Lesson Plan – Ocean in Motion

Summary

This lesson will introduce students to how the ocean is divided into different zones, the physical characteristics of these zones, and how water moves around the earths ocean basin. Students will also be introduced to organisms with adaptations to survive in various ocean zones.

Content Area

Physical Oceanography, Life Science

Grade Level

5-8

Key Concept(s)

- The ocean consists of different zones in much the same way terrestrial ecosystems are classified into different biomes.
- Water moves and circulates throughout the ocean basins by means of surface currents, upwelling, and thermohaline circualtion.
- Ocean zones have distinguishing physical characteristics and organisms/ animals have adaptations to survive in different ocean zones.

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Objectives

Students will be able to:

- Describe the different zones in the ocean based on features such as light, depth, and distance from shore.
- Understand how water is moved around the ocean via surface currents and deep water circulation.
- Explain how some organisms are adapted to survive in different zones of the ocean.

Resources

GCOOS Model Forecasts

Various maps showing Gulf of Mexico surface current velocity (great teaching graphic also showing circulation and gyres in Gulf of Mexico), surface current forecasts, and wind driven current forecasts.
http://gcoos.org/products/index.php/model-forecasts/

GCOOS Recent Observations

Gulf of Mexico map with data points showing water temperature, currents, salinity and more!
http://data.gcoos.org/fullView.php

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National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Unifying Concepts and Processes 2. Evidence, models, and explanation	Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have exploratory power. Models help scientists and engineers understand how things work
Unifying Concepts and Processes 5. Form and Function	The form or shape of an object or system is frequently related to use, operation, or function. Function frequently relies on form.

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National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Science As Inquiry A.1: Abilities necessary to do scientific inquiry	Students should develop general abilities, such as systematic observation, making accurate measurements, and identifying and controlling variables.
Physical Science B.1: Properties and changes of properties in matter	A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample.
Physical Science B.2: Motions and forces	The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.
Life Science C.5: Diversity and adaptations of organisms	Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive suc- cess in a particular environment.
Earth and Space Science D.1: Structure of the earth system	Water, which covers the majority of the earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle."

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National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Principle 1 (6-8, B.3., B.4.) Earth has one big ocean with many features B: Properties of ocean water	B.3: Density differences between masses of water can cause currents. B.4: The density of ocean water increases as salinity increases and temperature decreases.
Principle 1 (6-8, C., C.1., C.2., C.3., C.5., C.7.) Earth has one big ocean with many features C: Ocean Circulation	C: The ocean is one interconnected body of water that is in constant motion in a global circulation system. C.1. A global circulation system is generated from tides and different types of currents moving the water. C.2. Deep ocean currents are driven by density differences between masses of ocean water. C.3. The wind, combined with earths rotation drives surface currents in circular gyres in each ocean basin. C.5. Ocean circulation is influences by the positions of basins, continents, and other geologic features C.7. Currents transport heat, nutrients, and organisms throughout the ocean

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National Science Education Standard or Ocean Literacy Essential Principle	Learning Goals
Principle 5 (6-8, A.2.) The oceans supports a great diversity of life and ecosystems Primary productivity	A.2. Most primary productivity in the ocean takes place at the surface where there is plentiful sunlight for photosynthesis and nutrients to support growth.
Principle 5 (6-8, A.15., A.16., A.18.) The oceans supports a great diversity of life and ecosystems Diversity of ecosystem	A.15. Differences in light, temperature, pressure, density, and chemical makeup of this fluid environment lead to distinct vertically and horizontally distributed ecosystems. A.16. Ecosystems exist in layers of habitats and microhabitats due to gradients in specific environmental factors such as temperature, salinity, and oxygen within the water column. A.18. Adaptations to specific environmental conditions can result in vertical and horizontal zonation patterns.

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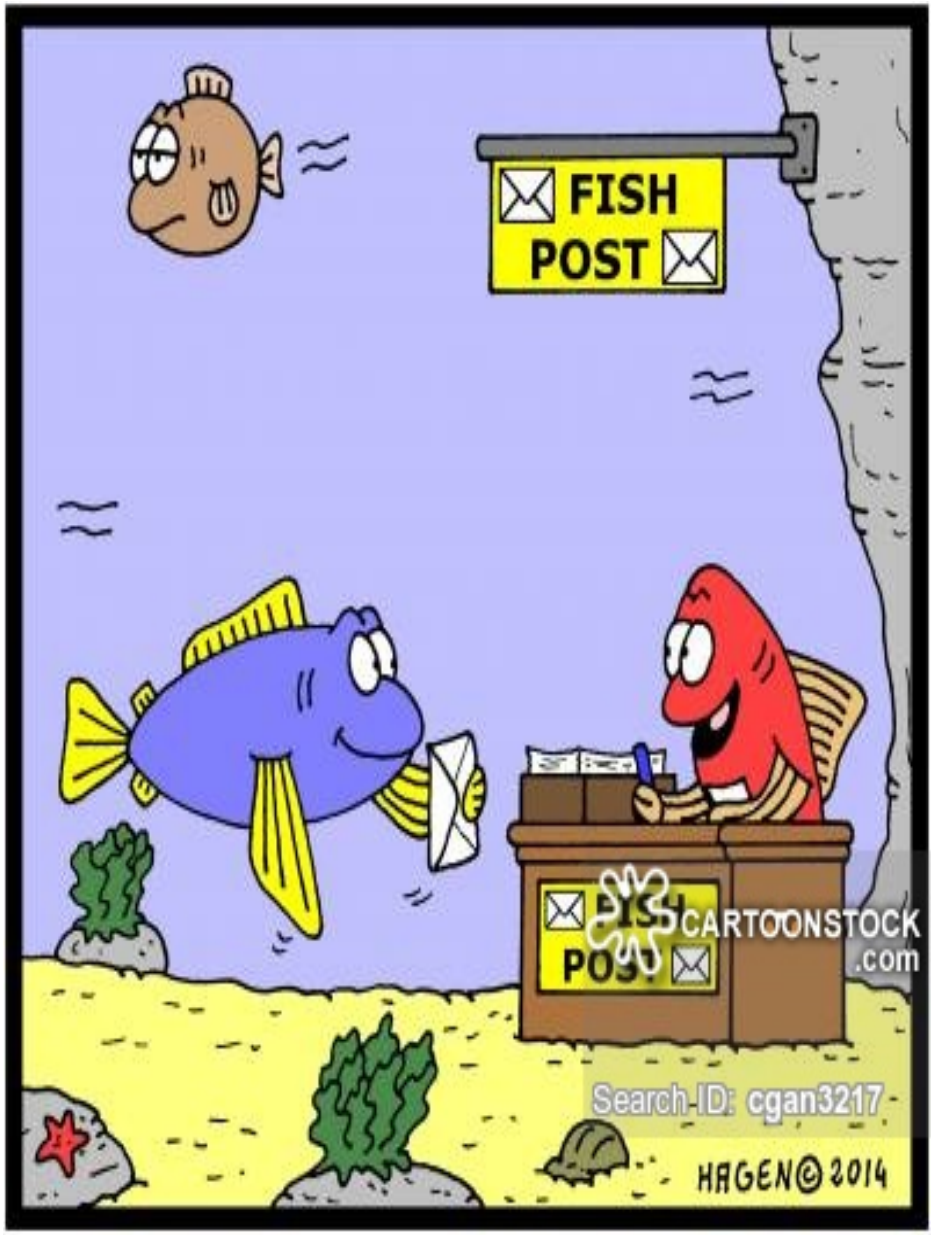

