

BASICS OF NEUROBIOLOGY

MOTOR SYSTEMS

ZSOLT LIPOSITS

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CHARACTERISTICS OF THE MOTOR SYSTEMS

EXTRAFUSAL STRIATED MUSCLE FIBERS AND ALPHA MOTONEURONS THAT INNERVATE THEM FORM THE MOTOR UNIT. THE SOMATO-MOTONEURONS ARE DISTRIBUTED IN THE BRAIN STEM AND THE SPINAL CORD. COLLECTIVELY, THEY ARE CALLED AS LOWER MOTONEURONS

LOWER MOTONEURONS ARE CONTROLLED BY UPPER MOTONEURONS. THE TERM REFERS TO DESCENDING PATHWAYS (CORTICOBULBAR, CORTICOSPINAL, RUBROSPINAL, TECTOSPINAL, VESTIBULOSPINAL, RETICULOSPINAL TRACTS) THAT REGULATE THE LOWER MOTO-NEURONS EITHER BY A DIRECT OR AN INTERNEURON-MEDIATED MANNER

THE MAIN MOTOR SYSTEMS INCLUDE THE MOTOR CORTEX, THE CEREBELLAR MACHINERY AND THE BASAL GANGLIA. THE LATTER TWO SYSTEMS ARE CHanneLED TO THE FRONTAL MOTOR CORTEX VIA THE VENTRAL LATERAL NUCLEUS OF THE THALAMUS

THE MAIN CORTICAL MOTOR SYSTEM USES THE CORTICOBULBAR AND CORTICOSPINAL TRACTS FOR EXECUTION OF VOLUNTARY MOVEMENTS. LESION OF THE UPPER MOTOR NEURON PATHWAYS RESULTS IN SPASTIC PARALYSIS, EXAGGERATED STRETCH REFLEX AND SOME ABNORMAL REFLEXES. CEREBELLAR DISORDERS CHANGE THE RATE, DIRECTION, RANGE AND FORCE OF MOVEMENTS. LESIONS OF THE BASAL GANGLIA ARE MANIFESTED IN DYSKINESIA

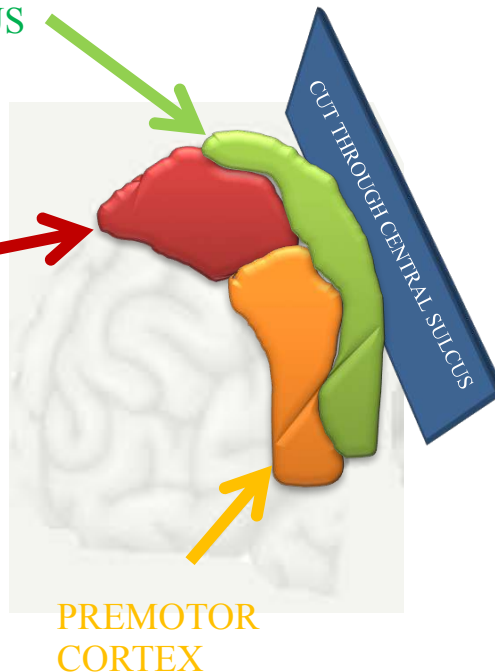
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THE MOTOR CORTEX

THE MOTOR CORTEX IS COMPRISED OF THE PRECENTRAL GYRUS, AS THE PRIMARY MOTOR CENTER, THE SUPPLEMENTARY MOTOR CORTEX AND THE PREFRONTAL MOTOR CORTEX AND CERTAIN PARIETAL LOBE REGIONS. THE MUSCLE GROUPS OF THE BODY ARE REPRESENTED IN A SOMATOTOPIC FASHION IN THE PRIMARY MOTOR CORTEX (MOTOR HOMUNCULUS)

