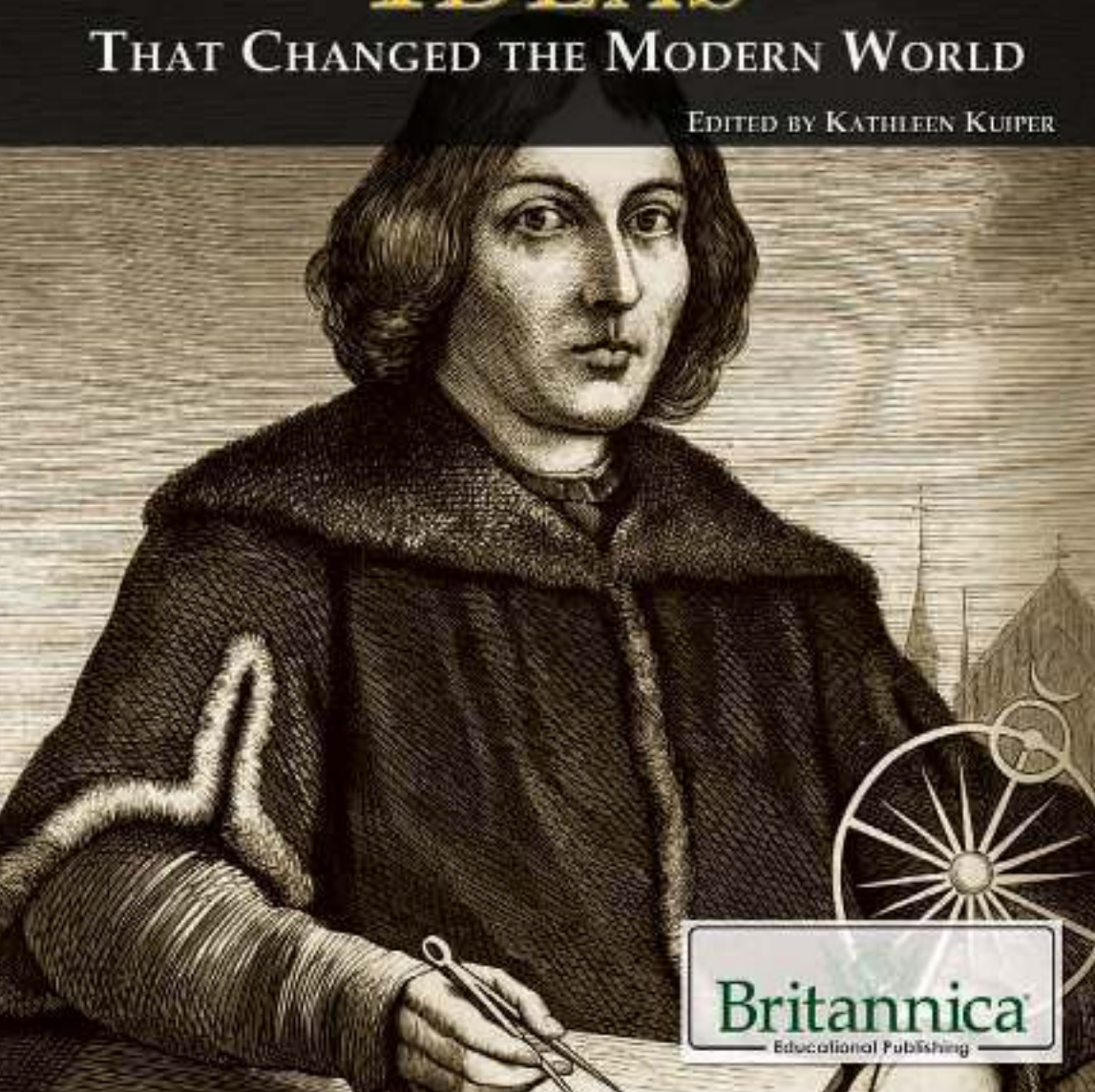


TURNING POINTS IN HISTORY

THE BRITANNICA GUIDE TO
**THEORIES AND
IDEAS**
THAT CHANGED THE MODERN WORLD

EDITED BY KATHLEEN KUIPER



Britannica
Educational Publishing

THE BRITANNICA GUIDE TO

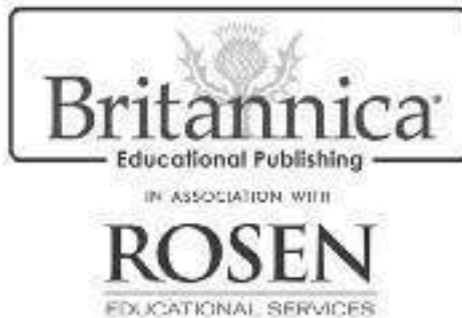
THEORIES AND
IDEAS

THAT CHANGED THE MODERN WORLD

TURNING POINTS IN HISTORY

THE BRITANNICA GUIDE TO
THEORIES AND
IDEAS
THAT CHANGED THE MODERN WORLD

EDITED BY KATHLEEN KUIPER, MANAGER, ARTS AND CULTURE



Published in 2010 by Britannica Educational Publishing
(a trademark of Encyclopædia Britannica, Inc.)
in association with Rosen Educational Services, LLC
29 East 21st Street, New York, NY 10010.

Copyright © 2010 Encyclopædia Britannica, Inc. Britannica, Encyclopædia Britannica,
and the Thistle logo are registered trademarks of Encyclopædia Britannica, Inc. All
rights reserved.

Rosen Educational Services materials copyright © 2010 Rosen Educational Services, LLC.
All rights reserved.

Distributed exclusively by Rosen Educational Services.
For a listing of additional Britannica Educational Publishing titles, call toll free (800) 237-9932.

First Edition

Britannica Educational Publishing

Michael I. Levy: Executive Editor

