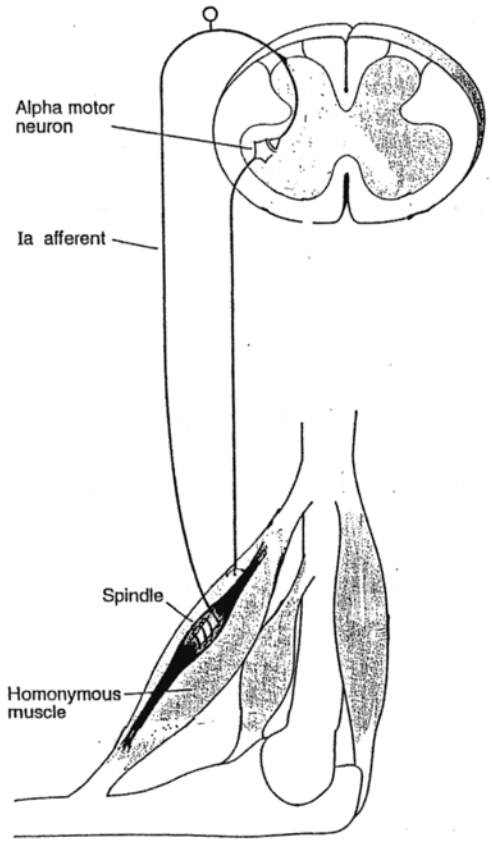
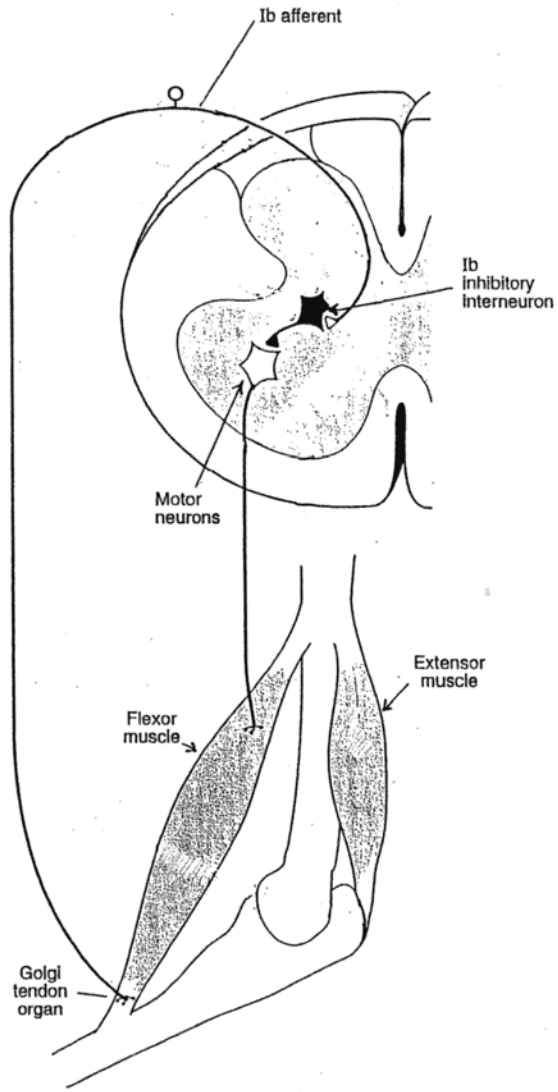
Spinal reflexes

Reflex pathways

1. Monosynaptic (stretch reflex)



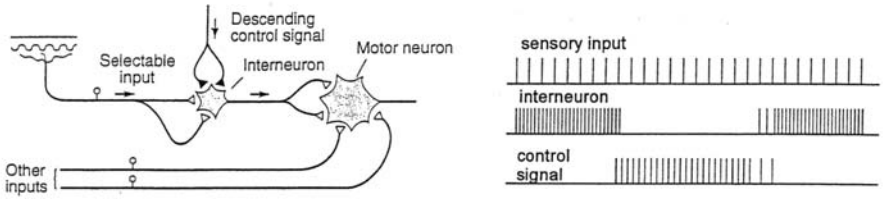
2. Polysynaptic (majority of spinal reflexes)



Function of interneurons in different networks

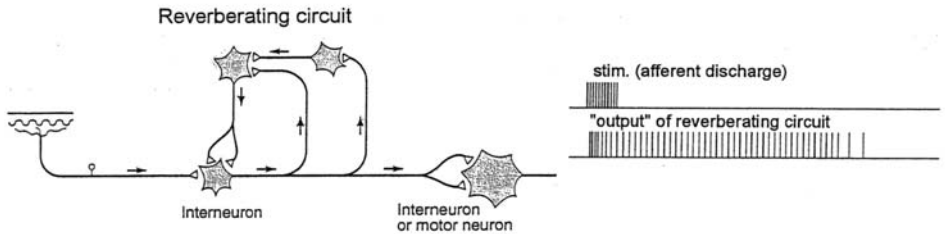
1. Mediating the action of sensory input upon motoneurons

