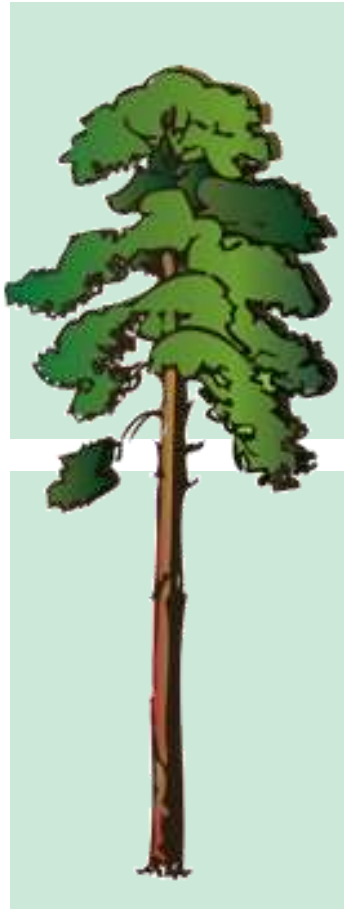
Plants Unit

Week 2 – How do plants get their food?



Waterford Biology

Plants Unit – W2 Driving Question

- **This week's driving question: How do plants get their food?**
- What do plants eat?
- How do plant cells get their energy?
- How do plant cells gain mass (atoms)?

Part 1 Recap

- Earlier we learned about van Helmont's tree experiment.
  - He weighed a seed and weighed the soil it was planted in.
  - The tree gained 169 lbs. but the soil lost almost no mass.
- Where did the mass of the tree come from?
- What claims can we make based on what we know?

REMINDERS FROM EARLIER WEEKS

Remember the following "rules" for energy and matter:

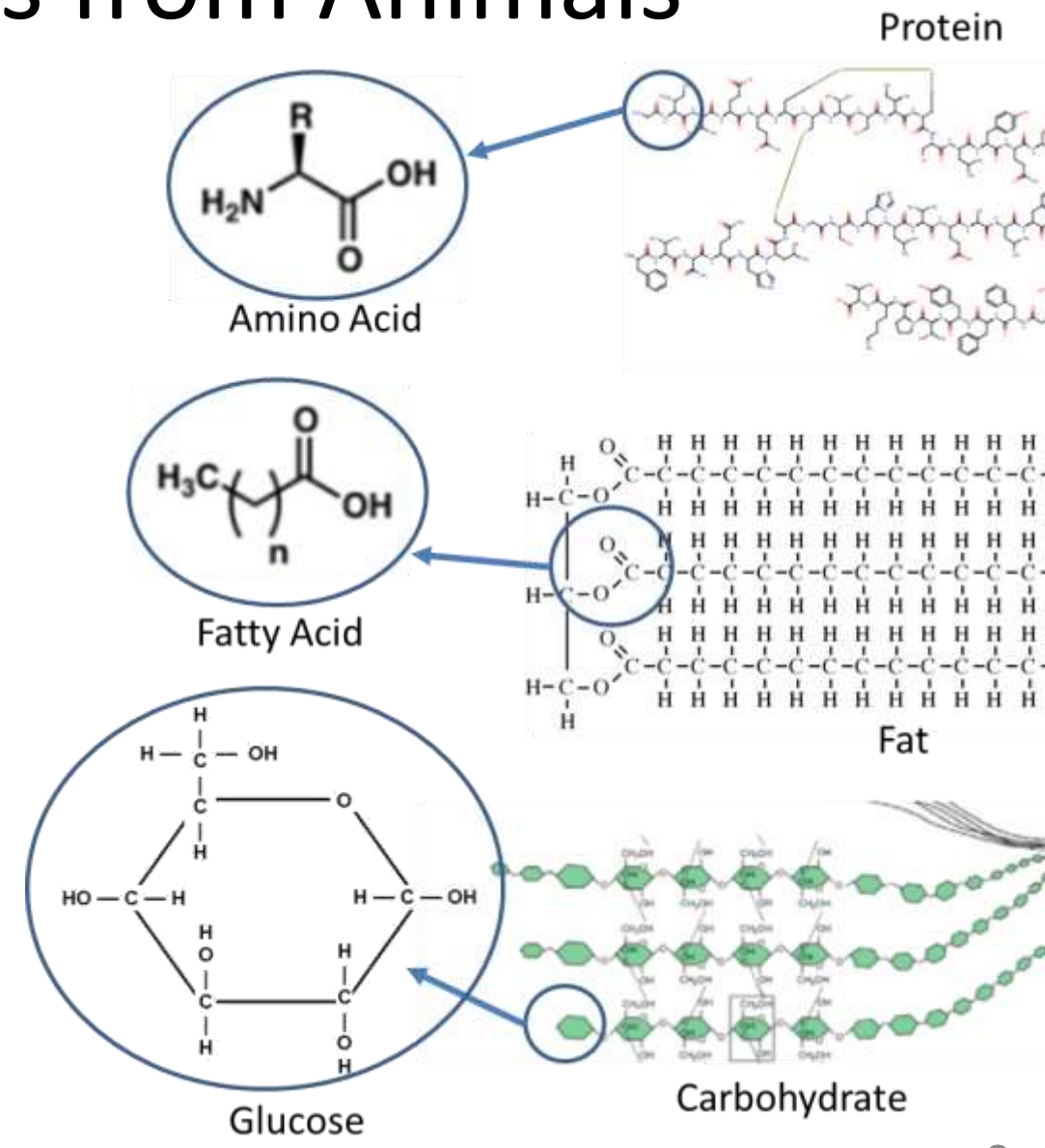
All solids, liquids, and gases are made of atoms.
Multiple atoms can bond together to form molecules.
E.g., water molecules consist of one oxygen atom & two hydrogen atoms.

In biology, **atoms last forever**.
An atom cannot be created or destroyed or turned into energy. *E.g., a carbon atom is always a carbon atom*.
However, atoms can be rearranged to form new molecules.

In biology, **energy lasts forever**.
Energy cannot be created or destroyed.
Energy exists as light, heat, motion, or as chemical energy.
Energy can transform. *E.g., light can transform into heat*.

