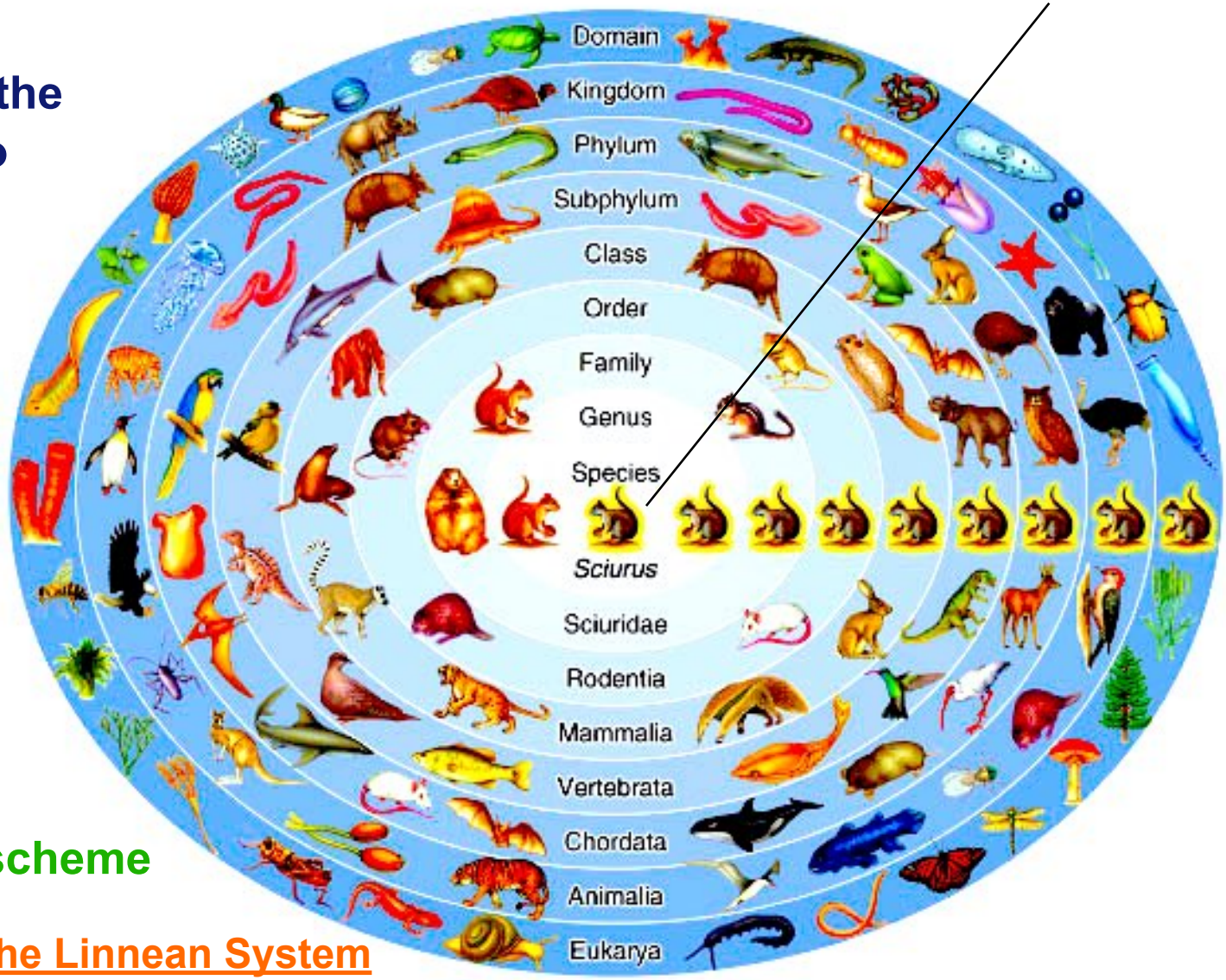
Organizing systems

- **Taxonomy** = the branch of bio that names & classifies species.
- This helps make sense out of the diversity
- Biology uses a Hierarchical scheme

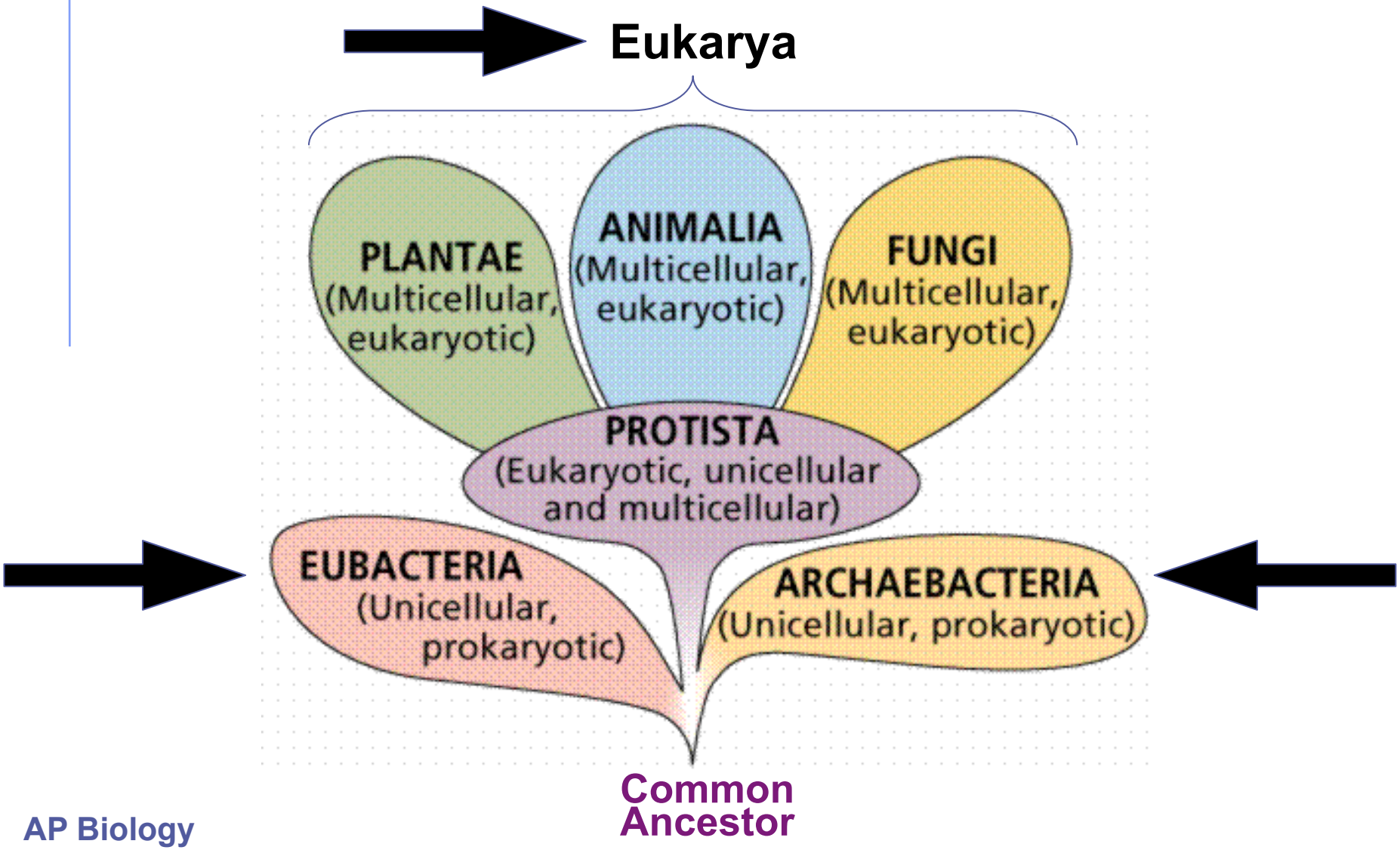


(Pictured = The Linnean System of Classification - groups species by increasing relatedness)

Life is Grouped into Three Broad Domains

Bacteria **Archaea** **Eukarya**

3 Domains of Life



http://www.emc.maricopa.edu/faculty/farabee/BIOBK/kingdoms.gif

The Prokaryotes = Cells that lack a nucleus & membrane-bound organelles

BACTERIA - the most diverse and widespread prokaryote. Most are single-celled and most are microscopic.

