WUHS Biology: Plants Unit

Packet 2 – How do plants get their food and gain mass?

Plants Unit – Packet 2 Driving Question

- **Driving Question: How do plants get their food and gain mass?**
- How do plants acquire the carbs, fats, and proteins their cells need using enzymes?
- How do plants use soil minerals?
- How do enzymes work?

Recap of Packet 1

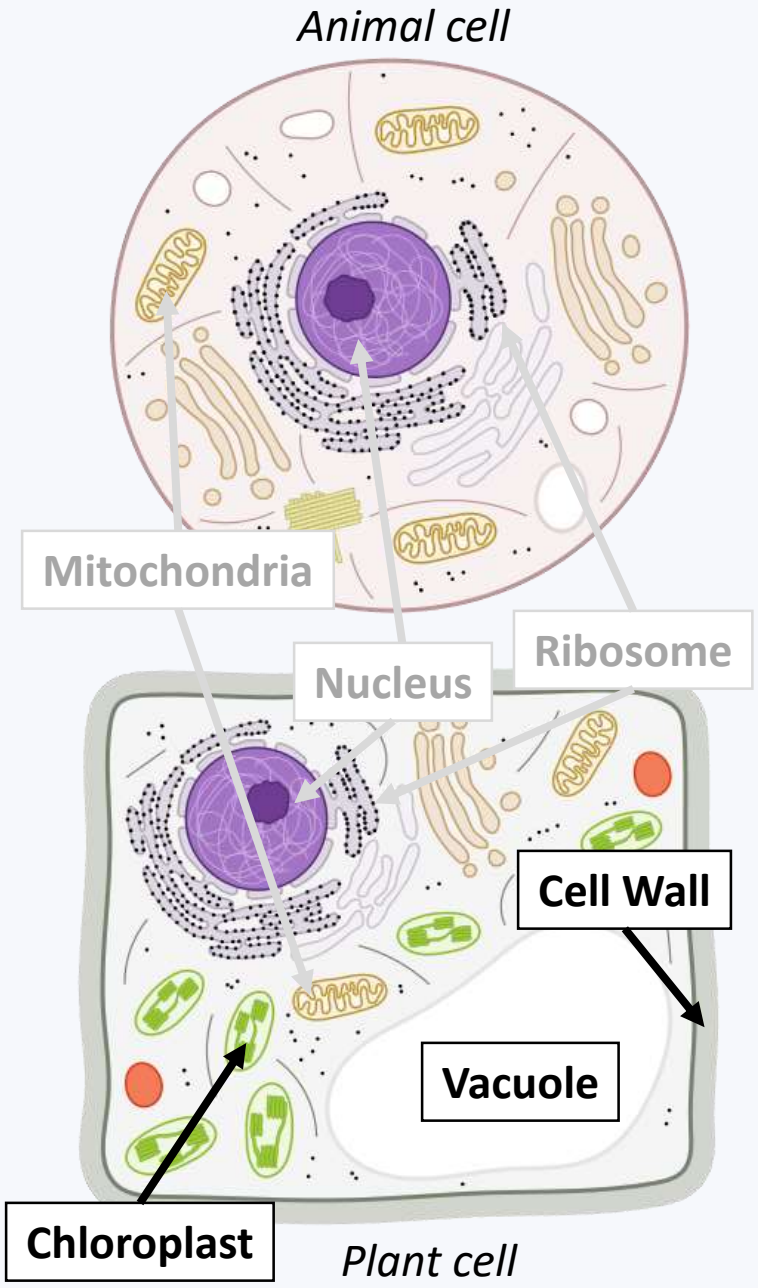
Plant and animal cells are composed of many of the same macromolecules and organelles.

Plant cells have three key organelles not found in animal cells (cell walls, vacuoles, and chloroplasts).

The cell wall is a tough shell made from cellulose (long chains of glucose). It acts like a plant's skeleton.

The vacuoles of plant cells are storage organelles. Plants store water and keep waste products in their vacuoles.

The chloroplast is the organelle that produces glucose molecules. The chloroplast uses light energy (like sunlight) to produce glucose and oxygen from CO_2 and H_2O in a process known as photosynthesis.



Plant cells have 3 key organelles not found in animal cells.

