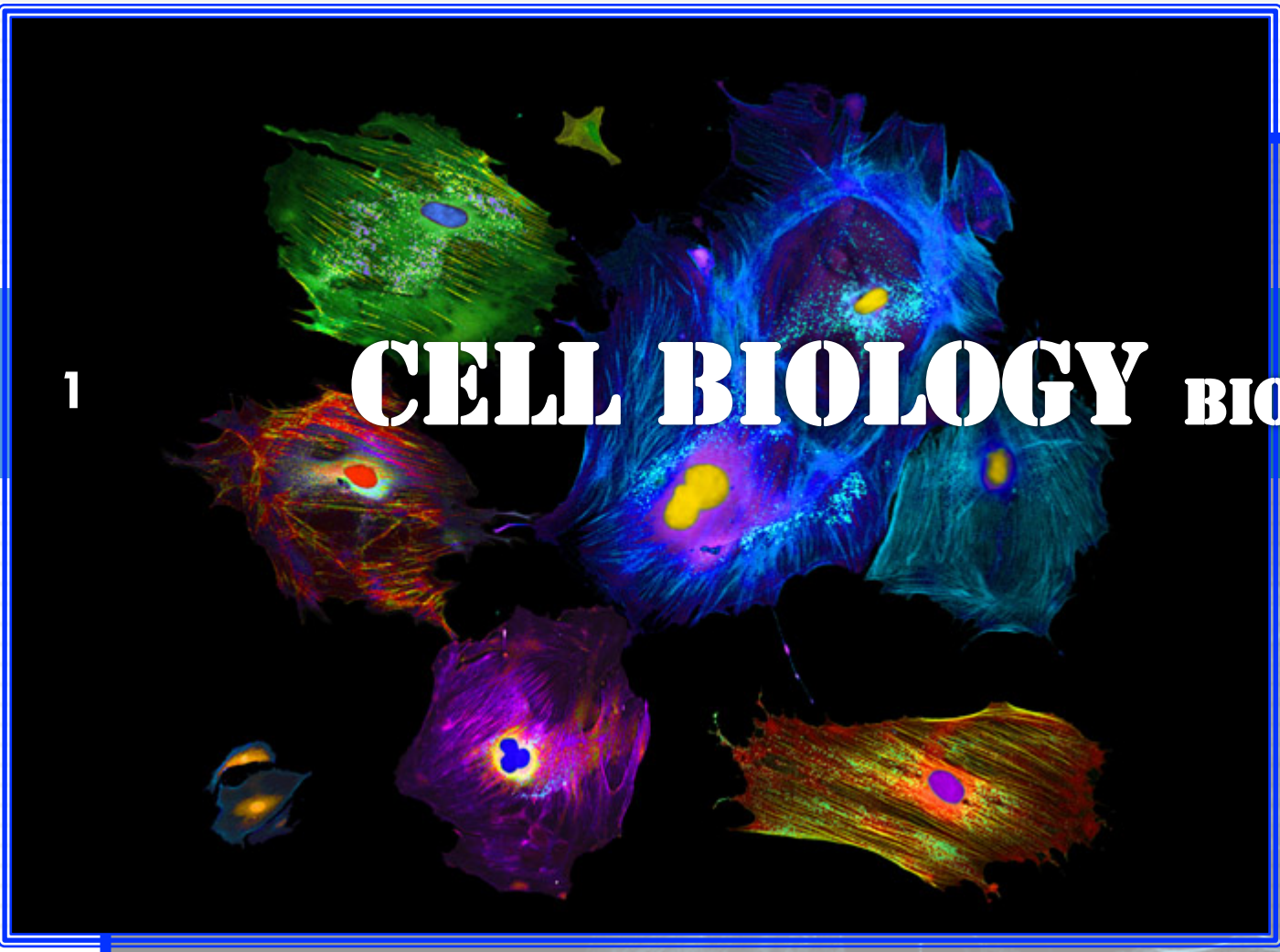


CELL BIOLOGY BIOL 266/4

Contact Information

Dr. Sonish Azam
Office: SP 375.23
Tel: 514-848-2424 ex 3488
Email: sonish.azam@concordia.ca
(Please mention BIOL 266 in subject)
Office hours: after the class or by appointment

Topics

TOPIC TO BE COVERED
Cells and Organelles
Biochemical Reactions: Respiration & Photosynthesis
Genes and Chromosomes
Membrane proteins and structure
Membrane transport
Protein sorting to organelles
General principles of cell signaling
Signal transduction pathways
Cytoskeleton
Mitosis and Cytokinesis
The universal cell cycle control system
Cell cycle check points
Cancer and Apoptosis

Textbooks

(1) Essential Cell Biology by *Alberts et al.* (4th Edition) published by Garland Publishing, Inc. in 2014.

(2) Cell and Molecular Biology: Concepts and Experiments by *Gerald Karp* (7th Edition) published by John Wiley & Sons, Inc. in 2013.

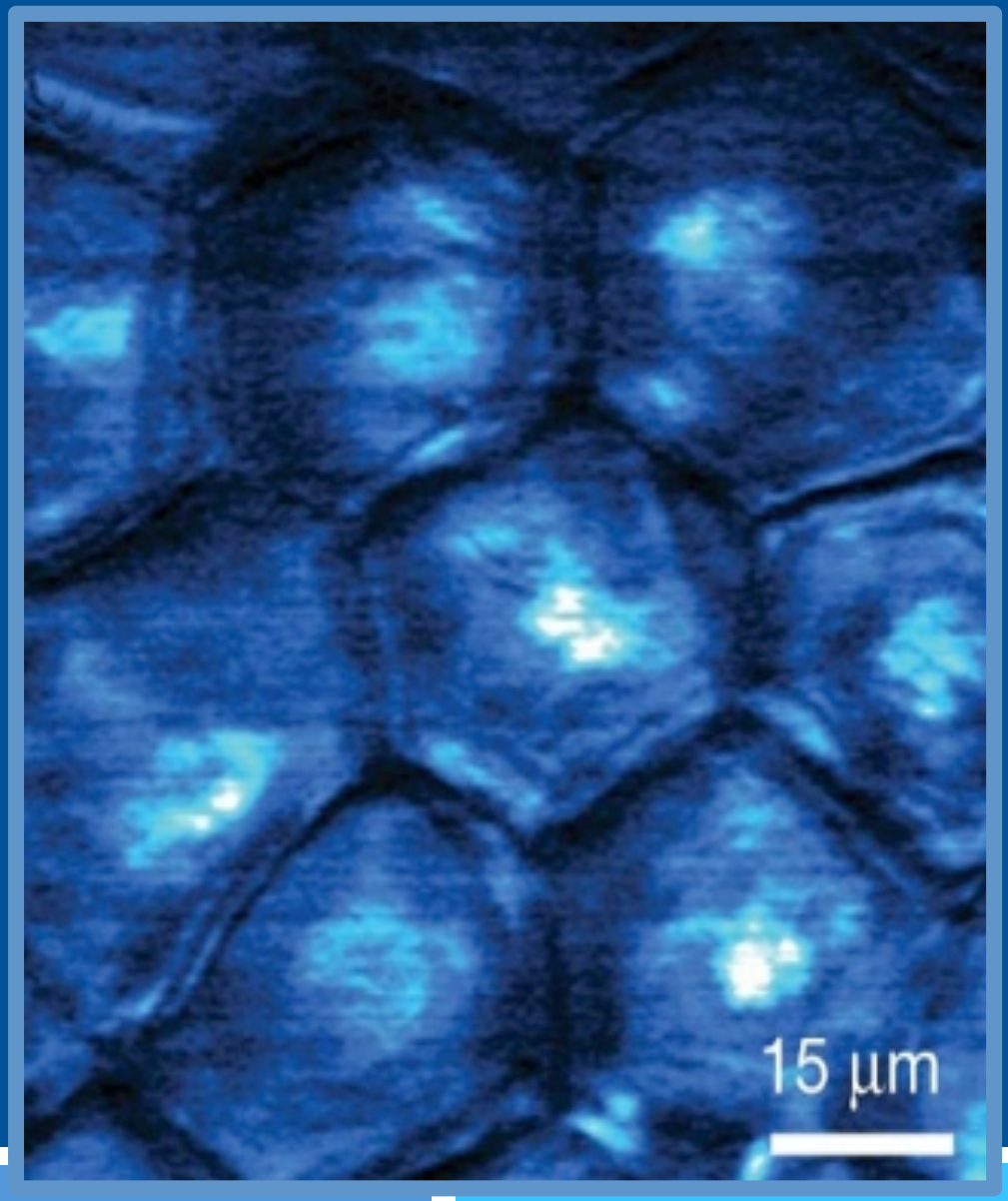
- *The textbooks are recommended, neither of them is required.*
- Additional reading will be posted on moodle website and announced in class

  Internet address: *http://moodle.concordia.ca*

Grading Scheme

- Midterm 30%
- In-class Activity/Assignment 12%
- i>clicker 3% (starts Jan 20th)
- Final exam 55%

Final exam will cover the entire course (cumulative)



