AQA GCSE Combined Science Foundation Homeostasis and Response **Knowledge Organiser**

Key Words

central nervous system (CNS)	The brain and spinal cord.
coordination centre	An area that receives and processes information from receptors. Includes the brain, spinal cord and pancreas.
effector	A muscle or gland that brings about a response to a stimulus.
gland	A group of cells which secrete hormones.
homeostasis	The regulation of the internal conditions of a cell or organism to maintain optimum conditions for function in response to internal and external changes.
hormone	A chemical substance secreted by an endocrine gland that regulates the activity of cells.
neurone	A nerve cell, a specialised cell that transmits electrical impulses around the body.
receptor	A specialised cell of the nervous or endocrine system that detects a stimulus.
reflex action	An automatic and rapid response to a stimulus that does not involve the conscious part of the brain.
response	The way the body reacts to a stimulus.
stimulus (plural: stimuli)	A change in the internal or external environment.
synapse	A gap between two neurones. Impulses pass across it by diffusion of chemical neurotransmitters.

Homeostasis

Homeostasis is the regulation of **internal conditions** of a cell or organism to maintain **optimum conditions** for function in response to internal and external changes. Homeostasis maintains optimum conditions for **enzyme action** and **cell functions**.

In humans, homeostasis regulates:

- blood glucose concentration;
- body temperature;
- water levels.

Homeostatic processes are controlled **automatically**. They involve either a **nervous response** controlled by the nervous system or a **chemical response** controlled by the endocrine system.

All control systems include the following key components:

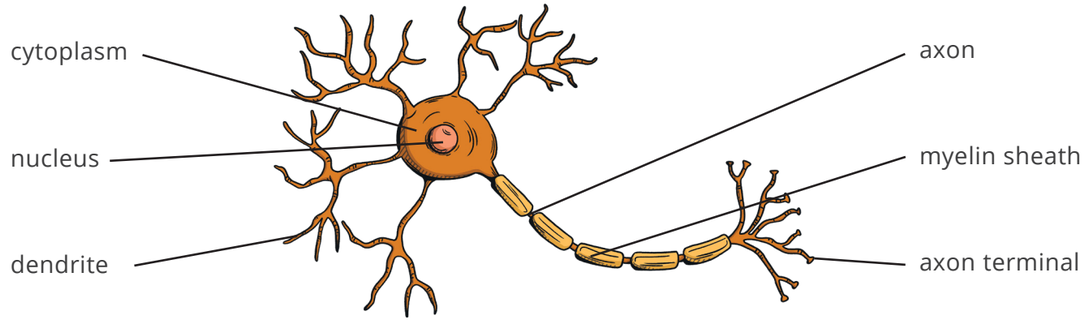
A **receptor** that detects changes in the environment called **stimuli**. The skin contains cells that act as receptors to the stimulus of pressure, for example.

A **coordination centre** such as the brain, spinal cord or pancreas, which processes the information it receives from the receptors.

An **effector** which carries out a **response**. The response restores internal conditions to optimal levels. Effectors are usually muscles or glands.

The Human Nervous System

In a nervous response, the key components of the control system are linked by nerve cells called **neurones**. Neurones are an example of **specialised cells**. They transmit electrical impulses through the nervous system to cause responses to occur.



Neurone Feature	Specialised Function
axon	A long, stretched-out fibre of cytoplasm which the electrical nerve impulse travels along.
axon terminal	Where chemicals called **neurotransmitters** are released. These pass across **synapses**, allowing the nerve impulse to pass between different neurones.
dendrite	Branches which receive neurotransmitter chemicals from other neurones. The dendrites convert these chemicals into electrical signals which travel down the body of the neurone.
myelin sheath	Layer of fatty tissue which surrounds the axon of some (but not all) neurones. It insulates the axon allowing the nerve impulse to be transmitted more efficiently.

There are three types of neurone:

1. **Sensory** neurones link the **receptor** to the **coordination centre**.
2. **Motor** neurones link the **coordination centre** to the **effector**.
3. **Relay** neurones are found within the coordination centre and connect the sensory and motor neurones.

