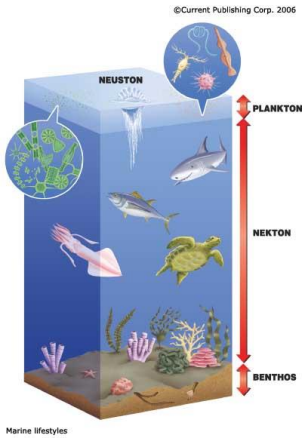
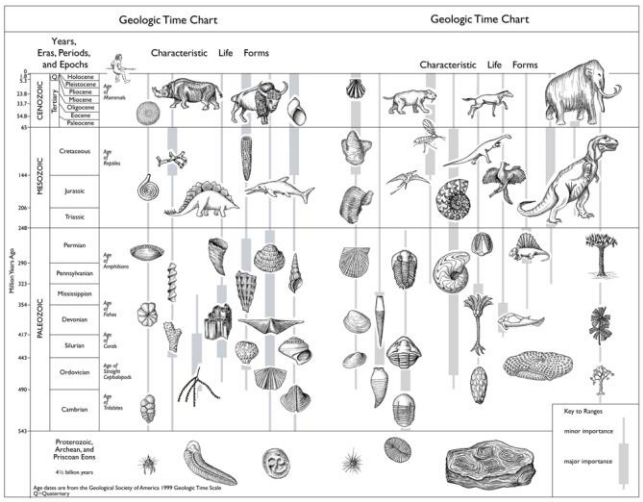
Life in the Ocean

Energy and Biogeochemical Cycles
The Physical Environment
Ocean Zones
Lifestyles by Zone



Life on Earth has _____ and _____



All of Earth's life forms are _____ and _____ universally the _____ way.

All species _____ from a _____ _____ _____ at life's origination _____

>100 million living species on Earth

Life requires _____

The _____ law of thermodynamics states that _____.

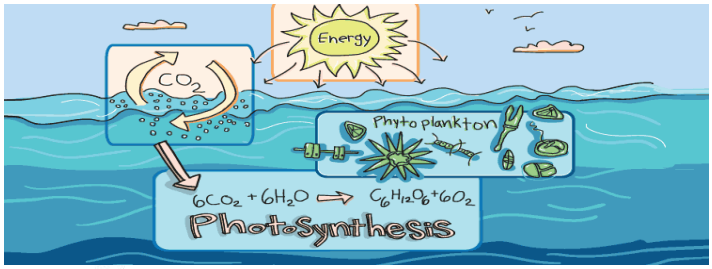
Energy is defined as the _____.

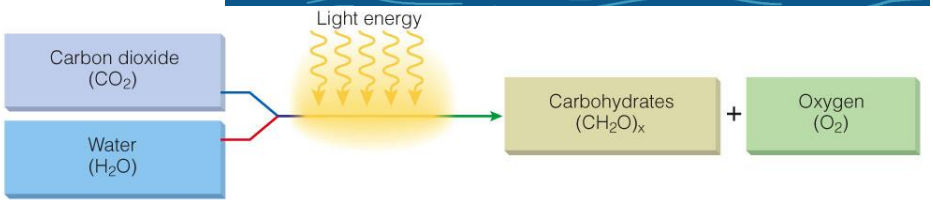
_____ is necessary for life because living systems use energy for processes of life including _____, _____, _____, _____ and _____.

What is the primary source of **energy** for (most) living organisms?..... _____!

Sunlight -> _____

Using _____, _____ _____ capture energy from the sun to _____(carbohydrates), absorbing _____ and releasing _____ in the process…





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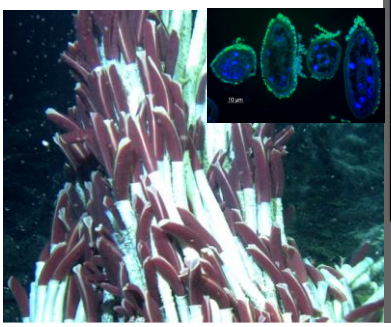
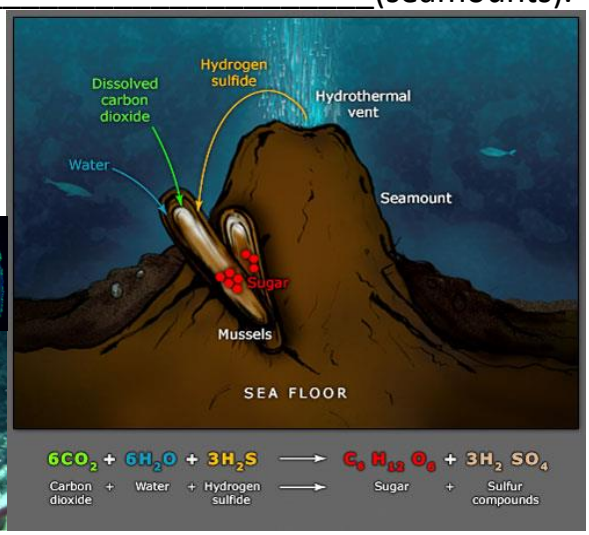
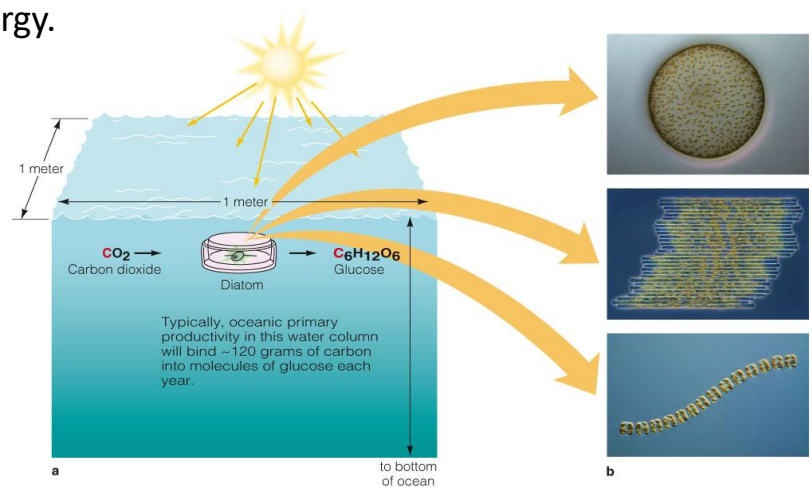
Hydrogen Sulfide -> _____ is the _____ of _____ from inorganic molecules (_____) in the environment. Occur at _____ _____(seamounts).

