

21A.303J / STS.060J

Anthropology of Biology

Spring 2022

Professor Stefan Helmreich

Course Description

If the twentieth century was the century of physics, the twenty-first has become the century of biology. This subject examines the cultural, political, and economic dimensions of biology in the age of genomics, biotechnological enterprise, biodiversity conservation, pharmaceutical bioprospecting, synthetic biology, global pandemic, and more. Although we examine such social concerns as genetic modification and reproductive rights, this is not a class in bioethics, but rather an anthropological inquiry into how the substances and explanations of biology — increasingly cellular, molecular, genetic, viral, and informatic — are changing, and with them broader ideas about the relationship between “nature” and “culture.” Looking at such scientific forms as cell lines, CRISPR, and epidemiological models, and drawing upon primary sources in biology, social studies of the life sciences, and literary and cinematic materials, we rephrase Erwin Schrödinger’s famous 1944 question, “What Is Life?” to ask, in the 2000s, “What Is Life Becoming?”

WHAT IS LIFE?

*The Physical Aspect of the
Living Cell*

BY

ERWIN SCHRÖDINGER

SENIOR PROFESSOR AT THE DUBLIN INSTITUTE FOR
ADVANCED STUDIES

*Based on Lectures delivered under the auspices of
the Institute at Trinity College, Dublin,
in February 1943*

CAMBRIDGE
AT THE UNIVERSITY PRESS
1944

Schrödinger, Erwin. *What is Life?: The Physical Aspect of the Living Cell*. Cambridge University Press, 1944. © Cambridge University Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

WHAT

Lynn Margulis and Dorion Sagan

IS

Foreword by Niles Eldredge

LIFE?

Margulis, Lynn and Dorion Sagan. *What Is Life?* University of California Press, 2000. © University of California Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

Meanings of 'life'

Synthetic biology provides a welcome antidote to chronic vitalism.

Many a technology has at some time or another been deemed an affront to God, but perhaps none invites the accusation as directly as synthetic biology. Only a deity predisposed to cut-and-paste would suffer any serious challenge from genetic engineering as it has been practised in the past. But the efforts to

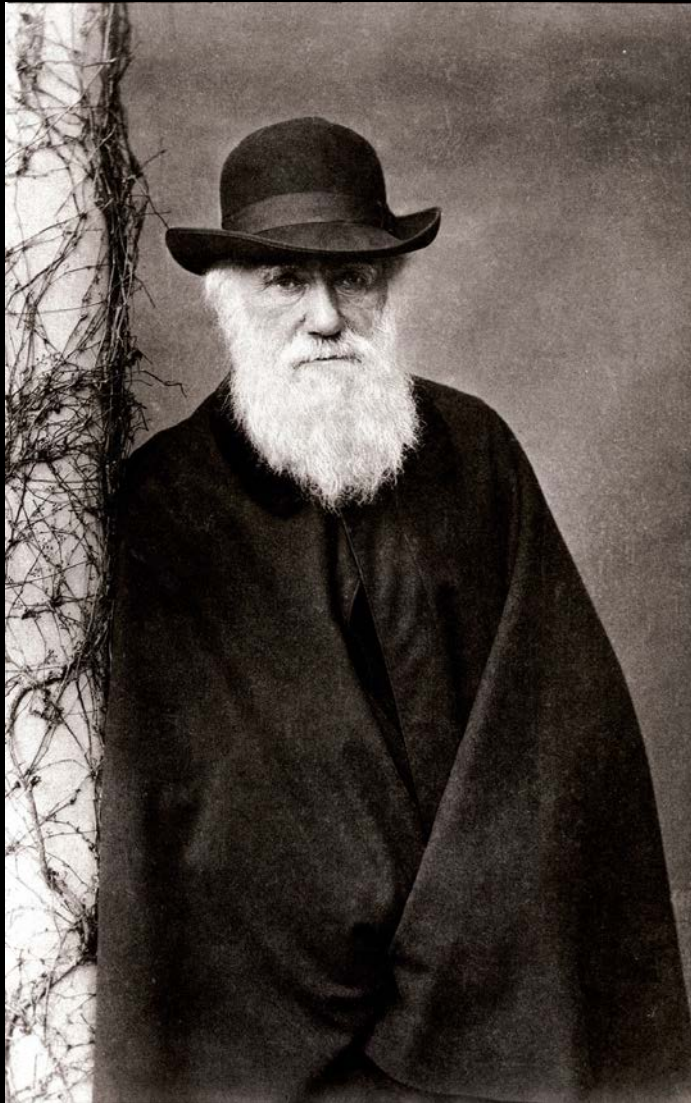
design living organisms from scratch — either with a wholly artificial genome made by DNA synthesis technology or, more ambitiously, by using non-natural, bespoke molecular machinery — really might seem to justify the suggestion, made recently by the ETC Group, an environmental pressure group based in Ottawa, Canada, that “for the first time, God has competition”.

That accusation was levelled at scientists from the J. Craig Venter Institute in Rockville, Maryland, based on the suspicion that they had synthesized an organism with an artificial genome in the laboratory. The suspicion was unfounded, but this feat will surely be achieved in the next few years, judging from the advances reported earlier this

Synthetic biology's view of life as a molecular process lacking moral thresholds at the level of the cell is a powerful one. And it can and perhaps should be invoked to challenge characterizations of life that are sometimes used to defend religious dogma about the embryo. If this view undermines the notion that a 'divine spark' abruptly gives value to a fertilized egg — recognizing as it does that the formation of a new being is gradual, contingent and precarious — then the role of the term 'life' in that debate might acquire the ambiguity that it has always warranted.

cells is that they force us to confront the contextual contingency of this troublesome idea. The trigger for the ETC Group's protest was a patent filed by the Venter Institute in October 2006 on a “minimal

the formation of a new being is gradual, contingent and precarious — then the role of the term 'life' in that debate might acquire the ambiguity that it has always warranted.



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Charles Darwin (1809-1882)

ON
THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE
FOR LIFE.

By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE
ROUND THE WORLD.'

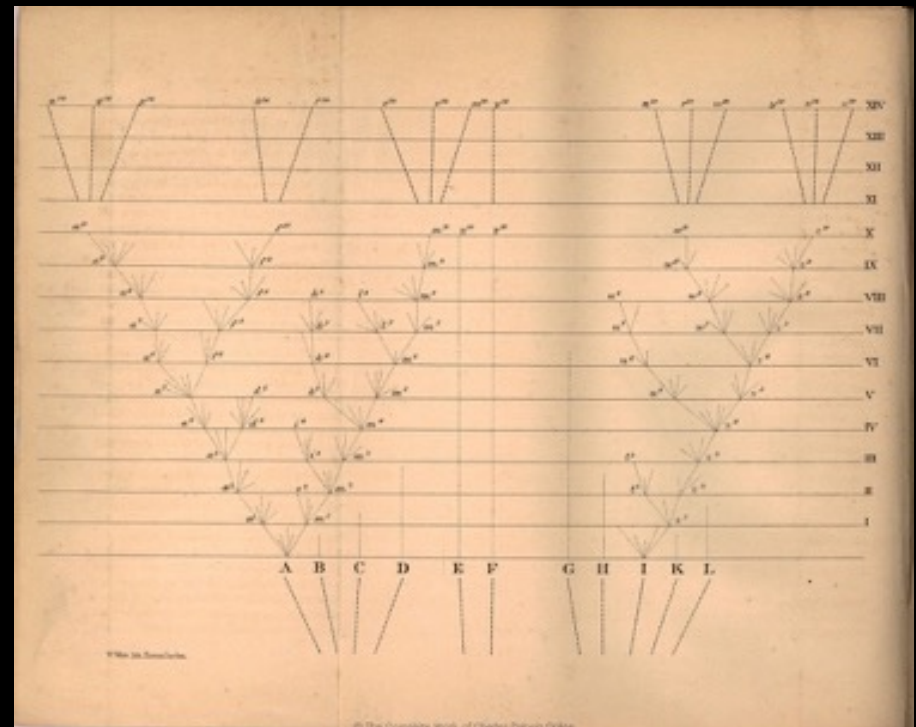
LONDON:
JOHN MURRAY, ALBEMARLE STREET.

1859.

The right of Translation is reserved.

Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.

