

Agenda

- **1:30 – 2:50:**
 - **Lecture Slides: Energy and Nutrient flow in Ecosystems**
 - **Activities 1, 2 and 3 during slide presentation**
 - No handout
 - Write out the questions along with the answers
 - Handwriting must be legible
- **2:50 – 3:20: Activity 4**
 - **Mid-term Presentation Meeting 1: Choose one Aquatic System or Biome**
 - **Due from each team: Presentation Topic, Team and member names**
 - **Due from each student:**
 1. Preliminary List of sub-topics
 2. Sources
 3. Half page write up on sub-topics

Ecosystems – Function

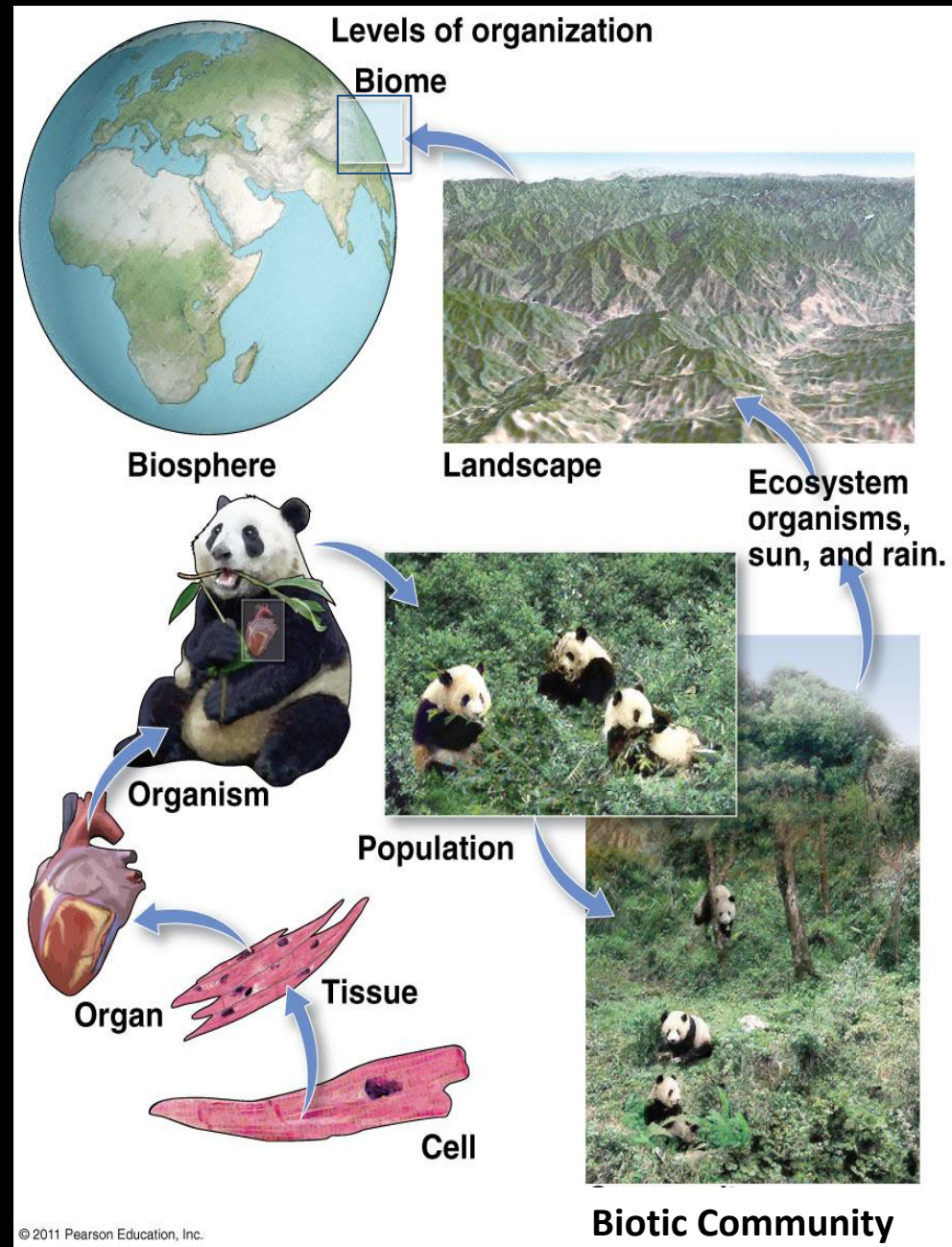


*Energy & Nutrient Flow in
Ecosystems*

Ecosystems Structure

Ecological Hierarchy

- How is an ecosystem sustained?
- How do individual organisms survive and thrive within the limits set by the Fundamental Biological Principle?
- They need Nutrients and Energy



Matter and Energy

Matter: All substances made up of **elements (atoms)** and **compounds (molecules)**