ARCHEA - Prokaryotes that live in extreme environments. Most are single-celled and most are microscopic.

The Eukaryotes = Cells have a nucleus & membrane-bound organelles

Kingdom Protista = Unicellular and simple multi-cellular eukaryotes like paramecia. Some perform photosynthesis while others consume food from their surroundings.

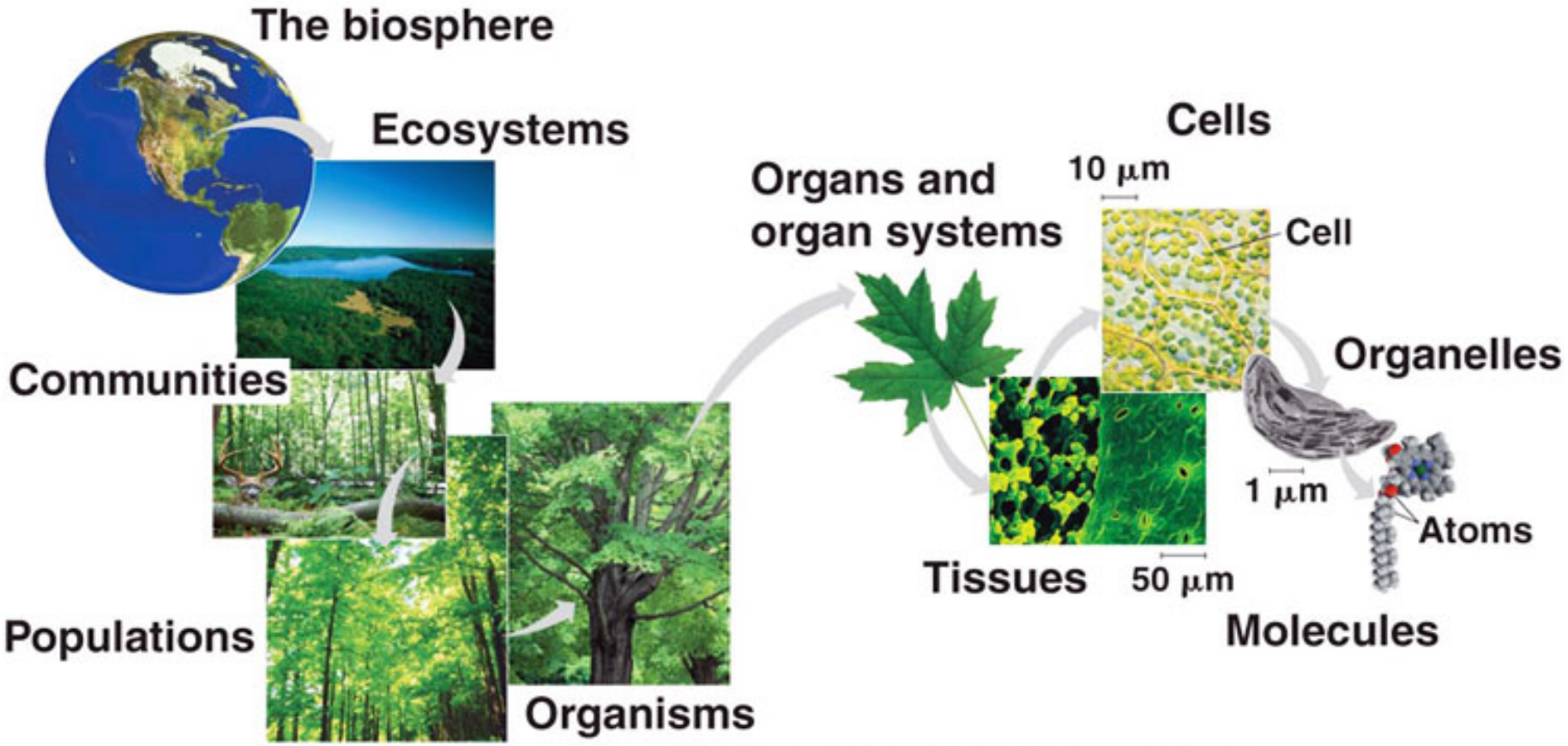
Kingdom Plantae = Multi-cellular eukaryotes that carry out photosynthesis, converting light energy into chemical energy stored in the chemical bonds in sugars.

Kingdom Fungi = Eukaryotes defined by how they obtains nutrients. Mushrooms absorb nutrients from their surroundings. Some even decompose dead organisms and organic wastes.

Kingdom Animalia = Multi-cellular eukaryotes that ingest other organisms, digesting them and absorbing the nutrients from our digestive tract. Humans belong to this kingdom.

New Properties emerge at each level in the biological hierarchy.

Emergent Properties = Properties that arise due to the arrangement and interactions of parts as complexity increases.



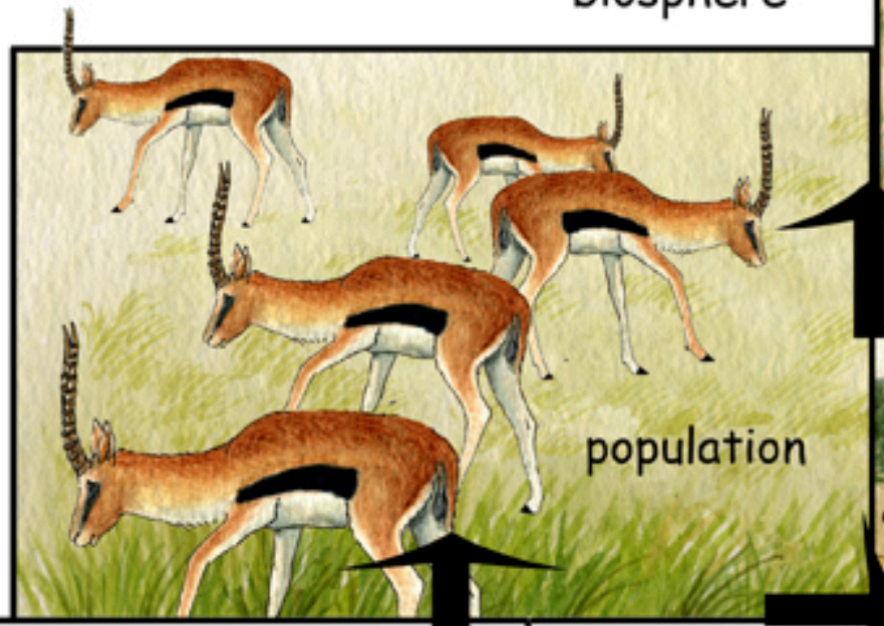
Some Terms Used to Organize Life on Earth.