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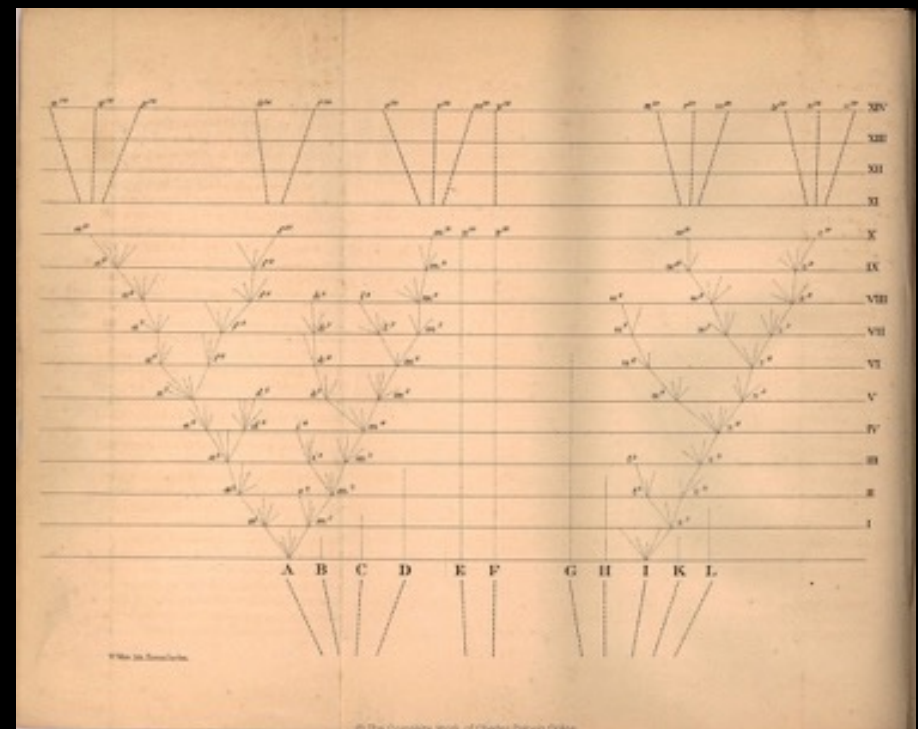
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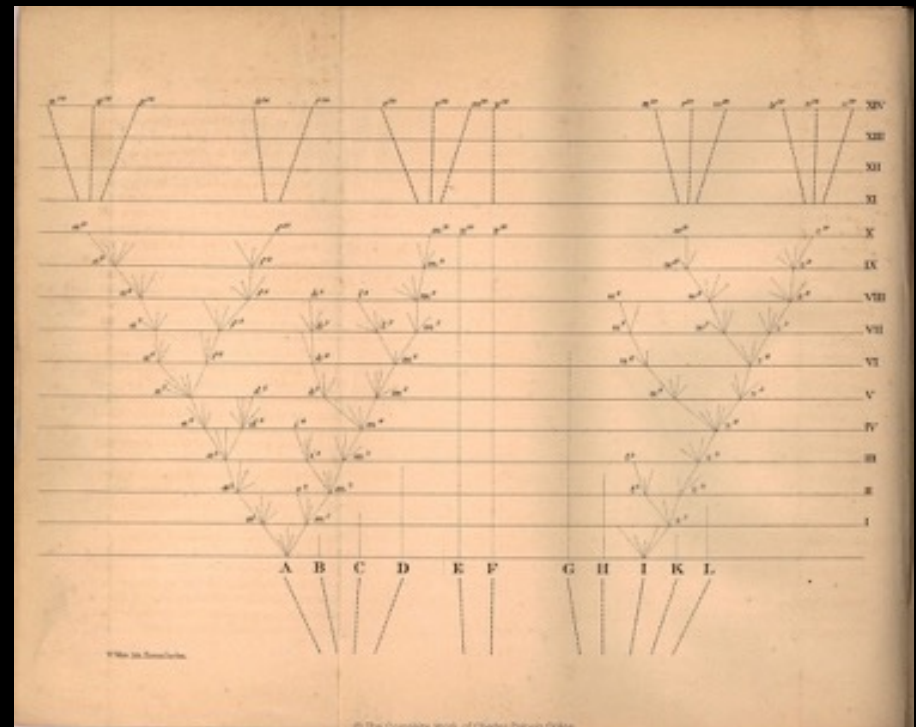
FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
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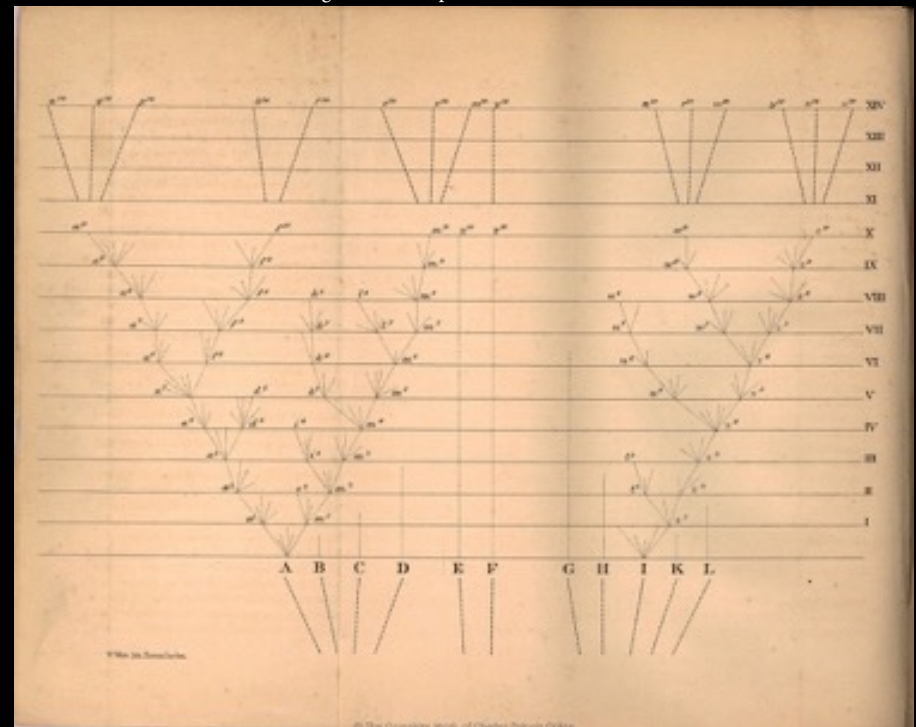
FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
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DARWIN PEDIGREE.

- Charles Robert • ^m 1839 • Emma WEDGWOOD
(1809—1882) (1808—1896)
1. William Erasmus • ^m 1877 • Sara SEDGWICK
b. 1839 (1839—1902)
 2. Anne Elizabeth (1841—1851)
 3. Mary Eleanor (1842—1842)
 4. Henrietta Emma • ^m 1871 • Richard Buckley LITCHFIELD
b. 1843 (1832—1903)
 5. George Howard • ^m 1884 • Maud DU PUY
b. 1845 b. 1861
 - i. Gwendolen Mary b. 1885
 - ii. Charles Galton b. 1887
 - iii. Margaret Elizabeth b. 1890
 - iv. William Robert b. 1894
 6. Elizabeth b. 1847
 7. Francis • ^m 1874 • first, Amy Richenda RUCK • ^m 1883 • second, Ellen Wordsworth CROFTS
b. 1848 (1850—1876) b. 1886 (1856—1903)
 - i. Bernard Richard Meirion b. 1876
 - ii. Frances Crofts b. 1886
 8. Leonard • ^m 1882 • first, Elizabeth Frances • ^m 1900 • second, Charlotte Mildred MASSINGBERD (Mildred), grand-dau. of the
b. 1850 FRASER (1846—1898) above Charles LANGTON b. 1868
(see WEDGWOOD pedigree)
 9. Horace • ^m 1880 • Emma Cecilia FARRER (Ida) dau. of
b. 1851 Lord FARRER, by his first marr. b. 1854 (see ALLEN pedigree)
 - i. Erasmus b. 1881
 - ii. Ruth Frances b. 1883
 - iii. Emma Nora b. 1885
 10. Charles Waring
(1856—1858)