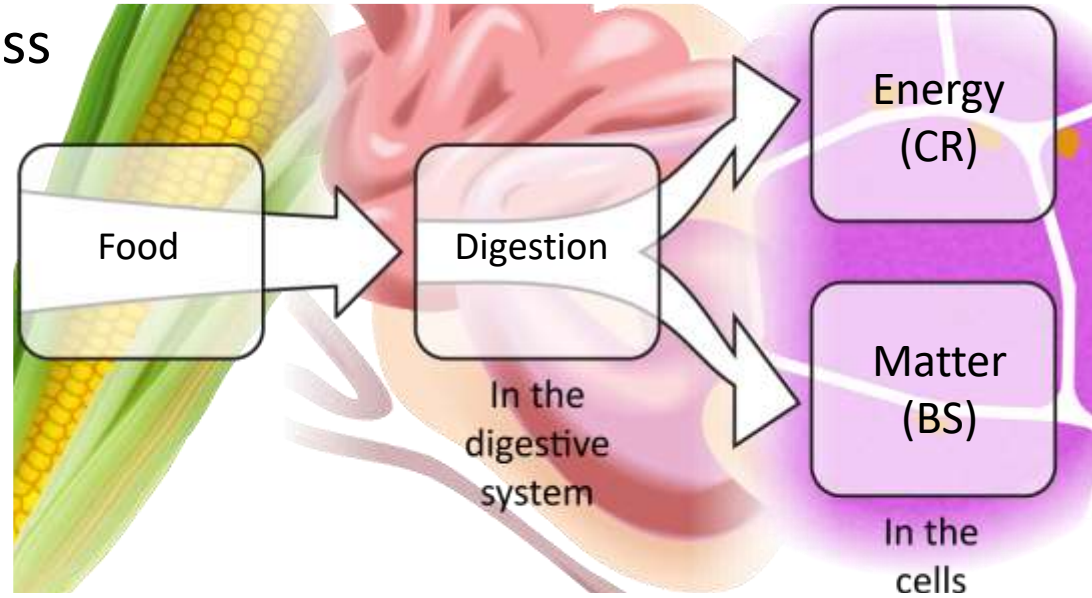
Reminders from Animals

- **A <u>macromolecule</u> is a long chain of individual molecules bonded together.**
  - Macromolecules do all the work of cells.
- **Cells are made from macromolecules.**
  - Cells form tissues, which form organs, which form systems.

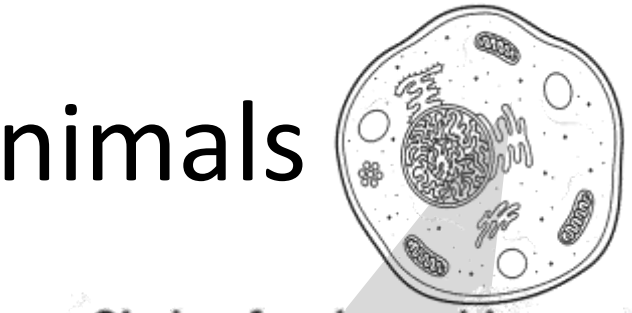


Reminders from Animals

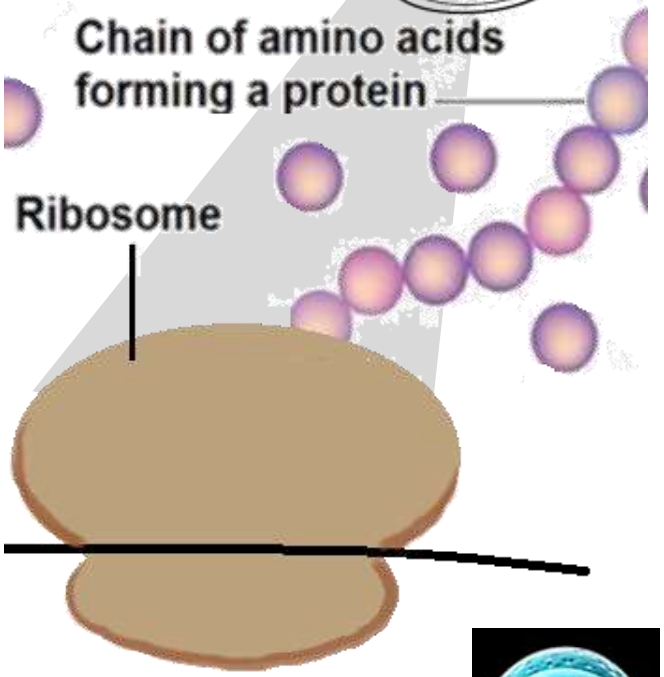
- **The food that animals consume provides either 1) energy or 2) matter.**
  - Cellular respiration is the process in which glucose and oxygen molecules are rearranged into CO_2 and H_2O to acquire chemical energy needed to recharge ATP.
  - Biosynthesis is the process in which organisms use consumed molecules to make macromolecules needed for cell function.

