

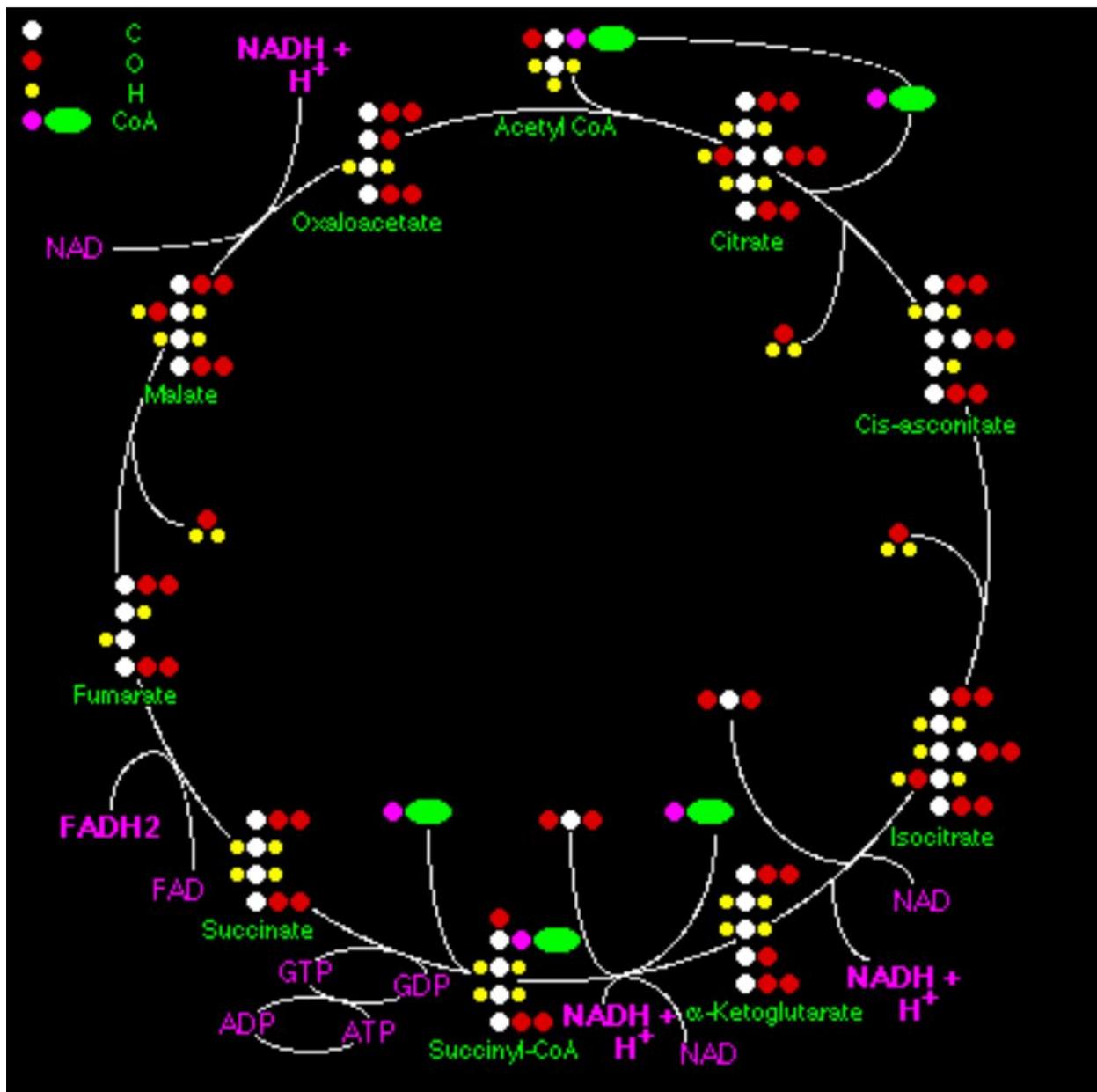
## The Krebs cycle and why minerals are so important for life:

**KREBS CYCLE** (or *citric acid cycle* or *tricarboxylic acid cycle*):

*For every two atoms of hydrogen transferred, three ATP molecules are generated.*

The sequence of chemical reactions, taking place in the mitochondria of cells, that is central to the metabolism of most living organisms. Named after its discoverer, *Sir Hans Krebs* (1900-1981), for which he was awarded a joint-Nobel Prize in 1953. The cycle involves the conversion of acetyl coenzyme A, derived from carbohydrates, proteins and fats in food, into hydrogen atoms or electrons, from which usable energy in the form of ATP is produced by the cytochrome electron transport chain.

