CENTRAL NERVOUS SYSTEM (CNS)

- CNS = central "switchboard" of the nervous system. Brain + spinal cord. Found in the dorsal cavity.

- Grey Matter - a major component of the central nervous system, consisting of neuronal cell bodies, dendrites and unmyelinated axons, glial cells (astroglia and oligodendrocytes) and capillaries.
  
  * Grey matter is made up of neuronal cell bodies. The grey matter includes regions of the brain involved in INTEGRATION: muscle control, sensory perception such as seeing and hearing, memory, emotions, and speech.

- White matter consists mostly of glial cells and myelinated axons that transmit signals from one region of the cerebrum to another and between the cerebrum and lower brain centers.
  
  * Fast, efficient transmission of a signal.

- PROTECTION OF THE CNS - several structures help protect brain and spinal cord from damage:

  1. MENINGES - 3 connective tissue membranes covering brain (lying externally).

    - Functions:
      * cover & protect CNS.
      * protect blood vessels
      * contain CEREBROSPINAL FLUID
      * partition the skull--stop infection in 1 region from spreading to other areas.

    - There are 3 meninges:

      (i) DURA MATER - tough outer covering; outer layer attaches to skull.

      (ii) ARACHNOID MATER - middle layer; separated from dura mater by the SUBDURAL SPACE. Underneath it is the SUBARACHNOID SPACE, filled with CEREBROSPINAL FLUID and blood vessels.

      (iii) PIA MATER - deepest; clings to the brain. Mostly areolar + minute blood vessels.

    - Clinical terms:

      * MENINGITIS - inflammation of meninges. If caused by bacteria or virus, may spread to neural tissue (= ENCEPHALITIS).
2. CEREBROSPINAL FLUID (CSF)

- found in and around the brain & spinal chord. Jelly-like fluid. Cushions CNS & gives nourishment.

* arises from, & similar in composition to, blood plasma.

* pH homeostasis is very important in CNS. This is why we don’t just use blood; blood is always undergoing changes in pH.

* normally, CSF is drained @ a constant rate. However. If something (tumor, swelling) stops drainage of CSF, result is HYDROCEPHALUS (“water on the brain”).

3. BLOOD-BRAIN BARRIER (and blood-spinal cord barrier)

- CNS is VERY susceptible to changes in environment (pH, etc.) - first organ to undergo damage if homeostasis is not maintained.

However, eating, exercise, etc. changes the internal environment minute-by-minute; there is a barrier between the brain and the circulatory system (blood) = BLOOD-BRAIN BARRIER (BBB).

* There is a “blood - spinal cord barrier”. Some consider it an extension of the BBB, others do not. Here, we will look at the BBB only.

- How formed?

  (i) Endothelium of capillaries serving brain is relatively impermeable.

  *VERY selective; lets glucose, AA pass via facilitated diffusion, but doesn't let other substances through.

  (ii) Thick basal lamina of the capillaries serving brain

  (iii) ASTROCYTES, through their shape, form a protective barrier.
I. BRAIN - found in the cranial cavity.

- CEPHALIZATION - increased elaboration of brain & the integration of neurons.
  * Increase of CEREBRAL CORTEX region (see later).
  * Increased complexity of wiring.

A) EMBRYONIC DEVELOPMENT, THE ADULT VESICLES and the VENTRICLES

- Developing embryo has 3 tissue layers.
  * this thickening folds into the neural plate; later, this "pinches off", forming the NEURAL TUBE (completed by 4th week).

* Anterior portion of tube → brain
* Posterior portion of tube → spinal cord
* NOTE: neural tube is a hollow tube.

- As development continues, notice 3 things:

1. In the embryo, tissue continues to expand and develop into the VESICLES.
* First, we have the embryonic regions, which we will not discuss here.

2. The embryonic vesicles expand and developed into the adult vesicles.

   The largest expansion is the telencephalon (Cerebrum) which expands laterally and posteriorly due to constraints within the skull.

