# AQA Separate Science

# Homeostasis & Response

# Revision Booklet


**Name:** _____

## 4.5 Homeostasis and Response

### 4.5.1 Homeostasis

### 4.5.2 The human nervous system

- 4.5.2.1 Structure and function
- 4.5.2.2 The brain (biology only)
- 4.5.2.3 The eye (biology only)
- 4.5.2.4 Control of body temperature (biology only)

### 4.5.3 Hormonal coordination in humans

- 4.5.3.1 Human endocrine system
- 4.5.3.2 Control of blood glucose concentration
- 4.5.3.3 Maintaining water and nitrogen balance in the body (biology only)
- 4.5.3.4 Hormones in human reproduction
- 4.5.3.5 Contraception
- 4.5.3.6 The use of hormones to treat infertility (HT only)
- 4.5.3.7 Negative feedback (HT only)

### 4.5.4 Plant hormones (biology only)

- 4.5.4.1 Control and coordination
- 4.5.4.2 Use of plant hormones (HT only)

# 4.5 Homeostasis and Response Pupil Checklist

| **4.5.1 Homeostasis** | **Review** |
|---|---|
| Explain that homeostasis is the regulation of the internal conditions of a cell or organism to maintain optimum conditions for function in response to internal and external changes. | ☺ 😐 ☹ |
| Recall that homeostasis maintains optimal conditions for enzyme action and all cell functions. | ☺ 😐 ☹ |
| Recall that in the human body, optimal conditions are maintained of:<br>• blood glucose concentration<br>• body temperature<br>• water levels.<br>• | ☺ 😐 ☹ |
| Recall that these automatic control systems may involve nervous responses or chemical responses. | ☺ 😐 ☹ |
| Describe control systems to include:<br><br>• cells called receptors, which detect stimuli (changes in the environment)<br>• coordination centres (such as the brain, spinal cord and pancreas) that receive and process information from receptors<br>• effectors, muscles or glands, which bring about responses which restore optimum levels. | ☺ 😐 ☹ |

| **4.5.2 The human nervous system**<br>**4.5.2.1 Structure and function** | **Review** |
|---|---|
| Explain how the structure of the nervous system is adapted to its functions. | ☺ 😐 ☹ |
| Recall that the nervous system enables humans to react to their surroundings and to coordinate their behaviour. | ☺ 😐 ☹ |
| Understand that iformation from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS). The CNS is the brain and spinal cord. The CNS coordinates the response of effectors which may be muscles contracting or glands secreting hormones. | ☺ 😐 ☹ |
| Recall the reflex arc<br><br>Stimulus → receptor → coordinator → effector → response | ☺ 😐 ☹ |
| Explain how the various structures in a reflex arc – including the sensory neurone, synapse relay neurone and motor neurone – relate to their function. Understand why reflex actions are important. | ☺ 😐 ☹ |
| Describe reflex actions as automatic and rapid; they do not involve the conscious part of the brain. | ☺ 😐 ☹ |
| Extract and interpret data from graphs, charts and tables, about the functioning of the nervous system. | ☺ 😐 ☹ |
| Translate information about reaction times between numerical and graphical forms. | ☺ 😐 ☹ |

| **4.5.2 The human nervous system**<br>**4.5.2.2 The brain (biology only)** | **Review** |
|---|---|
| Recall that the brain controls complex behaviour and has different regions that carry out different functions. | ☺ 😐 ☹ |
| Identify the cerebral cortex, cerebellum and medulla on a diagram and describe their functions. | ☺ 😐 ☹ |
| (HT only) Explain some of the difficulties of investigating brain function and treating brain damage and disease. | ☺ 😐 ☹ |

| | |
|---|---|
| (HT only) Describe how neuroscientists have been able to map regions of the brain to particular functions. Describe why investigation and treating brain disorders is very difficult. | ☺ 😐 ☹ |
| **4.5.2.3 The eye (biology only)** | **Review** |
| Relate the structures of the eye to their functions. This includes accommodation and adaptation. | ☺ 😐 ☹ |
| State why the eye is a sense organ. | ☺ 😐 ☹ |
| Identify the main structures of the eye and explain how their structure is related to their function. | ☺ 😐 ☹ |
| Describe accommodation in terms of ciliary muscles, suspensory ligaments and the lens. | ☺ 😐 ☹ |
| Describe myopia and hyperopia along with how they are corrected and new technologies. | ☺ 😐 ☹ |
| Interpret ray diagrams, to show how myopia and hyperopia can be corrected using spectacle lenses. | ☺ 😐 ☹ |
| **4.5.2.4 Control of body temperature (biology only)** | **Review** |
| Describe how body temperature is monitored and controlled. | ☺ 😐 ☹ |
| Describe the response if body temperature gets too high and too low. | ☺ 😐 ☹ |
| (HT only) Explain how the above mechanisms lower or raise body temperature in a given context. | ☺ 😐 ☹ |

| | |
|---|---|
| **4.5.3 Hormonal coordination in humans** | |
| **4.5.3.1 Human endocrine system** | **Review** |
| Describe the principles of hormonal coordination and control by the human endocrine system. | ☺ 😐 ☹ |
| Understand that the endocrine system is composed of glands which secrete chemicals called hormones directly into the bloodstream. The blood carries the hormone to a target organ where it produces an effect. Compared to the nervous system the effects are slower but act for longer. | ☺ 😐 ☹ |
| Understand that the pituitary gland in the brain is a 'master gland' which secretes several hormones into the blood in response to body conditions. These hormones in turn act on other glands to stimulate other hormones to be released to bring about effects. | ☺ 😐 ☹ |
| Identify the position of the following on a diagram of the human body:<br>• pituitary gland, pancreas, thyroid, adrenal gland, ovary, testes. | ☺ 😐 ☹ |
| **4.5.3.2 Control of blood glucose concentration** | **Review** |
| Recall that blood glucose concentration is monitored and controlled by the pancreas. | ☺ 😐 ☹ |
| Understand that if the blood glucose concentration is too high, the pancreas produces the hormone insulin that causes glucose to move from the blood into the cells. In liver and muscle cells excess glucose is converted to glycogen for storage. | ☺ 😐 ☹ |
| Explain how insulin controls blood glucose (sugar) levels in the body. | ☺ 😐 ☹ |
| Understand that type 1 diabetes is a disorder in which the pancreas fails to produce sufficient insulin. It is characterised by uncontrolled high blood glucose levels and is normally treated with insulin injections. | ☺ 😐 ☹ |
| Understand that type 2 diabetes the body cells no longer respond to insulin produced by the pancreas. A carbohydrate controlled diet and an exercise regime are common treatments. Obesity is a risk factor for Type 2 diabetes. | ☺ 😐 ☹ |
| Compare Type 1 and Type 2 diabetes and explain how they can be treated. | ☺ 😐 ☹ |
| Extract information and interpret data from graphs that show the effect of insulin in blood glucose levels in both people with diabetes and people without diabetes. | ☺ 😐 ☹ |

| | |
|---|---|
| (HT only) Understand that if the blood glucose concentration is too low, the pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood. | ☺ 😐 ☹ |
| (HT only) Explain how glucagon interacts with insulin in a negative feedback cycle to control blood glucose (sugar) levels in the body. | ☺ 😐 ☹ |

| **4.5.3 Hormonal coordination in humans** | |
|---|---|
| **4.5.3.3 Maintaining water and nitrogen balance in the body (biology only)** | **Review** |
| Explain the effect of cells of osmotic changes in body fluids | ☺ 😐 ☹ |
| (HT only) The digestion of proteins from the diet results in excess amino acids which need to be excreted safely. Describe the process of deamination. | ☺ 😐 ☹ |
| Describe the function of the kidneys in maintaining the water balance in the body. | ☺ 😐 ☹ |
| Translate tables and bar charts of glucose, ions and urea before and after filtration. | ☺ 😐 ☹ |
| (HT only) Describe the effect of ADH on the permeability of the kidney tubules. | ☺ 😐 ☹ |
| (HT only) Describe ADH negative feedback loops | ☺ 😐 ☹ |
| Describe the basic principles of kidney dialysis. | ☺ 😐 ☹ |
| **4.5.3.4 Hormones in human reproduction** | **Review** |
| Describe the roles of hormones in human reproduction, including the menstrual cycle. | ☺ 😐 ☹ |
| Understand that during puberty reproductive hormones cause secondary sex characteristics to develop. | ☺ 😐 ☹ |
| Describe oestrogen as the main female reproductive hormone produced in the ovary. At puberty eggs begin to mature and one is released approximately every 28 days. This is called ovulation. | ☺ 😐 ☹ |
| Describe testosterone is the main male reproductive hormone produced by the testes and it stimulates sperm production. | ☺ 😐 ☹ |
| Describe the several hormones are involved in the menstrual cycle of a woman.<br>• Follicle stimulating hormone (FSH) causes maturation of an egg in the ovary.<br>• Luteinising hormone (LH) stimulates the release of the egg.<br>• Oestrogen and progesterone are involved in maintaining the uterus lining. | ☺ 😐 ☹ |
| Explain the interactions of FSH, oestrogen, LH and progesterone, in the control of the menstrual cycle. | ☺ 😐 ☹ |
| Extract and interpret data from graphs showing hormone levels during the menstrual cycle. | ☺ 😐 ☹ |
| **4.5.3.5 Contraception** | **Review** |
| Evaluate the different hormonal and non-hormonal methods of contraception. | ☺ 😐 ☹ |
| Describe the variety of hormonal and non-hormonal methods of contraception that can control fertility<br><br>These include:<br>• oral contraceptives that contain hormones to inhibit FSH production so that no eggs mature<br>• injection, implant or skin patch of slow release progesterone to inhibit the maturation and release of eggs for a number of months or years<br>• barrier methods such as condoms and diaphragms which prevent the sperm reaching an egg<br>• intrauterine devices which prevent the implantation of an embryo or release a hormone<br>• spermicidal agents which kill or disable sperm<br>• abstaining from intercourse when an egg may be in the oviduct<br>• surgical methods of male and female sterilisation. | ☺ 😐 ☹ |

| **4.5.3 Hormonal coordination in humans** | |
|---|---|
| **4.5.3.6 The use of hormones to treat infertility (HT only)** | **Review** |
| Explain the use of hormones in modern reproductive technologies to treat infertility. This includes giving FSH and LH in a 'fertility drug' to a woman. She may then become pregnant in the normal way. | ☺ 😐 ☹ |
| Explain the use of hormones in modern reproductive technologies to treat infertility. This includes giving FSH and LH in a 'fertility drug' to a woman. She may then become pregnant in the normal way. In Vitro Fertilisation (IVF) treatment.<br>• IVF involves giving a mother FSH and LH to stimulate the maturation of several eggs.<br>• The eggs are collected from the mother and fertilised by sperm from the father in the laboratory.<br>• The fertilised eggs develop into embryos.<br>• At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother's uterus (womb | ☺ 😐 ☹ |
| Understand that although fertility treatment gives a woman the chance to have a baby of her own:<br>• it is very emotionally and physically stressful<br>• the success rates are not high<br>• it can lead to multiple births which are a risk to both the babies and the mother. | ☺ 😐 ☹ |
| **4.5.3.7 Negative feedback (HT only)** | **Review** |
| Explain the roles of thyroxine and adrenaline in the body. | ☺ 😐 ☹ |
| Understand that adrenaline is produced by the adrenal glands in times of fear or stress. It increases the heart rate and boosts the delivery of oxygen and glucose to the brain and muscles, preparing the body for 'flight or fight'. | ☺ 😐 ☹ |
| Recall that thyroxine from the thyroid gland stimulates the basal metabolic rate. It plays an important role in growth and development. | ☺ 😐 ☹ |
| Recall that thyroxine levels are controlled by negative feedback. | ☺ 😐 ☹ |

| **4.5.4 Plant hormones (biology only)** | |
|---|---|
| **4.5.4.1 Control and coordination** | **Review** |
| Describe phototropism and geotropism. Describe the effect of unequal auxin distribution. | ☺ 😐 ☹ |
| (HT only) Recall that gibberellins are important in initiating seed germination and that ethane controls cell division and ripening of fruits. | ☺ 😐 ☹ |
| **4.5.4.2 Use of plant hormones (HT only)** | **Review** |
| Describe the effects of some plant hormones and the different ways people use them to control plant growth. | ☺ 😐 ☹ |
| Recall that plant growth hormones are used in agriculture and horticulture. | ☺ 😐 ☹ |
| Recall that auxins are used as weed killers, as rooting powders and for promoting growth in tissue culture. | ☺ 😐 ☹ |
| Recall that ethane is used in the food industry to control ripening of fruit during storage and transport. | ☺ 😐 ☹ |
| Recall that gibberellins can be used to end seed dormancy, promote flowering and increase fruit size. | ☺ 😐 ☹ |

## 4.5 Homeostasis and Response Knowledge

### 4.5.1 Homeostasis

**Homeostasis** maintains optimal conditions for **enzyme** action throughout the body, as well as all cell functions.

In the human body, these include the control of:

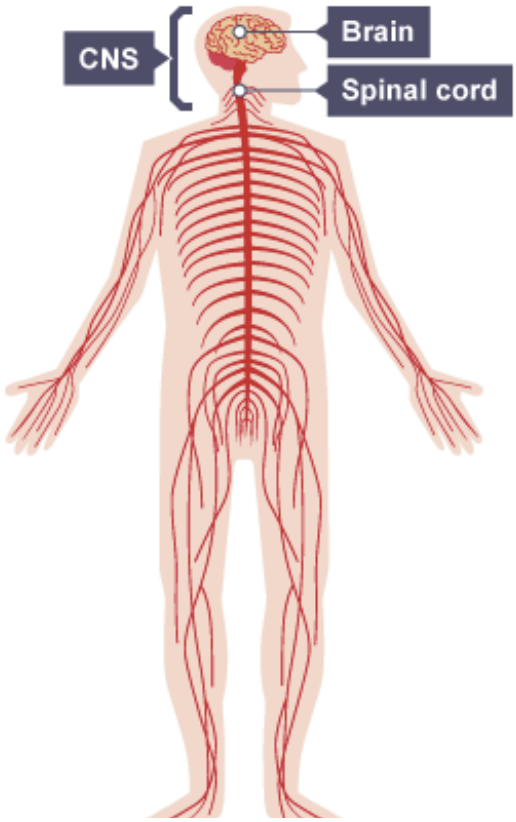
- **blood glucose** concentration
- body temperature
- water levels

These automatic control systems may involve nervous responses ( **nervous system**) or chemical responses (endocrine system).

**Nervous system**

The human nervous system consists of:

- the **central nervous system** – the brain and spinal cord
- the peripheral nervous system – nerve cells that carry information to or from the CNS



# The structure and function of the nervous system

The conditions inside our body must be carefully controlled if the body is to function effectively. The conditions are controlled in two ways with chemical and nervous responses.

All control systems include:

- Cells called **receptors**, which detect **stimuli** (changes in the environment).
- The coordination centre, such as the brain, spinal cord or pancreas, which receives and processes information from receptors around the body.
- **Effectors** bring about responses, which restore optimum levels, such as core body temperature and blood glucose levels. Effectors include muscles and glands, and so responses can include muscle contractions or hormone release.

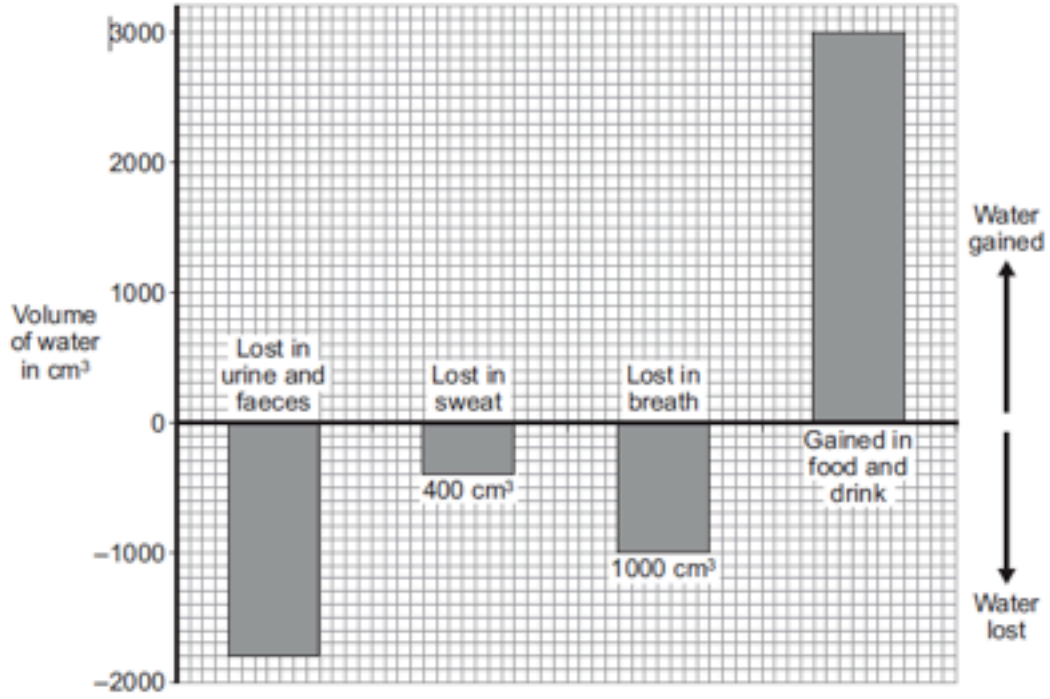
---

## 4.5.1 Homeostasis PPQ's

## Low demand

## PPQ 1

**Q1.** The bar chart shows different ways in which water is lost from and gained by the body on one day. The volumes of water lost in the sweat and in the breath are labelled on the bars.




(a) How much water was lost in the urine and faeces? _____ cm³ **(1)**

(b) Water is lost from the body in urine, faeces, sweat and breath.

What was the total volume of water lost from the body on this day?

Show clearly how you work out your answer.

_____

_____

Answer = _____ cm³

**(2)**

(c) The volume of water lost should balance the volume of water gained.

What should the person do to balance the water gained with the water lost?

_____

_____

_____

_____

**(2)**

**(Total 5 marks)**

## PPQ 2

### Q2.

The table shows four ways in which water leaves the body, and the amounts lost on a cool day.

| | WATER LOSS ($cm^3$) | |
|---|---|---|
| | COLD DAY | HOT DAY |
| Breath | 400 | the same |
| Skin | 500 | |
| Urine | 1500 | |
| Faeces | 150 | |

(a) (i) Fill in the table to show whether on a hot day the amount of water lost would be

**less** **more** **the same**

The first answer has been done for you.

**(3)**

(ii) Name the process by which we lose water from the skin.

_____

**(1)**

(b) On a cool day the body gained 2550 $cm^3$ of water.
1500 $cm^3$ came directly from drinking.
Give **two** other ways in which the body may gain water.

1. _____

2. _____

**(2)**

**(Total 6 marks)**

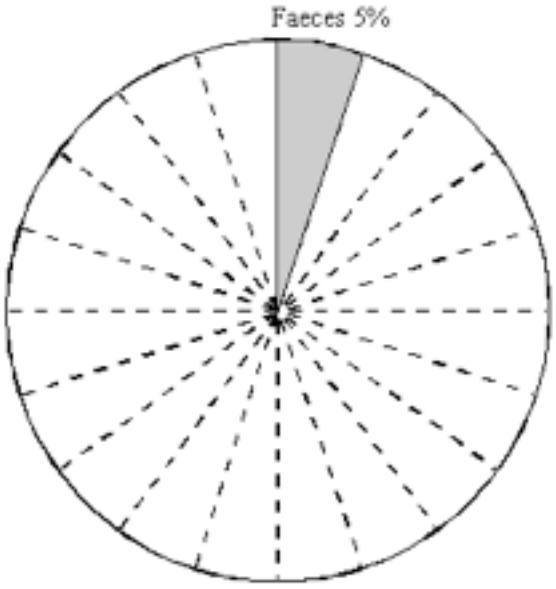
**PPQ 3**

**Q3.**

The table below shows how the body loses water.

| HOW WATER IS LOST | % (PERCENTAGE) |
|---|---|
| Breathing | 10 |
| Faeces | 5 |
| Sweat | 45 |
| Urine | 40 |

Complete the diagram by showing the water loss for breathing, sweat and urine.




**(Total 3 marks)**

## Standard demand

## PPQ4

**Q4.**

This question is about the nervous system.

(a) Describe the function of receptors in the skin.

_____

_____

_____

_____

**(2)**

(b) A response is caused when information in the nervous system reaches an effector.

(i) There are two different types of effector.

Complete the table to show:

- the two different types of effector
- the response each type of effector makes.

| Type of effector | Response the effector makes |
|---|---|
| 1 ..... | ..... <br> ..... |
| 2 ..... | ..... <br> ..... |

**(4)**

(ii) Some effectors help to control body temperature.

Give **one** reason why it is important to control body temperature.

_____

_____

**(1)**

**(Total 7 marks)**

## High demand

## PPQ 5

**Q6.**

Drinking after exercise to replace the water lost in sweat is called rehydration.
Scientists at a Spanish university investigated rehydration after exercise.

- 24 students took part in the investigation.
- All the students ran on a treadmill in a temperature of 40 °C until they were exhausted.
- 12 of the students were each given half a litre of beer to drink.
- The other 12 students were each given half a litre of tap water to drink.
- Both groups of students were then allowed to drink as much tap water as they wanted.
- The scientists measured how quickly each student rehydrated.
- The students who had been given beer rehydrated 'slightly better' than the ones given only water.

A newspaper reported the investigation.

The headline was

**'Forget water after a workout ... drink some beer instead.'**

The newspaper headline was **not** justified.

Explain why.