Express delivery through the Gulf Stream
is an extra $2 Sir...

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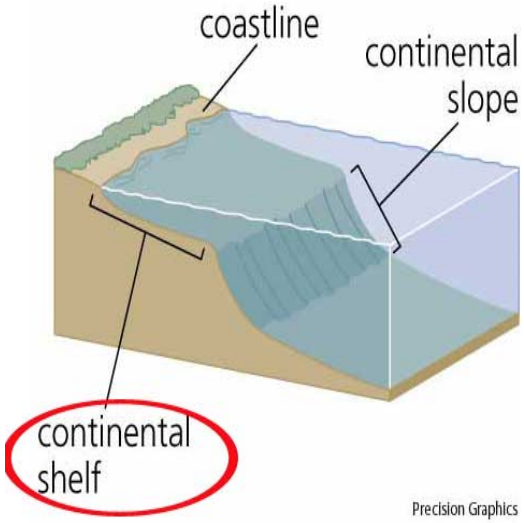
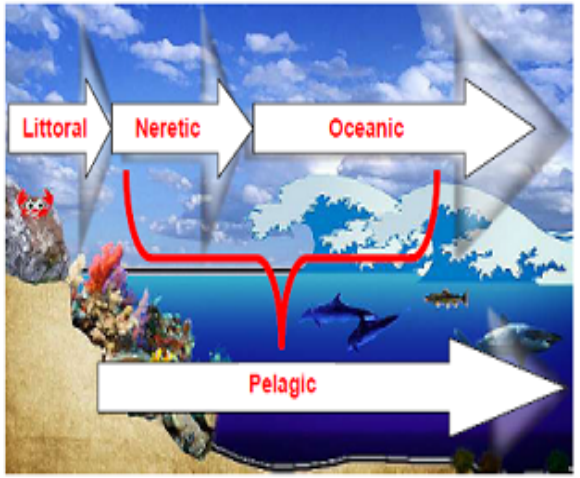
Last week you looked at some ways the ocean can be divided into zones.



HORIZONTAL ZONES are based on their position along the continental crust.

Littoral zone (intertidal zone): area between high tide and low tide.

Pelagic zone-the watery zone between the surface and bottom



- **Neritic zone** –the part of the pelagic zone that lies over the continental shelf.
- **Oceanic Zone**-the part of the pelagic zone that extends over water past the continental shelf.

