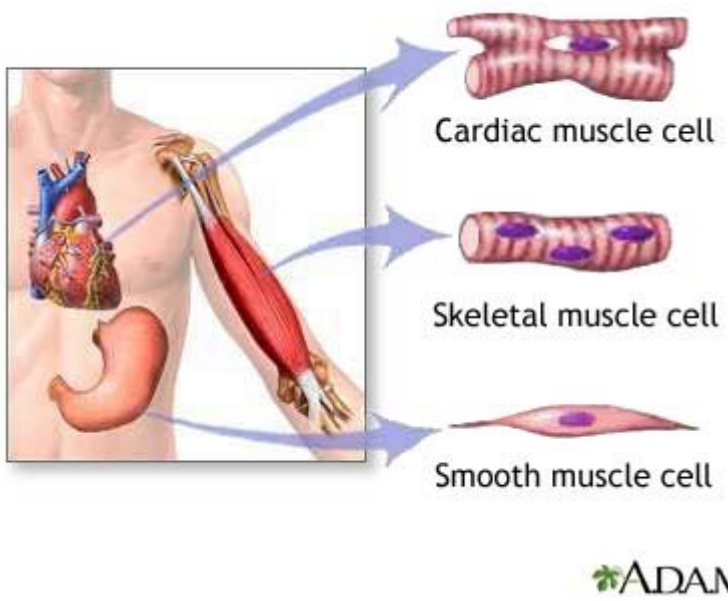
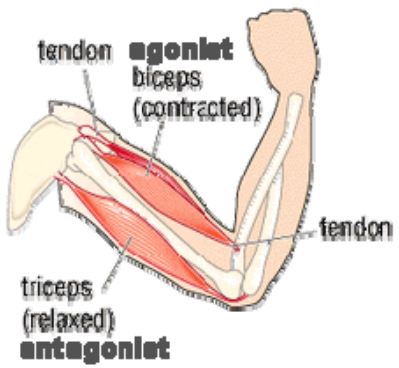
Chap 6. movement

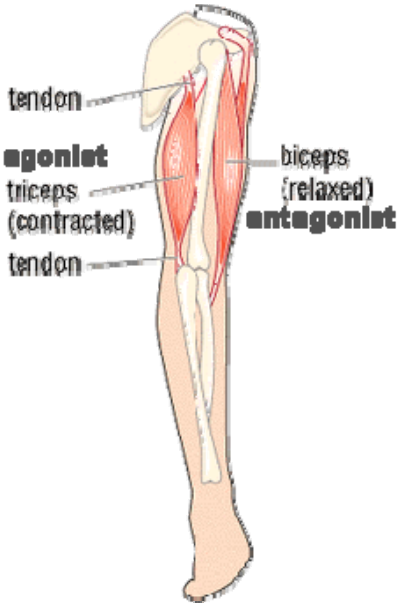
Robot



flexion

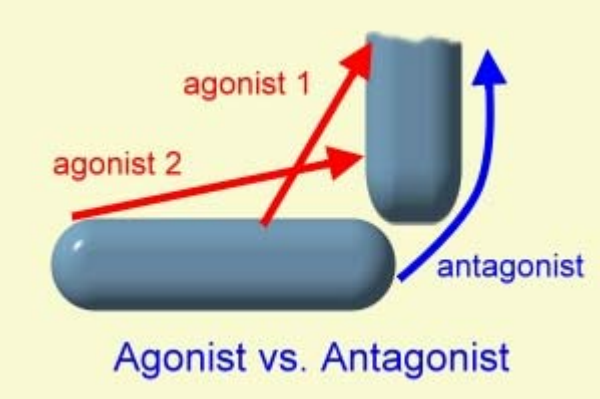


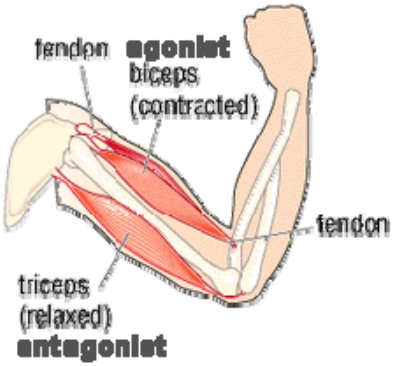
extension



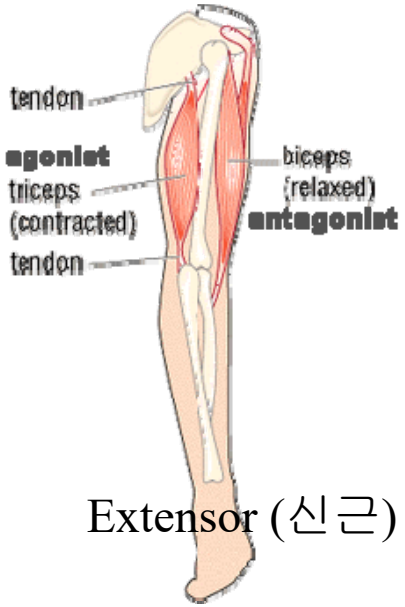
Proprioception: the sense of the relative position of neighboring parts of the body and strength of effort being employed in movement. It is provided by proprioceptors in skeletal muscles and in joints.

Agonist and antagonist



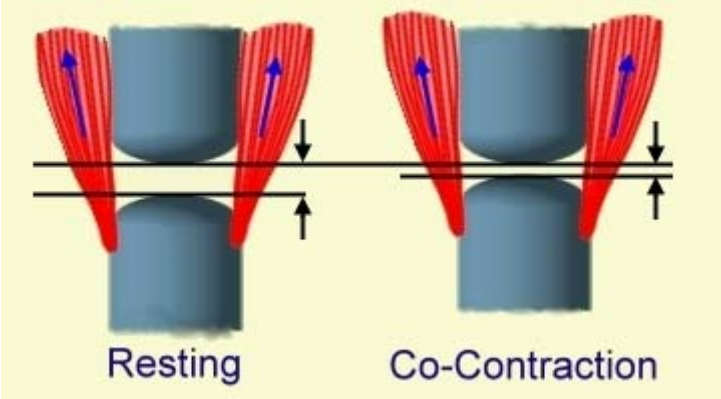


Flexor (굴근)

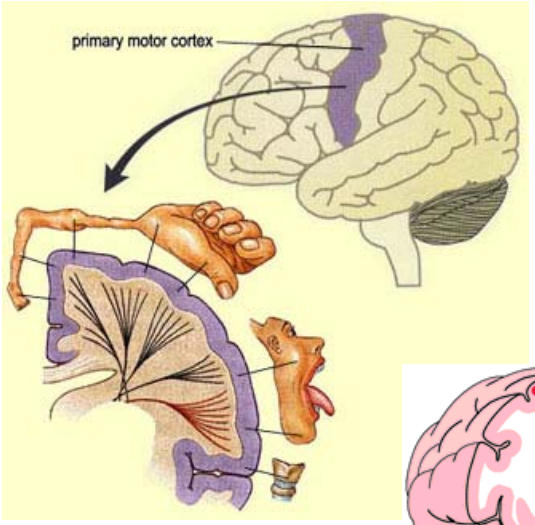


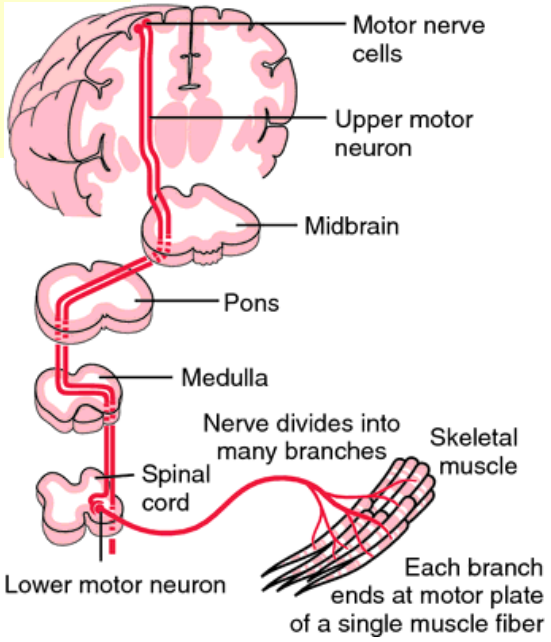
Extensor (신근)