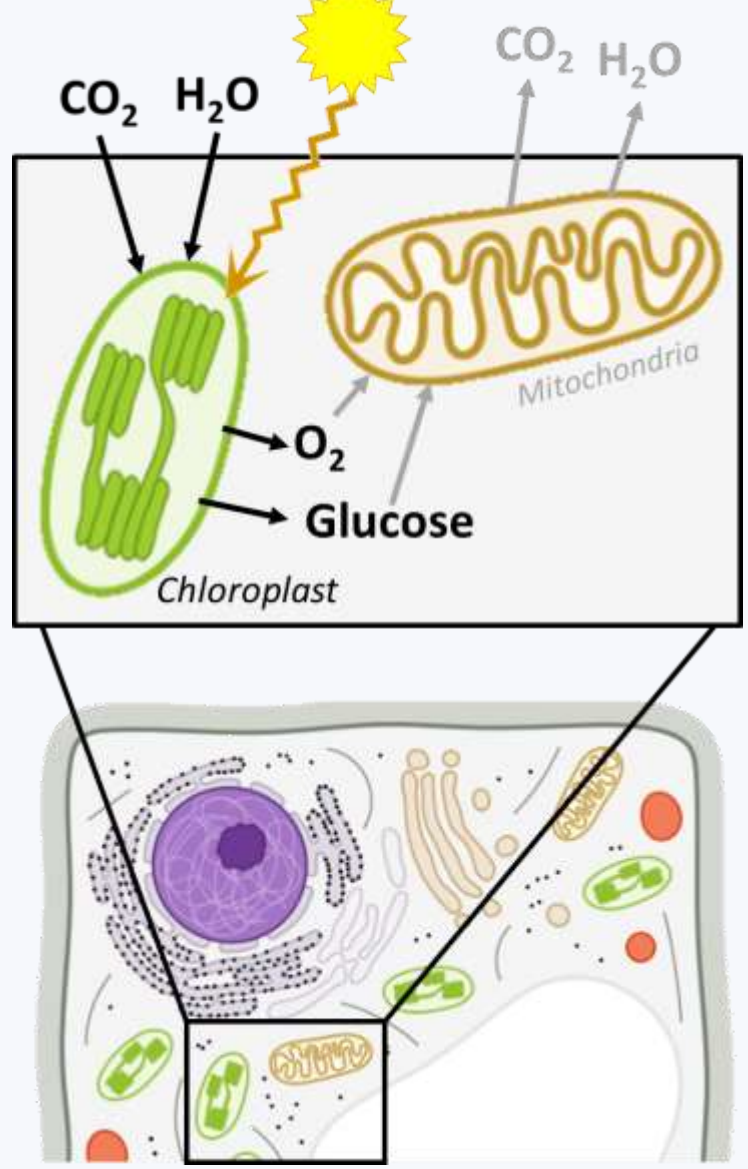
Recap of Packet 1

Most of the glucose and oxygen produced in the chloroplast are moved to the mitochondria for cellular respiration to recharge ATP.

Some glucose from photosynthesis is used to assemble cellulose, which makes up most of the mass of a plant.

Xylem consists of long tubes of cells that use evaporation to move water and minerals upward from the roots to its leaves.

Phloem forms long tubes of cells that use gravity to move molecules like glucose down from the leaves to other cells for respiration and biosynthesis.



During photosynthesis, CO_2 and H_2O are rearranged to form glucose and oxygen. Most glucose is used for cell respiration. Some forms cellulose.

Image Source

Acquiring Macromolecules

- **All cells, including plant cells, need carbohydrates, fats, and proteins to function.**
  - Animals acquire these macromolecules by consuming other organisms.
  - However, most plants cannot consume other organisms and must produce their own macromolecules.
- **Plant cells assemble glucose (and oxygen) using atoms from carbon dioxide and water.**
  - Most of this glucose is used for cellular respiration.
  - Some is used to create cellulose to form the plant cell walls.
  - The atoms in glucose can also be used to make the fatty acids and amino acids needed by plant cells.

Enzymes

- **Plant cells produce all the molecules their cells need using the atoms in glucose and soil minerals.**
  - All carbohydrates, fats, and proteins are formed from the atoms in glucose and soil minerals (*if needed*).
- **For example, plant cells can rearrange the atoms in glucose to form fatty acids.**
  - These fatty acids combine with phosphorus atoms in the soil to form plant cell membranes.
- **Plant cells can also rearrange the atoms in glucose with nitrogen from the soil to form the amino acids.**
  - These amino acids are assembled into proteins that enable the cell to function.

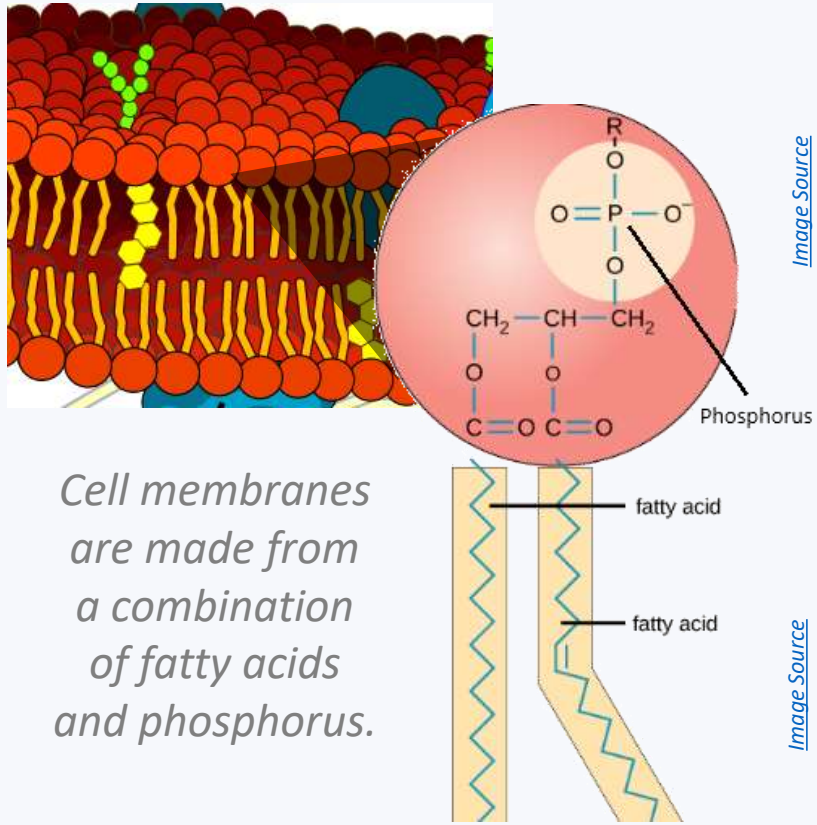
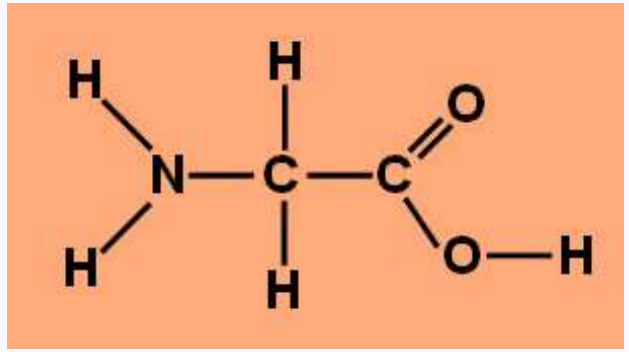