CELLS AND ORGANELLES

Lecture 1

BIOL 266/4

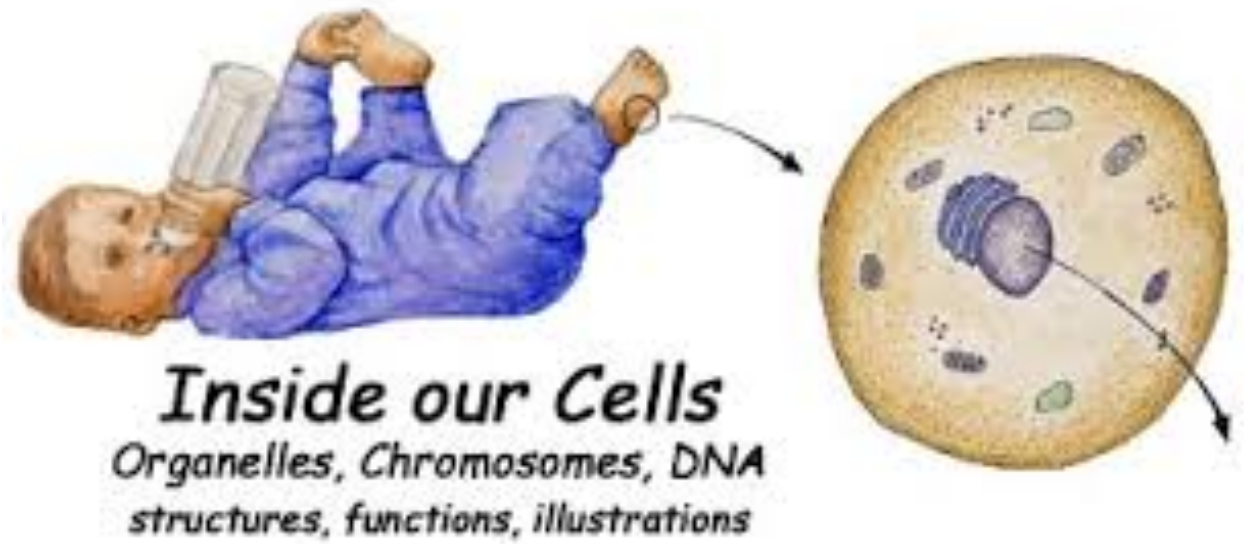
2014-15

Dr. S. Azam

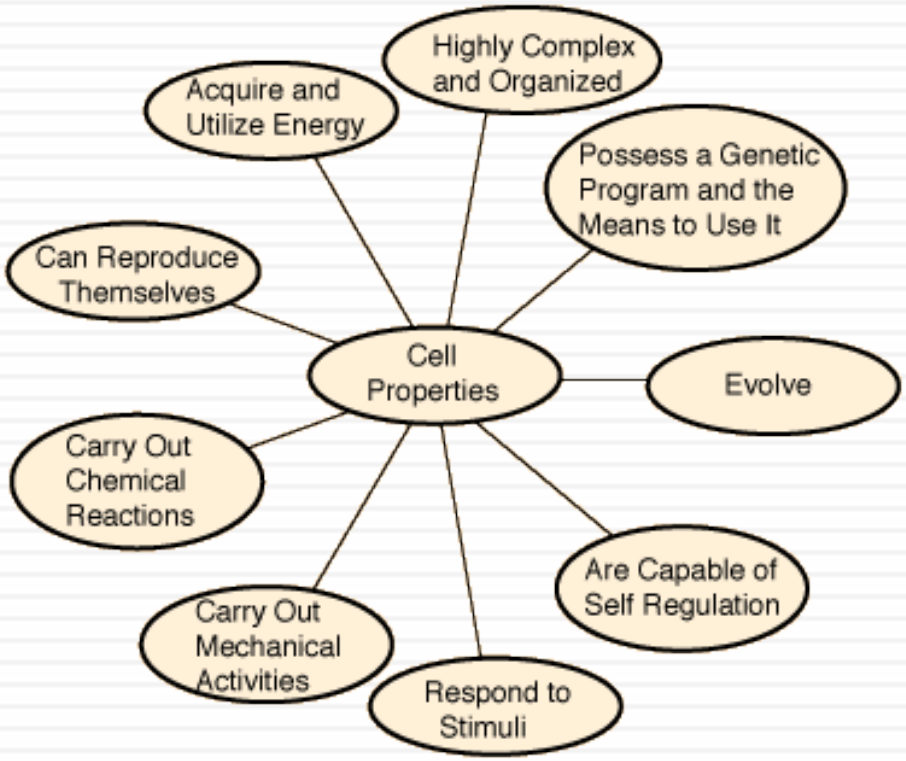
Biology Department
Concordia University

What does it mean to be living?

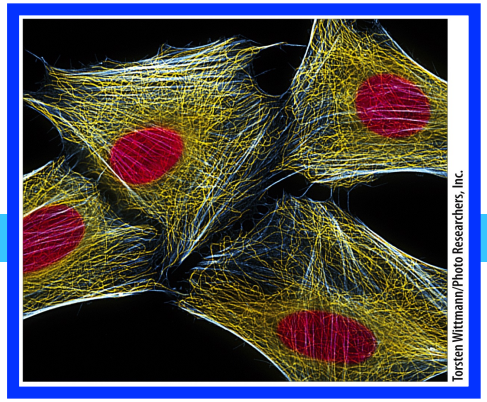
- Cells distinguish living organisms from non living things
- All living organisms are made up of cells
- Cells are the fundamental and structural unit of life



BASIC PROPERTIES OF A CELL



Basic Properties of Cells

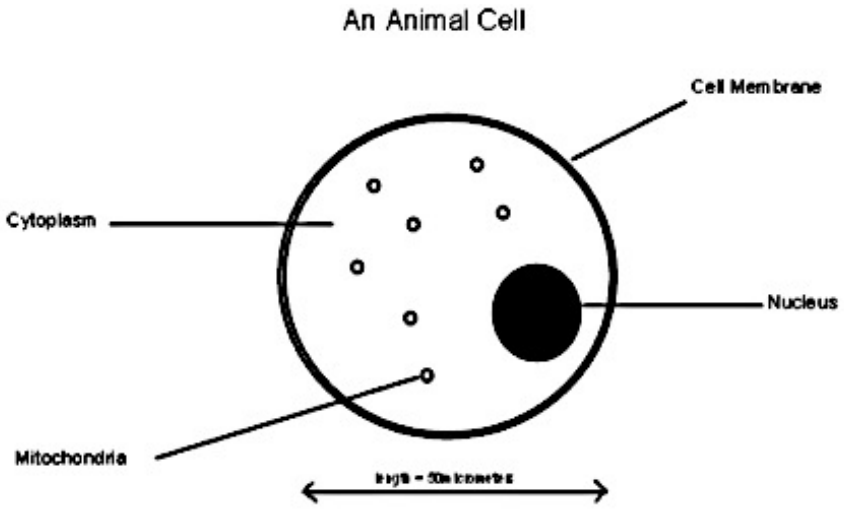


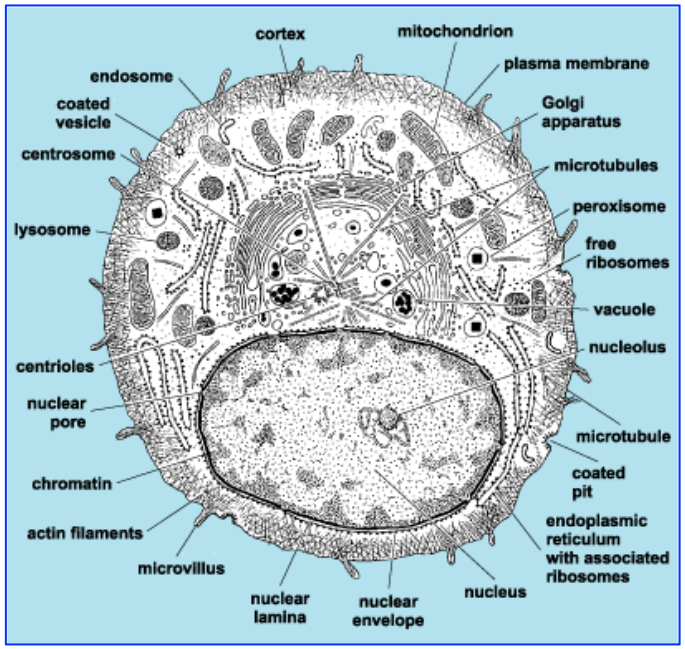
1. Life is the most basic property of cells.
2. Cells can grow and reproduce in culture for extended periods.
   - *HeLa cells* are cultured tumor cells isolated from a cancer patient (Henrietta Lacks) in 1951.
   - Cultured cells are an essential tool for cell biologists.

Basic Properties of Cells

3. Cells are highly complex and organized

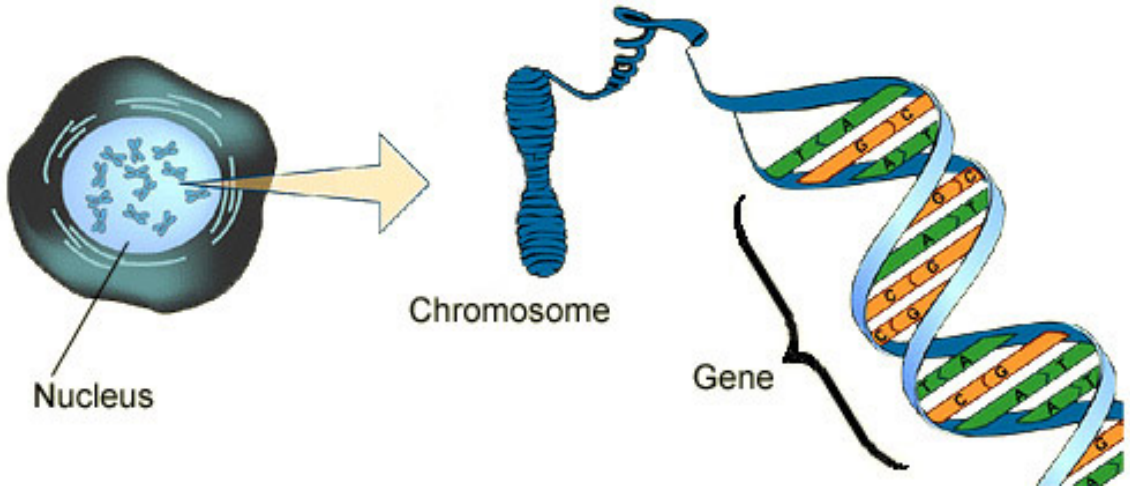
- Cellular processes are highly regulated.
- Cells from different species share similar structure, composition and metabolic features that have been conserved throughout evolution.





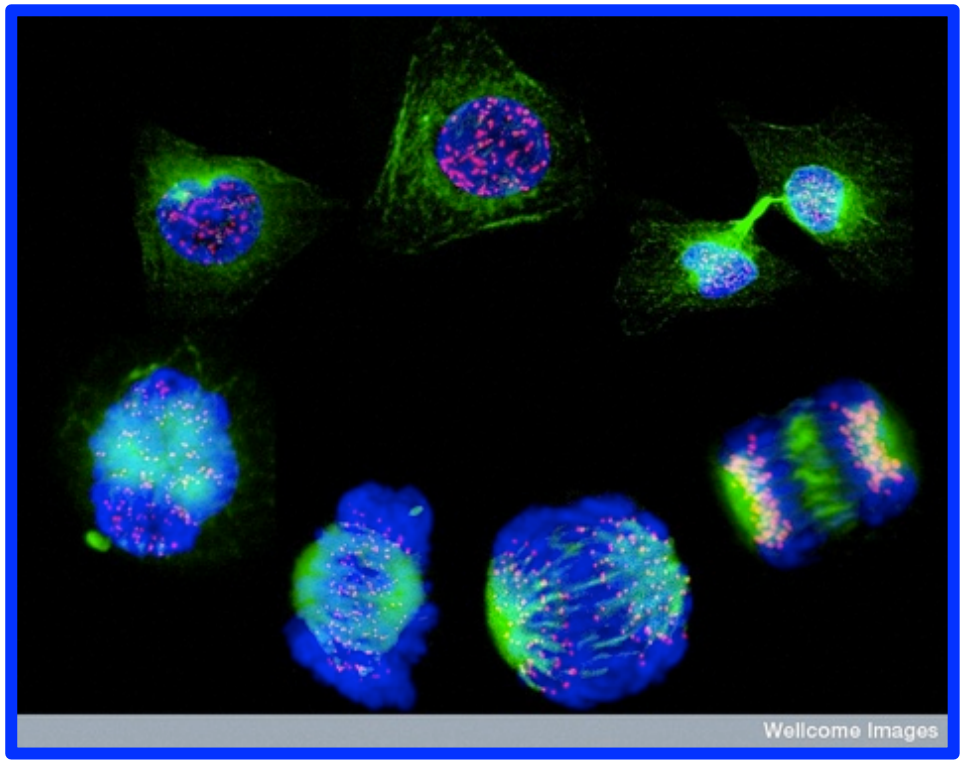
Basic Properties of Cells

4. Cells possess a Genetic Program and the means to use it
   - Genes encode information to build each cell, and the organism.
   - Genes encode information for cellular reproduction, activity and structure.

