Nervous System

Organization, Neuron, Brain, Spinal Cord & Nerves, Ear and Eye

Video Links and Diagrams

Chapters 10 & 11
Video

- http://www.youtube.com/watch?v=4M82WwFACLg
  - Part 1
- http://www.youtube.com/watch?v=PE2b5g07V_o
  - Part 2
Division of Nervous System

- Two Anatomical Divisions
  - Central nervous system (CNS)
    - Brain
    - Spinal cord
  - Peripheral nervous system (PNS)
    - All the neural tissue outside CNS
    - *Afferent* division (sensory input)
    - *Efferent* division (motor output)
      - Somatic nervous system
      - Autonomic nervous system

*Somatic means “Body”*
General Organization of the nervous system

CENTRAL NERVOUS SYSTEM
Brain & spinal cord

Information Processing

PERIPHERAL NERVOUS SYSTEM

Sensory information within afferent division

Motor commands within efferent division
includes

Somatic nervous system

Autonomic nervous system

Receptors
Somatic sensory receptors (monitor the outside world and our position in it)
Visceral sensory receptors (monitor internal conditions and the status of other organ systems)

Effectors
Skeletal muscle

Parasympathetic division
Sympathetic division

Smooth muscle
Cardiac muscle
Glands
Adipose tissue

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Central Nervous System

- http://www.youtube.com/watch?v=yq6GJiyj3HA
**Nervous System**

- **CNS – Central Nervous System**
  - Brain & Spinal Cord

- **PNS – Peripheral Nervous System**
  - 12 Cranial Nerves
  - 31 Spinal Nerve Pairs

**Somatic Division**

- Sensory Neurons from skin, skeletal muscles and joints to CNS
- Motor Neurons from CNS to skeletal muscles

**Autonomic Division**

- Sensory Neurons from visceral organs to CNS
- Motor Neurons from CNS to smooth & cardiac muscle and glands

*Fill in your Chart! Add the Arrows to your diagram!*
The Nervous system has three major functions: Fill in the Chart!

- **Sensory** – monitors internal & external environment through presence of receptors (sensory)
  - **Integration** – interpretation of sensory information (information processing); complex (higher order) functions
  - **Motor** – response to information processed through stimulation of effectors (motor)
    - muscle contraction
    - glandular secretion
Neurons and Neuroglia

Cell body, axon, dendrites, myelin sheath, synapse

Use the Graphic Organizer to take Notes
What makes up the brain, the spinal cord or your peripheral nerves?

- **Nerves** – bundle of neurons
- **Neurons** – cell that can conduct impulses by electrochemical changes
- **Neuroglia** – (glial cells) support and protection, 60% of the brain tissue

*Fill in your Graphic Organizer*
Neuroglial Cells

- **Astrocytes** – star shaped cells that support brain and spinal cord
- **Oligodendroglia** – small stars, semi-rigid support
- **Microglial** – small cells that protect the CNS, phagocytic (engulf bacteria and cellular debris)
- **Ependymal Cells** – produce cerebrospinal fluid and have cilia to move fluid
- **Schwann Cells** – form myelin sheaths around nerve fibers in the PNS
Neuroglial Cells of the CNS

- Astrocyte
- Oligodendrocyte
- Microglia
- Ependymal cells
Neurons  **Structure**

- **Single nucleus;** Cytoplasm with mitochondria, Golgi bodies, lysosomes, neurofibrils, rough ER
- **Dendrites** – short and branched processes
- **Axons** – single long process with an axon terminal that connects with the dendrites of other neurons
  - Enclosed in **Myelin Sheaths**
    - lipoprotein
    - Produced by Schwann cells
    - Node of Ranvier – gap in the sheath
- **Structural Types:** multipolar neurons, bipolar neurons, unipolar neurons
- **Functional Types:** sensory or afferent neuron, internuncial or association neurons, motor or efferent neurons
Basic Neuron Types

- Bipolar (Interneuron)
- Unipolar (Sensory Neuron)
- Multipolar (Motoneuron)
- Pyramidal Cell

