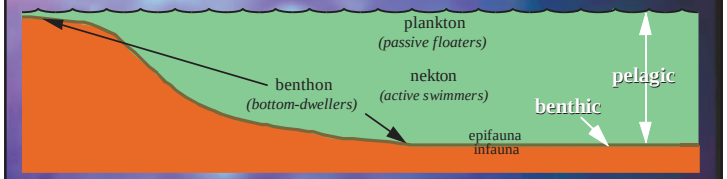
Distribution of Life in the Oceans

Here, There, and Almost Everywhere

Ocean habitats



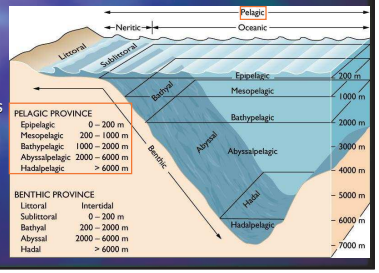
- **Pelagic** refers to the water column
  - *from surface to the just above the bottom*
- **Benthic** refers to the seafloor
  - *from salt marsh to the deepest trench*
- There are many more benthic species of animals than pelagic species
  - *~98% of all marine animal species live on or near the seafloor*

Mr. Ray sings …

"Oooh, let's name the zones, the zones, the zones,
Let's name the zones of the open sea!
Mesopolagic, bathypelagic, abyssalpelagic,
All the rest are too deep for you and me to see."

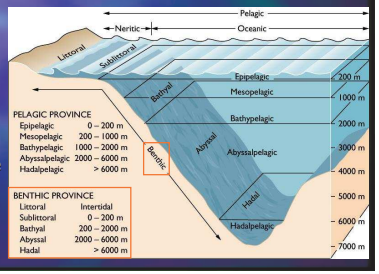
Ocean habitats ("biozones")

- the **pelagic** (water column) environments
  - broad:
    - neritic zone – overlies continental shelf
    - oceanic zone – beyond shelf break
  - specific:
    - epipelagic zone
      - illuminated surface layer
    - mesopelagic zone
      - "twilight," no photosynthesis
    - bathypelagic zone
      - totally dark, no living plants
    - abyssalpelagic zone
      - more than ½ ocean volume
    - hadalpelagic zone
      - deep-sea trenches



Ocean habitats ("biozones")

- the **benthic** (bottom) environments
  - shallow (shelf):
    - littoral (intertidal) zone – between high and low tide
    - sublittoral zone – beach to shelf break
  - deep:
    - bathyal zone
      - continental slope & rise
      - beneath mesopelagic and bathypelagic zones
    - abyssal zone
      - average deep ocean bottom
      - beneath abyssalpelagic zone
    - hadal zone
      - deep-sea trenches
      - beneath hadalpelagic zone



Light penetration zones

- **photic zone** – depth where light is sufficient for photosynthesis
- **dysphotic zone** – depth where illumination is too weak for photosynthesis
- **aphotic zone** – receives no light from the surface because it is all absorbed by the water above

photic zone
- epipelagic zone
  - illuminated surface layer

dysphotic zone
- mesopelagic zone
  - "twilight," no photosynthesis

aphotic zone
- bathypelagic zone
  - totally dark, no living plants
- abyssalpelagic zone
  - more than ½ ocean volume
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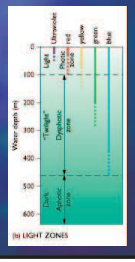
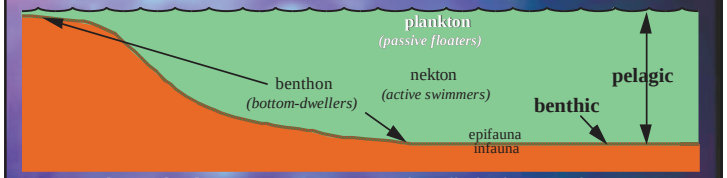
  - deep-sea trenches



Some terms

- **Heterotrophs** - organisms that *require food* in the form of organic compounds prefabricated by other organisms
- **Autotrophs** - organisms that can *synthesize* organic compounds (their body tissues) from inorganic substances (nutrients)
  - that is, they make their own food
  - two types:
    1. photosynthetic organisms
       - utilize *solar energy* to power photosynthesis
       - live in the photic zone
    2. chemosynthetic organisms
       - utilize *chemical reactions* to power chemosynthesis
       - commonly live near deep sea vents