Energy: The capacity to do work

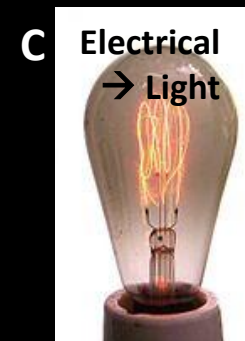
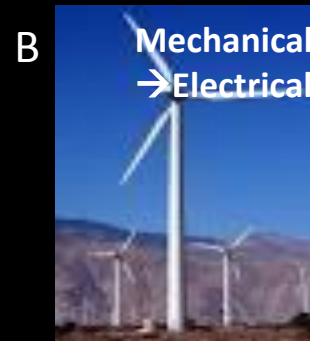
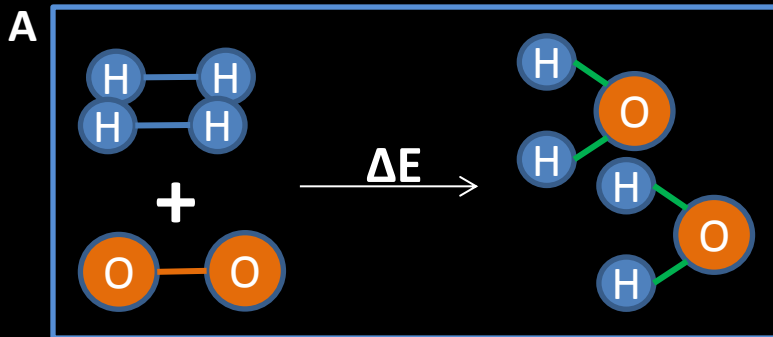
Potential (stored) **Kinetic** (from movement)

Matter and Energy obey **UNIVERSAL LAWS**

- The Law of **Conservation of Matter** (see A)

(The First and Second Laws of Thermodynamics) (see B & C)

- The Law of **Conservation of Energy**
- The Law of **Increasing Entropy**



Law of Increasing Entropy

The Total Entropy of a system and its surroundings can never decrease over time

Entropy:

- 1. It represents how uniformly energy is distributed in the system.**
 - 2. The more uniform it is, higher the entropy.**
- A system can work only if energy is non-uniformly distributed within it.**
 - Doing work means conversion of any form of energy to kinetic energy.**
 - During this process, some of the energy is lost to the surroundings where it gets evenly distributed – Irretrievable, heat loss!**

Consequence:

- 1. Energy cannot be converted with 100% efficiency**
- 2. Energy must be supplied continuously for a system to do work**

Scientific Fact:

The Matter Conservation Law

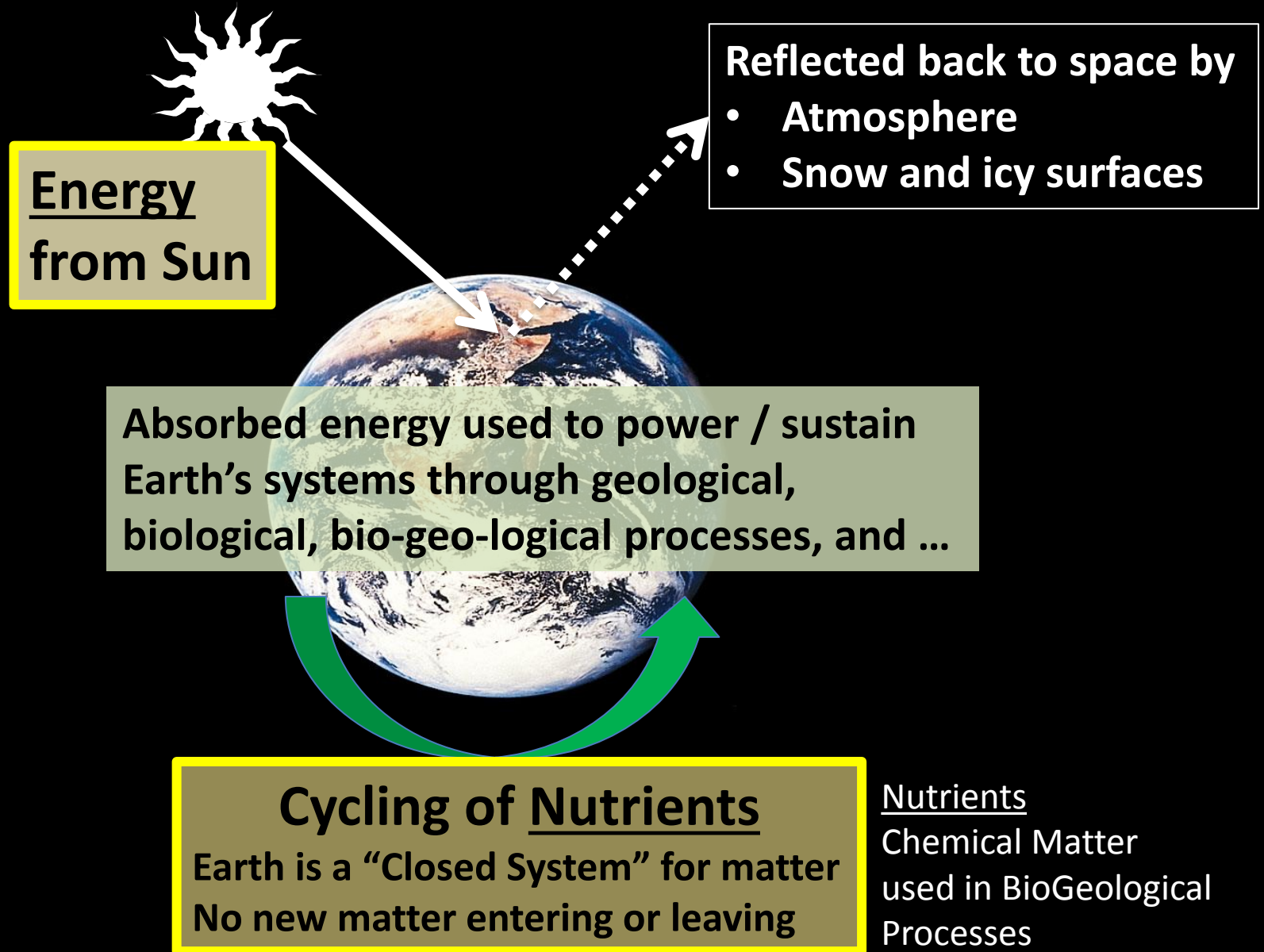
The First and Second Laws of Thermodynamics

