

Ms. Davis
Key

DO NOT TAKE WITH YOU!

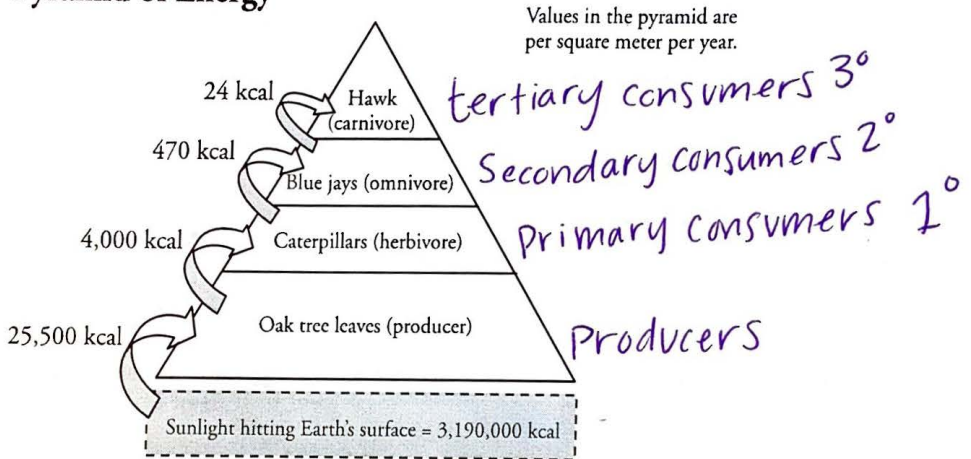
Ecological Pyramids

How does energy flow through an ecosystem?

Why?

Every organism in an ecosystem is either eating or being eaten. When cows eat grass, they obtain some of the energy that the grass transferred from the sunlight it absorbed. If cows could carry out photosynthesis, would they have access to more energy than they get as herbivores? Which organisms in an ecosystem require the most energy to sustain life?

Model 1 – Pyramid of Energy



- A unit used to measure energy is the **kcal**.
 - What is the source of all energy in the pyramid in Model 1?
The Sun! ☀️
 - How much energy does this source provide to a square meter of the Earth per year? (Be sure your answer includes units.)
3,190,000 kcal
- Label the pyramid levels in Model 1 with the following: primary producers, primary consumers, secondary consumers, and tertiary consumers.
- The arrows in Model 1 represent the energy available to the next level of the pyramid.
 - What percentage of the source energy from Question 1a is absorbed by the oak leaves in Model 1?
 $25,000 / 3,190,000 \times 100 = \sim 0.8\%$
 - By what process do the oak leaves harness this energy?

Photosynthesis

4. Describe how the consumers in one level of the pyramid obtain energy from the organisms at the previous level of the pyramid.

They eat them to obtain energy

5. Refer to Model 1.

- a. How much energy per year do the caterpillars in Model 1 obtain from eating the leaves in a square meter of the oak tree?

4,000 kcal

- b. What percentage of the energy that was originally absorbed by the oak leaves is passed on to the caterpillars?

$$4,000 / 25,000 \times 100 = 15.7\%$$

- c. What percentage of the energy absorbed by the oak leaves is not passed on to the caterpillars?

$$100 - 15.7 = 84.3\%$$

- d. With your group, list at least three possible uses and/or products of the energy absorbed by the oak leaves that did not contribute to the production of biomass.

growth, development, heat, movement

6. Calculate the percentage of energy that is transferred from one level of the pyramid in Model 1 to another for all of the levels.

- a. Oak leaves to caterpillars (see Question 5b).

$$4,000 / 25,000 \times 100 = \sim 15\%$$

- b. Caterpillars to blue jays.

$$470 / 4,000 \times 100 = \sim 12\%$$

- c. Blue jays to hawk.

$$24 / 470 \times 100 = \sim 5\%$$

7. Calculate the average percentage of energy that is transferred from one level to another using your answers in Question 6. Note that this average percentage transfer is similar for many different types of energy pyramids in nature.

$$15 + 12 + 5 = 32 / 3 = \sim 10.6\%$$

8. As a group, write a statement that describes the pattern of energy transfer among consumers within a pyramid of energy.

About 10% of energy is transferred between consumers.

9. What percentage of the caterpillars' original energy is available to the hawk?

0.6%.

10. What percentage of the oak leaves' original energy is available to the hawk?

~ 0.1%.



11. Explain why an energy pyramid in any ecosystem typically is limited to four or five levels only.

Since only ~10% gets passed on from level to level, there isn't enough energy available to sustain life at the top of the pyramid if there are more than 4-5 levels.

12. Propose an explanation for why populations of top carnivores, such as hawks, are always smaller than the populations of herbivores, such as caterpillars.

Because only ~10% of the energy gets transferred up the pyramid, it takes a lot of the previous level to sustain the next higher level. If the top level's population were to grow, the levels below it would also have to grow in order for the higher levels to get enough energy.



Read This!

Each level in the pyramid in Model 1 is a **trophic level**. The word "trophic" refers to feeding or nutrition. Model 1 shows one example of one organism that would be included in each level, but each level in an ecosystem includes many species of organisms.

