*November* 27, 1879.

THE PRESIDENT in the Chair.

In pursuance of the Statutes, notice was given from the Chair of the ensuing Anniversary Meeting, and the list of Officers and Council nominated for election was read as follows:—

*President.*—William Spottiswoode, M.A., D.C.L., LL.D.

*Treasurer.*—John Evans, D.C.L., LL.D.

*Secretaries.*— { Professor George Gabriel Stokes, M.A., D.C.L., LL.D.
Professor Thomas Henry Huxley, LL.D.

*Foreign Secretary.*—Professor Alexander W. Williamson, Ph.D., LL.D.

*Other Members of the Council.*—George Busk, V.P.L.S.; Professor Arthur Cayley, LL.D.; Major-General Henry Clerk, R.A.; Edwin Dunkin, F.R.A.S.; Augustus G. Vernon Harcourt, F.C.S.; Sir Joseph Dalton Hooker, C.B., K.C.S.I.; John Whitaker Hulke, F.R.C.S.; Lieut.-General Sir J. Henry Lefroy, C.B.; William Newmarch, Inst. Fr. Corr.; Professor Alfred Newton, M.A., V.P.Z.S.; Professor William Odling, M.B., V.P.C.S.; Sir James Paget, Bart., D.C.L.; William Henry Perkin, Sec. C.S.; Charles William Siemens, D.C.L.; John Simon, C.B., D.C.L.; Professor John Tyndall, D.C.L., LL.D.

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

The following Papers were read:—

I. "On the Structure of Serous Glands in Rest and Activity." By J. N. Langley, M.A., Fellow of Trinity College, Cambridge. Communicated by Professor Michael Foster, M.D., F.R.S. Received October 13, 1879.

*The Parotid Gland of the Rabbit.*

In young animals portions of this gland are sufficiently thin to allow them to be viewed by transmitted light in their normal state.

With care the gland of a narcotised animal can be stretched out and looked at without injury to the blood circulation. The rapid capillary current continues for many hours shooting around and between the alveoli. Stimulation of the sympathetic nerve in the neck, besides

causing a secretion in the glands, produces the most striking effects on the blood circulation; the current all but ceases.

The resting gland thus viewed shows alveoli, in which the boundaries of the cells are faintly marked out by light lines between the many granules that fill the cells. The granules stretch from lumen to basement membrane. No nuclei are to be seen in the alveoli, nothing but a mass of not very refractive granules with an indistinct network of light lines which mark the separate cells.

The secreting gland similarly viewed strikes the eye at once as being much more transparent; with a low magnifying power, the lobules even when thick, are no longer the dense dark masses of the resting gland. With a Zeiss D or E objective, it is seen that this is caused by the disappearance of the granules at the outer part of the alveoli, the part near the basement membrane. The later the stage of secretory activity, the larger the non-granular clear zone. It is however only in the earlier secretory stages that the clear portion is in the form of a ring in section, later the clear zone dips down at fairly regular intervals towards the lumen. The granules thus acquire a star-like arrangement. This comes about in the following manner:—As secretion goes on, the cells draw away from one another slightly at the lumen, and at their sides contiguous to the lumen (perhaps because they are there being used up): so that the lumen can be more or less distinctly seen with short prolongations running out between the cells; at the same time the granules disappear more rapidly from the interior than from the periphery of the cells, hence the granules become arranged in a clump at the luminar margin, and stretch out from this some little distance along the cell sides.

The rather troublesome method given above is not necessary for the observation of the living condition of the tissue; small pieces cut out and mounted without the addition of fluid preserve for a short time very closely their normal appearance. If to such a specimen any of the ordinary indifferent fluids be added, the granules become more highly refractive, and later a thorough alteration takes place in the cells, the granules originally present to a large extent at any rate disappear and others are formed.

A very satisfactory and economical method of noting the changes which take place in the gland during secretion, is to narcotise an animal and then to snip out small bits from various parts of the gland at different stages of sympathetic stimulation or pilocarpin injection. The alveoli, at first granular throughout, become less and less so, until hardly any granules are to be seen. At this later stage very little saliva can be obtained.

The cells, during the process of losing their granules, become much smaller; the reparation is not sufficient to cover the waste.

I may remark that it does not necessarily happen that every hungry

rabbit has parotid alveoli throughout granular, the secretion is not solely dependent on feeding, but in whatever stage the glands are at the beginning of an experiment, they become less granular after having been made to secrete.

