AS PSYCHOLOGY REVISION

BIOPSYCHOLOGY
3.2.1 Approaches in Psychology
Specification

3.2.1.1 Biopsychology

- The divisions of the nervous system: central and peripheral (somatic and autonomic).
- The structure and function of sensory, relay and motor neurons. The process of synaptic transmission, including reference to neurotransmitters, excitation and inhibition.
- The function of the endocrine system: glands and hormones.
- The fight or flight response including the role of adrenaline.
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

THE CENTRAL NERVOUS SYSTEM (CNS)

• The CNS is made up of the BRAIN and the SPINAL CORD

• The CNS CONTROLS BEHAVIOUR and REGULATES THE BODY’S PHYSIOLOGICAL PROCESSES

• So to do this the brain will need to:
  – Receive information from the SENSORY RECEPTORS (eyes, ears, skin, etc)
  – Be able to send messages to the muscles and glands of the body

THE BRAIN

• This is divided into four areas:
  CEREBRUM
  CEREBELLMUM
  DIENCEPHALON
  BRAIN STEM
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

THE CEREBRUM

CEREBRUM – This is the largest part of the brain divided into 4 other parts
- FRONTAL LOBES – functions such as speech, thought and learning
- PARietAL LOBES – sensory information (touch, pain, temperature)
- TEMPORAL LOBES – hearing and memory
- OCCIPITAL LOBES – visual information
- The cerebrum is split down the middle into two CEREBRAL HEMISPHERES
- Each hemisphere is specialised for particular behaviours and the two halves communicate with each other through the CORPUS CALLOSUM

THE CEREBELLUM

- This is found underneath the back of the cerebrum
- It controls a person’s MOTOR skills and balance, coordinating the muscles to cause precise movements
- Speech and motor problems and epilepsy are caused if there are abnormalities in the cerebellum
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

THE DIENCEPHALON

• This is found beneath the cerebrum and on top of the brain stem

• There are two important structures found here:
  
• The THALAMUS
  – This is a relay station for nerve impulses from the senses, steering them to the appropriate part of the brain to be processed

• The HYPOTHALAMUS
  – Functions include the regulation of body temperature, hunger and thirst
  – This is a link between the ENDOCRINE SYSTEM (glands and hormones) and the nervous system, controlling the release of hormones from the pituitary gland
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

THE BRAIN STEM

- This is responsible for regulating the automatic functions that are essential for life (breathing, heartbeat and swallowing)
- Motor and sensory neurons travel through the brain stem, allowing impulses to pass between the brain and the spinal cord

THE SPINAL CORD

- The main function of this is to relay information between the brain and the rest of the body
- This allows the brain to monitor and regulate body processes, like digestion and breathing, and to coordinate voluntary movements (e.g. muscle contraction)
- The spinal cord is connected to different parts of the body by pairs of spinal nerves, which connect with specific muscles and glands (they carry messages to and from muscles and glands)
- The spinal cord also contains circuits of nerve cells that enable us to perform some simple reflexes without direct involvement of the brain (e.g. pulling your hand away from something that is hot)
- If the spinal cord is damaged, areas supplied by spinal nerves below the damaged site will be cut off from the brain and will stop functioning
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

CENTRAL NERVOUS SYSTEM (CNS)

The brain is the centre of awareness. It is divided in two hemispheres. The cortex is more developed in humans than in all other animals.

The spinal cord is an extension of the brain. It transports messages to and from the brain to the peripheral nervous system. It is also responsible for reflexes.

THE PERIPHERAL NERVOUS SYSTEM

- This is made up of all the nerves outside of the CNS
- Its function is to relay nerve impulses from the CNS to the rest of the body and from the body back to the CNS
- There are two sections of the Peripheral Nervous System:
  - SOMATIC NERVOUS SYSTEM
  - AUTONOMIC NERVOUS SYSTEM (ANS)
THE PERIPHERAL NERVOUS SYSTEM

THE SOMATIC NERVOUS SYSTEM

- This is made up of 12 pairs of cranial nerves (nerves that come directly from the underside of the brain) and 31 pairs of spinal nerves (nerves that come directly from the spinal cord)
- These nerves have both SENSORY NEURONS and MOTOR NEURONS
- Sensory Neurons relay messages TO the CNS
- Motor Neurons relay information FROM the CNS to other areas of the body
- The somatic system is also involved in reflex actions without the involvement of the CNS, which allows for the reflex to occur very quickly

