OCEANOGRAPHY

12. Marine Life and the Marine Environment

part 2: notes from the textbook, integrated with original contributions

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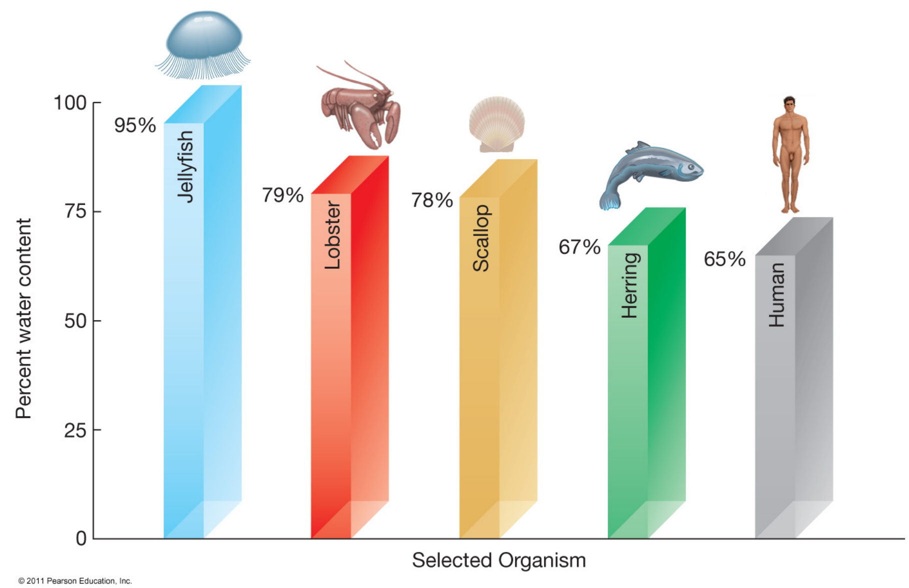
A whale surfacing in the coastal Pacific Ocean, a few miles north of Ketchikan, Alaska, U.S.A.

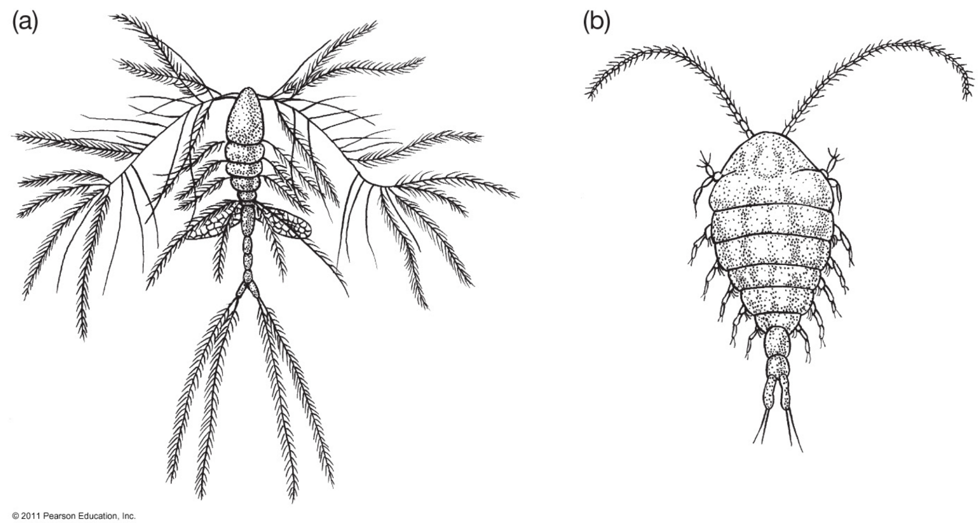
12.4 – How Are Marine Organisms Adapted to the Physical Conditions of the Ocean?

- The marine environment is more stable than land.
- Organisms in the ocean are less able to withstand environmental changes.
- Marine animals do not risk desiccation.



