The amazing plant cell.
The Plant Cell

- All living organisms are composed of cells. The cells are their building blocks, therefore the plant cells are the building blocks of plants.

- Each cell is functionally independent (it can live on its own under the right conditions). What does it involve?
  - Each cell uses sugars to get energy and stay alive
  - Each cell contains all necessary info to replicate and produce a multicellular organism.
  - Each plant cell has **Totipotency**: Can make a whole plant from a single cell (*only found in plant cells*).

- Levels of organization: atoms > molecules > **cells** > tissues > organs > whole plant
The cell was first discovered by Robert Hooke in 1665 (cork cells reminded him of monastary rooms called “cells”).

Cytology (the study of cells) is ruled by the **Cell Theory**. The cell theory has two main statements that have never been proven wrong and it applies to all living organisms.

- All organisms are composed of cells
- All cells arise from other cells (you can’t make cells from scratch, you need a pre-existent cell).
What Features Are Shared by All Cells?

- All Cells Are Enclosed by a Plasma Membrane
- All Cells Use DNA As a Hereditary Blueprint
- All Cells Contain Cytoplasm
- All Cells Obtain Energy and Nutrients from Their Environment.
- There are two kinds of cells: prokaryotic and eukaryotic.
The two types of cells

Prokaryotic Cells: Prokaryotic cells are small, relatively simple cells and they do not have a nucleus surrounded by a nuclear envelope. Bacteria are prokaryotic. These cells are 10 to 100 times smaller than animal or plant cells.

Eukaryotic Cells: These are larger and more complex than prokaryotic cells and they are partitioned into functional compartments. Eukaryotes are distinguished by the presence of a true nucleus. Multicellular organisms are eukaryotic. Some unicellular organisms are eukaryotic: algae, amoeba, etc.
**Prokaryotes**
Older organisms (3.5 byo)
Smaller (1-10 um)
No membrane bound organelles

**Eukaryotes**
More recent (1.5 byo)
Bigger 10 – 100 um
Have m.b. organelles
What Are the Main Features of Eukaryotic Cells?

- Let’s start by studying a generalized plant cell.

- A plant cell has a cell wall, the cell or plasma membrane, the cytoplasm (which holds the organelles) and the nucleus.
The Cell Wall protects the cell, adds support, increases the cell resiliency, helps control water pressure and helps preventing water loss.

The plasma membrane controls the cell’s contact with the environment.

The cytoplasm contains organelles. Many organelles have membranes as boundaries. These compartmentalize the interior of the cell, allowing the cell to carry out a variety of activities simultaneously.
The Outside: The cell wall

- Cell wall protects and supports cell
- Is made of CELLULOSE
- Allows water and other molecules to pass through (like a cardboard box)
Primary vs. Secondary cell wall

- Primary wall is formed early, located on the outermost layer.
- Secondary wall is deposited on the inside, between Primary cell wall and plasma membrane.
- Middle lamella: what ‘glues’ adjacent cells together.
The Cell Membrane

- It is the boundary of the Cell.
- The structure of the cell membrane is explained by the Fluid Mosaic Model. This model establishes that:
  - The Phospholipid Bilayer is the fluid portion of the membrane.
  - A Mosaic of proteins is embedded in the membrane
  - The cell membrane is selective and semi-permeable: It lets water and other molecules through but not all molecules.
Cell membrane
(plasma membrane)
Inside the Plant Cell:

- **Protoplast**: all of the plant cell enclosed by the cell wall (plasma membrane, cytosol, organelles)
- **Cytosol**: a matrix of water (90%), proteins, organic molecules, ions
- **Cytoplasm**: cytosol and organelles
Plant Cell Organelles and Cytoskeleton

- Organelles are sub-compartments within the cell. Some of them are membrane-bound. Each organelle has its own function.
  - Nucleus
  - Mitochondria
  - Chloroplast
  - Vacuole
  - Ribosomes
  - Endoplasmic reticulum
  - Golgi apparatus
  - Cytoskeleton (microtubules, microfilaments and intermediate filaments.)
The different organelles of an eukaryote cell can be grouped as:

- Protein Production: Ribosomes
- Energy organelles: Mitochondria, Chloroplasts
- Endomembrane system:
  - Rough Endoplasmic reticulum
  - Smooth Endoplasmic reticulum
  - Golgi apparatus

Cytoskeleton
Ribosomes

- Ribosomes contain rRNA and protein.
- A ribosome is composed of two subunits
- Ribosomes: are the site for protein synthesis
- Not membrane bound.
Mitochondria: Provides energy to cell by converting sugars into chemical energy.
Endomembrane System

Endoplasmic Reticulum (ER): a network of folded membranes throughout the cytoplasm.

- **Rough ER**: has ribosomes for protein synthesis.
- **Smooth ER**: lacks ribosomes. It is involved in the making of lipids and detoxing of the cell.

- **Golgi Apparatus**
Vacuole

- ONLY FOUND IN PLANT CELLS
- Makes up to 90% of plant cell volume
- Makes cells turgid
- Has its own membrane, called **tonoplast**
- **Vacuole**: Stores a watery solution of sugars, salts, acids and proteins.
Vacuole

- Often acidic content (sap), it’s what makes lemons and limes taste tart!
The Plastids

- Only found in Plant Cells.
- Organelles with two external membranes: The outer membrane and the inner membrane
- Amyloplasts: Filled with starch
- Chromoplasts: Filled with color pigments
Amyloplasts found in potato cells stained with IKI. These organelles store starch.
Chromoplasts found in the cytoplasm of red pepper cells.
Chloroplasts convert solar energy to chemical energy

- Chloroplasts are found in plants and some protists
- Chloroplasts convert solar energy to chemical energy in sugars
Parts of a chloroplast

Plant Cell Chloroplast

- Outer Membrane
- Inner Membrane
- Stroma
- Thylakoid
- Intermembrane Space
- Granum (Stack of Thylakoids)
Chloroplasts

- Contain chlorophyll (makes the plant green)
- Chloroplasts convert solar energy to chemical energy (found in sugars). This process is called Photosynthesis.
The Cytoskeleton

A network of protein fibers makes up the cytoskeleton
- **Microfilaments** of actin enable cells to change shape and move

- **Intermediate filaments** reinforce the cell and anchor certain organelles

- **Microtubules**
  - give the cell rigidity
  - provide anchors for organelles
  - act as tracks for organelle movement
The Nucleus

- nuclear envelope
- nucleolus
- nuclear pores
- chromatin

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What Role Does the Nucleus Play?

- The Nuclear Envelope (with its nuclear pores) controls Passage of Materials
- The Nucleus Contains Chromosomes
- Ribosome Components Are Made at the Nucleolus
Plant nucleus

- **Chromosomes:** DNA & proteins

- **Nucleolus:** Bodies where ribosomes are made
Plant vs. animal cells

- Plant cells have 3 things animal cells don’t:
  1) Cell walls
  2) Vacuoles
  3) Chloroplasts
The plant cell