

# Life in the Ocean: Marine Plants and Animals

## Energy Transfer

### Food Web Dynamics

#### Reading:

13.2-13.4, 13.6-13.8

14.2, 14.4, 14.7-14.9, 14.11- 14.12

Graphics: (top) "Mystery Squid", NOAA and Science, (middle) Lima sea star, K.Evans, photographer. Courtesy of National Marine Sanctuaries Photo Gallery. (bottom) Red shrimp. National Ocean Service Photo Gallery.

### Flows of Energy

Energy flows from the sun to organisms and is ultimately lost

Producers - build organic material from sunlight (photosynthesis)

Consumers - use organic material for energy (respiration)

Graphic: Garrison, Fig. 13.3.

### Cycles of Matter

Matter cycles between producers and consumers

Products of photosynthesis are used for respiration

Products of respiration are used for photosynthesis

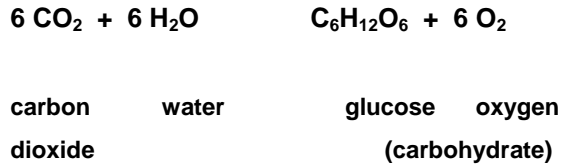
Graphic: Garrison, 4<sup>th</sup> Ed., Fig. 14.2.

### Photosynthesis

Photosynthesis binds energy into large

organic molecules:

sunlight



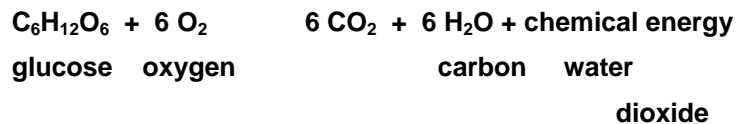
- Done by plants during sunlit hours

- The basis for most life on Earth

Graphics: Top: Marsh plant, South Carolina. NOAA National Estuarine Reserve Collection. Bottom: Red algae. National Museum of Natural History and the Smithsonian Institution.

## Respiration

Respiration converts organic matter to energy:



- Energy used for metabolism, movement, maintaining body heat

- Done by both plants and animals

Graphic: Top: Emperor penguins ,  
M. Van Woert, photographer.  
Bottom: Moonrise on Hobart Bay,  
Cmdr. J. Bortnaik, photographer.  
Courtesy of NOAA.

## Terrestrial (Land) and Marine Plants

Both need sunlight, CO<sub>2</sub>, nutrients and water, but...

- Land plants access water and nutrients via roots (favors large plants)
- Most ocean plants need to float to remain within the sunlit zone (favors very small plants)

Graphic: Pinet, Fig. 14.9.

<b>Comparison of Marine and Land Plants</b>		
Property	Marine Plants	Land Plants
Obtaining nutrients	roots	
	exchange across cell walls	
Obtaining sunlight	expansive leaves	float in euphotic zone
Structural support	trunks, stems	little or none required
Size	usually large	usually small

Graphics: (left) Coastal forest, courtesy of NOAA, (right) C.Wighamii, National Ocean Service Photo Gallery.

### **Phytoplankton - Small Marine Plants**

- Small and free-floating
- Energy obtained via photosynthesis
- Very abundant, 90-96% of total ocean primary productivity

**Small size allows:**

- diffusion of nutrients into cells and transfer of wastes out
- efficient use of cellular material

Graphic: Phytoplankter. Courtesy of NASA Goddard Space Flight Center.

### **Diatoms - Phytoplankters Living in Glass Houses**

- **Dominant type of phytoplankton**
- **Forms silica "shells"**
- **Store energy as oils (floatation)**
- **Free floating (no locomotion)**
- **Can live singly or form long chains**

Graphic: Diatom morphology, courtesy of the SeaWiFS project, NASA/GSFC and ORBIMAGE.

## **Coccoliths**

**Single-celled plants covered with calcium carbonate disks**

**Turn seawater "milky" during blooms**

**Shells can form thick sedimentary deposits**

Graphics: Coccoliths, courtesy of the SeaWiFS project, NASA/GSFC and ORBIMAGE.

## **Dinoflagellates**

**Single-celled plants that use flagella**

**(whiplike appendages) to adjust position and orientation**

**Many species are**

**toxic and can**

**cause harmful**

## **algal blooms**

Graphics: (top) Dinoflagellate.

Courtesy NASA Goddard Space

Flight Center, (center) Garrison,  
pg 391, (bottom) courtesy of the

SeaWiFS project and

NASA/GSFC.

## **Primary Productivity**

**Primary productivity = synthesis of organic matter from inorganic substances**

**Expressed in grams of carbon per unit area per unit time (grams/meter<sup>2</sup>/day or  
grams/meter<sup>2</sup>/year)**

Graphic: Garrison, Fig. 13.5a.

