

BASICS OF NEUROBIOLOGY

NETWORKING OF CEREBELLUM

ZSOLT LIPOSITS

Basics of Neurobiology: Networking of cerebellum

EXTRINSIC AND INTRINSIC NETWORK CONNECTIONS

AFFERENT FIBERS CARRY INFORMATION TO THE CEREBELLUM VIA MOSSY FIBERS AND CLIMBING FIBERS.

MOSSY FIBERS TERMINATE ON GRANULE CELLS IN THE CEREBELLAR CORTEX

CLIMBING FIBERS WIND AROUND THE DENDRITES OF PURKINJE CELLS

THE EXCITATORY AFFERENTS ALSO GIVE COLLATERALS TO THE DEEP CEREBELLAR NUCLEI

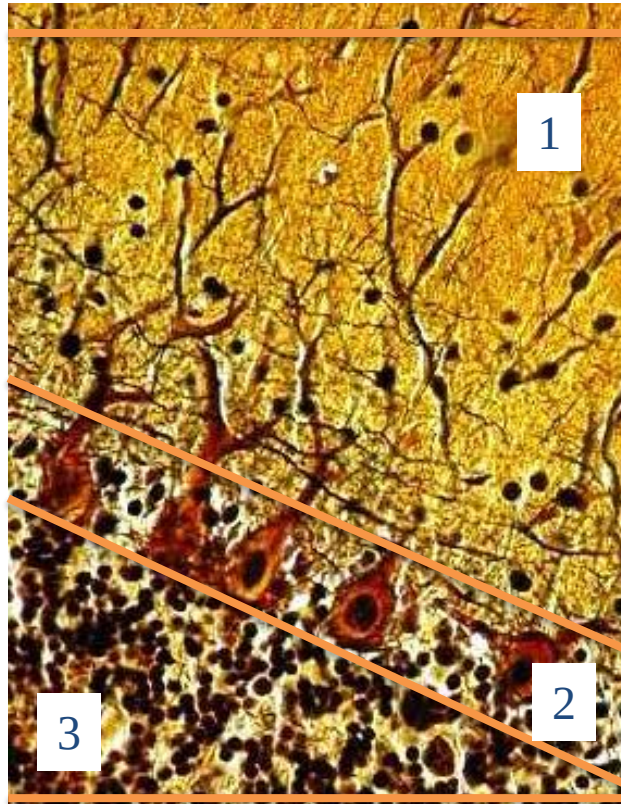
THE CEREBELLAR MACHINERY IS COMPOSED OF PURKINJE AND GRANULE CELLS, AS PRINCIPAL NEURONS, AND INHIBITORY INTERNEURONS LIKE BASKET CELLS, GOLGI NEURONS AND STELLATE CELLS. THE CEREBELLUM IS ALSO RICH IN GLIA CELLS. DURING DEVELOPMENT OF THE CEREBELLAR CORTEX, THE RADIAL, BERGMANN GLIA HAS A FUNDAMENTAL ROLE

THE CEREBELLAR CORTEX CONVERTS THE EXCITATORY INFORMATION INTO INHIBITORY SIGNALS TRANSMITTED BY THE AXONS OF PURKINJE CELLS MAINLY TO DEEP CEREBELLAR NUCLEI

THE DEEP NUCLEI AND THE PURKINJE CELLS ARE COUPLED TO THE NEURONAL PACEMAKER ACTIVITY OF THE INFERIOR OLIVE NEURONS WHOSE AXONS TRANSMIT SYNCHRONOUS AND RHYTHMIC EXCITATORY SYNAPTIC INPUTS

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DEPICTION OF CEREBELLAR NEURONS BY SILVER IMPREGNATION



1. THE MOLECULAR LAYER CONTAINS THE ARBORIZATION OF THE DENDRITIC TREES OF PURKINJE CELLS, BUNDLES OF PARALLEL FIBERS, CLIMBING FIBERS, CELL BODIES AND PROCESSES OF STELLATE, BASKET AND GOLGI CELLS AND ALSO GLIAL CELLS. THE DIVISION OF PRIMARY PURKINJE CELL DENDRITES AND THE LONGITUDINAL COURSE OF PARALLEL FIBERS ARE APPARENT

2. THE CELL BODIES OF PURKINJE CELLS AND THE ORIGIN OF THE MAIN DENDRITIC SHAFT ARE VISIBLE. THE LARGE SIZE OF THE PURKINJE CELL BODIES IS OBVIOUS, ESPECIALLY IN COMPARISON WITH NEURONS OF THE MOLECULAR AND GRANULE CELL LAYERS. BASKET CELL AXONS TERMINATE AROUND THE BASE OF PURKINJE CELLS

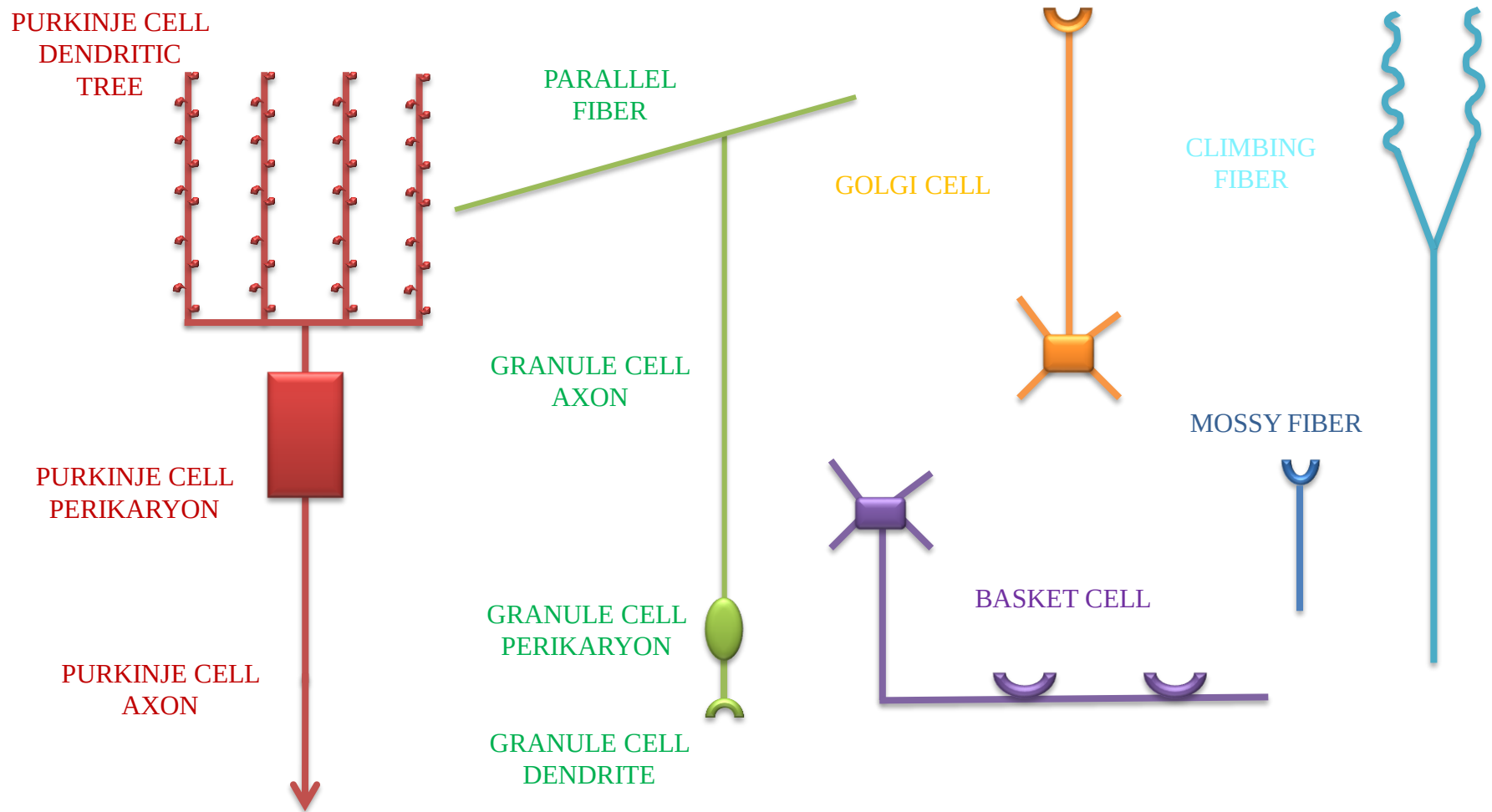
3. IN THE GRANULE LAYER THE CARDINAL FEATURE IS THE ABUNDANCE OF GRANULE CELLS. MOSSY FIBERS, CLIMBING FIBERS, PURKINJE CELL AXONS PASS THROUGH THE LAYER. REGARDING SYNAPTIC COMMUNICATION TAKING PLACE IN THIS LAYER, MOSSY FIBERS, GOLGI CELL AXONS AND DENDRITES OF GRANULE CELLS ESTABLISH THE CHARACTERISTIC CEREBELLAR GLOMERULI

