

- A thick solution in cells that is enclosed by the cell membrane.
- Mainly composed of water, salts, and proteins.
- All of the organelles in eukaryotic cells, such as the nucleus, endoplasmic reticulum, and mitochondria, are located in the cytoplasm.

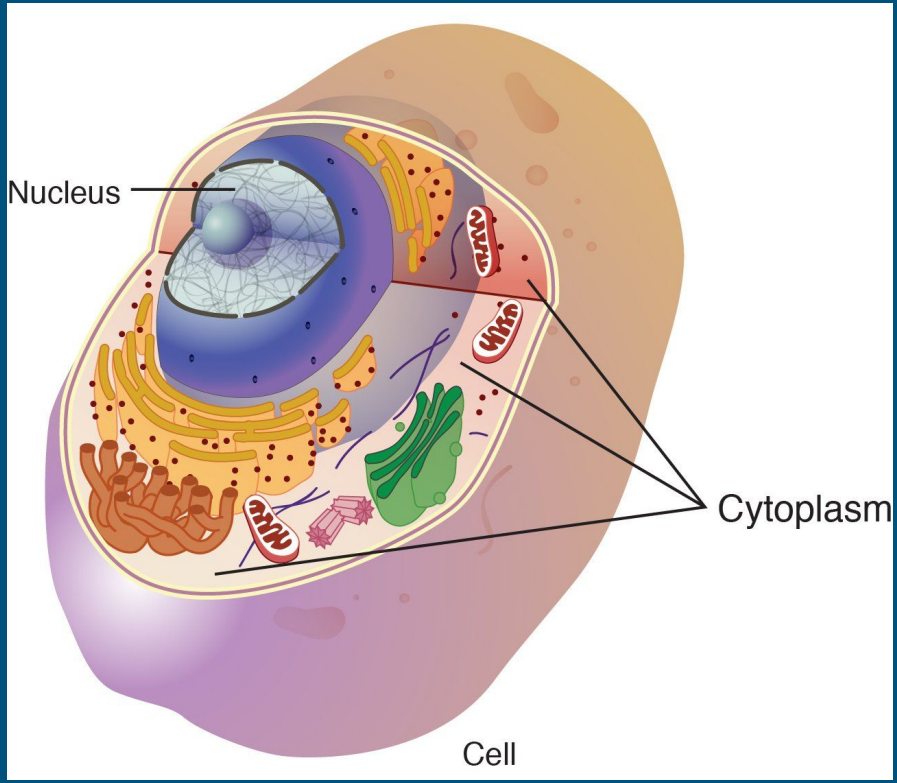


Figure 4

Cytoplasm: Endoplasm & Ectoplasm

- The cell's cytoplasm may be divided into endoplasm and ectoplasm.
- Endoplasm
  - The inner dense part of the cytoplasm
  - Separated from the nucleus by the nuclear envelope.
- Ectoplasm is the clear outer part of the cytoplasm
  - Ectoplasm is adjacent to the plasma membrane

("Endoplasm")

But how does this relate to my major (Web & Mobile Computing)?

- On the surface, there seems to be a tenuous connection between Web and Mobile Computing and Biology at best.
- However, the scientific approach to problem solving and scientific method can be applicable to solving computing related problems and creating new applications and software.

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