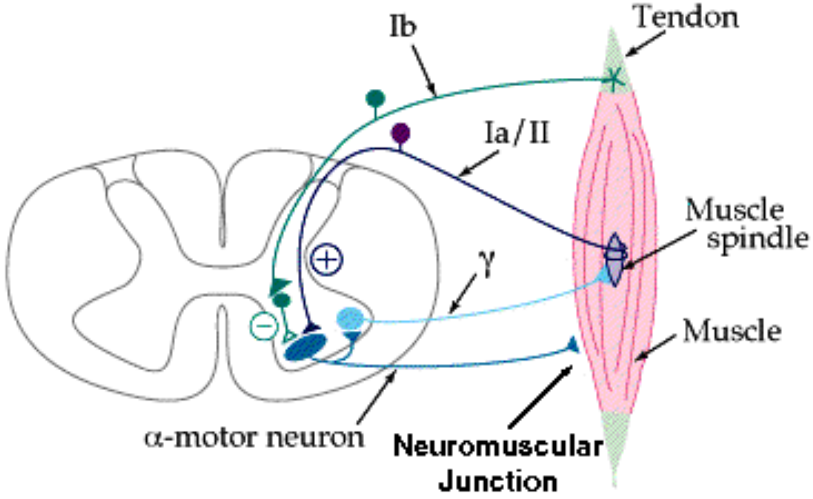
Agonist (작용근): the principal muscle that produces a joint motion or maintains a static posture
Antagonist (대항근): the muscle that contracts in the opposite direction of the agonist
http://www.pt.ntu.edu.tw/hmchai/Kinesiology/KINstructure/MuscleCoordination.htm



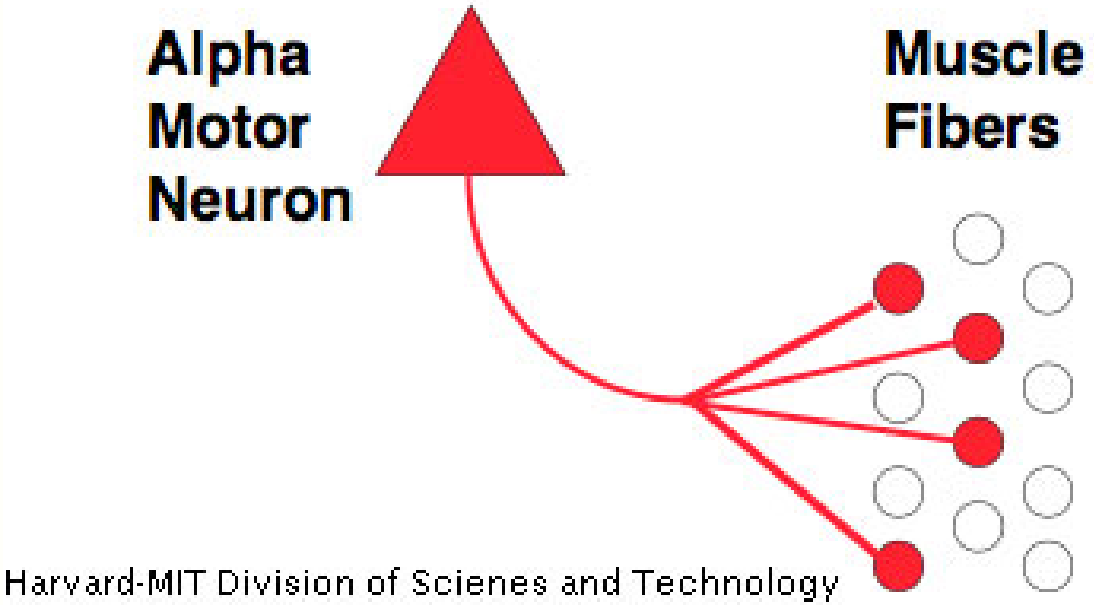
Co-contraction: agonists and antagonists contract simultaneously


primary motor cortex

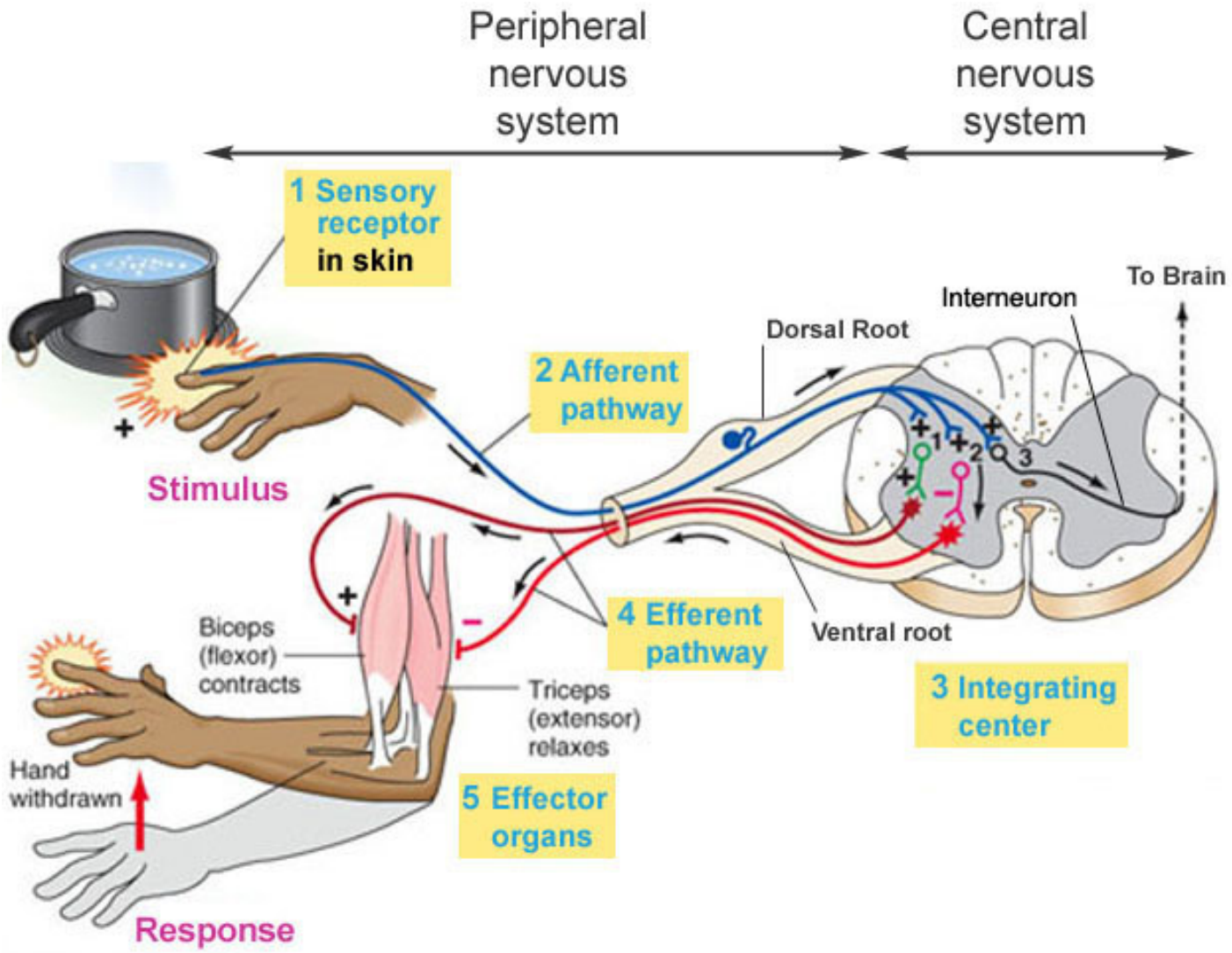

Motor nerve cells
Upper motor neuron
Midbrain
Pons
Medulla
Nerve divides into many branches
Skeletal muscle
Spinal cord
Lower motor neuron
Each branch ends at motor plate of a single muscle fiber


Ib
Tendon
Ia/II
Muscle spindle
γ
Muscle
α-motor neuron
Neuromuscular Junction

- A single neuron and all the muscle fibers it innervates are a **motor unit**
- The motor unit is the smallest division that the system can control individually



