Sulfur is found in all living organisms as a [constituent](https://www.merriam-webster.com/dictionary/constituent) of some proteins, vitamins, and hormones. Like carbon and nitrogen, sulfur cycles between the atmosphere, lithosphere, and hydrosphere; but, unlike these two other elements, it has major reservoirs in both the atmosphere and the lithosphere. As is true in the nitrogen cycle, the activities of microorganisms are crucial in the global cycling of this nutrient.

The process begins with geochemical and meteorological processes such as the weathering of rock. When sulfur is released from the rock and comes in contact with [air](https://www.britannica.com/science/air), it is converted into sulfate (SO4), which is taken up by plants and microorganisms and converted into organic forms. Animals acquire these organic forms of sulfur from their foods. When organisms die and decompose, some of the sulfur enters the tissues of microorganisms and some is released again as sulfate. There is, however, a continual loss of sulfur from terrestrial ecosystems as some of it drains into lakes and streams and eventually into the ocean as runoff. Additional sulfur enters the ocean through fallout from the atmosphere.

Once in the ocean, some of the sulfur cycles through marine [communities](https://www.merriam-webster.com/dictionary/communities) as it moves through [food](https://www.britannica.com/topic/food) chains, some re-enters the atmosphere, and some is lost to the ocean depths as it combines with iron to form ferrous sulfide (FeS), which is responsible for the black colour of marine sediments. Sulfur re-enters the atmosphere naturally in three major ways: sea spray releases large amounts of the element from the ocean into the atmosphere; [anaerobic respiration](https://www.britannica.com/science/anaerobic-respiration) by sulfate-reducing bacteria causes the release of [hydrogen sulfide](https://www.britannica.com/science/hydrogen-sulfide) (H2S) gas especially from marshes, tidal flats, and similar environments in which anaerobic microorganisms thrive; and [volcanic activity](https://www.britannica.com/science/volcanism) releases additional but much smaller amounts of sulfur gas into the atmosphere.

Since the [Industrial Revolution](https://www.britannica.com/event/Industrial-Revolution), [human](https://www.britannica.com/topic/human-being) activities have contributed significantly to the movement of sulfur from the lithosphere to the atmosphere as the burning of [fossil](https://www.britannica.com/science/fossil) fuels and the processing of metals have occasioned large emissions of [sulfur dioxide](https://www.britannica.com/science/sulfur-dioxide). Oxides of sulfur and nitrogen contribute to the [acid rain](https://www.britannica.com/science/acid-rain) that is common downwind from these industrial activities.

ROLE OF BACTERIA AND ARCHAEA IN SULPHUR CYCLE:

Sulfur is a component of a couple of vitamins and essential metabolites and it occurs in two amino acids, cysteine and methionine. In spite of its paucity in cells, it is an absolutely essential element for living systems. Like nitrogen and carbon, the microbes can transform sulfur from its most oxidized form (sulfate or SO4) to its most reduced state (sulfide or H2S). The sulfur cycle, in particular, involves some unique groups of procaryotes and procaryotic processes. Two unrelated groups of procaryotes oxidize H2S to S and S to SO4. The first is the anoxygenic photosynthetic purple and green sulfur bacteria that oxidize H2S as a source of electrons for cyclic photophosphorylation. The second is the "colorless sulfur bacteria" (now a misnomer because the group contains many Archaea) which oxidize H2S and S as sources of energy. In either case, the organisms can usually mediate the complete oxidation of H2S to SO4.

H2S----------------> S ----------------> SO4 litho or phototrophic sulfur oxidation

Sulfur-oxidizing procaryotes are frequently thermophiles found in hot (volcanic) springs and near deep sea thermal vents that are rich in H2S. They may be acidophiles, as well, since they acidify their own environment by the production of sulfuric acid.

Since SO4 and S may be used as electron acceptors for respiration, sulfate reducing bacteria produce H2S during a process of anaerobic respiration analogous to denitrification. The use of SO4 as an electron acceptor is an obligatory process that takes place only in anaerobic environments. The process results in the distinctive odor of H2S in anaerobic bogs, soils and sediments where it occurs.

Sulfur is assimilated by bacteria and plants as SO4 for use and reduction to sulfide. Animals and bacteria can remove the sulfide group from proteins as a source of S during decomposition. These processes complete the sulfur cycle.

The main steps of sulphur cycle are as follows:

The primary soluble form of inorganic sulphur found in soil is sulphate. Whereas plants and most microorganisms incorporate reduced sulphur (sulphide) into amino acid or other molecules, they take up sulphur in the oxidized sulphate form and then reduce it internally. This is called assimilatory sulphate reduction.

The release of sulphur from organic form is called sulphur mineralization. It occurs both, aerobic and anaerobic conditions. Appropriate enzymes are involved.

Sulphur oxidation is an important process in sulphur cycle. In presence of oxygen, reduced sulphur compounds can support the growth of a group of chemoautotrophic bacteria under strictly aerobic conditions. These include *Thiobacillus, Thiomicrospira, Achromatium, Beggiatoa, Thermothrix,* common in mud, hot springs, mining surfaces, and soil. Autotrophic sulphur-oxidisers also include a group of photo-autotrophic bacteria such as *Chlorobium,Chromatium, Sctothiorhodospira, Thiopedia, Rhodopseudomonas,* which are strictly anaerobes and are common in shallow water,anaerobic sediments, in anaerobic water.

Photoautotrophic oxidation of sulphur is brought about by green and purple sulphur bacteria. This group of bacteria evolved on early earth when atmosphere was devoid of oxygen. These microbes fix CO2 using light energy, but instead of oxidizing water to oxygen, they use oxidation of sulphide to sulphur.

Sulphur reduction occurs in three ways. One is assimilation of sulfate into cell components under aerobic or anaerobic conditions. In contrast, there are two dissimilatory pathways, both of which use an inorganic sulphur as a terminal electron acceptor.


**Figure:The Sulfur Cycle.**

The two types of sulphur, used as terminal electron acceptor are elemental sulphur and sulphate. These two types of metabolism are differentiated as **sulphur respiration** and **dissimilatory sulphate reduction.**

*Desulphuromonas acetooxidans, Desulphobacter, Desulphobulbus,Desulphococcus, Desulphosarcina and Desulphovibrio,* all collective ely are known as **sulphate-reducing bacteria(SRB).**