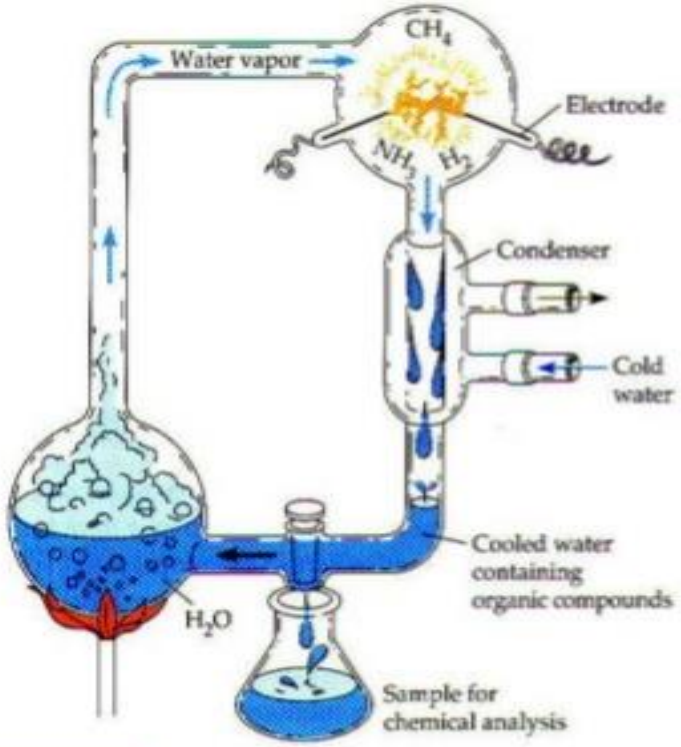
Theory of chemosynthesis

PHASE I: FORMATION OF ORGANIC MOLECULES

Urey-Miller hypothesis



- Proposed that amino acids can be synthesized outside living systems.
- They conducted experiments in which a gas mixture containing hydrogen, ammonia, methane and water vapor was subjected to electric spark.
- It yielded aldehydes, amino acids and carboxylic acids.

