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# Origin of Regenerating Brain in the Earthworm.

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Hescheler[1] described in detail the histogenetic processes following decapitation of the earthworm. He stated that the cerebral ganglia are formed from cells of the body wall ectoderm which have migrated posteriorly and medially. Nuzum and Rand[2] showed that this method of cerebral ganglia regeneration is by no means constant in *Allolobophora foetida* and that under certain conditions the epithelium of the dorsal pharynx wall may also contribute to brain formation. The latter had dissected only the cerebral ganglia from the head leaving the pharynx wall uninjured, whereas Hescheler's description was based on removal of 5 head segments.

In the course of a study of regenerating earthworm heads from another viewpoint, evidence confirmatory of Nuzum and Rand's findings was uncovered. In the present work 5 head segments were removed from *Helodrilus caliginosus* and in some cases 10 segments of ventral nerve cord in addition. In most specimens cere-

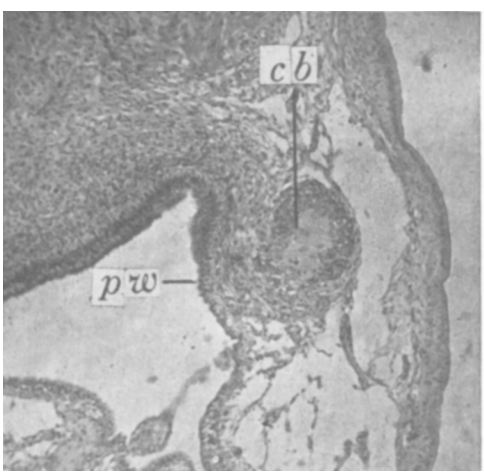


FIG. 1.

Animal IC 104. Formation of cerebral ganglia from dorsal pharynx wall, 26 days regeneration. Dorsal margin of animal above, anterior to right. pw = dorsal pharynx wall, cb = regenerating cerebral ganglia. × 64.

[1] Hescheler, K., *Jenaische Z. f. wiss. Zool.*, 1898, **31**, 521.

[2] Nuzum, M. F., and Rand, H. W., *Biol. Bull.*, 1924, **47**, 213.

bral ganglia regeneration followed closely the course described by Hescheler. In several cases, however, there was an obvious contribution from both body wall ectoderm and dorsal pharynx wall to the regenerating brain. In one striking instance (Fig. 1) only cells from the epithelium of the dorsal pharynx wall were passing to the regenerating ganglia and no evidence of movement of cells from the dorsal ectoderm was anywhere apparent. In this specimen there was evident a stream of epithelial cells passing dorsally and laterally, in a spiral manner, from the dorsal pharynx wall epithelium towards the position occupied by the new brain. The muscle and connective tissue layers of the pharynx wall have not regenerated and a basement membrane is lacking in this region. There are numerous mitoses in the cells of the dorsal pharynx epithelium immediately posterior to the regenerating cerebral ganglia and within the brain itself. The pharynx epithelium cells are round, with large, round, deeply-staining nuclei. The cells of this regenerating epithelium can be traced to continuity with the actively regenerating brain and the cells of the former are indistinguishable cytologically from the cells at or near the periphery of the regenerating cerebral ganglia. Farther within the brain these cells become progressively transformed into the large, characteristic nerve cells of this organ. The external epithelium of the body wall is newly regenerated, but it shows no activity anywhere involving the movement of cells towards the regenerating brain. At this stage the cerebral ganglia are of very nearly normal size.

In the specimen illustrated the regenerating dorsal pharynx wall is itself of ectodermal derivation and has not yet taken on its ultimate morphological and functional specialization. However, it is possible for the adult fully differentiated pharynx to form a new brain as was shown by Nuzum and Rand. In the present work the dorsal pharynx wall was injured but the last cited work demonstrated that such injury is not essential to cerebral ganglia formation.