Govern all the Earth's Systems and their interactions

- Including the Biosphere
- At all levels of the Ecological Hierarchy

Q: Where is the energy source and how is matter used?

Life on Earth Sustained by ...

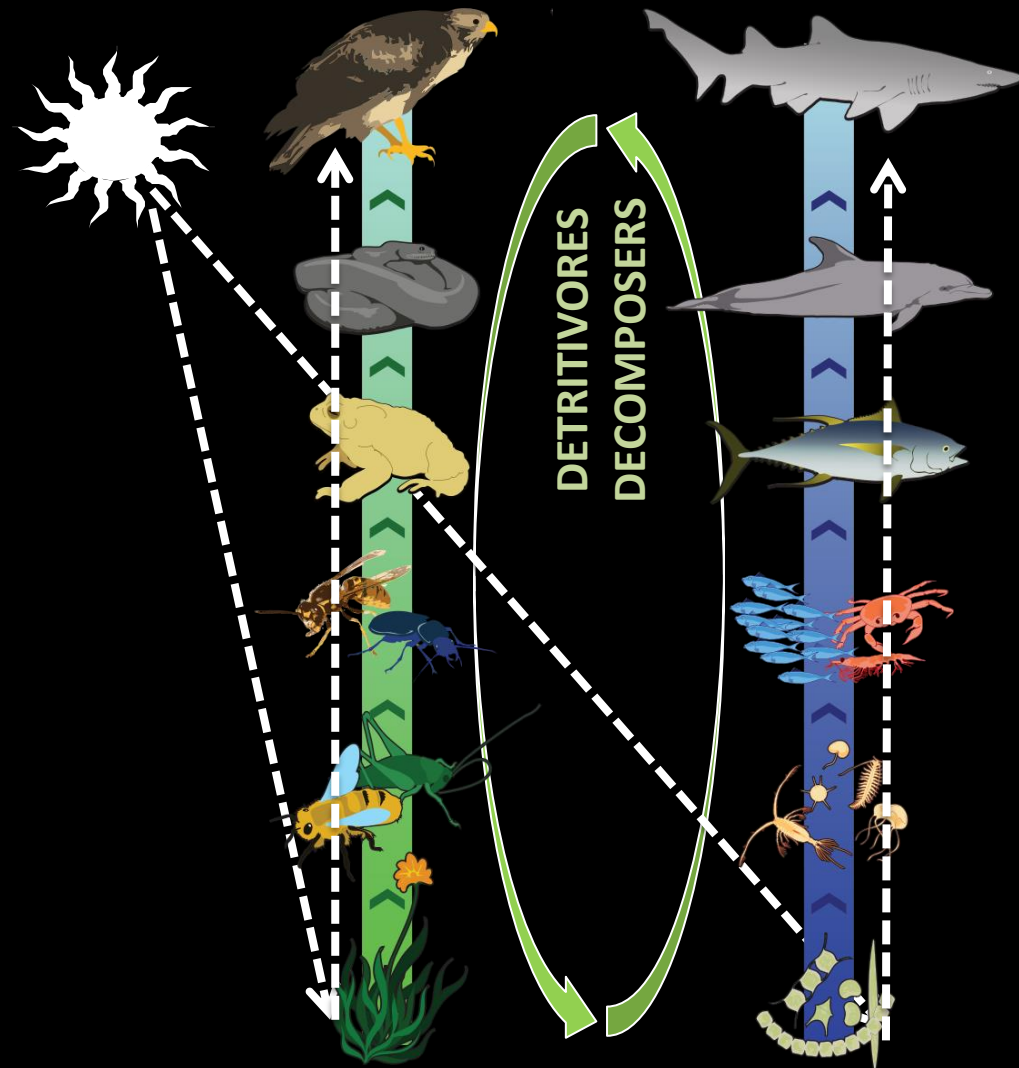




How do Matter (nutrients) and Energy
Flow in Ecosystems?

