

## **Organics and Organic Compounds: The Most Valuable Resource in the Universe**

### Abstract

This popular science article explores the unique significance of organic matter and organic compounds as a fundamental and perhaps the most valuable resource in the universe. It draws parallels between organic matter as the basis of life on Earth and its detection in various celestial bodies within and beyond the Solar System. The discussion covers chemical stability, structural diversity, and the potential role of organic compounds in the origin and evolution of life. Emphasis is placed on the universality of carbon chemistry as a key factor unifying biological and cosmochemical processes.

### Keywords

Organic matter, organic compounds, cosmochemistry, biochemistry, origin of life, interstellar molecules, amino acids, carbon, space, chemistry of life, cosmic resources, biological molecules.

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If you were to ask scientists what the most valuable resource in the universe is, you would hear different answers. Some might name water, others energy or hydrogen. A planetary scientist might point to rare metals, while an astrobiologist could highlight liquid solvents. Yet, the deeper science peers into nebulae, the clearer one thing becomes: the true value of the universe lies in organic matter.

The reason organic matter may seem ubiquitous is that we are surrounded by it. We consist of organic molecules, breathe, eat, think, and die within the realm of organic chemistry. All life on Earth is built on carbon chains, making it easy to take organic matter for granted. However, this perspective is an illusion born of observational bias. In reality, the ability of organic compounds suitable for life to exist stably requires extremely delicate and specialized conditions. Temperature, pressure, the presence of water, protection from ultraviolet and ionizing radiation, and chemical stability all limit the zones where organic matter can not only arise but also persist, accumulate, and engage in chain reactions. The emergence of even the simplest amino acids in the open cosmos is the result of millions of years and billions of random interactions. Where organic matter does appear, it is not merely an exotic substance but a unique chemical structure formed against entropy, environmental aggression, and thermodynamic discharge. This is what makes it truly valuable.

Organic compounds are found everywhere. They exist in Saturn's dust rings, in the icy hearts of comets, in meteorites discovered in Australia, and in the dense clouds

above Titan. Organic matter is not rare, but it is exceptional. It is not just the chemistry of life; it is a universal language of self-organization, energy, memory, and even evolution. It can not only exist but also assemble into complex forms, reproduce, react, and create systems. In a universe of rock and radiation, organic matter is the chemistry of complexity.

Today, it is no longer just a subject of scientific interest. Organic matter is becoming a hypothetical building material for future civilizations. It can serve as the basis for biotechnologies, autonomous synthetic ecosystems, genetic machines, energy storage systems, and even living environments capable of adaptation. As humanity ventures beyond Earth, organic matter transforms from a mere companion of life into a strategic resource, no less important than oxygen, water, or metals.

The universe holds many mysteries, especially regarding how unique forms of organic compounds emerge each time. The composition of organic molecules can vary significantly across different regions of galaxies. The more complex and unique these organic acids are, the higher their value. These molecules are not just chemical substances—they reflect the conditions and processes occurring in the farthest corners of the cosmos.

The universe contains vast quantities of resources—metals, minerals, water, and energy. At first glance, their abundance should facilitate the unimpeded development of any life forms or technologies. However, most of these resources are in states or locations that make extraction extremely difficult. Metals and minerals are often locked within dense asteroid or planetary cores, inaccessible without complex and costly technologies. Water in space exists as ice on distant

moons or comets, where extraction requires significant energy expenditure. Energy—whether solar or geothermal—is also unevenly distributed and location-dependent.

Organic matter is different: it is not so much inaccessible as it is rarely formed and exceptionally difficult to preserve in space. The formation of organic molecules requires specific combinations of factors, and their stability depends on a delicate balance between destructive and supportive processes. It is precisely this rarity and fragility that make organic matter truly valuable, as these molecules can serve as the foundation for complex biochemical systems not commonly found in the cosmos.

One might hypothesize that a “formula for life” exists in the universe—a set of carefully selected conditions that allow these complex molecules to persist, evolve, and participate in chemical reactions. This formula, as mentioned earlier, includes parameters such as temperature, pressure, the presence of water or other solvents, radiation levels, energy flows, and a chemical environment that does not destroy but supports and encourages the complexity of organic structures. Without such a fine balance, organic acids simply could not exist or fulfill their key role in the emergence of life.

These conditions are not always easy to detect, and they are far from universal. This is why, despite the apparent prevalence of organic matter, the emergence of life remains a rare and fragile phenomenon. In some corners of the universe, organic compounds exist only as primitive molecules incapable of transitioning to complex forms. In others—on planets with suitable climates, stable chemical

environments, and energy flows—organic matter begins to transform into primary biopolymers capable of self-replication and evolution.

Thus, organic matter is not just a chemical material but a kind of bridge between the inorganic and the living. Its role extends beyond Earth, becoming the foundation for hypotheses about the spread of life in the universe. Viewing organic compounds as the most valuable resource opens new perspectives for astrobiology, cosmic chemistry, and even future space exploration technologies.

