Nervous System
CNS and PNS

Brain

Brain: has 4 main parts:
1. Cerebrum
2. Diencephalon
3. Cerebellum
4. Brain Stem
   - Mid Brain
   - Pons
   - Medulla

Main Cavities of Brain
Lateral Ventricles are present in cerebral hemispheres
3rd ventricle is present in Diencephalon
4th ventricle is present in Medulla
Mid-Brain does not have a ventricle but a narrow duct Cerebral Aqueduct that joins 3rd and 4th ventricles
Choroid Plexus is present in roof of all 4 ventricles and secrete cerebrospinal fluid (CSF).

Cerebrum -1

Cerebrum is the largest part of brain.
Longitudinal fissure divides cerebrum into left and right cerebral hemispheres. Transverse fissure separates it from cerebellum
Central sulcus divides frontal and parietal lobes. Lateral cerebral sulcus = lateral fissure divides temporal lobe from frontal and parietal lobes.
Insula = insular cortex lies deep beneath frontal, parietal and temporal lobes. It regulates visceral functions, social behavior and cravings.
Cerebral cortex is the thin folded surface of cerebrum. Gyri (sing. Gyrus) are ridges and sulci (sing. Sulcus) are grooves. Primary areas for specific functions lie in cerebral cortex. Gray matter forms cerebral cortex.

Cerebrum-2

Primary Areas:
- General Motor area lies in front of central sulcus and control voluntary movements of skeletal muscles.
The area just behind central sulcus is the general Sensory Area to receive sensory input.
Primary vision area lies in visual cortex in occipital lobe.
Primary Gustatory Area lies on lateral side of frontal lobes and receives information about taste.
Primary Auditory Area lies in temporal lobes and receives information about sounds.
Primary Olfactory area lies in temporal lobe very close to frontal lobes and receives inputs about smells.
Association Areas lie next to primary areas and use inputs from other resources to take final decisions.

Cerebral Lateralization: Left hemisphere usually controls speech making; general interpretations; right hemisphere deals with spatial relationships, logical analysis. It occurs due to crossing of pyramids in medulla.

Functions of the Cerebrum

Conscious thought
Intelligence: Intellectual activity
Memory
Origin of complex patterns of movement

Gray M – White M – basal nuclei

Each Cerebral Hemisphere: has
Cerebral Cortex – formed of gray matter = cell bodies and unmyelinated nerve fibers
Cerebral white – formed of myelinated nerve fibers lies below gray matter and
Basal nuclei – lie deeper, have clusters of cell bodies in background of white matter.

The Diencephalon

The diencephalon is 2nd part of forebrain. It has
Epithalamus – roof of diencephalon and has
Choroid plexus – secretes CSF
Pineal body – is an endocrine gland

Thalamus – Very thick lateral walls of diencephalon and perform following functions:
Switching and relay center
Integration of conscious and unconscious motor and sensory pathways

Hypothalamus is floor of diencephalon
It maintains temperature and concentration of body fluids by homeostasis
Has hunger and thirst centers
Regulates anterior pituitary and other endocrine glands

The Brain Stem

Midbrain:
Anterior - Cerebral peduncles
Posterior - Corpora quadrigemina
Cerebral aqueduct – links 3rd and 4th ventricles
Functions:
Process visual, auditory reflexes
Generate involuntary movements

Pons:
is a thick bulge in front of medulla oblongata
Functions:
Links to cerebellum
Involved in control of movement

Medulla oblongata:
most inferior part of brain, leads to spinal cord
Has pyramids and olives
has 4th ventricle and choroid plexus in it
Functions:
Links brain and spinal cord
Relay sensory information
Cardiovascular centers and Respiratory centers

The Cerebellum
Cerebellum is the 2nd largest part of brain, lies posterior to medulla oblongata and pons
Has a small median constricted part – vermis and
2 cerebellar hemispheres, each formed of anterior, posterior, and flocculonodular lobes
Folia (leaves) are thin parallel ridges of gray matter
Arbor vitae: is tree like branching pattern made of white matter in background of gray matter
3 Cerebellar peduncles link to brain stem (Superior cerebellar peduncle), cerebrum (middle cerebellar peduncle), spinal cord (inferior cerebellar peduncle)
Functions:
Oversees postural muscles (flocculonodular lobes)
Stores patterns of movement
Fine tunes most movements

Limbic system

Limbic system is a functional division of brain having parts of gray and white matter. It has portions of frontal lobe and temporal lobe; thalamus and hypothalamus -parts of diencephalon, and structures around
them including many nuclei.

