MOLLUSK ECOLOGY

BIOSPHERE

Region of the earth's atmosphere and surface that is inhabited by life

ECOSYSTEM

Sum of all the physical and biological characteristics in a given area

COMMUNITY

Local association of organisms within an ecosystem

HABITAT

Actual physical environment in which organisms live

NICHE

Sum of all the physical, chemical, and biological limits on the organisms, its way of life, and the role it plays in the ecosystem

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ENVIRONMENTAL PHYSIOLOGY

Study of the environment's influence on the physiological function and performance of living organisms

LIMITING FACTORS IN THE MARINE REALM

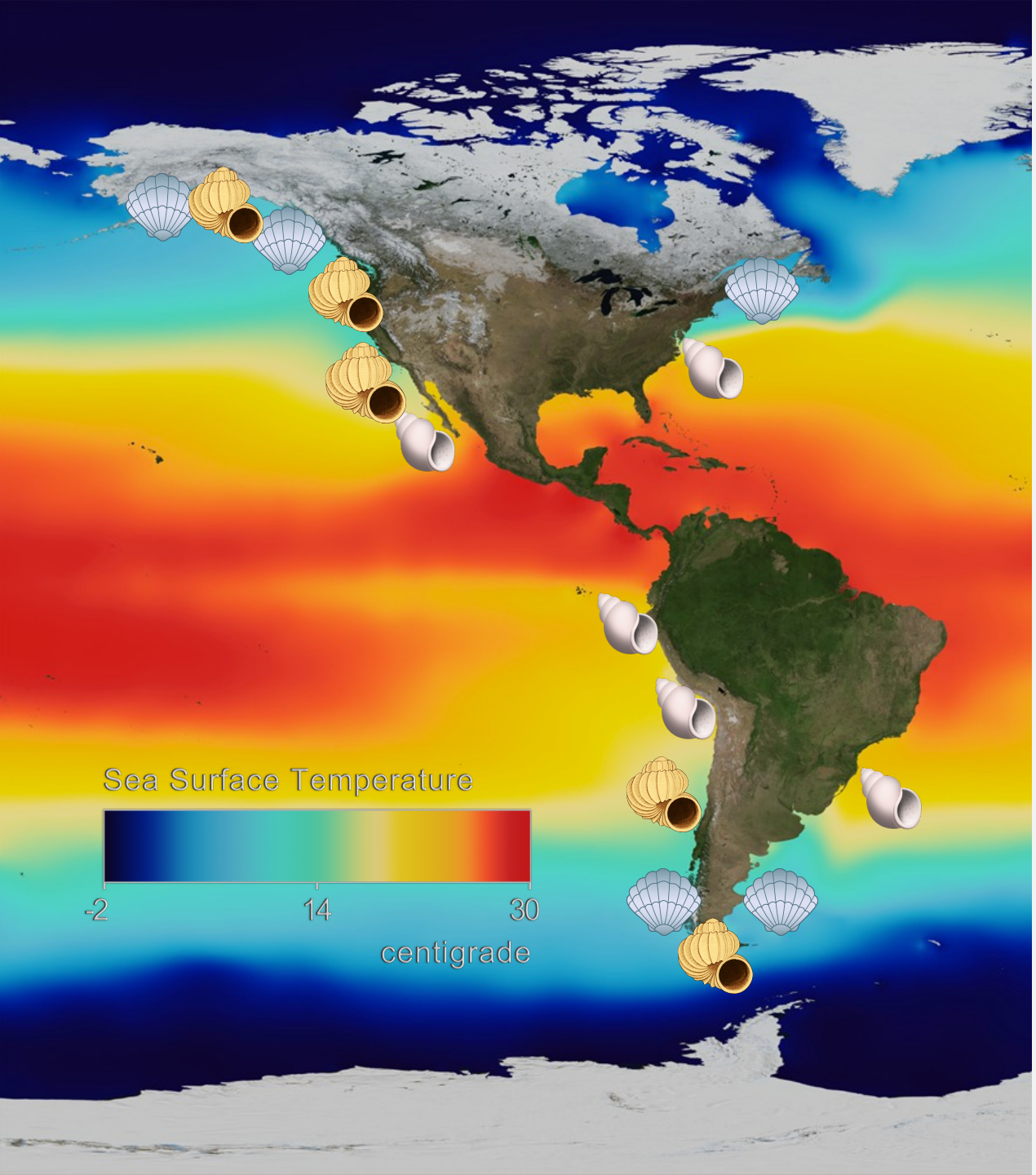
With a partner, brainstorm *three environmental factors that may limit where a marine mollusk may be able to live* in the ocean