PRECENTRAL GYRUS

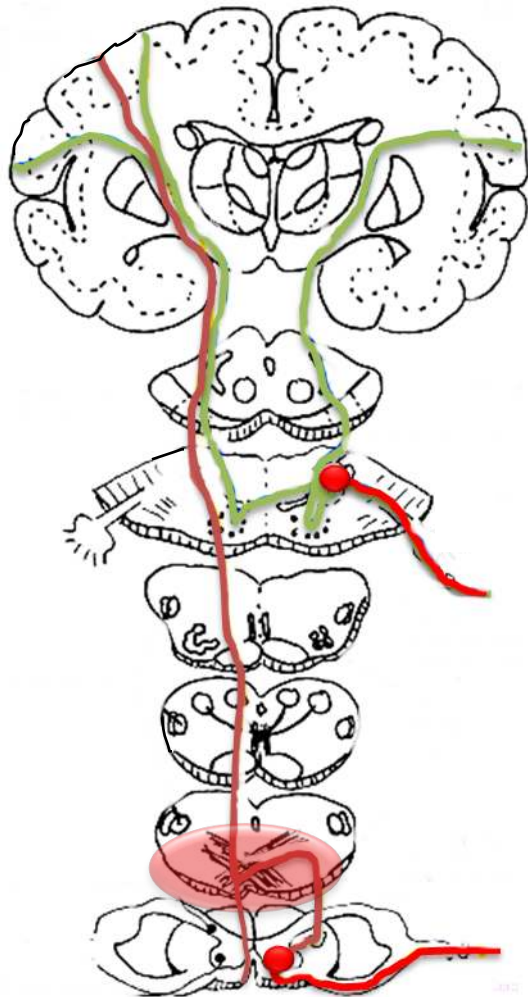
SUPPLEMENTARY
MOTOR CORTEX



NOTE THE LARGE REPRESENTATIONS
OF THE HAND AND THE TONGUE

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THE CORTICOBULBAR AND CORTICOSPINAL PROJECTIONS



THE DESCENDING **CORTICOBULBAR** MOTOR FIBERS SUPPLY MOTONEURONS OF THE BRAIN STEM, WHILE THE **CORTICOSPINAL** PROJECTION THAT SPLITS AT THE LEVEL OF THE MEDULLA FEEDS THE LOWER MOTONEURONS OF THE SPINAL CORD VIA THE **LATERAL AND ANTERIOR CORTICOSPINAL TRACTS**. NOTE THE BILATERAL INNERVATION OF THE TRIGEMINAL MOTOR NUCLEUS IN THE PONS. THE CROSSING OF THE MAJORITY OF CORTICOSPINAL AXONS IN THE MEDULLA IS HIGHLIGHTED BY PINK SHADOW