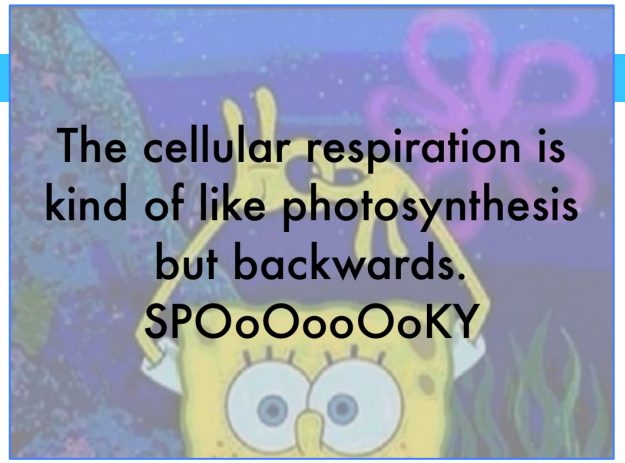


Basic Properties of Cells

5. Cells are capable of producing more of themselves
   - Cells reproduce, and each daughter cells receives a complete set of genetic instructions.



Basic Properties of Cells

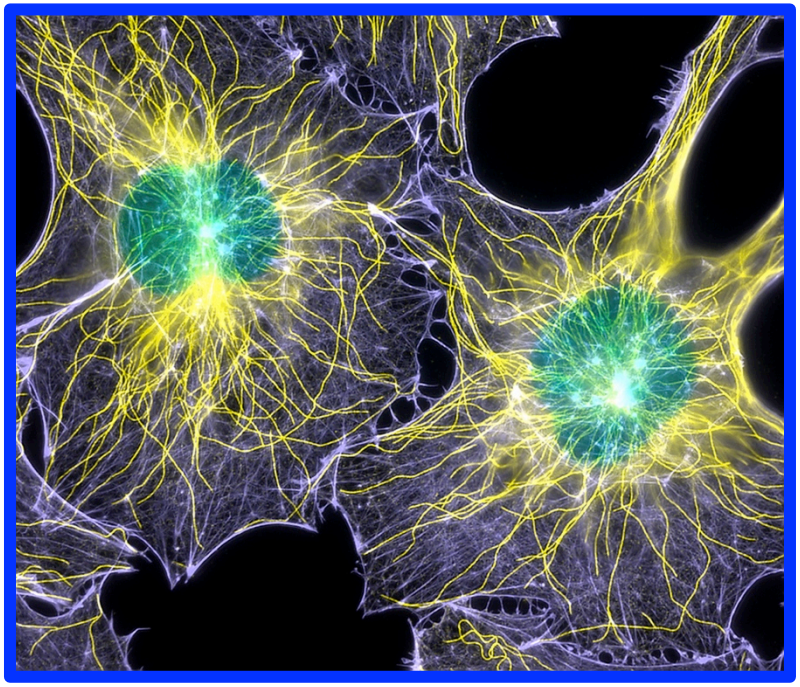


6. Cells acquire and utilize energy

- Photosynthesis provides fuel for all living organisms.
- Animal cells derive energy from the products of photosynthesis, mainly in the form of glucose.
- Cell can convert glucose into ATP (Respiration)—the energy currency of a living body

Basic Properties of Cells

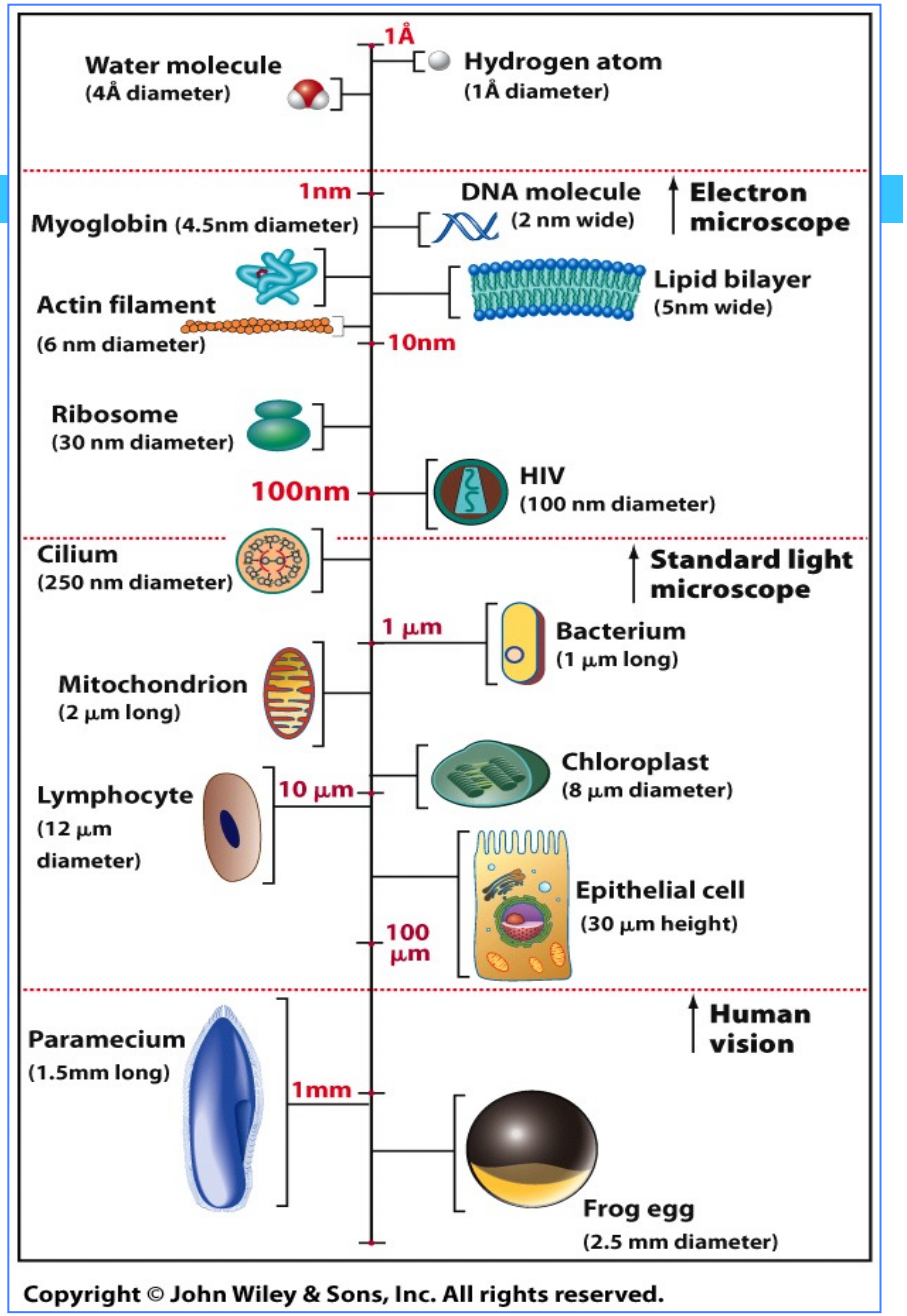
8. Cells engage in mechanical activities
9. Cells are able to respond to a Stimuli
10. Cells are capable of Self-Regulation
11. Cells evolve



The Sizes of Cells and Their Components

Cells are commonly measured in units of

- **micrometers**
  - (1 μm = 10^{-6} meter)
- **nanometers**
  - (1 nm = 10^{-9} meter).



Relative sizes of cells and cell components

Cells Vary in Appearance and Function

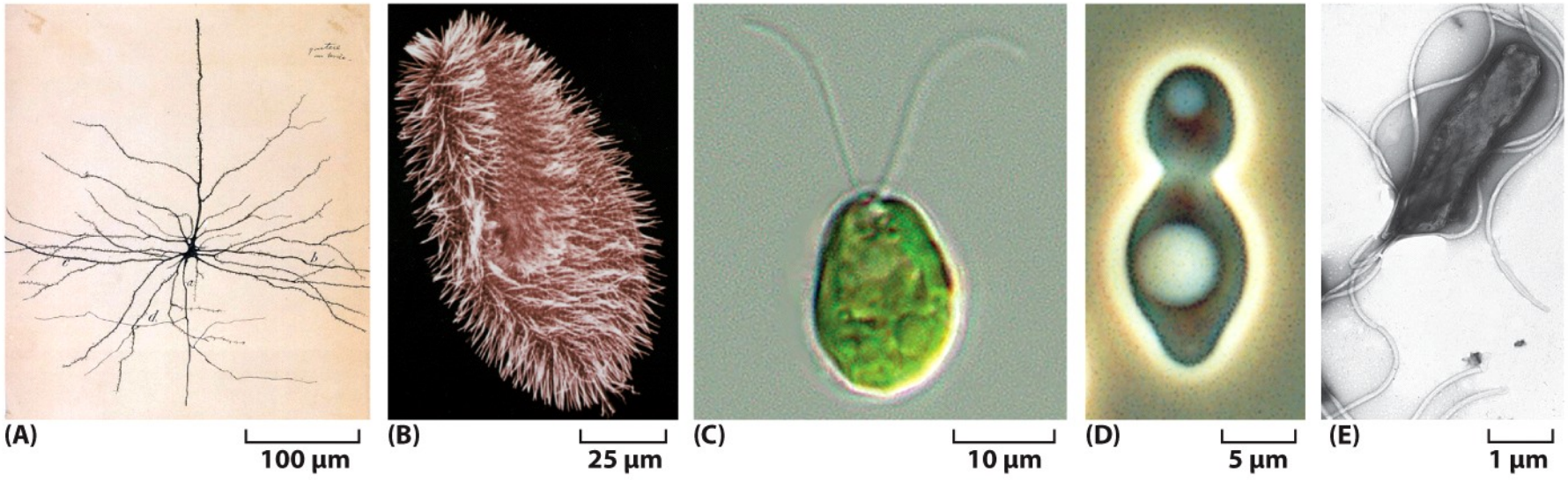


Figure 1-1 Essential Cell Biology, 4th ed. (© Garland Science 2014)

