

9. Terminology and Biological Dimensions

Prepared for EGY 105

Energy in our World

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Terminology pertaining to modern energy

- ▶ Renewable vs nonrenewable
- ▶ Traditional vs new energy
- ▶ Commercialized vs non-commercialized
- ▶ Centralized vs distributed generation
- ▶ On-grid vs off-grid

Stages of energy flow

from <http://www.fao.org/docrep/u2246e/u2246e02.htm>

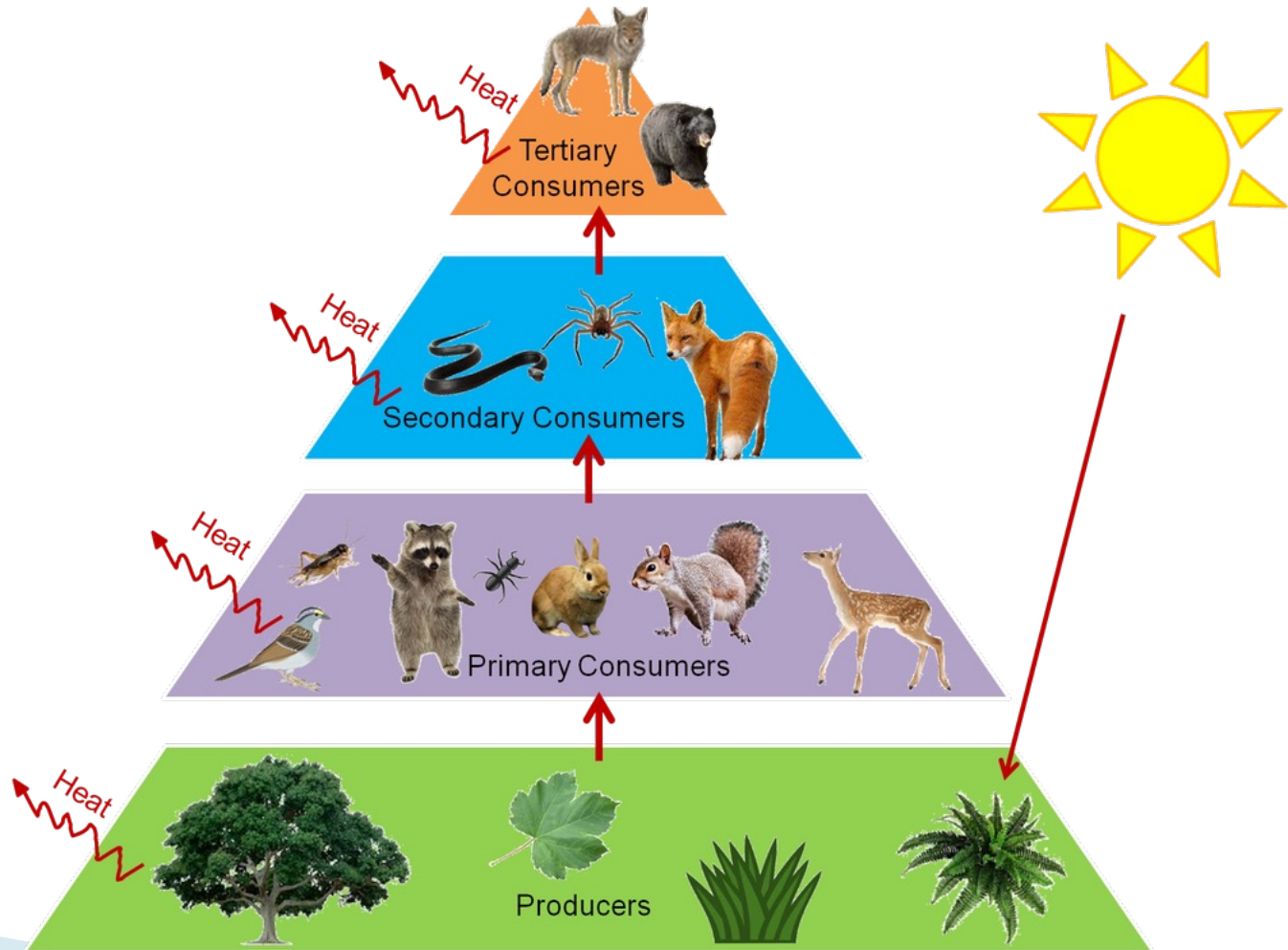
- ▶ Primary energy is the energy as it is available in the natural environment, i.e. the primary source of energy.
- ▶ Secondary energy is the energy ready for transport or transmission.
- ▶ Final energy is the energy which the consumer buys or receives.
- ▶ Useful energy is the energy which is an input in an end-use application.