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COURSE OF THE DESCENDING PYRAMIDAL PATHWAY

INTERNAL
CAPSULE



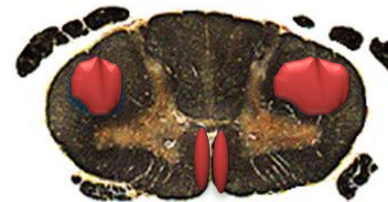
MIDBRAIN

PONS



MEDULLA

MEDULLA
AT CROSSING
SITE



SPINAL CORD

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CORTICOBULBAR/SPINAL PROJECTION WITHIN THE INTERNAL CAPSULE

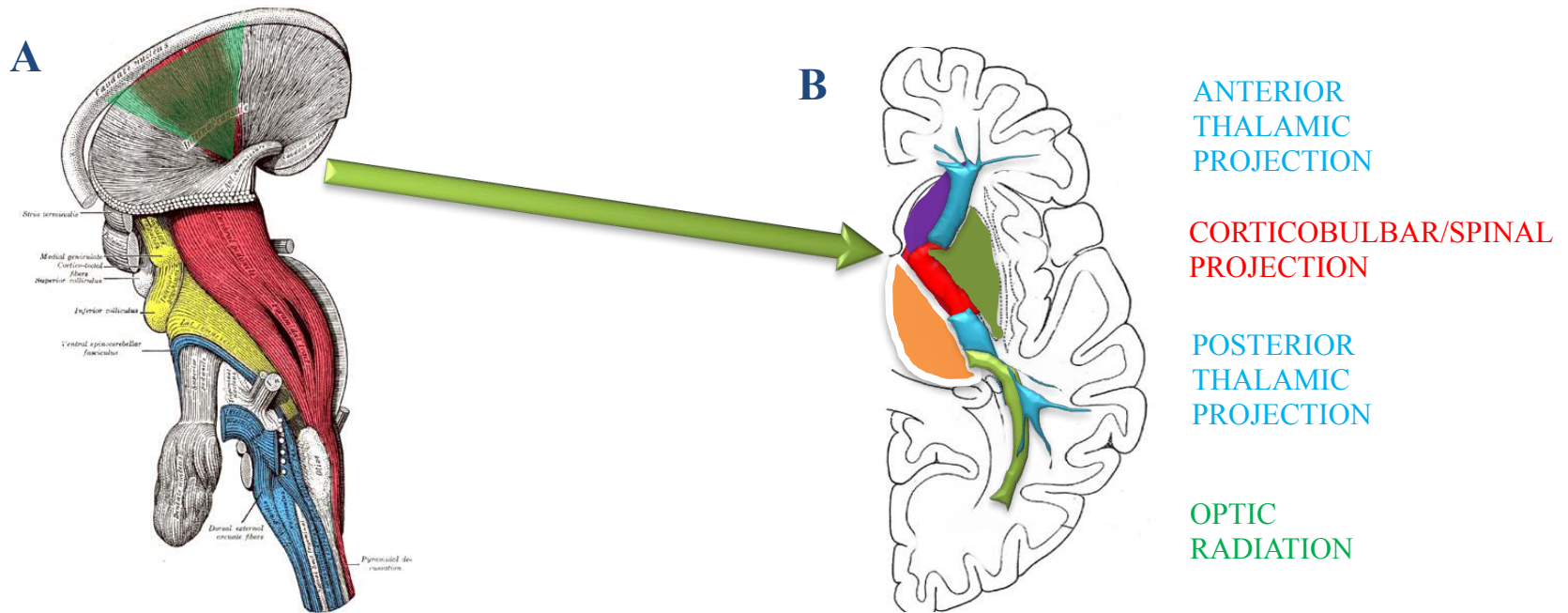
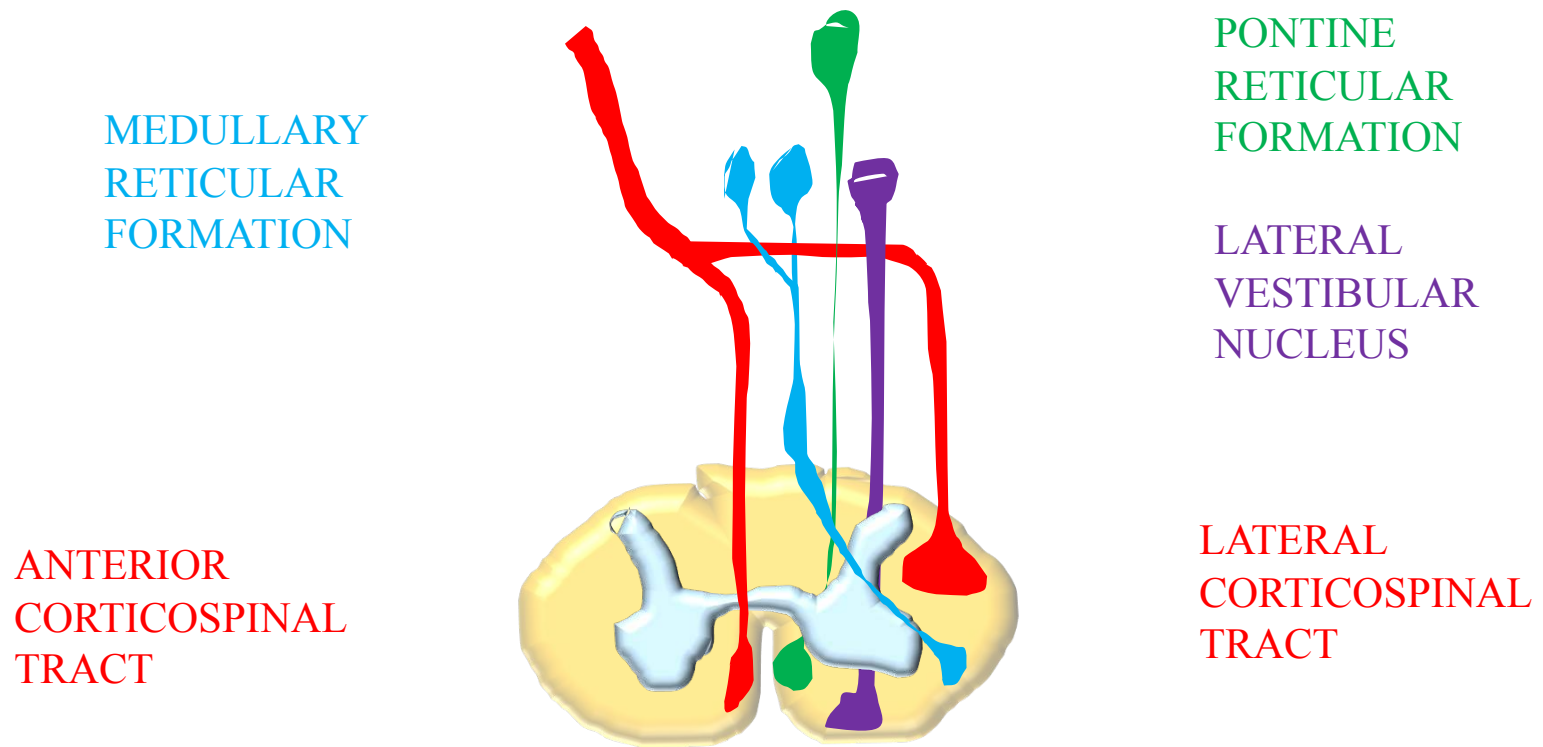


