SN4: sistemas perceptuales
sistema motor
percepción y acción

Sistemas sensoriales

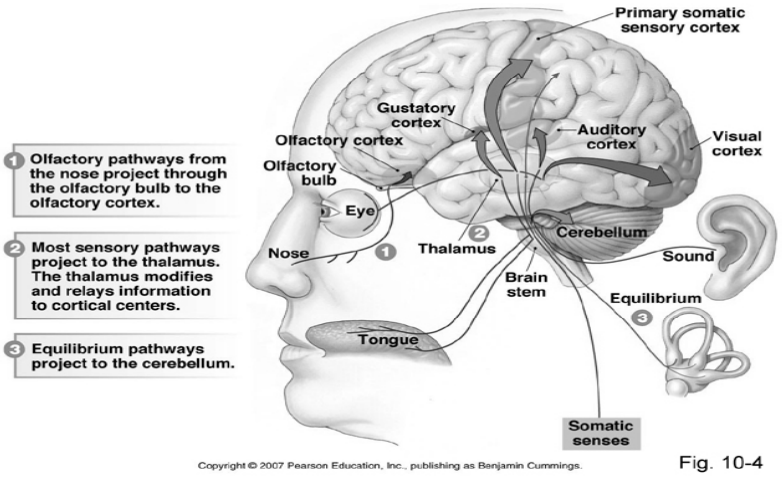
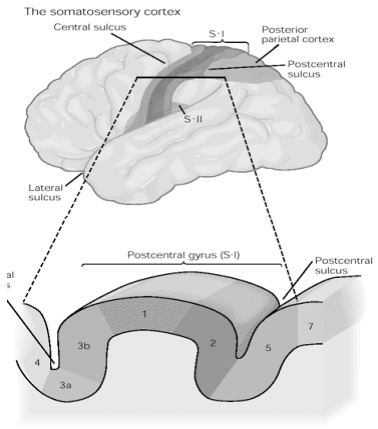


Fig. 10-4

Main types of sensory modalities

Sensory modality	Form of energy	Receptor organ	Receptor cell
Chemical			
common chemical	molecules	various	free nerve endings
arterial oxygen	O_2 tension	carotid body	cells and nerve endings
toxins (vomiting)	molecules	medulla	chemoreceptor cells
osmotic pressure	osmotic pressure	hypothalamus	osmoreceptors
glucose	glucose	hypothalamus	glucoreceptors
pH (cerebrospinal fluid)	ions	medulla	ventricle cells
Taste	ions and molecules	tongue and pharynx	taste bud cells
Smell	molecules	nose	olfactory receptors
Somatosensory			
touch	mechanical	skin	nerve terminals
pressure	mechanical	skin and deep tissue	encapsulated nerve endings
heat and cold	temperature	skin, hypothalamus	nerve terminals and central neurons
pain	various	skin and various organs	nerve terminals
Muscle			
vascular pressure	mechanical	blood vessels	nerve terminals
muscle stretch	mechanical	muscle spindle	nerve terminals
muscle tension	mechanical	tendon organs	nerve terminals
joint position	mechanical	joint capsule and ligaments	nerve terminals
Balance			
linear acceleration (gravity)	mechanical	vestibular organ	hair cells
angular acceleration	mechanical	vestibular organ	hair cells
Hearing	mechanical	inner ear (cochlea)	hair cells
Vision	electromagnetic (photons)	eye (retina)	photoreceptors



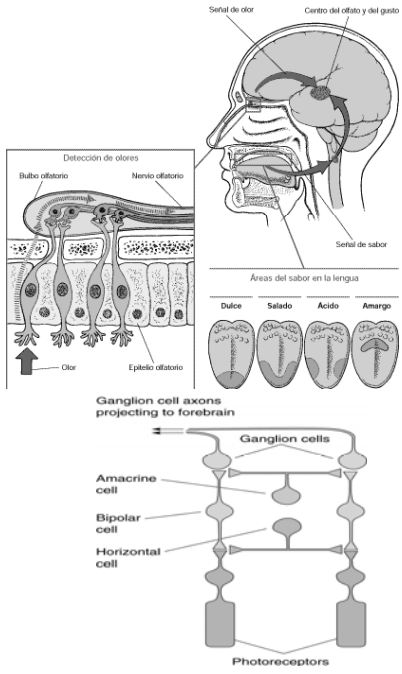
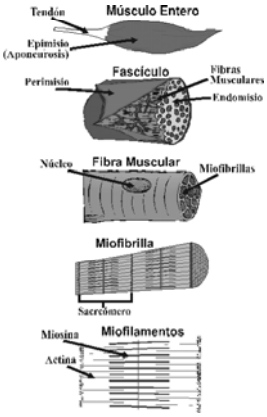
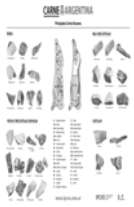


Figure 20-1 The neural architecture of the somatosensory system.
Top: A lateral view of a cerebral hemisphere illustrates the location of the primary somatic sensory cortices in the parietal lobe. The somatic sensory cortex has three major divisions: the primary (S-I) and secondary (S-II) somatosensory cortices and the posterior parietal cortex. The relationship of S-I to S-II and to the posterior parietal cortex is seen best from a lateral perspective of the surface of the cerebral cortex. Bottom: A section shows the four distinct cytoarchitectonic regions of S-I (Brodmann's areas 3a, 3b, 1, and 2) and their spatial relationship to area 4 of the motor cortex and areas 5 and 7 of the posterior parietal cortex.

