Microbes are everywhere: they are extremely abundant and diverse.

Microbes are found in every ocean environment imaginable. They thrive in the deep ocean, for example, where some microbes live in minerals deposited around hydrothermal vents. Certain microbes live inside the layers of steel that make up the walls of oil tankers, such as ICMF and BMFD, which are estimated to be around 3.5 billion years old.

Marine microbes are the most abundant and diverse biological entities in the ocean. They are single-celled organisms that come in a variety of shapes and sizes. They have no clearly defined nucleus to bound their DNA. The combined grouping of Bacteria and Archaea is also referred to as "Prokaryotes."

All remaining unicellular organisms and all visible forms of life are termed Eukaryotes. The eukaryotes have well-defined nucleuses to house their DNA. Bacteria and Archaea include many microorganisms, such as most algae (diatoms, coccolithophores, dinoflagellates) and protozoans.

Viruses are extremely small; they are even smaller than a cell. In fact, viruses are not even alive.

Microbes are highly efficient at nitrogen fixation, or converting atmospheric nitrogen into a form that is usable to living organisms. Although nitrogen makes up almost 80% of the Earth’s atmosphere, it is not in a form that plants can use. Without microbes to “fix” nitrogen, there would be no nitrogen available for plants to grow.

Many microbes live symbiotically with other organisms. In most cases, both organisms benefit from living together. For example, the花费叫 the photosynthetic microorganisms that live within and provide nutrients (mainly carbon) to the corals. In turn, the corals protect the microbes that live within and provide important habitat for the zooxanthellae, these corals will usually support a wide variety of marine life.

Some microorganisms are beneficial.

Marine microbes are a largely untapped resource that could yield benefits in medicine and technology. They also protect coastlines from erosion. In most cases, both organisms benefit from living together. For example, the花费叫 the photosynthetic microorganisms that live within and provide nutrients (mainly carbon) to the corals. In turn, the corals protect the microbes that live within and provide important habitat for the zooxanthellae, these corals will usually support a wide variety of marine life.

A dozen of the genus Bacillariophycceae showing long hair-like fruticose beard. (Micro*scope)

Microbes significantly impact our global climate.

Microbes help to maintain our global climate by regulating carbon dioxide (CO2) levels in the atmosphere. By breaking food, humans emit billions of tons of CO2 in the atmosphere each year. Marine microbes remove a significant portion of the CO2 we place in the atmosphere each year, which is critical in curbing human-induced climate change.

Microbes contribute to cloud development over the ocean by producing dissolved solids (DMS) gas. DMS forms fine particles, around which clouds develop. Some microbes are partly responsible for regulating the water cycle. In addition, clouds help to deflect sunlight, so marine microbes also help to keep our planet cool.

Microbes are highly efficient at nitrogen fixation, or converting atmospheric nitrogen into a form that is usable to living organisms. Although nitrogen makes up almost 80% of the Earth’s atmosphere, it is not in a form that plants can use. Without microbes to “fix” nitrogen, there would be no nitrogen available for plants to grow.

Many microbes live symbiotically with other organisms. In most cases, both organisms benefit from living together. For example, the花费叫 the photosynthetic microorganisms that live within and provide nutrients (mainly carbon) to the corals. In turn, the corals protect the microbes that live within and provide important habitat for the zooxanthellae, these corals will usually support a wide variety of marine life.

Thousands of different species of microbes have been identified, and the total known number of microbes is estimated to be around 10^30. (NASA)

Microbes are everywhere: they are extremely abundant and diverse.

Microbes are found in every ocean environment imaginable. They thrive in the deep ocean, for example, where some microbes live in minerals deposited around hydrothermal vents. Certain microbes live inside the layers of steel that make up the walls of oil tankers, such as ICMF and BMFD, which are estimated to be around 3.5 billion years old.

