

Marine and Aquatic Science I & II

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1 Water Properties and Quality MAQ.1

Conceptual Understanding: Water is essential to all life on Earth. The chemical and physical properties of water allow for all essential processes with biota. Analysis of water quality indicates ecosystem health and balance. Recycling water throughout the biosphere allows for replenishment of fresh water, but contaminations by human activities are hindering the total amount of potable fresh water.

- A Students will develop an understanding of the unique physical and chemical properties of water and how those properties shape life on Earth. MAQ.1A
- 1 Characterize the physical and chemical properties of water, including specific heat, surface temperature, universal solvent, and hydrogen bonding between water molecules (i.e., cohesion/adhesion/capillary action). MAQ.1A.1
 - 2 Describe the role of water within biological systems (e.g., provides the medium necessary to allow for life processes such as protein synthesis, enzymatic reactions, and passive transport). MAQ.1A.2
 - 3 Diagram, utilizing digital or physical models, the water cycle and how it relates to the total amount of fresh water available to living things at any given time. MAQ.1A.3
 - 4 Collect, analyze, and communicate quantitative data that includes dissolved oxygen, pH, temperature, salinity, mineral content, nitrogen compounds, and turbidity from an aquatic environment (i.e., hydrometer, refractometer, Secchi disk, and chemical test kits). MAQ.1A.4
 - 5 Research, analyze, and communicate current technology and career opportunities available to collect this data on a global scale using CTD, buoy data, or satellites. MAQ.1A.5
 - 6 Enrichment: Use an engineering design process to reduce the effects of pollution in aquatic ecosystems (e.g., microplastics, garbage patches, oil spills, and eutrophication). Students will design a proposed solution based on current research and/or observations and develop a model to test their design. Data from experimentation will be analyzed, organized graphically, and communicated to classmates to determine the effectiveness of the proposed solution. * MAQ.1A.6

2 Fluid Dynamics MAQ.2

Conceptual Understanding: Fluid dynamics include properties and features of waves, currents, and tides. Each of these is vital for uniformity of temperature and chemical balance within ecosystems. Physical changes can be attributed to the movement of water, including shoreline development, erosion, and island formation. Climate change is influencing changes in our present fluid dynamic models.

A Students will develop an understanding of the principles of fluid dynamics as it relates to both salt and freshwater systems. **MAQ . 2A**

- 1** Characterize wave features and wave properties, including wavelength, period, wave speed, breakers, and constructive waves and their effects on shoreline communities (e.g., headlands, embayments, shoreline erosion, and deposition). **MAQ . 2A . 1**
- 2** Survey predictable patterns of tides (i.e., tidal period and range, diurnal, semidiurnal, mixed, spring, and neap tides) to correlate with moon phases in graphical form. **MAQ . 2A . 2**
- 3** Summarize principles related to currents (e.g., global wind patterns, Coriolis effect, Ekman spiral, surface, thermohaline, upwelling, downwelling, El Niño, La Niña, hurricanes, Barrier Island movement). **MAQ . 2A . 3**
- 4** Research, analyze, and communicate scientific arguments to support climate models that predict how global and regional climate change can affect Earth's systems (e.g., precipitation and temperature and their associated impacts on sea level, global ice volumes, and atmosphere and ocean composition). **MAQ . 2A . 4**
- 5** Distinguish between lentic and lotic water systems, including water flow, seasonal overturn, and watershed mapping. **MAQ . 2A . 5**

3 Geological Features **MAQ . 3**

Conceptual Understanding: Plate tectonics explain present geological features that can be described in different aquatic ecosystems. Natural phenomena, such as sea floor spreading, are caused by plate tectonic action. The distance from shoreline and availability of light classifies different areas of the ocean.