Lines separate the three layers of the cerebellar cortex:

1. MOLECULAR LAYER
2. PURKINJE CELL LAYER
3. GRANULE CELL LAYER

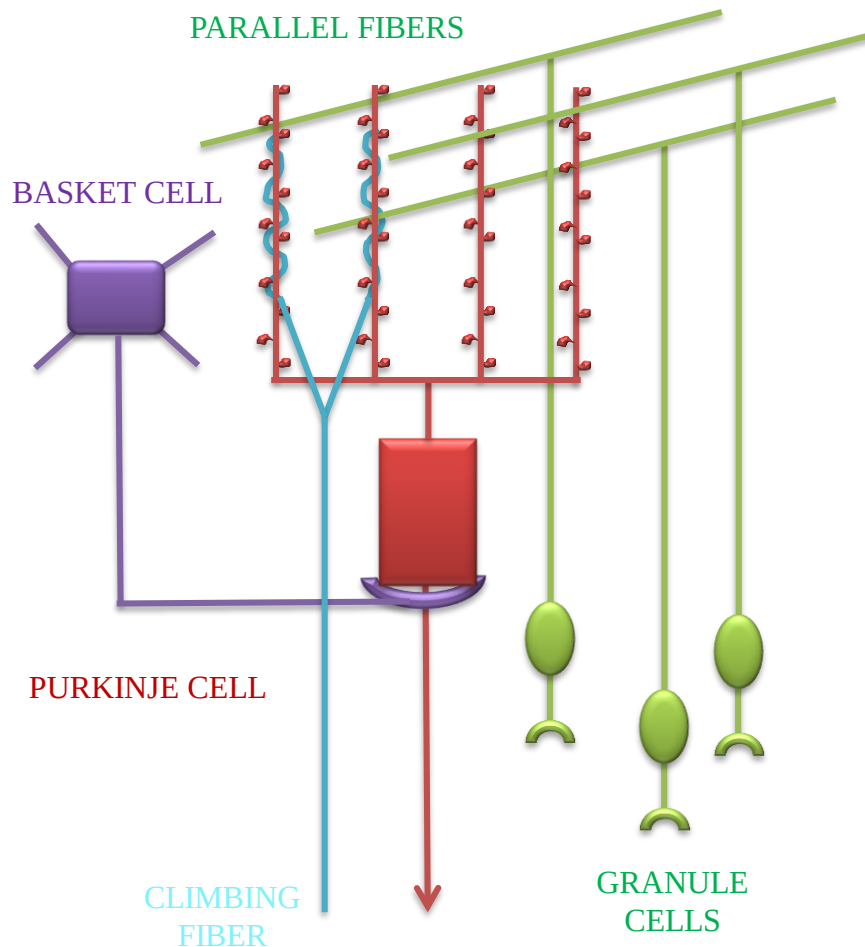
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MAIN CONSTITUENTS OF THE CEREBELLAR MACHINERY



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NEURONAL INPUTS TO PURKINJE CELLS



CLIMBING FIBERS ARISING FROM THE INFERIOR OLIVE OF THE MEDULLA WRAP AROUND THE DENDRITES OF THE PURKINJE CELL ESTABLISHING MULTIPLE SYNAPTIC CONTACTS

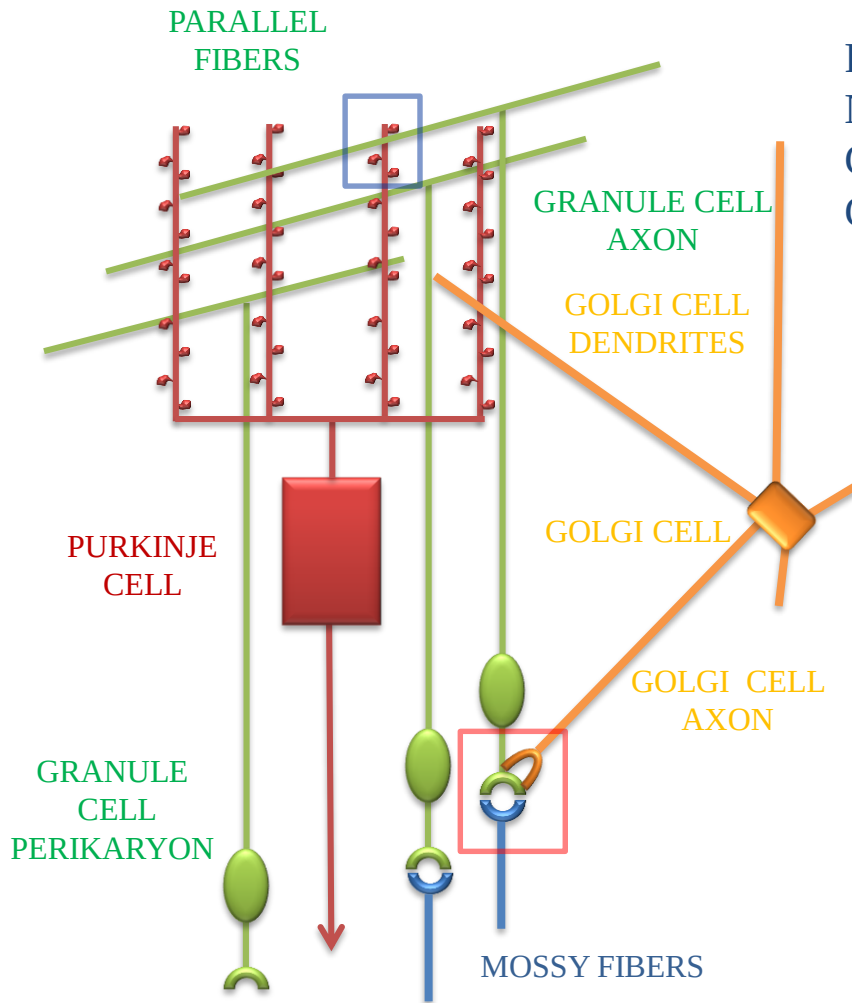
PARALLEL FIBERS ARE AXONS OF GRANULE CELLS THAT SYNAPSE WITH THE SPINES OF PURKINJE CELL DENDRITES. A SINGLE PURKINJE NEURON COMMUNICATES WITH ABOUT SEVENTY THOUSAND PARALLEL FIBERS

