NERVOUS SYSTEM
• The nervous system senses, interprets, and responds to changes in the environment.

• Two types of cells makes this possible:
  – the neuron
  – and the supporting cells ("glial cells").
Neurons are special cells which change state based on electrical currents and past history.
They are often referred to by their function, shape, or position relative to each other.

- **Motor neuron,**
- **Sensory neuron,**
- **Interneuron**
Dendrites and cell body receive input from sensory receptors and other neurons. They take the form of **graded potentials**.
• The **cell body** integrates input which may lead **the axon** to transmit an **action potential**.
• The **synaptic knobs** release neurotransmitters on other neurons or effector organs (e.g. muscles)
• Since neurons have highly specialized shapes, they rely on helper cells to assist metabolic activities.
• These are the supporting cells, or glial cells (glia = "glue").
• Axons often make use of **Schwann Cells** (glia) to increase transmission speeds.
General terminology

• **Central nervous system (CNS)** - consists of brain and spinal cord

• **Peripheral nervous system (PNS)** - nerves that connect CNS to peripheral sense organs and muscles
General terminology

Somatic nervous system - PNS nerves and ganglia that convey input from the sense organs or outputs involved in voluntary activity

• Autonomic nervous system - PNS nerves and ganglia that regulate involuntary functions such as blood pressure or heart beat
Nerves - bundles of multiple axons

- **afferent** nerves carry sensory information from sense organs towards CNS
- **efferent** nerves carry information away from CNS to muscles, glands, and sometimes to sense organs
- **mixed** nerves contain both afferent and efferent fibers
• **Ganglion** - an aggregation of cell bodies and neurites surrounded by a connective tissue sheath
Central nervous system (CNS) - consists of brain and spinal cord
The spinal cord

- Lies in dorsally situated vertebral column from base of brain to pelvis
- The spinal cord extends from the foramen magnum to the second lumbar vertabrae.
- It is covered with *pia*, *arachnoid*, and *dura mater* and is bathed in cerebrospinal fluid which is also found in the central spinal canal.
(a) Posterior view
• White matter - *Bundles of myelinated axons, that mostly connect parts of the cord with one another or with the brain*

• Because of myelin, they look white (ergo "white matter")
Axons of different neurons tend to travel together in bunches. These are called **nerves** (PNS) or **tracts** (CNS).

- Each tract or column carries specific sensory or motor information.
- **Dorsally** located columns generally carry sensory information up to brain.
- **Ventrally** located columns generally carry motor commands down from brain.
• Gray matter - *Cell bodies, dendrites, and synapses*

• Cell bodies (and dendrites)

• Since they don't have myelin, they tend to look grey ("grey matter")
• ventral horns contain motor neuron cell bodies, innervate somatic muscles
• dorsal horn contains neurons that receive sensory input
• cell bodies of sensory neurons located in dorsal root ganglion
• lateral regions of gray matter contain cell bodies of efferent autonomic neurons
Spinal nerves

- most sensory information enters cord via dorsal roots
- each dorsal root contains swelling, dorsal root ganglion, containing cell bodies of sensory neurons
- motor information leaves the cord via ventral roots
- dorsal and ventral roots fuse close to spinal cord to form spinal nerves, run out between vertebrae of backbone
- spinal nerves are identified and numbered according to the part of the cord they serve and position in that part
The vertebrate brain

- Gray matter at outer surface of brain-cortex
- Fiber tracts, white matter underneath
- Nuclei distinct collections of cell bodies
The meninges

• The brain is enclosed by three membranes - the meninges - within the skull.

• The tough, outer *dura mater* and the thin *pia mater* sandwich the *arachnoid mater*. 
The arachnoid mater is pierced by many channels and allows the circulation of the cerebro-spinal fluid around the surface and to the ventricles and central canal of the spinal cord.
Brain Development
Neural tube

- Brain and spinal cord originate from neural tube that runs length of embryo
• Anterior end of neural tube develops three distinct lobes-
  – forebrain (prosencephalon),
  – midbrain (mesencephalon)
  – hindbrain (rhombencephalon)
Forebrain becomes telencephalon and diencephalon
Hindbrain becomes cerebellum, pons, and medulla oblongata.
The hindbrain

- Includes medulla, pons, and cerebellum
- Medulla and pons (brainstem)
Brainstem nuclei

- Contain nuclei that help to control basic functions such as breathing, heart rate, blood pressure, and initiating reflexive actions—coughing, gagging, vomiting
- Medullary and pontine nuclei associated with cranial nerves, contain cell bodies of motor neurons whose axons leave brain via some of the cranial nerves
The Cerebellum

- coordinating motor action
- learning and memory of motor tasks
- participates in certain types of cognitive tasks that require mental manipulation of spatial relationships
The midbrain

- Corpus callosum
- Septum pellucidum
- Interthalamic adhesion
- Anterior commissure
- Hypothalamus
- Frontal lobe
- Mammillary body
- Optic chiasm
- Pituitary gland
- Fornix
- Choroid plexus in third ventricle
- Thalamus
- Habenular nucleus
- Epithalamus
- Pineal gland
- Part of the corpora quadrigemina
- Mesencephalic aqueduct
- Infundibulum
- Cerebellum
- Fourth ventricle

Midsagittal section
The midbrain

- **superior colliculus** - major visual center detecting and selecting targets for orienting movements of body, eyes
- **inferior colliculus** - located on dorsal midbrain posterior to superior colliculus, auditory processing structure
The midbrain

**Tegmentum** portion of midbrain that lies under cerebral aqueduct contains red nucleus and substantia nigra important in orientation reflexes, and voluntary movements, substantia nigra damaged in Parkinson's disease, a motor disorder.
Forebrain

- The diencephalon
- The telencephalon
The diencephalon

- consists mainly of thalamus and hypothalamus
Thalamus

• important relay station for sensory information
Hypothalamus

- Hypothalamus involved in homeostasis in three ways:
  - initiate or suppress behaviors such as eating or drinking that affect internal body conditions
  - regulates pituitary gland, exerts control over endocrine system, which in turn adjusts many internal conditions such as salt and water balance in blood
  - regulates many homeostatic conditions by control of autonomic system, which influences factors such as blood pressure and body temperature
The telencephalon

Consists of cerebral hemispheres plus a number of functionally related and important nuclei that serve functions such as motor control and emotional reactions
The cerebral hemispheres

- cerebral hemispheres linked by corpus callosum
- central sulcus divides each cerebral hemisphere into anterior and posterior halves
Four Lobes of the Cerebral Cortex, the Primary Sensory and Motor Cortex, and the Associative Cortex. (a) View from Base of Brain. (b) Midsagittal View, with Cerebellum and Brain Stem Removed. (c) Lateral View
• motor cortex lies just ahead of central sulcus
• postcentral gyrus process information from muscles and body surface somatosensory (touch)
• information from eyes processed in occipital lobe
• information from ears processed in a portion of temporal lobe
• information from nose processed in olfactory bulb
LOCALIZATION OF MOTOR AND SENSORY FUNCTIONS

LATERAL VIEW

- Supplementary motor
- Premotor
- Motor
- Somatosensory
- Somatosensory association
- Visual association
- Visual
- Auditory association
- Auditory
- Taste

The basal ganglia

- Group of nuclei clustered around thalamus (putamen, globus pallidus, caudate nucleus)

- Important in motor planning and control.