Marine microbes were the first life forms on Earth, yet much of the marine microbial community has yet to be described. Only a small percentage of the microbes that have been discovered have been cultured or grown in a lab. As a result, scientists are continually trying to develop new and effective ways to grow and study microbes.

It is estimated that fewer than 1% of the bacteria in the ocean have been cultured. This means that a world of discoveries awaits future microbiologists. Some marine microbes are beneficial to humans, while others have yet to be described.

Microbes are everywhere: they are extremely abundant and diverse.

Microbes are found in every ocean environment imaginable. They thrive in the deep ocean, for example, where some microbes live in minerals deposited around hydrothermal vents. Certain microbes live inside the layers of steel that make up the walls of oil tankers, such as ICMF and BMFD, which are estimated to be around 3.5 billion years old.

Marine microbes were the first life forms on Earth, yet much of the marine microbial community has yet to be described. Only a small percentage of the microbes that have been discovered have been cultured or grown in a lab. As a result, scientists are continually trying to develop new and effective ways to grow and study microbes.

It is estimated that fewer than 1% of the bacteria in the ocean have been cultured. This means that a world of discoveries awaits future microbiologists. Some marine microbes are beneficial to humans, while others have yet to be described.

Microbes are everywhere: they are extremely abundant and diverse.

Microbes are found in every ocean environment imaginable. They thrive in the deep ocean, for example, where some microbes live in minerals deposited around hydrothermal vents. Certain microbes live inside the layers of steel that make up the walls of oil tankers, such as ICMF and BMFD, which are estimated to be around 3.5 billion years old.

Marine microbes were the first life forms on Earth, yet much of the marine microbial community has yet to be described. Only a small percentage of the microbes that have been discovered have been cultured or grown in a lab. As a result, scientists are continually trying to develop new and effective ways to grow and study microbes.

It is estimated that fewer than 1% of the bacteria in the ocean have been cultured. This means that a world of discoveries awaits future microbiologists. Some marine microbes are beneficial to humans, while others have yet to be described.
Jamie Becker
Graduate Student
Massachusetts Institute of Technology and Woods Hole Oceanographic Institution Joint Program

Describe your research:
I work on elucidating the major compartments that make up as diverse Life in the ocean. This includes understanding the structure and function of marine microbial communities and how they contribute to global biogeochemical cycles. My research focuses on the interplay between microorganisms and their environment, with a particular emphasis on the role of marine viruses in shaping microbial community dynamics.

What is your research important? 
Understanding the role of marine viruses in shaping microbial community dynamics is crucial for predicting how marine ecosystems will respond to environmental change. This knowledge is essential for developing strategies to mitigate the impacts of climate change on marine ecosystems.

What is your favorite work-related activity? 
My favorite work-related activity is working in the field, where I have the opportunity to collect samples from diverse environments around the world. I particularly enjoy working at the intersection of virus-host interactions and environmental change, as it allows me to explore how these interactions are affected by changing ocean conditions.

Rachel Foster
Postdoctoral Scholar
University of California Santa Cruz

Describe your research: 
I mainly research the distribution, diversity, and physiological activity of cyanobacteria. They are particularly interested in symbioses (when two or more organisms live together in close association), especially when one of the partners is a cyanobacterium.

What is your favorite microbe? 
My favorite microbe is the unicellular cyanobacterium, which is a cyanobacterium commonly found as a symbiont of open ocean dinoflagellates. Generally though, I like studying cyanobacteria because they are ancient, they were responsible for oxygenating the planet, and they were also the precursor to the chloroplast.

What is the coolest experience you have had on the job or during your studies? 
I participated in the Antarctic Biological Training Course at McMurdo Station when I was a graduate student. While I was in Antarctica, I had the opportunity to see a research station in the South Pole to help study bacterial respiration. I was on the South Pole for six hours, and the thought that I was standing on the bottom of the Earth was an amazing feeling that I will never forget. Also, the view was breathtaking. Followed the path taken by the early explorers, and it was the most spectacular and most untouched landscape I have ever seen.