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Structure of a Typical Neuron

- Dendrite
- Cell body
- Node of Ranvier
- Axon
- Schwann cell
- Axon terminal
- Myelin sheath
- Nucleus
Label your diagram of the Neuron

- Axon
- Astrocyte
- Chromatophilic Substance
- Dendrite
- Microglial cells
- Myelin sheath
- Nucleus
- Node of Ranvier
- Oligodendrocyte
- Schwann cell
- Snyaptic knobs
Check your diagram
Neurons are connected by Synapses

- One-way junctions that ensure the nerve impulse travels in only one direction
Why are neurons connected?
Reflex Arc – pathway that results in a reflex; help maintain homeostasis (heartbeat, breathing rate, digestion rate)
Synapse - where the action happens

The next cell's plasma membrane

Transport protein

The synapse - where the action happens

Synaptic cleft
How does the Synapse carry the signal?
“Synapse Steps”

1. Electrical current travels down the axon
2. Vesicles with chemicals move toward the membrane
3. Chemicals are released and diffuse toward the next cell’s plasma membrane
4. The chemicals open up the transport proteins and allow the signal to pass to the next cell
The synapse carries a signal from cell to cell.

Neurotransmitters: adrenaline or epinephrine, acetylcholine, serotonin, dopamine, endorphins
Are all neurons equal in size?

- Brain vs spinal cord vs peripheral nerves?

About how many neurons are in the human brain? 100 billion
About how many neurons are in the spinal cord? 1 billion
How long do you think the longest axon in the world is? around 15 feet
How many synapses are in one neuron?

1,000 to 10,000!!
What do you think can change neurons and their connections?

- Accidents
- Drugs
- Alcohol
- Disease
What if neurons die here?
or here or here
or here or here
or here or here
or here or here
or here or here
Mindboggling Activity

- https://docs.google.com/presentation/d/1UXSZK_2p_rGHNUYQXzCyhjHviFdsDAA3SRY8CSD4pFo/present
  #slide=id.io

You need a piece of scrap paper and something to write with.
Brain

Cerebrum, cerebellum (occipital, parietal, frontal, temporal lobes), brain stem (medulla oblongata, pons, midbrain), thalamus, hypothalamus, pia mater, subarachnoid space, subdural space, dura mater, corpus callosum, cerebrospinal fluid, mesencephalon, diencephalon, pituitary gland, pineal gland, infundibulum, mamillary bodies
The Brain

- Weighs 1300 - 1400 g or 3 lbs
- One of the largest organs in body
- Made up of about 100 billion neurons
- “The most complex living structure on the universe”
  Society for Neuroscience
- Makes us who we are
Protect the Brain

1. Cranial Bones
2. Meninges
   - Dura Mater – outer
   - Arachnoid Mater – middle
   - Pia Mater – inner
3. Cerebrospinal fluid – shock absorber and circulates nutrients
Principal Parts of the Brain

- **Brainstem** – medulla oblongata and pons varolii
- **Diencephalon** – thalamus and hypothalamus
- **Cerebellum**
- **Cerebrum**

*See the Graphic Organizer*
Fill in the chart!

- Work with the class to complete the table with the functions of each part of the brain.
Sensory information such as vision, smell and hearing processed here. Higher cognitive functions.

Homeostasis: control of body temperature and osmoregulation. Secretes hormones.

Fine motor control, posture and balance.

Links the medulla with the thalamus.

Controls breathing, heart rate and blood pressure; reflex actions such as vomiting and sneezing.

Involved in control of visual and auditory systems. Also controls body movement.
Diagram of Brain Stem

- Forebrain (Cerebrum)
- Midbrain
- Pons
- Medulla Oblongata
- Spinal Cord
- Hindbrain (Cerebellum)
Label Your Diagrams

Use the pictures and your textbook.

The labels are on the diagrams.

Use the next three slides to check your brain diagrams.

