Nervous System and Brain Review

Bio 3201
Dont worry about:
  glial cells
Oligodendrocytes
Satelite cells etc
Nervous System

- Vital to maintaining homeostasis in organisms
- Comprised of: brain, spinal cord and neurons
- NS performs a variety of functions:
  - Regulating body temperature
  - Too much sugar
There are two major parts that comprise the nervous system:

1. The Central Nervous System
2. The Peripheral Nervous System
Central Nervous System

The CNS is comprised of two main parts:

1. the brain
2. the spinal cord.

Its function is to receive sensory information and initiate motor control.
Protection of the CNS

4 structures used in protection:

1. Skull - case around the brain
2. Vertebrae - enclose spinal cord
3. Meninges - protective membranes surrounding brain and spinal cord
4. Cerebrospinal fluid - fills spaces within the meninges to cushion and provide further protection
Structure of the Spinal Cord

- Function = provide communication between the brain and the peripheral nervous system (PNS)

- The spinal cord extends from the vertebrae in back through the bottom of the skull and into the base of the brain.

- Spinal Nerves will pass through the vertebrae and out to the PNS
Cross section of the spinal cord will show:

- Central canal with cerebrospinal fluid
- Gray matter
- White matter
Grey matter = brownish-gray in color and contains sensory neurons, motor neurons and interneurons (letter H)

= surrounding the gray matter - contains myelinated axons of interneurons that run together in tracts. Ascending (going up) tracts carry info to the brain. Descending tracts (going down) tracts carry info away from the brain
The structure of the Brain

- The brain process information transmitted from the senses so that the body can react to changes in the external and internal environment
- The brain makes up 2% of the body weight
- May contain 15% of the blood supply
- Consumes 20% of the body’s oxygen and glucose supply
- Involves neurons, an internal hormone system and complex interconnections
Parts of the Brain and Function

1. Cerebrum
2. Cerebellum
3. Medulla
4. Thalamus
5. Hypothalamus
6. Midbrain
7. Pons
8. Corpus callosum
Cerebrum - largest part of the brain, responsible for complex behaviour and intelligence. Interprets sensory information and initiates motor impulses.

Cerebellum - “little brain” responsible for motor skills
**Medulla oblongata** - this structure is the caudal-most part of the brain stem, between the pons and spinal cord. It is responsible for maintaining vital body functions, such as breathing and heart rate.

**Thalamus** - The structure has sensory and motor functions (sorts sensory info)
**Hypothalamus** - controls hunger, body temperature, aggression and other aspects of metabolism and behaviour

**Midbrain** - short segment of the brainstem b/w the cerebrum and the pons, involved mostly in sight and hearing
**Pons** - contains bundles of axons travelling between the cerebellum and the rest of the CNS. Also functions with the medulla to regulate breathing rate and has reflex centres involved in head movement.

**Corpus Callosum** - nerve fibres which separate the left and right hemispheres of the brain.
Brain Structure

- Cerebral cortex
- Frontal lobe
- Parietal lobe
- Temporal lobe
- Occipital lobe
Cerebral cortex = thin layer that covers each hemisphere of the brain and contains over 1 billion cells. The surface is made up of grey matter. Divided into four lobes:

1. Frontal
2. Parietal
3. Temporal
4. Occipital
Frontal lobe

Contains:

- Primary motor area
- Premotor area
- Motor speech (Broca’s area)
- Prefrontal area
**Parietal Lobe:**

Contains:

- Primary somatosensory area
- Somatosensory association area
- Primary taste area
Temporal Lobe:

Contains:
- Auditory association area
- Primary auditory area
- Sensory speech (wernicke’s) area
Occipital Lobe:

Contains:

- Primary visual area
- Visual association area
The Peripheral Nervous System (PNS)

- Includes the nerves that lead in and out of the CNS
- There are two divisions in the PNS
  - Autonomic Nervous System (ANS)
  - Somatic Nervous System (SNS)
The autonomic nervous system is not consciously controlled. The autonomic nervous system affects various organs in the body such as the heart, digestive tract, blood vessels, bladder, bronchi and eye. Some functions such as breathing may work in conjunction with the conscious mind.