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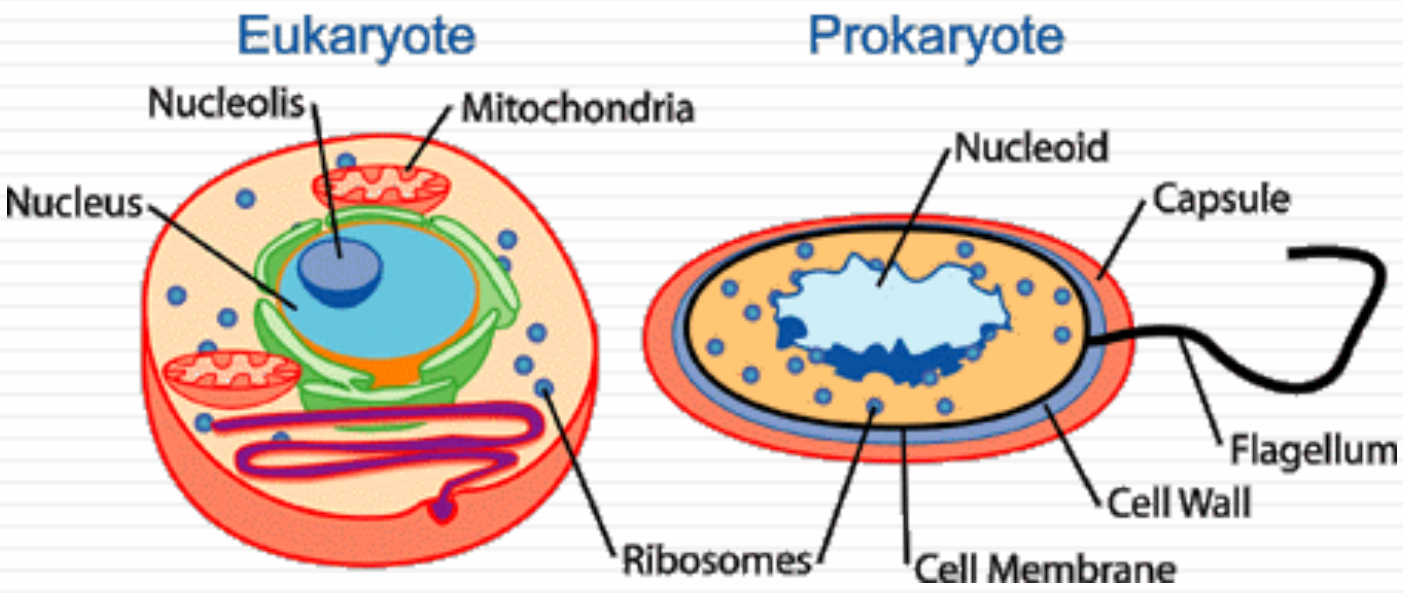
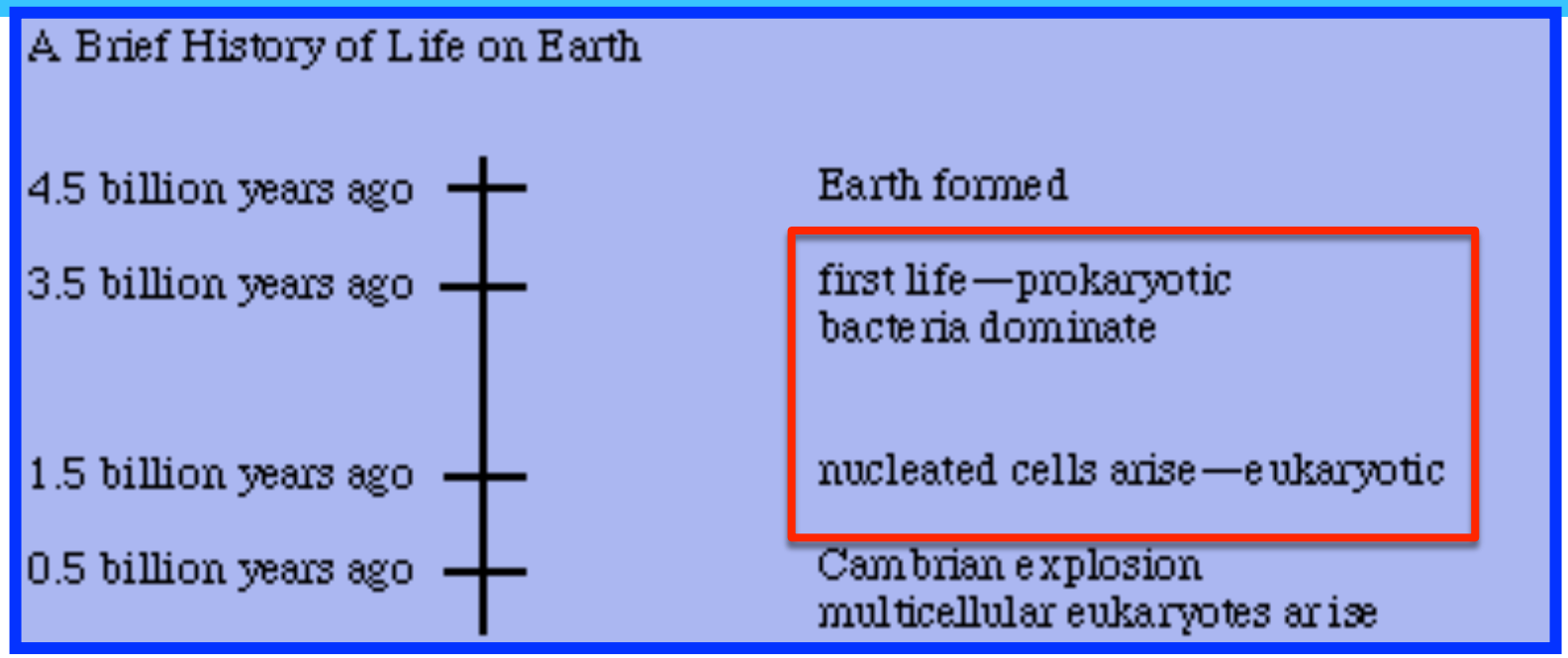
PROKARYOTES AND EUKARYOTES

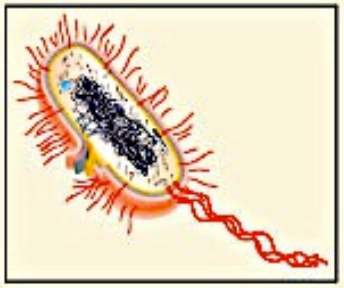


Two Different Classes of Cells

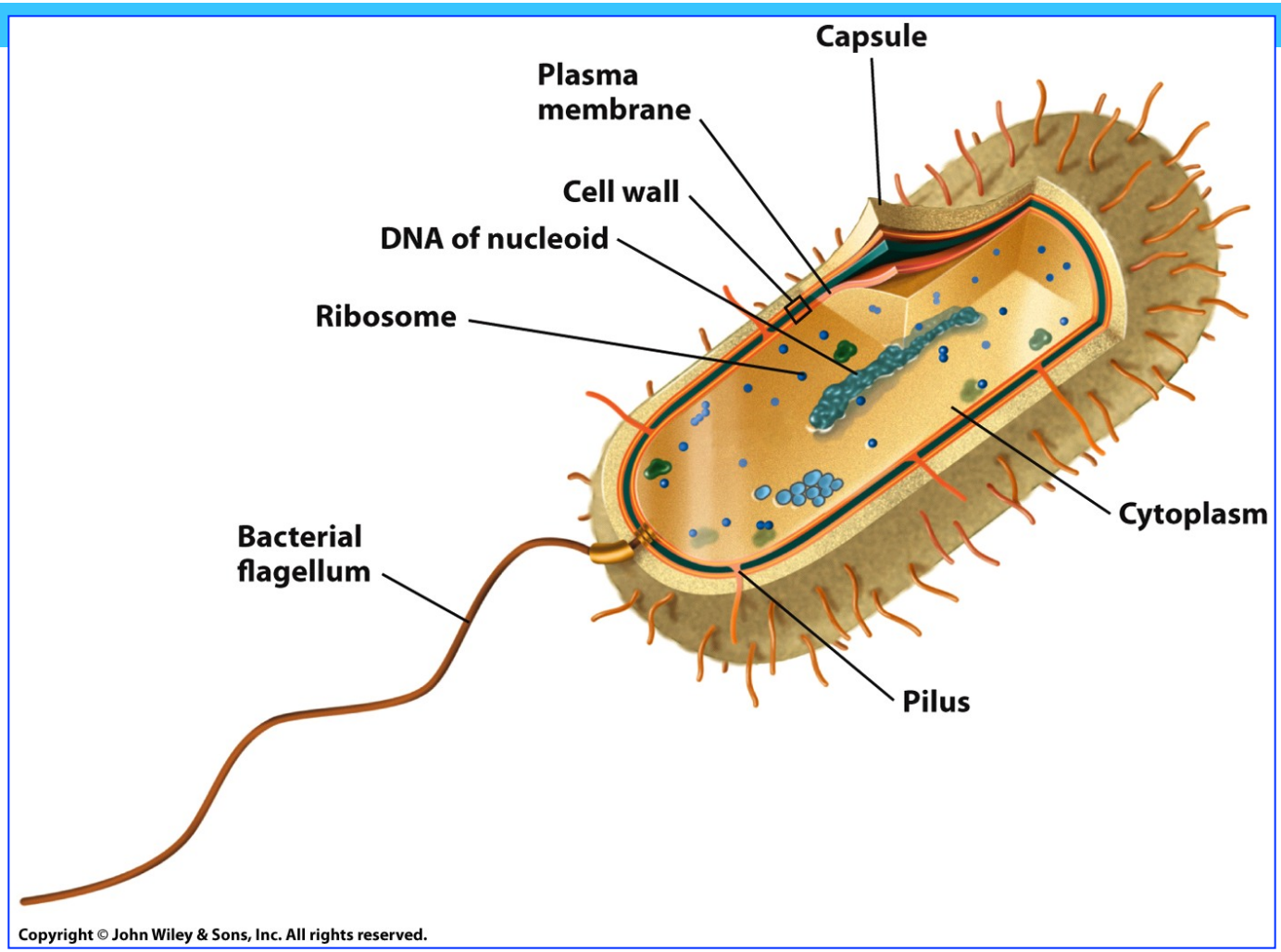


Prokaryotic and eukaryotic are distinguished mainly by their size and types of **organelles**.