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

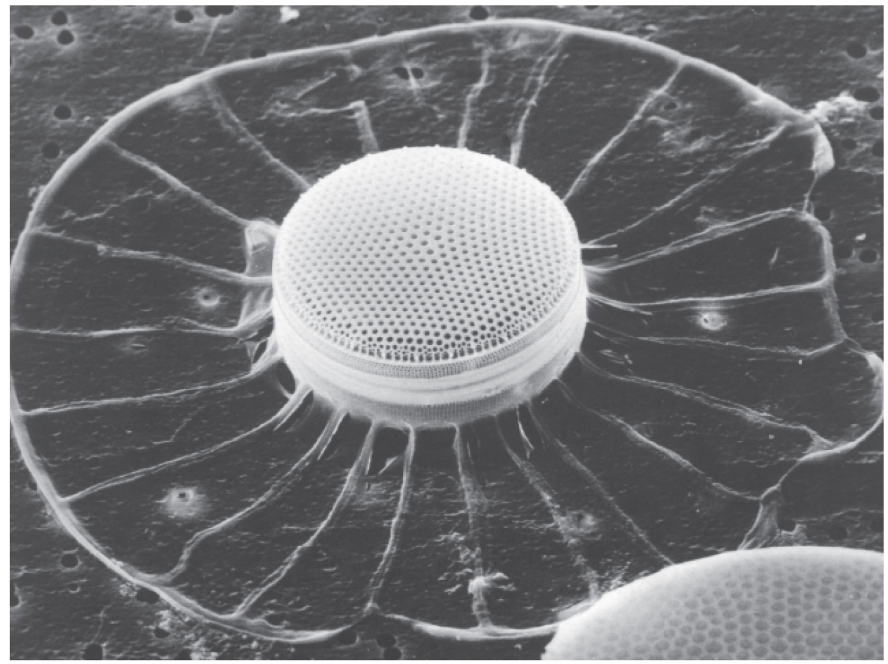


Adaptations of Marine Organisms

- Viscosity
  - resistance of a fluid to flow
  - examples: water vs. honey vs. tar
  - viscosity is controlled by composition and temperature
  - seawater is more dense, and hence more viscous, than fresh water
  - warm surface water is less viscous that cold deep water (or cold surface polar water)

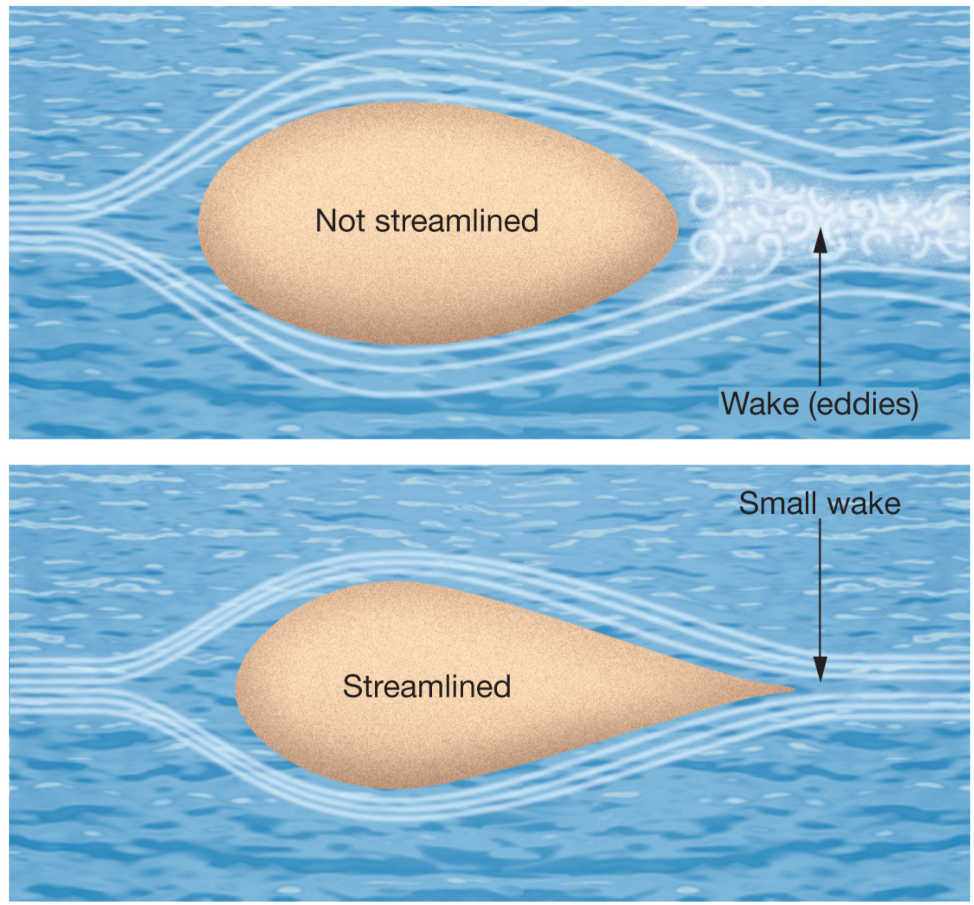
Adaptations of Marine Organisms

- Viscosity and organism size
- 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

