

Concept 2 – Food Chains, Food Webs and Mathematical Analysis of Energy Transfer

Curriculum Connection

20–A1.3k explain the structure of ecosystem trophic levels, using models such as food chains and food webs

20–A1.4k explain, quantitatively, the flow of energy and the exchange of matter in aquatic and terrestrial ecosystems, using models such as pyramids of numbers, biomass and energy.

Concept 2: Main Questions

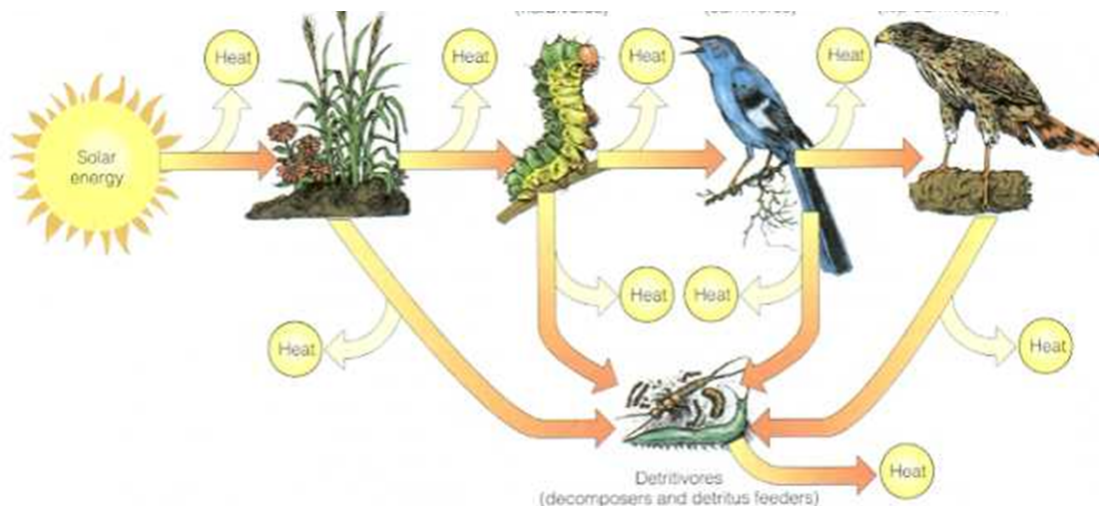
- 1. How is energy from the sun passed on to living things? (food chains, food webs, trophic levels)**
- 2. How do we analyze and model the amount of energy moving through the biosphere?**

Question 1 - How is energy from the sun passed on to living things?

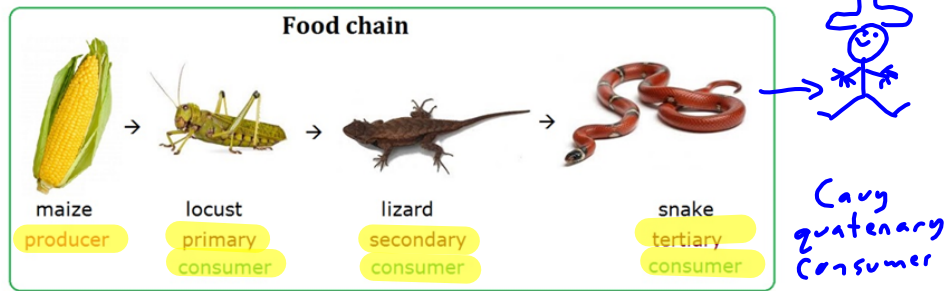
- Remember that photo/chemosynthesis are what captures energy and makes it available for living organisms in the biosphere
- Energy is then passed on when **one organism eats another**

Laws of Thermodynamics

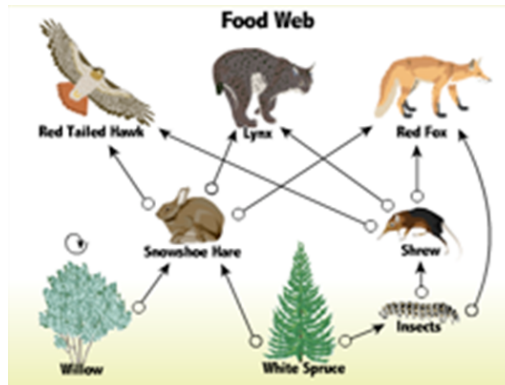
- **First Law of Thermodynamics**
 - energy cannot be created or destroyed, only transferred from one form to another
 - ex. photosynthesis transforms solar energy into the chemical energy stored in glucose
- **Second Law of Thermodynamics**
 - during any energy transformation, some of the energy is converted to an unusable form, usually thermal energy (heat)
- There is only a finite amount energy available to the biosphere, and every time that energy is transferred from one organism to the next, energy is lost from the biosphere as heat