A Students will understand the principles of plate tectonics, sea floor spreading, and physical features of oceanic zones. **MAQ . 3A**

- 1** Use geospatial data to analyze, explain, and communicate differences among the major geological features of specific aquatic ecosystems (e.g., plate tectonics, continental rise, continental slope, abyssal plain, trenches, sea mounts, island formation, and watersheds). **MAQ . 3A . 1**
- 2** Develop an understanding of plate tectonics to predict certain geological features (e.g., sea floor spreading, paleomagnetic measurements, and orogenesis). **MAQ . 3A . 2**
- 3** Classify zones of the ocean based on distance from shorelines (i.e., intertidal, neritic, oceanic, and benthic zones), temperature, and light availability (i.e., epipelagic, mesopelagic, bathypelagic, abyssopelagic, and hadopelagic). **MAQ . 3A . 3**
- 4** Classify zones of freshwater sources based on the velocity of current, depth, and temperature. **MAQ . 3A . 4**

4 Flora and Fauna **MAQ . 4**

Conceptual Understanding: Unique flora and fauna can be found in different aquatic ecosystems. Their features and unique biochemistry may serve to further the human quality of life. However, human impacts and natural events have altered many of these ecosystems in different ways.

A Students will examine characteristics of specific aquatic ecosystems and the effects of human and natural phenomena on those ecosystems. **MAQ . 4A**

- 1** Compare and contrast the unique biotic and abiotic characteristics of the following selected aquatic ecosystems: intertidal zone, wetlands/estuaries, coral reef, barrier islands, continental slope/shelf, abyss, rivers/streams/watersheds, and lakes/ponds. **MAQ . 4A . 1**
- 2** Recognize representative examples of plants and animals that would be specifically adapted to the aquatic ecosystems and identify adaptations necessary to survive. **MAQ . 4A . 2**
- 3** Determine the niches within trophic levels in the aquatic ecosystems by creating food webs and researching the symbiotic relationships that exist. **MAQ . 4A . 3**
- 4** Research, analyze, and communicate the effects of urbanization and continued expansion by humans on the aquatic ecosystems' biodiversity (e.g., land use changes, erosion and sedimentation, over-fishing, invasive/exotic species, and pollution). **MAQ . 4A . 4**
- 5** Explore the importance of species diversity to the biological resources needed by human populations, including food (e.g., aquaculture and mariculture), medicine, and natural aesthetics. **MAQ . 4A . 5**
- 6** Research, analyze, and communicate the effects of natural phenomena (e.g., hurricanes, floods, drought, and sea-level rise) on the aquatic ecosystems. **MAQ . 4A . 6**
- 7** Research, analyze, and communicate which and in what capacity local, state, and federal regulatory agencies are involved in different aquatic ecosystems, including current environmental policies already in place (e.g., the Clean Water Act and the Endangered Species Act). Research should include, but is not limited to, how humans can preserve animal diversity using habitat creation and conservation, research, legislation, medical and breeding programs, and management of genetic diversity at local and global levels. **MAQ . 4A . 7**
- 8** Enrichment: Choose an environmental issue that currently exists in one of the aquatic ecosystems and use an engineering design process to propose and develop a solution using scientific knowledge and best management practices (BMPs). Create an environmental action plan to include moral, legal, societal, political, and economic decisions that impact animal diversity in both the short and long term. Results from developed plans will be communicated with classmates. * **MAQ . 4A . 8**

Conceptual Understanding: Primary producers are the basis of every food web in aquatic ecosystems. While many producers are photosynthetic autotrophs, chemosynthesis is also a common form of energy conversion. Surveying shared and derived characteristics of producers demonstrates evolutionary development. Various methods are currently utilized to measure primary productivity in various ecosystems.

A Students will explore the biodiversity and interactions among aquatic life. **MAQ.5A**

- 1** Survey common primary producers and their roles in primary production in relation to geographical distribution within various aquatic ecosystems. **MAQ.5A.1**
- 2** List and describe common autotrophs that may be found in particular aquatic ecosystems, including prokaryotes (e.g., Cyanobacteria and Archaeobacteria), protists (e.g., diatoms, dinoflagellates, green algae, kelp, sargassum, and red algae), and plants (e.g., cord grasses, reeds, seagrasses, and mangroves). **MAQ.5A.2**
- 3** Recognize characteristics that are shared and derived using graphical representations of primary-producer evolution and develop cladograms/phylogenetic trees. **MAQ.5A.3**
- 4** Use dichotomous keys to identify sample producers within an aquatic ecosystem. **MAQ.5A.4**
- 5** Paraphrase energy conversion processes (e.g., photosynthesis and chemosynthesis). **MAQ.5A.5**
- 6** Enrichment: Research, analyze, and communicate historical and current methodologies for measuring primary productivity. Use an engineering design process to design and develop improvements to measure primary productivity (e.g., the light and dark bottle method and satellite data).