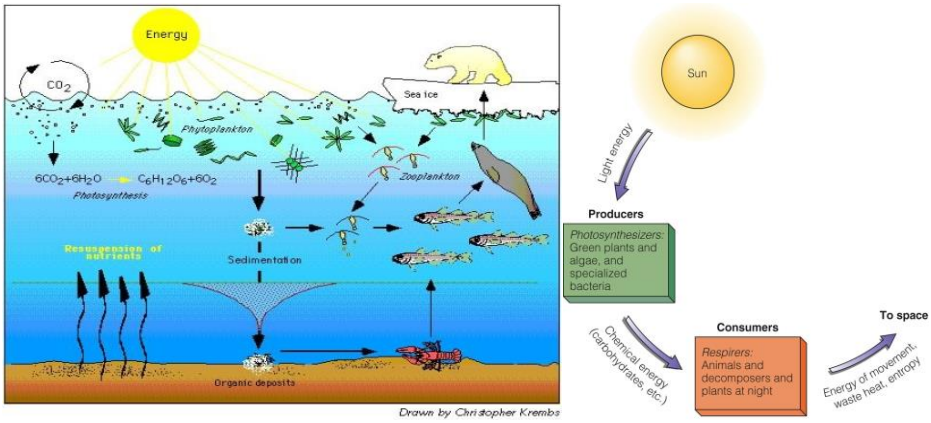




_____is the synthesis of _____ from _____ (remember the carbon cycle). _____ is the carbohydrate formed for energy.



Energy flows through living systems. At _____, energy is _____ and _____ into lesser forms.

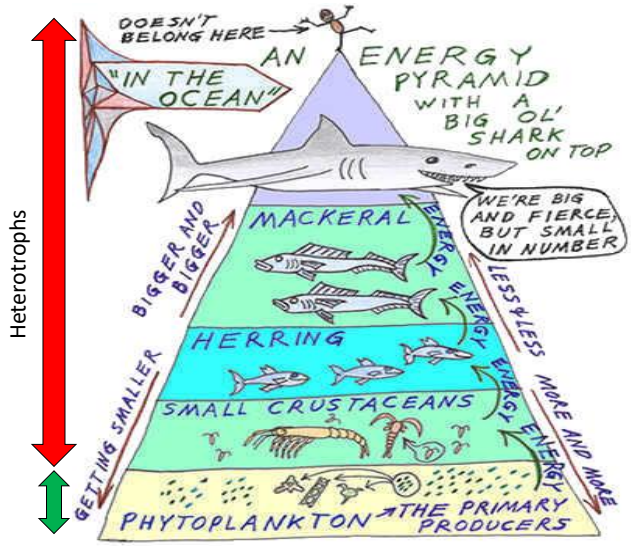


Food Webs Disperse Energy through Communities

- Terminology used to describe feeding relationships
- **Autotrophs –** organisms that _____, also called _____.
- **Heterotrophs –** organisms that must _____ _____ for energy
- **Trophic pyramid –** a model that describes _____
- **Primary consumers –** these organisms _____
- **Secondary Consumers –** these organisms _____ _____
- **Top consumers –** the _____ of the _____

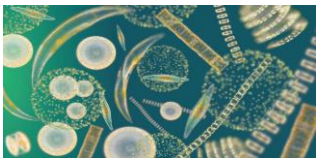
Energy Flow Through the Biosphere: Trophic pyramid

A trophic pyramid represents energy transfer from one level of organisms to the next as they consume each other.



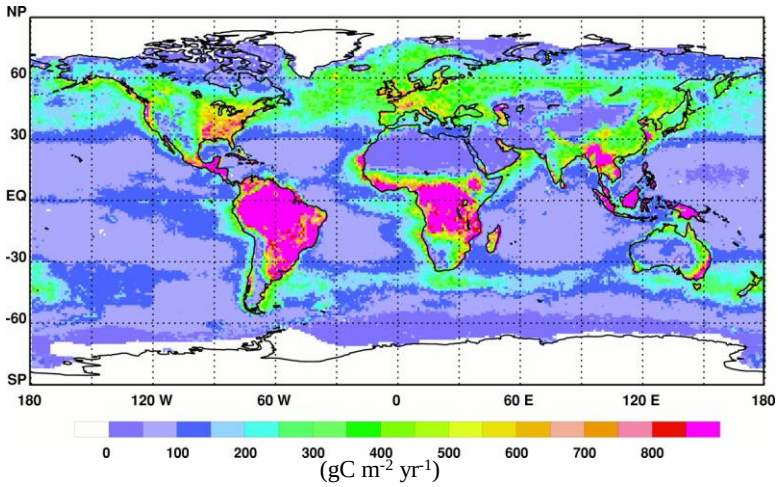
Phytoplankton are **primary producers**

_____ (algae) in the ocean absorb _____ _____ during photosynthesis, converting _____ carbon to _____ carbon, producing food for the _____ of the ocean food chain. 90 to 95% of carbohydrates in ocean surface water is produced.



Phytoplankton need _____and _____
(e.g., Nitrate, Silicate, Iron)

Global distribution of net primary production:
Most oceanic primary production occurs in _____ regions or _____.



_____ are **heterotrophic** and comprise most of the _____ _____ in the oceans

Zooplankton

Where do **zooplankton** 'fit' in food chains?

Review: a simple food chain:

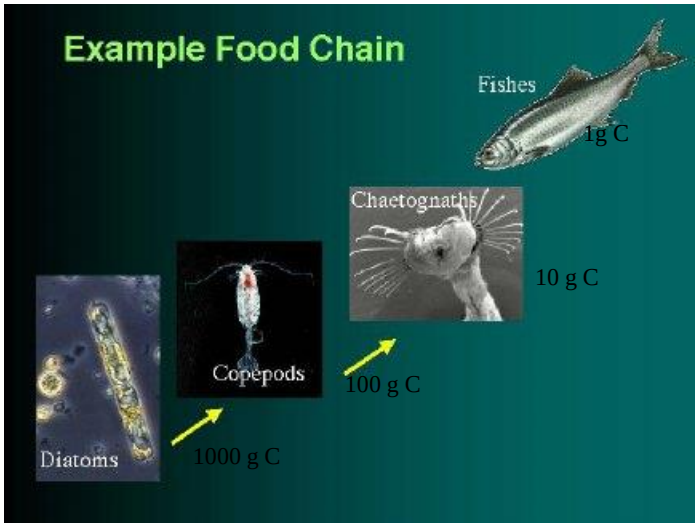
↑

_____ =
maybe you (or maybe some of you)
(probably an omnivore, but still a **heterotroph**)

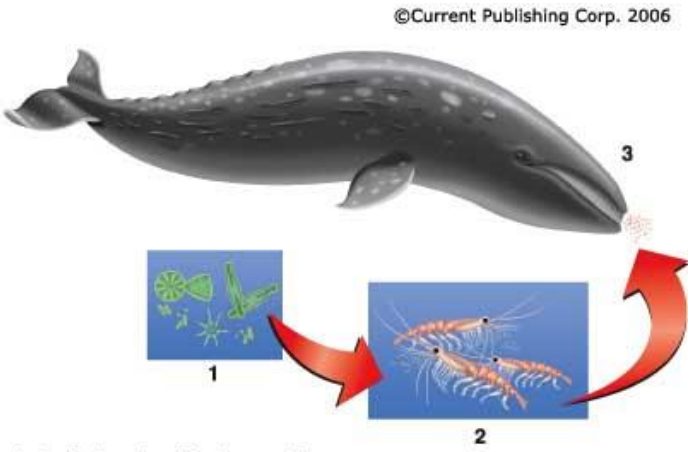
_____= cow
(a **heterotroph**)

_____= grass
(**autotroph**)

Plankton are the _____
in the oceans and it takes a lot of plankton at the bottom of the food chain to feed a fish at the top.



