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Lesson 1

Introduction

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The study of life uncovers overarching themes that connect all living organisms.

Unifying Themes of Life

1. Organization

hierarchical structure in which life is arranged, from the smallest unit (atoms) to the most complex (biosphere).



2. Information

genetic information is fundamental to life's processes, guiding the development, functioning, and reproduction of organisms. It involves the expression of genes to produce proteins and the transmission of genetic material from one generation to the next.



3. Energy & matter

living organisms acquire, use, and transform energy and matter to sustain life processes



4. Interactions

At any level of the biological hierarchy, interactions between the components of the system ensure smooth integration of all the parts, such that they function as a whole



5. Evolution

a process of biological change in which species accumulate differences from their ancestors as they adapt to different environments over time.



1. Organization

New properties emerge at different levels of biological organization.



◀ 1 The Biosphere
Even from space, we can see signs of Earth's life—in the mosaic of greens indicating forests, for example. We can also see the **biosphere**, which consists of all life on Earth and all the places where life exists: most regions of land, most bodies of water, the atmosphere to an altitude of several kilometers, and even sediments far below the ocean floor.

▶ 2 Ecosystems
Our first scale change brings us to a North American mountain meadow, which is an example of an ecosystem, as are a tropical forest, grassland, desert, and coral reef. An **ecosystem** consists of all the living things in a particular area, along with all the nonliving components of the environment with which life interacts, such as soil, water, atmospheric gases, and light.

▶ 3 Communities
The array of organisms inhabiting a particular ecosystem is called a biological **community**. The community in our meadow ecosystem includes many kinds of plants, various animals, mushrooms and other fungi, and enormous numbers of diverse microorganisms, such as bacteria, that are too small to see without a microscope. Each of these forms of life belongs to a *species*—a group whose members can only reproduce with other members of the group.

▶ 4 Populations
A **population** consists of all the individuals of a species living within the bounds of a specified area that interbreed with each other. For example, our meadow includes a population of lupines (some of which are shown here) and a population of mule deer. A community is therefore the set of populations that inhabit a particular area.

▲ 5 Organisms
Individual living things are called **organisms**. Each plant in the meadow is an organism, and so is each animal, fungus, and bacterium.

▼ 6 Organs
The structural hierarchy of life continues to unfold as we explore the architecture of a complex organism. This lupine leaf (consisting of six leaflets) is an example of an **organ**, a body part that is made up of multiple tissues and has specific functions in the body. Leaves, stems, and roots are the major organs of plants. Within an organ, each tissue has a distinct arrangement and contributes particular properties to organ function.

▼ 7 Tissues
Viewing the tissues of a leaf requires a microscope. Each **tissue** is a group of cells that work together, performing a specialized function. The leaf shown here has been cut on an angle. The honeycombed tissue in the interior of the leaf (left side of photo) is the main location of photosynthesis, the process that converts light energy to the chemical energy of sugar. The jigsaw puzzle-like "skin" on the surface of the leaf (right side of photo) is a tissue called epidermis. The pores through the epidermis allow entry of the gas CO₂, a raw material for sugar production.

▶ 8 Cells
The **cell** is life's fundamental unit of structure and function. Some organisms consist of a single cell, which performs all the functions of life. Other organisms are multicellular and feature a division of labor among specialized cells. Here we see a magnified view of a cell in a leaf tissue. This cell is about 40 micrometers (μm) across—about 500 of them would reach across a small coin. Within these tiny cells are even smaller green structures called chloroplasts, which are responsible for photosynthesis.

▼ 9 Organelles
Chloroplasts are examples of **organelles**, the various functional components present in cells. The image below, taken by a powerful microscope, shows a single chloroplast.