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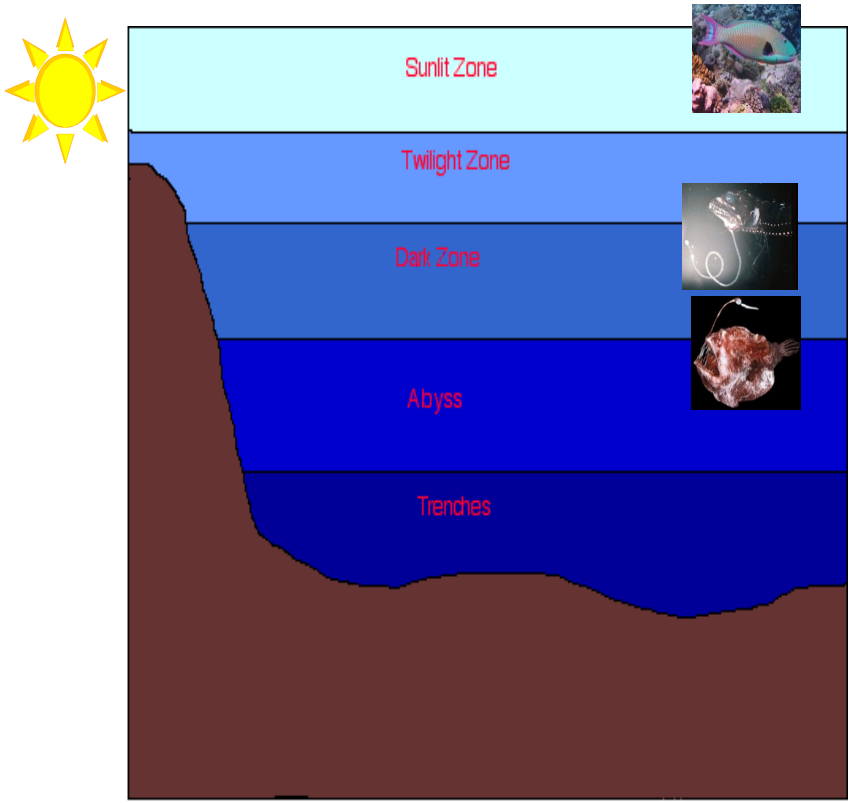
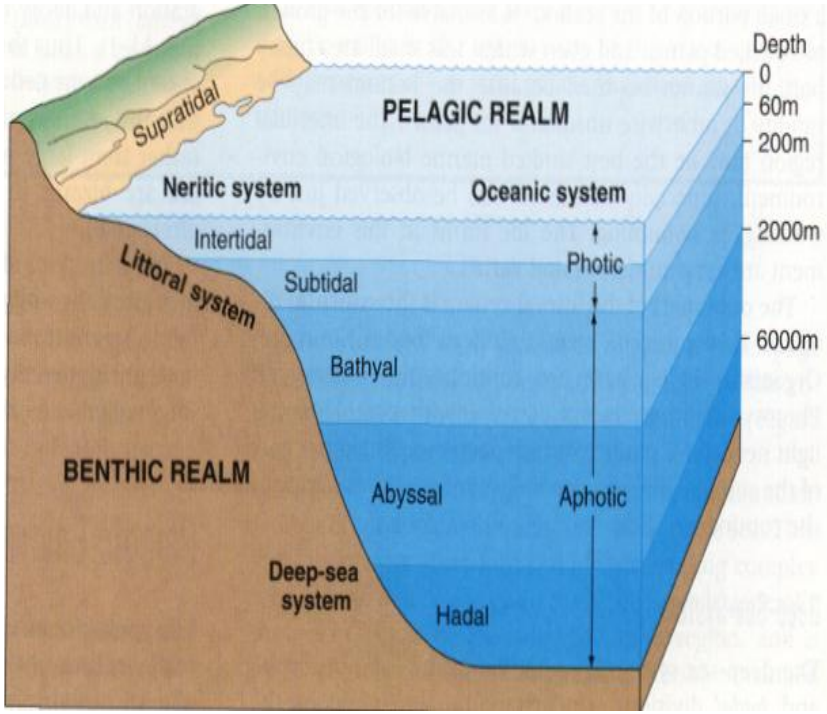
Another way oceans are divided into zones is in the vertical direction.

VERTICAL ZONES change with depth. The amount of **sunlight** and hydrostatic **pressure** are two ways zones are divided in the vertical direction.





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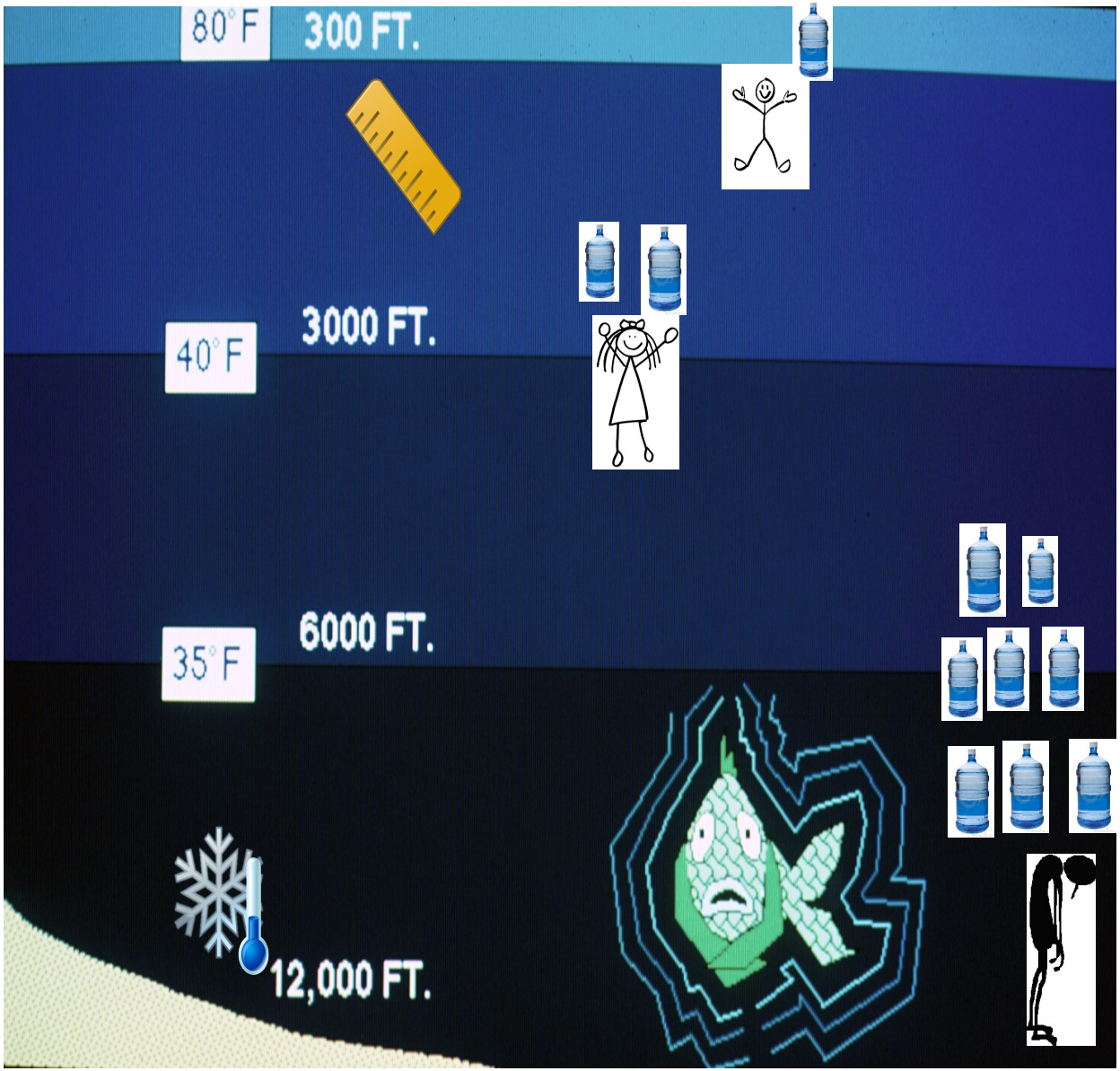

