LEARNING OBJECTIVES: PART 3

8. List the major subdivisions and anatomical landmarks of the brain
9. List the meninges & the order in which they are found around the brain
10. Identify the cerebral ventricles, surrounding fluid and difference between white and grey matter
11. Identify the four main lobes of the cerebrum and their functions
12. Identify the main brain regions involved in:
   - The control of movement
   - Receiving information on somatic sensation
   - Memory formation & storage and emotion
13. Describe the role of the hypothalamus, thalamus & cerebellum

MAJOR SUBDIVISIONS AND ANATOMICAL LANDMARKS OF THE BRAIN: LO8

- Brainstem
  - Medulla oblongata (myelencephalon)
  - Pons
  - Midbrain (mesencephalon)
- Cerebellum (metencephalon – w/ pons)
- Forebrain
  - Diencephalon (hypothalamus, thalamus, pituitary, epithalamus)
  - Cerebrum (telencephalon)

PROTECTION OF THE CNS

- Bony structures
  - Cranial (skull) encases brain
  - Vertebral column surrounds spinal cord
- Meninges
  - Three membranes between bone and nervous tissue (dura mater, arachnoid mater, pia mater)
- Cerebrospinal fluid (CSF)
  - Formed by selective transport across choroid plexus
- Blood-brain barrier
  - Tight junctions between capillary endothelial cells
THE MENINGES: LO9

Meninges are the connective tissue covering the brain and spinal cord.

Outer to innermost layers:
- Dura mater
- Arachnoid
- Pia mater

CEREBRAL VENTRICLES, SURROUNDING FLUID AND DIFFERENCE BETWEEN WHITE AND GREY MATTER: LO10

- Cerebral ventricles are spaces within the brain, they are connected and continuous with the spinal cord.
- 4 in total
- Produce CSF
CEREBRAL VENTRICLES, SURROUNDING FLUID AND DIFFERENCE BETWEEN WHITE AND GREY MATTER

- CSF contains mostly ions and some glucose. Different to plasma, with only a few lymphocytes present, very few plasma proteins — this is because of the BBB
-役 of CSF?
  - Shock absorption / mechanical trauma
  - Exchange of materials between neural cells & ISF
    - Only brain ISF (not blood or CSF) comes into direct contact with neurons & glial cells
  - 30 ml/h produced in the dog

BLOOD BRAIN BARRIER (BBB)

- highly selective, exchanges across capillaries in brain strictly regulated & limited
- Anatomically & physiologically, the BBB acts to limit exchange
  - Tight junctions inhibit exchange across cell walls
  - Only possible exchanges are through cells — diffuse across cells (lipid soluble substances), or membrane-bound protein carriers
CEREBRAL VENTRICLES, SURROUNDING FLUID AND DIFFERENCE BETWEEN WHITE AND GREY MATTER

- White matter – dense collections of myelinated fibres
  - "Wires" connecting computers to each other
- Grey matter – mostly cell bodies, dendrites and unmyelinated fibres
  - "Computers" of the CNS
- Integration of neural input & initiation of neural output → synapses within grey matter

STRUCTURE OF THE BRAIN

Figure 5-26 p187
THE CEREBRUM: LO11

80% of brain mass in human
2 hemispheres connected by corpus callosum ("information highway")
Responsible for higher mental functions

FOUR MAIN CEREBRAL LOBES: LO11

4 main functional lobes
- Frontal
- Parietal
- Temporal
- Occipital

Sulci (grooves) & gyri (wills) — increase SA in higher mammals
Outer layer = cerebral cortex (highly convoluted)
Inner core = basal nuclei / cerebral medulla
Remember — no part of the brain functions in isolation — complex interplay amongst the parts

FOUR MAIN FUNCTIONAL CEREBRAL LOBES: LO11

<table>
<thead>
<tr>
<th>Region</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal</td>
<td>Voluntary motor activity, planning/reasoning, mood, smell, social judgement, vocal ability</td>
</tr>
<tr>
<td>Parietal</td>
<td>Receives and integrates sensory information, movement</td>
</tr>
<tr>
<td>Occipital</td>
<td>Visual centre</td>
</tr>
<tr>
<td>Temporal</td>
<td>Hearing, smell, learning, memory, emotional behaviour, speech</td>
</tr>
</tbody>
</table>
### The Main Brain Regions Involved In: Control of Movement (LO12)