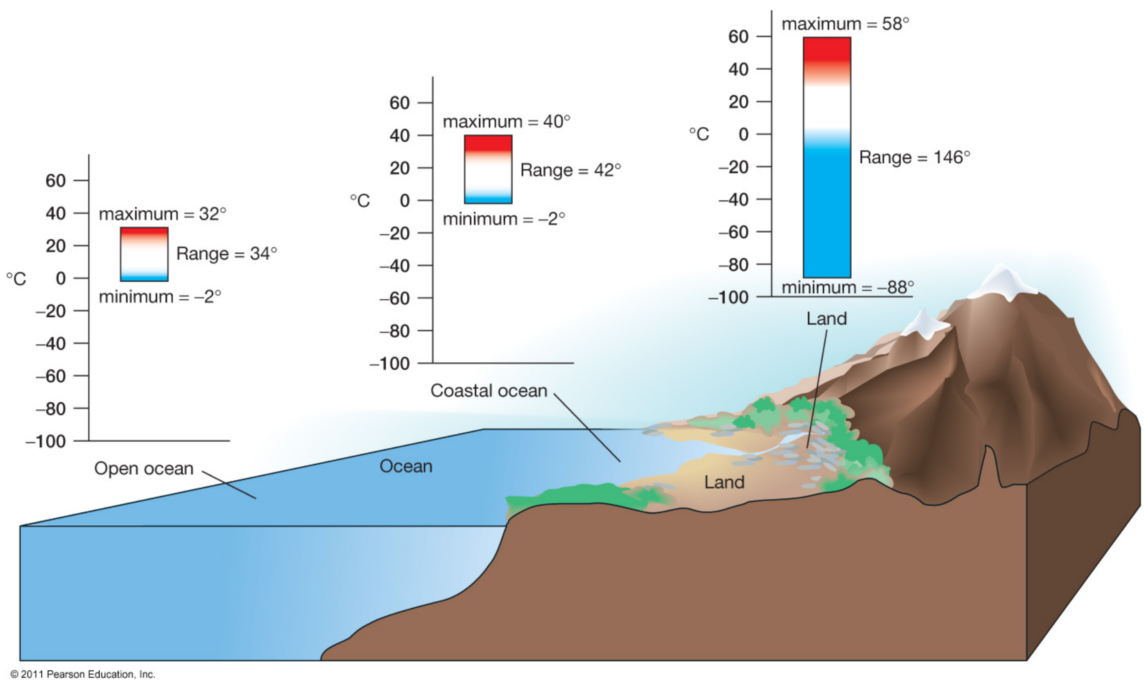


- Marine organisms also take advantage of water’s high viscosity to enhance chances of reproduction and to populate new habitats

- Broadcast spawning

Temperature and Marine Life

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



Ocean Temperature

- More stable than land for four reasons
  - Higher heat capacity of water
  - Ocean warming reduced by evaporation
  - Solar radiation penetrates deeply into ocean layers
  - Ocean mixing

Cold vs. Warm Water Species

- Smaller in cooler seawater
- More appendages in warmer seawater
- Tropical organisms grow faster, live shorter, reproduce more often
- More species in warmer seawater
- More biomass in cooler seawater (upwelling)

Temperature and Marine Organisms

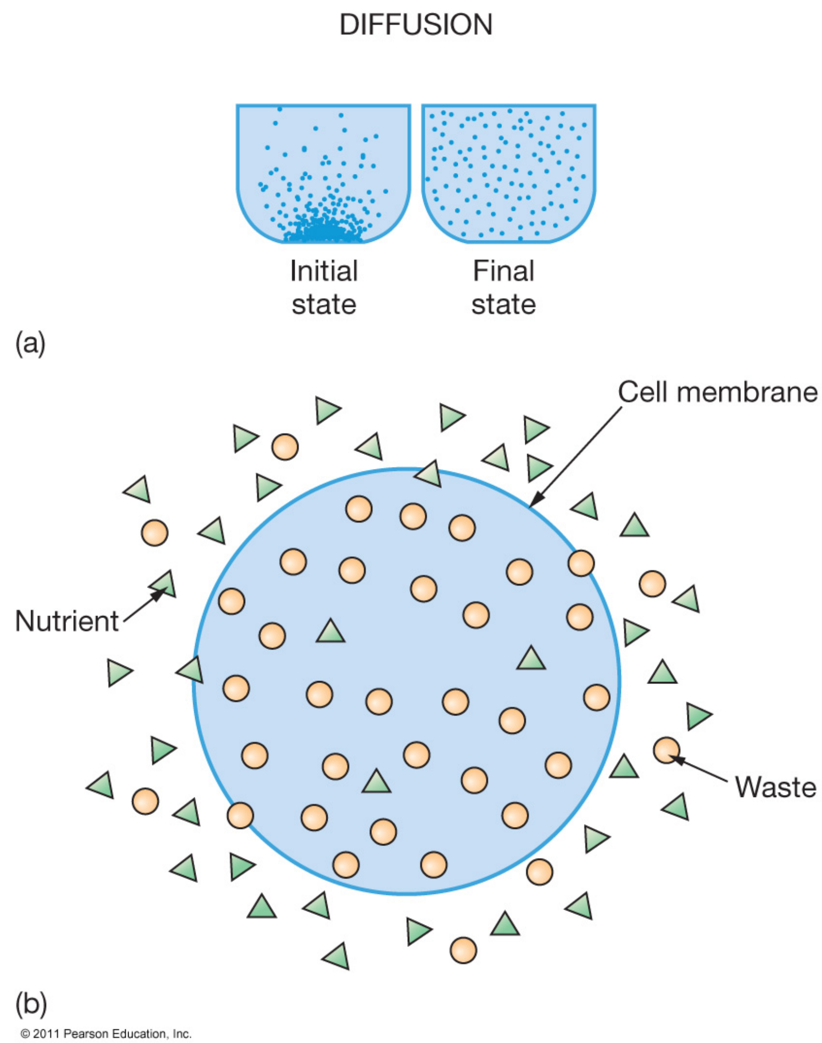
- Stenothermal
  - Organisms withstand small variation in temperature
  - Typically live in open ocean
- Eurythermal
  - Organisms withstand large variation in temperature
  - Typically live in coastal waters