LIMITING FACTORS IN THE MARINE REALM

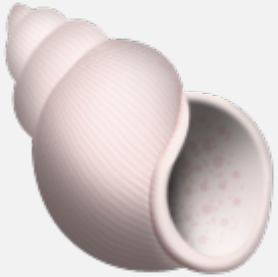
- Temperature
- Oxygen
- Salinity
- Depth
- Substrate

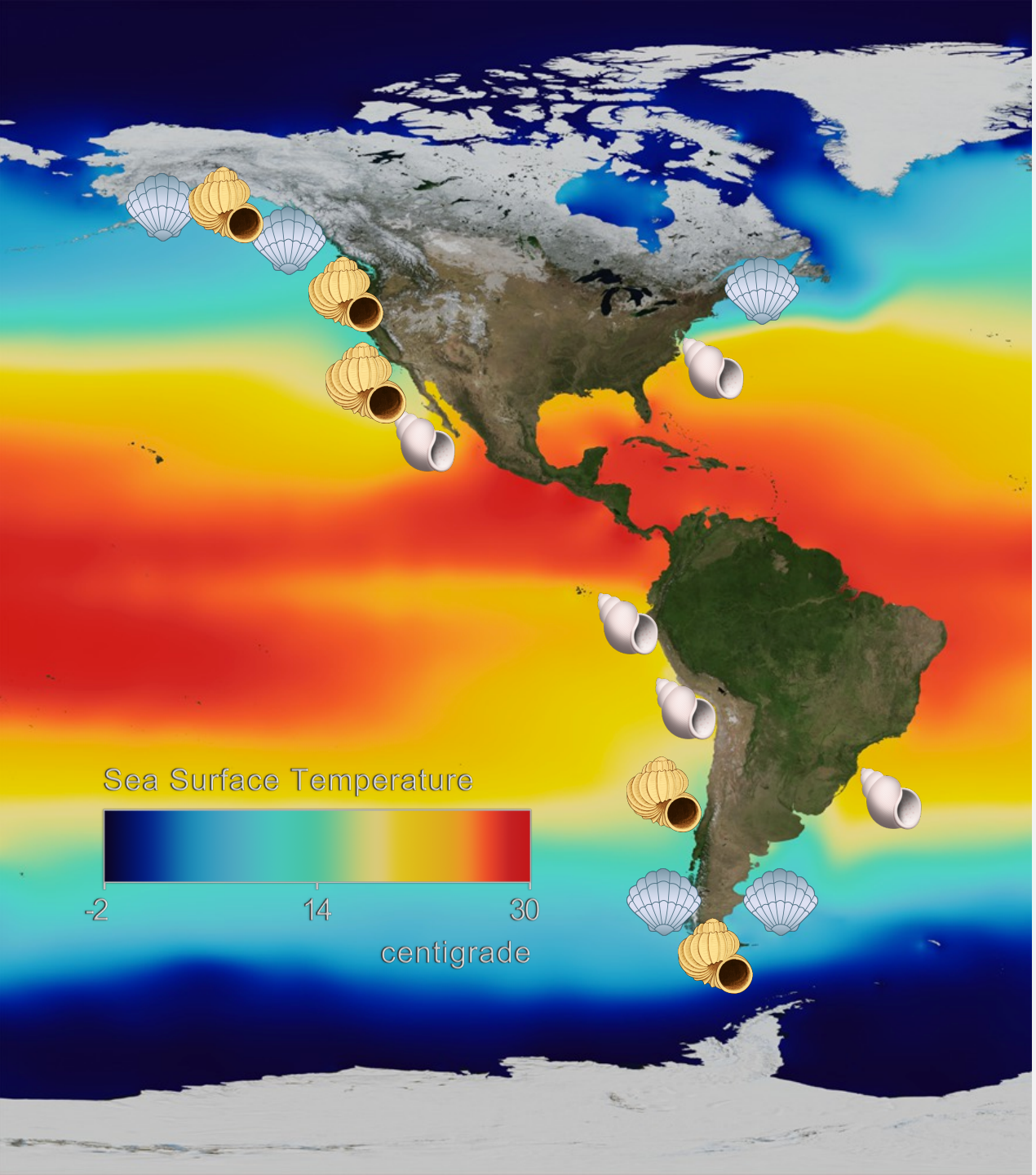
TEMPERATURE LIMITS

Some organisms tolerate only a limited range of temperatures while others can tolerate extremes



What are the temperature tolerances of the following mollusks?





