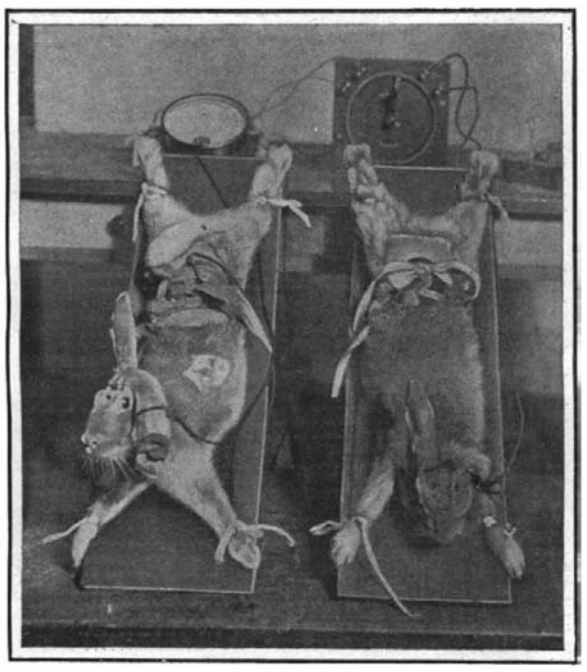
IONIC THERAPEUTICS.

When an electric current traverses a solution of a salt the latter is decomposed, the metal appearing at the negative pole or cathode and the acid radical at the positive pole or anode. Such a solution is called an electrolyte. Acids and alkalies are likewise electrolytes. Acids may be regarded as salts in which the metal is hydrogen, and alkalies as salts in which the acid is hydroxyl, OH.



Two Rabbits Traversed in Series by the Same Current Passing Through Electrodes of Strychnine Sulphate and Sodium Chloride.

Faraday gave the name ions (from the Greek *io*, to go) to the constituents of the electrolyte which appear at the electrodes and distinguished the anion (Greek *ana*, up) disengaged at the positive pole from the cathion (Greek *kata*, down) which appears at the negative pole.

The tissues of the human body are impregnated with saline solutions. They may therefore be regarded as electrolytes, and the electric conductivity of the body is an electrolytic conductivity.*

When an electric current passes through the human body the electrolytic molecules, most of which are molecules of sodium chloride, are dissociated, the electro-negative chlorine going to the positive electrode, or anode, and the electro-positive sodium to the negative electrode, or cathode. If the electrodes are of platinum or other substance which is not attacked by the ions, the anion chlorine, after giving up its negative electric charge to the anode, combines with some of the hydrogen of the watery tissues in the immediate vicinity, thereby partly destroying them, forming hydrochloric acid and setting free oxygen by a reaction which may be written: $2Cl + H_2O = 2HCl + O$. The electrolysis of living tissues, which has long been used in medical practice, is based on this process.

Let us suppose that it is desired to remove a small vascular tumor by electrolysis without leaving noticeable scars. A needle or a number of needles of gold or platinum, covered except at the point with insulating varnish, is thrust into the tumor. A current is then passed through the body, between these needles as the anode and a large and chemically inert cathode consisting, for example, of a bath of salt water in which the patient's hand is immersed. Under these conditions chlorine is evolved at the anode, causing intravascular coagulation and partial destruction of tissue, while the sodium which is set free at the cathode simply dissolves in the salt water without exerting any important effect upon the tissue of the hand. This is a typical example of medical electrolysis as formerly practised.

But the action is altogether different if the electrodes consist of solutions of salts, acids, or alkalies. In this case the passage of the current effects ionic exchanges between the body and the electrodes. For example, if the electrodes are spongy substances saturated with a solution of potassium iodide, the potassium, which is a cathion, will traverse the skin and the tissues in the direction from the anode to the cathode, while the anion iodine will enter the body at the cathode and travel in the opposite direction. This simple phenomenon may give rise to a revolution in therapeutics. Until recently it was believed that only an insignificant quantity of medicinal substances, or none, could be introduced into the body by means of the electric current, but it is now known that such introduction can be effected easily and regularly so as to produce at will local effects on the skin or general therapeutic or poisonous effects throughout the body, according to the electrolytic solution employed, the intensity of the current and the length of time during which it is applied.