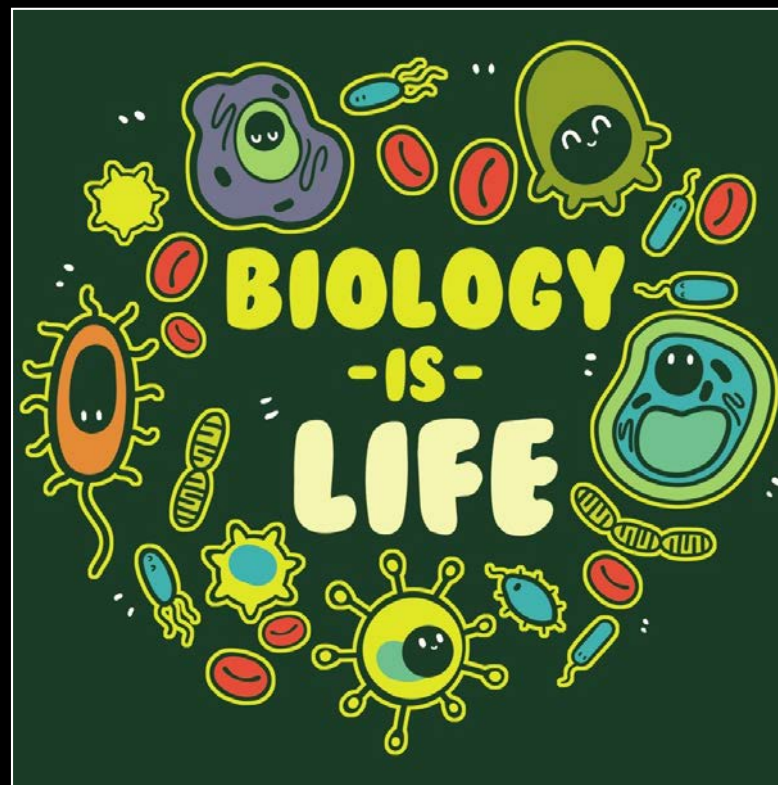
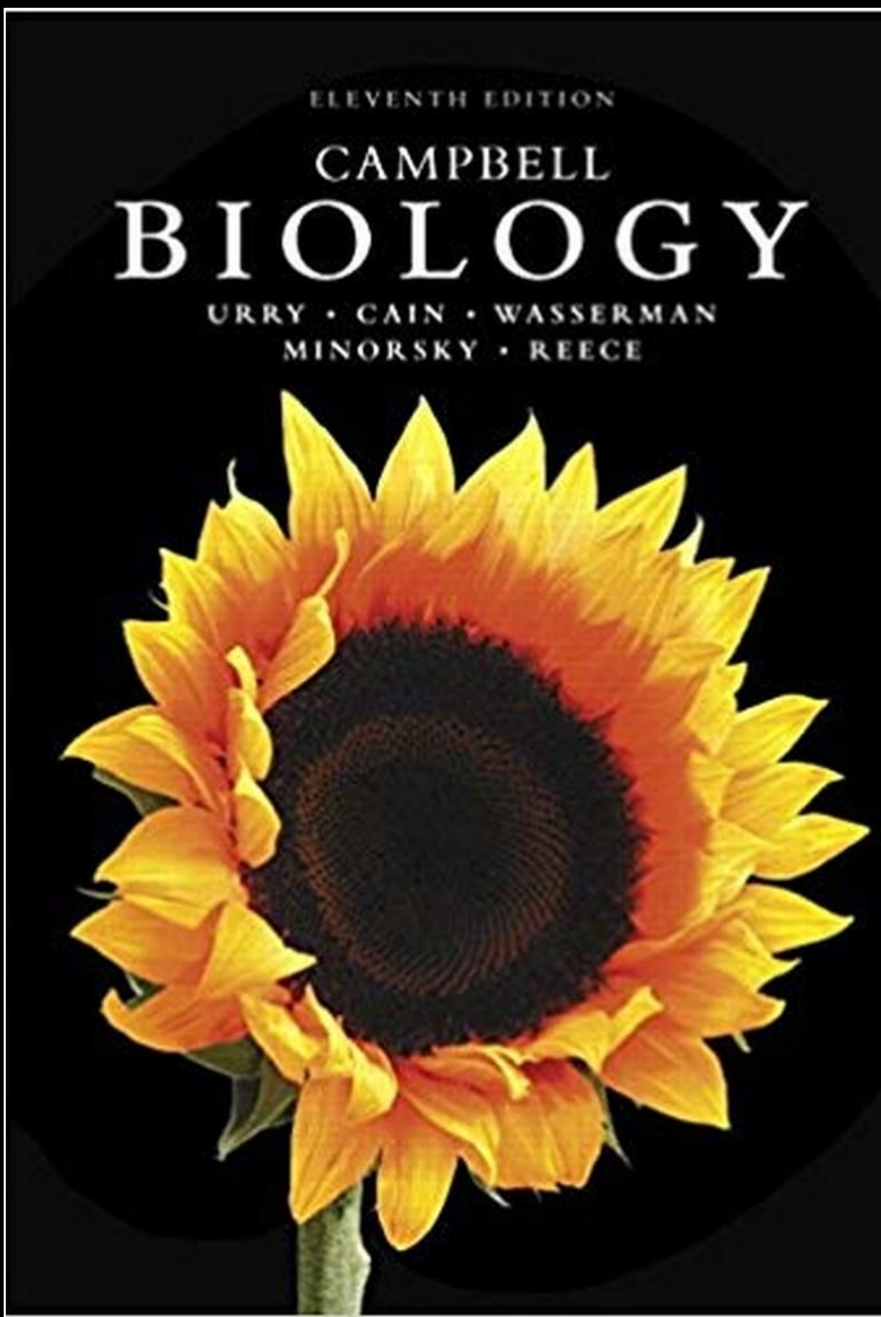
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Source: [Wikimedia Commons](https://commons.wikimedia.org/wiki/File:Anne_Elizabeth_Darwin.jpg).Anne Elizabeth Darwin
(1841 1851)Image by julia&keld on FindAGrave.com. © FindAGrave.com. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.Graves of
Mary Eleanor Darwin (1842 1842)
Charles Waring Darwin (1856 1858)

“If he had any inclination to think about his theory of natural selection at ... [the time of his children’s deaths], [Darwin] might easily have reflected on the melancholy fact that his ideas of struggle required the death of the weakest individuals, even of his own babies. His theory was a bleak theory of elimination.”

Browne, Janet. *Charles Darwin: The Power of Place*. Princeton University Press, 2003. © Princeton University Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

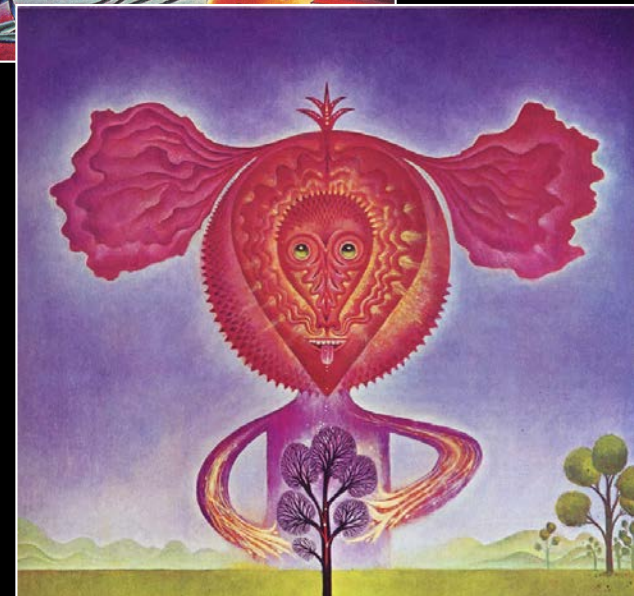
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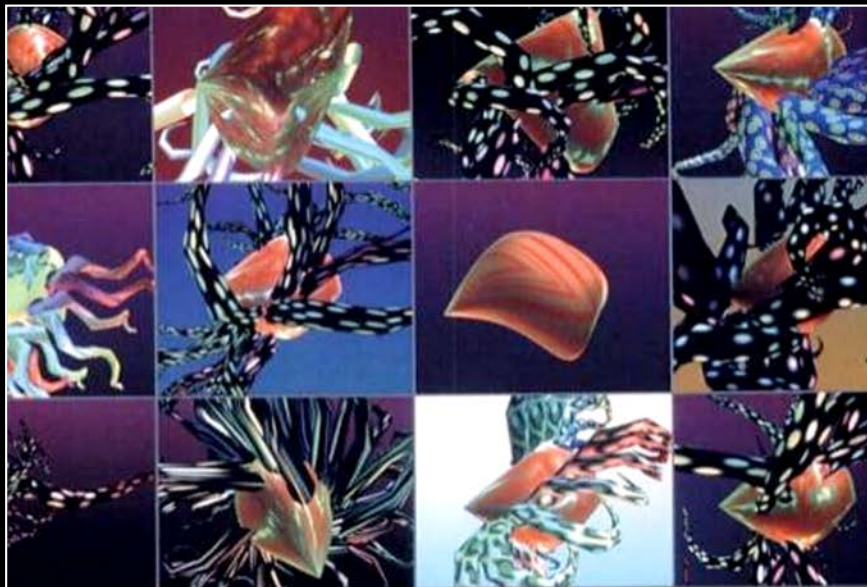
Urry, Lisa, Michael Cain, et al. *Campbell Biology*. 11th ed. Pearson, 2016. © Pearson. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

Biology Today



Biology Today textbook, 1972,
published by Communications Research Machines, Inc.