FIGURE **A** DEPICTS THE DOWNSTREAM COURSE OF CORTICOBULBAR/SPINAL FIBERS. NOTE THE CONVERGENCE (HIGHLIGHTED IN GREEN) TOWARD THE INTERNAL CAPSULE. FIGURE **B** ILLUSTRATES THE LOCATION OF THE CORTICOBULBAR/SPINAL PROJECTION IN THE INTERNAL CAPSULE. THE OPTIC RADIATION IS SHOWN IN GREEN

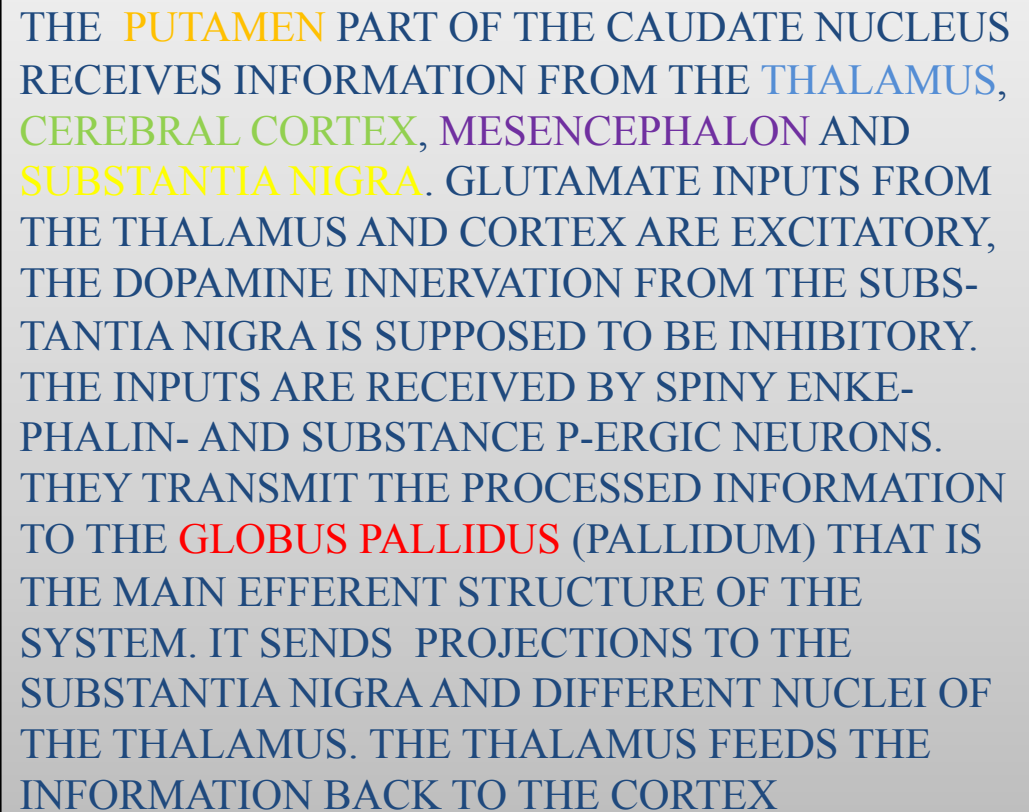
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ILLUSTRATION OF SOME DESCENDING UPPER MOTONEURON SYSTEMS