   - the forebrain expands so much that it expands laterally & posteriorly, covering the DIENCEPHALON and much of the midbrain.

   * As an adult, the cerebrum forms 2 independent hemispheres, which cover most of the posterior-lying regions.

3. Also, the open areas that arose from the tube expand laterally.

   *end up with BRAIN VENTRICLES (sections of the hollow tube) and BRAIN VESICLES (sections of the overlaying tissue).

   *eventually, the VENTRICLES divide into 3:
     
     Lateral ventricles
     (Previously known as ventricle 1 and ventricle 2)
     
     3rd ventricle
     4th ventricle

   * REMEMBER: these ventricles represent a continuous tube running through the CNS.
- Some terms for structures:

  Tract: analogous to a NERVE outside of the CNS: it is a bundle of cells whose job is to transport information quickly. They are myelinated.

  Nuclei: analogous to a GANGLION outside of the CNS: it is a collection of cell bodies.

  Commissure: Large chunk of white matter; moves information from one side to the other. Acts as an "information bridge".

  Association fibers - connect areas within a single hemisphere.

- The vesicles divide into functional regions (more detail during the rest of the section):

  * I ONLY WANT YOU TO KNOW THE COMMON NAMES OF THE ADULT VESICLES. The following functions are generalities; there are many more:

  1. Cerebrum: collect sensory input, analyze it, and make a command to the effectors.

     Conscious brain. You can be aware of signals going to or arising from the cerebrum. Other parts of the CNS may "notify" the cerebrum.

  2. Diencephalon: "Switching area" and visceral homeostasis. All sensory input coming up from lower regions is sent to the correct area of the cerebrum by the diencephalon.

     Make hormones responsible for maintaining homeostasis of visceral organs (control growth, control metabolism, control electrolyte & water levels, control temperature).

     Large part of the emotional brain (your awareness of visceral well-being), along with the cerebrum.

  3. Midbrain & Brain Stem: Regulate controlled, habitual, and timed events in the body (heart rate, respiratory rate, peristalsis, etc.). All animals share this area. Here are some of the most basic dopamine receptors for pleasure & habitual behaviors. Many visual and other reflexes are controlled here. Alertness and consciousness are activated here.

     - Also, all information moving up and down through the spinal cord passes through the brain stem.

     As the brain develops, the tracts move information up and down. The fibers switch sides at the brain stem, so the right half of the cerebrum communicates with the left side of the body, and vice versa.

  4. Cerebellum: Coordinate muscular activities from different parts of the body.
B) CEREBRUM - can be divided into 2 functional structures or regions:

1. CEREBRAL CORTEX – Grey matter “outer shell”.
   - Surrounds lateral ventricles.
   - Receives & interprets sensory input from body, makes a decision, and stimulates motor response.
   Increased surface area achieved via:
   * GYRUS (I) - elevated ridges of tissue.
   * SULCUS (I) - shallow grooves between gyri.

- CEREBRAL HEMISPHERES ("half circles") - structures of the CEREBRAL CORTEX. Superficial layers are grey, non-myelinated neural tissue.

   * As mentioned, left side communicates with the right side of the body, left side with the right side of the body.

   * Lateralization: "Right brain versus left brain".
     - One side is "categorical" (usually the left, which control the right side of the body) and is involved in analytical sequential thought, the other is "representational" (usually the right side) and puts everything into a holistic (“big picture”) view.

SIDE NOTE

- Memory of shapes, musical ability, non-verbal thought, recognition of faces on right.

- Rational symbolic thought, higher language skills on left with analysis.

   * But, either can be on the left or right side. Men are more lateralized than women. Believed to allow humans to preform basic needs, like eating, while watching environment for predators, etc.

   *The left side of the brain is dominant in about 97% of people.
     - Strong tie to "handedness", but not perfect. Categorical functions tend to be on the dominant side.

Google: Jill Bolte Taylor: My stroke of insight
CEREBRAL LOBES: originally a purely anatomical classification, but have been shown also to be related to different brain functions.