_____

_____

_____

_____

_____

_____

_____

_____

**(Total 3 marks)**

## 4.5.1 Homeostasis PPQ Answers

## Low demand

## PPQ MS1

### Q1.

(a) 1800

*allow - / minus 1800*

1

(b) 3200

*award both marks for correct answer irrespective of working*

*allow - / minus 3200*

*award **2** marks for 200 or -200 irrespective of working*

*allow ecf from part (a) for both routes to 2 marks*

*if no answer **or** incorrect answer then indication of addition of 1800 **or** their (a), 1000 and 400 gains **1** mark*

2

(c) drink more / take in more from food & drink

*allow ecf from (b), ie if answer to (b) is less than 3000 then accept drink less*

*if answer to (b) is exactly 3000 accept do nothing*

1

200 ($cm^3$)

*accept ecf from (b) answer should be difference between (b) and 3000 if answer to (b) is 3000 accept they are the same*

***NB** drink / take in 3200 ($cm^3$) of water = **1** mark*

*drink / take in 200 ($cm^3$) of water = **2** marks*

*ignore references to exercise / sweat*

1

**[5]**

---

## PPQ MS2

### Q2.

(a) (i) more
less
the same
(*accept* appropriate numbers)

*for 1 mark each*

3

(ii) sweating / evaporation / perspiration

*for 1 mark*

1

(b) in food / named solid food / eating
from respiration

*for 1 mark each*

2

**[6]**

---

## PPQ MS3

**Q3.**

1 sector correct

*gains 1 mark*

*but* all sectors correct B = 2 S = 9 U = 8

*gains 2 marks*

all sections labelled correctly (w.r.t. sector size)

*for 1 mark*

**[3]**

---

## Standard demand PPQ Answers

## PPQ MS4

**Q4.**

(a) detect changes in surroundings **or** detect stimuli

*allow any named stimulus for skin*

1

convert information to impulse

*allow send impulse to sensory neurones / brain*

1

(b) (i)

| | |
|---|---|
| muscle | contract(ion) |
| gland | release / secrete / produce chemical / hormone / enzyme |

***1** mark for each effector*

***1** mark for each response*

*response must match type of effector (if given)*

*ignore examples*

*ignore relax(ation) / movement for contraction*

*do **not** allow expansion for muscles*

4

(ii) any **one** from:

- (maintain temperature at which) enzymes work best
- so chemical reactions are fast(est)
- prevent damage to cells / enzymes

*allow prevent enzymes being denatured (by temperature being too high)*

1

**[7]**

---

## High demand

## PPQ MS5

**Q6.**

only 24 students tested **or** only one test **or** reference to lack of controls eg gender / age

1

students could drink as much water as they wanted

**or**

some students drank more water than others

**or**

some students drank water and beer

1

differences only slight

*ignore effects of beer or promotion of beer drinking*

1

**[3]**

---

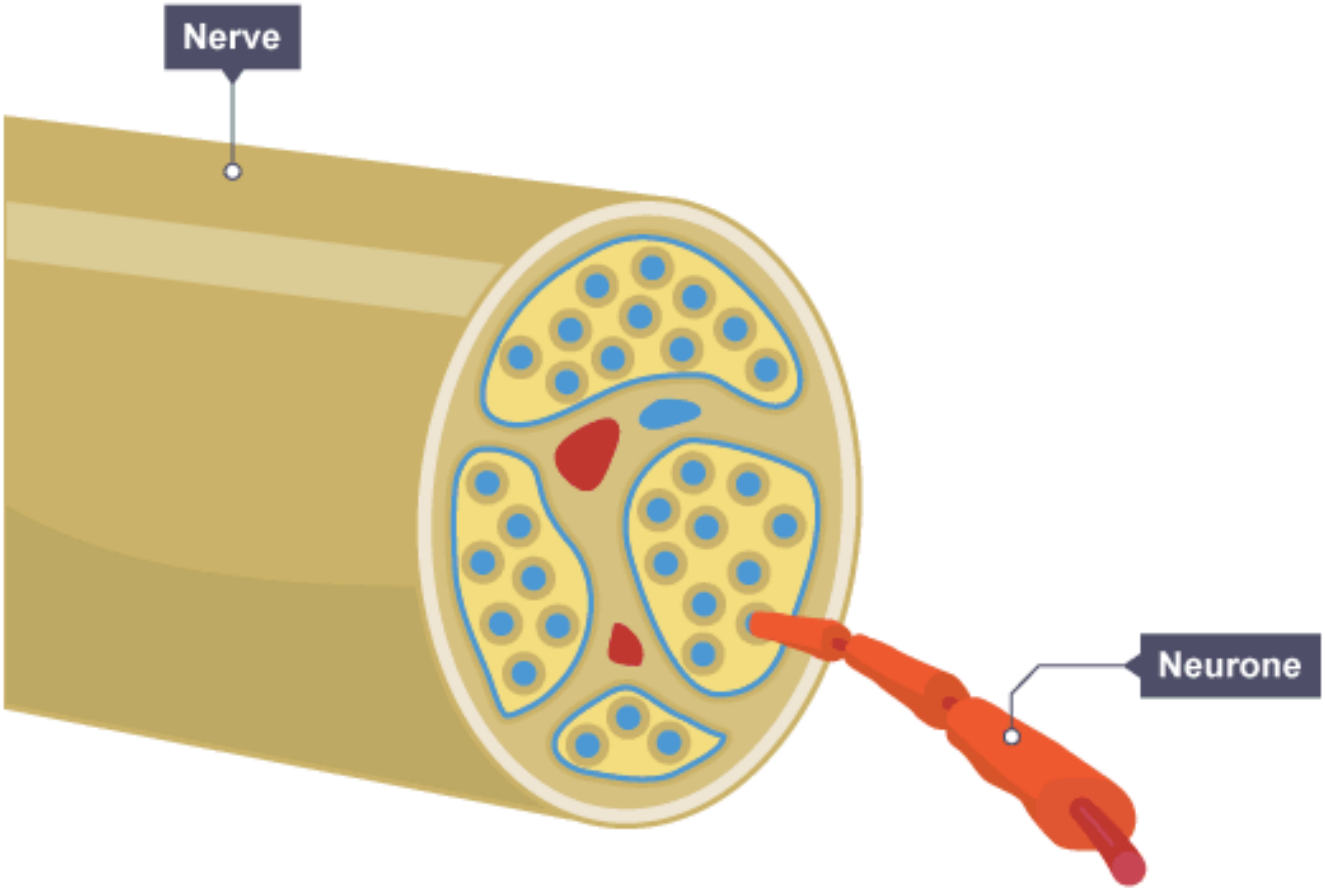
## 4.5 Homeostasis and Response Knowledge

### 4.5.2.1 The human nervous system

**Nerve cells**

Nerve cells are called **neurones**. They are adapted to carry electrical impulses from one place to another.

A bundle of neurones is called a nerve.




There are three main types of neurone: sensory, motor and relay.

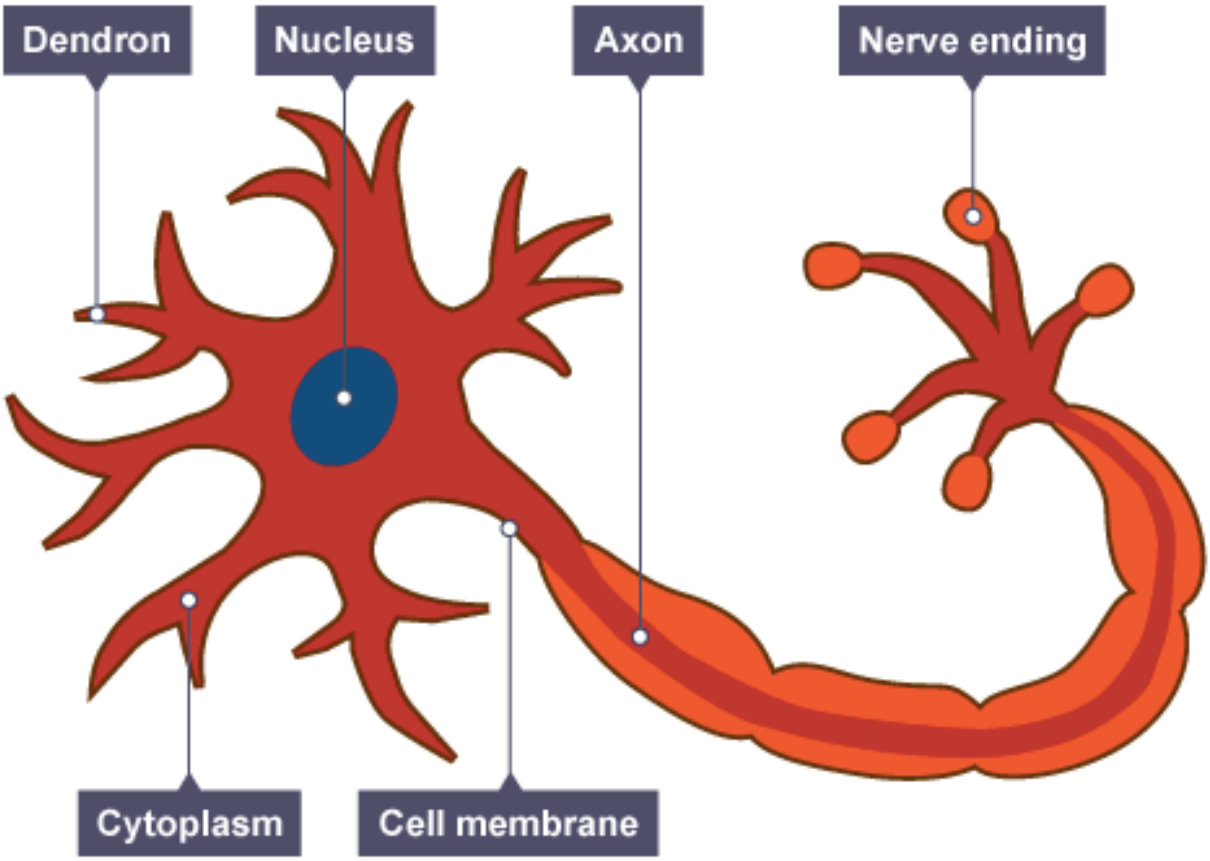
They have some features in common:

- A long fibre (axon) which is insulated by a fatty (myelin) sheath. They are long so they can carry messages up and down the body.
- Tiny branches (dendrons) which branch further as dendrites at each end. These receive incoming impulses from other neurones.

There are three main types of neurone: sensory, motor and relay.

They have some features in common:

- A long fibre (axon) which is insulated by a fatty (myelin) sheath. They are long so they can carry messages up and down the body.
- Tiny branches (dendrons) which branch further as dendrites at each end. These receive incoming impulses from other neurones.



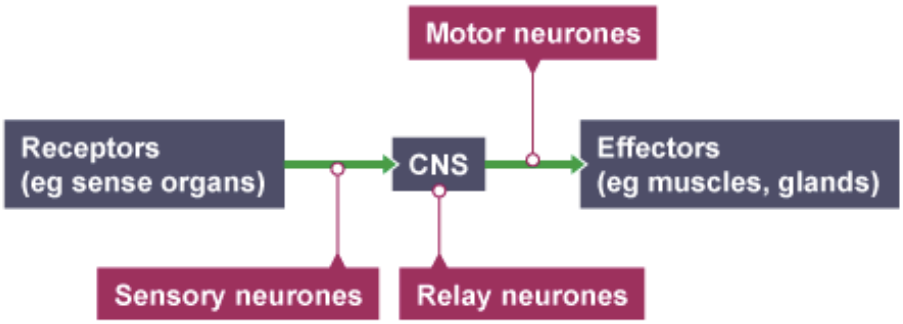

A motor neurone

### Receptors to effectors

Information from receptors passes along neurones, as electrical impulses to co-ordinators such as the central nervous system or CNS. The CNS is the brain and spinal cord. Muscles contracting or glands secreting hormones are the response of effectors coordinated by the CNS.

Stimulus → receptor → coordinator → effector → response

The diagram summarises how information flows from receptors to effectors in the nervous system.




### Receptors

Receptors are groups of specialised cells. They detect a change in the environment (stimulus) and stimulate electrical impulses in response. Sense organs contain groups of receptors that respond to specific stimuli.

| Sense organ | Stimulus |
|---|---|
| Skin | Touch, temperature and pain |
| Tongue | Chemicals (in food and drink, for example) |
| Nose | Chemicals (in the air, for example) |
| Eye | Light |
| Ear | Sound and poistion of head |

---

### Effectors

Effectors include muscles and glands - that produce a specific response to a detected stimulus.

For example:

- a muscle contracting to move an arm
- muscle squeezing saliva from the salivary gland
- a gland releasing a **hormone** into the blood

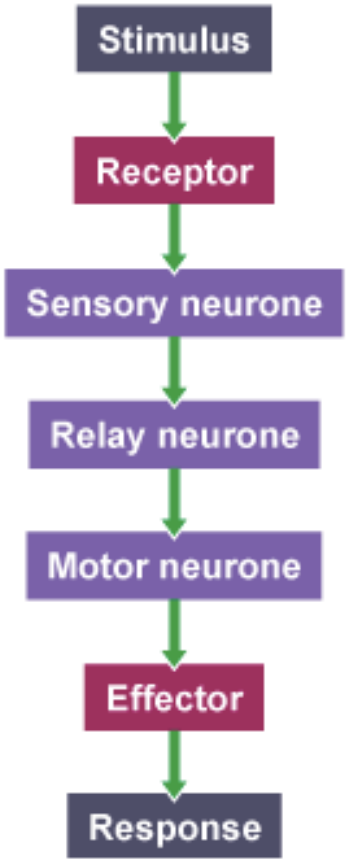
# Reflex arc

## Reflex actions

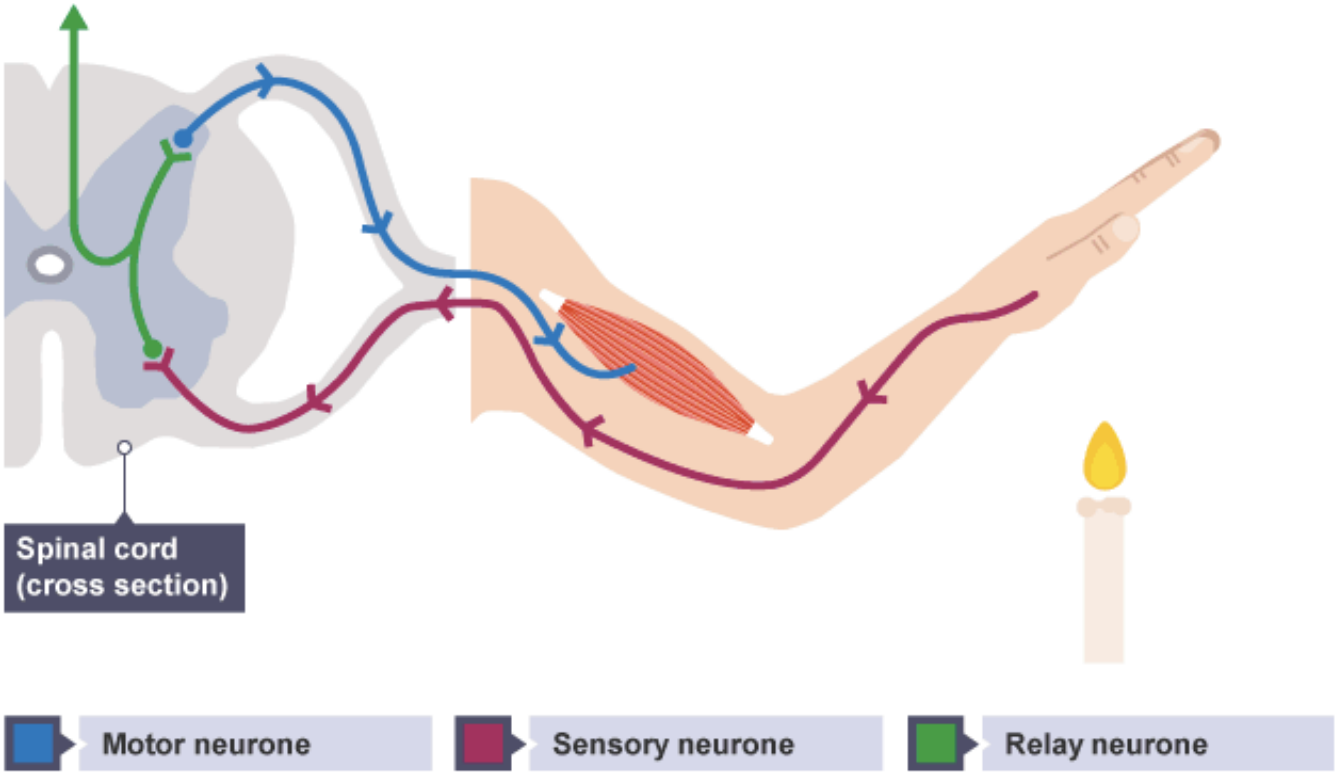
There are different types of neurones that work together in a **reflex action**.

This creates an automatic and rapid response to a stimulus, which minimises any damage to the body from potentially harmful conditions, such as touching something hot.

A reflex action follows this general sequence and does not involve the conscious part of the brain, which makes it much quicker.

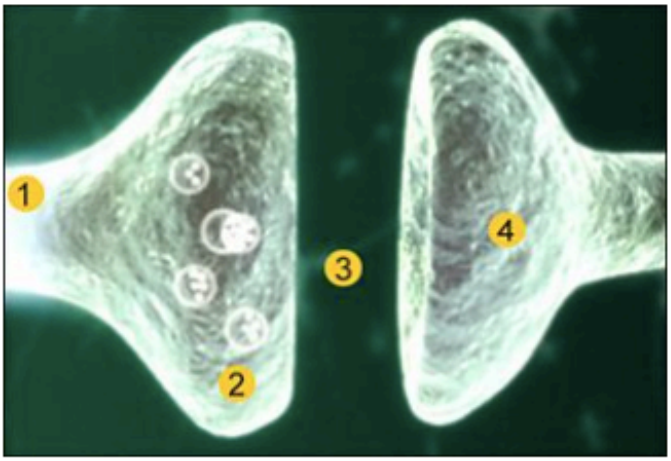



The nerve pathway followed by a reflex action is called a **reflex arc**. For example, a simple reflex arc happens if we accidentally touch something hot.




1. **Receptor** in the skin detects a stimulus (the change in temperature).
2. **Sensory neurone** sends electrical impulses to **relay neurone**, which are located in the spinal cord. They connect sensory neurones to motor neurones.
3. **Motor neurone** sends electrical impulses to an effector.
4. **Effector** produces a response (muscle contracts to move hand away).

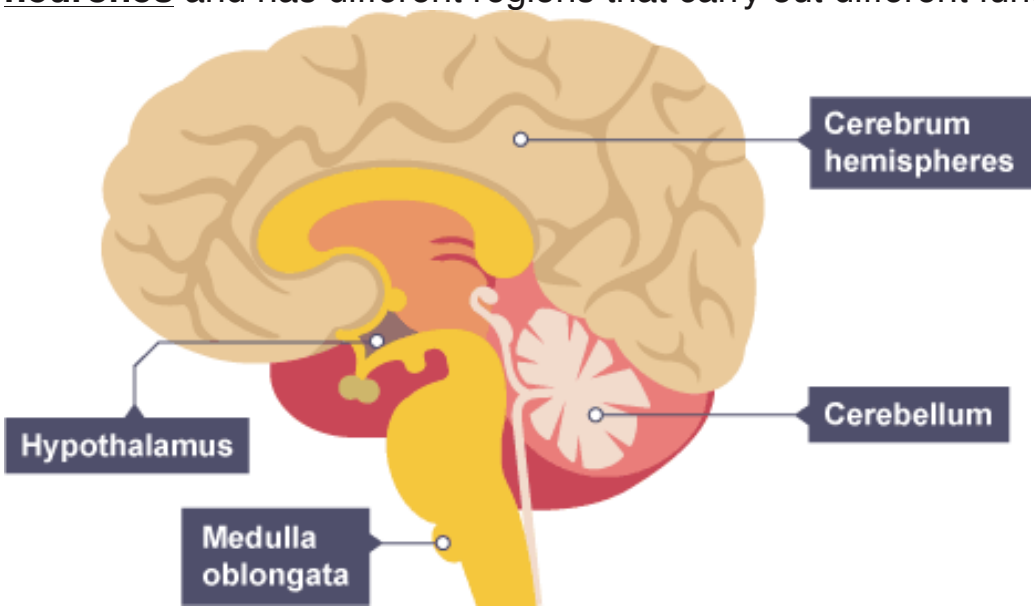
Where two neurones meet there is a small gap, a **synapse**.




1. An electrical impulse travels along the first axon.
2. This triggers the nerve-ending of a neurone to release **chemical messengers** called **neurotransmitters**.
3. These chemicals **diffuse** across the synapse (the gap) and bind with receptor molecules on the membrane of the second neurone.
4. The receptor molecules on the second neurone bind only to the **specific neurotransmitters** released from the first neurone. This **stimulates** the second neurone to transmit the electrical impulse.

## 4.5.2.2 The brain (biology only)

The **brain** controls complex behaviour. It is made of billions of interconnected **neurones** and has different regions that carry out different functions.




There are four main areas in the brain:

- The **cerebrum** (the outer layer is called the cerebral cortex), which is split into two hemispheres and is highly folded. It controls intelligence, personality, conscious thought and high-level functions, such as language and verbal memory.
- The **cerebellum**, which controls balance, co-ordination of movement

and muscular activity.

- The **medulla**, which controls unconscious activities such as heart rate and breathing rate,

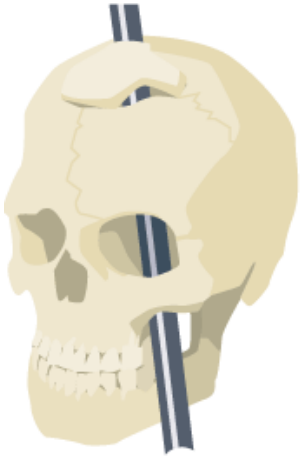
The **hypothalamus**, which is the regulating centre for temperature and water balance within the body.

**Investigating the brain - Higher**

Modern science has allowed scientists to discover how different parts of the brain function. Neuroscientists have been able to map various regions of the brain to particular functions by studying patients with brain damage, electrically stimulating different parts of the brain and using **MRI** scanning techniques.

**Brain damage**

A well-documented example of brain damage is of Phineas Gage, who in 1848 had a serious accident whilst laying railway tracks and an iron rod went through his skull.



Phineas Gage

Phineas survived the accident, but it was documented that his personality changed following it. It was noted that he lost his inhibitions socially and emotionally. Doctors realised the changes in Phineas were due to the damage in the particular parts of the brain that the iron rod had passed through. This important case allowed scientists to examine the effect of the injuries on his brain activity.