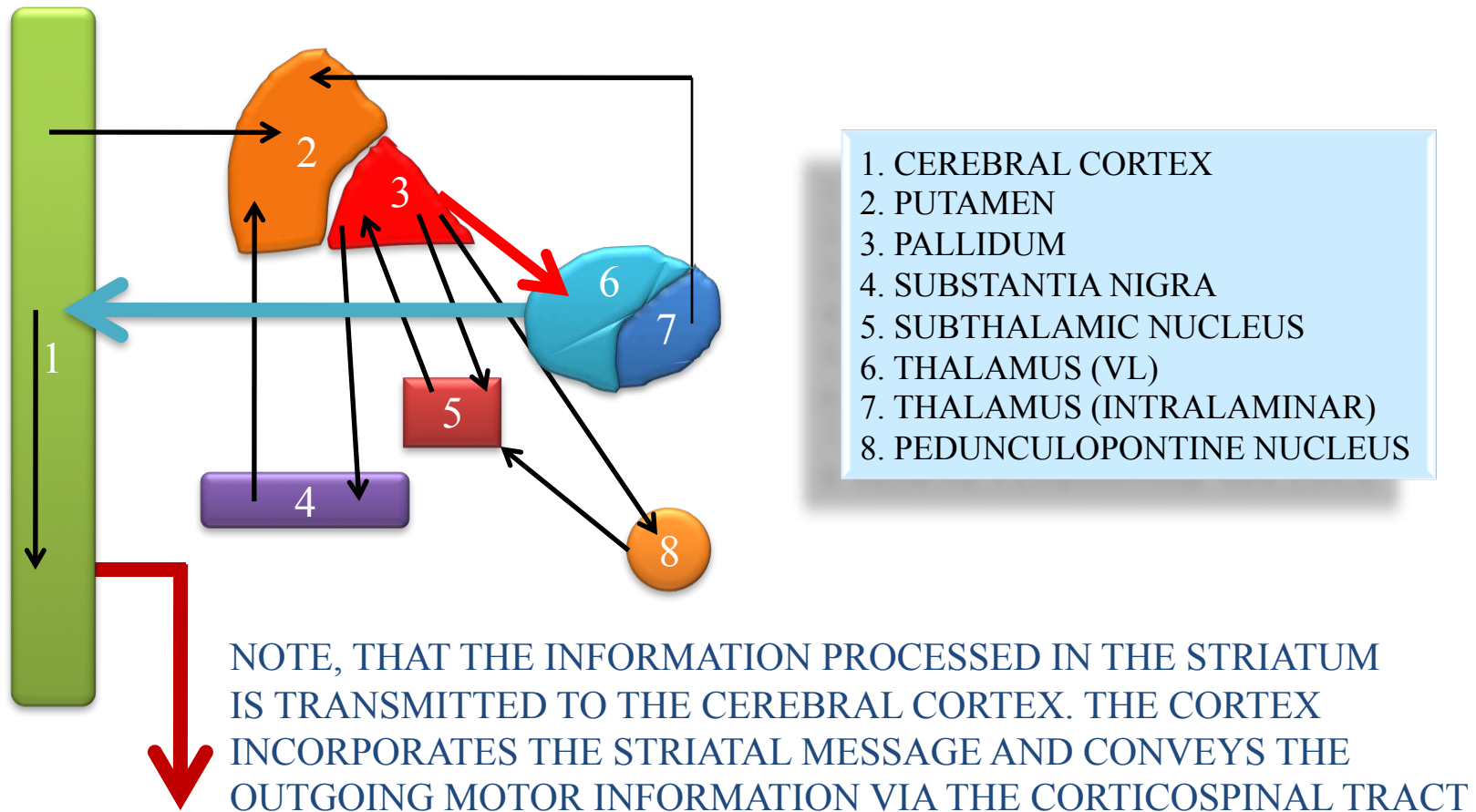
IN ADDITION TO PATHWAYS SHOWN IN THE FIGURE, THE SUPERIOR COLLICULI, THE NUCLEUS RUBER, THE INFERIOR OLIVE, NORADRENERGIC AND SEROTONERGIC CELLS GROUPS OF THE BRAIN STEM ALSO SEND PROJECTIONS TO THE CORD

