Close Reading: What is Marine Biology?

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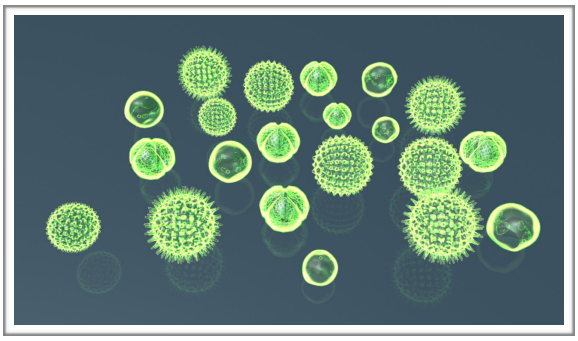
http://marinebio.org/oceans/marine-biology.asp

Simply put, marine biology is the study of life in the oceans and other saltwater environments such as estuaries and wetlands. All plant and animal life forms are included from the microscopic picoplankton all the way to the majestic blue whale, the largest creature in the sea—and for that matter in the world.

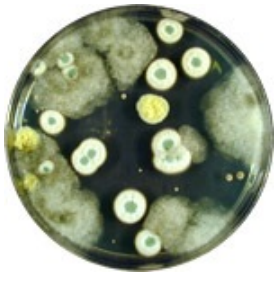
The study of marine biology includes a wide variety of disciplines such as astronomy, biological oceanography, cellular biology, chemistry, ecology, geology, meteorology, molecular biology, physical oceanography and zoology and the new science of marine conservation biology draws on many longstanding scientific disciplines such as marine ecology, biogeography, zoology, botany, genetics, fisheries biology, anthropology, economics and law.

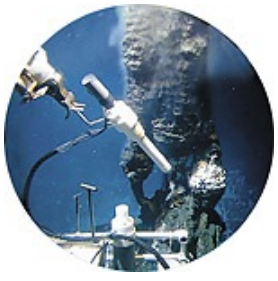
Like all scientific disciplines, the study of marine biology also follows the scientific method. The overriding goal in all of science is to find the truth. Although following the scientific method is not by any means a rigid process, research is usually conducted systematically and logically to narrow the inevitable margin of error that exists in any scientific study, and to avoid as much bias on behalf of the researcher as possible. The primary component of scientific research is characterization by observations. Hypotheses are then formulated and then tested based on a number of observations in order to determine the degree to which the hypothesis is a true statement and whether or not it can be accepted or rejected. Testing is then often done by experiments if hypotheses can produce predictions based on the initial observations.



The essential elements of the scientific method are iterations and recursions of the following four steps:

1. Characterization (observation)
2. Hypothesis (a theoretical, hypothetical explanation)
3. Prediction (logical deduction from the hypothesis)
4. Experiment (test of all of the above)





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These steps are all used in the study of marine biology, which includes numerous sub fields including:

- Microbiology: The study of microorganisms, such as bacteria, viruses, protozoa and algae, is conducted for numerous reasons. One example is to understand what role microorganisms play in marine ecosystems. For example, bacteria are critical to the biological processes of the ocean, as they comprise 98% of the ocean's biomass, which is the total weight of all organisms in a given volume. Microbiology is also important to our understanding of the food chain that connects plants to herbivorous and carnivorous animals. The first level in the food chain is primary production, which occurs at the microbial level. This is an important biological activity to understand as primary production drives the entire food chain.

  Scientists also study marine microbiology to find new organisms that may be used to help develop medicines and find cures for diseases and other health problems.

- Fisheries and Aquaculture: to protect biodiversity and to create sustainable seafood sources because of the world's dependence on fish for protein. There are many areas of study in this field.
  - The ecology of fisheries includes the study of their population dynamics, reproduction, behavior, food webs, and habitat.
  - Fisheries management includes studies on the impact of overfishing, habitat destruction, pollution and toxin levels, and ways to increase populations for sustainability as seafood.
  - Aquaculture includes research on the development of individual organisms and their environment. The objective is most often to develop the knowledge needed to cultivate certain species in a designated area in open water or in captivity in order to meet consumer demand. Technological advances have enabled seafood "farms" to produce high-demand products that traditional commercial fisheries cannot meet. This is a controversial area however, and an issue that will become of greater importance as our fish stocks continue to decline.

- Environmental Marine Biology: includes the study of ocean health. It is important for scientists to determine the quality of the marine environment to ensure water quality is sufficient to sustain a healthy environment. Coastal environmental health is an important area of environmental marine biology so that scientists can determine the impact of coastal development on water quality for the safety of people visiting the beaches and to maintain a healthy marine environment. Pollutants, sediment, and runoff are all potential threats to marine health in coastal areas. Offshore marine environmental health is also studied. For example, an environmental biologist might be required to study the impact of an oil spill or other chemical hazard in the ocean. Environmental biologists also study Benthic environments on the ocean bottom in order to understand such issues as the chemical makeup of sediment, impact of erosion, and the impact of dredging ocean bottoms on the marine environment.
- Deep-sea Ecology: advances in technology of equipment needed to explore the deep sea have opened the door to the study of this largely unknown space in the sea. The biological characteristics and processes in the deep-sea environment are of great interest to scientists. Research includes the study of deep ocean gases as an alternate energy source, how animals of the deep live in the dark, cold, high pressure environment, deep sea hydrothermal vents and the lush biological communities they support.
- Ichthyology: is the study of fishes, both salt and freshwater species. There are some 25,000+ species of fishes including: bony fishes, cartilaginous fishes, sharks, skates, rays, and jawless fishes. Ichthyologists study all aspects of fish from their classification, to their morphology, evolution, behavior, diversity, and ecology. Many ichthyologists are also involved in the field of aquaculture and fisheries.
- Marine Mammology: This is the field of interest to most aspiring marine biologists. It is the study of cetaceans—families of whales and dolphins, and pinnipeds (seals, sea lions, and the walrus). Their behaviors, habitats, health, reproduction, and populations are all studied. These are some of the most fascinating creatures in the sea; therefore, this is an extremely competitive field, and difficult to break into because the competition for research funding is also quite heavy.