A simple three-level food _____



A simple three-level food pyramid

Simple marine food **chain**…

Large fish (fourth order consumer, e.g., tuna)

↑

Medium fish (third order consumer)

↑

Fish larvae, carnivorous zooplankton (second order consumers)

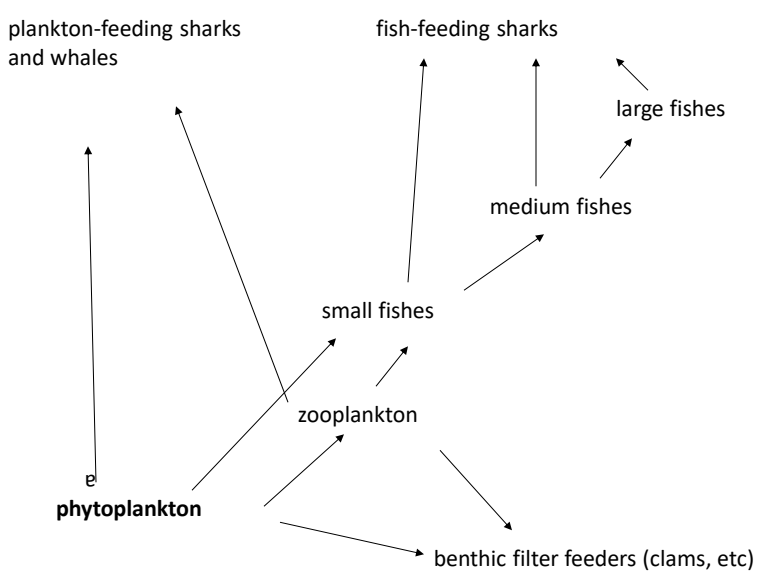
↑

_____ (first order consumers)

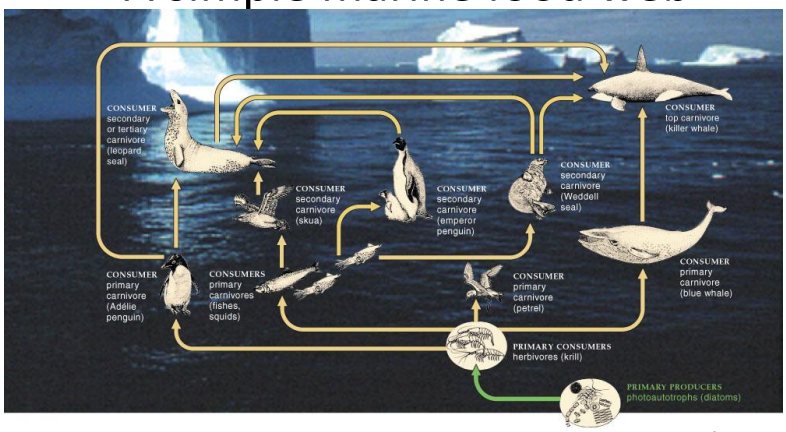
↑

_____ (autotrophs, producers)

… and food _____



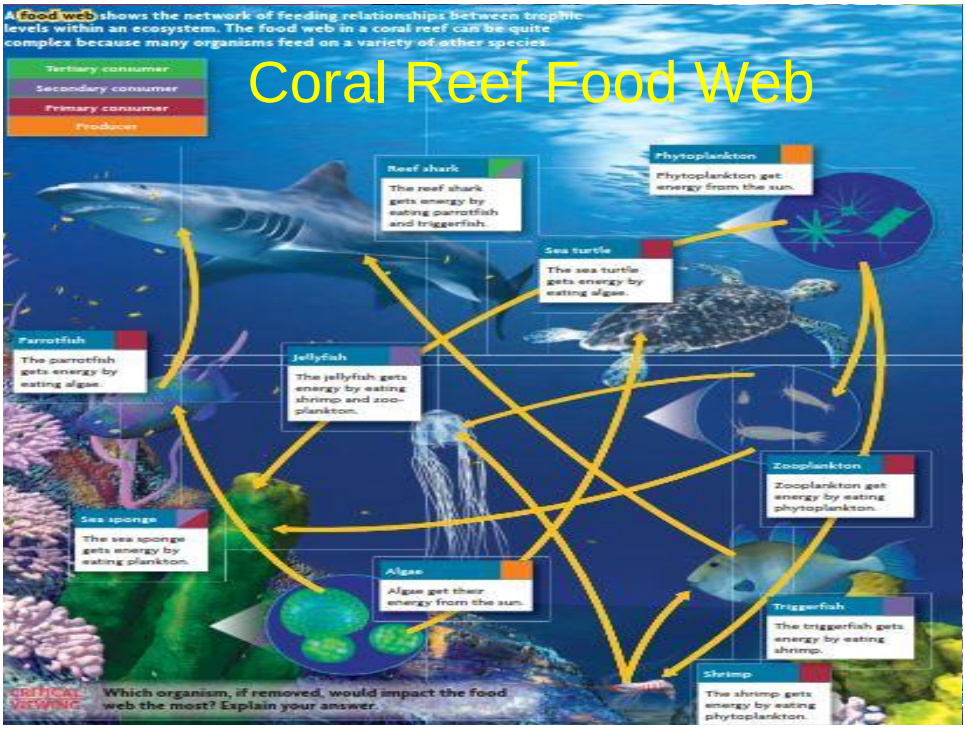
A simple marine food web



_____, and other primary producers, convert the energy from the sun into food used by the rest of the oceanic community.

This simplified _____ illustrates the major trophic _____ leading to an adult blue whale.

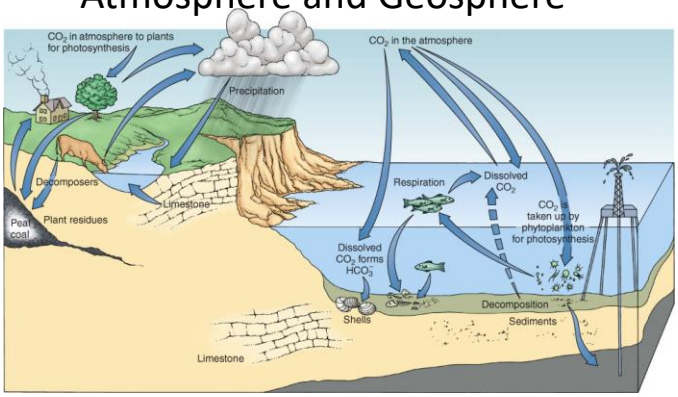
The arrows show the _____; the numbers on each area represent the _____ at which the organism is feeding.



