Section D: Sensory Mechanisms

1. The Brain

(a) Structures of the Human Brain

See diagram from your own notes.

(b) Functions of the Human Brain

Each of the individual structures identified within the brain have specific functions.

Cerebrum:
Site of **conscious** thought, responses and **higher centres**. The term higher centres refers to our abilities such as reasoning, imagination, creativity, independent thought and memory.

Cerebellum:
Controls **balance** and co-ordinates **movement**.

Medulla:
Controls **breathing** and **heart rate**.

Hypothalamus:
Contain centres that regulate **water balance** and body **temperature**.

The brain is the **most complex organ** within the human body, it can be **damaged easily**. If our brain is damaged by an impact to the skull, or by chemical means (e.g. alcohol or drugs), it may not be able to repair itself. The human brain **controls** the activities of most other **vital organs** within the body.

(c) Sensory and Motor Functions of the Cerebrum

The **Cerebrum** is a complex area of the brain. It is responsible for most of the **higher processes** which the brain performs. Each of these higher functions tends to be located within a specific area or region of the Cerebrum. Two areas of the Cerebrum, present in both the left and right hemispheres, are the "**Motor Strip**" and the "**Sensory Strip**".

(i) Sensory Strip

Information from the various **sensory organs** located throughout the body send information to the **cerebrum**, in particular to the **sensory strip**. Once information has reached the sensory strip, it is sent to **other parts** of the **brain** for processing.

The area of the sensory strip occupied by a particular organ is not relative to the size of the organ. Instead, it is **relative** to the **number** of **receptor cells** sending information.

(ii) Motor Strip

Information is passed from other parts of the brain through the **motor strip**, along **motor neurones**, to **muscles** of the body. The motor strip is responsible for controlling the **voluntary movements** of the **muscles**.

The area of the motor strip occupied by a particular group of muscles is not relative to their size. Instead, the area of the motor strip is relative to the number of **motor neurone endings** present in it.

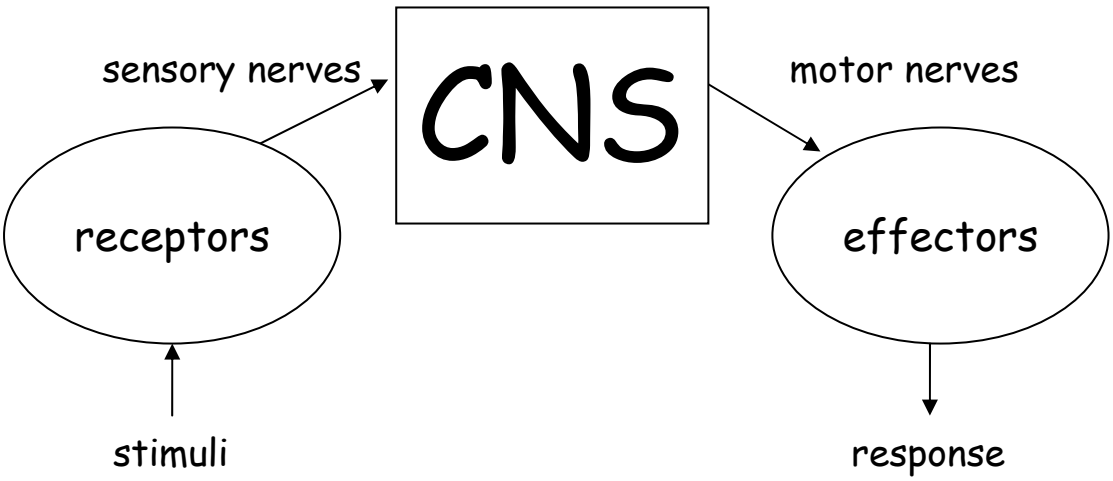
2. The Nervous System

(a) The brain, spinal cord and nerves

The human nervous system is made up of the **brain**, **spinal cord** and associated **nerves**.

The **brain** and **spinal cord** together make up the **Central Nervous System (CNS).** The **CNS** communicates with the rest of the body via its associated **nerves**.

The information flow, within the nervous system, is as follows:



The CNS receives a variety of information from **sensory organs** located throughout the body. It **processes** this information, before mediating an appropriate **response**.

Nerves are made of bundles of nerve cells called **neurones**. Each neurone is made up of a **cell body** attached to an **axon** (neurone fibre). This is a generalised structure, as the different types of nerves found in the human body are made up of different types of neurones.

i.e. sensory neurones, relay fibres and motor neurones.

(b) The Reflex Arc

The **reflex arc** exists as a **rapid protection** system, allowing the body to **respond** very **quickly** to potentially **harmful stimuli**. e.g. very hot surfaces or sharp pain.

When an impulse is transmitted through the reflex arc, a reflex action is mediated. A reflex action is an involuntary reaction to a stimulus. A reflex action does not require conscious thought by the brain, therefore is much faster.