<table>
<thead>
<tr>
<th>Level</th>
<th>Strategy (Goal of the Movement)</th>
<th>Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Strategy (goal of the movement)</td>
<td>Neocortex, Motor cortex</td>
</tr>
<tr>
<td>Middle</td>
<td>Tactics (sequence of muscle contractions, arrangement in space)</td>
<td>Cerebellum</td>
</tr>
<tr>
<td>Low</td>
<td>Execution</td>
<td>Brain stem, spinal cord</td>
</tr>
</tbody>
</table>
THE MAIN BRAIN REGIONS INVOLVED IN: RECEIVING INFORMATION ON SOMATIC SENSATION (LO12)

Somatic sensation allows your body to feel — pain, temperature, pressure.

Thalamus is the point where neural messages are collected. Messages come from mechanoreceptors, nociceptors and thermoreceptors.

The integration of messages happens in the somatosensory cortex (parietal lobe).

THE MAIN BRAIN REGIONS INVOLVED IN: MEMORY FORMATION & STORAGE AND EMOTION (LO12)

Prefrontal cortex: controls expression of emotions

Emotions formed in hypothalamus and amygdala: fear, anger, pleasure, love, etc.

Behaviour: often learned by rewards and punishments or responses of others

Aggression and fear: amygdala & hypothalamus

Feeding & satiety: hypothalamus

Libido: hypothalamus & limbic

Goal directed behaviour (punishment & reward): various forebrain sites, especially hypothalamus & midbrain.
**THE MAIN BRAIN REGIONS INVOLVED IN MEMORY FORMATION & STORAGE AND EMOTION**

**Hypothalamus**

- Maintenance of homeostasis
- Contains neural centres for hunger, thirst, and body temperature
- Contributes to the regulation of sleep, wakefulness, emotions and sexual performance
- Regulates hormone release from pituitary gland
- Coordinates sympathetic and parasympathetic reflexes

**Thalamus**

- Receives input from the limbic system and from all sensory angles apart from olfaction.
- Acts as a ‘filter’ for information (selective hearing)

**Cerebellum**

- Maintains body posture and balance, controls eye movements
- Coordinates movement
- Integrates information from proprioceptors
LEARNING OBJECTIVES: PART 3

14. How many pairs of cranial nerves are there and which one innervates the viscera?

15. Describe the gross and microscopic structure of the spinal cord.

16. Describe the general components of a typical reflex arc.

17. What are the main structural and functional features of the autonomic nervous system?

18. How do the two divisions of the autonomic nervous system differ in their general function?

HOW MANY PAIRS OF CRANIAL NERVES ARE THERE AND WHICH ONE INNERVATES THE VISCERA? LO14

Cranial nerves come directly from the brain, as opposed to spinal nerves.

12 pairs

- 2 from forebrain, 10 from midbrain/hindbrain

Some are afferent, some efferent

Mostly for head except vagus (X) for viscera

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Olfactory</td>
<td>Olfaction</td>
</tr>
<tr>
<td>II</td>
<td>Optic</td>
<td>Vision</td>
</tr>
<tr>
<td>III</td>
<td>Oculomotor</td>
<td>Controls eye movement</td>
</tr>
<tr>
<td>IV</td>
<td>Trochlear</td>
<td>Eye movement</td>
</tr>
<tr>
<td>V</td>
<td>Trigeminal</td>
<td>Mouth movements</td>
</tr>
<tr>
<td>VI</td>
<td>Abducens</td>
<td>Eye movement</td>
</tr>
<tr>
<td>VII</td>
<td>Facial</td>
<td>Taste</td>
</tr>
<tr>
<td>VIII</td>
<td>Vestibulocochlear</td>
<td>Hearing and equilibrium</td>
</tr>
<tr>
<td>IX</td>
<td>Glossopharyngeal</td>
<td>Swallowing muscles</td>
</tr>
<tr>
<td>X</td>
<td>Vagus</td>
<td>Motor control of larynx, pharynx, oesophagus, parasympathetic control of heart/lungs, gut</td>
</tr>
<tr>
<td>XI</td>
<td>Accessory</td>
<td>Head movement</td>
</tr>
<tr>
<td>XII</td>
<td>Hypoglossal</td>
<td>Tongue movement</td>
</tr>
</tbody>
</table>
GROSS AND MICROSCOPIC STRUCTURE OF THE SPINAL CORD: LO15

Vertebral column positioning determines the naming of the cord and nerves:
- Cervical, thoracic, lumbar, sacral, caudal
- Spinal cord ends in lumbar region and then fans out (cauda equina)
- Meninges same as in brain, but dura mater not fused. This makes the epidural space.

