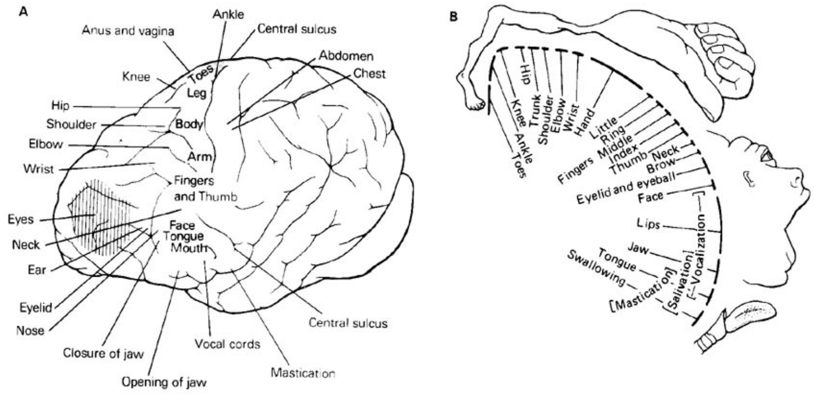
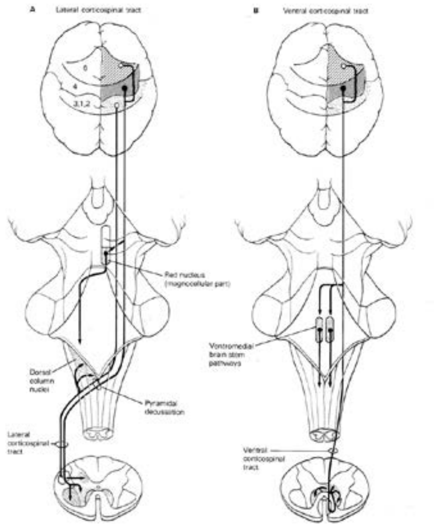
Body representation

38–1 The body is somatotopically represented in the motor cortex. **A.** Map of body representation in a lateral view of the motor cortex of the chimpanzee. The **shaded** area indicates the precentral gyrus; electrical stimulation of the region indicated by **vertical lines** produces eye movements. (Adapted from Sherrington, 1906.) **B.** Body representation in the human motor cortex. (Adapted from Penfield and Rasmussen, 1950.)

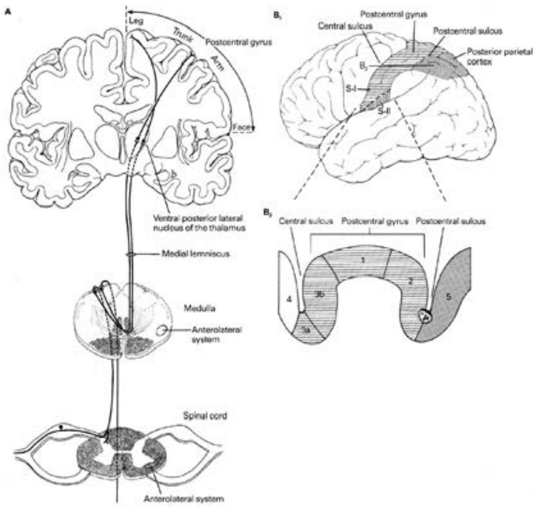


Dr. Wilder G Penfield

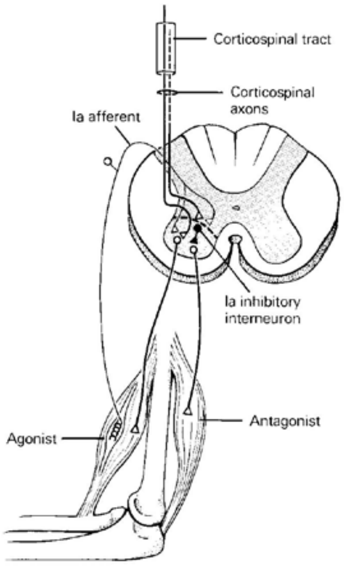
Cortico-spinal tract



Afferent system

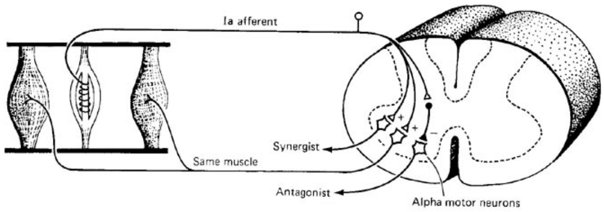


Corticospinal tract and reflex pathways



38–2 Corticospinal neurons exert inhibitory control on the Ia inhibitory interneuron.

