OIMB GK12 CURRICULUM

6th Grade **45-60 minutes**

Coral Reef Energy and Trophic Levels

Oregon Science Content Standards:
6.2 Interaction and Change: The related parts within a system interact and change
6.2L.2 Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources.

Ocean Literacy Principle:
5. The ocean supports a great diversity of life and ecosystems

Goals: Students will be able to:

- Define the term *trophic level*
- Understand that energy is lost between trophic levels
- Explain how energy is lost between trophic levels

Concepts:

- A trophic level is a level in a food chain.
- Food chains are not very energy efficient - 90% of energy is lost from one trophic level to the next.

Materials:

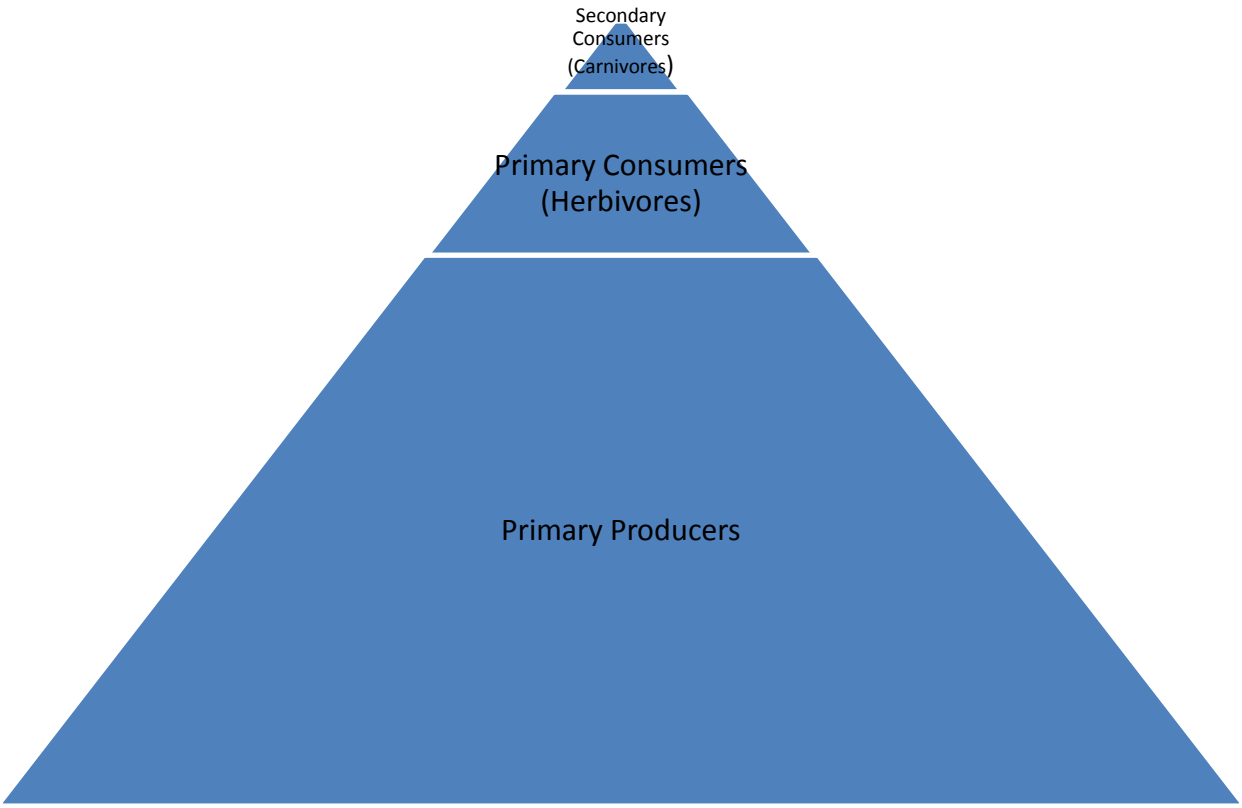
- One 10 inch X 10 inch piece of paper
- Coral Food Web Tags, one per student (example breakdown: 12 phytoplankton, 7 zooplankton, 6 coral, and 3 parrotfish)
- Energy Cards, approximately 50 depending on length of tag game
- For Optional activity – 2 buckets or tubs, one full of popcorn or packing peanuts

Background:
The **trophic level** of an organism is the position it occupies in a food chain. The number of steps an organism is from the start of the chain is a measure of its trophic level. Food chains start at trophic level 1, with primary producers (plants, phytoplankton, etc). Herbivores (such as cows or zooplankton that eat producers) are at the 2nd trophic level and are called primary consumers. Organisms at the 3rd trophic level or higher are carnivores and are referred to as secondary consumers, tertiary consumers, etc. The path along the chain forms a one-way flow along which energy travels in the form of food. Energy in the form of heat loss, metabolism, work, etc. is lost at each trophic level. Only 10% of the energy consumed is passed on to the next level.