Stages of energy flow

from <http://www.fao.org/docrep/u2246e/u2246e02.htm>

energy	technology	examples
Primary		coal, wood, hydro, dung, oil
	Conversion	power plant, kiln, refinery, digester
Secondary		refined oil, electricity, biogas
	Transport/ transmission	trucks, pipes, wires
Final		diesel oil, charcoal, electricity, biogas
	Conversion	motors, heaters, stoves
Useful		shaft power, heat

Energy in living systems



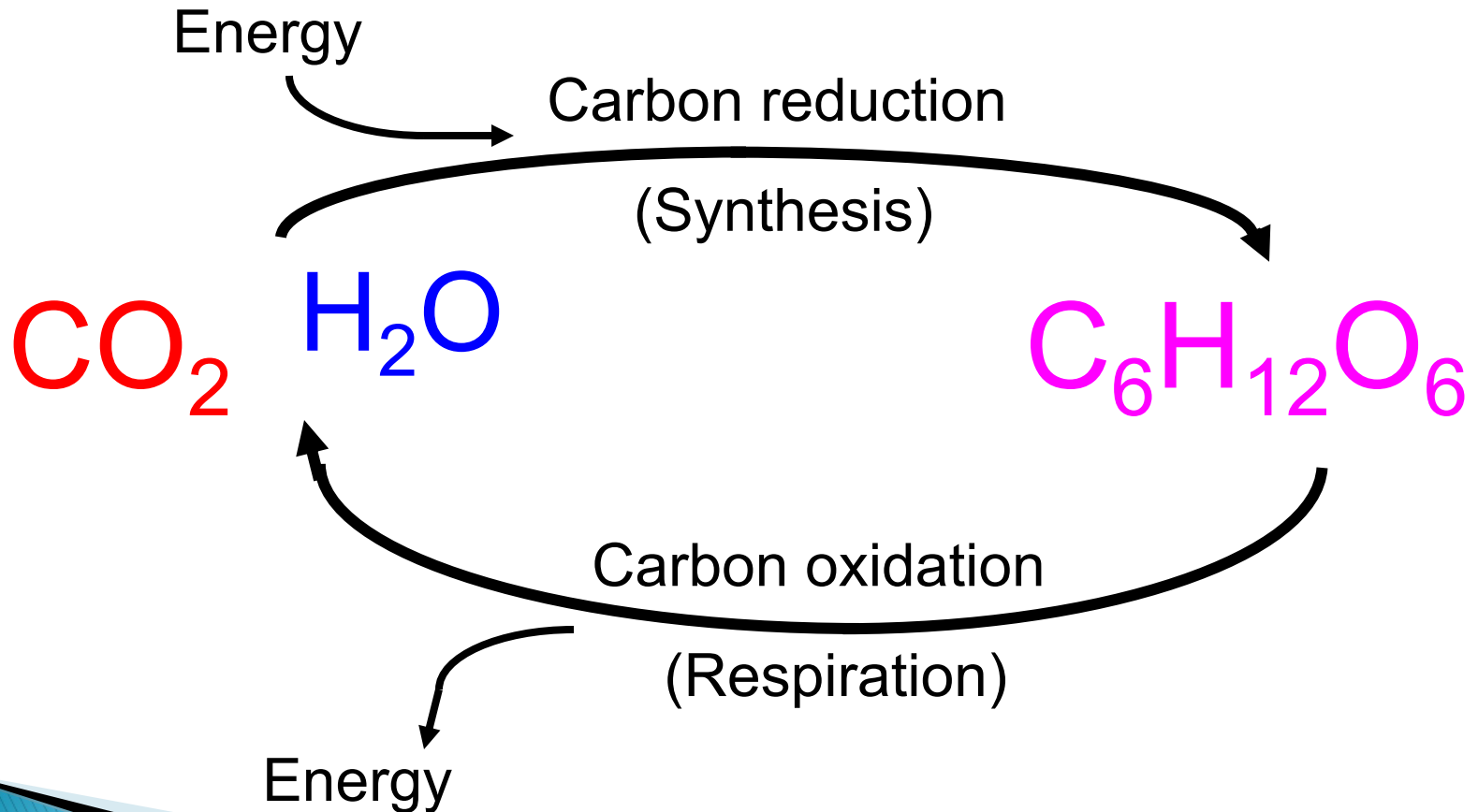
Energy in living systems – General principles