Food Chains – simplistic way of showing the transfer of energy from producers to consumers



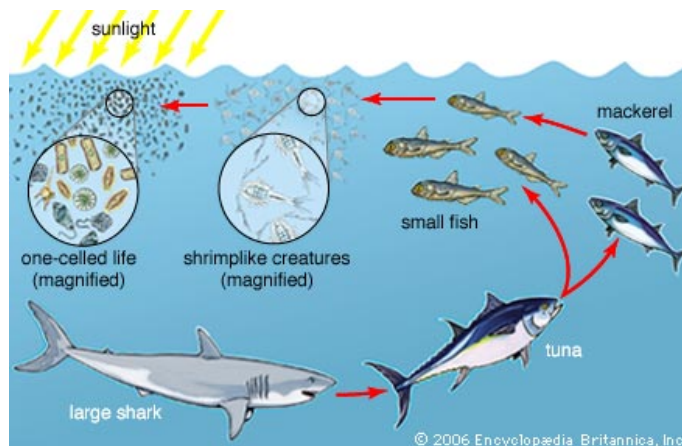
Food Webs – a more detailed way of showing energy transfer from a multiple producers to multiple consumers



Trophic Levels – category that defines an organism by how it gains its energy

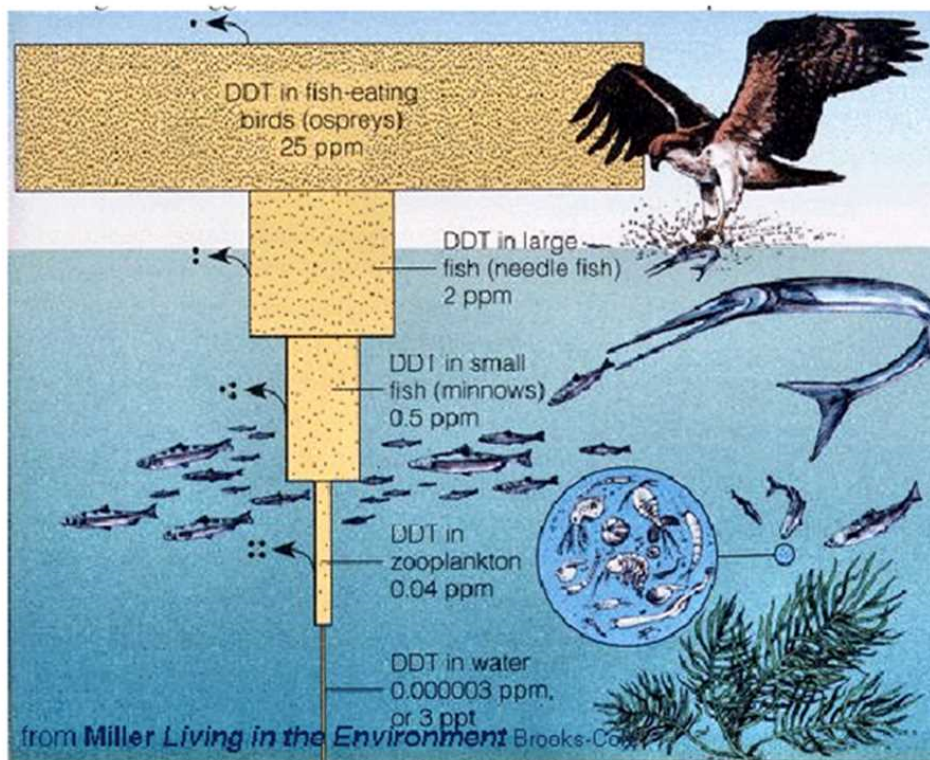
- the **1st trophic level** is made up of organisms that can make their own food (producers)
 - o these organisms are called **autotrophs**
 - o they use basic nutrients and sunlight (or another non-living energy source)
- the **2nd trophic level** is made up of organisms that feed on autotrophs
 - o organisms in the 2nd trophic level are called **primary consumers**
- the **3rd trophic level** is made up of organisms that feed on the primary consumers
 - o these organisms are called **secondary consumers**
- all consumers are also known as **heterotrophs**

Can there be more than 3 trophic levels?