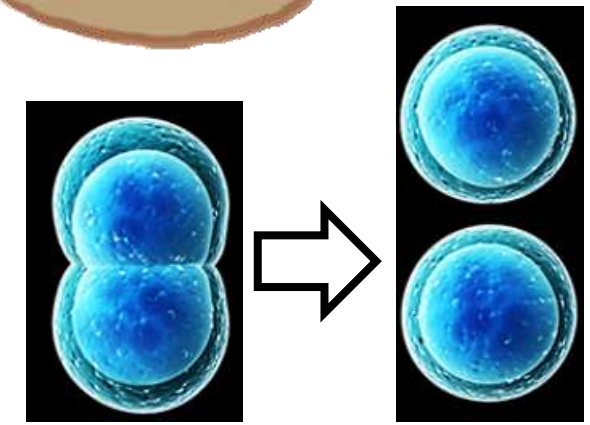


Reminders from Animals



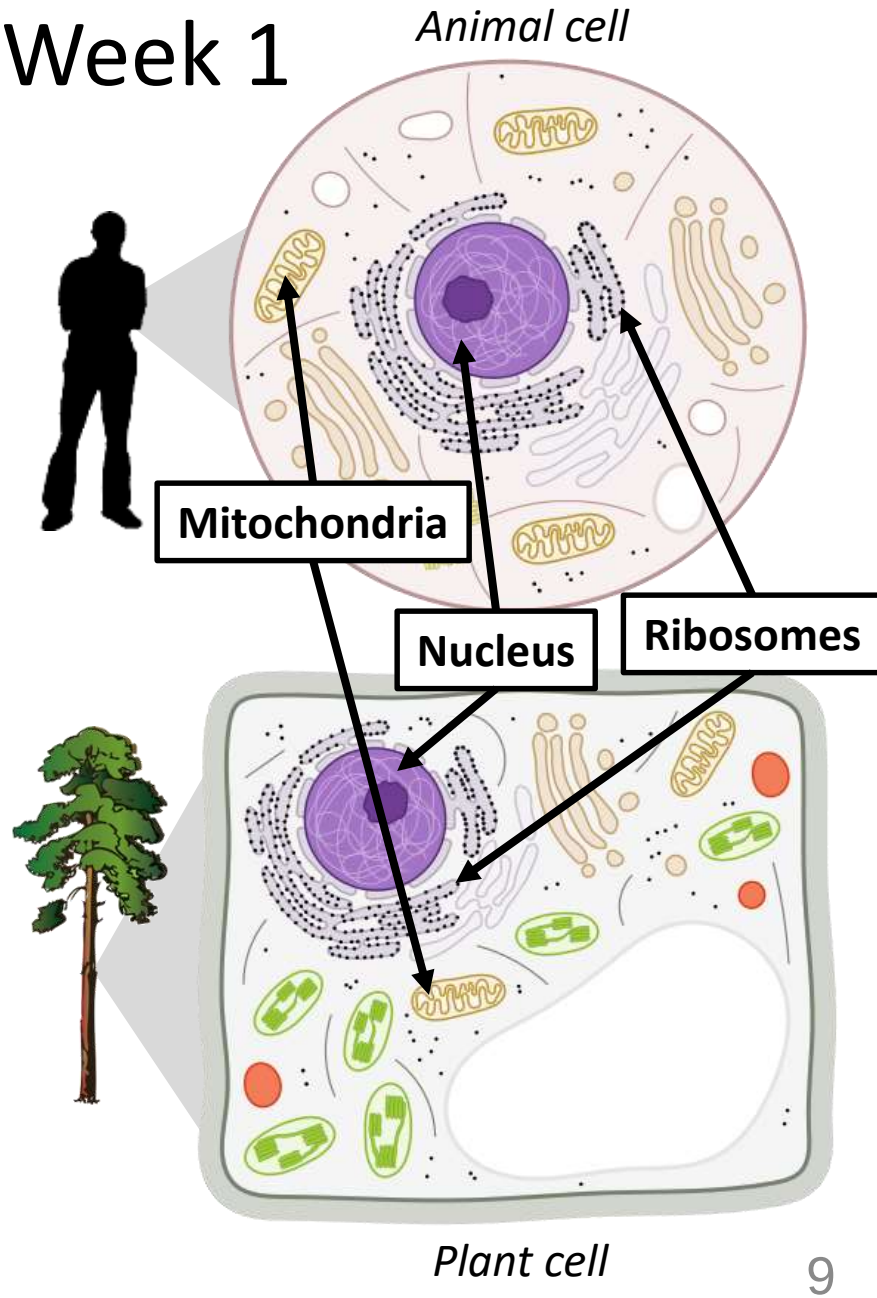
- **Biosynthesis is the process in which organisms use consumed molecules to make the macromolecules needed for its cells.**
  - Cells first absorb individual molecules from the blood.
  - Structures inside the cell then assemble individual molecules into macromolecules like proteins.
- **As a cell assembles macromolecules, the cell grows bigger.**
  - The process of dividing one large cell into two smaller cells is called <u>mitosis</u>.





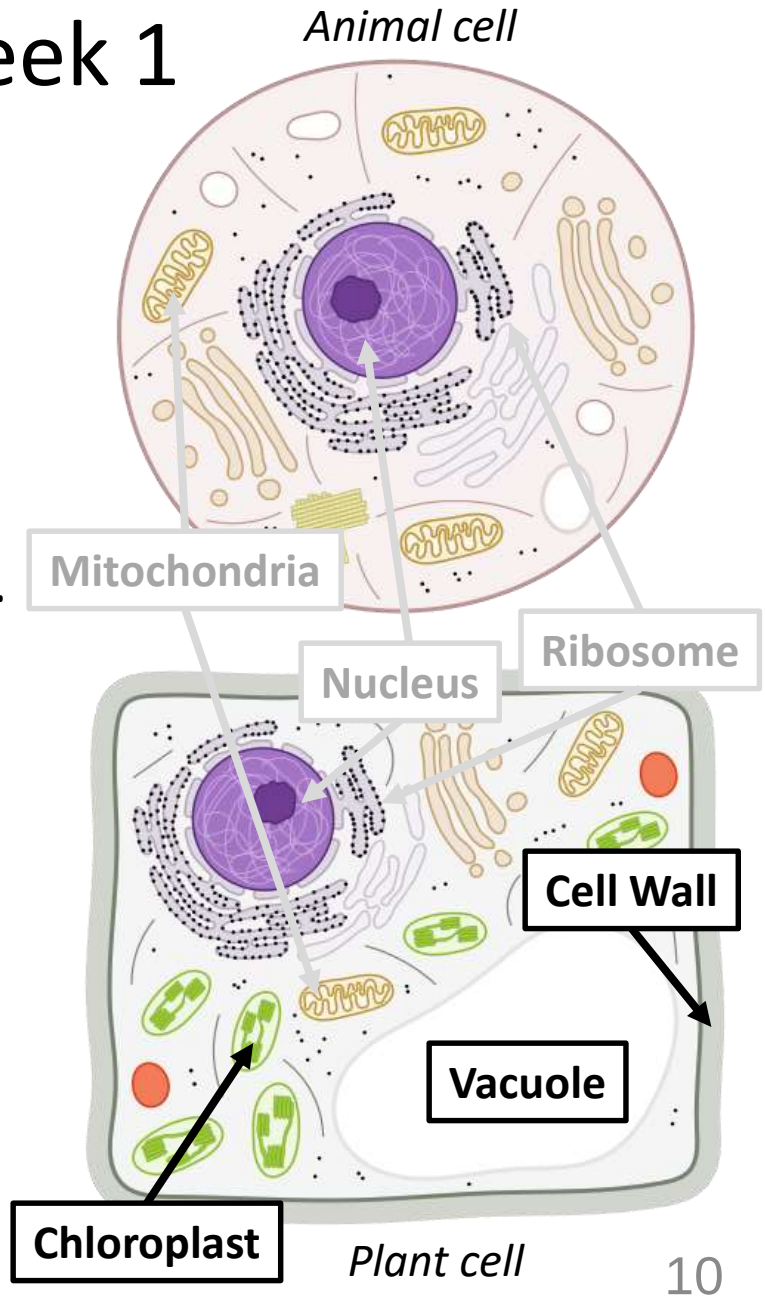
Reminders from Plants, Week 1

- **Most of the organelles found in animal cells are also found in plant cells.**
  - Plant cells also have a nucleus, mitochondria, and ribosomes, among other organelles.
  - Cell respiration, biosynthesis, and mitosis also occur in plant cells.
  - Both plants & animals are *eukaryotic* (their cells have organelles).