Marilyn L. Barton: Senior Coordinator, Production Control

Steven Bosco: Director, Editorial Technologies

Lisa S. Braucher: Senior Producer and Data Editor

Yvette Charboneau: Senior Copy Editor

Kathy Nakamura: Manager, Media Acquisition

Kathleen Kuiper: Manager, Arts and Culture

Rosen Educational Services

Jeanne Nagle: Senior Editor

Nelson Sá: Art Director

Matthew Cauli: Designer

Introduction by Holly Cefrey

Library of Congress Cataloging-in-Publication Data

The Britannica guide to theories and ideas that changed the modern world / edited by
Kathleen Kuiper. — 1st ed.

p. cm. — (Turning points in history)

Includes bibliographical references and index.

“In association with Britannica Educational Publishing, Rosen Educational Services.”

ISBN 978-1-61530-063-1 (eBook)

1. Civilization, Modern. 2. Intellectual life—History. 3. Science—History. 4. Philosophy,
Modern—History. I. Kuiper, Kathleen.

CB358.B69 2010

901—dc22

2009048166

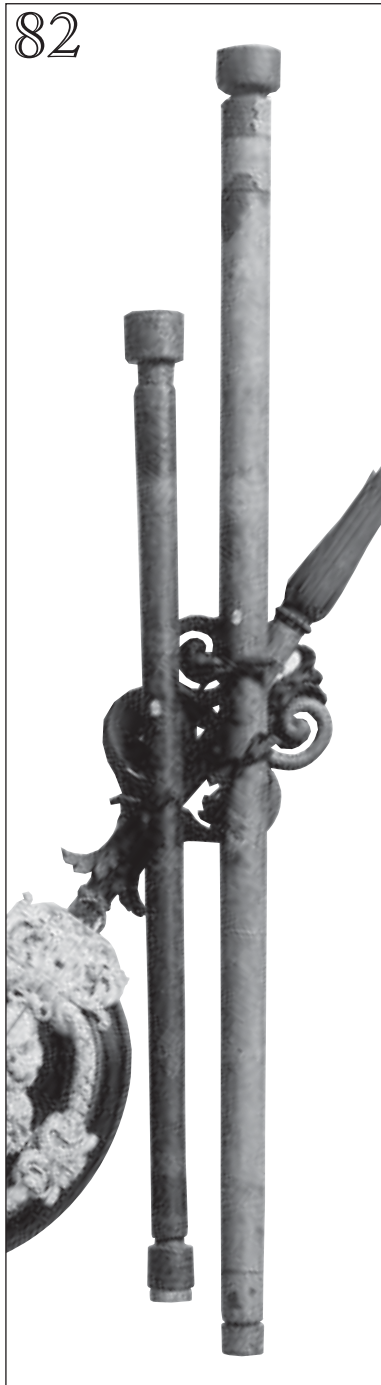
On the cover: *Nicolaus Copernicus's heliocentric concept of the solar system is but one of the theories and ideas that have had a profound effect on humankind throughout the ages.* Kean Collection/Hulton Archive/Getty Images