- ▶ Energy drives life processes
- ▶ Organisms are negentropic
 - Highly ordered, despite second law of thermodynamics
 - Require outside energy to live
 - From consuming organic molecules
 - From sunlight (photo-autotrophy)
 - From chemicals in the environment (chemo-autotrophy)

Energetics in living systems involves carbon reduction and carbon oxidation

- ▶ For sake of living systems:
 - Carbon reduction
 - Adding electrons and protons (hydrogen atoms) to carbon
 - Removing oxygen atoms from carbon
 - Carbon oxidation
 - Removing electrons and protons (hydrogen atoms) from carbon
 - Adding oxygen atoms to carbon

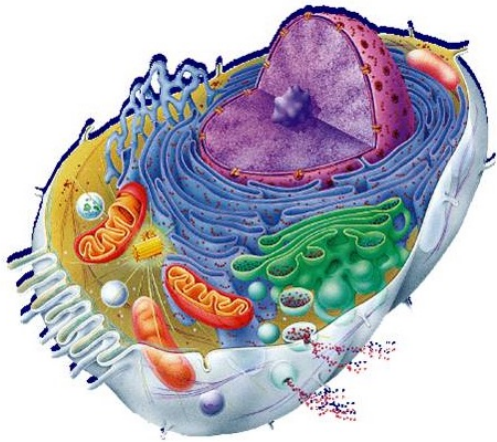
The oxidation–reduction cycle



Anabolic and catabolic reactions

- ▶ Anabolic – Building up complex organic molecules
 - CO_2 and H_2O to sugars
 - Simple sugars to complex carbohydrates
 - Amino acids to proteins
 - Simple organic molecules to complex fats
 - All require energy
- ▶ Catabolic reactions – Breaking down
 - Sugars to CO_2 and H_2O
 - Complex carbohydrates to simple sugars
 - Proteins to amino acids
 - Complex fats to simple organic molecules
 - All release energy

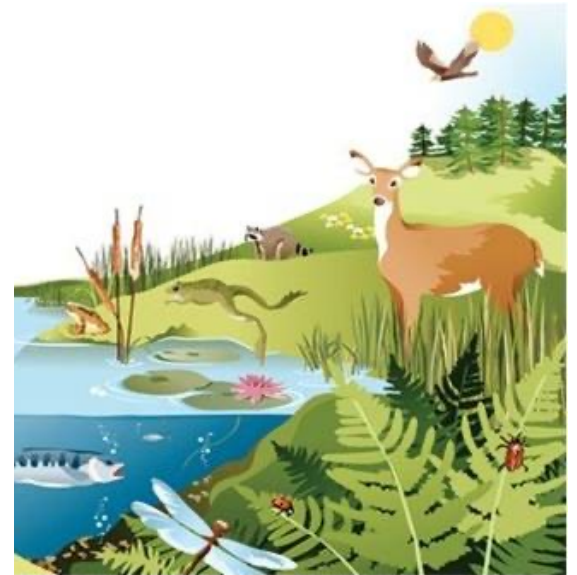
In living systems, energy can be studied at several levels.



