indicate) may differ in different animals according to their habits and modes of activity.

The results we have obtained are capable of numerous physiological and pathological applications, but for the present we content ourselves with the above brief statement of some of the more obvious conclusions which they seem to justify.

III. "On the Histology and Physiology of the Pepsin-forming Glands." By J. N. Langley, M.A, Fellow of Trinity College, Cambridge. Communicated by Dr. Michael Foster, F.R.S. Received March 11, 1881.

(Abstract.)

This paper contains an account of observations upon *Rana temporaria*, *Bufo vulgaris*, *Triton tæniatus*, *Triton cristatus*, and *Coluber natrix*.

In these animals the changes which take place in the pepsin-forming glands under various conditions, viz., digestion of varying amounts of food, attempted digestion of indigestible substances, as sponge, and fasting, were noted.

Omitting the pyloric glands, which in these animals form only a minimal amount of pepsin, all the pepsin-forming glands present certain phenomena in common. In all, the living gland-cells contain granules, which diminish during digestion. In each the amount of pepsin* contained by a definite weight of the gland-bearing mucous membrane is proportionate to the amount of granules contained by the gland-cells. An increase or diminution of the cell-granules, in whatever way it is brought about, is accompanied by a corresponding increase or diminution in the pepsin-content of the cells. Further, in different parts of the pepsin-forming region the amount of pepsin present is proportional to the granularity of the cells.

Hence we may conclude that the granules consist wholly, or in part, of pepsin or of some substance capable of giving rise to pepsin.

In some of these animals certainly, and probably in all, the fresh glands contain only a minimal quantity of pepsin, but, on the other hand, a large quantity of a substance from which pepsin can be obtained, *i.e.*, zymogen. It follows, then, that in the previously mentioned estimation of pepsin, the pepsin found resulted from the splitting up of zymogen, and consequently that the amount of zymogen contained by the gland-cells is proportional to their granularity.

* The dried mucous membrane was extracted with one hundred times its weight of hydrochloric acid, 0·2 per cent. Grützner's colorimetric method was used in making the estimations.

Hence we may conclude that the granules consist not of pepsin, but wholly or in part of zymogen.

The processes in these pepsin-forming glands, then, closely resemble the processes which go on in the pancreatic gland. The cell-protoplasm stores up zymogen. At the moment of secretion the zymogen is converted into ferment, and probably other organic substances found in the fluid secreted.

In all the glands, with the exception perhaps of those of the snake, the cells, which diminish somewhat in size as well as in granularity in the first period of digestion, recover more or less completely their normal size and their normal granularity during the latter period of digestion. In other words, at a time when the using up of granules is still proceeding, fresh granules are formed; and, since the granules result from protoplasmic metabolism, we may conclude, bearing in mind the increase in size of the cells, that the protoplasm is also growing.

Thus in any gland-cell, during at any rate the greater part of digestion, three processes are going on at the same time, viz., the growth of protoplasm, the formation of zymogen by the protoplasm, the conversion of zymogen into secretory products. There are certain reasons which make it in a high degree probable that these three processes go on during the whole of the digestive period. Under certain conditions, there is a preliminary increase in the size of the cells and the granules before the normal decrease sets in. When the decrease in the size of the cells does set in, it is not sufficient to allow us to suppose that there is no growth of protoplasm; the casting out of the granules which have disappeared would, if there were no protoplasmic growth, leave the cell much smaller. The analogy of the change in the mucous salivary glands during secretion affords an instance in which the cell-protoplasm increases steadily during activity.

Lastly, as regards the granules, it is clear that there might be a fairly rapid formation of granules without any obvious change in the cell, provided the using up of granules went on at an equal rate.

On the whole, then, it may be, I think, fairly concluded, that, from the beginning to the end of the digestive period, the three processes mentioned go on. If this be the case, the different appearances of any cell as regards size and granularity depend upon the relative rates with which the three processes proceed at different times.

