

Distribution of Earth's Water

- The oceans contain 97 percent of the water found on Earth.
- The remaining 3 percent is freshwater located in the frozen ice caps of Greenland and Antarctica and in rivers, lakes, and underground sources.
- The percentage of ice has ranged from near zero to as much as 10 percent of the hydrosphere over geologic time.

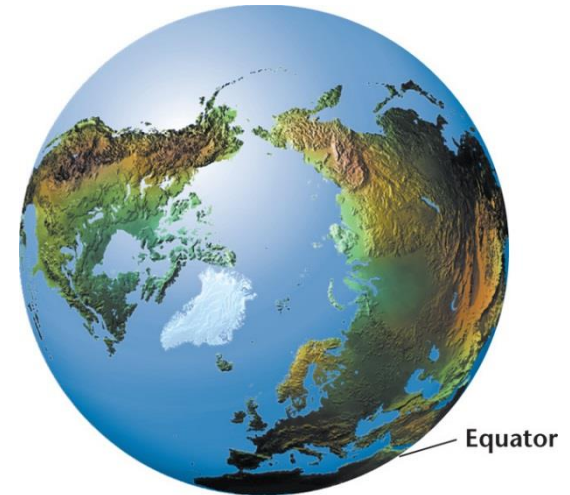
Distribution of Earth's Water

- 🔊 Global sea level is the level of the oceans' surfaces.
 - Sea level has risen and fallen by hundreds of meters in response to melting ice during warm periods and expanding glaciers during ice ages.
 - Tectonic forces that lift or lower portions of the seafloor has also affected sea level.

Distribution of Earth's Water

The Blue Planet

- Approximately 71 percent of Earth's surface is covered by oceans that have an average depth of 3800 m.
- Because most landmasses are in the northern hemisphere, oceans cover 61 percent of the surface.
- Water covers 81 percent of the southern hemisphere.