Salinity 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

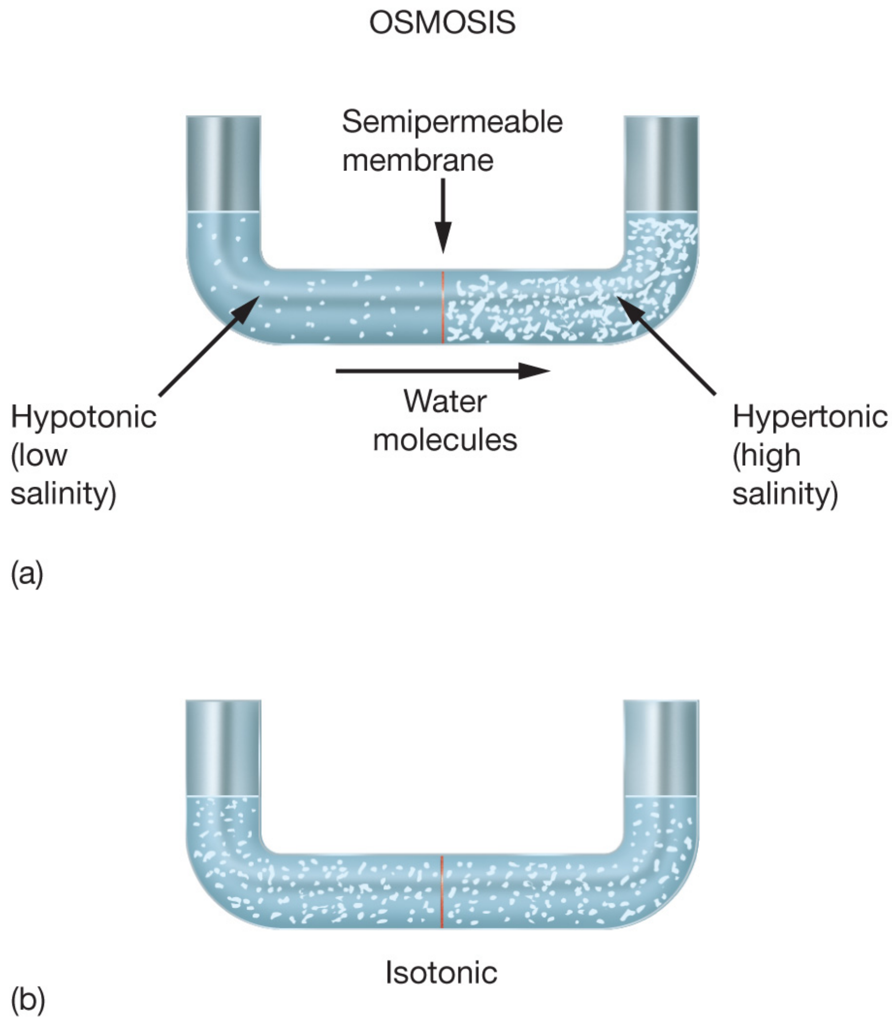
Salinity Adaptations

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



Osmosis

- When water solutions of unequal salinity are separated by a semi-permeable membrane, water molecules move from less concentrated to more concentrated solutions
- Osmotic pressure
  - In more concentrated solutions
  - Prevents passage of water molecules
- Isotonic
- Hypertonic
- Hypotonic



Marine vs. Freshwater Fish

(a) MARINE FISH
(Hypotonic)

(b) FRESHWATER FISH
(Hypertonic)

(a) Marine fish:

- Drink large quantities of water
- Secrete salt through special cells
- Small volume of highly concentrated urine

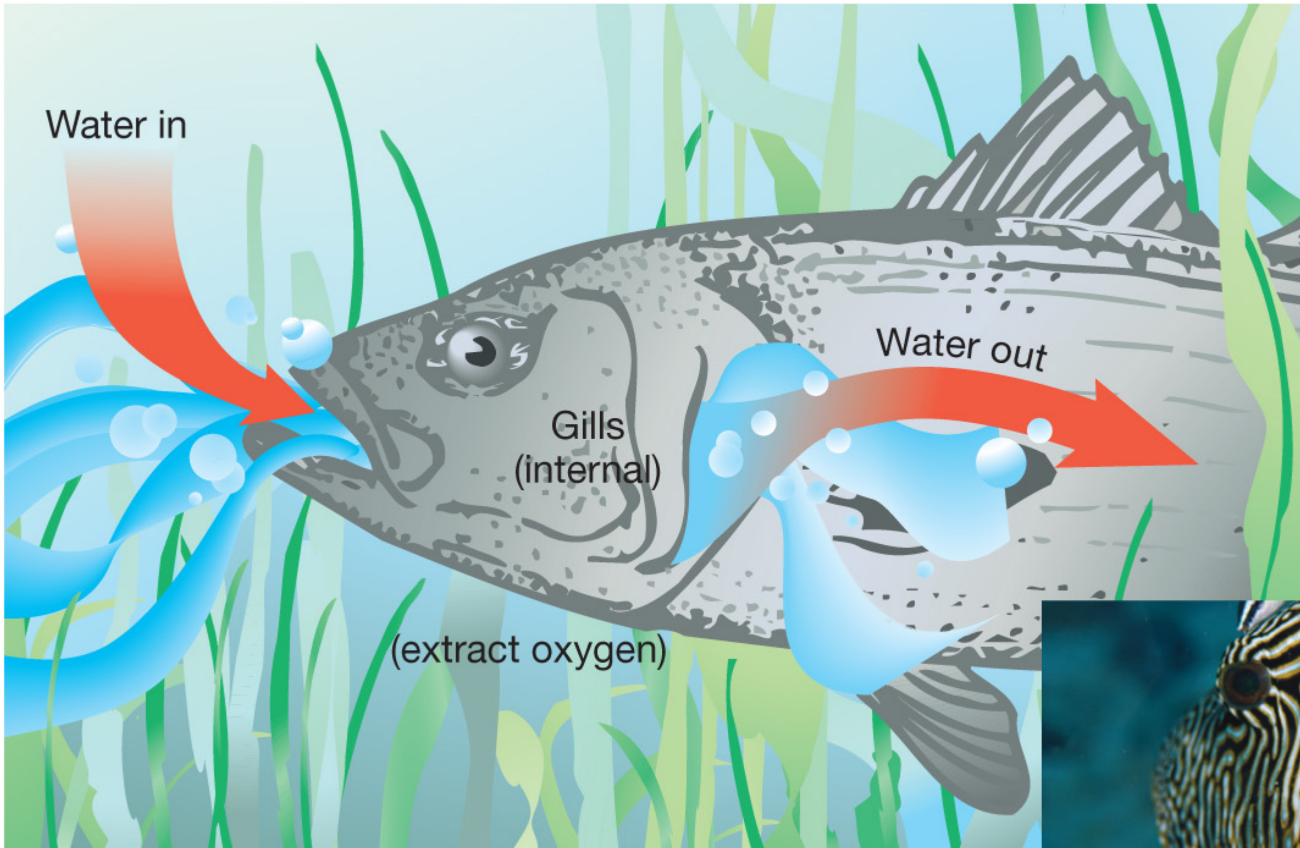
(b) Freshwater fish:

