Cations, Anions, and the Human Body

Dietary minerals are mainly inorganic ions. They are essential nutrients that must be obtained from the diet. Following is a list of some of the more important ions in the cells and fluids of our bodies:

- Sodium ions (Na^+) are the principal cations found outside cells in the body. They help regulate and control the level of body fluids. Too little Na^+ leads to diarrhea, anxiety, a decrease in body fluids, and circulatory failure. However, most people have the opposite problem—too much sodium ion—ingested mainly as table salt and salty snack foods. Too much Na^+ increases water retention, leading to high blood pressure (hypertension). About 50 million people in the United States suffer from hypertension. Uncontrolled hypertension can lead to stroke, heart attack, kidney failure, or heart failure. Antihypertensives are among the most prescribed drugs in the United States.
- Potassium ions (K^+) are the principal cations found inside cells in the body. Bananas, orange juice, and potatoes are good sources of K^+. Potassium ions help regulate cellular functions, including nerve impulses and heartbeats, and the level of body fluids.
- Chloride ions (Cl^-) are the principal anions found outside cells in the body. They serve as counterions (ions necessary to balance electrical charge) for Na^+ in the extracellular fluid and for H^+ in gastric juice. Like Na^+, chloride ions are ingested mainly as table salt. Like sodium and potassium ions, chloride ions are involved in maintaining acid–base and fluid balances. It is difficult to separate the effect of too much Cl^- from that of too much Na^+; both seem to be involved in hypertension. Too little dietary Cl^- is rare, but it can result from heavy sweating, chronic diarrhea, and vomiting.
- Calcium ions (Ca^{2+}) occur mainly in the skeleton and account for 1.5–2% of body mass. Ca^{2+} is therefore essential for building and maintaining bones and teeth. Also, Ca^{2+} plays a crucial role in blood clotting, muscle contraction, and the transmission of nerve signals to cells. An adequate supply of Ca^{2+} is especially important during pregnancy and in growing children. It helps to prevent osteoporosis in older people. Good sources of calcium are milk and other dairy products, nuts, and legumes.
- Magnesium ions (Mg^{2+}), like Ca^{2+}, are found mainly in the bones, but they are also vital components of many enzymes, which are substances our bodies need in order to release energy from the food we eat. Good sources of Mg^{2+} are green vegetables (Mg^{2+} is a component of the chlorophyll in all green plants), milk, bread, cereals, and potatoes.
- Phosphate ions exist mainly as $H_2PO_4^-$ and HPO_4^{2-} in body fluids. About 85% of the phosphorus-containing ions in the body are in the bones, where they act as the counterions for Ca^{2+}. Also, they play an important role in energy production from food. Good sources of phosphate are milk and other dairy products, cereals, and meat.
- In addition to the above ions, the body needs smaller amounts of ions found in trace minerals. These include the ions iron(II), chromium(III), copper(II), zinc, fluoride, iodide, and bicarbonate, as well as the hydrogen ion. Also required are compounds of manganese, molybdenum, and selenium, although these are not necessarily in the form of simple ions. These trace minerals play a variety of roles, several of which are discussed in other chapters.

Knowledge of ions is important not only to your success in a chemistry course but also to an understanding of many critical life processes.