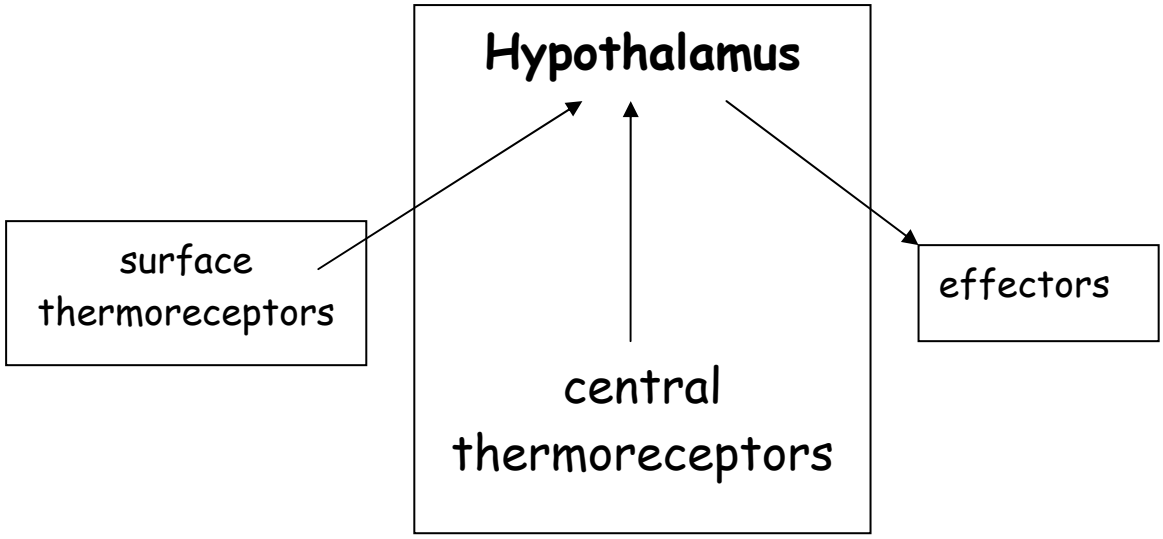
Examples of reflex action responses include:

- Limb withdrawl from a naked flame.
- Blinking due to an approaching object.
- Sneezing when we inhale dust.

(c) Regulation of Body Temperature

The hypothalamus:

- is the temperature control centre for the human body.
- receives surface temperature from thermoreceptors located in the skin throughout the body.
- contains central thermoreceptors to monitor core body temperature.
- Responds to the information it receives, by sending out appropriate motor impulses to effectors.



(i) Involuntary Control of Body Temperature

Involuntary control means that it happens **automatically**, it is controlled at a **subconscious** level by the **hypothalamus**. Body temperature is regulated by **negative feedback control**.

The skin has a primary role to play in the control of body temperature. Various mechanisms exist to modulate the amount of heat **lost** through the skin, and thereby control overall **body temperature**.

i.e. **sweating, body hairs** and **vasodilation / vasoconstriction**

Sweating: Sweating is the release of liquid water from glands of the skin. **Heat energy** from the body is used to convert the liquid water into water vapour. Heat energy is used in this process, and hence **removed** from the **body's** surface.

If the **hypothalamus** receives information that body temperature is too **high**, it will issue a motor response, and **increase sweating**.

If the **hypothalamus** receives information that body temperature is too **low**, it will issue fewer motor responses, and **decrease sweating**.

Body Hairs: Most surfaces of the human body are covered in a layer of fine **hairs**. These hairs may be **raised** and **lowered** dependent on the signals received from the **hypothalamus**.

If the hairs are **raised**, an **insulating** layer of air is trapped next to the skin - **reducing** the amount of heat lost by the skin. This **increases body temperature**. This happens when the hypothalamus receives information that body temperature is too **low**.

If the hairs are **lowered**, **no** insulating layer of air is trapped next to the skin – **increasing** the amount of heat lost by the skin. This **lowers body temperature**. This happens when the hypothalamus receives information that body temperature is too **high**.

Vasodilation/Vasoconstriction: Located in the upper layers of the skin is a dense network of **capillaries**. These capillaries act as a **radiator** to release heat through the **surface** of the skin.

If the **hypothalamus** receives information that body temperature is too **high**, then it will issue a motor response to the **arterioles** in the surface of the skin, causing them to **expand**. **More blood** will flow close to the surface of the skin, and therefore, **more heat** will be **lost** through the surface of the skin. This will **decrease** body temperature.

If the **hypothalamus** receives information that body temperature is too **low**, then it will issue a motor response to the **arterioles** in the surface of the skin, causing them to **constrict**. **Less blood** will flow close to the surface of the skin, and therefore, **less heat** will be **lost** through the surface of the skin. This will **increase** body temperature.

The hypothalamus is also capable of increasing body temperature by physical processes using **skeletal muscles** and the **liver**.

Shivering: If the hypothalamus detects a **decrease** in body temperature, then it can send nerve impulses to skeletal muscles causing them to **repeatedly contract** for a short period of time. This is called **shivering**, and generates heat. Shivering helps return body temperature to normal levels.

Liver: A high rate of **metabolic activity** in the **liver** generates a huge amount of **heat** energy. This heat energy is used by the body to maintain its temperature at an appropriate level. The hypothalamus can influence metabolic rate, and therefore the quantity of heat generated by the liver.

(ii) Voluntary Control of Body Temperature

Information is passed from the **Hypothalamus** to the **Cerebrum**. This allows a person to be aware of their surroundings, including their body temperature.

Under the correct circumstances, a person may feel hot or cold. It is then possible for that individual to make a **voluntary response** appropriate to the situation. A **voluntary response**

involves a person using **conscious thought** before performing an action.

Feeling hot:	have a cold drink. remove a layer of clothing.
Feeling cold:	have a hot drink add a layer of clothing.