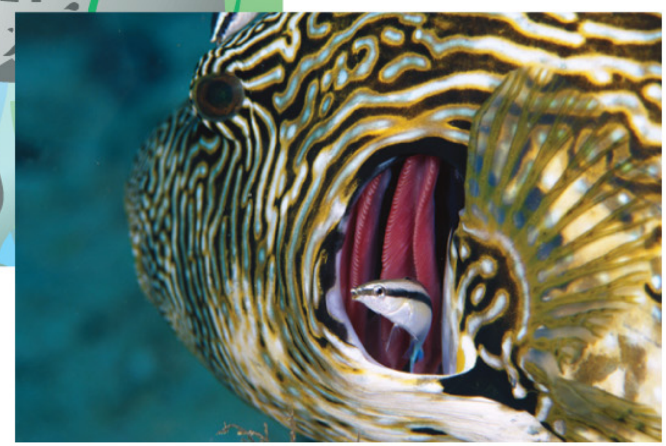
- Do not drink
- Cells absorb salt
- Large volume of dilute urine

Dissolved Gases

- Amount of dissolved gases (O_2, CO_2) in water increases with pressure and decreases with temperature (ocean surface vs. ocean bottom)
- Animals extract dissolved O_2 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

Gills on Fish





Water's Transparency

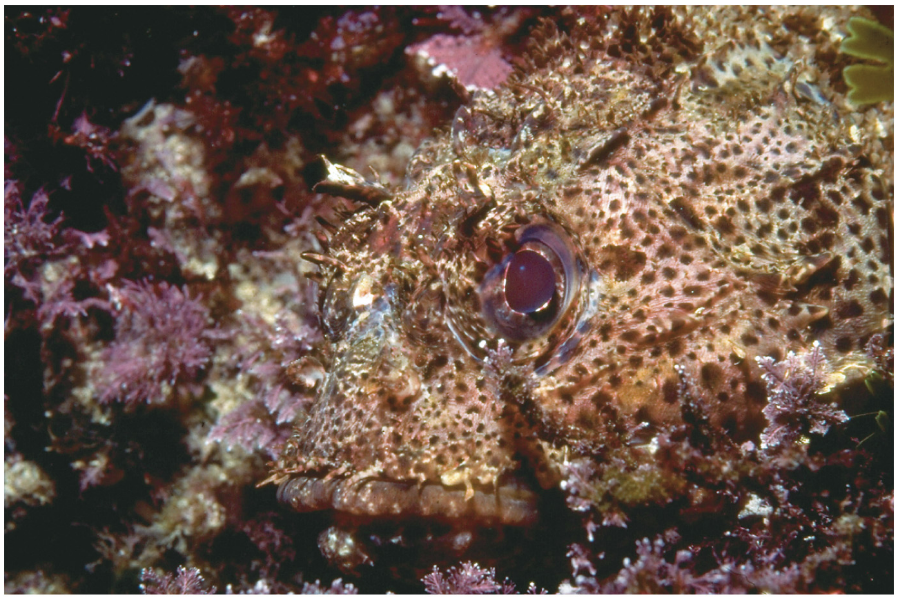
- Waters high transparency allows sunlight to penetrate to a depth of about 1000 m in the open ocean
- Many marine organisms see well
- There is need to hide (hunt and avoid being hunted)

- Some marine organisms are nearly transparent
  - Elude predators
  - Stalk prey

Adaptations to Marine Environment

- Camouflage through color patterns
- Countershading – dark on top, light on bottom
- Disruptive coloration – large bold patterns, contrasting colors make animal blend into background

Camouflage and Countershading



(a)

(b)

- Deep-Scattering Layer
  - Daily vertical migration of marine organisms
  - Stay at 900 m during the day
  - Rise to 100 to 200 m at night