Gating by interneurons



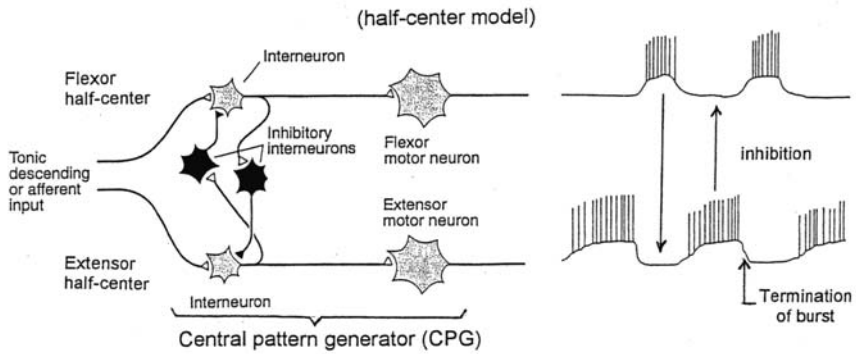
2. Prolongation of action of the input signal

Brief stimulus → long-lasting response



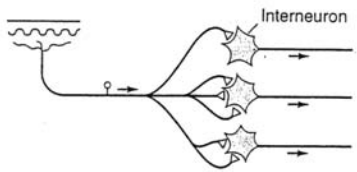
3. Generation of rhythmical motor patterns

(half-center model)

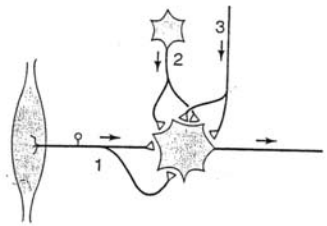


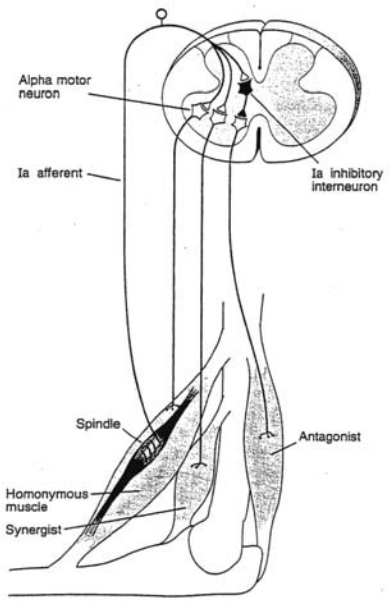
Divergent and convergent connections are important elements of motor coordination

