

From Woods Hole to the Deep Sea: Living in a Microbial World



Julie A. Huber

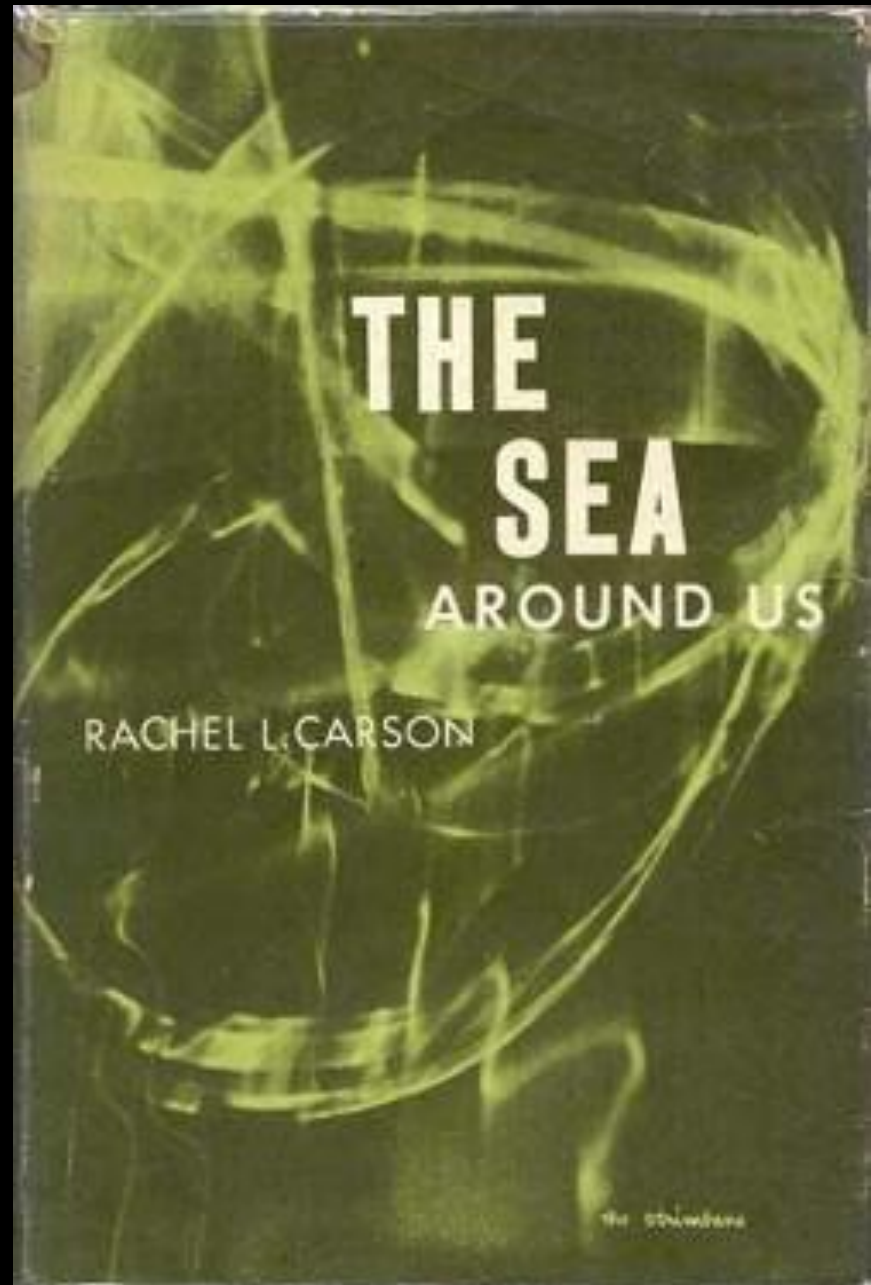
Marine Biological Laboratory

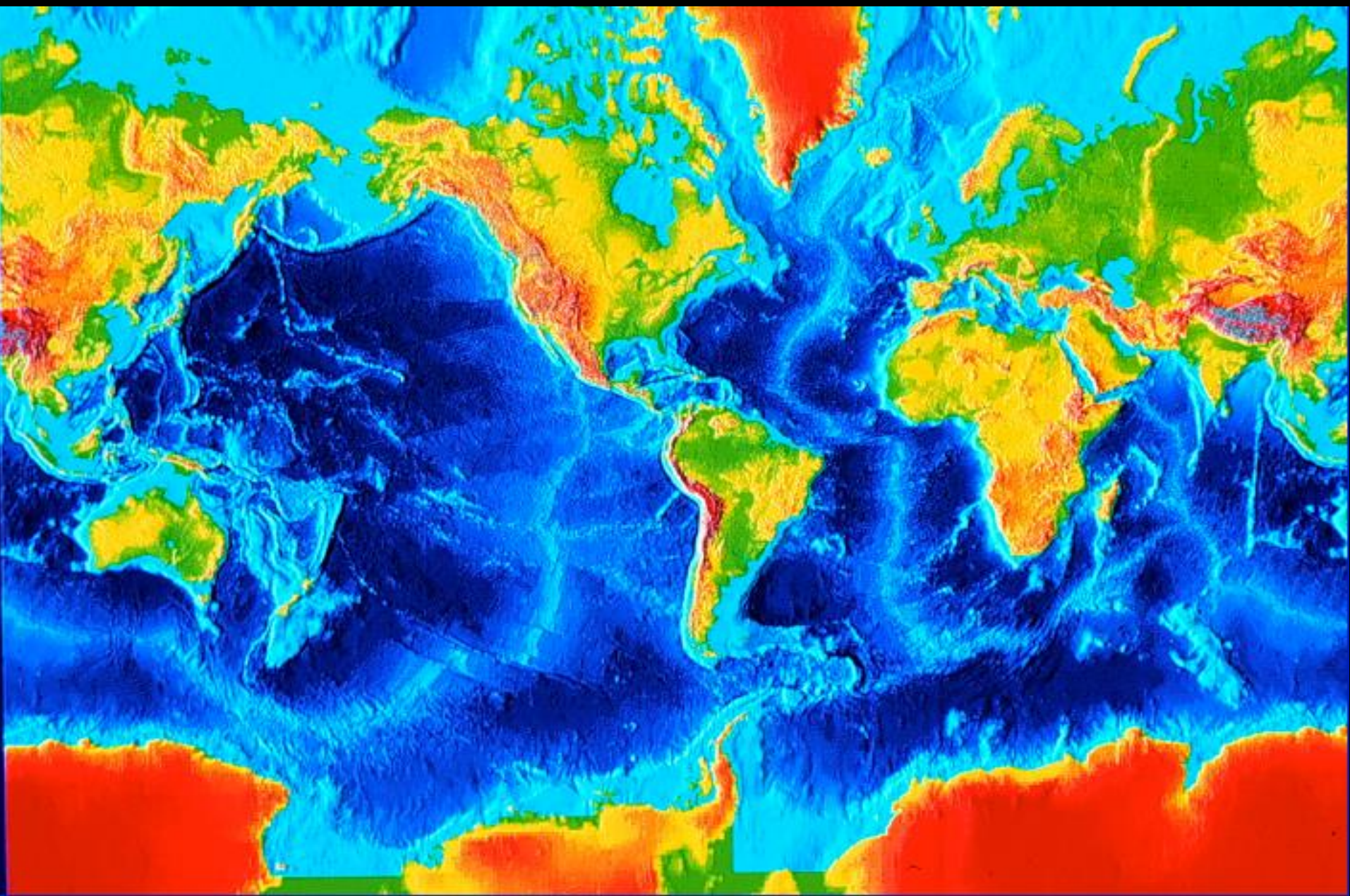
From Woods Hole to the Deep Sea: Living in a Microbial World


- **We live on Planet Microbe**
- **Rocks + Water = Energy**
- **We need to think DEEP**

Julie A. Huber

Marine Biological Laboratory





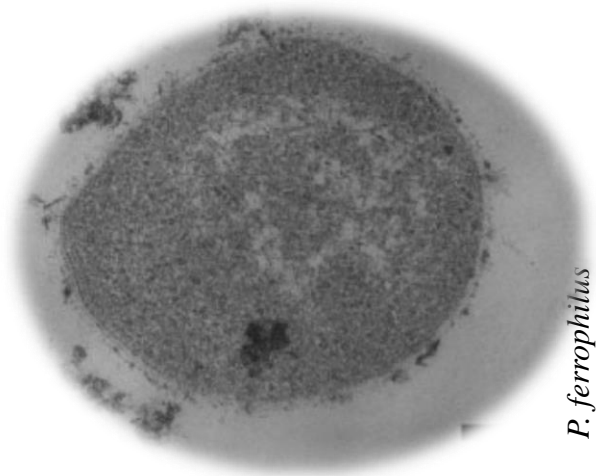
A satellite view of Earth showing the African continent and surrounding oceans. The image is centered on the African continent, with the Atlantic Ocean to the west and the Indian Ocean to the east. The Earth's surface is covered in a complex pattern of blue oceans, white clouds, and brown and green landmasses. The curvature of the planet is visible at the top and bottom edges.

How did life spread across the planet?
How did life diversify?
How do life and its environment co-evolve?
What does the future of life look like?