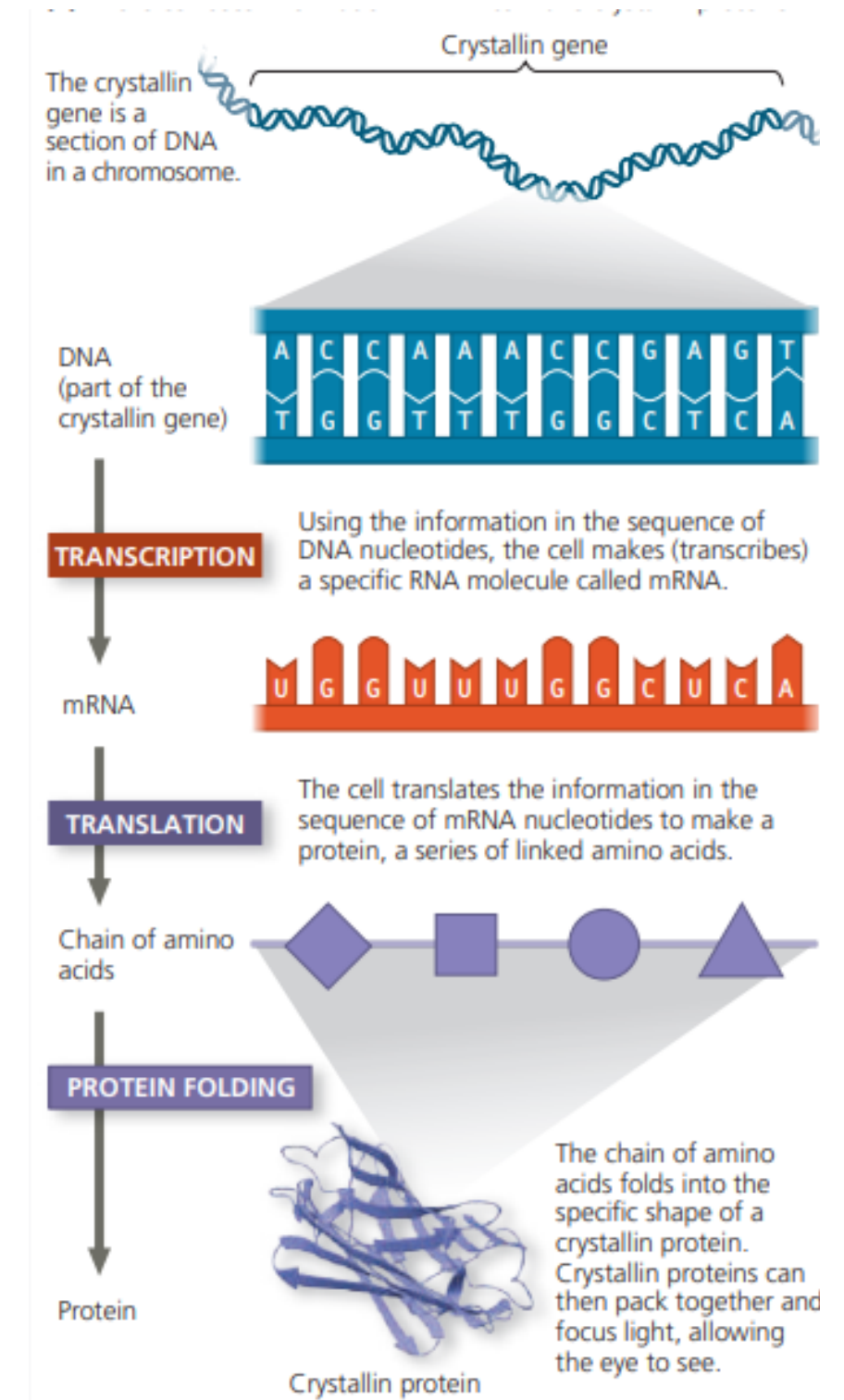
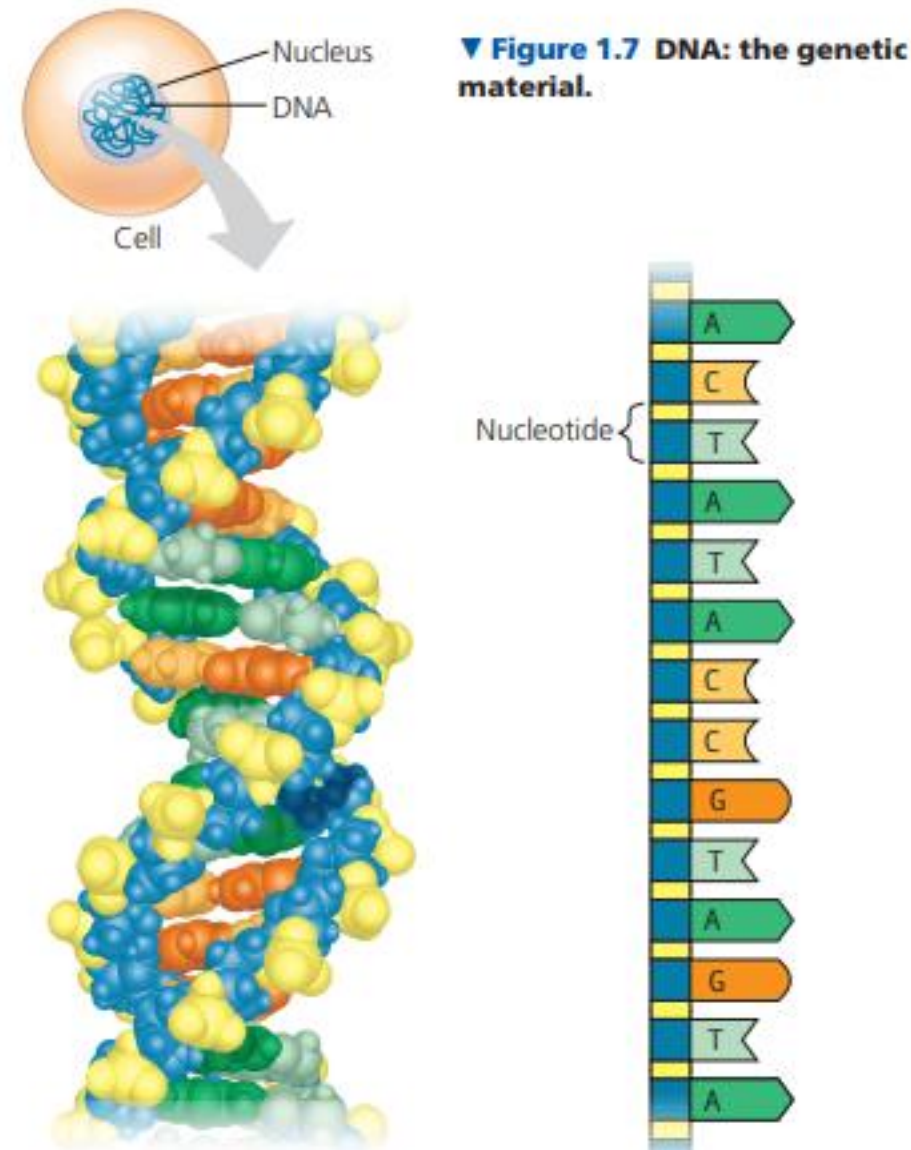
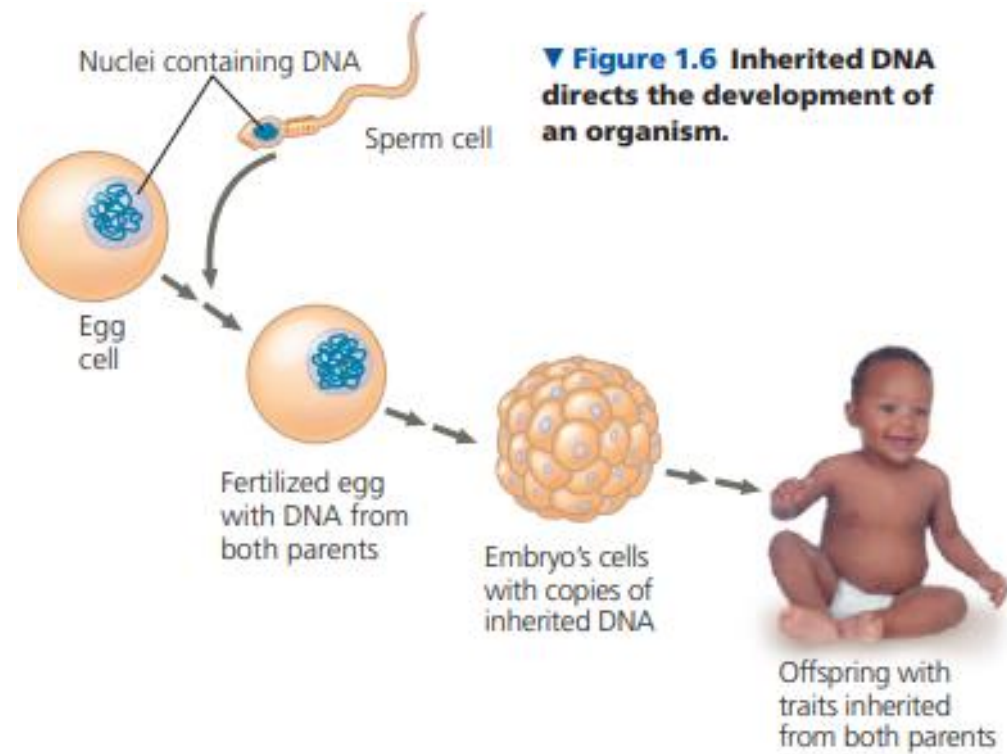
▼ 10 Molecules
Our last scale change drops us into a chloroplast for a view of life at the molecular level. A **molecule** is a chemical structure consisting of two or more units called atoms, represented as balls in this computer graphic of a chlorophyll molecule. Chlorophyll is the pigment that makes a leaf green, and it absorbs sunlight during photosynthesis. Within each chloroplast, millions of chlorophyll molecules are organized into systems that convert light energy to the chemical energy of food.

