Lecture 16

BT 203

Biochemistry

3-0-0-6

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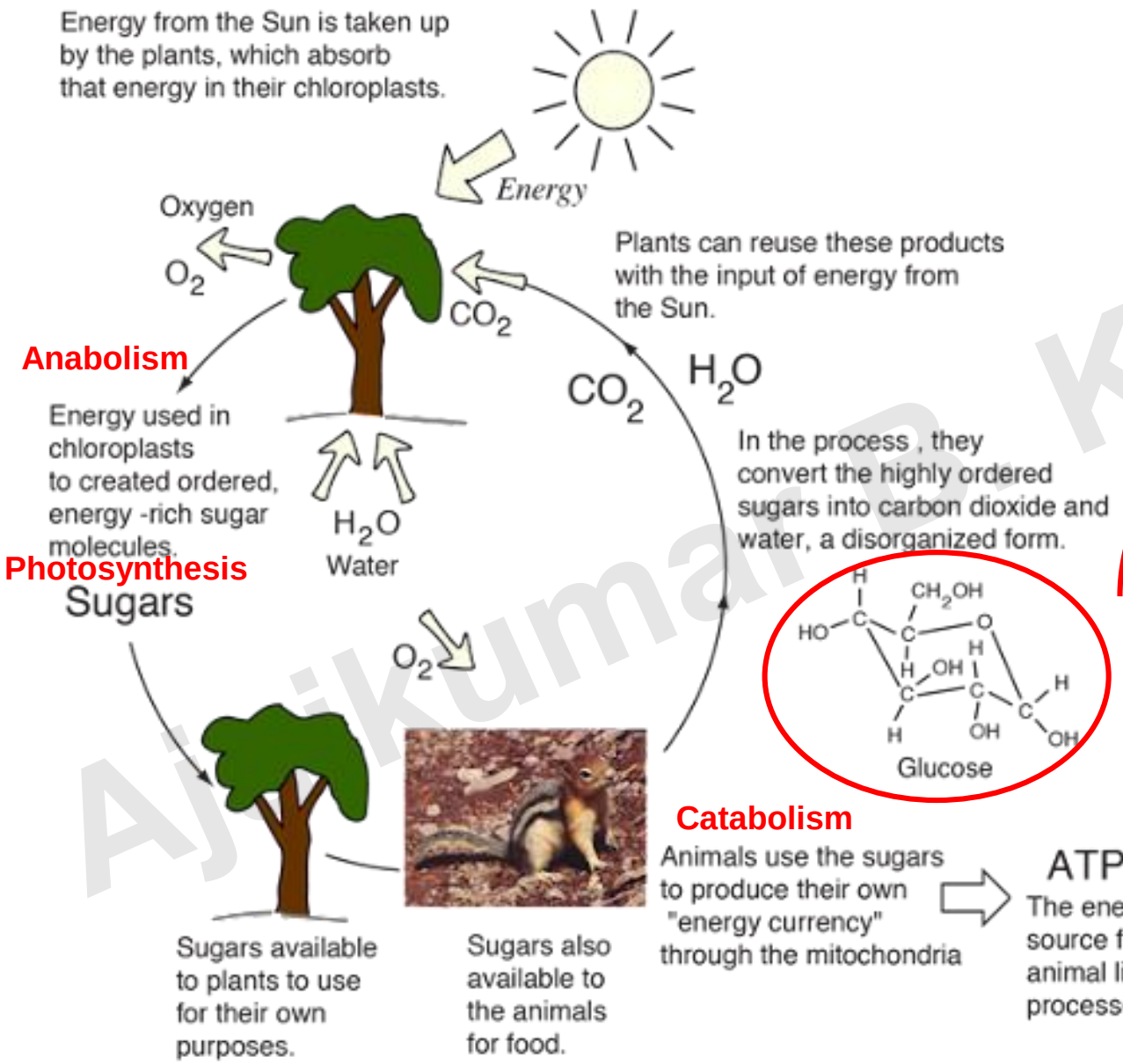
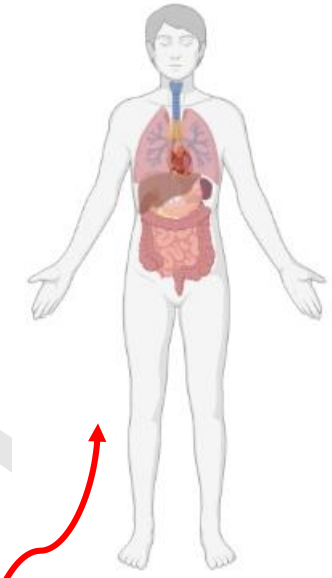
Important questions:

- How does the energy from sunlight we use for our day to day life?
- What are the major types of biomolecules that build up our cells, tissues, organs and body?
- What are the different levels of organization in our body?
- What are the different types of cells and tissues of our body?
- What are the different organ systems of our body?
- Why we call living organisms as highly complex machines?

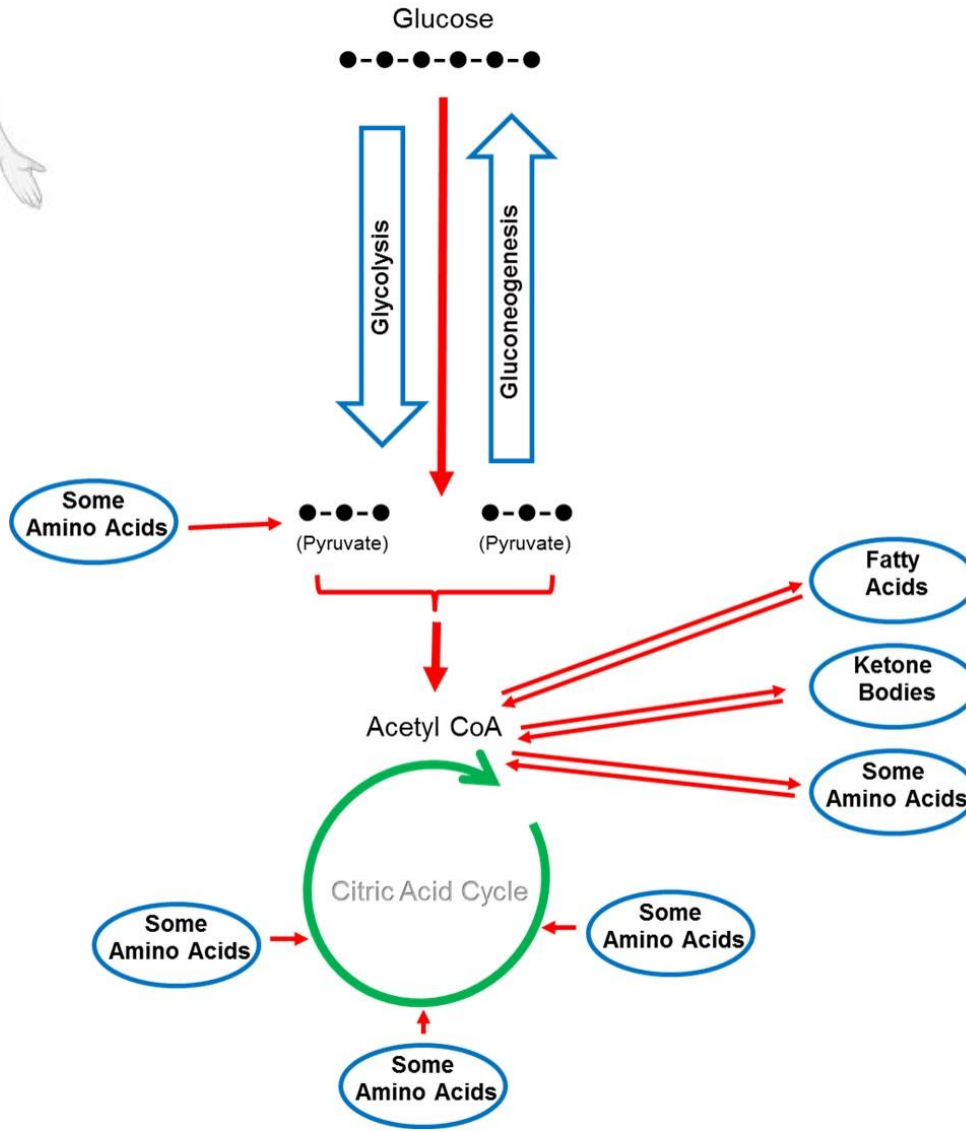
Energy Cycle





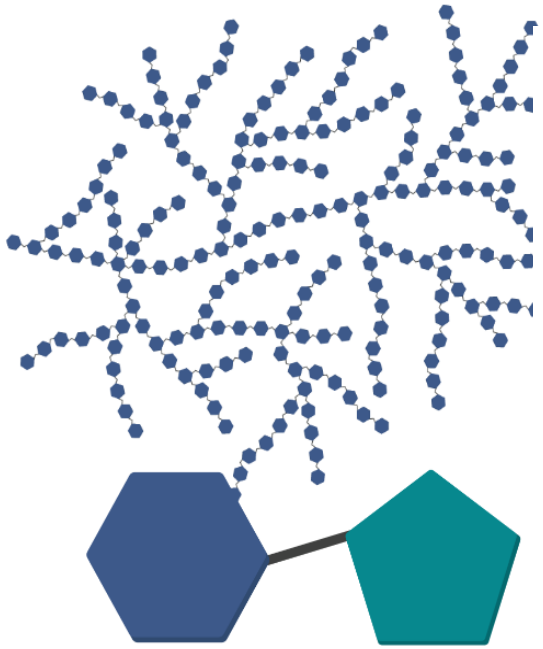
Glucose digested to produce other biomolecules