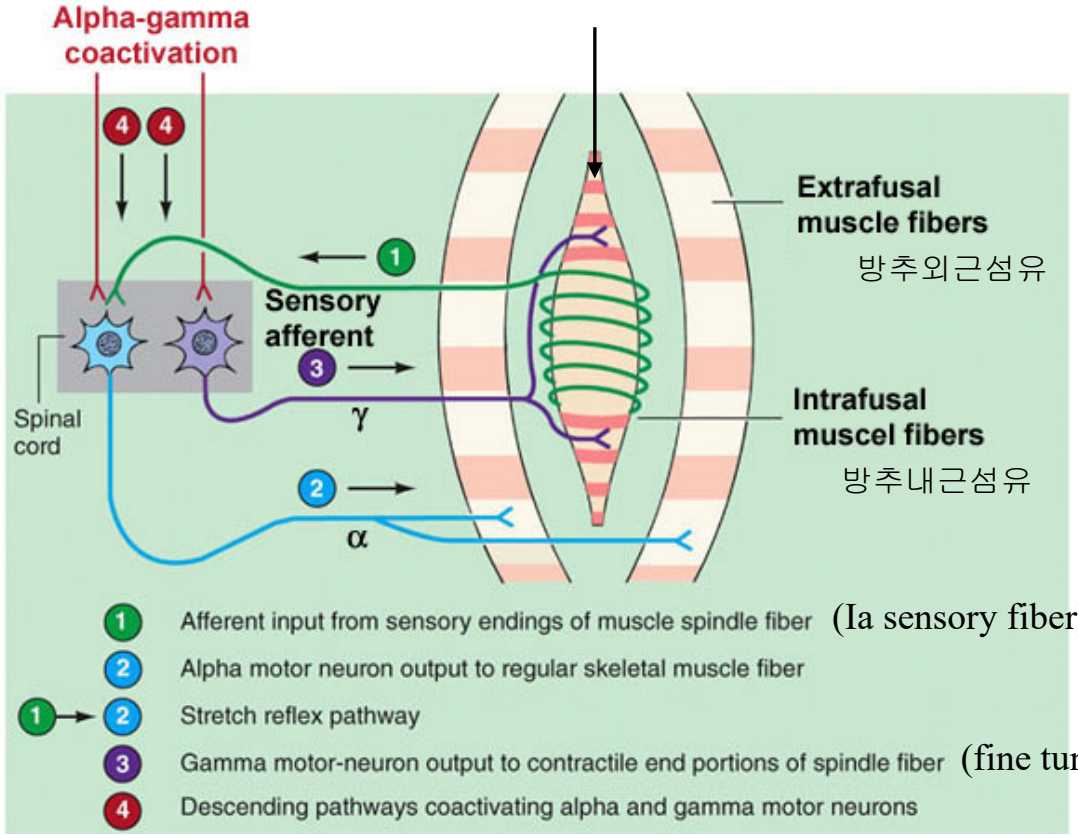
http://www.learnodes.com/2007/10/19/muscle-motor-units-and-neurons-from-the-bottom-up/


Peripheral nervous system
Central nervous system
1 Sensory receptor in skin
Stimulus
2 Afferent pathway
Dorsal Root
Interneuron
To Brain
Ventral root
3 Integrating center
4 Efferent pathway
Biceps (flexor) contracts
Triceps (extensor) relaxes
Hand withdrawn
5 Effector organs
Response

Alpha motor neurons: extrafusal muscle fibers
Gamma motor neurons (fine tuning): intrafusal muscle fibers

Ia sensory neuron (muscle length): muscle spindles
Ib sensory neuron (muscle tension): Golgi tendon organs

Muscle spindle (근방추): 신장수용기(stretch receptor)



(Ia sensory fiber)

(fine tuning)

Muscle spindle (stretch receptor): detects muscle length
constitutes proprioception together with Ia sensory fiber

