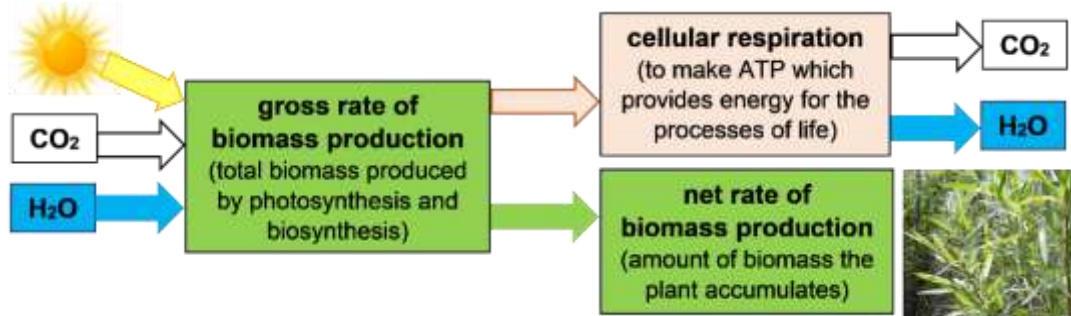


## Trophic Pyramids<sup>1</sup>

When you walk in a park or nature, you will see lots of plants, some primary consumers like squirrels, and very few predators like hawks. This activity will help you understand why plants are much more abundant than predators.

The **biomass** of an organism is the mass of all the organic molecules in the organism. A plant's biomass is produced by photosynthesis and biosynthesis. However, not all the sugar molecules produced by photosynthesis become part of the plant's biomass. This flowchart shows why.



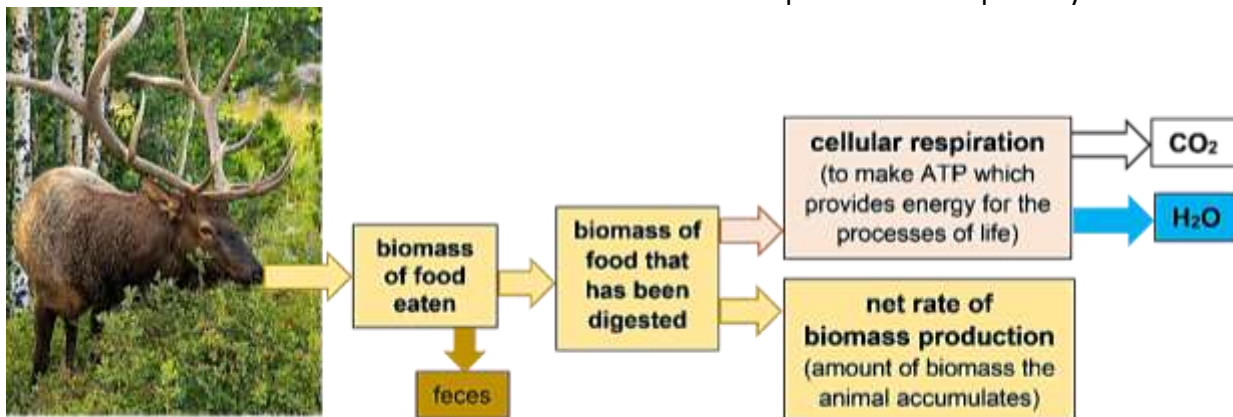
1. What happens to the sugar molecules produced by photosynthesis that do not become part of the plant's biomass?

2a. Which rate of biomass production describes the rate that biomass becomes available as food for primary consumers to eat?

gross rate of biomass production \_\_\_\_ net rate of biomass production \_\_\_\_

2b. Explain your reasoning.

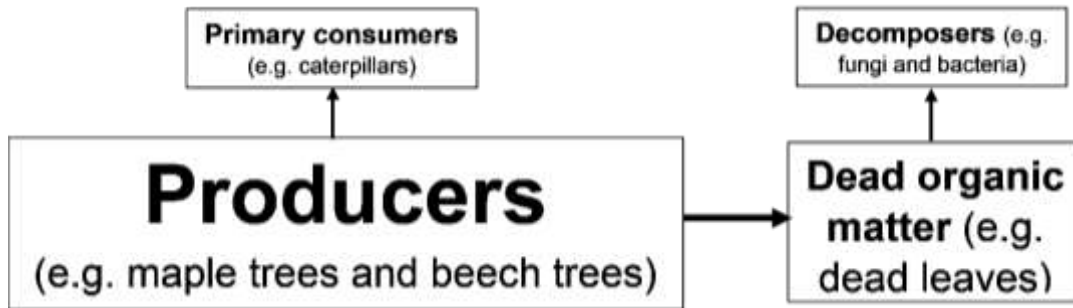
The flowchart below shows what happens when plant biomass is eaten by a primary consumer. Some food molecules are not digested and instead pass through the consumer's digestive system to be excreted in the feces; obviously, those molecules can't contribute to the consumer's biomass. Some digested food molecules are used for cellular respiration, so these molecules also do not contribute to the net rate of biomass production for primary consumers.



3. This flowchart shows two reasons why the net rate of biomass production for a consumer is less than the biomass of the food eaten by the consumer. Circle each reason.

<sup>1</sup> By Drs. Ingrid Waldron and Lori Spindler, Dept Biology, University of Pennsylvania. © 2024. This Student Handout and the Teacher Notes with instructional suggestions and background information are available at <https://serendipstudio.org/exchange/bioactivities/trophicpyr>.