## **Variations in Primary Productivity**

**Primary productivity is regionally variable**

**Some of the most productive ecosystems on Earth are marine**

Graphic: After Garrison, Fig. 13.5c.

## **Marine Plants – Limited by Light**

**The vertical distribution of marine plants is controlled by the availability of light**

**Below the euphotic zone, there is not enough light for photosynthesis**

**The depth of the euphotic zone depends on water clarity (the amount of  
suspended material in the water)**

Graphic: Garrison, Fig. 13.14.

## **Marine Plants – Limited by Nutrients**

**The geographic distribution of marine plants is controlled by the availability of**

## **nutrients**

**Regions with low nutrients have few phytoplankton**

**High nutrients:**

- **polar regions**
- **upwelling zones**

Graphic: Distribution of phosphate (a nutrient) in the surface ocean.

## **Seasonal Patterns of Primary Productivity Are Controlled by Light and Nutrients**

**Tropical regions have nearly constant production through the year**

**Mid-latitudes (temperate regions) have fall and spring blooms**

**Polar regions have short summer growing seasons**

Graphic: (left) See Garrison, Fig. 14.13 (green lines), (right) plant pigment concentration in the ocean, provided by the SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE, see Garrison Fig. 13.6.

## **The Spring Bloom**

**The shift from winter to spring is marked with an explosion in the abundance of marine phytoplankton**

**Conditions needed:**

- **abundant light, nutrients**
- **warm, calm conditions**
- **low grazing rates by animals**

Graphics: Ocean color (top) Feb 2001, (bottom) May 2001. Images courtesy of SeaWiFS and Orbimage. [\(animation\)](#)

## **Marine Food Webs**

Graphic: Garrison, Fig. 13.9.

## **Trophic Transfers**

**Only about 10% of food is stored in consumers as flesh**

- **each trophic step is about 10% of the mass of the step below**
- **large organisms are less common than small organisms**
- **most marine communities depend on plants for their “base”**

Graphic: Garrison, Fig. 13.8.

# Phytoplankton and Zooplankton

“Plankton” – drifting or weakly swimming organisms, can be plants or animals

## Phytoplankton

- marine plants
- primary producers (photosynthesizers)
- the base of many marine food webs

## Zooplankton

- marine animals
- primary consumers (plant eaters)
- the 1<sup>st</sup> animal link in many marine food webs

Graphics: (top) C. Wagami, courtesy of NOAA, (bottom) copepod  
with eggs, photo by R.Hopcroft, Univ. Alaska, Fairbanks, courtesy of NOAA.

## Suspension Feeders

Suspension (“filter”) feeders eat particles that are suspended in the water column

Typical foods: phytoplankton, small bits of dead organic matter

Require flow-through of water in order to filter out food

- active pumping (sponges)
- natural water motion due to waves or currents
- swimming (zooplankton)

Graphics: (top) Christmas tree worms *Spirobranchus giganteus* photo by J. Guttuso, courtesy of NOAA, (bottom) Garrison, Fig. 15.3b.

## Scavengers and Deposit Feeders Consumers (Predators)

Many medium-size and large organisms hunt for food

Predation strategies:

- foraging (actively moving in search of prey)

- ambushing (“sit and wait” –works best when metabolism is low or prey is abundant)
- cooperative hunting (hunting as a group)

**Predators can exert strong pressure on lower levels of the food web**

Graphic: (top) Nurse shark, (bottom) Moray eel, courtesy of NOAA Photo Library.

## **Apex Predators at the Top of the Food Web**

**Apex predators have evolved very effective hunting strategies**

**Sharks have excellent sensory systems**

- smell
- vision
- lateral line (detects vibrations)
- electroreceptors (detect small variations in electrical currents)

**Orcas (“killer whales”) are very intelligent and hunt cooperatively in groups**

Graphics: (top) White shark, photo by S. Anderson, (bottom) Orcas, courtesy of NOAA.

## **Apex Predators - Vulnerable to Predation by Humans**

**Because most apex predators produce few and infrequent young, populations of these animals can be depleted by overfishing**

**Example – sharks:**

- many years to maturity
- have few young
- many sharks need specific habitats for their young which are different from adult habitats



Graphics: White shark, photo by S. Anderson, courtesy of NOAA.

# **Abyssal Giants**

## **Preview of Next Lecture**

### **Ecological Interactions in Coastal and Open-Ocean Marine Communities**

**Reading: 16.2-16.13, 16.16- 16.17,  
16.20, 15.25, 9.12**

Graphic: Black rockfish in a kelp bed. Photograph by Kip Evans. Monterey Bay National Marine Sanctuary Collection. Courtesy of NOAA  
Kelp forest, S. Fisher courtesy of National Marine Sanctuaries and NOAA.