Sistema motor





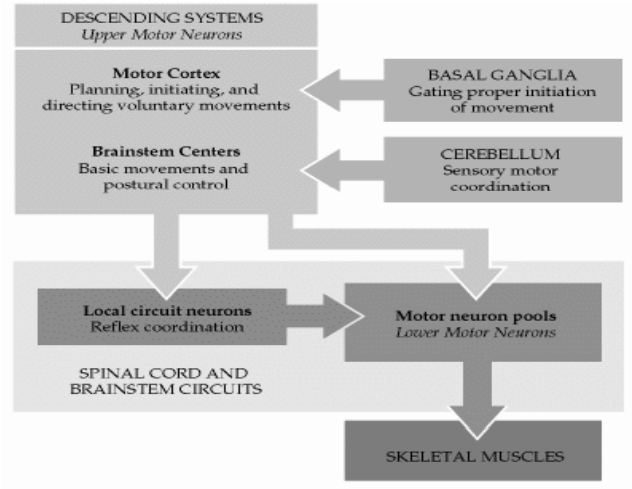
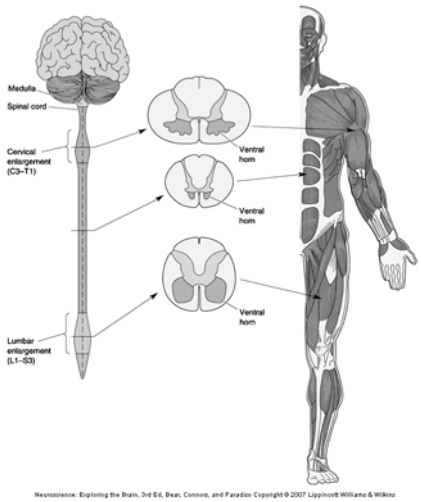
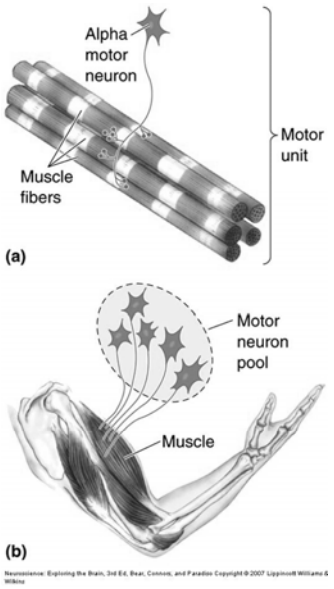
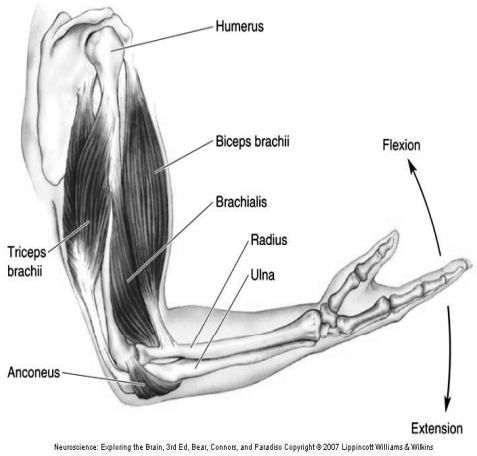
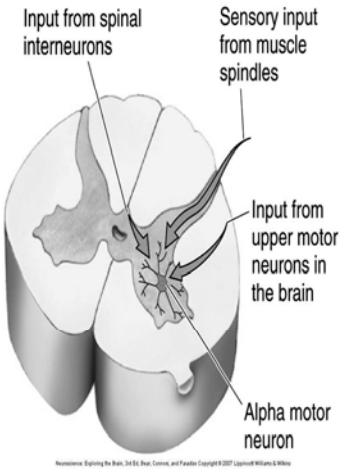


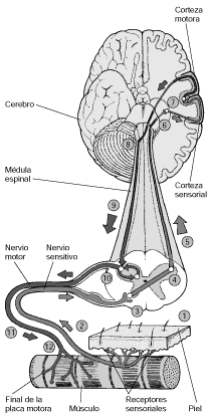
Figure 16.1. Overall organization of neural structures involved in the control of movement. Four systems—local spinal cord and brainstem circuits, descending modulatory pathways, the basal ganglia, and the cerebellum—make essential and distinct contributions to motor control.


Medulla
Spinal cord
Cervical enlargement (C3–T1)
Lumbar enlargement (L1–S3)
Ventral horn
Ventral horn
Ventral horn

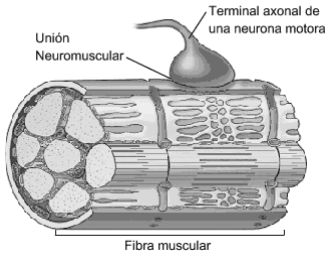

Alpha motor neuron
Motor unit
Muscle fibers
(a)
Motor neuron pool
Muscle
(b)


Humerus
Biceps brachii
Brachialis
Radius
Ulna
Triceps brachii
Anconeus
Flexion
Extension


Input from spinal interneurons
Sensory input from muscle spindles
Input from upper motor neurons in the brain
Alpha motor neuron