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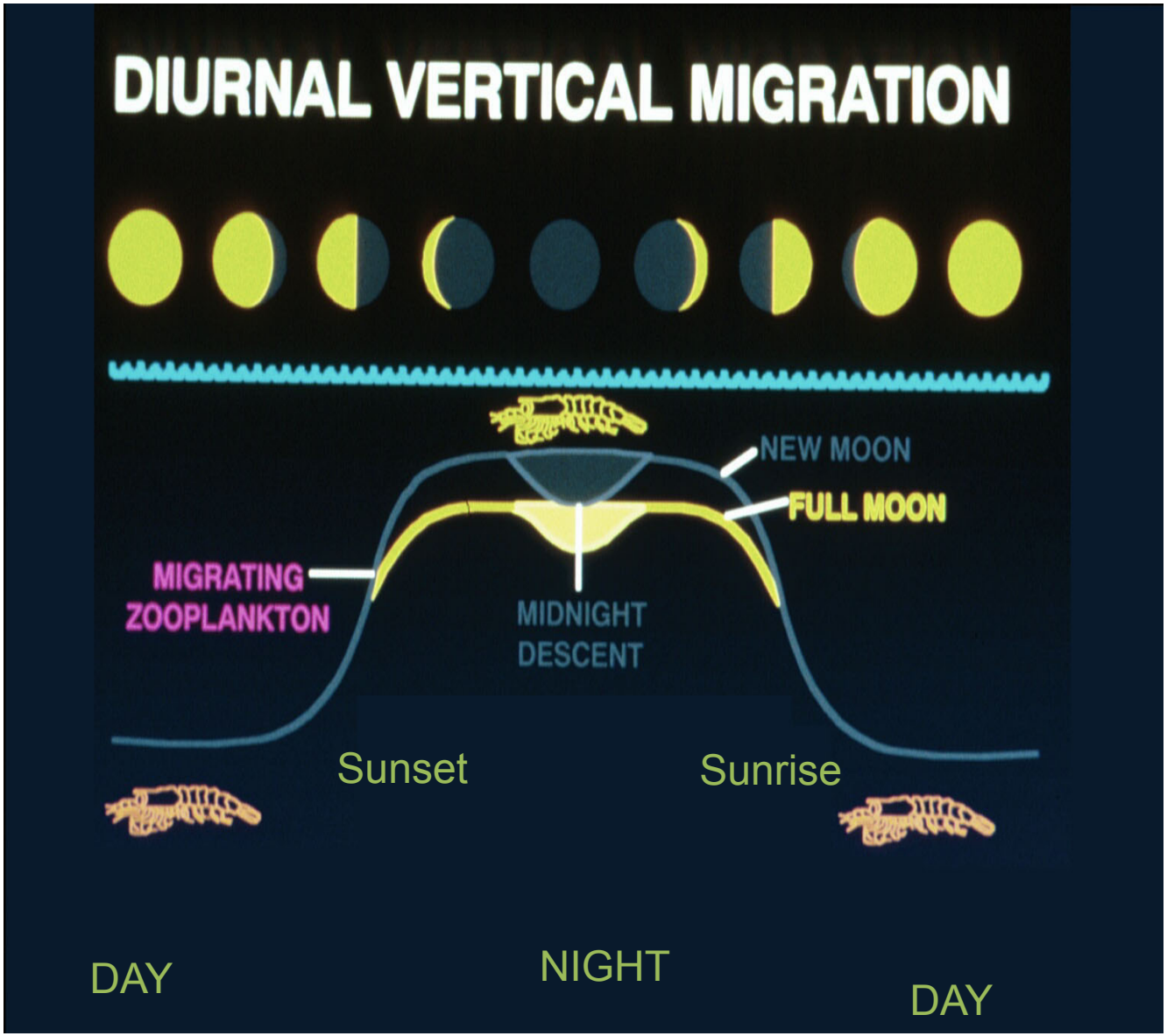
DIURNAL VERTICAL MIGRATION
NEW MOON
FULL MOON
MIGRATING ZOOPLANKTON
MIDNIGHT DESCENT
Sunset
Sunrise
DAY
NIGHT
DAY

Ocean in Motion: Part 1

- Like the zones of the ocean, we can look at how water moves around the ocean in two ways:
  - HORIZONTAL Movement or SURFACE CURRENTS
  - VERTICAL Movement or THERMOHALINE Circulation