Cell



Organism

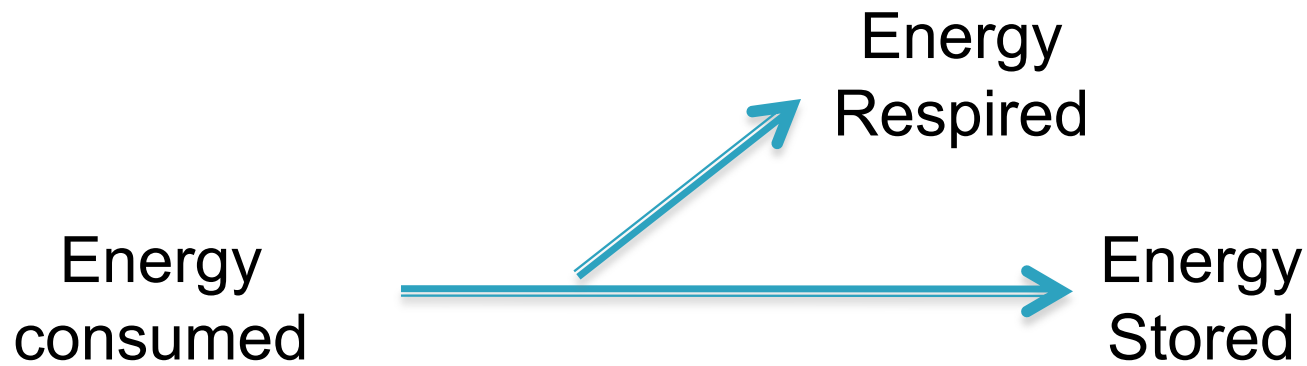


Ecosystem

Look first at whole organisms

- ▶ All organisms carry out catabolism
 - Break down organic molecules to get energy
 - Carbohydrates
 - Lipids
 - Proteins
- ▶ Organisms vary in source of organic molecules
 - Heterotrophs – consume other organisms
 - Animals, fungi, protozoans, some bacteria
 - Autotrophs – make their own organic molecules
 - Photoautotrophs – use sunlight as energy source
 - Plants, algae, some bacteria
 - Chemoautotrophs – Use chemical reactions as e.s.
 - Some bacteria