THE AUTONOMIC NERVOUS SYSTEM (ANS)

- Involuntary actions are regulated by the ANS (e.g. carrying out some actions without conscious awareness like digesting food, etc)
- The ANS is essential because vital body functions would not work as efficiently if we had to think about them
- The ANS is split into THE PARASYMPATHETIC NERVOUS SYSTEM and THE SYMPATHETIC NERVOUS SYSTEM
  - These sections of the ANS regulate the same organs but have the opposite effects
  - This is due to the neurotransmitters associated with each division
  - Generally the sympathetic system uses NORADRENALINE (also known as NOREPINEPHRINE) which has a stimulating effect and the parasympathetic system uses ACETYLCHOLINE which has inhibiting effects
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

THE PERIPHERAL NERVOUS SYSTEM

AUTONOMIC NERVOUS SYSTEM (ANS)

THE SYMPATHETIC NERVOUS SYSTEM (SNS)

• This is primarily involved in responses that help us deal with emergencies (e.g. fight or flight) such as increasing heart rate and blood pressure and dilating blood vessels in the muscles

• Neurons from the SNS travel to virtually every organ and gland in the body, preparing the body for the rapid action needed when the person is under threat
  – E.g. the SNS causes the body to release stored energy, pupils dilate and hair to stand on end. It slows bodily processes that are less important in emergencies (e.g. digestion, urination)

THE PARASYMPATHETIC NERVOUS SYSTEM (PNS)

• The PNS relaxes the actions caused by the SNS once the emergency has passed
  – E.g. the PNS slows the heartbeat down and reduces the blood pressure

• Another benefit is that digestion (inhibited when the SNS is aroused) begins again under PNS influences

• Because the PNS is involved with energy conservation and digestion, it is sometimes referred to as the body’s rest and digestion system
# The Opposing Actions of the Sympathetic and the Parasympathetic Nervous System

<table>
<thead>
<tr>
<th>Organ</th>
<th>Sympathetic Nervous System</th>
<th>Parasympathetic Nervous System</th>
</tr>
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<tbody>
<tr>
<td>Gut</td>
<td>Slows digestion</td>
<td>Increases digestion</td>
</tr>
<tr>
<td>Salivary glands</td>
<td>Inhibits saliva production</td>
<td>Increases saliva production</td>
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<tr>
<td>Heart</td>
<td>Increases heart rate</td>
<td>Decreases heart rate</td>
</tr>
<tr>
<td>Liver</td>
<td>Stimulates glucose production</td>
<td>Stimulates bile production</td>
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<tr>
<td>Bladder</td>
<td>Stimulates urination (relaxes the bladder)</td>
<td>Inhibits urination (contracting bladder)</td>
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<tr>
<td>Eye</td>
<td>Dilates pupils</td>
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<tr>
<td>Lungs</td>
<td>Dilates bronchi</td>
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The major sub-divisions of the human nervous system.
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• The divisions of the nervous system: central and peripheral (somatic and autonomic).

• The structure and function of sensory, relay and motor neurons. The process of synaptic transmission, including reference to neurotransmitters, excitation and inhibition.

• The function of the endocrine system: glands and hormones.

• The fight or flight response including the role of adrenaline.
STRUCTURE AND FUNCTION OF NEURONS

- Neurons carry neural information throughout the body
  - They are either sensory neurons, relay neurons or motor neurons
- Neurons consist of a cell body, dendrites and an axon
- Dendrites connect to the cell body (which controls the neuron)
- Impulses are carried along the axon from the cell body, where it terminates at the axon terminal (end)
- In many nerves they have an insulating layer that covers the axon, called the **MYELIN SHEATH**
  - This allows nerve transmitters to transmit more rapidly along the axon
- If the myelin sheath is damaged then the message slows down
- Neurons can be a few millimetres up to one meter
THREE TYPES OF NEURONS

1. Sensory Neuron
2. Interneuron
3. Motor Neuron
THREE TYPES OF NEURONS

SENSORY NEURONS
- These carry nerve impulses from sensory receptors (e.g. receptors for vision, touch, taste, etc.) to the spinal cord (found in eyes, ears, tongue and skin)
- They convert this information into neural impulses
- When these impulses reach the brain they are translated into sensations of visual input, heat, pain etc. so the appropriate reaction can be made
- Some neurons do not travel to the brain, they terminate at the spinal cord
  - This allows reflex actions to occur quickly without the delay of sending impulses to the brain