You may add color later on.
External structure of the brain

- Frontal lobe
- Parietal lobe
- Occipital lobe
- Temporal lobe
- Cerebellum
- Brain stem
  - Medulla
  - Pons
- Spinal cord
Internal structure of the brain

cerebral cortex
ventricle
hypothalamus
pituitary gland
Diencephalon
corpus collosum
thalamus
cerebellum
pons
midbrain
medulla oblongata
Fill in the Tree Diagram

- Take notes on the 4 parts of the brain using the note taker tree diagram pages.
I. Brainstem – Connects brain to spinal cord

- **Medulla Oblongata**
  - **White Matter** - ascending and descending tracts from brain parts to spinal cord
  - **Gray Matter** – consciousness and arousal
    - Diameter of blood vessels
    - Force of contraction and heartbeat
    - Basic rhythm of breathing

- **Pons Variolii** – bridge between spinal cord and brain
  - Control breathing

- **Midbrain – mesencephalon**
  - Movement of eyeballs and movement of head and trunk in response to loud noise.
II. Diencephalon – Part 1

- **Thalamus** – relay station for sensory impulses to reach the cerebral cortex
  - Pain & temperature recognition
- **Hypothalamus**
  - Body functions related to homeostasis
  - Controls and integrates the ANS
  - Mind over Body
  - Rage and aggressive feelings
  - Thirst
  - Waking and sleeping
  - Food Intake
1. Optic Tracts and Optic Chiasma (optic nerves cross)
2. Infundibulum which attaches to the pituitary gland
3. Mamillary bodies – memory and emotional responses to odor
4. Pineal Gland – part of the epithalamus, secretes melatonin (moods and behavior)
Figure F-2: The Cerebellum

The cerebellum is where learned movements are stored.
III. Cerebellum

- Second largest portion of the brain
- Shaped like a butterfly
- Two partially separated hemispheres connected by the vermis
- Mostly White Matter with a thin layer of Gray Matter (Cerebellar Cortex)
- Reflex center in coordinating complex skeletal muscular movements
- Body Balance
Major External Parts of the Human Brain
(Underside View)

- Frontal Lobe
- Olfactory Bulb
- Temporal Lobe
- Pons
- Cerebellum

Cranial Nerves Shown in BLUE
Part IV. Cerebrum

The largest division of the brain. It is divided into two hemispheres, each of which is divided into four lobes.
Cerebral Cortex - The outermost layer of gray matter making up the superficial aspect of the cerebrum.
Cerebral Features

1. **Gyri** – Elevated ridges “winding” around the brain.

2. **Sulci** – Small grooves dividing the gyri

3. **Fissures** – Deep grooves, generally dividing large regions/lobes of the brain
Gyri (ridge)

Fissure (deep groove)

Sulci (groove)
Lobes of the Cerebrum

- Frontal
- Parietal
- Occipital
- Temporal

Use the Graphic Organizer to take Notes

* Note: Occasionally, the Insula is considered the fifth lobe. It is located deep to the Temporal Lobe.
Lobes of the Cerebrum - Frontal

- It plays an integral role in the following functions/actions:
  - Memory Formation
  - Emotions
  - Decision Making/Reasoning
  - Personality

Modified from: http://www.bioon.com/book/biology/whole/image/1/i-
Lobes of the cerebrum

Frontal lobe
Parietal lobe
Occipital lobe
Temporal lobe

memory_game
Lobes of the Cerebrum - Parietal Lobe

- It plays a major role in the following functions/actions:
  - Senses and integrates sensation(s)
  - Spatial awareness and perception

Lobes of the cerebrum

- Complex movement motor area
- Higher functions association area
- Speech association area
- Smell sensory area
- Auditory sensory area
- Visual and auditory association area
- Visual sensory area
- Comprehension association area
- MAIN motor area
- MAIN sensory area
- Proprioception sensory area

Legend:
- Sensory areas
- Association areas
- Motor areas
Its primary function is the processing, integration, interpretation, etc. of VISION and visual stimuli.
They play an integral role in the following functions:

- Hearing
- Organization/Comprehension of language
- Information Retrieval
  - (Memory and Memory Formation)
Medical imaging technology

CT scans (computerised tomography):

Use X rays to identify major structures and can detect problems such as tumours and aneurisms.