TABLE 4.2 Principal Differences Between Prokaryotic and Eukaryotic Cells

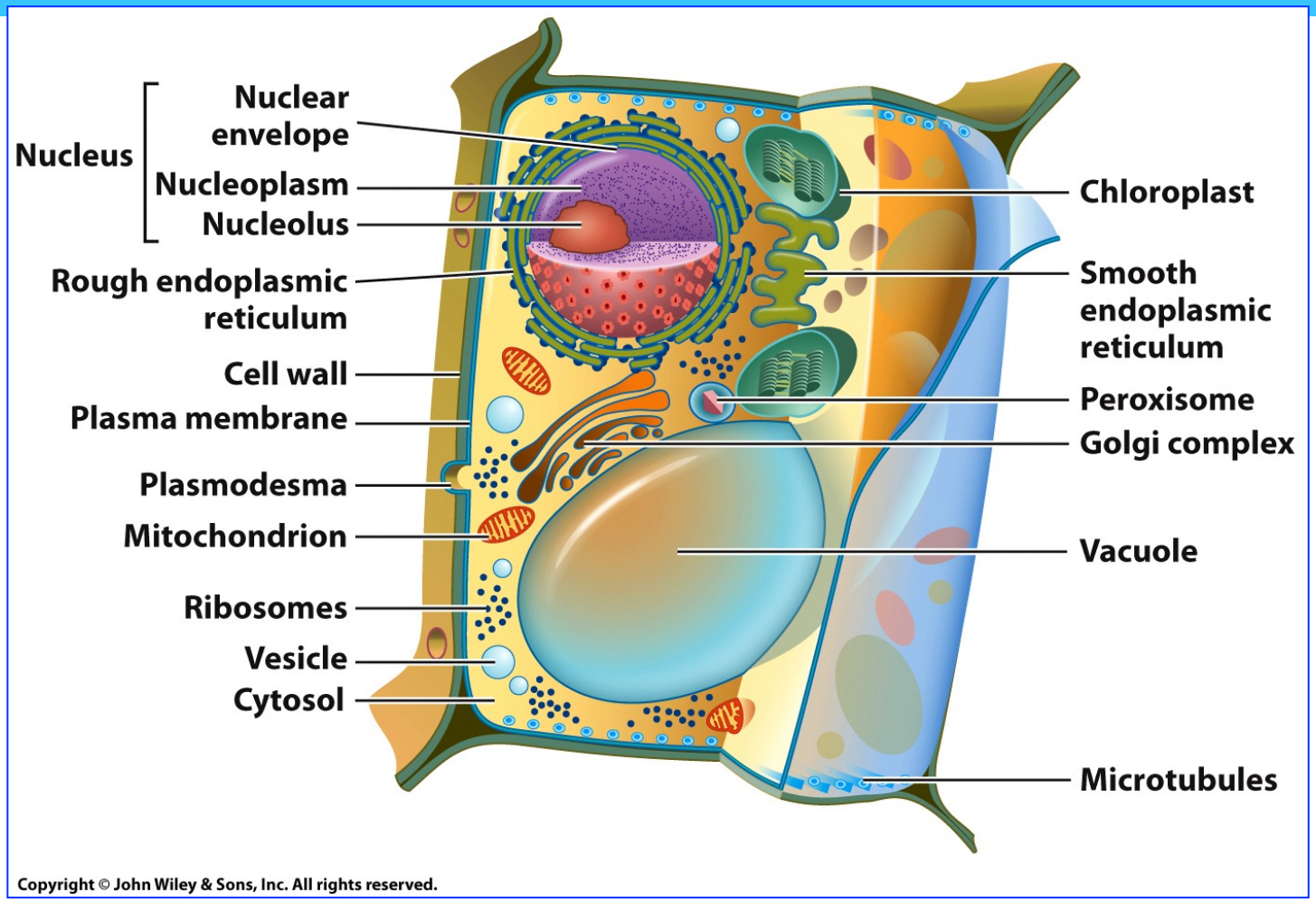
Characteristic	Prokaryotic	Eukaryotic
		
Size of cell	Typically 0.2–2.0 μm in diameter	Typically 10–100 μm in diameter
Nucleus	No nuclear membrane or nucleoli	True nucleus, consisting of nuclear membrane and nucleoli
Membrane-enclosed organelles	Absent	Present; examples include lysosomes, Golgi complex, endoplasmic reticulum, mitochondria, and chloroplasts
Flagella	Consist of two protein building blocks	Complex; consist of multiple microtubules
Glycocalyx	Present as a capsule or slime layer	Present in some cells that lack a cell wall
Cell wall	Usually present; chemically complex (typical bacterial cell wall includes peptidoglycan)	When present, chemically simple
Plasma membrane	No carbohydrates and generally lacks sterols	Sterols and carbohydrates that serve as receptors present
Cytoplasm	No cytoskeleton or cytoplasmic streaming	Cytoskeleton; cytoplasmic streaming
Ribosomes	Smaller size (70S)	Larger size (80S); smaller size (70S) in organelles
Chromosome (DNA)	Single circular chromosome; lacks histones	Multiple linear chromosomes with histones arrangement
Cell division	Binary fission	Mitosis
Sexual reproduction	No meiosis; transfer of DNA fragments only	Involves meiosis

Structure of a Prokaryotic Cell

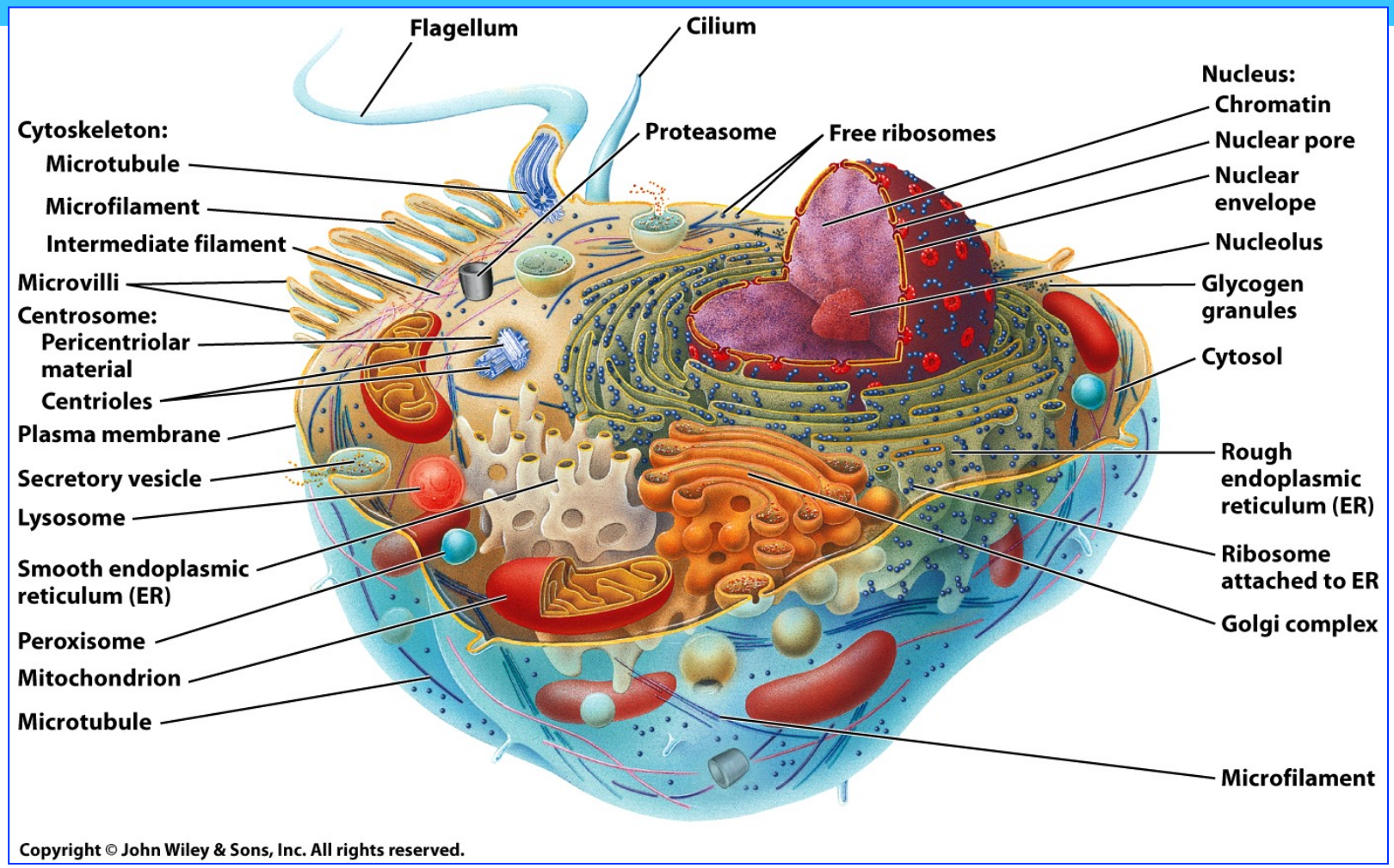


Bacterium

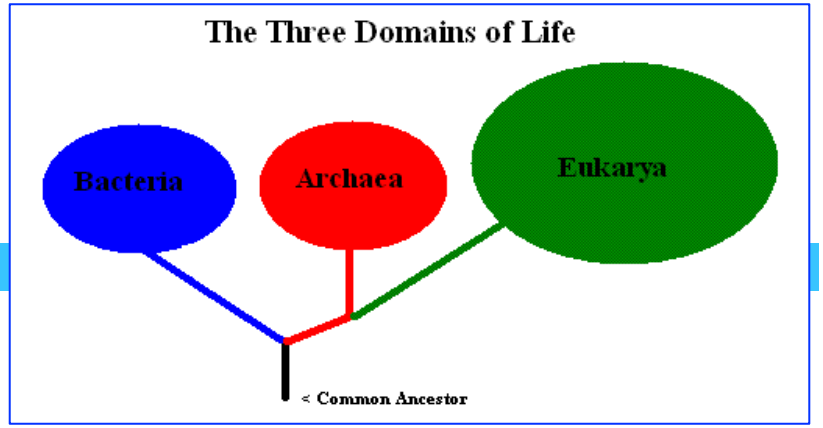
Structure of a Eukaryotic Cell: Plant Cell



