who sees in the cerebellum of whales a higher evolutionary form. Nor does the author agree with Jelgersma's view that the inferior olive is to be placed on an equality with the pons as a shunting station between the basal ganglia and the vermis. The pyramids in cetaceans are for the most part situated exactly between the pons and the tegmentum, thus presenting a different localization from that of the homologous element in man. The author describes the decussation of the paths in the upper cervical medulla but leaves the question open as to the destiny of the pyramids in the spinal column after the crossing. He thinks it very probable that they run caudal in the anterior column of the spinal cord. In the cerebellar cortex of dolphins an outer nuclear layer is perceptible which according to Vogt and Astwazaturow is the material from which the Purkinje cells are constructed. The author points out that this view is untenable because in dolphins both the nuclear layer and the Purkinje cells are found to be present. [J.]

Kappers, C. U. Ariëns. STRUCTURAL LAWS IN THE NERVOUS SYSTEM. THE PRINCIPLES OF NEUROBIOTAXIS. A lecture read in the University of London. [Brain, Vol. XLIV, 1921.] And

Kappers, C. U. Ariëns. DIXIÈME CONTRIBUTION A LA THÉORIE DE LA NEUROBIOTAXIS: LE TROPISME NUTRITIF DES DENDRITES ET SON RAPPORT AVEC LES PHÉNOMÈNES NEUROBIOTACTIQUES EN GÉNÉRAL. [l'Encephale, Janvier, 1922.]

In the first named paper the author points out that the position of the nerve cells (specially the motor nuclei,¹ have been considered here, but the phenomenon is confirmed for the midbrain and forebrain, by Herrick, Ell. Smith, Dart, Kehlenbeck, a. o.) is determined by the places from which the largest number of excitations reach the cells; a process of taxis or tropism which the author has called *neurobiotaxis*, since it occurs in the nervous system during life, and this word does not include any prejudice concerning the physico-chemical basis of the process.

The author emphasizes that there is always a selection in this process in so far as this shifting only occurs if such stimuli are synchronous with functional activities of those cells.

Synchronous (or immediate successive) stimuli determine the formation and outgrowth of the neurones. This is the first law of neurobiotaxis, which apparently is analogous to the law of association, which we know to be such an important factor in the construction of our mental images.

The second law includes that the result of these correlated influences is different as far as concerns the cytoplasm and dendrites on one hand and the axon on the other hand, the former growing out or shifting to the source of stimulation (*stimulo-petal*), the latter (the axon) growing

¹ Compare also: Phenomena of Neurobiotaxis as demonstrated by the motor nuclei of the Oblongata, JOURN. OF NERV. AND MENT. DIS. 1919.

away from the center of stimulation, following the irradiating stimulation itself (thus *stimulo-concurrent*). This stimulo-concurrent growth of the axon² has been proved by Bok. The dynamic polarization of the neurone is a result of its neurobiotactic polarization, *i.e.*, of the opposite tropistic character of axon and dendrites (which is also responsible for the irreversibility at the synaps).

The physico-chemical basis of this antipolar neurobiotactic condition is most probably a consequence of electric charges (colloid-electricity). The formation of the axon probably is caused by the action current, the formative character of which is also made probable by the influence of weak currents on regenerating fibers, whereas the dendrites (and the adult cytoplasm) migrate towards the electro-negative surface of a stimulated center. So the tropism of the dendrites appears to be a cathodotropic one, whereas the tropism of the axon—being opposite to this—is an anodo-tropic one.

The final endpoint of a stimulo-concurrent axis cylinder may be determined by an anodically increased center, as is presented by a nerve cell shortly after the cathodic increase (the stimulation curve being "biphasic"), the increase of negative electricity being immediately followed by a decrease under the normal condition, *i.e.*, by an anodic condition.