It is composed of (a. the sympathetic and (b. the parasympathetic nervous system. 

a. The sympathetic nervous system mainly controls organs in times of stress (fight or flight). This results in increases in the heart rate and breathing rate. Blood sugar is released from the liver to provide energy.

b. The parasympathetic nervous system is considered complementary to the sympathetic nervous system and is called “rest and digest”. It functions with actions that do not require immediate attention. It will also operate after a threat in which the nerves cause the heart rate and the breathing rate to slow.
The somatic nervous system is under conscious control. It is made up of sensory nerves that carry impulses from the sense organs to the CNS. It is also composed of motor neurons that transmit the commands of the CNS to the muscles. The somatic nervous system will also involve reflex actions that are not under conscious control.
CENTRAL NERVOUS SYSTEM

PERIPHERAL NERVOUS SYSTEM

SOMATIC NERVOUS SYSTEM
- Acetylcholine
- Voluntary
  - Skeletal muscle

AUTONOMIC NERVOUS SYSTEM
- Parasympathetic
  - Norepinephrine during sleep or light activity
- Sympathetic
  - Epinephrine during increased activity, danger, or stress

Involuntary
- Cardiac muscle
- Smooth muscle of organs, glands, and vessels
Somatic vs. Autonomic

- **Somatic efferent innervation**
  - Myelinated fiber
  - Somatic effectors (skeletal muscles)

- **Autonomic efferent innervation**
  - Myelinated preganglionic fiber
  - Unmyelinated postganglionic fiber
  - Autonomic ganglion
  - Visceral effectors (cardiac muscle, smooth muscle, glands)
The nervous system and homeostasis

NS responsible for reviving info from internal and external stimuli

Four (4) requirements are necessary for a nervous response to occur:

1. Sensory receptors detect stimuli (skin, eye and ear)
2. Method for impulse transmission (neuron)
3. Interpretation and analysis of impulses (brain and spinal cord)
4. Response carried out by the effector (muscle or gland)
Structure and Function of the Neuron
Schwann Cell - makes up the myelin sheath

Nodes of ranvier are indentations between each Schwann cell
Neuron

• Three basic types:
  – *Sensory Neurons*
    • Conduct nerve impulses from sensory receptor (eye or ear) to the brain & spinal cord
    • Travel from periphery to central site
    • Direction of travel is afferent
  – *Motor Neurons*
    • Carry neural instructions from the brain to muscles or glands
    • Travel from central nervous system to the periphery
    • Direction of travel is efferent
  – *Interneurons*
    • Most numerous of all types
    • Constitute neural tissue of brain & spinal cord
Reflex Arc
Neuron Function

- When there is no activity = neuron is at rest
- Impulse transmitted along a neuron = wave of depolarization
- Repolarization - process to bring the neuron back to rest
Action Potential
Action Potential - is an all or none response!
Neurotransmitters to know:

1. Acetylcholine (cholinesterase - breaks down acetylcholine - alzheimer's disease)
2. Noradrenaline (norepinephrine)
3. Glutamate
4. GABA (gamma amino butyric acid)
5. Dopamine
6. Serotonin
1. Acetylcholine (cholinesterase - breaks down acetylcholine - alzheimer's disease)

- Inhibitory and excitatory
- Involved in learning, mood, and memory in the CNS
- In PNS it stimulates skeletal muscles (sympathetic) but inhibits cardiac muscles (parasympathetic)
Noradrenaline/ norepinephrine

- Reduced levels are linked to depression

- Elevated levels will lead to stress (increase heart rate and glucose in blood stream)
Glutamate

- Used in the cerebral cortex and accounts for 75% of excitatory transmissions in the brain
- Oversupply stimulates the brain - producing migraines and seizures

Dopamine:

- Excitatory and inhibitory
- Elevates mood, controls sleep, cognition, attention and learning
- Reward system by inducing pleasurable effects
Serotonin

- Excitatory and inhibitory
- Sleep / wake cycle, mood, thermoregulation, attention and learning
- Reduced levels linked to depression
Drugs

1. Stimulants
2. Depressants
3. Hallucinatory drugs
4. Analgesics
5. Anesthetics
Disorders of the Nervous System

1. Multiple Sclerosis
2. Alzheimer’s Disease
3. Parkinson’s Disease
4. Meningitis
5. Huntington’s Disease
Multiple Sclerosis

Canada has the highest rate of multiple sclerosis (MS) in the world, with an estimated 100,000 Canadians living with the disease. While it is most often diagnosed in young adults aged 15 to 40, younger children and older adults are also diagnosed with the disease.