RELAY NEURONS
- Most neurons lie somewhere between the sensory input and the motor output
- They allow sensory and motor neurons to communicate with each other
- The relay neurons lie wholly within the brain and spinal cord

MOTOR NEURONS
- These neurons are located in the central nervous system (CNS) that project their axons outside the CNS and directly or indirectly control muscles
- They form synapses with muscles and control their contractions
- When motor neurons are stimulated they release neurotransmitters that bind to receptors on the muscle and trigger a response which leads to muscle movement
- When the axon of a motor neuron fires, the muscle with which it has formed a synapse with contracts
- The strength of the muscle contraction depends on the rate of firing of the axons or motor neurons that control it
- Muscle relaxation is caused by the inhibition of the motor neuron
SYNAPTIC TRANSMISSION

ACTION POTENTIAL
• Neurons must transmit information both within the neuron and from one neuron to the next
• The dendrites of neurons receive information from sensory receptors or other neurons
• This information is then passed down to the cell body and to the axon
• Once the information has arrived at the axon, it travels down its length in the form of an electrical signal known as an ACTION POTENTIAL

SYNAPTIC TRANSMISSION
• Once an action potential has arrived at the terminal (end) of the axon, it needs to be transferred to another neuron or tissue
• So it must cross the gap between the presynaptic neuron (the one sending the information) and the postsynaptic neuron (the one receiving the information)
  – This area is known as the SYNAPSE and includes the end of the presynaptic neuron, the membrane of the postsynaptic neuron and the gap between them
  – This gap is known as the SYNAPTIC GAP
SYNAPTIC TRANSMISSION

• At the end of the axon of the nerve cell are a number of sacs known as **synaptic vesicles**
• These contain chemical messengers that assist in the transfer of the impulse (**neurotransmitters**)
• As the action potential reaches the synaptic vesicles it causes them to release its contents (i.e. neurotransmitters) through a process called **EXOCYTOSIS**
• The neurotransmitters diffuse across the synaptic gap and binds on to specialised receptors on the surface of the cell that recognise it and are activated by that particular neurotransmitter
• Once activated the receptor molecules produce either excitatory or inhibitory effects on the postsynaptic neuron
SYNAPTIC TRANSMISSION

- The whole process of **SYNAPTIC TRANSMISSION** only takes a fraction of a second.
- The effects of the transmission are terminated at most synapses by a process called **RE-UPTAKE**.
- The neurotransmitter is taken up again by the presynaptic neuron where it is stored and made available for later release (a recycling programme).
- How quickly this happens determines how prolonged its effects will be.
  - I.e. if it is taken back quickly its effects on the postsynaptic neuron are short-lived and vice-versa.
- Some antidepressant drugs prolong the action of neurotransmitter by inhibiting the re-uptake process, leaving the neurotransmitter in the synapse for longer.
- Neurotransmitters can also be “turned off” after they have stimulated the postsynaptic neuron.
- This takes place through the action of enzymes produced in the body, which make the neurotransmitters ineffective.
EXCITATORY AND INHIBITORY NEUROTRANSMITTERS

- Neurotransmitters can be classified as either excitatory or inhibitory in their action
- **Excitatory neurotransmitters** (e.g. acetylcholine and noradrenaline) are the nervous system’s “on switches”
- These increase the likelihood that an excitatory signal is sent to the **postsynaptic cell**, which is then more likely to fire
- **Inhibitory neurotransmitters** (e.g. serotonin and GABA) are the nervous system’s “off switches” in that they decrease the likelihood of that neuron firing
- Inhibitory transmitters are generally responsible for calming the mind and body, inducing sleep and filtering out unnecessary excitatory signals

- An excitatory neurotransmitter binding with a postsynaptic receptor causes an electrical change in the membrane of that cell, resulting in an excitatory postsynaptic potential (EPSP)
  - Meaning that the postsynaptic cell is more likely to fire
- An inhibitory neurotransmitter binding with a postsynaptic receptor results in an inhibitory postsynaptic potential (IPSP)
  - Making it less likely that the cell will fire
EXCITATORY AND INHIBITORY NEUROTRANSMITTERS