Glucose is the primary molecule of life

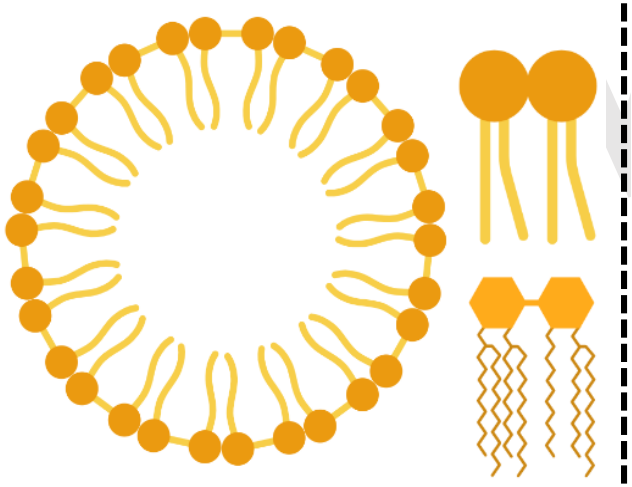


Building Blocks of Life

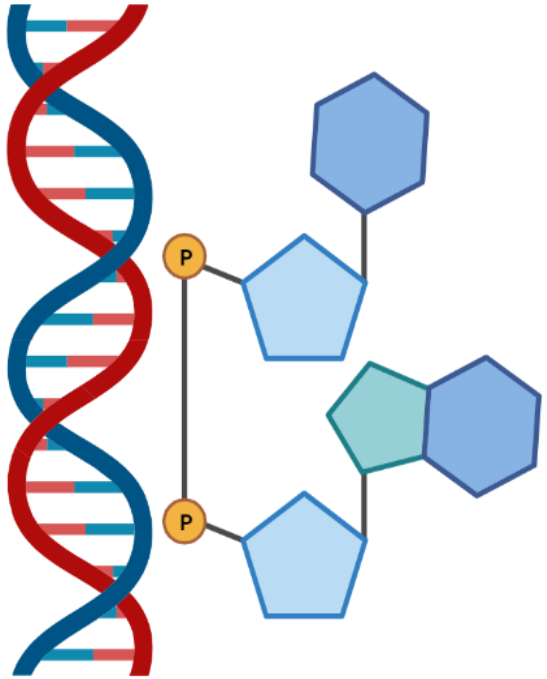
Carbohydrates



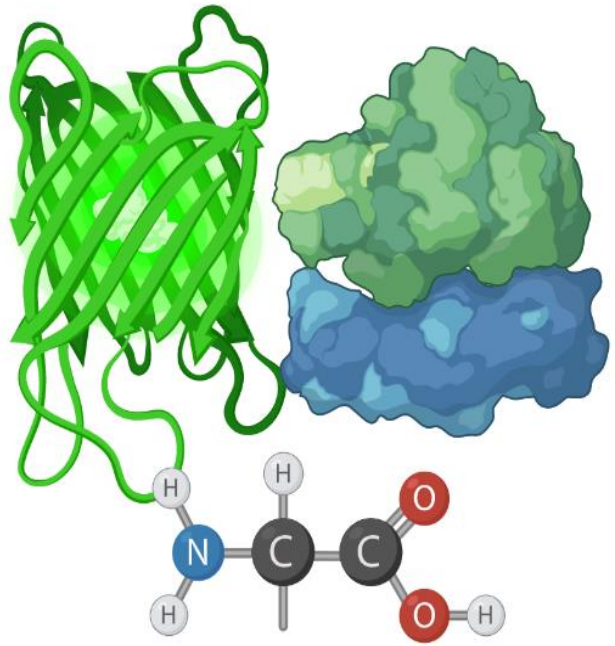
Lipids



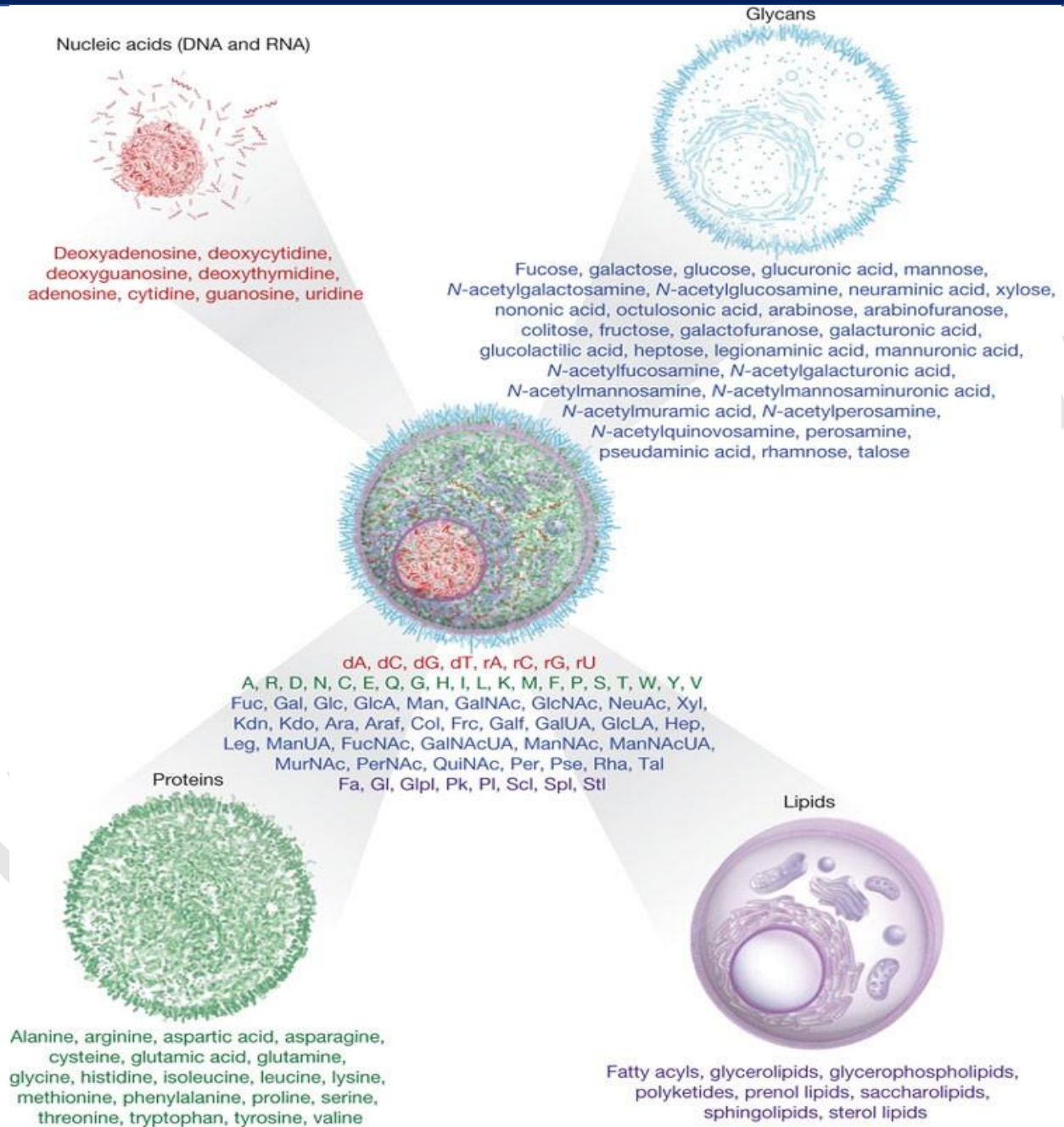
Nucleic Acids



Proteins



Building Blocks of Life

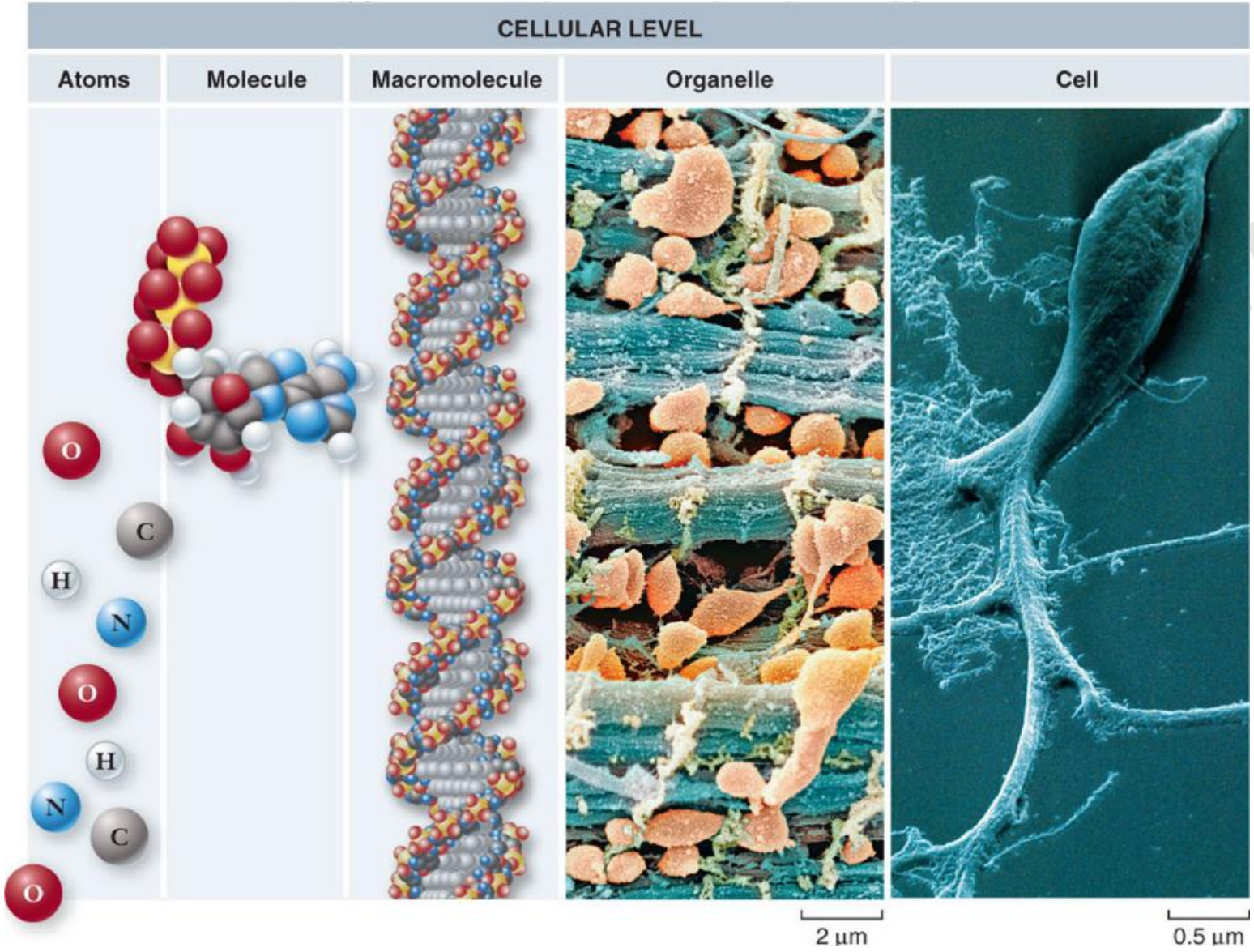


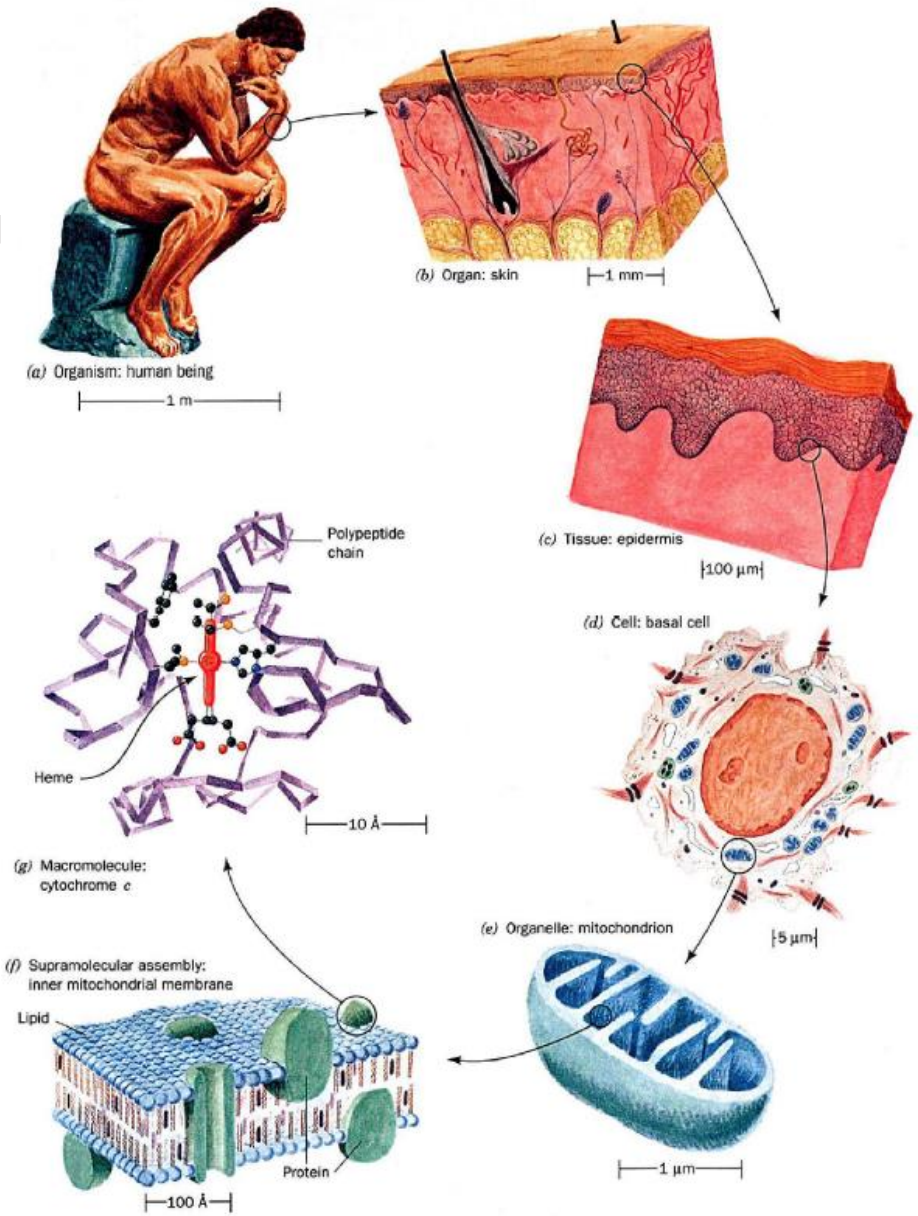
68 molecules formed from the fundamental four bio-molecules that form cells

- 20 natural amino acids used in the synthesis of proteins
- 32 carbohydrate molecules are the precursor of the major glycans present
- 8 major lipid families contributing to all the lipids present in the cells
- 8 nucleic acids in building the genetic code of life- DNA, RNA

Source: Marth, J. A unified vision of the building blocks of life. *Nat Cell Biol* **10,** 1015 (2008). https://doi.org/10.1038/ncb0908-1015