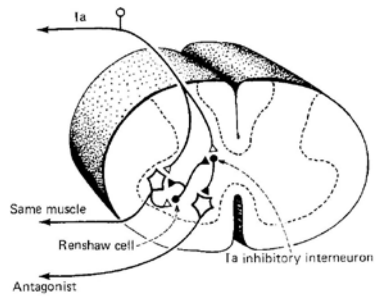
Myotatic reflex (Ia afferent)



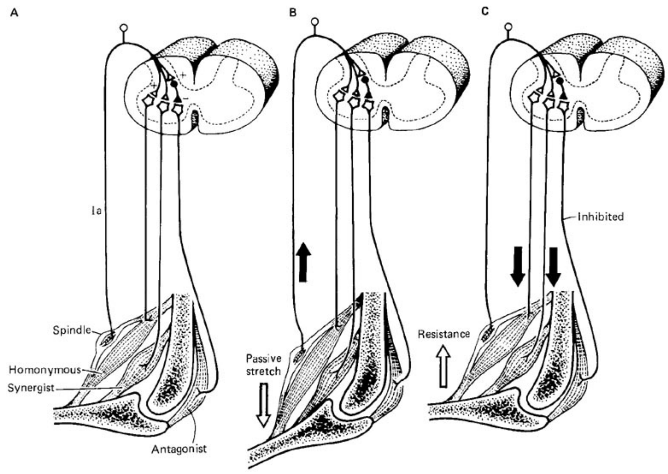
35–1 In the basic reflex circuitry for the myotatic reflex, Ia afferents monosynaptically excite motor neurons to the same (homonymous) muscle from which they arise and motor neurons to synergist muscles; they also inhibit motor neurons to antagonist muscles through an inhibitory (**black**) interneuron.

Renshaw inhibition

35–2 The elementary circuitry underlying recurrent inhibition involves the Renshaw cell, an inhibitory interneuron that is directly excited by collateral branches of spinal motor neurons; it inhibits many motor neurons, including the one that gave rise to its input. It disinhibits antagonist motor neurons by inhibiting Ia inhibitory interneurons.



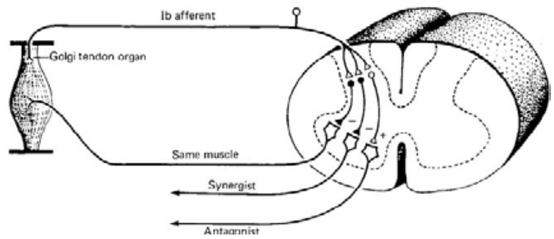
Synergists and antagonists



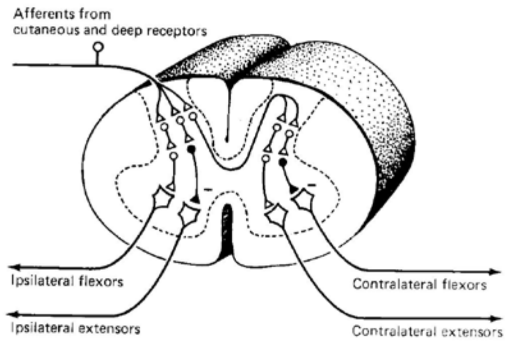
35–3 The role of Ia afferent fibers in the stretch reflex is exemplified by this reflex of flexor muscles. **A.** The connections of the Ia afferents excite the homonymous and synergist muscles and inhibit the antagonist muscles. **B.** Passive stretch of the limb (**open arrow**) gives rise to an increased Ia fiber discharge (**solid arrow**). **C.** The Ia fiber discharge causes homonymous and synergist alpha motor neurons to fire (**solid arrows**), producing resistance to the stretch (**open arrow**). (Figure adapted from Merton, 1972.)

Tendon reflex (Ib afferent)

35–4 All connections of the Ib afferent fibers to motor neurons are through interneurons. In the reflex mediated by the Ib afferent system, inhibitory interneurons (**black**) inhibit motor neurons to the muscle of origin and its synergists, and excitatory interneurons excite the antagonists.