CONTENTS

Introduction	12
Chapter 1: The Biological Sciences	21
The Origin of Life	21
The Death	
of Spontaneous Generation	22
The Origin of Primordial Life	23
<i>Antonie van Leeuwenhoek</i>	24
Cell Theory	25
The Problem	
of the Origin of Cells	28
The Protoplasm Concept	31
The Contribution	
of Other Sciences	32
<i>Marcello Malpighi</i>	34
Germ Theory	35
Discoveries in Clinical	
Medicine and Anesthesia	37
Advances at the End of the Century	38
<i>Louis Pasteur</i>	39
Genetics	40
Ancient Theories of Pangenesis	
and Blood in Heredity	41
Preformation	
and Natural Selection	43
The Work of Mendel	44
How the Gene Idea	
Became Reality	45
The Discovery of Linked Genes	46
Early Molecular Genetics	47
DNA and the Genetic Code	47
Recombinant DNA	
Technology and the	
Polymerase Chain Reaction	49
<i>Gregor Mendel</i>	50
Evolution	51
The Work of Charles Darwin	52
The Darwinian Aftermath	54
The Synthetic Theory	56



Molecular Biology and Earth Sciences	57
<i>Charles Darwin</i>	58
Ecology	60
<i>Charles Elton</i>	63
Chapter 2: Mathematics and the Physical Sciences	65
Arabic Numerals	65
<i>Al-Khwārizmī</i>	66
The Calculus	67
The Precalculus Period	67
Newton and Leibniz	70
<i>Gottfried Wilhelm Leibniz</i>	73
The Atomic Theory	74
<i>John Dalton</i>	77
The Roots of Astronomy	77
The Scientific Revolution	80
A Preponderance of Theories	80
<i>Nicolaus Copernicus</i>	83
Gravitational Theory	84
<i>Sir Isaac Newton</i>	86
Special Relativity	87
Light and the Ether	88
Einstein's Gedankenexperiments	90
Starting Points and Postulates	90
Relativistic Space and Time	91
Cosmic Speed Limit	94
$E = mc^2$	94
<i>Albert Einstein</i>	95
General Relativity	96
Principle of Equivalence	97
Curved Space-Time and Geometric Gravitation	99
Quantum Mechanics	100
Planck's Radiation Law	100
Einstein and the Photoelectric Effect	101
Bohr's Theory of the Atom	102
Scattering of X-rays	104
Broglie's Wave Hypothesis	105
<i>String Theory</i>	106



