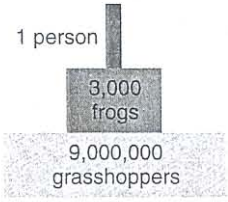
CRITICAL THINKING ISSUE

Should People Eat Lower on the Food Chain?

The energy content of a food chain is often represented by an *energy pyramid*, such as the one shown here in Figure 9.9*b* for a hypothetical, idealized food chain. In an energy pyramid, each level of the food chain is represented by a rectangle whose area is more or less proportional to the energy content for that level. For the sake of simplicity, the food chain shown here assumes that each link in the chain has one and only one source of food.

Assume that if a 75-kg (165-lb) person ate frogs (and some people do!), he would need 10 a day, or 3,000 a year (approximately 300 kg or 660 lb). If each frog ate 10 grasshoppers a day, the 3,000 frogs would require 9,000,000 grasshoppers a year to supply their energy needs, or approximately 9,000 kg (19,800 lb) of grasshoppers. A horde of grasshoppers of that size would require 333,000 kg (732,600 lb) of wheat to sustain them for a year.



(a)

(b)

Figure 9.9 (*a*) The total bulk (mass) of all the organisms making up each level of a food chain is less than that of the previous level. (*b*) Eating lower on the food chain.

As the pyramid illustrates, energy content decreases at each higher level of the food chain. The result is that the amount of energy at the top of a pyramid is related to the number of layers the pyramid has. For example, if people fed on grasshoppers rather than frogs, each person could probably get by on 100 grasshoppers a day. The 9,000,000 grasshoppers could support 300 people for a year, rather than only one. If, instead of grasshoppers, people ate wheat, then 333,000 kg of wheat could support 666 people for a year.

This argument is often extended to suggest that people should become herbivores (vegetarians, in human parlance) and eat directly from the lowest level of all food chains, the autotrophs. Consider, however, that humans can eat only parts of some plants. Herbivores can eat some parts of plants that humans cannot eat and some plants that humans cannot eat at all. When people eat these herbivores, more of the energy stored in plants becomes available for human consumption. The most dramatic example of this is in aquatic food chains. Because people cannot digest most kinds of algae, which are the base of most aquatic food chains, they depend on eating fish that eat algae and fish that eat other fish. So if people were to become entirely herbivorous, they would be excluded from many food chains. In addition, there are major areas of Earth where crop production damages the land but grazing by herbivores does not. In those cases, conservation of soil and biological diversity lead to arguments that support the use of grazing animals for human food. This creates an environmental issue: How low on the food chain should people eat?

Critical Thinking Questions

1. Why does the energy content decrease at each higher level of a food chain? What happens to the energy that is lost at each level?
2. The pyramid diagram uses mass as an indirect measure of the energy value for each level of the pyramid. Why is it appropriate to use mass to represent energy content?
3. Using the average of 21 kJ of energy to equal 1 g of completely dried vegetation (see Working It Out 9.3) and assuming that wheat is 80% water, what is the energy content of the 333,000 kg of wheat shown in the pyramid?
4. Make a list of the environmental arguments for and against an entirely vegetarian diet for people. What might be the consequences for U.S. agriculture if everyone in the country began to eat lower on the food chain?
5. How low do you eat on the food chain? Would you be willing to eat lower? Explain.

are common in streams and feed mainly on this deposited vegetation. Some of the animals are shredders that tear up leaves; others feed on the smaller pieces.

Other grazing animals move along the surfaces of rocks and scrape off attached algae. Many stream predators are larvae of land-dwelling insects, such as dragon-

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