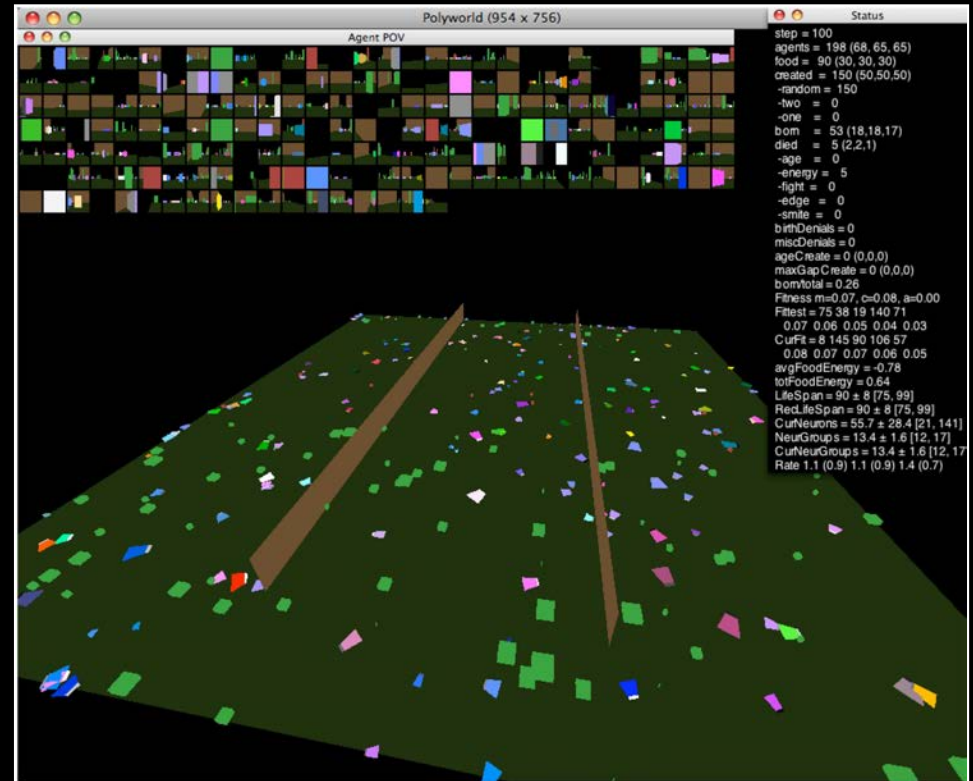
Illustrations for chapters on "Human Possibilities" and "Viruses"



S I L I C O N
S E C O N D
N A T U R E

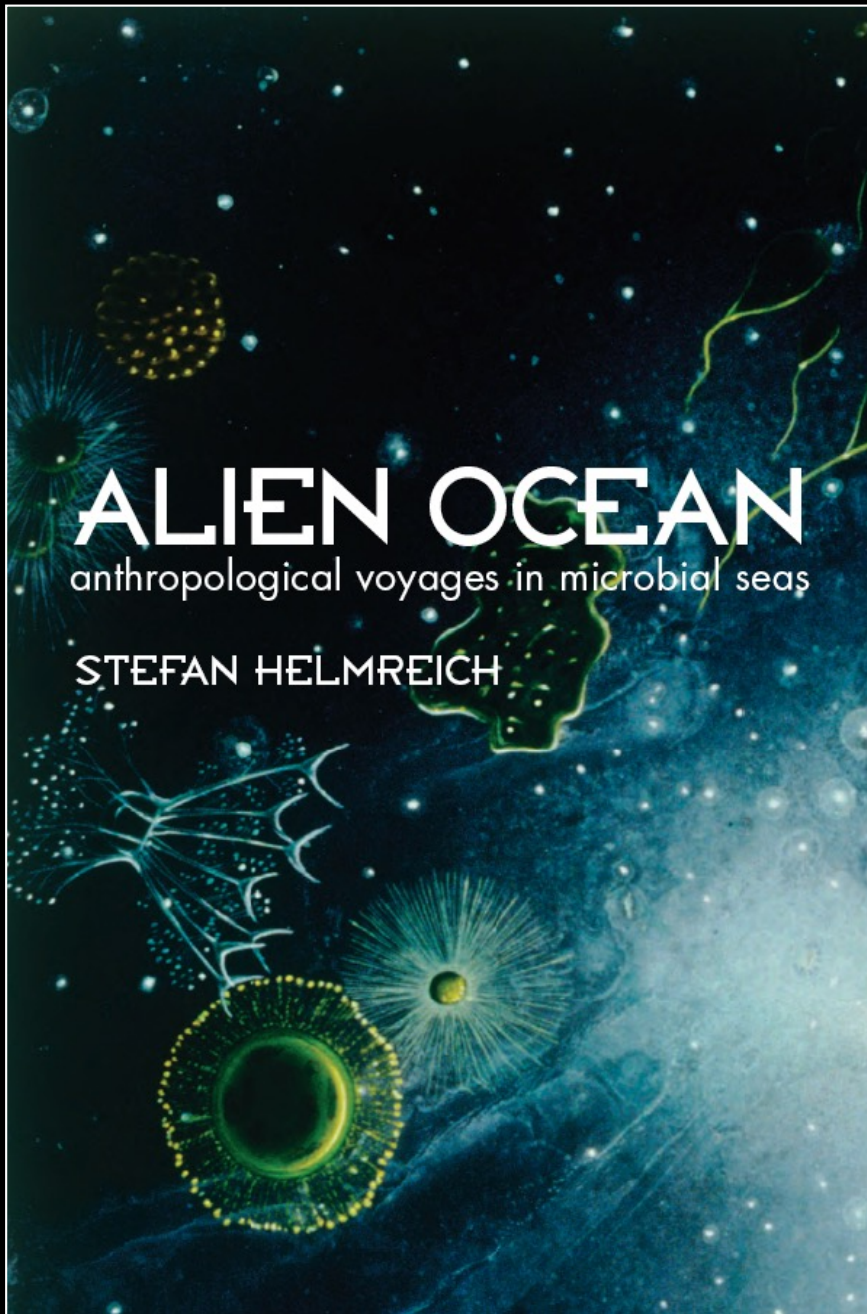
*Culturing Artificial Life
in a Digital World*
Stefan Helmreich.

Updated Edition With a New Preface



Screenshot of artificial life simulation “Polyworld,” designed by Larry Yaeger, early 1990s, showing “a graphical environment in which a population of trapezoid agents search for food, mate, have offspring, and prey on each other”

Image by [Polyworld](#) on Wikipedia. License CC BY-SA. © Polyworld. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