Structure of a Eukaryotic Cell: Animal Cell



Types of Prokaryotes



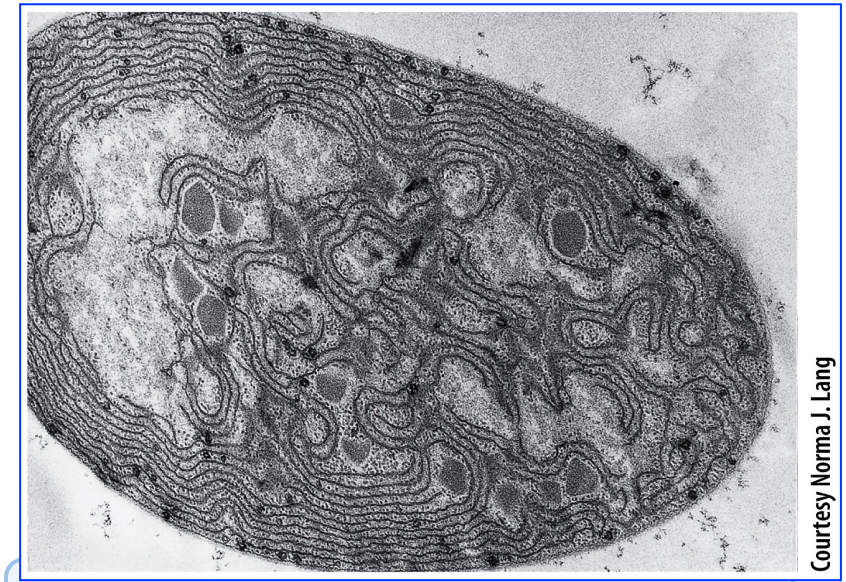
1. Domain Archaea

- Methanogens, Halophiles, Acidophiles and Thermophiles

2. Domain Bacteria

- Includes the smallest known cells – *mycoplasma*
- Includes *cyanobacteria* – photosynthetic bacteria
  - Cyanobacteria gave rise to green plants and an oxygen-rich atmosphere.
  - Some bacteria are capable of **nitrogen fixation**.

Types of Prokaryotes



Courtesy Norma J. Lang

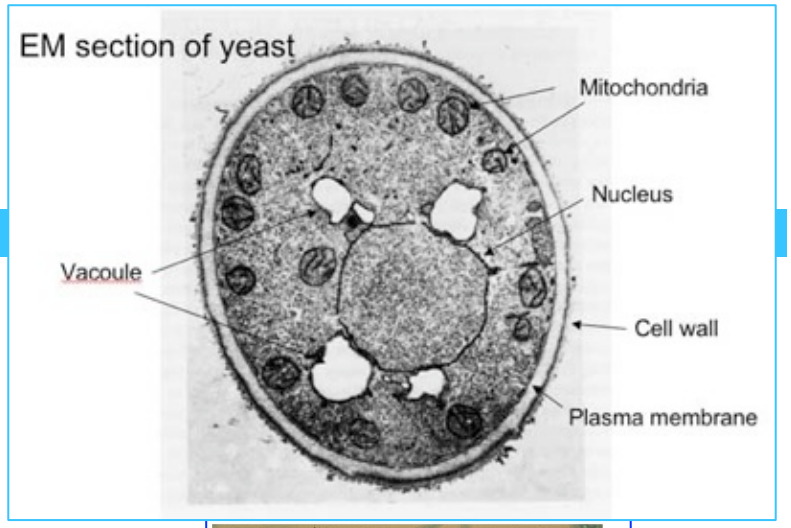
Cyanobacteria: electron micrograph

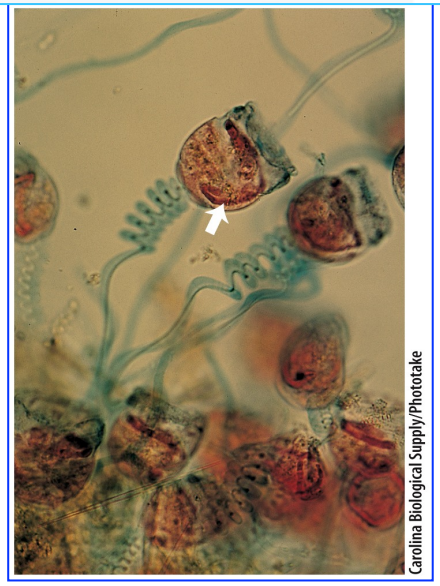
Courtesy Zoological Society of San Diego

Cyanobacteria in polar bear coats

Types of Eukaryotes

- Unicellular eukaryotes are complex single-celled organisms.
  - Vorticella have a contractile ribbon in the stalk and a large macronucleus that contains multiple copies of its genes.

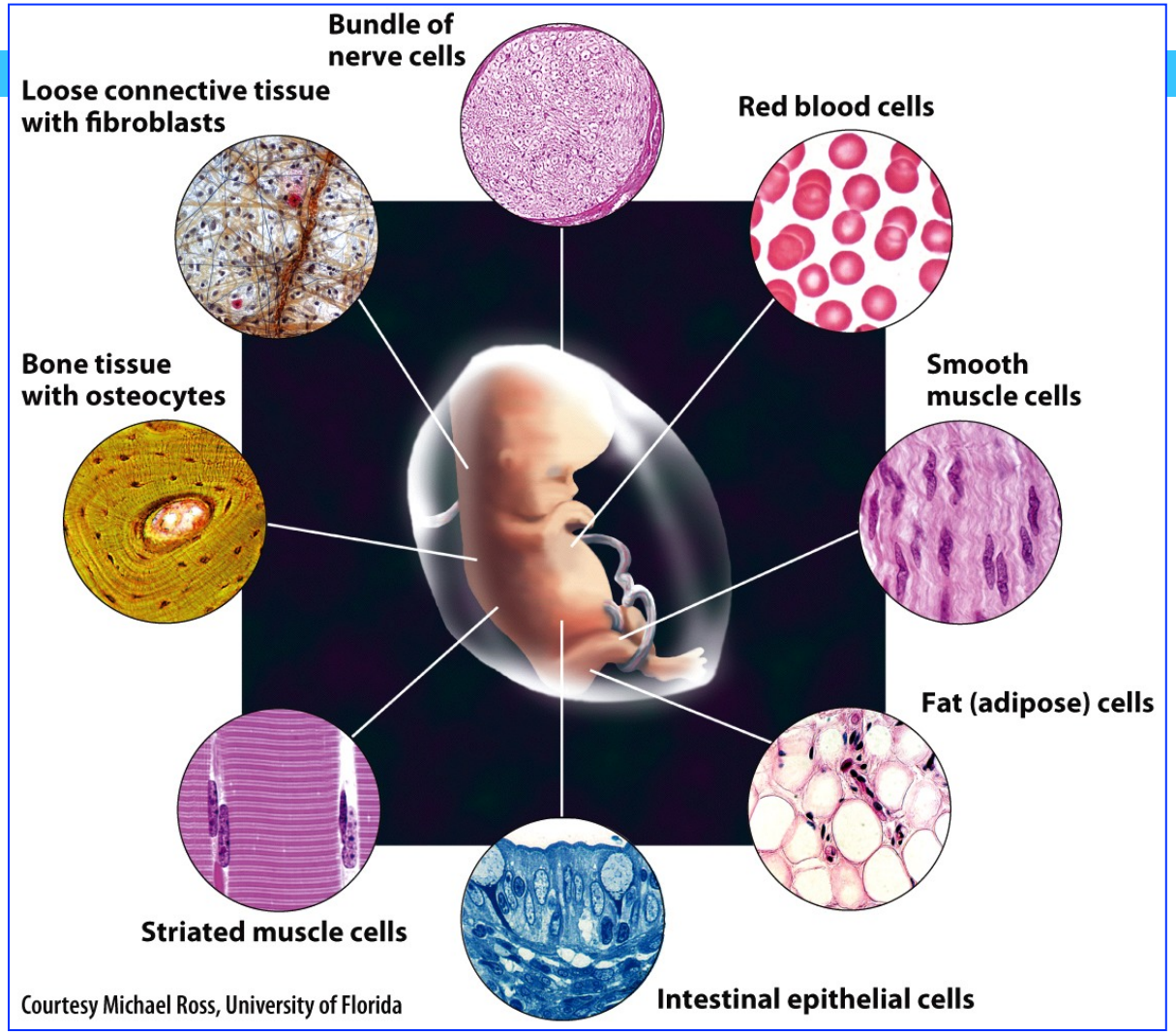




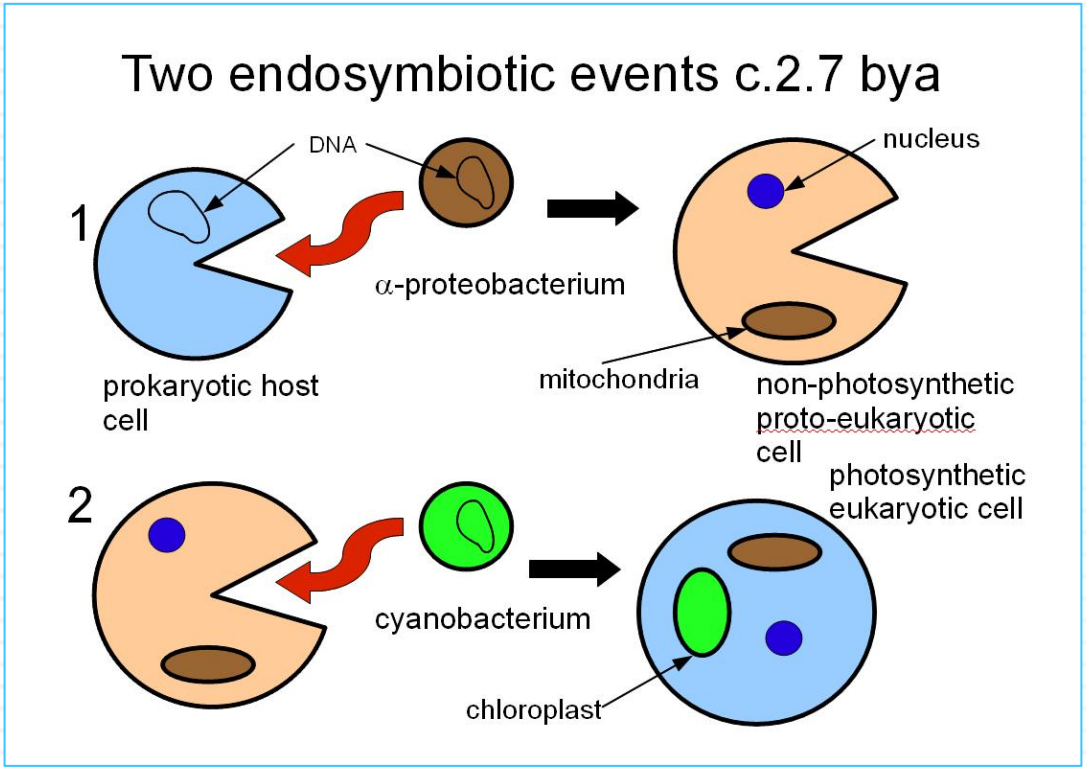
Types of Eukaryotes

- Multicellular eukaryotes have different cell types for different functions.
  - Differentiation occurs during embryonic development in other multicellular organisms.
  - Numbers and arrangements of organelles relate to the function of the cell.
  - Despite differentiation, cells have many features in common.