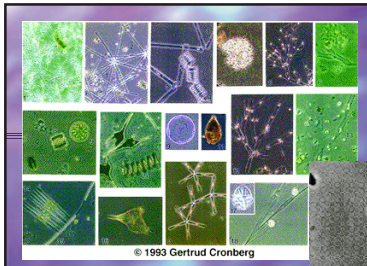
Plankton – "passive floaters"



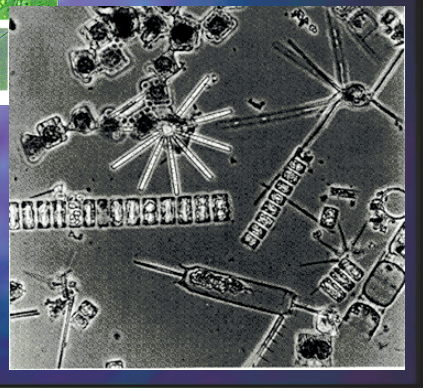
- **phytoplankton** - microscopic, single-celled, photosynthetic algae (diatoms, dinoflagellates, coccolithophorids)
- **zooplankton** - includes some animals (copepods, krill, jellies) and microscopic, single-celled intermediate plant/animal life forms (flagellates, ciliates, forams)
- **bacterioplankton** - many kinds of heterotrophic bacteria, and some photosynthetic bacteria (cyanobacteria)
- **meroplankton** - larval stage of some benthonic and nektonic animals (spend early part of life as plankton)

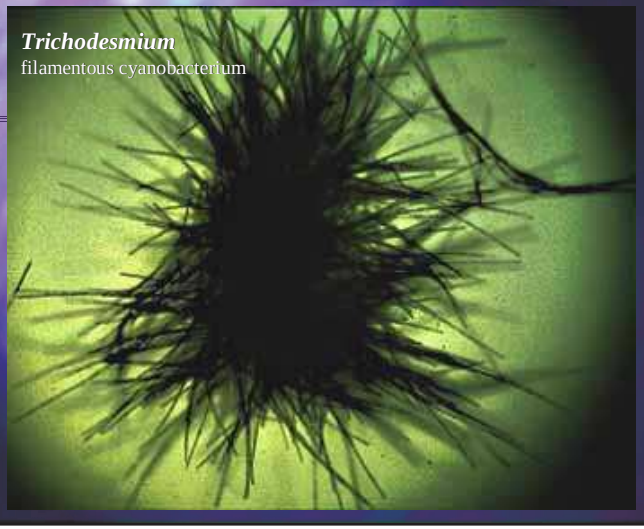
Diatom
(single-celled alga; here in a chain)

Note the green color due to the presence of **chlorophyll**



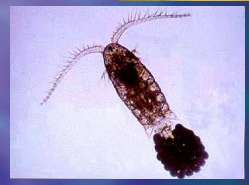
Phytoplankton (mostly colonial diatoms here)





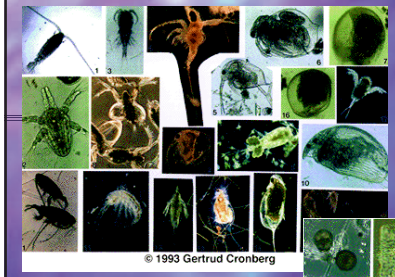
Trichodesmium
filamentous cyanobacterium

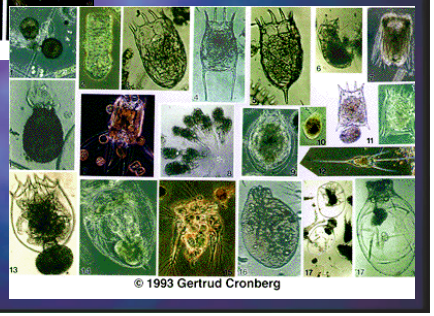
Copepods are flea-sized crustaceans; they are the most abundant animal in the ocean!