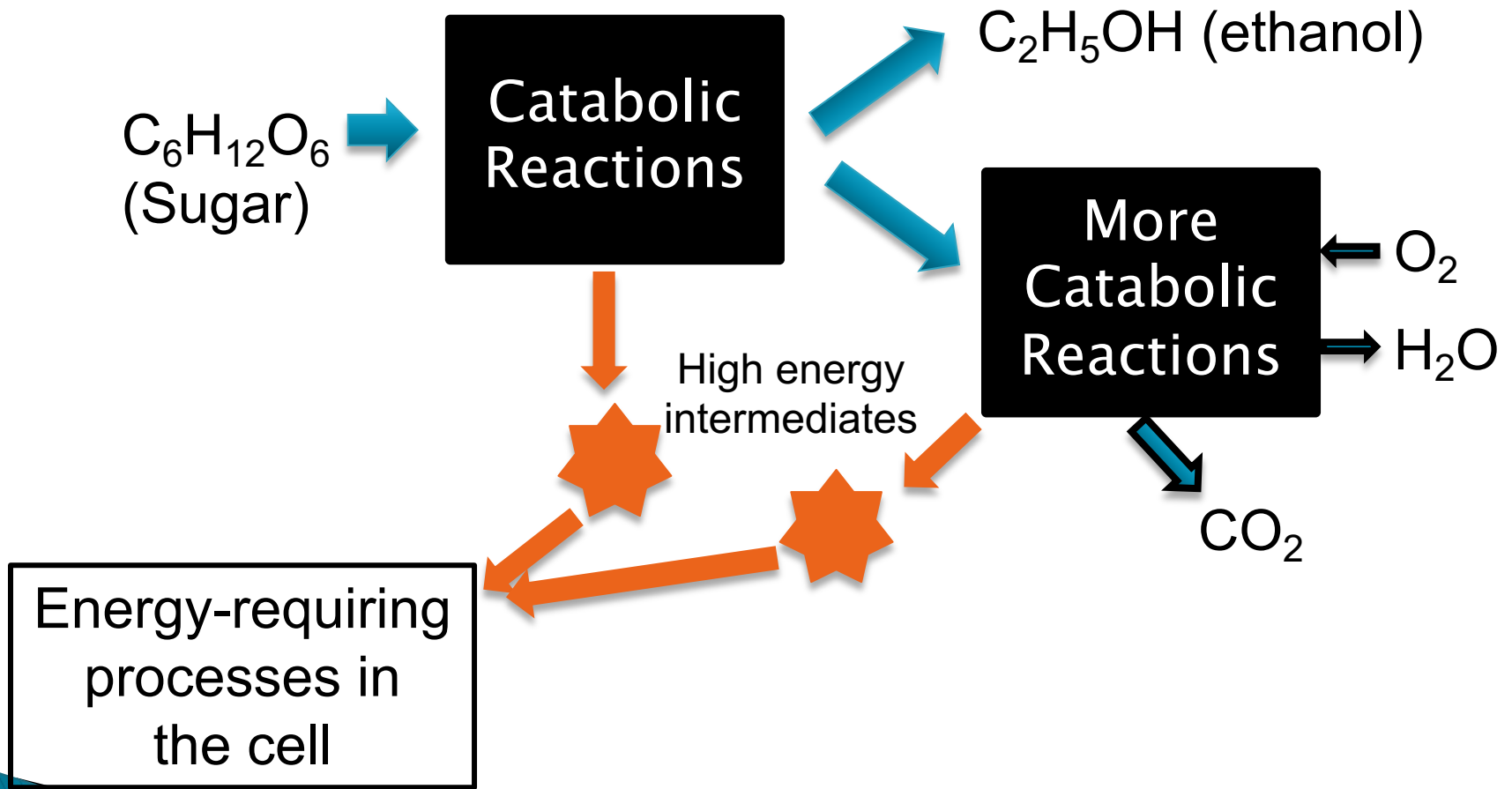
In an organism, some energy is saved in its body as organic molecules. The rest is respired.



Look at cells – respiration

- ▶ Most living cells carry out respiration through catabolic metabolism of organic molecules.
 - Metabolism – sequence of chemical reactions.
 - Many of those reactions release energy
 - Some of that energy stored as high energy intermediates.
 - Those intermediates used to drive energy-requiring processes (movement, growth, cell reproduction, synthesizing large molecules like proteins)
 - Some metabolism aerobic – use O_2 to make CO_2 & H_2O
 - Other metabolism anaerobic – no O_2 , make smaller organic molecules like ethanol.