Image Source

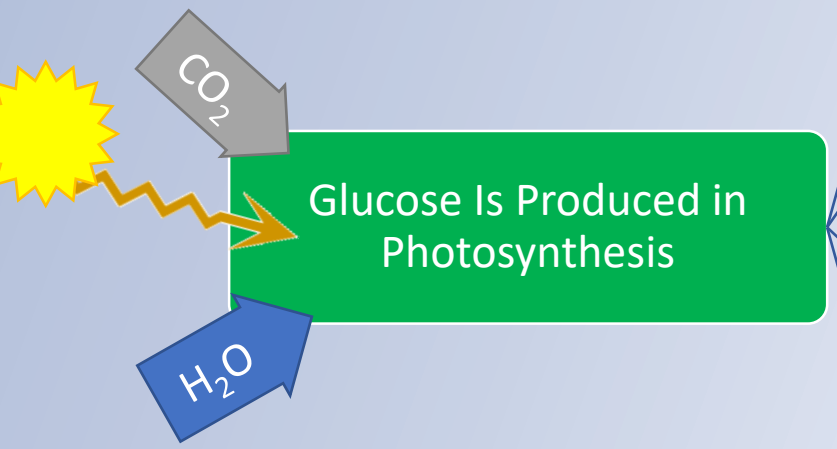
Cell membranes are made from a combination of fatty acids and phosphorus.

Image Source



Amino acids are made using atoms from glucose and nitrogen from soil.

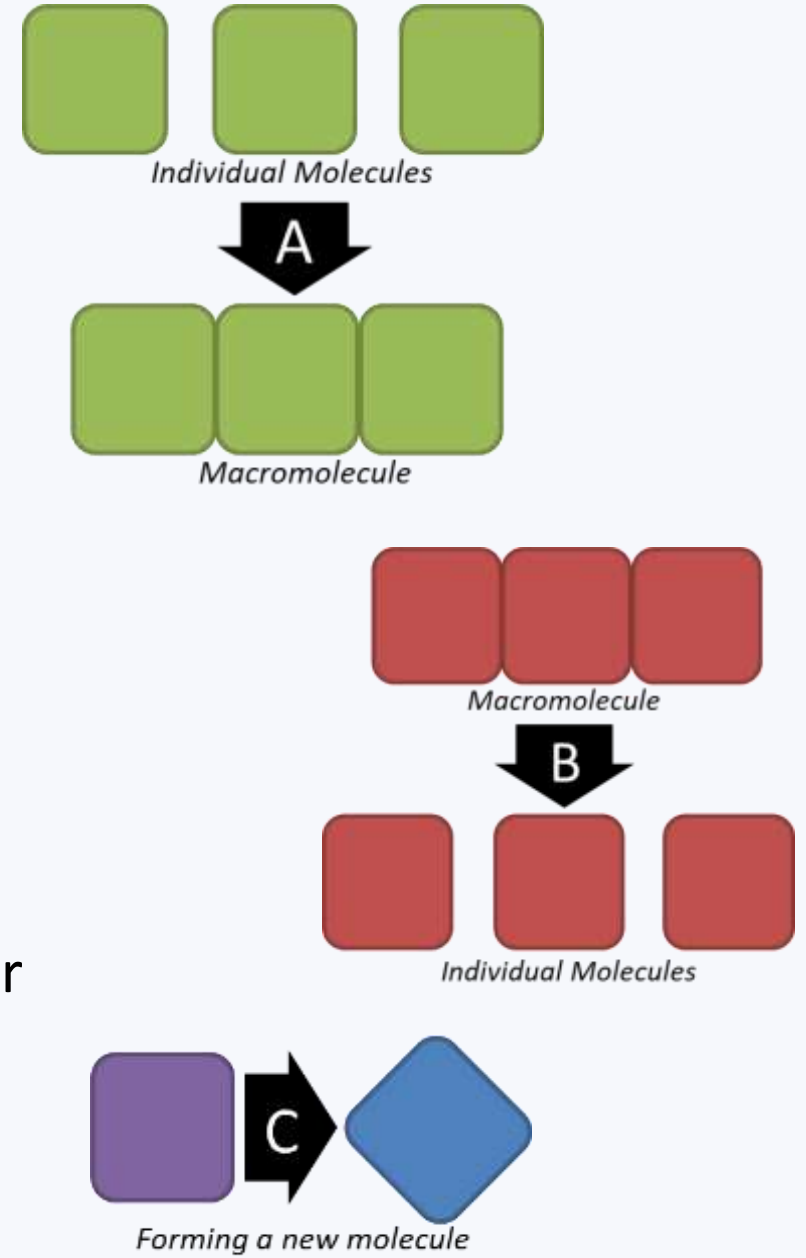
Tracing Changes to Glucose in Plant Cells



