1 **CHAPTER 12**

Marine Life and the Marine Environment

2 **Chapter summary in haiku form**

Crucible of life?
Where did it all get started?
“Primordial soup”

3 **Chapter Overview**

- Living organisms, including marine species, are classified by characteristics.
- Marine organisms are adapted to the ocean’s physical properties.
- The marine environment has distinct divisions.

4 **Classification of Life**

- Classification based on physical characteristics
- DNA sequencing allows genetic comparison.
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5 **Classification of Life**

- Living and nonliving things made of atoms
- Life consumes energy from environment.
- NASA’s definition encompasses potential for extraterrestrial life.
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6 **Classification of Life**

- Working definition of life
- Living things can
  - Capture, store, and transmit energy
  - Reproduce
  - Adapt to environment
  - Change over time
  -

7 **Classification of Life**

- Three domains or superkingdoms
- Bacteria – simple life forms without nuclei
- Archaea – simple, microscopic creatures
- Eukarya – complex, multicellular organisms
  - Plants and animals
  - DNA in discrete nucleus

8 **Classification of Living Organisms**

- Five kingdoms
  - Monera
  - Protoctista
  - Fungi
  - Plantae
  - Animalia
-

9 **Five Kingdoms of Organisms**

- Monera
  - Simplest organisms, single-celled
  - Cyanobacteria, heterotrophic bacteria, archaea
- Protoctista
  - Single- and multicelled with nucleus
  - Algae, protozoa
- Fungi

- Mold, lichen
-

10 **Five Kingdoms of Organisms**
- Plantae
  - Multicelled photosynthetic plants
  - Surf grass, eelgrass, mangrove, marsh grasses
- Animalia
  - Multicelled animals
  - Range from simple sponges to complex vertebrates
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11 **Taxonomic Classification**
- Carolus Linnaeus – 1758
  - Developed basis of modern classification of organisms
- Taxonomy – systematic classification of organisms
  - Physical characteristics
  - Genetic information

12 **Taxonomy**
- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species
  - Fundamental unit
  - Population of genetically similar, interbreeding individuals
  -
-

13 **Taxonomic Classification**

14 **Classification of Marine Organisms**
- Plankton (floaters)
- Nekton (swimmers)
- Benthos (bottom dwellers)
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15 **Types of Plankton**
- Most biomass on Earth consists of plankton.
- Phytoplankton
  - Autotrophic – can photosynthesize and produce own food
- Zooplankton
  - Heterotrophic – relies on food produced by others
-

16 **Other Types of Plankton**
- Bacterioplankton
  - Very small
  - At least half the ocean's photosynthetic biomass
  - Likely most abundant photosynthetic organism
- Virioplankton
  - Smaller than bacterioplankton
  - Not well understood, may limit abundance of other plankton through infection
- Holoplankton
  - Entire lives as plankton
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17 **Other Types of Plankton**

- Meroplankton
  - Part of lives as plankton
  - Juvenile or larval stages
- Macroplankton
  - Large floaters such as jellyfish or *Sargassum*
- Picoplankton
  - Very small floaters such as bacterioplankton
-

18 **Life Cycle of a Squid**

19 **Nekton**

- Independent swimmers
- Most adult fish and squid
- Marine mammals
- Marine reptiles

20 **Nekton**

21 **Benthos – Bottom Dwellers**

- Epifauna live on the surface of the sea floor.
- Infauna live buried in sediments.
- Nektobenthos swim or crawl through water above the seafloor.
- Benthos are most abundant in shallower water.
- Many live in perpetual darkness, coldness, and stillness.
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22 **Benthos**

23 **Hydrothermal Vent Communities**

- Abundant and large deep-ocean benthos
- Discovered in 1977
- Associated with hot vents
- Bacteria-like archaeon produce food using heat and chemicals.
-

24 **Number of Marine Species**

- Total cataloged species on Earth about 1.8 million
- Many marine species not yet identified due to exploration difficulties
- As many as 2000 new marine and terrestrial species discovered each year

25 **Number of Marine Species**

- More land species than marine species
- Ocean has relatively uniform conditions
- Less adaptation required, less speciation
- Marine species overwhelmingly benthic (98%) rather than pelagic (2%)
-

26 **Number of Marine Species**

- Census of Marine Life (CoML) -- $650 million 10 year program completed in 2010
- Discovered at least 1200 new marine species including yeti crab
- Assessed diversity, distribution, and abundance of marine organisms

27 **Number of Marine Species**

- Currently 250,000 documented marine species

28 **Adaptations of Marine Organisms**

- The marine environment is more stable than land.
- Organisms in the ocean are less able to withstand environmental changes.

29 **Adaptations of Marine Organisms**

- Protoplasm – substance of living matter
  - More than 80% of mass is water

- Marine animals do not risk desiccation.