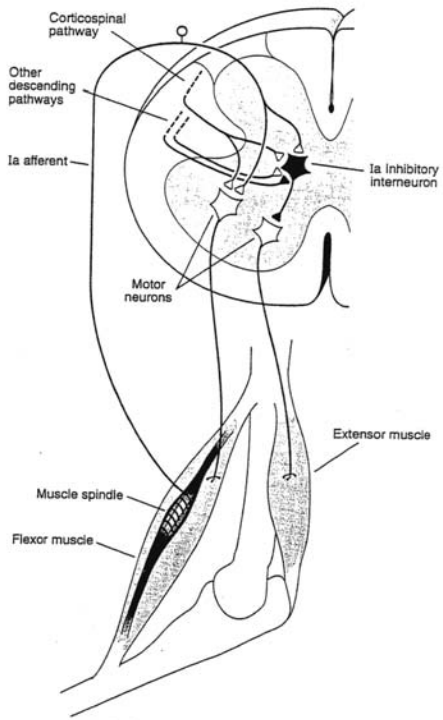
Divergence



Convergence

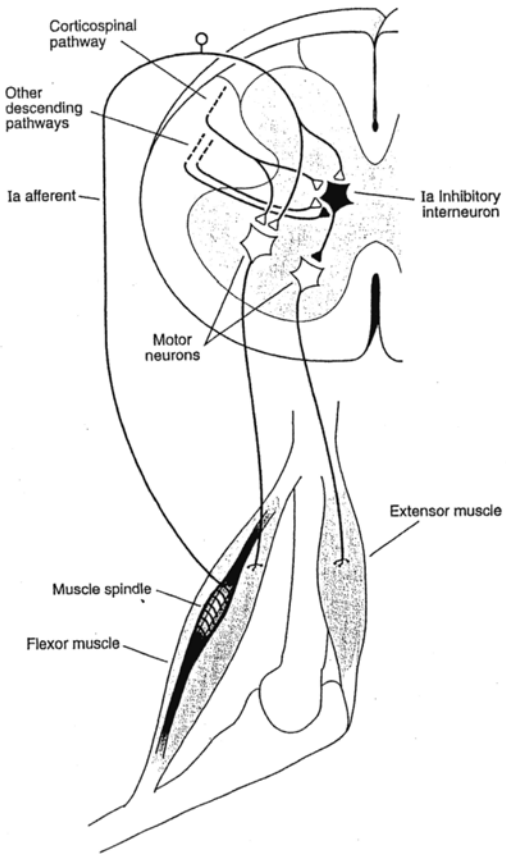




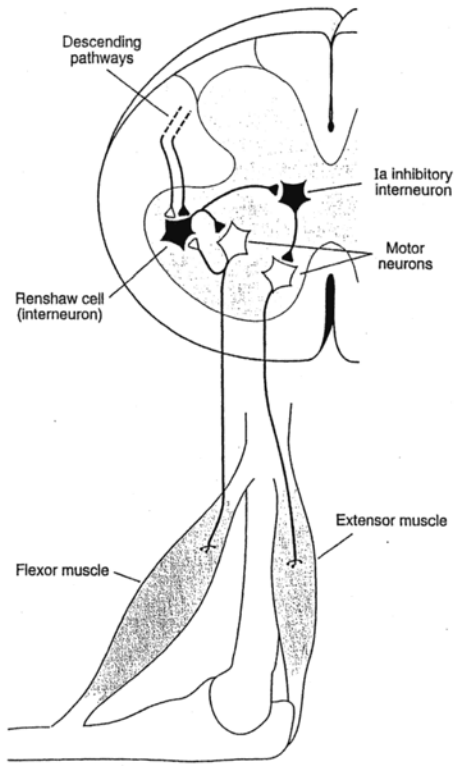


Three groups of identified interneurons are important elements of motor coordination

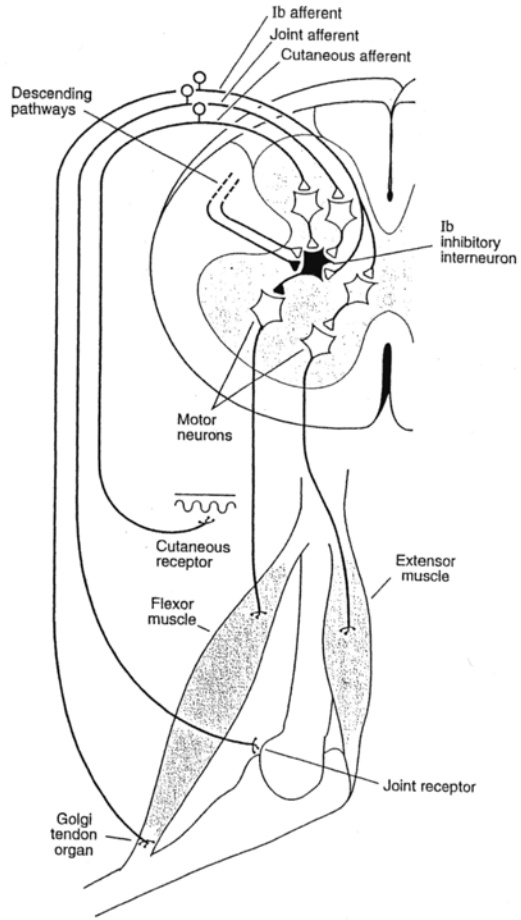
Group 1a inhibitory interneurons coordinate antagonistic muscles (reciprocal inhibition)



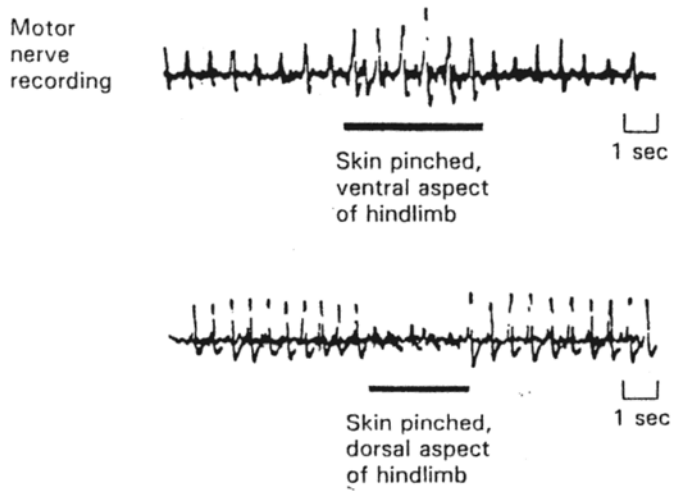
Renshaw cells mediate recurrent inhibition

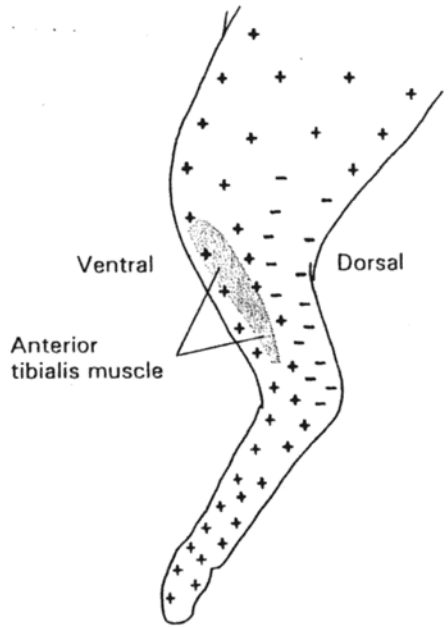


Group 1b inhibitory interneurons (Their influence on motoneurons depends on the combined inputs from many sources, both central and peripheral)