- Used for Cell Respiration
  - Rearranged back into CO_2 and H_2O.
- Assembled into Carbohydrates like Starch & Cellulose
  - Starch Provides Long Term Energy Storage
  - Cellulose Forms Cell Walls (*most of plant's mass*)
- Rearranged into Fatty Acids
  - Fatty Acids are Assembled into Fats
  - Soil Phosphorus → Fatty Acids Combine with Phosphorus to Form Membranes
- Soil Nitrogen → Combined with Nitrogen to Form Amino Acids
  - Amino Acids are Assembled into Proteins

Enzymes

- **Enzymes are what enable plant cells to change glucose molecules into other molecules.**
  - Enzymes are proteins that assemble, disassemble, or rearrange molecules to form new molecules.
  - Enzymes reduce the time and energy required for chemical reactions to occur in living organisms.
- **Enzymes can change other molecules over and over without being altered or destroyed.**
  - Enzymes move atoms to where they need to be in order for a new molecule to be formed.
  - However, the molecular structure of the enzyme itself will stay the same before and after a reaction.

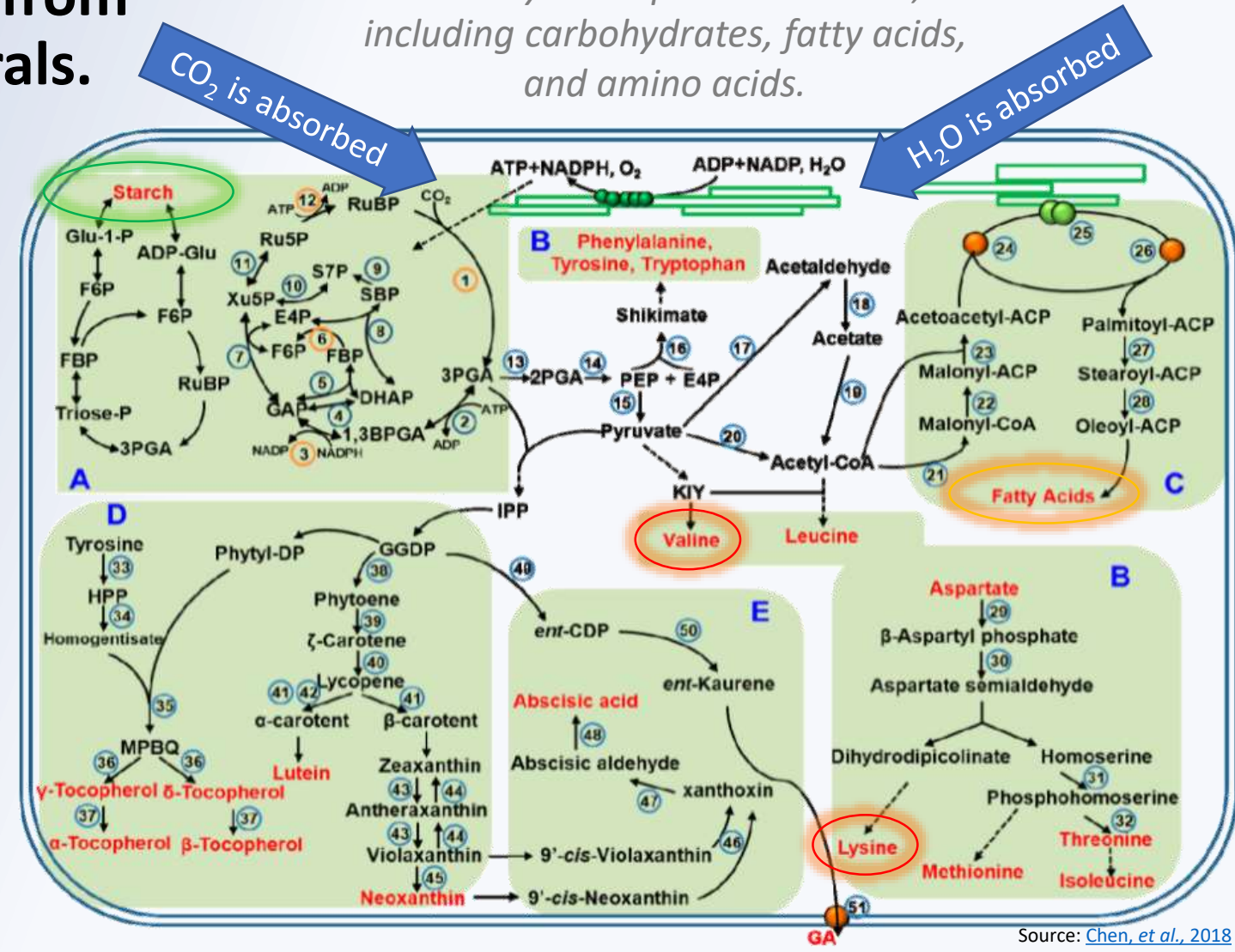


Enzymes are proteins that a) assemble, b) disassemble, or c) rearrange molecules.