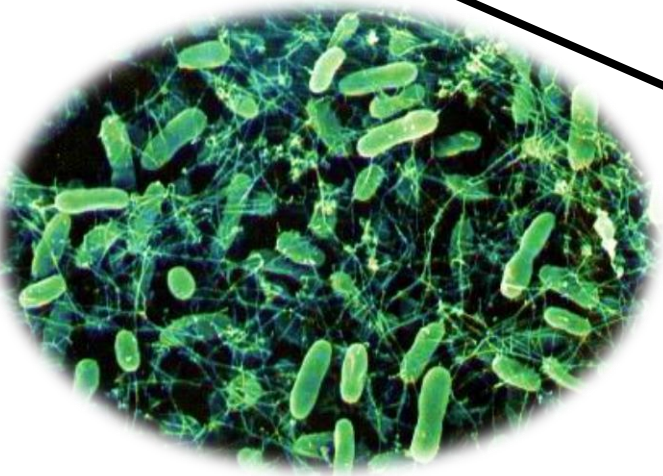
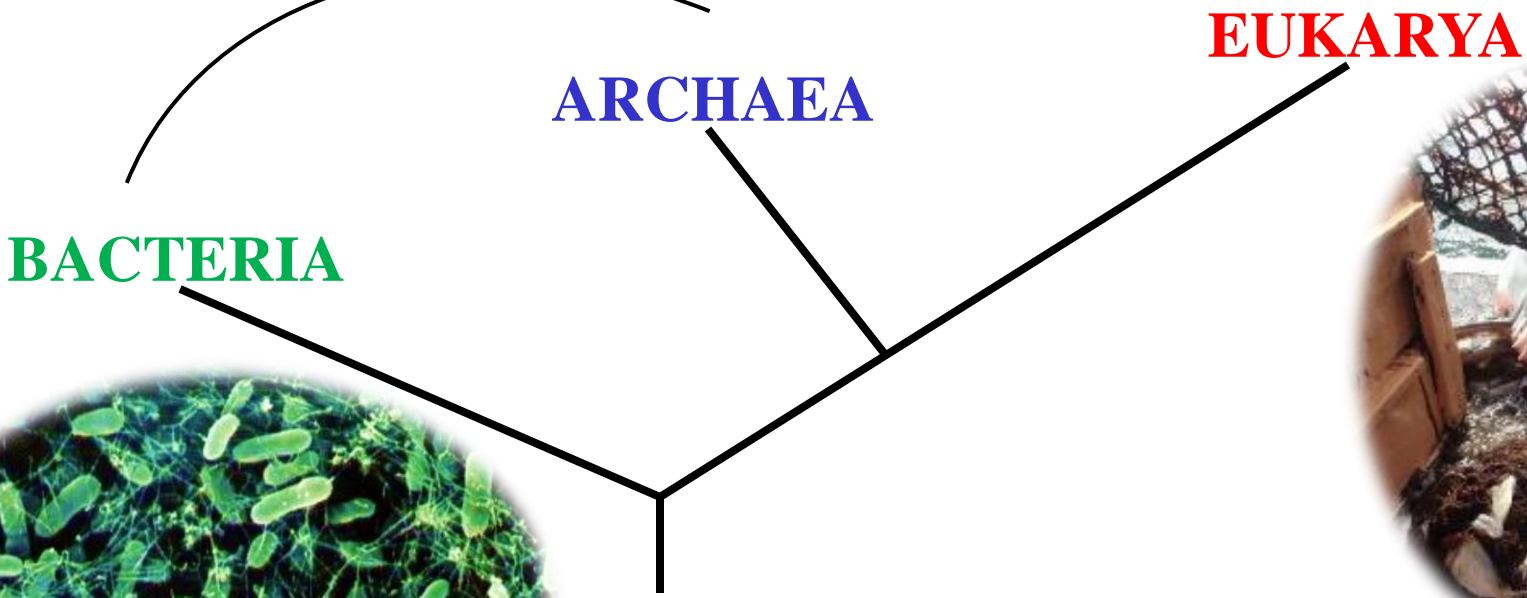
A satellite view of Earth showing the African continent and surrounding oceans. A semi-transparent horizontal band is overlaid across the center of the image. The text "Planet Microbe" is centered within this band in a white, serif font.

Planet Microbe

- No true nucleus
- Single chromosome
- No membrane-bound organelles
- Divide by binary fission