Non-invasive brain procedures include:

**Electrical stimulation**

Scientists have stimulated different parts of the brain with a weak electrical current and asked patients to describe what they experienced. If the motor area is stimulated, the patient makes an involuntary movement. If the visual area is stimulated, they may see a flash of colour. EEGs (Electroencephalograms) can be created and studied, to observe the electrical activity in the brain.

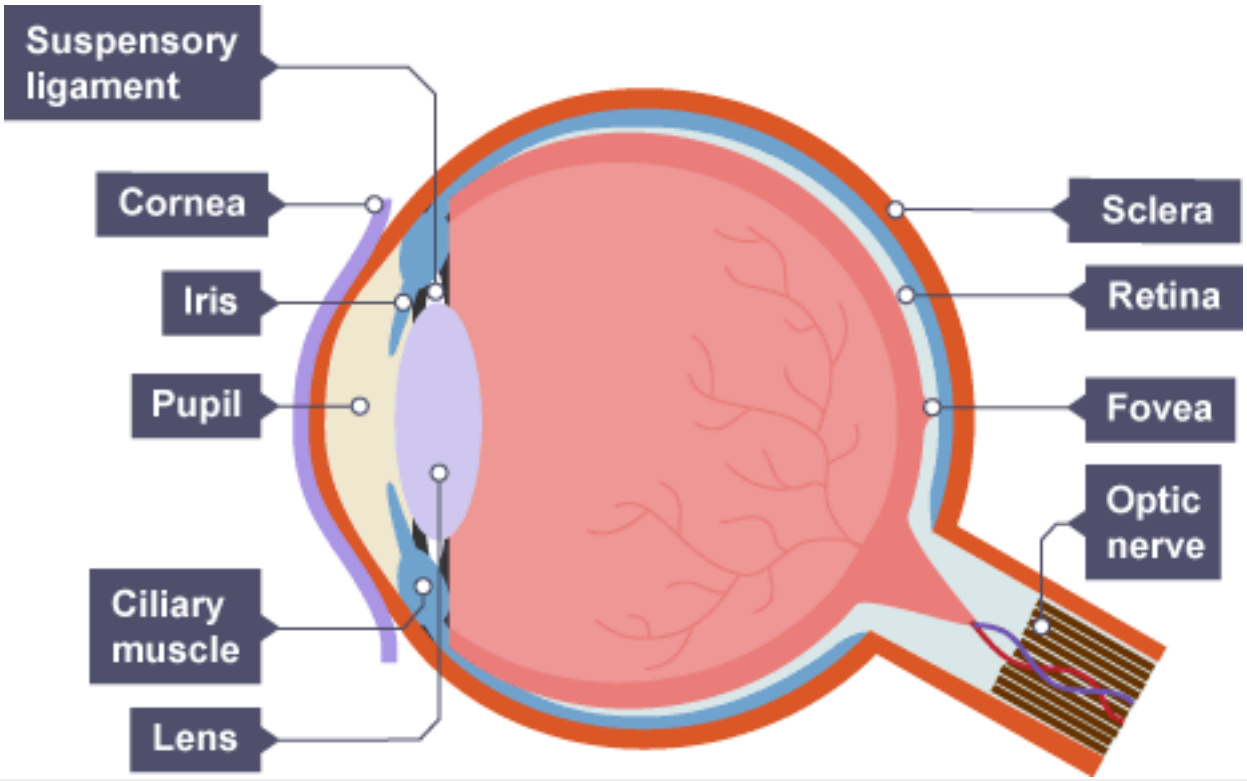
**MRI brain scans**

Modern imaging methods such as MRI (Magnetic Resonance Imaging) scans, use strong magnetic fields and radio waves to show details of brain structure and function. Patients are asked to perform various tasks and, by looking at the scan, scientists can see which parts of the brain are active when the task is carried out.

**Risks**
Brain surgery may be needed to remove a tumour or excess fluid, such as blood. All surgery carries a level of risk, but due to the complexity and delicacy of the brain, investigating and treating brain disorders can be very difficult. If surgery is undergone more damage or side-effects may be created, which could affect the patients' quality of life. Serious considerations about the risks involved against the benefits need to be undertaken first.

## 4.5.2.3 The eye (biology only)

The eye is a sense organ containing **receptors** sensitive to light intensity and colour.



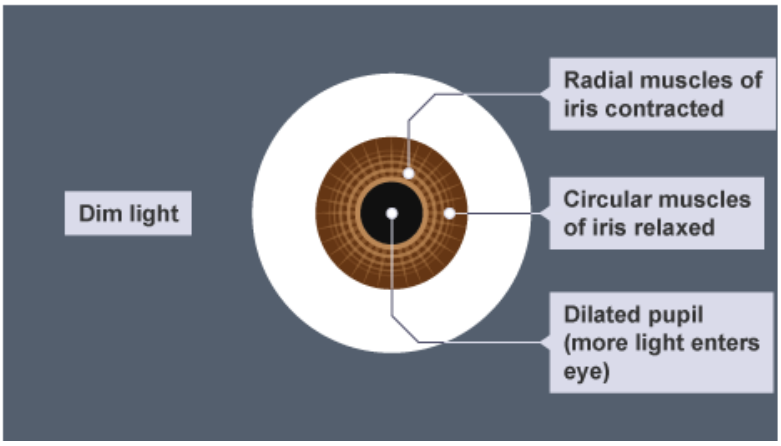

| Structure | Function |
|---|---|
| Cornea | Refracts light - bends it as it enters the eye |
| Iris | Controls how much light enters the pupil |
| Lens | Further refracts light to focus it onto the retina |
| Retina | Contains the light receptors |
| Optic nerve | Carries impulses between the eye and the brain |
| Sclera | Tough white outer layer of the eye. It helps protect the eye from injury |

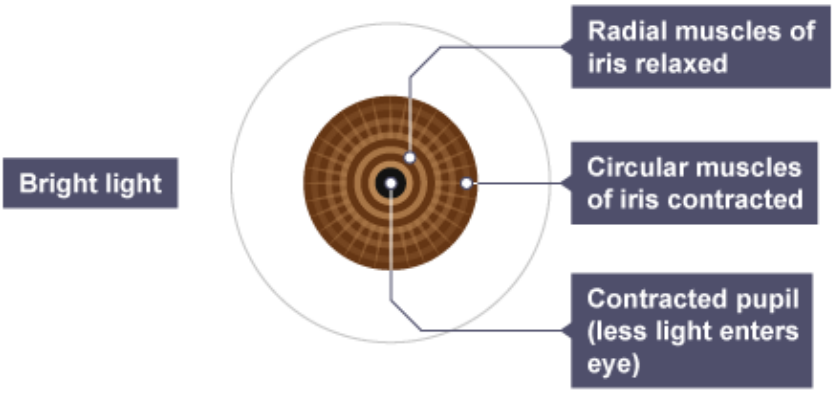
**The retina**
Light passes through the eyeball to the retina. There are two main types of light receptors - **rods** and **cones**. Rods are more sensitive to light than cones so they are useful for seeing in dim light. There are three different types of cone cells which

produce colour vision.

## The pupil reflex

The amount of light entering the eye is controlled by a reflex action. The size of the **pupil** changes in response to bright or dim light. This is controlled by the muscles of the iris.




### How the eye works – Higher

Accommodation is the process of changing the shape of the lens to focus on near or distant objects.

To focus on a **near** object – the lens becomes **thicker**, this allows the light rays to refract (bend) more strongly.

To focus on a **distant** object – the lens is pulled **thin**, this allows the light rays to refract slightly.

| Position | Ciliary muscles | Suspensory ligaments | Muscle tension | Lens shape | Refraction |
|---|---|---|---|---|---|
| Near | Contract | Slacken/loosen | Low | Fat/thicker | Light is refracted strongly |
| Distant | Relax | Stretched/tighten | High | Thin | Light is only refracted slightly |

**Correcting vision defects**

Two common defects of the eyes are myopia (short-sightedness) and hyperopia (long-sightedness). In both cases rays of light do not focus on the retina so a clear image is not formed.

These two defects are treated with spectacle lenses, which refract (bend) the light rays so that they do focus on the retina.

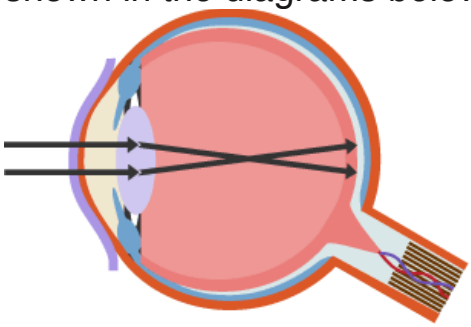
**Short sight**

Someone with **short-sight** can see near objects clearly, but cannot focus properly on distant objects.

Short sight is caused by one of the following:

- The eyeball being elongated - so that the distance between the lens and the retina is too great.
- The lens being too thick and curved - so that light is focused in front of the retina.

Short-sightedness can be corrected by placing a concave lens in front of the eye, as shown in the diagrams below.



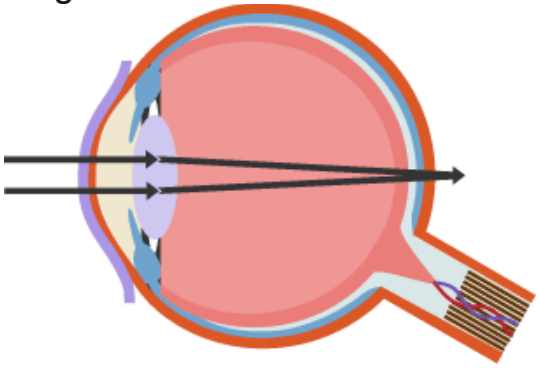
**Long-sight**

Someone who is **long-sighted** can see distant objects clearly, but they cannot focus properly on near objects.

Long-sightedness is caused by one of the following:

- the eyeball being too short - so the distance between the lens and retina is too small
- a loss of elasticity in the lens - meaning it cannot become thick enough to focus (which is often age-related)

As a result, the lens focuses light behind the retina instead of onto it. Long-sightedness is corrected by putting a convex lens in front of the eye, as shown in the diagrams below.



New technologies have provided alternatives to wearing spectacle lenses: the hard and soft contact lenses, laser surgery to change the shape of the cornea and a replacement lens in the eye. **Contact lenses** – work by being in 'contact' with your eye. They float on the surface of the cornea. They work like spectacle lenses, by focusing and refracting the light.

- **Laser surgery** – reshapes the cornea surgically. Common for myopia but can be used for some hyperopia conditions.
- **Replacement lens** – implanting artificial lenses is a recent development, and can placed in front of the original lens, through a small cut in the cornea, to correct an eye defect.

## 4.5.2.4 Control of body temperature (biology only)

Body temperature is one of the factors that are controlled during homeostasis. The human body maintains the temperature that **enzymes** work best, which is around 37°C. This process is controlled by the thermoregulatory centre, which is contained in the hypothalamus in the brain, and it contains receptors sensitive to the temperature of the blood. The skin also has temperature receptors and sends nervous impulses back to the thermoregulatory centre.

### Too hot

When we get too hot:

- **Sweat glands** in the skin release more sweat. The sweat evaporates, transferring heat energy from the skin to the environment.
- Blood vessels leading to the skin capillaries become wider - they **dilate** - allowing more blood to flow through the skin, and more heat to be lost to the environment. This is called **vasodilation**.

### Too cold

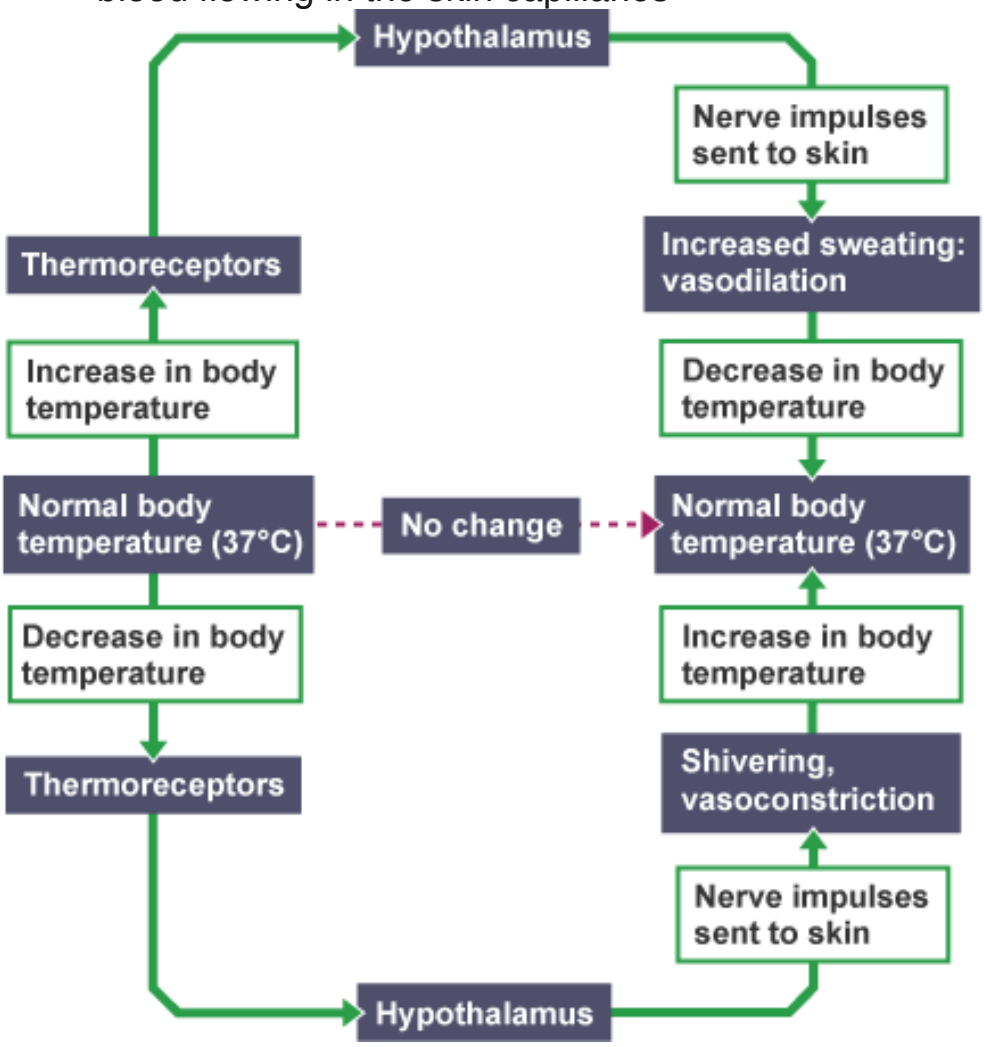
When we get too cold:

- Skeletal muscles **contract** rapidly and we **shiver**. These contractions need energy from **respiration**, and some of this is released as heat.
- **Blood vessels**, which lead to the skin capillaries, become narrower - they constrict – which allows less blood to **flow** through the skin and conserve the core body temperature. This is called **vasoconstriction**.

The hairs on the skin also help to control body temperature. The hairs lie flat when we are warm, and rise when we are cold.
If we are too cold nerve impulses are sent to the hair erector muscles which contract. This raises the skin hairs and traps a layer of insulating air next to the skin. Skin hairs lie flat when we are hot and stand upright when we are cold.

The control of body temperature is an example of a **negative feedback mechanism**. It regulates the amount of:

shivering (rapid muscle contractions release heat)
sweating (evaporation of water in sweat causes cooling)
blood flowing in the skin capillaries




**Vasoconstriction and vasodilation**

The amount of blood flowing through the skin capillaries is altered by vasoconstriction and vasodilation.

| | Too cold | Too hot |
|---|---|---|
| **Process** | Vasoconstriction | Vasodilation |
| **Arterioles** | Get narrower | Get wider |
| **Blood flow in skin capillaries** | Decreases | Increases |
| **Heat loss from skin** | Decreases | Increases |

## 4.5.2 The human nervous system PPQ's

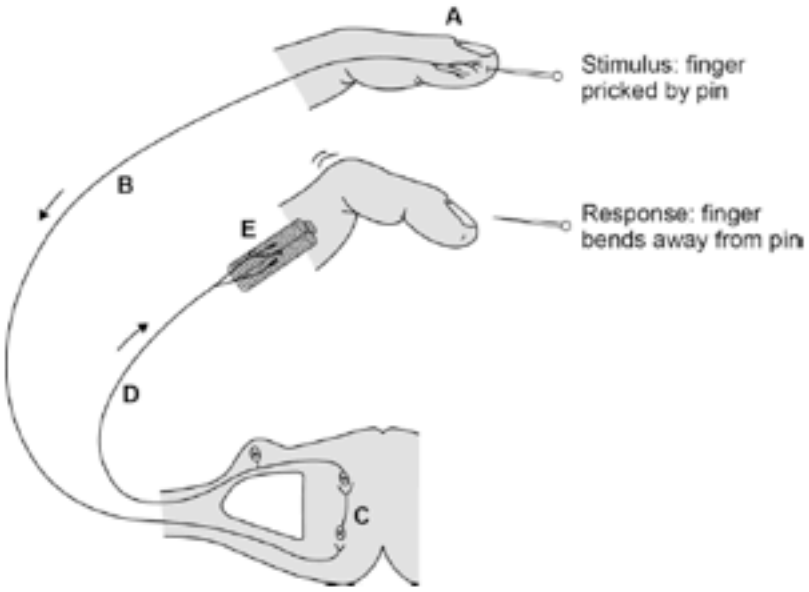
## Low demand

## PPQ 1

**Q1.** Our nervous system controls our reactions.

**Figure 1** shows the part of the nervous system involved in the rapid response to a stimulus.

**Figure 1**




(a) What is this type of rapid response called?

Tick **one** box.

- Circular action ☐
- Fast action ☐
- Forced action ☐
- Reflex action ☐

**(1)**

(b) Features of the nervous system are labelled **A**, **B**, **C**, **D** and **E** on **Figure 1**.

Draw **one** line from each feature to the correct label from **Figure 1**.

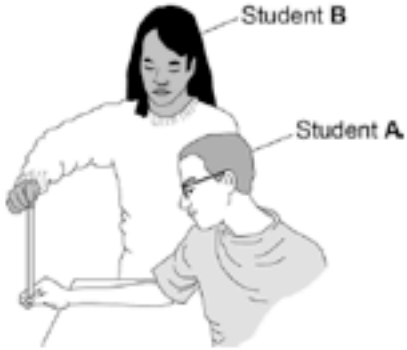
| Feature | Label |
| --- | --- |
| | A |
| Effector | B |
| Relay neurone | C |
| Sensory neurone | D |
| | E |

**(3)**

(c) Two students compare their reactions using a ruler.

This is the method used.

1. Student **A** sits with his elbow on a table top.
2. Student **B** holds the ruler so the bottom of the ruler is level with the top of student **A**'s thumb.
3. Student **B** drops the ruler.
4. Student **A** catches the ruler.
5. Record the drop distance.
6. Repeat steps 1 to 5 four more times.
7. Repeat the whole experiment with student **A** dropping the ruler and student **B** catching it.




Both students are right-handed.

The students are testing the hypothesis:

**the drop distance of the ruler is smaller when a right-handed person uses their right hand to catch the ruler.**

Student **A** uses his right hand to catch the ruler.

Student **B** uses her left hand to catch the ruler.

Complete the sentence.

Use an answer from the box.

| control | dependent | independent |
|---|---|---|

The drop distance was the _____ variable.

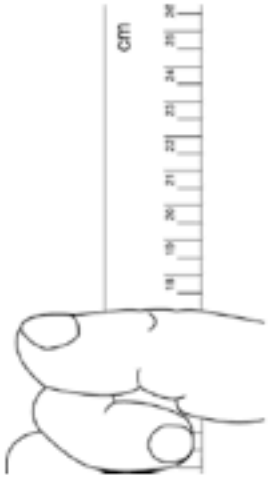
**(1)**

(d) The table below shows the students' results.

| Student | Drop distance in cm | | | | |
|---|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 |
| Student **A** | 17.5 | 15.5 | 15.0 | 23.5 | 17.0 |
| Student **B** | 20.5 | | 19.5 | 21.0 | 19.0 |

**Figure 2** shows student **B**'s Test 2 result.

**Figure 2**




Use **Figure 2** to complete the missing result for Test 2.

Write the answer in the table above.

**(1)**

(e) What was the resolution of the ruler the students used?

Tick **one** box.

- 0.1 cm ☐
- 0.5 cm ☐
- 1 cm ☐
- 10 cm ☐

**(1)**

(f) One of the results in the table above is anomalous.

Identify the anomalous result.

Give the reason why you chose your answer.

_____

_____

_____

**(2)**

(g) The students are testing the hypothesis:

**the drop distance of the ruler is smaller when a right-handed person uses their right hand to catch the ruler.**

The results in the table above are not a good test of the hypothesis.

What is one reason why?

Tick **one** box.

| | |
|---|---|
| The drop distances are very variable | ☐ |
| The drop distance for Student **A** is sometimes bigger than the drop distance for Student **B** | ☐ |
| The results are for the left and right hands of different people | ☐ |
| The drop distances are not measured accurately enough | ☐ |

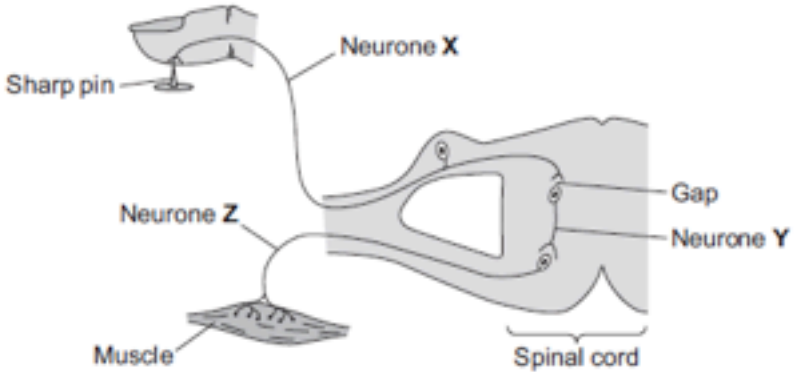
**(1)**

**(Total 10 marks)**

## PPQ 2

**Q2.**

The diagram below shows the pathway for a simple reflex action.




(a) What type of neurone is neurone **X**?

Draw a ring around the correct answer.

**motor neurone** **relay neurone** **sensory neurone**

**(1)**

(b) There is a gap between neurone **X** and neurone **Y**.