When the amount of change which takes place in the gland-cells of different animals during digestion is compared, very wide differences are found. The most striking comparison is perhaps afforded by the glands in *Triton tæniatus* and those in *Triton cristatus*. At the fourth hour of digestion, when the cells have apparently secreted approximately proportional amounts of pepsin, *i.e.*, when they have used up an approximately proportional amount of granules, the observable

diminution of granules in the gland-cells of *Triton cristatus* is enormously less than the observable diminution of granules in the gland-cells of *Triton tæniatus*.

This can, I think, only result from the formation of granules proceeding more hand-in-hand with the using up in the former than in the latter.

This and other similar facts lead us to conclude that the differences in the amount of histological change which takes place in the pepsin-forming glands of different animals, is the consequence of the three changes above-mentioned proceeding in each animal at different relative rates.

It is well known that in various glands, typically the pancreas, the granules are found during secretion aggregated around the lumina, the outer portions of the cells being non-granular and homogeneous. The cause of this appearance is, no doubt, in part due to a more rapid growth of protoplasm in the outer than the inner portions of the cells; in part, also, I think it is due to the granules being moved by the protoplasm towards the lumen. It is necessary, I think, to assume such a transference of granules, since neither the unequal growth of protoplasm, nor, what might also be imagined, an unequal using up of granules in the two regions of the cells, is sufficient to account for the changes which take place. Since the granules before they disappear become smaller, they will be smaller in that part of the cell in which they are being used up most actively. But, as a matter of fact, the granules are equally affected throughout the cell, so that the outer clear zone cannot arise from a more rapid using up of granules in that part of the cell. As to the more rapid growth of protoplasm, it fails to explain how the granules, which in the first stage of digestion become few and scattered in the outer half of the cell, can in the latter stages of digestion be arranged in a dense mass around the lumen; it leads, moreover, to the very improbable hypothesis that when the granules have entirely disappeared from the cells, the cell protoplasm has completely regrown from the periphery.

The pepsin-forming glands which we are considering in this paper, offer some other interesting forms of cell activity. In some no distinction of zones occurs, the granules become smaller and less frequent in all parts of the cells, without any alteration in their relative distribution; in others there is formed a small non-granular zone in the inner part of the cells. This inner non-granular zone, though obvious enough in certain states of the glands, does not reach the proportions which the outer non-granular zone attains in the pancreas and other similarly constructed glands.

Further, we find, in these glands, all stages of transition between the three types of cell-change in activity which have just been mentioned. Thus, the œsophageal glands of the frog form a large outer

non-granular zone, the oxyntic glands* of *Triton tæniatus*, form normally a less developed, though distinct, outer zone, this being less in the posterior than in the anterior oxyntic glands. In the glands of *Triton cristatus*, the outer zone is reduced to a minimum, or is represented only by a greater thinning out of granules in the peripheral part of the cells; the scanty œsophageal glands of the toad show a bare trace of a similar difference in the two parts of the cell. In the greater number of the oxyntic glands of the snake, and in the anterior oxyntic glands of the stomach of the toad, neither an outer nor an inner zone is formed, but in passing backwards to the posterior oxyntic glands in both of these animals, an *inner* non-granular zone gradually becomes obvious. The inner zone reaches its greatest development, so far as I have observed, in the posterior oxyntic glands of the frog.

In this brief account the general conclusions which can, I think, be drawn from the study of the pepsin-forming glands are only given, I have made no reference to the important papers of Heidenhain, Grützner, Swieçicki, Nussbaum, Partsch, and others on the same subject. I have discussed their work in the fuller paper, which contains the details on which the conclusions here given are based.

March 31, 1881.

THE PRESIDENT in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "On the Coefficients of Expansion of the Di-iodide of Lead, PbI_2, and of an Alloy of Iodide of Lead with Iodide of Silver, $PbI_2.AgI$." By G. F. Rodwell, F.R.A.S., F.C.S., Science Master in Marlborough College. Communicated by Professor A. W. Williamson, For. Sec. R.S. Received March 10, 1881.

(Abstract.)

The author having referred to his previous papers on the coefficients of the iodides of silver and mercury, and of certain chloro-

* I propose to use the term "oxyntic" (*ὀξυνειν*, to make sour, to acidulate) for those glands which are called by different observers by the inappropriate names "fundus," "peptic," or "rennet" glands.