See Also

▶ Gravitation
▶ Lagrangian Points

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Organelle

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Definition

An organelle is a specialized subunit inside a cell. It is separated from the surrounding cytoplasmic media by a lipid bilayer and plays a particular role or function within the cell similar to that of organs in an animal's body. The absence of a ▶ nucleus, a membrane-enclosed organelle containing the genome, is one of the major features that differentiate prokaryotes from eukaryotes. The most notable examples of organelles are those involved in energy transduction reactions in eukaryotes which were originated by endosymbiont bacteria: ▶ chloroplasts present in plants cells, algae and some protists which are responsible for ▶ photosynthesis, and ▶ mitochondria in almost all eukaryotes where ▶ respiration for energy production takes place. Other important organelles are hydrogenosomes involved in energy generation in anaerobic conditions; the endoplasmic reticulum responsible for many functions, including the synthesis of new membrane material; lysosomes involved in protein degradation and amino acid recycling; peroxisomes responsible for the degradation of oxidative stress products, like hydrogen peroxide; microfilaments and microtubules responsible for the internal structure of eukaryotic cells; and flagella and cilia involved in cell movement.

See Also

▶ ATP Synthase
▶ Chloroplast
▶ Eukarya
▶ Mitochondrion
▶ Motility
▶ Nucleus
▶ Photosynthesis
▶ Photosynthesis, Oxygenic
▶ Respiration

Organic Cyanide

▶ Nitrile

Organic Dust, Influence on the Origin of Life

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Keywords

Origin of life; Earth, external delivery of organics; Stellar evolution

Definition

This topic considers the possibility that organic dust particles of extraterrestrial (interplanetary, stellar, or interstellar) origin played a role in the origin of life on Earth.

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History

Current theories on the ► origin of life are centered on the hypothesis that under suitable conditions (e.g., a primordial soup), simple molecules can be synthesized into complex organic compounds which later develop into self-replicating living organisms. An initial laboratory basis for this hypothesis was the Miller-Urey experiment, in which a mixture of gaseous molecules (hydrogen, water, ammonia, methane) when subjected to electric discharge yielded complex organics such as amino acids. The discoveries of insoluble organic matter in carbonaceous meteorites (Cronin et al. 1987), organic contents in interplanetary dust particles (Flynn et al. 2003), and complex organic dust synthesized by stars (Kwok 2004) have raised the possibility that externally delivered organics may have allowed the origin of life on Earth to bypass some of the first steps of organic synthesis on the early Earth (Ehrenfreund et al. 2006; Kwok 2009).

Overview

Isotopic analysis of carbonaceous meteorites has also discovered the presence of presolar grains, ► star dust that is made in the asymptotic giant branch of stellar evolution and ejected into the ► interstellar medium by stellar winds (Zinner 1998). The fact that one can actually hold star dust in our hands is proof that star dust can travel across the Galaxy and reach our Solar System intact. The fact that organic matter in Solar System objects has been found to have hydrogen isotopic ratios that differ from the terrestrial D/H ratio also suggests that there is interstellar organic dust in the Solar System (Ehrenfreund et al. 2002; Nakamura-Messenger et al. 2006; Sandford et al. 2006).

Once arrived in our Solar System, these star dust particles have to find a way to Earth. The most commonly discussed mechanism of delivering extraterrestrial organic dust to the early Earth is through the Late Heavy Bombardment (Chyba and Sagan 1992). The frequent collisions between the Earth and asteroids and comets during the early times of the Solar System imply that a significant amount of external organic materials could be delivered to Earth (Ehrenfreund et al. 2006). Alternatively, the Earth, formed through the process of aggregation, may have contained a significant amount of primordial organic material. Since the organic star dust has a structure similar to that of ► kerogen, the primordial organic matter could be extremely resilient and may have survived the formation of the Earth.

At this time, there is no direct evidence that the early Earth had been enriched/contaminated by a large amount of external organic matter. If it was, there is also not yet any evidence that this organic matter played any role in the origin of life. However, the possible implications can be significant. In the traditional endogenous origin of organic matter theories on the origin of life, the evolution to life could be a rare event due to unique circumstances of the Earth. However, in the external delivery hypothesis, life could be common in the Galaxy, as all planetary systems in the Galaxy could have been equally enriched by organic star dust.

See Also

► Insoluble Organic Matter
► Interstellar Dust
► Late Heavy Bombardment
► Organic Dust, Synthesis by Stars
► Origin of Life
► Primordial Soup

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Organic Dust, Synthesis by Stars

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Keywords

Star dust; Stellar evolution

Synonyms

Organic grains; Organic solid particles

Definition

Organic dust consists of micron- or nanometer-sized carbon-based solid-state particles with aromatic (ring-like) and/or aliphatic (chain-like) structures. The solids could be in crystalline (periodic) form, or more likely, in amorphous (random) form. Possible examples of terrestrial counterpart are soot, which is a product of combustion of hydrocarbons in a flame, and ► kerogen, the most common form of organics on Earth formed from decayed living matter.

History

The existence of interstellar dust has been known since the early twentieth century through the effect of selective extinction on the light of distant stars. The chemical composition of the dust particles was initially assumed to include graphite, iron, or ice. Development in stellar nucleosynthesis led to the understanding that the element carbon is synthesized in the asymptotic giant branch (AGB) phase of stellar evolution. This led to the suggestion by Fred Hoyle that carbon-based solid particles could be produced by stars (Hoyle 1955). The possibility that some of this star dust might be organic in nature was first suggested in the 1970s (Hoyle and Wickramasinghe 1977). Later, it was suggested that organic compounds can be detected in the infrared part of the spectrum through their C–H stretching mode (Knacke 1977; Duley and Williams 1979).

After the discovery of the ► unidentified infrared emission (UIE) bands, it was realized that some astronomical spectra resemble the spectral features observed in automobile exhaust. This led to the suggestion that the carriers of the UIE bands may be related to polycyclic aromatic hydrocarbon molecules (Allamandola et al. 1985). This represents the beginning of the serious studies of organic compounds in space.

Overview

Since organic solids can take on many different forms, the identification of a specific organic solid is not as straightforward as in the case for inorganic minerals. Minerals generally have highly ordered lattice structure in a crystalline form and therefore possess optically active lattice vibrational modes. These produce clear infrared spectral signatures, allowing the identification of