The following results extend the observations reported by Brown and Sollmann :

1. In *frogs* weighing about 25 gm. no effect was observed after introduction per os, when less than 40 mg. was introduced. This amount caused only slight symptoms. Subcutaneous injection of 40 mg. caused death in about 60 hours. Injection of the same amount per rectum appeared to be more quickly followed by toxic results than when introduction occurred through either of the former channels. Introduction per os caused irritation of the throat, increased gastric secretion, ejection of gastric contents and increased peristalsis. It required per os approximately 1.5 gm. per kilo to produce general toxic results, among which were anhydrosis, twitching, and progressive weakening of the muscles, with paralysis of the forelegs preceding paralysis of the hind ones. In fatal cases the reflexes were abolished in the usual order. The general toxic effects after introduction subcutaneously or per rectum were about the same as those following introduction by way of the stomach.

2. *In warm-blooded animals* (mice and dogs) relatively large doses administered subcutaneously caused restlessness, twitching of the muscles, progressive paralysis, labored breathing, stupor, death. Paralysis of fore-legs preceded loss of power in the hind legs. Injection of 5 gm. of the chlorid into a dog weighing 15 kilos failed to cause death. Ingestion of 2 gm. with 100 gm. of meat, by a dog weighing 6 kilos, was followed in two hours by vomiting. The ejected matter was gradually eaten during the next few hours with no other apparent effect thereafter than loss of appetite and increased desire for water.

3. The most constant and pronounced general effect of the tetrachlorid of thorium was a progressive weakening of all the voluntary muscles.

Eleventh meeting.[1]

Zoölogical Laboratory of Columbia University. April 19, 1905. President Wilson in the chair.

25 (71). **"The relation between normal and abnormal development of the frog's egg": T. H. MORGAN.**

The method of development of the frog's egg may be changed

[1] Reprinted from *Science*, 1905, xxi, p. 741 ; *American Medicine*, 1905, ix, p. 744 ; *Medical News*, 1905, lxxxvii, p. 87.

by a number of external agents. If the eggs are revolved at the rate of 180 revolutions per minute; if they are put into salt solutions of definite strengths; if they are subjected to a low or to a high temperature; if they are deprived of sufficient oxygen or surrounded by carbon dioxid in solution; if they are placed on wet filter paper instead of developing under water — in any of these ways abnormal embryos result.

An examination of the effects of these external agents brings out two points of especial interest. First, that the effects are not gradual, *i. e.*, corresponding in degree to the increasing strength of the agent employed, but that no effects appear up to a certain point and then suddenly the agent begins to act. Increasing the strength of the agent above this point may for a small range increase the effect, but this occurs within extraordinarily narrow limits compared with the lower range of non-action. The most plausible explanation of this mode of behavior in most of the cases is as follows: The agents act by coagulating certain parts of the egg, thereby preventing their further development. Other parts of the eggs that are made up of different colloids or of different concentrations of colloids remain unaffected, and proceed to carry out their development as far as the presence of the injured region allows.

The second point was the one that the author spoke of especially. Despite the great diversity in the form of the abnormal embryos, most of them may be reduced to modifications of the same type. For example, in many cases the dark cells of the upper hemisphere do not grow down over the lower hemisphere to produce there the embryo, but, remaining at the top of the egg, partially constrict off from the yolk cells at, or even above, the equator of the egg. Out of these dark cells the abnormal embryo develops usually in the form of a ring. Sometimes one side only of the ring develops and a half embryo appears; sometimes only the anterior end of the ring develops and an anterior embryo appears (often more or less "open"), etc.

The author called especial attention to the fact that the abnormal embryo develops in the material of the upper hemisphere; while the normal embryo develops over the lower hemisphere. Two interpretations of this difference seem possible. Either the

material is totipotent and an embryo may develop anywhere in the egg, appearing in the less injured regions; or the material for normal and abnormal development is the same and becomes carried downward, during the early stage of normal development, from the upper into the lower hemisphere.

The author tested these alternatives in two ways. In the first place he removed with a needle the two anterior, or the two posterior, or even all four of the upper blastomeres at the eight cell stage. The results showed that when the two upper anterior blastomeres are removed, the head end of the embryo is defective; when the two upper posterior blastomeres are removed, the posterior end sometimes shows defects. When all four of the upper blastomeres are removed, no embryo develops, although the blastoporic rim may appear near the equator of the egg, the gastrulation process may begin, and the differentiation of the germ layers takes place to a certain extent.

The author concludes from these results that some at least of the material that goes to form the embryo, lies at first high up in the upper hemisphere of the egg. In the light of this conclusion, it became necessary to examine once more the early development, especially the pregastrula stages; for despite the fact that the frog has been a classic object of study with embryologists for over a hundred years, no one has suspected that the embryo-forming material lies in the upper hemisphere and is transported to the lower hemisphere *before* the lips of the blastopore have appeared.

Briefly, the author's examination showed that throughout the early period of segmentation the material of the upper hemisphere gets pushed far out to the sides of the egg. This is brought about largely by the development of the enormous segmentation cavity. During the later cleavage period, the yolk cells of the lower hemisphere push upward into the segmentation cavity, almost obliterating it. This upward movement of the cells in the interior is compensated for by the moving downward below the equator of the outer layers of the egg. In this way the embryo-forming material is carried into the lower hemisphere. Along its edge the lips of the blastopore develop. The dorsal, lateral and ventral lips roll over the yolk (or more accurately, the yolks draw in beneath their advancing lips), and the dorsal organs of the embryo

(the embryo in a narrower sense), appear over the lower, or yolk hemisphere of the egg.

26 (72). **"Rejuvenescence in protozoa": GARY N. CALKINS.**

The process of conjugation in protozoa involves either temporary or permanent union of two individuals. During this union there is a fusion of nuclear material from both organisms resulting in the formation of new cleavage nuclei in each exconjugant. The process is directly comparable with fertilization of an egg by a spermatozoön, and the biological significance of the phenomena involved is probably identical in all living things.

Since 1876 it has been generally assumed that one effect of conjugation is rejuvenescence or renewal of vitality in both of the exconjugants. This assumption has never been submitted to experimental proof. In his *Paramecium* work, begun in 1901, the author almost had the proof, but allowed the opportunity for obtaining it to slip through his fingers without realizing its importance at the time. The author's object in bringing this up at the present time is to announce that on the last day of February (1905) he started a new series of experiments with *Paramecium*, consisting of three different lines at present in about the fortieth generation after conjugation, mainly for the purpose of completing his earlier work.

Another point of general biological importance will also be investigated. In his original experiments the author found strong evidence that the old view that both exconjugants are rejuvenated is erroneous. In twenty pairs which were cultivated after separating from conjugation, one individual of each pair invariably outlived the other, thus indicating an incipient fertilization like that in metazoa. This phenomenon will be given careful study in the experiments now under way.

27 (73). **"Temperature and muscle fatigue": FREDERIC S. LEE.**

It has been pointed out previously by the author and others that the contraction process of the muscles of cold-blooded animals in the course of fatigue becomes greatly slowed, while those of warm-blooded animals show no such phenomenon. Lohmann has recently claimed that a cold-blooded muscle on being heated