(i) What word is used to describe a gap between two neurones?

Draw a ring around the correct answer.

**effector** **receptor** **synapse**

**(1)**

(ii) Draw a ring around the correct answer to complete the sentence.

Information passes across the gap as

- a chemical.
- an electrical impulse.
- pressure.

**(1)**

(c) Describe what happens to the muscle when it receives an impulse from neurone **Z**.
How does this reflex action help the body?

What happens to the muscle _____

_____

How this helps the body _____

_____

**(2)**

**(Total 5 marks)**

## PPQ 3

**Q3.**

The photograph shows a girl waiting to cross a road.

© Lionel Lassman

(a) Name **two** different sense organs she would use to detect when it is safe to cross the road.

1. _____

2. _____

**(2)**

(b) Which sense organ contains receptors that help the girl to keep her balance?

_____

**(1)**

(c) (i) Complete the sentence.

A car driver automatically brakes if a child dashes out into the road.

This is called a _____ action.

**(1)**

(ii) Draw a ring around the correct answer to complete the sentence.

In the nervous system, information passes along cells called

| |
|---|
| effectors |
| neurones |
| synapses |

.

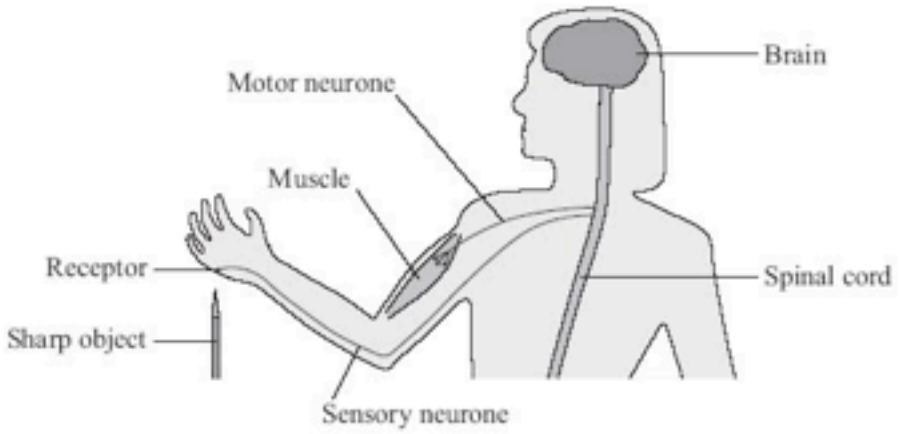
**(1)**

**(Total 5 marks)**

## PPQ 4

**Q4.**

A student accidentally touches a sharp object.
Her hand is immediately pulled away from the object.
The diagram shows the structures involved in this response.




(a) Use the correct word or phrase **from the diagram** to complete each sentence.

(i) The stimulus is detected by the _____

**(1)**

(ii) Impulses travel to the central nervous system along a

cell called a _____

**(1)**

(iii) Impulses travel from the central nervous system to the effector

along a cell called a _____

**(1)**

(iv) The hand is pulled away from the sharp object by the

_____

**(1)**

(b) Where in the body are there cells sensitive to:

(i) light _____

**(1)**

(ii) sound _____

**(1)**

(iii) changes in position? _____

**(1)**

**(Total 7 marks)**

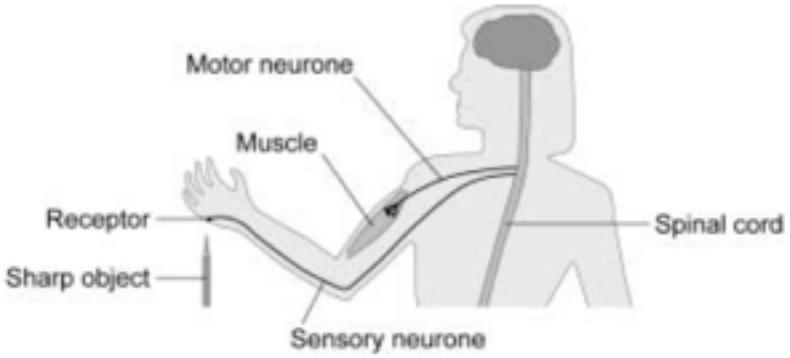
## PPQ 5

**Q5.**

A student accidentally touches a sharp object.

Her hand is immediately pulled away from the object.

The diagram shows the structures involved in this response.




Describe how the structures labelled on the diagram are involved in this reflex action.

_____

_____

_____

_____

_____

_____

_____

_____

**(Total 4 marks)**

## Standard demand

## PPQ 6

**Q6.**

Reflex actions are rapid and automatic.

(a) Name the following structures in a reflex action.

(i) The structure that detects the stimulus.

_____

**(1)**

(ii) The neurone that carries impulses to the central nervous system.

_____

**(1)**

(iii) The neurone that carries impulses away from the central nervous system.

_____

**(1)**

(iv) The structure that brings about the response.

_____

**(1)**

(b) Describe what happens at a synapse when an impulse arrives.

_____

_____

_____

_____

_____

**(2)**

(c) Some people have a condition in which information from the skin does not reach the brain.

Explain why this is dangerous for the person.

_____

_____

_____

_____

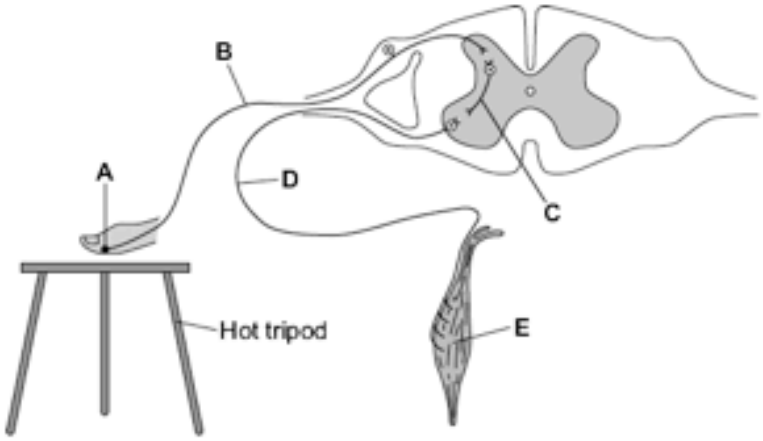
_____

**(2)**

**(Total 8 marks)**

## PPQ 7

**Q7.** If you touch a hot object you automatically pull your hand away. This is called a reflex action. The reflex action happens quickly and protects the body from harm. The diagram shows the structures involved in this reflex action.




The flow diagram shows the pathway of a nerve impulse in a reflex action. Use information from the diagram to complete the flow diagram.

Stimulus is the hot tripod.

↓

A Stimulus is detected by a ..... in the skin.

↓

B An impulse passes along a ..... neurone.

↓

C The impulse passes to a relay neurone in the ..... .

↓

D The impulse passes to a ..... neurone.

↓

E The impulse reaches the muscle. The muscle is the ..... .

↓

Response – hand pulled away from hot object.

**(5)**

**(Total 5 marks)**

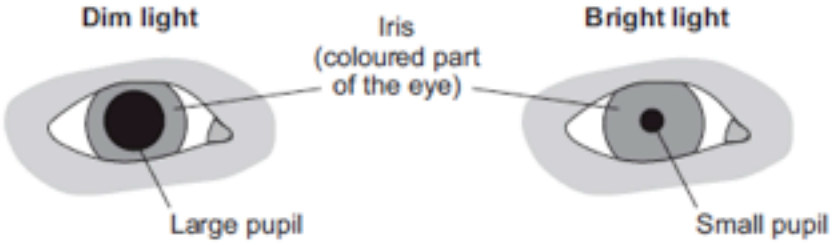
**PPQ 8**

**Q8.**

The pupil is the black part of the eye.
It is the opening for light to enter the eye and reach the receptor cells.
If bright light is shone into the eye, the pupil decreases in size.

This is an example of a reflex action.

The figure below shows two eyes, one reacting to dim light, the other reacting to bright light.




(a) Suggest how the reflex action of the eye to bright light is useful to the body.

_____

_____

_____

_____

**(2)**

(b) Picking up a book is a voluntary action.

Describe **two** differences between a reflex action and a voluntary action.

_____

_____

_____

_____

**(2)**

**(Total 4 marks)**

**Q9.**

Neurones pass information around the body.

(a) Why are reflex reactions important?

_____

**(1)**

(b) Caffeine is a drug found in coffee.

After a person drinks coffee information passes through neurones in the nervous system more quickly.

Suggest a hypothesis for the effect of caffeine concentration on reaction time.

_____

_____

**(1)**

(c) Two students investigated the effect of caffeine concentration on reaction time.

This is the method used.

1. Student **A** drinks a cup of coffee.
2. Student **B** holds a ruler above Student **A**'s hand.
3. Student **B** drops the ruler.
4. Student **A** catches the ruler as quickly as she can.
5. The distance the ruler falls is recorded.

Suggest how this method could be improved to produce valid results.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**

**(Total 8 marks)**

**PPQ 10**

**Q10.**

(a) Give **three** receptors which a mouse might use to detect food under natural conditions.

1. _____

_____

2. _____

_____

3. _____

_____

**(3)**

(b) Whilst observing mouse behaviour, a student drops a pen near the mouse's cage. The mouse jumps at the noise.

Describe, as fully as you can, the processes by which the mouse responds to the stimulus of the dropped pen.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**

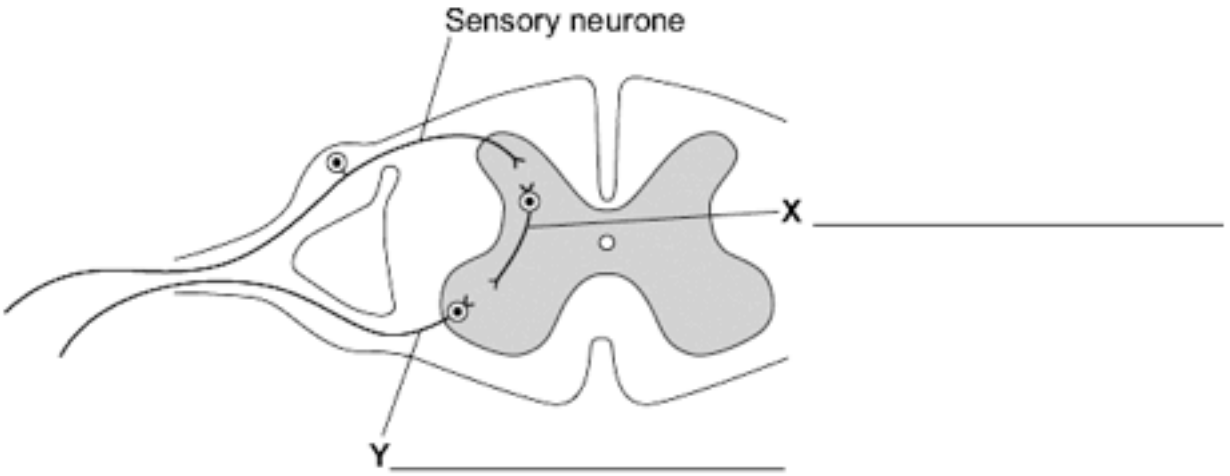
**(Total 9 marks)**

## High demand

## PPQ 11

**Q11.**

The diagram shows some of the structures involved in a reflex action.




(a) On the diagram, name the neurones labelled **X** and **Y**.

**(1)**

(b) Describe how information is transmitted from neurone **X** to neurone **Y**.

_____

_____

_____

_____

**(2)**

**(Total 3 marks)**

**PPQ 12**

**Q12.**

A dog runs across the road in front of a car. The driver slams her foot on the brakes.

(i) Explain how the nervous system brings about this response.

_____

_____

_____

_____

_____

_____

_____

**(4)**

(ii) Explain why alcohol consumption would affect the driver's response.

_____

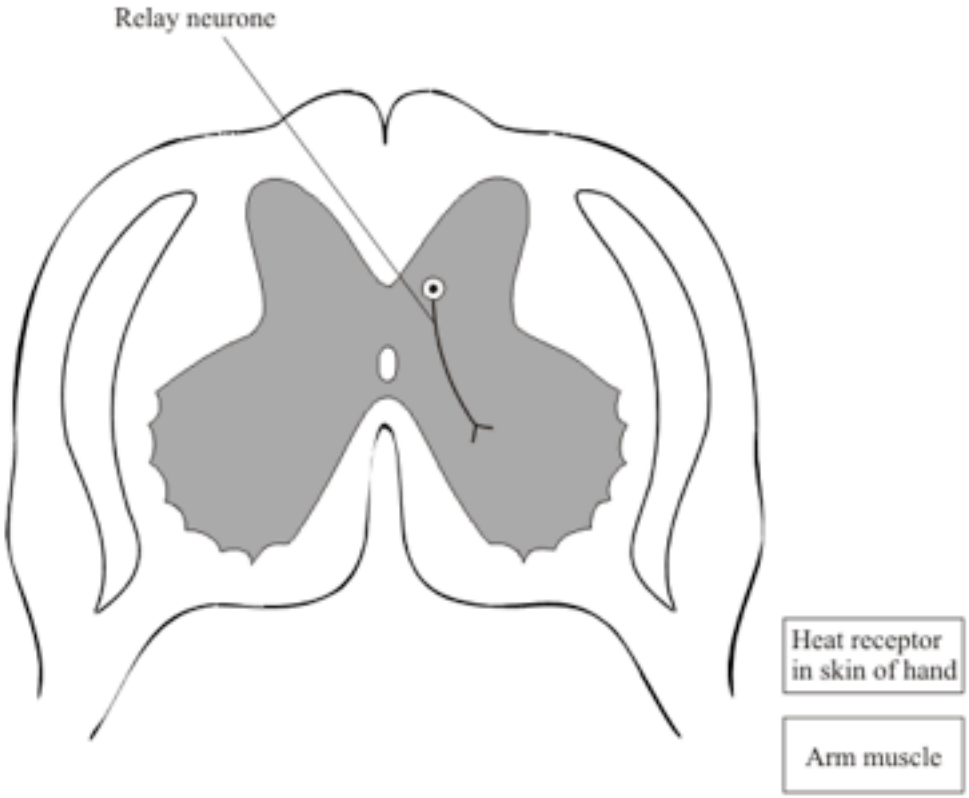
_____

**(1)**

**(Total 5 marks)**

**Q13.**

The diagram shows a section through the spinal cord.




(a) Coordination of a reflex movement of the arm, in response to the hand touching a hot object, involves three neurones. One of these, the relay neurone, is shown in the diagram. Complete the nerve pathway between the receptor and the muscle on the diagram by drawing and labelling:

(i) the sensory neurone;

(ii) the motor neurone.

**(2)**

(b) The nerve pathway linking the heat receptor in the hand with the arm muscle is about 1.5 metres in length. It would take the nervous impulse 0.02 seconds to travel this distance along a neurone. However, it takes about 0.5 seconds for the arm to start moving during the reflex response to the heat stimulus.

Explain the difference.

_____

_____

_____

_____

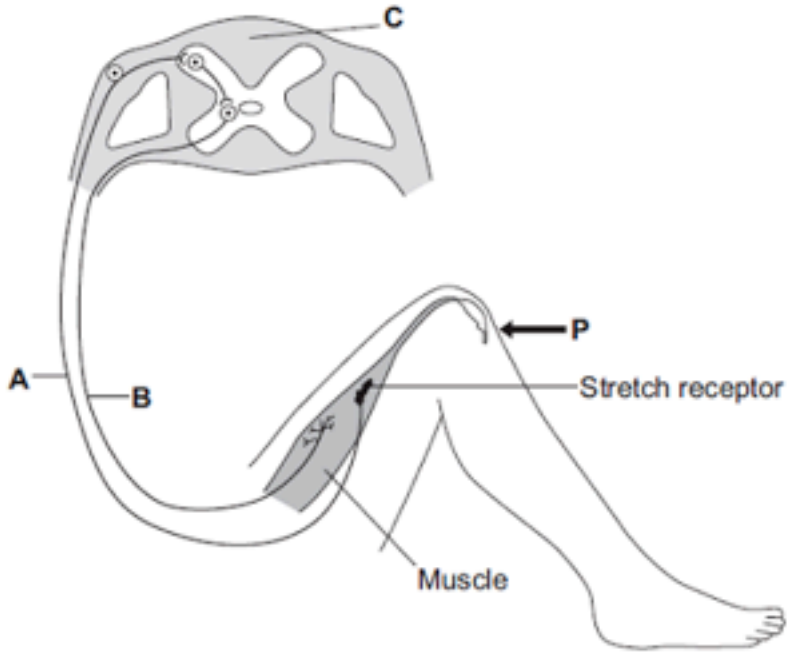
**(2)**

**(Total 4 marks)**

## PPQ 14

**Q14.**

The diagram shows the structures involved in the knee-jerk reflex. When the person is hit at point **P**, the lower leg is suddenly raised.




(a) Name the structures labelled **A**, **B** and **C**.

**A** _____

**B** _____

**C** _____

**(3)**

(b) How is information passed across a synapse?

_____

_____

**(1)**

(c) What is the effector in this response?

_____

**(1)**

**(Total 5 marks)**

**PPQ 15**

(c) Scientists investigated the effect of two toxins on the way in which information passes across synapses. The table below shows the results.

| Toxin | Effect at the synapse |
|---|---|
| Curare | Decreases the effect of the chemical on neurone **X** |
| Strychnine | Increases the amount of the chemical made in the relay neurone |

Describe the effect of each of the toxins on the response by muscles.

Curare _____

_____

_____

Strychnine _____

_____

_____

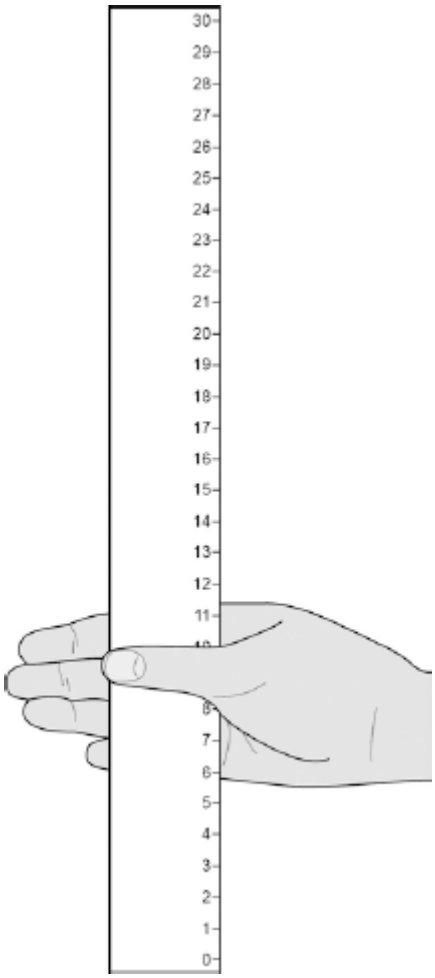
**(2)**

**(Total 6 marks)**

## Q16.

Two students investigated reflex action times. This is the method used.

1. Student **A** sits with her elbow resting on the edge of a table.
2. Student **B** holds a ruler with the bottom of the ruler level with the thumb of Student **A**.
3. Student **B** drops the ruler.
4. Student **A** catches the ruler and records the distance, as shown in the diagram below.
5. Steps **1** to **4** were then repeated.




(a) Suggest **two** ways the students could improve the method to make sure the test would give valid results.

1. _____

_____

2. _____

_____

**(2)**

(b) The table below shows Student **A**'s results.

| Test Number | Distance ruler dropped in mm |
|---|---|
| 1 | 117 |
| 2 | 120 |
| 3 | 115 |
| 4 | 106 |
| 5 | 123 |
| 6 | 125 |
| 7 | 106 |

What is the **median** result?

Tick **one** box.

106 ☐

115 ☐

116 ☐

117 ☐

123 ☐

**(1)**

(c) The mean distance the ruler was dropped is 116 mm. Calculate the mean reaction time. Use the equation:

**reaction time in s =** $\sqrt{\frac{\text{mean drop distance in cm}}{490}}$

Give your answer to 3 significant figures

_____

_____

_____

Mean reaction time = _____ s

**(3)**

(d) The students then measured Student **A**'s reaction time using a computer program.

This is the method used.

1. The computer shows a red box at the start.

2. As soon as the box turns green the student has to press a key on the keyboard as fast as possible.

3. The test is repeated five times and a mean reaction time is displayed.

Student **A**'s mean reaction time was 110 ms.

Using a computer program to measure reaction times is likely to be more valid than the method using a dropped ruler.

Give **two** reasons why.

1. _____

_____

2. _____

_____

**(2)**

(e) A woman has a head injury.

Her symptoms include:

- finding it difficult to name familiar objects
- not being able to remember recent events.

Suggest which part of her brain has been damaged.

_____

**(1)**

(f) A man has a head injury.

He staggers and sways as he walks.

Suggest which part of his brain has been damaged.

_____

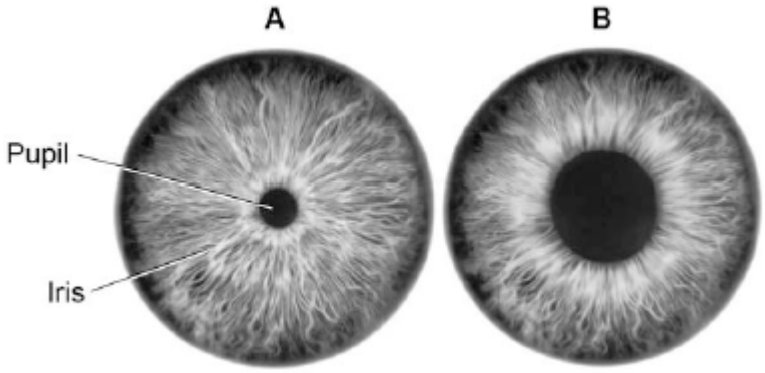
**(1)**

**(Total 10 marks)**

**PPQ17**

**Q17.** **Figure 1** shows a reflex in the iris of the human eye in response to changes in light levels.

**Figure 1**




@ Gandee Vasan/Stone/Getty Images

(a) Describe the changes in the pupil and iris going from **A** to **B** in **Figure 1**.

Explain how these changes occur.

Refer to the changes in light level in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(b) Some people wear glasses to improve their vision.