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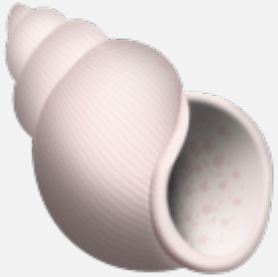


Only tolerates a limited range of warm temperatures

Only tolerates a limited range of cold temperatures

Tolerates a wide range of temperatures

TEMPERATURE LIMITS

Biological reaction rates vary with temperature and many are best at an optimal temperature and are less efficient or shut down all together when temperatures deviate from the optimum

- Metabolism
- Development
- Reproduction

TEMPERATURE LIMITS

van't Hoff's rule – for every 10°C of temperature increase *up to* the optimum, biological reaction rates increase by a factor of 1 to 6

But once the optimal temperature has been exceeded, the reaction rate declines rapidly until temperatures are so hot that they become lethal

TEMPERATURE LIMITS

Temperature is usually stable in marine communities → marine organisms are more intolerant to temperature extremes because they don't have to deal with temperature fluctuations on a regular basis

Long term extremes or changes can result in crisis for marine organisms – extinction

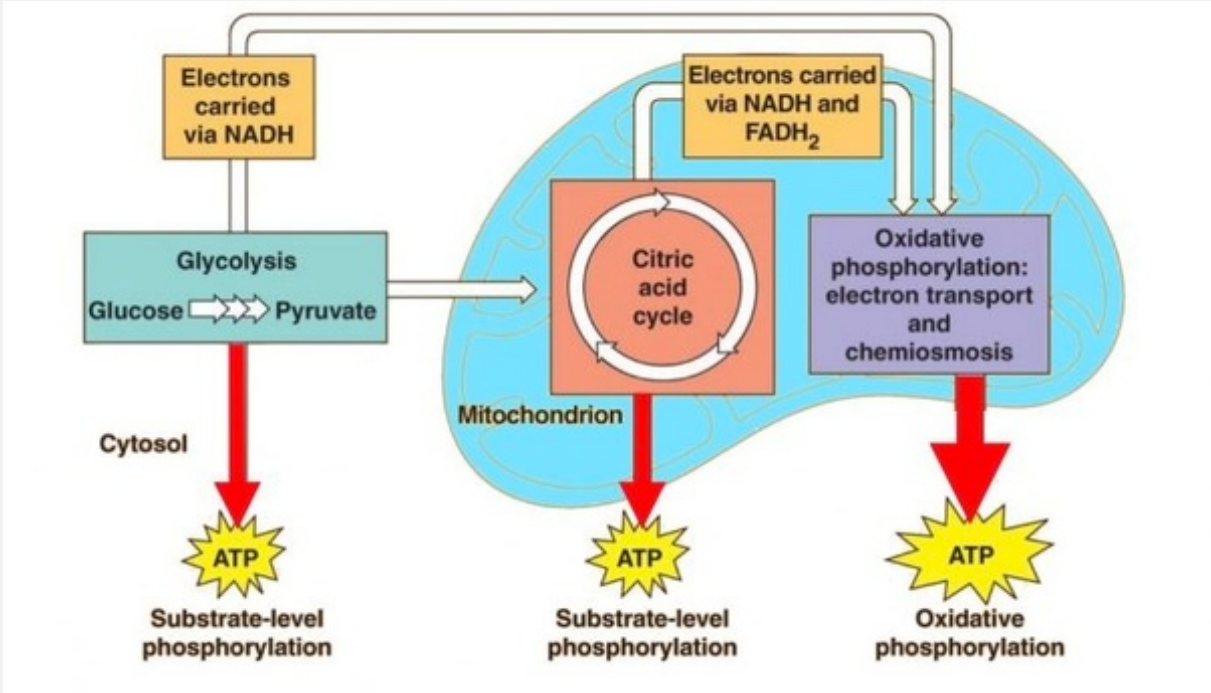
TEMPERATURE LIMITS

Temperature is related to other important limiting variables: oxygen content and salinity

Warmer water has less oxygen and is more saline because it's easier for minerals to dissolve but harder for gases

OXYGEN LIMITS

Oxygen is essential for **cellular respiration** - metabolic pathway that breaks down glucose and produces ATP (energy)