Shrimp-like krill

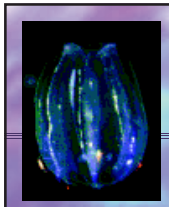
members of the zooplankton community

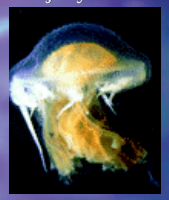


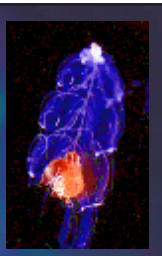


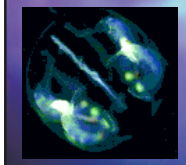
ctenophores

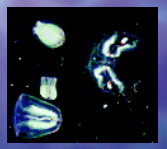
jellyfish

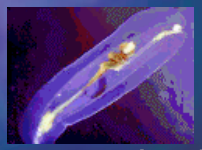


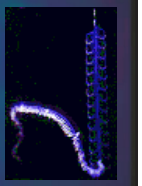






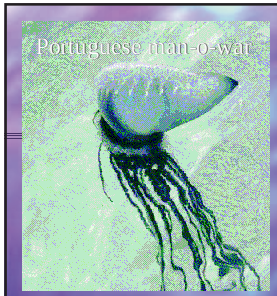


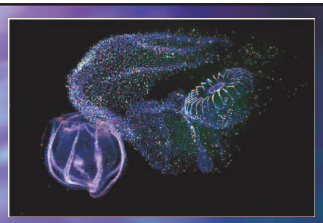




other gelatinous plankton