- **Organism:**
  - A single living individual, like a plant or animal, considered as a unit; the basic unit of life.
- **Population:**
  - A group of individuals of the same species living in the same area at the same time, capable of interbreeding.
- **Community:**
  - A collection of different populations (multiple species) living in the same area and interacting with each other.
- **Ecosystem:**
  - A community of living organisms along with their non-living physical environment (like air, water, and soil), interacting as a system.
- **Biosphere:**
  - The part of the Earth where life exists, encompassing all ecosystems and including the atmosphere, hydrosphere, and lithosphere where life can be found.

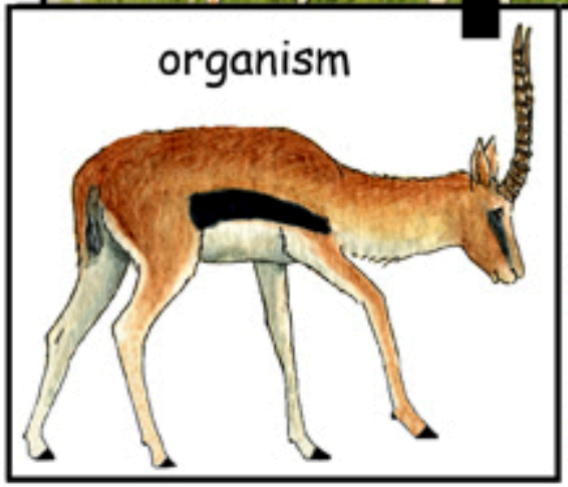
Ecology

Organizing Living Things in their Environments

biosphere



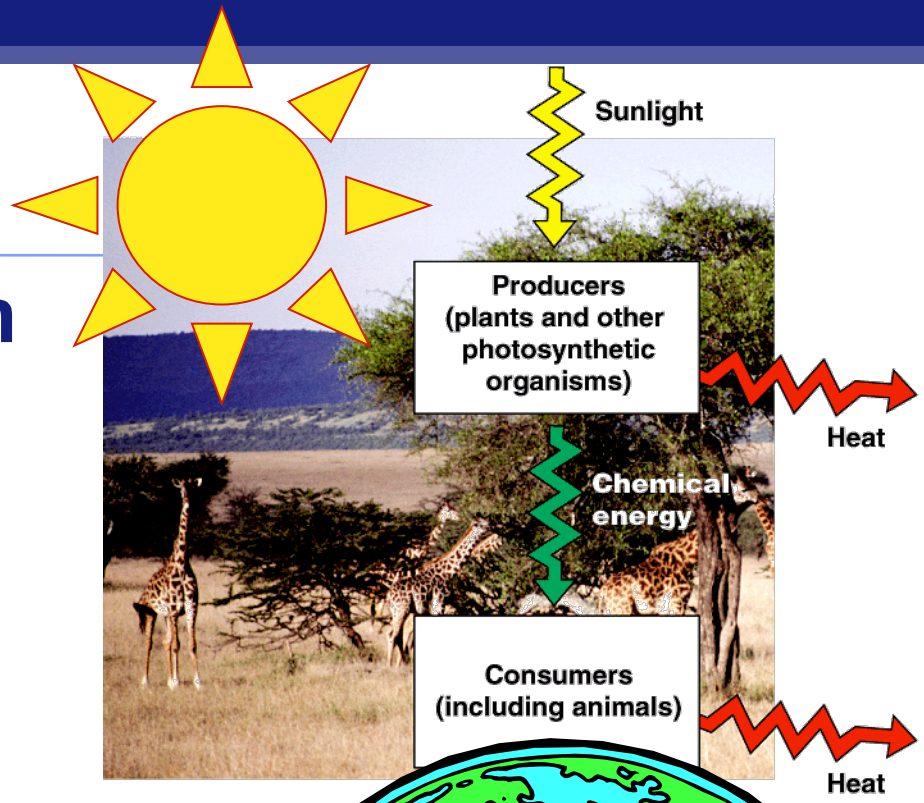
A **community** together with the non-living environment (air, water, etc.) is an **ecosystem**. All the ecosystems on Earth make up the **biosphere**.

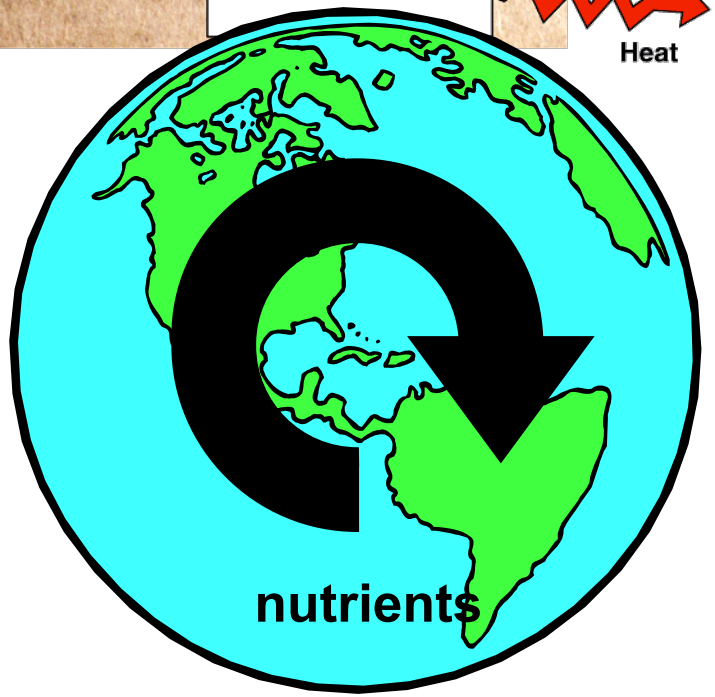


Individual living things are called **organisms**. Many organisms of one species living in one area is called a **population**. Many different populations living in one area is a **community**.

Energy transfer

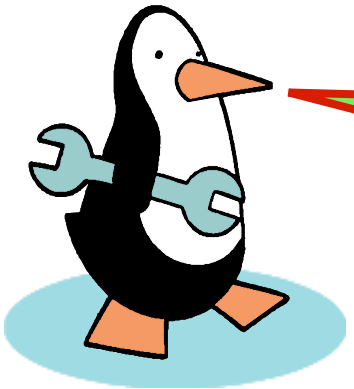
- **Life is an open system**
  - need input of energy
    - **energy** *flows through an ecosystem*
    - energy comes in, energy goes out
    - need a constant input
  - need input of materials (atoms)
    - **nutrients** are *recycled* in an ecosystem





Energy Transfer within Ecosystems

- **Producers**
  - **Where the SUN reaches:** Capture radiant energy and store it in the chemical bonds of the organic molecules they build
  - **Where NO sun reaches:** Extract chemical energy from small inorganic molecules and store it in the chemical bonds of organic molecules they build
    - **CAUTION: Producers do NOT produce/make energy**
      (They convert and store energy into a usable and accessible form)
      - Producers include organisms that can perform photosynthesis such as plants, certain types of protists (ex: green algae), cyanobacteria