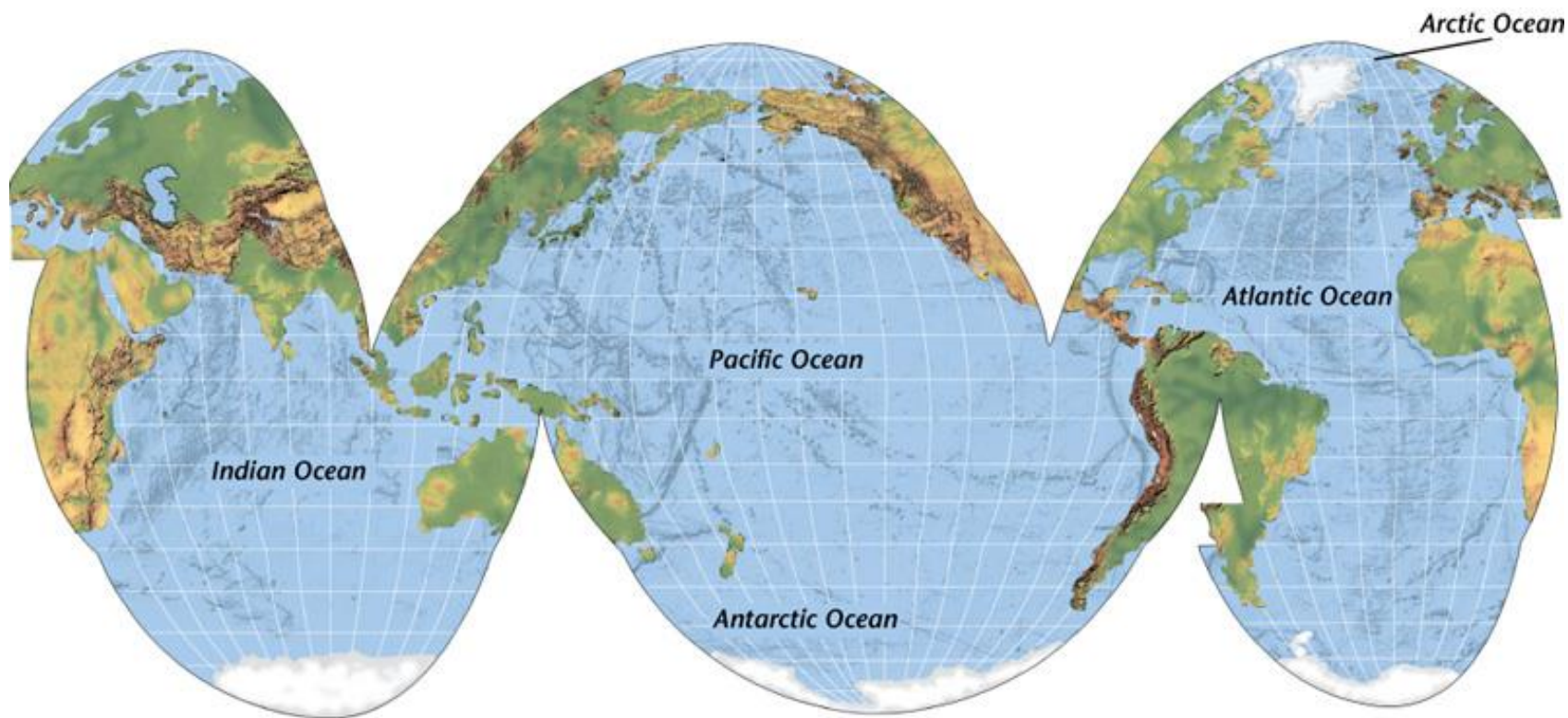
Distribution of Earth's Water

Major Oceans

- There are three major oceans:
 - The largest ocean, the Pacific, contains roughly half of Earth's seawater and is larger than all of Earth's landmasses combined.
 - The second-largest ocean, the Atlantic, extends from Antarctica to the arctic circle, north of which it is often referred to as the Arctic Ocean.
 - The third-largest ocean, the Indian, is located mainly in the southern hemisphere.
 - The water surrounding Antarctica, south of 50° south latitude, is known as the Antarctic Ocean.

Distribution of Earth's Water

Major Oceans



Section Assessment

3. Identify whether the following statements are true or false.

true

Oceans contain 97 percent of the water found on Earth.

true

Oceans cover 71 percent of Earth's surface.

false

The Earth's major oceans are isolated from each other by landmasses.

false

Presently, average global sea level is rising 1 to 2 cm per year.

Seawater

- Seawater is a solution of about 96.5 percent water and 3.5 percent dissolved salts.
- The most abundant salt in seawater is sodium chloride (NaCl).
- Most elements on Earth are present in seawater.
- Because these substances are dissolved, they are in the form of ions.

Seawater

Table 15-1 Major Ions in Seawater

Ion	Chemical Symbol	ppt in seawater
Chloride	Cl ⁻	19.35
Sodium	Na ⁺	10.76
Sulfate	SO ₄ ²⁻	2.71
Magnesium	Mg ²⁺	1.29
Calcium	Ca ²⁺	0.41
Potassium	K ⁺	0.39
Bicarbonate	HCO ₃ ⁻	0.14
Bromide	Br ⁻	0.067
Strontium	Sr ²⁺	0.008
Boron	B ³⁺	0.004
Fluoride	F ⁻	0.001
Total		~35.00

Chemical Properties of Seawater

- **Salinity** is a measure of the amount of dissolved salts in seawater that is expressed as grams of salt per kilogram of water, or parts per thousand (ppt).
 - The total salt content of seawater is, on average, 35 ppt, or 3.5 percent.
 - Seawater also contains dissolved gases and nutrients.