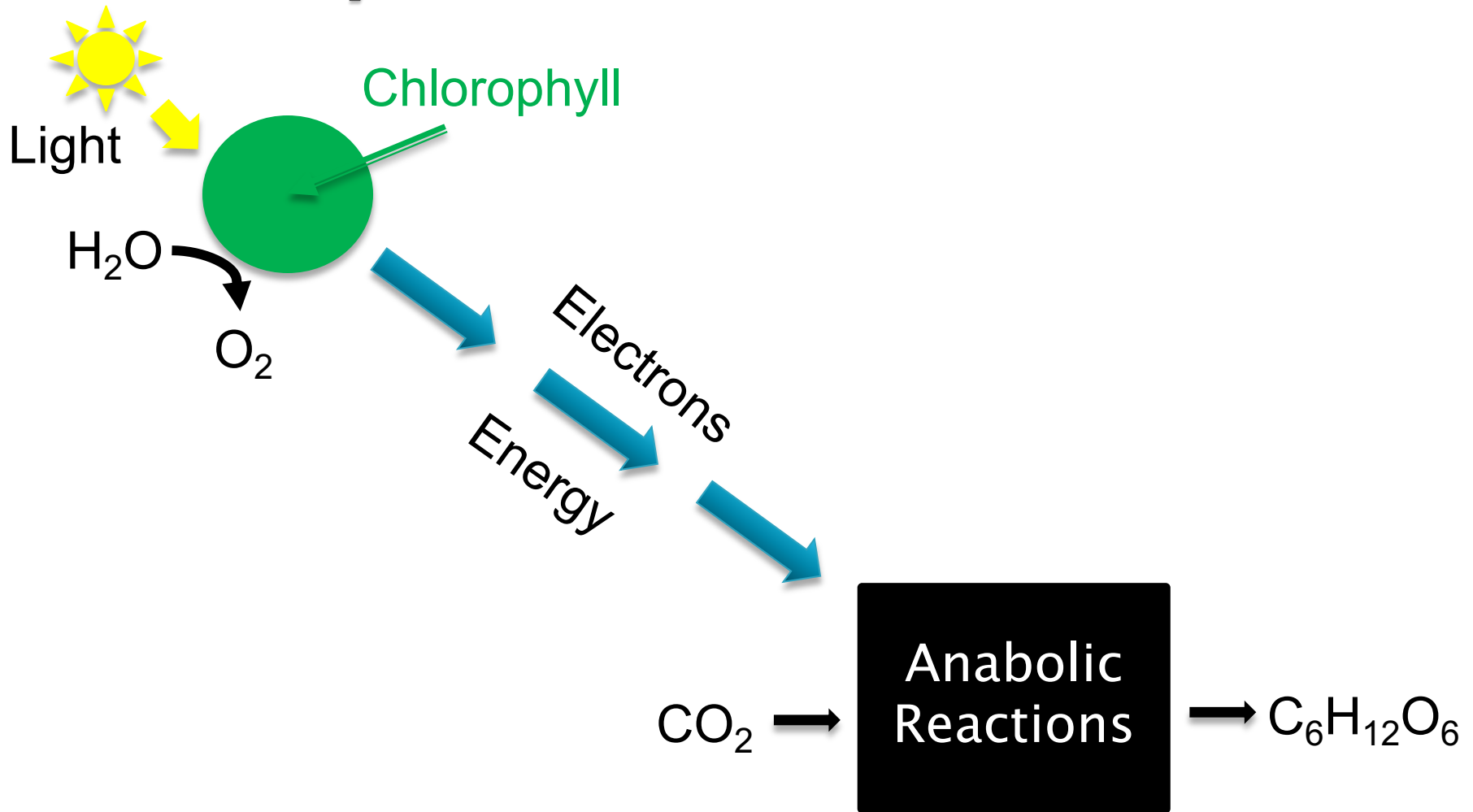
Respiration overview



Look at cells – photosynthesis

- ▶ Some cells are able to synthesize organic molecules from carbon dioxide, an electron source, and a source of energy.
 - Such cells often found in plants, algae, and some bacteria.
 - In photosynthesis:
 - Light is source of energy
 - Light must be trapped by pigments (e.g., chlorophyll)
 - Light energy causes electrons to flow between molecules
 - Those electrons eventually added to CO_2 , forming sugar (with energy input)
 - Water is source of electrons
 - Forms O_2 that is given off.

