X-Rays. An Introduction to the Study of Röntgen Rays. By G. W. C. KAYE. Longmans, Green & Co.

Since 1895, when Röntgen made his epoch-making discovery of the X-rays, an immense amount of research work, experimental and theoretical, has been done on their properties. This work has produced a remarkable series of discoveries of high interest and fundamental importance. A connected account of the latest results in this branch of physics by one who has made several important contributions to it can not fail to be welcome. Dr. Kaye has succeeded in producing a very useful summary of the latest results together with a brief account of the historical development of the subject and numerous practical details which should be useful to any one working with X-rays. The book contains a number of excellent illustrations.

A few minor errors have crept in; for example, on page 148 it is stated that the total ionization produced by a beam of homogeneous corpuscular rays is independent of the velocity of the corpuscles, which is obviously absurd.

Chapter XII. contains a clear account of the recent work, initiated by Lane, on the diffraction and reflection of X-rays by crystals, which has established the theory that X-rays are merely light rays of very short wave length.

Chapter XIII. contains a discussion of the various theories of X-rays which have been put forward. The problem which remains to be solved is the emission of high velocity electrons by matter when exposed to X-rays.

H. A. WILSON

Irritability, a Physiological Analysis of the General Effect of Stimuli in Living Substance. By MAX VERWORN, M.D., Ph.D. New Haven, Yale University Press, 1913.

To the physiologist who wishes, for the clearing of his vision, to return from time to time to a consideration of the fundamentals of his science, no better opportunity can be offered than that contained in the published volume of lectures on irritability by Professor Max Verworn. The biologist, too, will find in its pages an unusually rich presentation of the facts of cell behavior, interwoven, correlated and interpreted, with meanings that separately they fail to convey.

The book, a re-writing of the Silliman Lectures of 1911, is a philosophical treatment of the nature of irritability as one of the general manifestations of living material, followed by a study of the laws and effects of stimulation, undertaken for the light that such knowledge may throw on the nature of the vital processes of which irritability is a manifestation. Its facts are drawn from the results obtained during twenty years consistently devoted to the problem by Verworn and his pupils, and from the work of others in the same field. The importance of its conclusions may be estimated from the breadth of its experimental foundations.

The opening chapter gives a careful review of the historical development of our modern ideas of the subject, from the first generalizations of Glisson, with whom originated the "doctrine of irritability," down to Virchow's conclusion that nutritive, functional and formative reactions of cells are the basis alike of normal and pathological manifestations in cell activity. The importance of Virchow's teachings in the modern interpretation of diseased conditions has perhaps overshadowed their equally great importance to general physiology: indeed, these, with inhibition (Weber) and narcosis (Claude Bernard), may be looked upon as the starting-point of Verworn's philosophy.

The second lecture, on the nature of stimulation, is perhaps the most striking, containing as it does clearer definitions of the meaning of the words stimulation and irritability than we have had heretofore, and leading to a better understanding of the scope of the unsolved problem of the nature of the vital processes. Beginning with a lucid presentation of the difficulty in differentiating between the "cause," so-called, and the "conditions" of a biological, or indeed of any, process, it is pointed out that "all conditions for a state or process are of equal value for its existence, for

they are all necessary." And though we are prone to consider the last determining condition for a process as its cause, in reality "a state or process is solely determined by the sum total of its conditions." Living material by virtue of its irritability adapts itself to changes in the conditions of its existence, by various manifestations with which we are familiar. "Life is the entire sum of the vital conditions."

A stimulus is every alteration in the vital conditions, being a stimulus only when considered in relation to the previously existing state. The alteration may be subliminal, minimal, submaximal, or maximal; it may be harmless or injurious; short, long or the initiation of a new condition which is to persist. Since there are certain internal vital conditions that are always undergoing change, as in development, and external vital conditions that may exist unchanged, and independent of the vital process, a suggestion is made that for practical purposes stimulation be defined as "every alteration in the external vital conditions."

Having achieved the new viewpoint (and indeed the word "new" might be omitted, for most of us have none), the reader follows through equally lucid discussions of the characteristics and effects of stimuli, of the process of excitation, of conductivity, the refractory period, fatigue, interference and states of depression, meeting old facts in unexpected places, watching isolated observations falling into line, and finding new meanings in all that is placed before him.

To suggest that the book be read for pleasure is perhaps apparently to belittle its importance. If so the fault lies in the general notion of the meaning of pleasure. But it is undoubtedly true that the biological scientist has few such opportunities for simultaneously pursuing happiness and acquiring merit.

The reviewer had almost forgotten to refer to the excellence of the translation, for which the author makes gracious acknowledgment. The reader will find it very easy to forget that the book was not originally written in English.

C. C. S.

REGENERATION OF ANTENNÆ

Some interesting results have been achieved by experiments, made and reported by H. O. Schmit-Jensen,[1] on the regeneration of severed antennæ of Phasmidæ. A rather large number of small and half-grown larvæ of *Dixippus morosus* had been insufficiently supplied with fresh vegetable food and thus cannibalism appeared among them, and a number were found with one or both antennæ or some of their limbs missing. A single specimen attracted attention because of one of its attennæ having regenerated like a little foot. After the following molt this organ had increased in size and became still more foot-like in form.

This case of spontaneous homœosis caused the author to cut the antennæ from fifty newly hatched and sixty half-grown *Dixippus* larvæ, all the larvæ being from unfertilized eggs. The antennæ were severed between the first and second segments or between the second and third, sometimes the left antennæ being cut and sometimes the right and in some cases both were amputated. When both were cut the specimens died. In some cases where the single antenna was severed there was no regeneration, only a knot developing. But often there was produced, not a small antenna, as one might expect, but a tarsus consisting of from one to the normal five segments complete with terminal claws with the ordinary arolium between them. In four cases a tibia was also developed. In young larvæ there seemed to be a distinct increasing development of the foot-like characters of the regenerated organ with each molt. After the first molt succeeding amputation there appeared only a short knob. The next molt produced a segment with evident claws and the third molt brings the organ into more perfect tarsal formation. Some of the more perfect tarsus-like regenerations are, as shown by figures reproduced from photographs, almost indistinguishable from an actual foot, some, as stated above, even having the tibiæ present. In the older larvæ the place of severance

[1] *Meddel. fra Dansk naturh. Foren.*, Vol. 65, pp. 113–134, Figs. 1–7 (1913).