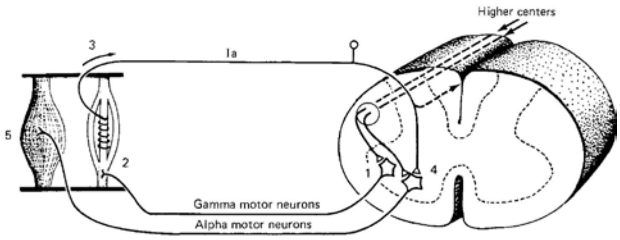
Reflex of cutaneous and deep receptors



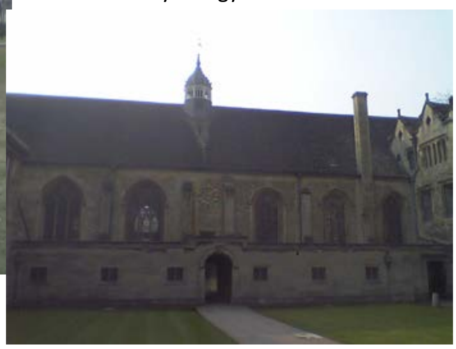
35–11 The basic circuitry for reflexes of cutaneous and deep receptor origin usually leads to ipsilateral flexion and contralateral extension via a network of excitatory and inhibitory interneurons.

Gamma motor neurons

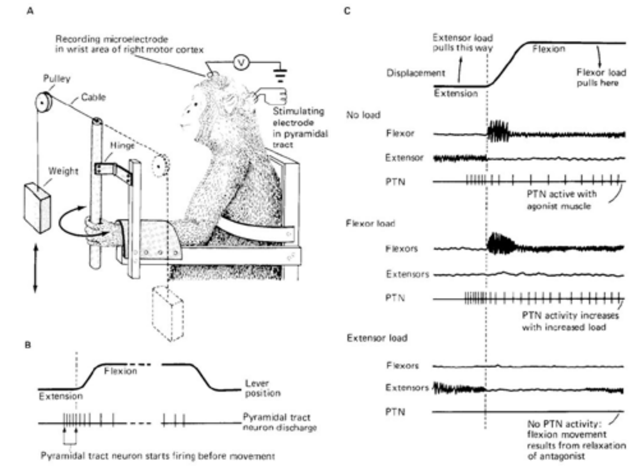
35–5 Alpha motor neurons can be activated via the gamma loop. The gamma motor neuron is activated by input from higher centers **(1)**, producing shortening of the spindle **(2)**, which gives rise to an increase in Ia fiber discharge **(3)**, which in turn increases the alpha motor neuron output **(4)**, thereby producing contraction of the extrafusal muscle **(5)**.



Sir Charles Sherrington
The Nobel Prize
in Physiology or Medicine 1932

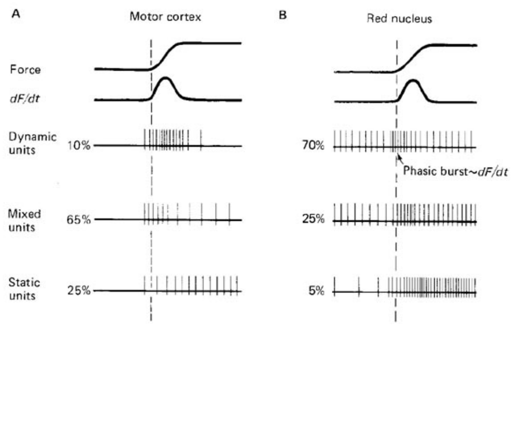


Experimental set-up



38–3 This experiment demonstrated that activity of motor cortical neurons reflects the direction of force exerted. **A.** Setup for recording discharge of specific pyramidal tract neurons in the motor cortex while awake monkey alternately flexes and extends its wrist. **B.** Pyramidal tract neuron starts firing before movement **(arrows)**. **C.** Records of a pyramidal tract neuron **(PTN)** that increases its activity with flexion of the wrist. Flexor and extensor electromyograms and pyramidal tract neuron discharge records are shown under different load conditions. Absence of neuronal activity with extensor load indicates that the neuronal output codes for force rather than displacement. (Adapted from Evarts, 1968.)

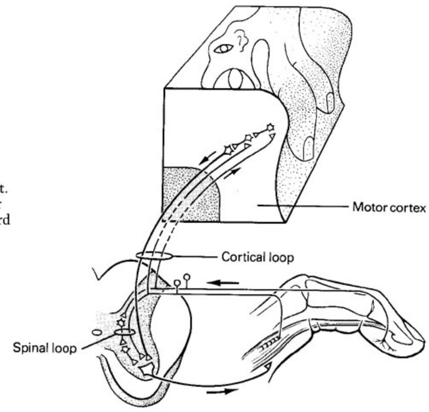
Activity of motor cortical neurons



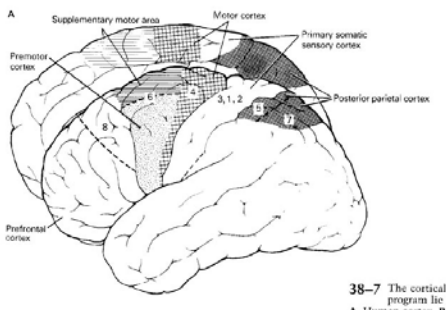
38–4 Dynamic, static, and mixed neurons are distinguished by their patterns of activity in the cat during voluntary isometric contraction. **A.** Recordings from the motor cortex. **B.** Recordings from rubrospinal neurons in the red nucleus. dF/dt = rate of change of force. Broken line denotes onset of movement. (Adapted from Ghez and Vicario, 1978; and Vicario, Martin, and Ghez, 1983.)

