The Nervous System: The Spinal Cord and Spinal Nerves

PowerPoint® Lecture Slides
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Introduction

- The *central nervous system* (CNS) consists of the spinal cord and brain.

- The **spinal cord** and **brain**
  - Functional independence

- The spinal cord
  - More than just a highway for information
  - Integrates and processes information
Figure 14.1  Gross Anatomy of the Spinal Cord
Gross Anatomy of the Spinal Cord

(b) Superior spinal cord, posterior view

(c) Cauda equina, posterior view

Figure 14.1 Gross Anatomy of the Spinal Cord
Gross Anatomy of the Spinal Cord

Figure 14.3  Posterior View of Vertebral Column and Spinal Nerves
Spinal Meninges

- Spinal meninges are specialized membranes that provide protection, physical stability, and shock absorption.

- Three meningeal layers:
  - The dura mater—tough, fibrous outermost layer
  - The arachnoid mater—middle layer
  - The Pia mater—innermost layer
Figure 14.2a  The Spinal Cord and Spinal Meninges (Anterior View)
Spinal Meninges

Figure 14.2b  The Spinal Cord and Spinal Meninges (MRI, Sectional View)
Spinal Meninges

Figure 14.2c The Spinal Cord and Spinal Meninges (Posterior View)

(c) Posterior view
Figure 14.2d  The Spinal Cord and Spinal Meninges (Sectional View)
Figure 14.4  Spinal Taps and Myelography
Sectional Anatomy of the Spinal Cord

- **Organization of Gray Matter**
  - Surrounds the central canal and contains cell bodies of neurons and glial cells
  - Groups of nuclei (sensory or motor) with specific functions
  - *Posterior gray horns* contain somatic and visceral sensory nuclei; *anterior gray horns* contain somatic motor nuclei.
  - *Lateral gray horns* contain visceral motor neurons.
  - *Gray commissures* contain the axons of interneurons that cross from one side of the cord to the other.
Sectional Anatomy of the Spinal Cord

- **Organization of White Matter**
  - Divided into 6 *columns*, which contain *tracts*
  - *Ascending tracts* relay information from spinal cord to brain
  - *Descending tracts* carry information from brain to spinal cord
Figure 14.5a  Histology of the Spinal Cord, Transverse Section
Figure 14.5b  Sectional Organization of the Spinal Cord
Sectional Anatomy of the Spinal Cord

Figure 14.5c  Sectional Organization of the Spinal Cord

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Figure 14.6    Anatomy of a Peripheral Nerve
Figure 14.6  Anatomy of a Peripheral Nerve (A Scanning Electron Micrograph)
Spinal Nerves

Nerve Pathways
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Figure 14.7b  Peripheral Distribution of Spinal Nerves (Sensory Fibers)
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Spinal Nerves

Figure 14.9  Peripheral Nerves and Nerve Plexuses
Figure 14.10  The Cervical Plexus
Spinal Nerves

Figure 14.11a  The Trunks and Cords of the Brachial Plexus
Figure 14.11b The Anterior View of the Brachial Plexus
Figure 14.11c  Posterior View of the Brachial Plexus
## Table 14.2 The Brachial Plexus