P. ferrophilus

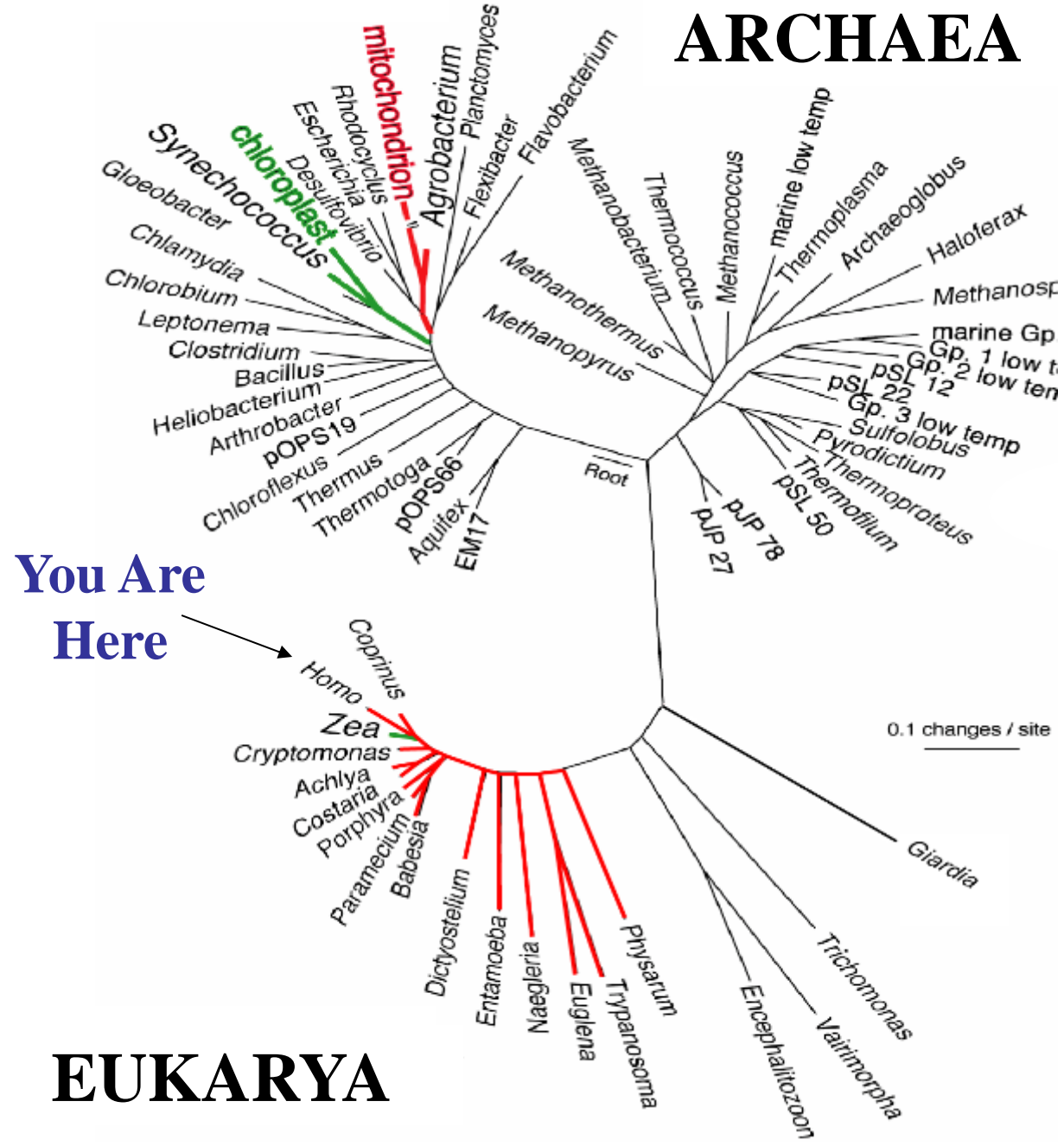


Dave Remsen, MBL

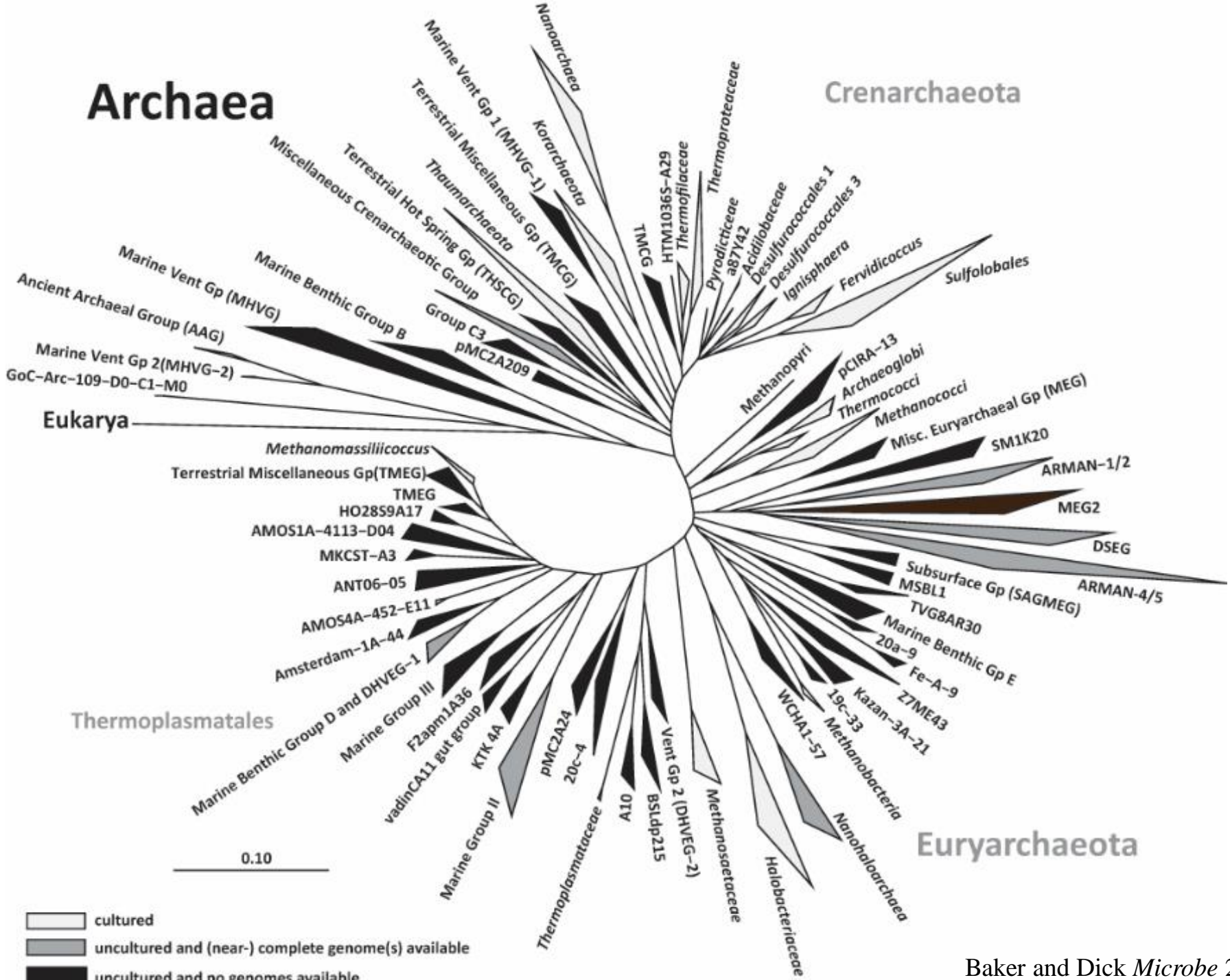
Universal Tree of Life

BACTERIA

ARCHAEA



Modified from Norman Pace



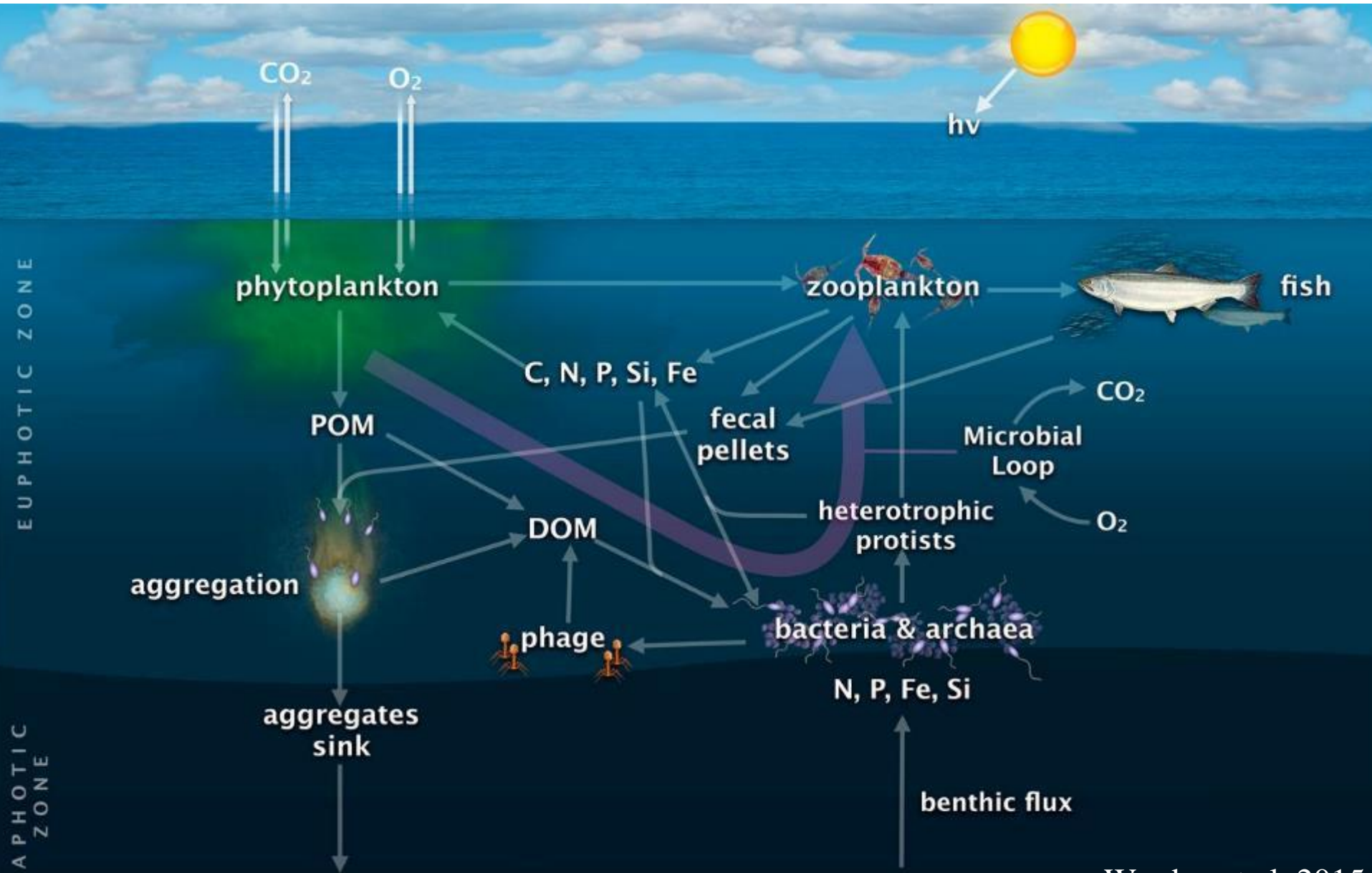
Planet Microbe

Though they be small, they are mighty!

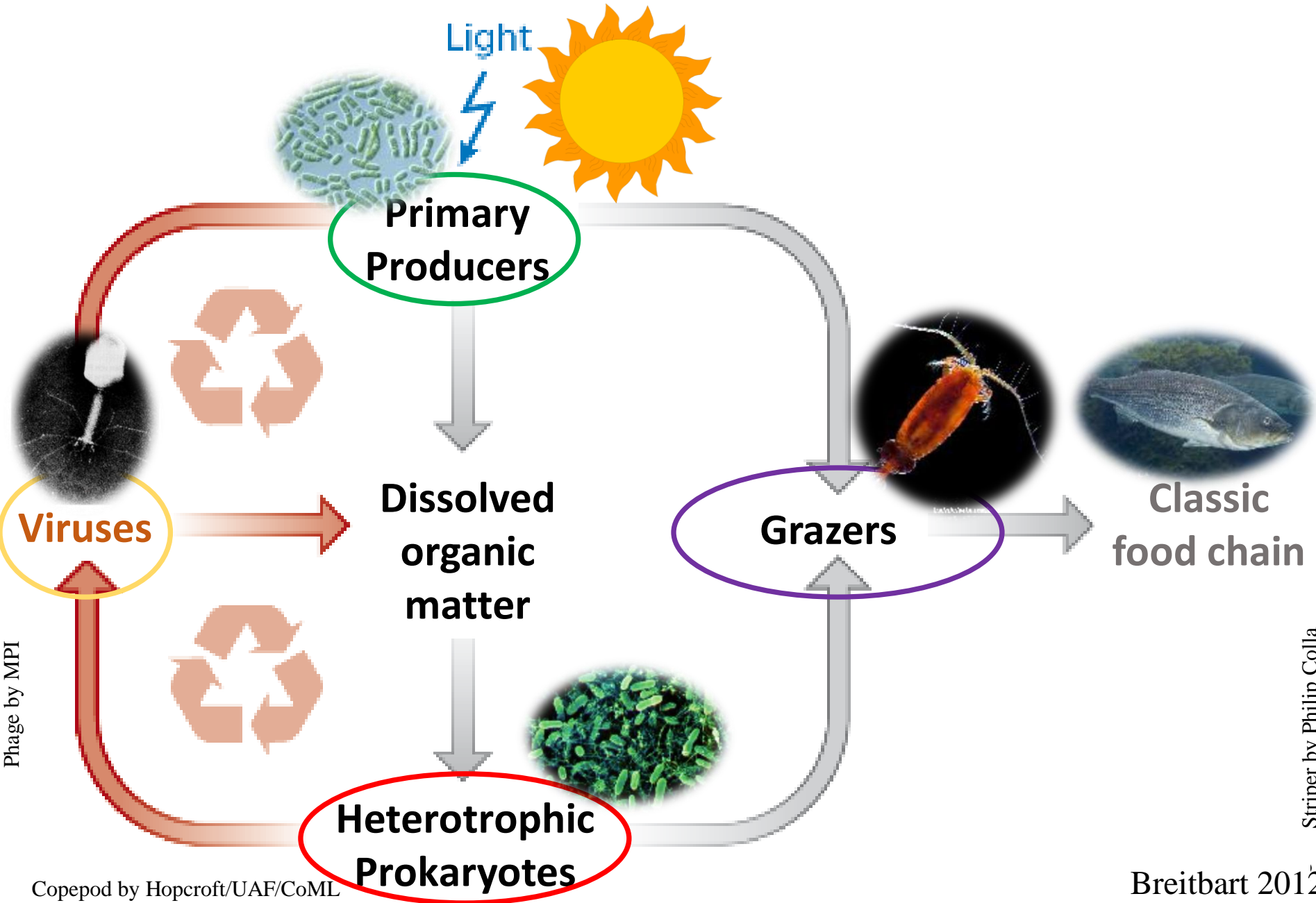
-Shakespeare (sort of)

