Chapter 6
Nervous system

Chapter 6.1
neuron and neuroglia cell physiology

6.1.1 neurons

- classes of neurons: different criterion
  afferent, efferent and interneurons
  Sensory, motor, inter-neurons
  Exciting and inhibitor
- neuroglia cells
A. photoplasmic astrocytes; B. Fibrous astrocytes, C. microglia, D. oligodendrocytes
Chapter 6.1 neuron and neuroglia cell physiology

6.1.2 physiology of reflex reaction

- reflex and reflex arc
  - conditioned reflex and no-conditioned reflex
  - reflex arc component
- reflex circuit
- characteristics of chemical synaptic transmission
Chapter 6.1 neuron and neuroglia cell physiology

6.1.2 physiology of reflex reaction

- coordination of reflex reaction
  - induction—reciprocal inhibition
  - irradiation
  - principle of final common path
  - dominant principle
  - the coordination of high center
  - feedback: negative and positive
Human and animal physiology; Nervous system
Chapter 6.2 motor function of CNS

6.2.1 motor units and muscle receptors
- motor unit
- muscle and tendon receptors
- stretch reflex
  - tendon reflex:
  - muscle tonus: spindle
  - Golgi tendon organ
Figure 5-1  Loading and unloading the muscle spindle. An intact muscle fiber with its type II afferent nerve fiber is shown parallel with the relaxed muscle fibers in a muscle. The firing site (1) of the la fiber is continuously monitored electrophysiologically, and muscle tension (2) is monitored electromyographically. In the "lengthening" state, stretched and relaxed muscle fibers are slightly stretched and then relaxed or vice versa. When stretch is applied by pulling the attached weight, stretch elicits la discharge (3), and tension increases (4). Simultaneously, the input to the motor neuron is abruptly increased (5). The alpha motor neurons are stimulated resulting in active contraction of the peripheral fibers. This shortens the spindle. This in turn increases the la discharge. As the spindle shortens, tension decreases (6). When the attached weight is removed, the spindle is subjected to an "unloading" cycle. In this condition, the tension decreases to the relaxed level (7), the la discharge returns to the baseline (8), and the input to motor neurons decreases (9). The spindle is re-stretched (10) and the cycle repeats. At the same time, the alpha motor neurons, the polar end of the spindle fibers shorten and allow the repositioning of the spindle. This mechanism allows for different levels of la discharge output and tension when the muscle is stretched or relaxed.
6.2.2 The spinal cord mediates reflex activity

- Monosynaptic and polysynaptic spinal reflex
- γ circle: significant
- The inverse stretch reflex
  - Flexor withdrawal reflex (屈肌反射)
  - Crossed extension reflex (对侧伸肌反射)
- Spinal shock
Human and animal physiology; Nervous system
Chapter 6.2 motor function of CNS

6.2.3 brainstem in the control of movement

- reticular formation function
- decerebrate rigidity
  - red nucleus
  - vestibular nuclei
  - reticular formation
Chapter 6.2 motor function of CNS

6.2.4 cerebral cortex in the control of movement

- **motor cortex:**
  - primary motor area
  - all of the cortical motor areas are topographically organized
  - supplementary motor cortex
- **corticospinal tract is the descending cortical motor pathway**
  - medullary pyramids
  - extrapyramidal system
Human and animal physiology; Nervous system
Chapter 6.2 motor function of CNS

6.2.5 basal ganglia in the control of movement

- **basal ganglia**
  - Striatum, Globus pallidus, subthalamic nucleus, and substantia nigra

- **control function**
  - Parkinson’s disease
  - Athetosis, under-muscle tonus
Figure 5-15  Nuclei and anatomic connectivity of the basal ganglia, showing the connections of major loops. The output of the striatum (caudate and putamen) to the globus pallidus and from there to the thalamus provides a major input to the frontal cortex for initiation of movement. PUT, putamen; GPe, external pallidal.
Chapter 6.2 motor function of CNS