Nerve impulses travel along the following pathway:

[stimulus] → receptor → sensory neurone → coordination centre → motor neurone → effector → [response]

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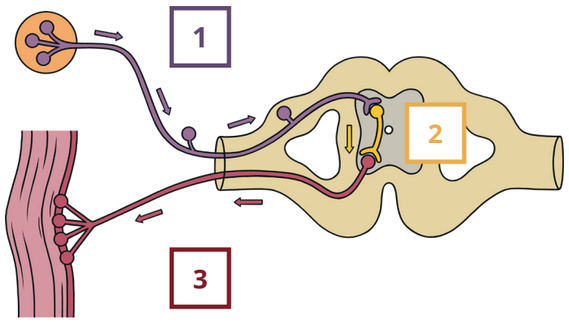
Reflex Arc

A reflex action occurs to prevent you from coming to harm. They do not require conscious thought: they are **rapid** and **automatic**.



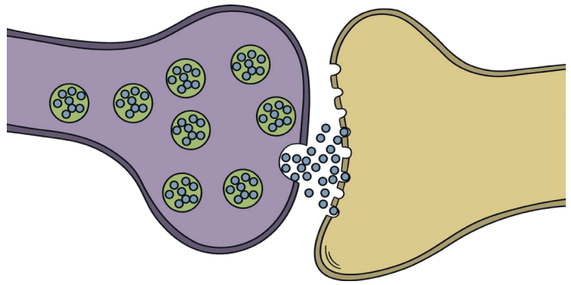
During a reflex action the nerve impulse travels along the following pathway:

1. The **receptor** detects a **stimulus** internally or from the environment. This causes a nerve impulse to travel along the **sensory neurone** to the closest part of the **central nervous system** (CNS). This is not always in the brain.
2. The CNS is the **coordination centre** for a reflex action and coordinates the response. This does not involve the conscious part of the brain to enable the response to be rapid. The **relay neurone** connects the **sensory neurone** to the **motor neurone**. The gaps between the neurones are called **synapses**.
3. The electrical impulse travels along the **motor neurone** to the **effector**. This causes a response to occur which prevents or reduces harm.

[stimulus] → receptor → sensory neurone → relay neurone → motor neurone → effector → [response]

Synapses

The small gaps between neurones are called **synapses**. The electrical nerve impulse cannot cross these gaps.



When the nerve impulse reaches the end of one neurone it causes chemicals called **neurotransmitters** to be released into the gap.

These **diffuse** across the gap and bind to receptor sites on the second neurone. This causes the second neurone to transmit an electrical nerve impulse.

Synapses account for a slight reduction in the speed of the transmission of nerve impulses.

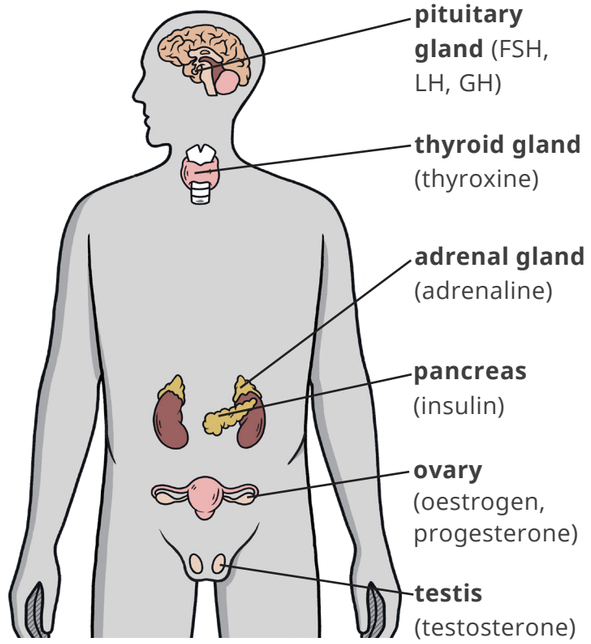
The Human Endocrine System

The endocrine system coordinates and controls the release of hormones from glands.