Enzyme Reactions

- **All plant molecules are formed from atoms in glucose and soil minerals.**
  - This image shows many of the enzymatic reactions in cells that create macromolecules needed by the cell.
  - These include fatty acids (*upper right*), carbohydrates like starch (*upper left*), and amino acids such as valine and lysine (*shown in red*).
  - Most of these reactions need multiple enzymes and have multiple steps.

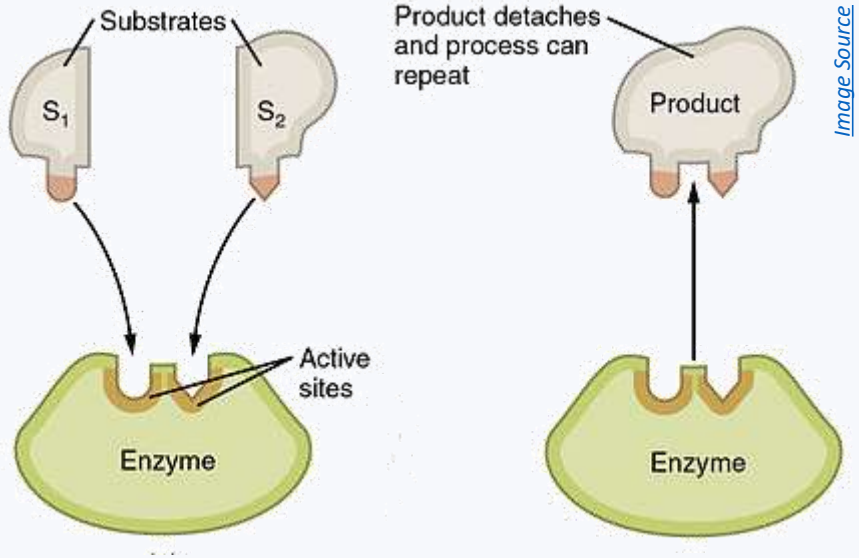
This shows the pathway from glucose to many other plant molecules, including carbohydrates, fatty acids, and amino acids.



Source: Chen, *et al.*, 2018

Enzymes

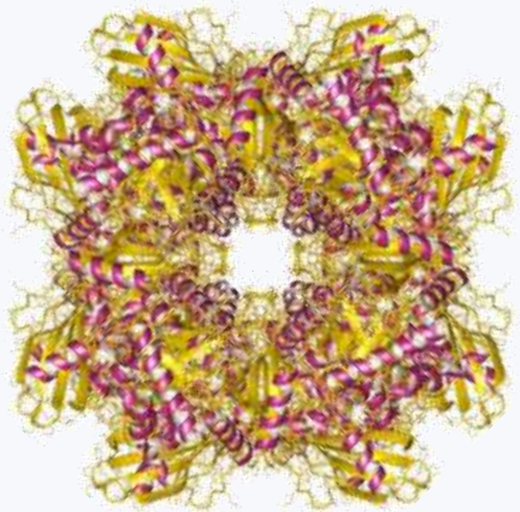
- **There are many different types of enzymes in plant cells.**
  - Cells contain thousands of different kinds of enzymes.



Each enzyme enables a specific reaction.

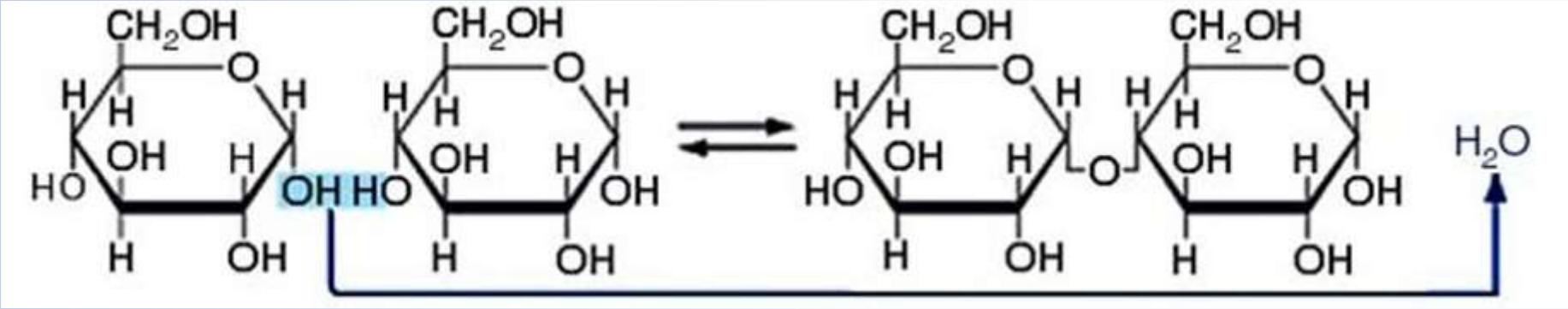
Image Source

- **Each enzyme is specific to a particular kind of reaction involving individual types of molecules.**
  - For example, *rubisco* is the enzyme that rearranges the atoms in CO_2 and H_2O to form glucose and oxygen.
  - Thousands of other enzymes are involved with thousands of other different reactions within each cell.



