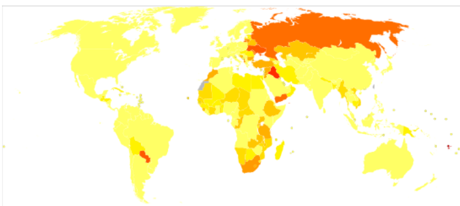
2.4.1: Foods- The Mineral Nutrients Potassium and Iodine

In a previous section on Elemental diet we looked at essential minerals that are sometimes called *"elements"*, but are really only usable to our bodies when they are supplied as *"compounds"*. Both potassium and iodine are essential nutrients, but each must be supplied in a compound if it is to be of any use (let alone nontoxic) to the body. Iodine deficiency leads to thyroid dysfunction and goiter, but very little iodine is required, so goiter is rare.[1] Potassium deficiency (hypokalemia, after kallium, the German name for potassium and source of the symbol, K) leads to muscle weakness, cramps, and constipation [2]. The Recommended Daily Allowances (RDA) for iodine and potassium are 150 µg and 4700 mg respectively, so we need about 30,000 times as much potassium as iodine. Luckily, most foods (especially oranges, potatos, and bananas) supply potassium, and KI is only necessary as therapy.



Map with mostly yellow regions with few red regions and a significant orange regions across areas of Russia.

Iodine deficiency ranges from <50 per 100,000 individuals (yellow) to over 800 (red)[3]

Goiter

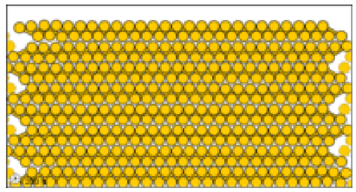
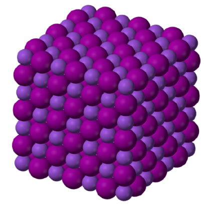
As we saw previously, the element iodine I_2 is a toxic, purple crystalline solid, while the nutrient must be supplied as part of a compound, like potassium iodide (KI). Iodine has a melting point of just 113 ^{o}C, where it also vaporizes significantly, and it boils at just 184.3 ^{o}C. Iodine has a high density of 4.93 g/cc. We'll see below that KI has entirely different properties.

Similarly, the element potassium (K) is a metal with the lowest density (0.89 g/cc) of any metal except lithium. It cuts like butter, has a melting point of only 63.38 ^{o}C and a boiling point of 759 ^{o}C. In the solid, K atoms are arranged in the lattice shown below. Potassium reacts explosively with water as shown in the video below or on YouTube:

Body centered cubic jmol: SID10534500

Because of the toxicity and reactivity of the element potassium, nutrient sources must contain the potassium in a compound like potassium iodide, KI, where it has entirely different properties. Potassium iodide is a white crystalline solid that looks and tastes like table salt (NaCl), dissolves in water, has a melting point of 631 ^{o}C, and a boiling point of 1330 ^{o}C. It's used, along with sodium iodide (NaI) to "iodize" salt.

 Potassium metal, K (the element)	 Iodine, I_2 (the element))	 Potassium iodide, KI (the mineral nutrient)

This option will not work correctly. Unfortunately, your browser does not support inline frames.	 Violet, solid iodine (I_2)	 White crystalline potassium iodide

$$2\text{ K (s)} + I_2\text{ (s)} \rightarrow 2\text{ KI (c)}$$

Reactants → Products

Here we have three views of the same reaction: At the top, the macroscopic appearance of the reactants and products; below them, the microscopic or atomic level representation of the atoms or molecules; and finally, a symbolic represenation in the form of a chemical equation. The solid state of the reactants is indicated by the "s" in parentheses, and the crystalline state of the product is indicated by "(c)". Liquids are designated by (l), gases by (g), and aqueous (water) solutions as (aq).

This equation may be interpreted microscopically to mean that 1 potassium atom and 1 iodine molecule react to form 2 potassium iodide units, but there is no such thing as an isolated KI unit. Rather, there's an extended lattice of alternating K^{1+} ions and I^{1-} *ions*.

When the *elements* potassium and iodine are heated together, they react even more energetically than potassium and water, to give the *compound* KI according to the equation above.

This illustrates Dalton's third postulate, which states that atoms are the units of chemical changes. Notice that there are just as many potassium atoms after the reaction as there were before the reaction. The same applies to iodine atoms. Atoms were neither created, destroyed, divided into parts, or changed into other kinds of atoms during the chemical reaction. The balanced chemical equation reinforces this idea.

The view of solid KI shown above is our first microscopic example of a **compound**. A compound is made up of two (or more) different *kinds* of atoms. Since these atoms may be rearranged during a chemical reaction, the compound can be decomposed into two (or more) different elements. The 1:1 ratio of K atoms to I atoms implied by the formula KI (subscript "1"s are assumed, so KI = K_1I_1) agrees with Dalton's fourth postulate that atoms combine in the ratio of small whole numbers.

References

1. en.Wikipedia.org/wiki/Goiter
2. en.Wikipedia.org/wiki/Hypokalemia
3. en.Wikipedia.org/wiki/Goiter