Reminders from Plants, Week 1

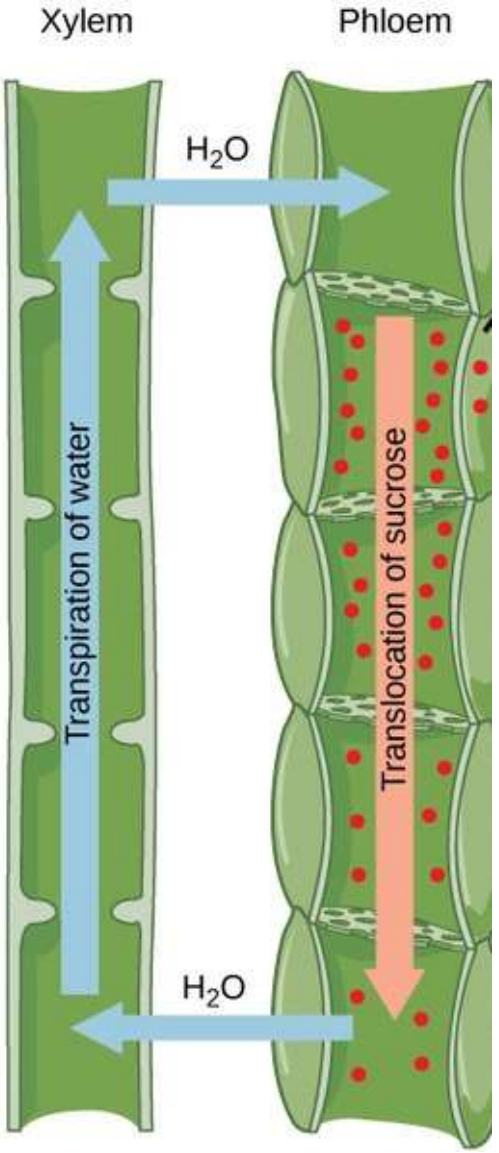
- **Plant cells have three organelles that animal cells do not:**
  - **<u>Chloroplasts</u>:** organelles that can transform light energy into chemical energy (high-energy bonds of glucose).
    - This process is called <u>photosynthesis</u>.
  - **<u>Cell Wall</u>**: a rigid shell made from cellulose surrounding the membrane that provides rigidity (like a skeleton).
    - <u>Cellulose</u>: a type of carbohydrate made from long chains of glucose.
  - **<u>Vacuole</u>**: a storage organelle for waste products and other molecules.



Reminders from Plants, Week 1

- **Plant cells are organized like animal cells.**
  - A group of plant cells form tissues.
  - Plant tissues form organs (roots, stems, leaves).
  - Plant organs form systems.

– **Plant tissues include xylem & phloem.**
  - Xylem are hollow tubes through which water and minerals move *up* through the plant as water is evaporated from pores in the leaves.
  - Phloem are tubes through which sugars move *down* throughout the plant via gravity.
  - Xylem & phloem in roots, stems, and leaves form a vasculature system (like the *circulatory system* in animals).