Rubisco is an enzyme that assembles glucose by taking carbon atoms from CO_2.

Image Source

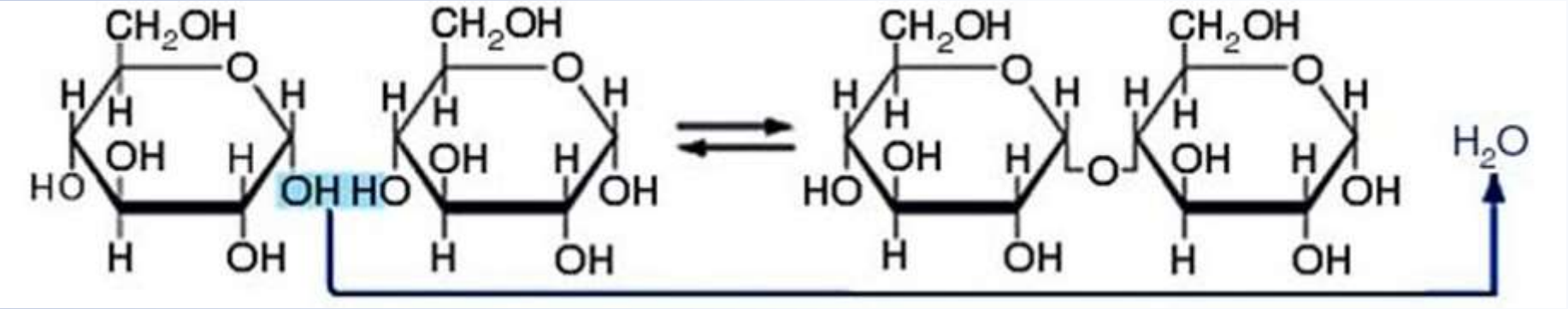


How Enzymes Work

The mechanisms of different enzymes

Assembling Macromolecules

- **Some enzymes assemble individual molecules into macromolecules.**
  - Enzymes do this by removing oxygen & hydrogen atoms from each molecule.
  - This causes the individual molecules to attach to each other, forming the macromolecule.
- **For example, the enzyme *starch synthase* assembles individual glucose molecules into carbohydrate macromolecules.**
  - These carbohydrate macromolecules can be used for long-term energy storage.
  - A similar enzyme called *cellulose synthase* works in the same way to assemble glucose to form the cellulose found in plant cell walls.



Starch synthase removes oxygen & hydrogen atoms from glucose. This causes glucose molecules to attach, forming a carbohydrate.

Image Source

Disassembling Macromolecules

- **Some enzymes are used to disassemble macromolecules.**
  - To do this, enzymes insert water between the molecules in macromolecules.
  - This causes the molecules to separate, disassembling the macromolecule.

- **For example, the enzyme *amylase* inserts water to disassemble carbohydrates into individual glucose molecules.**
  - This glucose can then be used for cell respiration in the plant cell's mitochondria.
  - This glucose can also be rearranged into other molecules needed in the plant cell.

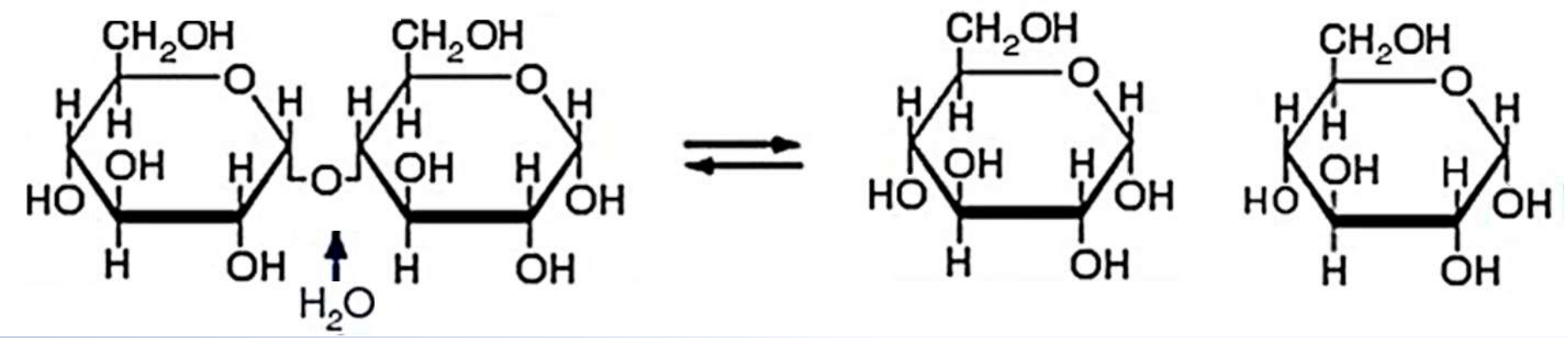


Image Source

Amylase disassembles carbohydrates by inserting water molecules between each glucose molecule. This causes each glucose to separate from each other.

Species Interactions

How enzymes allow species to interact

Image Source

Enzymes & Species Interactions

- **Enzymes enable different species to interact with each other.**
  - For example, when animals consume plants, they must use their digestive enzymes to disassemble plant macromolecules (carbs, fats, and proteins).
  - Animal cells then use other enzymes to perform cellular respiration and biosynthesis.
- **Without enzymes, cells would be unable to produce the molecules they need from other molecules in their environment.**
  - Plants and animals depend on enzymes to create the molecules their cells are made from using the atoms they can acquire from their surroundings.