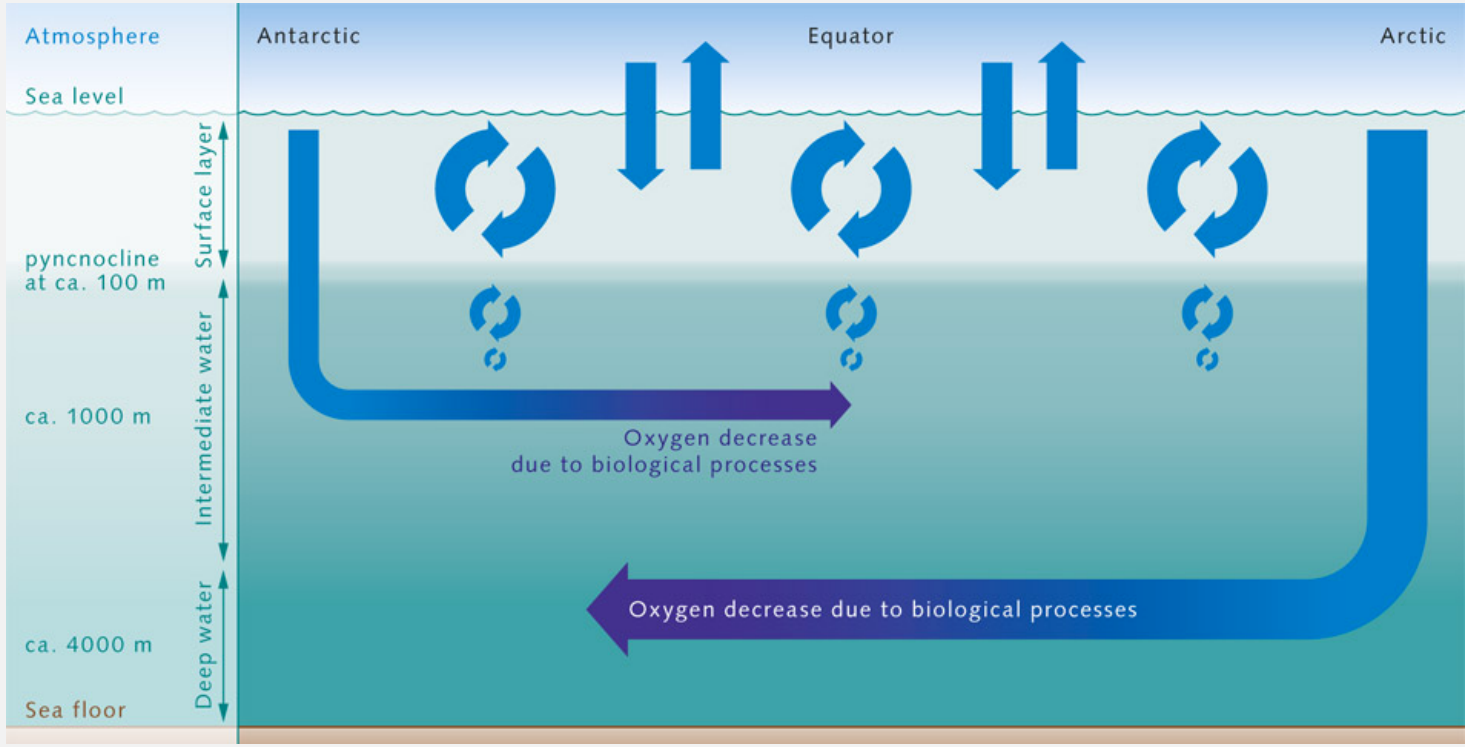
OXYGEN CONTENT CHANGES WITH DEPTH:

Aerobic (highly oxygenated) – surface waters

Dysaerobic (low oxygen) – 400m – 600m deep

Oxygen minimum zone (extremely low oxygen) – 600m – 1000m deep

Anaerobic (almost no oxygen) – deep stratified waters



OXYGEN LIMITS

Most marine life cannot tolerate low oxygen levels and lives in the near-surface waters

SALINITY

Salinity – total dissolved salts (especially NaCl) per volume of seawater (in parts per million, ‰)