BASKETS CELLS LOCATED IN THE MOLECULAR LAYER INNERVATE PURKINJE CELLS BY FORMING A DENSE TERMINAL FIELD AT THE AXON HILLOCK

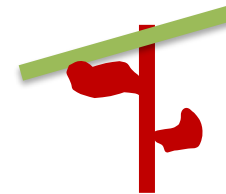
THE AXONS OF PURKINJE CELLS LEAVE THE CEREBELLAR CORTEX

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NEURONAL INPUTS TO GRANULE CELLS



PARALLEL FIBERS FORM EN PASSANT TYPE SYNAPSES WITH DENDRITIC SPINES OF PURKINJE CELLS (ENFRAMED IN BLUE). SYNONYM TERM: CROSS OVER SYNAPSE



MOSSY FIBERS COMMUNICATE WITH DENDRITES OF GRANULE CELLS. THE AXO-DENDRITIC SYNAPSES ARE CONTROLLED BY AXONS OF GOLGI NEURONS. THE COMPLEX SYNAPTIC STRUCTURE IS CALLED: CEREBELLAR GLOMERULUS (ENFRAMED IN RED)

GRANULE CELL DENDRITE

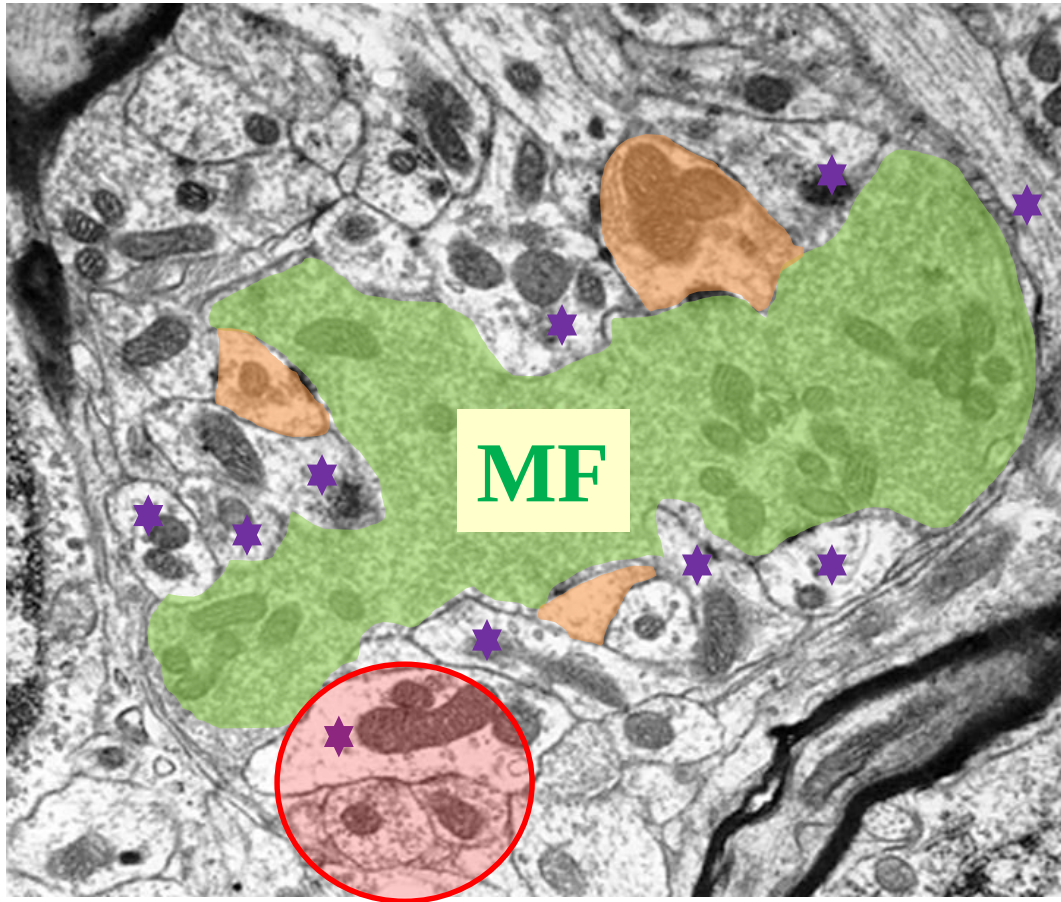
MOSSY FIBERS



GOLGI CELL AXON

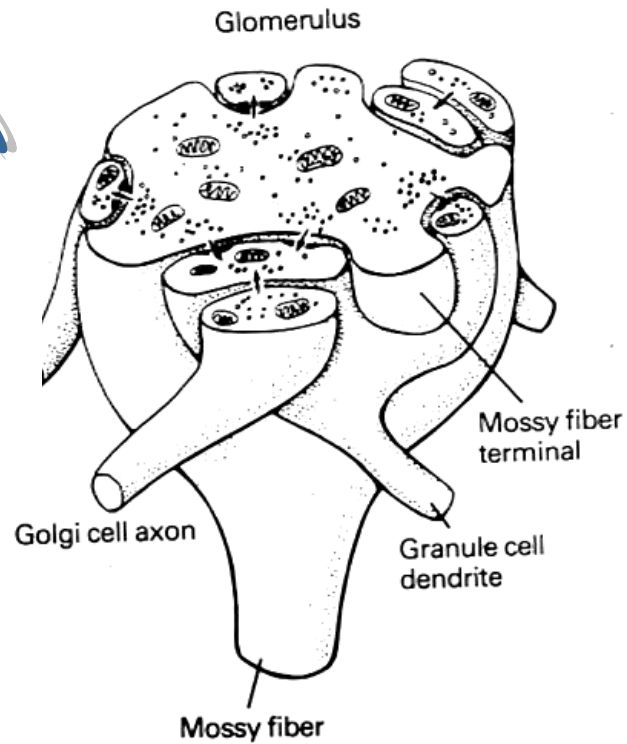
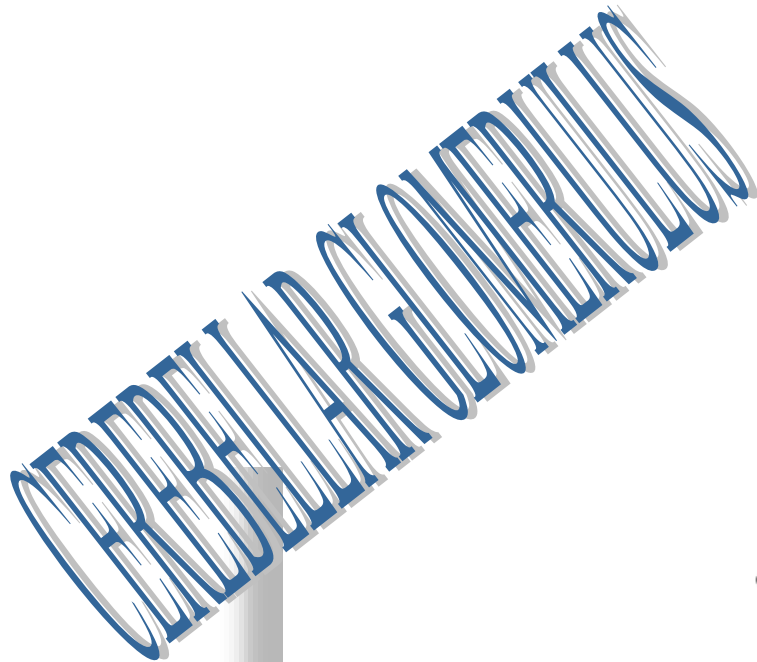
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CEREBELLAR GLOMERULUS

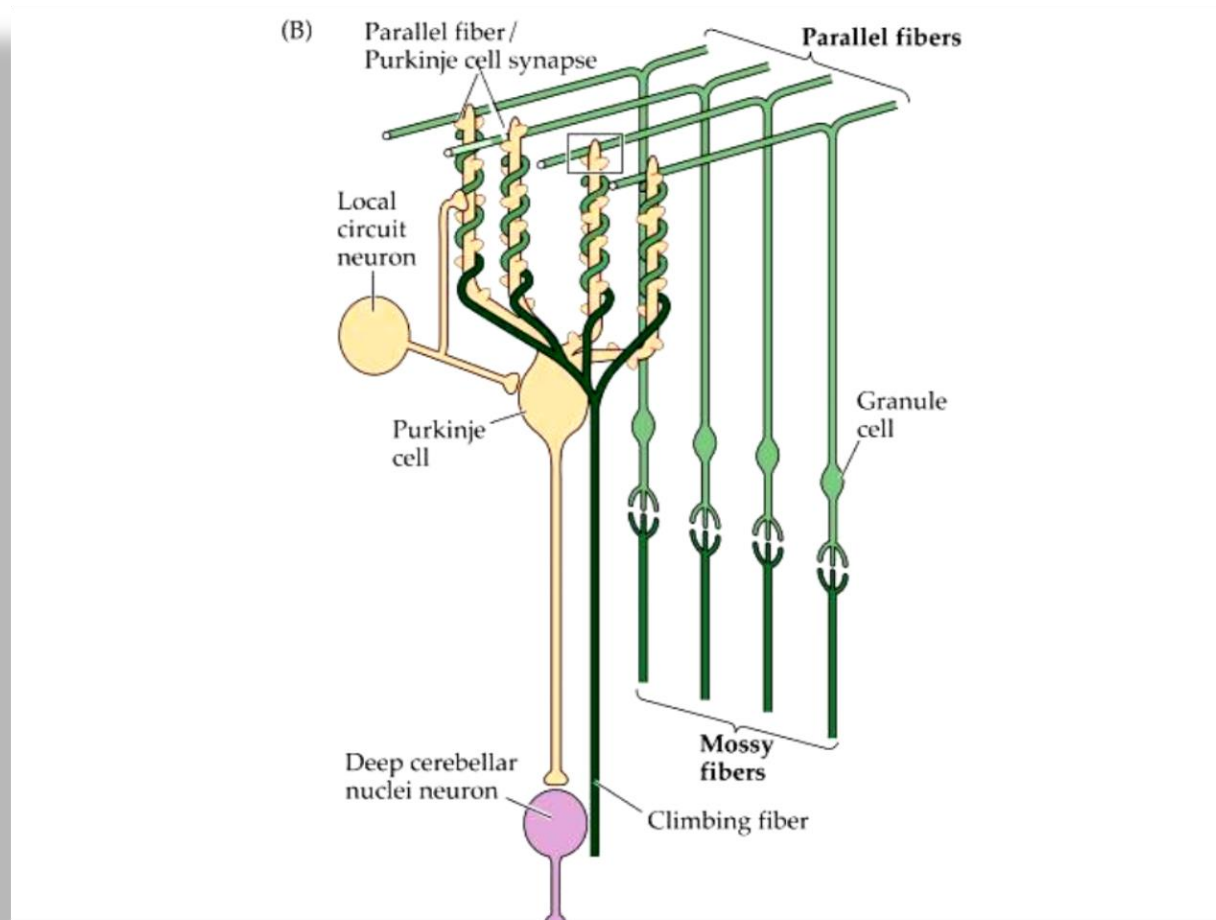


A LARGE AXON TERMINAL (MF) BELONGING TO A MOSSY FIBER IS HIGHLIGHTED IN GREEN COLOR. ITS SURFACE IS COVERED BY MULTIPLE DENDRITES (ASTERISKS) OF GRANULE CELLS. SOME OF THE DENDRITES RECEIVING ASYMMETRIC SYNAPSES ARE HIGHLIGHTED IN ORANGE COLOR. THE ENCIRCLED REGION SHOWS TWO AXON TERMINALS IN COMMUNICATION WITH A GRANULE CELL DENDRITE