**Krebs cycle** minerals are bound to organic compounds used by one of the body's principal metabolic processes for generating energy. The five main *Krebs cycle* group compounds are: *citrates/malates/succinates/glycinates/taurimates*.



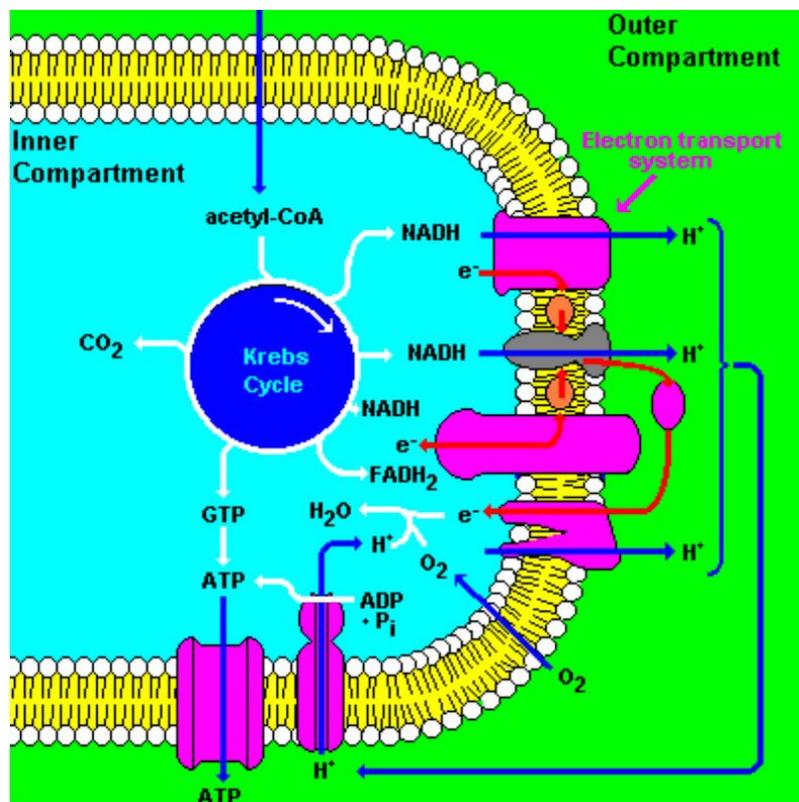
Four of the most important elements in the body are **minerals/vitamins/amino acids/essential fatty acids** (EFAs) that all work together synergistically. Depletion occurs with modern farming and processed foods or cooking methods.

Many scientists agree that the ancient ocean was a 'primordial soup' of organic chemicals, providing everything essential for life to originate. The Creator has established an inner ocean in every land-dwelling mammalian creature - including man. The composition of fluid that bathes cells and tissues is believed to be very similar to the ancient ocean of some 2 billion years ago. Minerals are dissolved in this fluid in very particular balances, which can easily become unbalanced.

**Electrolytes:** the most important role of minerals is that of electrolytes.

(Definition of Electrolyte: "A substance whose molecules split into individual ions when dissolved thus allowing it to conduct electrical energies" (Clayman p.397).

Membranes of cells are flexible and freely permeable to water. The interior of a cell contains an abundance of large and small organic molecules, most of which have an electric charge. These charged molecules attract charged inorganic molecules called *electrolytes*, such as sodium and potassium, forcing water out of the cell interior. If the cell didn't counteract this, the difference in water concentration across the cell membrane would cause more water to move into the cell by *osmosis*, eventually causing the cell to burst. Cells avoid this by using ATP energy to continuously pump sodium ions in or out of the cell. An *electro-chemical gradient* (across the cell membrane) is formed by minor differences in ionic concentration between the inside and outside of the cell. Cells utilize *chemical gradients* in many ways: nerve cells transmit impulses this way; *mitochondria* generate energy in this manner, and small molecules (such as sugars) are transported into cells this way.



This is a clear diagram showing just how important and integral the Krebs cycle is within the cellular structure.

**Minerals** also act as *cofactors* in many biochemical reactions. A *cofactor* is very similar to a vitamin *coenzyme* and both activate metabolic enzymes. Life cannot exist without enzymes and these huge, convoluted protein molecules have 'receptors' into which other molecules, called *substrates*, fit like a key in a lock. The enzyme can then reduce the energy needed for the *substrates* to react with each other, resulting in a new compound. Nearly all the body's complex organic molecules, including *amino acids*, *proteins*, *phospholipids*, RNA and DNA are built this way. In order to work, enzymes need mineral *cofactors*. The other factors provide the 'attachment points' where molecular groups can be attached and detached easily. In the *cofactor* ATP, *phosphorus* provides this function by creating an easily broken high-energy bond with an oxygen atom, the energy of which can be transferred into chemical reactions. (Iron uses this system to carry *oxygen* to the lungs and return *carbon dioxide* out of the body's system by exhalation. This exchange process occurs at cellular level initially.)