Mecanismo molecular de la contracción neuromuscular



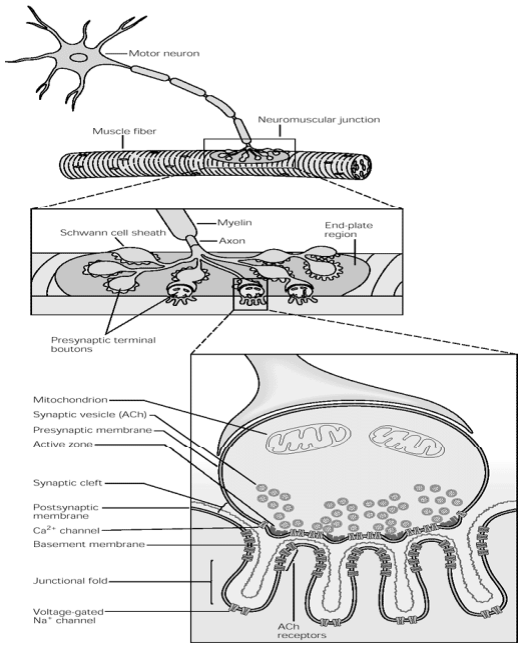


Figure 11-1 The neuromuscular junction is readily visible with the light microscope. At the muscle the motor axon ramifies into several fine branches approximately 2 µm thick. Each branch forms multiple swellings called presynaptic boutons, which are covered by a thin layer of Schwann cells.

The boutons lie over a specialized region of the muscle fiber membrane, the *end-plate, and are separated from the muscle membrane by a 100 nm synaptic cleft. Each presynaptic bouton contains mitochondria and synaptic vesicles clustered around active zones, where the acetylcholine (ACh) transmitter is released. Immediately under each bouton in the end-plate are several junctional folds, which contain a high density of ACh receptors at their crests. The muscle fiber is covered by a layer of connective tissue, the basement membrane (or basal lamina), consisting of collagen and glycoproteins. Both the presynaptic terminal and the muscle fiber secrete proteins into the basement membrane, including the enzyme acetylcholinesterase, which inactivates the ACh released from the presynaptic terminal by breaking it down into acetate and choline. The basement membrane also organizes the synapse by aligning the presynaptic boutons with the postsynaptic junctional folds. (Adapted in part from McMahan and Kuffler 1971.)*

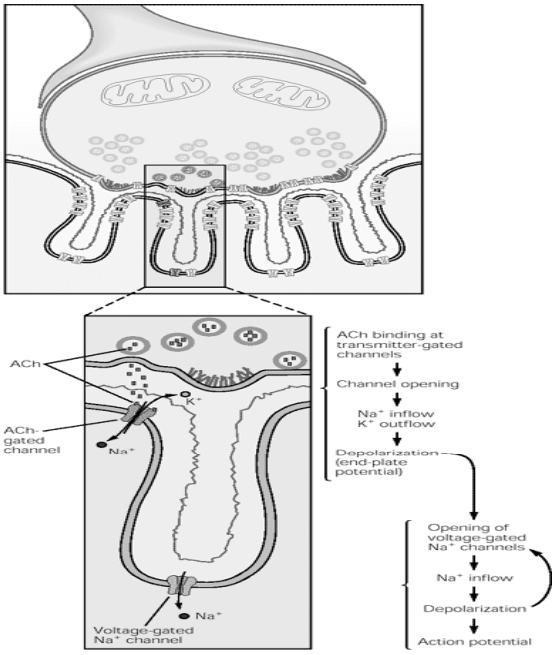


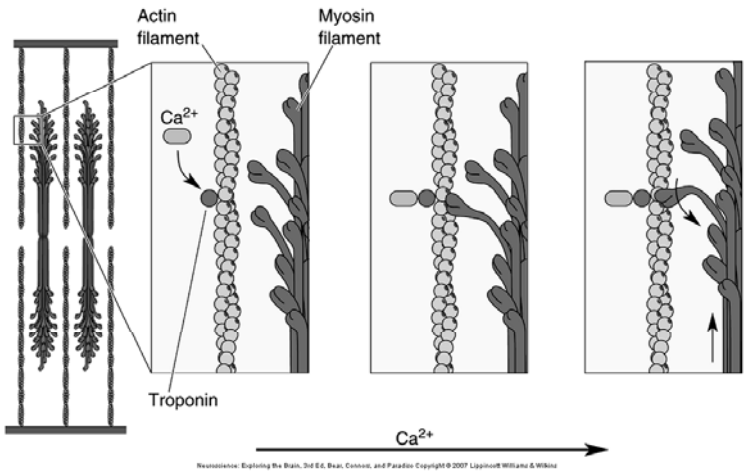
Figure 11-12 The binding of ACh in a postsynaptic muscle cell opens channels permeable to both Na+ and K+.

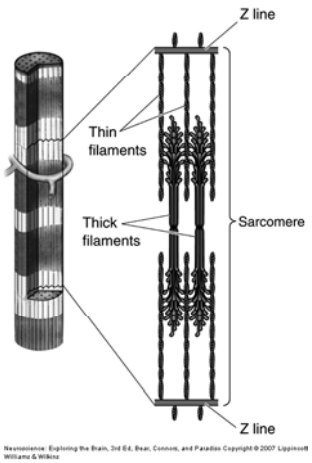
The flow of these ions into and out of the cell depolarizes the cell membrane, producing the end-plate potential. This depolarization opens neighboring voltage-gated Na+ channels in the muscle cell. To trigger an action potential, the depolarization produced by the end-plate potential must open a sufficient number of Na+ channels to exceed the cell's threshold. (After Alberts et al. 1989.)