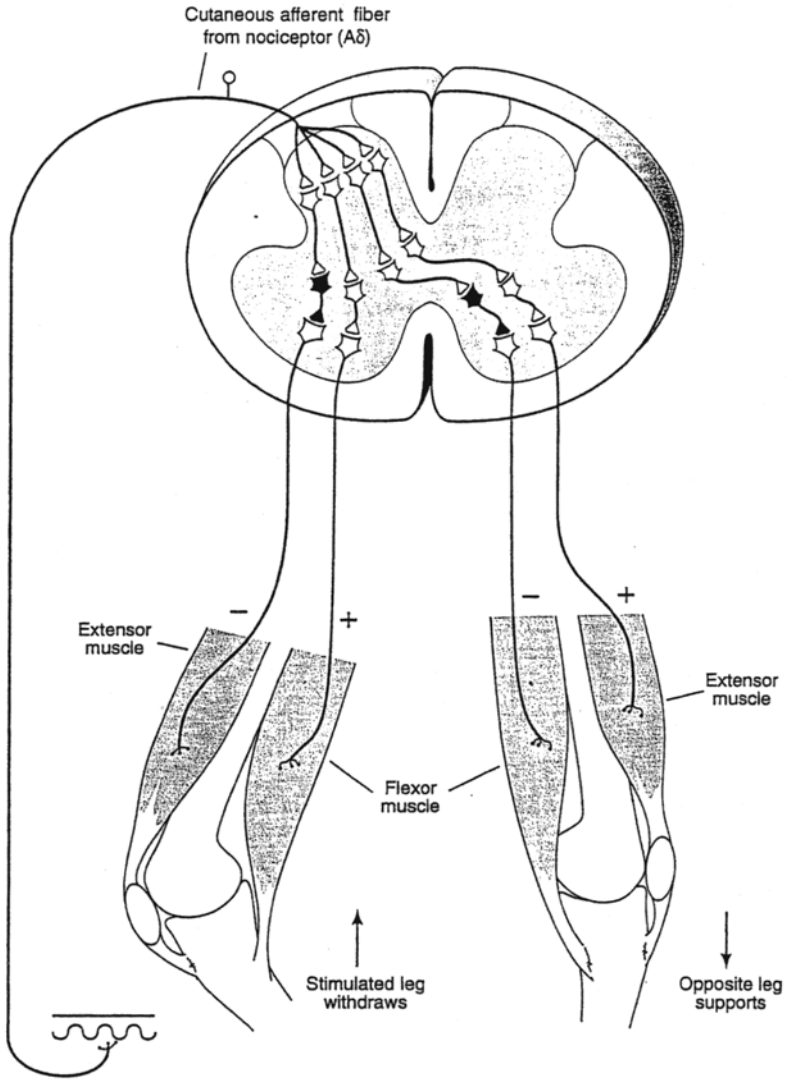


Cutaneous stimuli modulate the excitability of specific motor neuron pools

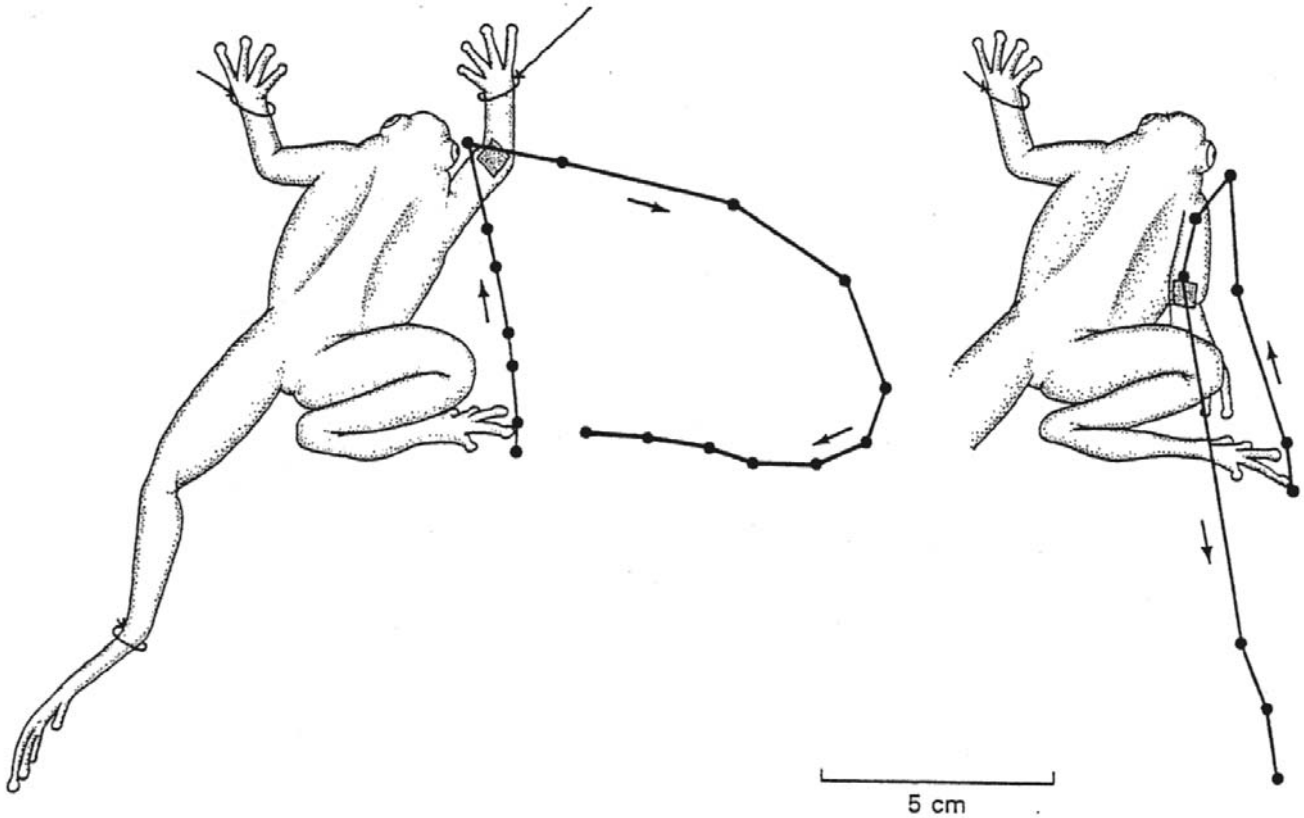




Flexion reflex and crossed extension reflex

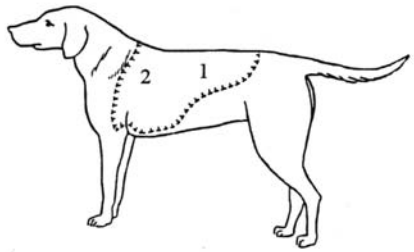


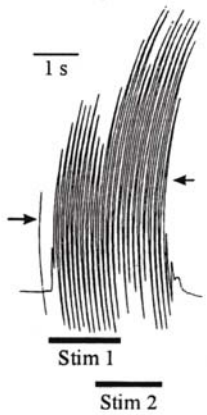
Wiping reflex adapts to different body postures



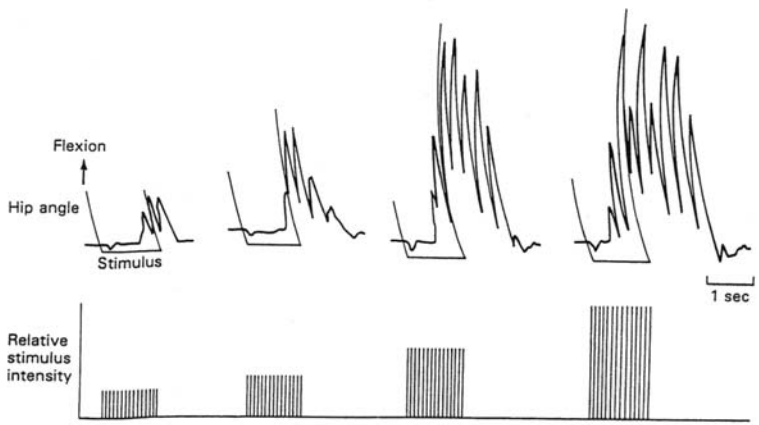
Scratch reflex

