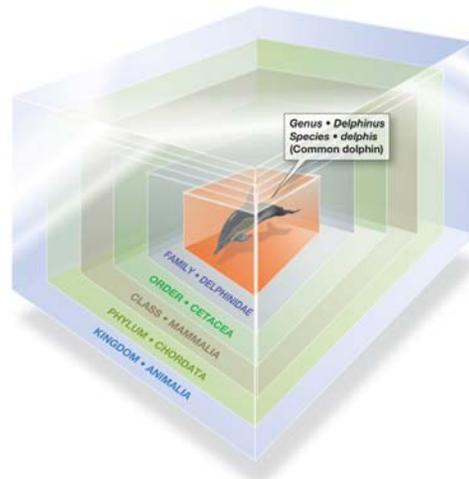


CH 12 Marine Life and the Marine Environment

- There are more than 250,000 identified marine species
- Most live in sunlit surface seawater
- A species' success depends on the ability to
 - find food
 - avoid predation
 - reproduce
 - cope with physical barriers to movement
- Marine organisms are adapted to the ocean's physical properties

Taxonomy

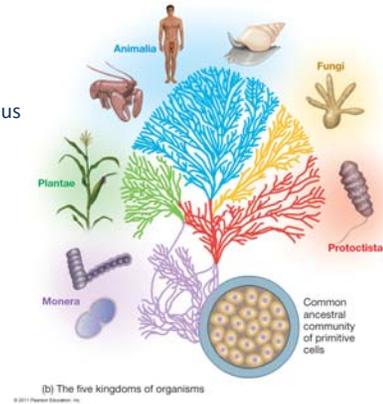
- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species
 - Fundamental unit
 - Population of genetically similar, interbreeding individuals



Classification of Living Organisms

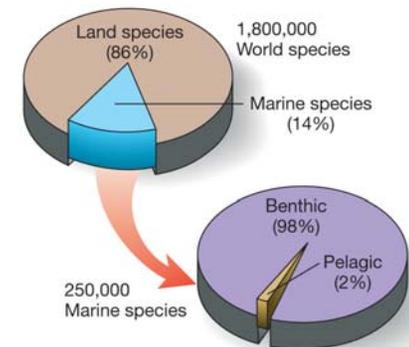
Five kingdoms

- **Monera**
 - Simplest organisms, single-celled
 - Cyanobacteria, heterotrophic bacteria, archaea
- **Protoctista**
 - Single- and multicelled with nucleus
 - Algae, protozoa
- **Fungi**
 - Mold, lichen
- **Plantae**
 - Multicelled photosynthetic plants
 - Surf grass, eelgrass, mangrove, marsh grasses
- **Animalia**
 - Multicelled animals
 - Range from simple sponges to complex vertebrates



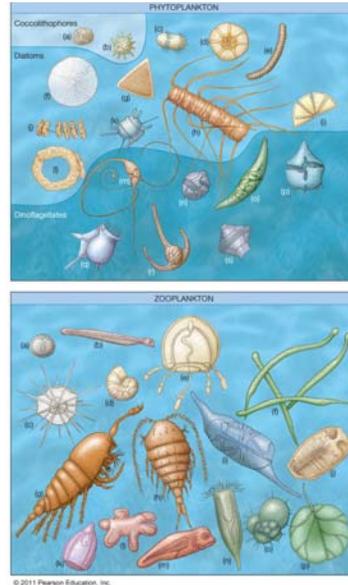
Classification of Marine Organisms

- **Plankton** (floaters)
- **Nekton** (swimmers)
- **Benthos** (bottom dwellers)