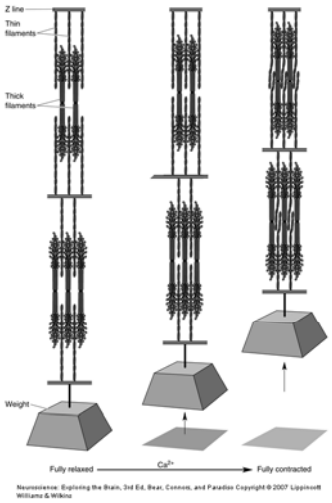
Excitation-Contraction Coupling

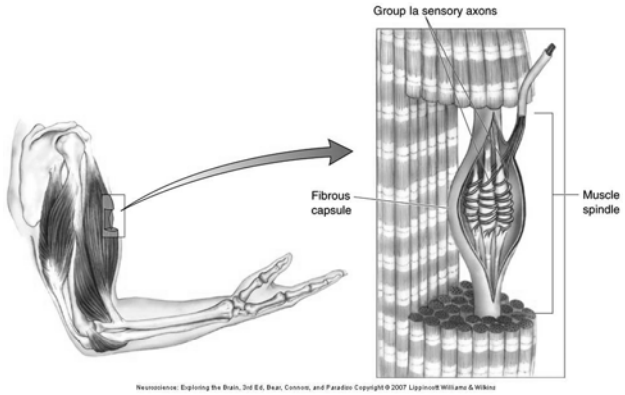
Muscle contraction

- Alpha motor neurons release Ach
- ACh produces large EPSP in muscle fibers (via nicotinic Ach receptors
- EPSP evokes action potential
- Action potential (excitation) triggers Ca2+ release, leads to fiber contraction
- Relaxation, Ca2+ levels lowered by organelle reuptake


Actin filament
Myosin filament
Ca^{2+}
Troponin
Ca^{2+}


Z line
Thin filaments
Thick filaments
Sarcomere
Z line


Z line
Thin filaments
Thick filaments
Weight
Fully relaxed
Ca^{2+}
Fully contracted



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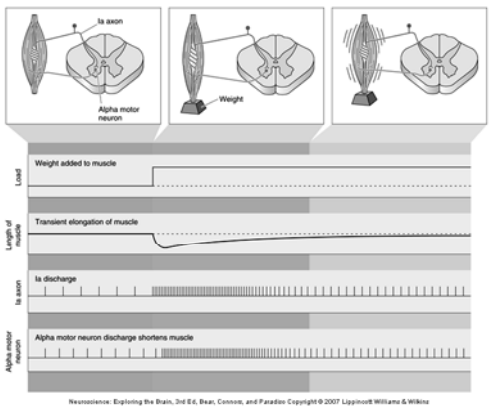

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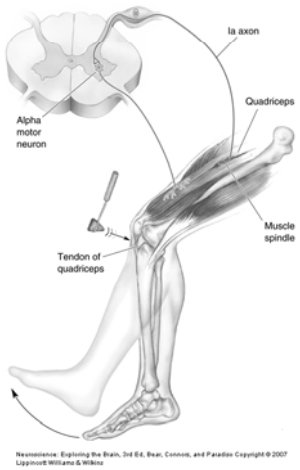

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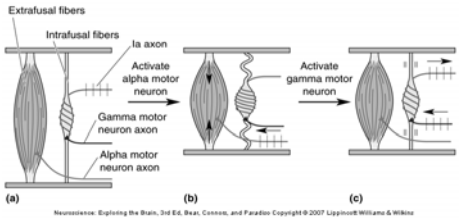
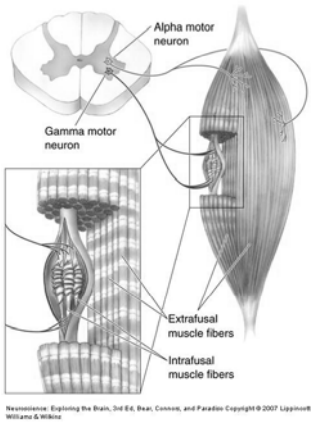
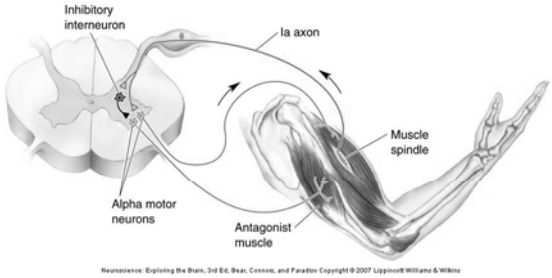
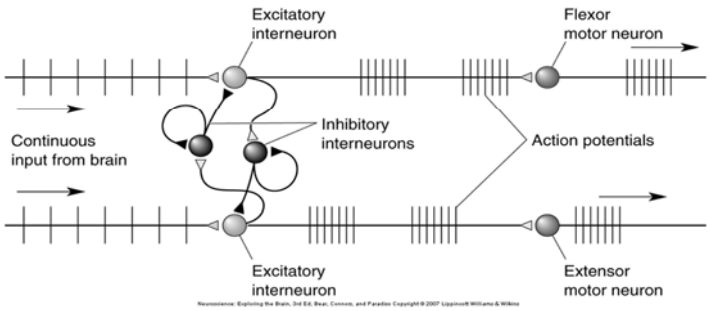
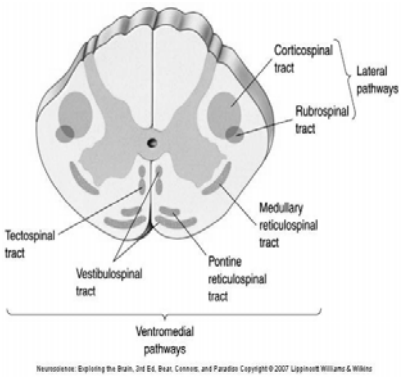