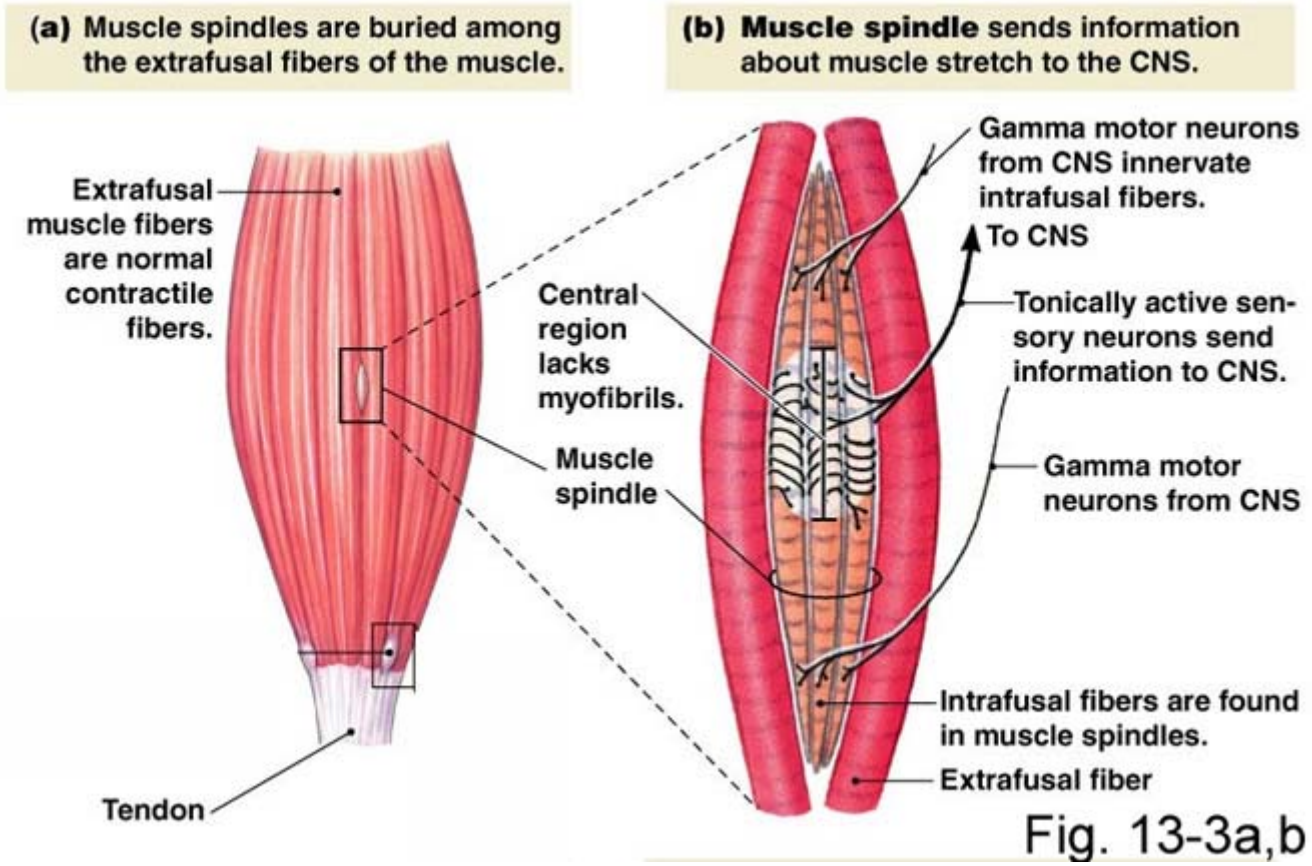
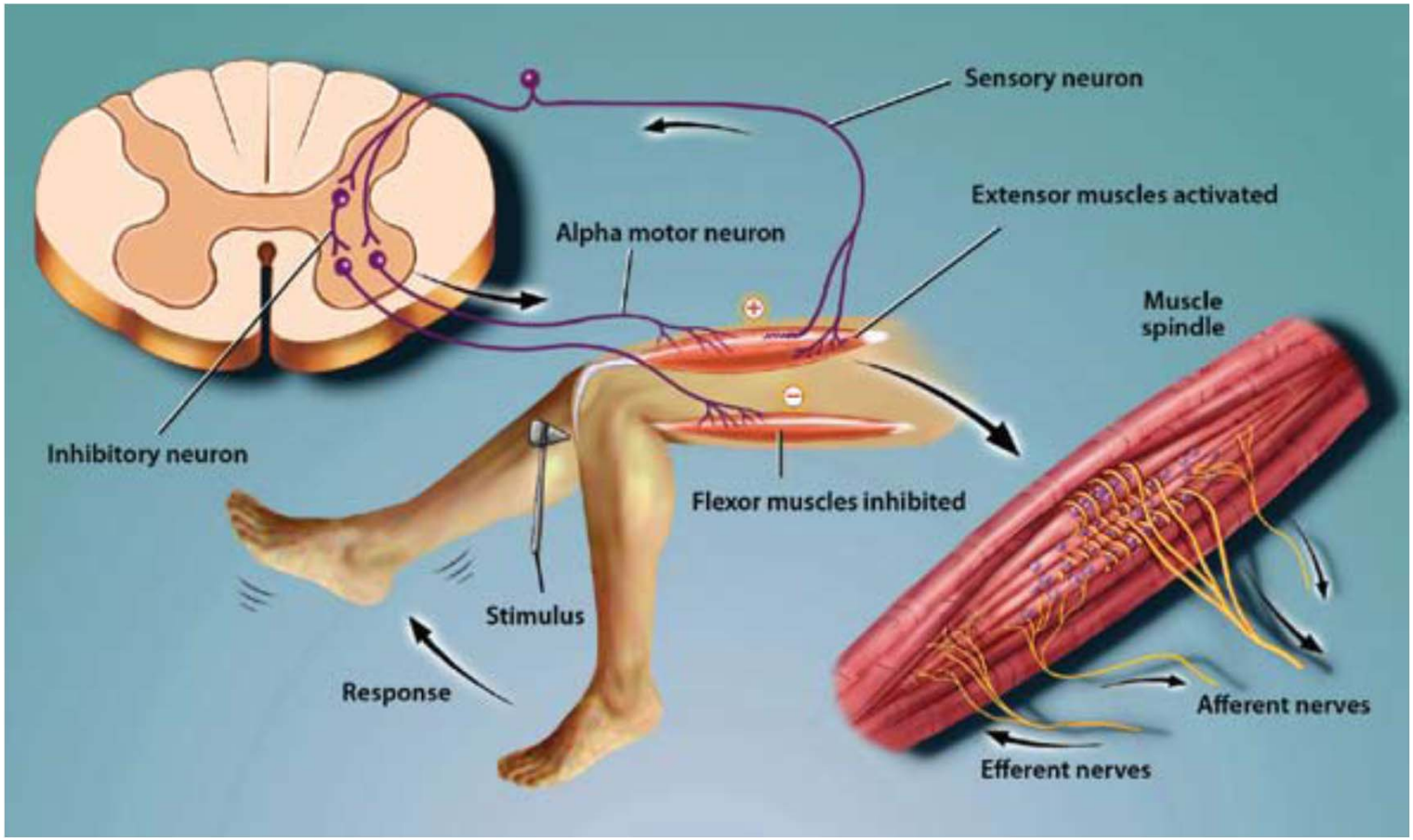
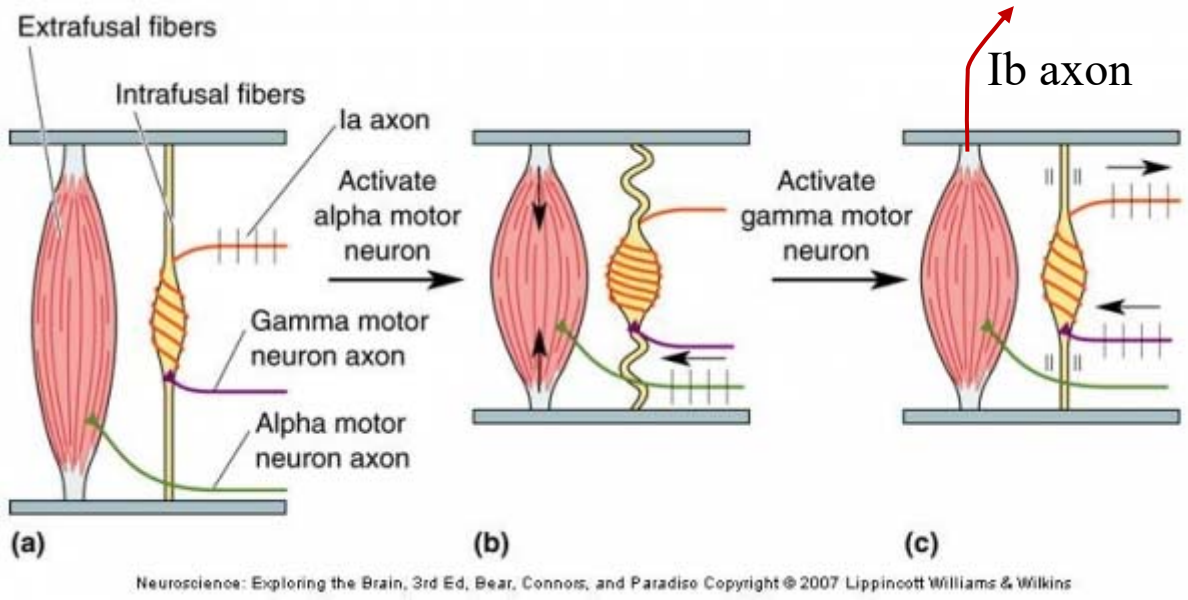


Fig. 13-3a,b

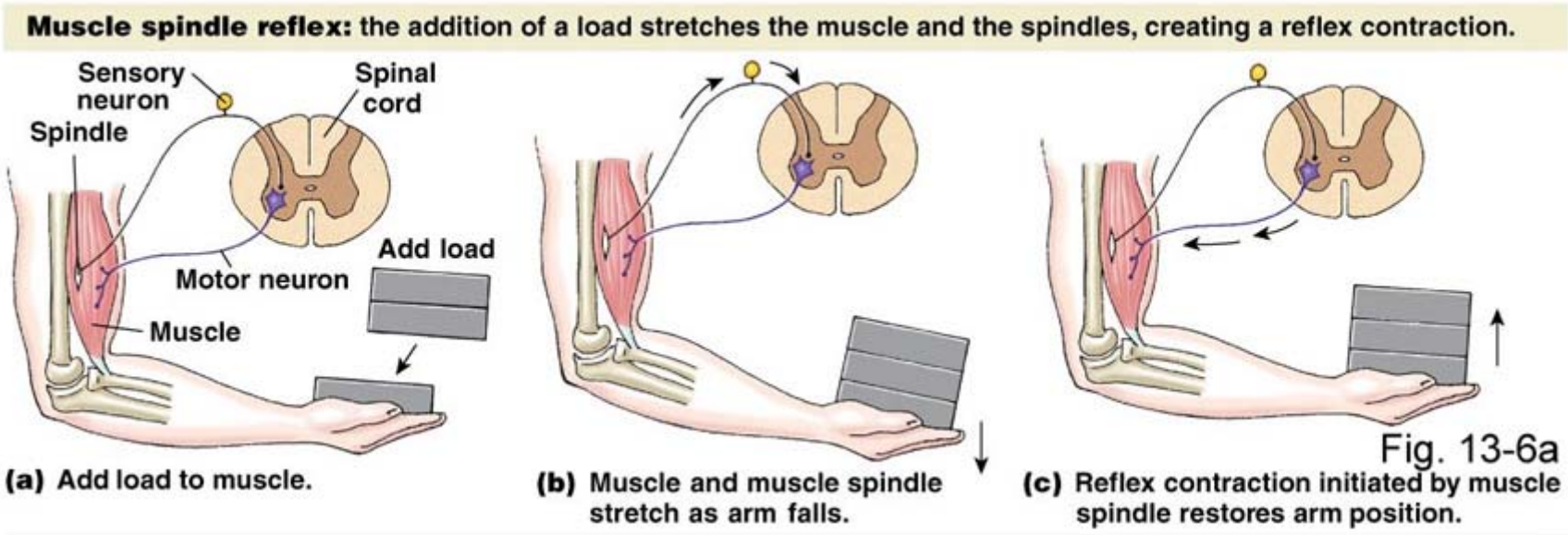
reflexes


Sensory neuron
Extensor muscles activated
Alpha motor neuron
Muscle spindle
Inhibitory neuron
Flexor muscles inhibited
Stimulus
Response
Afferent nerves
Efferent nerves

Muscle spindle reflex (stretch reflex)



The spindle has sensory receptors (Ia axon) that are activated anytime the muscle gets stretched. When a muscle gets stretched, the sensory Ia fibers automatically activate the alpha and gamma motor neurons in the spinal cord. The alpha motor neurons make the actual muscles contract back a little bit in response to that stretch.
The gamma motor neurons make the ends of the spindle fibers contract in order to keep the spindle "receptive" to length changes in the new range of motion (ROM). This is how the muscle spindle is able to stay sensitive in a moment to moment basis to length changes no matter what the joint angle / muscle length is.
So if something happens fast and delivers an unexpected quick stretch to the tissue that is potentially harmful, the spindle will send an automatic impulse to the muscle to contract back as a protective mechanism to "prevent" an overstretch injury. This is a reflex, meaning all this happens at the spinal cord level before our brains even realize what just happened.