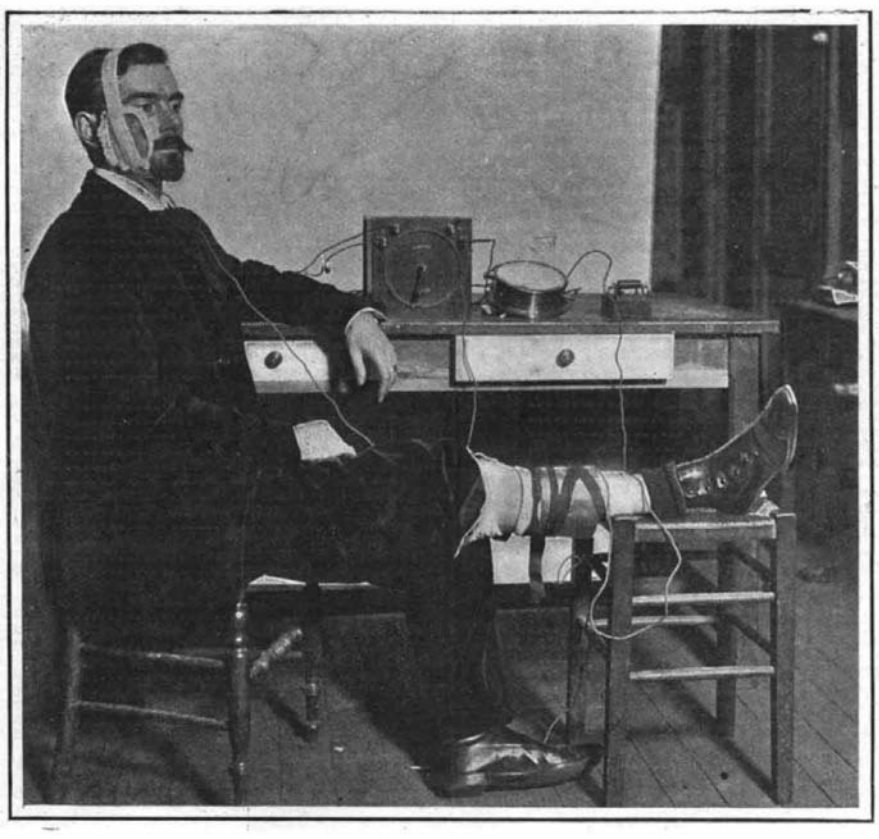
Dr. Leduc has proved this by numerous experiments, of which we here describe three, and afterward repeated by ourselves.

When electrodes saturated with potassium permanganate are placed in the ears of a rabbit, and the current is applied for a sufficient time, the inside of the ear which contained the cathode is found to be marked with uniformly distributed brown dots which cannot be removed by washing. These dots consist of manganese oxide, the negative ion resulting from the electrolytic partition of the molecule of potassium permanganate, and the oxide has been driven into the subcutaneous glands by the negative charge of the cathode. No marked change is observed in the inner skin of the other ear which was in contact with the anode.

If the cathode is a solution of potassium cyanide, death quickly ensues, but potassium cyanide at the anode produces no such effect.

On the other hand, strychnine sulphate employed as the anode soon produces characteristic tetanic convulsions and death, but the same solution is ineffective when used as the cathode.

To demonstrate the effect of the direction of the current, Dr. Leduc has devised the following elegant and instructive arrangement. The current is caused to flow through two rabbits arranged in series. The electrodes consist of tufts of absorbent cotton saturated with solutions of strychnine sulphate and sodium chloride and placed in contact with plates of metal attached to the conducting wires. The exterior electrodes through which the current enters the first and leaves the second rabbit are saturated with sodium chloride. The interior electrodes, through which and a short wire the current passes from one rabbit to the other, are saturated with strychnine sulphate. As strychnine is a cathion it moves toward the cathode. Hence strychnine ions penetrate the body of the second rabbit, which soon succumbs to convulsions. But the strychnine which is in contact with the first rabbit is already at a cathode. Consequently it does not enter the body of the animal, which remains unaffected. These methods are applicable to the human subject and make it easy to introduce definite medicinal ions. Dr. Leduc has cured facial neuralgia, in which repeated surgical operations had proved themselves ineffective, by the electrolytic introduction of salicylic acid into the diseased part.