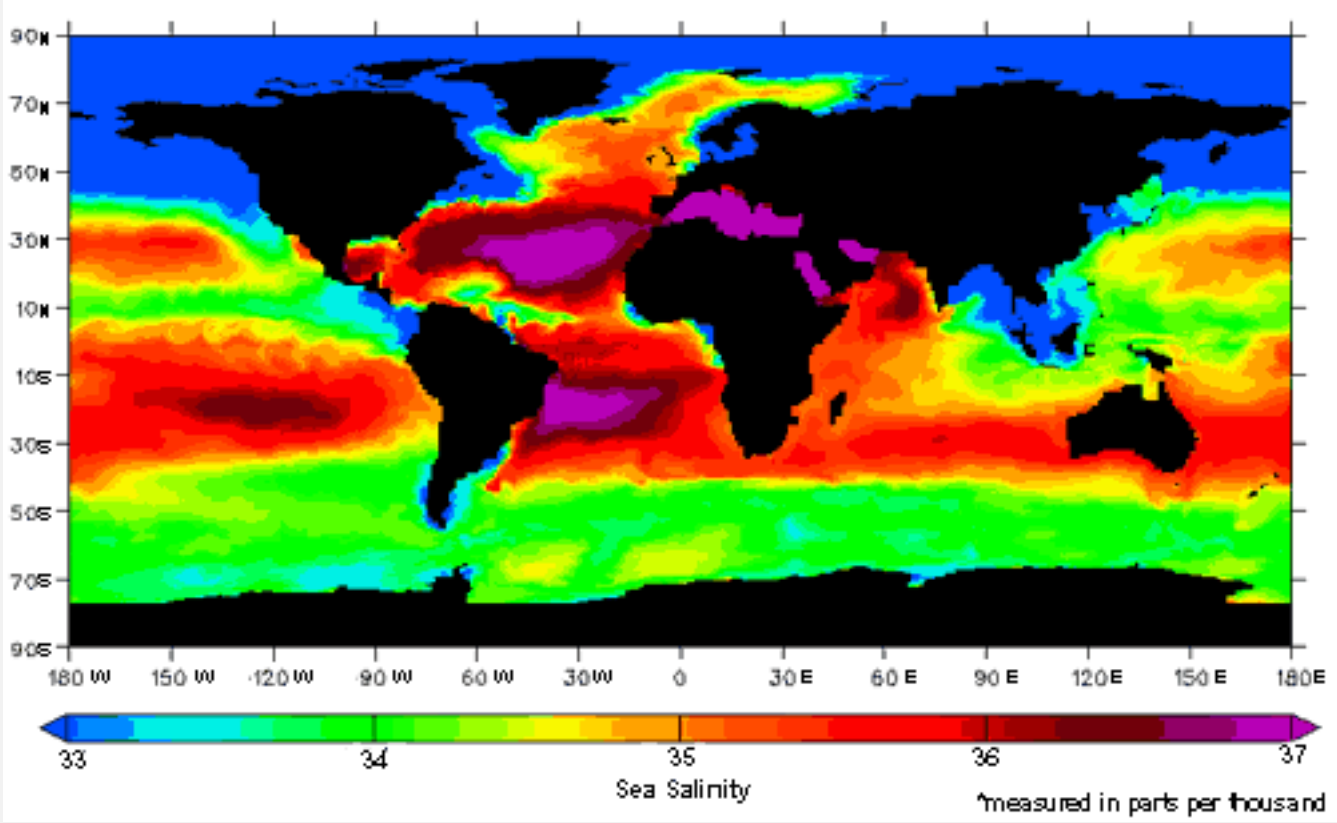
Freshwater = 0 to 0.5‰
Brackish water = 0.5 to 30‰
Seawater = 30 to 40‰
Hypersaline = 40 to 80‰
Brine = 80+‰

MARINE SALINITY

Centers of oceanic circulation (gyres) = 36.5‰ due to high evaporation due to heat which concentrates salts

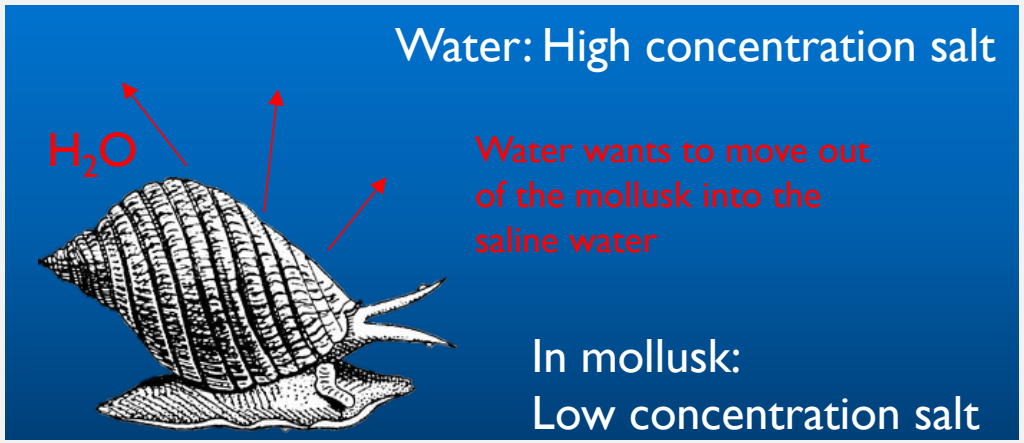
Polar regions = 32‰ due to low evaporation and high freshwater input from ice