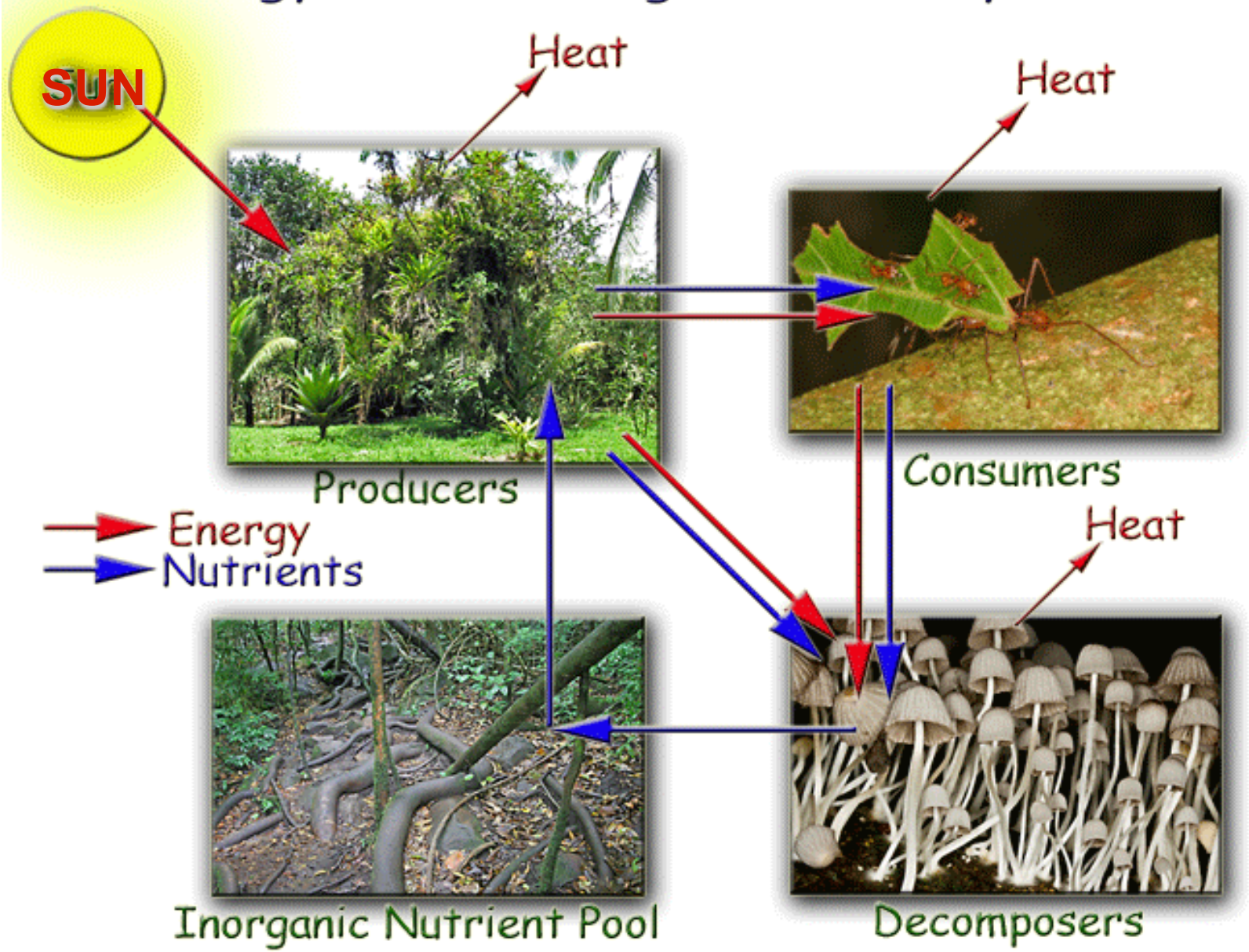


Producers convert the energy obtained from the sun or inorganic chemicals into a usable form (chemical energy in organic molecules) to all the other organisms in ecosystems

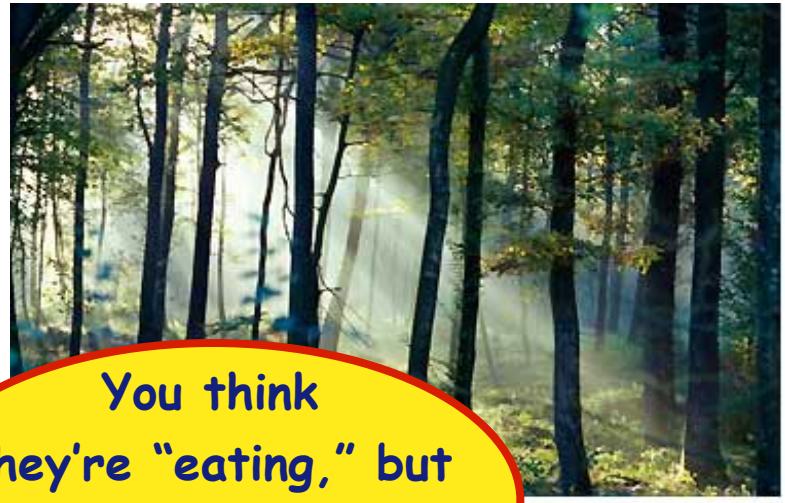
Energy Transfer within Ecosystems

- **Consumers**
  - Obtain their necessary energy in the form of chemical energy by absorbing high-energy organic molecules (which contain this chemical energy) from producers directly or indirectly.
    - **CAUTION: Consumers do NOT destroy energy**
      - Consumers include humans and other organisms incapable of conducting photosynthesis and chemosynthesis :)
- **Decomposers**
  - Like consumers, they obtain their necessary energy as chemical energy by absorbing high-energy molecules containing this chemical energy from producers and consumers
    - They help break down larger organic molecules in the bodies of producers and consumers into small inorganic molecules, returning them to the environment so producers can access these essential nutrients again.
      - Decomposers include bacteria and fungi