* FISSURES - deepened grooves; separate lobes of the cerebral cortex.

See Table 1 (below) for details on what you need to know regarding the surface features of the cerebrum.

| Table 1. Important Surface Features of the Cerebrum (The Cerebral Cortex). |
|-------------------------------|-------------------------------------------------------------------------------------------------|
| Longitudinal Fissure          | Separates the hemispheres.                                                                      |
| Transverse Fissure            | Separates the cerebrum from the cerebellum below it.                                           |
| Central Sulcus                | Separates the front and posterior lobes. All motor areas are anterior, all sensory areas are posterior to the central sulcus. |
| Frontal lobe                  | Control motor output. Perceive, communicate, understand, and appreciate.                      |
| Posterior lobes (Parietal,    | Sensory input, along with their association areas.                                             |
| Temporal, Occipital)          |                                                                                                 |

CEREBRAL CORTEXES: (HIGHER CORTICAL REGIONS): functional areas with an identifiable job.

(i) MOTOR AREAS - control motor functioning of the body. Found in the FRONTAL LOBE of the Cerebral Cortex. See Table 2 (below) for details on what you need to know regarding the motor areas of the cerebrum.

(ii) SENSORY AREAS - conscious awareness of sensation (i.e., sensory input). Occur in the PARIETAL, TEMPORAL and OCCIPITAL LOBES of the Cerebral Cortex. See Table 3 (below) for details on what you need to know on the sensory areas of the cerebrum.

(iii) ASSOCIATION AREAS - The association areas of the cerebrum consist of association tracts that connect motor and sensory areas and large parts of the cerebral cortex of the various lobes. They allow the motor and sensory areas to communicate. See Table 4 (below) for facts on what you need to know regarding the association areas.
**Table 2. Motor Areas of the Cerebral Cortex. Just know name and underlined function.**

<table>
<thead>
<tr>
<th>Area</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Motor Cortex</strong></td>
<td><strong>Precentral Gyrus</strong>&lt;br&gt;Control specific muscles or groups of muscles.&lt;br&gt;Stimulation of a specific point of the primary motor area results in a muscular contraction, usually on the opposite side of the body.</td>
</tr>
<tr>
<td><strong>Motor Speech Cortex</strong> (Broca's area)</td>
<td><strong>Broca's area (and other language areas) are located in the left cerebral hemisphere of most individuals regardless of whether they are left-handed or right-handed.</strong>&lt;br&gt;<strong>Production of speech.</strong></td>
</tr>
<tr>
<td><strong>Premotor Cortex</strong></td>
<td><strong>Immediately in front of the primary motor cortex.</strong>&lt;br&gt;Learned motor activities of a complex and sequential nature.&lt;br&gt;E.G.: It generates nerve impulses that cause a specific group of muscles to contract in a specific sequence to write a word.</td>
</tr>
</tbody>
</table>
Table 3. Sensory Areas of the Cerebral Cortex. Just know name and underlined function.

<table>
<thead>
<tr>
<th>Primary somatosensory cortex</th>
<th>Postcentral Gyrus</th>
<th>Receives sensations from the cutaneous and muscular receptors in various parts of the body. The amount of space given a particular part of the body determined by the functional importance of the primary somatosensory area is to localise exactly the points of the body where the sensations originate. Some parts of the body are represented by large areas in the primary somatosensory area. These include the lips, face and thumb. Other body parts, such as the trunk and lower limbs, are represented by relatively small areas.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Visual Cortex</td>
<td>Occipital Lobe</td>
<td>Vision</td>
</tr>
<tr>
<td>Primary Auditory Cortex</td>
<td>Temporal Lobe</td>
<td>Sound</td>
</tr>
<tr>
<td>Primary Olfactory Cortex</td>
<td>Temporal lobe</td>
<td>Smell</td>
</tr>
<tr>
<td>Primary Gustatory Cortex</td>
<td>Parietal lobe (close to temporal)</td>
<td>Taste</td>
</tr>
</tbody>
</table>

**SIDENOTE:** A cortical homunculus is a physical representation of the human body, located within the brain, based on the amount of brain allocated to the parts of the body. There are two types of cortical homunculus; sensory and motor.