Chemical Properties of Seawater

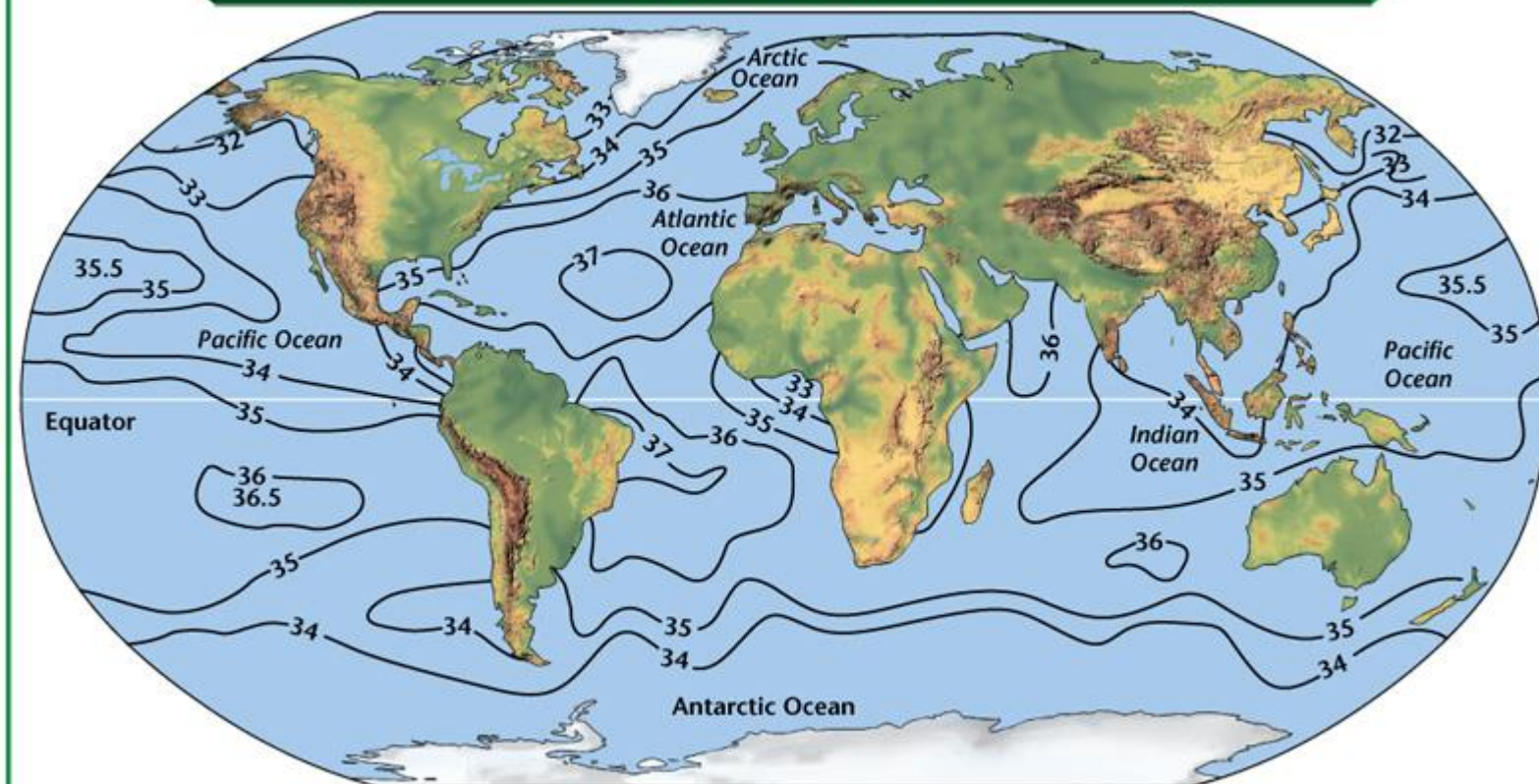
Variations in Salinity

- The actual salinities of the oceans vary from place to place.
 - Salinities may be as high as 37 ppt in subtropical regions where rates of evaporation exceed those of precipitation.
 - Salinities are lower in equatorial regions where precipitation is abundant.
 - Salinities of 32 or 33 ppt occur in polar regions where seawater is diluted by melting sea ice.
 - The lowest salinities often occur where large rivers empty into the oceans.



Chemical Properties of Seawater

Ocean Salinity



*All values are given in parts per thousand (ppt)