  - They do this to feed and to protect themselves from predators

Water Pressure

- Increases about 1 atmosphere (1 kg/cm^2) with every 10 meters (33 feet) deeper
- Many marine organisms – no inner air pockets
- Collapsible rib cage (e.g., sperm whale)

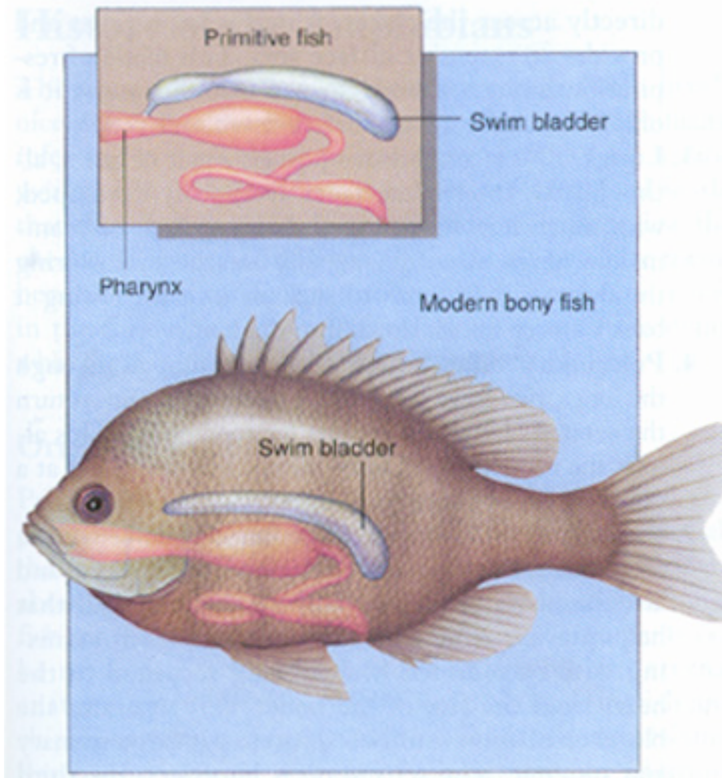
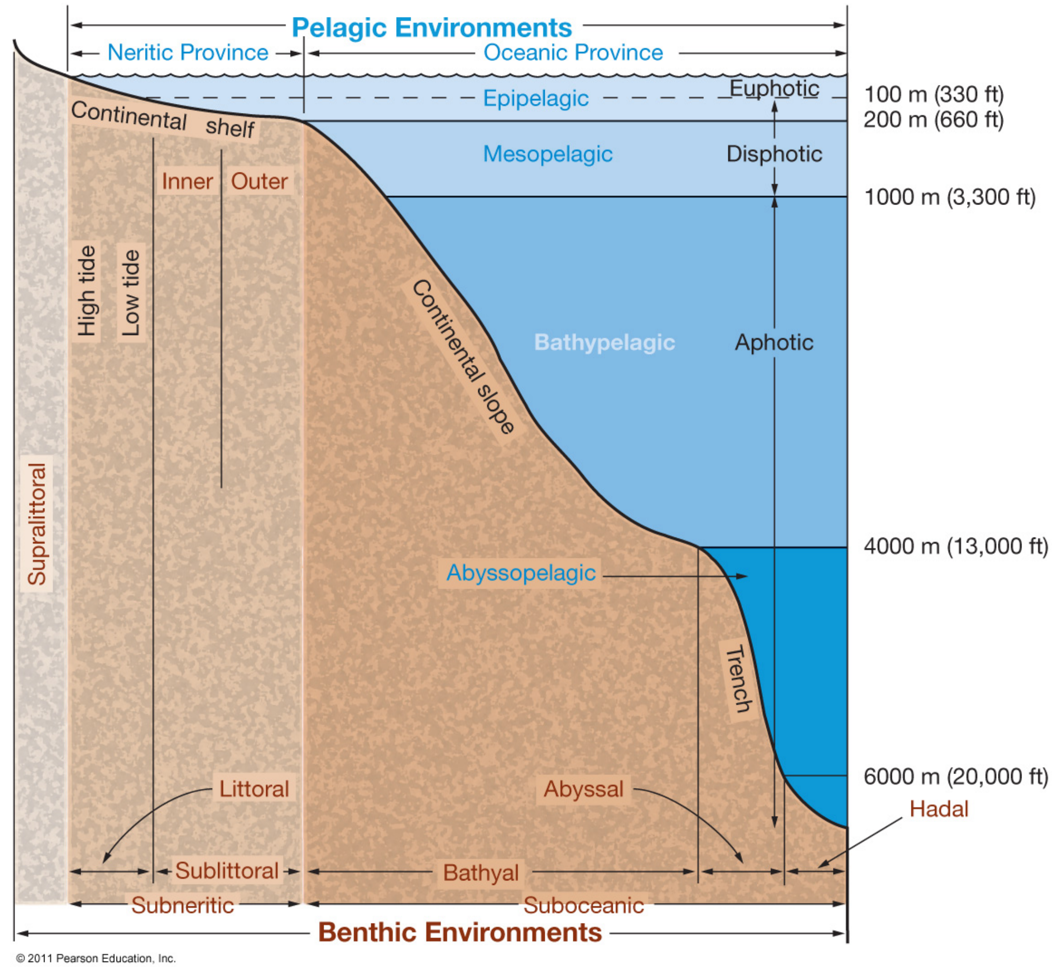


FIGURE 45.16
Diagram of a swim bladder. The bony fishes use this structure, which evolved as a ventral outpocketing of the pharynx, to control their buoyancy in water.