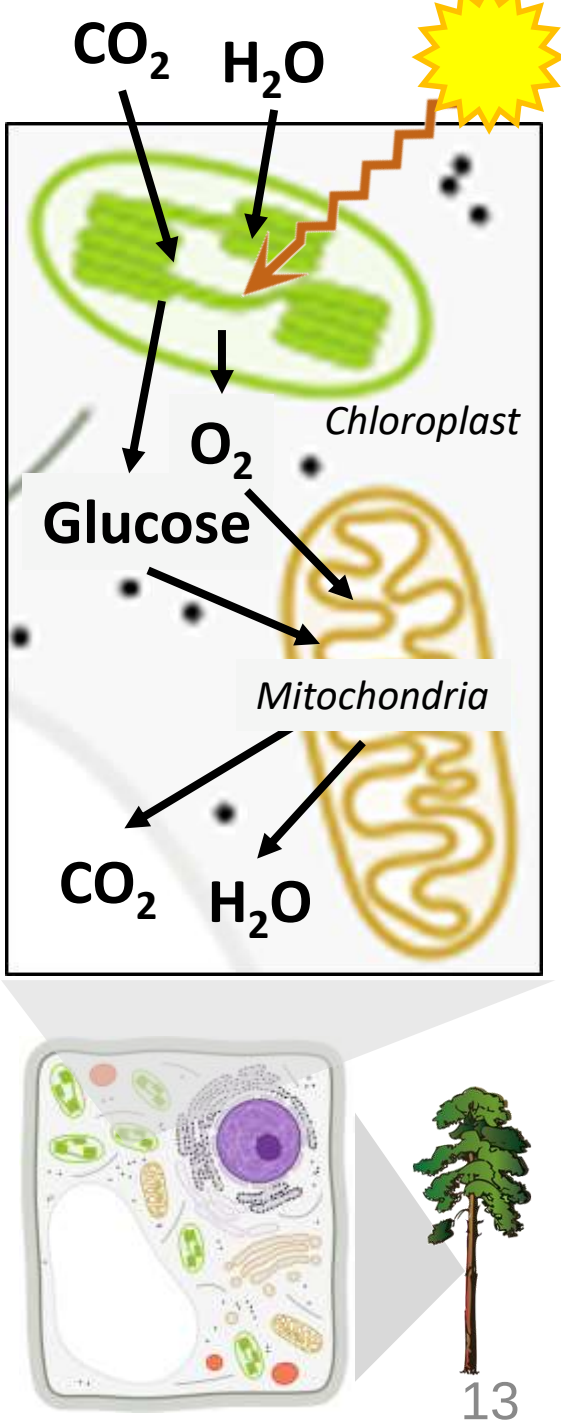


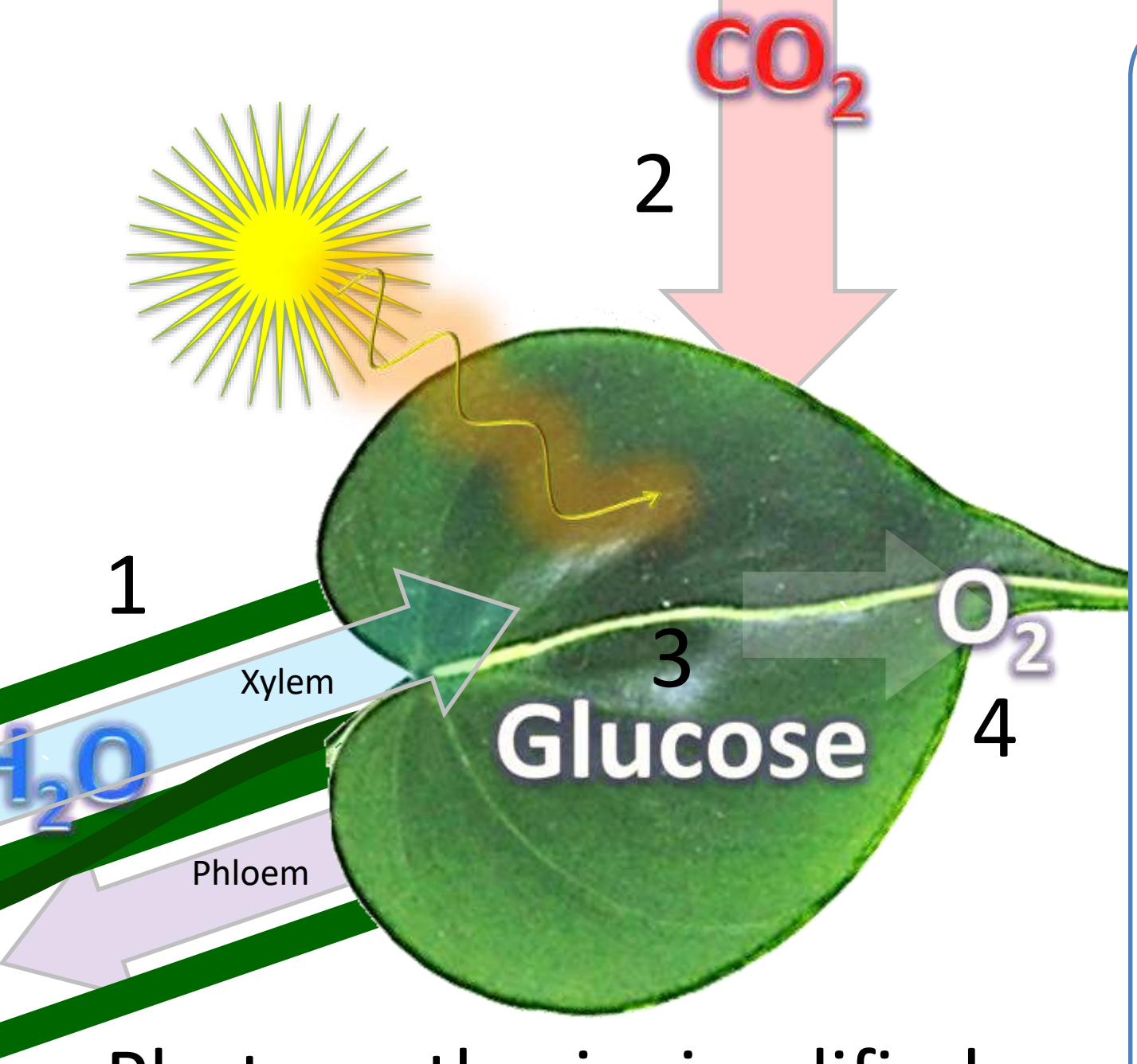
PHOTOSYNTHESIS

Photosynthesis

- **<u>Photosynthesis</u>: the process where water and carbon dioxide molecules are rearranged to form glucose and O_2 in the chloroplasts.**
  - Light energy is transformed into the chemical energy found in the bonds of glucose.

- **Glucose produced during photosynthesis can be used for a variety of purposes, including...**
  - A) The glucose can be immediately be used for cell respiration in the cell's mitochondria.
  - B) The glucose can be sent via phloem to other cells for cell respiration.
  - C) The glucose can be assembled into cellulose to form cell walls.





Photosynthesis simplified...

1. Evaporation pulls water up the xylem tubes into the leaves of the plant.

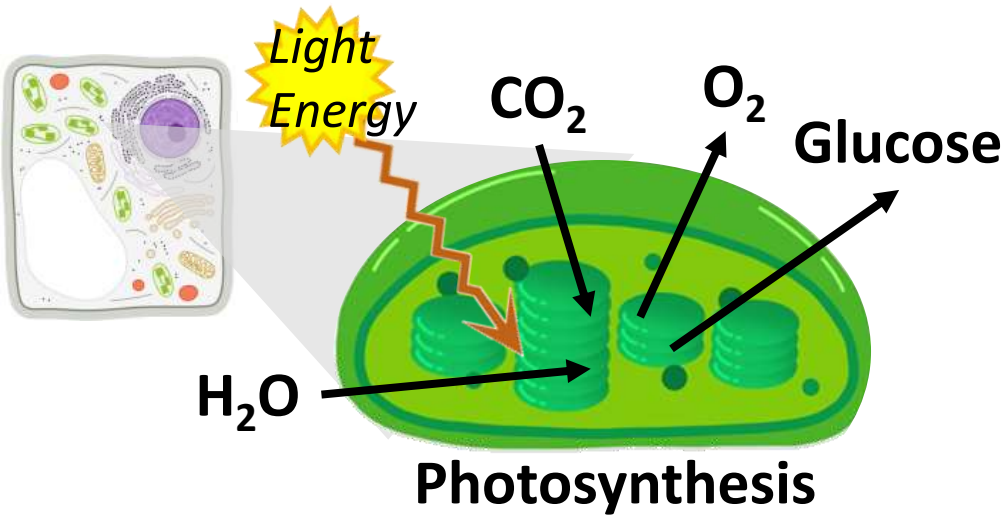
2. CO_2 is absorbed through pores in the leaves.

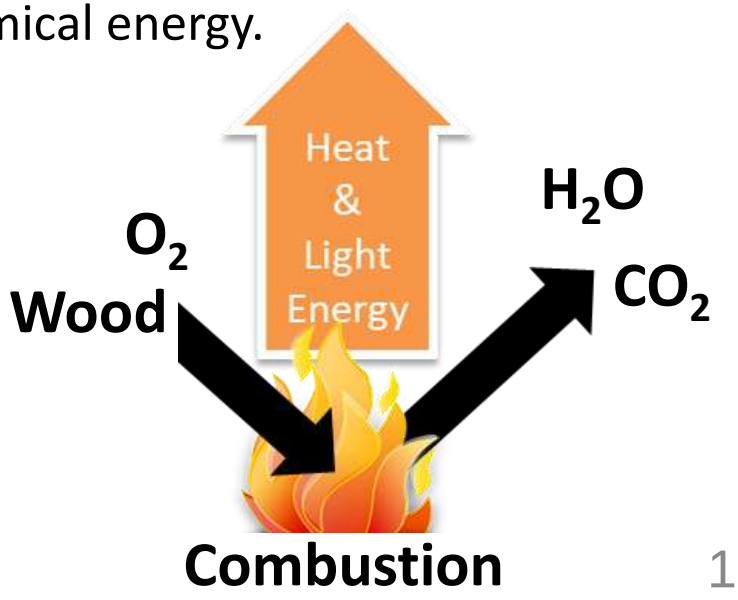
3. CO_2 and H_2O are rearranged to form glucose ($C_6H_{12}O_6$) and oxygen (O_2) using light energy.