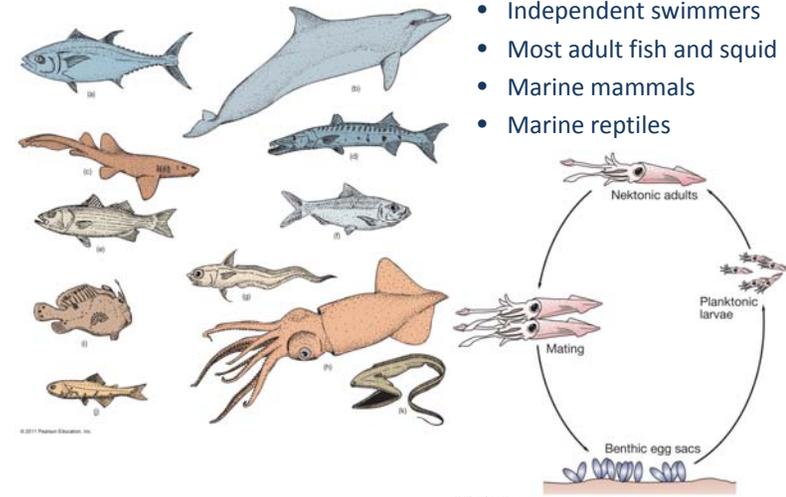


Types of Plankton

- Most biomass on Earth consists of plankton.
- **Phytoplankton**
 - Autotrophic
- **Zooplankton**
 - Heterotrophic

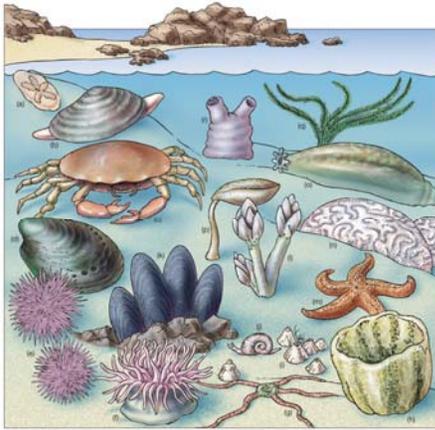


Nekton



- Independent swimmers
- Most adult fish and squid
- Marine mammals
- Marine reptiles

Benthos



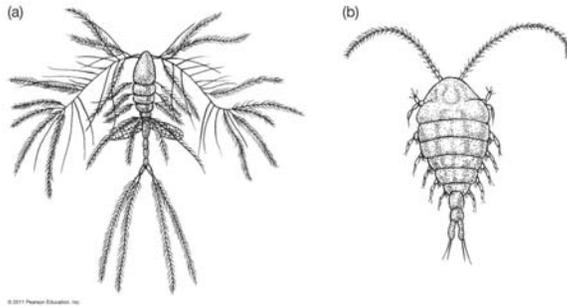
- **Epifauna** live on the surface of the sea floor.
- **Infauna** live buried in sediments.
- **Nektobenthos** swim or crawl through water above the seafloor.
- **Benthos** are most abundant in shallower water.
- Many live in perpetual darkness, coldness, and stillness.

Hydrothermal Vent Communities

- Abundant and large deep-ocean benthos
- Discovered in 1977
- Associated with hot vents
- Bacteria-like archaeon produce food using heat and chemicals.

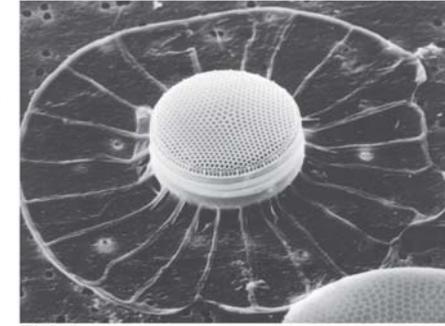
Adaptations of Marine Organisms

- Physical support
 - Buoyancy
 - How to resist sinking
 - Different support structures in cold (fewer) rather than warm (more appendages) seawater
 - Smaller size



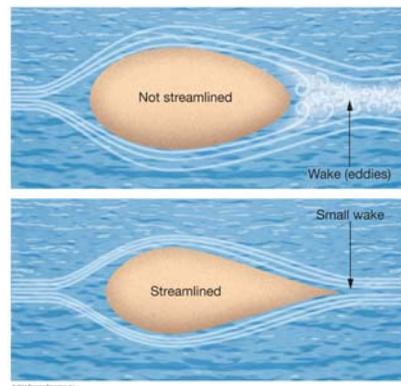
Adaptations of Marine Organisms

- High surface area to volume ratio
 - Unusual appendages to increase surface area
- Oil in micro-organisms to increase buoyancy



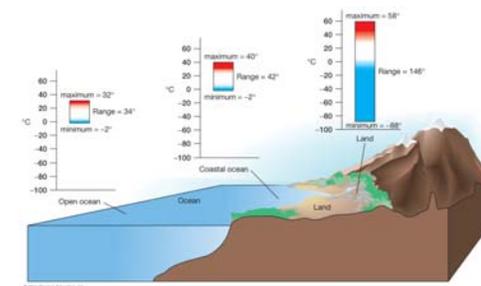
Viscosity and Streamlining Adaptations

- Streamlining important for larger organisms
- Less resistance to fluid flow
- Flattened body
- Tapering back end