**Figure 2** shows light entering the eye in a person with blurred vision.

**Figure 3** shows how this condition is corrected with glasses.

**Figure 2**

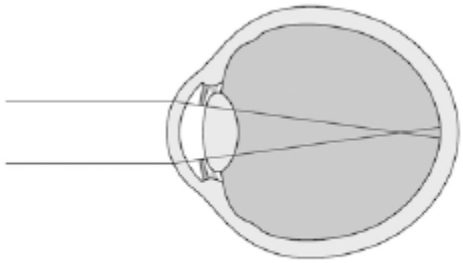
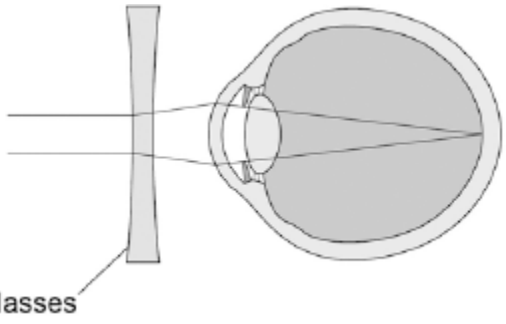


**Figure 3**




Compare **Figure 2** and **Figure 3**.

Explain how the blurred vision is corrected.

_____

_____

_____

_____

_____

_____

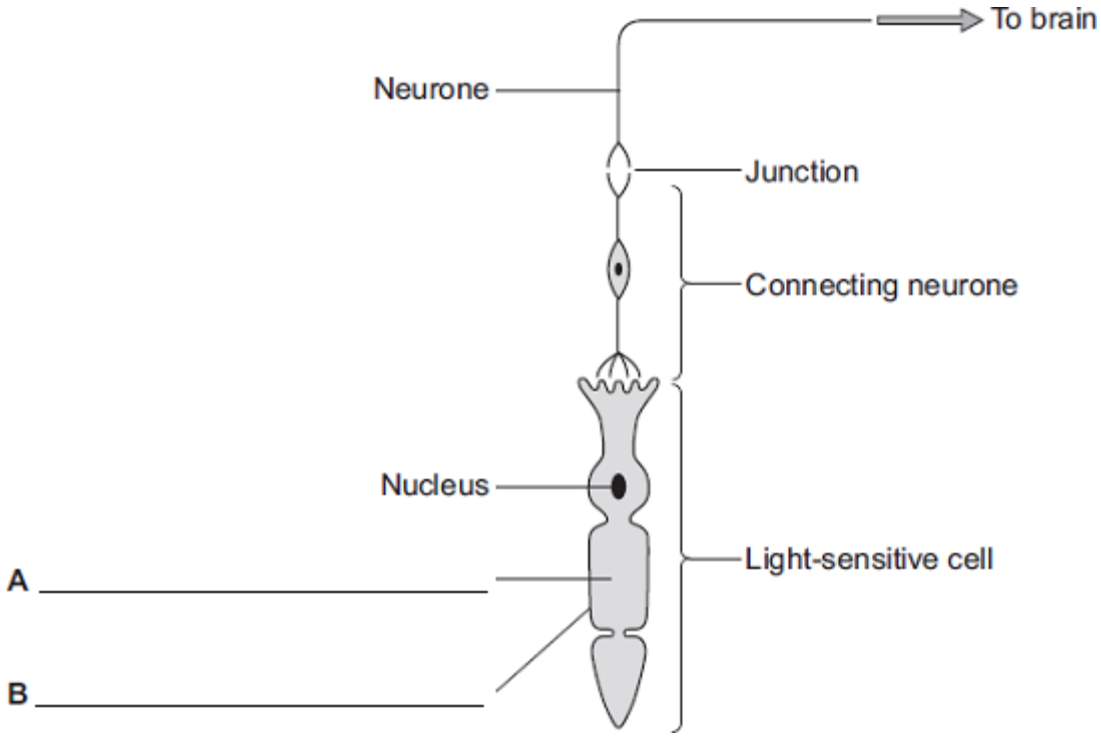
**(2)**

**(Total 6 marks)**

**PPQ18**

**Q18.** **Diagram 1** shows cells from the light-sensitive layer in the eye.

**Diagram 1**




(a) On **Diagram 1**, add labels to name part **A** and part **B** of the light-sensitive cell.

**(2)**

(b) There is a junction between the connecting neurone and the neurone carrying the impulse to the brain.

(i) What name is given to the junction?

_____

**(1)**

(ii) In what form is information passed across the junction?

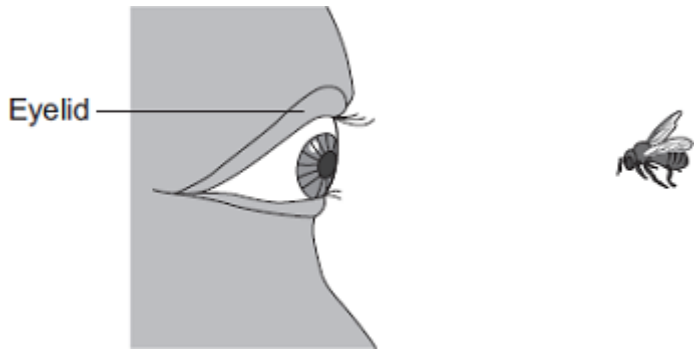
_____

_____

**(1)**

(c) **Diagram 2** shows a bee flying towards a man's eye.

**Diagram 2**




In the *blink reflex* , light from the bee reaches the light-sensitive cell in the eye. The muscles in the eyelid shut the man's eye before the bee hits the eye.

Describe the pathway taken by the nerve impulse in the *blink reflex*.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

**(Total 8 marks)**

## 4.5.2 The human nervous system PPQ answers

## Low demand

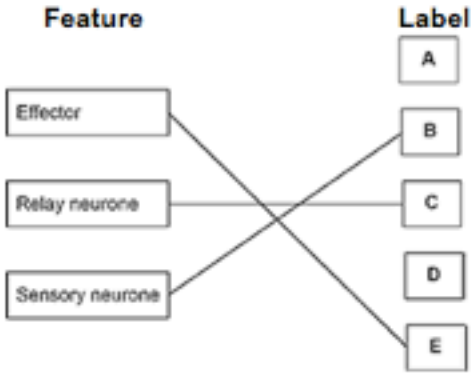
## PPQ MS1

**Q1.**

(a) Reflex action

1

(b)




*extra lines from the left negate the mark*

3

(c) dependent

1

(d) 17.0

*allow answers in range 17.0–17.3 cm*

1

(e) 0.5 cm

1

(f) 23.5

1

does not fit the pattern **or** at least 5 cm higher than the other values

1

(g) The results are for the left and right hands of different people

1

**[10]**

## PPQ MS2

**Q2.**

(a) sensory neurone

1

(b) (i) synapse

1

(ii) a chemical

1

(c) (What happens to the muscle)

*mark both parts of the question together*

any **one** from:

- contraction / contracts

  *ignore relaxation / relaxes / tenses*

1

- gets shorter

(How this helps the body)

idea of protection for body (from damage / pain)

*eg moves finger / arm away (from pin / stimulus / source of pain)*

1

**[5]**

---

## PPQ MS3

**Q3.**

(a) eye / sight / eyesight

*either order*

1

ear / hearing

*ignore light*

1

(b) ear

1

(c) (i) reflex

1

(ii) neurons

1

**[5]**

---

## PPQ MS4

**Q4.**

(a) (i) receptor

1

(ii) sensory neurone

1

(iii) motor neurone

1

(iv) muscle

1

(b) (i) eye(s)

*allow retina*

*ignore sight*

1

(ii) ear(s)

*ignore hearing*

*do **not** allow ear drum*

1

(iii) ear(s)

*ignore balance*

1

[7]

---

## PPQ MS5

**Q5.**

receptor detects stimulus / sharp object

1

impulse / information / message passes along sensory neurone to spinal cord

1

from spinal cord along motor neurone to muscle

1

muscle contracts

1

[4]

---

## Standard demand

## PPQ MS6

**Q6.**

(a) (i) receptor

*allow named receptor eg light receptor*

*ignore sensory neurone*

*allow sense organ / named sensory organ eg skin / eye*

1

(ii) sensory (neurone)

*allow afferent*

1

(iii) motor (neurone)

*allow efferent*

1

(iv) effector / muscle / gland / named

1

(b) any **two** from:

- impulse / information passes from one neurone to another **or** impulse / information passes across gap
- chemical / transmitter involved
- diffusion (across gap)

2

(c) brain / person not aware of pain / stimulus / can't feel

*allow brain/ person doesn't know / realise / unable to coordinate*

*ignore reflex*

*ignore information*

1

possibility of (permanent / serious) damage / eg burning

*ignore danger*

1

**[8]**

---

## PPQ MS7

**Q7.**

A – receptor

*ignore organ / nerve*

1

B – sensory

*allow sensor*

1

C – CNS / central nervous system

*accept spinal cord*
*allow coordinator*
*ignore brain*
*do **not** accept spine*

1

D – motor

1

E – effector

1

**[5]**

---

## PPQ MS8

**Q8.**

(a) reduces / controls amount of light entering the eye

*ignore stops light entering the eye*

1

(so) less chance of damage

*accept protects the retina allow*
*(so) can see better (in bright light)*

1

(b) any **two** from:

*allow converse statements*

A reflex action is:

- fast(er)
- automatic / not thought about
- involves few(er) neurones
- involves few(er) synapses
- does not (always) involve the brain

*allow nerves*

*do **not** allow reference to hormones*

2

**[4]**

---

## PPQ MS9

**Q9.**

(a) fast reaction to reduce / protect from harm

*allow named examples*

1

(b) higher caffeine concentration causes shorter reaction time.

*allow converse*

*ignore 'faster / slower reaction time'*

1

(c) **Level 3 (5–6 marks):**
A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered. The method would lead to the collection of valid results.

**Level 2 (3–4 marks):**
The bulk of a method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant techniques and procedures. The method may
not be in a completely logical sequence and may be missing some detail.

**Level 1 (1–2 marks):**
Discrete relevant points are made which demonstrate some understanding of the relevant scientific techniques and procedures. They may lack a logical structure and would not
lead to the production of valid results.

**0 marks:**
No relevant content.

**Indicative content**

- use decaffeinated coffee as control
- control volume of coffee
- blind trial or do not tell students which coffee they are drinking
- left for standard time between drink and test
- at least 10 minutes
- control start position of ruler
- control other factors such as light in the room
- same person for different concentrations
- repeat for each caffeine concentration
- use a range of caffeine concentrations
- start with lowest concentration of caffeine
- use caffeine solution instead of coffee to control for other ingredients
- repeat investigation with more people and calculate means

6

**[8]**

## PPQ MS10

### Q10.

(a) light/eye
smell/nose
taste/chemical/tongue

*for 1 mark each*

3

(b) 6 of e.g.
receptors in ear detect sound waves/vibrations
impulses/electrical signals to brain
brain co-ordinates response
impulses sent along nerves
to muscles/effectors which contract to bring about response

*any 6 for 1 mark each*

6

[9]

---

## High demand

## PPQ MS11

### Q11.

(a) X – relay (neurone)
Y – motor (neurone)

*both required for mark*
*must be in correct order*

1

(b) chemical (released from **X**)

*do **not** accept electrical impulse*
*accept chemical messenger / transmitter*
*accept neurotransmitter*
*accept named transmitter substance eg acetylcholine*

1

(crosses) synapse

*allow for **2** marks diffusion of the chemical across the synapse*

1

[3]

---

## PPQ MS12

## Q12.

(i) eyes as sense organs/detector/receptors in eye,
electrical signals (impulses),
to co-ordinator,
then to leg muscles/effector
*for 1 mark each*

4

(ii) affects the nervous system and slows down the reactions
*for 1 mark*

1

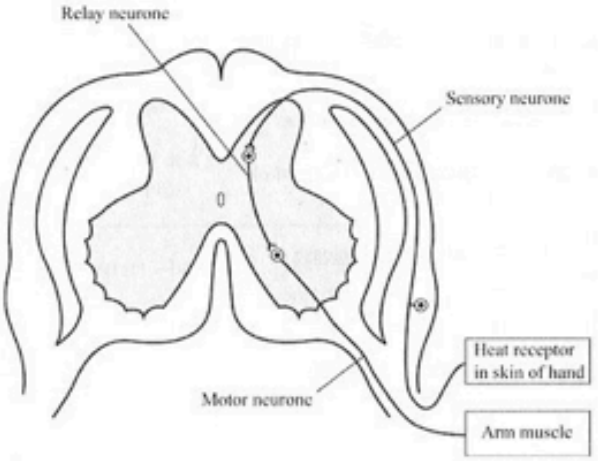
**[5]**

---

## PPQ MS13

## Q13.

(a)




sensory neurone correctly drawn **and** labelled
*from receptor + via dorsal root + cell body in ganglion + synapse to relay neurone*

1

motor neurone correctly drawn **and** labelled
*to muscle + via ventral root + same shape as relay neurone + synapse with relay neurone*
***OR** correct <u>pathways</u> for both neurones given (ie without synapse or cell bodies) **and** labelled,*
***or** correctly <u>drawn</u> but unlabelled = 1 mark for this part)*

1

(b) any **two** from:

reference to synapses / gaps between neurones

extra time for release / movement of chemical

extra time for development of muscle 'tone' / tension

2

**[4]**

---

## PPQ MS14

### Q14.

(a) **A** sensory (neurone)

*ignore nerve*

1

**B** motor (neurone)

*ignore nerve*

1

**C** spinal cord / central nervous system / white matter

*accept grey matter*

1

(b) by chemical / substance

*allow transmitter*

1

(c) muscle

*allow extensor*

*ignore muscle names*

1

**[5]**

---

## PPQ MS15

### Q15.

(a) motor

*allow efferent / postsynaptic*

*allow **another** relay (neurone)*

1

(b) release of chemical (from relay neurone)

*allow ecf for 'motor' neurone from (a)*

*allow release of neurotransmitter / named example*

1

chemical crosses gap / junction / synapse

*allow diffuses across*

*allow chemical moves to X*

1

chemical attaches to X / motor / next neurone (causing impulse)

1

(c) (curare) decrease / no contraction

*accept (muscle) relaxes*

1

(strychnine) increase / more contraction

*if no other mark awarded allow 1 mark for (curare) decrease / no response **and** (strychnine) increase / more response*

1

**[6]**

---

## Q16.

(a) any **two** from:
- drop the ruler from the same height each time
- let the ruler drop without using any force
- same type / weight of ruler
- thumb should be same distance from the ruler each time at the start
- use the same hand to catch the ruler each time
- carry out the experiment with the lower arm resting in the same way on the table

*allow description of holding bottom edge of ruler opposite the catcher's thumb*

**2**

(b) 117

**1**

(c) $\sqrt{\frac{11.6}{490}}$

**1**

0.1539

*allow 01539 with no working shown for **2** marks*

**1**

0.154

*allow 0.154 with no working shown for **3** marks*

**1**

*allow ecf as appropriate*

(d) no indication beforehand when the colour will change
**or**
you might be able to tell when the person is about to drop the ruler

**1**

measurement of time is more precise (than reading from a ruler)
**or**
resolution (of computer timer) is higher

**1**

(e) cerebral cortex

*allow cerebrum*

**1**

*ignore identified lobes*

(f) cerebellum

**1**

**[10]**

## PPQ MS17

## Q17.

(a) pupils dilated (at **B**)

*allow converse for **A***

1

in dim light / low light levels

1

because circular muscles (in iris) relax

1

(and) radial muscles contract

1

(b) figure 2 shows myopia where light does not focus on the retina

*allow refraction*

1

in figure 3 the lens bends the light so that light focuses on the retina

1

**[6]**

## PPQ MS18

## Q18.

(a) **A** cytoplasm

1

**B** (cell) membrane

1

(b) (i) synapse

1

(ii) (as) chemical

*accept neurotransmitter or named*

*ignore references to how the chemical is passed do **not** accept electrical*

1

(c) (from light-sensitive cell to connecting neurone) to sensory neurone

*ignore references to synapses accept 'nerve cell' for neuron(e) throughout penalise 'nerve' for neurone once only*

1

(sensory neurone) to brain / CNS

*allow (sensory neurone) to relay neurone / spinal cord*

1

(brain / CNS) to motor neurone

*allow (relay neurone / spinal cord) to motor neurone*

1

(motor neurone) to (eyelid) muscle

*ignore effector*

1

**[8]**

## 4.5 Homeostasis and Response Knowledge

### 4.5.3 Hormonal coordination in humans

#### 4.5.3.1 Human endocrine system

# Human endocrine system

## Hormones and nerves

A **hormone** is a chemical substance, produced by a **gland** and carried in the bloodstream, which alters the activity of specific **target organs**. An example of this is the release of the hormone adrenaline, which is released by the adrenal gland. One of its target organs is the heart, where it increases the heart rate.

Once a hormone has been used, it is destroyed by the liver.

Hormones can control the body, and the effects are much slower than the nervous system, but they last for longer.

---

There are important differences between nervous and hormonal **control**.

| | Nervous | Hormonal |
|---|---|---|
| **Type of signal** | Electrical (chemical at synapses) | Chemical |
| **Transmission of signal** | By nerve cells (neurones) | By the bloodstream |
| **Effectors** | Muscles or glands | Target cells in particular tissues |
| **Type of response** | Muscle contraction or secretion | Chemical change |
| **Speed of response** | Very rapid | Slower |
| **Duration of response** | Short (until nerve impulses stop) | Long (until hormone is broken down) |

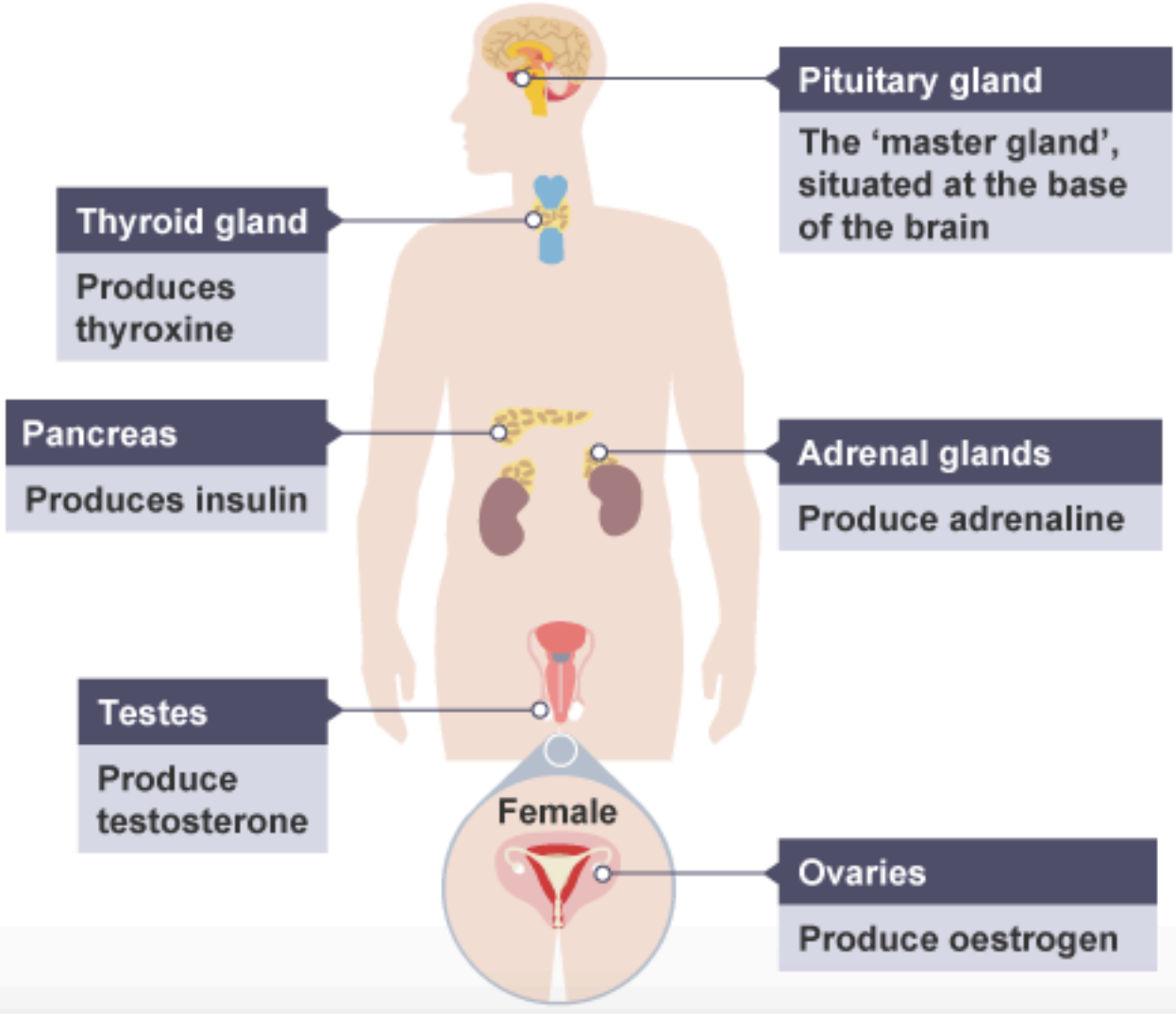
---

## Master gland

The **pituitary gland** in the brain is known as a 'master gland'. It secretes several hormones into the blood in response to the body's condition, such as blood water levels. These hormones can also act on other glands to stimulate the release of different types of hormones and bring about effects.

## Different hormones

The body produces a range of different chemical **hormones** that travel in the bloodstream and affect a number of different organs or cells in the body. The diagram below shows this in detail.



Important hormones released into the bloodstream include ADH (anti-diuretic hormone), adrenaline and insulin.

| | Source | Organ(s) | Role | Effects |
|---|---|---|---|---|
| **ADH** | Pituitary gland | Kidneys | Controlling the water content of the blood | Increases reabsorption of water by the collecting ducts |
| **Adrenaline** | Adrenal glands | Several targets including the respiratory and circulatory systems | Preparation for 'fight or flight' | Increases breathing rate, heart rate, flow of blood to muscles, conversion of glycogen to glucose |
| **Insulin** | Pancreas | Liver | Controlling blood glucose levels | Increases conversion of glucose into glycogen for storage |

---

## 4.5.3.2 Control of blood glucose concentration

# Control of blood glucose concentration by pancreas and insulin

### Regulating blood glucose

**Glucose** is needed by cells for **respiration**. It is important that the concentration of glucose in the blood is maintained at a constant level and controlled carefully. **Insulin** is a hormone - produced by the **pancreas** - that regulates glucose concentrations in the blood.