Elements _____ between _____ (Biotic) Organisms and Their _____(abiotic) Surroundings

- What are some atoms and molecules that cycle in _____?
- _____ - present in all organic molecules
- _____ - found in proteins and nucleic acids (RNA, DNA)
- _____ – found in rigid parts of organisms
- _____ - used for electron transport

The _____ Cycle Is Earth's Largest Cycle
Carbon cycles through the Biosphere, Hydrosphere, Atmosphere and Geosphere



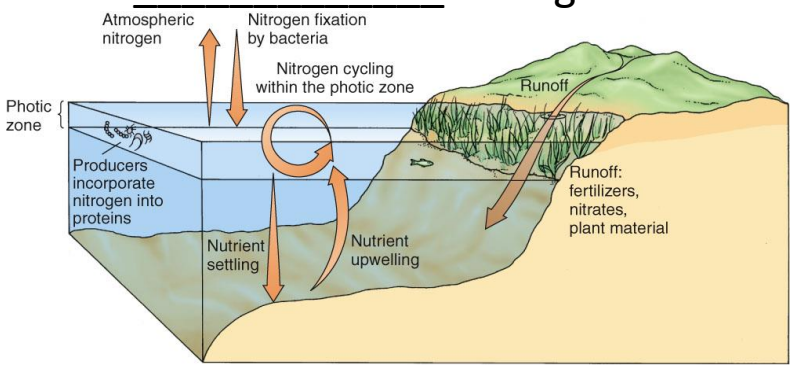
The Carbon Cycle in the Ocean.

_____dissolved in seawater is the _____ of the carbon atoms assembled into _____ (initially glucose) by _____. When this food is metabolized (_____), the carbon dioxide is _____ to the environment.

_____ Cycles through the Biosphere, Atmosphere, Hydrosphere and Geosphere

- Nitrogen fixed (combined with _____)
  - _____
  - _____
- Nitrification (N combined with _____)
- Denitrification (N _____ to _____)

Nitrogen Must Be "_____" to Be _____ to Organisms



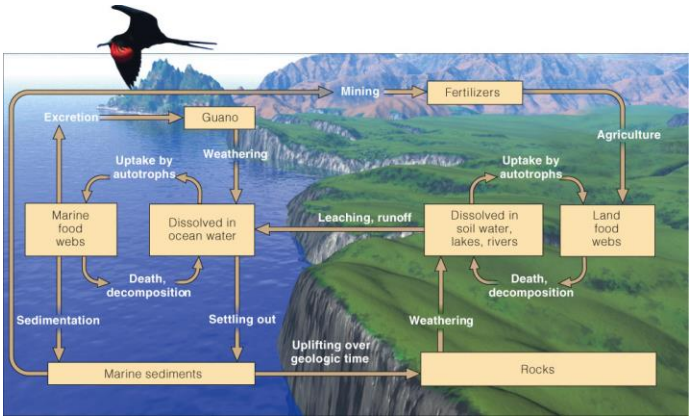
The Nitrogen Cycle in the Ocean.

Nitrogen is an _____ in the construction of _____ and nucleic acids (RNA, DNA). _____ and _____from the land bring useful nitrogen into the _____, where primary producers can incorporate it into essential molecules.

_____ Cycles through the Biosphere, Hydrosphere and Geosphere

- Cycles through _____, the earth's _____, and living _____
- _____ in the atmosphere!
- May be _____for plant _____.

Phosphorus Cycle in _____ Distinct Loops



The Phosphorus Cycle.

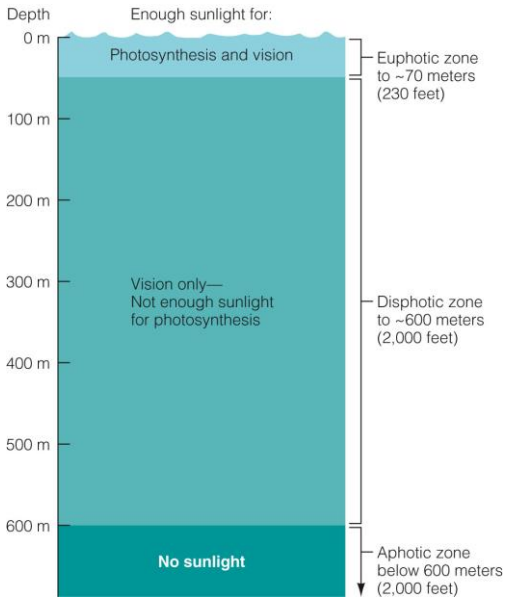
Phosphorus is an essential part of the _____compounds used by all of Earth's life-forms (e.g., _____). Note that it does _____ cycle through the _____.

Physical and **Biological Factors** Affect the Functions of an Organism

- A _____is a factor that can be _____ if present in quantities that are _____or _____.
  - Any factor required for life can become a **limiting factor** (ex: light, nitrogen, phosphorus).
- Any aspect of the **physical environment** that affects living organisms is a **_____.**
- What are the most important physical factors for marine organisms?
  - _____, _____, _____
  - _____, _____, _____

- **Biological factors** also affect _____in the ocean.
- Some **biological factors** that affect ocean organisms:
  - _____(and symbiotic relationships)
  - _____ (competition for space)
  - _____
  - _____
  - _____

Photosynthesis Depends on _____

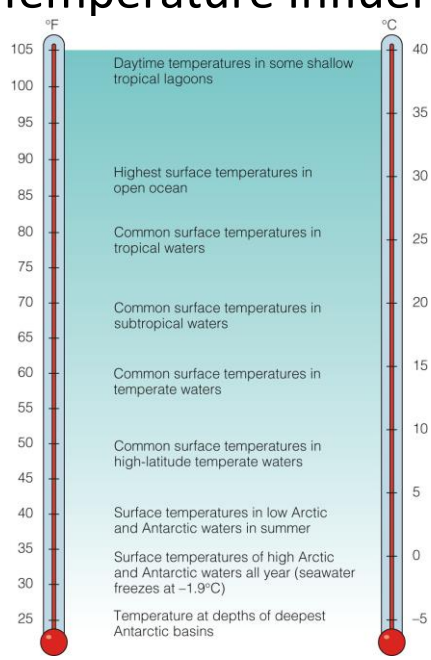


Most of the _____ _____of the ocean occurs in an area near the _____called the ***euphotic zone.***

Below the euphotic zone lies the _____.