The spinal cord generates a rhythmic movement without a rhythmic stimulus



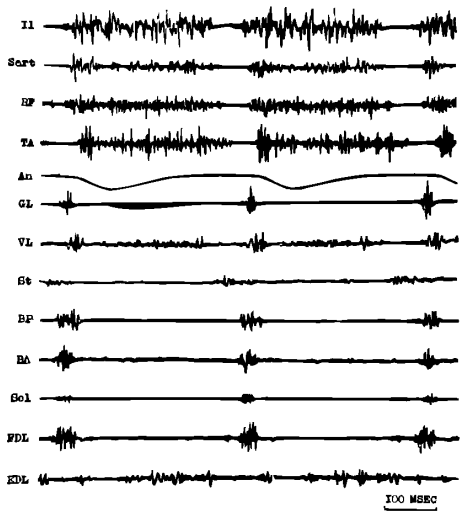


With increasing intensity of stimulus: (1) the amplitude of movements increases;
(2) the duration of reflex increases;
(3) the rhythm remains constant.

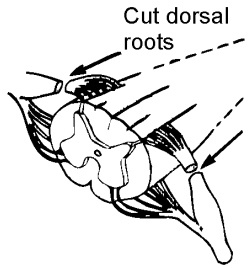


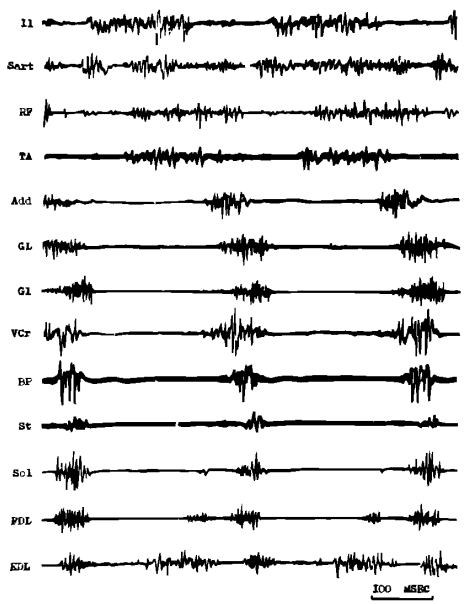
Network generating scratching does not require rhythmic sensory input from the limb