Sometimes a dye has to be injected into the blood.

CT scan showing a brain aneurism (swelling of the artery)
Magnetic resonance imaging (MRI): Uses high level magnetic field and radio waves to image soft tissues. It is useful for diagnosing tumours, clots, infections and brain damage.
Medical imaging technology

Functional magnetic resonance imaging (fMRI):

Monitors changes in brain activity by measuring the changes in blood flow and oxygen uptake.

Allows for the study of the different functions of the parts of the brain.
Brain and Art Activity

  - Using the markers draw your interpretation of the brain and it’s importance to the body
Class 3

April 24, 2014
Neural Tissue, Spinal Cord, and Spinal Nerves

Use the Graphic Organizer to take Notes
### Neural Tissue

- **White Matter** – groups of myelinated axons from many neurons with neuroglia.
  - Nerve tracts of the CNS
  - **Nerve** – bundle of fibers located outside the CNS, most are white matter
- **Gray Matter** – nerve cell bodies and dendrites
  - Cortex of brain
  - **Ganglia** – nerve cell bodies that are grouped together, gray matter
- **Tract** – white matter, bundle of fibers inside the CNS, long distances up and down the spinal cord, brain
  - Ascending (sensation) and descending (motor function) tracts
1. Continuation of the medulla oblongata of the brain stem
2. 16-18 inches
3. 31 segments each with a pair of spinal nerves
4. Protected by the bony spinal column, meninges, cerebrospinal fluid, loose connective tissue and adipose tissue.
5. Functions – convey sensory impulses from the periphery to the brain and conduct motor impulses from the brain to the periphery; integrate reflexes
**Sensory nerve root**
Impulses about bodily sensations are carried by sensory nerve fibres. These converge to form sensory roots at the back of the spinal cord. Impulses are then conveyed to the brain via nerve fibre tracts.

**Sensory root ganglion**
Each spinal nerve has a dorsal (posterior) sensory root ganglion, which is a cluster of nerve cell bodies.

**Motor nerve root**
Bundles of fibres called motor nerve roots leave the front of the spinal cord. The fibres conduct impulses from the central nervous system to control voluntary movement and involuntary processes such as digestion.

**Meninges**
The spinal cord is protected by three layers of connective tissue called meninges. Additional protection is provided by the cerebrospinal fluid circulating in the subarachnoid space.
Spinal Nerves

1. 31 pairs
2. Ventral and Dorsal Roots
3. Mixed nerves – both motor and sensory fibers

Named and numbered according to the region and level of the vertebral column

- 8 pairs cranial nerves
- 12 pairs of thoracic nerves
- 5 pairs of lumbar nerves
- 5 pairs of sacral nerves
- 1 pair of coccygeal nerves
The Spinal Cord

Cervical
(8 Cervical Nerve Pairs)

Thoracic
(12 Thoracic Nerve Pairs)

Lumbar
(5 Lumbar Nerve Pairs)

Sacrum (5 Sacral Nerve Pairs)

1 Coccygeal Nerve
Brain and Mind Video

- Icons of Science Mind and Brain.smi
Class 4

April 25, 2014
Eye

Sclera (white), cornea, choroid, ciliary body, lens, iris, pupil, aqueous humor, vitreous humor, optic nerve, retina (rods/cones), macula lutea with fovea centralis, optic disc (blind spot),
Eye

Lacrimal Gland:
- Pars orbitalis
- Pars palpebralis

Sclera
Iris
Pupil
Lacrimal punctum
Caruncula
Lacrimal canaliculi
Lacrimal sac
A sphere filled with two fluids