6.2.6 cerebellum in the control of movement

- three functional division
  - Vestibulocerebellum
  - Spinocerebellum
  - Cerebrocerebellum
Connections of the cerebellum. Excitatory connections are indicated with a ◀ and inhibitory connections are indicated with a ◇.
Chapter 6.3
autonomic nervous system

6.3.1 Overview of the autonomic nervous system
- Anatomy
- Functional characteristics of ANS
  - Dual innervation
  - With actions that usually oppose each other
- Chemical transmission: Ach and NE

Chapter 6.3
autonomic nervous system

6.3.2 The sympathetic nervous system
- sympathetic division innervates all organs of the body
- sympathetic division is anatomically designed to permit a generalized response to stress
- parasympathetic nervous system
6.3.3 Central integration of ANS

- simplest autonomic reflex has no “center” of integration
- ANS ganglia are sites of integration of reflexes
- CNS coordinates reflexes involving both the somatic and ANS
Chapter 6.4
Sensory function of CNS

6.4.1 sensory projecting pathway

- spinal and brainstem pathways
  - dorsal column-medial lemniscal system: tactile, arm proprioception(skin, muscle and spindle, \textit{deep sensation})
    - decussation in medulla
  - anterolateral system: pain, temperature and much lesser tactile: decussation in spinal cord

- specific projection system
- nonspecific sensory projection system
Human and animal physiology; Nervous system
Human and animal physiology; Nervous system

Summary diagram of the major ascending somatic sensory systems. The dorsal column-medial lemniscal system mediates tactile sensations and arm proprioception, the anterolateral system mediates pain and temperature sensations, and to a much lesser extent, tactile sensation. A general understanding of the organization of these two ascending systems reveals key principles underlying the organization of sensory systems of the brain and provides a basis for localizing sites of injury following trauma. Both systems relay sensory information to the contralateral brain, however, deafferentation occurs at different levels. In the dorsal column-medial lemniscal system the axons of second-order neurons cross the midline at the medulla, in contrast, the anterolateral system deaferentates in the spinal cord. The organization within each pathway is both serial and parallel.

浅部感觉：触、压、振动，关节

深部感觉：触、压、振动、关节
6.4.1 sensory projecting pathway

- specific projection system
  sensory relay nuclei
  connected nuclei

- nonspecific sensory projection system
  cells that project widely to cortex
Chapter 6.4
Sensory function of CNS

6.4.2 sensory cortex
Chapter 6.5
The higher function of CNS

6.5.1 the electroactivities of the cerebral cortex

- evoked and auto-evoked potential
- electroencephalogram(EEG)
  - beta waves
  - alpha waves
  - theta waves
  - delta waves
- the mechanism of cortex potential forming
The patterns of brain waves recorded by the EEG are designated alpha, beta, theta, and delta waves, based on frequency and relative amplitude. In epilepsy, abnormal spikes and large summated waves appear as many neurons are activated simultaneously.

Axons of cerebral cortical neurons project inwardly, perpendicular to the surface of the brain. Dendrites form a dense arbor at the brain’s surface. Electrodes of the EEG measure summated postsynaptic potentials in dendrites of cortical cells, which lie closest to the electrode placed on the scalp.
The cycle of wave patterns through one sleep episode. Sleep begins with stage 1 of slow-wave sleep, then progresses through stages 2, 3, and 4 as the waves decrease in frequency and increase in amplitude. From stage 4 the EEG returns in reverse order to stage 1, at which time the first REM sleep period occurs, about 90 minutes after onset of sleep. The cycle repeats through the night, with the REM periods increasing in length and stages 3 and 4 of slow-wave sleep diminishing in length through the night. (Modified from Kandel ER, Schwartz JH, Jessel TM. Principles of Neural Science. 3rd ed. New York, Elsevier, 1991.)
Chapter 6.5
The higher function of CNS

6.5.2 conditioned reflex theory
- the formation of condition reflex
  classical conditional reflex
  operant conditioning
- the characteristics of conditional reflex
  extinction of conditional reflex
- Human’s conditioned reflex
  first and second signal system
Human and animal physiology; Nervous system

[Diagram of the brain with labeled parts: W, V, S, H]