30 **Adaptations of Marine Organisms**

- Physical support
  - Buoyancy
  - How to resist sinking
  - Different support structures in cold (fewer) rather than warm (more appendages) seawater
    - Changes in water viscosity with temperature
  - Smaller size
-

31 **Adaptations of Marine Organisms**

- High surface area to volume ratio
- Cube a – greater resistance to sinking per unit of mass than cube c
- Phytoplankton benefit from being small

32 **Adaptations of Marine Organisms**

- Unusual appendages to increase surface area
- Oil in micro-organisms to increase buoyancy
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33 **Viscosity and Streamlining Adaptations**

- Streamlining important for larger organisms
  - Shape offers least resistance to fluid flow
- Flattened body
- Tapering back end
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34 **Reproduction**

- Broadcast spawning – eggs and sperm directly released into seawater
- Marine organisms take advantage of water's high viscosity to enhance reproduction chances

35 **Temperature and Marine Life**

- Narrow range of temperature in oceans
- Smaller variations (daily, seasonally, annually)
- Deep ocean is nearly isothermal
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36 **Comparison of Ocean and Land Temperatures**

37 **Ocean Temperature**

- More stable than land for four reasons
  - Higher heat capacity of water
  - Ocean warming reduced by evaporation
  - Solar radiation penetrates deeply into ocean layers
  - Ocean mixing

38 **Cold vs. Warm Water Species**

- Floating orgsnisms smaller in warmer seawater
- More appendages in warmer seawater
- Tropical organisms grow faster, live shorter, reproduce more often
- More species in warmer seawater
- More biomass in cooler seawater (upwelling)
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39 **Temperature and Marine Organisms**

- Stenothermal
  - Organisms withstand small variation in temperature
  - Typically live in open ocean
- Eurythermal

  - Organisms withstand large variation in temperature
  - Typically live in coastal waters
-

40 **Salinity and Marine Organisms**
- Stenohaline
  - Organisms withstand only small variation in salinity
  - Typically live in open ocean
- Euryhaline
  - Organisms withstand large variation in salinity
  - Typically live in coastal waters, e.g., estuaries
-

41 **Salinity Adaptations**
- Extracting minerals from seawater
- High concentration to low concentration
  - Diffusion
  - Cell membrane permeable to nutrients, for example
  - Waste passes from cell to ocean
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42 **Diffusion**

43 **Osmosis**
- Water molecules move from less concentrated to more concentrated solutions
- Osmotic pressure
  - In more concentrated solutions
  - Prevents passage of water molecules

44 **Osmosis**
- Isotonic – organism's body fluid salinity same as ocean
- Hypertonic – seawater has lower salinity than organism's fluids
- Hypotonic – organism's fluids have lower salinity than ocean
-

45 **Marine vs. Freshwater Fish**

46 **Dissolved Gases**
- Animals extract dissolved oxygen (O_2) from seawater through gills.
- Gills exchange oxygen and carbon dioxide directly with seawater.
- Low marine oxygen levels can kill fish.
- Gill structure and location varies among animals.

47 **Gills on Fish**

48 **Water's Transparency**
- Many marine organisms see well.
- Some marine organisms are nearly transparent.
  - Elude predators
  - Stalk prey
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49 **Adaptations to Marine Environment**
- Camouflage through color patterns
- Countershading – dark on top, light on bottom
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50 **Camouflage and Countershading**

51 **Camouflage and Countershading**

52 **Deep Scattering Layer**
- Daily migration of many marine organisms to deeper, darker parts of ocean
- Dense concentration of organisms creates "false bottom" recorded on sonar readings
- Protection from predators

- Causes increased vertical mixing of ocean waters

53 **Deep Scattering Layer**

54 **Disruptive Coloration**

- Large, bold patterns, contrasting colors make animal blend into background
-

55 **Water Pressure**

- Increases about 1 atmosphere (1 kg/cm^2) with every 10 meters (33 feet) deeper
- Many marine organisms – no inner air pockets
- Collapsible rib cage (e.g., sperm whale)
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56 **Water Pressure**

- Many fish have swim bladder
  - Adjusts buoyancy and allows fish to regulate depth

57 **Divisions of the Marine Environment**

- Pelagic (open sea)
  - Neritic (< 200 meters) and oceanic
- Benthic (sea floor)
  - Subneritic and suboceanic

58 **Pelagic Environment**

- Divided into biozones
- Neritic Province – from shore seaward, all water < 200 meters deep
- Oceanic Province – depth increases beyond 200 meters

59 **Oceanic Province**

- Epipelagic
  - Only zone to support photosynthesis
  - Dissolved oxygen decreases around 200 meters
- Mesopelagic
  - Organisms capable of bioluminescence common
  - Contains dissolved oxygen minimum layer (OML)
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60 **Ocean Province**

- Bathypelagic and abyssopelagic zones – 75% of living space in oceanic province
- Bioluminescence common in mesopelagic and deeper
  - Ability to biologically produce light
- Detritus feeding shrimp – predators at depth

61 **Ocean Zones Based on Light Availability**

- Euphotic – surface to where enough light exists to support photosynthesis
- Disphotic – small but measurable quantities of light
- Aphotic – no light

62 **Benthic Environments**

63 **Benthic Environments**

- Supralittoral – transition from land to sea floor above spring high tide line; spray zone
- Subneritic – spring high tide shoreline to 200 m, about ½ the continental shelf
  - Littoral – intertidal zone
  - Sublittoral – shallow subtidal zone
    - Inner – extends to depth where marine algae no longer grow atttached to ocean bottom
    - Outer – inner sublittoral to shelf break or 200 m

64 **Suboceanic Province**

- Bathyal – continental slope
- Abyssal
  - More than 80% of benthic environment

  - Animal tracks in abyssal clay
- Hadal
  - Below 6000 m
  - Only deep trenches on continental margins
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65 **End of Chapter**