![Diagram of the spinal cord and meninges](image)
CAUDA EQUINA (LATIN FOR HORSE’S TAIL)

GROSS AND MICROSCOPIC STRUCTURE OF THE SPINAL CORD: LO15

HORNS: grey matter
- Dorsal – interneuron cell bodies (sensory receiving)
- Ventral – motor neuron cell bodies
- Lateral – autonomic nervous system

COLUMNS: white matter
- Axons
- Grouped into tracts of common locations and functions

ROOTS: connecting points between spinal nerves and spinal cord

Figure 5-17 p178
TYPICAL REFLEX ARC: LO16

Spinal cord function:
- Links brain and body
- Integrates information without brain input

Reflex arc is that simple integration
STIMULUS

Receptor
Sensory (afferent) pathway
Interneuron (integration)
Motor (efferent) pathway
Effector organ - Action response

MAIN STRUCTURAL AND FUNCTIONAL FEATURES OF THE AUTONOMIC NERVOUS SYSTEM: LO17

Innervate organs whose function is not normally under voluntary control (no brain input)
- smooth muscles, cardiac muscle, glands

This includes most visceral organs and blood vessels
- Therefore regulates all body systems
- Including skeletal muscle since muscles contain blood vessels

AUTONOMIC NERVOUS SYSTEM

- **Sympathetic system**
  - Preparation for strenuous physical activity in *emergency* situations (fight or flight)
  - Heart rate increases
  - Respiratory airways open
  - Glycogen and fat stores are broken down
  - Blood vessels supplying skeletal muscle dilate
  - Pupils dilate

- **Parasympathetic system**
  - General housekeeping activities in *relaxed* situations
  - Digestion
  - Emptying the urinary bladder

**Components of a reflex arc**
- Afferent pathway (sends impulses to the brain)
- Efferent pathway (sends impulses to the effector organs)
- Integrating center (spinal cord)
- Effector organs (response)
How do the two divisions of the autonomic nervous system differ in their general function? LO18

**Sympathetic NS**
- Fight or flight

**Parasympathetic NS**
- Rest or digest

**Table 5-2: Effects of the Autonomic Nervous System on Various Organs**

<table>
<thead>
<tr>
<th>Organ</th>
<th>Sympathetic NS</th>
<th>Parasympathetic NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td>Increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>Airways</td>
<td>Dilate</td>
<td>Constrict</td>
</tr>
<tr>
<td>Digestive tract</td>
<td>Inhibit</td>
<td>Activate</td>
</tr>
<tr>
<td>Skeletal blood vessels</td>
<td>Dilate</td>
<td>Constrict</td>
</tr>
<tr>
<td>Peripheral blood vessels</td>
<td>Contract</td>
<td>No change</td>
</tr>
<tr>
<td>Energy stores</td>
<td>Release</td>
<td>No change</td>
</tr>
</tbody>
</table>

**Notes:**
- Sympathetic NS: Increased heart rate, decreased salivary gland secretion.
- Parasympathetic NS: Decreased heart rate, increased salivary gland secretion.

**Legend:**
- SNS: Sympathetic Nervous System
- PSNS: Parasympathetic Nervous System
<table>
<thead>
<tr>
<th>Glands</th>
<th>Effect on Exocrine Glands</th>
<th>Effect on Endocrine Glands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exocrine Glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salivary glands</td>
<td>Stimulation of small volume of thick saliva in mouth</td>
<td></td>
</tr>
<tr>
<td>Sertoli cells</td>
<td>None</td>
<td>Stimulation of insulin and glucagon secretion</td>
</tr>
<tr>
<td>Brain activity</td>
<td>Increased alertness (exceptions unknown)</td>
<td>None</td>
</tr>
</tbody>
</table>