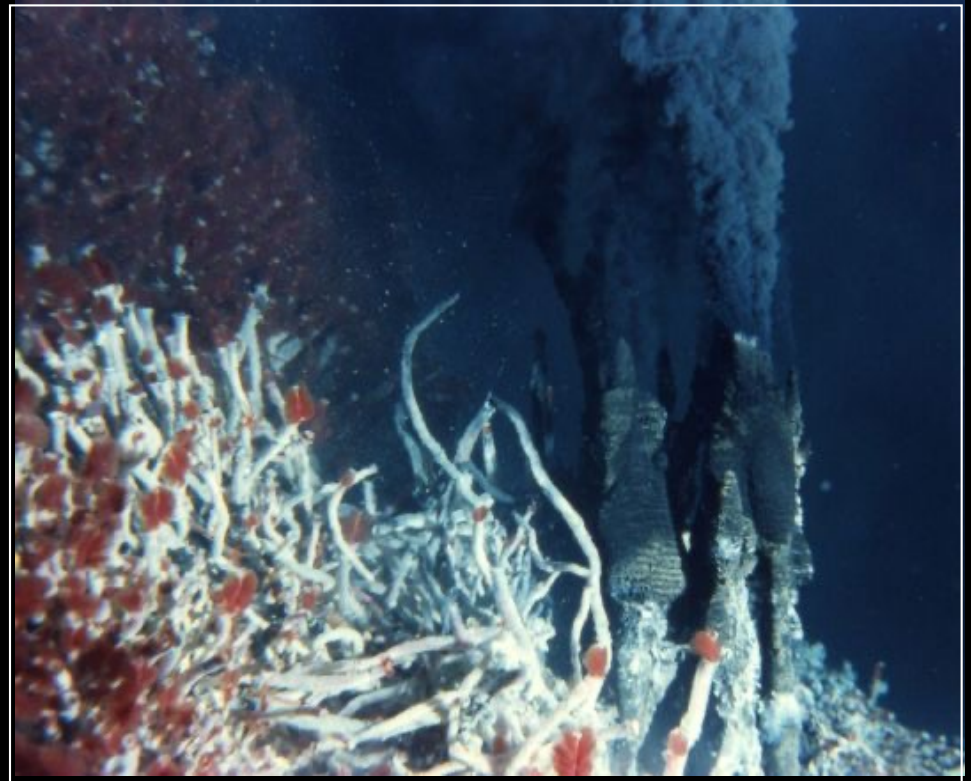


ALIEN OCEAN

anthropological voyages in microbial seas

STEFAN HELMREICH

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A hydrothermal vent on the Juan de Fuca Ridge in the North Pacific Ocean off Vancouver Island (British-Columbia, Canada)

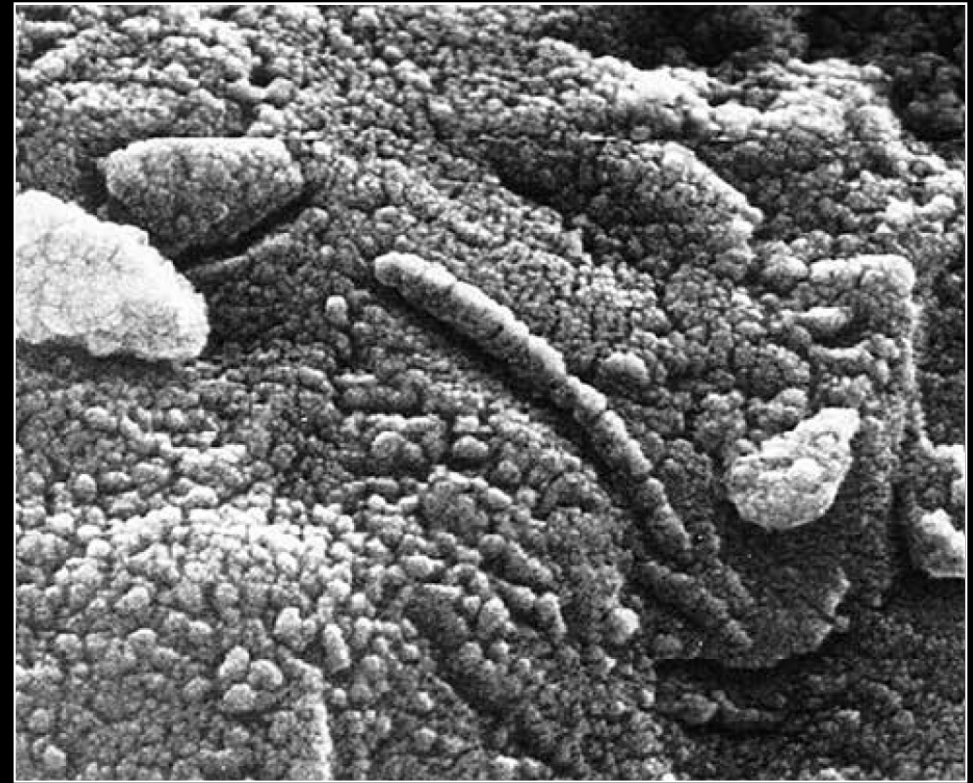
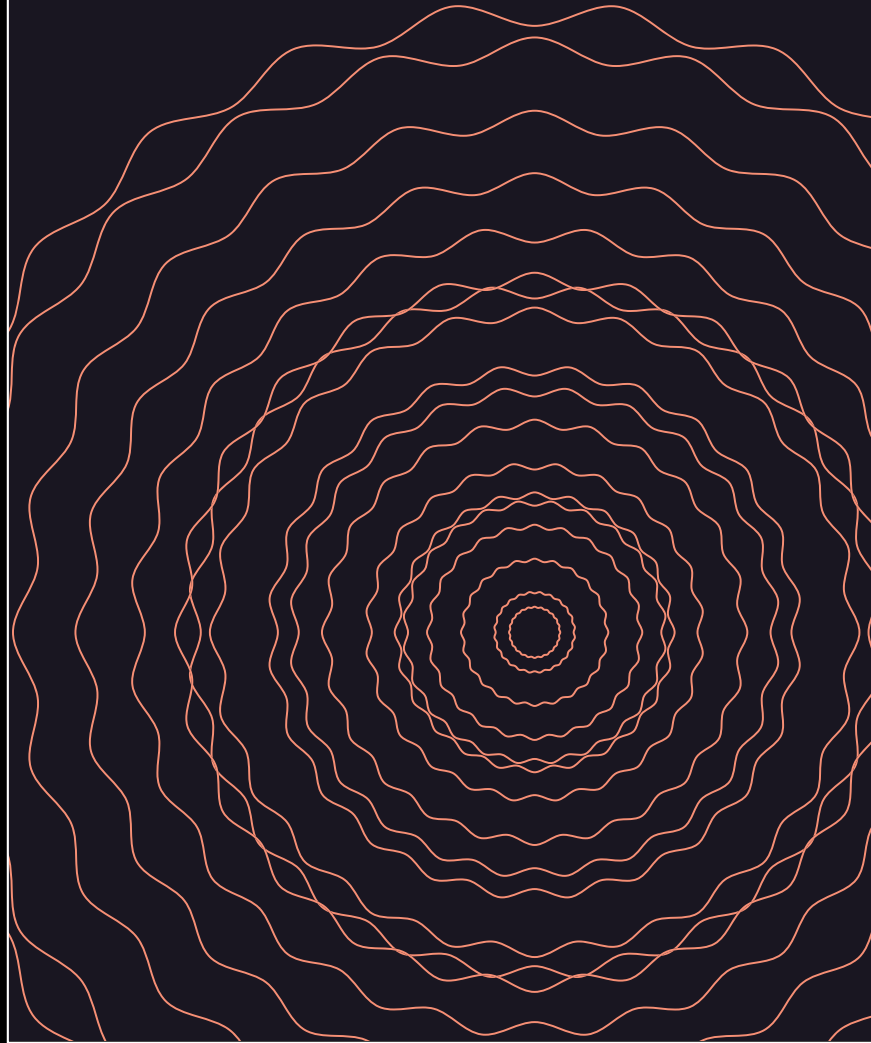
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Helmreich, Stefan. *Alien Ocean: Anthropological Voyages in Microbial Seas*. University of California Press, 2009. © University of California Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

Sounding the Limits of Life

Essays in the
Anthropology of
Biology and Beyond

Stefan Helmreich



Ovoid forms inside Martian meteorite ALH84001, as depicted through scanning electron microscopy. The elongated shape in the center is some several hundred nanometers in length. Discussed in D. S. McKay, E. K. Gibson Jr., et al., "Search for Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001," *Science* 273 (1996): 924-930. Image: NASA.

Image by NASA. This image is in the public domain. Source: [Wikimedia Commons](#).