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- **Emerging properties:** characteristics or behaviors that arise from the interactions of simpler components within a system, which cannot be predicted by examining the individual components alone.
- **Structure & function:** form or structure of a biological entity is closely related to its function.

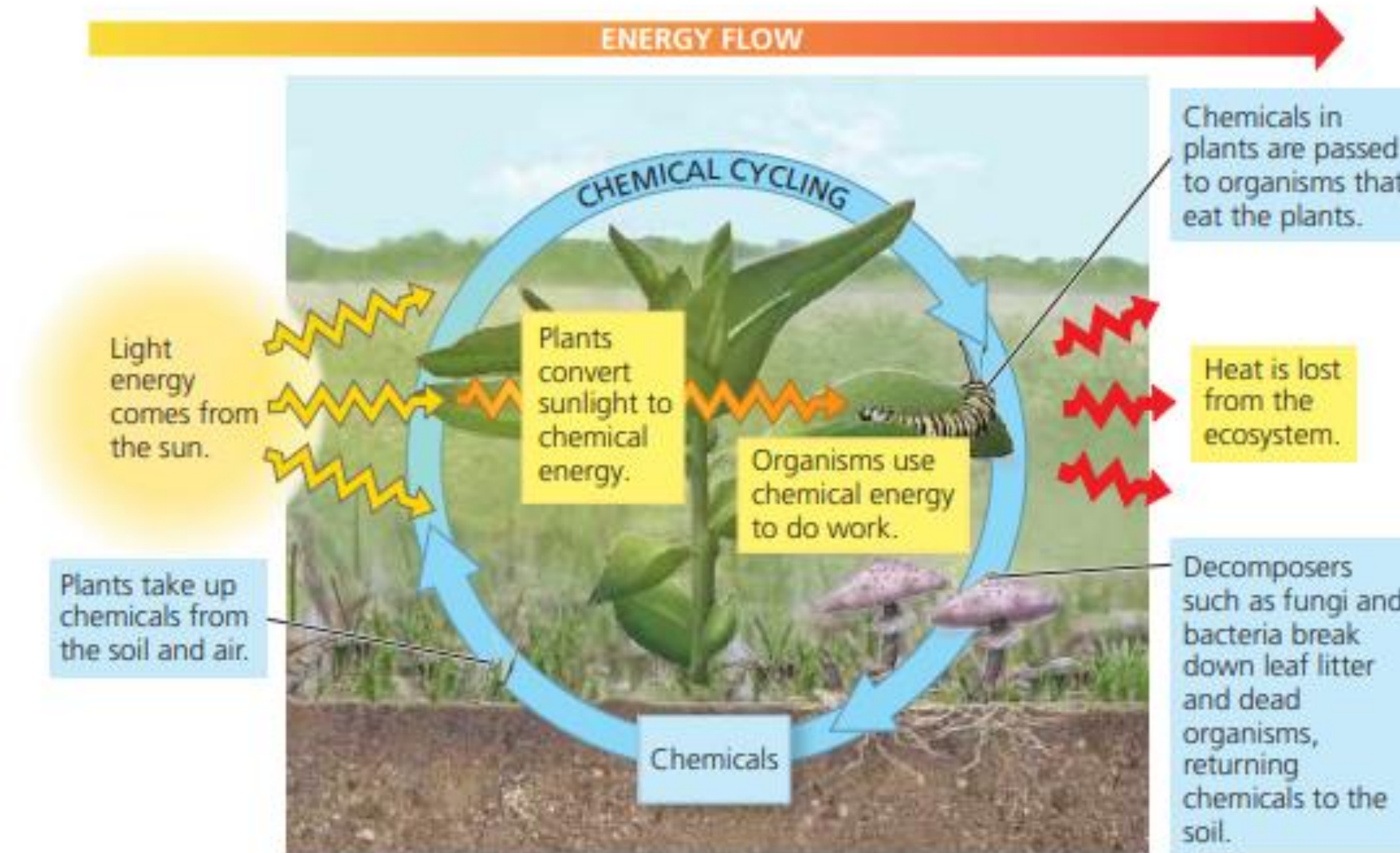
2.Information

Life's processes involve the expression and transmission of genetic information.