Levels of Organization

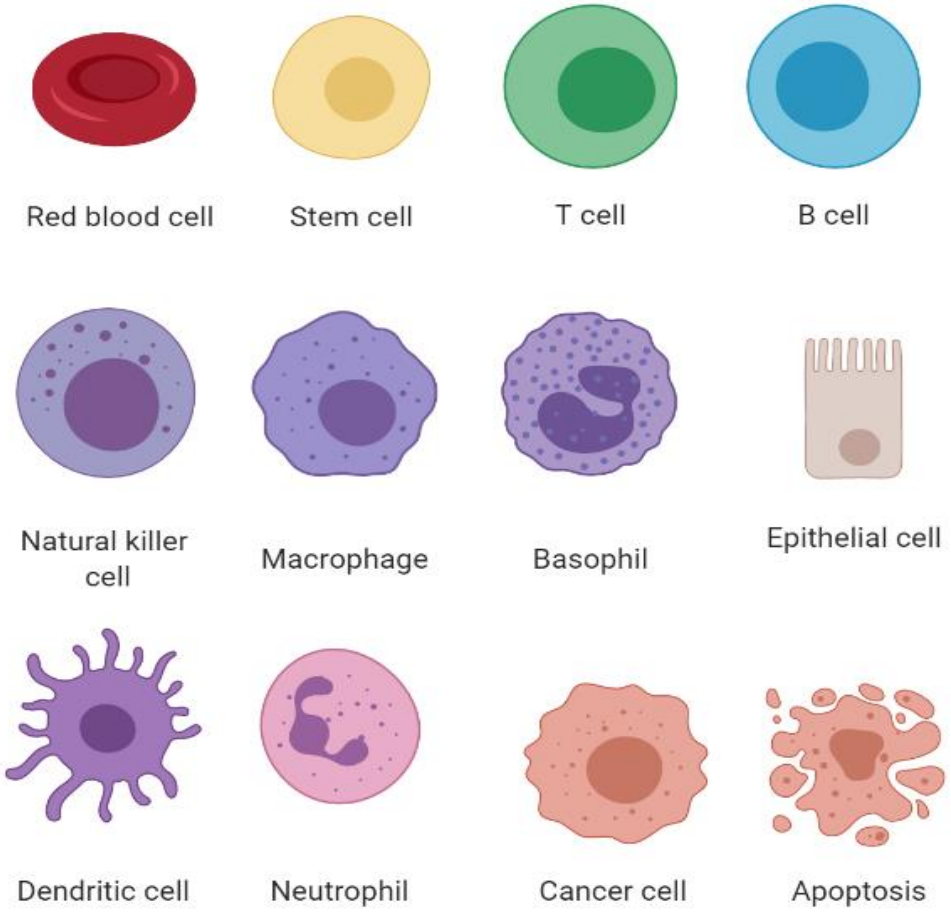




Different Cells and Tissues of Our Body

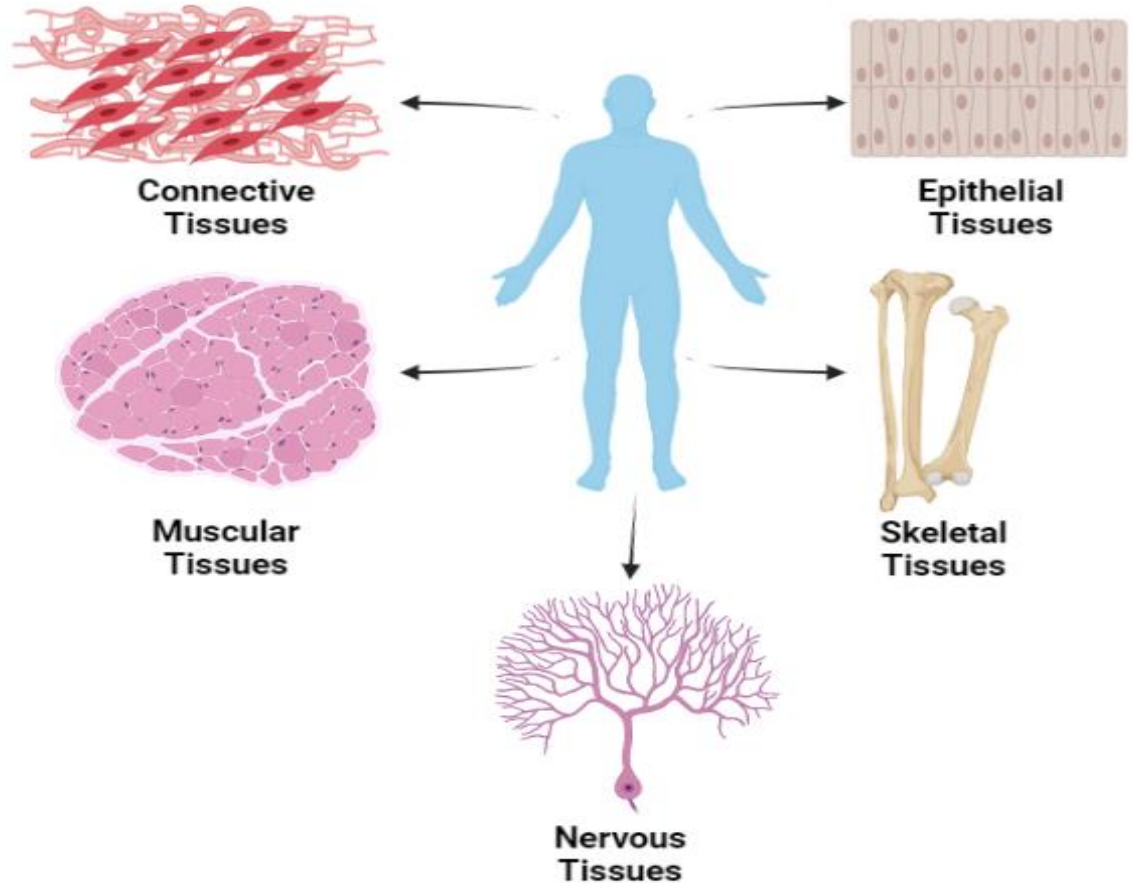
Types Cells

- 37.3 trillion cells
- 200 different cell types



Tissues

- Connective , epithelial, Muscle and Nervous tissues
- Gluteus Maximus-largest muscle
- Masseter-Strongest muscle



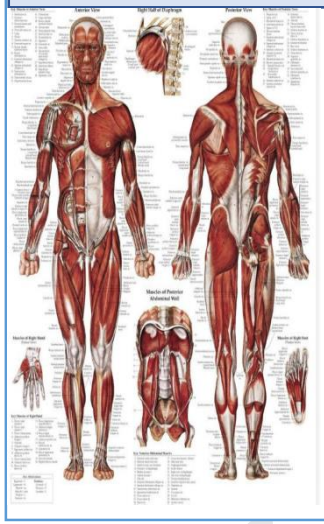
Organ System

Skeletal System

Consists of
- 206 bones
- Cartilage
- Ligaments

Main Functions
- Provide Structure
- Protects Internal Organs

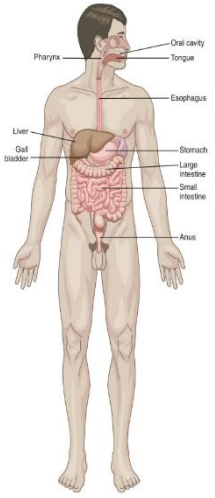
Muscular System



Consists of
- 600 muscles

Main Functions
- Supports the body
- Allows movement

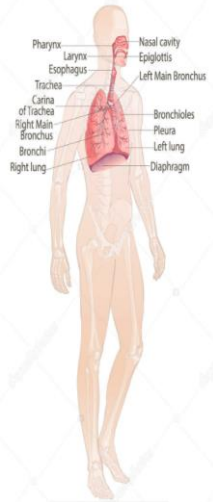
Digestive System



Consists of
- Oral cavity
- Esophagus
- Stomach
- Intestine
- Rectum

Main Functions
- Digestion
- Absorption
- Secretion

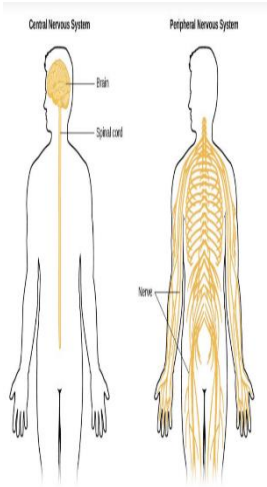
Respiratory System



Consists of
- Nose
- Trachea
- Lungs

Main Functions
- Gas exchange
- Acid-base balance
- Defense and metabolism
- phonation