<table>
<thead>
<tr>
<th>Spinal Segments</th>
<th>Nerve(s)</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>C₃–C₆</td>
<td>Nerve to subclavius</td>
<td>Subclavius muscle</td>
</tr>
<tr>
<td>C₃</td>
<td>Dorsal scapular nerve</td>
<td>Rhomboid and levator scapulae muscles</td>
</tr>
<tr>
<td>C₅–C₇</td>
<td>Long thoracic nerve</td>
<td>Serratus anterior muscle</td>
</tr>
<tr>
<td>C₉, C₁₀</td>
<td>Suprascapular nerve</td>
<td>Supraspinatus and infraspinatus muscles; sensory from shoulder joint and scapula</td>
</tr>
<tr>
<td>C₉–T₁</td>
<td>Pectoral nerves (medial and lateral)</td>
<td>Pectoralis muscles</td>
</tr>
<tr>
<td>C₁₀, C₁₁</td>
<td>Subscapular nerves</td>
<td>Subscapularis and teres major muscles</td>
</tr>
<tr>
<td>C₁₀–C₁₃</td>
<td>Thoracodorsal nerve</td>
<td>Latissimus dorsi muscle</td>
</tr>
<tr>
<td>C₁₀, C₁₁</td>
<td>Axillary nerve</td>
<td>Deltoid and teres minor muscles; sensory from skin of shoulder</td>
</tr>
<tr>
<td>C₁₀–T₁</td>
<td>Medial antebrachial cutaneous nerve</td>
<td>Sensory from skin over anterior, medial surface of arm and forearm</td>
</tr>
<tr>
<td>C₁₀–T₁</td>
<td>Radial nerve</td>
<td>Many extensor muscles on the arm and forearm (triceps brachii, anconeus, extensor carpi radialis, extensor carpi ulnaris, and brachioradialis muscles); supinator muscle, digital extensor muscles, and abductor pollicis muscle via the deep branch; sensory from skin over the posterolateral surface of the limb through the posterior brachial cutaneous nerve (arm), posterior antebrachial cutaneous nerve (forearm), and the superficial branch (radial portion of hand)</td>
</tr>
<tr>
<td>C₅–C₇</td>
<td>Musculocutaneous nerve</td>
<td>Flexor muscles on the arm (biceps brachii, brachialis, and coracobrachialis muscles); sensory from skin over lateral surface of the forearm through the lateral antebrachial cutaneous nerve</td>
</tr>
<tr>
<td>C₆–T₁</td>
<td>Median nerve</td>
<td>Flexor muscles on the forearm (flexor carpi radialis and palmaris longus muscles); pronator quadratus and pronator teres muscles; radial half of flexor digitorum profundus muscle, digital flexors (through the anterior interosseous nerve); sensory from skin over anterolateral surface of the hand</td>
</tr>
<tr>
<td>C₆, T₁</td>
<td>Ulnar nerve</td>
<td>Flexor carpi ulnaris muscle, ulnar half of flexor digitorum profundus muscle, adductor pollicis muscle, and small digital muscles through the deep branch; sensory from skin over medial surface of the hand through the superficial branch</td>
</tr>
</tbody>
</table>
Figure 14.12 The Cervical and Brachial Plexuses
Figure 14.13a  Anterior View of the Lumbar Plexus
Spinal Nerves

Figure 14.13b  Anterior View of Sacral Plexus

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Spinal Nerves

Figure 14.13c  Anterior View of the Lumbar and Sacral Plexuses

(c) The lumbar and sacral plexuses, anterior view

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Figure 14.13d  Posterior View of Sacral Plexus
Figure 14.14    The Lumbar and Sacral Plexuses
Figure 14.14 The Lumbar and Sacral Plexuses
Spinal Nerves

Figure 14.14 The Lumbar and Sacral Plexuses
Reflexes

- A reflex is an immediate involuntary response to a specific stimulus.
- The neural “writing” of a single reflex is referred to as a reflex arc.
- Reflexes are classified according to:
  - Their development (innate and acquired)
  - The site where information processing occurs (spinal and cranial)
  - The nature of resulting motor response (somatic and visceral or autonomic)
  - The complexity of the neural circuit (monosynaptic and polysynaptic)
The Reflex Arc
Reflexes

Figure 14.15  A Reflex Arc

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Reflexes

INNATE REFLEXES
- Genetically determined

ACQUIRED REFLEXES
- Learned

REFLEXES can be classified

by development

SPINAL REFLEXES
- Processing in the spinal cord

CRANIAL REFLEXES
- Processing in the brain

by processing site

by response

by complexity of circuit

SOMATIC REFLEXES
- Control skeletal muscle contractions
- Include superficial and stretch reflexes

VISERAL (Autonomic) REFLEXES
- Control actions of smooth and cardiac muscles, glands

MONOSYNAPTIC
- One synapse

POLYSYNAPTIC
- Multiple synapses (two to several hundred)

Figure 14.16 The Classification of Reflexes
Figure 14.17a,b  Neural Organization and Simple Reflexes (Monosynaptic Reflex)
Figure 14.17a.b  Neural Organization and Simple Reflexes (Polysynaptic Reflex)
Figure 14.18  Stretch Reflexes
Reflexes

Figure 14.18 Stretch Reflexes

(b) Patellar reflex

KEY
- Sensory neuron (stimulated)
- Motor neuron (stimulated)