Bioaccumulation (Biomagnification)

- when a toxin increases in concentration as you move up a food chain
- energy decreases as you move up a food chain, but toxins accumulate as you move up a food chain



Limits on Energy Transfer in an Ecosystem

Producers

- Photosynthetic organisms use some of the glucose they make as energy to carry out their life processes (cellular respiration)
- Producers (on average) capture **1%** of the energy available from the sun
- Therefore, not all the energy the plant trapped is available to the primary consumer

Primary Consumers

- they don't digest all of what they eat, some is lost in feces
- most of the energy that they digest is used to keep them alive (cellular respiration)
- the heat produced by cellular respiration is lost to the surroundings
- approx. **10%** of the producers energy is used by the primary consumer

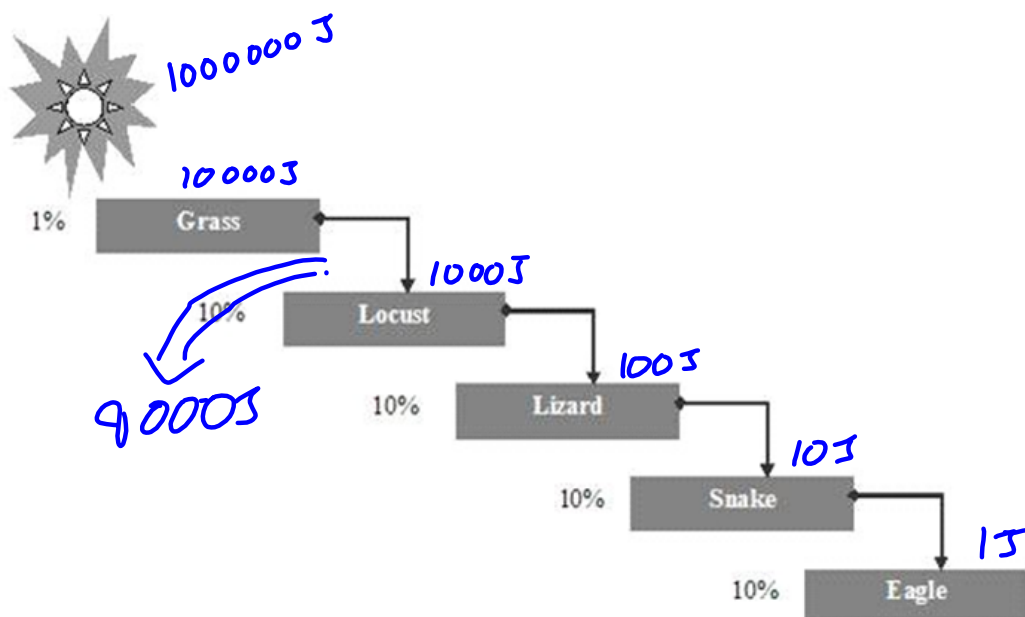
Secondary/Tertiary/Quaternary Consumers

- they don't digest all of what they eat, some is lost in feces
- most of the energy that they digest is used to keep them alive (cellular respiration)
- the heat produced by cellular respiration is lost to the surroundings
- approx. **10%** of the primary consumers energy is used by the secondary consumer

Decomposers (Detritivores)

- the feces and dead remains of all animals and plants are used as energy by decomposers
- decomposers convert the remaining matter into heat and the raw material plants need to grow

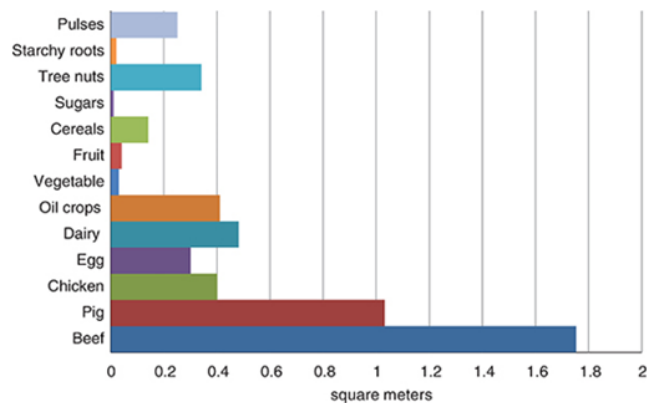
1% and 10% Rules



Outcome 1 – Concept 2 – Question 1 Review Questions

Read pages 22-27

1. In your own words, explain what is meant by the term trophic level.
2. What type of food would be consumed by a secondary consumer? Explain your answer.
3. Distinguish between a food chain and a food web. Give examples of each.
4. In your own words, explain the first and second laws of thermodynamics.
5. Explain why only about 10 % of the energy available in a plant is transferred to the primary consumer.
6. What trophic level are you in? Do you fit only in one trophic level? Explain
7. One solution to feeding a rapidly growing world population is to switch to a more plant based diet. Using your knowledge of trophic levels, the laws of thermodynamics and the 10% rule, explain why this solution may help.



Land required to produce 100g of each food