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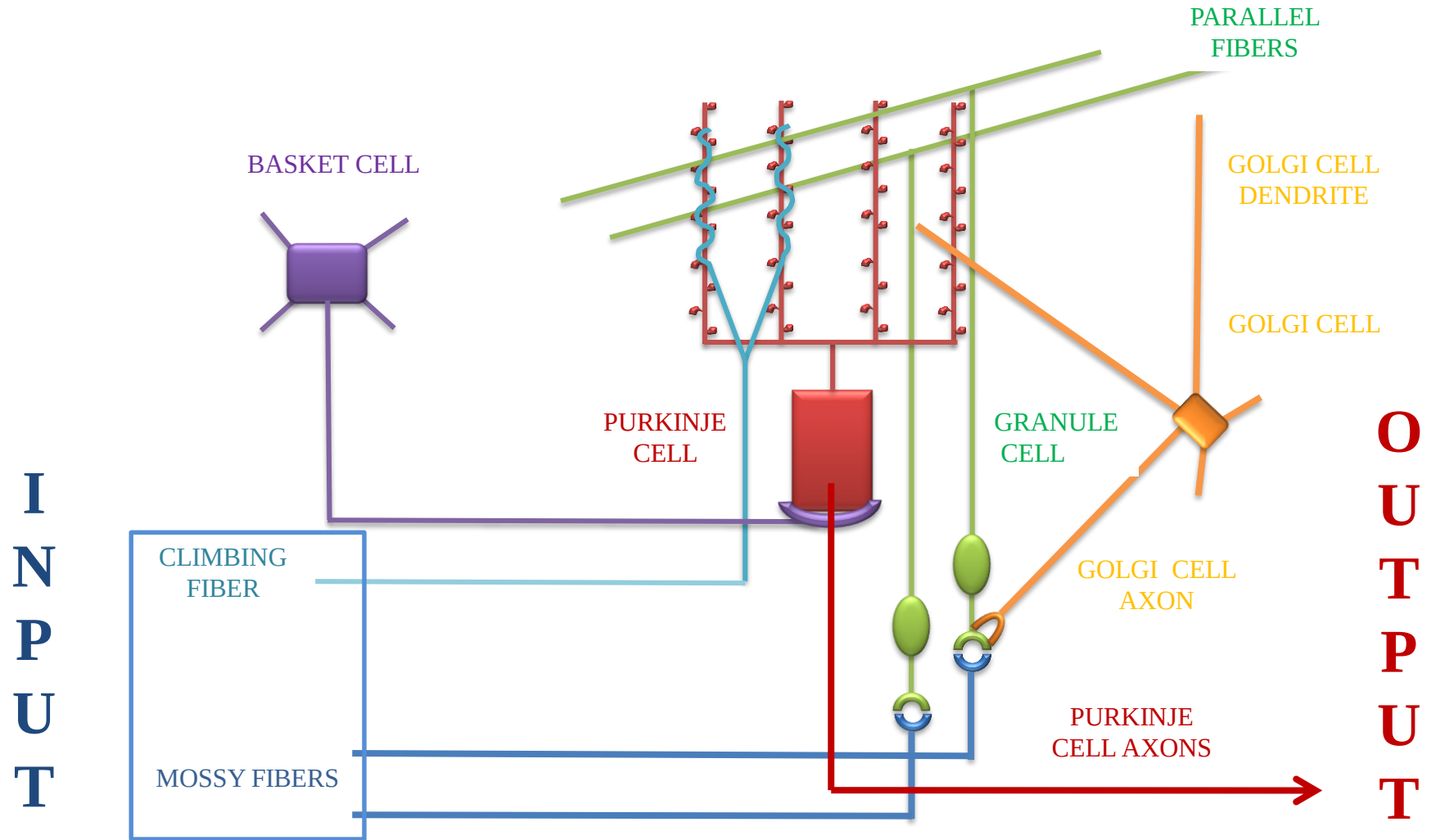


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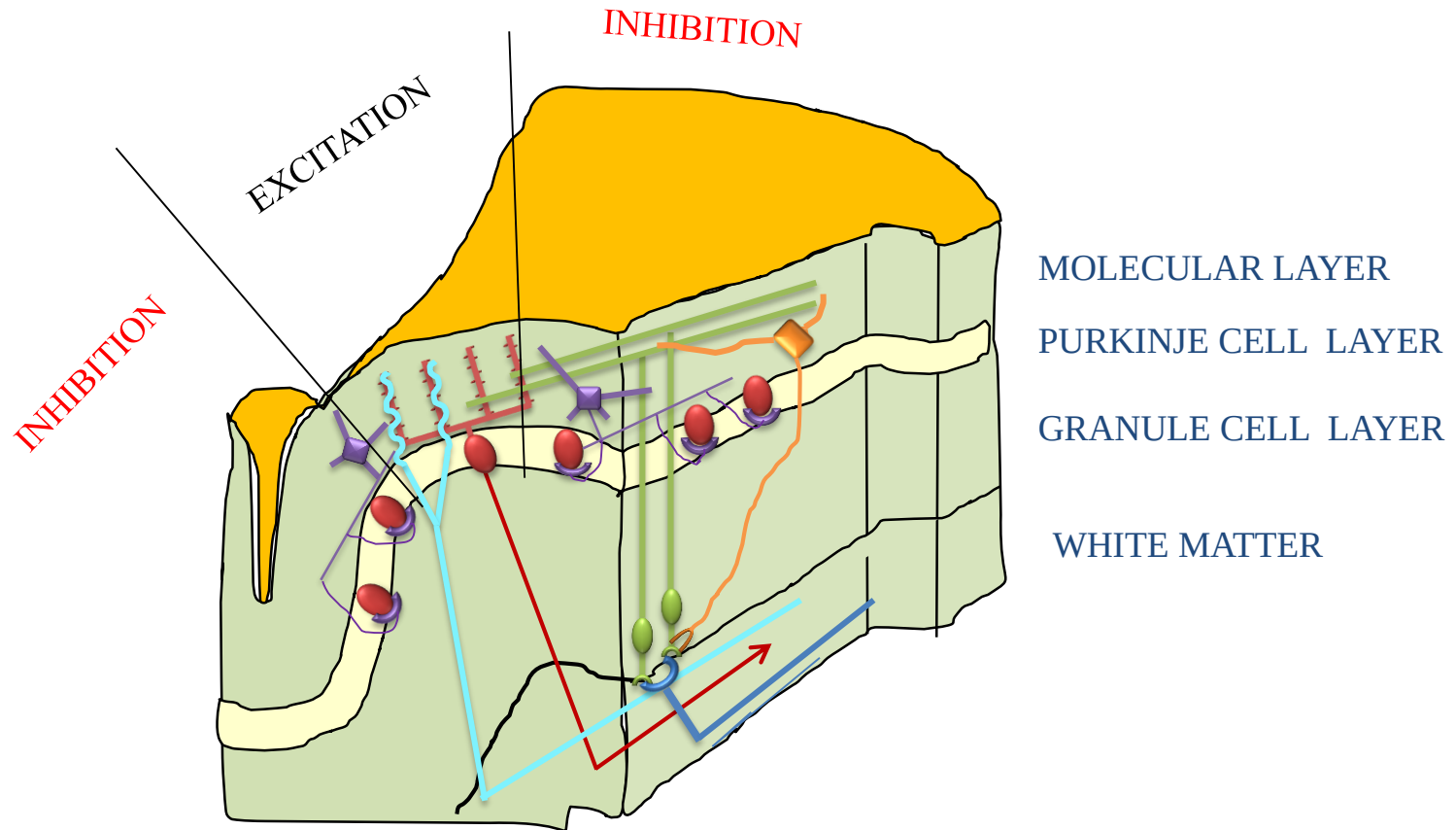
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THE NEURONAL CIRCUIT OF THE CEREBELLUM



