Investigation 1.B: Weave Your Own Food Web

Purpose: Using the rule of 10, calculate the percentage of the Sun's energy that is available to you through your diet, based on the food choices you make.

Procedure

1. For three days, keep a full record of the food and beverages you eat. Design a chart to record your food and beverage intake. Be sure to include both the type and amount of food or drink consumed, other than water. Be as accurate as you can. For instance, if you eat a slice of pizza, you should record all the items and approximate amounts of each (i.e. the dough, as well as all the toppings) separately. You may have to rely on your own judgment at times, as not all food will fall into a neat category.

2. Using the nutritional information from food labels, the Internet, and/or the library, look up the amount of energy in each food or beverage item you consumed and record the values in kilojoules (kJ). Since the food energy recorded on most food labels show kilocalories (kcal), rather than kilojoules, you will need to convert all kilocalorie values to kilojoules. One kilocalorie is equal to 4.2 kilojoules (1 kcal = 4.2 kJ). (Note that the "calories" shown on food labels are actually kilocalories. Sometimes they are capitalized to indicate this. Thus, 1000 calories = 1 Calorie = 1 kilocalorie.) Try to be as accurate as you can.

3. Calculate the total number of kilojoules of food energy you ate over the entire three days. Then calculate your average daily consumption by dividing this total by three.

4. Organize the food and beverages you consumed over the three days into the following categories:

   Producers (First Trophic Level): Includes all plant based food such as grains, vegetables, fruit, and all sweeteners.
   Primary Consumers (Second Trophic Level): Includes plant-eating organisms (herbivores) such as most livestock (cattle, chicken, lamb) and some wild game (deer, moose, bison), plus eggs and dairy. Also includes aquatic herbivores such as tilapia, carp, and catfish, as well as shellfish.
   Secondary Consumers (Third Trophic Level): Includes flesh-eating (carnivorous) fish such as salmon, sardines, and trout. Because pigs eat both plant and animal tissue, include pork in this category as well.
   Tertiary Consumers (Fourth Trophic Level): Includes higher-level carnivores such as tuna and sharks, which feed on many fish and sea animals. Tertiary consumers are higher on the food chain than secondary consumers. If you are unsure which category a food or beverage falls into, research it on the Internet or in the library. If that fails to provide an answer, make an educated guess.

5. Using the food record you kept, calculate the number of kilojoules contained in the food you consumed in each category. Once you have calculated these totals, divide each total by three to get the average number of kilojoules you consumed each day from each trophic level.

6. Next, divide each daily average by the average number of kilojoules you consumed daily (calculated in Step 3). This will give you the percentage of your diet that comes from each trophic level. For instance, imagine that you get 5862 kJ from the first trophic level and that your total consumption of food energy per day is 8373 kJ. To calculate the percentage of your diet from the first trophic level:

$$\frac{5862 \text{ kJ}}{8373 \text{ kJ}} \times 100 = 70 \text{ percent}$$

This means that 70 percent of the energy in your diet comes from producers. Similarly, if you consume 1674 kJ from the second trophic level and 837 kJ from the third trophic level, 20 percent of the energy in your diet comes from primary consumers and 10 percent comes from secondary consumers.

7. Create a food web that illustrates the food you consumed over the three-day period. Place yourself in the highest trophic level and use arrows to show the path that energy follows through the food web.

Analysis

1. What percentage of your food comes from producers? From primary consumers? From secondary consumers? From tertiary consumers?

2. Using the rule of 10 and the assumption that the producers transform about 2% of the Sun's energy through photosynthesis, determine the percentage of the Sun's energy assimilated through your current diet. You may want to draw food chains to help you visualize how much energy is transferred between trophic levels. Refer to the food chains in Thought Lab 1.1 as a guide. For example:

   Step 1: If 70% of the energy in your diet comes from producers, the percentage of the Sun's energy represented by this portion of your diet is calculated as follows:
   $$0.70 \times 0.02 = 0.0014 = 0.14\%$$
   (What do these values mean? 0.70 is equivalent to 70%; it is the percentage of energy from producers in your diet. 0.02 is equivalent to 2%. It is the percentage of the Sun's energy captured by producers during photosynthesis.)

   Step 2: If 20% of the energy in your diet comes from primary consumers, the percentage of the Sun's energy represented by this portion of your diet is:
   $$0.20 \times 0.02 \times 0.10 \times 0.10 = 0.00004 = 0.0040\%$$

Step 3: If 10% of the energy in your diet comes from secondary consumers, the percentage of the Sun's energy represented by this portion of your diet is:

$$0.10 \times 0.02 \times 0.10 \times 0.10 \times 0.10 = 0.000002 = 0.00020\%$$

Step 4: Therefore, the total percentage of the Sun's energy assimilated is:

$$0.14\% + 0.0040\% + 0.00020\% = 0.1460\% = 0.15\%$$

3. Compare your results with those of your classmates. Who assimilated the largest percentage of the Sun's energy through their diet? Who assimilated the least? Determine what percentage of these students' food came from which trophic levels. From what trophic level did the person who assimilated the highest percentage of the Sun's energy consume the most food? What about the person who assimilated the least?

4. How many trophic levels are represented in the longest food chains in your food web? Do you think you would assimilate more of the Sun's energy if your food chains were longer? What if they were shorter?

Extension

5. It requires seven times more land to sustain a meat-based diet than a plant-based diet. In other words, the same amount of land required to feed one meat eater can grow enough crops to feed seven vegetarians. Similarly, the world's cattle eat the same amount of food that would feed 8.7 billion people if humans consumed it directly. Finally, it is estimated to take about 43 000 L of water to produce about half a kilogram of ground beef (Dr. David Pimentel, professor of ecology and agricultural sciences at Cornell University, 1997). Based on these facts, what would be the benefits of vegetarianism in overcrowded or densely populated nations?