- Microbes are EVERYWHERE (inc. in/on you!)
- A petagram ($\sim 10^{15}$ g) of carbon in marine microbes
 - All the people on Earth together weigh about 4×10^{13} grams
- Microbes were the only form of life for most of our biological history (~ 3.5 Billion Years)
- Microbes mediate biogeochemical cycles (carbon, oxygen, nitrogen, etc) that shape Earth's habitability

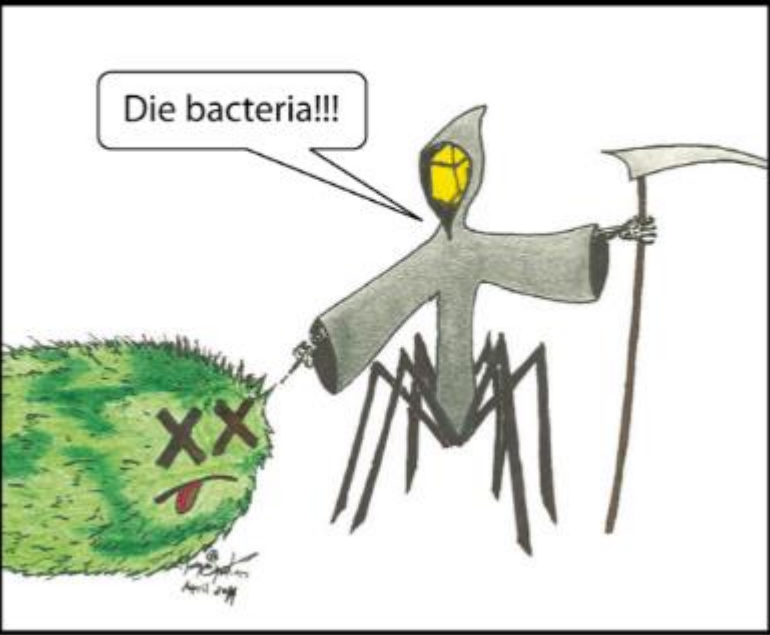
Marine Food Webs



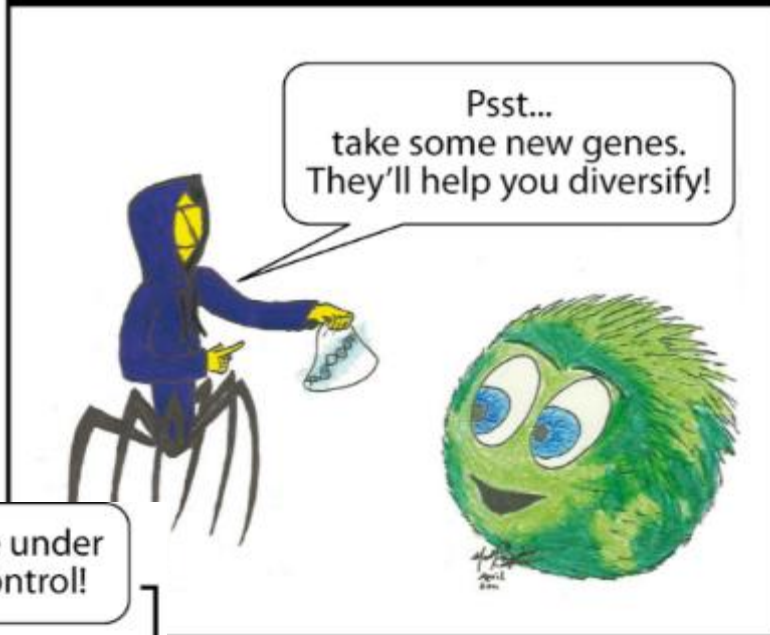
Marine Food Webs



Phages are efficient killers of marine bacteria, releasing 10 billion tons of carbon per day.

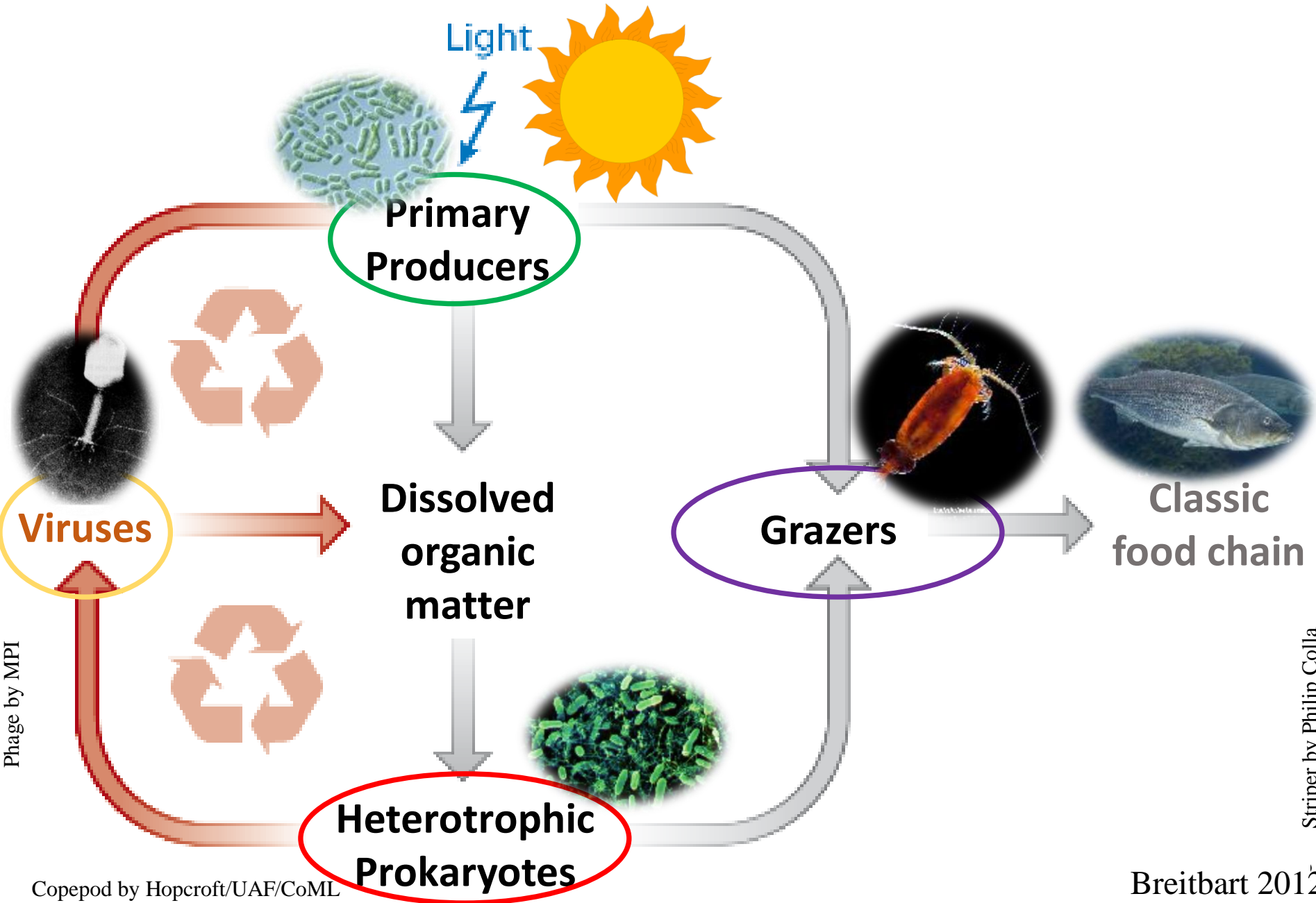


Phages are a major source of gene transfer in the oceans, affecting host diversity and function.



Phage infection can affect host metabolism through expression of phage-encoded auxiliary metabolic genes or regulation of host gene expression.