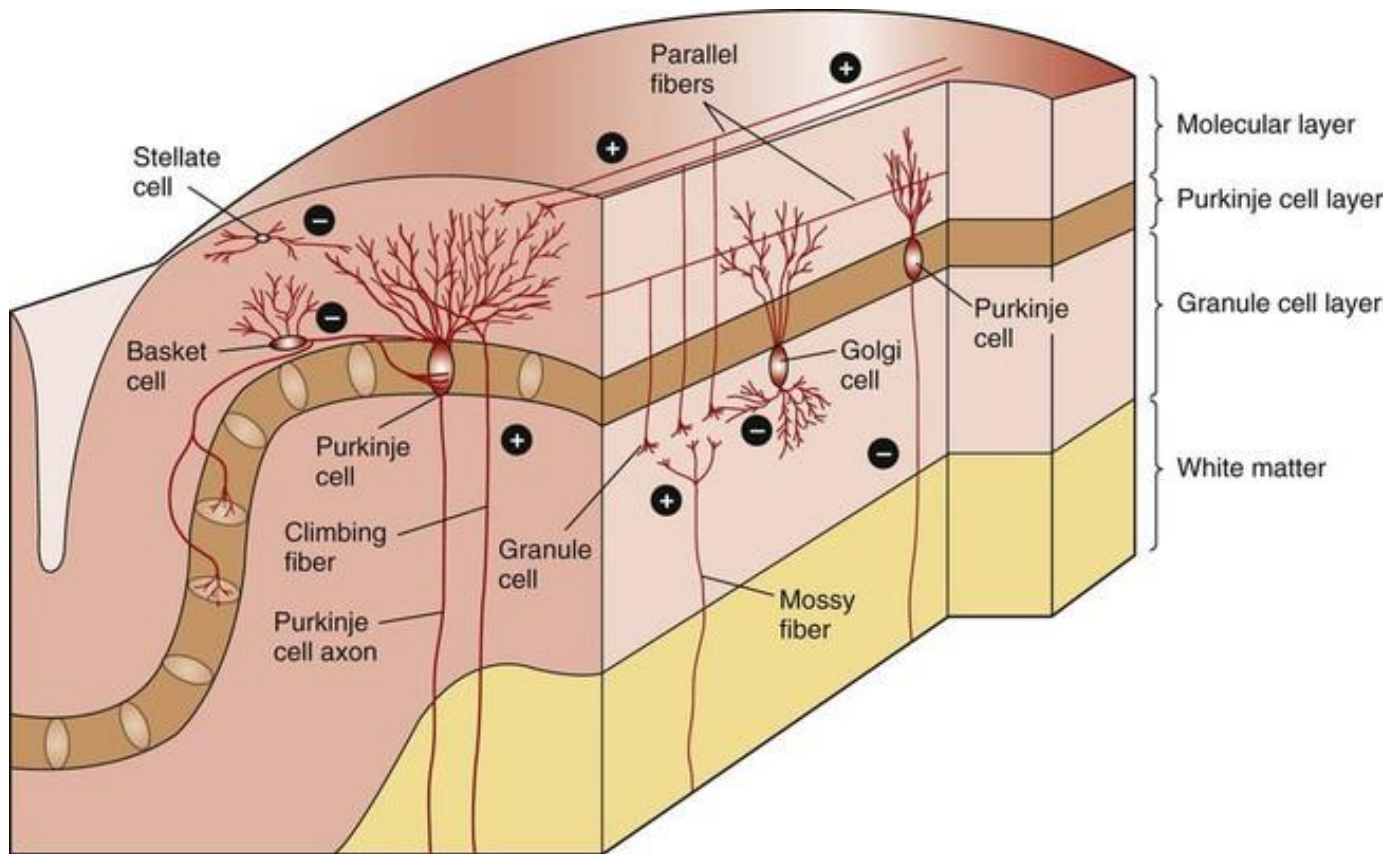
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COLLATERAL INHIBITION



ACTIVATED CEREBELLAR CORTICAL REGIONS ARE SURROUNDED BY INHIBITED ZONES.
THE BASKETS CELLS GENERATE THE COLLATERAL INHIBITION