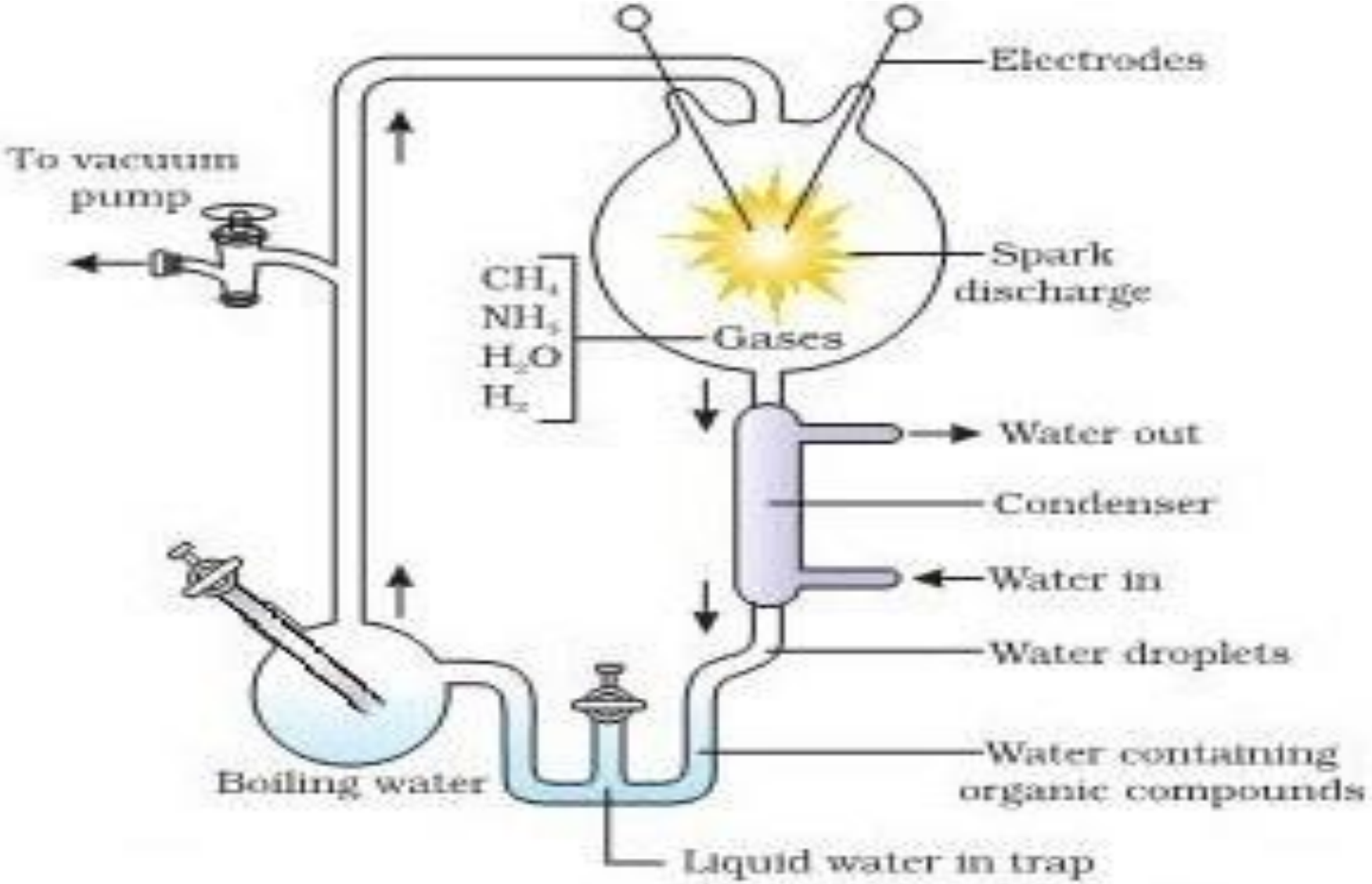


Figure 7.1 Diagrammatic representation of Miller's experiment

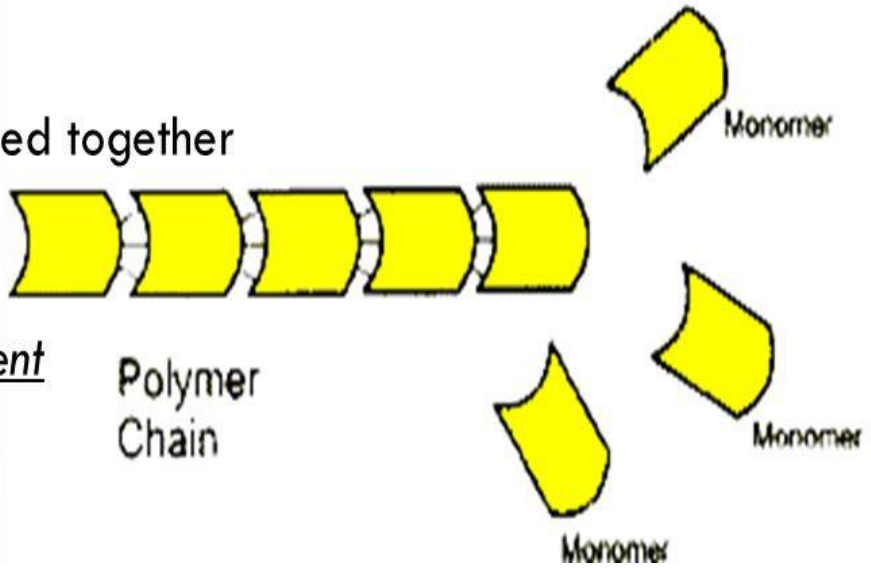
What are Macromolecules?