Extrafusal fibers
Intrafusal fibers
Ia axon
Activate alpha motor neuron
Gamma motor neuron axon
Alpha motor neuron axon
Activate gamma motor neuron
(a)
(b)
(c)


Alpha motor neuron
Gamma motor neuron
Extrafusal muscle fibers
Intrafusal muscle fibers


Inhibitory interneuron
Ia axon
Muscle spindle
Alpha motor neurons
Antagonist muscle


Excitatory interneuron
Flexor motor neuron
Continuous input from brain
Inhibitory interneurons
Action potentials
Excitatory interneuron
Extensor motor neuron



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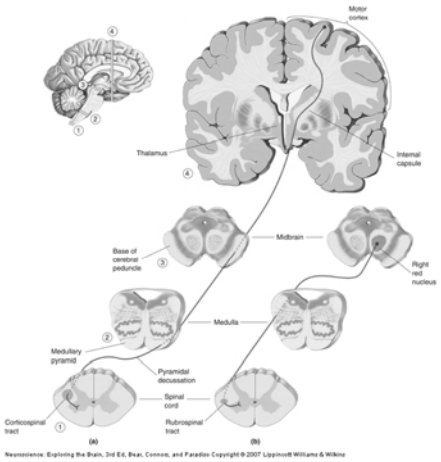

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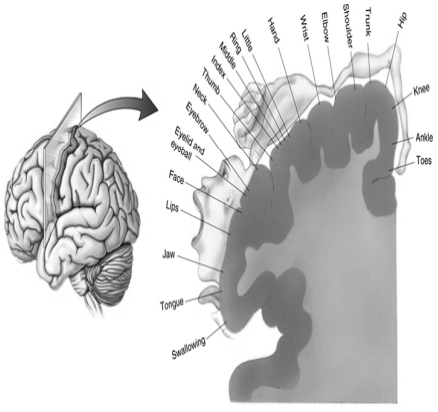

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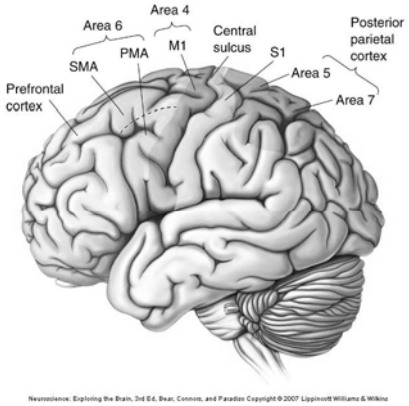

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Diseases Affecting the Motor System

- Amyotrophic Lateral Sclerosis (ALS)
  -motor neuron disease
- Duchenne Muscular Dystrophy
  -dystrophin deficit
- Myasthenia Gravis
  -autoimmune ACh receptors
- Parkinson's disease
  - DA neurons in substantia nigra