Helmreich, Stefan. *Sounding the Limits of Life: Essays in the Anthropology of Biology and Beyond*. Princeton University Press, 2015. © Princeton University Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

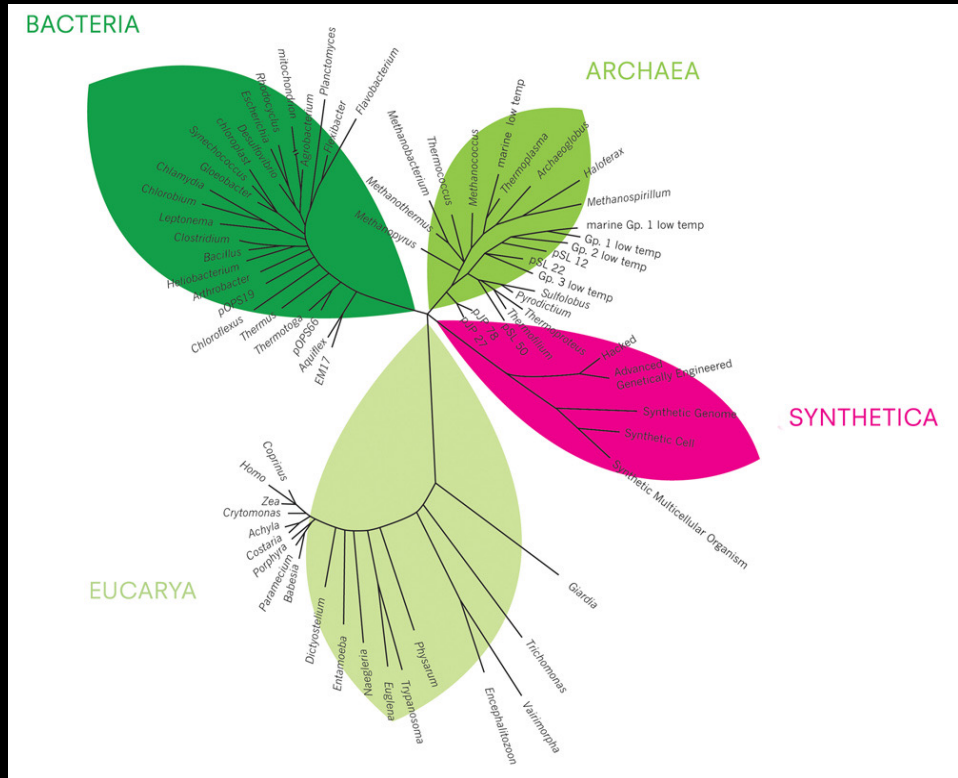
SYNTHETIC

How Life Got Made



SOPHIA ROOSTH

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Alexandra Daisy Ginsberg, "The Synthetic Kingdom," 2009
<https://www.daisyginsberg.com/work/synthetic-kingdom>

Roosth, Sophia. *Synthetic: How Life Got Made*. University of Chicago Press, 2017. © University of Chicago Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

Life Forms: A Keyword Entry

IN A 2007 REPORT JOINTLY ISSUED by the United States National Research Council's Committee on the Limits of Organic Life in Planetary Systems and Committee on the Origins and Evolution of Life, biologists interested in the possibility of life on other planets speculate that living systems might employ ammonia, sulfuric acid, or methane as a solvent in the way life on Earth uses water.¹ Perhaps just as remarkable as the project of chemical conjecture delivered by this report, however, is the document's opening inscription: *Dedicated to Non-Human-Like Life Forms, Wherever They Are.*² Leaving aside the authors' probable intention that "non-human-like" should rather read "unknown" or "extraterrestrial," what captures our attention in this address is its most workaday term: *life forms*. How did life come to have a form? More modestly and narrowly: where did the term *life form* come from? And what has *life form* come to mean in the contemporary moment, when it is possible to use the term to refer to as-yet conjectural manifestations, manifestations that may redefine the very referent of life itself?

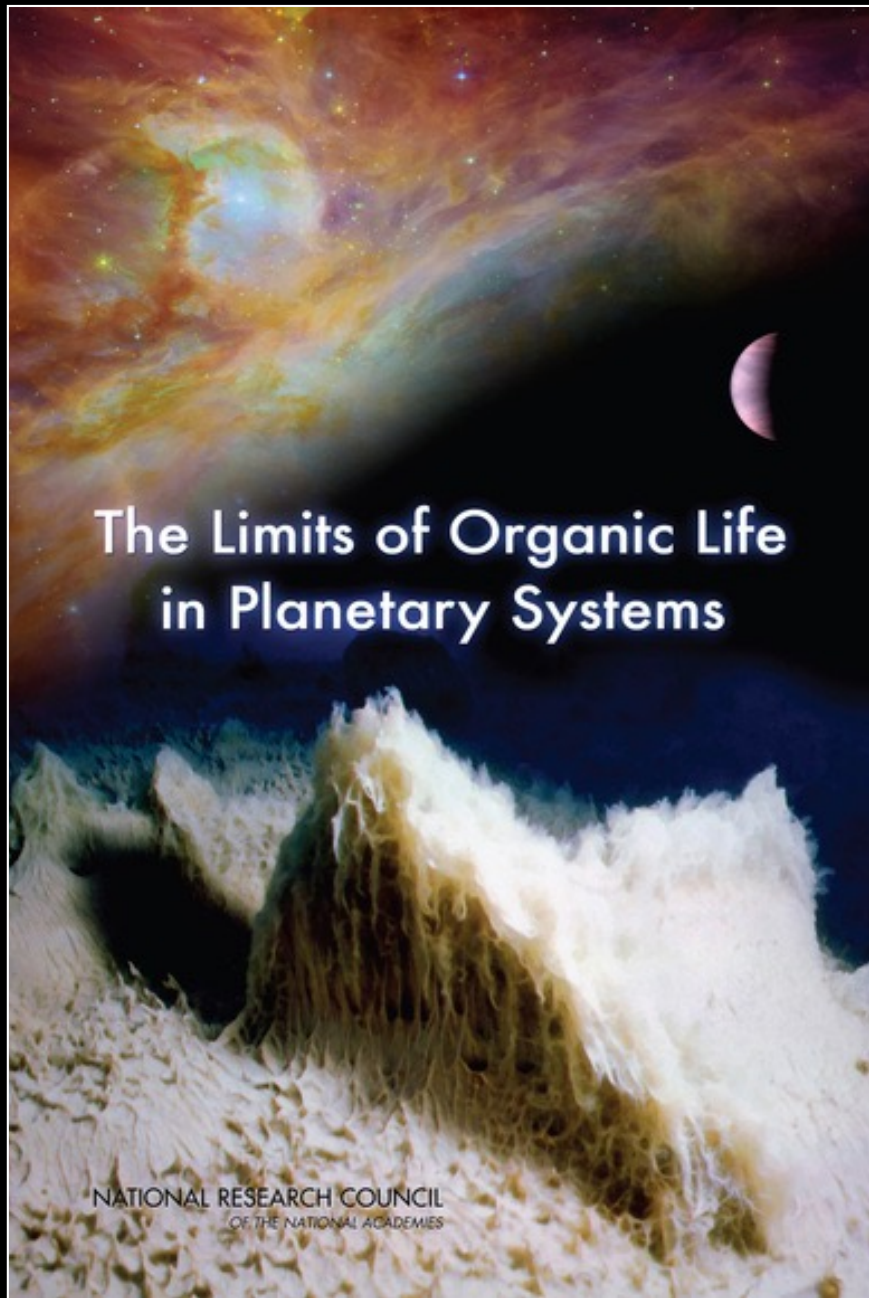
In *The Life of Forms in Art*, art historian Henri Focillon writes, "Form is surrounded by a certain aura: although it is our most strict definition of space, it also suggests to us the existence of other forms."³ Inspired by Focillon, we ask: how does the concept of life form operate to suggest the existence of other life forms? We argue that *life form* has, since its earliest nineteenth-century enunciations, pointed to a space of possibility within which life might take shape. Exactly how that space is understood and theorized has transformed as the term has traveled into the present. We suggest that *life form* has moved from its origins as a term referring to abstract, idealized, aesthetic possibilities through reference to biogeographic and evolutionary possibilities to, today, conjectural and future possibilities.

ABSTRACT We deliver a "keyword" account of the term *life form* as it has been used in natural philosophy and biology over the last two hundred years, beginning with its appearance in German as *Lebensform*. We argue that *life form* has, since its earliest enunciations, pointed to a space of possibility within which life might take shape, but that the way that space is imagined and theorized in biology has transformed substantially; *life form* originated as a term referring to idealized, aesthetic possibilities, then transformed to describe biogeographic and evolutionary potentialities, and today, in the age of synthetic biology and astrobiology, has come to signal conjectural and future possibilities. / REPRESENTATIONS 112, Fall 2010 © The Regents of the University of California. ISSN 0734-6018, electronic ISSN 1533-855X, pages 27-53. All rights reserved. Direct requests for permission to photocopy or reproduce article content to the University of California Press at <http://www.ucpressjournals.com/reprintinfo.asp>. DOI:10.1525/rep.2010.112.1.27.