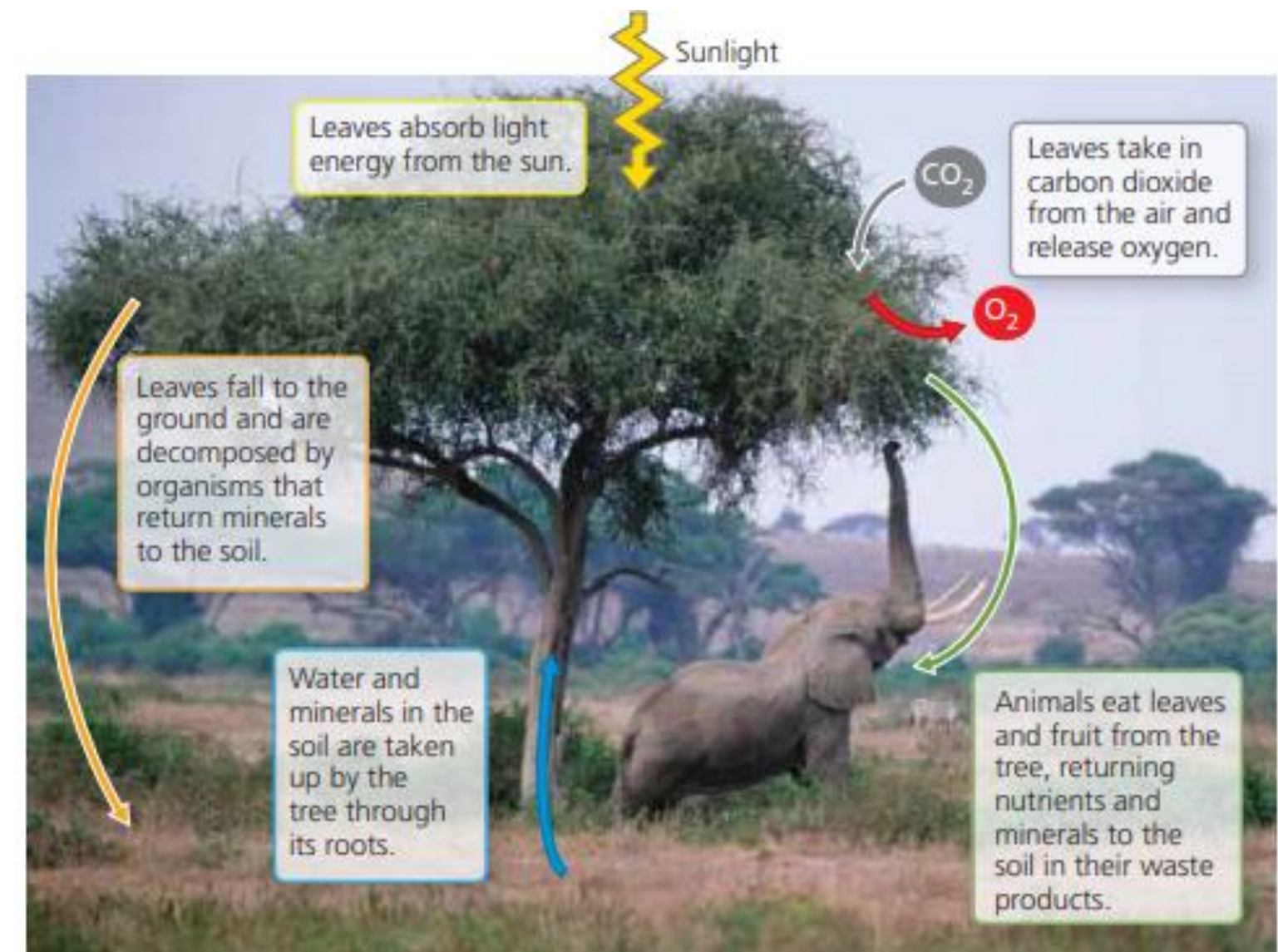
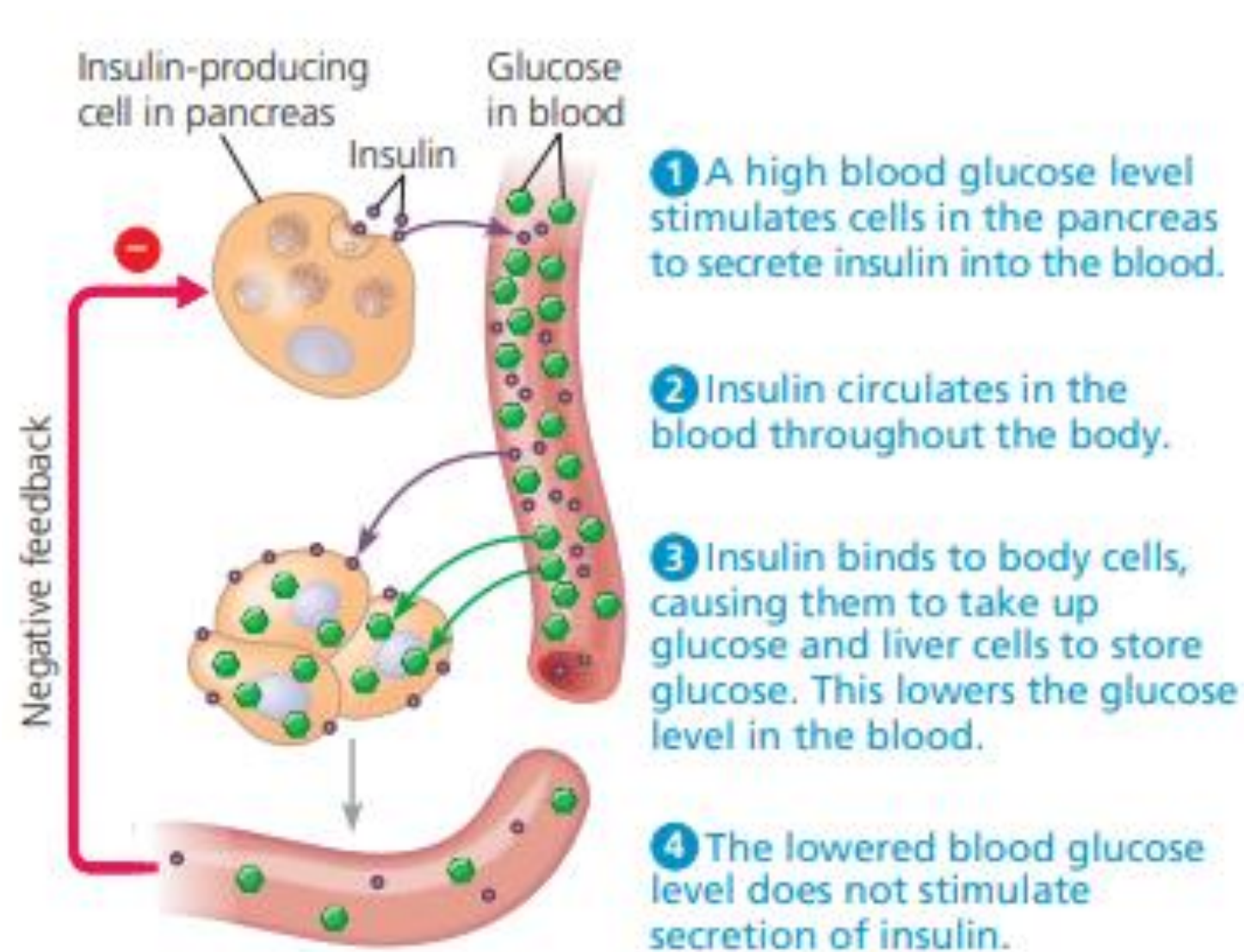
3. Energy and Matter

Life require the tranformation of energy and matter.