Input-output organization of motor cortical neurons

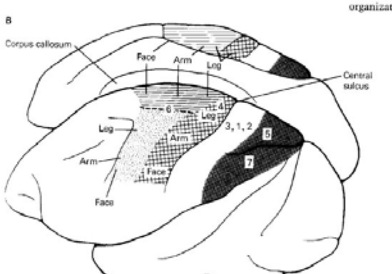
38–5 Input–output organization of the neurons in the cortical efferent zone controlling a flexor of the digit. The neurons are activated by either stretch of the muscle or stimulation of the skin. A parallel pathway in the spinal cord is also shown. (Adapted from Asanuma, 1973.)



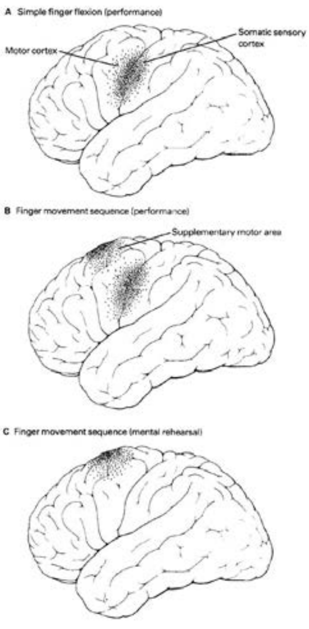
Pre-motor area



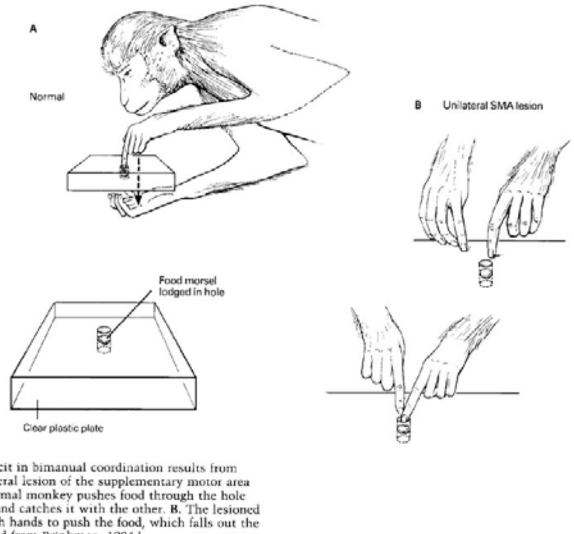
38–7 The cortical regions responsible for the central motor program lie near the motor cortex (Brodmann's area 4). **A.** Human cortex. **B.** Macaque monkey cortex. The somatotopic organization in the motor and premotor cortices is indicated.



Role of premotor cortical areas



38–9 Changes in cerebral blood flow (increase indicated by **stippling**) during finger tasks indicate different roles played by the different cortical areas. **A.** Activity during simple finger flexion against a spring. **B.** Activity during a complex sequence of finger movements. **C.** Activity during mental rehearsal of sequence. (Adapted from Roland et al., 1980.)



38–10 A deficit in bimanual coordination results from unilateral lesion of the supplementary motor area (**SMA**). **A.** A normal monkey pushes food through the hole with one hand and catches it with the other. **B.** The lesioned animal uses both hands to push the food, which falls out the bottom. (Adapted from Brinkman, 1984.)

