

Deep Sea

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The Deep Sea

1. Extent of the Deep Sea
2. Conditions in the Deep Sea
 - A. Cold
 - B. High Pressure
 - C. Dark
 - D. Low Biomass
3. Hydrothermal Vents

1. Extent of the Deep Sea

- 75% of the ocean reaches depths >3000 m
 - Much is broad, flat, sediment covered
 - Abyssal plains separated by oceanic mountain ranges (ridges) and deep trenches
 - To 6000 m
 - Most extreme pressure environments on earth
 - One of the most inaccessible environments on earth
 - Expensive
 - Difficult to bring intact animals to surface
 - Difficult for humans to enter environment
 - Studies of deep sea habitats fragmentary
- ** deep sea is about 4000 m

1. Conditions in the Deep Sea

- Conditions are extreme but relatively constant:
 - A. High Pressure
 - 300-600 atm
 - B. Cold
 - ~ 2° C below 3000 m
 - C. Dark
 - Specialized eyes
 - Many bioluminescent animals
 - D. Low Biomass (= little food)

How do deep sea organisms deal with these extreme conditions?

A and B High Pressure & Cold

- Enzymes of closely related deep and shallow water spp differ

- **Enzymes** operate optimally within a range of temperatures
- **Enzymes** of deep - sea organisms most efficient at catalyzing reactions at low temps
- **Phospholipids (PL) in cell membranes of deep and shallow water animals differ**
- Phospholipids must remain fluid for proper cell function
- High pressure/ cold temp reduces fluidity
- Cell membranes PL of deep- sea animals are unsaturated - contain double bonds
- Kinky PL with double bonds cannot be packed together as tightly as PL with no double bonds - saturated
- Kinky PL with double bonds respond differently to temp than PL with no double bonds - saturated
- Fluidity of cell membranes maintained under high/low temp
- Deep- Sea and polar fishes = very unsaturated and Antarctic spp because it is cold
- **Unsaturation = contains double bonds**

A. Dark

- **Bioluminescence** - already looked at
- **Eyes of deep- sea animals are specialized**
 - **Size**
 - Often larger
 - Permit more light to retina
 - **Rods**
 - More rods- as many as 6 layers vs 1 or 2 in shallow animals
 - Closely packed
 - **Sensitivity to light**
 - More sensitive eyes
 - Detect light levels 100x lower than humans
 - **Pigments**
 - **Tapetum lucidum**

Pigments

- Retinas of deep water animals contains different types of pigments than retinas of shallow water animals
- Deep sea eyes most sensitive to light of **480 nm** wavelength (blue light)
- Shallow organisms most sensitive to light of 520 nm wavelength

Tapetum lucidum

- Guanine layer behind retina
- Reflects light back through photoreceptors a 2nd time
- Shutter system opens and closes exposing guanine
- Activated at night in shallow animals
- Constantly functioning in deep water fish

No sunlight, no photosynthesis

What is the source of energy in deep sea?

Energy comes from above

- Small % of surface production reaches depths
- Dead phytoplankton, zooplankton, crustaceans from above
- Some only available after bacterial breakdown

A. Low Biomass

- Majority of benthic feeders are deposit feeders
 - Engulf sediment and extract bacteria and dead organic matter
- Low Biomass, but fairly diverse communities
- Reproduction
 - Few planktonic larvae- little chance of reaching photic zone
 - Tendency towards few, large eggs
- Shift in common spp
 - Polychaete & other worms, echinoderms (sea cucumbers), crustaceans (isopods, amphipods)
 - Decreased abundance of seastars, bivalves and other mollusks
- Less energy available for consumption means:
- Less energy for **metabolism**
 - Consequences : lower metabolic rate in deep sea animals
- Less energy for **growth**
 - Consequences: slower growth and smaller size in deep sea
 - Small = vulnerable to predation
 - How do you get big with little energy for growth?
 - Reduce energy/ unit volume
 - Increase low energy matter (water)
 - Decrease high energy matter (muscle)
 - Many deep- sea animals are soft and flabby
- Less energy for **locomotion**
 - Consequences : less energy for locomotion in deep sea
 - Can reduce energy for locomotion with **increased buoyancy**

Density (g/cm³)

- Animals that are more dense than SW have to swim (expend energy) to maintain position in water column (avoid sinking)
- Decreased density (increased buoyancy) allows animals to maintain position in water column using less energy
- When density (ρ) of an animal = ρ SW the animal is **neutrally buoyant**
- Many deep - sea animals are neutrally buoyant - selection pressure
- Approaches to reducing density (increasing buoyancy):
 1. **Reduce dense matter**
 - Skeleton, muscle, skin
 2. **Increase light matter**
 - Gas, lipid, water

** Lipids, ovary, water = light matter

Density of sea water = 1.027 g/cm³)

Organs, skin, muscle, skeleton = dense matter

The density of an animal

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1. **Reduce dense matter**
 - Reduce **heavy ions** (Mg, SO₄)