Marine Food Webs



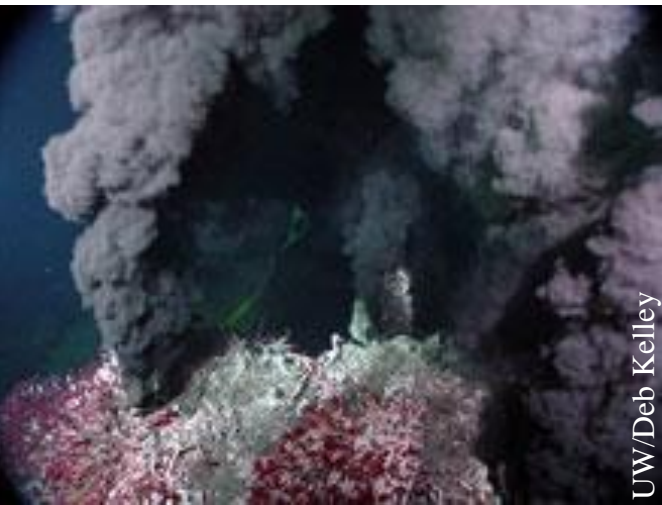
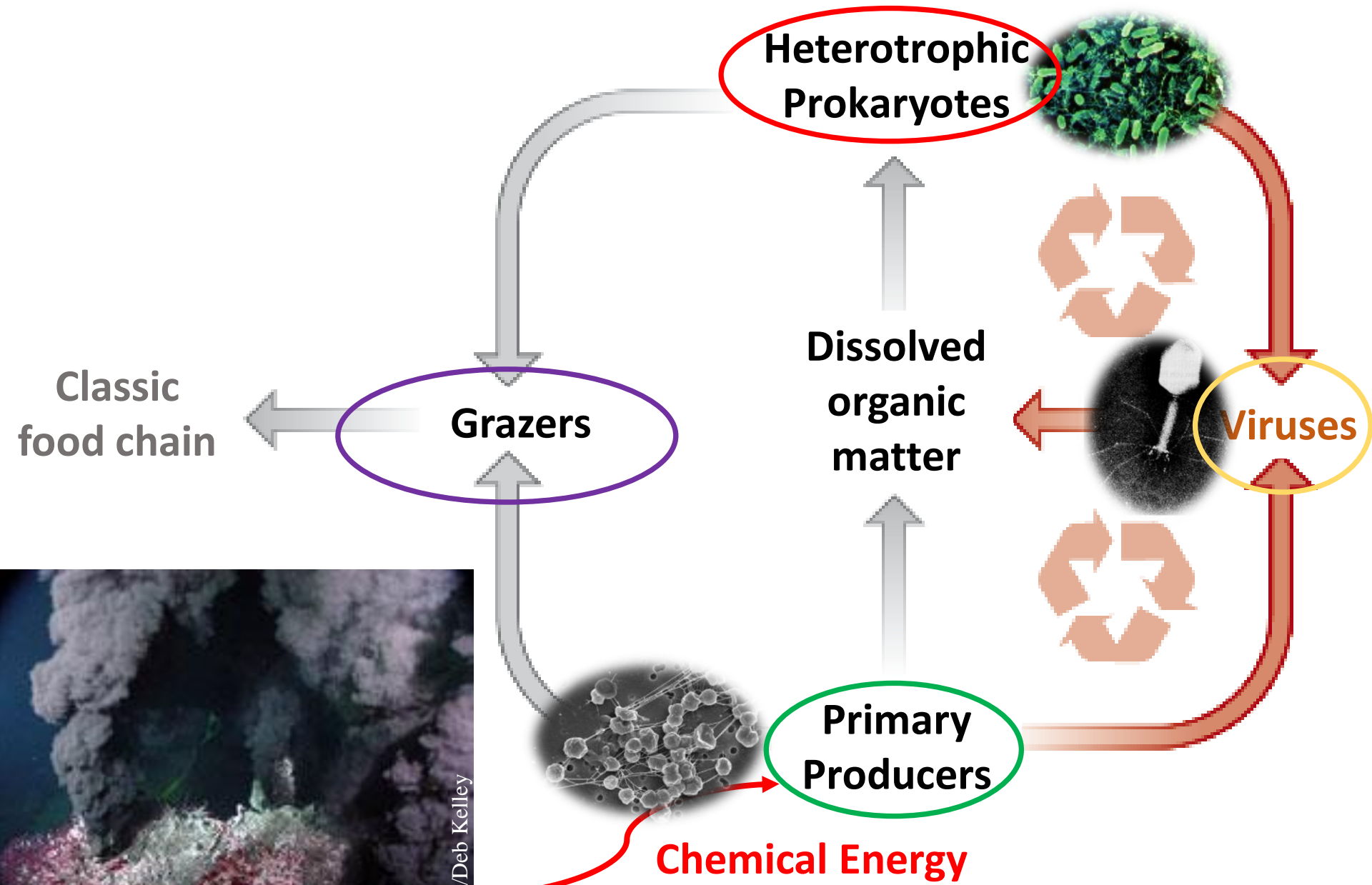
Phage by MPI