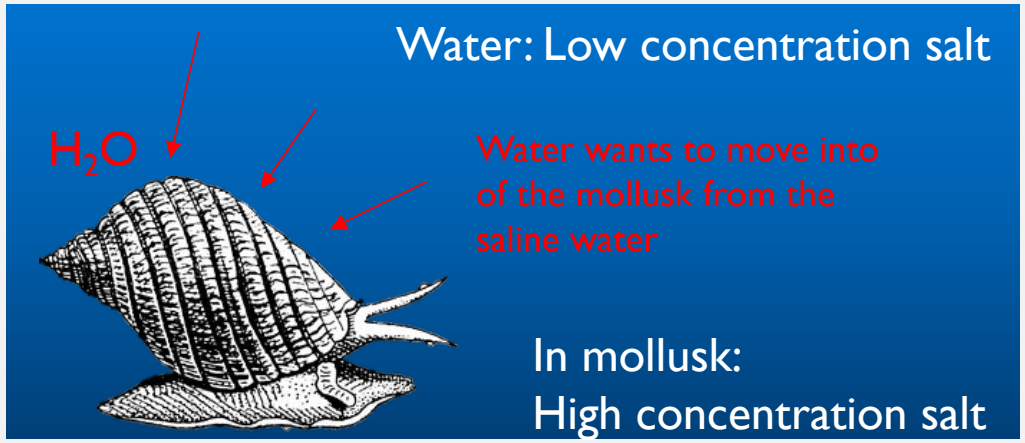
Nearshore regions fluctuate the most from different amounts of runoff from freshwater rivers and estuaries



SALINITY LIMITS

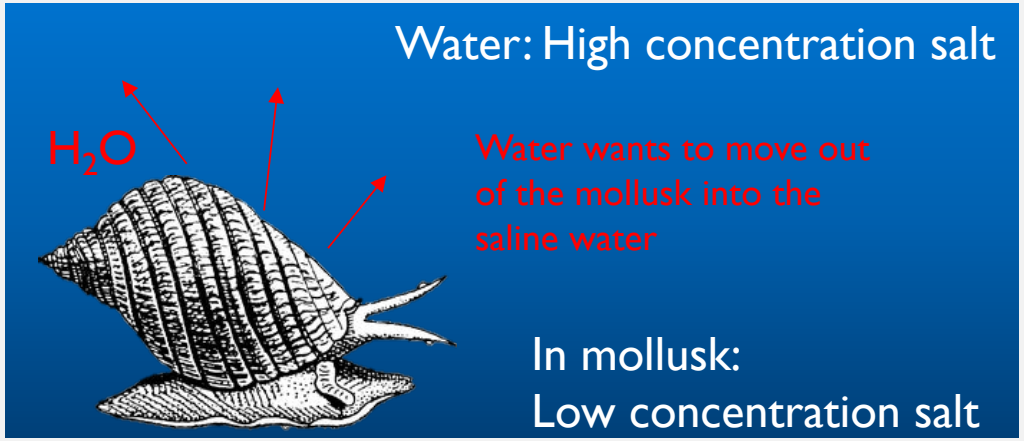
Affects **osmotic regulation** (maintenance by an organism of an internal balance between water and dissolved materials regardless of environmental conditions) of organisms