- **Layer One:**
  - **Sclera** – white connective tissue; White of Eye
  - **Cornea** – transparent part that allows light into eye
- **Layer Two:**
  - **Choroid** – blood vessels and pigment cells, black and absorbs light
- **Layer Three:**
  - **Retina** – gray with light sensitive cells called rods and cones

Use the Graphic Organizer to take Notes
Other parts

- **Ciliary Body** – smooth muscle that holds the *lens* in place
- **Lens** – biconvex, transparent and flexible
- **Iris** – colored part of the eye, smooth muscle that surrounds the pupil, regulates the amount of light
- **Pupil** – opening for light to enter eye
Interior of Eye – Two Compartments

- Front of Lens – Aqueous Humor
  - Bends light
  - Source of nutrients
  - Maintains ocular pressure
- Posterior to Lens - Vitreous Humor
  - Ocular pressure
  - Bends light
  - Holds the retina and lens in place
Retina

- Photosensitive cells
  - **Rods** – sensitive to light and function in dim light
  - **Cones** – need lots of light, produce color
    - Red, green or blue
- Rods and Cones synapse with the neurons of the eye and synapse with the **optic nerve**
  - Rhodopsin – pigment in rod cells that uses Vitamin A
- **Macula Lutea** – center of retina, yellowish spot
  - **Fovea centralis** – sharpest vision
  - **Optic Disc** – blind spot, no receptor cells
Diagram of the human eye with labeled parts:

- Iris
- Cornea
- Pupil
- Aqueous humour
- Lens
- Vitreous humour
- Macula
- Retina
- Sclera
- Optic disc
- Optic nerve
- Choroid
- Retinal pigment
- Epithelium
Muscles of the right orbit as viewed from the side.
Add the missing labels to your diagram of the Eye!

- Anterior Chamber
- Choroid
- Ciliary Body
- Cornea
- Iris
- Lens
- Macula
- Optic disk
- Optic Nerve
- Retina
- Sclera
- Vitreous body
Aqueous Humor

Check your diagram
Optical Illusions Activity

- [Link to Google Slides presentation](https://docs.google.com/presentation/d/1dDRx9a7M-1104Y13aTB35zvwcTfrBeG1QruLk7AUocg/present#slide=id.io)

- You need scrap paper and something to write with
Ear

External/Middle/Internal Ear; Pinna (auricle), external auditory meatus, tympanic membrane (ear drum), cerumen (ear wax), malleus (hammer), incus (anvil), stapes (stirrup), oval window, round window, auditory or Eustachian tube, cochlea, vestibule, semicircular canals
External Ear

- **Auricle or Pinna** – elastic cartilage, allows sound waves to enter
- **External Auditory Meatus** – ear canal, directs sound waves to ear drum, lined with hairs and cerumen (ear wax) to protect ear drum from foreign objects
- **Tympanic Membrane** – ear drum, silver gray and thin, vibrates with sound waves

Use the Graphic Organizer to take Notes
Middle Ear

- **Auditory Ossicles** or ear bones
  - **Malleus** – hammer
  - **Incus** – anvil
  - **Stapes** – stirrup

- Transmit and amplify sound vibrations to **Oval Window** and **Round Window** to connect to inner ear.

- **Auditory or Eustachian Tube** – opens to the pharynx to equalize air pressure between middle ear and environment
The inner ear contains interconnecting chambers and tunnels within the temporal bone. The cochlea, vestibule, and semicircular canals are all components of the inner ear. The equilibrium (balance) is controlled within the inner ear.
How Does Hearing Work?

Excessive noise exposure is one of the leading causes of hearing loss. The tiny hair cells in the inner ear are easily damaged by loud noise and once you lose them, they never grow back!
Label your diagram of the Ear

- Pinna (Outer Ear)
- Ear Canal
- Middle Ear
- Inner Ear
- Malleus
- Incus
- Semicircular Canals
- Cochlea
- Eustachian Tube
- Ear Drum
- Stapes
Check your diagram
Focus Free-Write

- The next slide is a drawing by MC Escher. Write for 3 minutes about what you see in the picture and how it challenges your mind.