Chap 8. Organization of the Nervous System

Three main functions:
1. Sensory Reception
2. Central Processing
3. Motor Output

Divided into CNS and PNS
A. CNS = Central Nervous System
   - Brain and Spinal Cord
   (and eyes and interneurons)
B. PNS = Peripheral Nervous System
   - most sensory and motor axons

Flow of Information

Afferent Signal -> CNS -> Efferent Signal -> Response

Very Simple
- e.g., Sensing Effectors
- (a) Single-cell connectin
- (b) Monosynaptic reflex arc

Simple Monosynaptic
- (c) Polysynaptic reflex arc

Interneurons Polysynaptic
- Interneurons
- Central nervous system
- Motor neuron
- Effector cell

Sensing Effectors

Sensors with Afferent and Efferent Properties/Homeostasis
- e.g., osmolarity and antidiuretic hormone (ADH)

Flow of Information

Convergence
- Allow comparison of information, integration etc.

Divergence
- Send same signal to several parts of CNS

Parallel Processing
- Multitask
- As opposed to sequential
Evolution of Nervous System (p. 283)

- Based on the neuron
- Elaboration of Reflex Arc
- Group neurons into CNS
- More neurons in complex organisms
- New structures added on to old (not replaced)
- Size of CNS region correlated with importance
- Topological Maps

Structural and Functional Regions

CNS
- Most neuronal somata incl. motor neurons
- Interneurons
  Nuclei = collections of somata w/ similar function
  Tracts = bundles of axons from nuclei

PNS
- Nervous system outside CNS
  Nerves = axon bundles from sensory + motor neurons
  Ganglia = somata of some autonomic neurons and most sensory neurons

Nerve usually with both Afferent and Efferent axons

CNS - Spinal Cord
  - Retains evidence of segmented ancestors

CNS - Brain
  Vertebrate bilaterally paired nerve connections to periphery

Structural and Functional Regions

- Efferent NS
  1. Somatic/Voluntary
     - skeletal muscle
  2. Autonomic
     - smooth muscle
     - cardiac muscle
     - glands
     "housekeeping"
     A. Sympathetic
        ~ fight or flight
     B. Parasympathetic
        ~ rest and digest

CNS - Spinal Cord
- Anatomy
  White matter = myelin
  Gray matter = somata and dendrites

Cerebrospinal Fluid in spinal canal
Dorsal root, horn = afferent
Ventral root, horn = efferent

Spinal Reflexes:
- locomotion / walking
- chicken w/o head

Dorsal Root Ganglion (PNS)
- afferent sensory somata

CNS - Brain

Sensory
- Olfactory
- Optic
- Oculomotor
- Trochlear

Motor
- V Trigeminal ~ Both
- VI Abducens
- VII Facial
- VIII Vestibulocochlear

IX Glossopharyngeal
- X Vagus
- XI Spinal accessory
- XII Hypoglossal
CNS - Brain Anatomy

- **Medulla oblongata**
  
  Respiration, autonomic funct, some sensory (hearing, equil.)

- **Cerebellum**
  
  Coordinate motor output.
  
  Integrates info. from proprioceptors (stretch and joint)
  
  visual, auditory

  More convoluted (↑ s.a.) in higher groups

  Birds with large cerebellum to handle 3D flight

- **Pons (and tectum)**
  
  Integrate and communicate

  Visual, tactile, auditory maps

  ~ body movement coordination in some groups

- **Cerebral Cortex**
  
  In higher groups takes over function of tectum

---

CNS - Brain Anatomy (con't)

- **Thalamus**
  
  Sensory and motor coordination

  Often communicates with cerebral cortex

- **Amygdala**
  
  Processes info. and output related to emotions

- **Hypothalamus**
  
  Also involved in emotions

  Body temp, eating, drinking, sex

  Water and electrolyte balance

- **Olfactory Bulb**
  
  Key sense in many vertebrate groups

  Anterior position

- **Cerebrum** (covered by cerebral cortex)
  
  More evolved in higher groups (size and folds)...

---

**Cerebrum and Cerebral Cortex**

- **Folds** increase surface area and # neurons

- **Functional Regions**
  
  1. **Sensory cortex**
     
     somatosensory, auditory, visual

     - sensory homunculus ("little man")

  2. **Motor cortex**
     
     - often similar to sensory cortex map

  3. **Association cortex**
     
     - memory, future, thought, communication

Relative importance of each region changes among vertebrate groups

---

8-10 Randall et al. 2002
Autonomic NS (vs Voluntary/Somatic)

Antagonistic Groups in Balance (see Table 8-1):
A. Sympathetic (f or f)
B. Parasympathetic (r + d)

Both function via reflex arcs, but often opposite effects
Efferent signal with two neurons:
1. Preganglionic (NT released is ACh)
2. Postganglionic (PNS, receptor is nicotinic ACh)

Difference between Symp. and Para. is in:
1. Location of postganglionic somata
2. Postganglionic NT
3. Receptors on target tissues
4. Muscle reflexes in spinal cord, autonomic to brain

Chap 9. Endocrine System – Glands and Hormones

Secretions with consequences
All cells secrete, but
Specialized secretory cells grouped into glands
Secrete same specialized substance (e.g., hormone)

Nervous System neurotransmitter acts near and fast
Other secretions, such as hormones, may act more distantly and over a longer time period

Helpful list of abbreviations on page 357.
Glandular Secretion

Secretory Granules/Vesicles - similar to synaptic vesicles but usually larger

Exocytosis - common release mechanism

Regulation via Calcium - remember that free cytosolic calcium concentration is correlated with exocytosis (including of NT, hormones, etc.)

Glandular Secretion

Response to stimulus
- Hormone
- Neurotransmitter
- Action Potential
- etc. (e.g., osmolarity and ADH)

Storage before Secretion
- Large molecules easily stored because can’t leave readily
- Small molecules often stored bound to accessory proteins
- Some molecules actively/continuously taken into vesicles
- Steroid hormones (lipid soluble) tend to leak out soon
  - Hydrophobic steroid and thyroid hormones move in blood, bound to carrier proteins