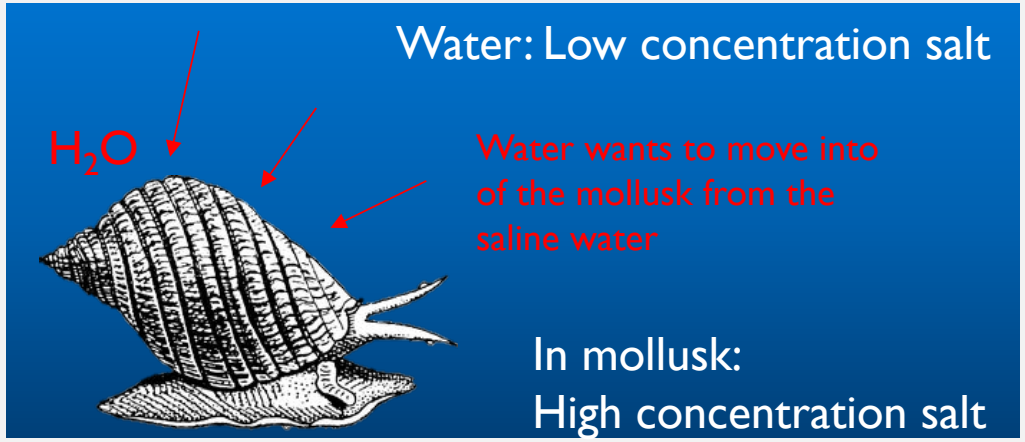


SALINITY LIMITS

Most organisms animals do not have mechanisms to regulate the content of their body salts (oysters and mussels are exceptions) when they live in waters that are different than their internal fluids so salinity changes are lethal



Mollusk shrivels up



Mollusk explodes

DEPTH LIMITS

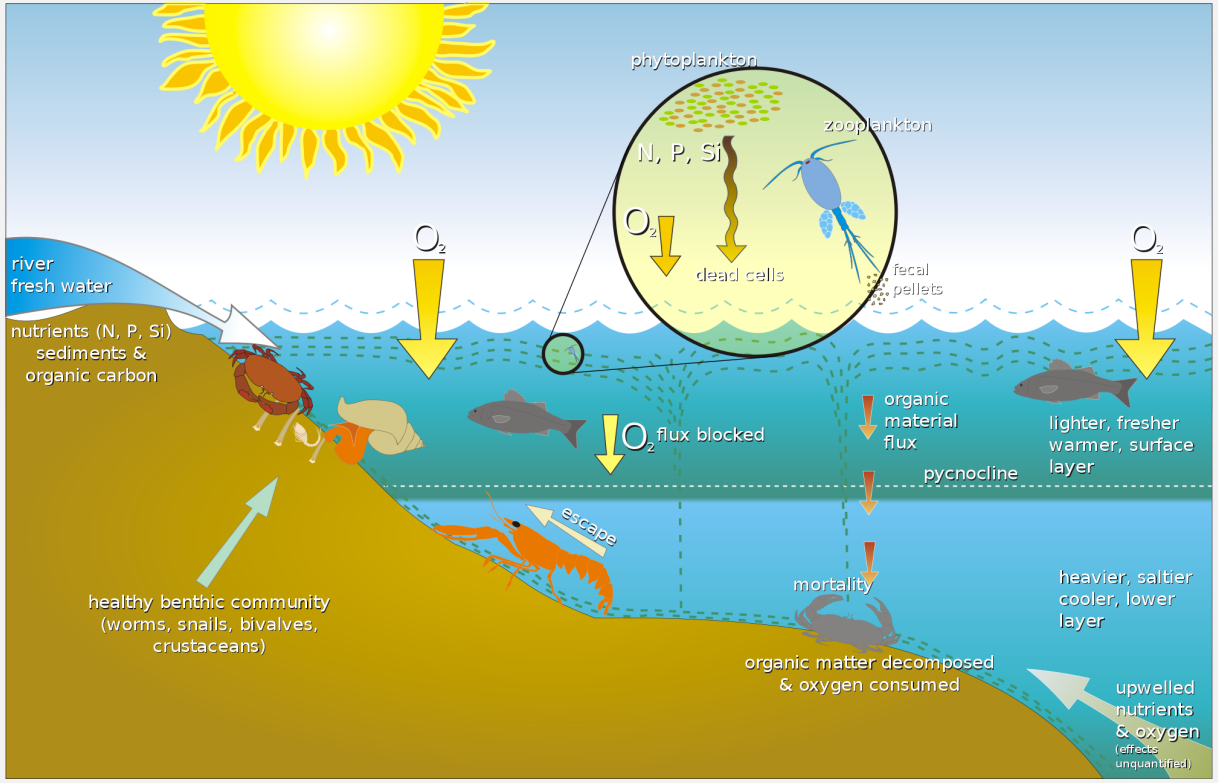
As depth increases the following decrease:

- Light and primary productivity
- Temperature
- Dissolved oxygen
- Carbonate concentration