The Expanding Universe:	
The Big Bang Theory	108
The Evolution of Stars	
and the Formation	
of Chemical Elements	111
Solar-System Astronomy	113
<i>George Gamow</i>	114
Plate Tectonics	114
Alfred Wegener and the	
Concept of Continental Drift	115
Isostasy	115
Driving Forces	116
Evidence Supporting	
the Hypothesis	116
Paleomagnetism, Polar	
Wandering, and	
Continental Drift	117
Gestation and Birth	
of Plate Tectonic Theory	118
Determination of	
Plate Thickness	121
Plate-Driving Mechanisms	
and the Role of the Mantle	122
<i>Alfred Wegener</i>	122
Geologic Time	123
Knowledge of Landforms	
and of Land-Sea Relations	123
Paleontology and Stratigraphy	124
William Smith	
and Faunal Succession	125
Charles Lyell	
and Uniformitarianism	126
Louis Agassiz and the Ice Age	127
Geologic Time and	
the Age of the Earth	127
<i>William Smith</i>	128
Chapter 3: The Arts	130
Perspective	130
<i>Filippo Brunelleschi</i>	133
Abstract Art	135
<i>Maurice Denis</i>	137



Impressionism	138
<i>Claude Monet</i>	140
Expressionism	141
The Visual Arts	142
Literature and Drama	147
Other Arts	148
<i>Oskar Kokoschka</i>	150
Cubism	151
Origins of the Style	151
The First Phase	151
The Second Phase: Analytical Cubism	152
The Third Phase: Synthetic Cubism	154
<i>Georges Braque</i>	154
Modernism	155
Modernism in Literature	156
<i>Ezra Pound</i>	157
Modernism in Other Arts and Architecture	158
Harmony	159
The Roots of Harmony	161
Harmony Before the Common Practice Period	162
Classical Western Harmony	169
<i>Jean-Philippe Rameau</i>	171
Montage	171
<i>Sergey Eisenstein</i>	174
Theory of Architecture	175
Distinction Between the History and Theory of Architecture	177
Distinction Between the Theory of Architecture and the Theory of Art	179
Functionalism	182
The Art of Building	184
“Commodity, Firmness, and Delight”:	
The Ultimate Synthesis	187
<i>Vitruvius</i>	197



Green Architecture	198
The Rise of Eco-Awareness	199
Green Design Takes Root	201
The Principles of Building Green	205
The Challenges to Architecture	207
<i>Renzo Piano and the California Academy of Sciences</i>	209
Urban Planning	211
The Development of Urban Planning	213
Urban Form	221
The Scope of Planning	224
<i>Jane Jacobs</i>	233

Chapter 4: The Social Sciences, Philosophy, and Religion 235

Mass Production	235
The Industrial Revolution and Early Developments	236
Pioneers of Mass Production Methods	238
Manufacturing Pioneers	239
<i>The Assembly Line</i>	239
Theories of Child Development	241
Psychoanalytic Theories	242
Piaget's Theory	244
Learning Theory	245
<i>Jean Piaget</i>	247
Psychoanalytic Theory	247
Screen Memories	248
The Interpretation of Dreams	250
Further Theoretical Development	252
<i>Sigmund Freud</i>	253
Human Rights	255
<i>Universal Declaration of Human Rights</i>	257
Conscience	258
<i>George Fox</i>	259



Sin	260
<i>John Calvin</i>	262
Soul	262
<i>Augustine</i>	265
The Problem of Evil	266
The Problem	266
Theistic Responses	267
<i>Hannah Arendt</i>	269
Just War	269
<i>Jihad</i>	272
Natural Law	273
<i>Jean-Jacques Rousseau</i>	276
Punishment	278
Theories and Objectives of Punishment	278
Punishment in Islamic Law	284
Punishment in Asian Societies	286
<i>Cesare Beccaria</i>	287
Utopia	288
<i>Sir Thomas More</i>	292
Monotheism	293
Amarna Style	294



Chapter 5: Politics and the Law	298
Neutrality	298
<i>Hague Conventions</i>	300
Due Process	302
Democracy	304
History	304
Contemporary Democratic Systems	308
Equal Protection	311
<i>Bush v. Gore</i>	312
International Law	316
Definition and Scope	316
Historical Development	319
International Law and Municipal Law	325
<i>Jeremy Bentham</i>	328
Social Contract	329
<i>Thomas Hobbes</i>	331