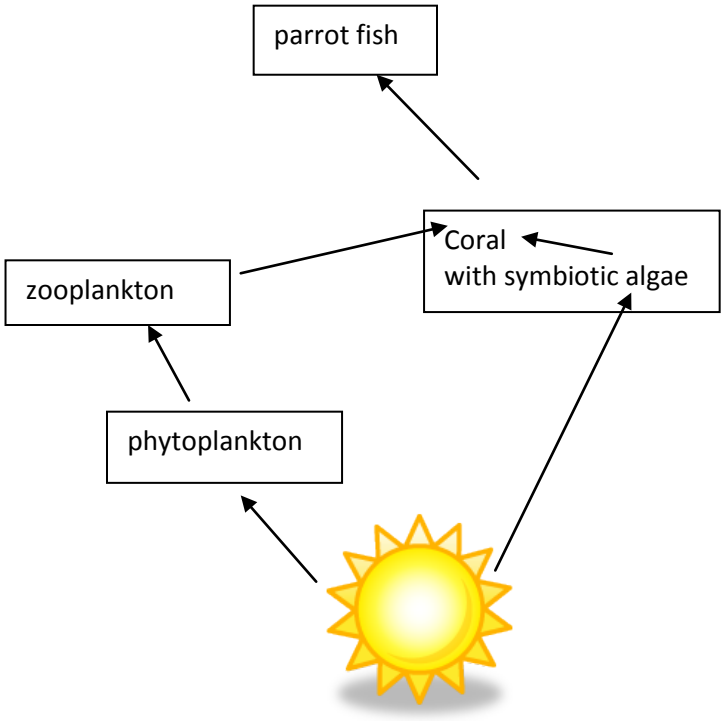
Lesson Plan:

1. Review with students the difference between a food chain and a food web. (If students are unfamiliar with food webs, the teacher may want to do the "Open Ocean Food Web Activity" from 5th grade, which can be modified to include animals found in coral reefs).

2. Using a basic food chain (sun-grass-cow-people), introduce the term *trophic level* to students.
3. Explain how energy enters a food chain (usually from the sun via photosynthesis, exceptions include chemosynthetic organisms at hydrothermal vents), and what happens to the energy throughout the food chain. Explain how the energy is used by plants and animals and how the energy is "lost" (not really lost, but unavailable to the next level as it has been converted into heat, etc.).
4. For a visual example, line up 3 students and tell them they are grass, a cow and a human in that order. Have "grass" hold up the 10x10 inch sheet of paper. Explain to the students that the grass gets its food by capturing energy from the sun and converting it to food (by photosynthesis). It has converted energy from the sun into 100 calories of food (represented by the 10 x 10 inch sheet). Now, the cow eats the grass. The "cow" takes the paper. Describe how the cow is pumping blood around its body to stay warm and to move around and to chew and do all the other things that cows do. Eventually, only 10% of the energy that the cow eats from the grass is turned into "more cow" by the cow growing (have the cow tear off a 1x10 inch strip of the paper and hold it up). The rest of the energy is used by the cow to survive and find and eat more food (put it in the recycled bin since that energy was converted into other forms). When a person eats the cow, the same thing happens. Have the human take the strip of paper. The human uses most of the energy it gets from the cow to ride a skateboard, dance, play basketball, eat, do homework, etc. Only 10% would be available for the next level (have the human tear off and hold up one square inch of the sheet, putting the rest in the recycle bin). If the human were eaten by a lion, the lion would only get this small percent of the original energy. Ask the students what percent? (1%)
5. Because so much energy is lost from one level to the next, there need to be more primary producers than primary consumers, more primary consumers than secondary consumers, etc. Draw a pyramid with primary producers at the base, primary consumers (herbivores) on top of them, secondary consumers (carnivores) on top of them.