4. Interactions

Interactions helps to reveal the complexity and interdependence of biological systems



Feedback regulation: mechanisms that organisms use to maintain homeostasis and ensure that biological processes operate within optimal ranges.

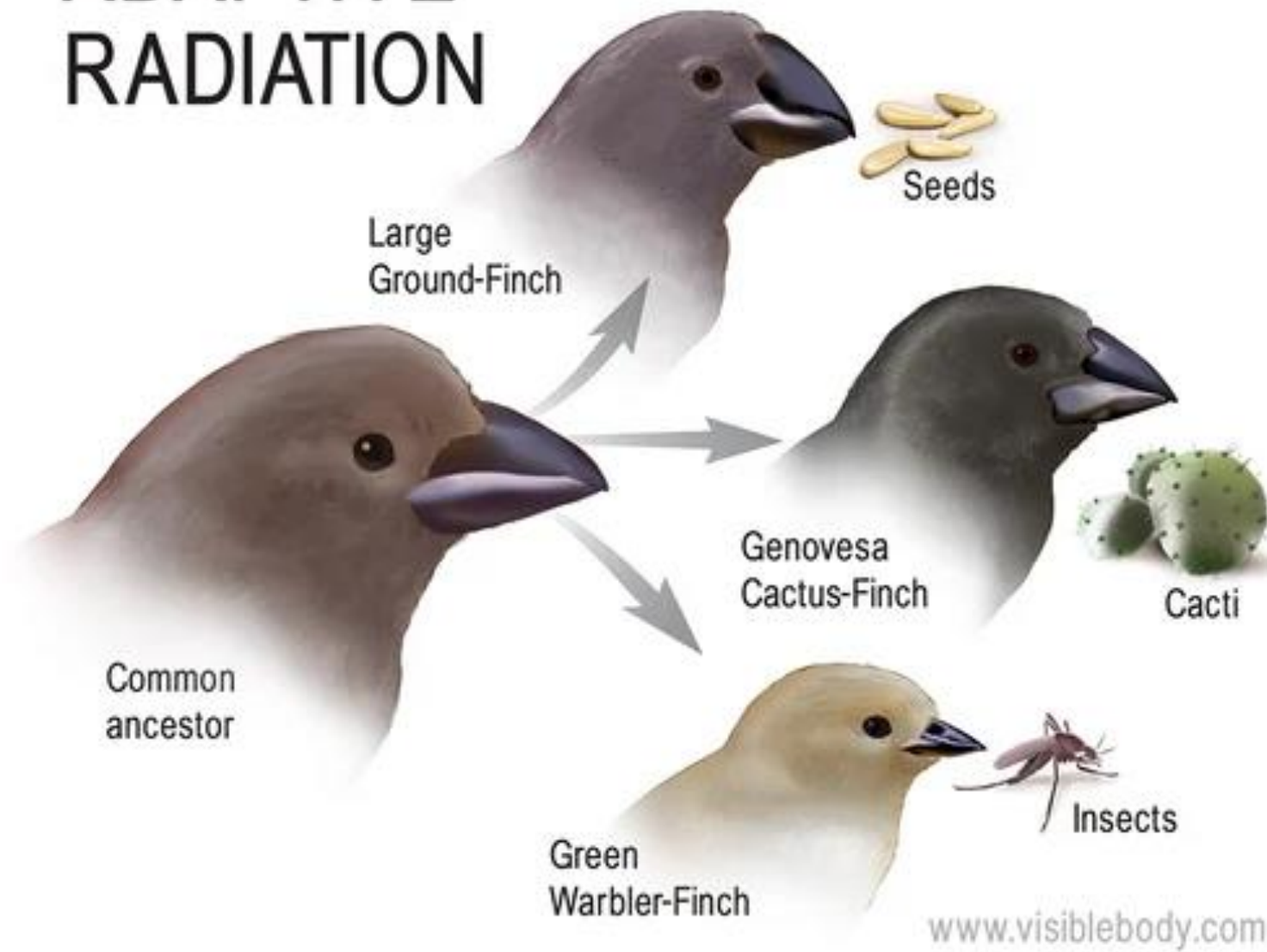
1. *Negative—a loop in which the response reduces the initial stimulus*

2. *Positive—an end product speeds up its own production*

5. Evolution

provides a framework for understanding how species adapt to their environments, how new species arise, and how all life forms are interconnected through common ancestry.

ADAPTIVE RADIATION



Thank You

For Your Attention