神経系の機能についての原則

1. 強度は活動電位の頻度で表される。
   例： 運動野の出力細胞の発火頻度は力に比例する。光刺激に対する網膜細胞の応答

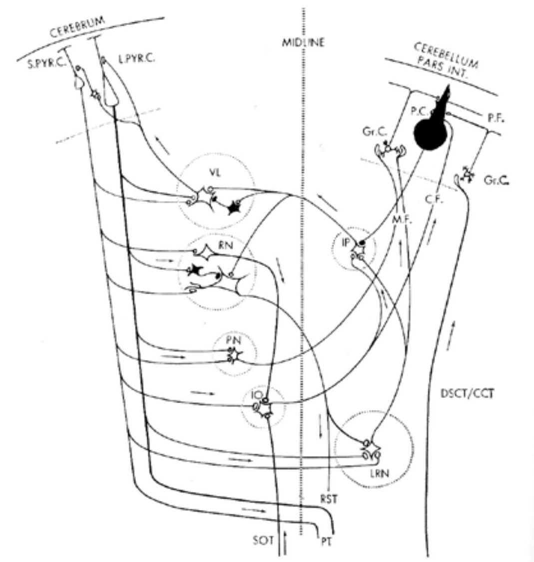
2. 感覚、運動さらには特定の感覚、特定の運動は異なる神経細胞が受け持つ
   例： 運動のtonicあるいはphasicな応答に係わる。 視覚も同様。

3. 感覚、運動ともにトポロジーを持つ
   例： 体部位局在。網膜部位対応

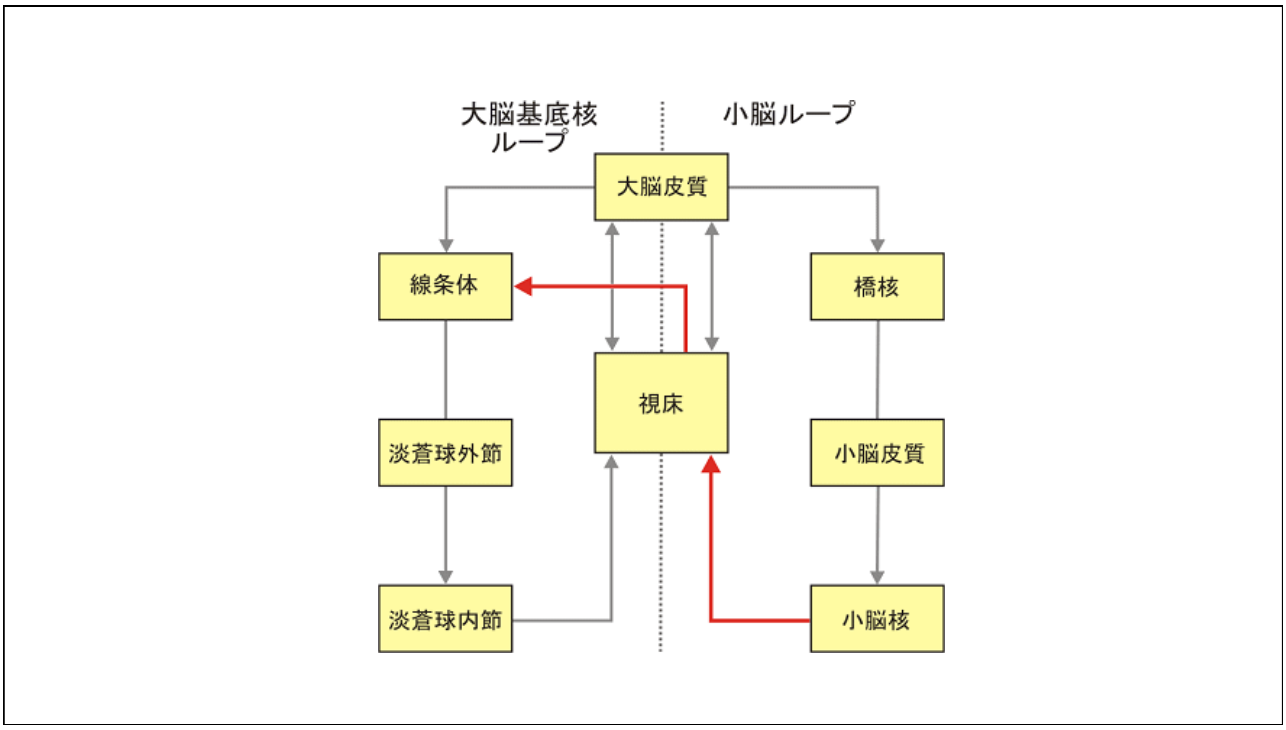
4. 拮抗的な作用によってバランスをとる
   例： 伸筋と屈筋に対する興奮性と抑制性の相反的神経支配。

5. 高次中枢ではより特化した機能
   例： 運動野と高次運動野の違い。視覚野の単純型細胞と複雑型細胞の反応。

Relation between cerebrum and cerebellum



Alen and Tsukahara, 1974


大脳基底核
ループ
小脳ループ
大脳皮質
線条体
橋核
視床
淡蒼球外節
小脳皮質
淡蒼球内節
小脳核