This explains also the fact (Sherrington) that the threshold of a reflex is lowered, *i.e.*, that the transmission of a current is favored by a just preceding excitation, and that a connection just established between two neurones is apt to coördinate more connections and so to establish a common final path for several other excitations occurring at about the same time in the nervous system.

The connection between motor root fibers (axons) and muscles may be also explained from this standpoint,³ the outgrowth of axons in muscles being determined by the electric condition of the muscle after a preceding non-nervous contraction (muscles are formed before the nerves). So the influence of the nerve roots on muscles would be originally more an integrating than a stimulating one. That proliferation of muscle-tissue may have the same influence as a contraction of muscle-tissue is made probable by Cajal's experiments concerning the growth of collaterals in proliferating cicatrices.

It seems probable that potassium acts an important part in directing the growth of axons (in the generation of these electric conditions), its presence being demonstrated in the axis cylinder as well as in the anisotropic discs in which the motor fibers end. Potassium being a kation, represents an anodic pole (+). That electric forces may influence

² To this may be added that very young neuroblasts (as long as no Nissl substance has developed), may also shift in the direction of the axon, stimulo-concurrent, as also placodecells do.

³ It may also be that the negative surface electricity attracts the dendrites to the surface of a muscle (sensory muscle fibers), the interior anodic increase in the muscle substance attracting the (motor) axon.

neuronic growth is moreover experimentally shown by Ingvar⁴ in Harrison's laboratory.

In the *second paper* the author discusses the relation between the early nutritive tropism of dendrites, as is most clearly shown by the so-called horizontal cells of Cajal, and their later stimulo-petal cathodic tropism.

The author emphasizes that the part acted by the dendrites and the cytoplasm in the assimilation of oxygen, already supposed by Golgi, is confirmed by his researches on the localization of oxydizing enzymes (oxydases), which he, like Graeff, Katsanuma and Marinesco, found only to occur in the dendrites and the cytoplasm, not in the axon. Also Unna's experiments with "rongalit white," showing the presence of a large quantity of oxygen in the dendrites and cytoplasm, confirm this view.

That the nutritive tropism of dendrites and their early tendency to assimilatory surfaces (Tretjakoff) can later on change in a stimulative tropism is easy to explain from the fact that stimulation enhances the assimilation of oxygen (Mott), as has been experimentally proved by L. Hill (trans. Roy. Soc. London, Series B, Vol. 193), and as is in perfect harmony with Hering's thesis that the autonome (that is, the unstimulated, nutritive) absorption of oxygen is enhanced by an "allonome" (*i.e.*, stimulative) absorption of oxygen at the pole where the stimulus enters the neurone.

Thus nutritive and stimulative tropism of the dendrites are not contrary to each other, but the one may be transformed in the other on account of their fundamental relation. At the end of this second article the author discusses Child's booklet (*The Origin and Development of the Nervous System*), in which the electro-chemical base of the neuro-biotactic process is confirmed, but which, in addition to several valuable suggestions and facts, contains some misunderstandings of the author's statements made in his Ninth Contribution on Neurobiotaxis (Journ. of Comp. Neur., Vol. XXVII, 1917).

4. MEDULLA, PONS, MIDBRAIN, BASAL GANGLIA.

Vogt, C. u. O. ON PATHOLOGICAL LESIONS IN THE CORPUS STRIATUM AND THEIR SYMPTOMATOLOGY. [Sitzungsbericht d. Heidelberg, 1919.]

In the présent paper the two parts of the corpus striatum (caudate nucleus and striatum on the one hand, and the globus pallidus on the other) are analyzed. There are five sections in the paper. The first deals with the essential anatomical details of what they consider the primitive motor mechanism of the nervous system. This has not undergone any fundamental modification in man, as compared with the apes, on account of the assumption of the upright posture and the development of speech in the former, and the corpus striatum has more or less the

⁴ Reaction of cells to the galvanic current in tissue-cultures. Proc. Soc. Exper. Biol. and Med. 1920, Vol. 17.