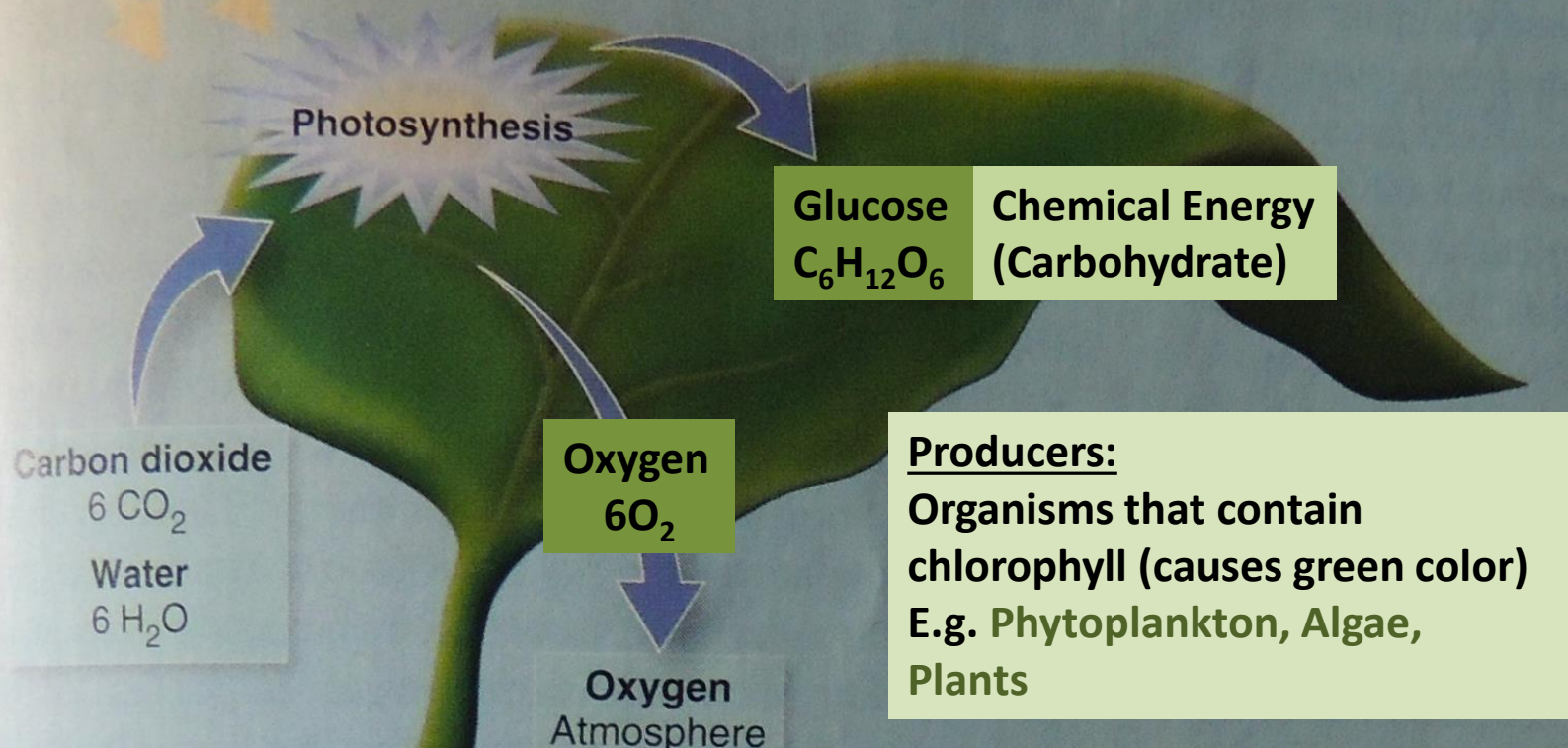
Life sustained by
One way flow of Energy from the Sun
Cycling of Nutrients (Chemical Matter)

- How do Energy and Nutrients enter the Ecosystem?
- How do they move through the Ecosystem?
- How are those first chemicals that store energy formed?



Producers: Energy and Nutrients

Photosynthesis: A Chemical reaction that occurs in Producers
Uses solar radiation and abiotic resources to make Glucose



Photosynthesis (Activity 1)

“Using sunlight to make carbohydrates”

Photosynthesis Questions:

1. Where is the energy for photosynthesis coming from?
2. Write and label the chemical reaction for photosynthesis.
3. Where does it occur?
4. Is life sustainable? Why?
5. Why is it important to you? List at least 3 reasons...



Photosynthesis (Activity 1)

“Using sunlight to make carbohydrates”

Photosynthesis Questions:

1. Where is the energy coming from? The SUN
2. Write and label the chemical reaction for photosynthesis.

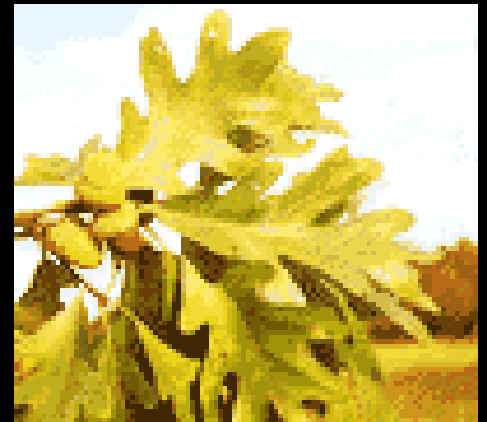


3. Where does it occur? In green life forms such as plants, algae, phytoplankton
4. Is life sustainable? Yes! The sun shines! Matter is cycled! It's been around for 3.5 Billion Yrs.
5. Why is it important to you? List at least 3 reasons...