DEPTH LIMITS

As depth increases the following decrease:

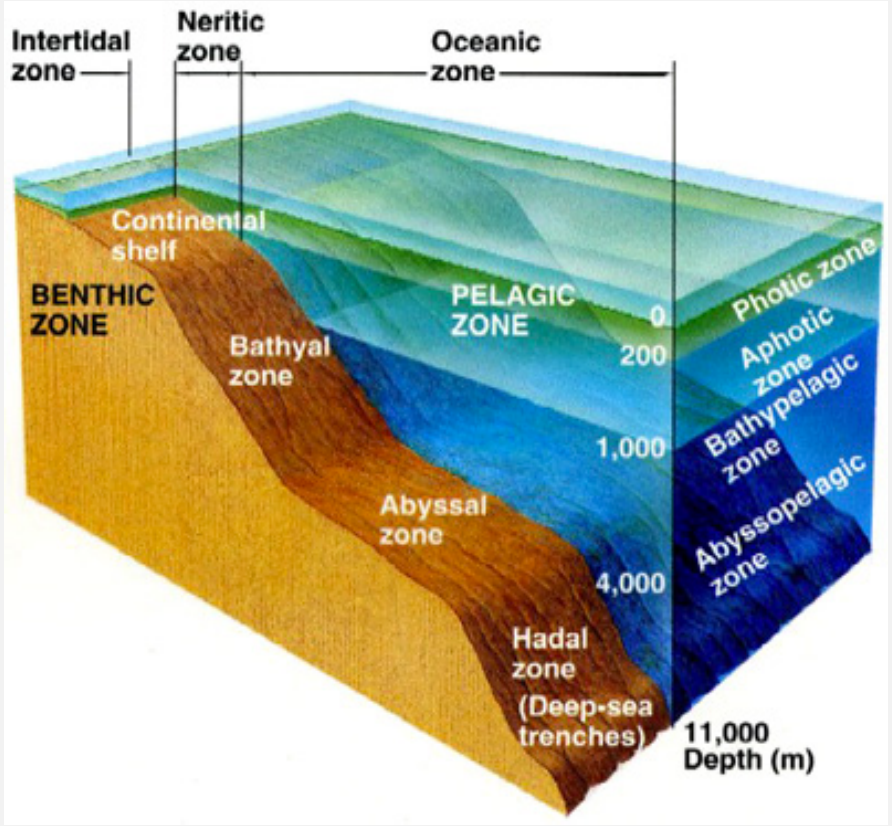
- Light and primary productivity – less food for filter feeders
- Temperature – back to temp limits
- Dissolved oxygen – back to oxygen limits
- Carbonate concentration – causes shells to dissolve



DEPTH LIMITS

Mollusks have depth preferences based on their feeding, temperature, and oxygen preferences

Some are only found in intertidal habitats, while others are usually found on offshore shelf or abyssal habitats



SUBSTRATE LIMITS

Substrate - the surface or material on or from which an organism lives, grows, or obtains its nourishment

SUBSTRATE LIMITS

Tidepool animals that like to live attached require a hard and rocky substrate

Detritus (waste or debris produced by other organisms) feeders prefer soft, muddy substrate where they can burrow and feed

Filter feeding burrowers prefer coarse sand because mud clogs their gills

All of these things (temperature, oxygen, salinity, depth, and substrate) control the distributions of marine mollusks in ecosystems

PALEOECOLOGY

Use the understanding of modern processes and modern organisms and communities to attempt to decipher past ecologies

HOW CAN WE FIGURE OUT ENVIRONMENTAL TOLERANCES OF FOSSIL MOLLUSKS?

If they have modern analogues or relatives, compare with relatives

Mollusks have a very slow rate of evolution (they don't change much over time) so we can assume that modern relatives have the same tolerances as their recent ancestors

HOW CAN WE USE ENVIRONMENTAL TOLERANCES OF FOSSIL ANIMALS TO UNDERSTAND PREVIOUS CLIMATE?

Look for highly sensitive organisms that can be good indicators of previous environments

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Mollusks have distinct distributions based on multiple marine variables

HOW CAN WE USE ENVIRONMENTAL TOLERANCES OF FOSSIL ANIMALS TO UNDERSTAND PREVIOUS CLIMATE?

With a partner, discuss:

What would you infer about the paleotemperature if you found a fossil mollusk in Connecticut whose living relatives are only found in coastal Florida?

What if you found a lot of mollusk fossils who have modern relatives that live in deep water?