The formation of complex organic acids is an exceedingly rare and intricate process, requiring a unique combination of energy influences such as cosmic radiation, ultraviolet photons, and thermal energy, which arise almost randomly under specific conditions. This interplay of energy flows triggers chemical reactions leading to the creation of molecules capable of serving as the basis for life. Such a rare and delicate balance can be likened to a “divine touch,” where chance and the physics of the universe converge to create unique conditions for the birth of organic matter.

Comets, asteroids, and meteorites act as cosmic “couriers” of organic matter, delivering these molecules to planetary surfaces. Upon impact, they can bring both simple organic substances and complex molecules, significantly enriching a planet’s chemical potential and creating the prerequisites for the emergence of life.

Organic compounds in the universe astonish with their diversity and uniqueness, reflecting the varied chemical conditions in which they form. In different regions of galaxies, the composition and structure of organic matter can differ substantially due to variations in temperature, pressure, elemental availability, and radiation

levels. This chemical variability gives rise to a wide spectrum of molecules—from simple hydrocarbons to complex polymers and organic acids.

Of particular importance are complex organic acids and polymers, considered key precursors to life. These molecules can form stable structures and participate in chemical reactions leading to the self-assembly of biopolymers such as proteins and nucleic acids. Their presence in space creates the preconditions for the transition from inorganic chemistry to biology, making them truly invaluable resources for understanding the origin and spread of life.

The stable existence of organic molecules in the universe depends on numerous factors, collectively termed the “formula for life”—a combination of environmental parameters that create conditions for the stability and development of organic matter. Key among these are temperature, pressure, chemical composition, and the presence of suitable solvents. The temperature must be low enough to prevent molecular destruction but high enough to sustain chemical activity. Pressure influences chemical stability and molecular interactions, while the environment’s composition determines the possibilities for reactions and self-assembly.

Solvents play a special role—they provide a medium in which organic molecules can move, interact, and form more complex structures. Water is traditionally regarded as the universal solvent for life on Earth due to its polarity and ability to support a wide range of chemical reactions. However, alternative solvents may exist elsewhere in the universe—ammonia, methane, ethane, or even more exotic compounds could serve as solvents, creating unique conditions for the existence

and evolution of organic matter. The diversity of such environments expands our understanding of where and how life might arise beyond Earth.

Organic molecules play a pivotal role in the transition from simple chemical compounds to living systems. Their ability to self-assemble and interact lays the foundation for the first biopolymers—proteins, nucleic acids, and lipids. These biopolymers form primary structures resembling cell membranes and initiate processes of self-replication and metabolism. Thus, organic matter becomes not just chemistry but the foundation for the emergence of life, bridging physical-chemical laws with biological functions. This bridge from chemistry to biology is one of science's greatest mysteries, the unraveling of which could help us understand how life arose and evolves in the universe.

Complex organic molecules begin not only to connect but also to propagate, replicating structures akin to themselves. This process of self-replication—a key step in the transition from chemistry to life—creates the basis for evolution at the molecular level. In this process, molecules compete for limited resources, growing more complex and refined, leading to the emergence of the first primitive systems capable of adaptation and development. It is this self-replication and propagation that became the earliest manifestations of life in the universe.

In the harshest and most unstable corners of the cosmos—near stars, on volcanically active planets, or in the deep oceans of icy moons—organic molecules encounter extreme conditions that can both destroy and stimulate their development. High temperatures, radiation, pressure, and chemical aggression pose challenges to organic stability, yet these same factors often act as catalysts, accelerating chemical reactions and fostering molecular complexity. Mineral

surfaces, crystalline structures, and metallic compounds further aid in organizing molecules, facilitating their assembly into more complex biopolymers. Without such extreme conditions and catalysts, the evolution of organic matter would likely be far slower or even impossible, underscoring their importance for the emergence of life.

Modern missions and telescopes are focused on detecting organic molecules and potential biosignatures on planets and moons within the Solar System, as well as in exoplanetary atmospheres. Analyzing the composition of comets, asteroids, and interstellar dust helps us understand the prevalence of organic matter. Spectroscopy, robotic missions, and soil sampling provide key data on the presence and state of organic compounds. The search for life requires integrating data from diverse sources, understanding chemical processes, and developing new technologies. Success in this field will open a new chapter in our understanding of our place in the universe and the possibility of life in other forms.

Organic compounds in the universe offer unique opportunities for space colonization and the advancement of biotechnology. Utilizing cosmic organic matter could be the key to creating artificial ecosystems and bioregenerative systems on other planets, ensuring life support and sustainability for colonies. Understanding the nature and diversity of organic matter will enable humanity to adapt to new environments and expand its presence beyond Earth.

The value of organic compounds transcends science, touching on profound questions about life and consciousness. Organic matter becomes a symbol of life's universality, its diversity, and its potential manifestations in the farthest reaches of the universe. Studying these molecules helps us rethink our place in the cosmos,



grasp the essence of life, and open new horizons for philosophical reflections on consciousness and existence.