The **pituitary gland** is also known as the 'master gland' because it secretes many hormones which in turn control the function of other glands. These include follicle stimulating hormone (FSH), luteinising hormone (LH) and growth hormone (GH).

Nervous vs Chemical Responses

	Nervous	Chemical
signal type	electrical impulses	hormones
transmission medium	neurones	bloodstream
response speed	rapid	relatively slow
duration	relatively short (reflexes occur in less than a second)	relatively long (puberty occurs over many years)
target area	specific	large



Control of Blood Glucose

The **pancreas** is both the **coordination centre** and the **effector** for maintaining a normal blood glucose concentration.

The pancreas releases the hormone **insulin** when the concentration of glucose in the blood is too high.

Insulin causes the cells to absorb the excess glucose, and this is converted to another molecule called **glycogen** by the **liver** and **muscles**. The liver and muscles then store the glycogen. They can convert it back to glucose when blood glucose levels become too low.

normal blood glucose concentration → blood glucose concentration becomes **too high** → **pancreas** releases **insulin** which causes the cells to absorb **glucose** → **liver** and **muscle cells** convert the glucose into **glycogen** to be **stored** → normal blood glucose concentration

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Diabetes

There are two types of diabetes: **Type 1** and **Type 2**. Although both prevent the maintenance of blood glucose concentration, the risk factors and treatments for each are different.

Type 1 Diabetes:

- an autoimmune disorder;
- the cells in the pancreas which produce insulin are destroyed by the body;
- the body cannot produce enough insulin to regulate blood glucose concentration;
- treated using insulin injections;
- diet and exercise help to control blood glucose concentration;
- a lifelong condition;
- cause unknown but thought to be a combination of genetic and environmental factors.

Type 2 Diabetes:

- a metabolic disorder;
- body cells stop responding to the insulin produced by the pancreas, causing blood glucose concentration to increase;
- treated by following a carbohydrate-controlled diet, avoiding sources of dietary sugar, and exercising;
- can be reversed with a healthy lifestyle;
- risk factors include: being overweight or obese, having a high carbohydrate or sugar diet, not exercising, smoking and having high blood pressure.

Hormones in Human Reproduction

During **puberty**, secondary sex characteristics such as the development of breasts in females and the growth of facial hair in males are triggered by the release of reproductive hormones.

Hormone	Gland	Primary Function
follicle stimulating hormone (FSH)	pituitary gland	causes maturation of an egg in the ovary
luteinising hormone (LH)	pituitary gland	stimulates the release of the egg (ovulation)
oestrogen	ovary	thickens and maintains the lining of the uterus
progesterone	ovary	maintains the lining of the uterus
testosterone	testis	controls the production of sperm

The **menstrual cycle** occurs in females approximately every **28 days**, although this varies between women. It involves the process of building the lining of the **uterus** in preparation for it accommodating the egg cell released from the **ovary** during **ovulation**.

If the egg cell is not **fertilised** by a sperm cell then the lining breaks down, causing **menstruation** to occur. This is commonly called 'having a period.'

Required Practical: Human Reaction Time

Aim: To investigate how handedness affects human reaction time.

Independent Variable: which hand is used

Dependent Variable: reaction time

Control Variables:

- starting position of the ruler
- use of cues (physical and verbal)
- practice
- starting position of thumb and first finger

Equipment:

- metre ruler
- table
- chair
- reaction time conversion table

Method:

1. Ask your partner to sit at a table with their dominant (writing) arm outstretched so their entire hand is hanging from the edge of the table.
2. Hold the metre ruler vertically between your partner's thumb and first finger. Their thumb and first finger should be held as far apart as possible.
3. Ensure that the 0cm mark on the ruler is pointing downwards and in line with the thumb.
4. Check that the person sitting is ready. Remind them that the aim is to catch the ruler as quickly as possible after it is dropped using their thumb and first finger.
5. Drop the metre ruler without warning your partner it is about to happen.
6. Read the measurement on the metre ruler from the top of your partner's thumb and record this in a results table.
7. Repeat this nine more times to get ten results in total for their dominant hand.
8. Repeat the investigation using your partner's non-dominant hand.
9. Use a reaction time conversion table to convert the measurement on the ruler to a reaction time.
10. Calculate the average reaction time for each hand, remembering to discount any anomalous results.