27

The screenshot shows the OED entry for "life form, n." The header includes the OED logo and the text "Oxford English Dictionary The definitive record of the English language". A search bar is visible in the top right. The entry title "life form, n." is prominently displayed in red. Below the title are options for "View as: Outline | Full entry" and "Quotations: Show all | Hide all". The pronunciation is given as "/ˈlaɪf fɔːm/, U.S. /ˈlaɪf ˌfɔ(ə)rɪm/". The frequency is indicated by a row of colored dots. The origin is "Formed within English, by compounding." and the etymology is "< LIFE n. + FORM n. In sense 2 after German *Lebensform*...". The first definition is "1. A living organism." followed by a "Thesaurus" link. Three historical quotations are provided: 1850 *Q. Homœopathic Jrnal.* 2 219, 1869 *Anthropol. Rev.* 7 18, and 1895 *Science* 4 Jan. 23.

New Oxford American Dictionary. 3rd ed. Oxford University Press, 2010. © Oxford University Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.



The Limits of Organic Life in Planetary Systems

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

Committee on the Limits of Organic Life in Planetary Systems
Committee on the Origins and Evolution of Life

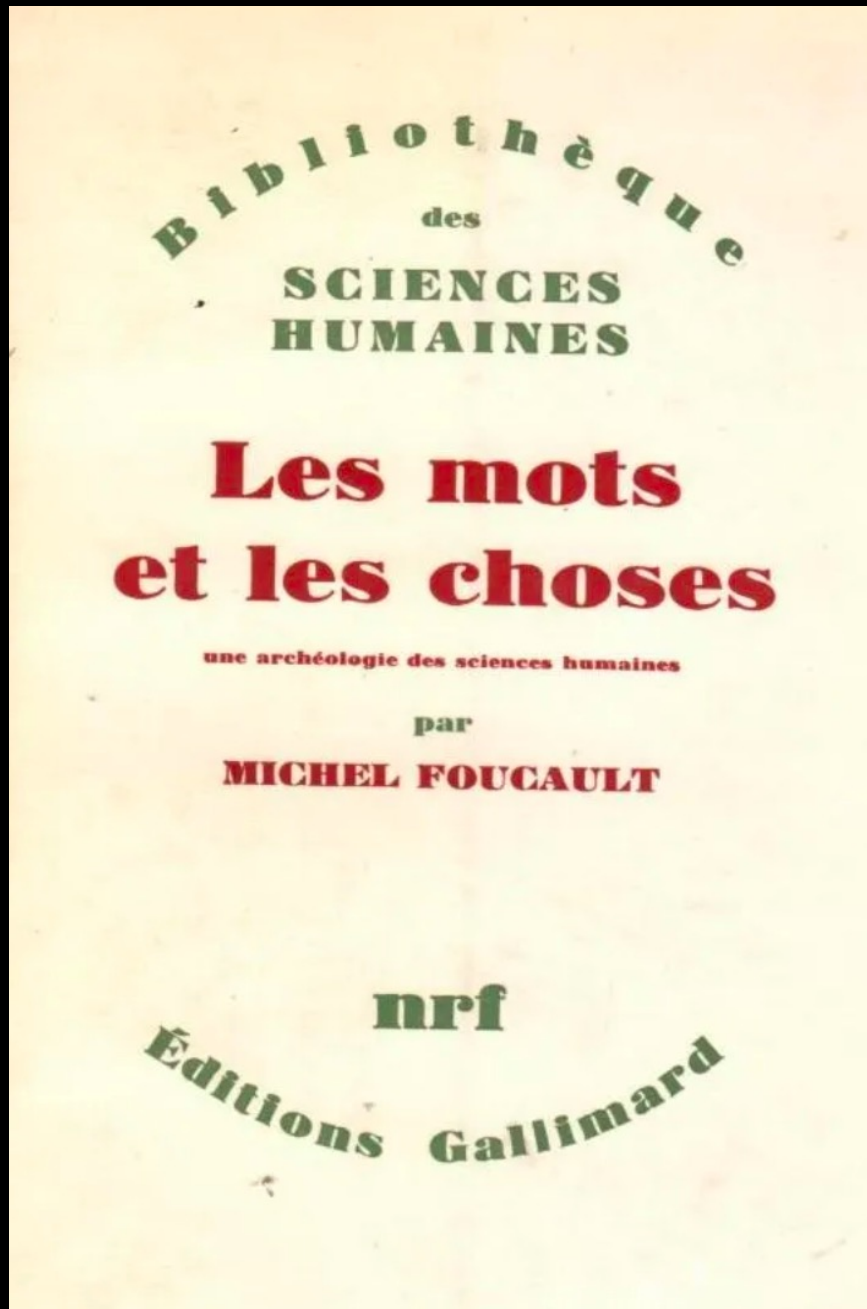
Space Studies Board
Division on Engineering and Physical Sciences

Board on Life Sciences
Division on Earth and Life Studies

Dedicated to

*Non-Human-Like Life Forms,
Wherever They Are*

National Research Council of the National Academies. *The Limits of Organic Life in Planetary Systems*. National Academies Press, 2007. © National Academies Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.



“Historians want to write histories of biology in the eighteenth century; but they do not realize that biology did not exist then, and that the pattern of knowledge that has been familiar to us for a hundred and fifty years is not valid for a previous period. And that, if biology was unknown, there was a very simple reason for it: that life itself did not exist. All that existed was living beings, which were viewed through a grid of knowledge constituted by *natural history*.”

RECHERCHES
SUR L'ORGANISATION
DES CORPS VIVANS,
ET PARTICULIÈREMENT

Sur son origine, sur la cause de ses développemens et des progrès de sa composition, et sur celle qui, tendant continuellement à la détruire dans chaque individu, amène nécessairement sa mort;

Précédé du Discours d'ouverture du Cours de Zoologie, donné dans le Muséum National d'Histoire Naturelle, l'an X de la République;

PAR J. B. LAMARCK,

De l'institut National de France, l'un des Professeurs-Administrateurs du Muséum d'Histoire Naturelle, des Sociétés d'Histoire naturelle, des Pharmaciens et Philomatique de Paris, de celle d'Agriculture de Seine-et-Oise, etc.



A PARIS,

CHEZ { L'AUTEUR, au Muséum d'Histoire Naturelle;
MAILLARD, Libraire, rue du Pont de Lodi,

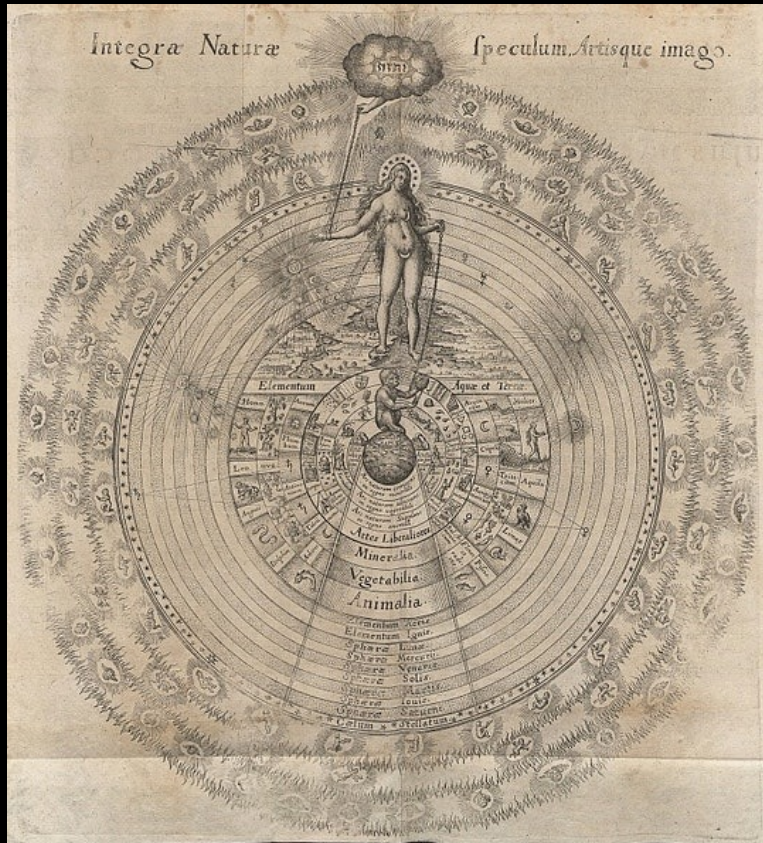


Jean-Baptiste Lamarck
(1744-1829)