Striper by Philip Colla

Copepod by Hopcroft/UAF/CoML

Breitbart 2012

Marine Food Webs



UW/Deb Kelley

Methanogen by Maryland Astrobiology Consortium

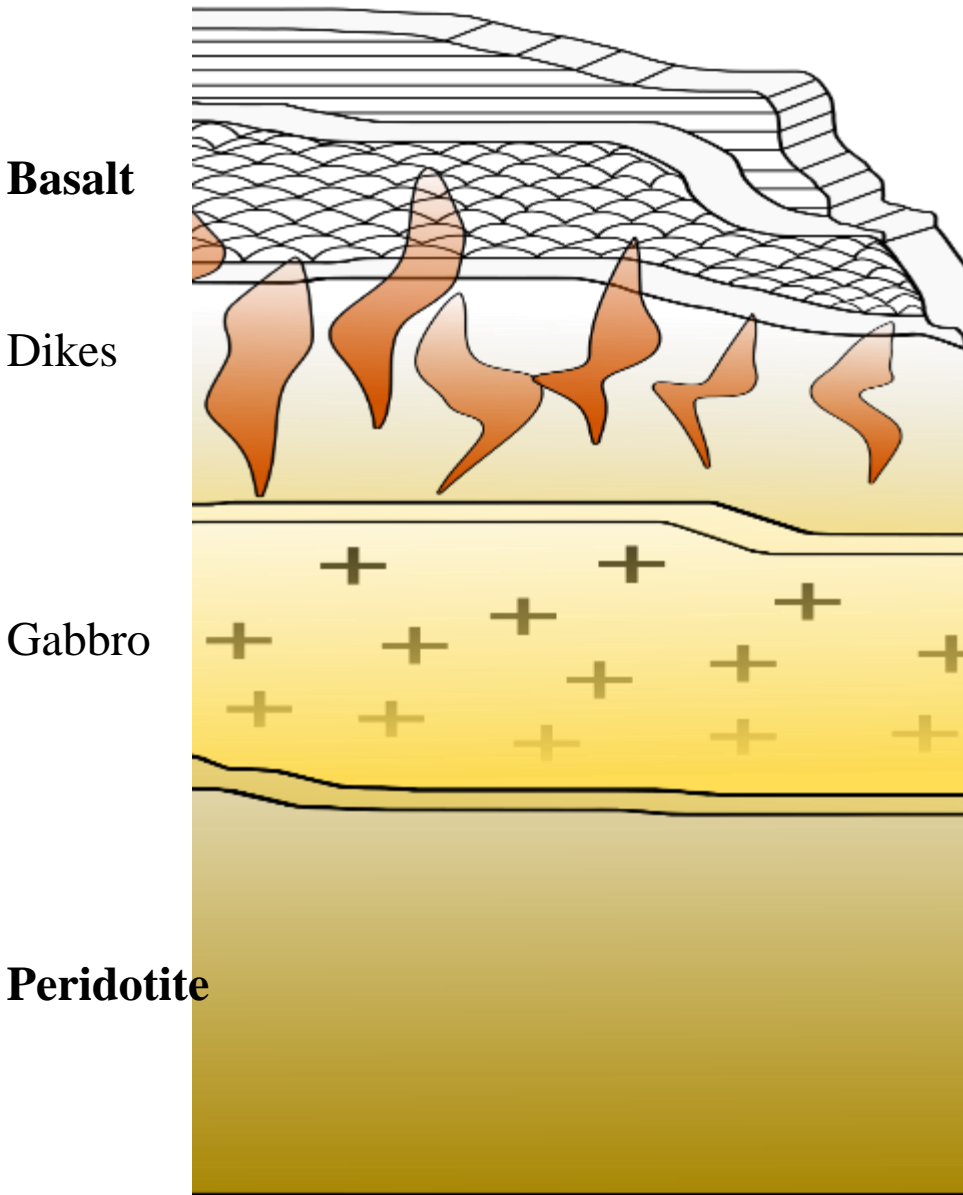
Breitbart 2012

(R)evolutionary Crosstalk between Earth & Life

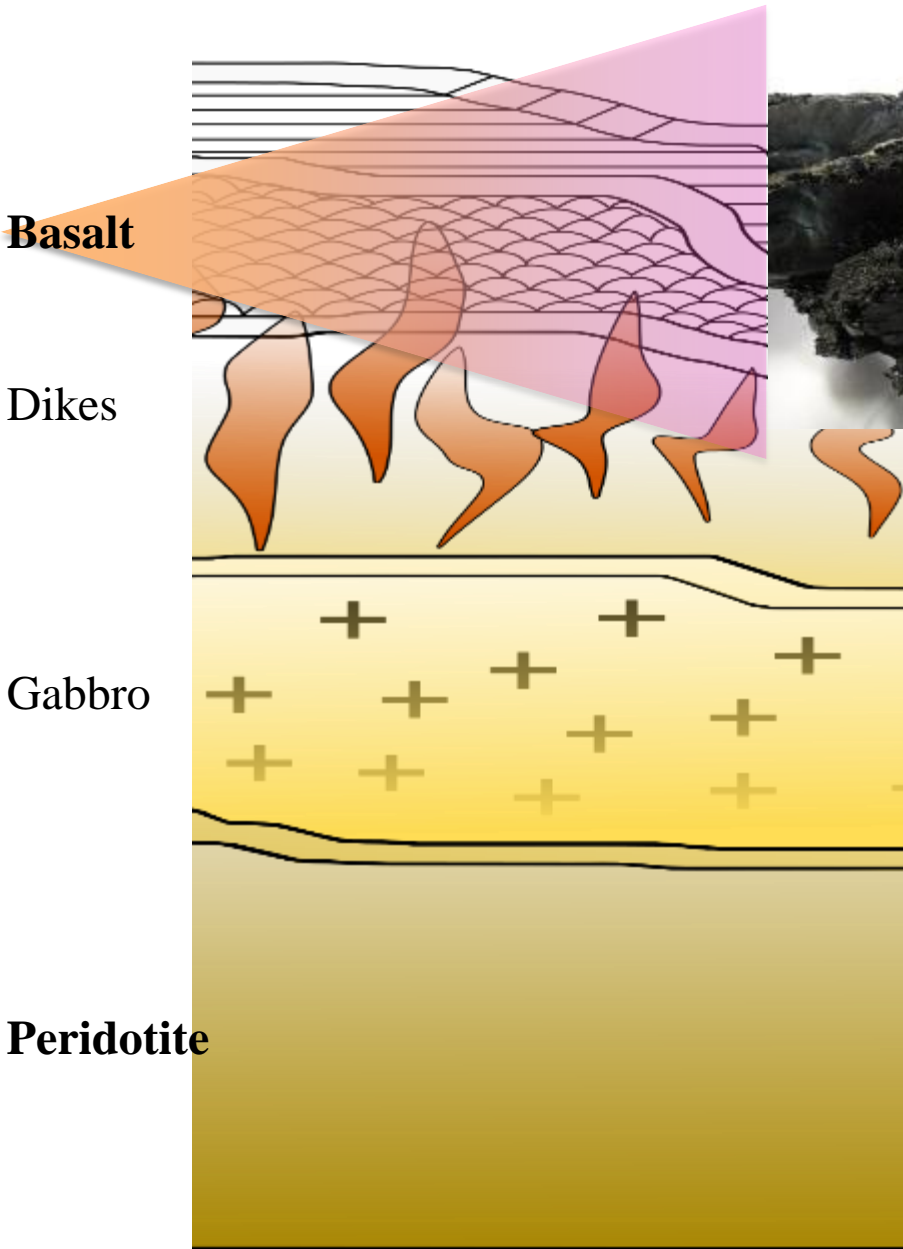
Rocks + Water = **Energy**



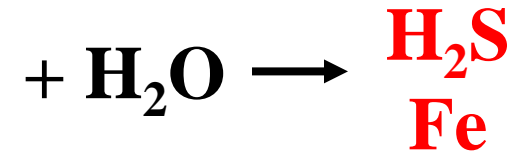
Rocks + Water = Energy



Rocks + Water = Energy

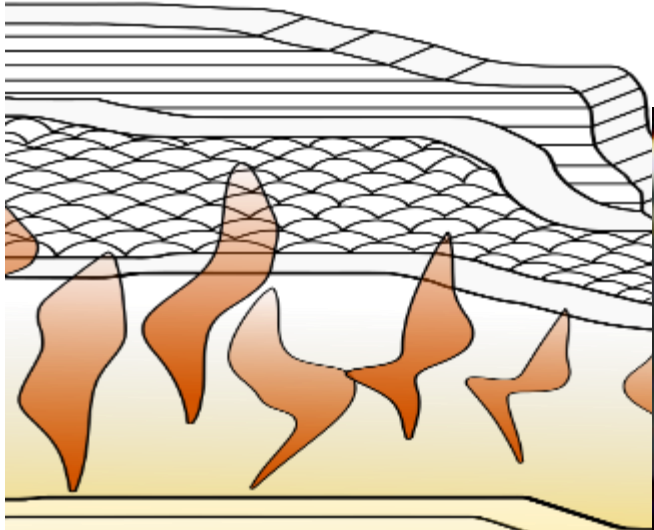


Mafic



Rocks + Water = Energy

Basalt



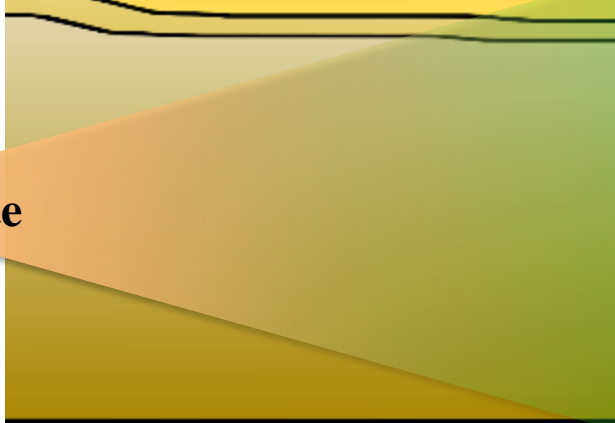
Dikes



Gabbro



