Chapter 4
The Cell’s Endomembrane System—Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Peroxisomes, Vacuoles, Vesicles

Overview
- Play key role in synthesis (& hydrolysis) of macromolecules in cell
- Various “players” modify macromolecules for various functions

Endoplasmic Reticulum
- **Function**
  - manufactures membranes & performs many bio-synthesis functions
- **Structure**
  - membrane connected to nuclear envelope & extends throughout cell
  - accounts for 50% membranes in eukaryotic cell
  - rough ER = bound ribosomes
  - smooth ER = no ribosomes

Types of ER
- **Smooth ER function**
  - Factory processing operations
    - many metabolic processes
      - synthesis & hydrolysis
      - enzymes of smooth ER…
        - synthesize lipids, oils, phospholipids, steroids & sex hormones
        - hydrolysis (breakdown) of glycogen (in liver) into glucose
        - detoxify drugs & poisons (in liver)
          - ex. alcohol & barbiturates
  - Factory processing operations
    - produce proteins for export out of cell
      - protein secreting cells
      - packaged into transport vesicles for export

Rough ER function
- Produce proteins for export out of cell
- protein secreting cells
- packaged into transport vesicles for export
Membrane Factory
- Synthesize membrane phospholipids
  - build new membrane
  - as ER membrane expands, bud off & transfer to other parts of cell that need membranes
- Synthesize membrane proteins
  - membrane bound proteins synthesized directly into membrane
  - processing to make glycoproteins

Golgi Apparatus
- Function
  - finishes, sorts, & ships cell products
    - “shipping & receiving department”
  - center of manufacturing, warehousing, sorting & shipping
  - extensive in cells specialized for secretion

Which cells have a lot of Golgi?

Golgi apparatus
- Structure
  - flattened membranous sacs = cisternae
    - look like stack of pita bread
  - 2 sides = 2 functions
    - cis = receives material by fusing with vesicles = “receiving”
    - trans buds off vesicles that travel to other sites = “shipping” (transport)

Golgi processing
- During path from cis to trans, products from ER are modified into final form
  - tags, sorts, & packages materials into transport vesicles
    - Golgi = “UPS headquarters”
    - Transport vesicles = “UPS trucks”
      - delivering packages that have been tagged with their own barcodes

Putting it together...

Lysosomes
- Structure
  - membrane-bounded sac of hydrolytic enzymes that digests macromolecules
    - enzymes & membrane of lysosomes are synthesized by rough ER & transferred to the Golgi
  - only in animal cells
**Lysosomes**

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1960 | 1974

1974 Nobel prize: Christian de Duve
Lysosomes discovery in 1960s

**Cellular digestion**

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<td>• Lysosomes fuse with food vacuoles</td>
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**The Recycler**

Fuse with organelles or macromolecules in cytosol to recycle materials

**Lysosomal enzymes**

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<td>• Lysosomal enzymes work best at pH 5</td>
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**When things go wrong…**

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<td>• What if a lysosome digestive enzyme doesn’t function?</td>
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**Sometimes its supposed to work that way…**

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<td>• Apoptosis = cell death</td>
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Fetal development

*syndactyly*

6 weeks

15 weeks

Peroxisomes

- Other digestive enzyme sacs
  - in both animals & plants
  - breakdown fatty acids to sugars
    - easier to transport & use as energy source
  - detoxify cell
    - detoxifies alcohol & other poisons
  - produce peroxide (H$_2$O$_2$)
    - must breakdown
      - H$_2$O$_2$ $\rightarrow$ H$_2$O

Vacuoles & vesicles

- Function
  - little “transfer ships”
    - Food vacuoles
      - phagocytosis, fuse with lysosomes
    - Contractile vacuoles
      - in freshwater protists, pump excess H$_2$O out of cell
    - Central vacuoles
      - in many mature plant cells

Vacuoles in plants

- Functions
  - storage
    - stockpiling proteins or inorganic ions
    - depositing metabolic byproducts
    - storing pigments
    - storing defensive compounds against herbivores
    - selective membrane
      - control what comes in or goes out

Putting it all together…