Ia sensory neurons stimulates alpha motor neurons
The sensitivity is controlled by gamma motor neurons

Golgi tendon organ:

a proprioceptive sensory receptor
detects the force applied by a contracting muscle

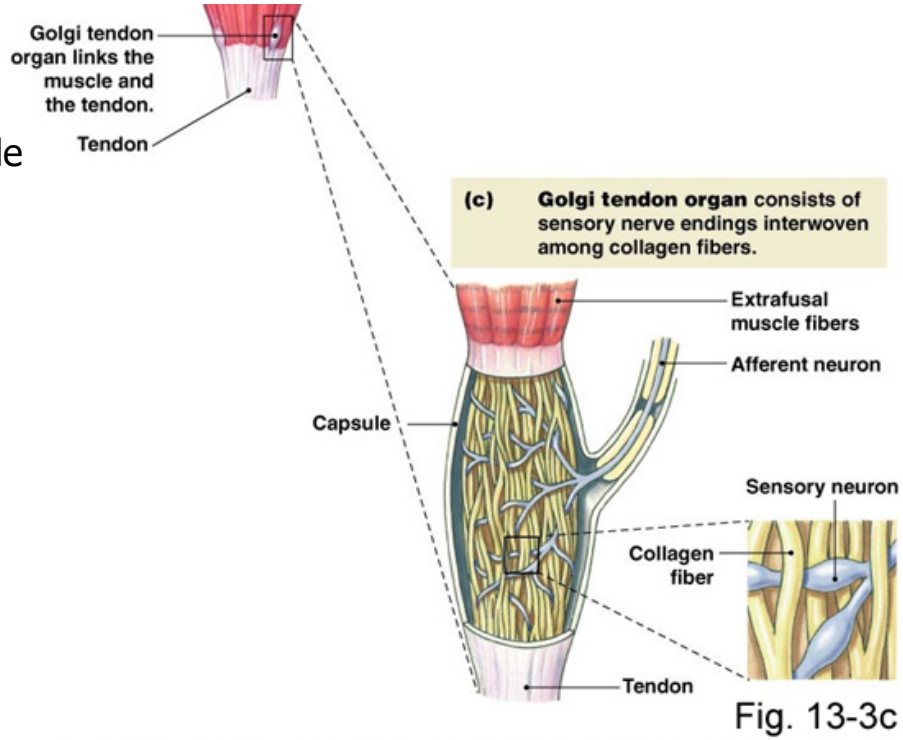


Fig. 13-3c

When the muscle generates force, the sensory terminals are compressed. This stretching deforms the terminals of the Ib afferent axon, opening stretch-sensitive cation channels. As a result, the Ib axon is depolarized and fires nerve impulses that are propagated to the spinal cord. The action potential frequency signals the force being developed by the 10 to 20 motor units within the muscle. This is representative of whole muscle force.

Golgi tendon reflex protects the muscle from excessively heavy loads by causing the muscle to relax and drop the load.

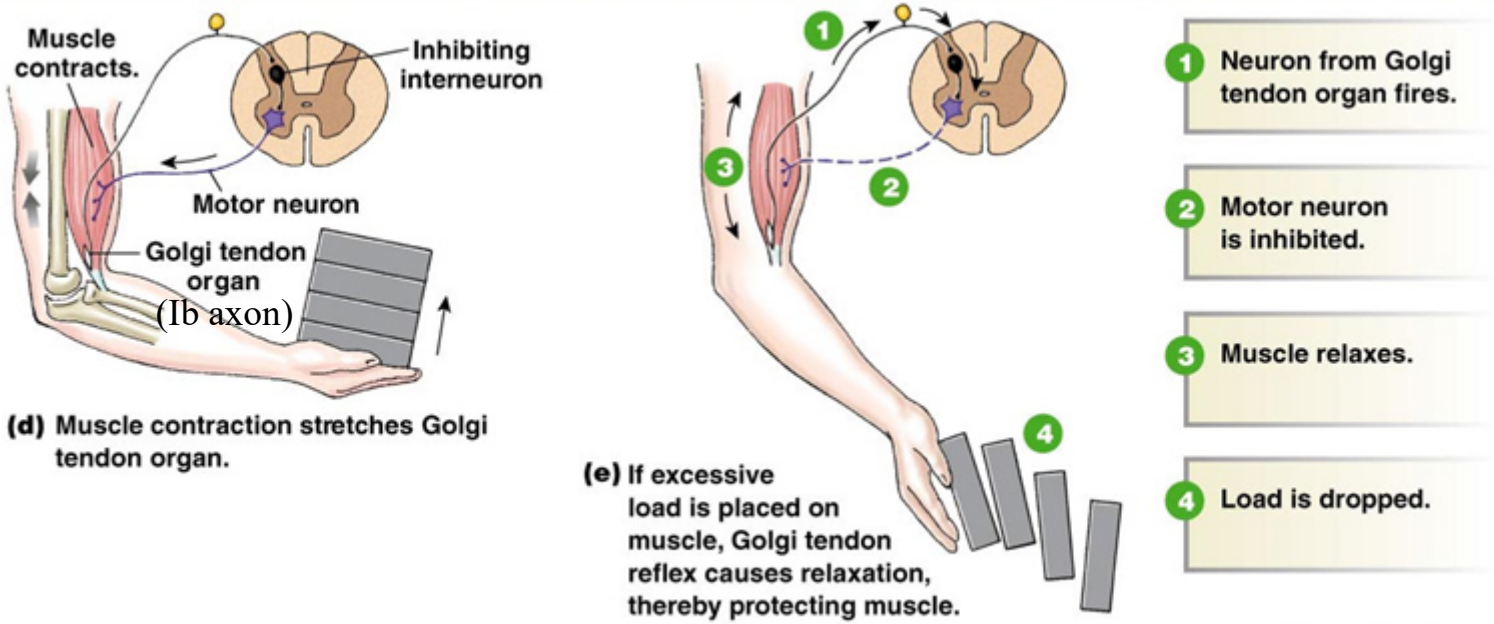
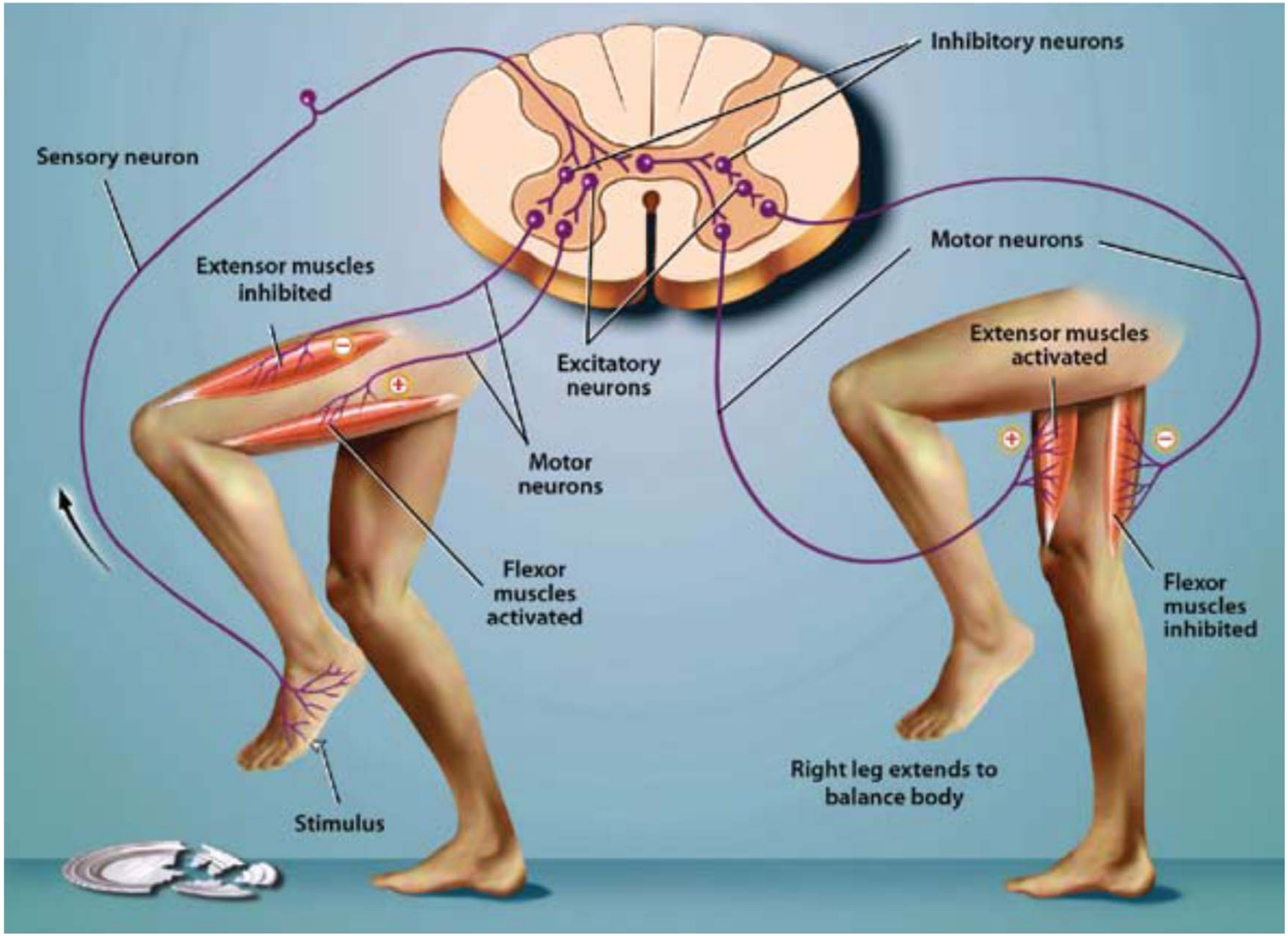


