Intro to the Cell

• All living things are composed of cells
• All cells originate from pre-existing cells

Cell Basics

• Cells are relatively small - this assures a big surface to volume ratio
• Enclosed by a membrane bilayer
• All communication crosses thru bilayer
• Sense/respond to environment thru bilayer
• Nutrients and waste products thru bilayer
• DNA to orchestrate - Information Solution
Intro to the Cell

High surface area–to–volume ratio

Campbell Fig 6.7
A Key way to study the Cell: Microscopy

Light microscopy:

Fluorescence: Shows the location of molecules in the cell by tagging them with fluorescent dyes or antibodies

Phase-contrast: Enhances contrast in cells by amplifying variations in density

Confocal: Uses lasers and special optics to optically section fluorescently-stained cells
A Key way to study the Cell: Microscopy

Electron Microscopy: Uses beam of electrons instead of light

Scanning EM: 3D image of the surface of a cell or specimen

Transmission EM: Section through a cell or specimen
What's Key for Microscopy
**Prokaryotes: BASICS**

- Lack a true nucleus and have no internal membranes

They solve the 3 Problems:

**Containment:**
- plasma membrane
- No internal compartments
- Can fold plasma membrane - Why?

**Specificity (workers):** ribosomes, proteins

**Information:**
- RNA
- DNA - free in the cytoplasm “Nucleoid”
  - 1 chromosome, circular
  - extra small minichromosomes: plasmids

*Plus - Structural support:*
- cell wall - peptidoglycan (protein + sugar attached)
- capsule - polysaccharide

In cytoplasm and membrane
Prokaryotes: BASICS

Mating: Can share information - increases diversity
Pili: hairs on the surface

Motility: Important for sensing environment and changing directions
Flagella: on surface and crosses membrane

“Tumble and Swim”

(a) A typical rod-shaped bacterium
(b) A thin section through the bacterium Bacillus coagulans (TEM)
Eukaryotes: Animal

- Have a nucleus and internal membranes

They solve the 3 Problems:

**Containment:**
- plasma membrane
- internal compartments: **Organelles**
  - vary in size: BIG: nucleus
  - Med: mitochondria
  - small: vesicle

**Specificity (workers):** ribosomes, proteins

**Information:**
- RNA
- DNA - enclosed in the nucleus
  - multiple chromosome - linear
  - no plasmids!

*Plus - Structural support:*
- inside: cytoskeleton
- outside: extracellular matrix (ECM)
Eukaryotes: PLANTS

• Same as animal cells

• Containment ✓
• Info ✓
• Specificity (workers) ✓

• Special organelle: chloroplast
  vacuole: water storage

• Structural: have cytoskeleton on inside
  • But also have a cell wall on the outside (Not ECM)
Parts of the cell

**CYTOSKELETON**
- Microfilaments
- Intermediate filaments
- Microtubules
- Peroxisome

**ENDOPLASMIC RETICULUM (ER)**
- Rough ER
- Smooth ER

**NUCLEUS**
- Nuclear envelope
- Nucleolus
- Chromatin (DNA)

**MEMBRANOUS SYSTEM**
- Endoplasmic reticulum
- Golgi apparatus
- Lysosome
- Mitochondrion
- Ribosomes

**PLASMA MEMBRANE**

Figure 6.9

04-26-16: Lecture 8
Eukaryotes: The Organelles

Nucleus:

- **Information storage organelle**
- Enclosed by a double membrane - “nuclear envelope”
- Inside is DNA - DNA is bound by proteins - “chromatin”
- Dark spot is the nucleolus - site for rRNA synthesis
- Has its own internal skeleton
  - Nuclear lamina (made up of lamins)
- Has a transport system: Nuclear pores
Eukaryotes: The Organelles

Mitochondria:

• Energy processing organelle
• Respiration
• Outer membrane
• Inner membrane
• Matrix
• Cristae: infoldings of the inner membrane - Why?

  More surface area to pack lots of ETC and ATP synthase!

• Has its own DNA - circular (similar to prokaryotes)
• Own ribosomes
Eukaryotes: The Organelles

Chloroplasts: In plants only!

- Photosynthesis
  - Inside stroma
  - Thylakoids
- Has own DNA - circular
- Has ribosomes
- Outer/Inner membrane
Eukaryotes: The Organelles

Endosymbiosis Theory

Mitochondria and Chloroplasts:
• Double membrane enclosed
• Same size as bacteria
• Has own DNA that is circular
• Ribosomes are bacteria-like
• Respiration or photosynthesis - known prokaryotic activities
Eukaryotes: The Organelles

Endosymbiosis Theory

Euk. cell

Membrane of larger cell

Prok. cell

Membrane of smaller cell

Double membrane
Endomembrane system

• Related through direct physical continuity or by the transfer membrane as vesicles
• The endomembrane system regulates protein traffic and performs metabolic functions in the cell

• Nuclear membrane
• Endoplasmic Recticulum
• Golgi apparatus
• Lysosome
• Vacuoles
• Vesicles

• Plasma membrane*

*Related through direct physical continuity or by the transfer membrane as vesicles

The endomembrane system regulates protein traffic and performs metabolic functions in the cell.
Nuclear Membrane

- Double membrane
- Nuclear pore complex - regulate traffic in and out
- In physical contact with ER
Ribosomes synthesize proteins

Bound ribosomes - make membrane and secreted proteins

Free ribosomes - make cytosolic proteins
Endoplasmic Reticulum - 2 Types

• Rough ER (RER)
  
  Closest to nuclear membrane
  Make all secreted and membrane proteins
  Makes all organellar proteins
  Involved in protein folding
    Disulfide bridge formation
    Quality control of tertiary and quaternary folding
    Glycosylation - addition of sugars

• Smooth ER (SER)
  
  Detoxification of Drugs
  Phospholipid synthesis
Golgi Apparatus

Sorting Organelle

collects, packages, and distributes molecules synthesized at one location in the cell and utilized at another location

Adds additional glycosylation (zip codes) In Golgi stacks

All membrane and secreted proteins must pass through the golgi
cis face (receiving side), trans face (shipping side), golgi stacks, cisterna
Glycosylation: addition of sugars

Membrane proteins
made in RER
folded properly
destined for the plasma membrane (PM)
need modifications (Zip code) to send to the right place

Enzymes in the RER: will modify Serine and Threonine

Condensation rxn

Outside cell

hydrophilic

inside cell

PM

Condensation rxn

\[ \text{OH} + \text{Sugar} \rightarrow \text{O} \]

H2O
Golgi Apparatus

- Vesicle budding from rough endoplasmic reticulum
- Migrating transport vesicle
- Fusion of vesicle with Golgi apparatus

- Cisternae
- cis face
- trans face
- Proteins
- Golgi apparatus
- Trans face
- Ribosome
- Protein
- Vesicle budding from rough endoplasmic reticulum
- Migrating transport vesicle
- Fusion of vesicle with Golgi apparatus

04-26-16: Lecture 8
Lysosome

Digestive Organelle

- Digest damaged organelles
- Digest food that enters the cell by phagocytosis
- Low pH - acidic environment
- Contains lots of proteases

04-26-16: Lecture 8
Lysosome

Digestive Organelle

- Digest damaged organelles
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- Contains lots of proteases
Cytoskeleton

Network of protein fibers supporting cell shape and anchoring organelles

actin filaments, microtubules, and intermediate filaments
Cytoskeleton

- Structural support
- Motility
- Trafficking