

ENERGY AND TROPHIC LEVELS

HOW MANY PEOPLE CAN LIVE ON SOYBEANS ALONE?

INTRODUCTION: A trophic level contains all organisms that are the same number of energy transfers away from the original source of energy (for example, sunlight) that enters an ecosystem. For example, all producers belong to the first trophic level, and all herbivores belong to the second trophic level in a food chain or a food web. High trophic levels can exist for animals even higher on the food chain.

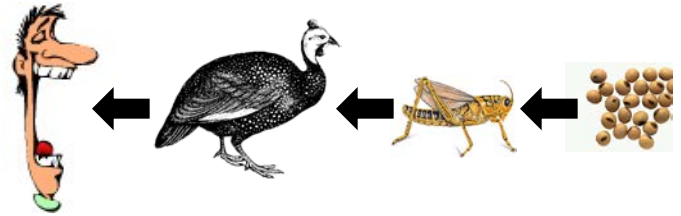
OBJECTIVES:

1. Calculate and compare human food needs at different trophic levels, using that data to construct a biomass pyramid.
2. Analyze the benefits and drawbacks of eating at lower trophic levels on a global scale.

BACKGROUND INFORMATION: The owner of a soybean farm raises guinea hens both to eat (tastes like chicken) and because they eat the insects. Guinea hens will eat grasshoppers, other insect pests, and ticks. They also act as a “watchdog” by making a lot of noise when intruders approach their territory. The farmer allows the Guinea hens free range in his fields during the day and provides roosts (shelter) for them at night.

For the purpose of this investigation, you will make the following assumptions:

- ☀ the farmer eats 1 guinea hen per day for a year
- ☀ 1 guinea hen eats 25 grasshoppers per day
- ☀ 1,000 grasshoppers have a mass of 1 kilogram
- ☀ 1 grasshopper eats 30 grams of soy per year
- ☀ 1 human eats 600 grasshoppers per day
- ☀ dry soybeans have 3.3 calories/gram of energy.



PRE-LAB QUESTIONS:

1. What do food chains and food webs illustrate?
2. Draw an **energy pyramid** for the human, guinea hen, grasshopper, soybeans above. Assume the soybeans contain 2,000 calories of energy.
3. Why is **energy flow** in ecosystems shown in the form of a pyramid?
4. How much energy is **lost** moving up each level in the energy pyramid?

PROCEDURE:

1. Calculate the answers to the questions below. *Show the set up of your calculations and show the cross cancelling of all units. Label your answers with proper units. **NO CALCULATORS***

LABORATORY QUESTIONS:

1. Calculate the number of grasshoppers one guinea hen eats per year.
2. How many grasshoppers are needed for a year's supply of guinea hens that the farmer eats each year (assume all guinea hens lived the entire year)?

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3. What is the total mass, in Kg, of the grasshoppers needed to feed all the hens for one year?
4. How many kilograms of soybeans are needed to feed all the grasshoppers for one year?
5. How many people could the grasshoppers feed in a year if a person ate grasshoppers?
6. The farmer needs 3,000 calories per day. If people ate the same amount of soybeans that were needed to feed all of the grasshoppers (from #4 above) many people would the soybean crop feed?

POST-LAB QUESTIONS:

7. Draw a **biomass pyramid** using your calculations to this point.
8. Why do most food chains not have a fourth and/or fifth trophic level?
9. It seems, by a simple analysis, that the Earth could support many more people if we all ate at a lower trophic level.
 - a. Outline three pros and three cons of such a practice.
 - b. On average, cows produce 19 kg of protein per acre per year and soy plants produce 200 kg of protein per acre per year. Relate these data to the fact that people in the less developed countries usually eat at lower trophic levels than those in developed countries.
10. Comment on the success of omnivores (animals that eat plants and meat), such as coyotes, rats, and humans, and the fact that they can eat at many trophic levels.
11. Think back to the foods you have eaten over the past few days and:
 - a. Estimate what percent of the mass of the food in your diet comes from the first trophic level.
 - b. Estimate what percentage of the mass of the food in your diet comes from the second trophic level.
 - c. Estimate what percentage of the mass of the food in your diet comes from the third or higher trophic level.
12. Large predatory fish, which may be part of your diet at times, usually exist at the third or fourth trophic level. Explain why it may not be a good idea to eat these fish often, if at all. (*Hint: look up bioaccumulation and toxins*)