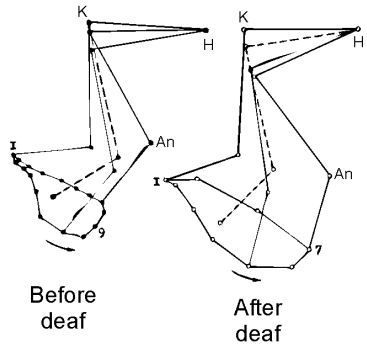
Before deafferentation

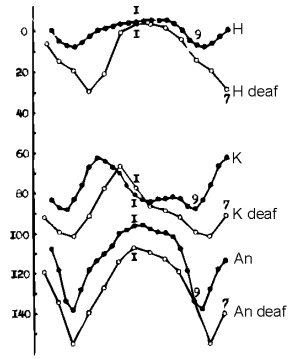


After deafferentation

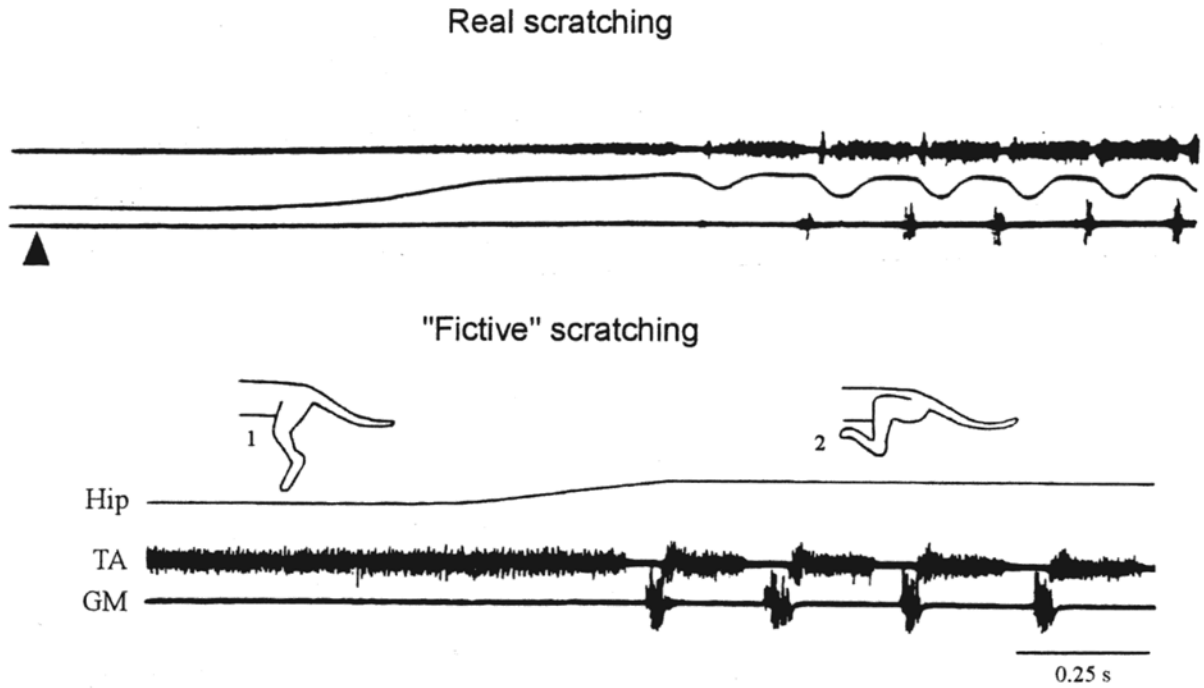