Functions:
- Establish emotions and related drives
- Link intellectual functions of cerebral cortex to autonomic functions of brain stem
- Control reflexes associated with eating
- Store and retrieve long-term memories

Reticular Formation
- Is a meshwork of gray and white matters in brain stem
- Reticular Activating System = RAS:
  - Ascending part and controls consciousness
  - RAS is stimulated by inputs from many sources except smells
  - Awake – RAS fully activated
  - Sleep – RAS is partially activated
  - Coma – RAS inactivated
- Descending part of RAS has connections with cerebellum and spinal cord; it controls muscle tone
- Damage to neurons here causes Parkinson’s disease

Meninges – CNS coverings

**Meninges:** Dura mater, Arachnoid and Pia Mater cover brain and Spinal Cord.
- **Dura mater:** Tough mother. Outermost is dura mater. Dura mater has sinuses filled with venous blood. Epidural space is cavity inner to it.
- **Arachnoid mater:** is middle covering. It has fibers making a network in subarachnoid space, cavity inner to it (spider web like arrangement).
- **Pia mater:** Delicate mother, is innermost covering and is in contact with brain or spinal cord.

**Meningitis:** is bacterial or viral inflammation of meninges covering brain and spinal cord. It is treatable but can be dangerous.

Blood-Brain Barrier

**Blood-Brain-Barrier** is formed of capillary cells with tight junctions and Astrocytes. It does not allow all things in blood to enter brain.
- Choroid plexus is a network of fine capillaries present in the roof of all 4 ventricles and secrete Cerebrospinal fluid = CSF.
- CSF supports brain, provides nourishment and protection. CSF moves freely in ventricles and central canal of spinal nerve cord. It passes through foramina in roof of 4th ventricle and enters subarachnoid space. From here CSF diffuse through Arachnoid Villi (clusters of slender extensions) into superior sagittal sinus by penetrating the inner layer of dura mater. It returns CSF to venous blood.

Spinal Nerve Cord

**Spinal Cord:** has a narrow central canal lined with ependyma and filled with cerebrospinal fluid. Gray matter lies around central canal and has 2 anterior and 2 posterior extensions = Horns. The outer part is formed of white matter. It has anterior, posterior, and lateral funiculi (sing. = funiculus) in it.
- Ascending and descending pathways lie in Funiculi(seen in T.S.).
- Spinal cord is S-shaped. Thoracic curvature – posterior; Sacral curvature - anterior

Peripheral Nervous System

Any nerve tissue outside CNS is PNS. It consists of
- **Cranial Nerves:** 12 pairs – 1st, 2nd, and 8th sensory; 3rd, 4th, and 6th motor – eyeball muscles; 11th and 12th also motor; and 5th, 7th, 9th, and 10th are mixed nerves.
- Mnemonic from Lab manual by Eric Wise is, “Old Oliver Ogg Traveled To Africa For Very Good Vacations and Holidays”.
**Spinal Nerves:** 31 pairs = 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal

Cranial and Spinal nerves are Somatic sensory, visceral sensory and Somatic motor in function. **Autonomic Nervous System** is visceral motor in function and has sympathetic and parasympathetic divisions.