The sensory homunculus:
Table 4. Association Areas of the Cerebral Cortex. Do not worry about location. Just know name and underlined function.

<table>
<thead>
<tr>
<th>Area</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefrontal Cortex</td>
<td>Anterior-most portion of the Frontal Lobe.</td>
<td>This brain region has been implicated in planning complex cognitive behavior, personality expression, decision making, and moderating social behavior. Abstract thought. Cognition = Learning ability.</td>
</tr>
<tr>
<td>Language areas, including Wernicke's area</td>
<td>Frontal lobe, including prefrontal cortex and Temporal lobe (Wernicke's).</td>
<td>Complex speech and language. Nerve impulses pass to the premotor regions that control the muscles of the throat, voice box and mouth. The impulses from the premotor area to the muscles allow the coordinated contractions that enable you to speak. Wernicke's = understanding language. More areas involved. Complex processing.</td>
</tr>
<tr>
<td>Sensory Association Areas</td>
<td>Adjacent to the &quot;Primary Sensory&quot; areas</td>
<td>Perceptions (meaning of senses). E.G.: Auditory Association Area determines whether a sound is noise, speech, or music. Visual Association Area put a &quot;thought&quot; on a sight, such as &quot;hat&quot; or &quot;wife&quot;</td>
</tr>
<tr>
<td>Gnostic area</td>
<td>Complex pathways, mostly in the Parietal lobe, but including the somatosensory, visual and auditory association areas.</td>
<td>Forms a &quot;thought&quot;. It integrates sensory interpretations from the association areas and impulses from the other areas so that a common thought can be formed from the various sensory inputs.</td>
</tr>
</tbody>
</table>

- Clinical pathologies:

* Agnosia is the inability to process sensory information. Often there is a loss of ability to recognize objects, persons, sounds, shapes, or smells.

  Damage to VISUAL CORTEX leads blindness; however, damage to VISUAL ASSOCIATION AREA can lead to a loss of comprehension of what they see (Visual agnosia - inability to recognize what is seen)

* Aphasia – damage to brain causes communication problem.
  Broca's Aphasia – inability to form words.
  Wernicke's Aphasia – inability to form coherent sentences.

**Lots of YouTube videos.**

* Injury to Gnostic area leads to imbecility, lose ability to interpret entire situation.

2. CEREBRAL WHITE MATTER - communication lines between various structures or regions within the cerebrum and between the cerebrum and other brain regions (among other things).

Aggregates of gray matter such as the basal ganglia and brain stem nuclei are spread within the cerebral white matter.

See Table 5 (below) for the white structures you need to know, as well as the aggregated pieces of gray matter.
Table 5. Cerebral White Matter & Associated Structures

<table>
<thead>
<tr>
<th>Structure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corpus callosum</td>
<td><strong>Large commissure running between the 2 cerebral hemispheres.</strong> Facilitates interhemispheric communication.</td>
</tr>
<tr>
<td>The basal ganglia (cerebral nuclei)</td>
<td><strong>Masses of grey matter (nuclei) within the white matter of each cerebral hemisphere.</strong> Control large subconscious movements of skeletal muscles, such as moving hands while speaking, arm movement while walking, regulating muscle tone required for some body movements, etc.</td>
</tr>
<tr>
<td>Amygdala</td>
<td><strong>Masses of grey matter (nuclei) within the temporal lobes.</strong> Critical role in memory &amp; emotional reactions, including fear (part of the <strong>limbic system</strong>; see later)</td>
</tr>
</tbody>
</table>

- **Clinical Pathologies:**

  * **PARKINSON’S DISEASE (PD)** -
    The primary symptoms of Parkinson's disease result from greatly reduced activity of dopamine-secreting cells caused by cell death in the midbrain (see later section on the brain stem)

    The basal ganglia of the cerebrum, which are innervated by the dopaminergic system, are the most seriously affected brain areas in PD.