Temperature and Marine Life

- Narrow range of temperature in oceans
- Smaller variations (daily, seasonally, annually)
- Deep ocean is nearly isothermal

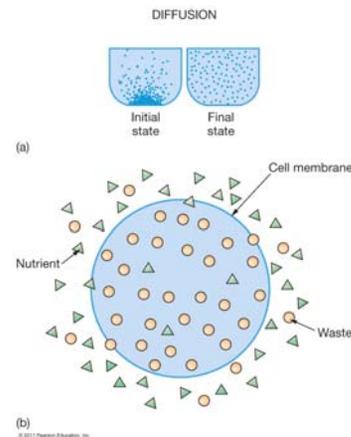


Temperature and Marine Organisms

- **Stenothermal**
 - Organisms withstand small variation in temperature
 - Typically live in open ocean
- **Eurythermal**
 - Organisms withstand large variation in temperature
 - Typically live in coastal waters

Salinity Adaptations

- Extracting minerals from seawater
- High concentration to low concentration
 - **Diffusion**
 - Cell membrane permeable to nutrients, for example
 - Waste passes from cell to ocean



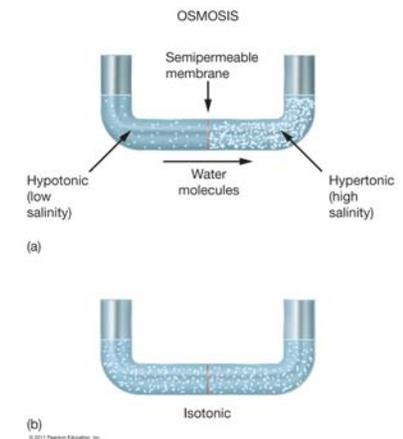
Salinity and Marine Organisms

- **Stenohaline**
 - Organisms withstand only small variation in salinity
 - Typically live in open ocean
- **Euryhaline**
 - Organisms withstand large variation in salinity
 - Typically live in coastal waters, e.g., estuaries

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Osmosis

- Water molecules move from less concentrated to more concentrated solutions
- Osmotic pressure
 - In more concentrated solutions
 - Prevents passage of water molecules
- **Isotonic**
- **Hypertonic**
- **Hypotonic**

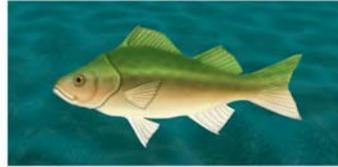


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Marine vs. Freshwater Fish

(a) MARINE FISH
(Hypotonic)

- Drink large quantities of water
 - Secrete salt through special cells
 - Small volume of highly concentrated urine
- © 2011 Pearson Education, Inc.

(b) FRESHWATER FISH
(Hypertonic)

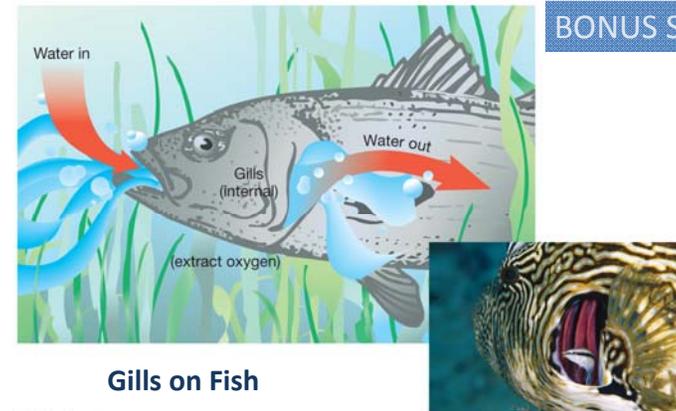
- Do not drink
- Cells absorb salt
- Large volume of dilute urine

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Water Pressure

- Increases about 1 atmosphere (1 kg/cm²) with every 10 meters (33 feet) deeper
- Many marine organisms – no inner air pockets
- Collapsible rib cage (e.g., sperm whale)