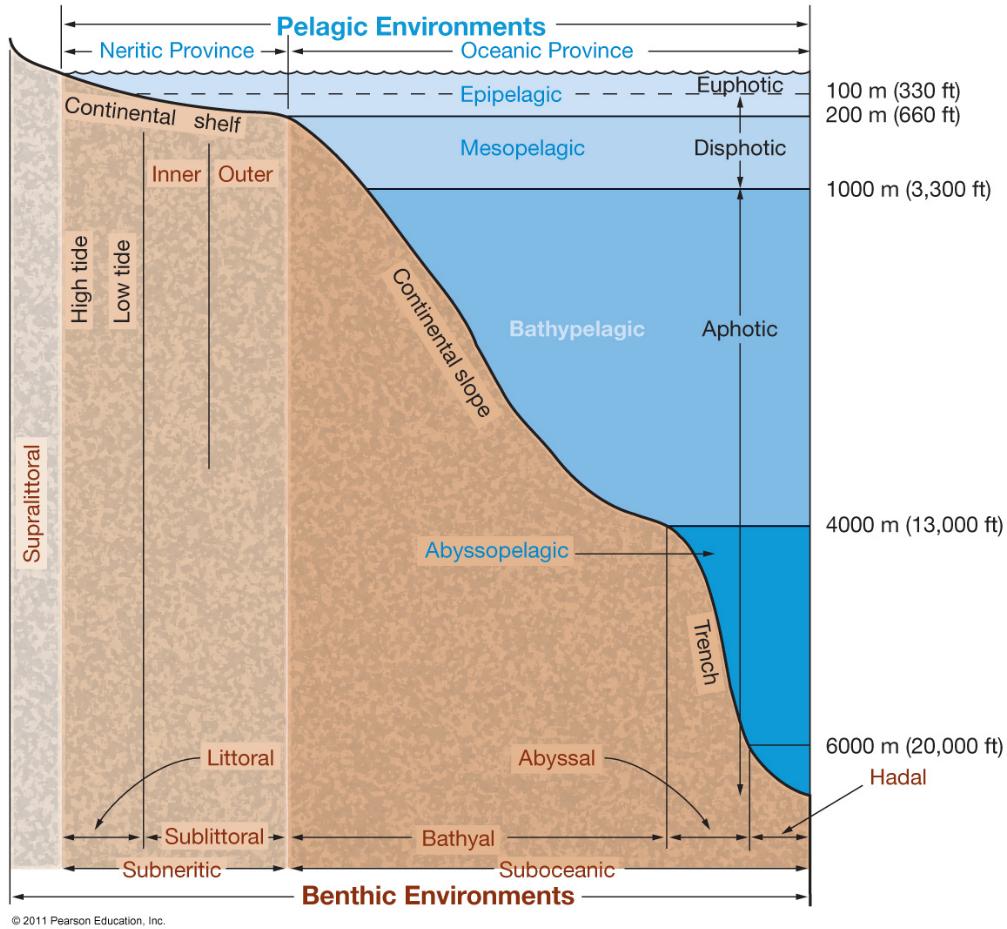
12.5 – What Are the Main Divisions of the Marine Environment?

- Pelagic (open sea)
  - Neritic (< 200 meters) and oceanic
- Benthic (sea floor)
  - Subneritic and suboceanic