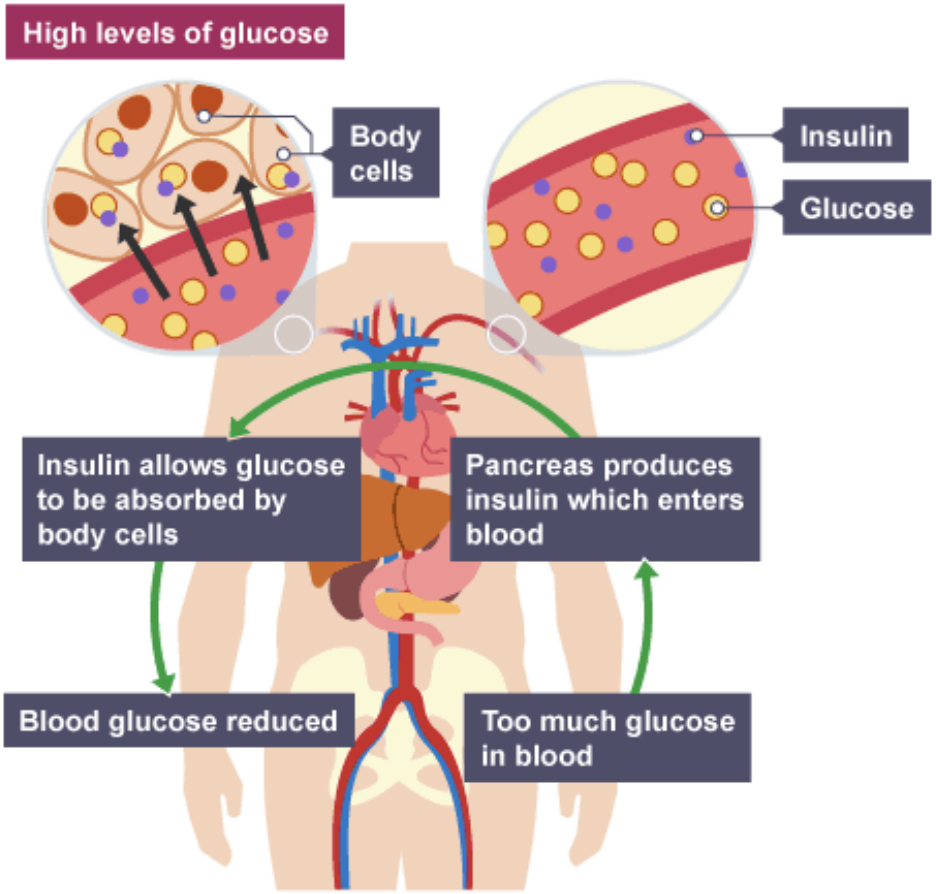
If the blood glucose concentration is too high, the pancreas produces the hormone insulin that causes glucose to move from the blood into the cells. In liver and muscle cells excess glucose is converted to **glycogen** for storage, and will be used at a later date.

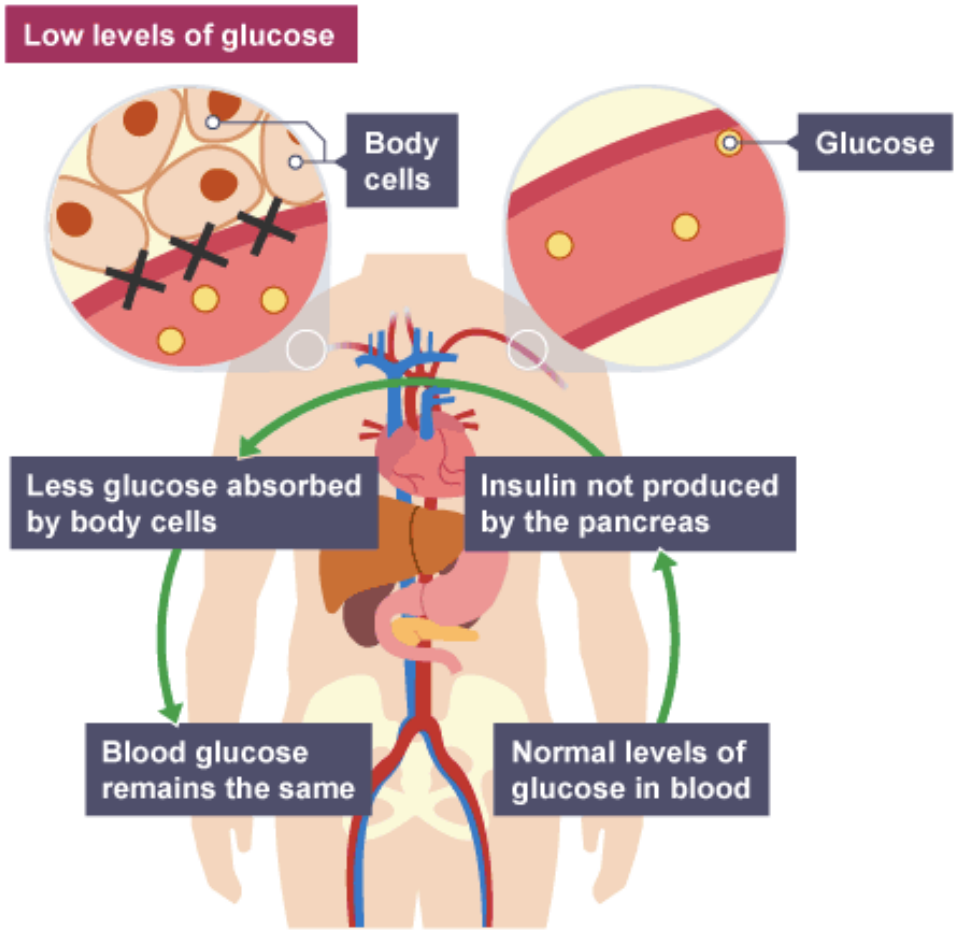
### Action of insulin

| | Low glucose | High glucose |
|---|---|---|
| **Effect on pancreas** | Insulin not secreted into the blood | Insulin secreted into the blood |
| **Effect on liver** | Does not convert glucose into glycogen | Converts glucose into glycogen |
| **Effect on blood glucose level** | Increases | Decreases |

---

The diagram illustrates how insulin works in the body:






**Diabetes** is a condition where the blood **glucose** levels remain too high. It can be treated by injecting **insulin**. The extra insulin causes the liver to convert glucose into **glycogen**, which reduces the blood glucose level.

There are two types of diabetes - type 1 and type 2.

### Type 1 diabetes

Type 1 diabetes is a disorder in which the pancreas fails to produce enough insulin. This can be detected from an early age. It is characterised by uncontrolled high blood glucose levels and it can be controlled by injecting insulin.

People with type 1 diabetes have to monitor their blood sugar levels throughout the day. Their levels of physical activity and their **diet** affect the amount of insulin needed.

They can *help* to control their blood glucose level by being careful with their diet, and eat foods that will not cause large increases in blood sugar level, and by exercising, which can lower blood glucose levels due to increased **respiration** in the muscles.

### Type 2 diabetes

In type 2 diabetes the person's body cells no longer respond to insulin produced by the pancreas. It is more common in older people. It can be controlled by a **carbohydrate** controlled diet and an exercise regime. Carbohydrate is digested into glucose, which raises the overall blood glucose level. There is a correlation between rising levels of **obesity** in the general population and increasing levels of type 2 diabetes.

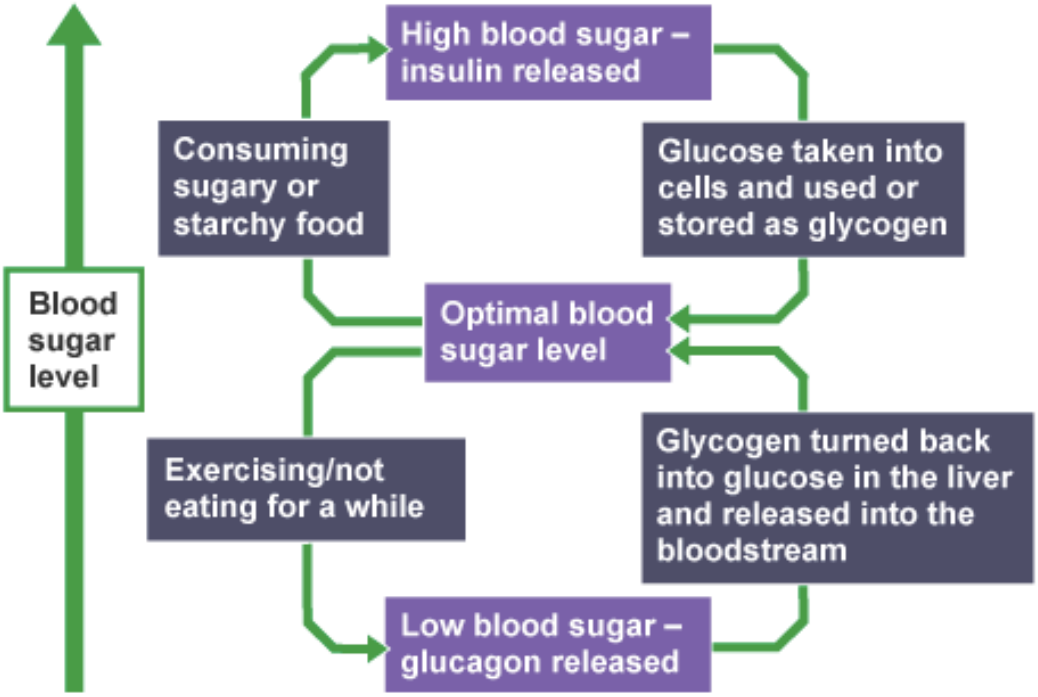
---

# Role of glucagon in control of blood sugar levels – Higher

## Negative feedback

In blood glucose regulation, the hormone insulin plays a key role. When blood sugar rises in the blood, insulin sends a signal to the liver, muscles and other cells to store the excess glucose. Some is stored as body fat and other is stored as glycogen in the liver and muscles. Whereas, if the blood glucose level is too low, the liver receives a message to release some of that stored glucose into the blood. This change is brought about by another hormone produced by the pancreas called glucagon.

This is an example of negative feedback.



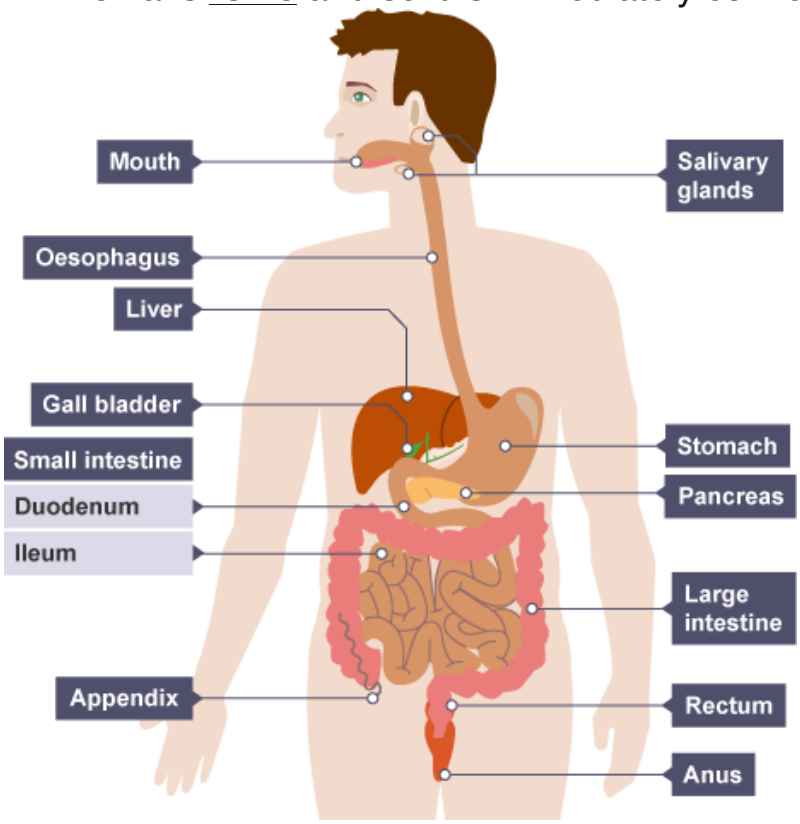
**Action of insulin**

| | Low glucose | High glucose |
|---|---|---|
| **Effect on pancreas** | Insulin not secreted into the blood | Insulin secreted into the blood |
| **Effect on liver** | Does not convert glucose into glycogen | Converts glucose into glycogen |
| **Effect on blood glucose level** | Increases | Decreases |

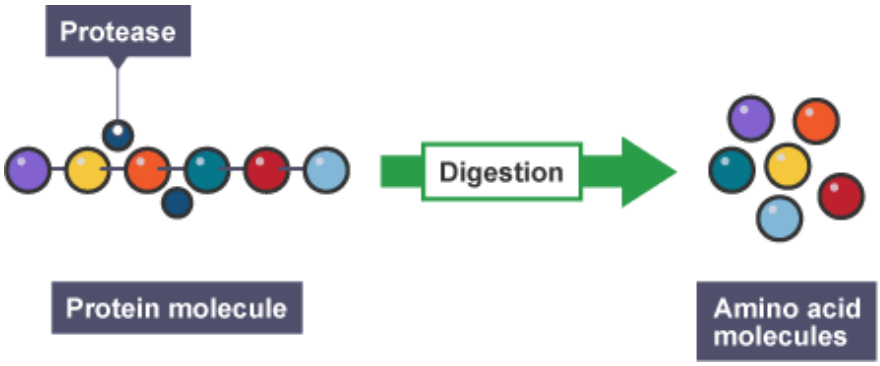
---

## 4.5.3.3 Maintaining water and nitrogen balance in the body (biology only)

The digestion of proteins from the diet results in excess amino acids, which need to be excreted safely. In the liver these amino acids are deaminated to form **ammonia**. Ammonia is **toxic** and so it is immediately converted to **urea** for safe excretion.




Once we have eaten our food, it is then digested by the body. The **digestion** of **proteins** is broken down by **protease** enzymes into **amino acids** in the stomach and small intestine.




When excessive amounts of protein are eaten, the excess amino acids produced from digesting proteins are transported to the liver from the small intestine. The liver controls the amino acid concentration in the body, as excess amino acids which need to be **excreted** safely. The body is unable to store proteins or amino acids.

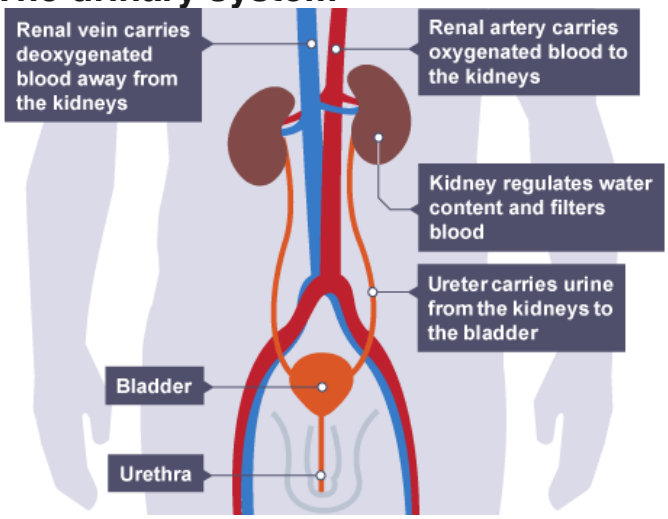
In the liver ammonia is formed by the deamination of amino acids. It is highly toxic and cannot be allowed to accumulate in the body. Excess ammonia is converted to urea. Urea and water are released from the liver cells in to the bloodstream and transported to the kidneys where the blood is filtered and the urea is passed out of the body in the urine.

**Maintaining water balance in the body**

**Kidneys**

The **kidneys** are organs of the urinary system - which remove excess water, salts and urea.

**The urinary system**




Blood is transported to the kidney through the renal artery. The blood is filtered at a high pressure and the kidney selectively reabsorbs any useful materials such as glucose, salt ions and water. After it has been purified, the blood returns to the circulatory system through the renal vein.

The kidneys produce urine and this helps maintain water balance. The urine is taken from the kidneys to the bladder by the ureters. The bladder stores the urine until it is

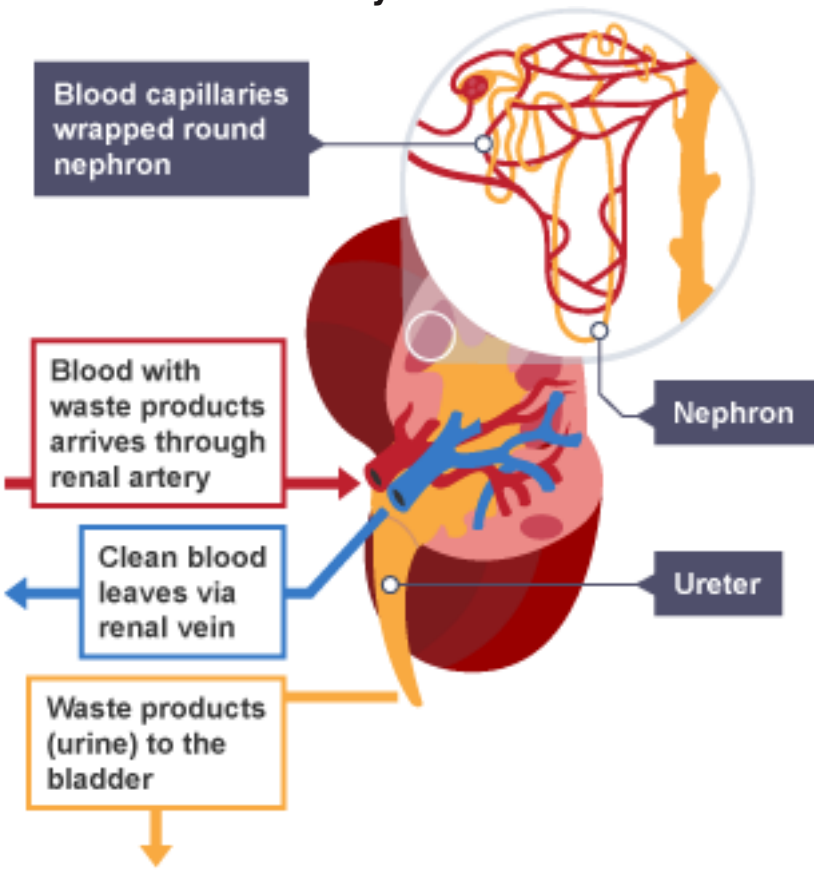
convenient to expel it from the body.
Note that **'ureter'** differs from the word **'urethra'**. The ureters are tubes that carry urine from the kidneys to the bladder, whereas the urethra is the tube that carries urine out of the body.

**Urine**

Urine contains water, **urea** and salts. Urea is produced in the liver when excess amino acids are broken down. Urea is the main waste product removed in the urine, as it is not reabsorbed in the kidney.

**The nephron**

**The role of the kidney**




Each kidney contains over one million microscopic filtering units called nephrons. Each nephron is made of a tubule and is responsible for 'cleaning' the blood by removing urea and excess water and mineral ions.
The kidney works in a number of different stages:

**Stage 1 - Filtration**

Blood passes through the nephron inside the kidneys, there are many capillaries inside the kidney, and the blood is under high pressure at the start of the nephron, which aids the ultrafiltration of the blood. Small molecules are filtered out and pass into the nephron tubule. These small molecules include ureas, **water, ions, and glucose**. However, large molecules, such as blood proteins, are too big to fit through the capillary wall and remain in the blood.

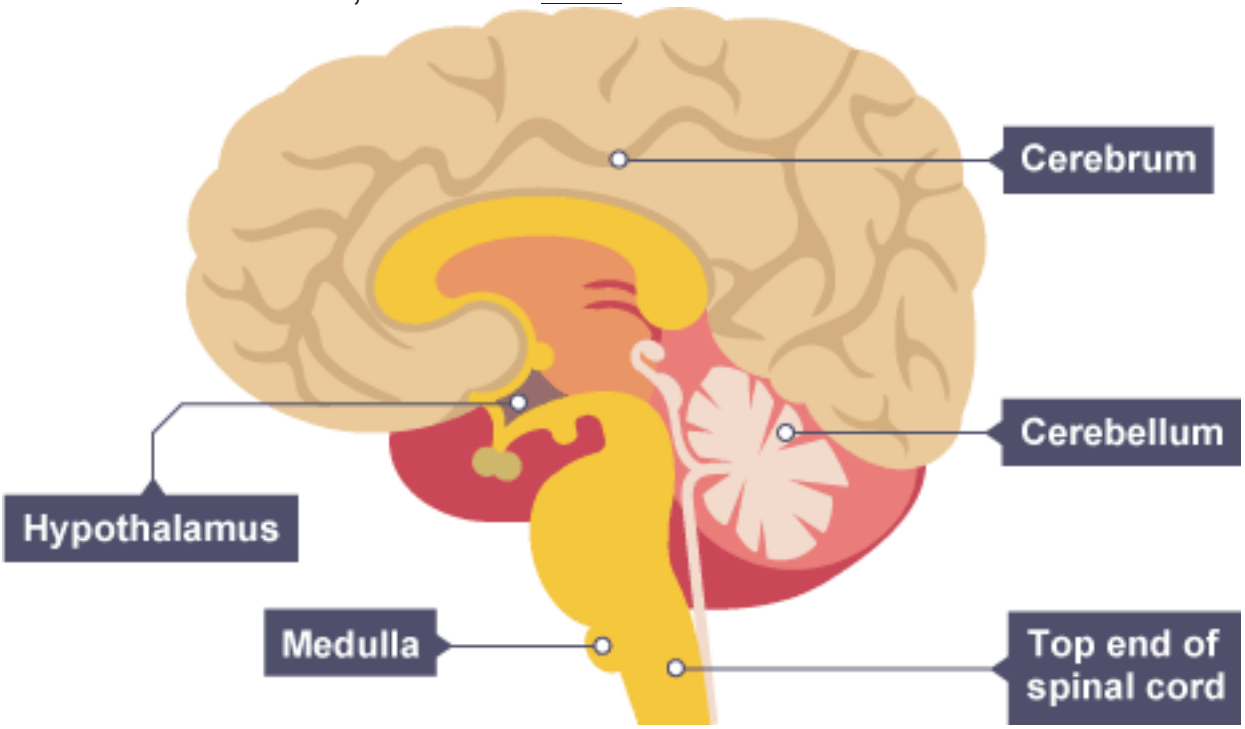
**Stage 2 - Selective reabsorption**
Having filtered out small essential molecules from the blood - the kidneys must reabsorb the molecules which are needed, while allowing those molecules which are not needed to pass out in the urine. Therefore, the kidneys selectively reabsorb only those molecules which the body needs back in the bloodstream.
The reabsorbed molecules include:

- all of the glucose which was originally filtered out
- as much water as the body needs to maintain a constant water level in the blood plasma
- as many ions as the body needs to maintain a constant balance of mineral ions in the blood plasma

**Stage 3 - The formation of urine**
The molecules which are not selectively reabsorbed (the urea, excess water and ions) continue along the nephron tubule as **urine**. This eventually passes down to the bladder.
In carrying out these processes, the kidney is able to fulfil its functions of regulating the water and ion balance of the blood plasma, as well as keeping the level of urea low.