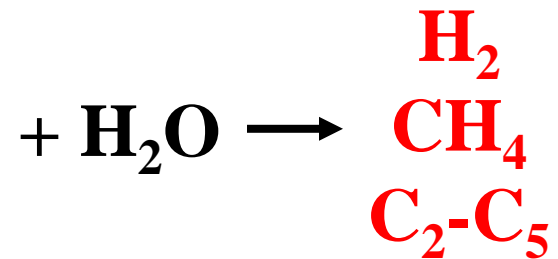
Peridotite



Ultramafic



Mosaic courtesy of Kelley and Elend (UW), IFE, URI-IAO, NOAA



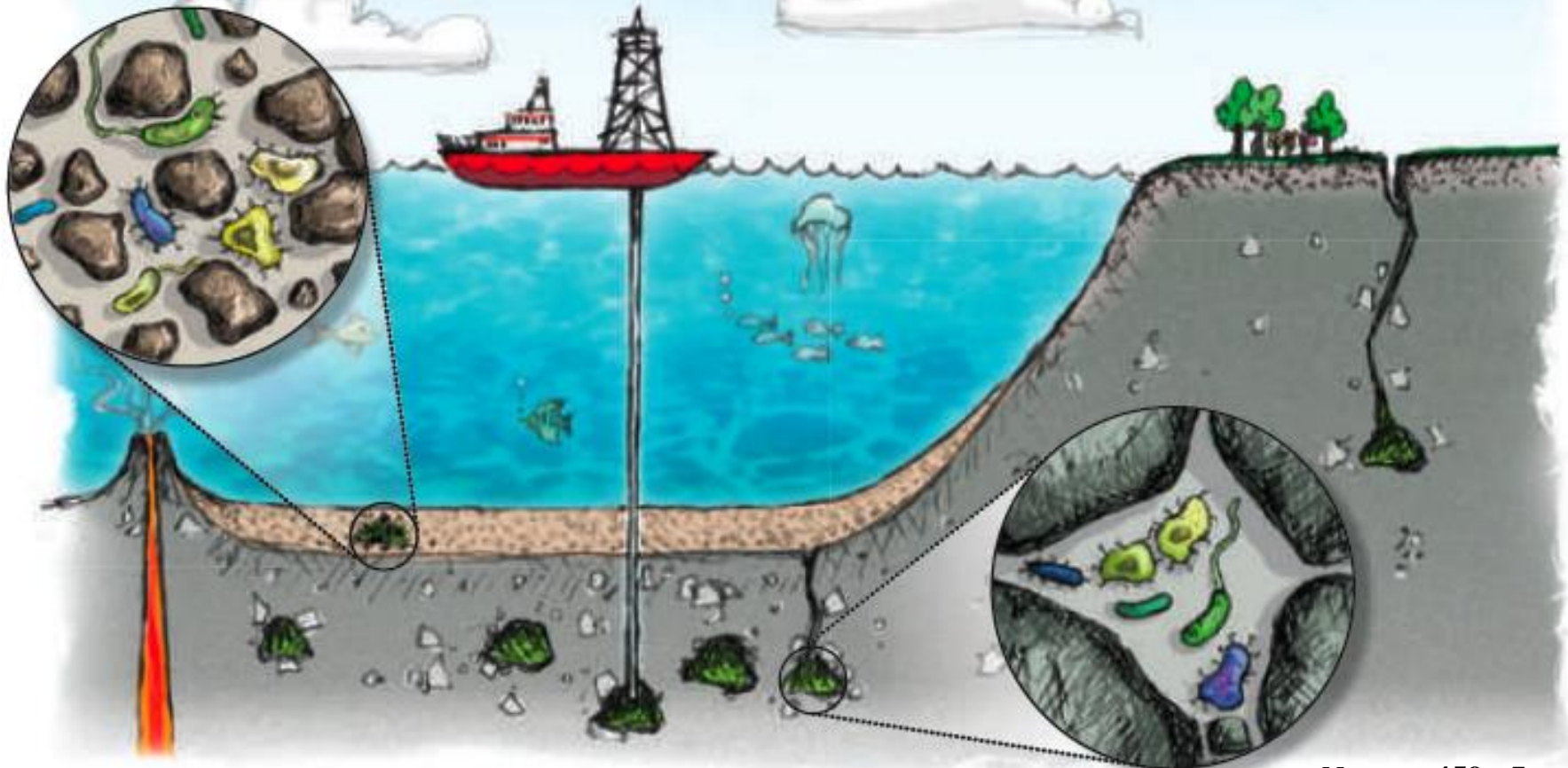


NEWS FEATURE

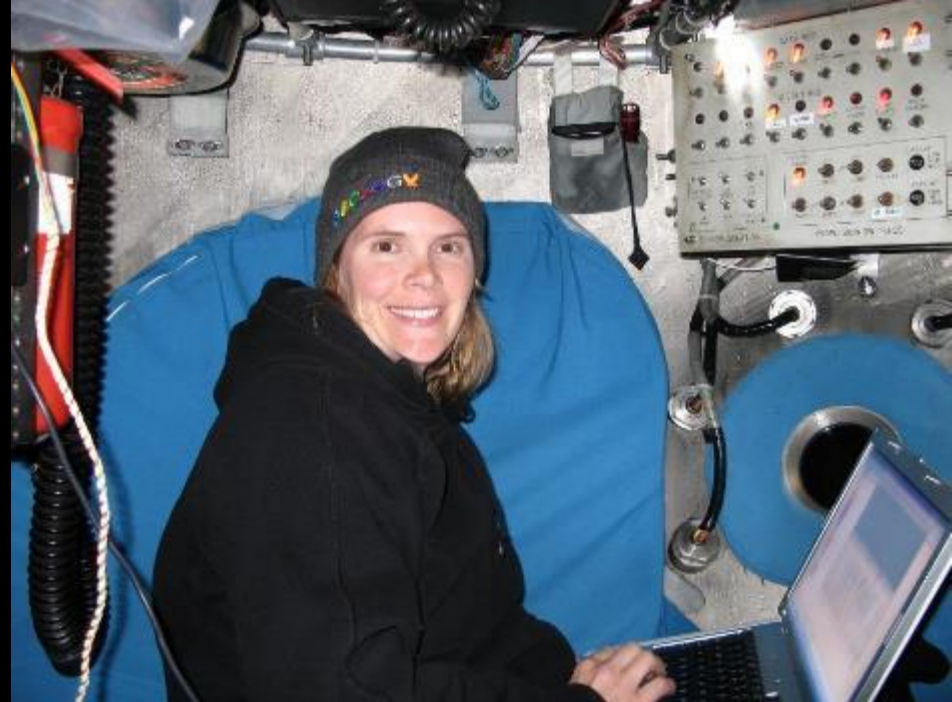
Amanda Leigh Mascarelli

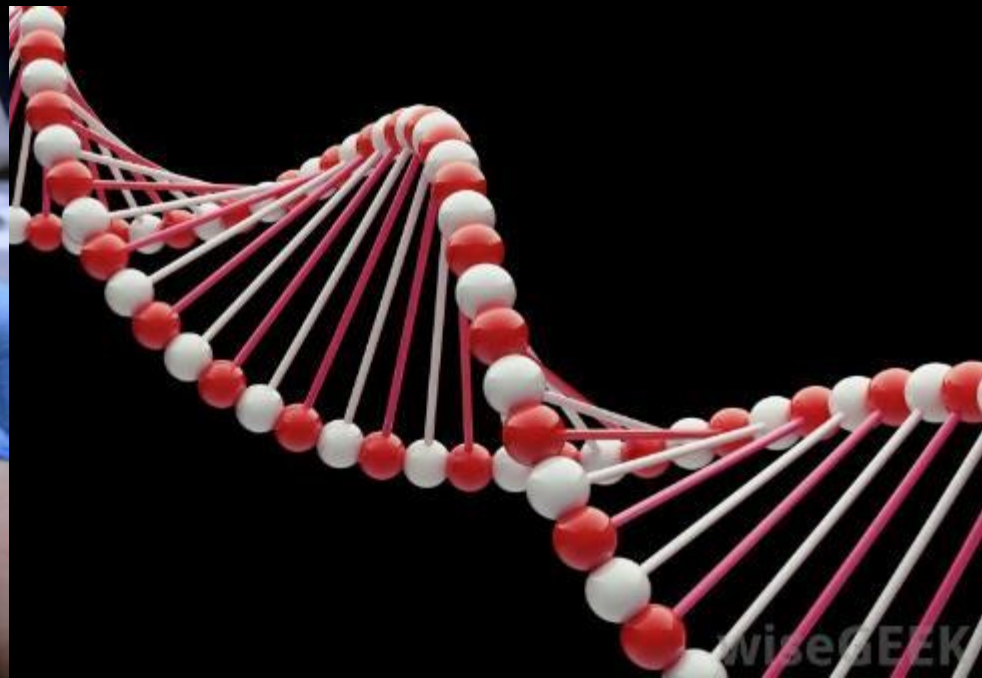
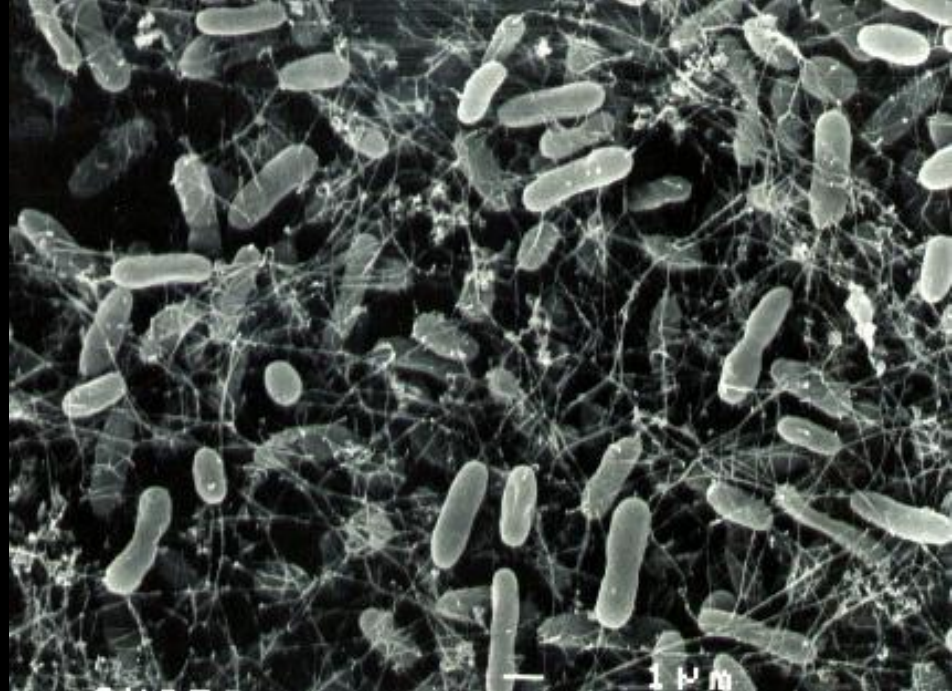
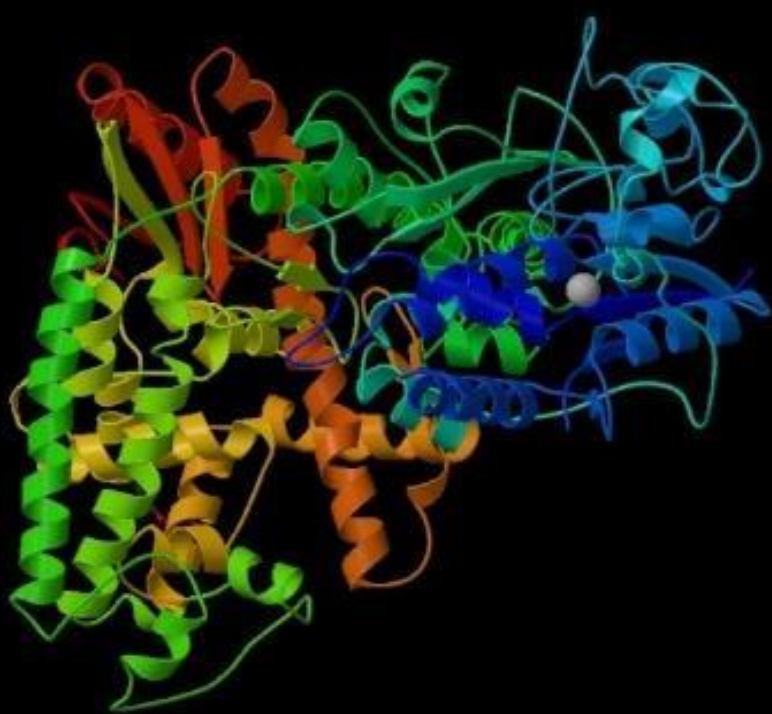
BIOLOGY'S DEEP DARK SECRETS

Subsurface microbial communities have been found within sub-sea-floor sediments, in the underlying ocean crust and far below the surface of the continents.