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Nature and Function</th>
<th>Passes through</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Olfactory</td>
<td>Sensory, smell; passes through cribriform plate</td>
<td>olfactory foramina</td>
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<tr>
<td>2</td>
<td>Optic</td>
<td>Sensory, sight; form optic chiasm</td>
<td>optic canal</td>
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<tr>
<td>3</td>
<td>Oculomotor</td>
<td>Motor, eyeball muscles, eyelids, iris</td>
<td>superior orbital fissure</td>
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<tr>
<td>4</td>
<td>Trochlear</td>
<td>Motor, superior oblique muscle of eyeball</td>
<td>superior orbital fissure</td>
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<tr>
<td>5</td>
<td>Trigeminal</td>
<td>Mixed, sensory for face, orbit, mouth, nose motor – controls chewing</td>
<td>superior orbital fissure, foramen spinosum, foramen ovale</td>
</tr>
<tr>
<td>6</td>
<td>Abducens</td>
<td>Motor, lateral rectus muscle of eyeball</td>
<td>superior orbital fissure</td>
</tr>
<tr>
<td>7</td>
<td>Facial</td>
<td>Mixed, taste from anterior 2/3 rd tongue, motor for face expression, salivary and lacrimal glands</td>
<td>internal acoustic meatus, stylomastoid foramen</td>
</tr>
<tr>
<td>8</td>
<td>Vestibulocochlear</td>
<td>Sensory; balance and hearing</td>
<td>internal acoustic meatus</td>
</tr>
<tr>
<td>9</td>
<td>Glossopharyngeal</td>
<td>Mixed, sensory posterior 1/3 rd tongue, pharynx, motor- parotid salivary gland and muscles in pharynx</td>
<td>jugular foramen</td>
</tr>
<tr>
<td>10</td>
<td>Vagus</td>
<td>Mixed, pharynx and larynx, viscera; carries PS fibers</td>
<td>jugular foramen</td>
</tr>
<tr>
<td>11</td>
<td>Accessory Spinal</td>
<td>Motor, sternocleidomastoid and trapezius</td>
<td>jugular foramen</td>
</tr>
<tr>
<td>12</td>
<td>Hypoglossal</td>
<td>Motor, muscles of tongue</td>
<td>hypoglossal canal</td>
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</tbody>
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**Spinal Nerves**

- The Spinal Nerves - 31 Pairs = 8 Cervical, 12 Thoracic, 5 Lumbar, Sacral and 1 Coccygeal
- Spinal nerve: origin – dorsal root and ventral root; dorsal root has ganglion; roots combine to form spinal nerve
- Spinal nerve branches: dorsal – sensory; ventral – motor
- Nerve Plexus—A complex, interwoven network of nerves
- Four Large Plexuses
  - Cervical plexus – phrenic nerve
  - Brachial plexus – Axillary, musculocutaneous, radial, and ulnar nerves
  - Lumbar plexus – femoral nerve
  - Sacral plexus – sciatic nerve, tibial and main fibular nerves
- Dermatome—is a region of the body surface monitored by a pair of spinal nerves

**Autonomic Nervous System** has 2 divisions sympathetic and parasympathetic. These always work antagonistic to each other.
<table>
<thead>
<tr>
<th><strong>Sympathetic</strong> = Thoracolumbar division</th>
<th><strong>Parasympathetic</strong> = Craniosacral division</th>
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</thead>
<tbody>
<tr>
<td>1. Preganglionic neurons lie in lateral horns of gray matter in thoraco-lumbar part of spinal cord and enter lateral ganglia through spinal nerves.</td>
<td>1. Preganglionic neurons lie in brain nuclei of cranial nerves and sacral part of spinal cord.</td>
</tr>
<tr>
<td>2. Thoraco-lumbar - Sympathetic trunks (T1-T12 – L1-L5)</td>
<td>2. Cranio-sacral – 3rd, 7th, 9th, 10th cranial nerves and spinal nerve cord through 2nd, 3rd, 4th sacral spinal nerves</td>
</tr>
<tr>
<td>3. Post ganglionic fibers are <strong>Adrenergic</strong> and secrete epinephrine formerly called adrenalin.</td>
<td>3. Post ganglionic fibers are <strong>Cholinergic</strong> and secrete Acetylcholine.</td>
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<td>4. Pre ganglionic fibers (before synapse) are shorter than postganglionic fibers</td>
<td>4. Pre ganglionic fibers are longer than postganglionic fibers</td>
</tr>
<tr>
<td>5. Fight or flight – response to unusual stimuli (emergency, excitement, exercise, embarrassment), increases activity</td>
<td>5. Maintains house-keeping activities, conserves energy, promotes digestion, defecation and diuresis – passing out enough urine</td>
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