

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

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HALOGEN ELEMENTS AND THEIR IMPORTANCE IN LIVING ORGANISMS

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Annotation: A wider study of the importance of each element in living organisms. Wider application of the biological significance of the functioning of halogens. Production of a database for students. Processing and discussion of the information we know and do not know. Deeper study of the importance of macro and microelements in the body

Keywords: Halogens, fluorine (F), chlorine (Cl), bromine (Br), iodine (I), and astatine (At) sulfur, oxygen, phosphorus, hydrogen sulfide, frash process, , hemoglobin, oxyhemoglobin.

Introduction.

Biogenic elements are essential chemical elements that play crucial roles in the structure, function, and metabolism of living organisms. These elements are typically classified into two categories based on their abundance and biological significance: major elements and trace elements.

Major Biogenic Elements:

1. Carbon (C): Carbon is the backbone of organic molecules, forming the basis of all organic compounds essential for life. It's a key component of carbohydrates, lipids, proteins, and nucleic acids.
2. Hydrogen (H): Hydrogen is ubiquitous in biological systems, present in water and organic molecules. It participates in chemical reactions, especially in energy transfer and acid-base reactions.
3. Oxygen (O): Oxygen is vital for cellular respiration, where it serves as the final electron acceptor in the electron transport chain. It's also a component of water and organic molecules.

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4. Nitrogen (N): Nitrogen is a crucial component of proteins, nucleic acids (DNA and RNA), and many coenzymes. It's obtained from the environment as ammonia or nitrate and is essential for growth and development.
5. Phosphorus (P): Phosphorus is a component of nucleic acids (phosphate groups in DNA and RNA), ATP (adenosine triphosphate, the primary energy carrier in cells), and phospholipids (major components of cell membranes).

Trace Biogenic Elements:

1. Sodium (Na) and Potassium (K): These electrolytes are essential for nerve function and muscle contraction.
2. Calcium (Ca): Calcium is crucial for bone and teeth formation, muscle contraction, and nerve function.
3. Magnesium (Mg): Magnesium is a cofactor for many enzymes and is involved in ATP metabolism.
4. Iron (Fe): Iron is essential for oxygen transport (hemoglobin) and electron transport (cytochromes).
5. Zinc (Zn): Zinc is a cofactor for many enzymes and plays a role in gene expression and immune function.
6. Copper (Cu): Copper is involved in electron transport and antioxidant defense (as a cofactor for superoxide dismutase).
7. Manganese (Mn): Manganese is a cofactor for several enzymes involved in metabolism.
8. Iodine (I): Iodine is necessary for thyroid hormone synthesis.

These biogenic elements are obtained by organisms from their environment (either directly or through consumption of other organisms) and are utilized in various biochemical processes that sustain life. They are essential for growth, reproduction, and maintaining homeostasis within cells and organisms.

Environmental Impact:

The availability and cycling of biogenic elements in ecosystems are crucial for maintaining ecological balance and sustainability. Human activities, such as agriculture and industrial processes, can affect the distribution and concentration of these elements, impacting both terrestrial and aquatic ecosystems.

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In conclusion, biogenic elements are indispensable components of life, supporting the intricate biochemical machinery that enables organisms to grow, reproduce, and adapt to their environments. Understanding their roles and interactions within biological systems is essential for advancing fields such as medicine, agriculture, and environmental science, ensuring the health and well-being of both organisms and ecosystems alike.

Halogens are a group of chemical elements that include fluorine (F), chlorine (Cl), bromine (Br), iodine (I), and astatine (At). While not typically considered essential in the same way as carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur halogens do play various roles in living organisms:

1. Iodine (I) in Thyroid Hormone Synthesis:

Iodine is crucial for the synthesis of thyroid hormones (thyroxine and triiodothyronine) in the thyroid gland. These hormones regulate metabolism, growth, and development. Iodine deficiency can lead to thyroid disorders and developmental issues.

2. Chlorine (Cl) in Digestive Processes:

Chlorine, in the form of chloride ions (Cl^-), combines with hydrogen ions (H^+) in the stomach to form hydrochloric acid (HCl). This acid is essential for the digestion of food, particularly proteins, and activates enzymes involved in digestion.

3. Antimicrobial Properties of Halogens:

Halogens, particularly chlorine and iodine, have antiseptic properties. They are used as disinfectants to kill pathogens and sterilize surfaces in medical and industrial settings.

4. Biological Signaling and Regulation:

Halogens can influence biological signaling pathways and regulatory mechanisms. For example, bromine is found in certain marine organisms and may play roles in chemical signaling and defense mechanisms.