4. O_2 is released. Glucose is used for cell resp. or biosynthesis.

“Reverse Combustion”

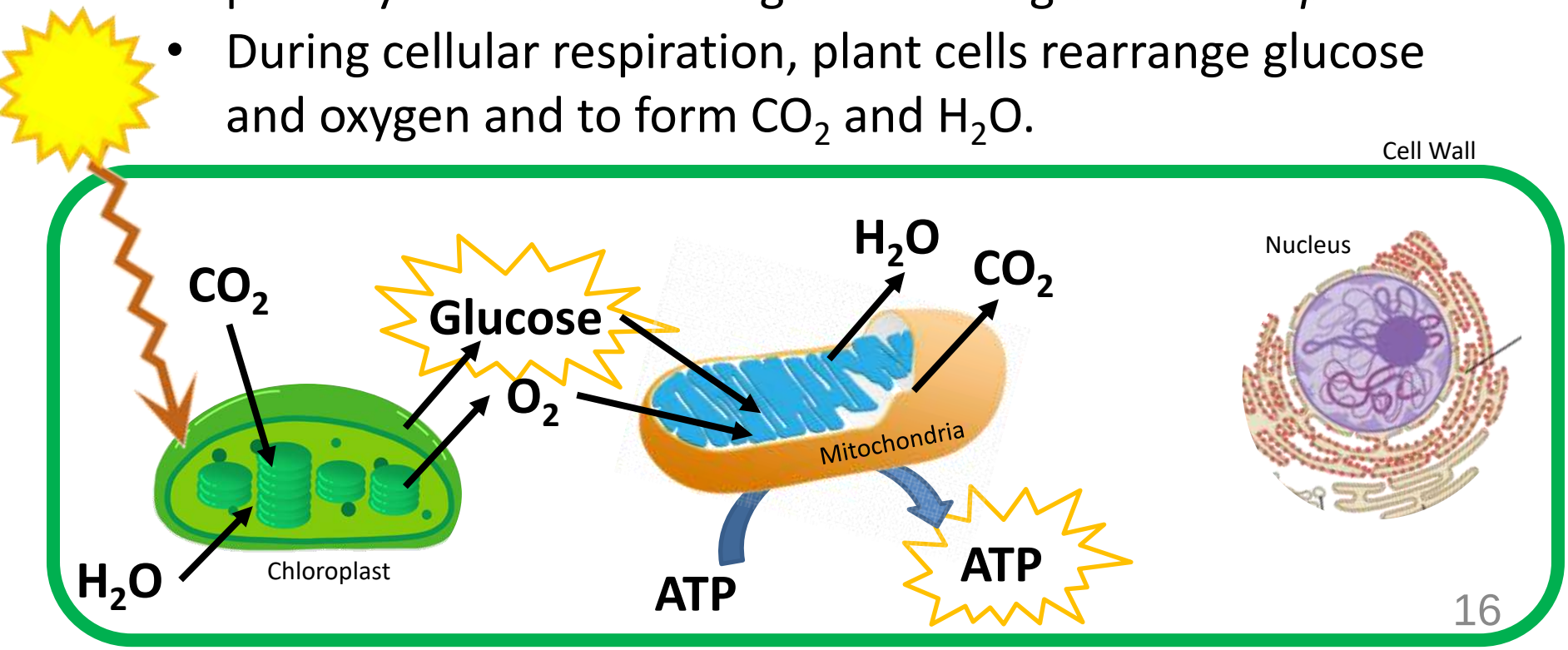
- **Photosynthesis is like “reverse combustion”.**
  - In *combustion*, oxygen (O_2) and molecules w/ C-C & C-H bonds are rearranged to produce CO_2 and H_2O.
    - Chemical energy transforms into light energy.
  - During *photosynthesis*, CO_2 and H_2O are rearranged into glucose and oxygen.
    - Light energy transforms into chemical energy.