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TYPES OF SYNAPSES IN THE CEREBELLAR CORTEX

PARALLEL CONTACT

CLIMBING FIBER-PURKINJE CELL DENDRITE

CROSS OVER SYNAPSE

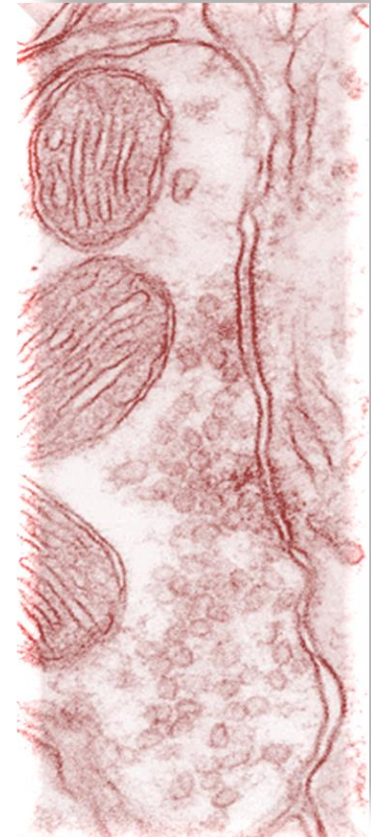
PARALLEL FIBER- PURKINJE CELL DENDRITE

GLOMERULAR SYNAPSE

MOSSY FIBER-GRANULE CELL DENDRITE-GOLGI CELL AXON