    Four motor symptoms are considered cardinal in PD: tremor, rigidity, slowness of movement, and postural instability.

    One surgical procedure: **Pallidotomy**: destroy Globus Pallidus (a basal nucleus) with an electrode inserted through top of brain.

  * **EPILEPSY** - a common and diverse set of chronic neurological disorders characterized by seizures.

    In people who have epilepsy, cerebral cortical neurons misfire and result in seizures. This is similar to an electrical brainstorm. The seizure prevents the brain from:
1. Interpreting and processing incoming sensory signals (like visual, somatosensory and auditory information).

2. Controlling muscles. That is why people with epilepsy may fall down and twitch.

Longer explanation at the end of this document

C) DIENCEPHALON - central core of the forebrain. Major relay station: relays all incoming and outgoing neural input to appropriate regions. Encloses the 3rd ventricle. **See Table 6 for specifics.**

Epithalamus: the connection between the limbic system to other parts of the brain.

Hypothalamus performs numerous vital functions, most of which relate directly or indirectly to the regulation of visceral activities.

Thalamus has multiple functions. It may be thought of as a kind of switchboard of information.

In particular, every sensory system (with the exception of the olfactory system) includes a thalamic nucleus that receives sensory signals and sends them to the associated primary cortical area.

Table 6. Diencephalon Functions

<table>
<thead>
<tr>
<th>General Functions:</th>
<th>Encloses the 3rd ventricle. Relay center for sensory info into the cortex, &amp; motor output to the lower centers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epithalamus</td>
<td>Pineal Gland: Connection to emotional brain. Secretes the hormone melatonin, regulates sleep/wake cycle.</td>
</tr>
<tr>
<td>Thalamus</td>
<td>None specified: Mediates most sensory input to the cortex, and motor output. All sensory input synapses with thalamic nuclei (except olfaction). Emotions &amp; visceral functioning also mediated here, communicating with the Amygdala.</td>
</tr>
</tbody>
</table>

- Clinical pathologies of hypothalamus: disorders in body homeostasis. Dehydration, obesity, severe weight loss, emotional disorders, sleep disorders, endocrine complications, etc. Tumor on the pituitary leads to serious endocrine problems. More detail in "Limbic System" (this chapter) and Endocrine section of class.
D) MIDBRAIN & BRAIN STEM - produces the rigid programmed, automated behaviors needed for survival. 10 of the 12 CRANIAL NERVES originate from the stem.

Table 7. Midbrain & Brain Stem Functions

<table>
<thead>
<tr>
<th>General Functions:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Produces rigid, programmed behavior. Associated with 10 of the 12 cranial nerves, importantly the Vagus Nerve.</td>
<td>Critical role in alertness and consciousness.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pons</td>
<td></td>
<td>Relay between higher brain centers &amp; spinal cord.</td>
</tr>
<tr>
<td>Medulla oblongata</td>
<td>Corpo quadrigemina</td>
<td>1) CARDIOVASCULAR CENTER - several nuclei adjust the force &amp; rate of heart contractions &amp; blood pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) RESPIRATORY CENTER - several nuclei adjusting rate &amp; depth of breath.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) VARIOUS OTHER CENTERS - nuclei associated with the vomiting centers, swallowing centers, coughing centers, sneezing centers, etc.</td>
</tr>
</tbody>
</table>

- Pathologies of the brain stem can result to abnormalities in the function of cranial nerves which may lead to visual disturbances, pupil abnormalities, and co-ordination problems. Loss of consciousness (coma). See “Reticular Activating System” later in chapter.
E) CEREBELLUM - receives motor from cerebral cortex that is on way to body tissue and is responsible for the TIMING and COORDINATION of body’s responses to sensory input.

Cerebellar hypoplasia - Cerebellum not matured at birth. Seen in some dog and cat breeds.