Below the disphotic zone lies the _____ ***aphotic zone*** (where sunlight never reaches).

Temperature Influences _____



<- Temperatures of marine waters capable of supporting life.

Some isolated areas of the ocean, notably within and beneath hydrothermal vents, may support living organisms at temperatures of up to 400°C (750°F)!

Temperature and Metabolic Rate

- **Metabolic rate** (the rate at which _____ _____ reactions occur) increases with _____.
- **<u>Ectothermic animals</u>**:
  _____ temperature = _____ (most fish).
- **<u>Endothermic animals</u>**:
  "_____" with a stable, _____ _____ temperature (marine mammals, few fish).

Chemical Factors That Affect Marine Life

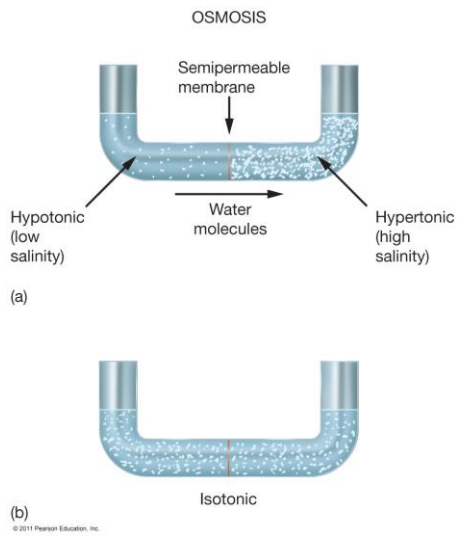
<u>Diffusion and Osmosis</u>

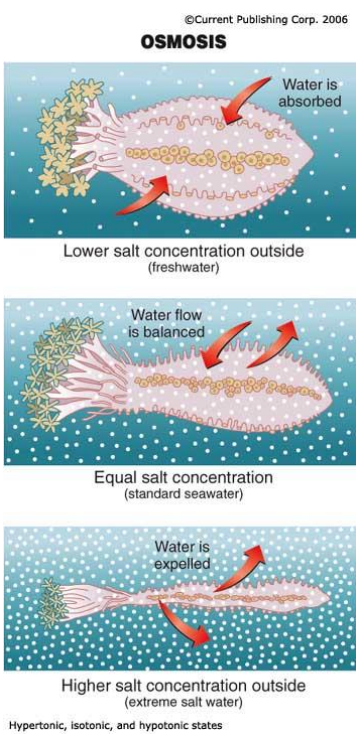
Diffusion is the tendency for a liquid, gas, or solute to _____from an area of _____ concentration ____ an area of _____ concentration.

Osmosis is _____ through a _____ (selective) cell membrane.

Osmosis

- _____ molecules move from ____ _____ to _____ concentrated solutions
- Osmotic pressure
  - High in more concentrated solutions
  - Prevents passage of water molecules
- _____ =
- _____ =
- _____ =



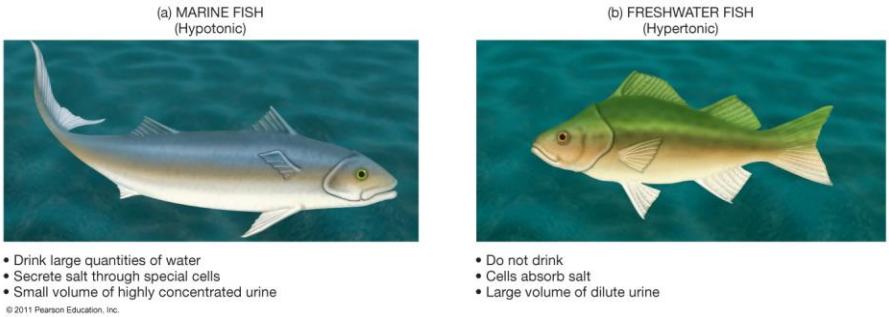


In _____, aquatic animals are **hypertonic** to their environment and water is _____.

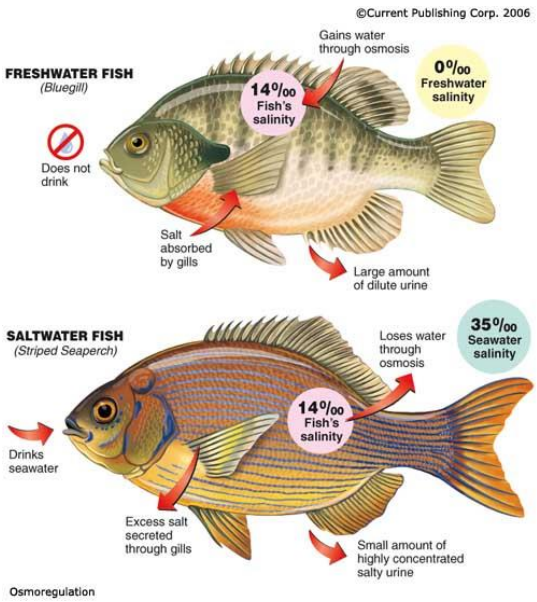
Isotonic is when aquatic animals have same salt concentration as their environment

In highly _____water, animals are **hypotonic** to their environment and water is _____, resulting in dehydration.

Marine vs. Freshwater Fish



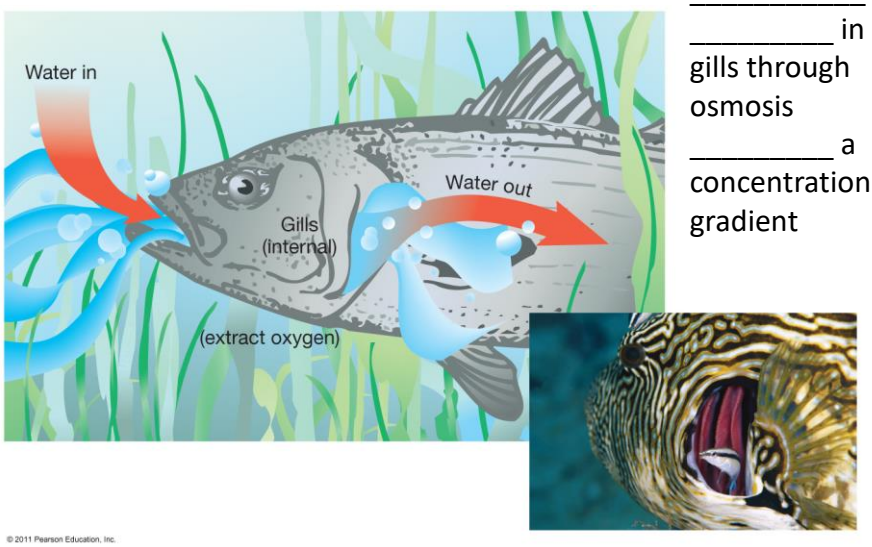
Do fish drink water?



Freshwater fish _____ water from their environment and do _____need to _____ water.