Minerals act as *cofactors* in over 1000 different reactions in the body. Magnesium alone is necessary for the functioning of over 300 enzymes. The absorption of many minerals seems to be enhanced by the presence of *amino acids*.

### **Copper:**

Copper is found in the greatest concentrations in the kidneys and nails, lesser amounts in the brain, liver, heart and skeleton. Most copper is found in the blood, muscle, liver and bone. Copper is a *cofactor* for several *oxygenases*, (enzymes which allow oxygen to be used in respiration.) These include *cytochrome* and *oxidase*, the terminal component of the *electron transport chain*, which accounts for about 90% of the total oxygen uptake in most cells. Copper is also one of the key elements in a *superoxide dismutase* (SOD), which provides intracellular defense against *superoxide* anions. It is also a constituent of the enzyme *ceruloplasmin*, an extra cellular scavenger of *super oxide* and other *oxygen* radicals. Copper is therefore a very important *antioxidant*.

Copper aids in the formation of bone, hemoglobin and red blood cells. It works in balance with zinc and vitamin C to form **estalin**. It is also involved in the healing process, energy production, hair and skin coloring and taste sensitivity. It is also needed for healthy skin and joints.

Osteoporosis is an early sign of copper deficiency. Copper is also essential for the formation of collagen, one of the fundamental proteins making up bone, skin and connective tissue. 70% of the body's connective tissue in the dermis is made up of collagen.

### **Magnesium:**

A *cofactor* in over 300 metabolic enzymes, magnesium activates most of the key enzymes that allow the glycolytic and *Krebs cycles* to turn sugar and fat into ATP bio-energy in the *mitochondria* of the cells. This is necessary for the stabilization and storage of ATP energy (as MgATP). It is the main energy source for the sodium-potassium pump in cell membranes. This pump maintains the proper difference between potassium levels in the cell and sodium levels outside the cell, which creates the electrical potential for nerve cell conduction. Magnesium is critical for proper nerve and muscle activity and is also involved in cellular protein and DNA/RNA synthesis, metabolism of fatty acids and calcium metabolism.

Sodium and potassium are the body's primary *electrolytes*. The difference in ionic concentration between the potassium-rich intracellular fluid and sodium-rich extra cellular fluid creates electrical potential necessary for nerve conduction and muscle movements. Proteins, embedded in cell membranes, which constantly pump potassium in and sodium out, maintain this balance. Energy for this is supplied by magnesium and in the form of ATP energy (MgATP).

**Selenium:**

It has recently been discovered that an enzyme - *glutathione peroxidase* - containing four selenium atoms in its structure, appears to catalyse the oxidation of *glutathione* (found in nearly all cells), a reaction that facilitates the detoxification and removal of *peroxidase* and free radicals from cells. This enzyme is also very important to the body's ability to break down and excrete harmful substances. It is also thought that selenium, together with vitamin C, may be involved in recycling vitamin E, the most important *peroxide* quencher in cell membranes. Vitamin E can then return to duty after it has been oxidized through interaction with free radicals. Selenium, bound to the amino acid *cysteine* to form *selenocysteine*, may regulate the synthesis of *glutathione peroxidase*.

**Zinc:**

- Zinc functions in over 100 enzyme systems in the body associated with carbohydrate and energy metabolism, protein and *nucleic acid* synthesis. It is important in the metabolism of vitamins A and E and therefore assists with anti-oxidation.
- Zinc synthesises DNA and protein, including *collagen*.
- Zinc activates the enzyme, *superoxide dismutase*, found in the *cystol* of all cells and defends cells against the dangerous superoxide radical.
- Zinc detoxifies alcohol in the body and is important in vitamin A metabolism, especially in *retinal enzymes* essential for sight.
- Zinc also synthesises the retinal binding protein in the liver, which is required for the transport of vitamin A through the blood.
- Zinc is the mineral *coenzyme* for *collagenase*, a key enzyme in *collagen* production.
- Zinc is necessary for production of T (*thymus*) cells, a form of white blood cells, involved in production of antibodies.
- Copper *sebacate* (an *amino acid*) enhances the absorption of zinc. Both are positive ions and compete for absorption.