Absolutism	332
<i>Louis XIV</i>	334
Nationalism	336
The Identification of State and People	336
Cultural Nationalism	338
European Nationalism	339
Asian and African Nationalism	344
<i>Puritanism and the Establishment of the Holy Commonwealth</i>	349
Intellectual-Property Law	353
The Emergence of Intellectual-Property Law	353
Internet Domain Names	355
The World Trade Organization and Intellectual-Property Law	356
Economic and Ethical Issues	357
Theoretical Debates	358
Trends	361
<i>Trademark</i>	362



Glossary	366
For Further Reading	369
Index	371



*I*ntroduction



At choice moments throughout time, individuals have posed new ideas or theories that have gone against the grain. Someone decided what is known is not enough and asked—sometimes demanded—that the world look at an issue, circumstance, or traditional method in a whole new way. The story of humanity is rife with such turning points. Some have begun as small changes but reverberated, building in strength until their impact on the world became tremendous. Others were so essential that they were expressed almost immediately on a global scale.

This book examines the theories and ideas that have inextricably altered the foundation of existence—atomic theory, evolution, absolutism, Modernism, and natural law among them. The players behind each concept are highlighted throughout, and each chapter includes information about the climate and cultural perspectives from which each crucial moment sprang.

The biological sciences have engendered any number of theories designed to explain the origin, structure, function, and evolution of living organisms. In this discipline, ideas are continually put to the test through research and experimentation, then challenged and enhanced as new facts come to light. For instance, the ancient Greek belief that life was spontaneously generated gave way to the conceit that every living creature emanated from a fertilized egg.

Although scientists had begun observing and cataloguing various kinds of cells as early as the 1600s, it wasn't until much later that they truly began to understand their nature, how they functioned and reproduced. Cell theory—the notion that all living things are made from cells, and that all vital functions occur within them—was formulated in the 1800s by two German scientists, Theodore Schwann and Matthias Schleiden.

The situation was much the same when it came to germ theory. Since at least 100 BCE, investigators had suspected that disease was caused by tiny invaders. But it wasn't until the 19th century, when Italy's Agostino Bassi showed that a particular silkworm disease was caused by a fungus, that this theory was proved. Such studies underscored the need for stringent sanitary standards to combat the specific bacteria and viruses that threatened the health and well being of humans and animals. French chemist Louis Pasteur took this concept one step further, developing vaccines to contain or prevent the spread of diseases such as anthrax, cholera, and rabies. In this way, cell theory and germ theory helped save untold millions of lives.

Other biological science turning points have centred on the subject of diversity. Evolutionary theory charts the progression of life from a single progenitor, generally moving from simple to complex forms all the while. Evolution makes distinctions among various species. Genetics, on the other hand, concentrates on variations within species. The ability to determine the transmission of individual inherited traits by studying genes—or, in modern times, mapping links on the DNA chain—has yielded life-altering breakthroughs in the way humans grow food, solve crimes, reproduce, and, perhaps most important, treat disease.

The physical sciences have witnessed their fair share of momentous change due to ideas wrought from observation and conjecture. Several well-known, fundamental theories and scientific concepts are associated with the study of nonliving entities: Albert Einstein's theory of relativity ($E = mc^2$); the legend of Isaac Newton getting konked on the head by an apple, which illustrates laws governing the universal force of attraction known as gravity.

Many turning points in human comprehension of the universe have come about through the study of astronomy, a field that itself stemmed from ideas conceived by curious stargazers. Astronomy and mathematics, a field that makes good use of the theoretical in order to solve problems, are closely linked. Ancient astronomers believed the order of the universe was fundamentally mathematical in nature, and used arithmetic to predict celestial movements. As time went by, astronomers (who were also frequently mathematicians by trade) honed equations and progressions to get a more accurate reading of the night sky. The development of calculus in the late 1600s made it possible to gauge area and volume and predict the movement patterns of distant celestial objects. Today calculus is the basic entry point for anyone wishing to study physics, chemistry, biology, economics, finance, or actuarial science.