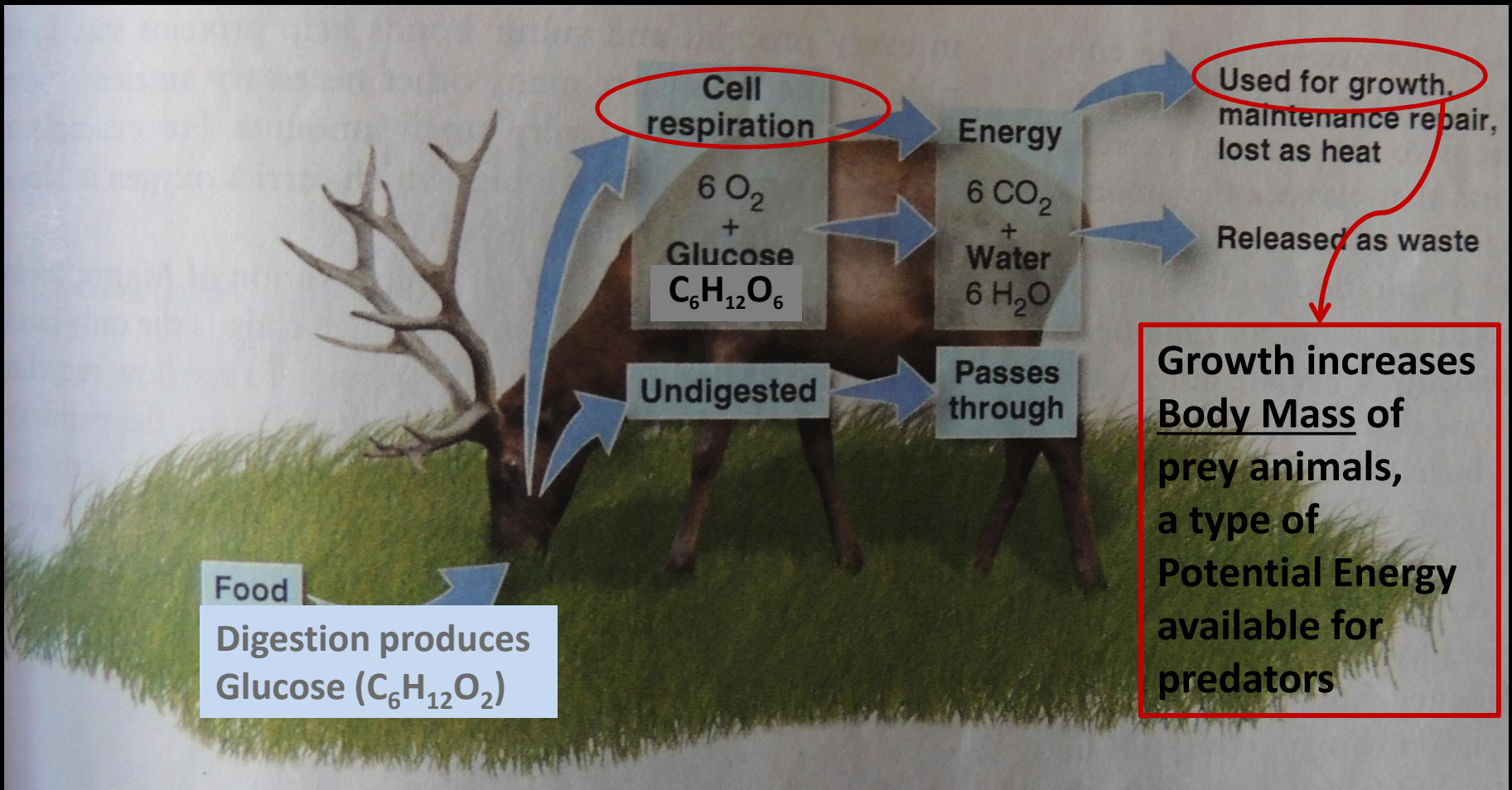


Here are some ways plants benefit us!

- **Produce oxygen**
- **Take up carbon dioxide**
- **Convert radiant energy into chemical energy**
 - **Produce food (carbohydrates)**
- **Aesthetics!**
 - **Shade**
 - **Gives us beauty!**



Consumers: Energy and Nutrients

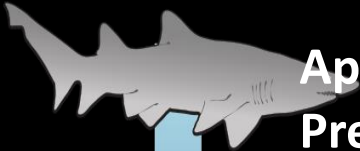


**Cell Respiration: Chemical Reaction that depends on producers for nutrients
Releases Energy that sustains consumers**

Level

Category

6



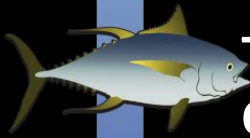
Apex
Predator

5



5th level
Consumer

4



Tertiary
Consumer

3



Secondary
Consumer

2



Primary
Consumer

1



Producer

Food Chain

- **Sequence of organisms** in the flow of energy and nutrients, each of which is a source of nutrients for the organism that *consumes* it

- Trophic levels
- Trophic categories
- “Troph” = “nutrition”

- Producers (auto-trophs)
- Consumers (hetero-trophs)
- Primary Consumers (prey)
- Secondary and above (predators)

Food Web

- Most prey species have multiple predators, and many predators have multiple prey species, leading to a web!
- A **web** is a **complex network** of many interconnected **food chains**

Sustainability and Trophic Categories

Consumers (heterotrophs)

- Herbivores, carnivores, omnivores
- Animals, zooplankton, some bacteria, some protists, fungi