F) FUNCTIONAL BRAIN SYSTEMS - networks of neurons that work together to perform a function; not localized in one location. We will consider 2 of them:

1. LIMBIC SYSTEM - our emotional or AFFECTIVE BRAIN.

Parts of the cerebral hemispheres and diencephalon constitute the limbic system.

Primary function: determines visceral homeostasis (how you “feel” about things) - pleasure, anger, rage, fear, sorrow, sexual feelings, docility and affection. It is therefore sometimes called the "visceral" or "emotional" brain.

Together with portions of the cerebrum, the limbic system also functions in memory

* Odors, etc. elicit emotional response and memories.

* Consists of part of the diencephalon (mostly hypothalamus) = the "switch" between autonomic & emotional response.

Emotional stress can cause physical problems: ulcers, high BP, etc. = PSYCHOSOMATIC ILLNESS (NOT “imaginary”) and PLACEBO EFFECT (people do get better 40-50% of the time; not just "in their heads").
Also connected with the higher cortical regions = connection between thoughts & emotions - you are aware of your emotions!

**emotions can override logic, and logic can override emotions.

Includes the amygdala and hippocampus (new structure – converting short-term memory to long-term memory, and spatial navigation)

- Clinical Condition:

  Alzheimer’s disease (AD), also known as Alzheimer disease, or just Alzheimer’s, accounts for 60% to 70% of cases of dementia.

  It is a chronic neurodegenerative disease that usually starts slowly and gets worse over time.

  The most common early symptom is difficulty in remembering recent events (short-term memory loss).

  As the disease advances, symptoms can include problems with language, disorientation (including easily getting lost), mood swings and loss of motivation, not managing self-care, and behavioral issues.

  As a person’s condition declines, they often withdraw from family and society. Gradually, bodily functions are lost, ultimately leading to death. Although the speed of progression can vary, the average life expectancy following diagnosis is three to nine years.

  Common: 3 million US cases per year
2. RETICULAR FORMATION

- Functions to arouse brain as a whole: alert, consciousness.
  * consists of far-flung axonal connections throughout brain & spinal cord.

* RETICULAR ACTIVATION SYSTEM (RAS) - fibers that go up into cerebral cortex, allowing sensory info to activate consciousness.

** Some people like to study in a noisy area - activates the brain!

** The RF also acts as a filter - repetitive, weak inputs are filtered out!

99% of all sensory input is filtered out as "unimportant" - or, brain would not be able to function if consciously we were aware of all incoming sensory input (peripheral vision, touch of clothes, etc.).

* But, the brain IS recording it!

LSD removes the sensory dampers - you notice ALL sensory input (colors, shapes, etc).

Alcohol & tranquilizers depresses them.

COMA - damage to this system, such as a damaged brain stem.

I) HOMEOSTATIC IMBALANCES OF THE BRAIN

1. TRAUMATIC INJURIES

   CONCUSSION: “Shaking”. Injury is slight, symptoms are transient.
   CONTUSION: “Bruising”. More pronounced, many symptoms

2. DEGENERATIVE AND DEVELOPMENTAL BRAIN DISEASES

   (i) STROKES (CEREBROVASCULAR ACCIDENTS or CVA): blocked blood flow leads to tissue damage and tissue death.

   Unfortunately, neurons do not undergo mitosis, and therefore extensive damage is not usually repairable. Some recovery is seen, as neurons sprout new branches.


   * Sometimes, “Embolic” or “Thrombotic” - Often, due to a clotting problem, in which case future CVAs are a danger.

   Hemorrhagic - ruptured vessel causes bleeding onto the brain.

   (iii) CEREBRAL PALSY - (palsy = “paralysis”) neuromuscular disability where voluntary muscles are poorly controlled as a result of brain damage.

   * May be accompanied with secondary mental impairment, but cerebral palsy refers to the motor impairment.

   * Causes:
     - Intrauterine infections, teratogens.
     - A temporary lack of oxygen to fetus during very difficult delivery, or soon after birth, especially toxins and injury to brain
     - Premature babies are especially susceptible
II. THE SPINAL CORD

- 2-way conduction system to & from the brain, where most integration occurs.