6. Present the coral food web that students will be use for this activity.



- Phytoplankton is at the first trophic level (it is a *producer*, and makes its own food).
- Defining trophic level for corals is tricky. Shallow water corals are at both the second trophic level and third trophic level because they have a symbiotic relationship with microscopic algae living in their tissues. The corals get energy from the algae so in this sense are *primary consumers*. Corals are also *secondary consumers* at the third trophic level, because they also eat zooplankton and other small organisms they catch with their tentacles.
- Zooplankton that eat phytoplankton are *primary consumers* at the second trophic level.
- Parrotfish eat coral, so are *secondary and tertiary consumers* at the third and fourth trophic level.

7. **Activity:** Assign students to be one of the four organisms from the food web by handing out coral food web tags. Hand out more phytoplankton than the others, and fewer parrotfish- for example, 12 phytoplankton, 7 zooplankton, 6 coral, and 3 parrotfish. The teacher is the sun. Hand out an "Energy card" to each phytoplankton and coral (because of their symbiotic algae). "Energy cards" are squares with 100 smaller divisions on them. The students then play tag. Zooplankton can only tag phytoplankton. Coral can only tag zooplankton, and parrotfish can only tag coral. Once a prey organism has been tagged, it has to give 10% of its energy to the predator (tear off a single square from the Energy Card), and return the rest of the Energy card to the teacher who puts it into a "Converted "Lost" Energy" pile, and gives the students a new "Energy Card". When 'eaten', coral can either return to the sun for another energy card, or chase after zooplankton for energy. If a predator tags prey and the prey does not have energy yet, the predator gets nothing. Parrotfish and zooplankton cannot go to the sun for energy, but have to get energy from tagging prey with energy.
8. After the game is finished, gather the students and show them how much converted "lost" energy has been gathered throughout the game to reinforce the concept of inefficient energy transfer. Review with the students how energy is lost between trophic levels.
9. As an extension, discuss how coral bleaching will affect this food chain. (The symbiotic algae only survive under limited temperature ranges. If corals no longer get energy from their symbiotic algae, they will be more susceptible to disease and starvation. Corals without their symbiotic algae appear "bleached" without the color of the algae in their tissues.)

Assessment: Question the students after the activity. Discuss the results of the activity and listen for student comprehension.

Optional Activity – Popcorn Pass:

An optional (or additional) activity is to have the students pass energy from one to the other. Have them stand in a straight line. At either end of the line place one bucket or tub. One of the buckets is empty, and the other is full (of popcorn, packing peanuts, etc.) Tell the students that the straight line represents a food chain, and that the full bucket represents the Sun. The energy comes from the sun. Energy is transferred from one trophic level to another up the food chain,

until the last remnants of energy are consumed by decomposers (the empty bucket). Have students pass energy (popcorn), hand to hand, up the line and drop it in the empty bucket at the end. Travel up the line signifies organisms being eaten in a food chain. It helps if you have two separate lines of students, and turn it into a competition to see who can move their popcorn from the full to empty bucket first. Tell them speed is very important and it doesn't matter if they drop some (this encourages sloppiness). As the activity progresses, students will notice that a lot of the popcorn or energy is dropping on the floor. After 1 minute, stop the activity and review with the students what has occurred. It is likely they will see that a lot of popcorn was dropped, and very little popcorn made it to the other bucket. Students near the Sun were probably picking up large handfuls, but students at the end were getting very small handfuls. Discuss how this relates to trophic level energy loss.

GK12 Fellow: Michelle Schuiteman

Additional Web References for coral reefs and trophic levels:

http://www.waterencyclopedia.com/Ce-Cr/Corals-and-Coral-Reefs.html

http://www.bbc.co.uk/nature/blueplanet/infobursts/trophic_levels_bg.shtml

http://www.waterencyclopedia.com/Da-En/Ecology-Marine.html

Energy Card (Can shrink or enlarge as needed)

Coral Food Web Tags

CORAL
2nd and 3rd trophic levels (I get energy from algae AND eat animals that eat animals that make their own food)

PHYTOPLANKTON
1st trophic level (I make my own food)

ZOOPLANKTON
2nd trophic level (I eat animals that make their own food)

PARROTFISH
3rd and **4th** trophic level (I eat animals that get energy from algae AND that eat animals that eat animals that make their own food)