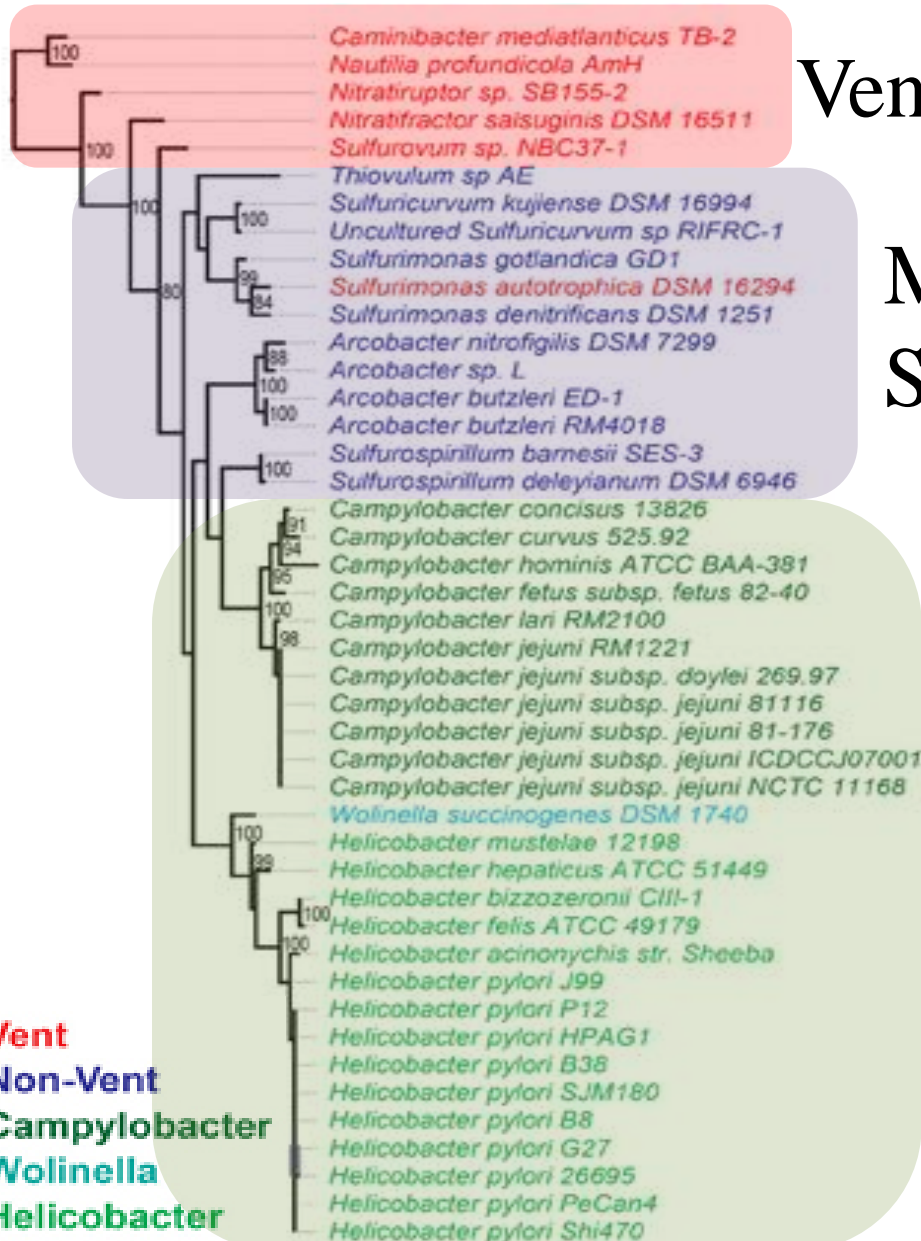


N. SPENCER





Epsilonproteobacteria



Vent Endemic: Most Ancient

Marine & Terrestrial
Sulfidic Systems

Food-borne diarrhea

Gastric ulcer, cancer

Exploiting microbial hyperthermophilicity to produce an industrial chemical, using hydrogen and carbon dioxide

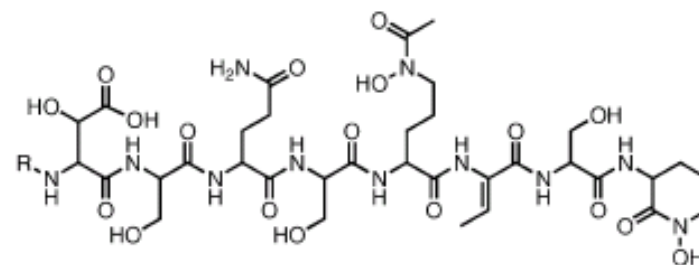
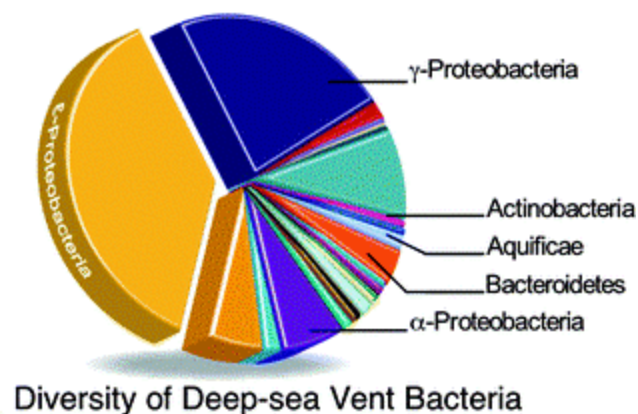
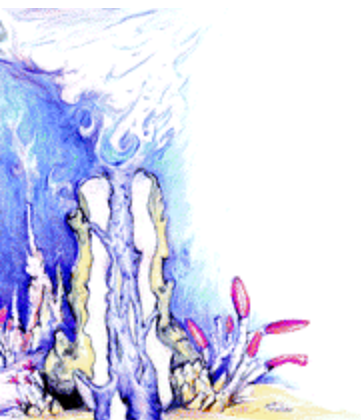
Matthew W. Keller^{a,1}, Gerrit J. Schut^{a,1}, Gina L. Lipscomb^a, Angeli L. Menon^a, Ifeyinwa J. Iwuchukwu^a, Therese T. Leuko^a, Michael P. Thorgersen^a, William J. Nixon^a, Aaron S. Hawkins^b, Robert M. Kelly^b, and Michael W. W. Adams^{a,2}

^aDepartment of Biochemistry and Molecular Biology, University of Georgia, Athens, GA 30602; and ^bDepartment of Chemical and Biomolecular Engineering, North Carolina State University, Raleigh, NC 27695

Deep-Sea Hydrothermal Vents: Potential Hot Spots for Natural Products Discovery?

Thornburg, Zabriskie and McPhail
J. Nat. Prod., 2010, 73, pp 489–499

JOURNAL OF
**NATURAL
PRODUCTS**



Extreme Archaea May be an Untapped Source of Antibacterial Drugs

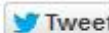
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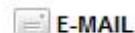
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Catherine Griffin

First Posted: Nov 24, 2014 09:53 AM EST



It turns out that Archaea may actually be a rich and untapped source of antibacterial drugs. Scientists have taken a closer look at this family of single-celled organisms and have found that they may just hold unknown applications. (Photo : Jeremy Teaford, Vanderbilt University; Photo Anna Louse Reysenbach, Portland State University)

The reboot of seafloor mining

Nautilus Minerals is back on track to be the first bona fide seafloor metals miner.

Kip Keen | 6 January 2015 09:20



Permanent carbon dioxide storage in deep-sea sediments

Kurt Zenz House^{*†}, Daniel P. Schrag^{*}, Charles F. Harvey[‡], and Klaus S. Lackner[§]

^{*}Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA 02138; [‡]Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139; and [§]Earth Engineering Center, Columbia University, New York, NY 10027

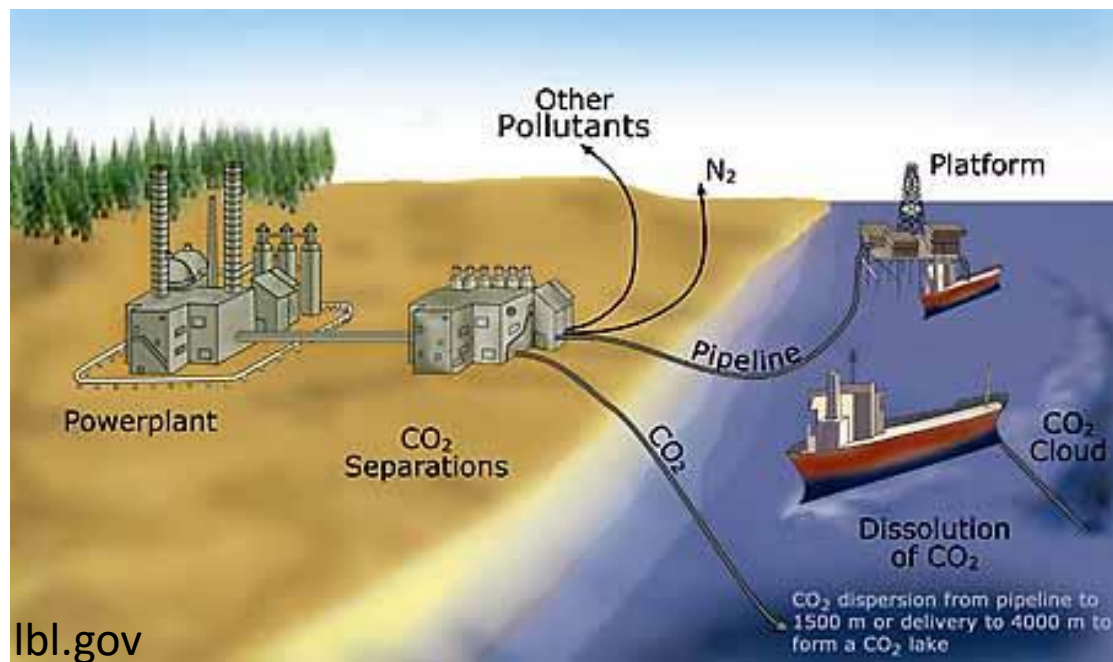
Communicated by John P. Holdren, Harvard University, Cambridge, MA, June 27, 2006 (received for review November 10, 2005)

Carbon dioxide sequestration in deep-sea basalt

David S. Goldberg^{*}, Taro Takahashi, and Angela L. Slagle

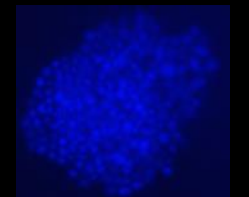
Lamont–Doherty Earth Observatory, 61 Route 9W, Palisades, NY 10964

Communicated by Wallace S. Broecker, Lamont–Doherty Earth Observatory of Columbia University, Palisades, NY, May 7, 2008 (received for review April 3, 2008)



Multi-Disciplinary Science

- Astrobiology
- Biochemistry
- Biogeography
- Climate
- Ecology
- Energy
- Engineering
- Evolutionary Biology
- Geochemistry
- Geology
- Microbiology
- Modeling
- Natural Resources
- Oceanography



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Julie A. Huber

Marine Biological Laboratory

Most Marine Ecosystems are Important & Understudied

Microbes, Viruses, Resources, Carbon, etc.

Understanding them Demands
Multi-Disciplinary BIG Science



Thanks!

jhuber@mbl.edu