You can use a similar method when investigating how different independent variables affect human reaction time. For example, whether your partner has consumed caffeine.

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Contraception

Method	Type	How It Works	Advantages	Disadvantages
oral contraceptives (the pill or the mini pill)	hormonal	Contains hormones that inhibit the production of FSH. This prevents eggs from maturing. The combined pill contains synthetic oestrogen and progesterone. The mini pill contains progesterone only. Contraceptive pills also work by thickening the cervical mucus, making it harder for the sperm to enter the uterus.	• easy to administer yourself • can reduce period pain • free and widely available • highly effective at preventing pregnancy when taken correctly	• have to remember to take it daily • does not protect against STIs • can have some side effects like headaches and nausea
contraceptive injection, implant or skin patch	hormonal	Contain the hormone progesterone which inhibits the maturation and release of eggs in the same way as the contraceptive pill. A new contraceptive patch is placed on the skin weekly. A contraceptive injection is carried out approximately every three months. The implant remains inserted for around three years.	• as above with the contraceptive pill • you do not have to remember to take it every day • highly effective at preventing pregnancy	• can have some side effects • does not protect against STIs • the implant may need minor surgery to remove
barrier methods including condoms and diaphragms	non-hormonal	When used correctly, barrier methods prevent the sperm from coming into contact with an egg. Condoms are placed over the penis to catch the semen released following ejaculation. Diaphragms are worn inside the vagina to prevent sperm passing through the cervix.	• protect against STIs when used correctly • no hormonal side effects • can be used by males and females • widely available and free from clinics	• can split or tear if used incorrectly • commonly made from latex which some people have allergies to (latex-free condoms are also available)
intrauterine devices and systems (IUD/IUS) (the coil)	both	A small T-shaped device containing copper (IUD) or a hormone similar to progesterone (IUS) which is placed into the uterus by a medical professional. Both make it difficult for sperm to reach the egg, and for a fertilised egg to implant into the lining of the uterus.	• lasts for up to ten years depending on the type • one of the most effective forms of contraception • suitable for women who cannot have oestrogen • can make periods lighter and less painful	• does not protect against STIs • has to be inserted and removed by a medical professional which can be uncomfortable • there is a risk of infections when the device is fitted
spermicidal agents	non-hormonal	A cream, foam or gel which kills or immobilises sperm. Condoms are often coated in a layer of spermicide to increase their effectiveness. Spermicide is rarely used as the sole method of contraception.	• effective when used with a barrier method like a condom or diaphragm • no hormonal side effects • easy to apply yourself	• not very effective at preventing pregnancy when used on its own • does not protect against STIs • not as widely available as other methods
abstaining from sexual intercourse (natural family planning)	non-hormonal	Partners abstain from sexual intercourse near and during ovulation. Fertility is tracked by keeping a record of the menstrual cycle, body temperature and cervical secretions in order to avoid pregnancy.	• does not cause any side effects • acceptable to all faiths and cultures • increases self-awareness of fertility, which can be useful for people who plan to get pregnant in the future	• does not protect against STIs • requires the commitment of daily monitoring of the menstrual cycle • fertility signs can be affected by stress and illness making this method less effective
surgical methods (sterilisation)	non-hormonal	In females, the oviducts are blocked using clips, tied or are cut. They can also be removed. This prevents sperm from coming into contact with an egg. In males, the tubes which carry the sperm to the penis, are cut, tied or sealed. This means there is no sperm present in the ejaculate.	• highly effective at preventing pregnancy • does not affect hormone levels or sex drive • it is very rare to have any long-term health effects after surgery	• does not protect against STIs • usually impossible to reverse so should be considered a permanent treatment • risk of surgical complications and infection