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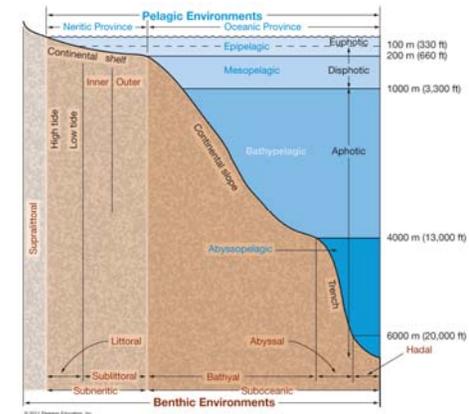
Gills on Fish

- Animals extract dissolved oxygen (O₂) from seawater through **gills**.
- Gills exchange oxygen and carbon dioxide directly with seawater.
- Low marine oxygen levels can kill fish.
- Gill structure and location varies among animals.

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Pelagic Environment

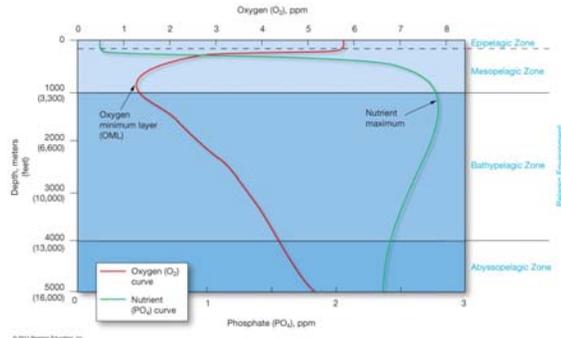
- Divided into **biozones**
- **Neritic Province** – from shore seaward, all water < 200 meters deep
- **Oceanic Province** – depth increases beyond 200 meters



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Dissolved Oxygen with Depth

- Dissolved oxygen minimum layer (OML) about 700-1000 meters
- Nutrient maximum at about same depths
- O₂ content increases with depth below



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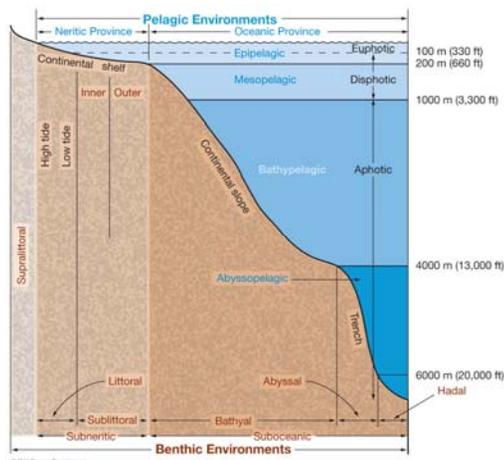
Ocean Zones Based on Light Availability

- **Euphotic** – surface to where enough light exists to support photosynthesis
- **Disphotic** – small but measurable quantities of light
- **Aphotic** – no light

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Benthic Environments

- **Supralittoral**
- **Subneritic**
 - Littoral
 - Sublittoral
 - Inner
 - Outer
- **Suboceanic**
 - Bathyal
 - Abyssal
 - Hadal



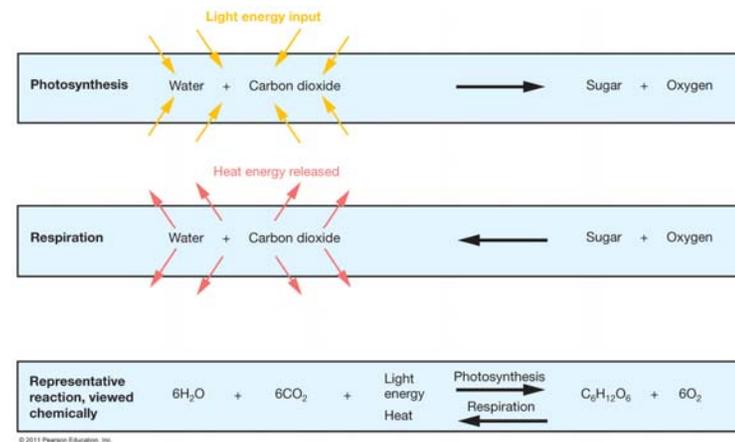
CH 13 Biological Productivity and Energy Transfer

- **Productivity is the same as photosynthesis, which is affected by sunlight and nutrients.**
- **Productivity is globally and seasonally variable.**
- **Feeding relationships are represented by food chains and food webs.**
- **Oceans are being overfished.**

Primary Productivity

- Primary productivity is the rate at which energy is stored in organic matter.
- **Photosynthesis** uses solar radiation.
- **Chemosynthesis** uses chemical reactions.
- 99.9% of the ocean's biomass relies directly or indirectly on photosynthesis for food.