Energy Flow Through The Ecosystem



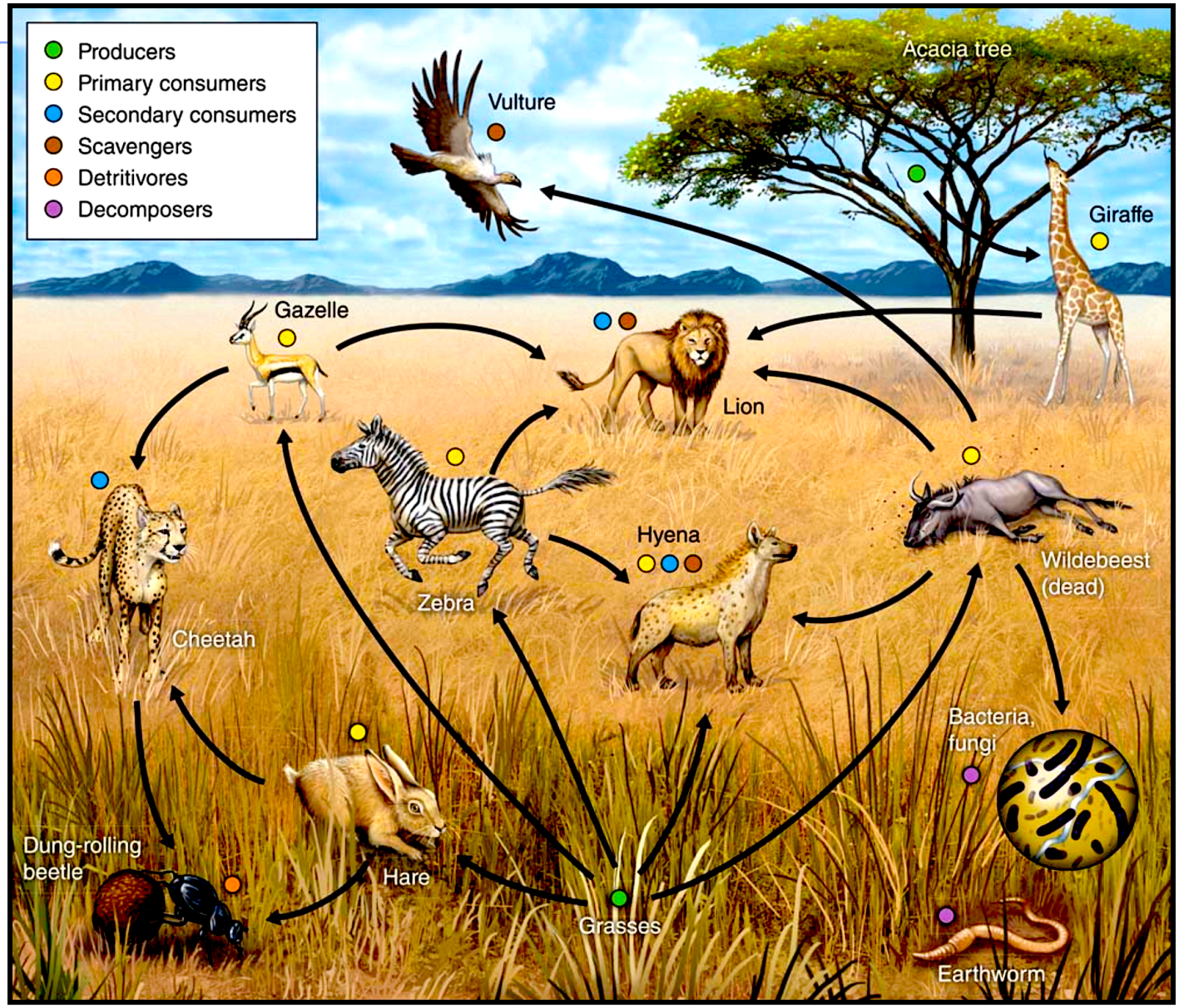
Energy utilization



You think they're "eating," but they're harvesting energy!

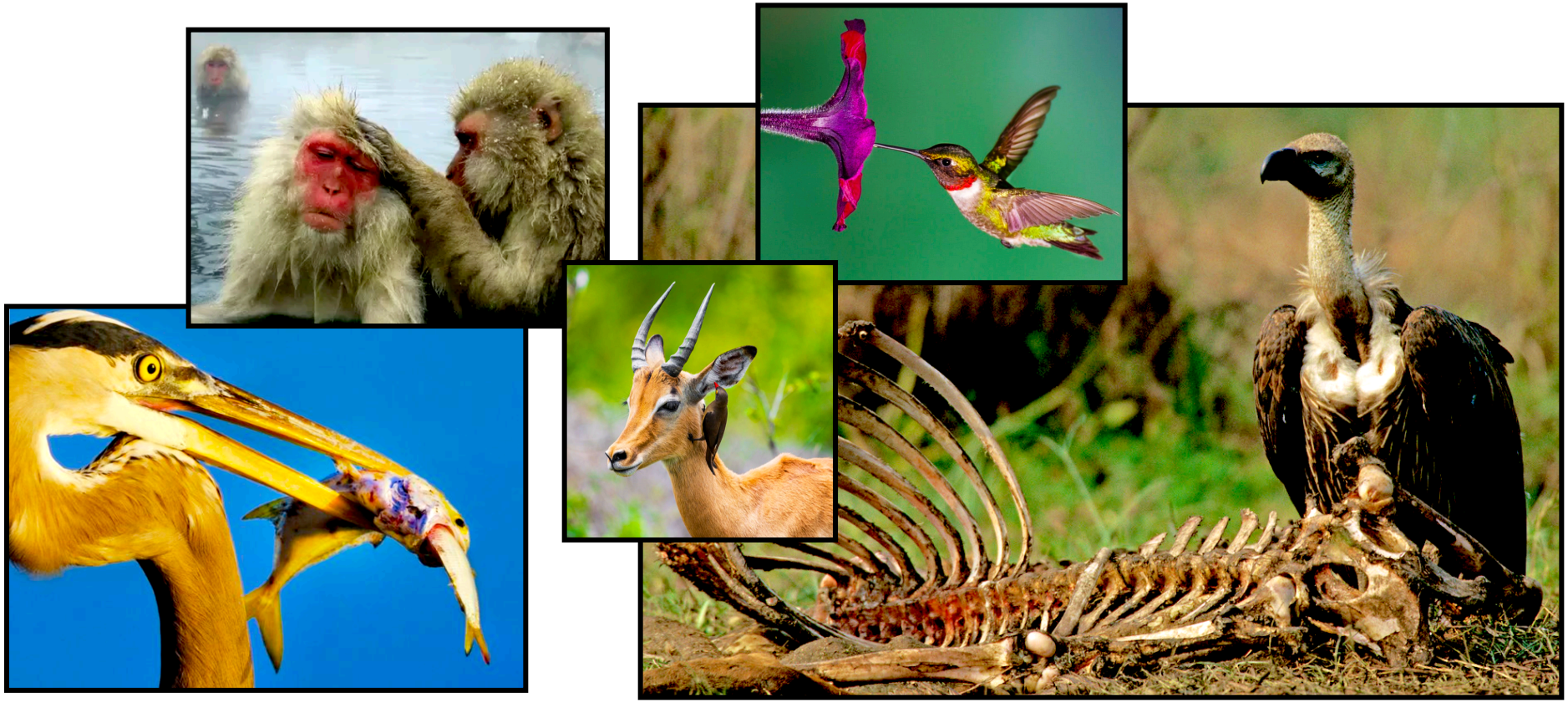
Interdependence exists throughout nature

- **For example: Necessary energy flows through ecosystems because of the feeding relationships between organisms**



Interdependence exists throughout nature

- **No organism is an island standing alone - organisms interact and affect one another at multiple levels in nature**
  - **Examples: Population (all of the organisms of one species living in a certain location), communities (composed of many species within a given area), ecosystems (all the biotic and abiotic factors within an area)**

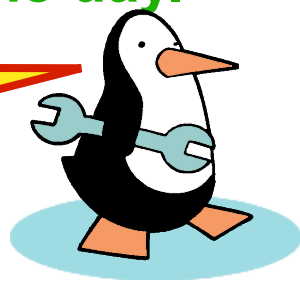


Give it a try… "Energy Transfer"

Like jackrabbits, elephants have many blood vessels in their ears that help them cool their bodies by radiating heat. Which of the following statements about this radiated energy would be accurate?

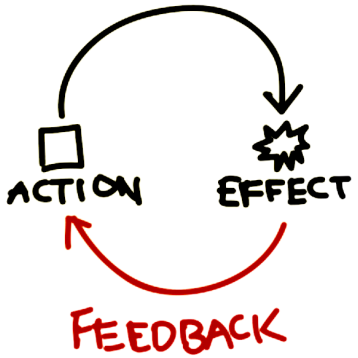
A. **The original source of the energy was the sun.**
B. **The energy will be recycled through the ecosystem.**
C. **The radiated energy will be trapped by predators of the elephants.**
D. **More energy is radiated in cold conditions than in hot conditions.**
E. **More energy is radiated at night than during the day.**

Only the energy stored in tissues
(body matter) is available for predators!
Not the energy lost as HEAT!