Physical Properties of Seawater

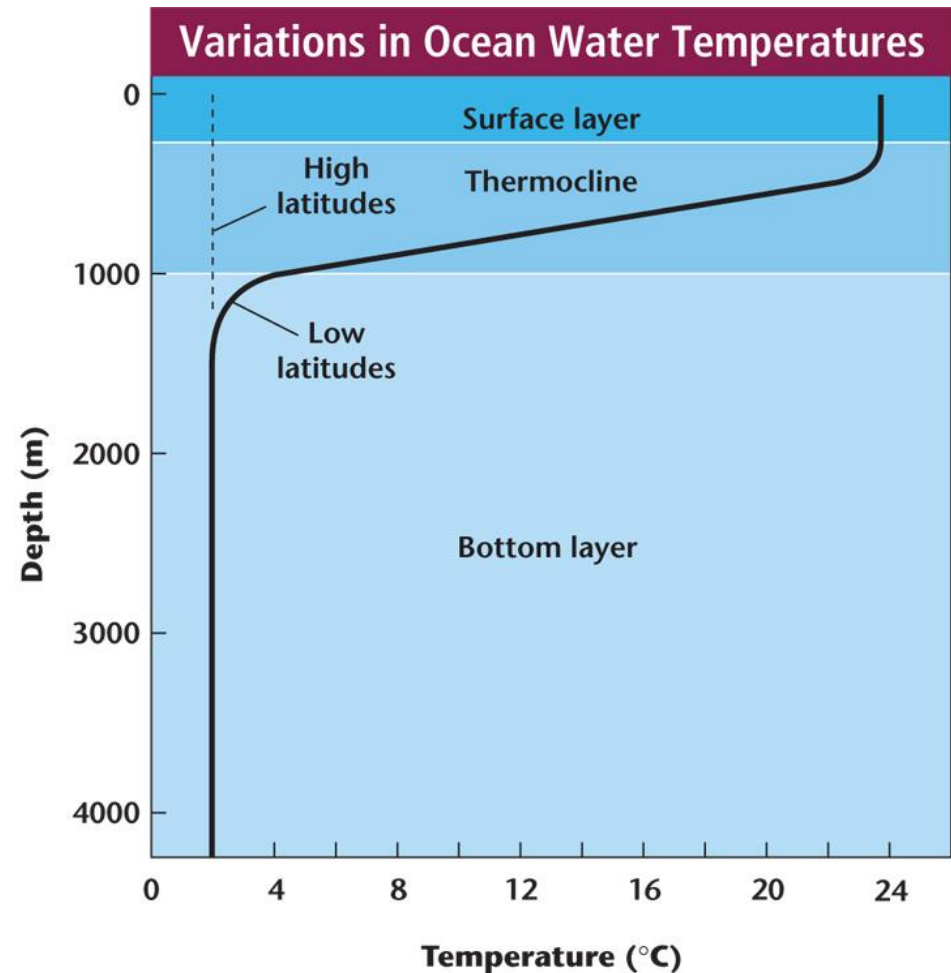
- Freshwater has a maximum density of 1.00 g/cm^3 .
- Seawater is denser than freshwater because salt ions are heavier than water molecules.
- The density of seawater ranges from about 1.02 g/cm^3 to 1.03 g/cm^3 depending on its salinity and temperature.
- Because salt ions interfere with the formation of hydrogen bonds, the freezing point of seawater is -2°C .

Ocean Layering

- Ocean surface temperatures range from -2°C in polar waters to 30°C in equatorial regions, with the average surface temperature being 15°C .
- Ocean water temperatures decrease significantly with depth.