BASKET LIKE SYNAPSE

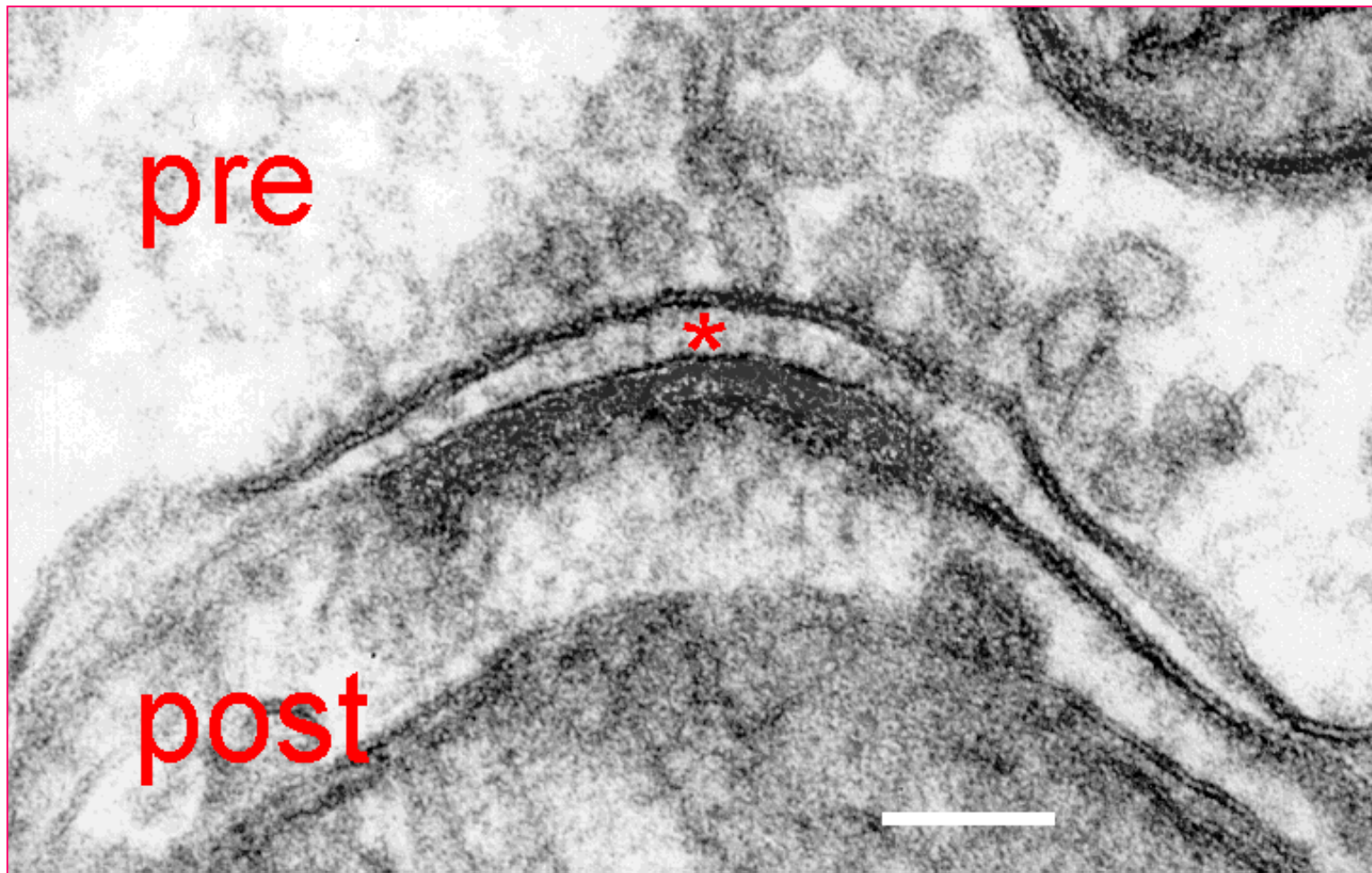
BASKET CELL AXON-PURKINJE CELL BODY



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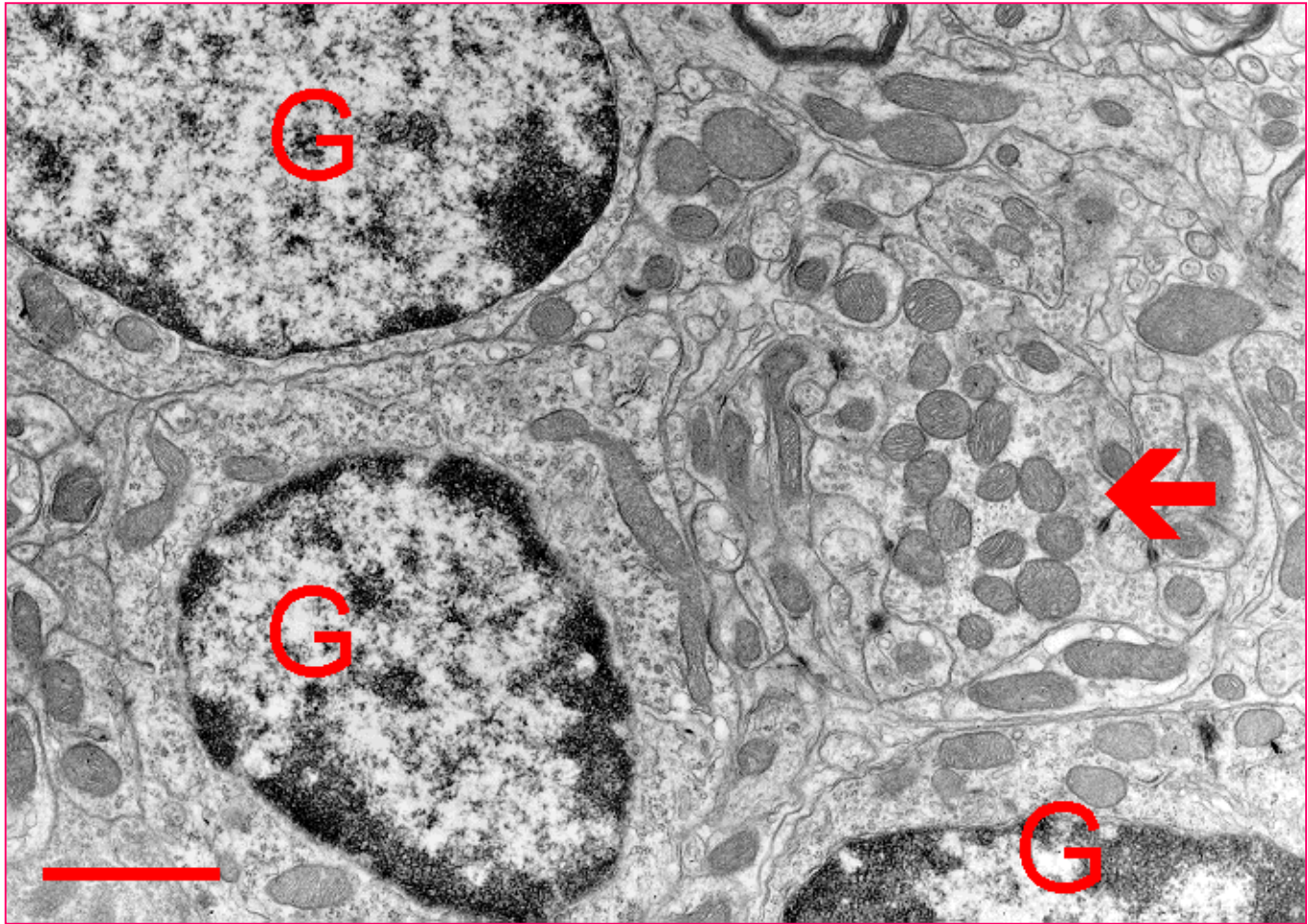
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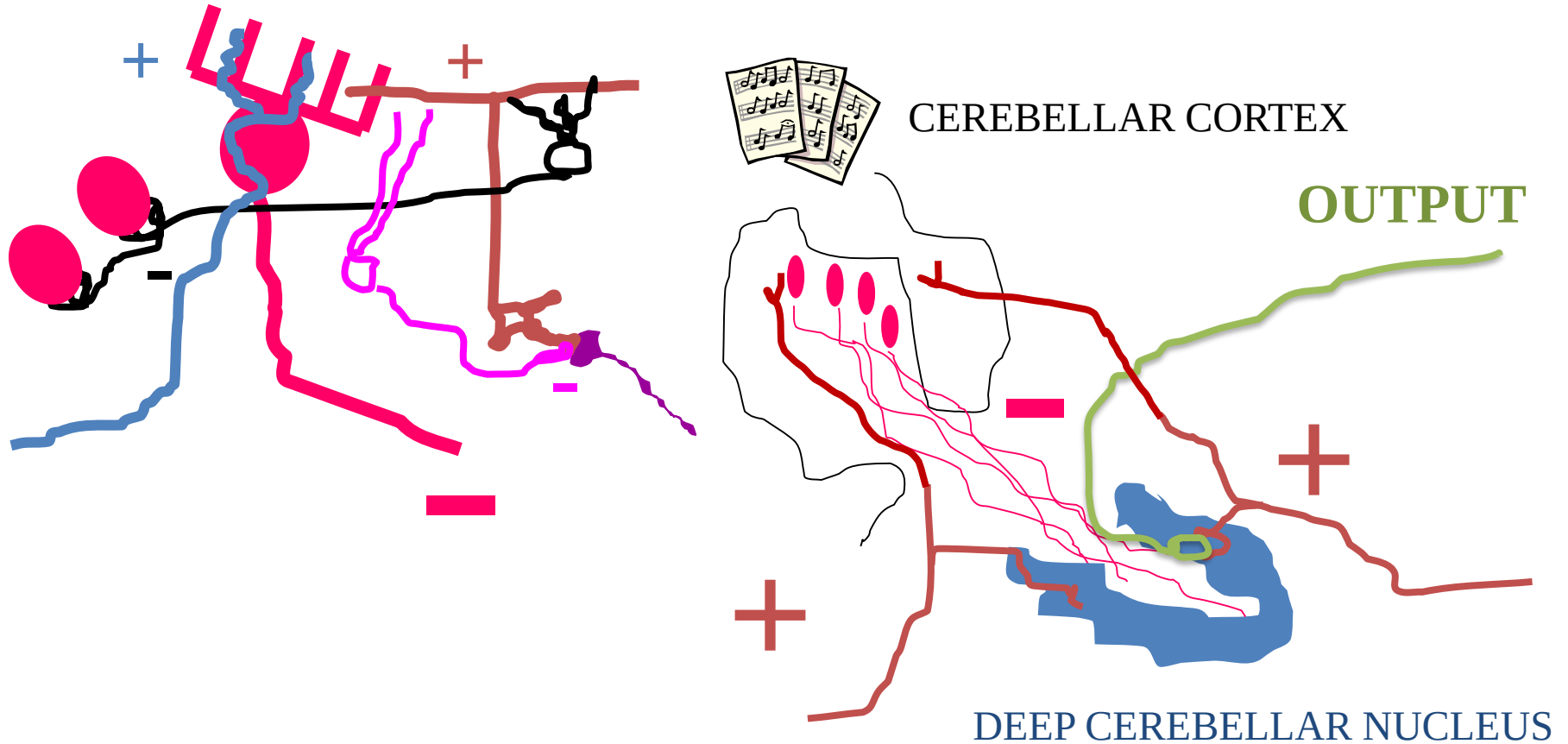