Pelagic Environment

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

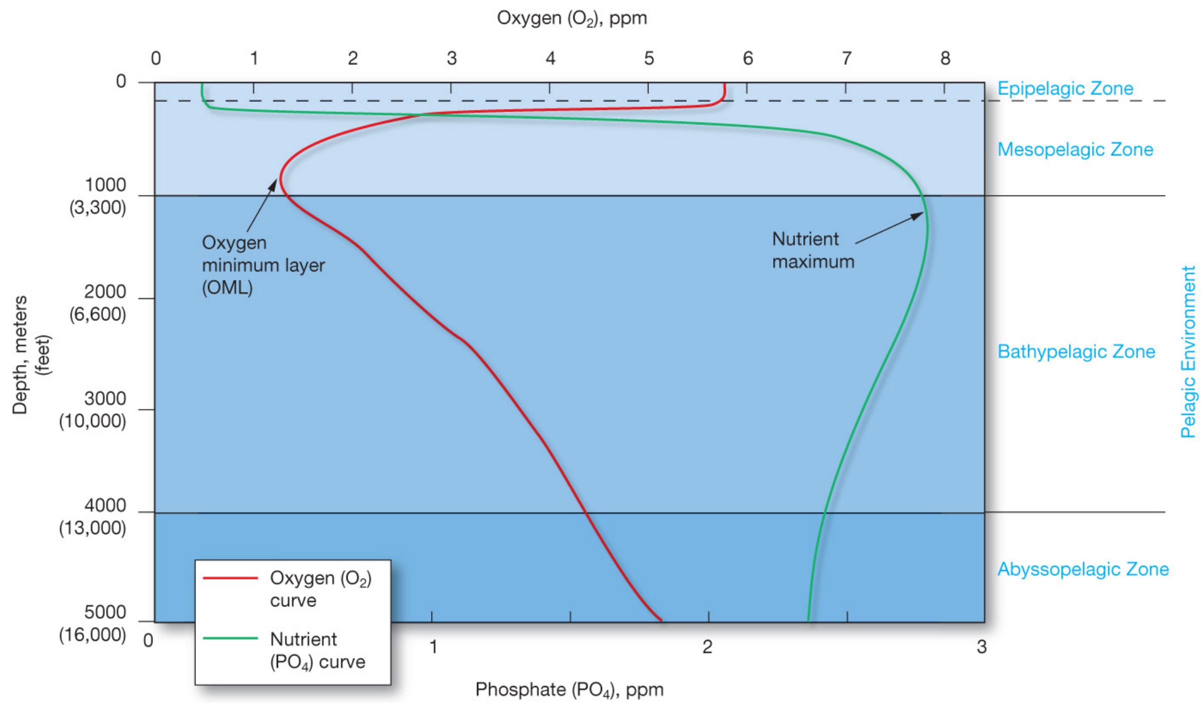


Oceanic Province

- Further subdivided into four biozones
- Epipelagic
  - Only zone to support photosynthesis
  - Dissolved oxygen decreases around 200 meters
- Mesopelagic
  - Organisms capable of bioluminescence common
- Bathypelagic
- Abyssopelagic

Dissolved Oxygen with Depth

- Dissolved oxygen minimum layer (OML) about 700-1000 meters
- Nutrient maximum at about same depths
- O_2 content increases with depth below

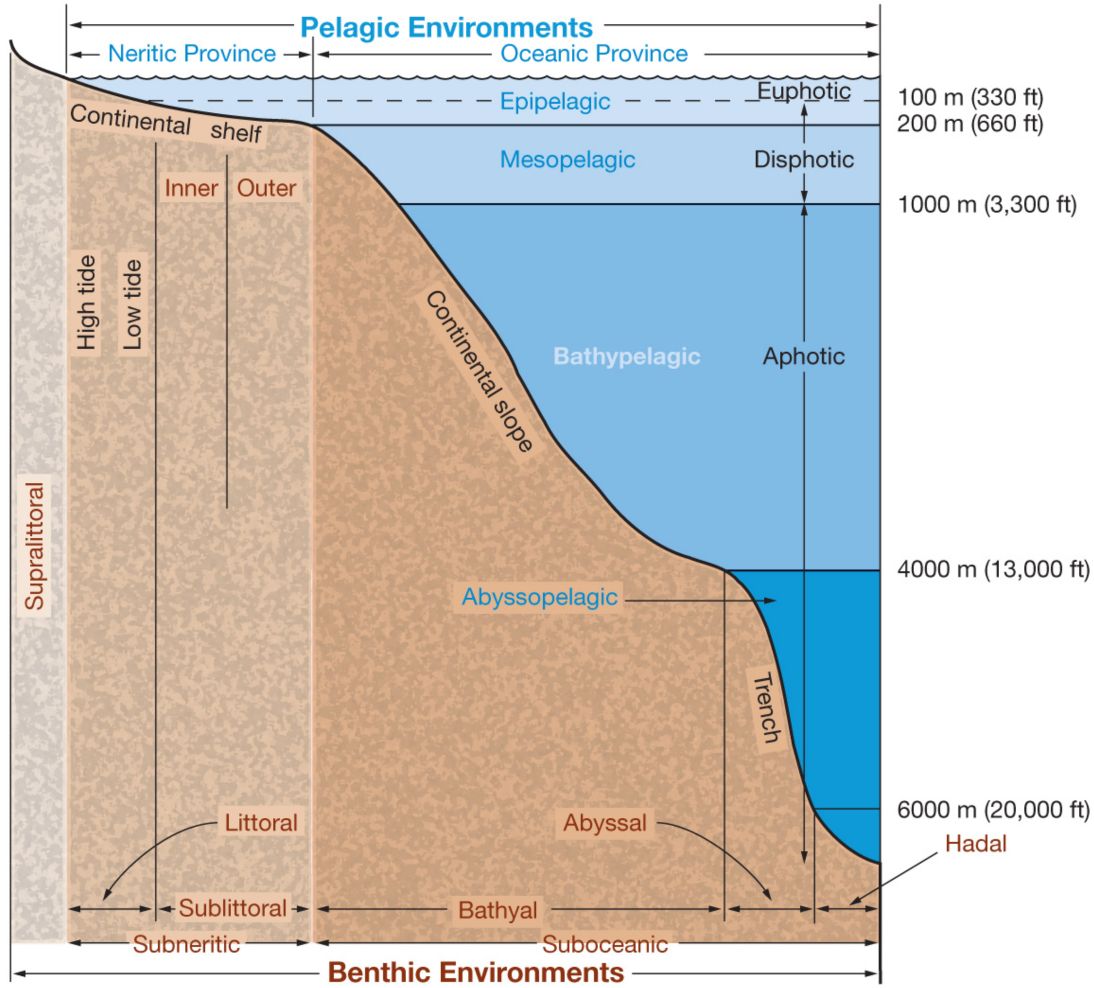


Ocean Zones Based on Light Availability

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

Benthic Environments

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



Organisms of the Deep

End of CHAPTER 12, part 2
Marine Life and the Marine Environment