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One area of research currently being conducted on whales is the impact of military sonar on their health and well-being. The scientific community believes that high frequency sound waves cause internal damage and bleeding in the brains of whales, yet the military denies this claim. Military sonar can also interfere with the animal's own use of sonar for communication and echolocation. More research is needed; however, in recent years science has proven the claims to be valid and the military has begun limiting its use of sonar in specific areas.

- Marine Ethology: The behavior of marine animals is studied so that we understand the animals that share the planet with us. This is also an important field for help in understanding how to protect endangered species, or how to help species whose habitats are threatened by man or natural phenomena. The study of marine animal behavior usually falls under the category of ethology because most often marine species must be observed in their natural environment, although there are many marine species observed in controlled environments as well. Sharks are most often studied in their natural habitat for obvious reasons.

Why Study Marine Biology?

Life in the sea has been a subject of fascination for thousands of years. One of the most important reasons for the study of sea life is simply to understand the world in which we live. The oceans cover 71% (and rising) of this world, and yet we have only scratched the surface when it comes to understanding them. Scientists estimate that no more than 5% of the oceans have been explored. Yet, we need to understand the marine environment that helps support life on this planet, for example:

Health of the oceans/planet
- Climate change
- Pollution (toxicology, dumping, runoff, impact of recreation, blooms)
- Coral reefs
- Invasive species...

Human health
- Air quality
- Dissolution of carbon dioxide...

Sustainability and biodiversity
- Overfishing
- Endangered species
- Impacts on the food chain...

Research and product development
- Pharmaceuticals
- Biomedical applications
- Alternate energy sources....

How is Marine Biology Studied?

Advances in technology have opened up the ocean to exploration from the shallows to the deep sea. New tools for marine research are being added to the list of tools that have been used for decades such as:

- Trawling - has been used in the past to collect marine specimens for study, except that trawling can be very damaging to delicate marine environments and it is difficult to collect samples discriminately. However when used in the midwater environment, trawls can be every effective at collecting samples of elusive species with a wide migratory range.

- Plankton nets - plankton nets have a very fine weave to catch microscopic organisms in seawater for study.
- Remotely operated vehicles (ROVs) - have been used underwater since the 1950s. ROVs are basically unmanned submarine robots with umbilical cables used to transmit data between the vehicle and researcher for remote operation in areas where diving is constrained by health or other hazards. ROVs are often fitted with video and still cameras as well as with mechanical tools for specimen retrieval and measurements.
- Underwater habitats - the National Oceanic and Atmospheric Administration (NOAA) operates Aquarius, a habitat 20 m beneath the surface where researchers can live and work underwater for extended periods.
- Fiber optics - Fiber optic observational equipment uses LED light (red light illumination) and low light cameras that do not disturb deep-sea life to capture the behaviors and characteristics of these creatures in their natural habitat.
- Satellites - are used to measure vast geographic ocean data such as the temperature and color of the ocean. Temperature data can provide information on a variety of ocean characteristics such as currents, cold upwelling, climate, and warm water currents such as the Gulf Stream. Satellites are also used for mapping marine areas such as coral reefs and for tracking marine life tagged with sensors to determine migratory patterns.
- Sounding - hydrophones, the microphone's counterpart, detect and record acoustic signals in the ocean. Sound data can be used to monitor waves, marine mammals, ships, and other ocean activities.
- Sonar - similar to sounding, sonar is used to find large objects in the water and to measure the ocean's depth (bathymetry). Sound waves last longer in water than in air, and are therefore useful to detect underwater echoes.
- Computers - sophisticated computer technology is used to collect, process, analyze, and display data from sensors placed in the marine environment to measure temperature, depth, navigation, salinity, and meteorological data. NOAA implemented computer technology aboard its research vessels to standardize the way this data is managed.

Marine Biology versus Biological Oceanography

The difference between the terms "marine biology" and "biological oceanography" is subtle, and the two are often used interchangeably. As mentioned above, marine biology is the study of marine species that live in the ocean and other saltwater environments. Biological oceanography also studies marine species, but in the context of oceanography. So a biological oceanographer might study the impact of cold upwellings on anchovy populations off the coast of South America, where a marine biologist might study the reproductive behavior of anchovies.

Close Reading Questions

Directions: Please answer the following questions on a separate piece of paper.

1. Name three disciplines that are part of Marine Biology.
2. List the four basic steps of the scientific method.
3. Select three areas of study from the following list and *summarize* in detail: Microbiology, Fisheries and Aquaculture, Environmental Marine Biology, Deep Sea Ecology, Ichthyology, Marine Mammalogy, Marine Ethology.
4. List and describe two ways marine biology is studied.
5. In your own words, what is the difference between Marine Biology and Oceanography?