Portuguese man-o-war





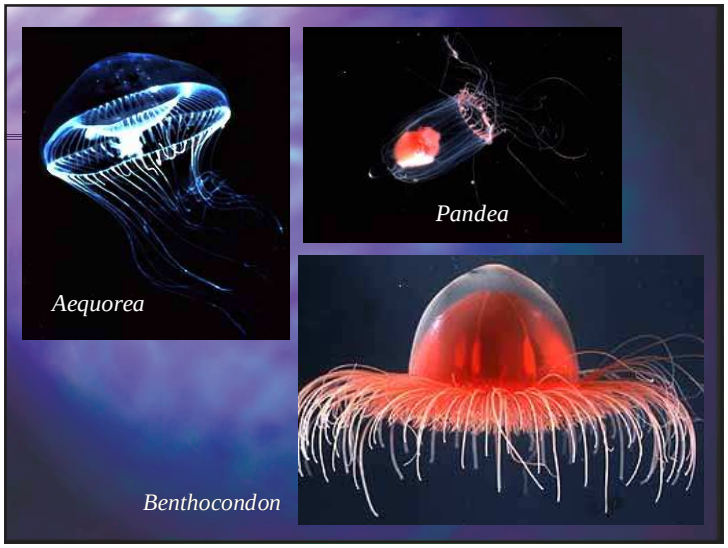
jellyfish & ctenophore

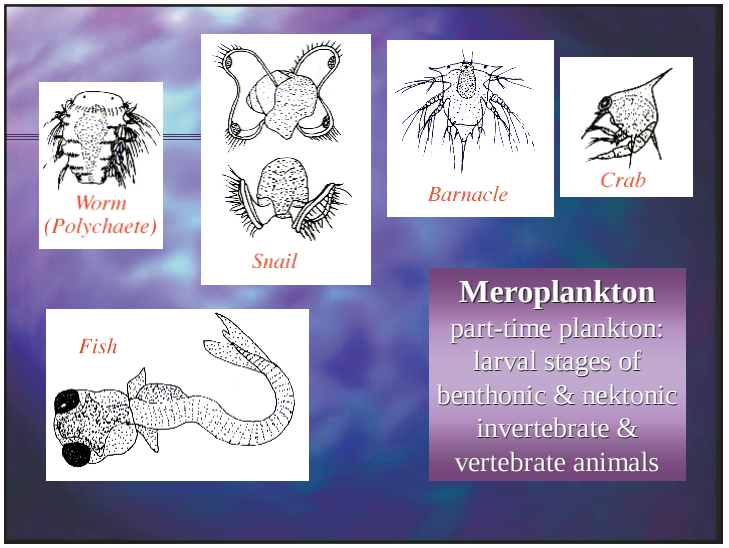
jellyfish stranded on shore

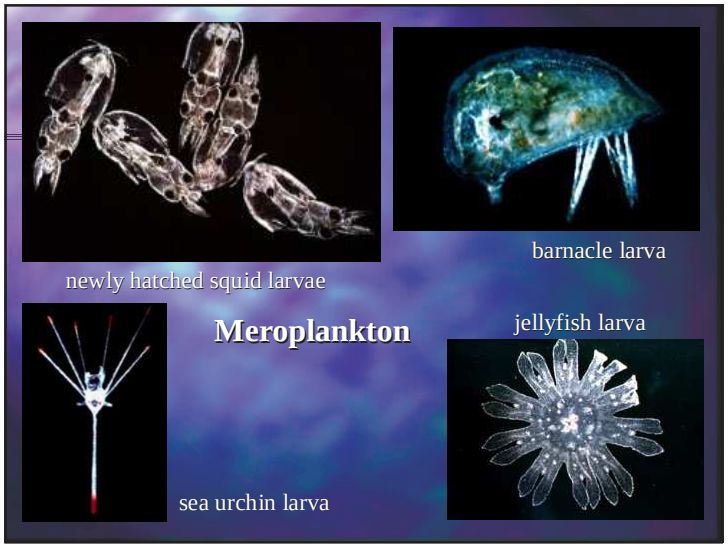
Physophora
(a siphonophore)

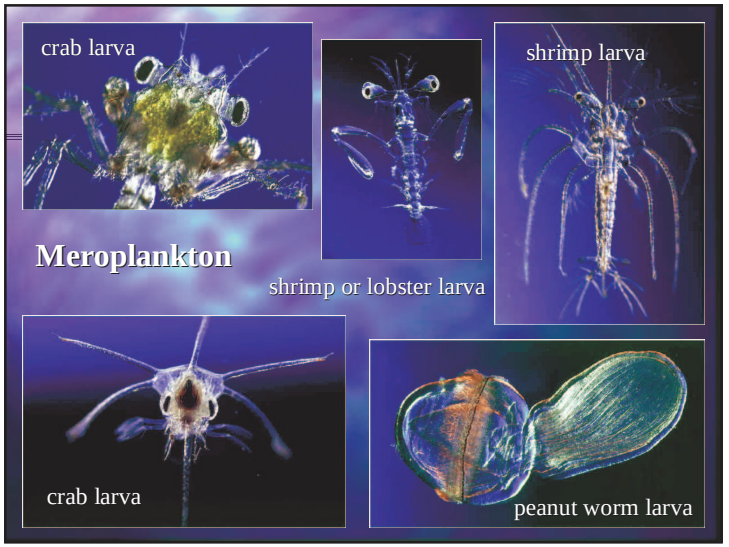
Bolinopsis

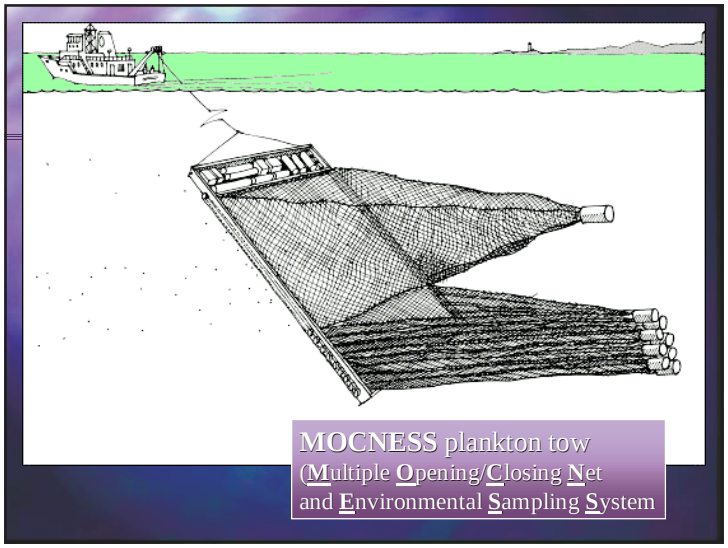
Ctenophores


Aequorea
Pandea
Benthocondon


Worm (Polychaete)
Snail
Barnacle
Crab
Fish
Meroplankton
part-time plankton: larval stages of benthonic & nektonic invertebrate & vertebrate animals

