The Deep Sea
Chapter Four

The Deep Sea

- The deep sea is the part of the marine environment that lies below the level of effective _____ penetration for phytoplankton photosynthesis in the open ocean and deeper than the depth of the continental shelves (>200m).

The Oceanic Zone (review from chapter one)

- Divisions of the oceanic zone:
  - epipelagic: 0 - 200 m in depth, this the _____ zone (lighted)
  - mesopelagic: 200 - 1,000 m in depth, lower boundary in the tropics is the 10^{o}C isotherm
  - bathypelagic: 2,000 - 4,000 m in depth, 10^{o}C to 4^{o}C (benthic zone is the bathyal zone)
  - _____: 4,000 m to 6,000 m, overlying the plains of the major ocean basins (benthic zone is the abyssal zone)
  - hadalpelagic: 6,000 - 10,000 m in depth, includes the open water of the deep oceanic trenches (benthic zone is the hadal zone)

Light & Salinity

- Except in the upper limits of the mesopelagic zone, no light penetrates into the deep ocean. This lightless area is called the _____ zone.
- _____ is relatively constant below the first few hundred meters.

Pressure

- In the ocean, pressure increases 1 atmosphere for each _____ in depth. In the ocean, pressure increases 1 atmosphere for each 10 m in depth. This leads to a pressure of more than 1,000 atm in the Mariana Trench. Organisms that live under great pressure employ a number of adaptations. Organisms that live under great pressure employ a number of adaptations:
  - lack of air-filled organs
  - lower _____ rates
  - homeoviscous adaptation: incorporation of more fluid lipids into cell membranes to help in membrane transport
  - decreased _____-forming (calcium carbonate is more soluble under pressure)

Temperature

- The greatest and most rapid changes in temperature occur where the surface waters meet the deep waters (the _____) and where hydrothermal vents emit hot water.
  - Thermoclines vary in thickness, and are strongest in the tropics.
  - _____ vents emit water as high as 400^{o}C

Oxygen

- Virtually all the water of the deep sea has its origin at the surface in the Arctic or Antarctic seas. Here, the oxygen-rich cold water sinks and flows north or south to make up the deep water of the world's ocean.
- At a depth of 500 to 1,000 meters, the oxygen minimum zone is found. This is an area of lower oxygen levels, caused by _____ of organisms coupled with the lack of _____ that occurs at the surface.

Food

- The deep sea is removed from the photosynthetic zone and has no _____ production except for the chemosynthesis that occurs at hydrothermal vents. Food is therefore a scarce resource, originating primarily from organic material that falls down through the deep sea.

Anatomical Differences in Mesopelagic and Bathypelagic Fishes

- Mesopelagic Fishes
  - color: silver
  - _____: many
  - jaws: short
  - eyes: large
  - swim bladder: present
  - heart: large
  - gills: many _____
- Bathypelagic Fishes
  - color: black
  - photophores: few
  - jaws: long
  - eyes: small
  - _____ _____: absent
  - heart: small
  - gills: few filaments

Biological Characteristics of Deep-Sea Organisms

- Ecological
  - low mortality due to low _____ pressure
  - slow, indeterminate growth
  - low population densities
- Reproduction and Development
  - few eggs, large, yolk-rich
  - late _____ maturity
  - slow embryological development
  - breed usually once (semelparous)
- Physiological
  - low _____ rate
  - high water content
  - small size

Abyssal Plain

- The Abyssal Plain is the largest ocean ecosystem. This flat, _____ covered area is rich in organic material that has floated down from above as marine snow. The abyssal plain is dominated by _____ and arthropods, which scour the ocean floor for detritus.

Mid-Ocean Ridge

- The Mid-Ocean Ridge system is the largest mountain chain on Earth. They are geologically important because they occur at _____ plate boundaries where new ocean floor is created through volcanic activity. This volcanic activity also gives rise to another important ecosystem, the hydrothermal vent.

Hydrothermal Vents

- All vent systems depend on the primary productivity of _____ (chemosynthetic) bacteria that form organic compounds from hydrogen sulfide (H_2S). Organisms of the hydrothermal vent are adapted to high water temperature, and typically have short life spans.

Methane Seep

- Methane Seeps are the cold water cousins of the hydrothermal vent. The base of the food chain is also dependant on chemosynthesis, but the bacteria are feeding on _____ instead of H_2S. Due to the colder temperatures, organisms here are often long lived. _____ worms at a methane seep can live several hundred years, compared to those at hydrothermal vents that may live only a few years.