Learning Objectives

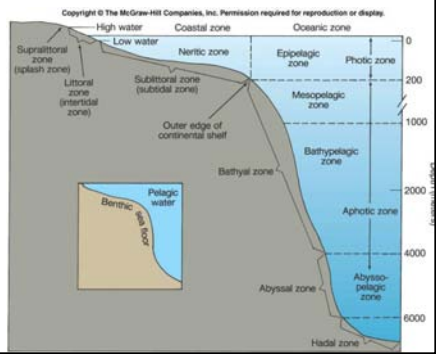
1. To understand how ocean life is grouped together
2. How do the changes in important physical properties in the oceans affect marine organisms?
   temperature, salinity, pressure,buoyancy, and the availability of light
3. Understand how organisms adapt to abiotic and biotic stresses
4. To learn about the close relationships that occur between different marine species

Marine Biology & Ecology

- Study of the abundance and distribution of marine organisms
- Study the relationships between organisms and their environment

Environmental Zones

•Benthic Zone
•Pelagic Zone
  •Neritic Zone
  •Oceanic Zone

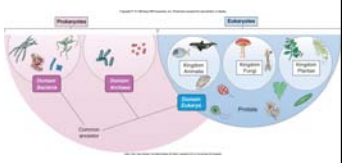


11.1 Groups of Organisms -relatedness

• Can be grouped by either their relatedness or their function
•Lifestyle: Benthos, Plankton, Nekton
•Taxonomy - based on shared morphology
• Domain, Kingdom, Phylum, Class, Order, Family, *Genus, Species*
•Eukarya, Animalia, Chordata, Mammalia, Primate, Hominid, *Homo Sapiens*

3 Domains of life

•Bacteria
•Archaea
  •Both are prokaryotes - unicellular, no cell nucleus.
  •Have differing DNA
•Eukarya
  • Unicellular or multicellular
  •Complex cells with a nucleus

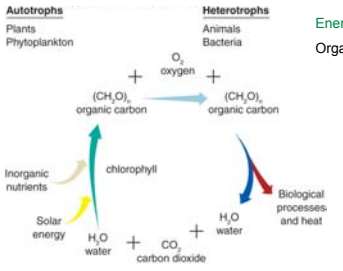


11.2 Groups of Organisms - function

• Can be grouped by either their relatedness or their function
•Most basic division: How does the organism derive its energy and carbon

Energy:
Sunlight (photo) or chemicals (chemo)

Carbon:
CO_2



11.2 Groups of Organisms - function

•Photoautotrophs use sunlight and inorganic nutrients to generate organic matter via photosynthesis

•Chemoautotrophs use sunlight and inorganic nutrients to generate organic matter via chemosynthesis

•Prokaryotes can be Photoautotrophs, Chemoautotrophs or Heterotrophs

•Autotrophs form the base of the food chain. They generate organic compounds and fuel the growth of organisms that require those compounds as food

Vocabulary Review

Combining Relatedness & Function

- Prokaryotes
- Eukaryotes
- Photoautotrophs
- Chemoautotrophs
- Heterotrophs

In the Ocean

What would be an example of a Photoautotrophic Eukaryote?

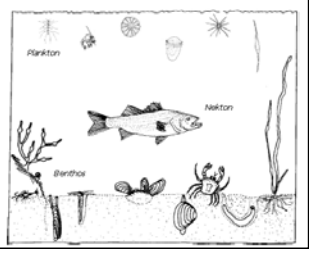
What would be an example of a Heterotrophic Eukaryote?

What would be an example of a Chemoautotrophic Prokaryote?

11.4 Groups of Ocean Organisms

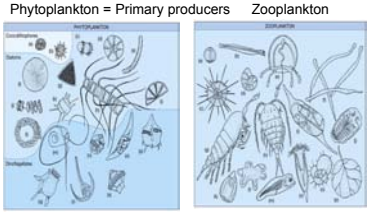
- For ocean life the most important classifier is ecology (habitat)

- Plankton - drift
  - Phytoplankton: Photoautotrophs
  - Zooplankton: Heterotrophs
  - Bacterioplankton: Heterotrophic prokaryotes
- Nekton - swim faster than currents
- Benthos - live on, in, or attached to the sea floor regardless of depth
  - Epifauna live on surface. Either sessile or mobile
  - Infauna live within the sea floor



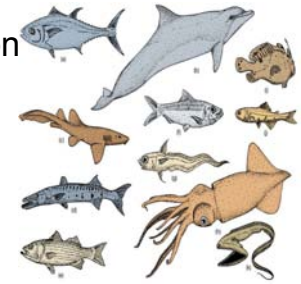
Plankton

Phytoplankton = Primary producers Zooplankton



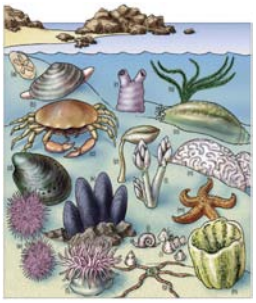
- Size: Small (microscopic – to a few mm)
- Float or swim – but move with the currents (size)
- 3 categories: phytoplankton, zooplankton, bacterioplankton

Nekton



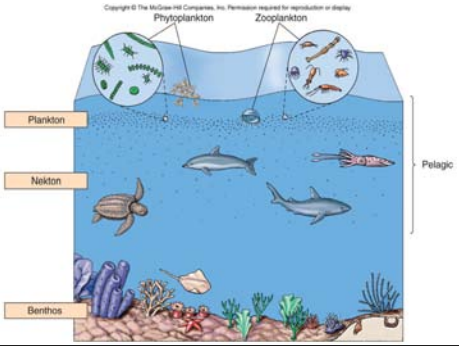
- Size: Larger (> mm).
- Free swimming – can swim against currents.