Detritivores (heterotrophs)

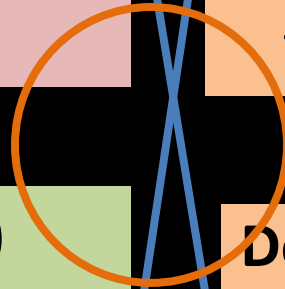
- Eats detritus (dead biotic material – dead plant matter, fecal wastes of animals & dead animals)
- Animals, birds, insects, worms, fungi, bacteria

Producers (autotrophs)

- Plants, phytoplankton, some bacteria and protists

Decomposers (heterotrophs)

- Break down detritus - Secrete enzymes that “decays” or “rots” detritus
- Fungi, bacteria



Activity 2: Food Web

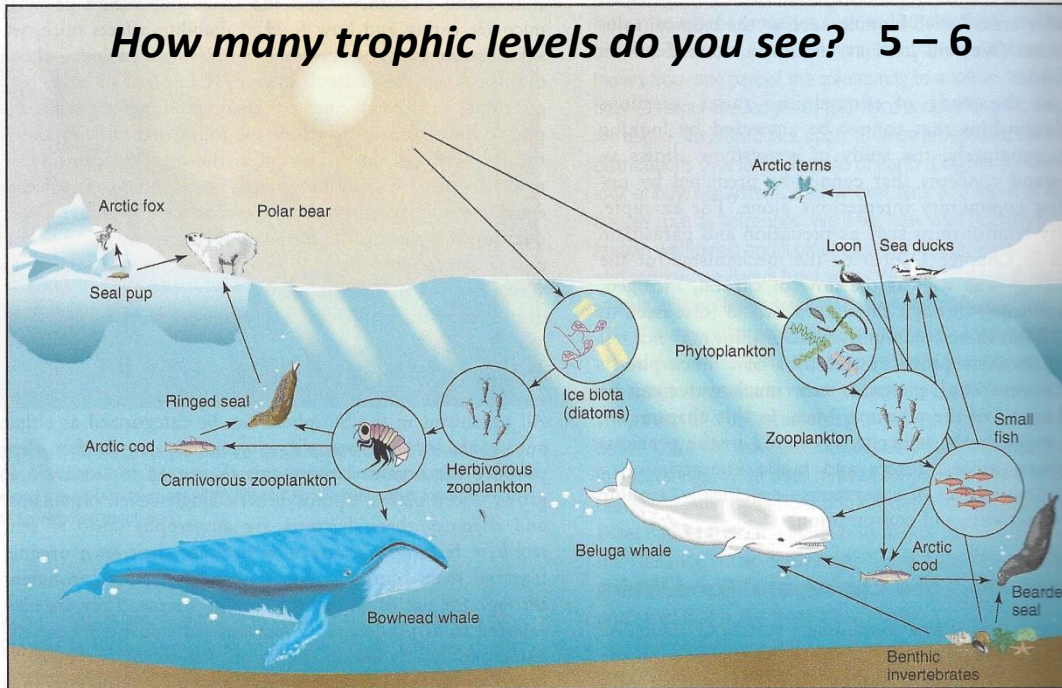
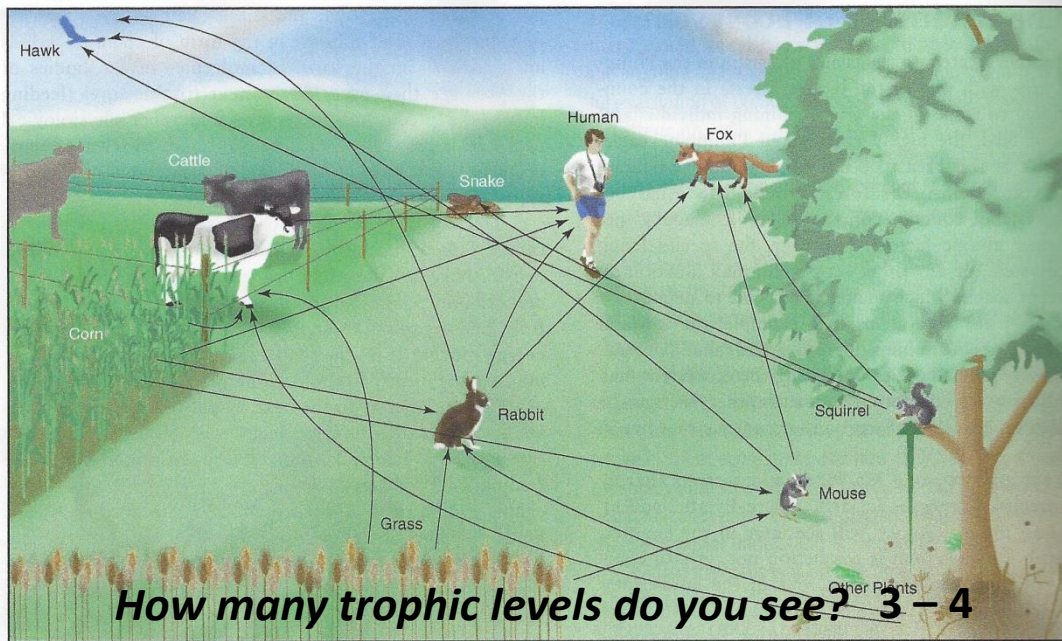
- 1. Write down at least 2 food chains in the terrestrial ecosystem**
- 2. Write down at least 2 food chains in the aquatic ecosystem**
- 3. Identify and write down the longest food chain in the aquatic ecosystem**

