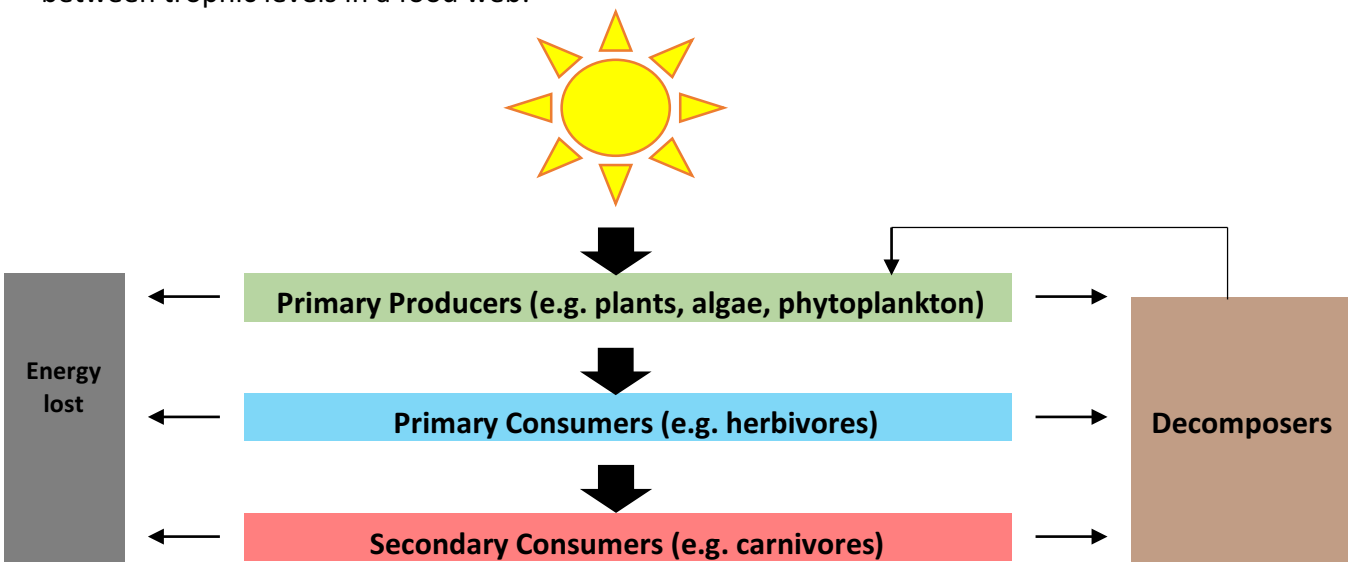
Assignment 3: Energy Transfer

Introduction

The diagram below summarizes our basic understanding of the direction of energy transfer between trophic levels in a food web:



Every second, the sun provides ~1300 watts of energy per square meter of Earth (Hathaway 2010). This light energy is converted into chemical energy by primary producers. The chemical energy, in the form of organic compounds, then transfers through the rest of the ecosystem. The 2nd Law of Thermodynamics tells us that these transfers are inefficient. In fact, only 10% of the energy at one trophic level is available to the next (Lindeman 1942). As a result, the number of organisms and total biomass of organisms tends to decrease from primary producers, to primary consumers, to secondary consumers, and so on. An energy pyramid is typically used to illustrate these relationships. In this assignment we will test the accuracy of the 10% rule by measuring and analyzing the energy transfer from rodents to burying beetles.

Hathaway, D. 2010. Ask An Expert: Our Powerful Sun. National Aeronautics and Space Administration. Accessed on November 19, 2016, at https://www.nasa.gov/connect/chat/solar_chat.html.

Lindeman, R.L. 1942. The trophic-dynamic aspect of ecology. *Ecology* 23: 399-418.

Learning Goal

Students will be able to answer the question, "How do organisms obtain and use matter and energy to live and grow?"

Instructions

Part I: Experiment

1) Access the online Burying Beetle module at http://kmrobson.jimdo.com/burying-beetle-module/. Click on the download button for the experiment titled "Burying Beetle Biomass Conversion." Follow the directions to carry out the experiment.

Part II: Analysis

1) Return to the online module and navigate to the data sets section. Click on the button labeled "Beetle Biomass Sample Data." Download the Google Sheets file as an Excel document. Add the information from your data table (question #8) to the Excel file. For each container, calculate how much of the carcass mass was converted into larvae mass. Express these values as percentages.

a) Calculate an average % of mass converted: _____ *2 pts*

2) What two trophic levels are represented by the rodents and the burying beetles? Does the conversion of biomass between these trophic levels match the 10% rule? *2 pts*

3) Explain what happens to <u>all</u> the energy consumed by beetle larvae. In other words, if only 10% is converted into biomass, what happens to the other 90%? *2 pts*

4) Molles (2013) supports a 5-20 % range for the energy transfer between trophic levels. While the concept of an energy pyramid is easy to understand through the 10% rule, we need to acknowledge that there is variation in the natural world. For instance, is the energy transfer between trophic levels more efficient for endotherms or ectotherms? Explain your answer. *2 pts*

Molles, M. C. 2013. Ecology: Concepts and Applications. Seventh Edition. McGraw-Hill, New York, NY.

5) Smith et al. (2000) studied the reproductive strategies of *N. investigator* populations along an elevation gradient. They discovered that at high elevations, *large* carcasses provision *bigger* larvae; however, at low elevations, *large* carcasses provision *more* larvae**.**
Which reproductive strategy (bigger larvae or more larvae) was favoured by the beetles in your experiment? Justify your answer with quantitative evidence. *4 pts*

6) Smith and Heese (1995) found that beetles don't bury carcasses less than 16 g. Propose an ecological explanation for this behaviour. Use the terms "cost" and "benefit." *2 pts*