The arts also lend themselves quite well to new ideas. In fact, finding new and creative ways of expression is the artist's stock in trade. With regard to the fine arts (painting, drawing, sculpting), this spirit of artistic innovation is evident in the various movements that have taken art in a variety of directions.

During the Renaissance—a time of great cultural change throughout Europe—painting and drawing literally took on a new dimension with the advent of perspective. Giving depth to objects in a way that makes them pop off the flat page, perspective was made popular by Filippo Brunelleschi. In his work as an architect and engineer, Brunelleschi reintroduced the concept of the vanishing point, which is a distant spot in a drawing or rendering where parallel lines converge. The eye is drawn to the vanishing point, creating the illusion of depth and three-dimensionality. Several influential Renaissance

artists, including Donatello and Fra Angelico, employed perspective in their work.

Other movements in the graphic arts that have served as turning points include Impressionism (accurately recording reality using light and colour) and Expressionism (distorted reality meant to arouse the viewer's emotions). In the 20th century, many artists abandoned realistic portrayals altogether in favour of abstraction. Instead of classic representational methods, abstract art uses lines, texture, and colour, rather than representation or figuration, to convey meaning.

One of the most far-reaching movements in the arts was Modernism. Coming on the heels of World War I, Modernism permeated every facet of the arts. Many creative people—writers, artists, philosophers, composers, and architects—used their creations to make a break with convention. Impressionism and Abstract Expressionism were modernist approaches to art. Modernist literature, exemplified by the works of T.S. Eliot, Virginia Woolf, Gertrude Stein, and James Joyce, among others, experimented with new forms and manners of expression. Dancers abandoned traditional steps for free-form movement, architects embraced clean lines and unadorned facades, and composers experimented with atonality.

Another important milestone, which changed the experience of music, is the incorporation of harmony into vocal and instrumental compositions. Church choirs in the 9th century are credited with the first usage of harmony. The fuller, richer sound afforded by voices rising in intervals was received so favourably by listeners that composers embraced the use of polyphony and favoured it over the unison musical line.

The visual replaces the aural when it comes to a key turning point in motion picture production—the montage.

In its broadest sense, montage means to assemble various elements to make a unified whole. The cinematic definition is a matter of the way in which film is edited to create a cohesive sequence of storytelling. This can be done narratively, by exploring a character or location from several angles or over time; graphically, using a method that links shots by physical appearance; or ideationally, where images are spliced together more or less by topic as a way of solidifying an idea the director is trying to get across in a certain scene. The introduction of montage occurred very early on in the history of filmmaking. Pioneering directors Edwin S. Porter and D.W. Griffith popularized the technique in America, while montage was refined and used to great effect by Russian directors in the early 20th century.

Turning points in the social sciences have sought to clarify and strengthen people's understanding of society and social relationships, why they work and why they fail. They constitute changes that have affected behaviour and human interaction. Mass production and the assembly line greatly altered the role of the worker, negotiations between employers and employees, and even international relations with regard to trade practices.

Other crucial social science turning points include the advent of psychoanalysis, including the study of child behaviour. Psychologists such as Sigmund Freud sought answers much deeper below the surface, revealing that human behaviour is the result of many factors, including repressed memories and desires. Beyond the psyche—or, more accurately, intertwined with it—is the idea that human beings have a conscience that guides their behaviour. The conscience gives rise to the notion of what is good and evil.

Religious concepts that have had an impact on human behaviour include the notions of sin and the soul. The


relation of the soul to the body has been a subject of philosophical debate for centuries. The ancient Greek theologian and philosopher Augustine of Hippo claimed that the body and soul were separate and that the latter contained the true essence of a person. In the Middle Ages, Thomas Aquinas contemporized the idea of the soul that had already long been pondered from the time of early Hebrews and ancient Greeks. Modern philosophers have held a number of opinions, anything from the soul being equivalent to the mind to it being merely a justification for the development of ethics.