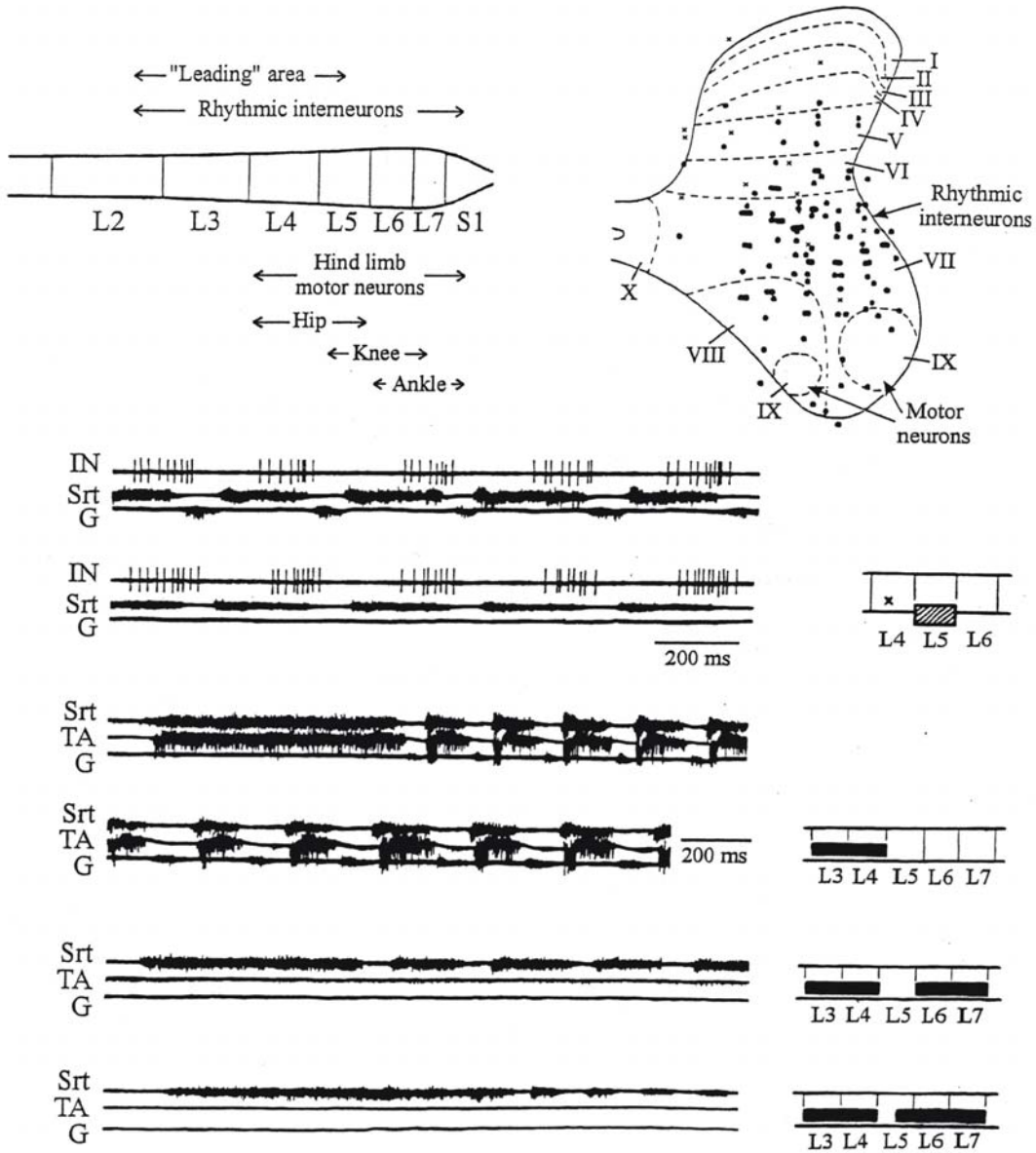




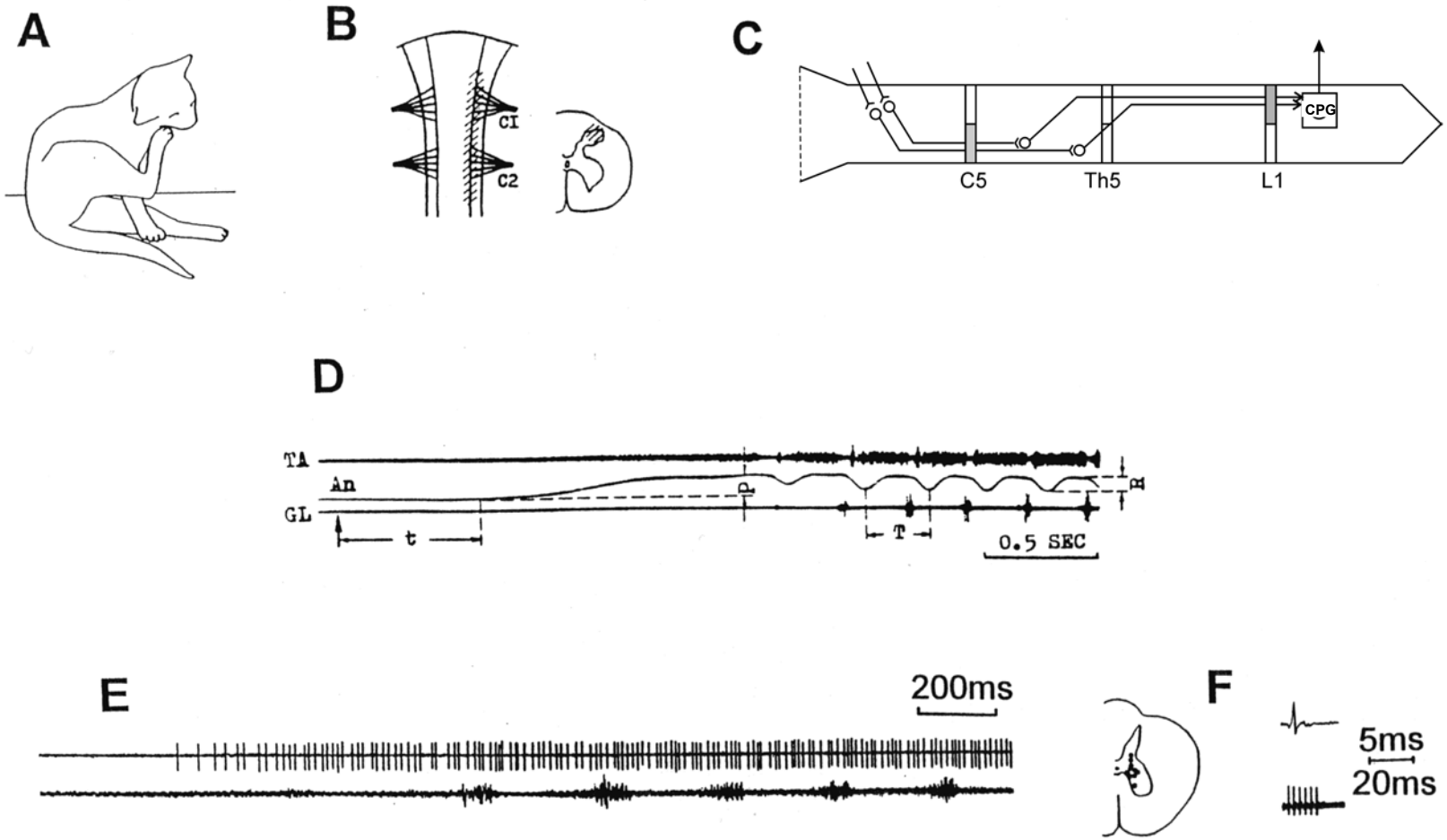
Tonic afferent input from the hindlimb plays a gating role



