per 100 cc limb volume.[4] Following thyroidectomy there was no significant change in 2 cases, while in one there was a drop from a high normal to a lower normal level. In the hypothyroid subject, the blood flow in the hand was 4.4 cc.

On comparing the blood flow readings with the other data collected at the same time, it was noted that a gross correlation existed between the blood flow to the forearm and the basal metabolic rate, but none between the latter and the blood flow to the hand. No relationship was observed between the circulation time and the blood flow in either the hand or forearm.

In view of the increased cardiac output[5] and increased blood volume[6] found in hyperthyroidism, an augmented rate of blood flow to the extremities might be anticipated. The fact that this was observed only in the forearm and not in the hand would suggest that there is some other factor, possibly related to the intrinsic differences between these 2 vascular beds,[7] which is operating in the hand to modify the vascular responses associated with the hyperthyroid state.

Conclusion. The rate of blood flow through the forearm is increased in hyperthyroidism.

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Regeneration of Olfactory Cells.*

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It is generally held that nerve cells which have been destroyed are not restored. While this may well be true for the type of nerve cells which are usually considered in this connection, it has not been demonstrated to apply to the neurons of the olfactory nerve, the cell

[4] Abramson, D. I., unpublished observations.

[5] *a.* Grollman, A., *The Cardiac Output in Health and Disease,* Charles C. Thomas, 1932, p. 242; *b.* Fullerton, C. W., and Harrop, G. A., Jr., *Bull. Johns Hopkins Hosp.,* 1930, **46**, 203; *c.* Boothby, W. M., and Rynearson, E. H., *Arch. Int. Med.,* 1935, **55**, 546.

[6] *a.* Gibson, J. G., 2nd, and Harris, A. W., *J. Clin. Invest.,* 1939, **18**, 59; *b.* Goldbloom, A. A., and Libin, I., *Arch. Int. Med.,* 1935, **55**, 484.

[7] Abramson, D. I., and Ferris, E. B., Jr., *Am. Heart J.,* 1940, **19**, 541.

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bodies of which retain the primitive location in the surface epithelium found in certain lower forms of animal life (neuroepithelium). The cell bodies of the olfactory nerve (olfactory cells) are located for the most part in the mid-zone of the fairly thick pseudostratified columnar epithelium of the olfactory mucosa.[1] Each cell gives off two processes: (1) a superficial stout one, or dendrite, which extends slightly beyond the surface of the mucosa and (2) a deep one, or axone, which passes centralward to the olfactory bulbs under the frontal lobe of the brain. These processes can be demonstrated only by special staining procedures, such as the Bodian method for showing neurofibrils,[2] and are less easily stained than the fibrils of other nerves.

In previous communications[3] we have reported that it is possible to induce a high degree of resistance in monkeys against intranasal inoculation with the virus of poliomyelitis by a previous irrigation of the nasal passages with a 1% solution of zinc sulfate. The resistance so induced generally lasts at least one month, but is almost without exception followed by a return of susceptibility within the next 3 or 4 months. It is initiated by an extensive coagulation necrosis of the olfactory mucosa, followed usually within a day or two by its separation, more or less en masse, from the underlying lamina propria and adjacent glands of Bowman.[1] Since the olfactory cells occur chiefly in the mid-zone of the olfactory epithelium it is obvious that they must be cast off with the necrotized epithelium. If the generally accepted view regarding the failure of nerve cells to regenerate applies to olfactory cells also, these should then be lost permanently and not appear in the new epithelium.

Following the separation of the damaged epithelium from the lamina propria general epithelial repair takes place rapidly. The cells which participate in this re-epithelization seem to come largely from the ducts and glands of Bowman adjacent to the denuded surface; in part also from the Schwann cells of nearby olfactory nerve bundles. The new epithelium usually attains the thickness of the normal within the space of a few days, but abnormalities in cell arrangement make it for a time distinguishable from normal mucosa. It is not the purpose of this communication to describe the general re-epithelization, nor the features of the new epithelium,

1 Schaeffer, J. P., *The Nose and Olfactory Organ*, Phila., 1920, Blakiston; *Special Cytology*, Ed. by E. V. Cowdry, Hoeber, 1928, I, 47.

2 Bodian, D., *Anat. Rec.*, 1936, **65**, 89.

3 Schultz, E. W., and Gebhardt, L. P., *J. Am. Med. Assn.*, 1937, **108**, 2182; Schultz, E. W., *Am. J. Surg.*, 1938, **42**, 178; *Am. J. Pub. Health*, 1940, **30**, 175.

but to report observations indicating that destroyed olfactory cells also are restored, at least partially, following this re-epithelization. This seems evident from an examination of several thousand specially stained histological sections of olfactory mucosae, obtained from more than 200 monkeys previously treated with zinc sulfate (or with other necrotizing agents), the animals having been sacrificed at varying intervals of time, from one day to more than 6 months after one or more intranasal irrigations with the chemical solution. The nature of our observations can be indicated only briefly and include: (1) the presence in about 2 weeks of cells, or nests of cells, resembling olfactory cells, but apparently without dendritic and axonal processes, along with similar cells seemingly in the act of forming such processes; (2) abnormalities in the form, orientation, grouping and distribution of olfactory cells in later stages, together with unusual prominence of axones and olfactory nerve bundles in the lamina propria in association with such cells in late membranes; (3) the extent of mucosa which after some months shows a varying number of olfactory cells, compared with the extent of the initial destruction usually seen within 2 or 3 days after applying the solution.

Apparently such restoration as is effected is seldom complete with relation to the total number of cells. In some cases it seems to have been extensive, in others only slight. Certain factors which may influence the degree of restitution are under consideration. Obviously, evidence of the extent of the regeneration, even more than the fact of regeneration itself must be largely circumstantial for it is quite impossible ever to be certain of the actual extent of the initial destruction.

Regarding the origin of the new olfactory cells, we can at present only state that their progenitors seem to share in the initial general epithelization.

Further studies are in progress to rule out other explanations for the observations made.