Throughout history, ethical conceits such as right and wrong have given rise to ideas concerning fair and equal treatment. These include important universal concepts such as human rights and natural law, which is a theory that there is an innate, common set of rules that all people follow simply because of their basic nature as human beings. For instance, people everywhere understand that killing an innocent person is wrong; they don't need a written, man-made law to tell them that. However, societies throughout the world have always thought it was a good idea to institute what is known as "positive laws"—those that are decreed and agreed to by various cultures—as well. Many positive, or man-made, laws have been influenced by natural laws. Those who do not follow natural and positive laws, or otherwise behave in a manner that is contrary to the greater societal good, are subject to punishment.

In general, people follow rules, regulations, and laws that are created to bring about harmony in a society. When the rules are broken, so is the peace. Therein lies one of the most interesting turning points in political and legal thought, the social contract. To live within society, humans give up certain individual rights, entering

into an agreement with those in power in order to remain at peace. Great thinkers through the centuries, including Thomas Hobbes and Jean-Jacques Rousseau, have created works about the social contract that defined, and redefined, humans' understanding of their rights and place in society.

There is a common belief that laws should not be designed merely to protect life and property alone. Original ideas must and should be safeguarded as well. This is the theory behind intellectual-property law. Because ideas can be stolen, and can occur to more than one person at once, many societies have established laws to ensure a balanced legal approach to giving credit where credit is due. After a thorough examination of this book's contents, readers are sure to agree that theories and ideas are well worth protecting.



Chapter I: THE BIOLOGICAL SCIENCES

The probing of the origin of life, cell theory, germ theory, and genetic inheritance, as well as the ideas regarding evolution and ecology—the development of a sense of how living things interact and form a system of relationships—represent profound turning points in human history. This chapter addresses some of the discoveries that have affected the way we think about ourselves, other living things, and life’s vital processes.

THE ORIGIN OF LIFE

If a species can develop only from a preexisting species, then how did life originate? Among the many philosophical and religious ideas advanced to answer this question, one of the most popular was the theory of spontaneous generation, according to which living organisms could originate from nonliving matter. With the increasing tempo of discovery during the 17th and 18th centuries, however, investigators began to examine more critically the Greek belief that flies and other small animals arose from the mud at the bottom of streams and ponds by spontaneous generation. Then, when the English physician William Harvey announced his biological theory *ex ovo omnia* (“everything comes from the egg”), it appeared that he had solved the problem, at least insofar as it pertained to flowering plants and the higher animals, all of which develop from an egg. But Antonie van Leeuwenhoek’s subsequent disquieting discovery of animalcules demonstrated the existence of a densely populated but previously invisible world of organisms that had to be explained.

A 17th-century Italian physician and poet, Francesco Redi, was one of the first to question the spontaneous origin of living things. Having observed the development of maggots and flies on decaying meat, Redi in 1668 devised a number of experiments, all pointing to the same conclusion: if flies are excluded from rotten meat, maggots do not develop. On meat exposed to air, however, eggs laid by flies develop into maggots. But renewed support for spontaneous generation came from the publication in 1745 of a book, *An Account of Some New Microscopical Discoveries*, by John Turberville Needham, an English Catholic priest; he found that large numbers of organisms subsequently developed in prepared infusions of many different substances that had been exposed to intense heat in sealed tubes for 30 minutes. Assuming that such heat treatment must have killed any previous organisms, Needham explained the presence of the new population on the grounds of spontaneous generation. The experiments appeared irrefutable until Lazzaro Spallanzani, an Italian biologist, repeated them and obtained conflicting results. He published his findings about 1775, claiming that Needham had not heated his tubes long enough nor had he sealed them in a satisfactory manner. Although Spallanzani's results should have been convincing, Needham had the support of the influential French naturalist Buffon; hence the matter of spontaneous generation remained unresolved.