I have said that the changes can be seen either after sympathetic stimulation or after injection of pilocarpin. This is noteworthy, since Heidenhain,* dealing with alcohol-hardened specimens, failed to observe any of the changes after pilocarpin injection, which he could obtain by stimulation of the sympathetic nerve.

The appearances in the gland described above are not observed in alcohol-hardened specimens.

It will be remembered that Heidenhain describes the secreting gland as being, in alcohol specimens, more granular than the resting; this depends on the relative amounts of cell substances soluble and insoluble in alcohol.

Treated with osmic acid and subsequently with alcohol the gland has a markedly different appearance in the resting and active state.

In the resting state the alveolar cells viewed with a Zeiss F have a close-meshed network throughout. The nuclei are fairly apparent, evenly stained, rather compressed, and peripherally placed. With Zeiss D the cells appear densely granular.

In the active state the punctated look caused by a network and interfibrillar substance of differing staining power is absent, the cells stain fairly evenly throughout, thus the nuclei are with difficulty seen; they are spherical, and are placed more in the middle of the cell.

*The Parotid Gland in the Dog, Cat, and Rat.*

In these animals the account given above of the resting and active states in the main holds. A more prolonged secreting activity is, however, necessary to produce the clear zone and star arrangement of the granules.

In a former paper† I have mentioned that when just sufficient atropin to paralyse the secretory nerves is injected into the blood, the paralysing effect can be antagonised and a slight secretion obtained many times in succession by injecting small quantities of warm pilocarpin into the duct. I was curious to observe if the secretion obtained by repeatedly antagonising the atropin effect would produce the secretory change. The experiment was tried on a cat, and with a positive result, the granules at the periphery of the alveoli disappeared, a clear zone was formed.

In the dog few observers have seen any saliva follow stimulation of the sympathetic nerve. Heidenhain‡ obtained only now and then a

* Pflüger. "Arch. f. d. Ges. Physiologie," Bd. xvii, p. 45, 1878.

† Foster. "Journal of Physiology," vol. i, p. 356, 1878.

‡ *Op. cit.*, p. 29.

drop or two; he found, nevertheless, that the stimulation caused a marked change in the histological characters of the gland. This I have tried in one dog only; then stimulation of the sympathetic a little below the superior cervical ganglion caused a flow of saliva, slow indeed, but sufficiently distinct. Stimulation about one minute out of every two to three minutes gave in three hours 1·3 cub. centims. of saliva. This is not a great quantity, but the quality of the saliva was most remarkable, it was a thick jelly; if the result of successive stimulations were allowed to collect in the cannula, the whole came out in a cohering clot. From time to time, indeed, it was found necessary to clear the duct by squeezing the clotted saliva out of it. The saliva was kindly analysed for me by Mr. Waters, of Christ's College. It contained 8·477 per cent. of solids, of which 7·803 per cent. was organic matter.

It is possible, though I think very improbable, that in stimulating the sympathetic, Jacobson's nerve was stimulated reflexly, and hence the apparent presence of secretory fibres in the sympathetic. The highest percentage of solids obtained by Heidenhain * by combined stimulation of the sympathetic and Jacobson's nerve was 2·82 per cent.

The gland examined fresh showed a beginning clear zone, often only seen as a thinning of granules at the periphery; after a larger amount of saliva had subsequently been obtained by pilocarpin injection the clear zone became more marked.

*The Sub-maxillary Gland of the Rabbit.*

In the fresh state this has one very characteristic point, the transition cells are crowded with large conspicuous granules. The outlines of the ductule or transition cells apart from these granules are quite unrecognisable, they appear as patches and bands much darker than the surrounding gland substance. Some of the cells, which from their shape would be called ductule cells, certainly contain similar granules, though they are, I am inclined to believe, absent from the ductule cells, springing immediately from the ducts. The absence of cell outlines and the difficulty of obtaining thin sections of the fresh gland makes a decision on this point difficult to arrive at.

The alveoli are clearer than in the parotid; they contain granules not so refractive and rather smaller than those in the parotid. I have been unable in the animals of varying age with which I have worked to find any *constant* difference in hunger and digestion, exceptions to what I regard as the rule being all too frequent. The rule is, I think, mainly from experiments on stimulation of the sympathetic and injection of pilocarpin, that during secretion the granules disappear from the outer portion of the cells. The exceptions I have spoken of

* *Op. cit.*, p. 30.

were the following:—In some adult rabbits in digestion the clear zone was very doubtfully apparent; in some young rabbits in hunger there were distinctly two zones, and in one or two of adult and young sympathetic stimulation produced but very little effect.