• A nerve cell can receive both EPSP’s and IPSP’s at the same time
• The likelihood of the cell firing is determined by adding up the excitatory and the inhibitory synaptic input
• The net result of this calculation (or SUMMATION) determines whether or not the cell fires

The strength of an EPSP can be increased in two ways
– In SPATIAL SUMMATION a large number of EPSP’s are generated at many different synapses on the same postsynaptic neuron at the same time
– In TEMPORAL SUMMATION a large number of EPSP’s are generated at the same synapse by a series of high-frequency action potentials on the presynaptic neuron

The rate at which a particular cell fires is determined by what goes on in the synapses
– If excitatory synapses are more active, the cells fire at a high rate
– If inhibitory synapses are more active, the cells fire at a much lower rate, if at all
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ENDOCRINE SYSTEM

ENDOCRINE GLANDS

• Endocrine glands produce and secrete hormones

• The major glands of the endocrine system is the pituitary gland, adrenal glands and reproductive organs (testes or ovaries)
  – Each one producing different hormones which regulate the activity of organs and tissue in the body

• The endocrine system is regulated by feedback
  – E.g. a signal is sent from the hypothalamus to the pituitary gland in the form of a “releasing hormone”
  – This causes the pituitary gland to secrete a “stimulating hormone” into the bloodstream
  – This hormone then signals the target gland to secrete its hormone
  – As levels of this hormone rise in the blood, the hypothalamus shuts down the secretion of the releasing hormone and the pituitary gland shuts down secretion of the stimulating hormone
  – This slows down secretion of the target gland’s hormone, ending in stable concentrations of hormones in the bloodstream

HORMONES

• Hormone comes from the Greek word hormao (meaning “I excite”)
  – Meaning hormones “excite” or stimulate parts of the body

• These are chemicals that circulate in the bloodstream and are carried to target sites

• A given hormone usually only affects a limited number of cells (TARGET CELLS)

• Target Cells respond to a particular hormone because they have receptors for that hormone

• Cells that don’t have these receptors cannot be stimulated by that hormone

• When enough receptor sites are stimulated by hormones, a physical reaction in the target cell takes place

• Too much or too little at the wrong time can result in dysfunction of the bodily systems
  – E.g. extremely high levels of cortisol can lead to Cushing’s syndrome (characterised by high blood pressure, obesity and depression).
ENDOCRINE SYSTEM

PITUITARY GLAND
• This produces hormones whose primary function is to influence the release of hormones from other glands (which regulates many of the body’s functions)
• The pituitary is controlled by the hypothalamus (found just above the pituitary gland)
• The hypothalamus receives information from various sources about the basic functions of the body, then use this information to help regulate these functions
  — On way is to control the pituitary gland
• The pituitary gland (“master gland”) produces hormones that travel in the bloodstream to their specific target
• These hormones either directly cause changes in physiological processes in the body or stimulate another gland to produce another hormone
• High levels of hormones produced in other endocrine glands can stop the hypothalamus and pituitary glands from releasing more of their own hormones
• This is called negative feedback and prevents hormone levels from rising too high

HORMONES PRODUCED BY THE PITUITARY GLAND
• The pituitary gland is split into the anterior (front) pituitary and posterior (back) pituitary and they each release different hormones which target different glands or cells
  — E.g. the anterior pituitary releases ACTH as a response to stress by stimulating the adrenal glands to produce cortisol
  — The anterior pituitary also produces two hormones important in the control of reproductive functioning and sexual characteristics (females = ovaries to produce oestrogen and males = testes to produce testosterone
  — E.g. the posterior pituitary releases oxytocin, which stimulates contraction of the uterus during childbirth (it is also important for mother-child bonding)

The Pituitary Gland
ADRENAL GLANDS
• The two adrenal glands sit on top of the kidneys and is made up of two parts:
  – The ADRENAL CORTEX is the outer part and releases hormones necessary for life
  – The ADRENAL MEDULLA is the inner part and releases hormones not necessary for life

HORMONES PRODUCED BY THE ADRENAL GLANDS – ADRENAL CORTEX
• The adrenal cortex produces cortisol which regulates and supports a number of important bodily functions (e.g. cardiovascular and anti-inflammatory)
  – Cortisol production is increased in response to stress
  – If the cortisol is low then the person has low blood pressure poor immune function and an inability to deal with stress
• The adrenal cortex also produces aldosterone which is responsible for maintaining blood volume and blood pressure