5. Environmental Interactions:

Halogens can interact with organic compounds and affect ecological processes. For instance, bromine compounds can be involved in marine biogeochemical cycles and microbial interactions in marine ecosystems.

6. Industrial and Pharmaceutical Applications:

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Halogens and their compounds have industrial applications, such as in the production of chemicals, plastics, and pharmaceuticals. Fluorine, in particular, is used in the synthesis of fluorinated compounds with specialized properties in medicine and materials science.

7. Radioactive Halogens:

Astatine (At) is a radioactive halogen and is rare in nature. It has been studied for potential medical applications in targeted cancer therapy (radioimmunotherapy).

In summary, while halogens are not typically considered essential for basic biological functions like energy metabolism or cellular structure, they do play significant roles in specific biochemical processes, ecological interactions, and industrial applications. Understanding these roles helps in appreciating their impact on both biological systems and human activities.

In the main part, we will get to know Halogens in detail

Main part.

Fluorine. Fluorine is not considered an essential element for living organisms in the same way as carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur are. In fact, fluorine's reactivity and toxicity generally preclude its incorporation into biological molecules like proteins and nucleic acids.

However, fluorine can still play a role in living organisms in certain contexts:

1. Dental Health:

Fluoride ions (F^-) are beneficial for dental health when consumed in small, controlled amounts. Fluoride helps prevent tooth decay by enhancing the remineralization of tooth enamel and inhibiting the growth of bacteria that cause cavities.

2. Industrial and Environmental Exposure:

Fluorine and its compounds are sometimes encountered in industrial settings and can inadvertently affect living organisms through environmental exposure. Chronic exposure to high levels of fluorine compounds can have toxic effects on the skeletal system and other organs.

3. Medical Imaging:

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Fluorine-18 (^{18}F) is a radioactive isotope of fluorine used in positron emission tomography (PET) imaging. It is incorporated into biologically active molecules and allows for non-invasive imaging of physiological processes in the body.

4. Chemical Interactions:

Fluorine's chemical properties are sometimes exploited in pharmaceuticals and other synthetic compounds to modify molecule stability, alter biological activity, or enhance properties like lipophilicity (ability to dissolve in fats).

In summary, while fluorine is not essential for life and can be toxic at high levels, its presence and use in certain applications can impact living organisms in beneficial or adverse ways, depending on the context and concentration. However, its role in biological systems is limited primarily to dental health benefits from fluoride and niche applications in medical and chemical sciences.

Chlorine. Chlorine is an essential element for living organisms, primarily in the form of chloride ions (Cl^-). It plays several critical roles in biological systems:

1. Electrolyte Balance:

Chloride ions are one of the major electrolytes in the body, along with sodium (Na^+) and potassium (K^+). They help maintain proper osmotic pressure and electrolyte balance both inside and outside cells, which is essential for cellular hydration and function.

2. Digestion:

- Hydrochloric acid (HCl) is produced in the stomach by combining chloride ions with hydrogen ions (H^+). This acid is crucial for the digestion of food, particularly breaking down proteins and activating digestive enzymes.

3. Immune Response:

- Chloride ions are involved in the immune response. Neutrophils, a type of white blood cell, use chloride channels to generate hypochlorous acid (HOCl) from chloride and hydrogen peroxide (H_2O_2), which is an important antimicrobial agent.

4. Nerve Function:

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- Chloride ions play a role in nerve function by influencing the excitability of neurons. They help maintain the resting membrane potential of neurons, which is crucial for transmitting electrical signals.

5. Fluid Balance:

- Chloride ions contribute to the movement of fluids across cell membranes and the regulation of blood pH. They assist in maintaining proper blood volume and pressure, as well as acid-base balance.

6. Transport of Carbon Dioxide:

- Chloride ions can also combine with carbon dioxide (CO_2) in red blood cells to form bicarbonate ions (HCO_3^-), which is an important mechanism for transporting CO_2 from tissues to the lungs for elimination.

Overall, chlorine's importance in biological systems underscores its role in maintaining physiological functions such as digestion, nerve transmission, immune response, and fluid balance. Without adequate chloride ions, many essential processes in the body would be compromised, highlighting chlorine's essentiality for life.

Bromine. Bromine, like chlorine, is a halogen and is found in trace amounts in living organisms. While not considered an essential element like carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur (CHONPS elements), bromine does play several roles in biological systems:

1. Thyroid Function:

Bromine can affect thyroid function similarly to iodine. It competes with iodine for uptake and binding in the thyroid gland, influencing thyroid hormone production and metabolism.