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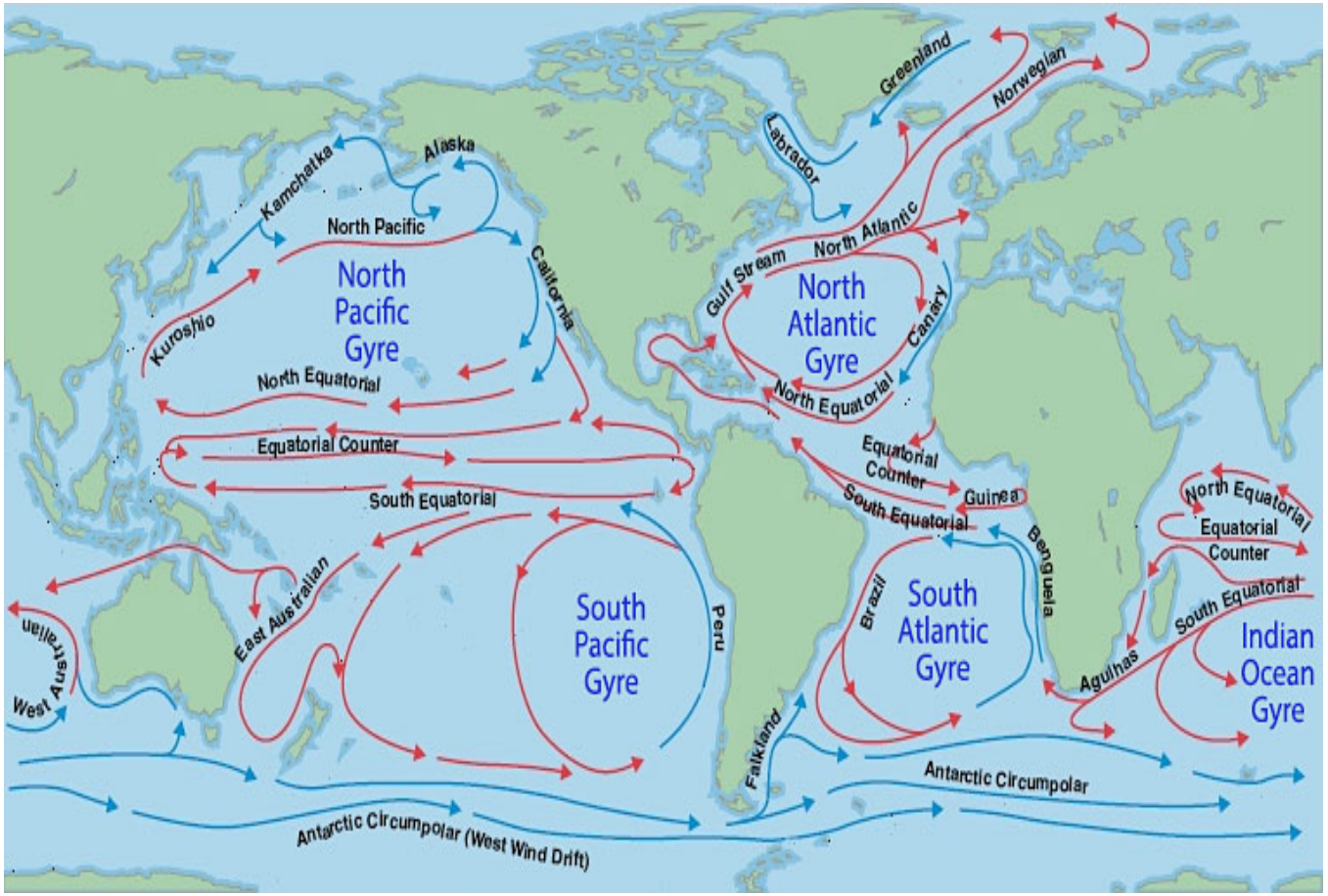
Surface currents



The combination of global wind patterns and forces created by Earth's rotation result in a large system of circular ocean currents called ocean gyres.

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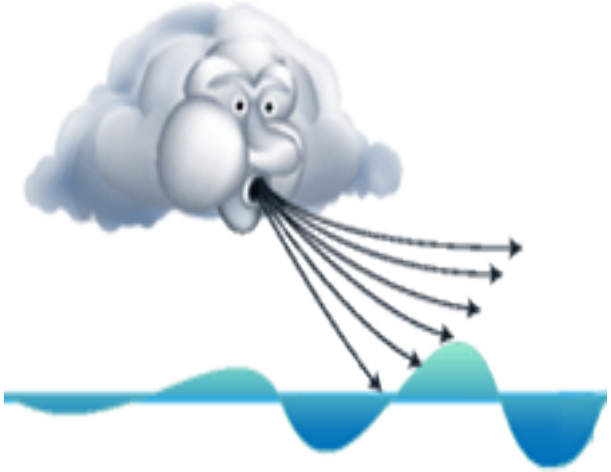
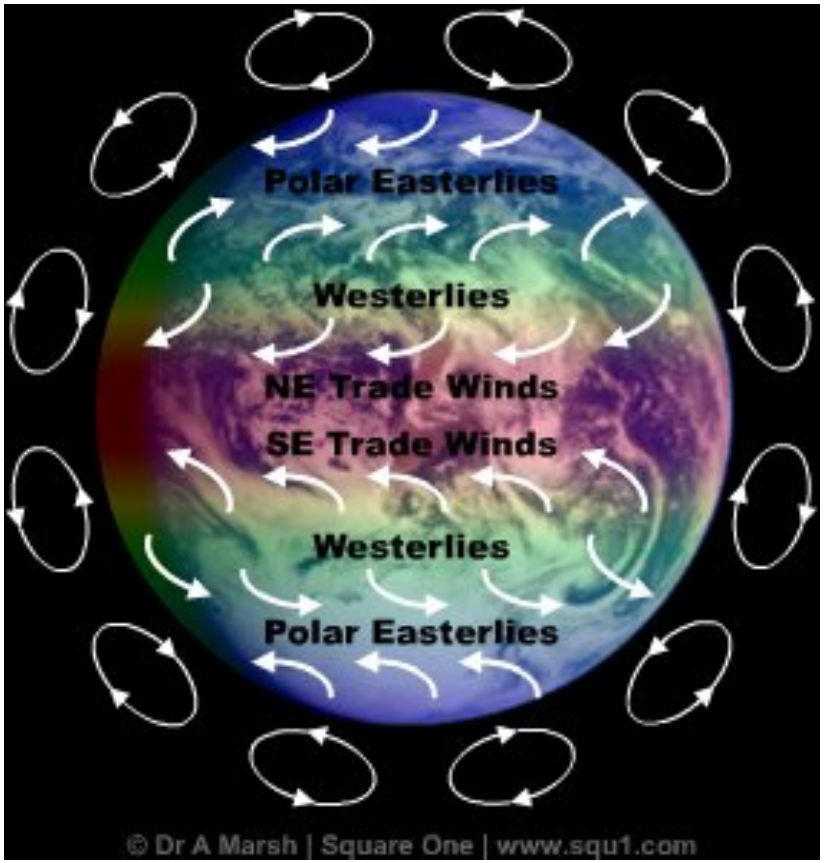
Two main factors affect the strength of surface currents:



The speed of the wind
The distance over which the wind travels (fetch)



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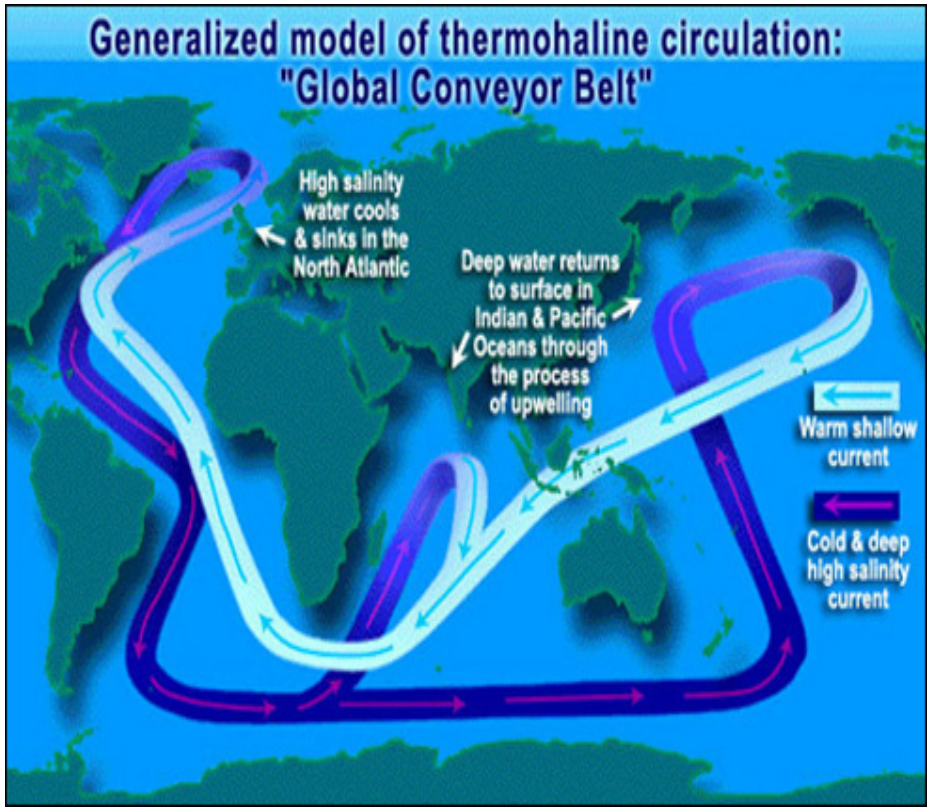
Thermohaline Circulation

"Thermo"=temperature "Haline"=salt



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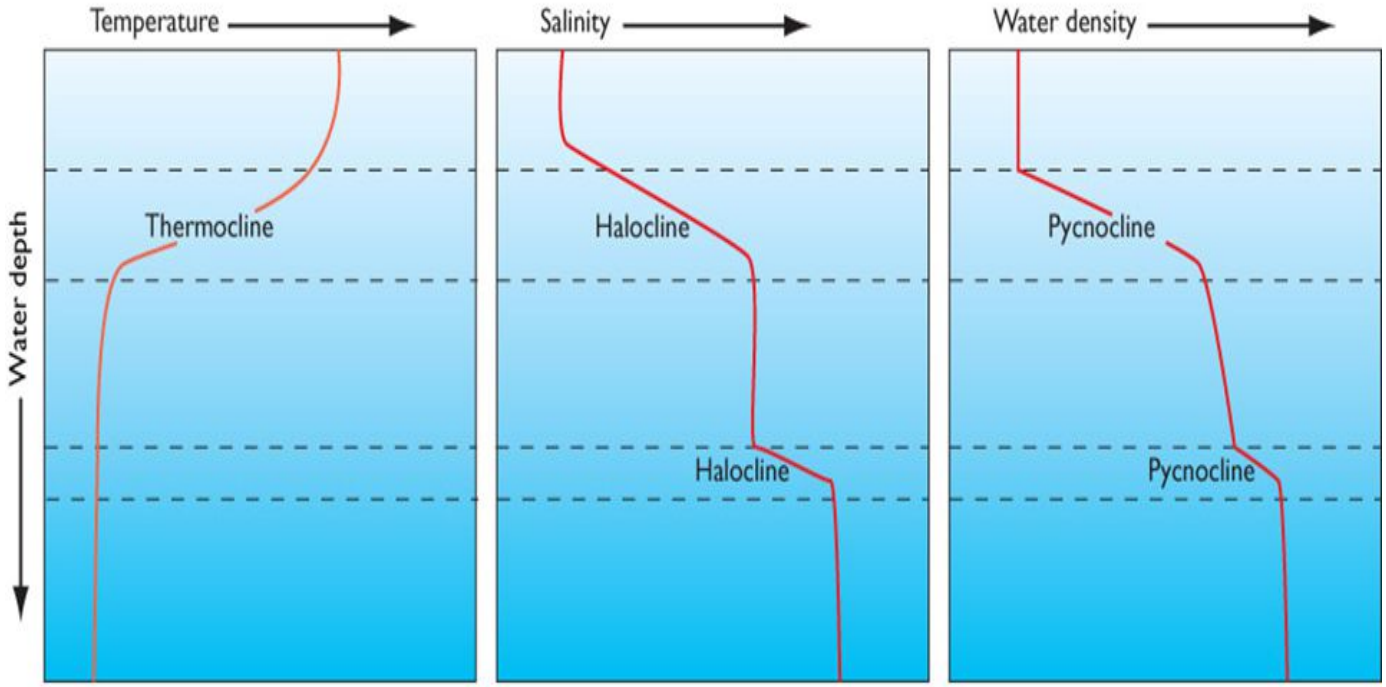
Thermocline, Halocline, and Pycnocline



"Clines" or places where rapid changes in conditions take place are often the boundaries where a lot of things happen!