- Some integration occur in the spinal cord - REFLEXES (decision is made in the spinal cord; never makes it to the brain).

  *really just an extension of the same tissue composing the brain; also contains an inner grey matter (where integration occurs), surrounded by a superficial white matter layer (where long-distance relay occurs), surrounded by the same 3 meninges, CSF and an epidural space (filled with blood vessels and a thick fat layer that serves as a cushion).

- Gross anatomy will be dealt with in lab.

A) GRAY MATTER & SPINAL ROOTS

- Neurons (in bundles called “nerves”) carry info to spinal cord. Enter through DORSAL ROOT, characterized by a DORSAL ROOT GANGLION. Enter gray matter, interconnect with INTERNEURONS. Then, leave spinal cord via the ventral root and carry info back out to effector cells.

- a cross section of the spinal cord reveals white matter surrounding an inner gray matter mass that is “butterfly-shaped”
  * Central canal with CSF
  * 3 “columns”

- The columns are myelinated tracks, which are conducting information superiorly & inferiorly.

  Superiorly-bound info is sensory going to brain. These are "ascending tracks".

  Inferiorly-bound info is motor output. These are "descending tracks".

- Clinical pathologies:

  * Poliomyelitis ("polio") - virus that destroys the anterior horn motor neurons. Flu-like symptoms; but, if virus advances, can have enough neural damage to cause paralysis.
B) WHITE MATTER & SPINAL TRACKS
- contains both myelinated & non-myelinated neurons. Neurons run up and down through the spinal cord in bundles called TRACKS.

*ASCENDING - run upward; = sensory input. Some (4 out of 6) go to cortex for conscious input. Some important ascending tracks:

(i) Lateral & anterior spinothalamic (spine to thalamus): pain, pressure, temperature input.
(ii) Anterior & posterior spinocerebellar tracks(spine to cerebellum) : info on location of body parts to cerebellum, which coordinates movements.
(iii) Dorsal column pathway: carry different sensory kinesthetic (joint sense) & proprioception to cerebral cortex (conscious brain).

* DESCENDING - run downward; = motor output. Two kinds:

(i) PYRAMIDAL (corticospinal) - voluntary movement control. Primary somatic control.
(ii) ALL OTHER TRACKS (extrapyramidal) - functions varied. Many somatic tracks of "non-conscious skeletal muscle control".

C) Clinical pathologies involving the spinal cord:

1. TRAUMATIC INJURIES

*PARALYSIS - damage to spinal cord or roots causes motor loss.

* FLACCID PARALYSIS - damage to ventral root leads to loss of neural input to muscles; not only loss of motor control but also of muscle tone.

ATROPHY = muscle tissue eventually turned into fibrous connective tissue, not reversible, permanent loss of muscle mass.

* PARAPLEGIA (FLACCID) - damage between T1 and L1 vertebrae leads to loss of lower limb control.


Torso problems, also (loss of bladder control, sexual dysfunction, etc.). If at C1, loss of respiratory control, also.

* QUADRIPLEGIA (SPASTIC) - associated with severe cerebral palsy. Spasticity of the limbs as opposed to strict paralysis. Hypertonia of the muscles due to damaged motor neurons.

While affecting all four limbs more or less equally, can still present parts of the body as stiffer than others, such as one arm being tighter than another arm, etc.
2. DEGENERATIVE AND DEVELOPMENTAL SPINAL CORD DISEASES

*AMYOTROPHIC LATERAL SCLEROSIS (LOU GEHRIG’S DISEASE or ALS): progressive destruction of anterior horn and pyramidal tracks.

Loss of speech, swallowing, and breathing; death in 5 years or less after diagnosis.

Genetic base.

* SPINAL BIFIDA - incomplete formation of the spinal arches, usually in the lumbosacral region.

Worst case = SPINA BIFIDA CYSTICA, a sac-like protrusion of spinal cord appears; can lead to paralysis, hydrocephaly and severe infections.

Linked to maternal folic acid intake during pregnancy.