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LECTURE 1

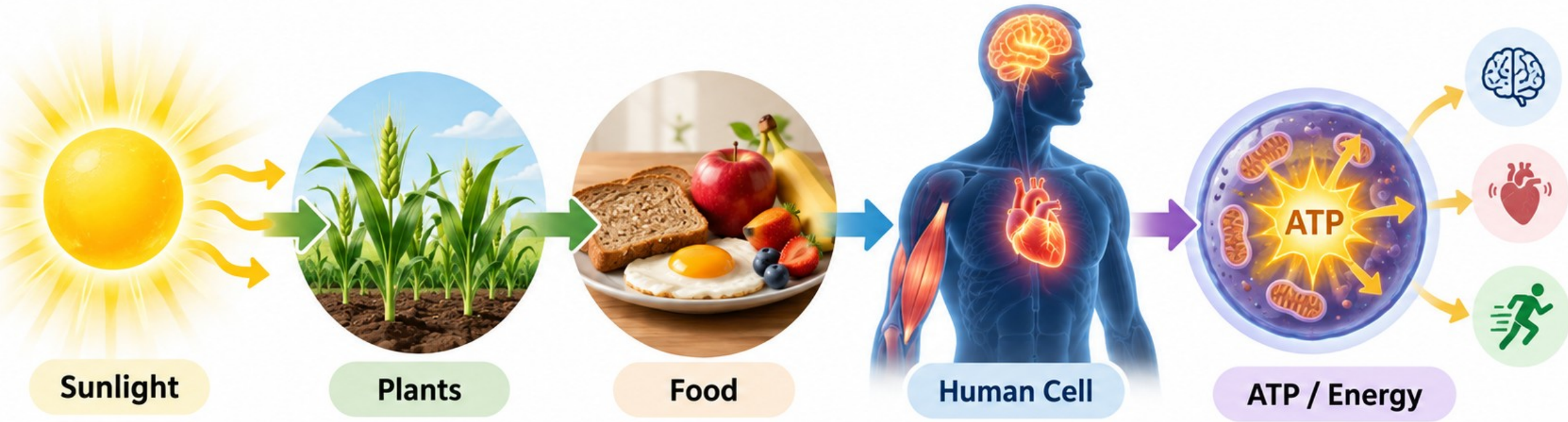
Introduction to Bioenergetics

Where does biological energy come from, and how do cells use it?

Fundamental Principles of Bioenergetics

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Where does the energy in our food come from?



Learning objectives

By the end of the lecture, students should be able to:

- Define bioenergetics
- Explain why cells need energy
- Distinguish phototrophs from chemotrophs
- Distinguish autotrophs from heterotrophs
- Describe the basic flow of energy in cells

What is bioenergetics?

Bioenergetics is the study of energy transformation in living organisms.



Examples: sunlight, glucose, proton gradients, ATP

Why do living organisms need energy?

Growth

Building new cellular material

Movement

Muscle contraction and motility

Transport

Moving substances across membranes

Biosynthesis

Making proteins, DNA and lipids

Reproduction

Cell division and development

Maintenance

Repair and homeostasis

Different forms of energy in biology

Chemical energy

Stored in chemical bonds
Example: glucose

Light energy

Captured by pigments
Example: chlorophyll

Electrochemical energy

Stored as ion gradients
Example: H^+ gradient

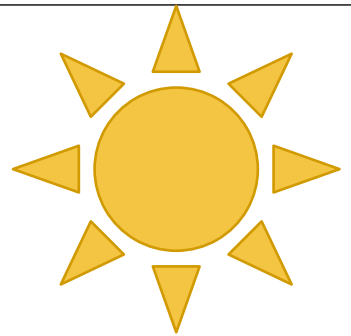
Mechanical work

Movement and contraction

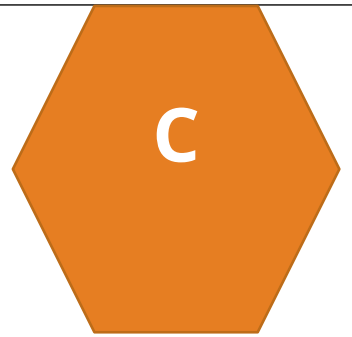
Heat

Released during energy conversion

Where does biological energy come from?



Two major energy sources



LIGHT

Plants, algae, cyanobacteria

CHEMICALS

Organic or inorganic compounds

Phototrophs vs chemotrophs

Classification by energy source

Phototrophs

Energy source: LIGHT

Examples:
- plants
- algae
- cyanobacteria

Chemotrophs

Energy source: CHEMICAL COMPOUNDS

Examples:
- humans
- animals
- fungi
- many bacteria

Key question: Where does the organism get ENERGY?