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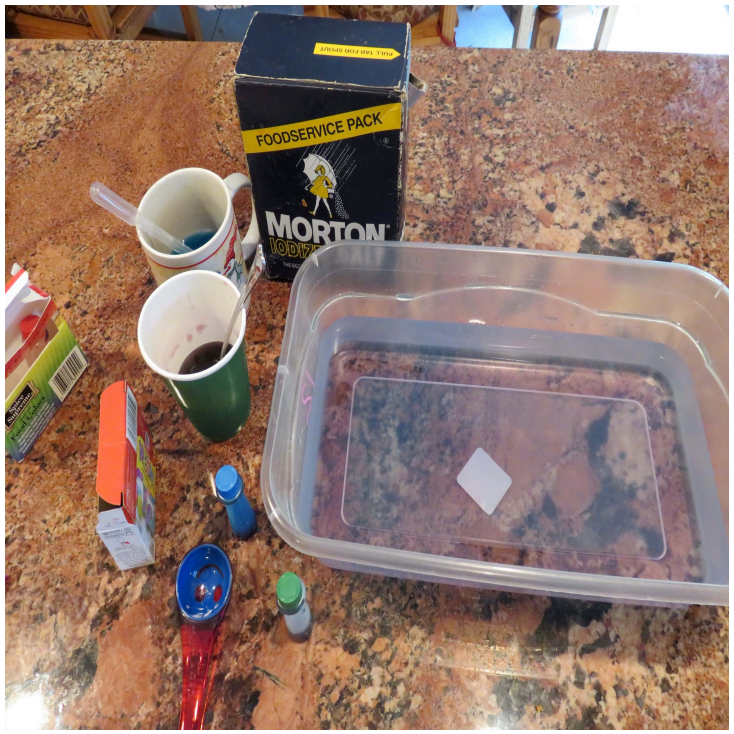
Activity: Experiment with density and ocean circulation

This activity can be done in the classroom with the materials listed below. Students will manipulate the water in bins with salt water and cold water (different densities) and observe the effects. Students can also simulate the effect wind has on ocean currents and circulation by blowing across the experimental bin of water.

Materials

- Plastic bin
- Paper cups
- 60 cc syringe
- pipet
- Table salt
- Food coloring
- Water (room temperature and warm)
- Ice cubes



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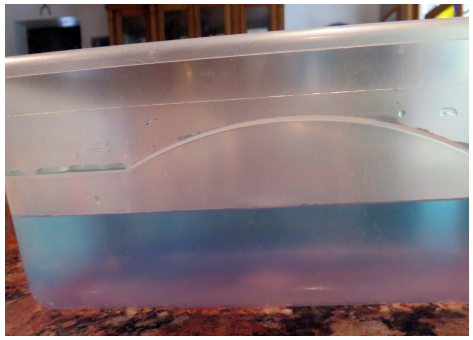
Experiment with density and ocean circulation: Part 1

- We will work in teams of two. You will need one bin per team.



- Fill the plastic bin about half way with tap water.

- Take one paper cup and fill half way with water. Add 1 tablespoon of salt and ONLY two drops of food coloring. Mix well. Add ice cubes and let chill a minute.

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- Fill the 60 cc syringe with HALF your saltwater/dye mixture.
- Holding the tip of the syringe at the BOTTOM of the bin with the tap water, slowly push down to release the water. Watch it flow. How does it move?
- Fill the syringe with the remaining saltwater/dye mixture. This time, keep the syringe tip right at the surface of the water and gently release into the bin with the tap water. How does it move?

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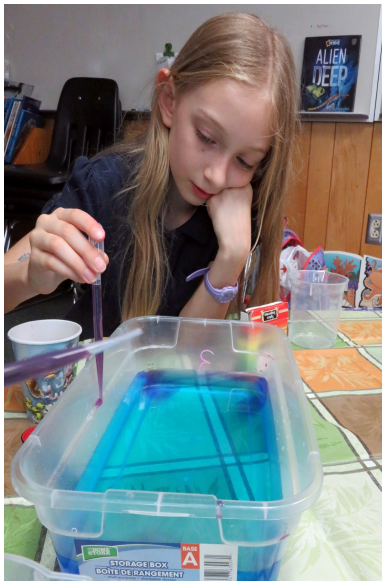
Experiment with density and ocean circulation: Part 2

- Rinse your paper cup with tap water.
- Fill your paper cup half way with warm water and add ONLY two drops of food coloring. Mix the dye into the water.
- Take a pipet and fill with your warm water/dye mix. Hold your filled pipet against the inside plastic of your container just above the tap water. Gently squeeze to release the liquid. It should drip down the side of the container before hitting the water. You and your partner can each use a pipet and continue this process until all the mixture has been added to the bin.



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- Observe how/where the warm water/ dye mixture moves. Is it the same or different than the cold saltwater mixture?

- Create wind by blowing on the surface of your “ocean.” Try to observe what happens to the deep water below the area where you create wind friction. Can you get the saltwater at the bottom to upwell—move toward the surface?

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Part 3: How are animals adapted to survive in the different zones of the ocean?

How do they find food?

How do they find mates?

How do they avoid predators?

What creatures can you create that can stay in the intended zone?

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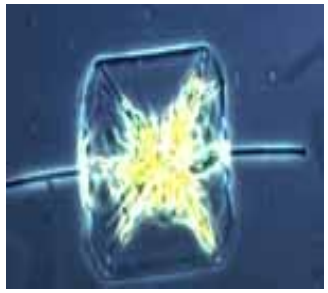
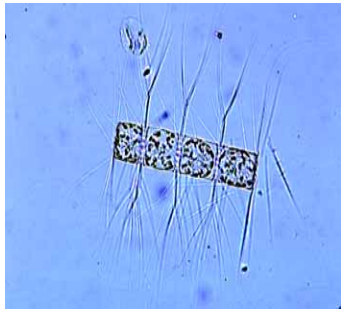