Benthos



- Infauna vs. epifauna

Marine habitats & resident fauna



Marine fauna

- Is the distribution of marine fauna within the marine ecosystem random?

No. The observed distribution of marine fauna is determined by organism adaptations to abiotic and biotic factors.

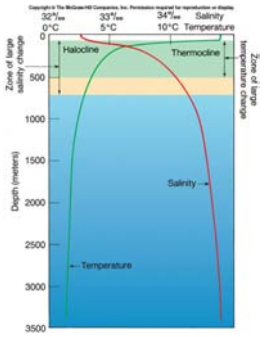
11.5 Facts of Ocean Life

- Stresses
  - Abiotic
  - Biotic
- Adaptations

Explains species abundance and diversity

Abiotic Stresses

- Gravity
- Temperature
- Pressure
- Salt Content
- Water Motion
- Light Limitation
- Nutrient Limitation

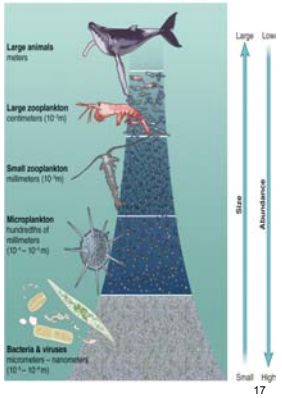


Biotic Stresses

- Predation
- Competition
  - Food
  - Space
  - Reproduction
- Parasitism
- CO_2, O_2 levels
- Nutrients

11.3 Size

- Size and abundance are inversely related in the oceans
- Organisms span an incredible range of sizes and abundances, from microns to meters and millions per mL to hundreds per ocean basin



Your body size determines many of your strategies.

- If you are Small:
  - You have a high surface area to volume ratio.
  - Most of your cells are close to the exterior of your body.
  - Diffusion is an option to move nutrients and oxygen into your body and remove wastes.
  - Conductive heat transfer works well.
  - Viscosity controls your locomotion.

Your body size determines many of your strategies.

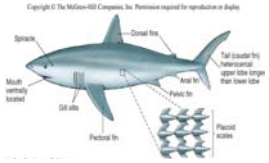
- If you are LARGE:
  - You have a low surface area to volume ratio.
  - Relatively few of your cells are close to the exterior of your body.
  - Diffusion is NOT an option to move nutrients and oxygen into your body and remove wastes. Active transport must be used.
  - Conductive heat transfer DOES NOT WORK.
  - GRAVITY (and inertia) control your locomotion.

Gravity

- How do you maintain position in the water column?
- Plankton:
  - High surface area to volume ratio
  - Add spines, appendages or exoskeleton to your surface to increase surface area
  - Maintain density very near that of seawater
  - Incorporate swimming devices that work in viscous circumstances – flagella, cilia, flat legs

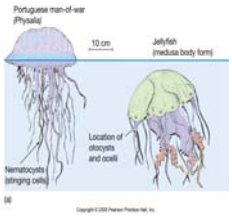
Nekton strategies to avoid sinking

- Gas pockets -> float on surface
- Store oil or blubber
- Active swimming
- Heterocercal caudal fin -> provides lift (sharks)
- Adjust buoyancy -> swim bladders



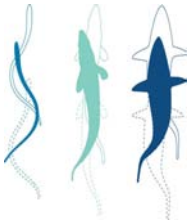
Nekton strategies to avoid sinking

- Gas pockets and swimming bells:
  - Large Cnidarians



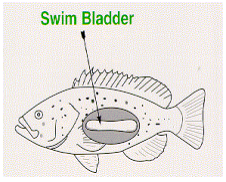
Nekton strategies to avoid sinking

- Active swimming



Nekton strategies to avoid sinking

- Increase buoyancy by storing gas
  - swim bladders
  - chambered shells



Light

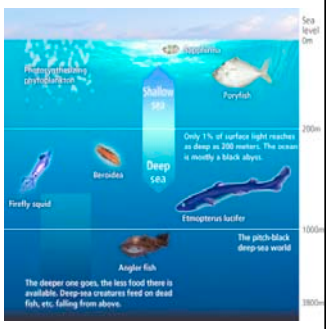
•Euphotic Zone - photosynthesis

•Twilight Zone - objects can be seen during day

•Aphotic Zone - no light

•Phytoplankton must be able to adapt to large changes in light levels. They often are mixed into the deeper, darker waters.