Saltwater fish _____ water to their environment and _____ _____ seawater and secrete salt through their gills.

Gills on Fish



_____ _____ in gills through osmosis

_____ a concentration gradient

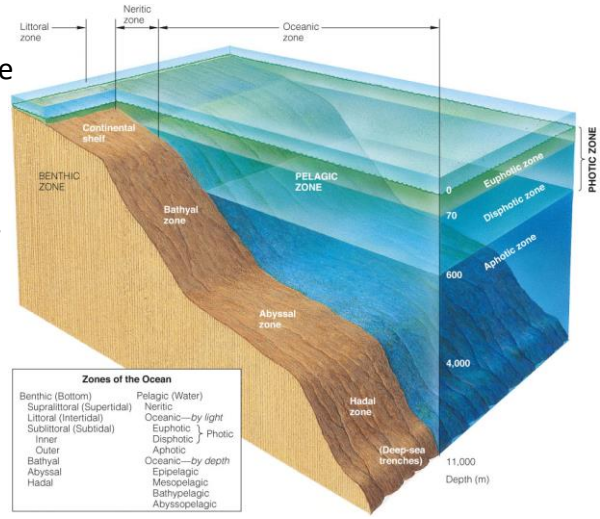
Ocean Zones and Lifestyles

- _____ most basic subdivisions:
- _____ _____ = water column between the bottom and the surface
- _____ _____ = ocean bottom

The Marine Environment Is Classified into Distinct Zones

Scientists divide the marine environment into **zones**, areas with _____ _____ features.

Zones are _____ by _____ and the _____ of the organisms found there.



The Pelagic Zone

_____ = continental shelf

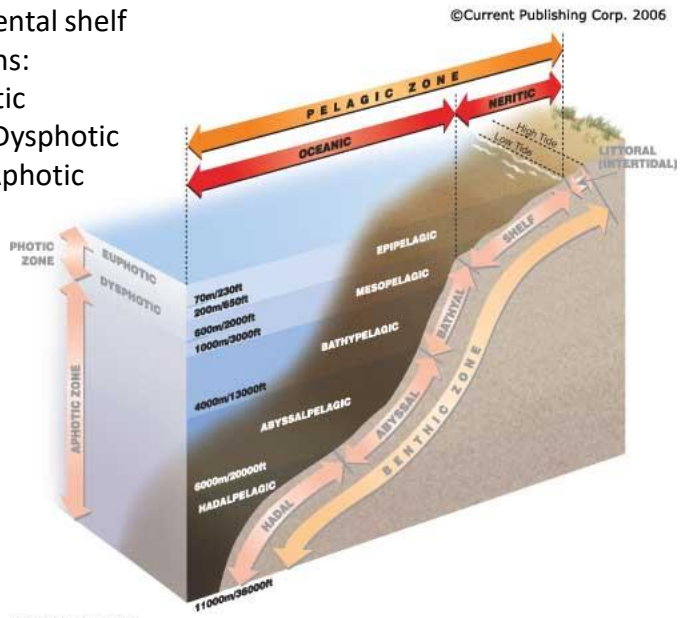
Oceanic subdivisions:

_____ ~ Euphotic

_____ ~ Dysphotic

_____~ Aphotic

(see next slide for definitions)



The pelagic zone

_____: upper, _____ (photic) region of the ocean; usually ca. 100-200 meters deep.

_____: region of _____ light (dysphotic), usually ca. 200-1000 meters deep.

_____: _____ (aphotic), ca. 1000-4000 meters deep

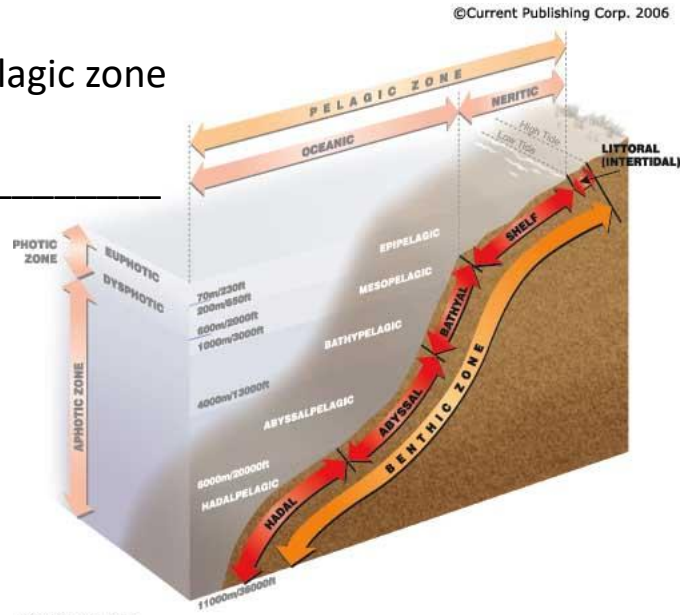
_____: very deep, near bottom zone, ca. 4000-6000 meters deep

Where is the benthic zone? At the _____

Under the pelagic zone

Littoral zone=

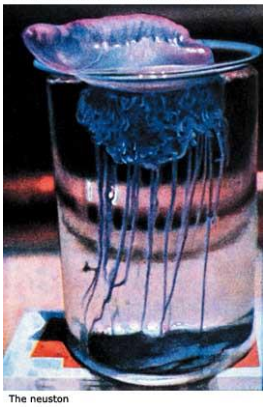
_____



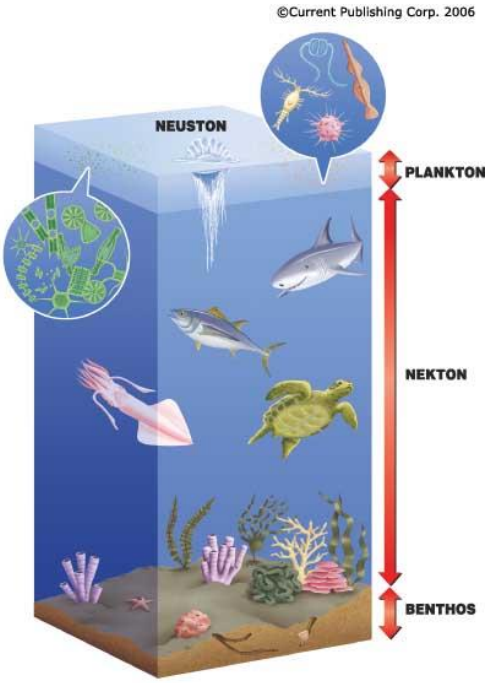
The benthic zone

Who lives where?