Ocean Layering

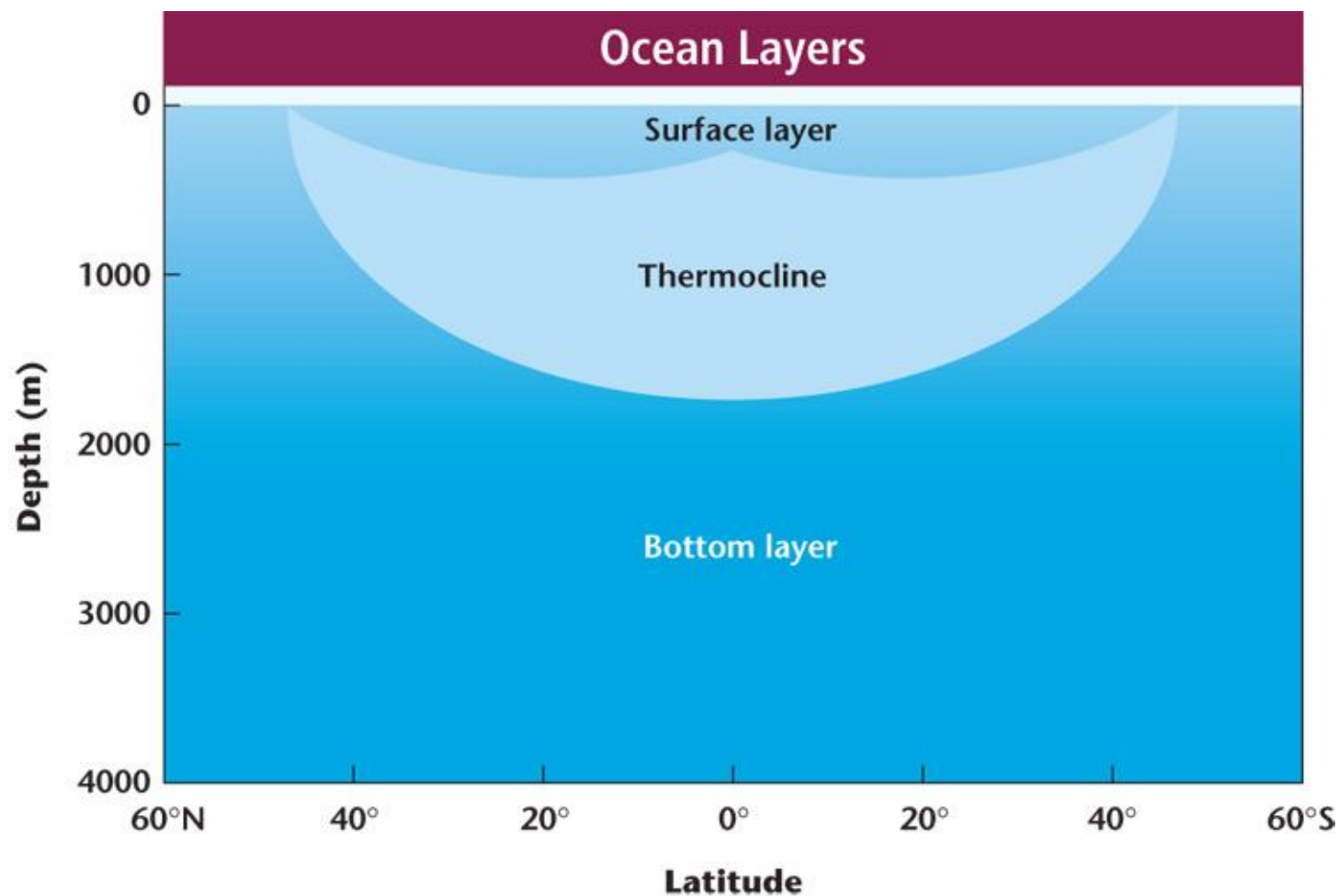
 A typical ocean temperature profile plots changing water temperatures with depth. (Draw this diagram, p. 397)



Ocean Layering

- Based on temperature variations, the ocean can be divided into three layers.
 - The first layer is a relatively warm, sunlit, surface layer some 100 m thick.
 - The **thermocline** is a transitional layer which is characterized by rapidly decreasing temperatures with depth.
 - The bottom layer is cold and dark with temperatures near freezing.

Ocean Layering



Ocean Layering

- Both the thermocline and the warm surface layer are absent in polar seas, where water temperatures are cold from top to bottom.
- In general, ocean layering is caused by density differences of warm and cold water.

Water Masses, Conveyor Belt

- Cold water migrates toward the equator as a cold, deep water mass along the ocean floor.
 - To start, sea ice that forms in the polar regions does not incorporate salt ions into growing ice crystals, causing them to accumulate beneath the ice.
 - As the cold water beneath the ice becomes saltier and denser than the surrounding seawater, it sinks.
 - Surface currents in the ocean also bring relatively salty midlatitude or subtropical waters into polar regions where they cool and sink.
 - The dense, salty water then migrates toward the equator as a cold, deep water mass along the ocean floor.