THE DEATH OF SPONTANEOUS GENERATION

After a number of further investigations had failed to solve the problem, the French Academy of Sciences, in January 1860, offered a prize for contributions that would "attempt, by means of well-devised experiments, to throw new light on the question of spontaneous generation." In response to this challenge, Louis Pasteur, who at that time was a

chemist, subjected flasks containing a sugared yeast solution to a variety of conditions. Pasteur was able to demonstrate conclusively that any microorganisms that developed in suitable media came from microorganisms in the air, not from the air itself, as Needham had suggested. Support for Pasteur's findings came in 1876 from an English physicist, John Tyndall, who devised an apparatus to demonstrate that air had the ability to carry particulate matter. Because such matter in air reflects light when the air is illuminated under special conditions, Tyndall's apparatus could be used to indicate when air was pure. Tyndall found that no organisms were produced when pure air was introduced into media capable of supporting the growth of microorganisms. It was these results, together with Pasteur's findings, that put an end to the doctrine of spontaneous generation.

When Pasteur later showed that parent microorganisms generate only their own kind, he thereby established the study of microbiology. Moreover, he not only succeeded in convincing the scientific world that microbes are living creatures, which come from preexisting forms, but also showed them to be an immense and varied component of the organic world, a concept that was to have important implications for the science of ecology. Further, by isolating various species of bacteria and yeasts in different chemical media, Pasteur was able to demonstrate that they brought about chemical change in a characteristic and predictable way, thus making a unique contribution to the study of fermentation and to biochemistry.

THE ORIGIN OF PRIMORDIAL LIFE

In the 1920s a Soviet biochemist, A.I. Oparin, and other scientists suggested that life may have come from nonliving matter under conditions that existed on the primitive

Earth, when the atmosphere consisted of the gases methane, ammonia, water vapour, and hydrogen. According to this concept, energy supplied by electrical storms and ultraviolet light may have broken down the atmospheric gases into their constituent elements, and organic molecules may have been formed when the elements recombined.

Some of these ideas have been verified by advances in geochemistry and molecular genetics; experimental efforts have succeeded in producing amino acids and proteinoids (primitive protein compounds) from gases that may have been present on the Earth at its inception, and amino acids have been detected in rocks that are more than three billion years old. With improved techniques it may be possible to produce precursors of or actual self-replicating living matter from nonliving substances. But whether it is possible to create the actual living heterotrophic forms from which autotrophs supposedly developed remains to be seen.

Although it may never be possible to determine experimentally how life originated or whether it originated only once or more than once, it would now seem—on the basis of the ubiquitous genetic code found in all living organisms on Earth—that life appeared only once and that all the diverse forms of plants and animals evolved from this primitive creation.

ANTONIE VAN LEEUWENHOEK

(b. Oct. 24, 1632, Delft, Neth.—d. Aug. 26, 1723, Delft)

The Dutch microscopist Antonie van Leeuwenhoek was the first to observe bacteria and protozoa. In his youth he was apprenticed to a draper; a later civil position allowed him to devote time to his hobby: grinding lenses and using

sample content of The Britannica Guide to Theories and Ideas That Changed the Modern World
(Turning Points in History)

- [read online Anatomy & Physiology for Speech, Language, and Hearing \(4th Edition\)](#)
- [download online The Wooden Shepherdess \(Human Predicament Series, Book 2\) pdf, azw \(kindle\), epub, doc, mobi](#)
- [Frommer's Walt Disney World and Orlando 2012 pdf](#)
- [read The Tracks of My Tears](#)
- [download online A History of the Urals: Russia's Crucible from Early Empire to the Post-Soviet Era here](#)

- <http://twilightblogs.com/library/Mathematics-for-Econometrics--4th-Edition-.pdf>
- <http://qolorea.com/library/Essentials-of-Clinical-Supervision.pdf>
- <http://www.rap-wallpapers.com/?library/Harper-s-Rules--A-Recruiter-s-Guide-to-Finding-a-Dream-Job-and-the-Right-Relationship.pdf>
- <http://www.mmastyles.com/books/Medieval-Art--A-Topical-Dictionary.pdf>
- <http://www.khoi.dk/?books/A-History-of-the-Urals--Russia-s-Crucible-from-Early-Empire-to-the-Post-Soviet-Era.pdf>