Space exploration requires long journeys under extreme conditions, posing serious threats to human life. During such voyages, the body is exposed to vacuum, drastic pressure and temperature fluctuations—from scorching heat to freezing cold. These factors can cause severe tissue damage, cardiovascular and respiratory system failures, and acute conditions related to decompression.

Prolonged weightlessness leads to muscle atrophy, bone density loss, cardiovascular deterioration, and weakened immunity. Cosmic radiation presents another danger, increasing the risk of cancer and DNA damage. Psychological stress and isolation exacerbate health issues, reducing stress resilience and cognitive function.

These hazards make space travel inherently perilous for explorers, necessitating the development of advanced protective systems, life support, and medical care. Without overcoming these challenges, the exploration of space and the search for organic matter in distant corners of the universe remain uncertain.

Advancing technologies capable of sustaining life in space demands immense intellectual resources—a combination of human intellect and artificial intelligence. Human imagination, creativity, and holistic thinking guide research directions, while AI aids in analyzing vast datasets, modeling complex systems, and optimizing solutions. The more educated and passionate people there are on Earth, the broader the field for new ideas and innovations capable of addressing cosmic

challenges. This synergy between science and technology is the key to creating sustainable life-support systems beyond our planet.

If we imagine that organic compounds truly hold universal value in the universe, we cannot rule out the existence of life forms that also seek to discover, utilize, or protect them. If such beings exist on other planets—with different chemical compositions, conditions, and developmental histories—they may take entirely unpredictable forms, sizes, and modes of thought. Their perception of the world, goals, and attitudes toward other life forms could differ so drastically that contact or even conflict of interests becomes inevitable. In this context, space exploration may evolve not just as a scientific pursuit but also as a potential rivalry—especially if organic matter is perceived not merely as the chemistry of life but as a strategic resource.

Potential competition for organic matter in the universe demands sober reflection on our strengths and weaknesses. Our civilization is highly dependent on a narrow range of vital conditions. Any interference—even minimal—could have catastrophic consequences. We are vulnerable not because our technologies are weak but because we exist within a fragile and finely balanced system where the slightest shift in equilibrium could prove fatal.

Our civilization relies on strictly limited ranges of temperature, pressure, atmospheric composition, solar radiation, and orbital mechanics. These are not universal parameters of life but a unique case against the backdrop of a lifeless, chaotic cosmos. We did not merely adapt to these conditions—we were born from them. Thus, any interference, however minor, could disrupt the very foundation of

our existence. Herein lies the paradox: we are strong in knowledge but fundamentally vulnerable to the nature of the world in which we strive to survive.

If we imagine the existence of a more advanced extraterrestrial life form with access to planetary-scale technologies, it becomes clear that any potential conflict would hardly resemble anything familiar to us. Direct confrontation in the conventional sense loses relevance. Manipulating solar radiation, altering orbital parameters, or even controlling biospheres—these are forms of intervention that may be available to civilizations operating at a different level of development. Our weaknesses are evident: dependence on a star, specific atmospheric conditions, and even the presence of liquid water.

Yet, it is this very fragility that makes organic matter especially valuable. Destroying us could mean losing not just a civilization but also a unique form of organic matter shaped under rare and difficult-to-replicate conditions. Organic acids, biopolymers, complex molecular structures—all are the results of long evolution and an unstable yet extraordinarily delicate balance. They are not just resources—they are the outcome of billions of years of interaction between the cosmos and life. This is why, in hypothetical competition, it is not always rational to eliminate a rival if they preserve what cannot be recreated.

These are, of course, hypothetical musings, but they are important for expanding the horizons of perception. Popular science writing thrives on the boundary between the known and the speculative. Such conjectures not only captivate attention but also foster new approaches to real research. Even if assumptions about extraterrestrial competition, technologies, or the uniqueness of organic

matter are never confirmed, the very act of contemplating them can inspire significant discoveries—in chemistry, astrobiology, engineering, and philosophy.

## **Conclusion**

Organic matter is not just the building material of life; it is the foundation of a complex chemistry that unites the cosmos and the biosphere. It manifests in stellar nebulae, icy bodies, planetary atmospheres, and living organisms. Its universality, stability, and capacity for self-organization make organic matter a kind of universal language of matter, one that the entire universe might potentially speak. We may not know if life exists beyond Earth, but organic matter is already there—and this is the primary condition without which life itself would be impossible. This is why organic compounds represent the most valuable resource not only for science but also for the future of humanity as a cosmic species.

## **Final Thoughts**

Organic matter and organic compounds are the foundation upon which not only Earth's biology rests but also all of cosmochemistry—and possibly the very basis for life in the universe. Understanding their nature opens new horizons in studying the origin of life, its spread, and its resilience under the most extreme conditions. These molecules are not just chemical structures but a universal language through

which the universe “communicates” with the living, uniting physics, chemistry, and biology into a single system.

This is why organic matter is the most valuable resource—it connects the past, present, and future, allowing us not only to understand where we came from but also how to create new forms of life and civilizations beyond Earth. The study of organic matter is the path to unraveling the mystery of life on a universal scale, its diversity, and its unpredictability.