Fig. 13-6b

flexion withdrawal: crossed extension reflex in the opposite leg



Integration of voluntary movements

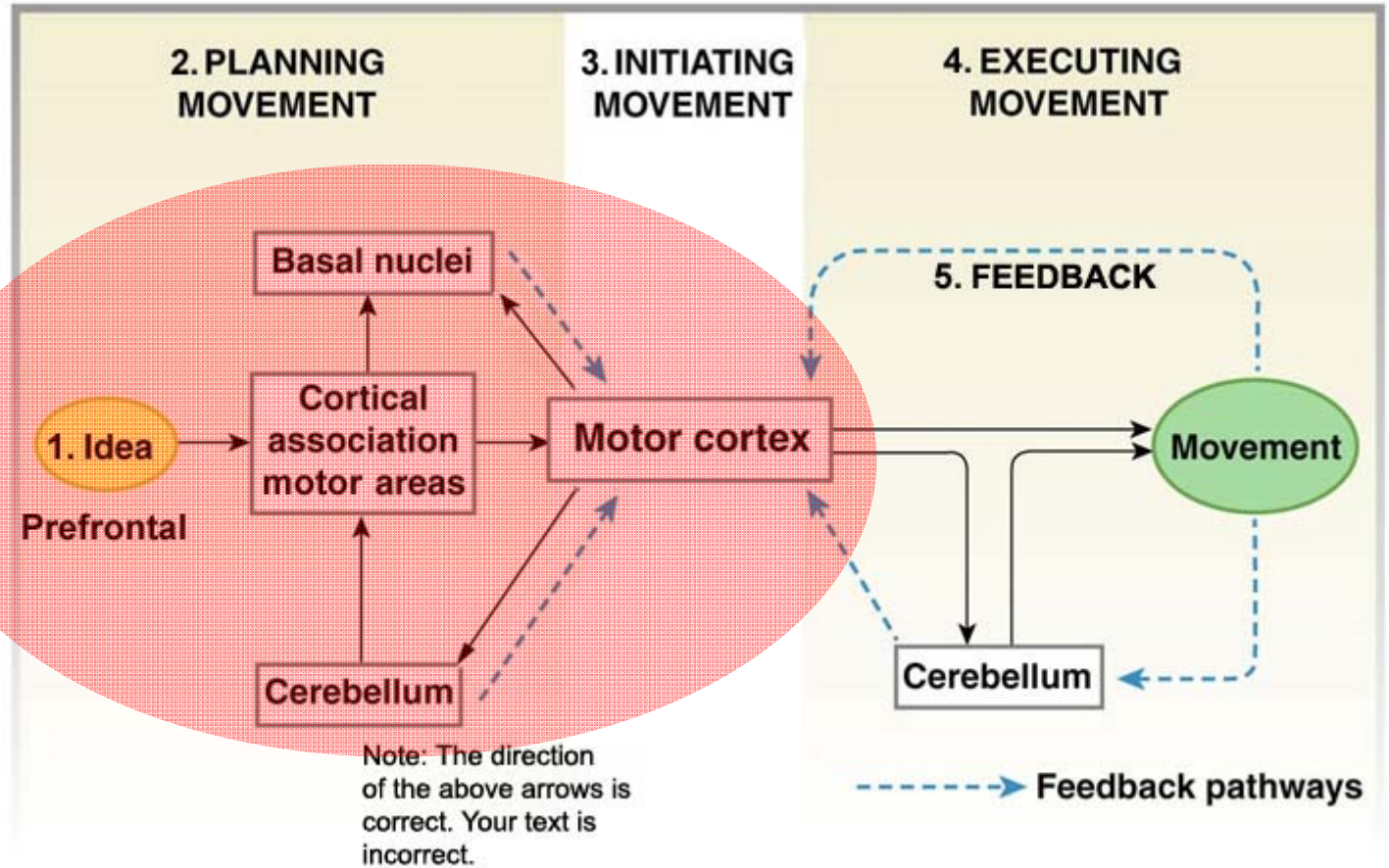
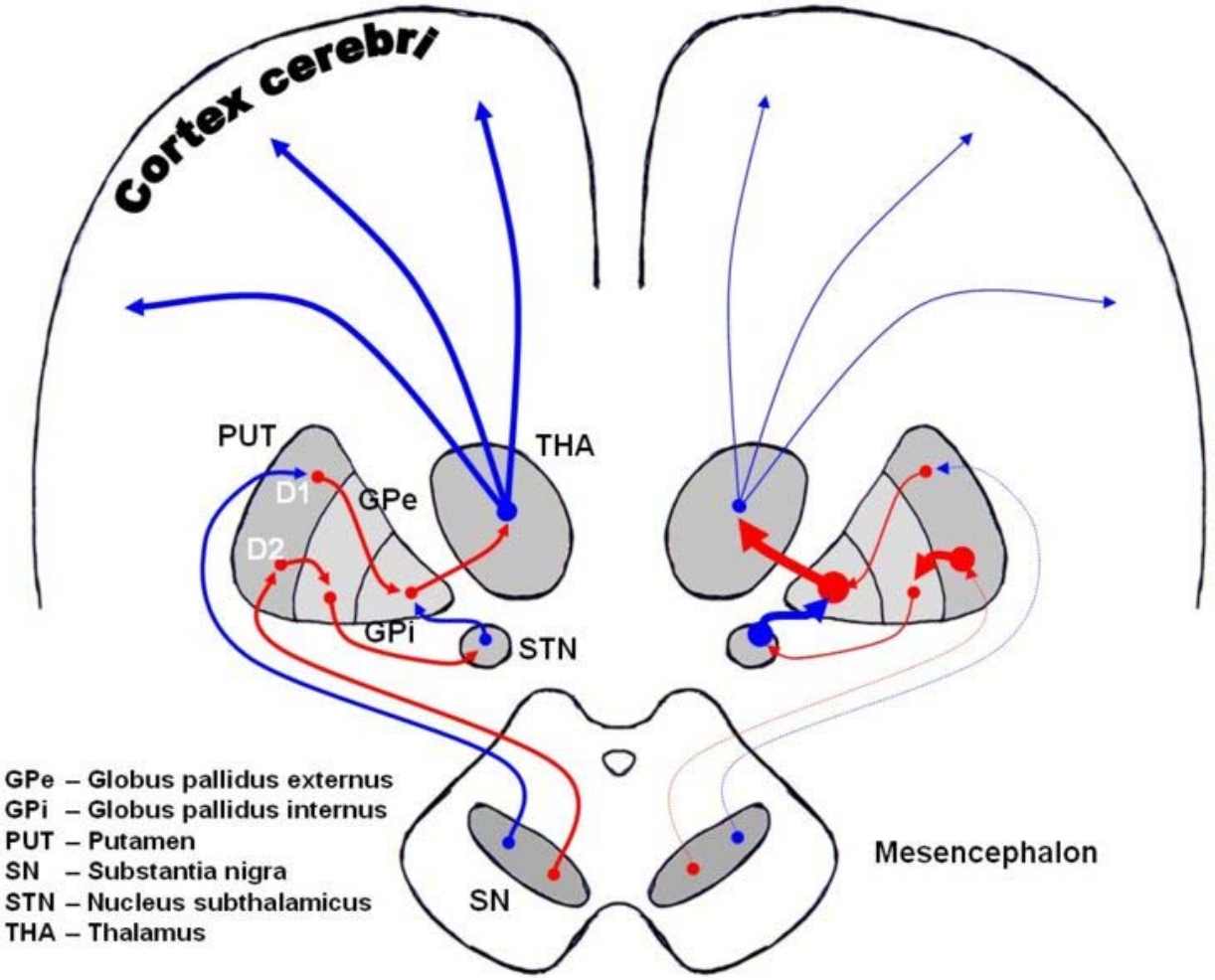
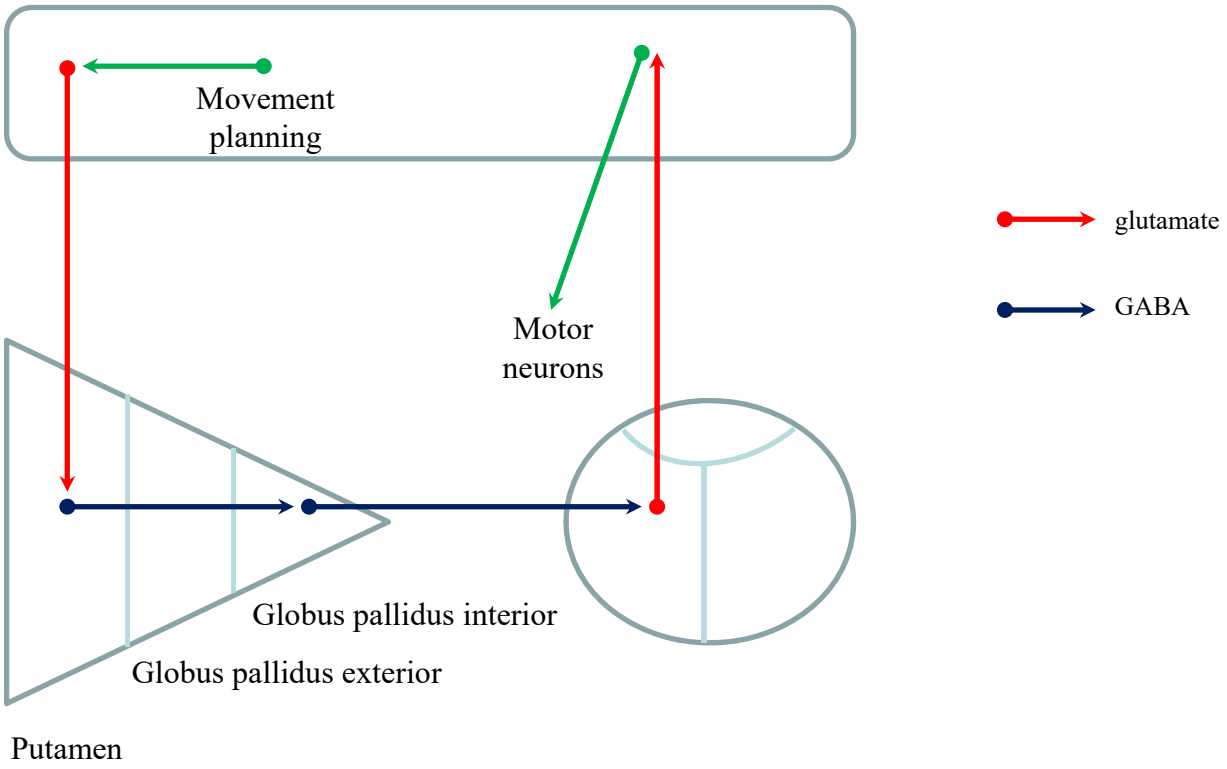