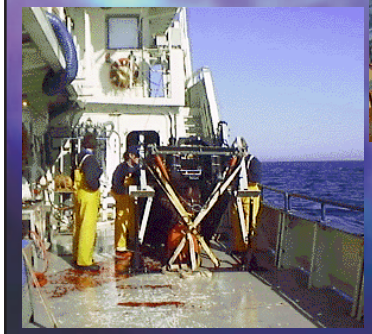

newly hatched squid larvae
barnacle larva
Meroplankton
jellyfish larva
sea urchin larva


crab larva
shrimp larva
Meroplankton
shrimp or lobster larva
crab larva
peanut worm larva



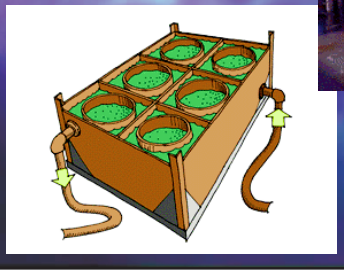
MOCNESS plankton tow
(**M**ultiple **O**pening/**C**losing **N**et
and **E**nvironmental **S**ampling **S**ystem

MOCNESS Plankton Tow

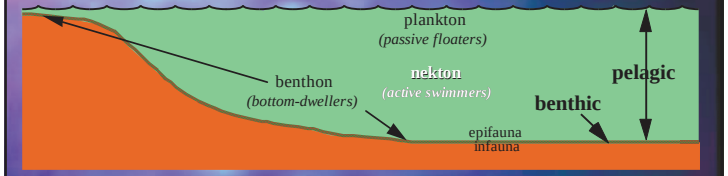


plankton nets

Deck incubator for studies
of living plankton



Nekton – "active swimmers"



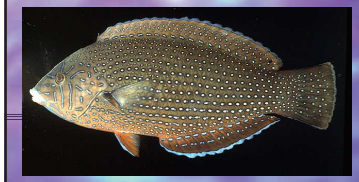
- organisms capable of moving independently of ocean currents
- some invertebrates (squid)
- many marine vertebrates (pelagic fish, marine mammals, marine reptiles)