Regulation Through Feedback Loops

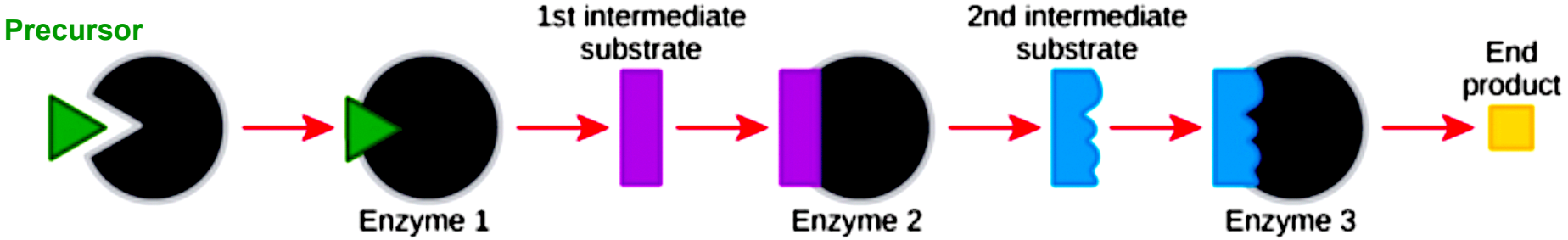
- **Regulation away from or towards a certain result is often accomplished through feedback loops**
  - **In a feedback loop, the end result of an action controls whether more or less of that same action will occur.**
    - **In Negative Feedback Loops, the end result of an action decreases, stops, or reverses more of that action.**
    - **In Positive Feedback Loops, the end result of an action encourages more of that action.**



- **Why do organisms need to regulate?**
  - **Organisms need to maintain a "steady state" *(prevent fluctuations of certain variables inside the cell/body)* in the face of changing conditions in the environment**
    - **Maintaining this 'steady state' is termed homeostasis**
      - **We need to be able to stop or reverse a change, biochemical pathway, or behavior from occurring to maintain homeostasis.**
  - **Other times, however, we may need to temporarily encourage more of a certain activity or change, and move a way from a certain "set point" *(to encourage a deviation from the typical state or from homeostasis inside the cell/body)***

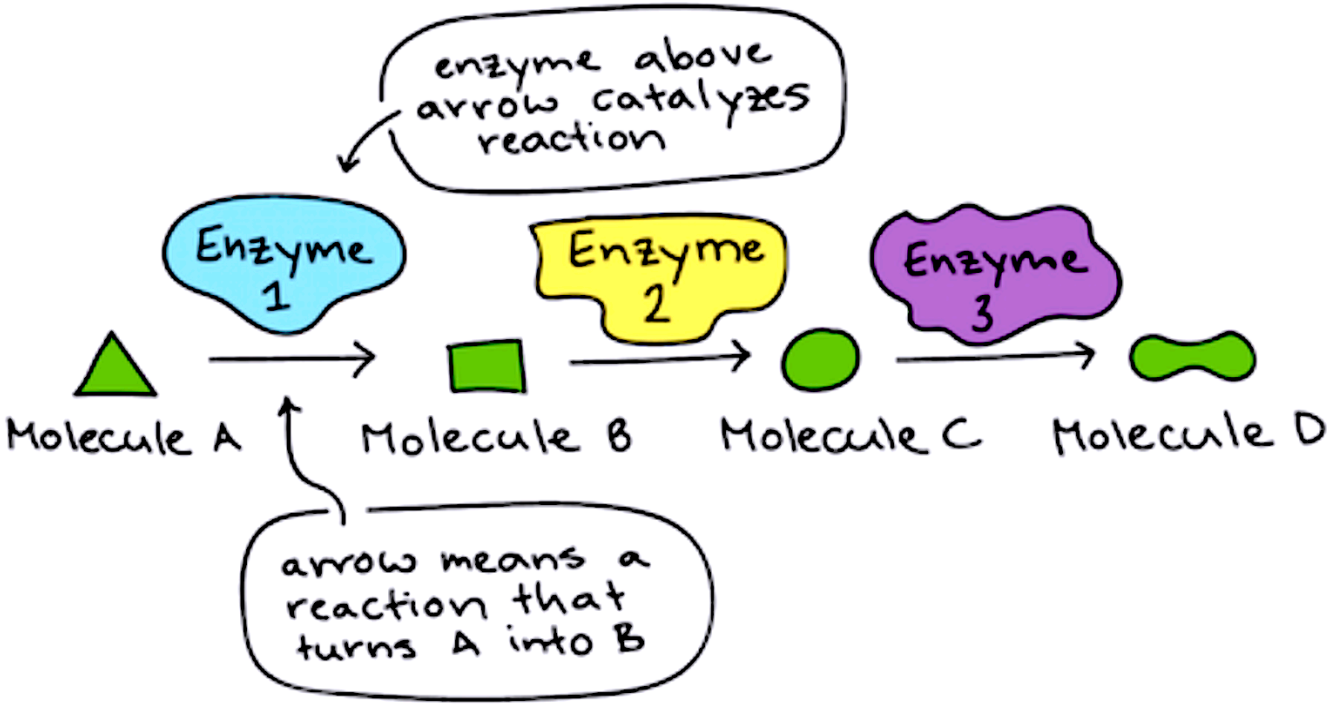
Example: Biochemical Pathways Can be Regulated By Feedback

- Cells are constantly carrying out thousands of chemical reactions needed to keep the cell, and your body as a whole, alive and healthy.
  - These chemical reactions are often linked together in chains or pathways.
- Biochemical Pathways (also called Metabolic Pathways) involve a series of enzyme-mediated reactions where the product of one reaction is used as the substrate in the next.
  - They involve a series of connected chemical reactions that feed one another.
    - The pathway takes in one or more starting molecules or reactants, referred to often as precursors, and, through a series of intermediates, converts them into final products.



Example: Biochemical Pathways Can be Regulated By Feedback

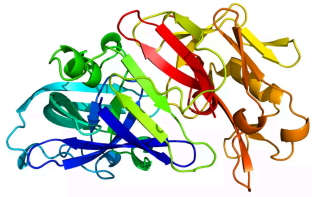
- **Chemical Reactions in Biochemical Pathways don't take place automatically and without assistance.**
  - **Instead, each chemical reaction in a pathway is facilitated, or catalyzed, by a specific protein called an enzyme.**
    - **Each type of enzyme catalyzes a specific chemical reaction.**
    - **When chemical reactions are linked into chemical pathways, each step in the pathway is catalyzed by its own distinct enzyme.**



Example: Biochemical Pathways Can be Regulated By Feedback

- **Negative Feedback Regulation (Feedback Inhibition) or in Positive Feedback Regulation (Feedback Activation) in metabolic/biochemical pathways involve regulating enzyme activity.**
  - **Enzymes are needed for chemical reactions to take place. These enzymes help reactants convert into products.**

- **Certain enzymes (BIOLOGICAL CATALYSTS) can be turned off as needed so that a product of a biochemical pathway can't be made when that product starts accumulating in excess or isn't necessary.**