Arrow points to the direction of flow of nutrients and energy

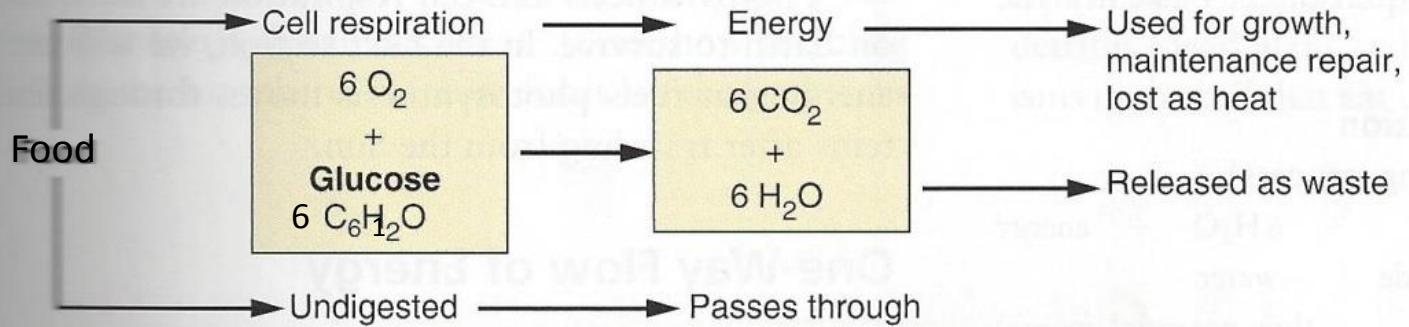
Predator



Prey



Why so few Trophic Levels?



Minus energy used for maintenance, repair, heat loss

The remaining energy stored in the body mass, aka BIOMASS, available to the Next Trophic Level