Source: Public Domain Pics

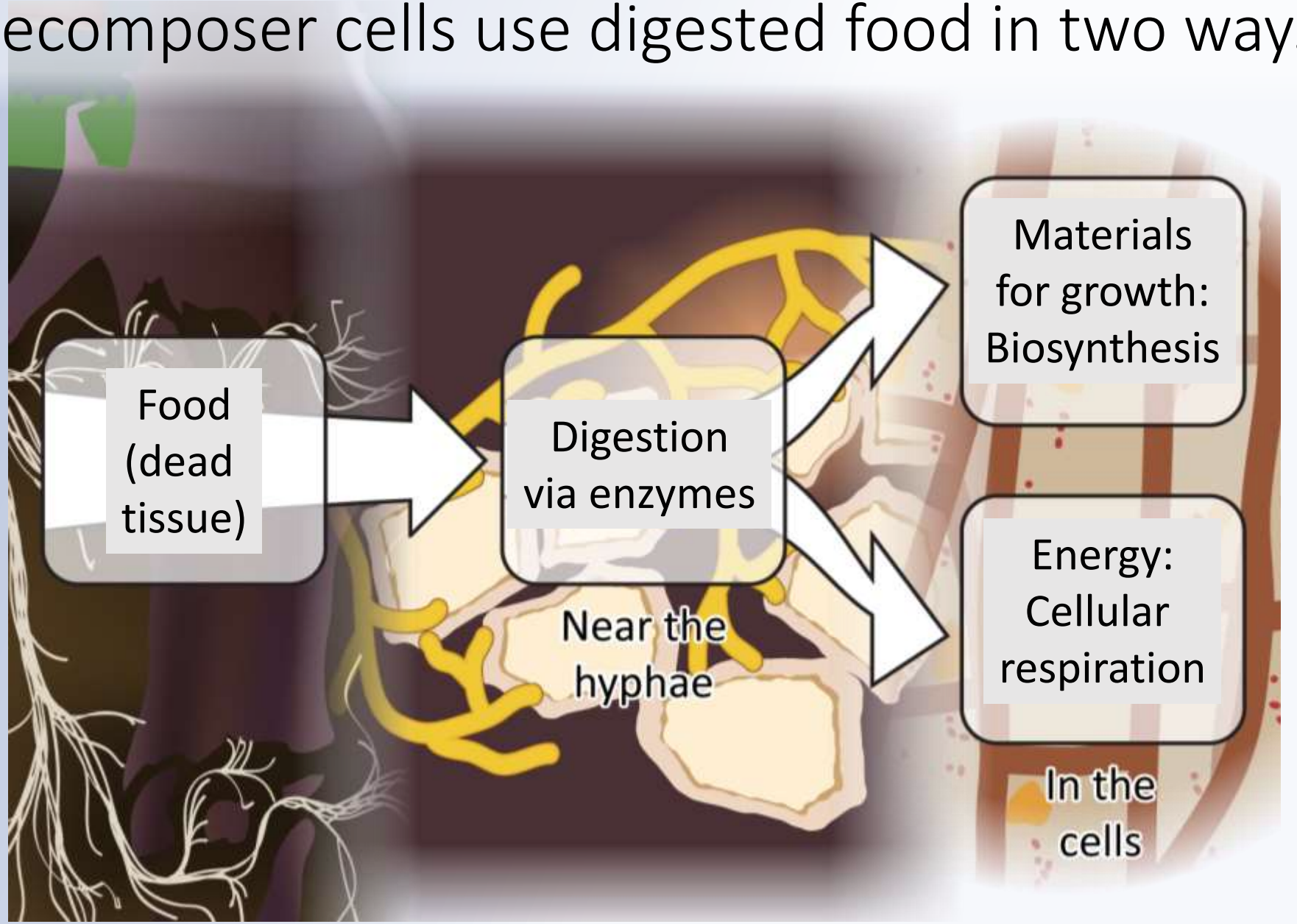
Decomposers

- **When plants & animals die, their cells are broken down by decomposers.**
  - Decomposers (like fungi & bacteria) are organisms that break down dead tissues.
- **Decomposers use enzymes to disassemble the macromolecules in the cells of dead organisms.**
  - Decomposer cells then use other enzymes for cellular respiration and biosynthesis.
- **Decomposers are necessary for species to continue interacting.**
  - Decomposers convert most of the mass of dead organisms back into the CO_2 and H_2O needed for photosynthesis in plants.

Source: Pixfuel

Decomposers secrete enzymes that enable them to break down macromolecules within the cells of dead tissue. Decomposers then use glucose, amino acids, and fatty acids within their own cells.