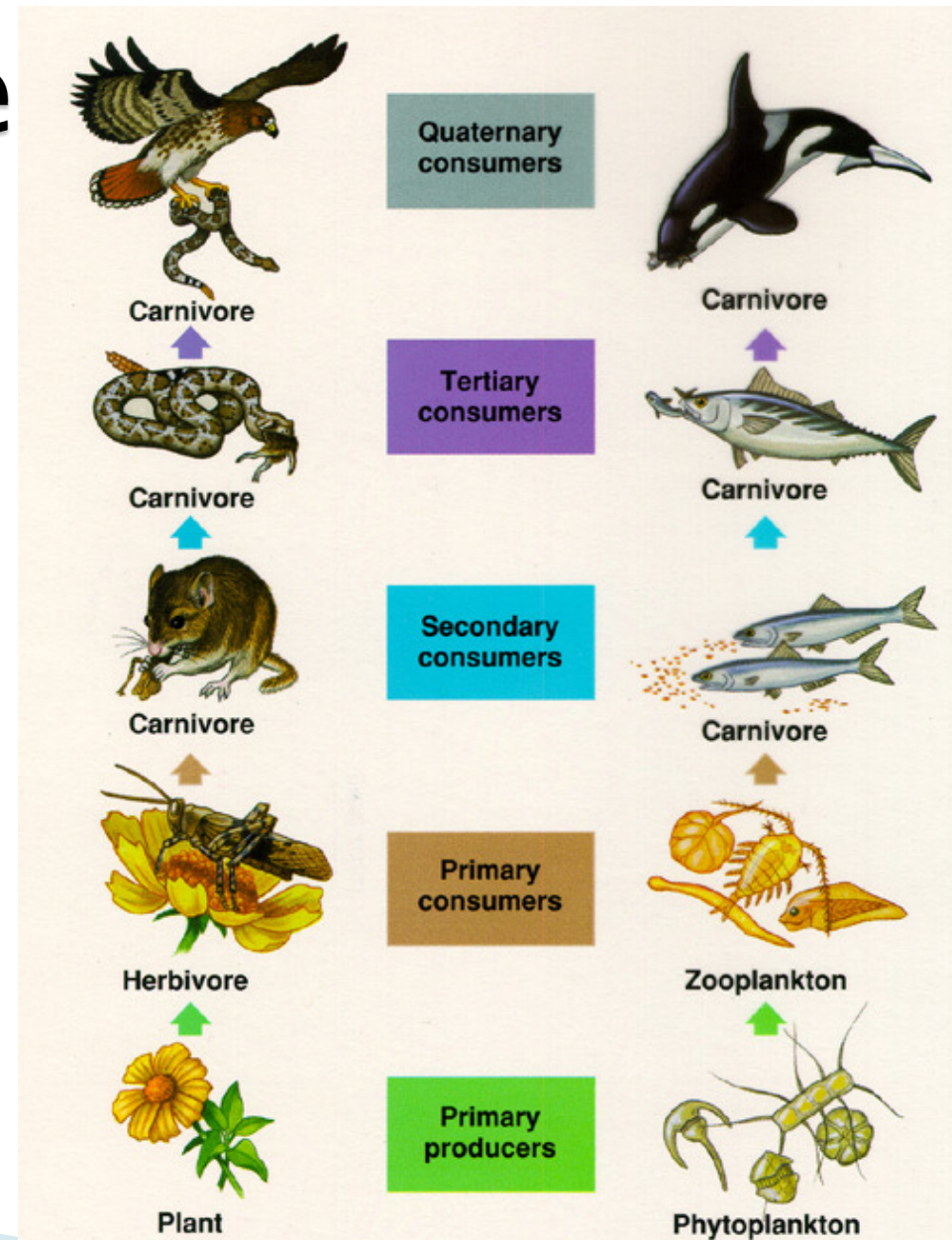
Photosynthesis overview



Look at energy flow in ecosystems

- ▶ Ecosystems consist of all organisms in an area
 - Plants, animals, fungi, bacteria
- ▶ Plus nonliving components
 - Air, water, soil
- ▶ Examples of ecosystems
 - Forests, meadows, lakes, rivers, oceans

Organisms in ecosystems are organized into different trophic levels



Energy flows through ecosystems

Energy lost at each step (usually 90%)