Cell Differentiation in Multicellular Eukaryotes

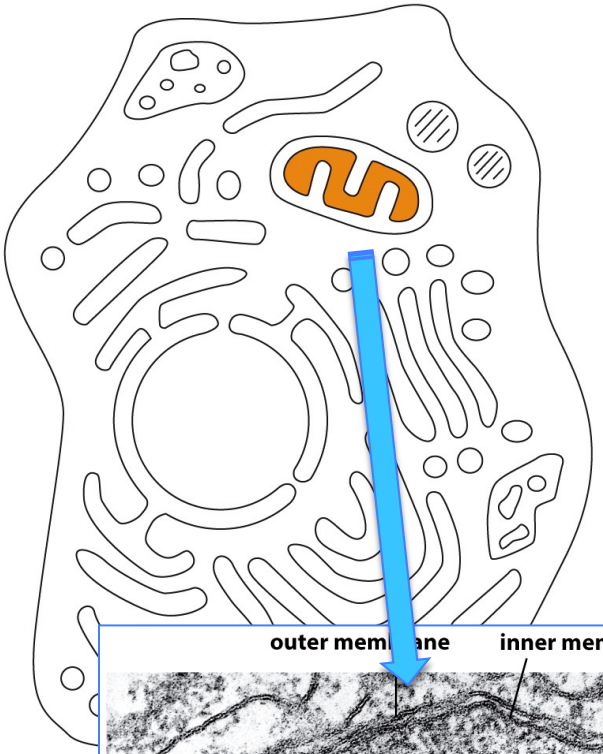


ENDOSYMBIOTIC THEORY



Mitochondria

- Present in essentially all eukaryotes
- Generate usable energy from food to power the cell
- Enclosed in two membranes: outer and inner that forms cristae
- Involved in cellular respiration and production of ATP (the energy currency)
- Contain its own DNA



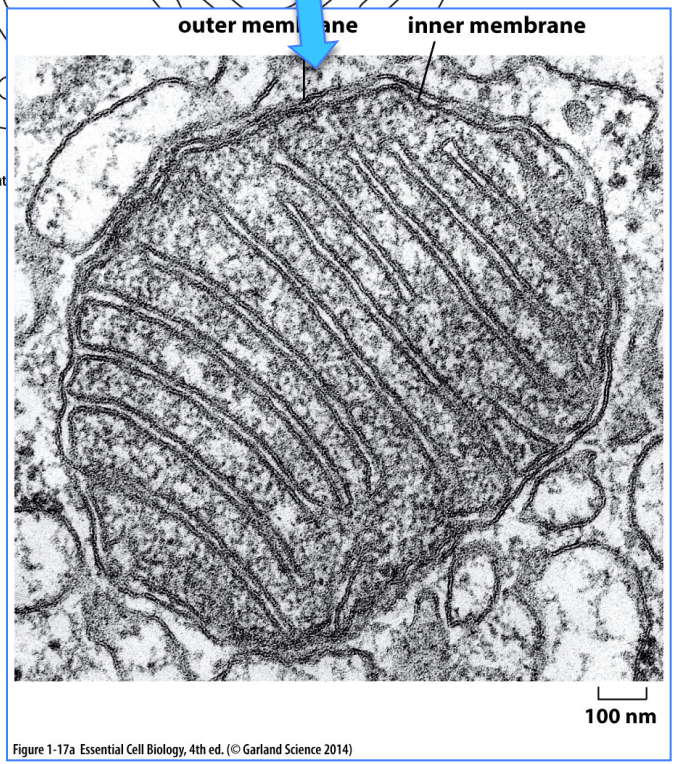


Figure 1-17a Essential Cell Biology, 4th ed. (© Garland Science 2014)

Chloroplasts

- Found in plants and algae
- Possess two membranes + thylakoid membrane (which contains green pigment-chlorophyll)
- Carry out photosynthesis: trap solar energy and convert into chemical energy
- Contain its own DNA

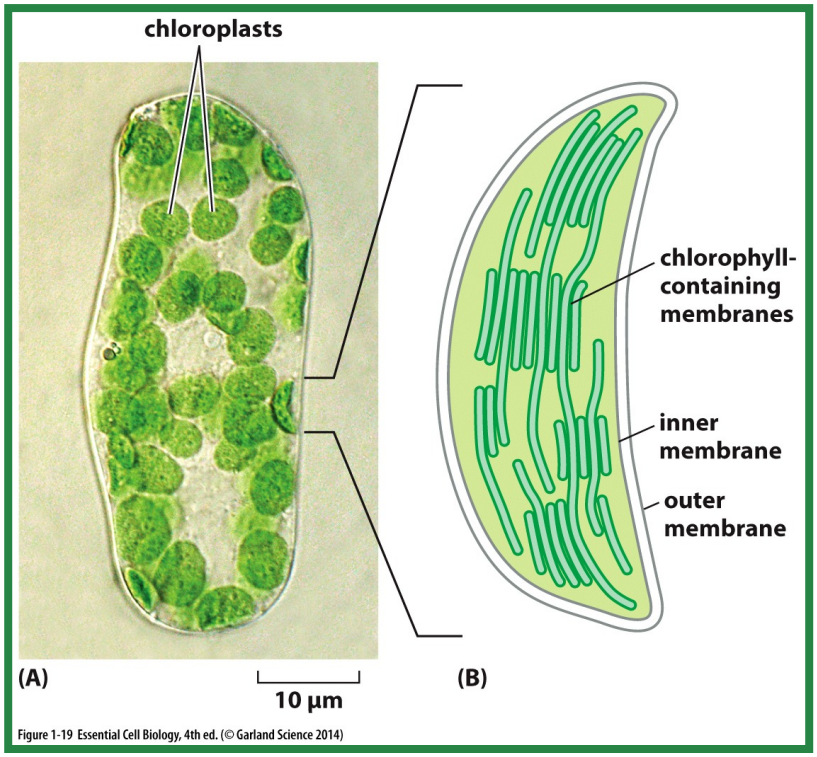


Figure 1-19 Essential Cell Biology, 4th ed. (© Garland Science 2014)

Endosymbiotic Theory: Mitochondrion

- Mitochondria originate from aerobic bacteria
  - engulfed by ancestral eukaryotic cells
  - lived in symbiosis with the host

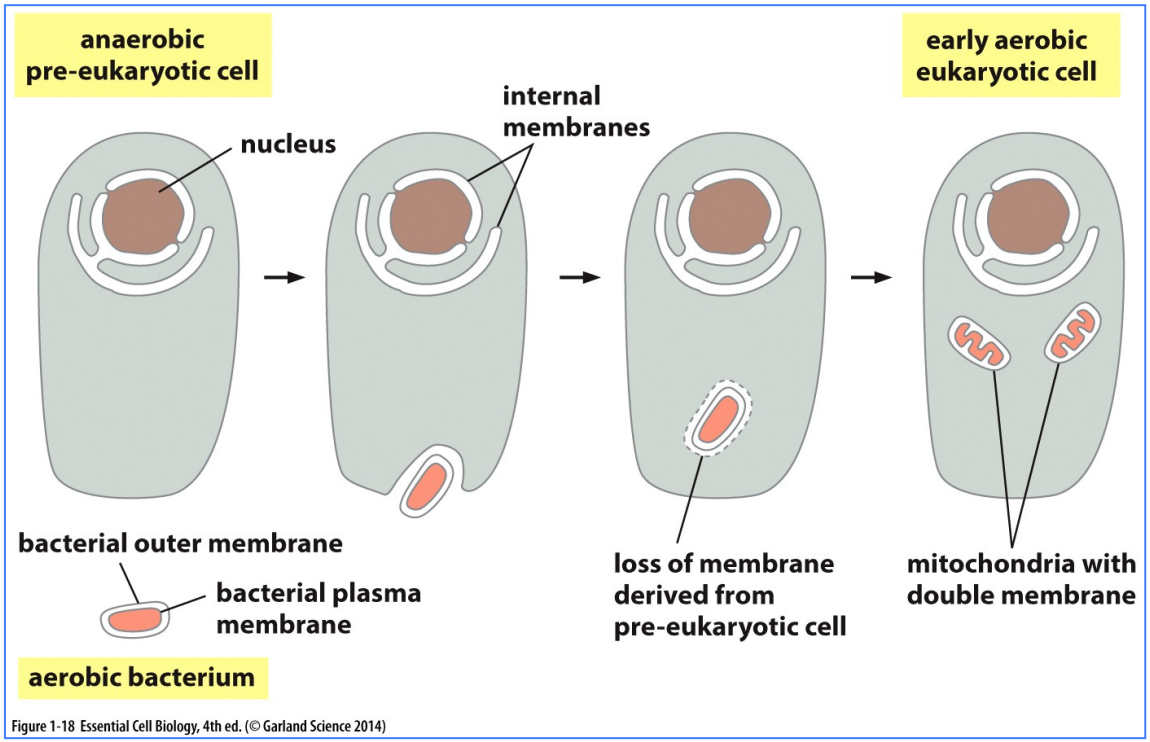


Figure 1-18 Essential Cell Biology, 4th ed. (© Garland Science 2014)

Endosymbiotic Theory: Chloroplast

- Chloroplast originate from photosynthetic bacteria
  - engulfed by ancestral eukaryotic cells that already contained mitochondria