IONIC THERAPEUTICS IN THE TREATMENT OF RHEUMATISM.

One of the most regular therapeutic effects of electrolytic treatment is its resolvent action on hardened tissues and scars. For this purpose a solution of sodium chloride is employed as a cathode. Dr. Leduc cites the case of a young soldier whom an abscess in the hand had left with complete anchylosis or immobility of the fingers. In a military hospital the patient had received without benefit various treatments, including forcible working of the joints under chloroform, and had finally been discharged as incurable. He was then treated by electrolysis. The injured hand was immersed in a bath of salt water, which served as a cathode, and a current of 0.03 ampere was applied for half an hour. Two such treatments effected a complete cure. The writers have also obtained remarkable and very rapid cures in cases of stiffness of the joints caused by wounds. Electrolytic medication is still in its infancy, but it seems destined to have a great future.

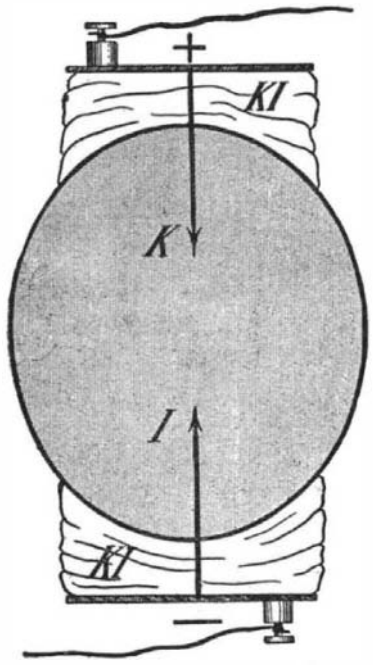


Diagram Illustrating the Movements of Ions Through a Human Body.

The spongy electrodes on opposite sides of the body are saturated with potassium iodide (K I). Potassium (K) enters the body from the anode above, and iodine (I) enters from the cathode below as indicated by the arrows.

In the words of Prof. Leduc: "It is difficult to imagine how absurd will appear in the future our present practice of disseminating throughout the body, in order to act upon a very small region and a coarse tissue, substances which are particularly injurious to the most delicate and important tissues, such as those of the nervous centers. It should be one of the objects of medicine to substitute local for general treatment whenever it is possible to do so. Toward the attainment of this object the electro-ionic method offers means not presented by any other system of medication. It enables us to introduce into cells impermeable to many drugs, the entire series of ions and to obtain the specific effect of each."—From the French of Drs. P. Desfosses and A. Martinet in La Nature.

* Stéphane Leduc: Les nouvelles théories des solutions dans leurs rapports avec la médecine. Les Ions, les médications électrolytiques. Published in La Presse Médicale, Nos. 70, 72, 74, 76.

One-Eyed Fish Produced at Will by Proper Breeding.

Writing in Science, Dr. Charles R. Stockard, of Columbia University, gives a brief account of an interesting experiment in artificially producing a single median eye in the fish embryo by means of sea-water solutions of magnesium chloride. It seems that *Fundulus* embryos when developed in certain strength solutions of $MgCl_2$ in sea-water form a large single median eye. This condition is comparable to the one-eyed human monsters known as *Cyclops*, *Cyclopia*, or *Synophthalmia*.

The single eye results from an antero-medio-ventral fusion of the elements of the two optic vesicles at an early developmental stage. This fusion is more or less complete in the different embryos.

The large compound optic cup induces the formation of a single lens. This lens is formed from ectoderm different in position from that of the normal lens-forming region. The lens is abnormally large in size as is also the optic cup, and the size of the former varies directly with that of the latter. It is probable that there is no localization of lens-forming substance in the ectoderm of the fish embryo. This inter-relationship in the development of the optic cup and lens is interestingly compared with the processes of development in the amphibian eye as shown by recent experiments.

Mixed sea-water solutions of $MgCl_2$ and NaCl also cause the one-eyed condition. Since such a defect is characteristic of the $MgCl_2$ action when used in sea-water solutions one must infer that the Mg constituent in the mixture is responsible for the result.