2. Antimicrobial Properties:

Bromine and bromide ions (Br^-) have mild antiseptic properties and can be used as disinfectants. They have been historically used in medical treatments for skin conditions and as antiseptics in wound care.

3. Biological Processes:

Bromine is occasionally found in organic molecules in nature, where its presence can alter the chemical properties of the molecule. Some marine organisms, like certain algae and bacteria, incorporate bromine into secondary

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metabolites that serve ecological roles, such as defense mechanisms or signaling molecules.

4. Environmental Impact:

Bromine compounds can be released into the environment through natural processes and human activities. In aquatic ecosystems, bromine can interact with organic matter and influence nutrient cycling and microbial processes.

5. Industrial Uses:

Bromine compounds are also utilized in various industrial applications, such as flame retardants and as intermediates in chemical synthesis.

In summary, while bromine is not considered essential for life in the same way as some other elements, its presence and biological interactions can have significant implications in certain contexts. Understanding its roles in thyroid function, microbial ecology, and ecological interactions helps in comprehending its impact on living organisms and ecosystems.

Iodine. Iodine is a crucial trace element that is essential for the proper functioning of the human body and many other organisms. Here are the key roles and importance of iodine in living organisms:

1. Thyroid Hormone Synthesis:

Iodine is a vital component of thyroid hormones, primarily thyroxine (T4) and triiodothyronine (T3). These hormones are synthesized in the thyroid gland and are critical for regulating metabolism, growth, and development throughout the body. Without sufficient iodine, the thyroid gland cannot produce adequate amounts of these hormones, leading to disorders like hypothyroidism (underactive thyroid) or goiter (enlarged thyroid gland).

2. Metabolic Regulation:

Thyroid hormones influence the metabolic rate of cells and tissues, helping to regulate energy production and expenditure. They play a crucial role in maintaining body temperature, heart rate, and energy metabolism.

3. Development and Growth:

Adequate iodine intake is essential during pregnancy and early childhood for proper fetal and infant brain development. Thyroid hormones are critical for the development of the central nervous system, including the brain and spinal cord. Iodine deficiency during pregnancy can lead to irreversible

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cognitive impairment and developmental delays in children, a condition known as cretinism.

4. Immune Function:

Iodine plays a role in maintaining immune function. It has been shown to have antioxidant properties and may contribute to the body's defense against oxidative stress and inflammation.

5. Regulation of Reproductive Function:

Thyroid hormones, influenced by iodine levels, are involved in regulating reproductive function, including menstrual cycles and fertility in both men and women.

6. Iodine-Containing Compounds:

Iodine is also found in other biological molecules and compounds. For example, it is a component of iodinated lipids and proteins, which may have specific roles in cellular function and signaling pathways.

Sources of Iodine:

Iodine is obtained primarily through the diet, with significant sources including iodized salt, seafood (such as fish and seaweed), dairy products, and eggs. In regions where iodine deficiency is prevalent, iodized salt programs have been implemented to ensure sufficient intake.

Iodine is indispensable for human health and the health of many other organisms. Its role in thyroid hormone synthesis and regulation impacts metabolism, growth, development, and overall physiological function. Adequate iodine intake is crucial for maintaining optimal health throughout life stages, from fetal development through adulthood.

Conclusion.

In conclusion, halogens play diverse and significant roles in living organisms, despite not being considered essential elements for life in the same way as carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur (CHONPS elements). Here are the key points summarizing their roles:

1. **Iodine (I) and Thyroid Function:** Iodine is essential for the synthesis of thyroid hormones, which regulate metabolism, growth, and development. It is crucial during pregnancy and early childhood for proper brain development.

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2. **Chlorine (Cl) and Digestion:** Chlorine, in the form of chloride ions, is necessary for the production of hydrochloric acid in the stomach, which aids in the digestion of food, particularly proteins.
3. **Antimicrobial Properties:** Halogens such as chlorine and iodine have potent antiseptic properties and are used as disinfectants to kill pathogens and sanitize surfaces in medical and industrial settings.
4. **Environmental Interactions:** Halogens interact with organic compounds in natural environments, influencing ecological processes and biogeochemical cycles, particularly in marine ecosystems.

While their roles vary widely, halogens collectively contribute to the complexity and functionality of biological systems, ecological interactions, and human activities. Understanding these roles helps in appreciating their impact on both natural environments and human health and technology.

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