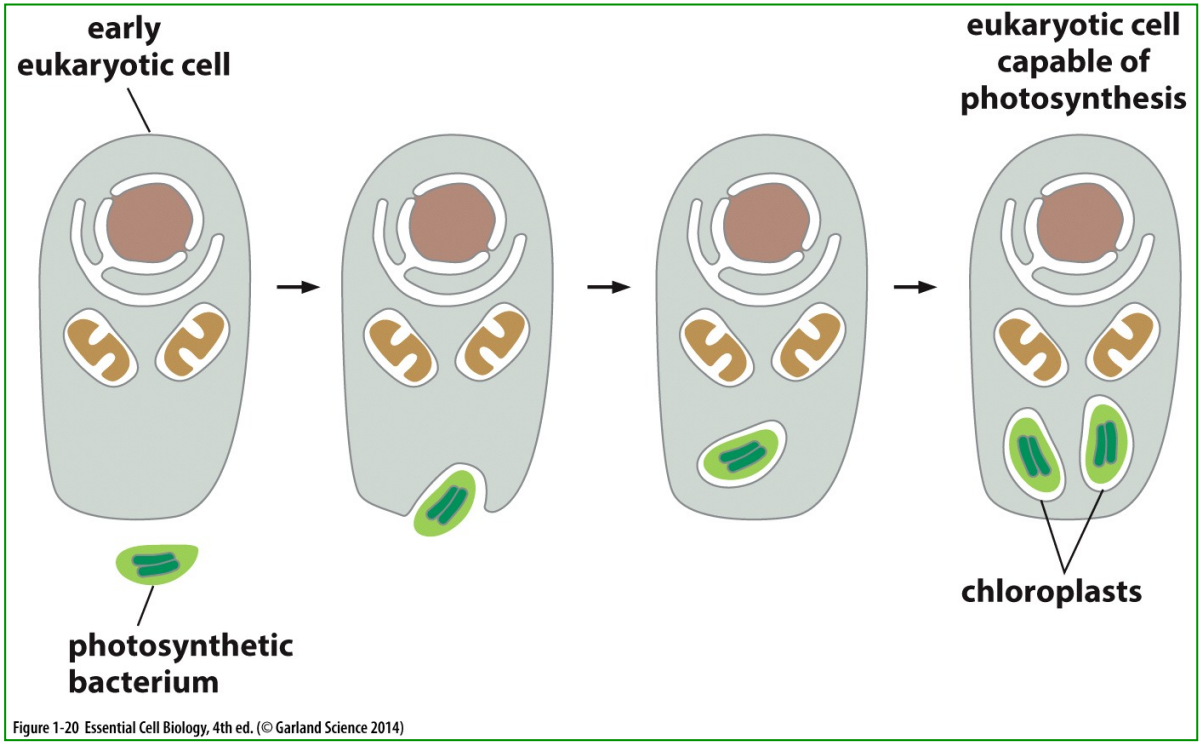
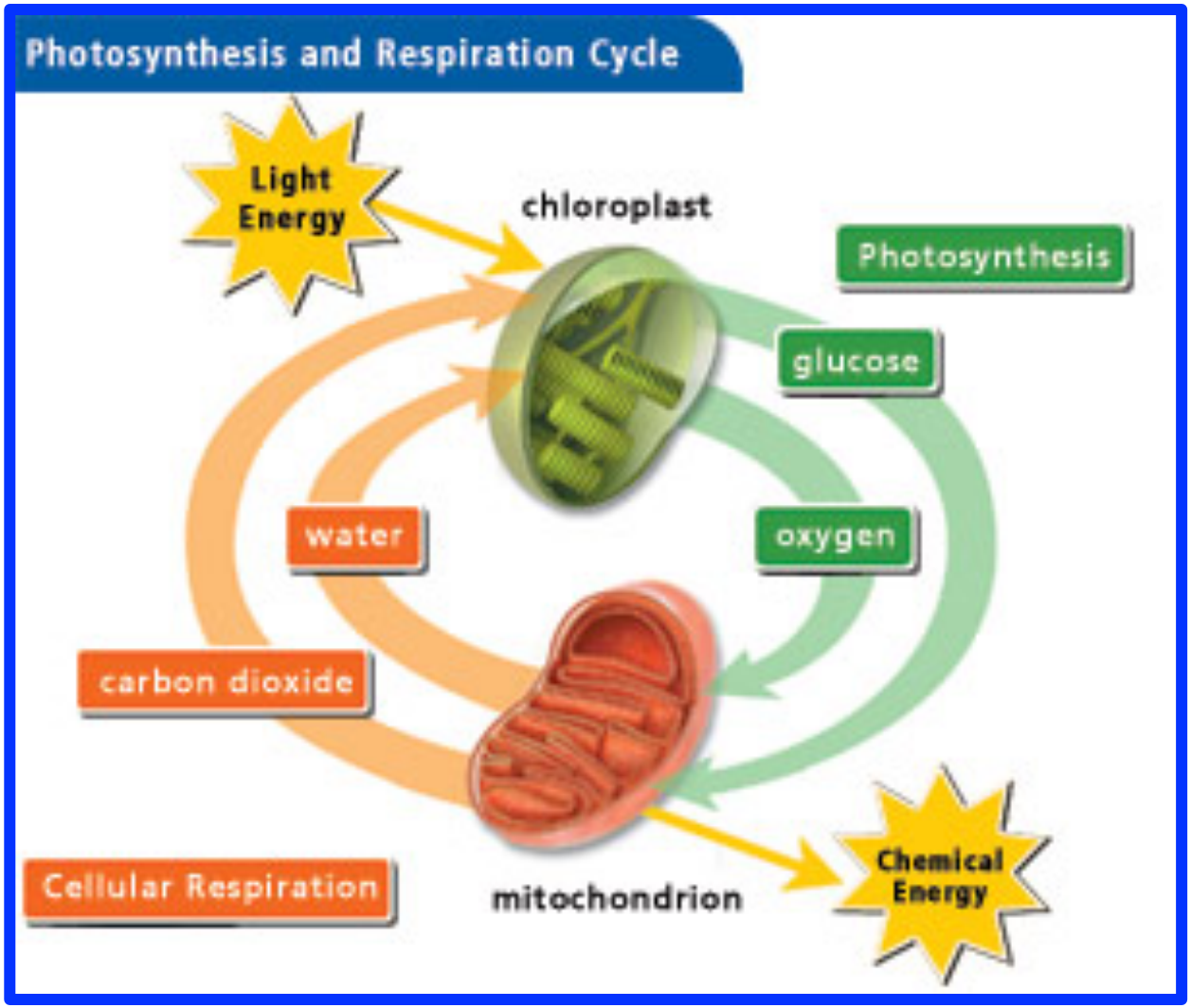


Figure 1-20 Essential Cell Biology, 4th ed. (© Garland Science 2014)

Mitochondria and Chloroplasts

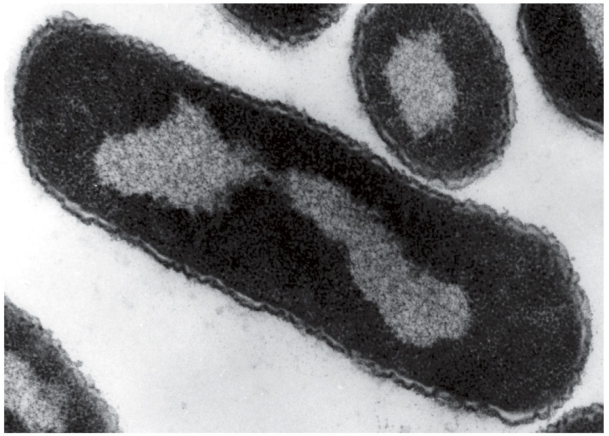


MODEL ORGANISMS

Model Organisms

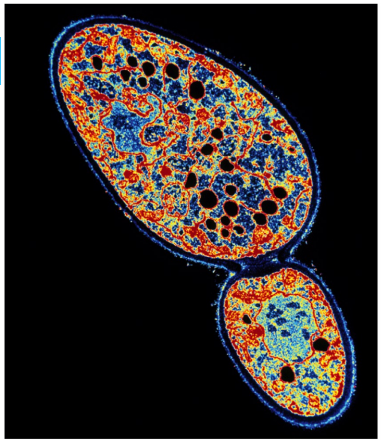
- All cells have descended from a common ancestor
- Fundamental properties of the ancestor is conserved through evolution
- Study of one organism contributes to understanding the others
- Model Organisms
  - Certain organisms are easier to study than others.
  - Some reproduce rapidly and others are transparent

What properties of the following creatures turn them into model organisms?



Biophoto Associates/Photo Researchers

Escherichia coli (bacterium)

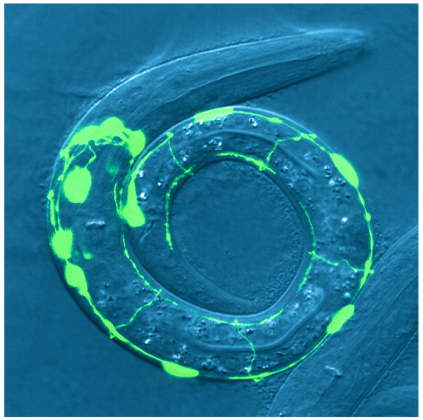


Biophoto Associates/Photo Researchers

Saccharomyces (yeast)

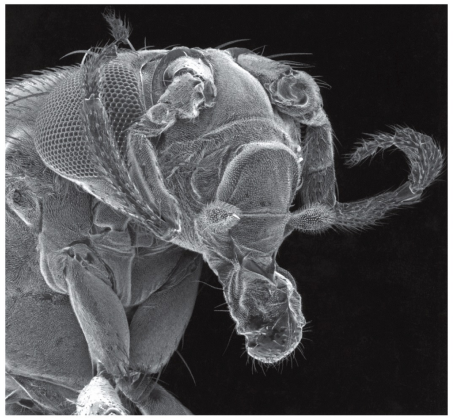
Jean Claude Revy/Phototake

Arabidopsis (mustard plant)



Courtesy Erik Jorgensen, Department of Biology, University of Utah. From Trends Genetics, Vol. 14, cover #12. © 1998, with permission from Elsevier.

Caenorhabditis elegans (nematode)



David Scharf/Photo Researchers, Inc.

Drosophila (fruit fly)

Ted Spiegel/ © Corbis

Mus musculus (mouse)

Some interesting links

- https://www.youtube.com/watch?v=gFuEo2ccTPA
- https://www.youtube.com/watch?v=umKAkEr_HLI
- https://www.youtube.com/watch?v=jbLkc8xSFnU

Put your thinking cap on….

1. The first human cells to be successfully cultured were derived from a malignant tumor. Do you think such cells be better subjects for cell culture? Why?
2. The antibiotic streptomycin inhibits protein synthesis in bacteria. If this antibiotic is added to a culture of animal cells, protein synthesis in the cytosol continues normally. However, over time, the population of mitochondria in the cell becomes depleted. Specifically, it is observed that the protein-synthesis machinery inside the mitochondria is inhibited.
   - Explain this observation based on what you know about the origins of the modern eukaryote.
   - What do you expect to observe if, in a new experiment, animal cells are treated with diphtheria toxin, a compound that is known to block cytosolic protein synthesis but does not have any impact on bacterial growth?