puffer fish

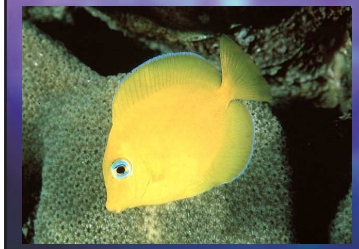

yellow-fin tuna


red-tail wrasse


giant sunfish


blue-spotted wrasse

Red Sea surgeonfish


blue tang surgeonfish

yellow belly damselfish

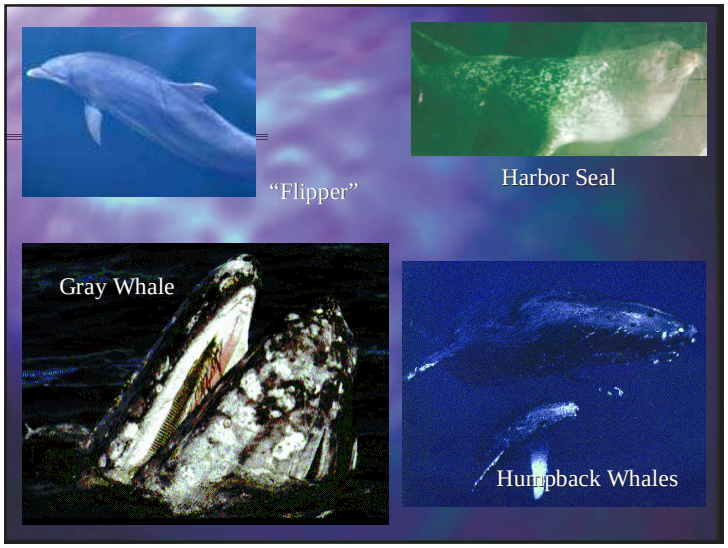

Great White Shark

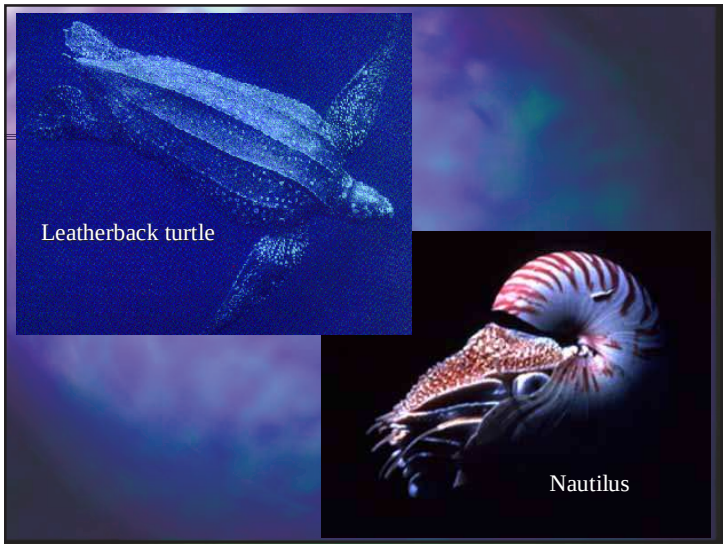

Reef Shark


skates

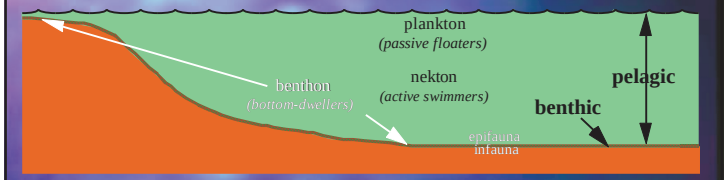

Hammerhead Sharks


Whale Shark



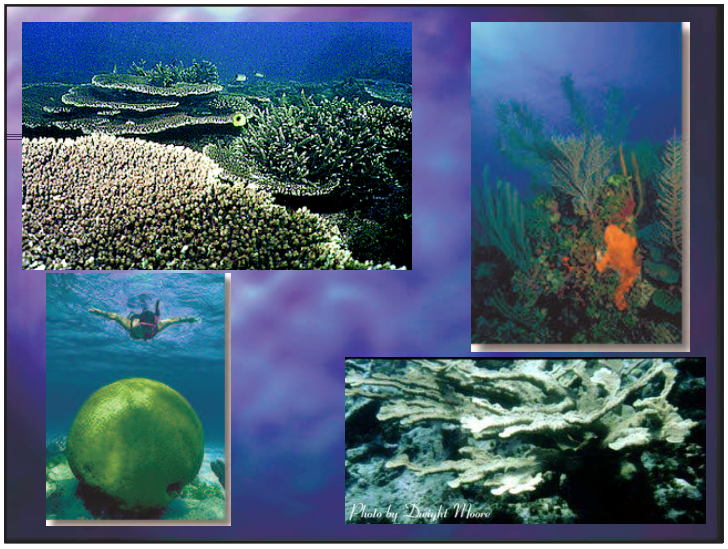


Benthon – "bottom-dwellers"



- organisms that live on the seafloor (epifauna & epiflora) or buried within sediments (infauna):
- most marine invertebrates (clams, mussels, oysters, snails, barnacles, lobsters, crabs, sea urchins, starfish, sea cucumbers, corals, anemones, sponges, worms)
- attached plants (sea grasses) and algae (kelp and other seaweeds)
- "ground fish" (flounder, sole, cod, haddock)


anemones (epifauna)



Environmental controls on distribution

- light
- temperature
- salinity
- food availability
- water density
- water viscosity
- dissolved nutrients
- pollution
- space to live
- cover
- habitat

- our focus …
  - temperature
  - salinity

Effects of Temperature

- **Rates** of diffusion, osmosis, and metabolism are strongly temperature-dependent.
  The higher the temperature, the higher the rate of molecular movement into or out of cells, and the higher the rate of biological activity including growth rates, motility, and life span.
- Temperature also controls the concentration of dissolved gases in water (CO_2 for photosynthesis, O_2 for animal respiration)
  The higher the temperature, the less dissolved gas that water can hold ***(i.e., cold water holds more dissolved gas)***
- **Stenothermal** organisms can tolerate only a *narrow* range of temperatures (deep and/or mobile organisms)
- **Eurythermal** organisms can tolerate a *wider* range of temperatures (shallow and/or sessile organisms)