Archival Photography by Sean Linehan, NOS, NGS



The neuston

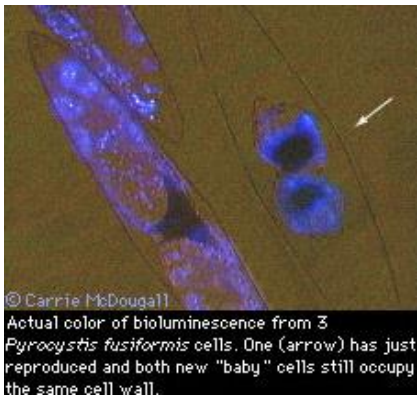


Marine lifestyles

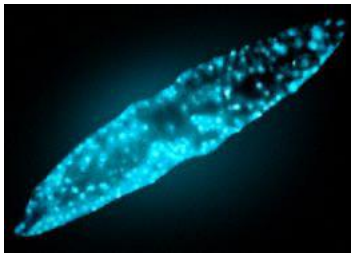
What are plankton, nekton and benthos?

- _____ (Greek *planktos* = wanderer) is a group of _____-like algae (_____) and _____ (_____) that exist adrift in the ocean currents. They cannot swim faster than the current!

Pyrocystis fusiformis



Actual color of bioluminescence from 3 *Pyrocystis fusiformis* cells. One (arrow) has just reproduced and both new "baby" cells still occupy the same cell wall.



More on biolumiscence later…

Examples of zooplankton…

- _____ (Greek *nekton* meaning *swimming)* are _____ from shrimps to whales, usually predators.

Anchovies

NURP

Vertebrate nekton

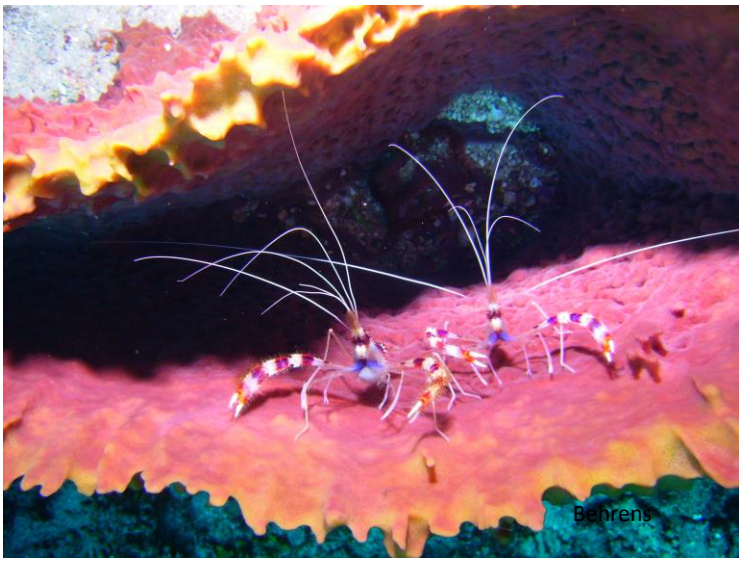
- _____ organisms live on the _____ (or in _____ and mud). For example starfish, sea urchins, clams…

http://www.smbaykeeper.org/images/site_images/Purple-sea-urchin.jpg

What am I?

What am I?

What am I?

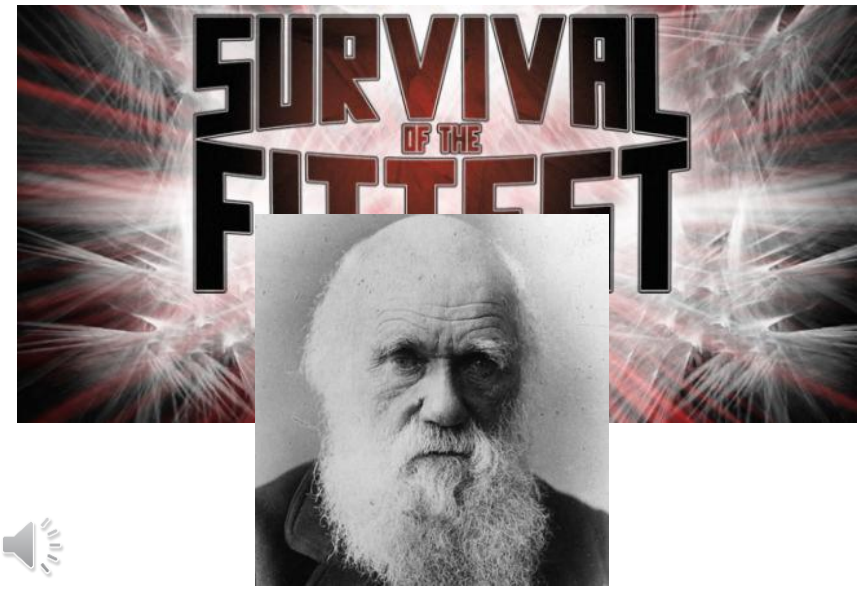


What am I?

What am I?

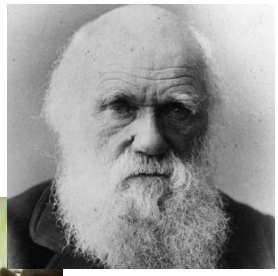
More plankton coming soon!

Variety of Life: Evolution Appears to Operate by Natural Selection

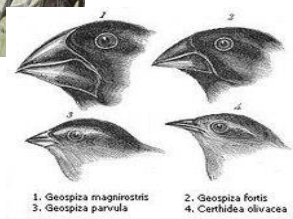


Variety of Life: Evolution Appears to _____ by _____

- Earth's organisms have changed, or evolved, over _____.
- _____ occurs _____ the process of _____ _____.
- The environment _____ _____ that are well _____. Their favorable traits are retained because they contribute to the organism's _____ _____.