- Large organic compounds in living cells.
- "Giant Molecules"
- Made from thousands to even hundreds of thousands of smaller molecules

- Most are formed by **POLYMERIZATION**
  - Large molecules are built by joining smaller ones together

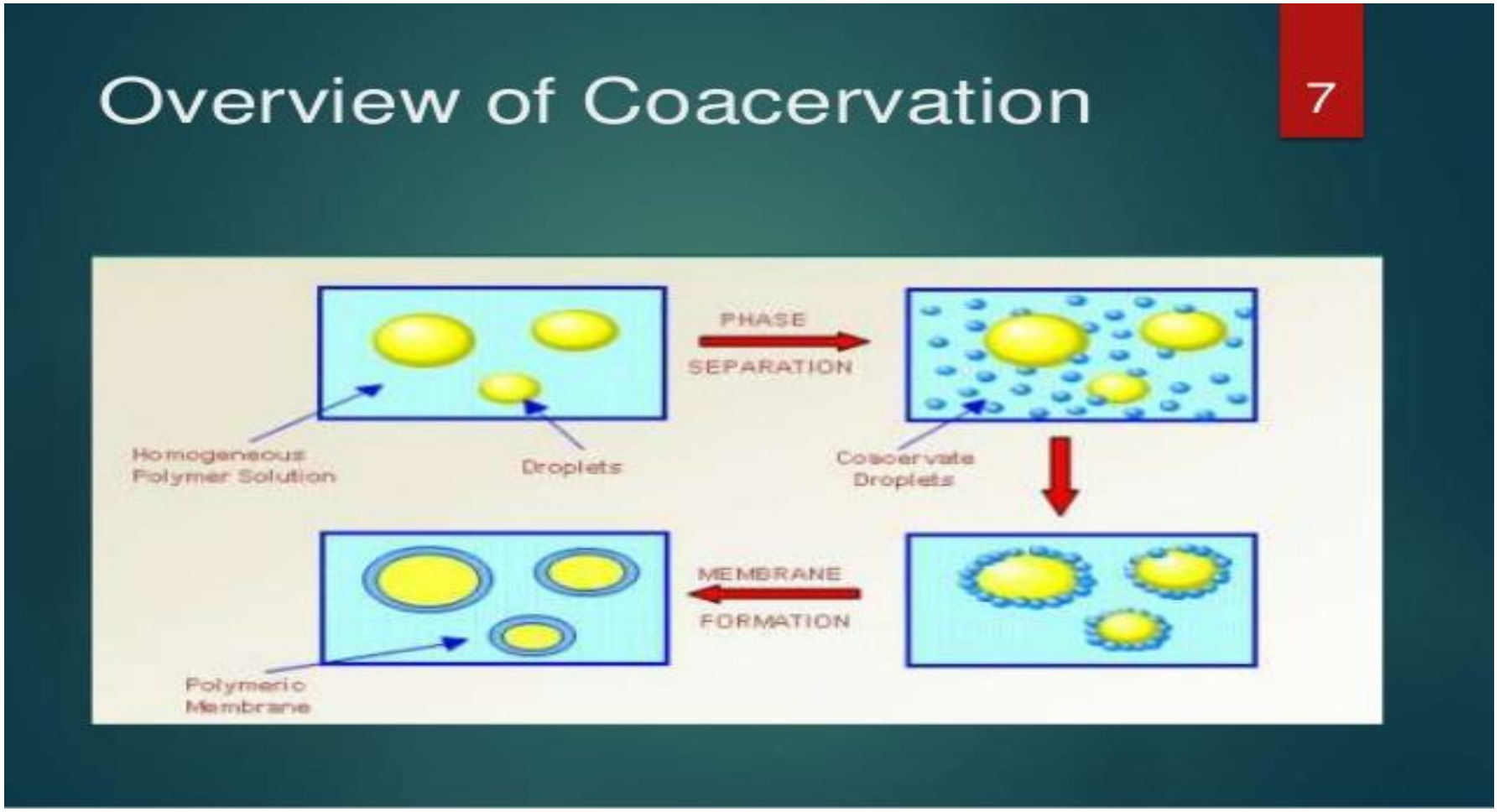
  - **Monomers:** smaller units
  - **Polymers:** many monomers joined together

  - They may be *identical* or *different*



- S.W. Fox
- Guanine
- Ureido succinic acid
- Adenine
- uracil

III;Formation of molecular aggregates



Coacervate. ... The name "**coacervate**" derives from the Latin coacervare, meaning "to assemble together or cluster". The process of **coacervation** was famously proposed by Alexander Oparin and J. B. S. Haldane as crucial in his early theory of abiogenesis (origin of life/proiskhozhdenie zhizni).