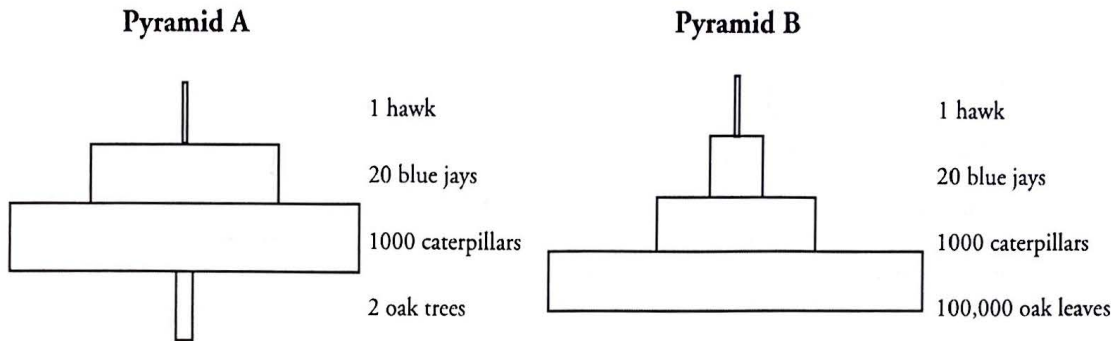
13. List at least three other species that might be found in the trophic level with the oak trees.

grass, flowers, bushes, other trees

14. List at least three other species that might be found in the trophic level with the blue jays.

Robins, snakes, bears, owls

Model 2 – Pyramid of Numbers



15. Compare and contrast the two pyramids in Model 2. List at least two similarities and two differences.

you can do this one 😊

16. How does the number of organisms change as you move up the levels in Pyramid A compared to Pyramid B?

you can do this one, too 😊

17. Are the “producers” levels in the two pyramids in Model 2 referring to the same organisms or different organisms? Explain.

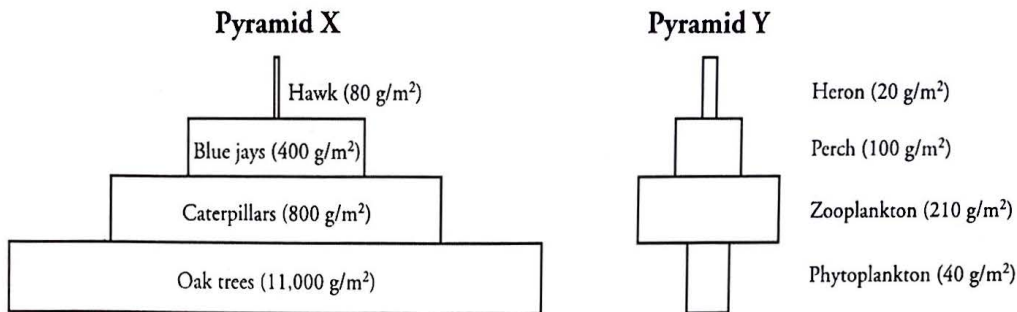
They are referring to the same organism. The leaves are part of the tree. The difference is that Pyr. B is just focusing on the energy producing part of the tree.

18. Which of the two pyramids in Model 2 gives a more accurate account of what occurs in this ecosystem? Use complete sentences to explain your reasoning.

Pyramid A because the tree is the organism (Producer) not the individual leaves.



Model 3 – Pyramid of Biomass



19. Biomass is measured as grams of dry mass within an area. What is the mass of the oak trees in Pyramid X of Model 3?

$11,000 \text{ g/m}^2$

20. What is the mass of the phytoplankton in Pyramid Y of Model 3?

40 g/m^2

21. Refer to Model 3.

- a. Identify the trend in biomass as you move up the trophic levels in Pyramid X.

The biomass in Pyr. X decreases as you move up to the next trophic level.

- b. Is the trend in biomass in Pyramid X the same as seen in Pyramid Y? Explain your answer.

The biomass initially increases, but then it decreases after that. This is because the Producers are very small & therefore do not make up a large biomass as a whole.

Read This!

Phytoplankton are microscopic aquatic organisms that are quickly consumed by microscopic animals (zooplankton). Because they are eaten so quickly there is a need for the phytoplankton to reproduce rapidly for survival.

22. Explain why the Pyramid Y ecosystem can exist with a smaller biomass at the producer level.

It can exist because the biomass reproduces quickly, therefore there are always new producers to replace the ones that get eaten. This quick reproduction can provide enough energy to sustain other trophic levels.

23. Use examples from the previous models to explain the advantage of using a pyramid of energy or biomass rather than a pyramid of numbers to explain the relationship between different trophic levels.


Energy Pyramids are more consistent (10% rule)

Extension Questions

24. What type of organisms are missing from all of the trophic pyramids shown in Models 1–3?

The Pyramids are missing decomposers that help return the nutrients back to the Producers.

25. Explain why a vegetarian diet is considered a more energy-efficient diet for humans than one based on beef, chicken or pork.

A vegetarian diet is considered more energy-efficient because there is more of the original from the sun  available at the producer level & therefore more energy is transferred to the consumer than if you were to eat at higher trophic levels. For example, if you consumed a cow for energy, only 0.1% of the original energy from the sun reaches you. If you eat vegetables, 10% of the original energy from the sun reaches you.

