28.11. Vertebrate nervous systems have central and peripheral components

- **Central nervous system (CNS).** Brain and spinal cord.
- Both contain fluid-filled spaces which contain cerebrospinal fluid (CSF).
- The central canal of the spinal cord is continuous with the ventricles of the brain.
- White matter is composed of bundles of myelinated axons.
- Gray matter consists of unmyelinated axons, nuclei, and dendrites.
- **Peripheral nervous system.** Everything outside the CNS.

28.12-13. The divisions of the peripheral nervous system interact in maintaining homeostasis

- Structural composition of the PNS.
- Paired cranial nerves that originate in the brain and innervate the head and upper body.
- Paired spinal nerves that originate in the spinal cord and innervate the entire body.
- Ganglia associated with the cranial and spinal nerves.
- Functional composition of the PNS.
- A closer look at the (often antagonistic) divisions of the autonomic nervous system.

28.15. Evolutionary older structures of the vertebrate brain regulate essential automatic and integrative functions:

- **The Brainstem.** The “lower brain.”
- Consists of the **medulla oblongata, pons, and midbrain.**
- Derived from the embryonic hindbrain and midbrain.
- Functions in homeostasis, coordination of movement, conduction of impulses to higher brain centers.
- **Medulla oblongata.**  
  Contains nuclei that control visceral (autonomic homeostatic) functions.
  - Breathing, Heart and blood vessel activity. Swallowing, Vomiting, Digestion.
  - Relays information to and from higher brain centers.
- **Pons.**  
  Contains nuclei involved in the regulation of visceral activities such as breathing.
  - Relays information to and from higher brain centers.
- **The Midbrain.**  
  Contains nuclei involved in the integration of sensory information.
  - The **reticular activating system (RAS)** of the **reticular formation.**
  - Regulates sleep and arousal. Acts as a sensory filter.
  - Sleep and wakefulness produce patterns of electrical activity in the brain that can be recorded as an **electroencephalogram (EEG).**
  - Most dreaming occurs during REM (rapid eye movement) sleep.
The cerebrum is the most highly evolved structure of the mammalian brain

- The **cerebrum** is derived from the embryonic telencephalon. Divided into left and right **cerebral hemispheres**.
- The **corpus callosum** is the major connection between the two hemispheres.
- The left hemisphere is primarily responsible for the right side of the body.
- The right hemisphere is primarily responsible for the left side of the body.
- **Cerebral cortex**: outer covering of gray matter.
- **Neocortex**: region unique to mammals.
- **Basal nuclei**: internal clusters of nuclei.

### 28.16. Regions of the cerebrum are specialized for different functions

- The **cerebrum** is divided into frontal, temporal, occipital, and parietal lobes.
- **Frontal lobe** - Contains the primary motor cortex.
- **Parietal lobe** - Contains the primary somatosensory cortex
- Integrative Function of the Association Areas.
- Much of the cerebrum is given over to association areas - areas where sensory information is integrated and assessed and motor responses are planned.
- The brain exhibits plasticity of function. For example, infants with intractable epilepsy may have an entire cerebral hemisphere removed. The remaining hemisphere can provide the function normally provided by both hemispheres.
- **Lateralization of Brain Function.**
- **The left hemisphere**. Specializes in language, math, logic operations, and the processing of serial sequences of information, and visual and auditory details. Specializes in detailed activities required for motor control.
- **The right hemisphere**. Specializes in pattern recognition, spatial relationships, nonverbal ideation, emotional processing, and the parallel processing of information.
• **Language and Speech.**

- **Broca’s area.** Usually located in the left hemisphere’s frontal lobe. Responsible for speech production.

- **Wernicke’s area.** Usually located in the right hemisphere’s temporal lobe. Responsible for the comprehension of speech.

- Other speech areas are involved in generating verbs to match nouns, grouping together related words, etc.

**28.16 Emotions learning and memory.**

- In mammals, the **limbic system** is composed of the hippocampus, olfactory cortex, inner portions of the cortex’s lobes, and parts of the thalamus and hypothalamus.

- Mediates basic emotions (fear, anger), involved in emotional bonding, establishes emotional memory

- **amygdala** is involved in recognizing the emotional content of facial expression.
28.20 Memory and Learning.

- **Short-term memory** stored in the frontal lobes.
- The establishment of **long-term memory** involves the hippocampus.
- Functional changes in synapses in synapses of the hippocampus and amygdala are related to memory storage and emotional conditioning.
- **Long-term depression (LTD)** occurs when a postsynaptic neuron displays decreased responsiveness to action potentials. Induced by repeated, weak stimulation.
- **Long-term potentiation (LTP)** occurs when a postsynaptic neuron displays increased responsiveness to stimuli. Induced by brief, repeated action potentials that strongly depolarize the postsynaptic membrane. May be associated with memory storage and learning.