Photosynthesis

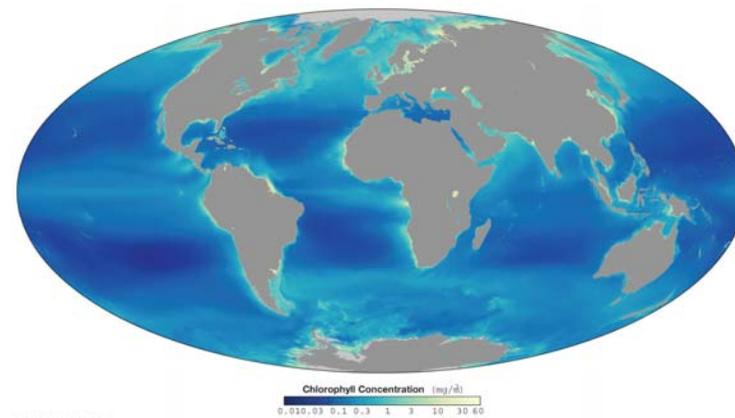


Measurement of Primary Productivity

- Directly – capture plankton in plankton nets
- Measure radioactive carbon in seawater
- Monitor ocean color with satellites
 - Green pigment chlorophyll
 - SeaWiFS



Ocean Chlorophyll – SeaWiFS



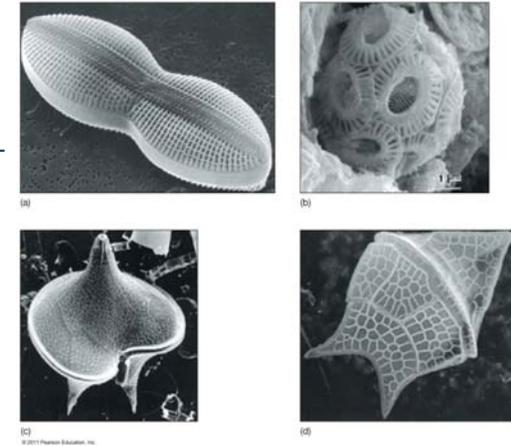
Macroscopic Algae

- “Seaweeds”
 - **Brown algae**
 - **Green algae**
 - **Red algae**
 - Most abundant and most widespread
 - Varied colors



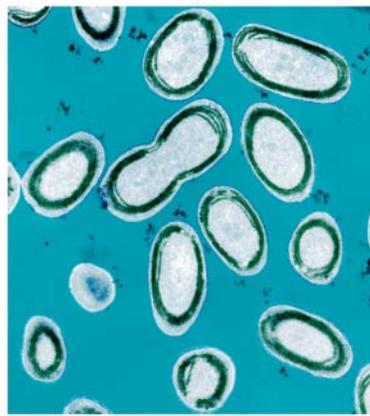
Microscopic Algae

- Produce food for 99% of marine animals
- Most planktonic
- Golden algae
 - Diatoms – tests made of silica
 - Coccolithophores – plates of calcium carbonate
- Dinoflagellates
 - Red tide (harmful algal bloom)
 - Toxins
 - Fish kills
 - Human illness



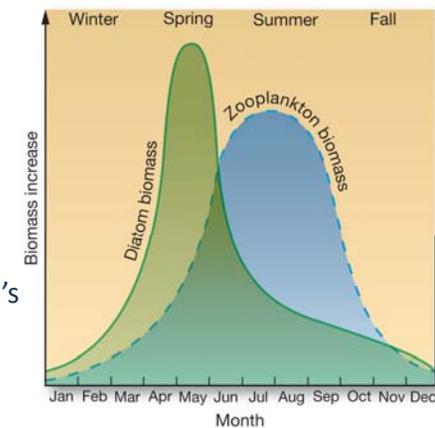
Photosynthetic Bacteria

- Extremely small
- May be responsible for half of total photosynthetic biomass in oceans
- Exert critical influence on marine ecosystems