Ocean Currents

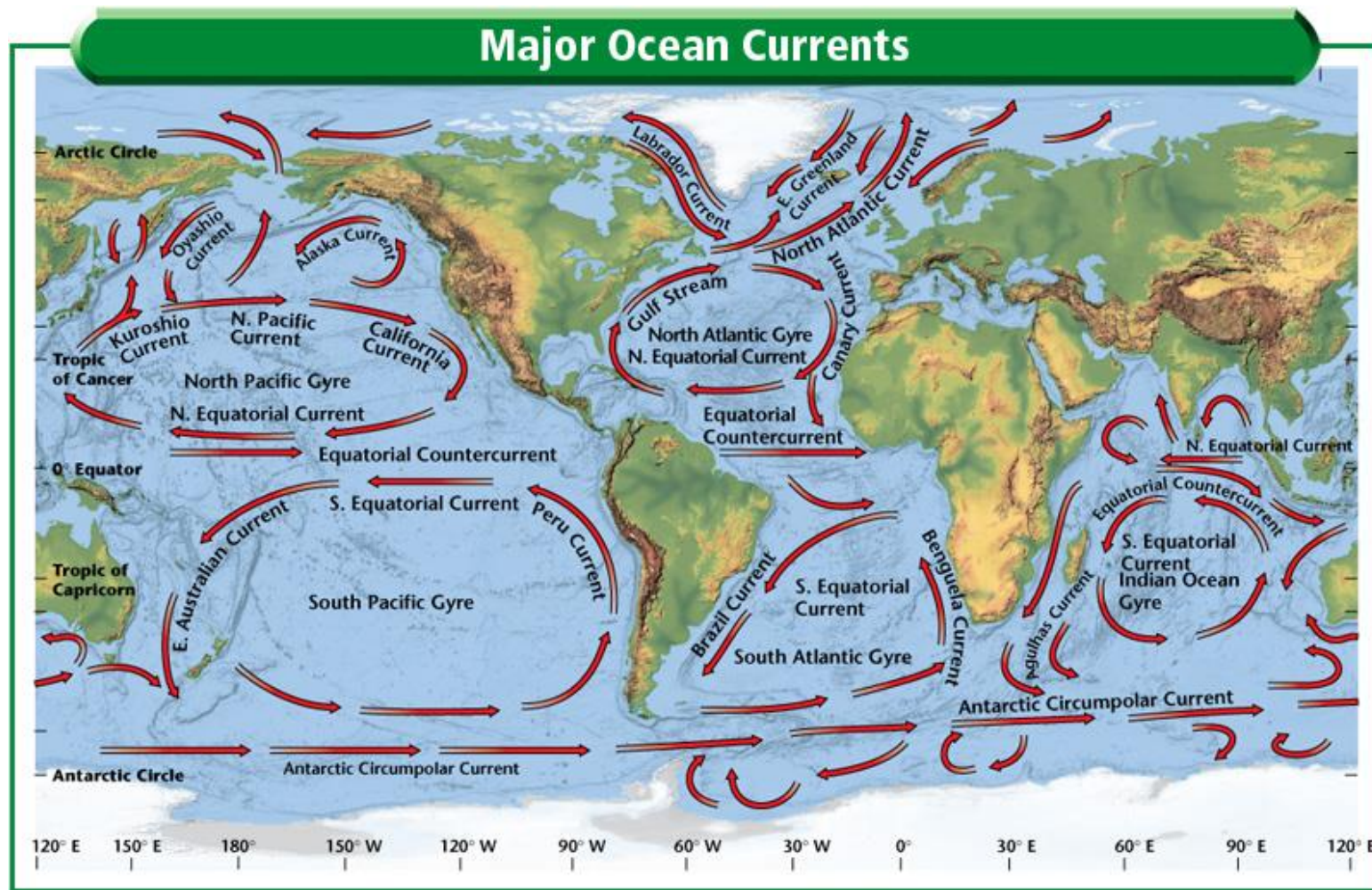
- 🔊 A **density current** moves slowly in a vertical motion to/from the deep ocean and is caused by differences in the temperature and salinity of ocean water, which in turn affect density.
- 🔊 **Surface currents** are wind-driven currents that affect mainly the upper few hundred meters of the ocean and can move as fast as 100 km per day.
- Surface currents follow predictable patterns influenced by Earth's global wind systems.