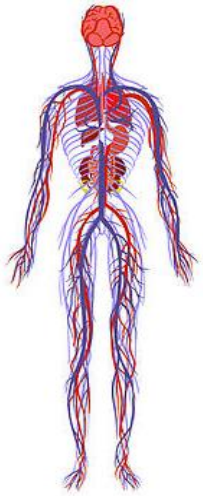
Nervous System



Consists of
- Brain
- Spinal cord
- 7 trillion nerves

Main Functions
- Sensation
- Integration
- Response

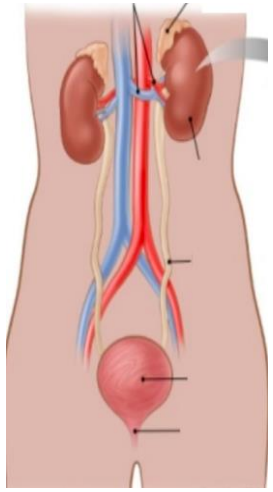
Circulatory System



Consists of
- Heart
- Blood vessels
- Blood
- Lymphatic system

Main Functions
- Transports …. to and from the tissues

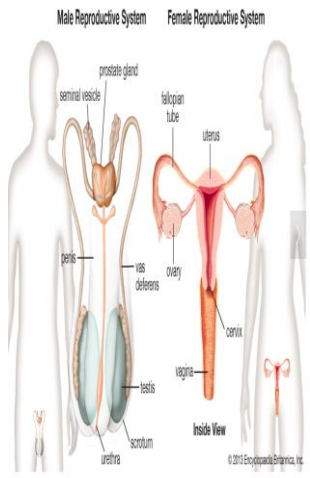
Urinary System



Consists of
- Skin
- Liver
- Kidneys
- lungs

Main Functions
- Excretion
- Acid-base balance

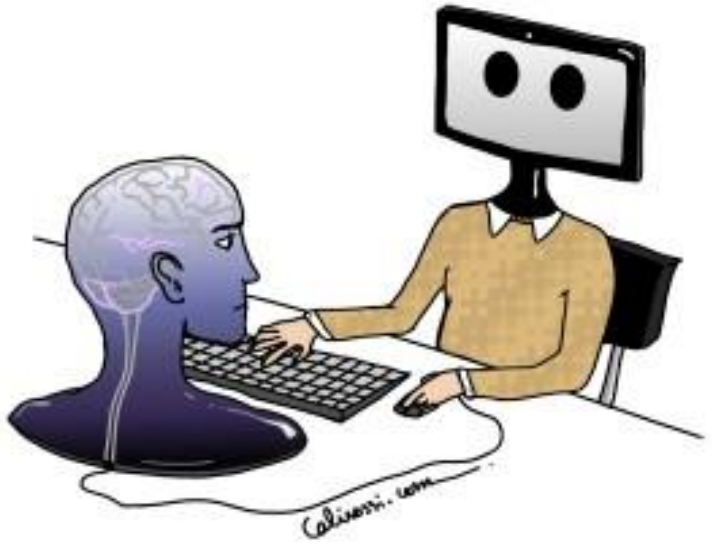
Reproductive System

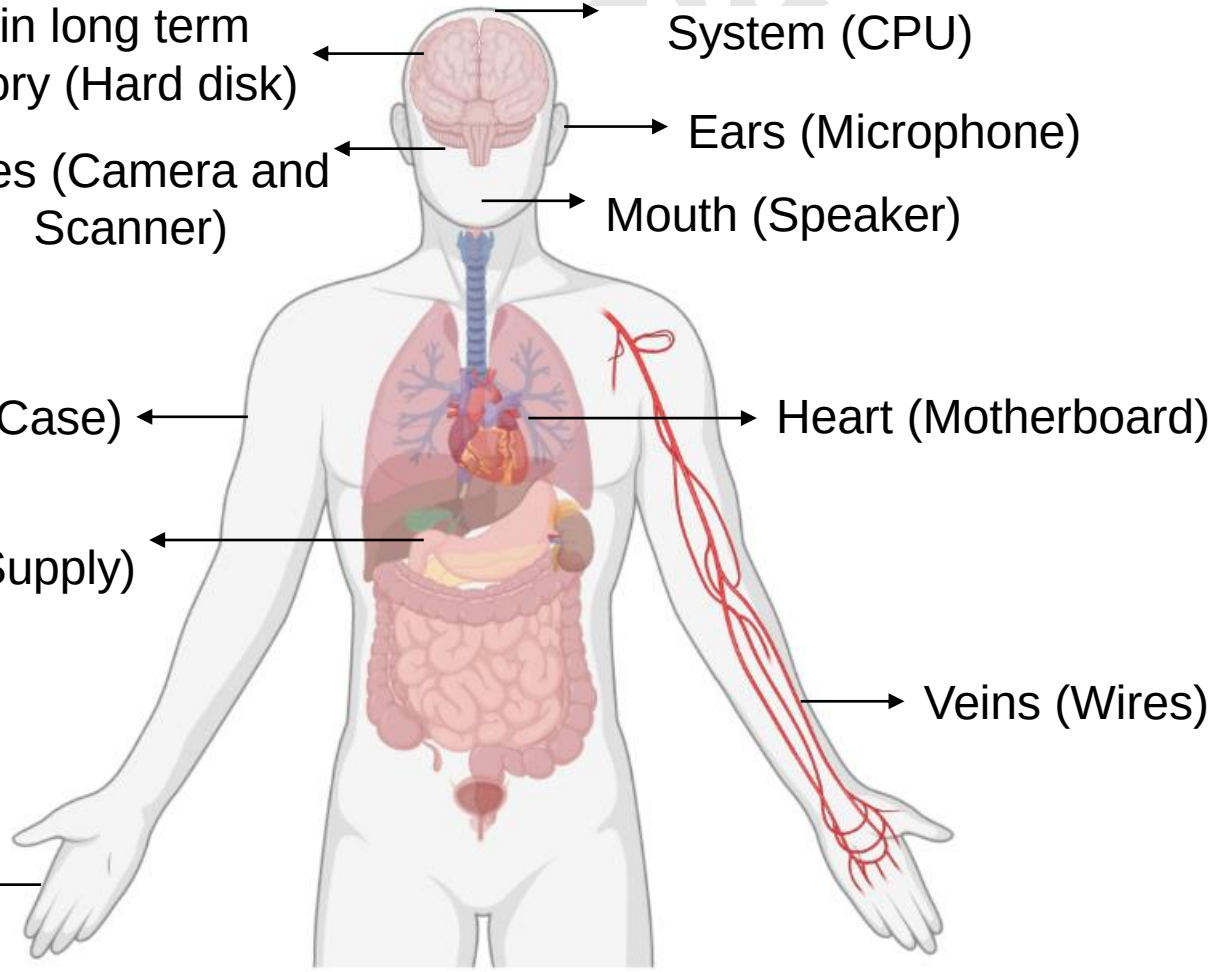


Consists of
- Uterus
- Ovaries
- Prostate
- testes

Main Functions
- Sexual development
- Reproduction

Is Human Body a Machine ??





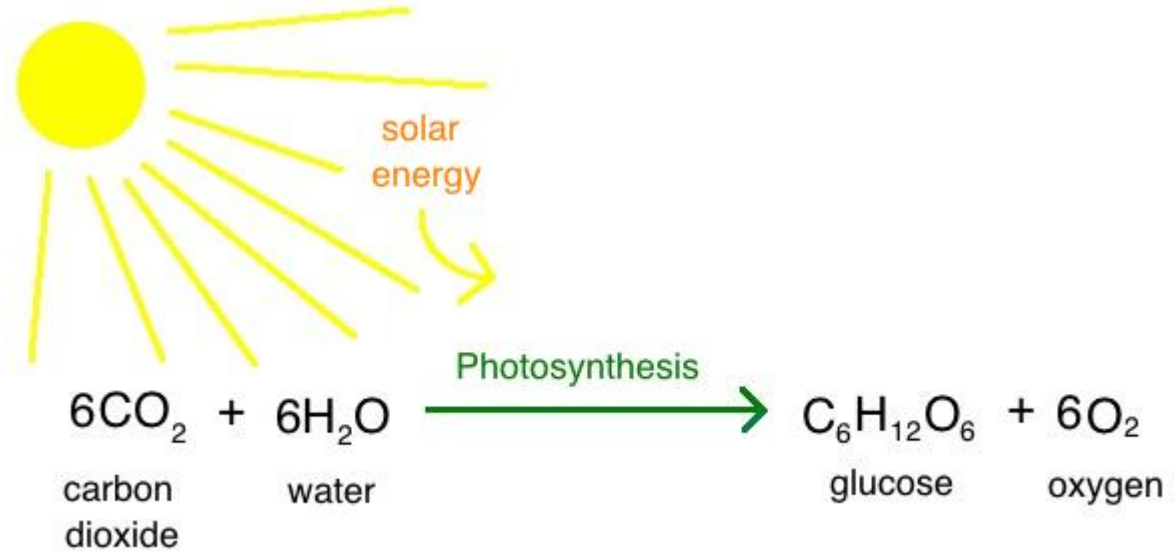
Key Concepts

- Energy Cycle
- Types of biomolecules- Carbohydrates, Lipids, Nucleic Acids, Proteins
- Levels of Organization
- Types of organs, tissues and cells
- Facts about human body

Photosynthesis

- Photosynthesis is the process in which light energy is converted to chemical energy in the form of sugars.