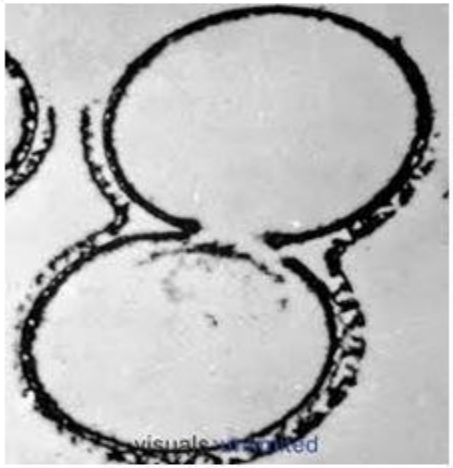
Characteristics of Coacervates

1. Identity – each one has a unique mixture of biomolecules; properties of clay
2. A water film acts as a barrier like a cell membrane
3. Grows in size
4. When large enough, it breaks down into small globules with the same traits as that of the "parent"

- Disfavour: contemporary proteins; unstable

Life's Origin

Evidence suggests that 200–300 million years after Earth had liquid water, cells similar to modern bacteria were common.



Under certain conditions, large organic molecules form tiny bubbles called ***proteinoid microspheres***.

Microspheres are not cells, but they have selectively permeable membranes and can store and release energy.

Hypotheses suggest that structures similar to microspheres might have gained characteristics of living cells.

- **Fox's experiment**
- Characteristics:
- Easily formed
- Stable
- Osmotic properties
- Lipid protein mebrane
- Split apart and can combine too

RNA-First Hypothesis

- Through the Wormhole video clip #2i in class 20:00 -27:00
- The first genetic information and enzymes were RNA molecules
- Why RNA? **RNA can act as a catalyst to**:
  - Bind amino acids together to form proteins
  - Replicate itself to create more RNA (animation #1)

Thomas and Altam: Ribozymes

RNA-First Hypothesis

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Summary on The Origin of Life

Theories: Cairns-Smith

The order of the events in the origin of life:

clay → enzymes → cells → genes

He believed that the beginning of life was a natural clay crystal directing the synthesis of enzyme molecules absorbed to its surface.

The clay and enzymes learned to make cell membranes and became encapsulated in cells.

The cells contained clay crystals performing in a crude fashion the functions in a modern cell by nucleic acids.

Later on, a cell discovered that RNA is a better genetic material than clay and hence the RNA-based life survived.