Autotrophs vs heterotrophs

Classification by carbon source

Autotrophs

Main carbon source: CO_2

Examples:
- plants
- algae
- cyanobacteria
- some bacteria

Heterotrophs

Carbon source: ORGANIC COMPOUNDS

Examples:
- animals
- fungi
- many bacteria

Key question: Where does the organism get CARBON?

Do not mix these two classifications

ENERGY SOURCE

PHOTO = light

CHEMO = chemicals

CARBON SOURCE

AUTO = CO_2

HETERO = organic carbon

Energy flow in nature



Energy is transformed, transferred, and partly released as heat.

Catabolism and anabolism

Catabolism

Complex molecules → simpler molecules

Releases usable energy

Example:
Glucose → CO_2 + H_2O + energy

energy →

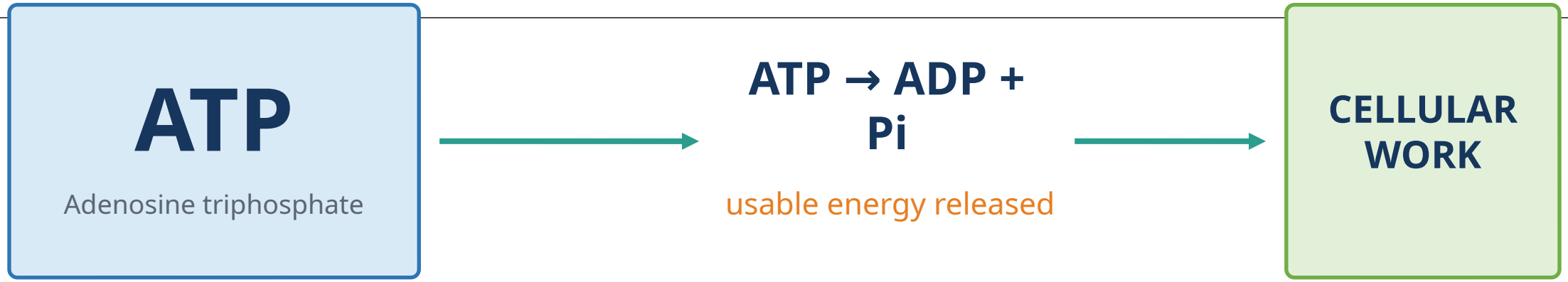
Anabolism

Simple molecules → complex molecules

Requires energy

Example:
Amino acids → proteins

ATP: the energy currency of the cell



ATP transfers energy between cellular processes.

Photosynthesis: converting light energy



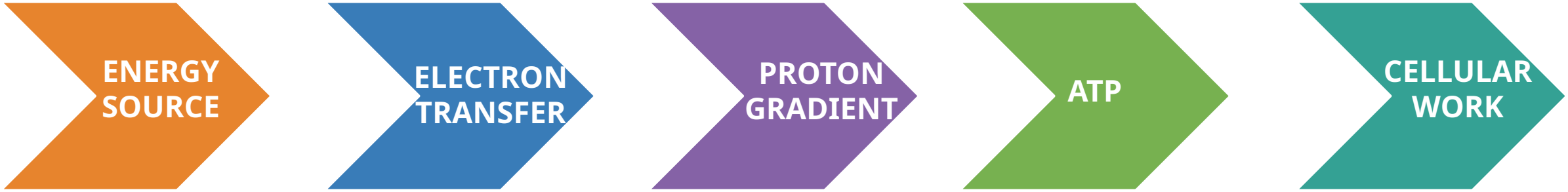
Light energy becomes chemical energy.

Respiration: extracting energy from nutrients



Cells convert chemical energy into ATP through electron transfer.

The central idea of this course



We will return to this pathway again and again.

Quick check

Answer together — no calculation

1

A cyanobacterium uses light. Is it a phototroph or chemotroph?

2

A human gets energy from food. Is a human a phototroph or chemotroph?

3

CO_2 is the main carbon source. Autotroph or heterotroph?

4

What molecule is often called the energy currency of the cell?

1) phototroph 2) chemotroph 3) autotroph 4) ATP

Summary

- Bioenergetics studies energy transformation in living systems.
- Cells need energy for growth, transport, biosynthesis and maintenance.
- Energy can come from light or chemical compounds.
- ATP transfers usable energy between cellular processes.