Biomass Distribution

Much less biomass at the Secondary and higher Consumer levels

Carnivores/Predators
Secondary Consumers

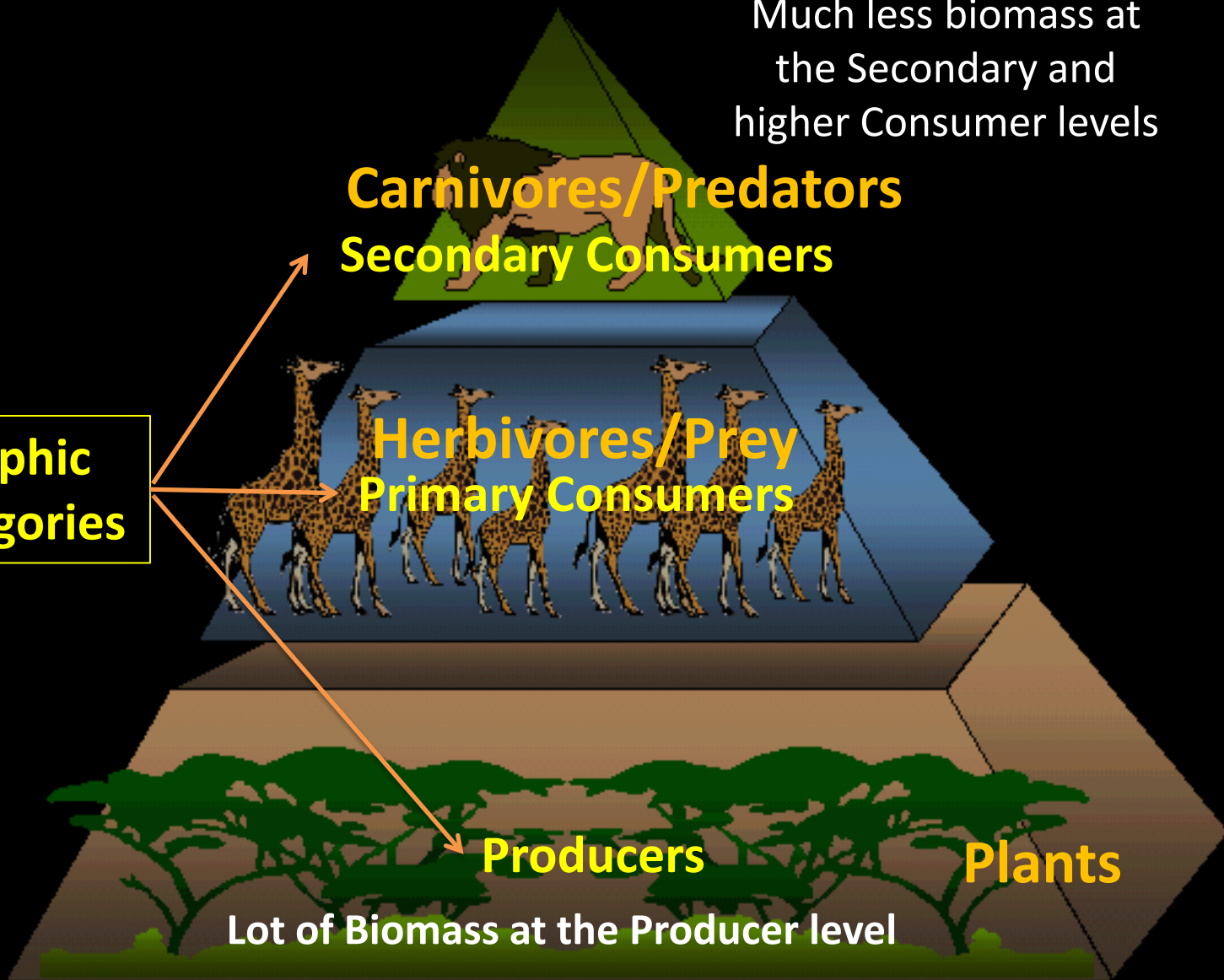
Herbivores/Prey
Primary Consumers

Trophic Categories

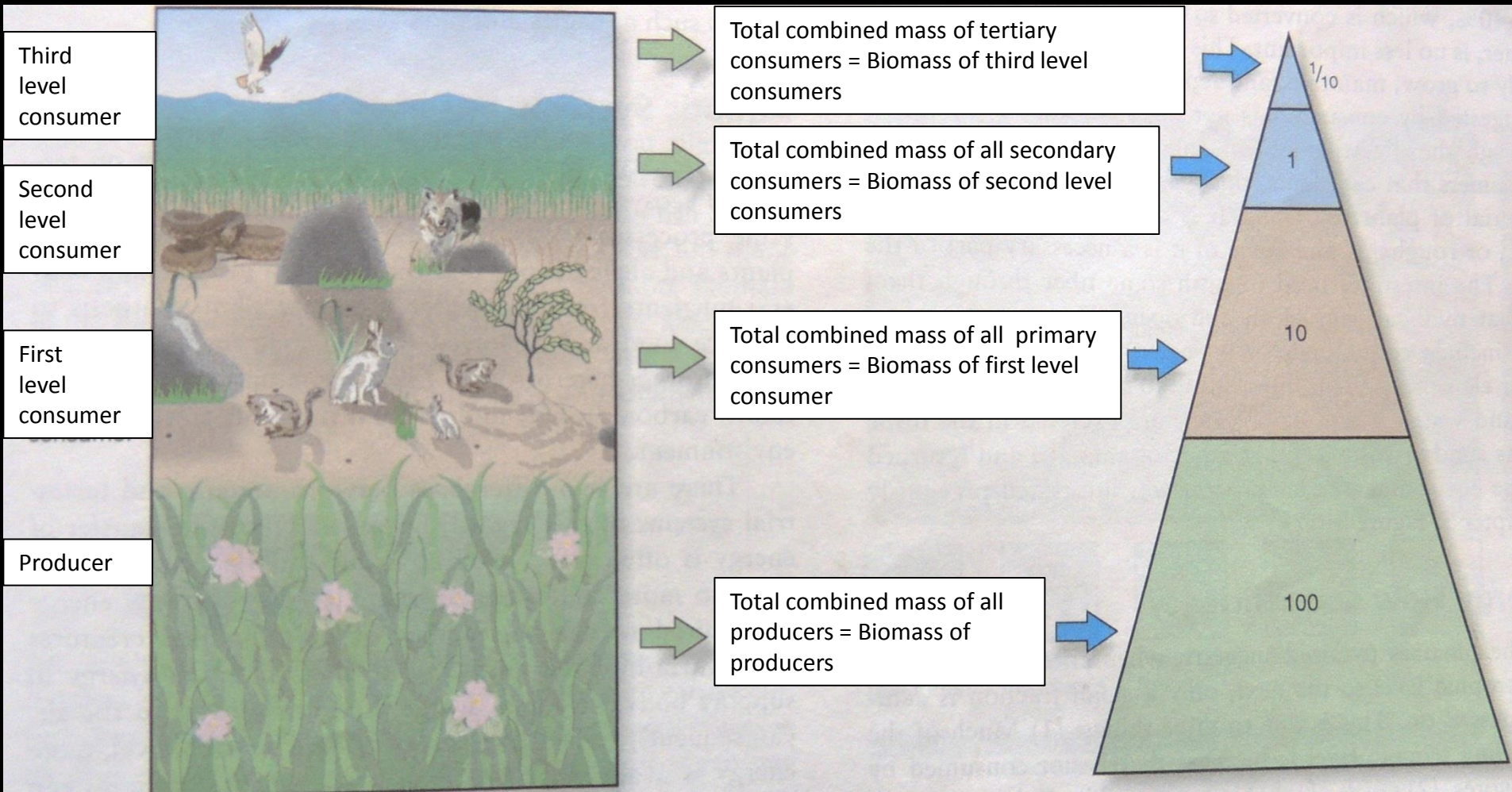
Producers

Plants

Lot of Biomass at the Producer level



How much Biomass is Transferred between Trophic Levels? $\frac{1}{10}$



Activity 3: Biomass Distribution

1. Scientists say that eating like a vegetarian is the most ecologically sustainable way to feed ourselves. Explain why that might be.

Trophic Cascade

How Wolves Change Rivers

Activity 4

- **Mid-term Presentation Meeting 1**
 - Choose one Aquatic or Terrestrial Biome
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- **Due from each student: (turn in page to me before end of class)**
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