PNS and CNS

Chapters 8 and 9

Nervous System Organization

• Peripheral Nervous System (PNS)
  – connects CNS to sensory receptors, muscles and glands
• Central Nervous System (CNS)
  – control/integrating center
  – brain + spinal cord

Peripheral Nervous System

• Rapid Communication
• Consists of:
  – 12 pairs cranial nerves
  – 31 pairs spinal nerves

Nerves

• axons of many neurons bundled together
• transmit signals between brain or spinal cord and other body regions

Peripheral Nervous System

• Sensory (Afferent)
  – convey impulses from sensory receptors to CNS
  – Afferent (sensory) neurons
• Motor (Efferent)
  – convey impulses away from CNS to periphery
  – Efferent (motor) neurons

Motor Component

• Somatic Nervous System (Voluntary)
  – conduct impulses from CNS to skeletal muscles
• Autonomic Nervous System (Involuntary)
  – convey impulses from CNS to smooth muscle, cardiac muscle and glands
Somatic Nervous System Structure

- Single motor neuron cell leading from the CNS directly to the muscle
- Cell body of motor neurons located in CNS

Autonomic Nervous System Structure

- Two neurons involved in efferent pathway (CNS to effector)
  - 1st (preganglionic) has cell body in CNS
    - synapses with 2nd in the autonomic ganglion
  - 2nd (postganglionic) sends signal from auton. gang. to the effector organ

Sympathetic and Parasympathetic Divisions

- Sympathetic (thoracolumbar)
  - dominates in stressful situations
  - prepares body for activity (‘Fight or Flight’)
  - adrenergic effects (use norepinephrine)
- Parasympathetic (craniosacral)
  - dominates during relaxed situations
  - precise control over the body
  - cholinergic effects (use acetylcholine)

Sympathetic vs. Parasympathetic Effects

<table>
<thead>
<tr>
<th>Organ</th>
<th>Sympathetic</th>
<th>Parasympathetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>increases HR</td>
<td>decreases HR</td>
</tr>
<tr>
<td>Blood vessels to visceral organs</td>
<td>constrict</td>
<td>dilate</td>
</tr>
<tr>
<td>Blood vessels to heart + skeletal muscle</td>
<td>dilate</td>
<td>constrict</td>
</tr>
<tr>
<td>Digestive tract</td>
<td>decreases motility</td>
<td>increases motility</td>
</tr>
</tbody>
</table>

Central Nervous System

- Control and integration
- Consists of
  - brain
  - spinal cord

Spinal Cord

- Links brain and PNS
- Controls some involuntary functions
- Protected by vertebral column
- 31 pairs of spinal nerves
  - Sensory Component
  - Motor Component
Spinal Cord Structure

- Dorsal Root = sensory
  - Dorsal root ganglion = afferent cell bodies
- Ventral Root = motor
  - Roots join to form spinal nerve
- Interneurons
  - White Matter = axons (myelin)
    - found in outer layer
  - Gray Matter = primarily cell bodies, dendrites
    - found in inner layer

Spinal Reflexes

- Spinal cord alone can respond to some stimuli
- Reflex - simple, stereotyped response to a stimulus

Brain

- \(10^{11}\) (100 billion) neurons
- grey matter mostly on outside (cortex)
- four fluid-filled chambers (ventricles)
- composed of sections:
  - Prosencephalon (forebrain)
    - telencephalon (Cerebrum)
    - diencephalon (Hypothalamus and Thalamus)
  - Mesencephalon (midbrain)
  - Rhombencephalon (hindbrain)
    - metencephalon (cerebellum, pons)
    - myelencephalon (medulla oblongata)

Telencephalon (Cerebrum)

- Largest part of brain
  - 80% total brain wt
- Cerebral Hemispheres (L and R)
  - connected by corpus callosum
- Surface = cerebral cortex
  - most of the grey matter of the cerebrum
- Deep folds (sulci) in between convolutions (gyri)

Cerebral Lobes

- Cortex divided into paired lobes
  - Parietal
  - Frontal
  - Temporal
  - Occipital
  - Insula
- Each has distinctive functions
Parietal Lobes

- Perception of somesthetic senses (touch, pressure, heat, cold, pain)
  - Somatosensory cortex - postcentral gyrus of the central fissure
- Understanding language and formulating words
  - Angular gyrus
- Interpretation of textures and shapes

Somatosensory Cortex

- Receives info. from various parts of body
- Each region receives info. from specific body area (somatotopic)
- diff. parts of body are not equally represented
  - hands and face have larger areas dedicated to processing of information
- receives info. from opposite side of body (decussation)

Frontal Lobes

- voluntary movement of skeletal muscle (motor cortex)
- personality
- higher intellectual processes
  - planning, decision making
- verbal communication
  - Broca’s area - motor mechanisms for speech

Motor Cortex

- Precentral gyrus of the central fissure
- Controls voluntary movements of skeletal muscles
- Somatotopic
- More area dedicated to body regions movements requiring precise movements
- Decussation

Temporal and Occipital Lobes

- Temporal Lobe
  - auditory cortex
    - perception and interpretation of auditory info
    - storage of auditory and visual experiences
    - Language comprehension (Wernicke’s area)
- Occipital Lobe
  - processing of visual information
  - visual cortex
    - interpretation of visual images
    - motor activity of eyes
    - correlation of images with previous visual experiences

Insula Lobe

- Located beneath frontal and temporal lobes
- Functions
  - Memory
  - Sensory integration (pain)
  - Cardiopulmonary responses to stress
Internal Grey Matter

- basal nuclei
  - control of voluntary movements
  - inhibition activity for maintaining muscle tone
  - maintaining purposeful motor activity while suppressing unwanted activity
  - monitor/coordinate slow sustained contractions
- Gulf war syndrome – degeneration of basal nuclei

Diencephalon

- Thalamus
  - accepts sensory info. and sends it to cortex.
  - Epithalamus - roof of third ventricle
    - choroid plexus - produces cerebrospinal fluid
    - pineal body - produces melatonin
      (reproduction, circadian rhythms)
- Hypothalamus
  - motivational behavior
  - hunger, thirst, body temperature,
  - neural control of hormonal release from the pituitary gland

Mesencephalon

- Located btw diencephalon and pons
  - corpora quadrigemina, red nucleus, substantia nigra, cerebral peduncles
- visual reflexes
- auditory information relay
- motor coordination
  - links cerebrum and cerebellum
  - Parkinson’s disease
    - degeneration of the substantia nigra
  - motivational (reward) behavior

Metencephalon

- Pons
  - interface for four pairs of cranial nerves
  - control of respiration
- Cerebellum
  - coordination of body movements, posture, balance
  - Damage = jerky movements, difficulty walking

Myelencephalon

- Medulla oblongata
  - control of basal survival functions
    - Cardiac Center
      - regulates HR and contractile force
    - Respiratory Center
      - regulates respiration
    - Vasomotor Center
      - controls blood vessel diameter and blood pressure
Reticular Formation

- Interneurons in medulla, pons, midbrain, thalamus and hypothalamus
- receives and integrates incoming sensory info.
- relays sensory info. to the cerebral cortex
  - nonspecific arousal of cerebrum