

# NEW EXPLANATION OF NERVE PHENOMENA

## Discoveries of Dr. A. F. Mathews of Chicago University.

### Underlying Principles of Nerve Action— Prof. Loeb's Researches Into the True Nature of Death.

Physicians in this city, especially those whose practice is largely confined to nervous diseases, were yesterday much interested in the discovery reported from Chicago of the underlying principles of nerve action. This discovery is described as taking the form of the enunciation of a general law, many of whose manifestations have been known hitherto, but which are now for the first time grouped logically together, with the addition of new facts disclosed by recent experiment.

It is shown by the discoverer, Dr. Albert F. Mathews, that a new and general explanation can now be offered of nerve phenomena, which were hitherto only partly understood. The discovery, it is believed, will simplify the whole science of physiological chemistry, adding materially to the knowledge of the nerve specialist and perhaps alleviating distress and prolonging life.

The details have been laid before the members of the American Physiological Society, now holding their annual meeting in Chicago, and have been described by Prof. Jacques Loeb of the University of Chicago as "the most nearly fundamental physiological generalization in fifty years." Dr. Albert F. Mathews, who makes the announcement, is Professor of Physiological Chemistry in the University of Chicago. He is a young man, and at one time worked in biology under Prof. Wilson at Columbia and later became an instructor in physiology in the Harvard Medical School. He was a pupil of Kossels's, one of the foremost physiological chemists of the world, at the University of Heidelberg.

Dr. Mathews has done much original work with Prof. Loeb and coincident with the announcement by the former is one from Prof. Loeb telling of his own experiments looking to the determination of the true nature of death, which he describes as not a cessation of action but a morphological process, which he has temporarily arrested by the use of potassium cyanide solutions on sea urchin eggs. He is now experimenting with Dr. Mathews in the logical continuance of this work.

Neurologists and nerve specialists in this city yesterday in many instances declined to express an opinion upon the work of Dr. Mathews until they were more fully informed as to exactly what he claimed. More than one distinguished physician frankly stated that the subject was so complicated as to be incomprehensible to the lay mind, and that, in fact, no one could understand it thoroughly but a physiological chemist, of whom there are few in New York.

#### VIEWS OF PHYSICIANS.

This was the view of the subject taken by Dr. Charles L. Dana when asked for his opinion by a reporter for THE NEW YORK TIMES. At the same time, Dr. Dana said that the announcement from Chicago appeared to show that a considerable advance had been made.

"It seems to me," said Dr. Dana, "that this comes from a professional physiologist, who has probably pushed forward the solution of these physiological phenomena a step further, so that they are a little more intelligible to the trained technical mind. But I do not believe that it is a solution that will make the phenomena of nerve action any more clear to the laity." Dr. Dana stated further that the complexities of this subject were so great that even a physiological chemist could not fully comprehend the reasoning and conclusions of Dr. Mathews without a careful reading and study thereof.

Dr. Edward C. Spitzka made a careful perusal of the fourteen paragraphs in the summary of Dr. Mathews's theory.

"This work," said Dr. Spitzka, "seems to be based upon scientific principles. Very possibly he has approached the kernel of an important solution. The only thing that I look upon as problematical in the light of our past knowledge is his statement about the antidotal action of alcohol to snake poison. And I do not understand the meaning of the postponing of death by the use of cyanide solutions, as described by Dr. Loeb, for they are themselves highly poisonous."

Dr. George F. Shrady said:

"This theory is rather a striking one, and apparently very plausible, in view of the fact that it is founded on good scientific principles of induction. Of course the theory is in its tentative stage, and more experiments are required before it can be positively affirmed, but there seems enough in it to command the attention of scientific men. The explanations made by the distinguished professor are very ingenious, and are based on well-known physical laws. In some respects this is a new discovery in the matter of explaining the facts, although many of the facts themselves are matters of long observation among experimenters, and he has also acquired some new facts in reference to the relation of ions to the disturbances of nerve energy. This would tend to establish a somewhat different general law explaining the action of therapeutic agents. In that respect it may open the door to the establishment of a new therapeutic principle."

"The position taken by Dr. Mathews is a very broad and comprehensive one, and it is impossible to say at this time what its ultimate outcome may be in the way of its application to practical therapeutics. At this stage it could hardly be considered important except in establishing a general principle in outlining further work and experiment."

Dr. W. J. Gies, instructor in Physiological Chemistry in the College of Physicians and Surgeons, has known Dr. Mathews for a long time, and said yesterday that the generalizations of the latter were important and ingenious.

"It will clear up mysteries connected with the functions of the nerves," said Dr. Gies, "and should bear on the whole question of the relation of the nerves to the rest of the body. This theory will go a long way to explain the changes that take place in the nerves when a man becomes intoxicated or the neural changes that account for the effects of anaesthetics. It may be regarded as one of the most important generalizations in biology made during recent years."

Among the things which the theory of Dr. Mathews is held to explain are nerve and muscle stimulus, transmission of nerve influence, muscular contraction and expansion, the heart beat, the operation of anaesthetics, and the phenomena of intoxication, and, as carried into a further branch of experiment by Prof. Loeb, it is concerned with the mystery of death.