* **MAQ.5A.6**

6 Invertebrate Consumers **MAQ.6**

Conceptual Understanding: Many consumers found within aquatic ecosystems range from single-celled protozoa to multicellular invertebrates. While many of these consumers share basic morphological characteristics, derived characters demonstrate evolutionary relationships. Varied adaptations are found among these organisms for successful niches within selected ecosystems.

A Students will investigate characteristics of aquatic invertebrates. **MAQ . 6A**

- 1** Characterize aquatic representatives of the following taxa: Protozoa (e.g., foraminiferans, radiolarians, amoeba, and paramecium), Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Rotifera, Mollusca, Arthropoda, Bryozoa, Brachiopoda, and Echinodermata. **MAQ . 6A . 1**
- 2** Identify characteristics that are shared and derived using graphical representations of animal evolution (i.e., cladograms and phylogenetic trees) and develop cladograms and phylogenetic trees. **MAQ . 6A . 2**
- 3** Develop a dichotomous classification key to be used in the identification of sample aquatic invertebrates. **MAQ . 6A . 3**
- 4** Compare and contrast major body plans (e.g., asymmetry, radial, bilateral symmetry, acoelomate, pseudocoelomate, and eucoelomate). **MAQ . 6A . 4**
- 5** Explain various life cycles found among animals (e.g., polyp and medusa in cnidarians, multiple hosts and stages in the platyhelminthic life cycle, and arthropod metamorphosis). **MAQ . 6A . 5**
- 6** Dissect representative taxa (e.g., clam and squid), collect data, compare their internal and external anatomy, analyze, explain, and communicate results. **MAQ . 6A . 6**
- 7** Using key morphological and physiological adaptations found within animal taxa, assess how animals interact with their environment to determine their ecological roles. **MAQ . 6A . 7**
- 8** Enrichment: Given a niche in a specific environment, use an engineering design process to design an animal, listing characteristics based on your knowledge of shared and derived characters, internal and external anatomy, and how the animal would adapt morphologically and physiologically relative to its ecological role and specific environment. * **MAQ . 6A . 8**

7 Vertebrate Consumers **MAQ . 7**

Conceptual Understanding: Other consumers that inhabit aquatic ecosystems are found within Phylum Chordata. While many of these consumers share basic morphological characteristics, derived characteristics demonstrate evolutionary relationships. Various adaptations are found among these organisms for successful niches within selected ecosystems.

A Students will investigate characteristics of aquatic chordates. **MAQ.7A**

- 1** Characterize aquatic representatives of the following taxa: Hemichordata, Urochordata, Cephalochordata, and Vertebrata (including Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia). **MAQ.7A.1**
- 2** Identify characteristics that are shared and derived using graphical representations of animal evolution and develop cladograms/phylogenetic trees. **MAQ.7A.2**
- 3** Utilize a dichotomous key to identify select aquatic vertebrates. **MAQ.7A.3**
- 4** Differentiate various life cycles found among animals (e.g., egg, tadpole, and adult stages of the amphibian life cycle; leathery eggs on land in reptiles; hard-shelled eggs in Aves; placental, marsupial, or monotremes in mammals; viviparous, ovoviviparous, and oviparous animals). **MAQ.7A.4**
- 5** Dissect representative taxa (e.g., shark, fish); collect data; compare their internal and external anatomy; and analyze, explain, and communicate results. **MAQ.7A.5**
- 6** Using key morphological and physiological adaptations found within aquatic vertebrate taxa, assess how animals interact with their environment to determine their ecological roles. **MAQ.7A.6**
- 7** Enrichment: Given a niche in a specific environment, use an engineering design process to design an animal, listing characteristics based on your knowledge of shared and derived characteristics, internal and external anatomy, and how the animal would adapt morphologically and physiologically relative to its ecological role and specific environment.
* **MAQ.7A.7**