4.5 The nucleus is the cell’s genetic control center

- The nucleus
  - contains most of the cell’s DNA and
  - controls the cell’s activities by directing protein synthesis by making messenger RNA (mRNA).
- DNA is associated with many proteins in structures called chromosomes.

4.5 The nuclear envelope

- is a double membrane and
- has pores that allow material to flow in and out of the nucleus.
- The nuclear envelope is attached to a network of cellular membranes called the endoplasmic reticulum.

- The nucleolus is
  - a prominent structure in the nucleus and
  - the site of ribosomal RNA (rRNA) synthesis.

4.6 Ribosomes make proteins for use in the cell and export

- Ribosomes are involved in the cell’s protein synthesis.
  - Ribosomes are synthesized from rRNA produced in the nucleolus.
  - Cells that must synthesize large amounts of protein have a large number of ribosomes.
4.7 Overview: Many cell organelles are connected through the endomembrane system

- Many of the membranes within a eukaryotic cell are part of the endomembrane system.
- Some of these membranes are physically connected and some are related by the transfer of membrane segments by tiny vesicles (sacs made of membrane).
- Many of these organelles work together in the
  - synthesis,
  - storage, and
  - export of molecules.

4.8 The endoplasmic reticulum is a biosynthetic factory

- There are two kinds of endoplasmic reticulum—smooth and rough.
  - Smooth ER lacks attached ribosomes.
  - Rough ER lines the outer surface of membranes.
  - Although physically interconnected, smooth and rough ER differ in structure and function.
4.8 The endoplasmic reticulum is a biosynthetic factory

**Smooth ER**
- Is involved in a variety of diverse metabolic processes.
  - Produces enzymes important in the synthesis of lipids, oils, phospholipids, and steroids.
  - Other enzymes help process drugs, alcohol, and other potentially harmful substances.
  - Some smooth ER helps store calcium ions.

**Rough ER**
- Makes additional membrane for itself and
- Makes proteins destined for secretions.

4.9 The Golgi apparatus finishes, sorts, and ships cell products

- The Golgi apparatus serves as a molecular warehouse and finishing factory for products manufactured by the ER.
  - Products travel in transport vesicles from the ER to the Golgi apparatus.
  - One side of the Golgi apparatus functions as a receiving dock for the product and the other as a shipping dock.
  - Products are modified as they go from one side of the Golgi apparatus to the other and travel in vesicles to other sites.

4.10 Lysosomes are digestive compartments within a cell

- A lysosome is a membranous sac containing digestive enzymes.
  - The enzymes and membrane are produced by the ER and transferred to the Golgi apparatus for processing.
  - The membrane serves to safely isolate these potent enzymes from the rest of the cell.

**4.10 Lysosomes are digestive compartments within a cell**

Lysosomes help digest food particles engulfed by a cell.
1. A food vacuole binds with a lysosome.
2. The enzymes in the lysosome digest the food.
3. The nutrients are then released into the cell.
4.10 Lysosomes are digestive compartments within a cell

- Lysosomes also help remove or recycle damaged parts of a cell.
  1. The damaged organelle is first enclosed in a membrane vesicle.
  2. Then a lysosome
     - fuses with the vesicle,
     - dismantles its contents, and
     - breaks down the damaged organelle.

4.11 Vacuoles function in the general maintenance of the cell

- Vacuoles are large vesicles that have a variety of functions.
  - Some protists have contractile vacuoles that help to eliminate water from the protist.
  - In plants, vacuoles may
    - have digestive functions,
    - contain pigments, or
    - contain poisons that protect the plant.

4.13 Mitochondria harvest chemical energy from food

- Mitochondria are organelles that carry out cellular respiration in nearly all eukaryotic cells.
- Cellular respiration converts the chemical energy in foods to chemical energy in ATP (adenosine triphosphate).

4.14 Chloroplasts convert solar energy to chemical energy

- Chloroplasts are the photosynthesizing organelles of all photosynthesizing eukaryotes.
- Photosynthesis is the conversion of light energy from the sun to the chemical energy of sugar molecules.
4.16 The cell’s internal skeleton helps organize its structure and activities

- The cytoskeleton is composed of three kinds of fibers.
  1. **Microfilaments** (actin filaments) support the cell’s shape and are involved in motility.
  2. **Intermediate filaments** reinforce cell shape and anchor organelles.
  3. **Microtubules** (made of tubulin) give the cell rigidity and act as tracks for organelle movement.

- Cells contain a network of protein fibers, called the **cytoskeleton**, which functions in structural support and motility.

- Scientists believe that motility and cellular regulation result when the cytoskeleton interacts with proteins called motor proteins.
4.17 Cilia and flagella move when microtubules bend

*While some protists have flagella and cilia that are important in locomotion, some cells of multicellular organisms have them for different reasons.*

- Cells that sweep mucus out of our lungs have cilia.
- Animal sperm are flagellated.

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4.17 Cilia and flagella move when microtubules bend

- A flagellum, longer than cilia, propels a cell by an undulating, whiplike motion.
- Cilia work more like the oars of a crew boat.
- Although differences exist, flagella and cilia have a common structure and mechanism of movement.

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4.17 Cilia and flagella move when microtubules bend

- Both flagella and cilia are made of microtubules wrapped in an extension of the plasma membrane.
- A ring of nine microtubule doublets surrounds a central pair of microtubules. This arrangement is called the 9 + 2 pattern and anchored in a basal body with nine microtubule triplets arranged in a ring.
4.17 Cilia and flagella move when microtubules bend

- Cilia and flagella move by bending motor proteins called dynein feet.
  - These feet attach to and exert a sliding force on an adjacent doublet.
  - The arms then release and reattach a little further along and repeat this time after time.
  - This “walking” causes the microtubules to bend.

4.19 The extracellular matrix of animal cells functions in support and regulation

- Animal cells synthesize and secrete an elaborate extracellular matrix (ECM) that
  - helps hold cells together in tissues and
  - protects and supports the plasma membrane.
  - Remember they discussed this in the Cell Video we watched, this is not specific to an individual
    - Skin cells can be placed on burn victims without rejection

4.20 Three types of cell junctions are found in animal tissues

- Adjacent cells communicate, interact, and adhere through specialized junctions between them.
  - Tight junctions prevent leakage of extracellular fluid across a layer of epithelial cells.
  - Anchoring junctions fasten cells together into sheets.
  - Gap junctions are channels that allow molecules to flow between cells.

4.21 Cell walls enclose and support plant cells

- A plant cell, but not an animal cell, has a rigid cell wall that
  - protects and provides skeletal support that helps keep the plant upright against gravity and
  - is primarily composed of cellulose.
- Plant cells have cell junctions called plasmodesmata that serve in communication between cells.
4.22 Review: Eukaryotic cell structures can be grouped on the basis of four basic functions

- Eukaryotic cell structures can be grouped on the basis of four functions:
  1. genetic control,
  2. manufacturing, distribution, and breakdown,
  3. energy processing, and
  4. structural support, movement, and communication between cells.