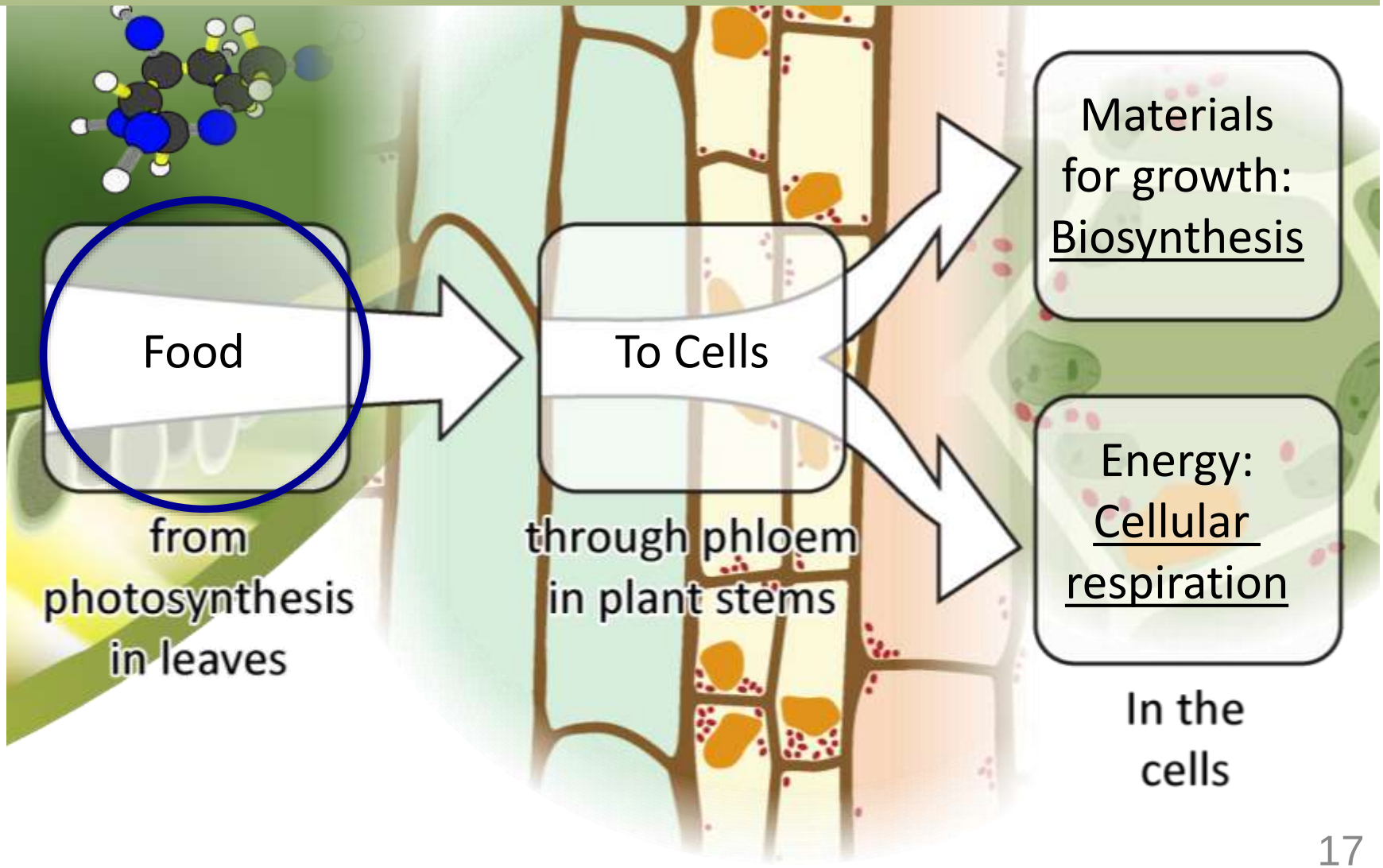


Photosynthesis -> Cell Respiration

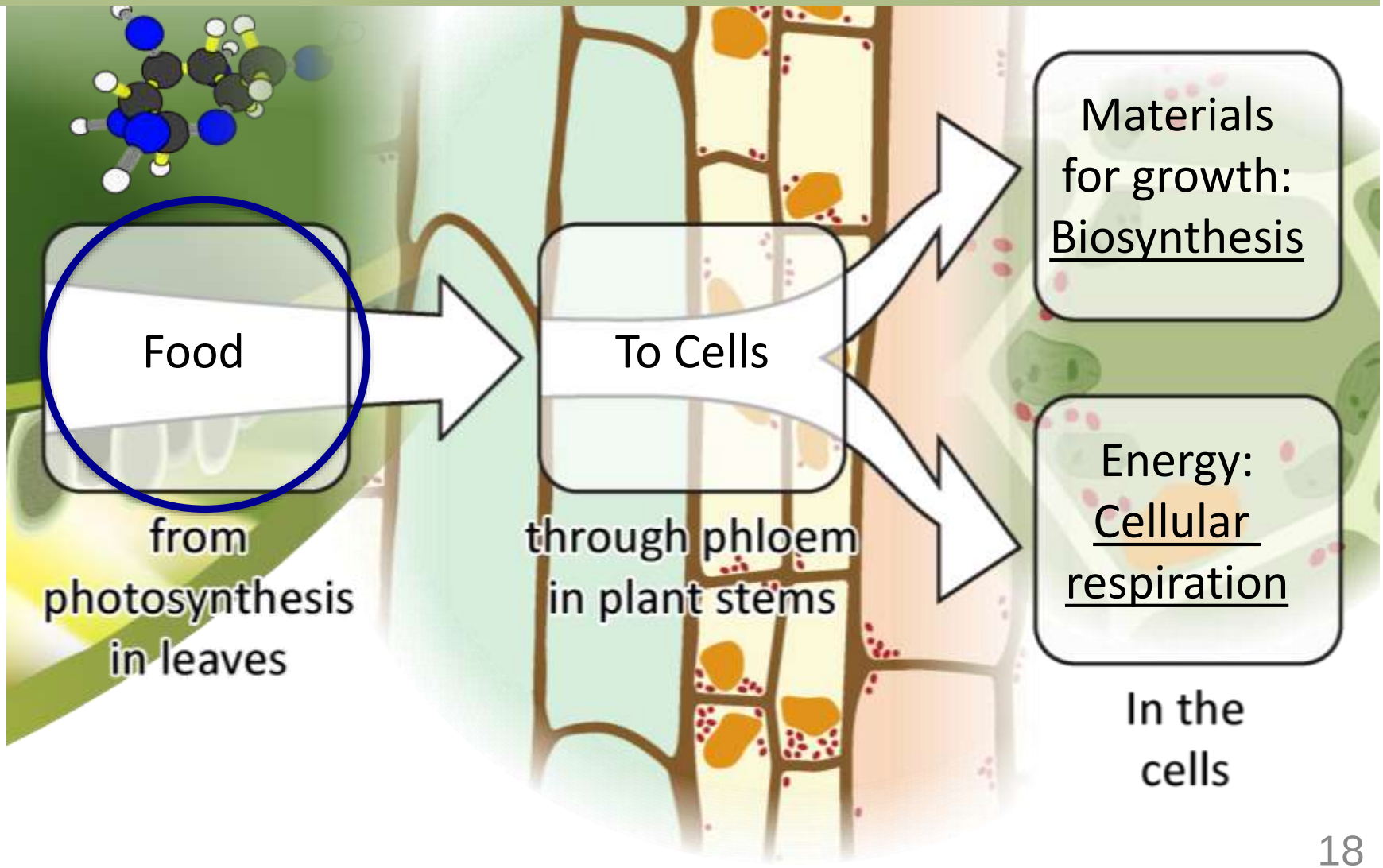
- **Photosynthesis is necessary to provide plant cells with a source of chemical energy.**
  - Plants use some of the glucose they produce during photosynthesis to recharge ATP during *cellular respiration*.
  - During cellular respiration, plant cells rearrange glucose and oxygen and to form CO_2 and H_2O.



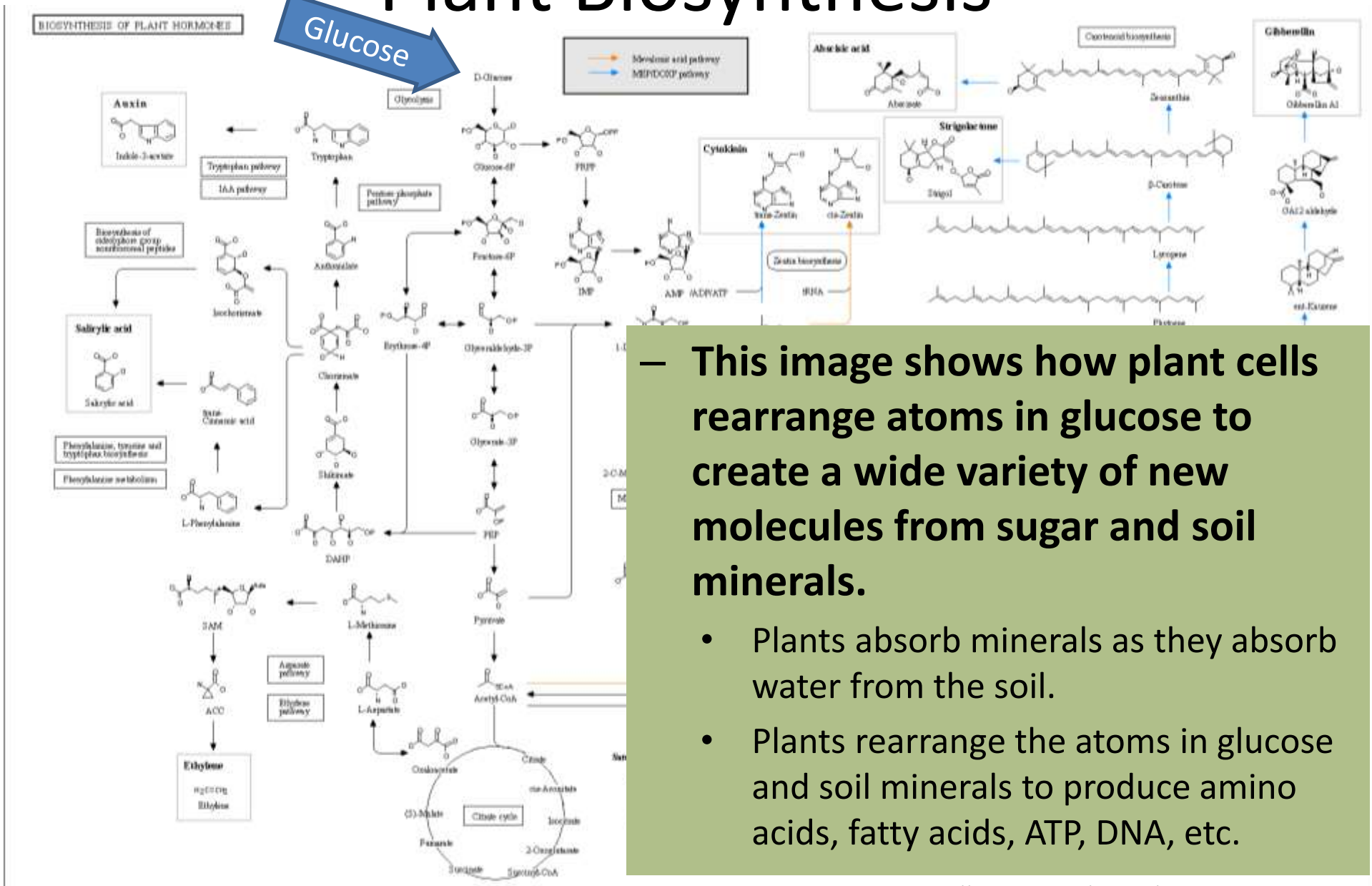
– **Photosynthesis is also necessary to provide plant cells with the atoms needed for biosynthesis.**
  - The glucose molecules that plants produce provide most of the atoms needed to produce all other plant molecules.