Polar Ocean Productivity

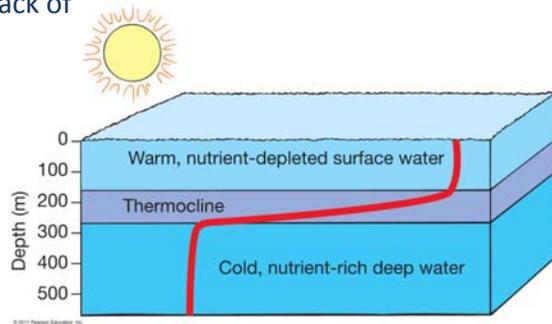
- Winter darkness
- Summer sunlight
- **Phytoplankton** (diatoms) bloom
- **Zooplankton** (mainly small crustaceans) productivity follows
- Example: Arctic Ocean's Barents Sea



(a) Barents Sea productivity

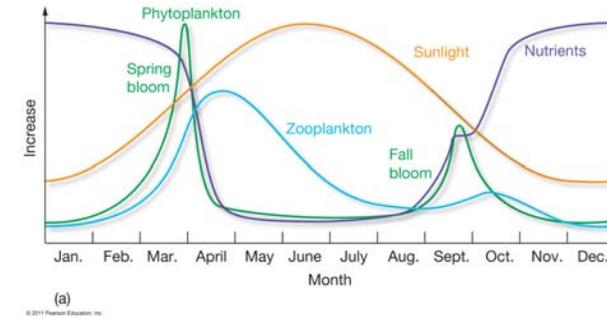
Productivity in Tropical Oceans

- Permanent thermocline is barrier to vertical mixing
- Low rate of primary productivity – lack of nutrients

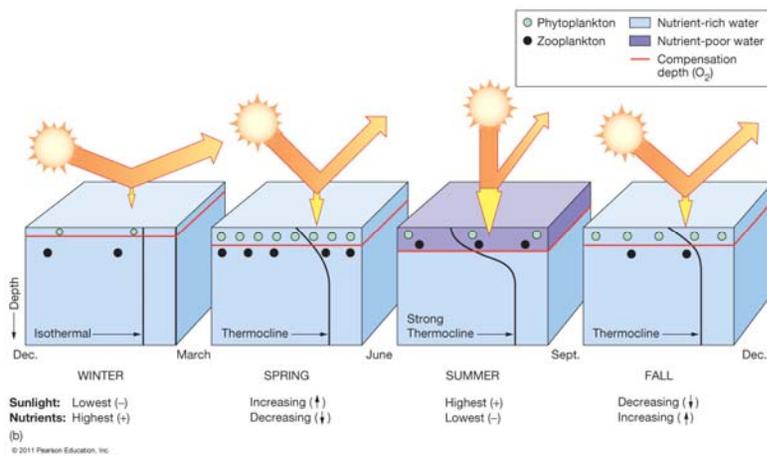


Temperate Ocean Productivity

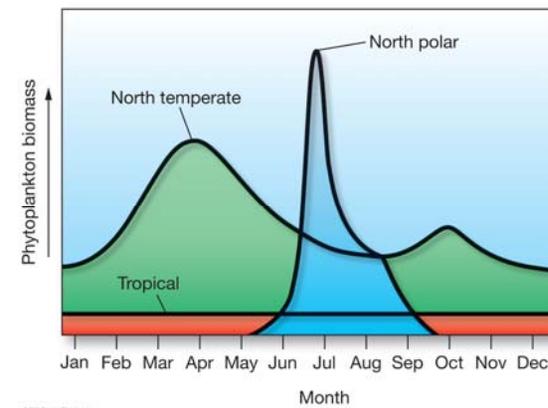
- Productivity limited by
 - Available sunlight
 - Available nutrients