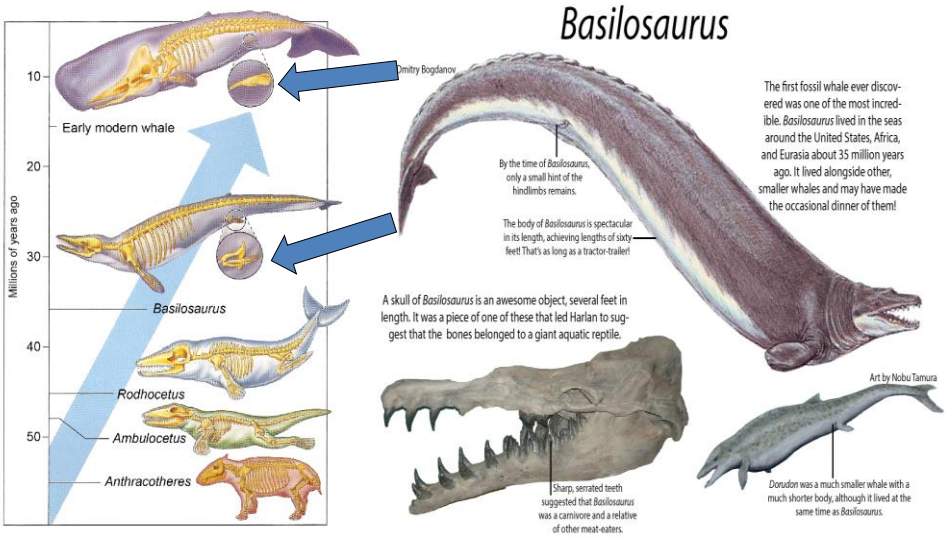


New Species evolve from new adaptive traits

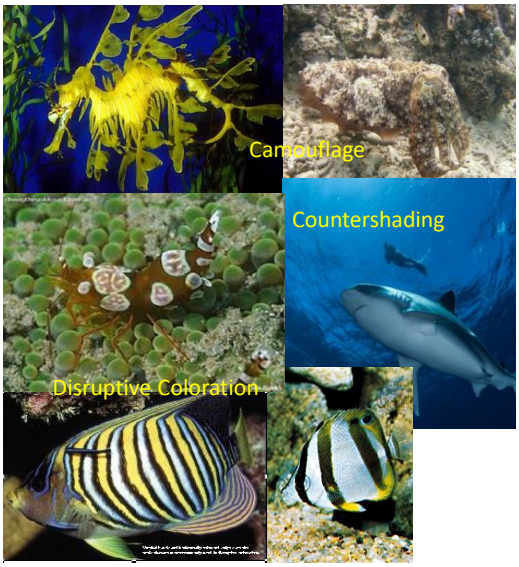


Finches from Galapagos Archipelago

Evolution of the Modern Whale (Mysticetes)



Types of Adaptations in the Marine Environment



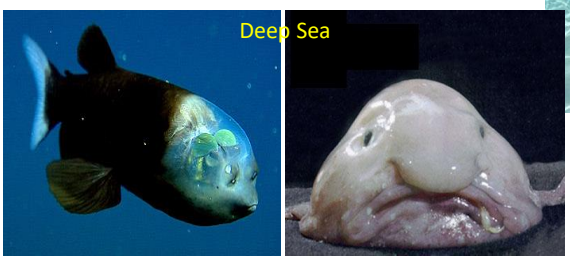
_____: organisms use body patterns, colors or body parts for concealment. Why adaptive?

_____: Organisms are dark on top, light on the bottom. Why adaptive?

_____: large bold patterns, contrasting colors make animal blend into background. Why adaptive?

Types of Adaptations in the Marine Environment

How has **Body Plan** adapted to the living space or Environment?



Barrelfish

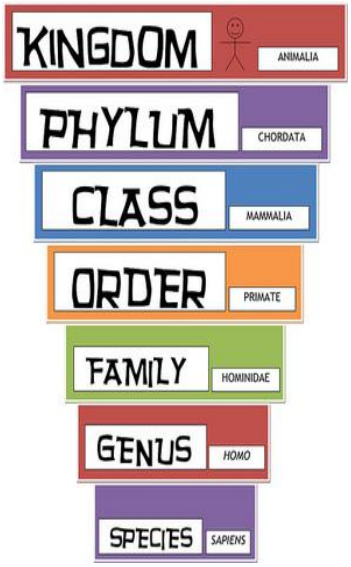
Blobfish

Types of Adaptations in the Marine Environment

- _____ _____: Advertise the organism as noxious or harmful to predators
- **Chemical** and **structural** ***defenses***
  - _____
  - _____

Classification of Organisms

- What were the contributions of _____ _____?
- He was one of the first to use a system of _____ _____
- He developed a classification system based on _____ **of related traits**
- He developed a system of _____ for organisms



Review of Classification

- Why do we need classification?
  - Identify _____ between organisms
  - Identify key _____ of organisms
  - Avoid _____

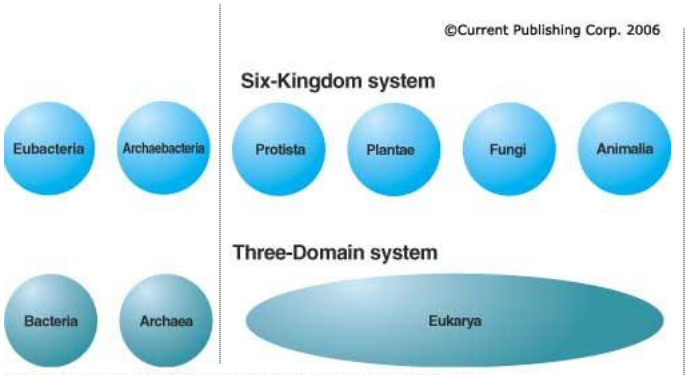
Budd Christman NOAA

Dolphin mammal

Bob Brown - fishdeco.com

Dolphin fish

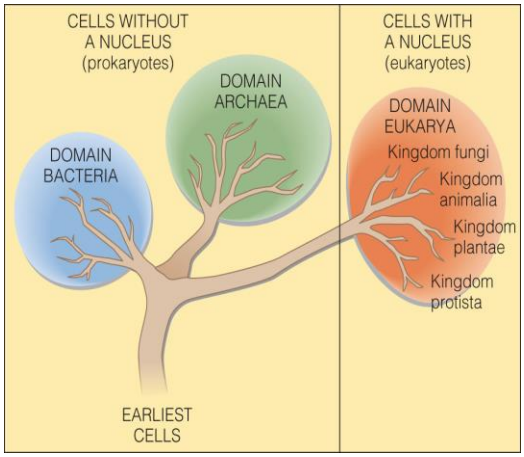
_____ Kingdoms and Three Domain Systems



Comparing the three-domain and six-kingdom system of classification

Systems of Classification May Be Artificial or Natural

Three Domain System

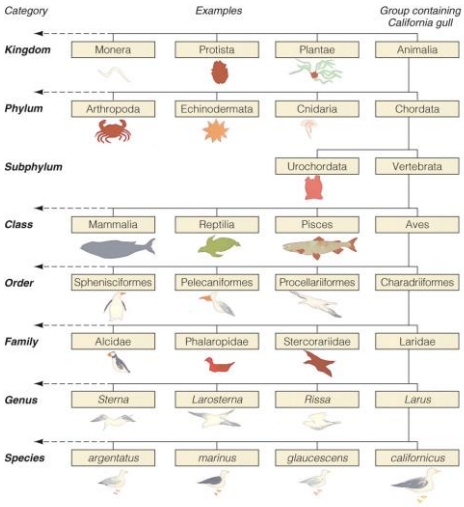


A family tree showing the relationship of **6 kingdoms** presumably evolved from a distant **common ancestor**.

_____: The Bacteria and Archaea contain single-celled organisms _____ _____ or organelles.

_____: The fungi, protists, animals, and plants contain organisms _____ cells having _____ and organelles; collectively, they are called eukaryotes.

Systems of Classification May Be Artificial or Natural



Hierarchy Classification of Six Kingdoms