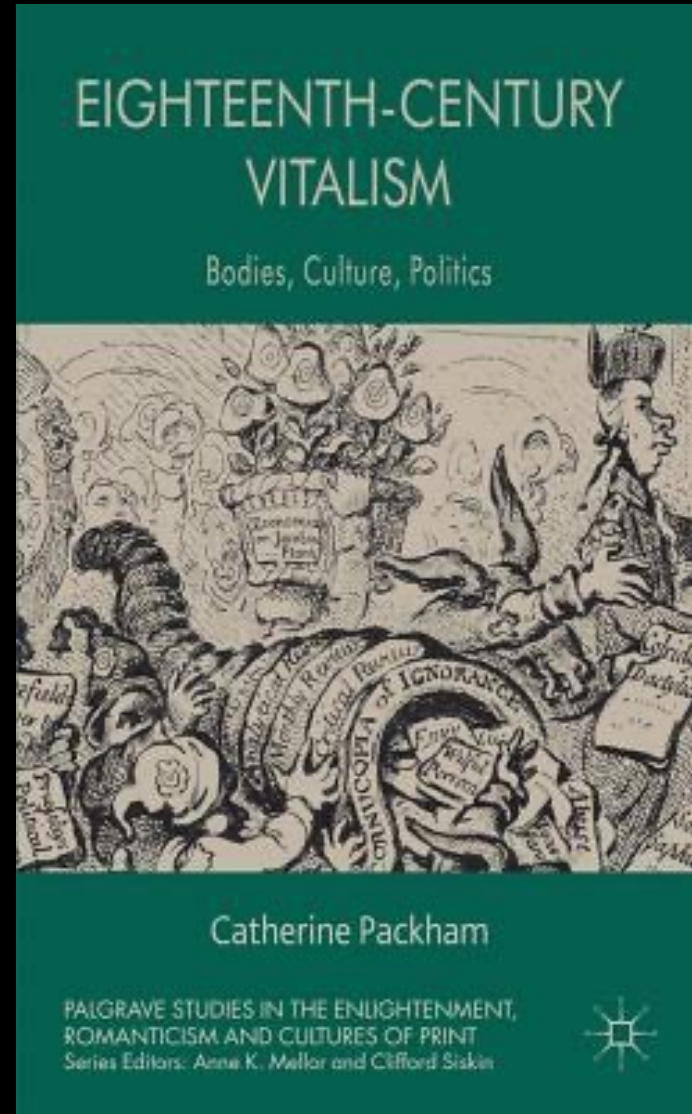
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Museum of Ole Worm, Copenhagen, interior. Engraving, 1655.

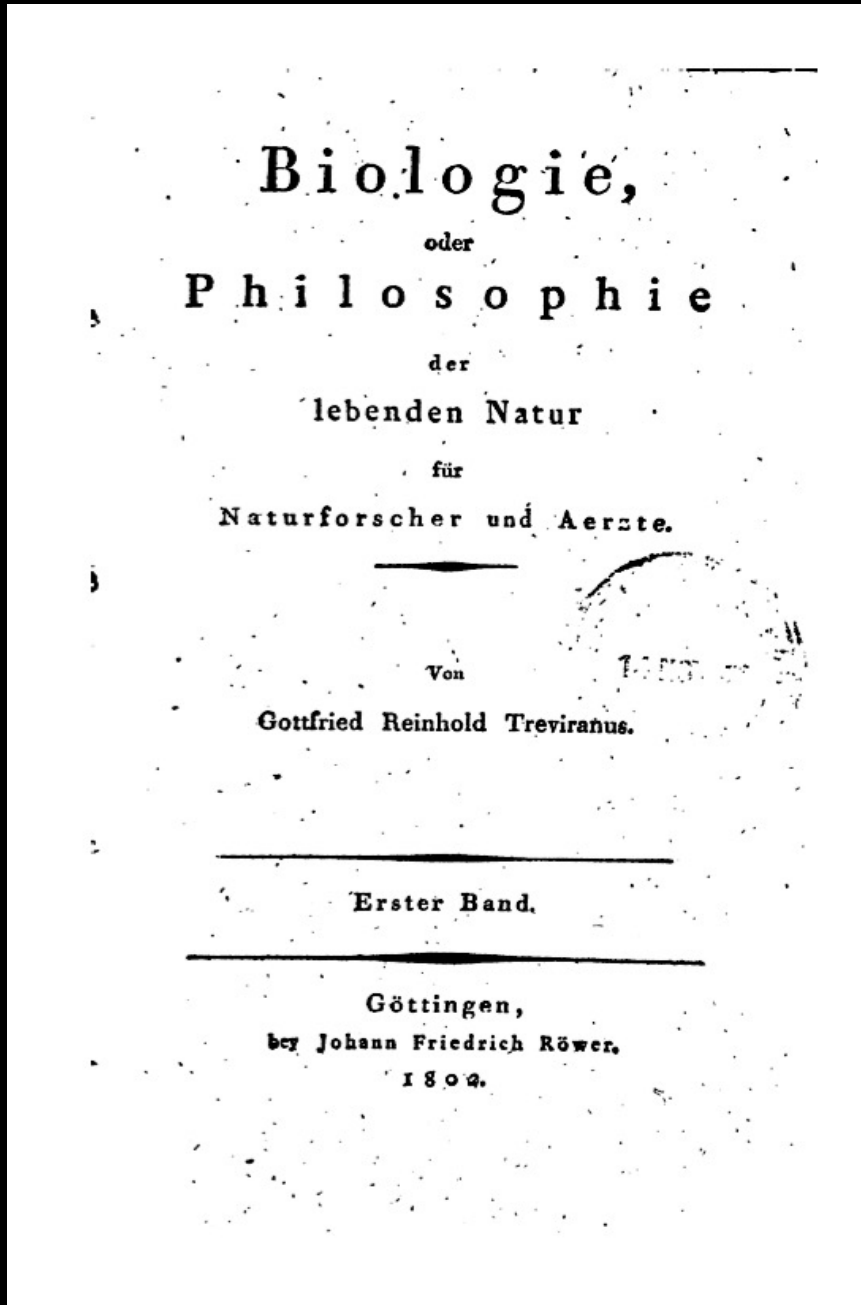


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The great chain from God to nature and from nature to man.
 Robert Fludd, *Utriusque cosmi maioris scilicet...* 1617-1618



Packham, Catherine. *Eighteenth-Century Vitalism: Bodies, Culture, Politics*. Palgrave Macmillan, 2012. © Palgrave Macmillan. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

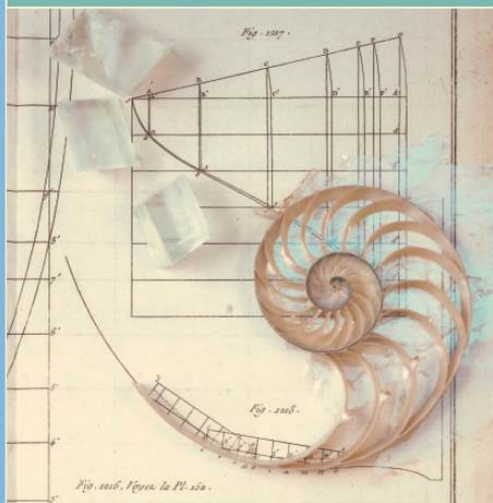


Gottfried Reinhold Treviranus
(1776-1837)

"The objects of our research will be the different forms and manifestations of life."

EVELYN FOX KELLER

MAKING SENSE OF LIFE



Explaining Biological Development
WITH
Models, Metaphors, and Machines

Keller, Evelyn Fox. *Making Sense of Life: Explaining Biological Development with Models, Metaphors, and Machines*. Harvard University Press, 2003. © Harvard University Press. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/help/faq-fair-use/>.

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Evelyn Fox Keller

“the significance of demarcating biology as a distinctive scientific field ... was the establishment of an intellectual space from which the category of ‘life’ could be taken as a given”

LEBENSFORM, *f.*: die physische beschaffenheit der weltkörper und die auf denselben möglichen lebensformen [the physical properties of heavenly bodies and the life forms possible upon them]. *Jenaer litt.-zeitung* 1838, no. 179 s. 468.

from Deutsches Wörterbuch of Jakob and Wilhelm Grimm

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Spring 2022

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