Temperate Ocean Seasonal Cycle



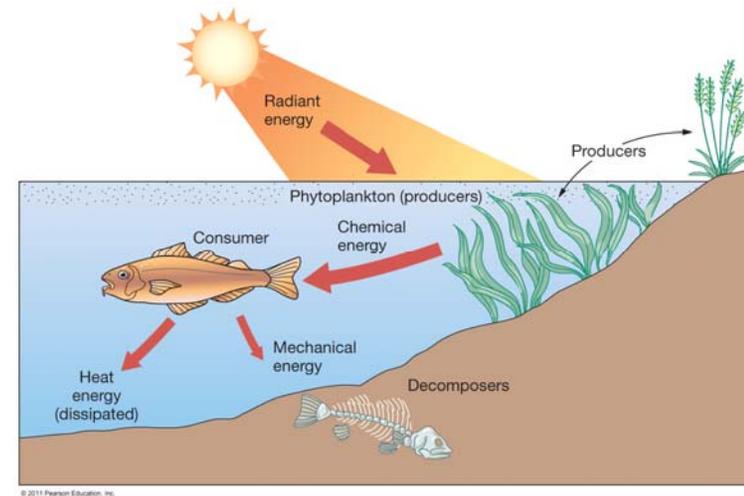
Comparison of Global Productivities



Energy Flow in Marine Systems

- Three categories of organisms:
 - **Producers**
 - Nourish themselves with photosynthesis or chemosynthesis
 - Autotrophic
 - **Consumers**
 - Eat other organisms
 - Heterotrophic
 - **Decomposers** – break down dead organisms or waste

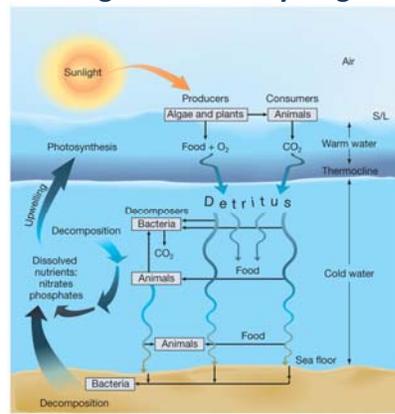
Energy Flow in Marine Systems



Nutrient Flow in Marine Ecosystems

• Biogeochemical cycling

- **Herbivores** – eat plants
- **Carnivores** – eat other animals
- **Omnivores** – eat plants and animals
- **Bacteriovores** – eat bacteria

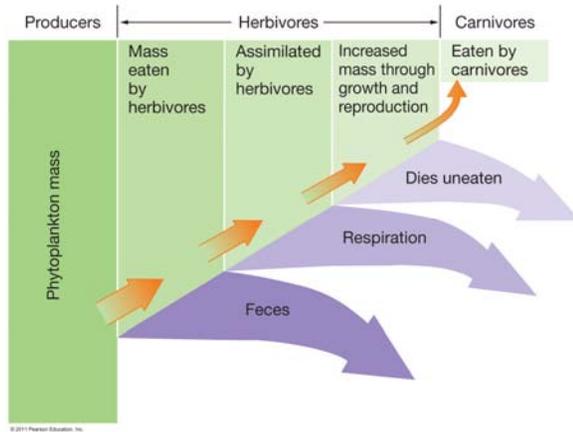


Feeding Strategies

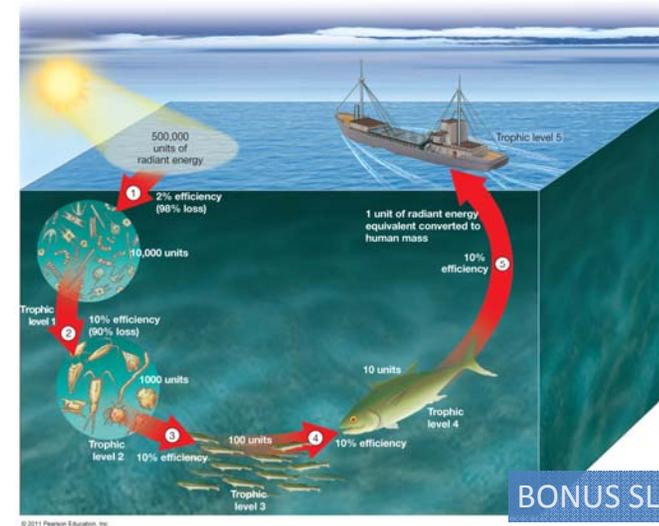
- **Suspension feeding or filter feeding**
 - Take in seawater and filter out usable organic matter
- **Deposit feeding**
 - Take in detritus and sediment and extract usable organic matter
- **Carnivorous feeding**
 - Capture and eat other animals

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Trophic Levels



Ecosystem Energy Flow and Efficiency



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Biomass Pyramid

- The number of individuals and total biomass decreases at successive trophic levels.
- Organisms increase in size.