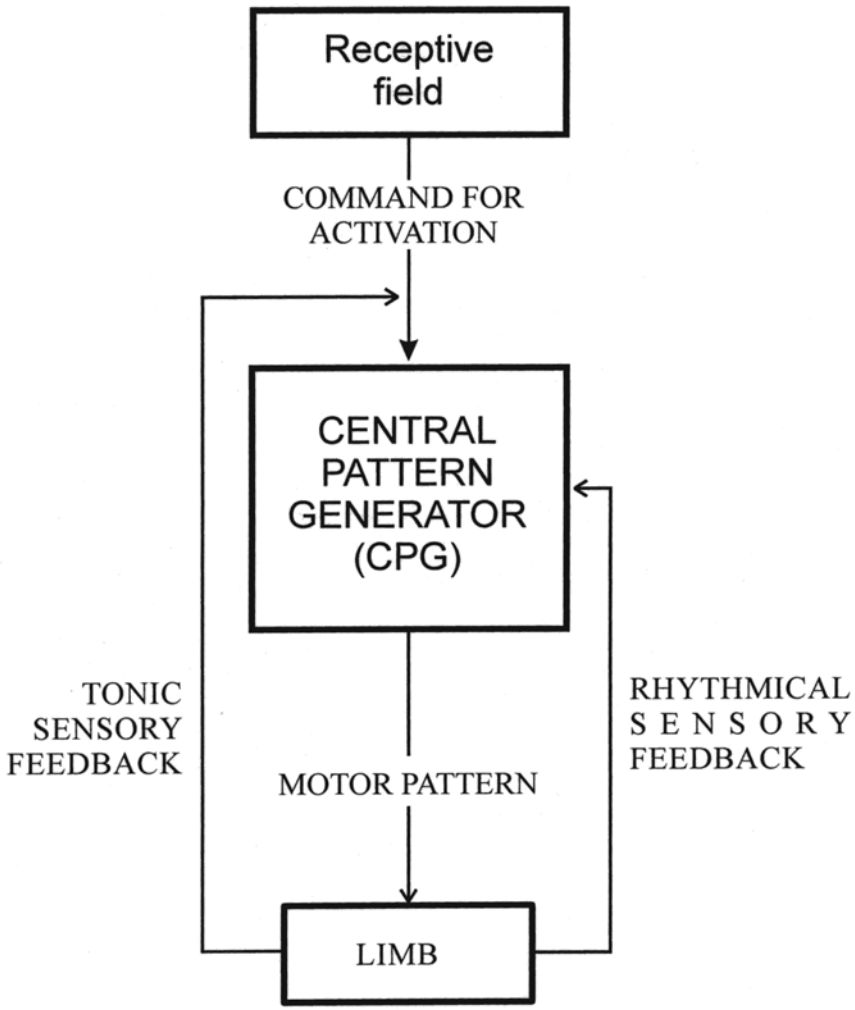
Localization of scratching CPG in the spinal cord



Neurons transmitting signals from receptors to scratching CPG



Organization of scratch reflex



Conclusions

1. Spinal reflexes are initiated by sensory stimuli that activate the receptors in muscles, joints, and skin. These stimuli activate the neuronal network in the spinal cord. This network affects a specific group of muscles.

2. Spinal reflex networks perform three main functions: (1) control of individual muscles, (2) coordination of muscle action around a joint, (3) coordination of muscles at different joints.

3. Interneurons are important elements of spinal networks. They (i) mediate influences of sensory input upon motoneurons and (ii) constitute the networks generating complicated patterns (reverberating network, rhythm generator). Three groups of inhibitory interneurons (1a, 1b and Renshaw cells) coordinate muscle action around a joint.

4. Spinal reflex circuits provide the higher centers with a set of elementary patterns of coordination, from relatively simple combinations, like reciprocal innervation at a single joint, to more complex spatial patterns of movement, such as flexion reflex, and temporal patterns, as in the scratch reflex.

5. Spinal reflexes are not entirely stereotyped but rather are adapted to the initial position of the body segments and the external loads acting to oppose movement. Because this information reaches the lower levels directly, higher centers can activate these reflex circuits to produce voluntary movements and need not be concentrated with the details of shaping the movement patterns to current circumstances.