THE PURKINJE CELLS – A THROWBACK IN TIME

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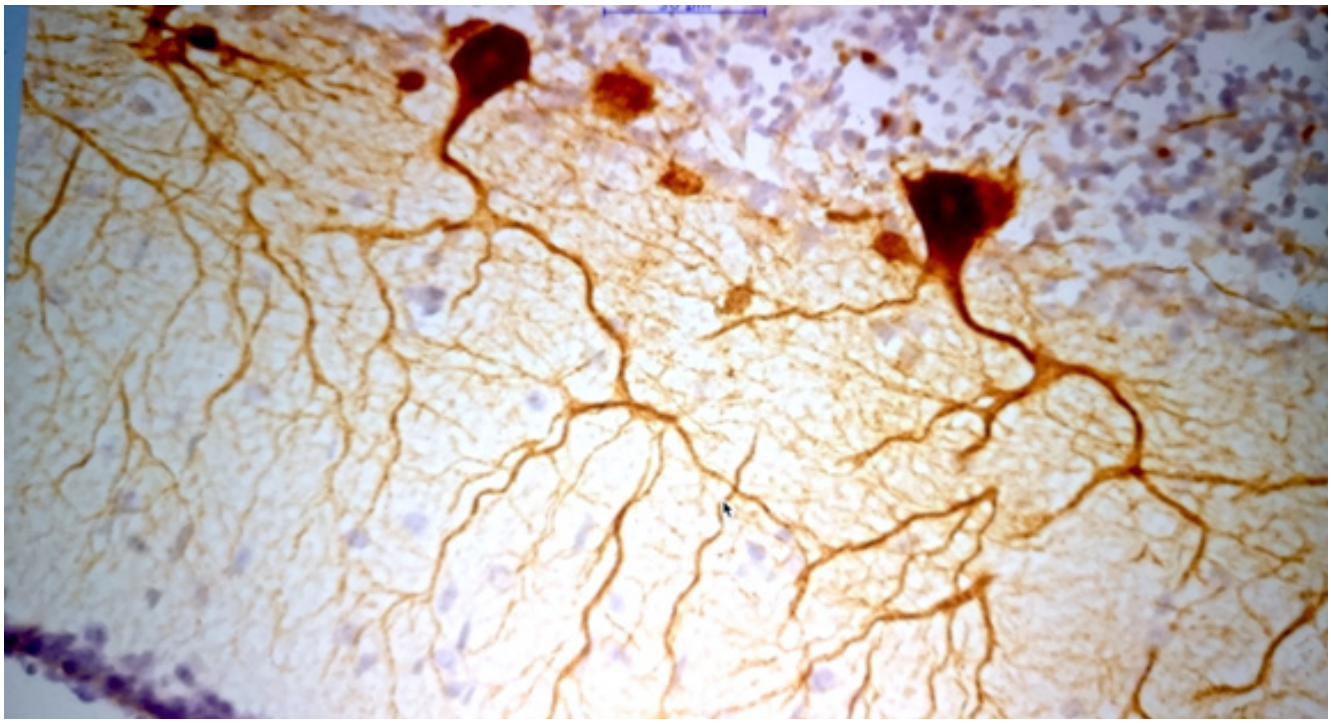

Purkinje neurons (PN), or Purkinje cells (PC) were first discovered by the Czech anatomist and physiologist Jan Evangelista Purkinje in 1837. He described the cells bodies being flask-like in shape with a diameter of 25 to 40 microns situated between the granular layer and the molecular layer (ML) of the cerebellum cortex. Unlike other type of neurons, the Purkinje cell axon takes off directly from the cell body without any hillock, the initial segment being unmyelinated, but the reminder of the axon is heavily myelinated. A moderate number of canaliculi and mitochondria have been shown within the axon.

Using the electronic microscopy, the PC dendrites were visualized as they divide and redivide in the ML, as they contain numerous mitochondria and elements of granular endoplasmic reticulum in the peripheral portion of the large dendrites (1).

Even more, three types of synapse are seen on the PNs. The first one is the axodendritic which contains a 300 Angstroms space between the pre and the postsynaptic membranes. The terminal button contains one or more mitochondria and synaptic vesicles. The second type is the axosomatic synapse with 180 to 200

Angstroms space between the pre and postsynaptic membranes and the third one, the axoaxonic synapse, which was not studied in detail. These latter synapses are located on the proximal, unmyelinated portion of the PC axon.

PCs are involved in motor control (such as hand movement) and learning. They are also a central signaling node, modulating both inhibitory and excitatory neuronal cell numbers, being the only cells that emit signals from the cerebellum cortex, though they can receive inputs from hundreds of thousands of neurons. By releasing gamma-aminobutyric acid (GABA), a neurotransmitter that inhibits certain neurons from transmitting impulses, PNs control the output signals of the cerebellum cortex, through the axon that carries electric impulses (2).

Studies on mammals show that PC synthesize progesterone and estradiol during embryogenesis. These hormones promote the development of PCs (growth of dendrites), of synapses (synaptogenesis), but also of the spinogenesis (development of spines on the dendrites).

Neurogenesis of the cerebellum cortex is initiated from two primary germinal epithelia: the ventricular zone (VZ) and the upper rhomboid lip (RL). A subset of inhibitory GABAergic neurons, including PNs and deep cerebellar nuclei during embryogenesis rise from the VZ (3). PC progenitors migrate along radial glial fibers away from the VZ and into an intermediate domain known as the cortical transitory zone (CTZ). From the CTZ, PN precursors migrate around nuclear transitory zone (NTZ) forming a reproducible array of clusters in the subpial zone. In addition, many PNs

which develop during embryogenesis die probably from a lack of intrinsic survival mechanisms. Even more, some dislocated PCs may fail to connect properly to their postsynaptic targets (4).

On the other hand, the loss of or damage to PCs can give rise to certain neurological diseases. During embryonic growth, Purkinje cells can be permanently destroyed by exposure to alcohol, contributing to the development of fetal alcohol syndrome. The loss of Purkinje neurons has been observed in children with autism (who have smaller PNs than normal) and in individuals with Niemann-Pick disease type C, an inherited metabolic disorder (2, 4).

To conclude, it is significant to take into consideration that the result of PNs dysfunction may have important implications for human neurodevelopmental disorders rooted in excitatory-inhibitory imbalance.

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