Effects of Salinity

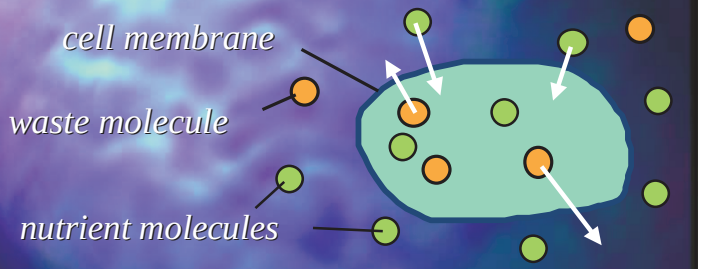
- **Salinity** is an important control on the distribution of organisms because of osmotic pressure.
- **Stenohaline** organisms can tolerate only a narrow range of salinity (deep and/or mobile organisms).
  Many organisms are not be able to tolerate the high salinities (>40‰) of some subtropical lagoons or the reduced salinities (<30 ‰) of coastal waters or estuaries
- **Euryhaline** organisms can tolerate a wider range of salinities (surface and/or sessile organisms).
  Coastal organisms must be able to cope with daily and seasonal swings in salinity related to tidal movement, evaporation, precipitation and river runoff

Environmental Tolerance of Marine Organisms	Mid-Latitude Intertidal Communities	Deep-sea vent Communities
Temperature	***Eury-thermal***	***Steno-thermal***
Salinity	***Eury-haline***	***Steno-haline***

Diffusion and Osmosis

- Seawater poses a special problem for many marine organisms because of a difference in **ionic concentration** (salinity) between the body fluids of an organism and its salt water environment.
- Cell walls are **semi-permeable**; some molecules pass through, others are screened out.
- **Diffusion** is the passive movement of molecules from high concentration to low concentration.
- **Osmosis** is the diffusion of water molecules into or out of a cell.
- If there is a difference, or gradient, between the inside and outside of the cell, an osmotic pressure will cause water molecules to move
  - *from* high concentration of water (=low salinity)
  - *to* low concentration of water (=high salinity).

Diffusion occurs on any concentration gradient across a cell membrane, including the regulation of nutrients and waste prodcuts.

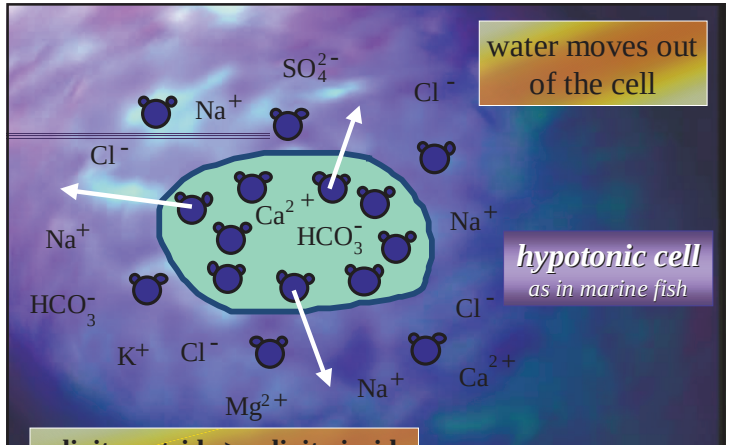


diffusion: high concentration → low concentration

nutrients move into the cell, **wastes** move out

Osmotic Pressure

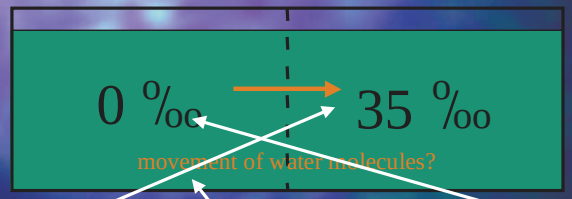
- Cells and tissue having an ionic concentration less than the seawater they live in: **hypotonic**
  - *many salt water fish and marine mammals have evolved strategies to overcome the loss of water (**dehydration**) from their cells*
- Cells and tissue having an ionic concentration greater than the environment they live in: **hypertonic**
  - *fresh water fish have evolved strategies to rid themselves of excess water from their cells*
- Cells and tissue with an ionic concentration equal to the environment they live in: **isotonic**
  - *sharks, rays, and many marine invertebrates*



salinity outside > salinity inside
(water is more concentrated on the inside of the cell relative to "salts")

Thought experiment

Below is a fish tank which is divided into two parts; a semipermeable membrane separates the two halves. The left side contains fresh water and the right side contains salt water. An osmotic pressure exists across the membrane barrier.



which side represents the conditions that would affect a fresh water fish?

and if we drink salt water?

which side represents the conditions that would affect a salt water fish?