HORMONES PRODUCED BY THE ADRENAL GLANDS – ADRENAL MEDULLA
• The adrenal medulla releases adrenaline and noradrenaline, hormones that prepare the body for fight or flight
  – Adrenaline helps the body respond to stressful situations by increasing heart rate, and blood flow to the muscles and brain and converting glycogen to glucose to provide energy
  – Noradrenaline constricts the blood vessels, causing blood pressure to increase
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FIGHT OR FLIGHT RESPONSE

AMYGDALA AND HYPOTHALAMUS

• When we are faced with a threat the **AMYGDALA** is activated (associates sensory signals with emotions like fear or anger)

• The amygdala then sends distress signals to the **HYPOTHALAMUS** (which is like a command centre in the brain that communicates with the rest of the body through the **SYMPATHETIC NERVOUS SYSTEM = SNS**)

• The body’s response to stress involves two major systems:
  – One for **ACUTE STRESSORS** (i.e. sudden) like a personal attack
  – One for **CHRONIC STRESSORS** (i.e. ongoing) like a stressful job
FIGHT OR FLIGHT RESPONSE

RESPONSE TO ACUTE (SUDDEN) STRESSORS

SYMPATHETIC NERVOUS SYSTEM (SNS)

• When the SNS is triggered, it starts to prepare the body for the rapid action necessary for fight or flight

• It sends signals to the ADRENAL MEDULLA, which then releases the hormone ADRENALINE into the bloodstream

  ADRENALINE

  • When adrenaline is released into our bloodstream it makes the heart beat faster and increases blood pressure (taking blood to the muscles, heart and other vital organs quicker)

  • Digestion is inhibited (suppressed)

  • Breathing becomes more rapid (to take in as much oxygen per breath as possible)

  • Glucose and fats are also released into the bloodstream, supplying energy to the areas needed

PARASYMPATHETIC NERVOUS SYSTEM (PNS)

• When the threat has passed the PNS (found in the AUTONOMIC NERVOUS SYSTEM = ANS) reduces the stress response

• Heart rate is slowed down and blood pressure is reduced

• The PNS also starts digestion again
FIGHT OR FLIGHT RESPONSE

RESPONSE TO ACUTE (SUDDEN) STRESSORS

Stressor presented

↓

SNS in the ANS aroused to prepare for fight or flight

↓

SNS neurones stimulate the adrenal medulla (of adrenal gland)

↓

This releases adrenaline into the blood

↓

The body responds by increasing size of pupil, heart rate, blood pressure, breathing rate etc
FIGHT OR FLIGHT RESPONSE

RESPONSE TO CHRONIC (ONGOING) STRESSORS

• If the brain continues to perceive something as threatening, a second system starts

• When the initial surge of adrenaline subsides, the hypothalamus activates a stress response system called HPA AXIS (consisting of the Hypothalamus, the Pituitary Gland and the Adrenal Glands)

• H – The HYPOTHALAMUS
  – The HPA Axis relies on a series of hormonal signals to keep the SNS working. With the continued threat the Hypothalamus releases CORTICTROPHIN-RELEASING HORMONE (CRH) which is released into the bloodstream in response to the stressor

• P – The PITUITARY GLAND
  – CRH arrives at the pituitary gland which releases ADRENOCORTICOTROPHIC HORMONE (ACTH). From the pituitary gland ACTH is transported in the blood to its target site in the Adrenal Gland

• A – The ADRENAL GLANDS
  – ACTH arrives at the adrenal glands and stimulates the ADRENAL CORTEX to release stress-related hormones, including CORTISOL. This is responsible for several effects in the body important to fight-or-flight (positive like quick bursts of energy and negative like lowered immune response)

• FEEDBACK
  – This system is very efficient at regulating itself
  – Both the pituitary gland and hypothalamus have special receptors monitoring the circulation of cortisol levels
  – If these rise above normal, they initiate a reduction in CRH and ACTH levels which brings the cortisol levels back to normal
FIGHT OR FLIGHT RESPONSE

RESPONSE TO CHRONIC (ONGOING) STRESSORS OVERVIEW

Perception of stressors by higher brain centres

Hypothalamus

CRH

Pituitary Gland

ACTH

Adrenal Cortex

Cortisol causes stress effects in the body

Negative Feedback