NEURONAL LINKS AND LOCAL CIRCUITS OF THE STRIATUM



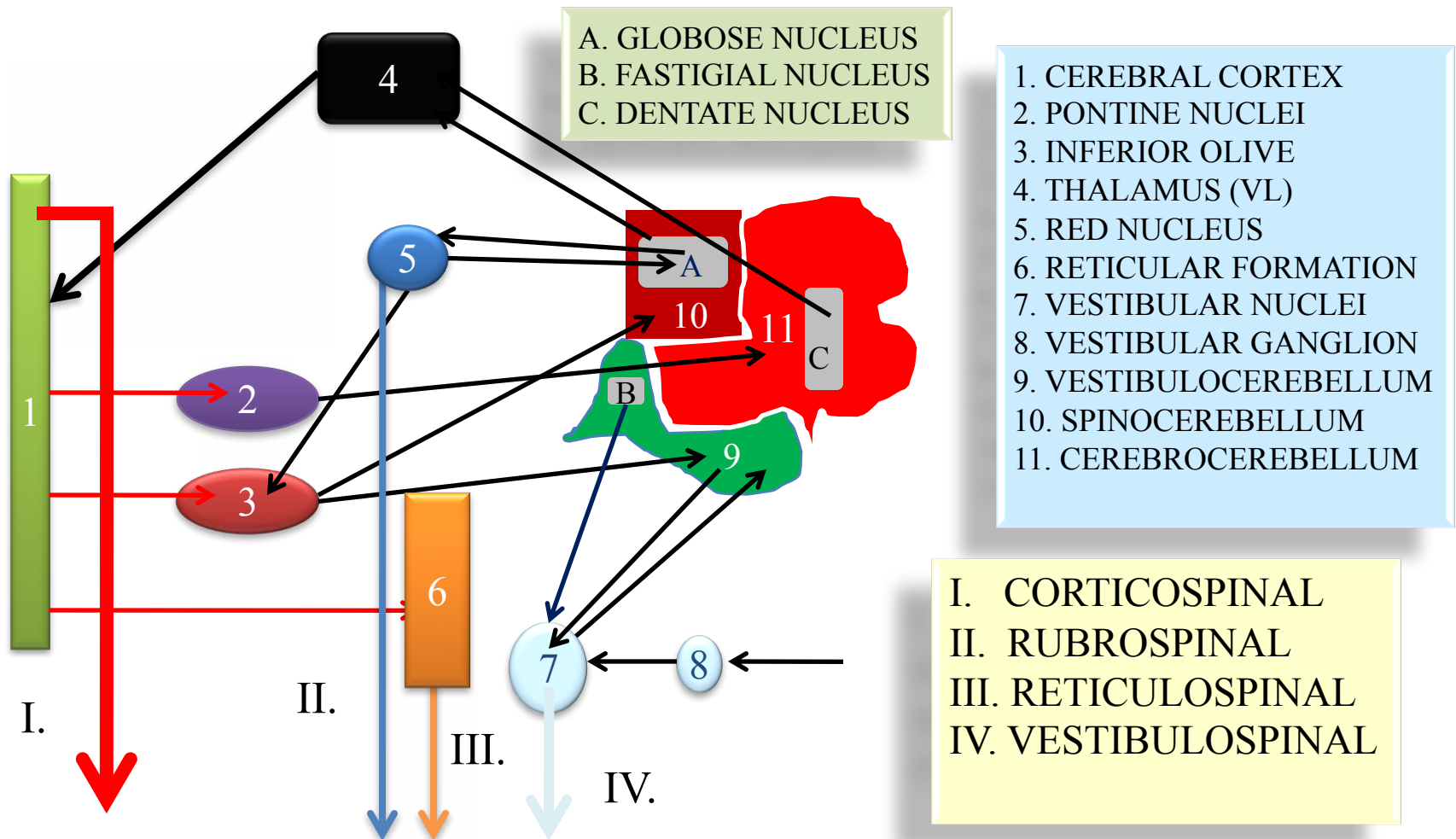
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ROLE OF THE STRIATUM IN THE MOTOR SYSTEM