- In a process driven by light energy, glucose molecules (or other sugars) are constructed from water and carbon dioxide, and oxygen is released as a byproduct. The glucose molecules provide organisms with two crucial resources: energy and fixed—organic—carbon.



Photosynthesis

The ecological importance of photosynthesis

- Photosynthetic organisms, including plants, algae, and some bacteria, play a key ecological role. They introduce chemical energy and fixed carbon into ecosystems by using light to synthesize sugars. Since these organisms produce their own food—that is, fix their own carbon—using light energy, they are called photoautotrophs (literally, self-feeders that use light).

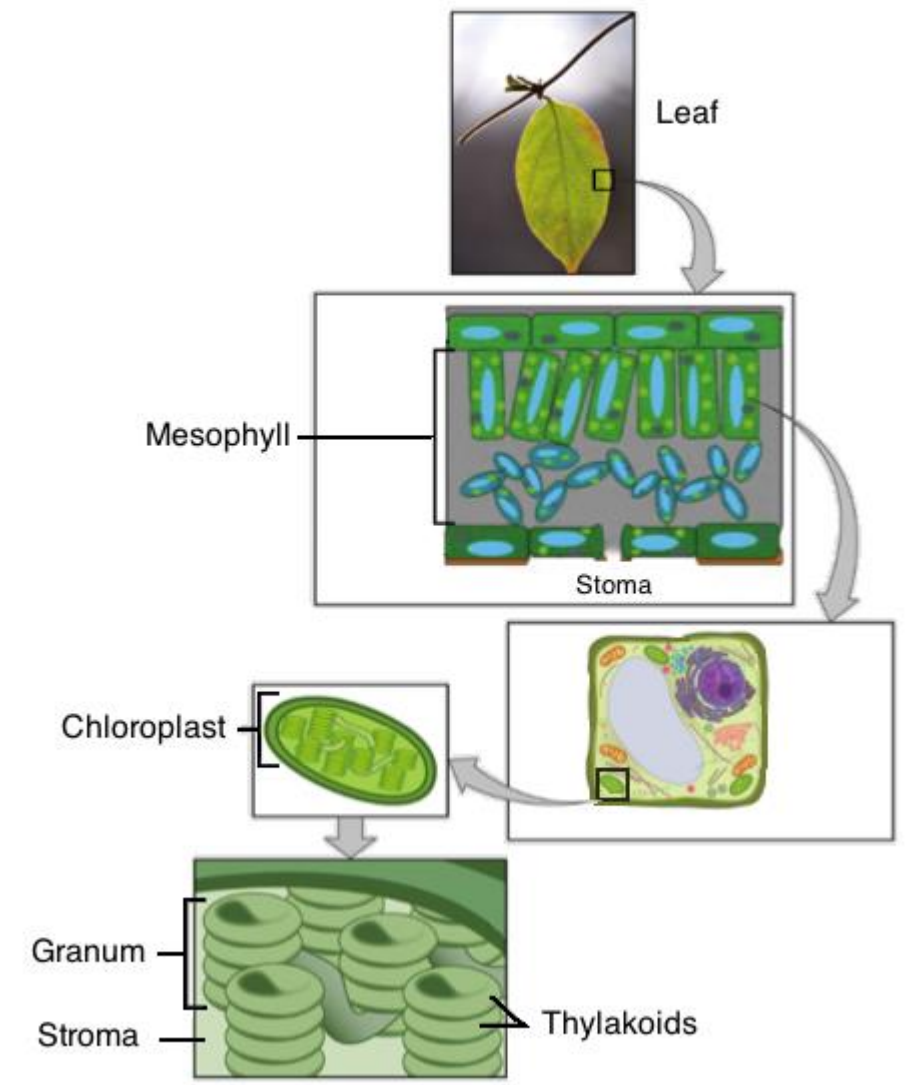
- Humans, and other organisms that can't convert carbon dioxide to organic compounds themselves, are called heterotrophs, meaning different-feeders. Heterotrophs must get fixed carbon by eating other organisms or their by-products. Animals, fungi, and many prokaryotes and protists are heterotrophs.

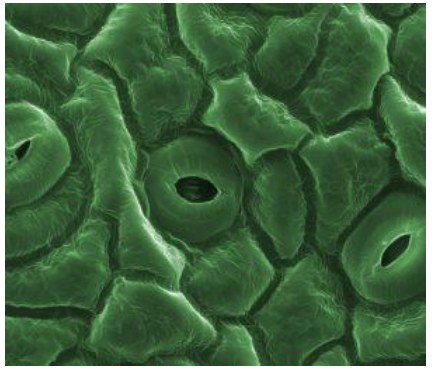
Photosynthesis

Leaves are sites of photosynthesis

- Plants are the most common autotrophs in terrestrial—land—ecosystems. All green plant tissues can photosynthesize, but in most plants, but the majority of photosynthesis usually takes place in the leaves. The cells in a middle layer of leaf tissue called the mesophyll are the primary site of photosynthesis.

- Small pores called stomata—singular, stoma—are found on the surface of leaves in most plants, and they let carbon dioxide diffuse into the mesophyll layer and oxygen diffuse out.





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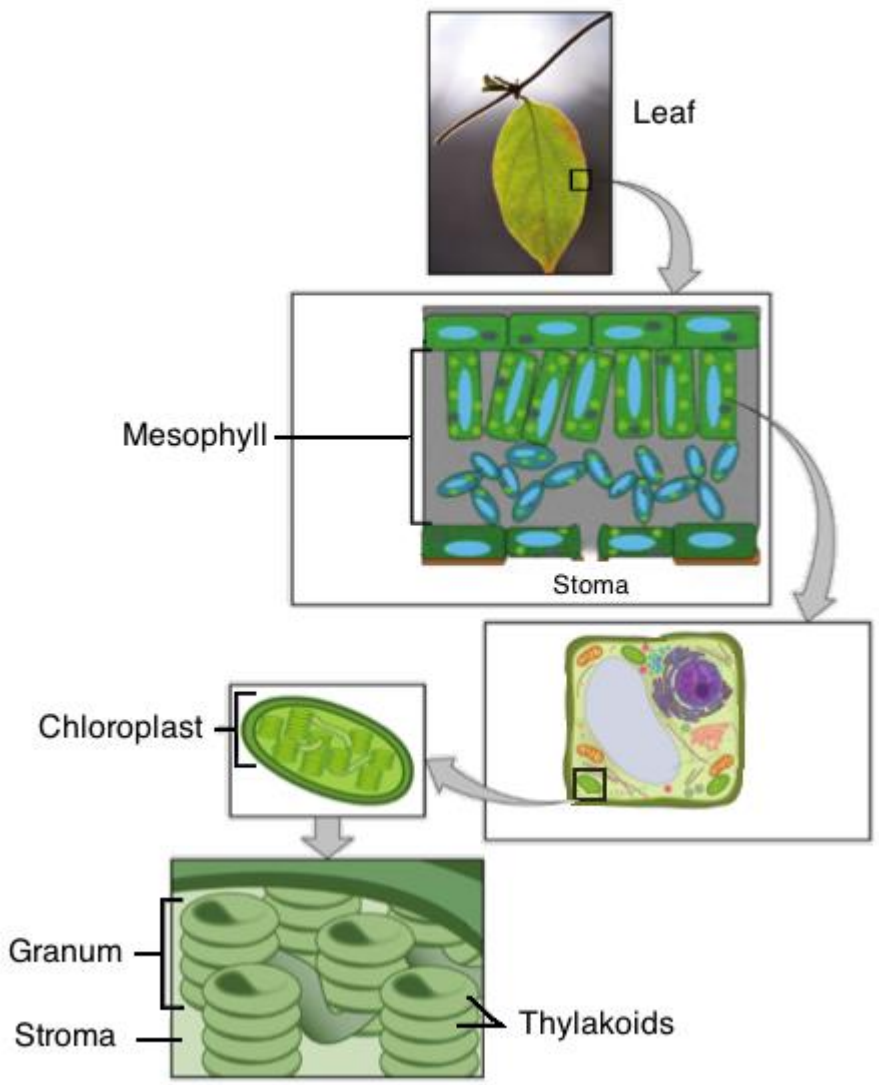
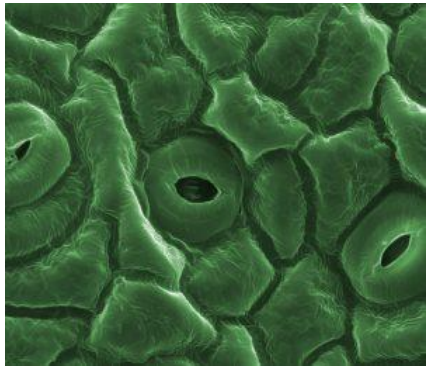
- Small pores called stomata—singular, stoma—are found on the surface of leaves in most plants, and they let carbon dioxide diffuse into the mesophyll layer and oxygen diffuse out.
- Each mesophyll cell contains organelles called chloroplasts, which are specialized to carry out the reactions of photosynthesis.
- Within each chloroplast, disc-like structures called thylakoids are arranged in piles like stacks of pancakes that are known as grana—singular, granum.
- The membrane of each thylakoid contains green-colored pigments called chlorophylls that absorb light.
- The fluid-filled space around the grana is called the stroma, and the space inside the thylakoid discs is known as the thylakoid space.
- Different chemical reactions occur in the different parts of the chloroplast.