Decomposer cells use digested food in two ways

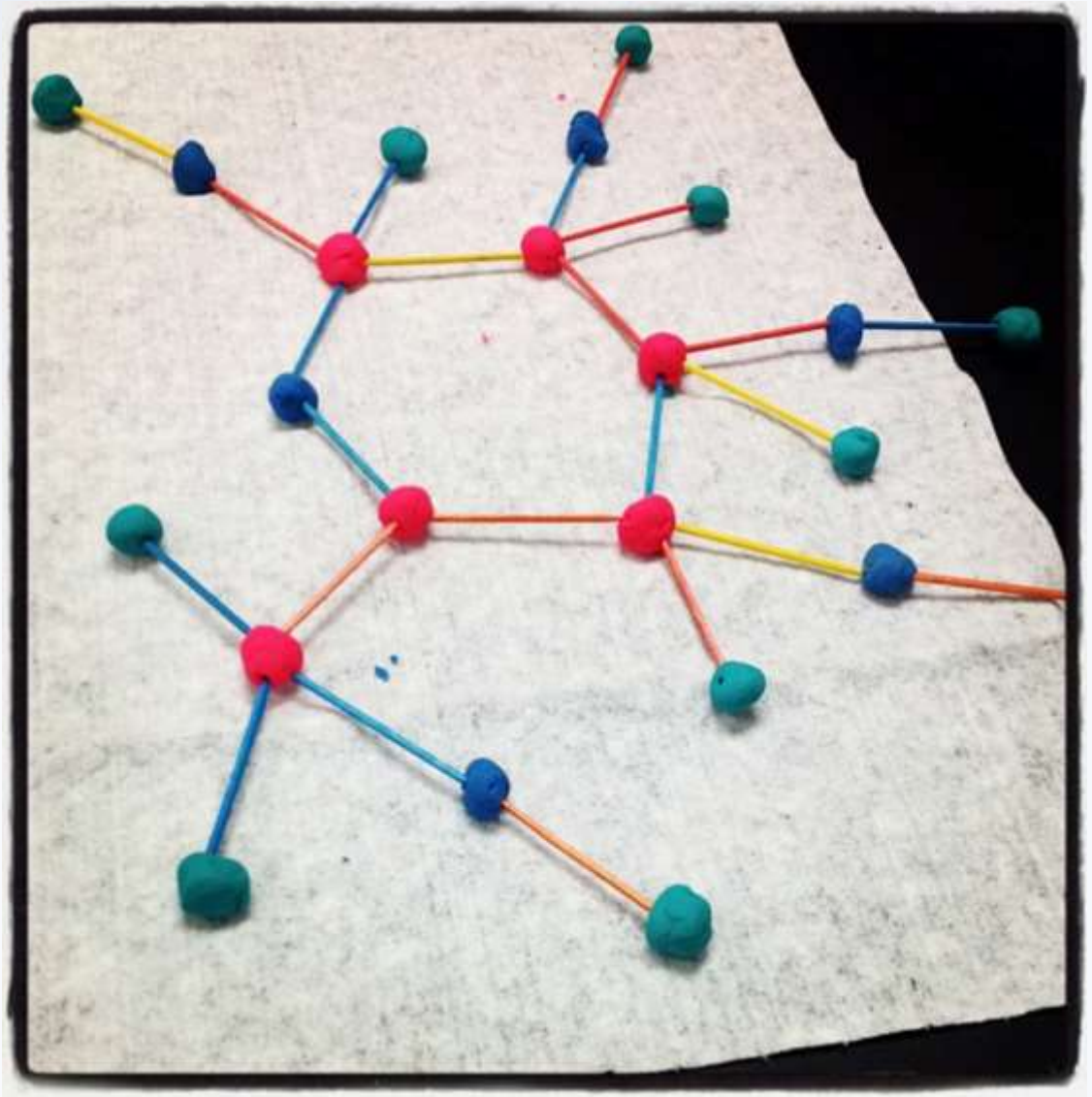


Revising Our Claims

- **Revisit your ideas from Part 1.**
  - How could you improve your responses to our Driving Questions?
- **Driving Question: How do plants get their food and gain mass?**
- How do plants acquire the carbs, fats, and proteins their cells need using enzymes?
- How do plants use soil minerals?
- How do enzymes work?

Looking Ahead: Part 3 Investigation

- **In Part 3, you will use molecular models to explain how glucose is created during photosynthesis.**
- **You will also use these models to explain how glucose can be changed by enzymes into other molecules the plant needs.**



Key Points

- **All cells need carbohydrates, fats, and proteins to function. Most plants cannot consume other organisms and must produce their own macromolecules.**
  - All carbohydrates, fats, and proteins in plant cells are formed from the atoms in glucose and soil minerals.
- **Enzymes are what enable plant cells to take atoms from glucose molecules and soil minerals to form other molecules.**
  - Enzymes reduce the time and energy required for chemical reactions to occur in living organisms.
  - Enzymes can change other molecules over and over without being altered or destroyed.

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Key Points

- **Some enzymes assemble individual molecules into macromolecules by removing oxygen & hydrogen atoms from each molecule.**
  - This causes the individual molecules to attach to each other, forming the macromolecule.
- **Some enzymes are used to disassemble macromolecules by inserting water molecules into macromolecules.**
  - This causes molecules to separate, disassembling the macromolecule.
- **Enzymes enable different species to interact with each other.**
  - Without enzymes, cells would be unable to produce the molecules they need from other molecules in their environment.
- **When plants & animals die, their cells are broken down by decomposers such as bacteria and fungi.**
  - Decomposers use enzymes to disassemble the macromolecules in the cells of dead organisms for use in cell respiration and biosynthesis.

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Key Vocab

- **<u>Enzymes</u> are proteins that assemble, disassemble, or rearrange molecules to form new molecules.**
- **<u>Decomposers</u> (like fungi & bacteria) are organisms that break down dead tissues.**

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