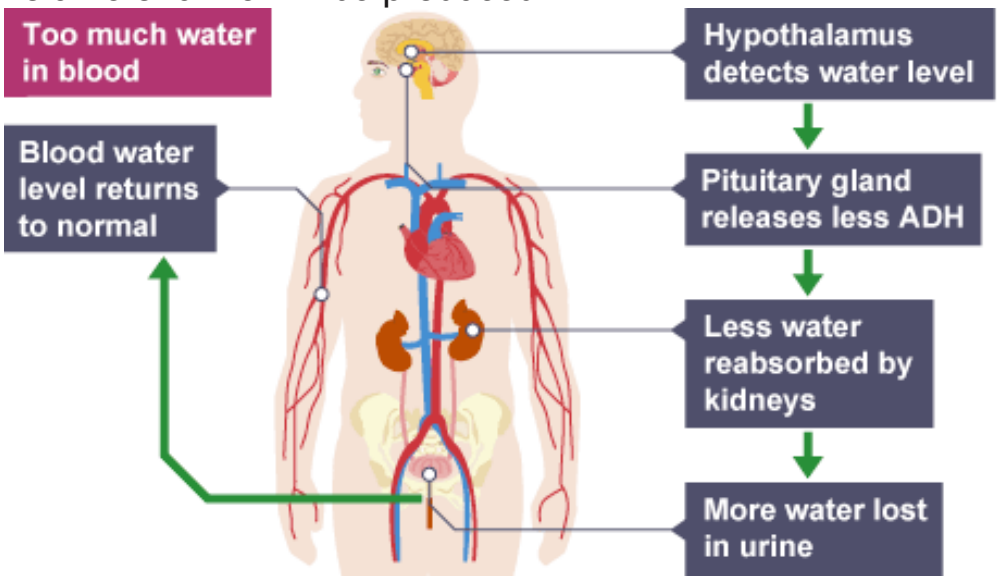
**The effect of ADH on tubule permeability and in water balance – Higher**

**ADH**
Two important areas inside the brain are the **hypothalamus**, which detects changes in the blood plasma, and the **pituitary gland**, which regulates the release of the anti-diuretic hormone, known as **ADH**.

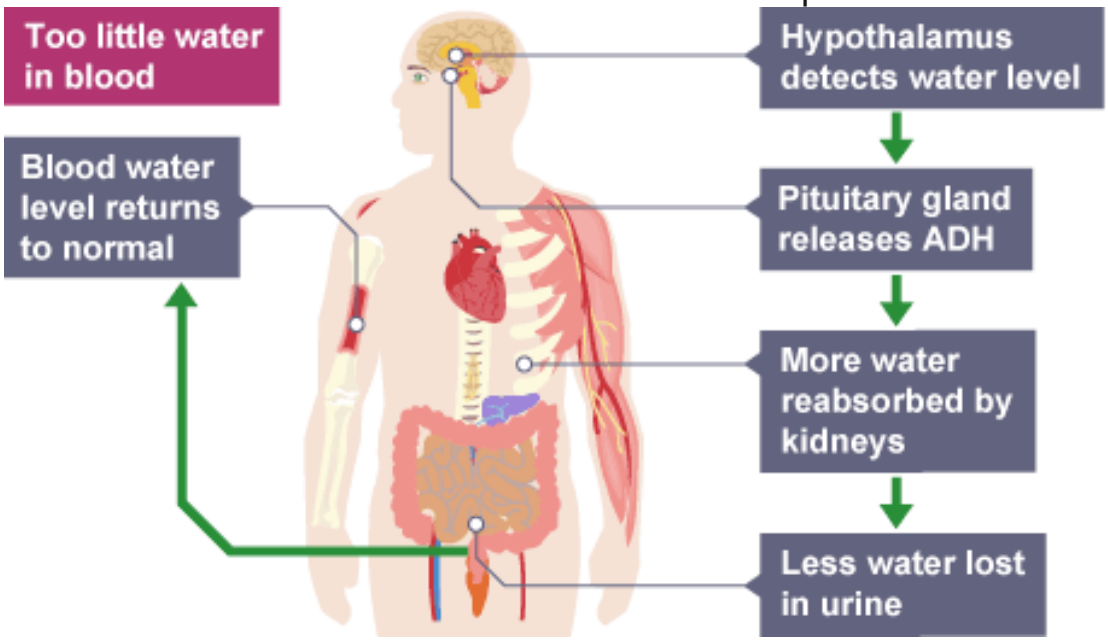


Different amounts of ADH are released into the bloodstream according to the concentration of water in the **blood plasma**. ADH is released by the pituitary gland when the blood is too concentrated and it causes the kidney tubules to become more **permeable**. This allows more water to be reabsorbed back into the blood during selective reabsorption.

If a person has consumed a large volume of water and has not lost much as sweat, too much water might be detected in the blood plasma. If this occurs, less ADH will be released, which results in less water being reabsorbed and a dilute and larger volume of urine will be produced.




If a person becomes too hot and sweats a lot, but doesn't drink enough water to replace what was lost, too little water might be detected in the blood plasma. More ADH will be released, which results in water being reabsorbed and a more concentrated but smaller volume of urine will be produced.

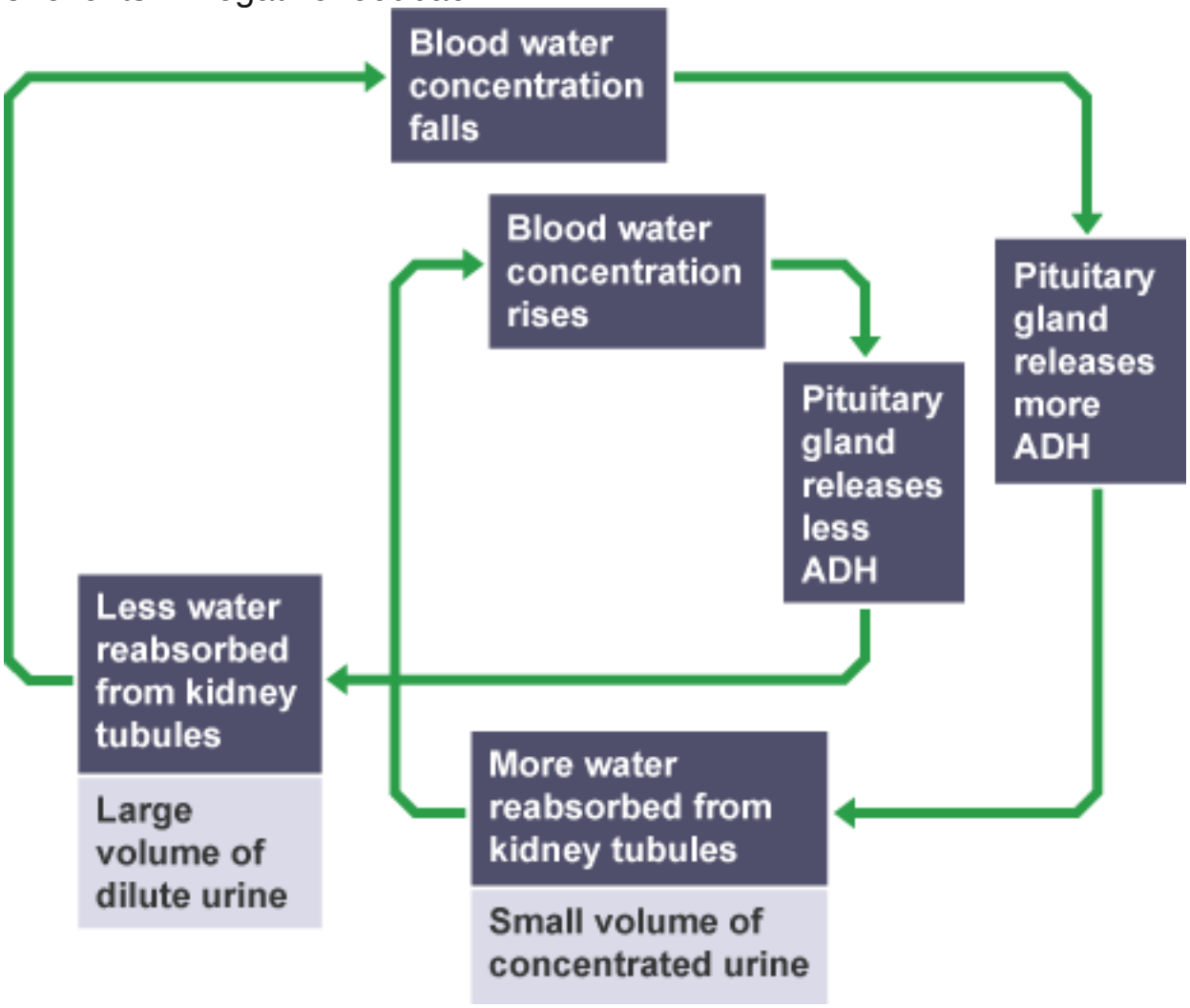



This type of control is an example of the negative feedback mechanism. It aims to

keep the concentration of the blood plasma constant.

| Plasma | Problem | ADH release | Effect of ADH | Effect on urine |
|---|---|---|---|---|
| High concentration | Too little water | Increases | More water reabsorbed by nephrons | More concentrated |
| Low concentration | Too much water | Decreases | Less water reabsorbed by nephrons | More dilute |

A negative feedback control system responds when conditions change from the ideal or set point and returns conditions to this set point. There is a continuous cycle of events in negative feedback.

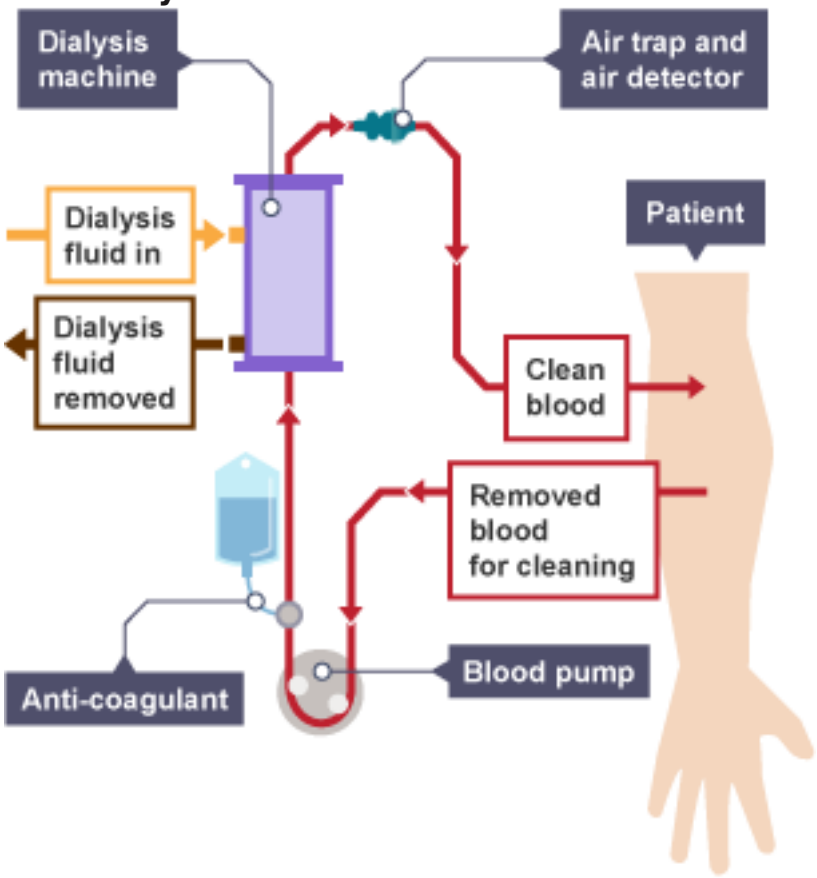


**Treating kidney failure by dialysis**
**Water and waste**
**The consequences of kidney damage or disease**
The kidney is responsible for the removal of waste products from the blood. Damage from accidents or disease can lead to a build-up of poisonous wastes in the body. Humans can survive with one kidney, but for people who suffer from total kidney failure this would be fatal if not treated. Treatment is available for kidney failure and can be by organ transplant or by using kidney **dialysis**.
In this procedure, patients are connected to a dialysis machine which acts as an artificial kidney to remove most of the urea and restore/maintain the water and ion balance of the blood.

Patients with kidney failure can be kept alive by using kidney dialysis until a **transplant** becomes available, but they have several disadvantages:

- they are expensive
- the patient must have his or her blood connected to the machine for several hours every week
- patients must follow a very rigid diet to avoid complications
- they only work for a limited time for a patient

**How dialysis works**



How dialysis works

Unfiltered blood that is high in urea is taken from a blood vessel in the arm, mixed with blood thinners or an **anti-coagulant** to prevent clotting, and pumped into the dialysis machine. Inside the machine the blood and dialysis fluid are separated by a **partially permeable membrane** the blood flows in the opposite direction to dialysis fluid, allowing exchange to occur between the two where a concentration gradient exists.
Dialysis fluid contains:

- a **glucose** concentration similar to a normal level in the blood
- a concentration of ions similar to that found in normal blood plasma
- no **urea**

As the dialysis fluid has no urea in it, there is a large concentration gradient - meaning that urea moves across the partially permeable membrane, from the blood to the dialysis fluid, by diffusion. This is very important as it is essential that urea is removed from the patients' blood.

As the dialysis fluid contains a glucose concentration equal to a normal blood sugar level, this prevents the net movement of glucose across the membrane as no concentration gradient exists. This is very important as the patients' need to retain glucose for respiration.

And, as the dialysis fluid contains an ion concentration similar to the ideal blood plasma concentration, movement of ions across the membrane only occurs where there is an imbalance.

- If the patient's blood is too **low in ions**, they will diffuse from the dialysis fluid into the blood, restoring the ideal level in the blood.
- If the patient's blood is **too high in ions**, the excess ions will diffuse from the blood to the dialysis fluid.

**Advantages of dialysis**
Kidney dialysis allows a person with kidney failure to maintain their health.
The overall effect of this is that the blood leaving the machine and returning into the patient's arm will have:

- greatly reduced levels of urea – it is 'cleaned blood'
- no overall change in blood glucose levels
- the correct water and ion balance maintained or restored (with only excess ions removed)

**Disadvantages of dialysis**
Kidney dialysis requires highly specialised and expensive machinery. The patient must be connected to this machinery 2-3 times a week for periods (on average) of between 4-6 hours at a time. This is time consuming and restrictive, as this mainly

happens in hospital.
As the filtration only works when they are connected, kidney patients must monitor their diet carefully in between dialysis sessions. They need to avoid eating foods with a high salt content or a high protein content as excess amino acids are broken down into urea. This again can be difficult to control and monitor, but will help maintain the health of the patient.
Finally, dialysis will only work for a limited amount of time before a transplant is needed, and sadly many patients will die before a suitable one is found.

**Treating kidney failure by transplant**

**Kidney transplants**

Kidney transplantation is an alternative method for treating kidney failure and can save a patient's life. This procedure involves implanting a kidney from an organ donor into the patient's body to replace the damaged kidney. This is better than using a restrictive dialysis machine, as the recipient can lead a normal life afterwards.

As with all cells, the donor kidney cells will have protein antigenson their surface. Antigens are unique to each of us (with the exception of identical twins), and allow our body to identify our own cells from those of potential pathogens.

Differences in the antigens of the donor kidney cells and those of the patient receiving the transplant would mean that the patient's immune system would quickly form antibodies against the kidney cell antigens, and would ultimately destroy the kidney. This is known as **organ** rejection. This is potentially very harmful for the patient.

**Precautions against rejection**

Two precautions can be taken to reduce organ rejection:

1. **Tissue typing** - a kidney is given to patients who have antigens that are very similar to the antigens of the donor kidney. This can lead to long waits for transplants while compatible donors become available - during which time patients must undergo dialysis, and in some cases they will die before a match is found.
2. **Immuno-suppressant drugs** – these drugs must be taken by transplant patients for the rest of their lives. They suppress the immune system, greatly reducing the immune response against the donor kidney. The negative effect of this is that it also suppresses the immune response against pathogens which enter the body, increasing the risk of infections.

Even with these two precautions, most donor kidneys will only survive for an average period of 8-9 years before the patient will require a further transplant or a return to dialysis.

**Transplants versus dialysis**

The table below shows some of the pros and cons for both kidney dialysis and kidney transplants

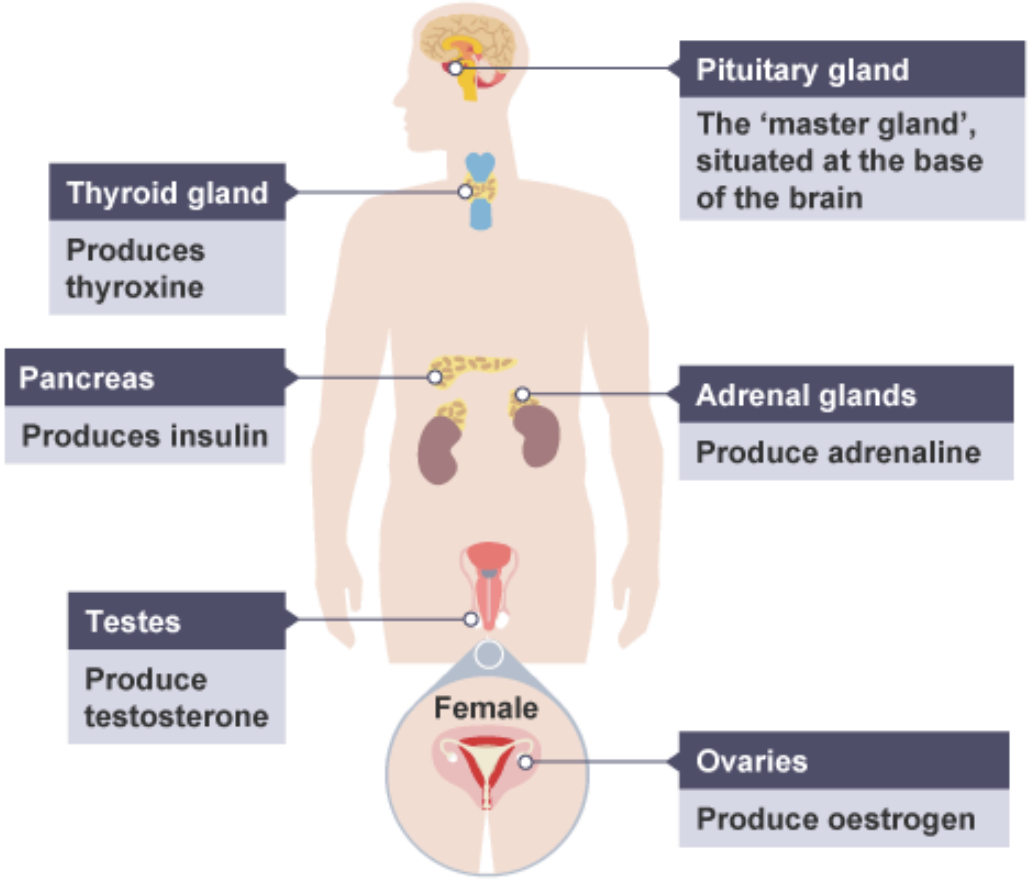
| | Advantages | Disadvantages |
|---|---|---|
| **Transplants** | Patients can lead a more normal life without having to watch what they eat and drink | Must take immune-suppressant drugs which increase the risk of infection |
| | Cheaper for the NHS overall. | Shortage of organ donors |
| | | Kidney only lasts 8-9 years on average |
| | | Any operation carries risks |
| **Dialysis** | Available to all kidney patients (no shortage) | Patient must limit their salt and protein intake between dialysis sessions |
| | No need for immune-suppressant drugs | Expensive for the NHS |
| | | Regular dialysis sessions - impacts on the patient's lifestyle |

## 4.5.3.4 Hormones in human reproduction

# The role of reproductive hormones in the menstrual cycle

A **hormone** is a chemical substance, produced by a **gland** and carried by the blood, which alters the activity of specific **target organs** (and is then destroyed by the liver).

Different hormones affect different organs or cells.



## Puberty

Puberty is the stage in life when a child's body develops into an adult's body. The changes take place gradually, usually between the ages of 10 and 16.

During puberty, reproductive hormones cause secondary sex characteristics to develop:

- **testosterone** - produced by the testes – is the main male reproductive hormone and it stimulates sperm production
- **oestrogen** - produced by the ovaries – is the main female reproductive hormone. At puberty, eggs begin to mature and one is released approximately every 28 days. This is ovulation.

### Changes during puberty

A variety of changes happen to boys and girls during puberty.

| Boys only | Boys & girls | Girls only |
|---|---|---|
| Voice breaks | Pubic hair grows | Voice deepens gradually |
| Hair grows on face and body | Underarm hair grows | Hips get wider |
| Body becomes more muscular | Sexual organs grow and develop | Breasts develop |
| Testes start to produce sperm cells | | Ovaries start to release egg cells - menstruation starts |

The **menstrual cycle** is a recurring process which takes around 28 days. During the process, the lining of the **uterus** is prepared for pregnancy. If implantation of the fertilised egg into the uterus lining does not happen, the lining is then shed. This is known as **menstruation**.