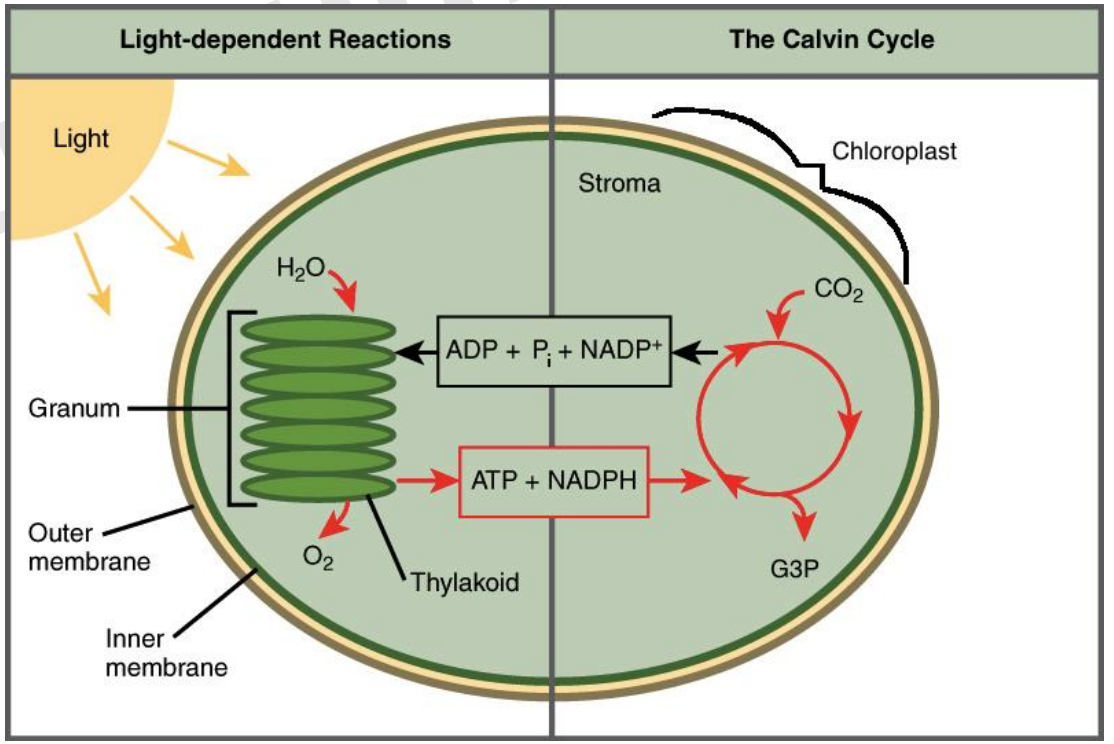
Photosynthesis

The light-dependent reactions and the Calvin cycle

- Photosynthesis in the leaves of plants involves many steps, but it can be divided into two stages: the light-dependent reactions and the Calvin cycle.

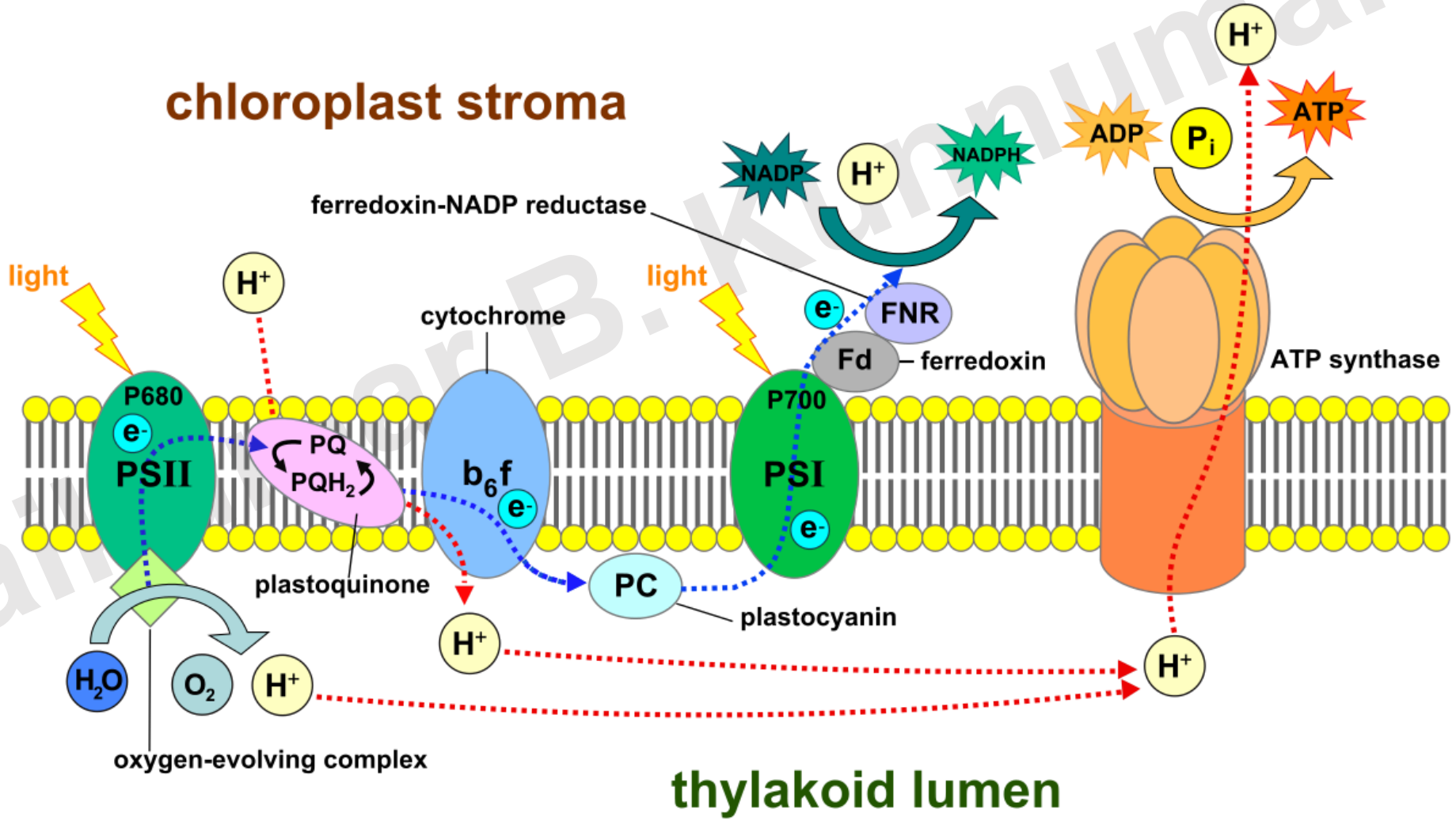
- The light-dependent reactions take place in the thylakoid membrane and require a continuous supply of light energy. Chlorophylls absorb this light energy, which is converted into chemical energy through the formation of two compounds, \text{ATP}ATPstart text, A, T, P, end text—an energy storage molecule—and \text{NADPH}NADPHstart text, N, A, D, P, H, end text—a reduced (electron-bearing) electron carrier. In this process, water molecules are also converted to oxygen gas—the oxygen we breathe!