Formation of plasma membrane

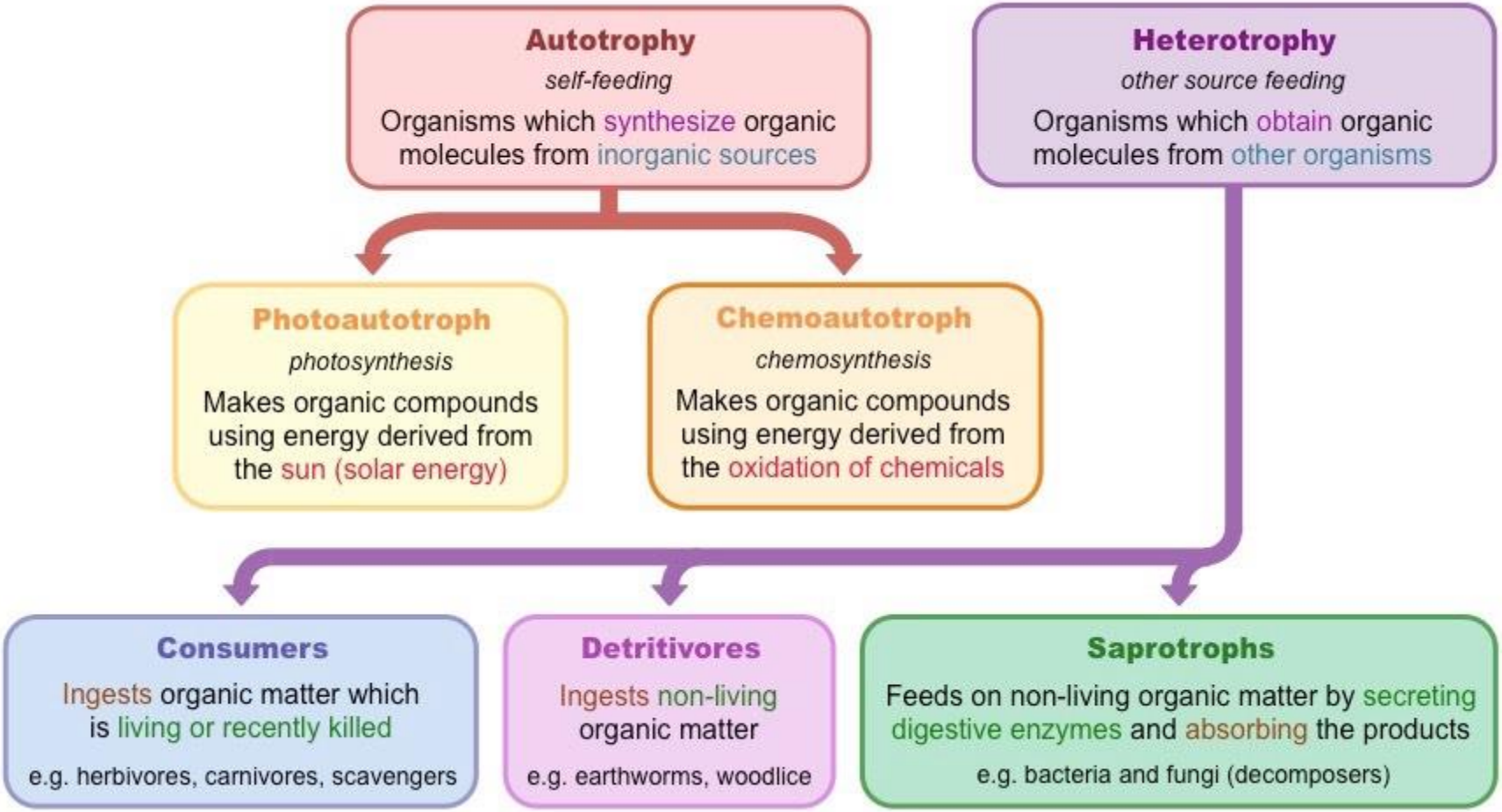
- Fox’s microsphere
- Oparin’s work

Phase IV: Formation of replicating system

- Protein first hypothesis
- RNA first hypothesis
- Cairn Smith theory

Proteins and RNA evolved simultaneously

Phase V: Evolution of Photosynthesis

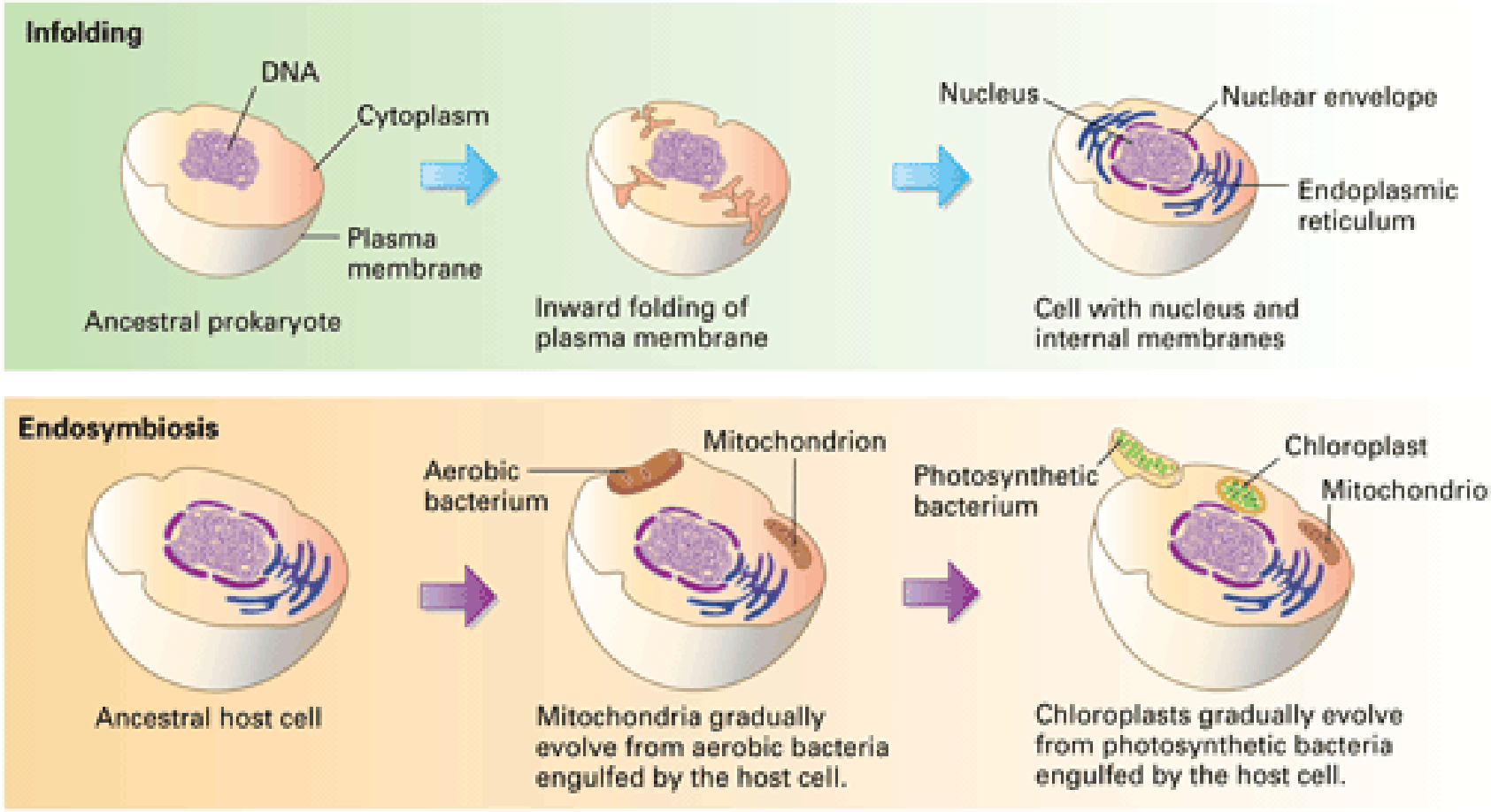


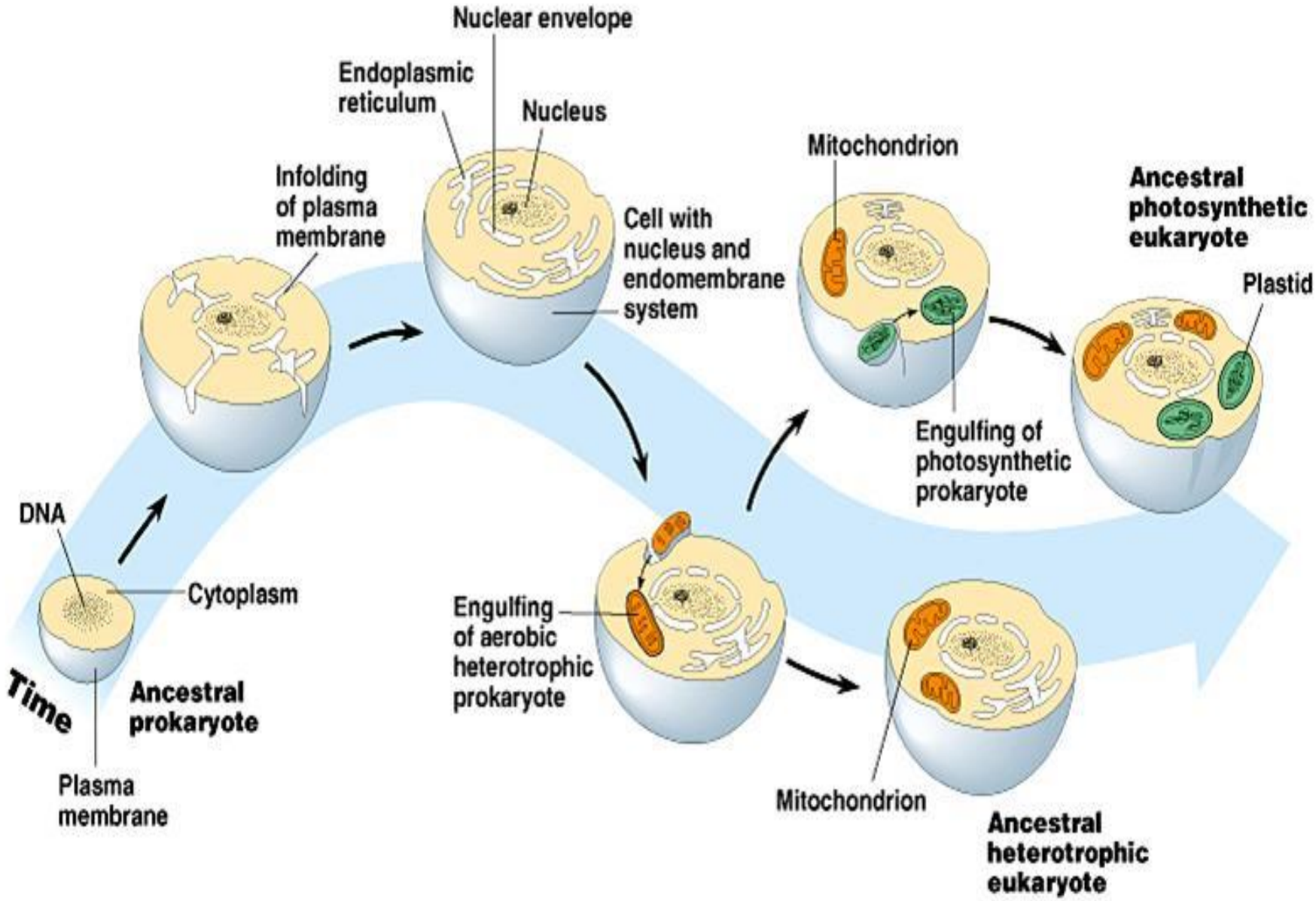
Major* Nutritional Types of Microorganisms

Major Nutritional Types	Energy source	Hydrogen/ electron	carbon source	Representative Microorganisms