If you had to give advice to someone who wanted to become a microbial oceanographer, what would you tell them? 
My advice would be to parallel your research with the advancements in technology. The field is growing fast and expanding in many molecular directions; having the tools of a field oceanographer with the genomic analyses will be instrumental for the future of microbial oceanographers.

C-MORE
The Center for Microbial Oceanography: Research and Education (C-MORE) was established in 2006 by the National Science Foundation (NSF) to meet the needs of an expanding interdisciplinary field. C-MORE is a collaborative research and education center that brings together scientists from diverse disciplines to address fundamental questions about the role of microbial processes in ocean biogeochemistry.

Areas of research range from genomic surveys, to studies of the genetic basis of oceanic productivity, to ecosystem modeling. C-MORE researchers are working to understand the diversity, distribution, and physiological activity of microbes in marine environments, from the microscopic to global in scale.

Education and Outreach:
The C-MORE education and outreach program is focused on increasing scientific literacy in microbial oceanography, providing the best possible training for the next generation of microbial oceanographers, and to facilitate outreach to the public.

C-MORE offers support to graduate students and postdoctoral scholars through a variety of opportunities. For instance, C-MORE offers internships at all six partner institutions. C-MORE also supports a series of the art marine courses at the University of Hawai‘i for graduate students and postdoctoral scholars. For more information, please visit cmore.soest.hawaii.edu and click on “Education and Outreach.”

Jamie on a research ship near New Caledonia. 

Jesse at the ceremonial Kilo Moana C-more.sowest.hawaii.edu

Brenner Wai
Undergraduate Student
Research Assistant
University of Hawai‘i at Manoa

Describe your research: 
I study marine microbes that are involved in chemical processes in the world’s oceans. My research focuses on the interplay between microorganisms and their environment, with a particular emphasis on the role of marine viruses in shaping microbial community dynamics.

What is your research important? 
Understanding the role of marine viruses in shaping microbial community dynamics is crucial for predicting how marine ecosystems will respond to environmental change. This knowledge is essential for developing strategies to mitigate the impacts of climate change on marine ecosystems.

What is your favorite work-related activity? 
My favorite work-related activity is working in the field, where I have the opportunity to collect samples from diverse environments around the world. I particularly enjoy working at the intersection of virus-host interactions and environmental change, as it allows me to explore how these interactions are affected by changing ocean conditions.

Workshop: Dringenberg Peninsula bivalves.

Drifting: Pteropods

Survival suits.

Click on “Education and Outreach.”

This brochure may be reproduced free of charge for educational purposes. The latest version may be downloaded from cmore.soest.hawaii.edu.

Key Concepts in Microbial Oceanography

C-MORE
The Center for Microbial Oceanography: Research and Education (C-MORE) was established in 2006 by the National Science Foundation (NSF) to meet the needs of an expanding interdisciplinary field. C-MORE is a collaborative research and education center that brings together scientists from diverse disciplines to address fundamental questions about the role of microbial processes in ocean biogeochemistry.

Areas of research range from genomic surveys, to studies of the genetic basis of oceanic productivity, to ecosystem modeling. C-MORE researchers are working to understand the diversity, distribution, and physiological activity of microbes in marine environments, from the microscopic to global in scale.

Education and Outreach:
The C-MORE education and outreach program is focused on increasing scientific literacy in microbial oceanography, providing the best possible training for the next generation of microbial oceanographers, and to facilitate outreach to the public.

C-MORE offers support to graduate students and postdoctoral scholars through a variety of opportunities. For instance, C-MORE offers internships at all six partner institutions. C-MORE also supports a series of the art marine courses at the University of Hawai‘i for graduate students and postdoctoral scholars. For more information, please visit cmore.soest.hawaii.edu and click on “Education and Outreach.”

Workshop: Dringenberg Peninsula bivalves.