- The Calvin cycle, also called the light-independent reactions, takes place in the stroma and does not directly require light. Instead, the Calvin cycle uses \text{ATP}ATPstart text, A, T, P, end text and \text{NADPH}NADPHstart text, N, A, D, P, H, end text from the light-dependent reactions to fix carbon dioxide and produce three-carbon sugars—glyceraldehyde-3-phosphate, or G3P, molecules—which join up to form glucose.



Photosynthesis

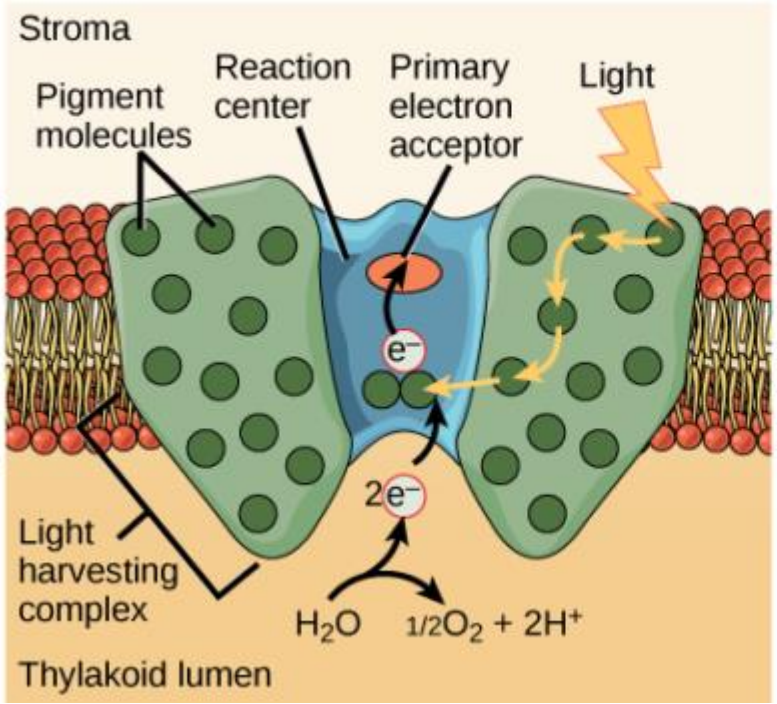
The light-dependent reactions



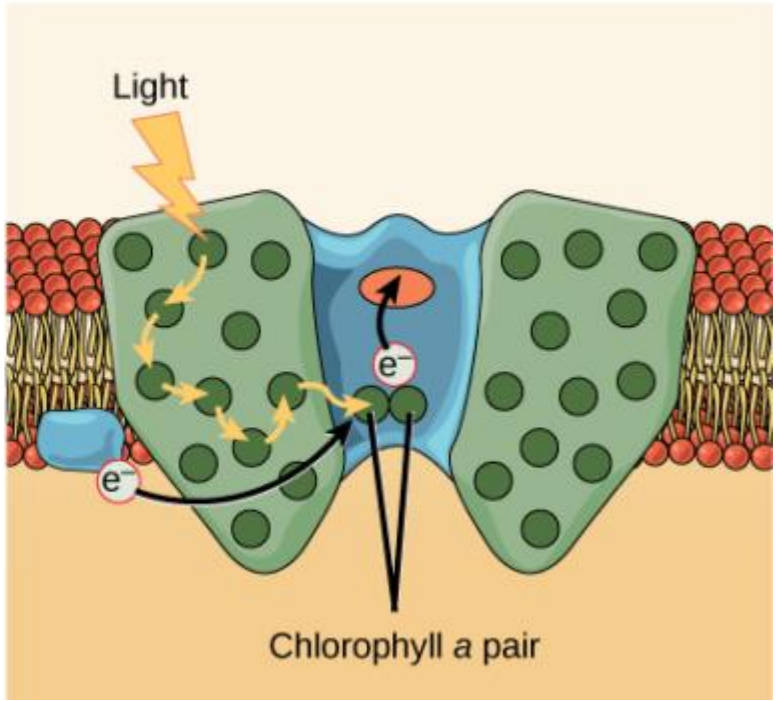
Photosynthesis

The light-dependent reactions

(a) Photosystem II (P680)

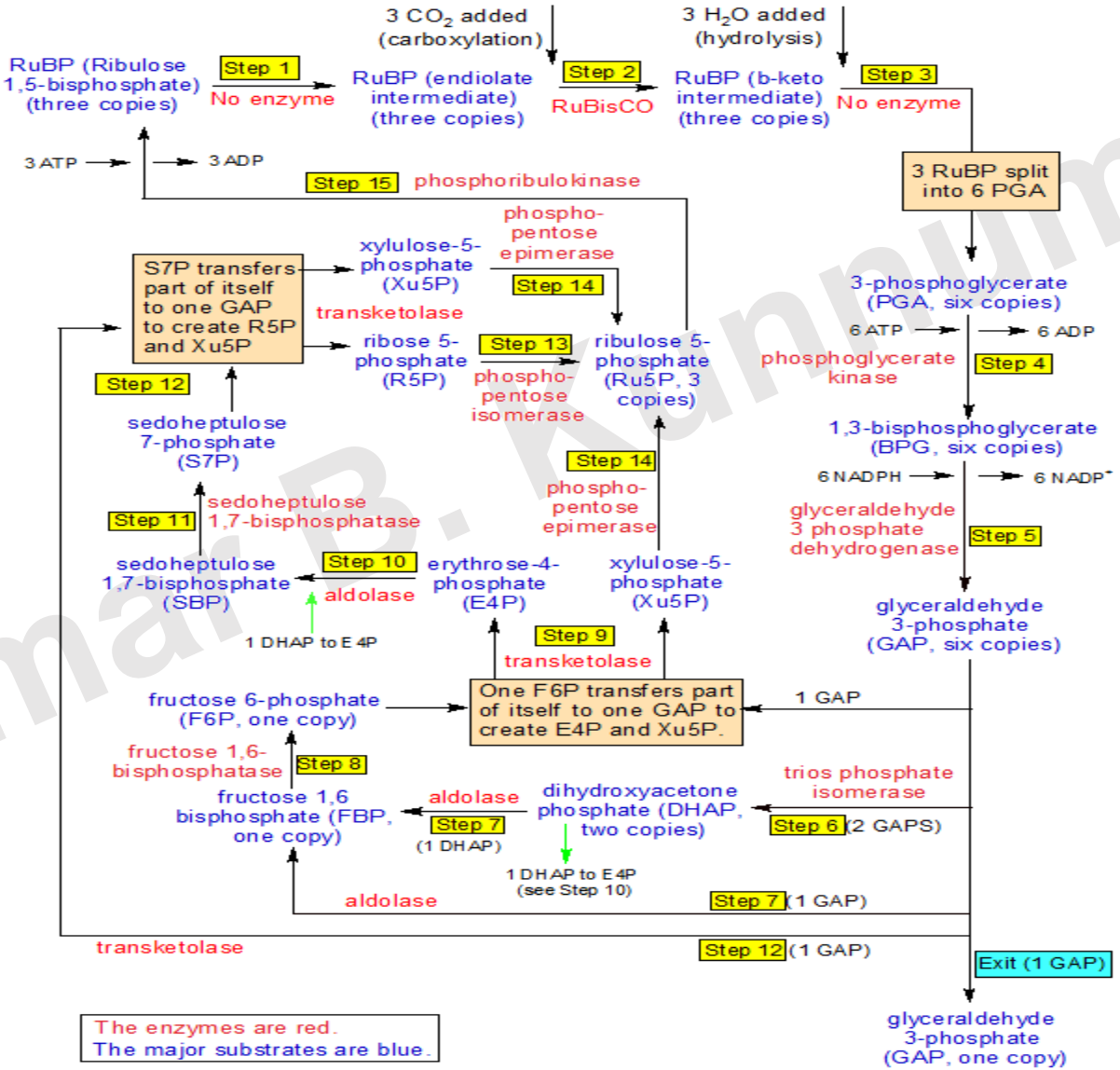


(b) Photosystem I (P700)



Photosynthesis

Calvin cycle



Photosynthesis