Photolithotrophic autotrophy (Photolithoautotrophy) (photoautotrophs)	Light energy	Inorganic hydrogen/electron (H/e–) donor	CO_2 carbon source	Algae Purple and green sulfur bacteria Cyanobacteria
Photoorganotrophic heterotrophy (Photoorganoheterotrophy) (Photoheterotrophs)	Light energy	Organic H/e– donor	Organic carbon source	Purple nonsulfur bacteria Green nonsulfur bacteria
Chemolithotrophic autotrophy (Chemolithoautotrophy) (Chemoautotrophs)	Chemical energy source (inorganic)	Inorganic H/e– donor	CO_2 carbon source	Sulfur-oxidizing bacteria Hydrogen bacteria Nitrifying bacteria Iron-oxidizing bacteria
Chemoorganotrophic heterotrophy (Chemoorganoheterotrophy) (Chemoheterotrophs)	Chemical energy source (organic)	Organic H/e– donor	Organic carbon source	Protozoa, Fungi, Most nonphotosynthetic bacteria (including most pathogens)

- Prokaryotes-Heterotrophs—autotrophs (chemo and autotrophs)

Phase VI: EVOLUTION OF EUKARYOTES





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Support of endosymbiotic theory

- Same size as bacteria
- Inner membrane of chloroplast similar to blue green algae and of mitochondria is similar to anaerobic bacteria
- DNA similar to of bacteria
- Size and properties of ribosomes present in mitochondria and chloroplast are also similar with bacteria and blue green algae respectively