•For example, what happens to phytoplankton when a large storm goes by?



Bioluminescence

• Within cells a specific enzyme acts on a substrate to produce light

•Often triggered by physical movement - wake of a boat

• Main reason: Predator Avoidance

- •"Startle" the predator
- •Call attention to the predator

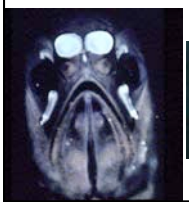
Brittle Star

Bioluminescence: Other reasons

•Bacteria glow so they will be eaten

•Attract and lure prey

•Use the light to see (flashlight fish)



Color

• Many organisms are transparent to blend into the water

•Camouflage

- – Corals
- – Ocean floor

•Countershading - light undersides, dark backs

Salinity

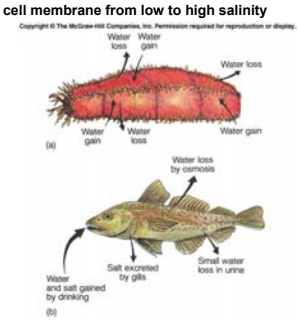
Organisms must maintain internal salt content. To maintain salt content different from surrounding waters, organism must add or remove salt

Osmosis - transfer of water through cell membrane from low to high salinity

Most benthos - Internal salt content same as external. Salinity hardly varies at ocean bottom.

Most fish - Internal salt content lower than external. Must continuously drink seawater and excrete salt.

Sharks & Rays - maintain high levels of urea (which acts like a salt) in tissues. Eliminates the osmotic gradient



Salinity

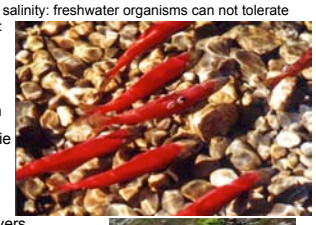
Most marine species are limited by salinity: freshwater organisms can not tolerate saltwater, & vice versa. Exceptions:

•Salmon - Anadromous

- •Spawn in fresh water
- •Juveniles migrate to ocean
- •Adults return to spawn & die

•Eels - Catadromous

- •Spawn in Sargasso Sea
- •Migrate to estuaries and rivers
- •Return to Sea to spawn & die



Thermal Regulation

- Poikilotherms
  - Invertebrates and most fish
  - No regulation of body temperature
  - Cold water species tend to be slow growers, longer lived and larger sized (slow metabolism)
  - Geographical range is restricted by t
  - Shifts in water temp. (El Nino) cause migrations
- Homeotherms
  - Regulate body temperature
  - Seabirds
  - Marine Mammals
  - Some fish
  - Greater geographic range, can migrate large distances

Pressure

•Surface: 1 atm (~15 lb/in^2)
6 km: 600 atm (4.5 tons/in^2)

• Deep living organisms: No gas filled cavities. Fish fill swim bladders with oil, not air

Table 14.2 Record Depths of Breath-Hold Divers

Species	Dive Depth (m)	Dive Depth (ft)
Human (*Homo sapiens*)	105	347
King penguin (*Aptenodytes patagonicus*)	240+	792+
California sea lion (*Zalophus californianus*)	250	825
Ridley sea turtle (*Lepidochelys olivacea*)	250	825
Common porpoise (*Delphinus delphis*)	260	858
Killer whale (*Orcinus orca*)	260	858
Emperor penguin (*Aptenodytes forsteri*)	>500	>1650
Bottle-nose dolphin (*Tursiops truncatus*)	535	1766
Pilot whale (*Globicephala melaena*)	610	2013
Beluga whale (*Delphinopterus leucas*)	650	2145
Weddell seal (*Leptonychotes weddellii*)	>700	>2310
Leatherback turtle (*Dermochelys coriacea*)	>1000	>3300
Elephant seal (*Mirounga angustirostris*)	>1500	>4950
Sperm whale (*Physeter catodon*)	>2000	>6600

Data from G. L. Kooyman, *Diverse Divers, Physiology and Behavior*, 1989; and G. L. Kooyman and P. J. Ponganis, *The Challenges of Diving to Depth*, 1997.

Pressure and air breathing fauna that dive to great depths....

- Penguins: can dive to > 500 m on one breath.
- Sperm whales: can dive >2000 m on one breath.
- These and others have specialized hemoglobin in their blood that can slowly release oxygen.
- Sperm whales have rib cages and lungs that are designed to collapse with pressure and reinflate under normal conditions.

13.6 Close Associations

- Symbiosis - close ecological relationship between different species. 3 types:
- Commensalism - one partner benefits, one partner is unaffected
  - Barnacles/marine mammals
- Mutualism - both partners benefit
  - Clownfish/anemone
  - Zooxanthellae

Mastigias papuae , this jellyfish lacks a mouth and cannot feed. It gets all of its nutrition from zooxanthellae

Close Associations

- Symbiosis - close ecological relationship between different species. 3 types:
- Parasitism - one partner lives at the expense of another. Parasites get food/shelter while harming their hosts

Sea lice/juvenile salmon