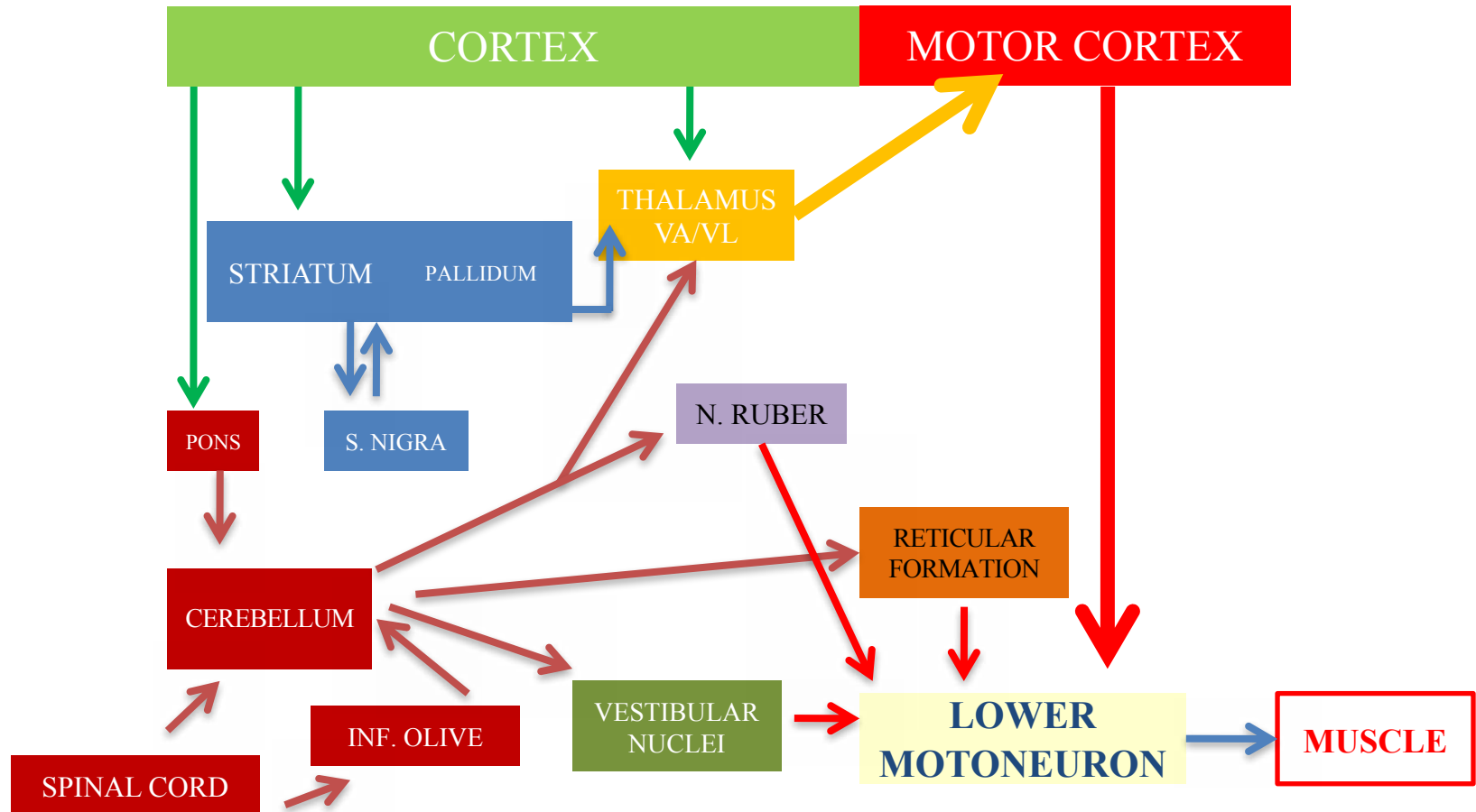
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ROLE OF CEREBELLUM IN CONTROL OF MOVEMENT



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INTEGRATION OF THE DIFFERENT MOTOR SYSTEMS



SIGNS OF MOTONEURON LESIONS

UPPER VERSUS LOWER MOTONEURON

• Sign	• Upper Motor Neuron Lesions	• Lower Motor Neuron Lesions
• Weakness	• Yes	• Yes
• Atrophy	• No ^a	• Yes
• Fasciculations	• No	• Yes
• Reflexes	• Increased ^b	• Decreased
• Tone	• Increased ^b	• Decreased

^a Mild atrophy may develop due to disuse

^b With acute upper motor neuron lesions; tone may be decreased