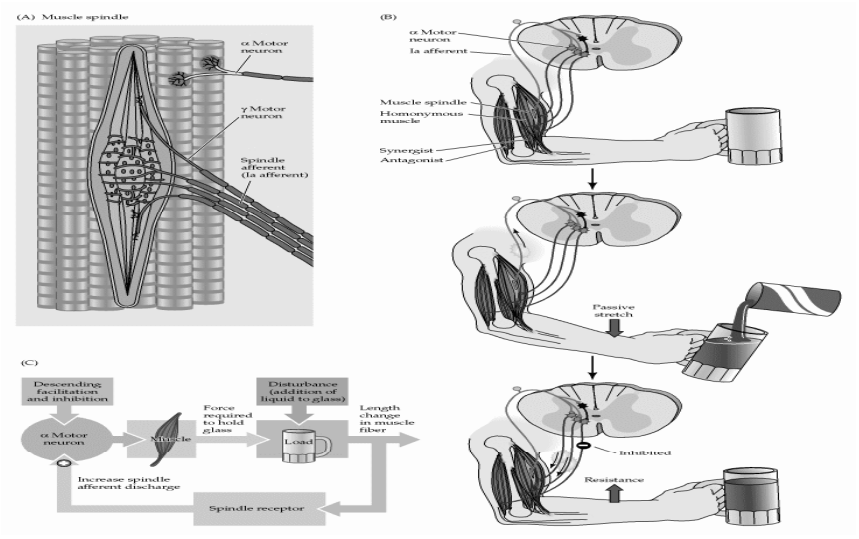
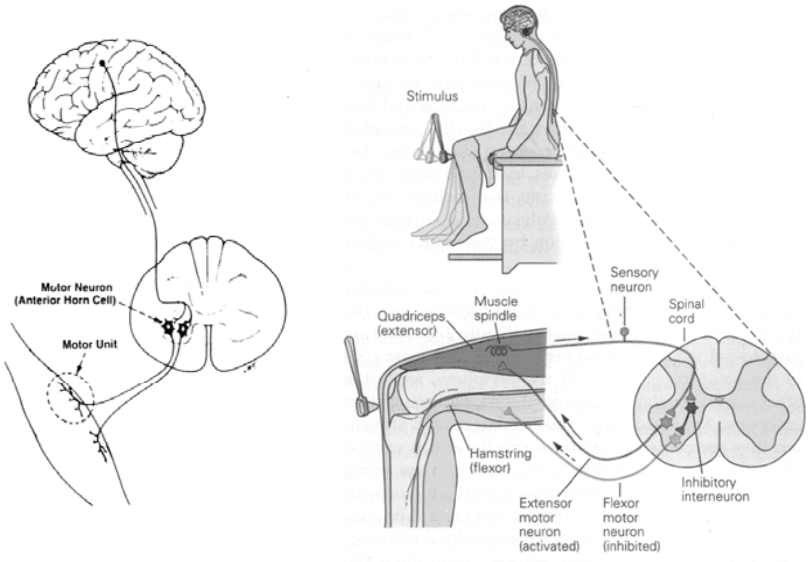
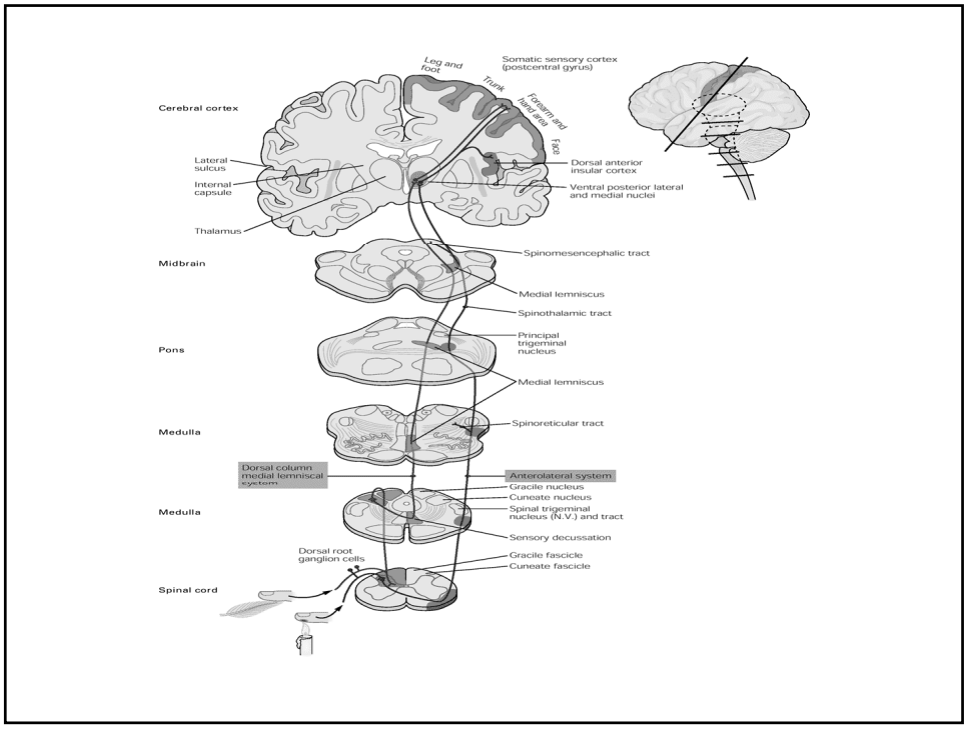
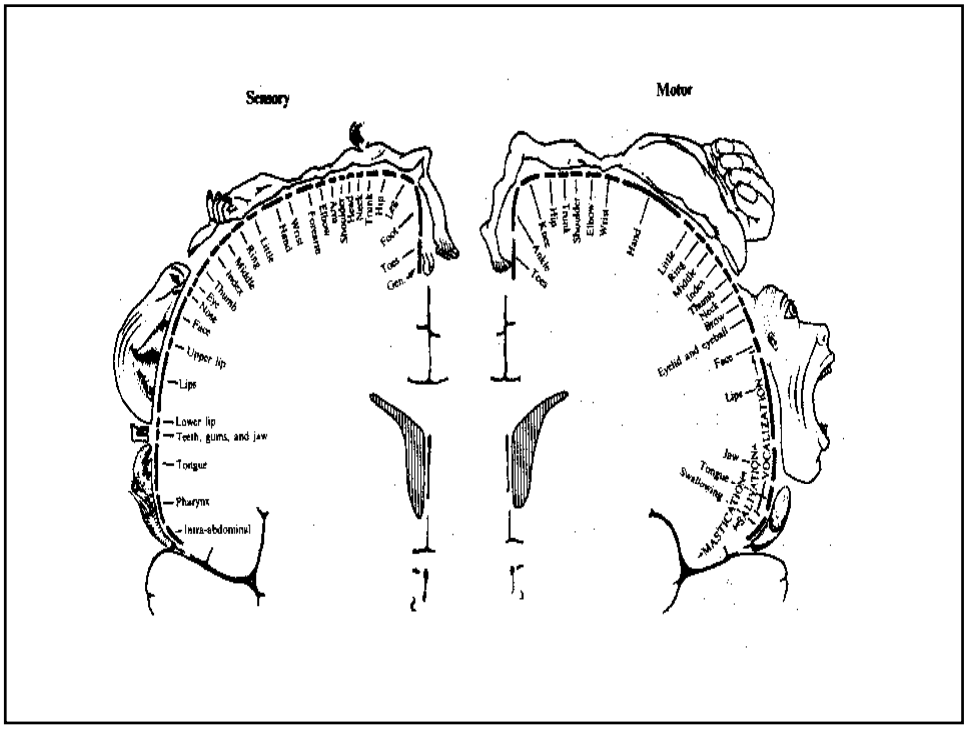
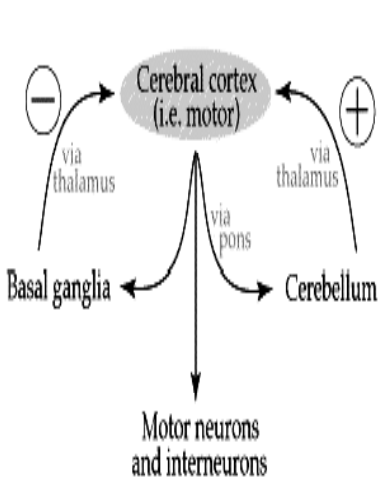