Nussbaum * found that the transition cells stained black with osmic acid, whilst the alveolar cells were but lightly coloured. His conclusion from this that the transition cells formed the ferment was contested by me † on the ground that if the gland were treated with alcohol before treating with osmic acid, the transition cells did not stain black, and that it was highly improbable that the ferment had been dissolved by alcohol. Nussbaum, in a later paper,‡ upholds his opinion and rejects my argument on the ground that he can obtain a substance from the gland which is insoluble in alcohol, and which yet does stain black with osmic acid, this substance being the ferment.

It is a matter easy to decide; a fresh gland is placed in absolute alcohol for twenty-four hours; sections are made and placed in osmic acid one per cent. for the time mentioned by Nussbaum, viz., two hours, and examined. The whole has a yellowish-brown tint, the transition cells are but a trifle more deeply stained than the alveolar cells; they have to be looked for instead of striking the eye in the manner they do when the gland is treated with osmic acid first and alcohol afterwards. A stay of twenty-fours in the acid does not materially alter the appearances. It is, perhaps, hardly necessary to bring forward my original argument; for numerous later experiments have shown me that the prominence of the transition cells and their depth of tint depend on the subsequent treatment with alcohol rather than on the prior treatment with osmic acid. The gland, placed in osmic acid one per cent. and that only, for two hours, has the ducts darkest stained, the transition cells are slightly deeper in tint than the alveolar cells, mainly because the former are evenly stained throughout, whereas the latter are not; both are yellowish-brown. One, two, or even more days do not make the transition cells conspicuous. But if, after two hours in osmic acid, the glands are placed in dilute alcohol 50 to 75 per cent. for twenty-four hours, sections show the brown-black clumps of the transition cells scattered amongst the much lighter-coloured alveoli. The ducts are in this case equally or even less dark than the transition cells. If alcohol be used absolute instead of diluted, the appearances are similar, but in the first day or two at any rate, less marked.

In other glands, too, I have found that the selective staining of osmic acid is best brought out by subsequent treatment with alcohol.

The resting and active glands treated with osmic acid and alcohol

* Max Schültze. "Arch. f. Mik. Anat.," Bd. xiii, p. 724, 1877.

† Foster. "Journal of Physiology," vol. i, p. 68, 1878.

‡ Max Schültze. "Arch. f. Mik. Anat.," Bd. xvi, p. 543, 1879.

show differences similar to those described above for the parotid under similar circumstances. In early digestive stages, however, the granules appear sharper and more refractive, the distinctness of the cell network depends largely on the alcohol treatment.

I can confirm the observations of Bermann* on the presence of a "tubular gland" in the sub-maxillary of the rabbit. The large lumen and small cubical epithelium of the majority of the tubes do not suggest that it has any important secretory function.

*The Infraorbital and Lachrymal Glands of the Rabbit.*

In these glands the two zones in the secretory condition are even more conspicuous than in the parotid. Even more readily too than in parotid can lobules thin enough for observation be obtained.

In different animals the alveoli may be granular throughout, or may have a more or less distinct outer non-granular zone. But whichever condition occurs the granules can always be diminished by setting up a secretion with pilocarpin. A similar change, I think, too, occurs on stimulation of the sympathetic.

These glands are distinguished from the parotid and sub-maxillary by preserving fairly their normal aspect after osmic acid and alcohol treatment. The resting gland is not unlike, in chief features, the resting parotid; the network is particularly obvious.

When a clear zone is present in the fresh state it stains easily with osmic acid, showing ordinarily no network; with a small non-granular zone the granular zone appears as a network in the preserved specimen, as the former increases the latter appears more granular and less as a network. In activity the nuclei become spherical, move towards the middle of the cells, and become less conspicuous.

Recalling what has been said of the parotid and sub-maxillary glands, it will be seen that in these, as well as in the infraorbital and lachrymal glands, the alveolar cells in the secreting condition stain much more homogeneously with osmic acid than they do in the resting condition. In the two latter glands the homogeneous staining corresponds in extent with the clear zone of the fresh specimen, in the parotid this is to a slight extent only the case, in the sub-maxillary gland scarcely at all. I am inclined to think that by a modified use of osmic acid, the normal appearances in all these glands may be more nearly preserved than is commonly the case, though, undoubtedly, a great part of the divergence mentioned above in their behaviour in the secretory state, depends on a chemical difference in the substances broken down and re-formed.

The investigations, of which the foregoing is a brief account, were carried on in the Physiological Laboratory of the University of Cambridge.

* "Ueber die Zusammensetzung der Glandula Submaxillaris." Würzburg, 1878.