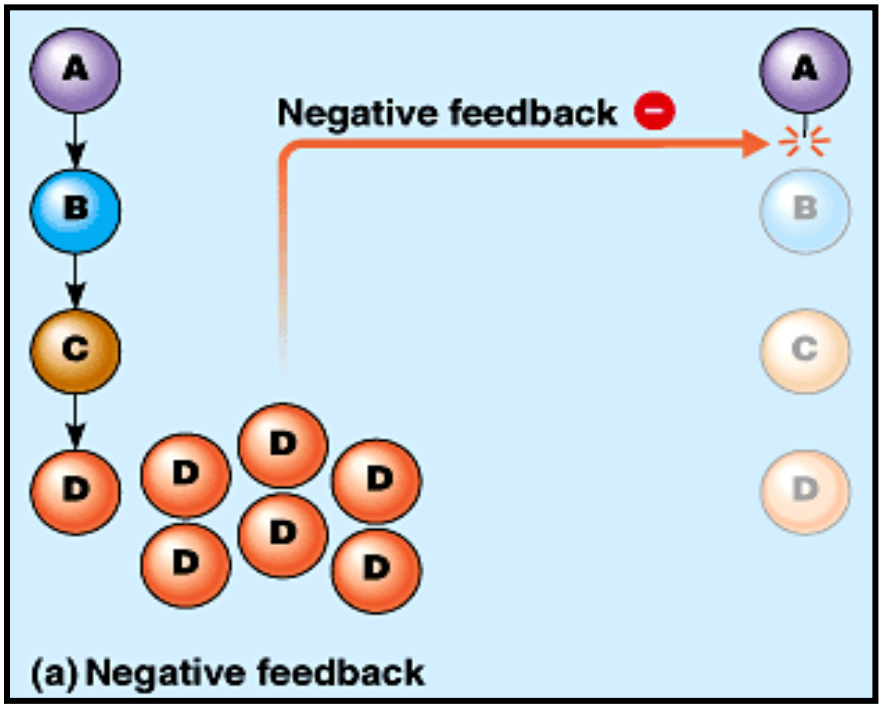


- **Other enzymes (BIOLOGICAL CATALYSTS) can be turned on or enhanced further as needed so that a product of a biochemical pathway starts being made or is made even more efficiently/rapidly than before.**

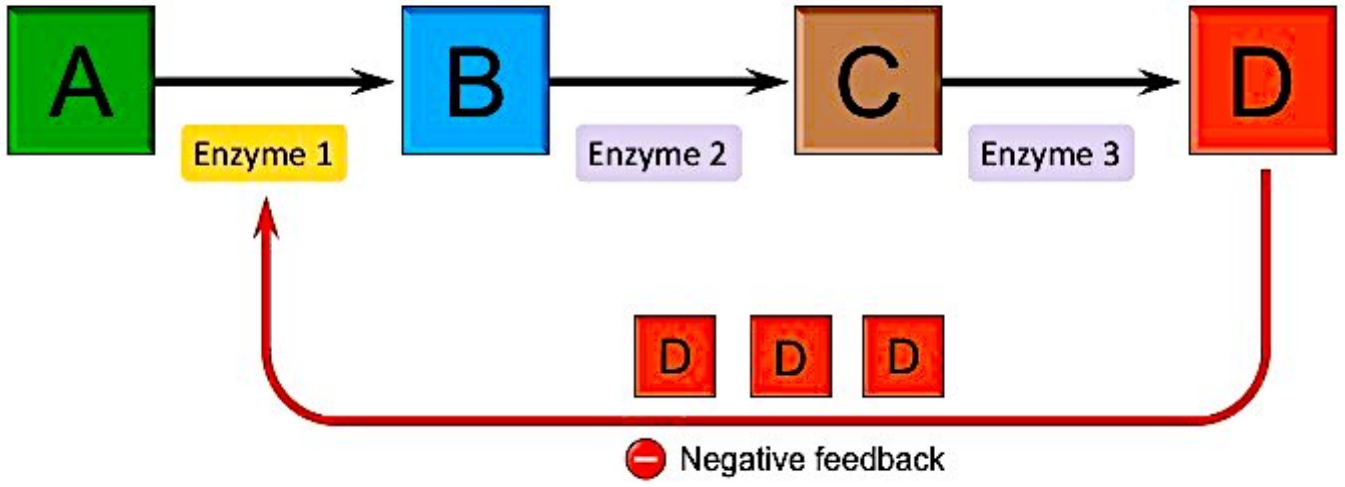
NEGATIVE Feedback Regulation Example

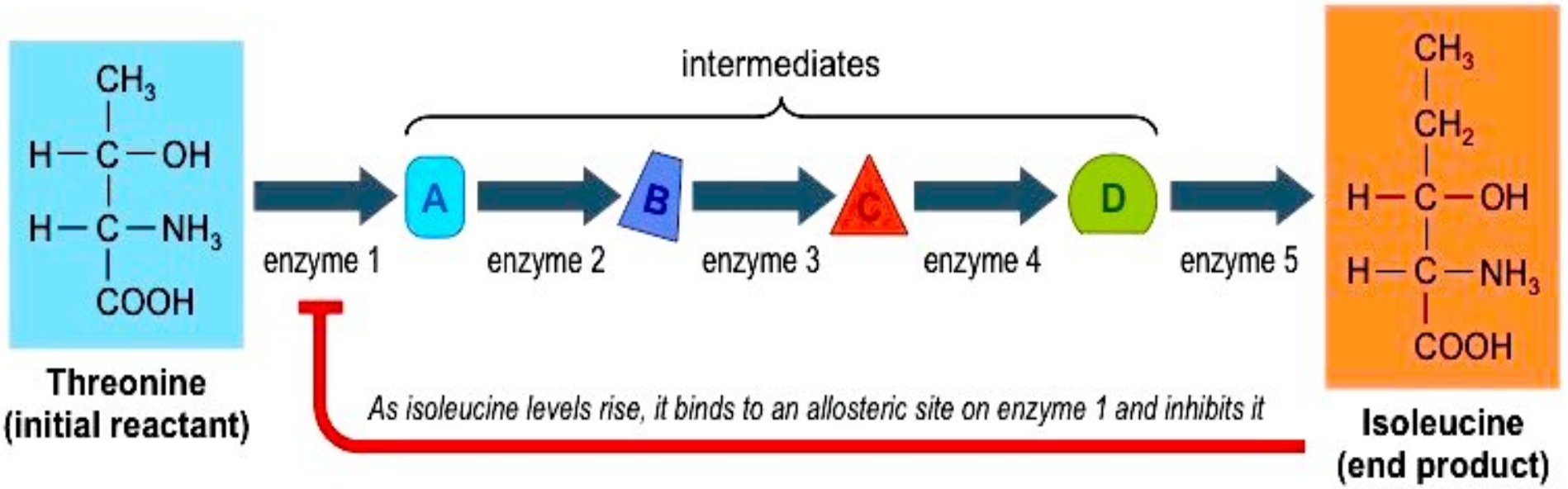
- Involves enzyme inhibition in biochemical pathways
  - Enzymes (BIOLOGICAL CATALYSTS) are turned off as needed so that a product of a biochemical pathway isn't made when that product starts accumulating in excess.
    - Each type of enzyme catalyzes a specific chemical reaction.
    - These reactions are often linked into chemical pathways, each step in the pathway being catalyzed by its own enzyme.

- In Negative Feedback or Feedback Inhibition, accumulation of the final product of a biochemical pathway inhibits an enzyme that works earlier in the pathway, slowing down or stopping production of more of the final product of the pathway.