4. Researchers evaluated the net rate of biomass production at different trophic levels in a forest in New Hampshire. The relative size of the boxes in this flowchart indicates the relative magnitude of the net rate of biomass production for the producers, primary consumers, and decomposers. Notice that the net rate of biomass production is lower for the primary consumers plus decomposers than for the producers. Add to this flowchart to show two reasons why. (Hint: See bottom of the previous page.)

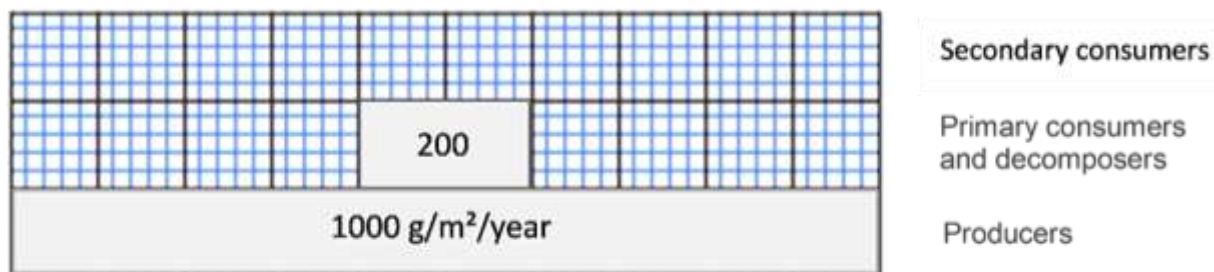


5a. The left column of this table shows a summary food web for this forest. (Each trophic omnivore is classified in the consumer level of the main type of food it eats.) The right column lists the net rates of biomass production at each trophic level in this forest. Circle the only rate that would be possible for the secondary consumers in this forest.

	Net Rate of Biomass Production (g/m <sup>2</sup> /year)
Secondary consumers (e.g. birds)	30? 200? 1000?
↑	
Primary consumers + Decomposers	200
↑	
Producers	1000

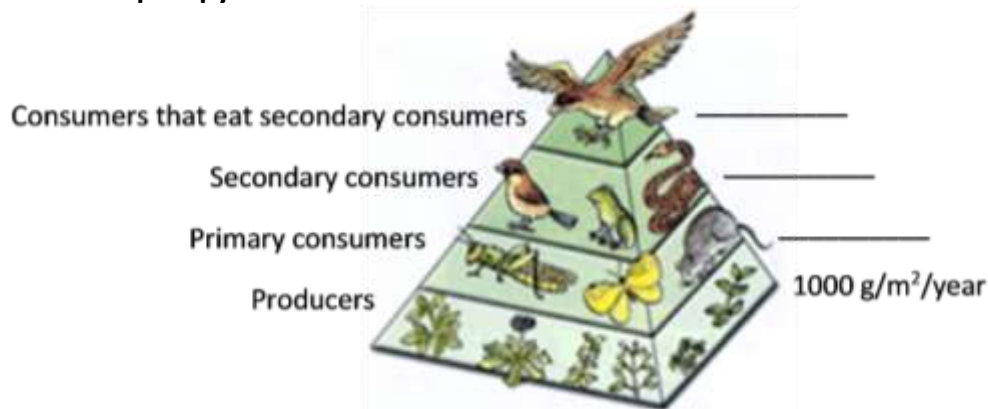
5b. Explain your reasoning.

5c. The length of each bar in this graph shows the net rate of biomass production for the producers in the forest and for the primary consumers plus decomposers. Add to the graph to show the net rate of biomass production for the secondary consumers.



5d. Explain why animals that eat secondary consumers are very rare.

Information about the relative rates of biomass production at different trophic levels is often displayed in a **trophic pyramid** like this one.

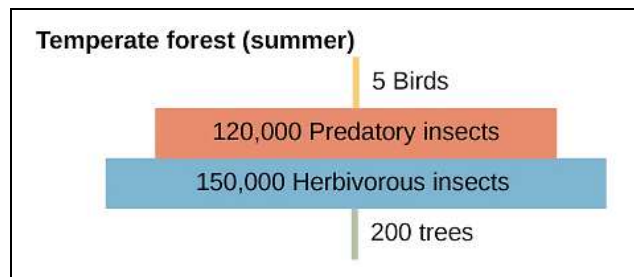


Scientists sometimes use the general estimate that the net rate of biomass production for each trophic level is about 10% of the rate for the trophic level just below it.

**6a.** Use the 10% estimate to calculate the net rate of biomass production at each consumer trophic level in the above trophic pyramid.

**6b.** This 10% estimate is sometimes described as the 10% rule. What evidence from the forest ecosystem indicates that this 10% rule is not accurate in some cases?

**7.** It might be tempting to apply the 10% rule to estimate that the number of primary consumers should be 10% of the number of producers. The figure on the right gives the number of individuals per hectare in a forest. Explain why there are many more primary consumers than producers in this forest.



**8a.** For lunch, Pat had a baked potato and Erin had a hamburger with no bun. They each consumed the same amount of biomass, but from different trophic levels. In comparison to the amount of land needed to produce Pat's potato, how much land was needed to produce enough cattle feed to produce Erin's hamburger?

- roughly 10% as much land to produce enough cattle feed to produce the hamburger
- roughly the same amount of land to grow the potato and the cattle feed
- roughly 10 times as much land to produce enough cattle feed to produce the hamburger

**8b.** Explain your reasoning.