Fig. 13-10

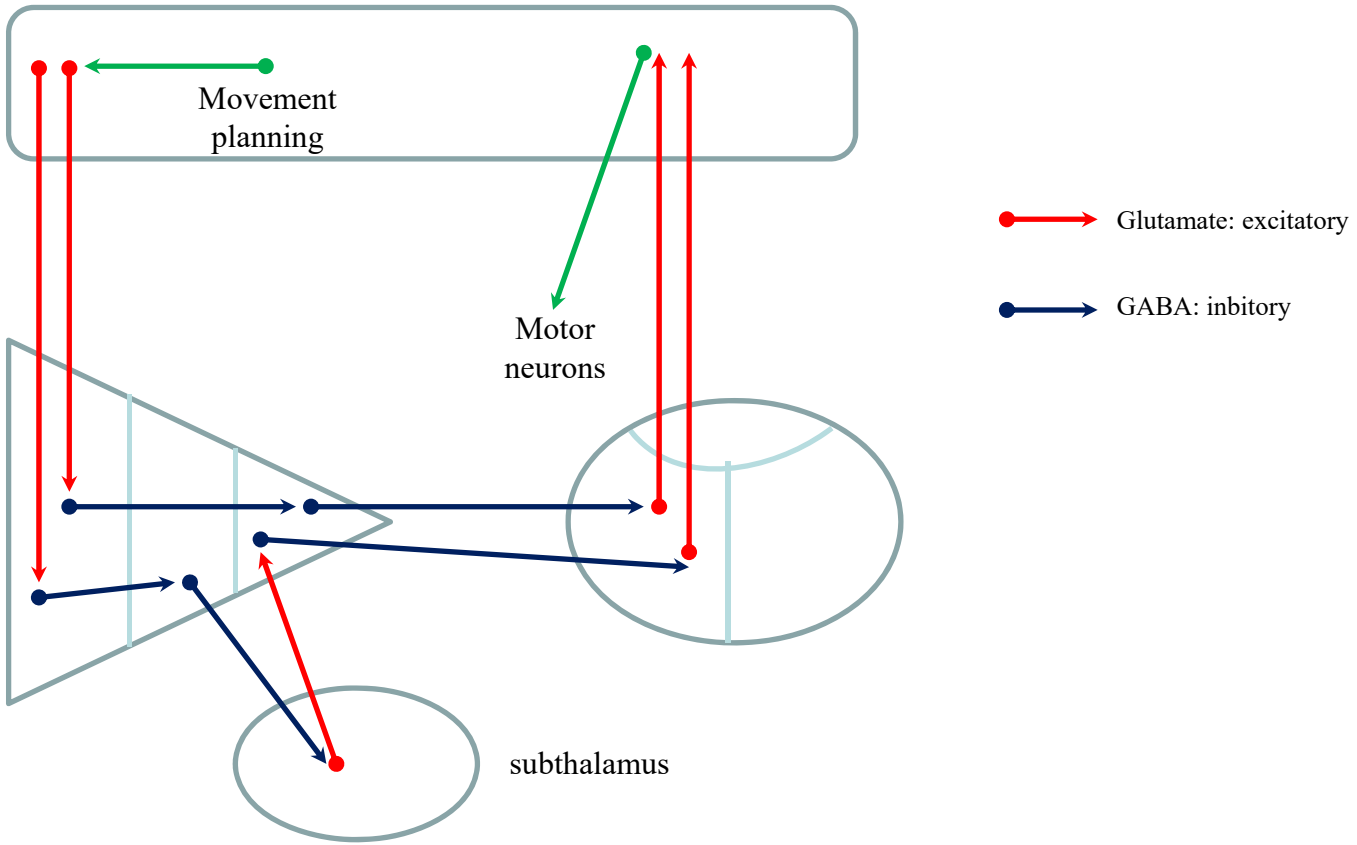


The image shows dopaminergic pathways of the human brain in normal condition (left) and Parkinsons Disease (right). Red Arrows indicate suppression of the target, blue arrows indicate stimulation of target structure

Direct pathway (Utube: Dr. Najeeb)