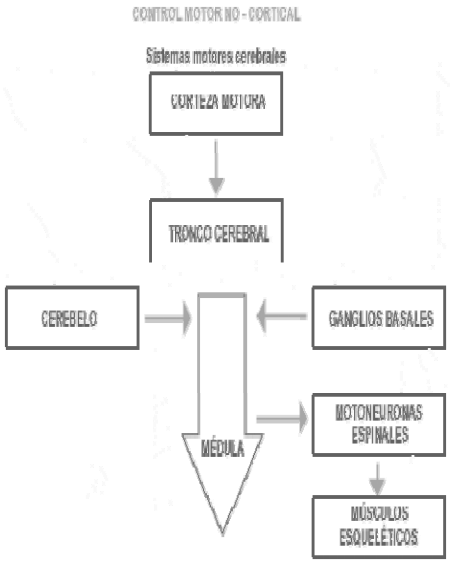
Figure 16.9. Stretch reflex circuitry. (A) Diagram of muscle spindle, the sensory receptor that initiates the stretch reflex. (B) Stretching a muscle spindle leads to increased activity in Ia afferents and an increase in the activity of α motor neurons that innervate the same muscle. Ia afferents also excite the motor neurons that innervate synergistic muscles, and inhibit the motor neurons that innervate antagonists (see also Figure 1.5). (C) The stretch reflex operates as a negative feedback loop to regulate muscle length.

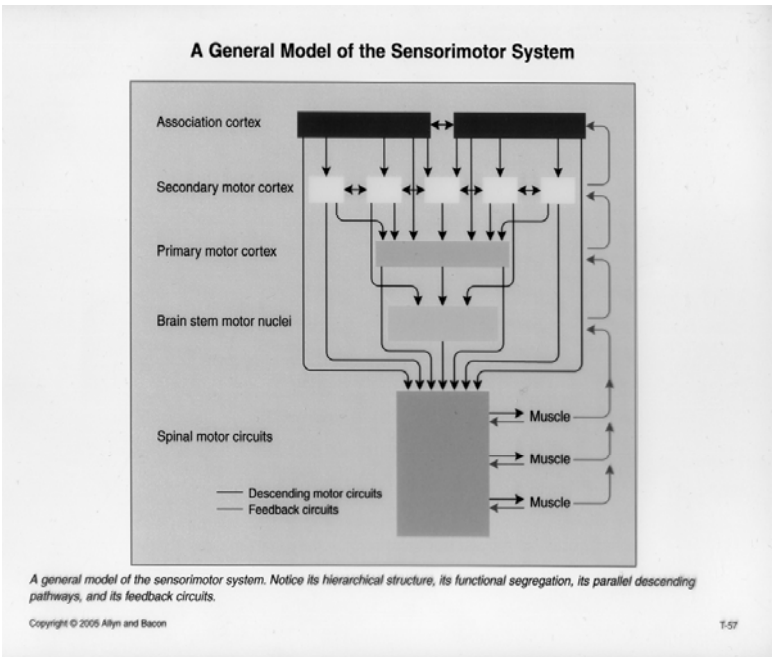



Cerebral cortex
Midbrain
Pons
Medulla
Medulla
Spinal cord
Leg and foot
Trunk
Forearm and hand
Face
Somatic sensory cortex (postcentral gyrus)
Lateral sulcus
Internal capsule
Thalamus
Dorsal anterior insular cortex
Ventral posterior lateral and medial nuclei
Spinomesencephalic tract
Medial lemniscus
Spinothalamic tract
Principal trigeminal nucleus
Medial lemniscus
Spinoreticular tract
Dorsal column medial lemniscal system
Anterolateral system
Gracile nucleus
Cuneate nucleus
Spinal trigeminal nucleus (N.V.) and tract
Sensory decussation
Dorsal root ganglion cells
Gracile fascicle
Cuneate fascicle


Sensory
Motor
Face
Upper lip
Lips
Lower lip
Teeth, gums, and jaw
Tongue
Pharynx
Intra-abdominal
Toes
Foot
Leg
Hip
Trunk
Shoulder
Elbow
Wrist
Hand
Little
Ring
Middle
Index
Thumb
Neck
Brow
Eyelid and eyeball
Jaw
Swallowing
MASTICATION
VOCALIZATION


Cerebral cortex
(i.e. motor)
via
thalamus
via
thalamus
via
pons
Basal ganglia
Cerebellum
Motor neurons
and interneurons


CONTROL MOTOR NO - CORTICAL
Sistemas motores cerebrales
CORTEZA MOTORA
TRONCO CEREBRAL
CEREBELO
GANGLIOS BASALES
MÉDULA
MOTONEURONAS
ESPINALES
MÚSCULOS
ESQUELÉTICOS