– **Glucose can be used in multiple forms of biosynthesis.**
  - Glucose can be assembled into long chains to form cellulose.
  - Atoms in glucose can be rearranged with minerals from the soil to form amino acids, fatty acids, etc.



Plant Biosynthesis

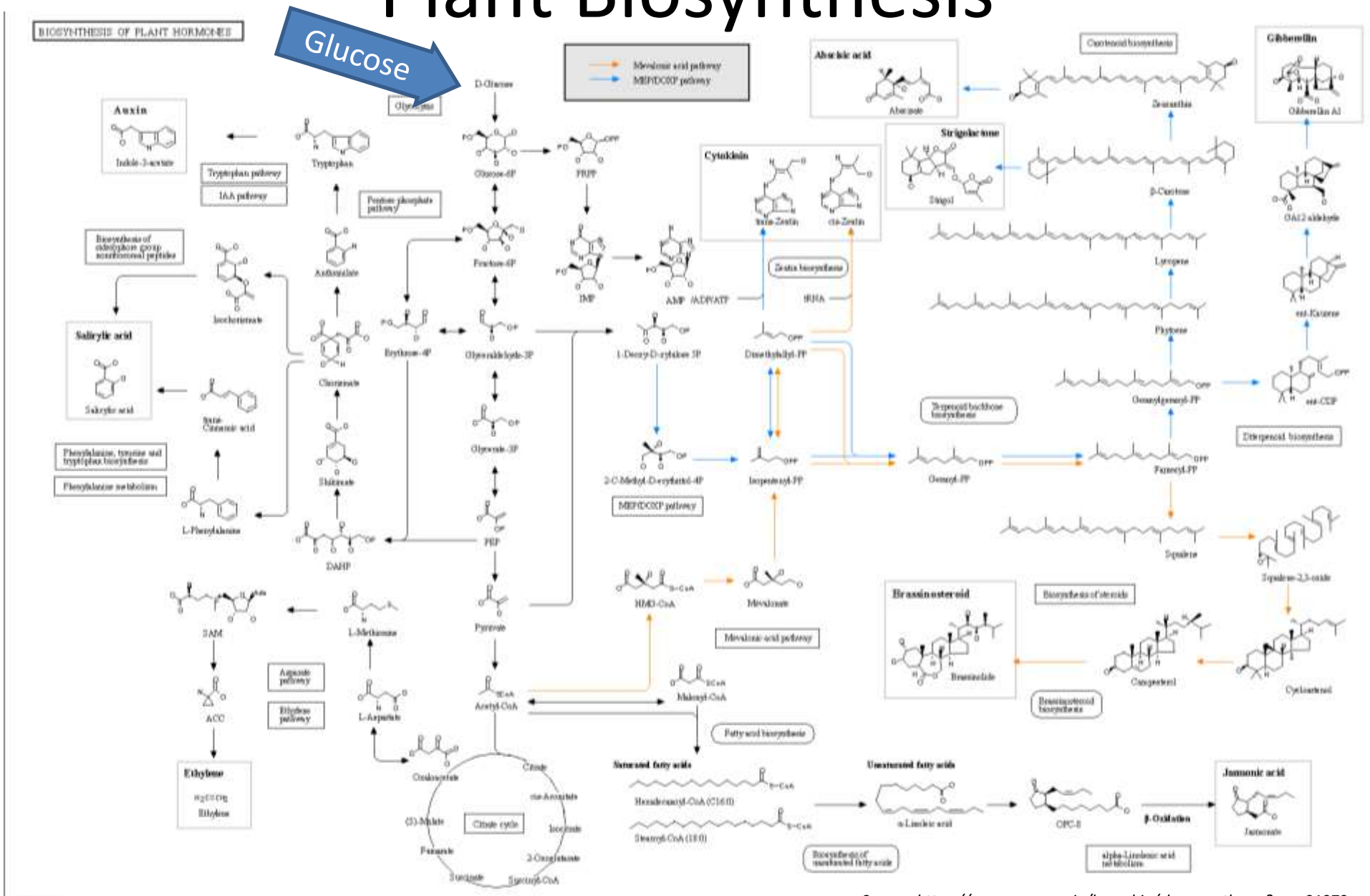


- **This image shows how plant cells rearrange atoms in glucose to create a wide variety of new molecules from sugar and soil minerals.**
  - Plants absorb minerals as they absorb water from the soil.
  - Plants rearrange the atoms in glucose and soil minerals to produce amino acids, fatty acids, ATP, DNA, etc.

Source: https://www.genome.jp/kegg-bin/show_pathway?map01070

This image only shows the biosynthesis of plant hormones. The full array of metabolic pathways in living organisms can be found at http://biochemicalpathwayswallchart.blogspot.com/2010/10/roche-biochemical-pathways-wall-chart.html

Plant Biosynthesis



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Revising Our Claims

- **Revisit this week's driving question: How do plants get their food?**
- What do plants eat?
- How do plant cells get their energy?
- How do plant cells gain mass (atoms)?
- Revise your explanation using the following terms: *photosynthesis, chloroplasts, glucose, cell respiration; mitochondria; biosynthesis; cell walls, cellulose, soil minerals.*
- What do you still need to know to answer this question? What is still uncertain or unknown?

Looking Ahead: Part 3 Investigation

- In Part 3, you will be conducting two investigations.
  - In 3A, you will compare changes in BTB between plants kept in the dark vs. light.
  - In 3B, you will model photosynthesis using Play-doh.