Ocean Currents

Gyres

- The continents deflect ocean currents to the north and south causing closed circular current systems, called gyres, to develop.
- There are five major gyres: the North Pacific, the North Atlantic, the South Pacific, the South Atlantic, and the Indian Ocean.
- The parts of all gyres closest to the equator move towards the west as equatorial currents until they are deflected toward the poles by a landmass.
- After cooling in the polar regions, the current, deflected by landmasses, moves back toward the equator.

Ocean Surface Currents

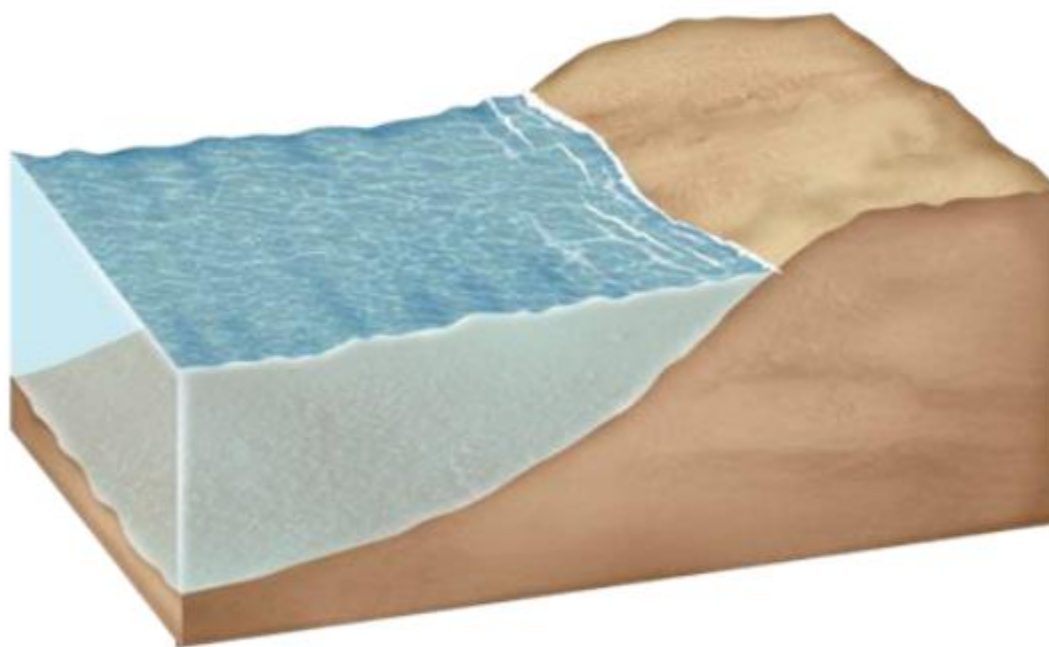


Upwelling

 **Upwelling** is the upward motion of ocean water from the sea floor.

- Areas of upwelling exist mainly off the western coasts of continents in the trade-wind belts.
- Upwelling waters are rich in nutrients, which support abundant populations of marine life.

Upwelling



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Multiple Choice

1. Approximately how much of Earth's surface is covered by oceans?
- a. 51 percent
 - b. 61 percent
 - c. 71 percent
 - d. 81 percent

Because most landmasses are located in the northern hemisphere, oceans cover only 61 percent of the surface there. However, 81 percent of the southern hemisphere is covered by water.

Multiple Choice

2. Of the areas listed below, which generally has the lowest ocean salinity?
- a. subtropical regions
 - b. tropical regions
 - c. temperate regions
 - d. polar regions**

In the polar regions, seawater is diluted by melting sea ice. On a localized level, the lowest salinities often occur where large rivers empty into the oceans.

Multiple Choice

4. What is the average ocean surface temperature?
- a. 8°C
 - b. 12°C
 - c. 15°C
 - d. 18°C

Surface temperature of Earth's oceans varies between -2°C in the polar regions to 30°C in equatorial regions.

Multiple Choice

5. Which of the following is the most prevalent ion in seawater?

- a. chloride
- b. sulfate
- c. sodium
- d. magnesium

Chloride has a concentration of 19.35 ppt in seawater. It is followed by *sodium* (10.76 ppt), *sulfate* (2.71 ppt), and *magnesium* (1.29 ppt).