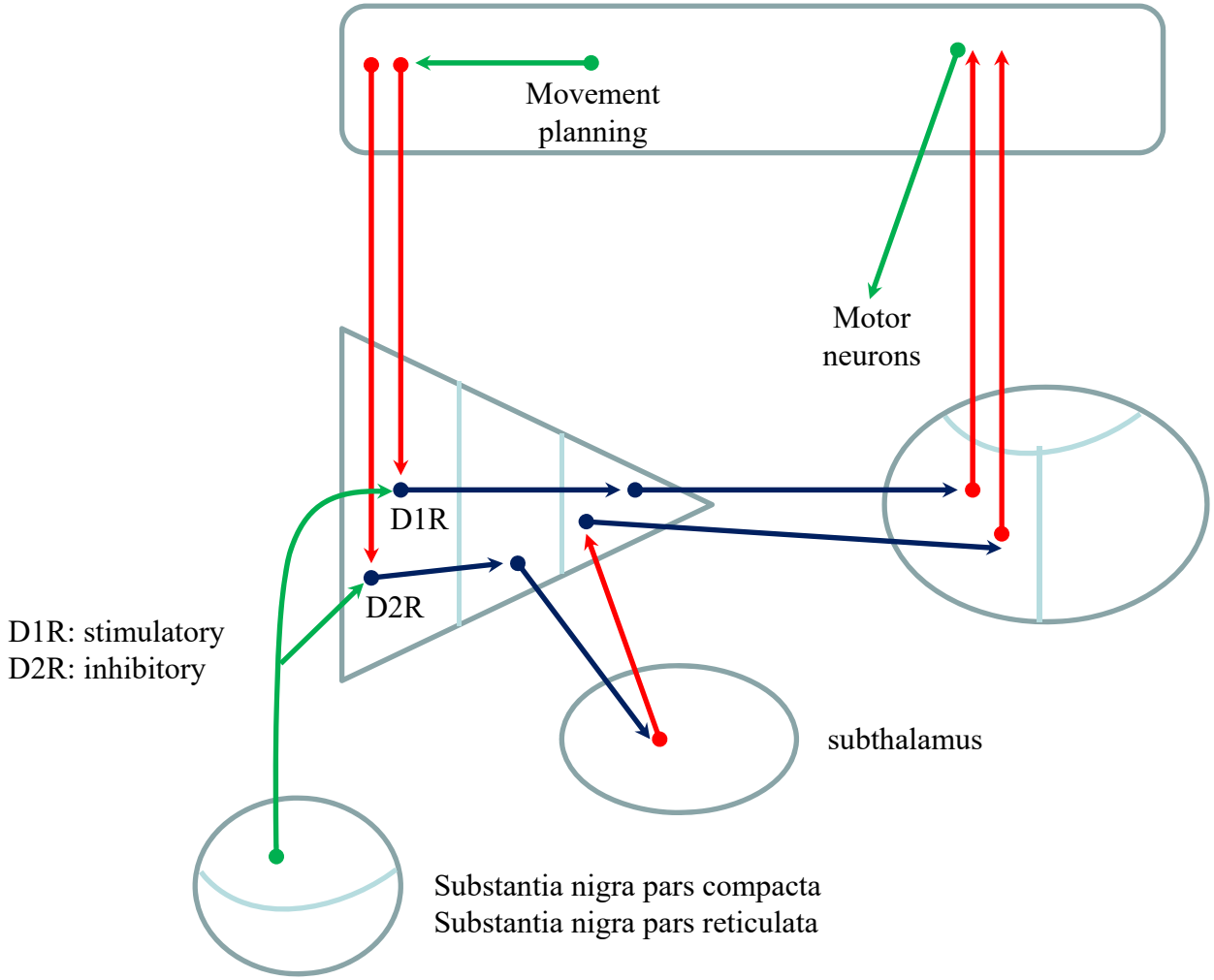
Indirect pathway



The direct and indirect pathways are therefore antagonist in their functions

Modulatory role of substantia nigra

The antagonistic functions of the direct and indirect pathways are modulated by the substantia nigra pars compacta (SNc), which produces dopamine.

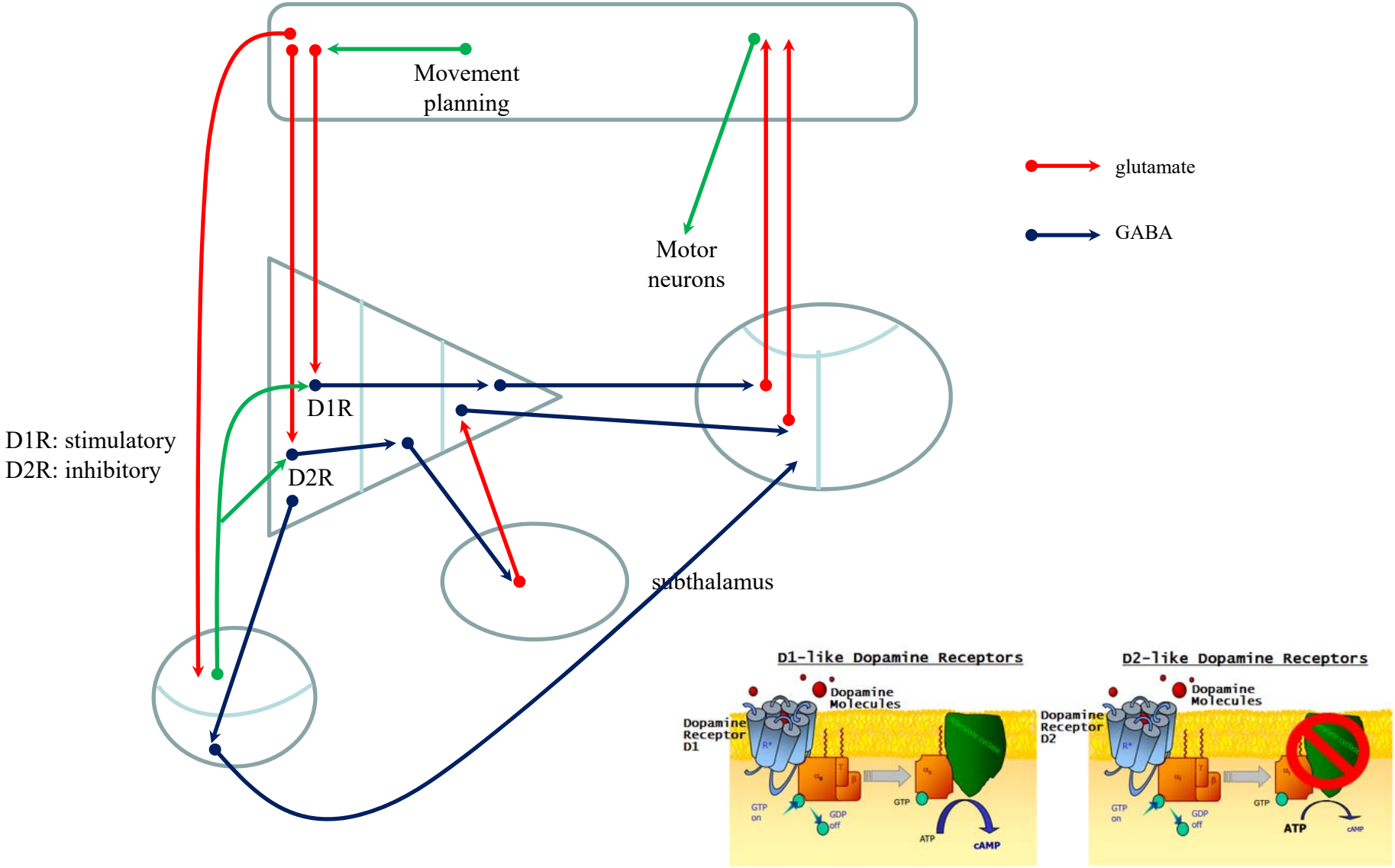


The antagonistic functions of the direct and indirect pathways are modulated by dopamine. In the presence of dopamine, D1R stimulate the GABA neurons, favoring the direct pathway, and thus increasing movement.

In the presence of dopamine, D2R inhibit GABA neurons, which reduces the indirect pathways inhibitory effect.

Dopamine therefore increases the excitatory effect of the direct pathway (causing movement) and reduces the inhibitory effect of the indirect pathway (preventing full inhibition of movement).

Modulatory role of substantia nigra



Play soccer with robot