Diatom



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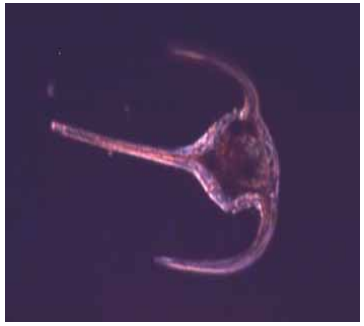
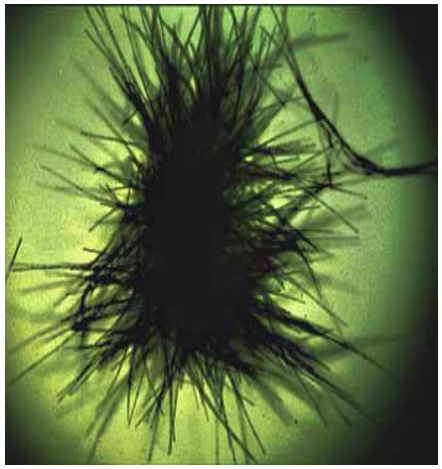


Dinoflagellate

Dinoflagellate



Blue green algae

Phytoplankton: DRIFTING PLANTS

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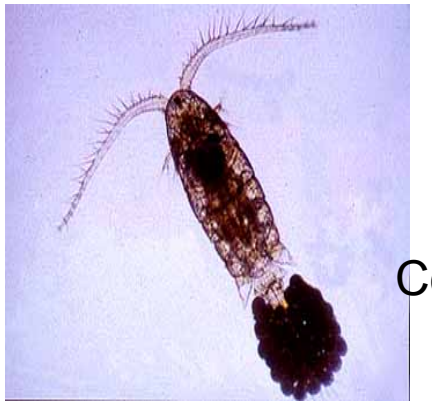
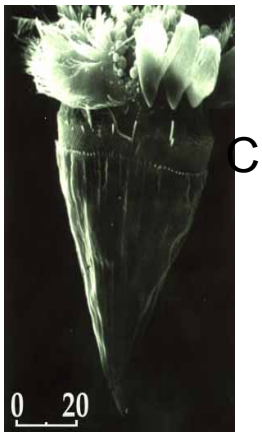
barnacle

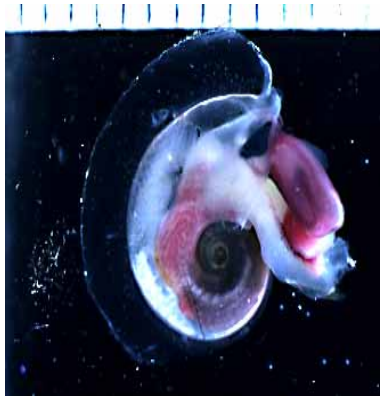


Copepod

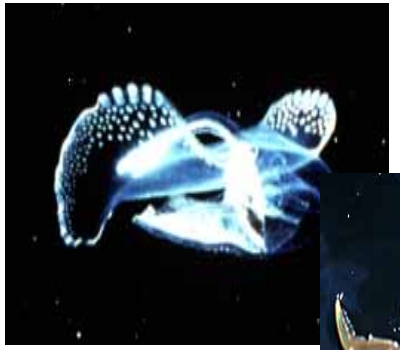
Copepod



Ciliate



Heteropod



Pteropod

Zooplankton: DRIFTING ANIMALS

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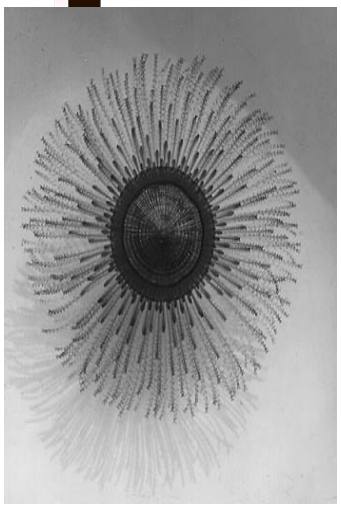
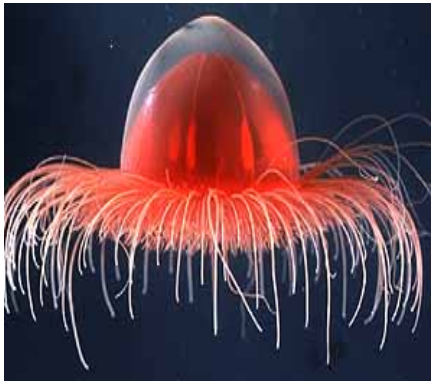
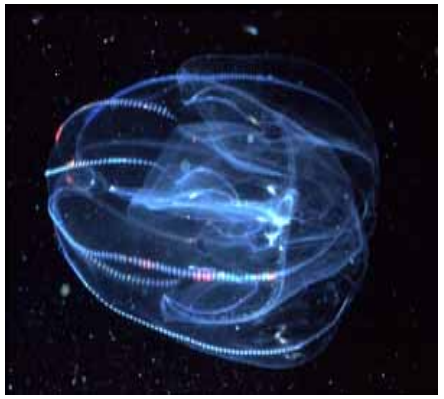
Gelatinous Zooplankton...







Have Soft Bodies

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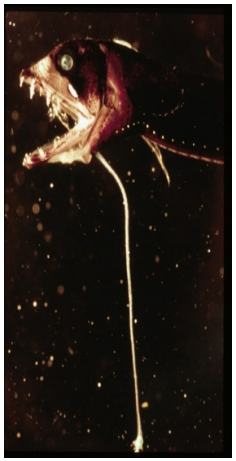
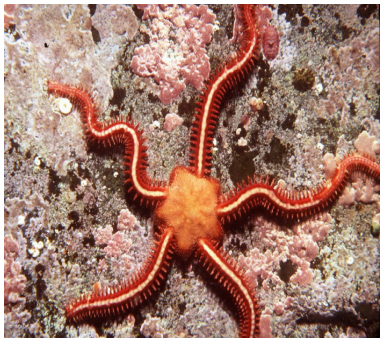
PELAGIC animals live in the water column

BENTHIC animals live on or near the sea floor





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