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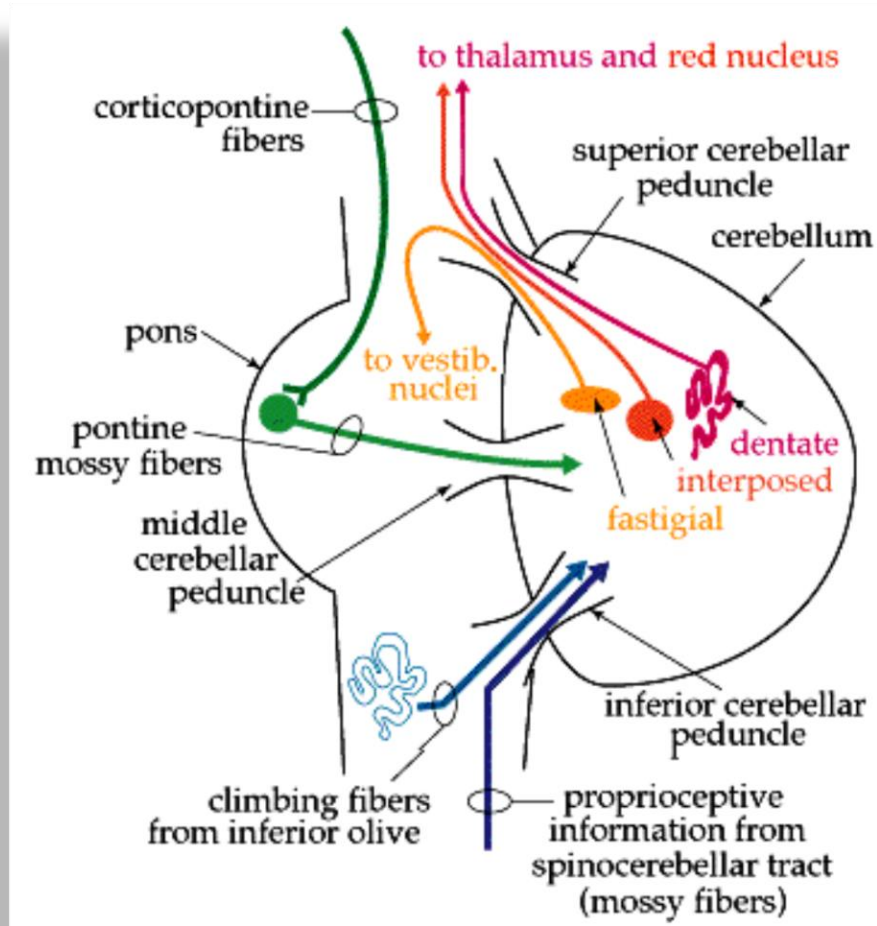


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FUNCTIONAL CONSIDERATIONS



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EXTRINSIC CONNECTIONS OF THE CEREBELLUM

EFFERENT PATHWAY

CEREBELLO-RUBRO-THALAMO-CORTICAL TRACT

AFFERENT PATHWAYS

TR. RETICULOCEREBELLARIS

TR. PONTOCEREBELLARIS

TR. VESTIBULOCEREBELLARIS

TR. OLIVOCEREBELLARIS

TR. SPINOCEREBELLARIS POSTERIOR

TR. SPINOCEREBELLARIS ANTERIOR