A General Model of the Sensorimotor System
Association cortex
Secondary motor cortex
Primary motor cortex
Brain stem motor nuclei
Spinal motor circuits
Muscle
Muscle
Muscle
Descending motor circuits
Feedback circuits
A general model of the sensorimotor system. Notice its hierarchical structure, its functional segregation, its parallel descending pathways, and its feedback circuits.
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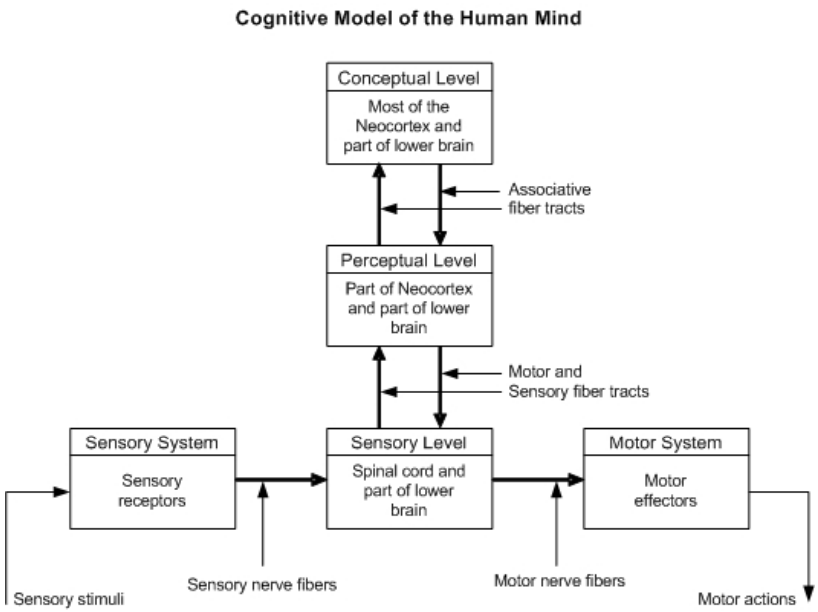
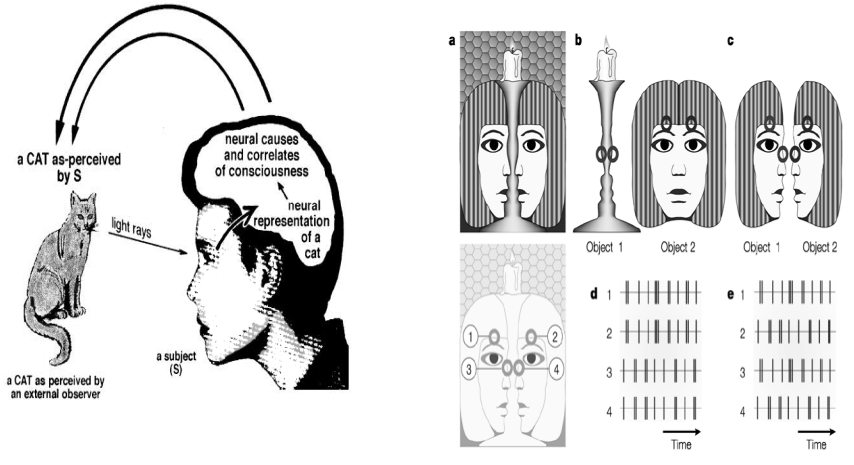
T-57





Nature Reviews | Neuroscience

Temporal binding has been suggested as a remedy to the problem of how to define dynamic functional relations between neurons in distributed sensorimotor networks. The proposal is that this 'binding problem' could be solved by exploiting the temporal aspects of neuronal activity[16, 17, 18, 40, 41, 42, 43]. The model predicts that neurons that respond to the same sensory object might fire in temporal synchrony with a precision in the millisecond range. However, no such synchronization should occur between cells that are activated by different objects in sensory space. Such a temporal integration mechanism would provide an elegant solution to the binding problem, as synchrony would selectively tag the responses of neurons that code for the same object, and demarcate their responses from those of neurons activated by other objects. This highly selective temporal structure would allow the system to establish a distinct representational pattern — an assembly[21] — for each object, and so enable figure–ground segregation. Moreover, such a temporal binding mechanism could establish relationships between neuronal responses over large distances, solving the integration problem imposed by the anatomical segregation of specialized processing areas.

Review
Nature Reviews Neuroscience 2, 704-716 (October 2001) |
doi:10.1038/35094565

Dynamic predictions: Oscillations and synchrony in top–down processing

Andreas K. Engel[1], Pascal Fries[2,3] & Wolf Singer[4]

Classical theories of sensory processing view the brain as a passive, stimulus-driven device. By contrast, more recent approaches emphasize the constructive nature of perception, viewing it as an active and highly selective process. Indeed, there is ample evidence that the processing of stimuli is controlled by top–down influences that strongly shape the intrinsic dynamics of thalamocortical networks and constantly create predictions about forthcoming sensory events. We discuss recent experiments indicating that such predictions might be embodied in the temporal structure of both stimulus-evoked and ongoing activity, and that synchronous oscillations are particularly important in this process. Coherence among subthreshold membrane potential fluctuations could be exploited to express selective functional relationships during states of expectancy or attention, and these dynamic patterns could allow the grouping and selection of distributed neuronal responses for further processing.