NEGATIVE Feedback Regulation Example

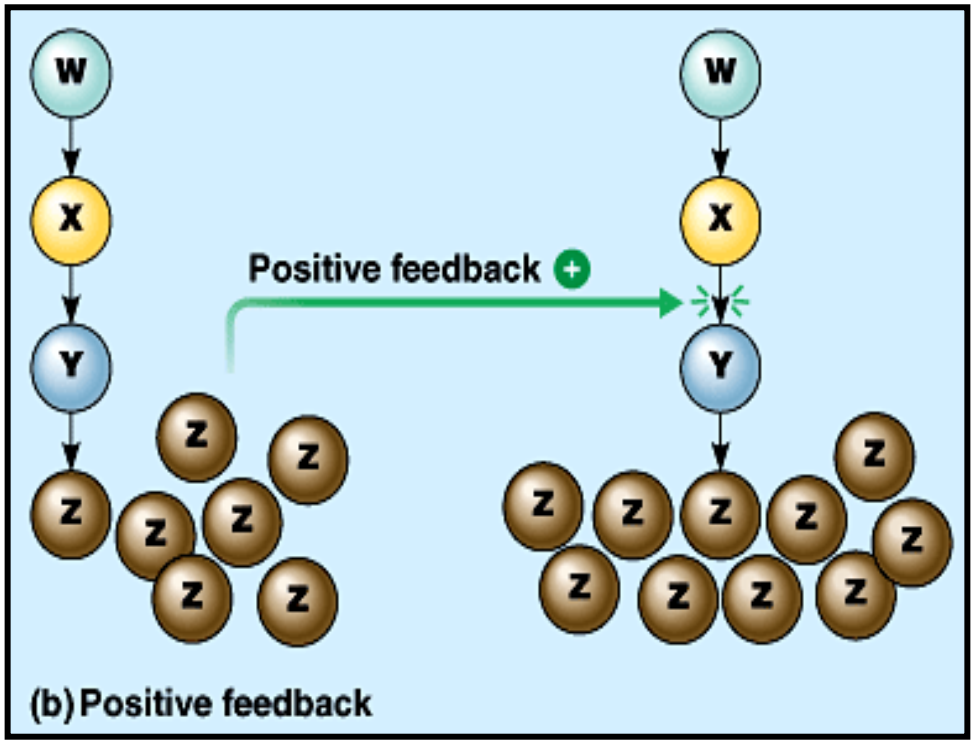




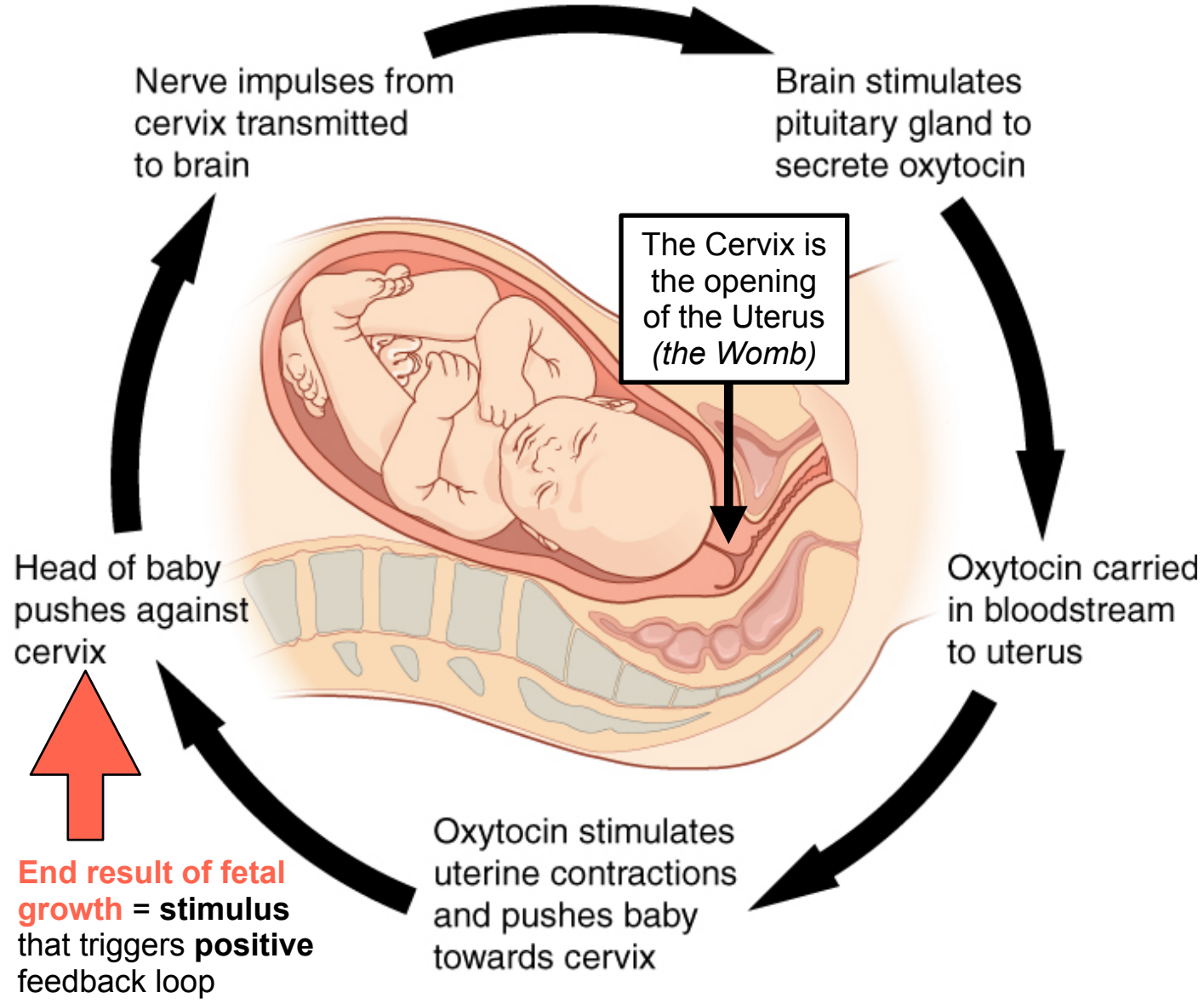
POSITIVE Feedback Regulation Example

- Enzyme activity enhancement in a biochemical pathway
  - In Positive Feedback, the product of the biochemical pathway stimulates (enhances the activity of) an enzyme used earlier in a chemical pathway.

- Whereas the production of end product is halted in negative feedback, in Positive Feedback or Feedback Activation, accumulation of the final product of a biochemical pathway enhances an enzyme that works earlier in the pathway, increasing production of the final product of the pathway, resulting in even more product formation.



POSITIVE Feedback Regulation Example Not Involving a Biochemical Pathway



Human Childbirth

PRESSURE on the cervix, as a result of the fetus size and position, indirectly causes uterine contractions to start, which **causes even more pressure** on the cervix. This **additional pressure** indirectly stimulates even stronger and longer uterine contractions, which **causes still more pressure** in a loop that continues until the fetus is pushed out of the mother's body during delivery.

Science, Technology & society

- Science is an intensely social activity with most scientists working in teams.
  - Cooperation and competition characterize the field
  - Science & technology must function within the rules of society
- The goal of science is to *understand* natural phenomena while technology *applies* scientific knowledge for some specific purpose.