#### DR. MATHEWS'S SUMMARY.

Dr. Mathews summarizes his discoveries in fourteen paragraphs. These, as published by The New York Sun in a dispatch from Chicago yesterday morning, are as follows:

First—Motor nerves contain or consist of a colloidal solution the colloidal particles of which carry positive electrical charges.

Second—Nerve protoplasm is stimulated by the passage of the colloidal particles from a condition of a solution to that of gelation, or jellying.

Third—This change is brought about by the action of ions, electrically charged atoms or groups of atoms, which bear negative charges. The stimulating action of any chemical compound depends on these negative charges. These ions (anions) having one charge, are less efficient than those with two or three. In other words, the stimulating action of any ion is proportional to the number of negative charges it bears.

Fourth—The colloidal particles of the nerves are held in solution by positively charged ions, sodium, potassium, calcium, hydrogen, &c., and the effectiveness of these ions in preventing stimulation varies directly with the number of positive charges they bear. A one-charged ion, such as sodium, is less poisonous than a three-charged, such as iron.

Fifth—By these facts chemical stimulation is shown to be identical with electrical. Whenever in any part of a nerve negative charges are in excess the nerve is stimulated, that is, the colloids pass from a solution to a jelly. The stimulus always arises at the cathode or negative electrode.

Sixth—The irritability of a nerve is diminished whenever the solution of the colloids is rendered more permanent. It increases as the nerve approaches the gelation state. All positively charged ions thus diminish irritability, negative increase it. This explains electrotonus, as the irritability of the nerve is increased near the cathode and reduced at the anode.

Seventh—Heat diminishes the irritability of the nerve by rendering the solution more stable; cold increases it by rendering it less stable. At high temperatures gelation takes place and the nerve is stimulated.

Eighth—The nerve is stimulated mechanically because the colloidal particles are forced together. As they coalesce their surface becomes less. Less positive charges can reside on it and part of the negative charges previously induced in the surrounding water are set free and immediately precipitate the next group of colloids.

Ninth—These in their turn set free negatives

which precipitate the next group, and so the nerve impulse is carried. Technically these negative changes are called the negative variation, and this stimulates each successive element of the nerve.

Tenth—Anaesthetics all dissolve fat. They reduce the irritability of the nerve or protoplasm because the colloids in the nerve are largely fat compounds and more soluble in a mixture of ether and water than in water alone. All anaesthetics render the colloidal solution more permanent and prevent gelation.

Eleventh—Besides the number of electrical charges in the ions there is some other factor which determines the action of salts. Thus potassium is more effective in reducing irritability than sodium; fluorine is far more effective as a stimulant than chlorine, although all carry only a single charge. It is believed that this difference of efficiency in monovalent anions or cations is dependent upon the rate of rotation of the electron or the positive or negative point-charge about the atom with which it is associated. The electron rotates about the fluorine atom about twice as fast as about the chlorine atom.

Twelfth—The stimulating action of any anion or the poisonous action of any cation is hence a function, first of the number of charges rotating about the atom; second of the rate of rotation of these charges, and third of the circumference of their orbits.

Thirteenth—Chemical stimulation is thus, by the electro-magnetic theory of light, shown to be identical with stimulation by light waves. The stimulating action of any anion increases as the spectrum of that anion approaches the ultra-violet.

Fourteenth—The long light waves and heat waves are in their action like those of the positively charged ion.

Dr. Loeb showed a year ago that sodium chloride solution would stimulate the heart to increased action. This was the "injection of salt water cure" which created a world-wide sensation. He has since been working to determine how the sodium accomplished that end, and began the study of muscle stimulus. Dr. Mathews also took this up and began a series of experiments on frogs and found that the nerve when it is stimulated has a tendency toward coagulation. He found that nerves were formed of a kind of fluid, technically called colloidal, the particles whereof had positive electrical charges. Dr. Loeb found that muscle is colloidal in nature, and that a negative current or motor-impulse entering the nerve precipitates the colloids, and this contracts the nerves.

The "ion" referred to by Dr. Mathews is the unit of matter, or smallest atom, as used by physiological chemists. Drunkenness and anaesthesia are explained by this theory, for the colloids are dissolved in the highly sensitive brain cells, making the solution more stable, reducing the power to send motor currents to the muscles. Snake poison coagulates the nerve colloids, but alcohol dilutes this substance and is thus an antidote.

#### DR. LOEB'S EXPERIMENTS.

Dr. Loeb told the physiologists of his experiments on sea urchin eggs. Death, he said, was not a negative process, a breaking down of tissues, but an active agent, born with the birth of the egg and destined, if not checked, to gain the upper hand. Dr. Loeb said he had been able to check this. "This means," said he, "that on a minute scale the secret of eternal life is in the power of mankind." He had immersed the eggs in a solution of potassium cyanide, and had for several days held the death process in check. Under ordinary conditions, the unfertilized egg dies in a few hours. At the end of several days the eggs were again examined, and found to be capable of fertilization and of producing healthy animals.

These experiments of Dr. Loeb were regarded by New York physicians yesterday as theoretical. The suggestion that they held out the hope of the extinction of death was regarded as so much absurd nonsense. It was described as a prolongation of life, just as science every day now prolongs life, yet cannot avert death. None of the physicians in this city who were seen in regard to the subject believed that Dr. Loeb claimed anything further than the illustration of a scientific principle, and that he had not pretended to be able to control or avert death.