**Energy Flow in an Ecosystem**

(modified from http://kenpitts.net/bio/ecology/ecological\_pyramids\_2006.htm)

**Background Information:**

All organisms in an ecosystem need an input of energy to survive. Some organisms, such as plants, are *autotrophs* and use solar energy from the sun to produce their own food. Other organisms, such as animals, are *heterotrophs* and must take in food as their source of energy.

The available energy in an ecosystem passes from organism to organism as they feed on one another. The levels of feeding in an ecosystem are called *trophic levels*. Organisms at the lowest trophic level, the producers, manufacture food for the rest of the organisms in the ecosystem. The organisms that feed off of the producers and/or each other are called *consumers* – there are several levels of consumption, as shown in the diagram below.



Finally, the *decomposers* break down waste and dead organisms in the ecosystem, recycling the nutrients so they are available to organisms once again.

When a consumer eats another organism, only a fraction of the energy taken in is used for growth. About 50% of the food is not digested and is excreted as waste. About 40% of the food is used for biological work such as cellular respiration, and is subsequently “lost” as heat. Therefore, only about 10% of the energy in the food is used for growth and is therefore available to the next trophic level. Pyramids of energy, biomass, and numbers can be constructed to show a graphical representation of this rule.

In this lab, you will construct ecological pyramids in order to show the relationships among organisms at different trophic levels.

**Energy Flow in an Ecosystem Student Answer Sheet:**

Pre-lab questions

1. Identify the original source of energy for a terrestrial (land) ecosystem.
2. Differentiate between autotrophic and heterotrophic organisms
3. Explain which organisms in an ecosystem are responsible for recycling nutrients and how they accomplish this.
4. Explain the meaning of the 10% rule.
5. What happens to the energy that is used for cellular respiration?

**Procedure:**

Each group will be receiving a bag which represents a particular ecosystem. The colored beans in the bag represent the organisms that live in the ecosystem. Each color of bean stands for an organism from a particular trophic level. One color of bean stands for the producers in the ecosystem. Another color stands for the primary consumers (herbivores), the secondary consumers (carnivores or omnivores), and the tertiary consumers (top carnivores).

**Hypothesis:**

Which trophic level do you expect to have the MOST organisms? Which do you expect to have the least?

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1. Count the number of organisms (beans) in each trophic level. Put the colored beans in 4 separate piles. Record the numbers in the data table below.
2. Weigh the empty paper cup on the scale provided.
3. Put each pile of colored beans in the cup one at a time and weigh the beans.
4. Record the mass (to the nearest 0.1 of a gram) of each group of colored beans in the table provided **(remember to subtract the weight of the cup from the weight of the beans + cup in order to ONLY find the weight of the beans)**
5. Construct pyramids of numbers, biomass, and energy based on your data.

**Data:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Measurement | Producers(Trophic Level 1) | Primary Consumers(Trophic Level 2) | Secondary Consumers(Trophic Level 3) | TertiaryConsumers(Trophic Level 4) |
| Numbers |  |  |  |  |
| Mass (g) |  |  |  |  |

Biomass Pyramid

Numbers Pyramid

Tertiary

Consumers

Secondary consumers

Primary consumers

Producers

**Analysis:**

1. Compare your prediction about the numbers of organisms at each trophic level with your actual results.
2. Assume that for each organism, there are 100 calories of energy available.

Do the math!

|  |  |  |  |
| --- | --- | --- | --- |
| **Trophic level** | **Number of organisms** | **Calories in each organism** | **Total calories in trophic level** |
| **Producer** |  | X 100 |  |
| **Primary consumer** |  | X 100 |  |
| **Secondary consumer** |  | X 100 |  |
| **Tertiary consumer** |  | X 100 |  |

1. Construct an energy pyramid showing the number of calories of energy available at each trophic level:

Tertiary

Consumers

Secondary consumers

Primary consumers

Producers

Energy Pyramid

1. Calculate the PERCENTAGE of energy that was transferred from one trophic level to the next using the following equation:

 ending calories / beginning calories x 100 = % energy transferred

For example:

90 calories (primary consumers) / 1000 calories (producers) x 100 = 9%

Complete the table below:

|  |  |
| --- | --- |
| **Trophic levels** | **% energy transferred** |
| Producers 🡪 primary consumers |  |
| Primary consumers 🡪 secondary consumers |  |
| Secondary consumers 🡪 tertiary consumers |  |

**Conclusion:**

Use the background information AND the pyramids of numbers, biomass and energy that you have created to develop an argument to support the following statement:

*In an ecosystem, there are always fewer top predators (ie. hawks, lions, sharks) because large numbers of other organisms are required to support them.*