Several hormones control this cycle – for example, they are involved in controlling the release of an egg each month from an ovary, and changing the thickness of the uterus lining.

| Hormone | Produced | Role |
|---|---|---|
| FSH (follicle stimulating hormone) | Pituitary gland | Causes an egg to mature in an ovary. Stimulates the ovaries to release oestrogen |
| Oestrogen | Ovaries | Stops FSH being produced (so that only one egg matures in a cycle). Repairs, thickens and maintains the uterus lining. Stimulates the pituitary gland to release LH. |
| LH (luteinising hormone) | Pituitary gland | Triggers ovulation (the release of a mature egg) |
| Progesterone | Ovaries | Maintains the lining of the uterus during the middle part of the menstrual cycle and during pregnancy. |

If a woman becomes pregnant, the **placenta** produces progesterone. This maintains the lining of the uterus during pregnancy and means that menstruation does not happen.

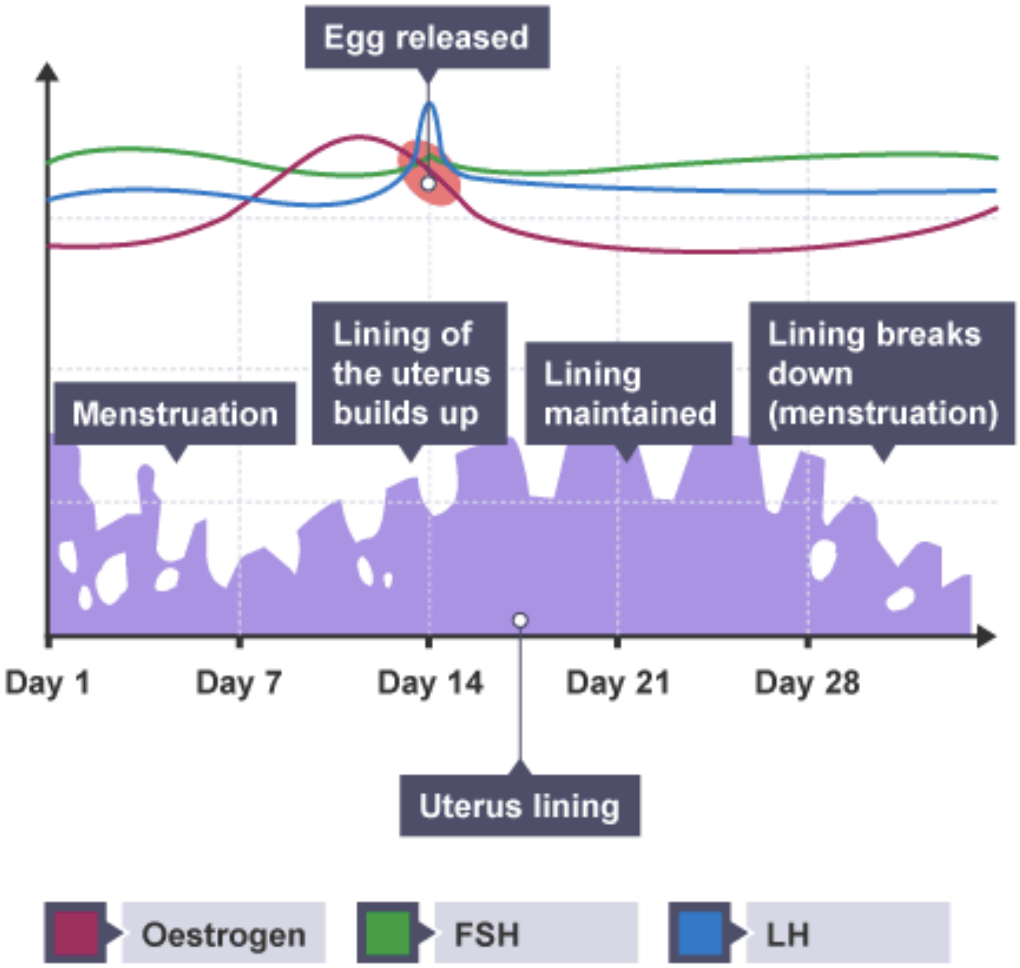
---

# Oestrogen and progesterone in the control of the menstrual cycle

Several **hormones** are involved in the **menstrual cycle** of a woman:

- **follicle stimulating hormone (FSH)** causes the maturation of an egg in the ovary
- **luteinising hormone (LH)** stimulates the release of the egg
- **oestrogen** is involved in repairing and thickening the uterus lining, **progesterone** maintains it

The menstrual cycles last for approximately 28 days, and graphs can be used to follow changes to the hormones during this process.



## 4.5.3.5 Contraception

# Hormonal methods of contraception

### Oral contraceptives

Human **fertility** is controlled by **hormones**, so fertility can be controlled using hormonal forms of contraception.


The oral contraceptive, which is known as the pill, contains **oestrogen** or **progesterone**. These hormones inhibit the production of **FSH**, and eggs cannot mature.

### Benefits and risks

Oral contraceptives are more than 99% effective if taken correctly and can reduce the risk of certain cancers.

However, there are possible side effects, such as changes in weight, mood and blood pressure due to high levels of oestrogen. Modern pills contain much less oestrogen.

Contraceptive injections, implants or skin patches contain slow release progesterone to inhibit the maturation and release of eggs.

---

# Non-hormonal methods of contraception

Fertility can be controlled without hormones.

These methods include:

- Physical barrier methods such as condoms and diaphragms, which prevent the sperm reaching an egg
- Intrauterine devices (IUD) also known as a coil, prevent the implantation of an embryo or release of a hormone
- Spermicidal agents which kill or disable sperm
- Abstaining from intercourse when an egg may be in the oviduct
- Surgical methods of male and female sterilisation. An example is a vasectomy, where the sperm ducts are cut and tied.

**Benefits and risks**

- Condoms are easy and quick to use, but sometimes they can tear or rip.
- Diaphragms need to be put in just before sex and left in several hours afterwards.
- IUDs need to be fitted by a health professional. IUD can remain in position for up to 10 years. However, there is a small risk of causing an ectopic pregnancy.
- Spermicidal agents can be added to other physical barriers such as condoms, but some people can have allergic reactions to these.
- Abstaining can be used successfully, but if the timings are not accurate the chance of pregnancy is high.
- Surgical methods cannot be reversed, and is considered permanent.

## 4.5.3.6 The use of hormones to treat infertility (HT only)

# Hormones used in reproductive technology to treat infertility – Higher

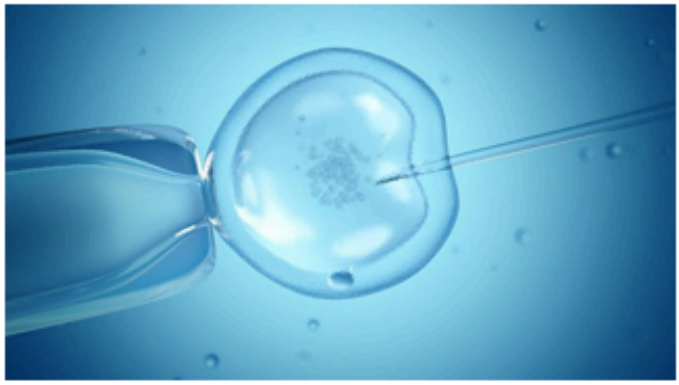
### Fertility treatments

Some women have difficulty becoming pregnant because they don't produce enough FSH to allow their eggs to mature. Fertility drugs contain **FSH** and **LH**, which stimulate eggs to mature in the ovary.

Fertility treatments increase a woman's chance of becoming pregnant, although the treatment may not always work. On the other hand, because the treatment boosts the production of mature eggs, it increases the chance of twins or triplets. Multiple pregnancies carry a risk of complications, and may lead to premature or underweight babies.

### In vitro fertilisation (IVF) treatment

If a couple are having difficulty conceiving a child because there are issues with the quality of the man's sperm, or a woman has blocked oviducts, then **IVF** can be used.



- IVF involves giving a mother FSH and LH to stimulate the maturation of several eggs.
- The eggs are collected from the mother and fertilised by sperm from the father in a dish in the laboratory.
- The fertilised eggs develop into embryos.
- At the stage when they are tiny balls of cells one or two embryos are inserted into the mother's uterus (womb)

The development of microscopy techniques have allowed IVF treatments to be developed further.

---

# Evaluating infertility treatments – Higher

The NHS has to choose which couples they can fund for IVF. If they cannot be treated on the NHS, some people chose to pay privately for treatment. This is very expensive, and costs approximately £5000.

The chances of a successful pregnancy vary depending on the age of the woman involved. As a woman's age increases, the chance of conception decreases. In particular, the chances of a woman over the age of 43 becoming pregnant decreases to a 5% success rate.

Data from the NHS choices website shows that:

In 2010, the percentage of IVF treatments that resulted in a live birth was:

- 32.2% for women under 35
- 27.7% for women aged 35-37
- 20.8% for women aged 38-39
- 13.6% for women aged 40-42
- 5% for women aged 43-44
- 1.9% for women aged over 44

**Advantages of IVF**

- It allows people to have babies of their own, who otherwise can't due to a variety of reasons.
- It has a safe track record and has been used since 1978. The embryos can be screened for genetic diseases, which is important for families that already have an affected child. Only unaffected embryos are used.
- Unused eggs can be used for research or donated to other couples.

### Disadvantages of IVF

- There are side effects form the drugs used, such as hot flushes and severe headaches.
- There is a possibility of multiple births, which is dangerous for mother and babies.
- Ovarian hyper-stimulation syndrome (OHS), when too many eggs develop in the ovaries.
- It is very emotionally and physically stressful.
- The success rates are not high.

## Ethical concerns

Some people worry about the ethical implications of IVF. They are concerned that couples may want 'designer babies' with 'desirable' qualities, so may only want certain fertilised eggs. For example, they may want a girl if they have lots of boys in the family.

Also, the embryos that are not used may be destroyed. Some people consider embryos to be new lives and view their destruction as unethical.

---

## 4.5.3.7 Negative Feedback (HT Only)

# Negative feedback systems in hormonal control – Higher

### Homeostatic control

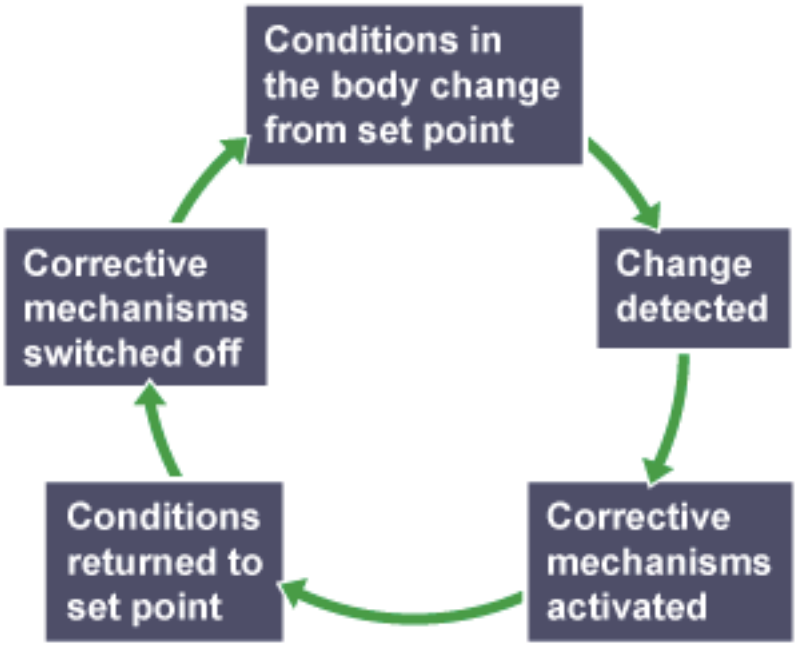
In animals, conditions such as water concentration, temperature, and glucose concentration must be kept as constant as possible. Control systems that keep such conditions constant are examples of **homeostasis**; this is the maintenance of constant internal conditions in an organism.

A **negative feedback mechanism** is an important type of control that is found in homeostasis. A negative feedback control system responds when conditions change from the ideal or set point and returns conditions to this set point. There is a continuous cycle of events in negative feedback.

### General stages in negative feedback

In general this works by:

- if the level of something rises, control systems reduce it again
- if the level of something falls, control systems raise it again

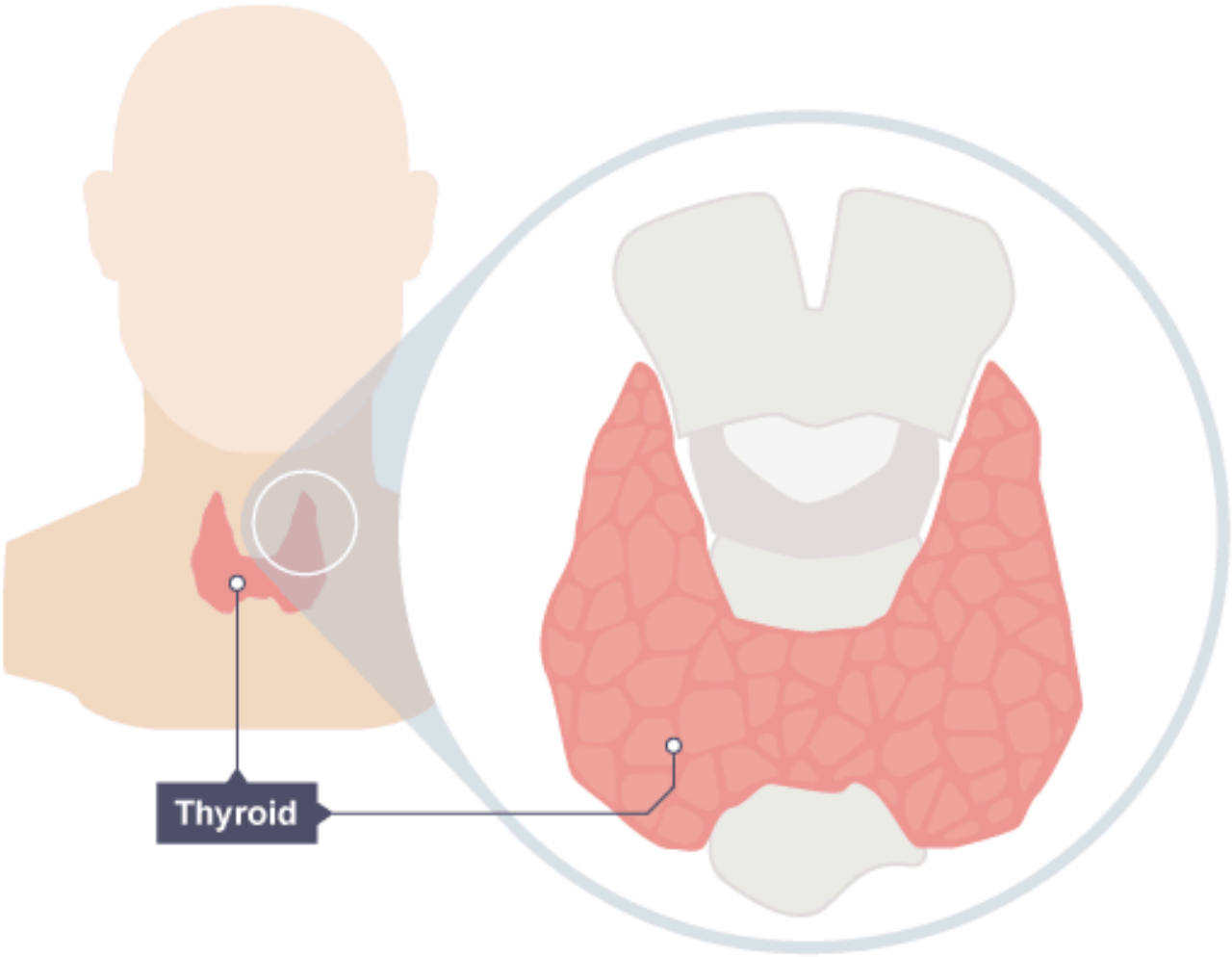


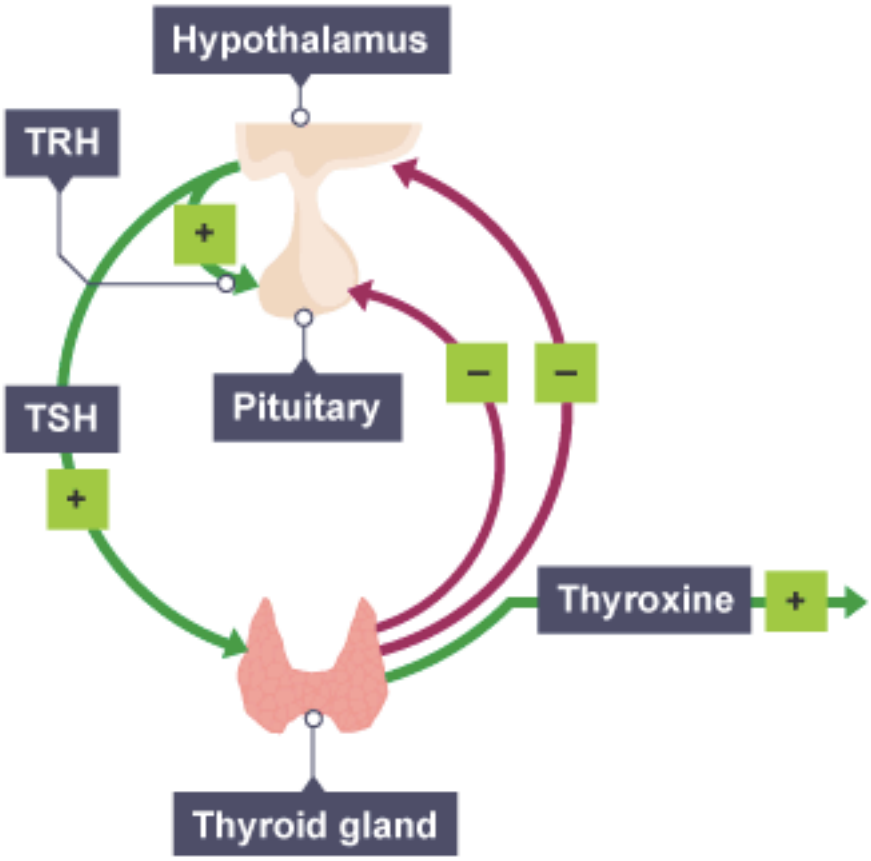

Negative feedback flowchart

An example of negative feedback is the control of body temperature. Body temperature is controlled by the hypothalamus in your brain, and if your body gets too hot, your body begins to sweat to try and reduce it. Conversely if the body gets too cold, it begins to shiver to try and raise the temperature.

# Thyroxine and adrenaline – Higher

Thyroxine is produced from the thyroid gland, which stimulates the basal metabolic rate. It controls the speed at which oxygen and food products react to release energy for the body to use. Thyroxine plays an important role in growth and development. Thyroxine levels are controlled by **negative feedback**.






The **hypothalamus** and **pituitary gland** have important roles in detecting and controlling thyroxine levels.

1. **Low thyroxine** levels in the bloodstream stimulate the hypothalamus to **release TRH** and this causes the pituitary to **release TSH** so the thyroid **releases more** thyroxine. So blood levels return to normal.
2. **Normal thyroxine levels** in the bloodstream **inhibit TRH** release from the hypothalamus and this inhibits the release of **TSH** from the pituitary, so normal blood levels are maintained.

---

Adrenaline is produced by the adrenal glands in times of fear or stress. It targets vital organs, increases the heart rate and boosts the delivery of oxygen and glucose to the brain and muscles, preparing the body for 'flight or fight'. Adrenaline is **not** controlled by negative feedback.

When adrenaline is released into the bloodstream it creates multiple effects:

- increases breathing rate, heart rate, and conversion of glycogen to glucose so more energy is released in the muscles
- it diverts blood away from areas, such as the digestive system, towards the muscles

The effects of adrenaline allow the body to prepare for action in situations where a quick response may be essential.

---

## 4.5.2 Hormonal control in humans PPQ's

## Low demand

## PPQ 1

**Q1.** A person with Type 1 diabetes does **not** produce enough of the hormone insulin.

(a) Where is the hormone insulin produced?

Tick **one** box.

- Brain ☐
- Pancreas ☐
- Pituitary ☐
- Thyroid ☐

**(1)**

(b) How does insulin travel around the body?

_____

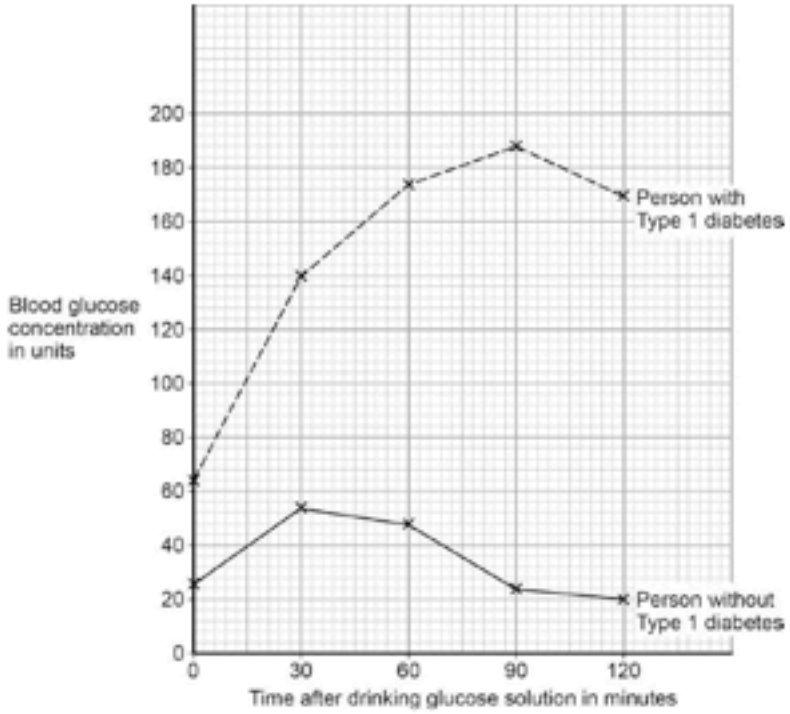
_____

**(1)**

(c) The same concentration and volume of glucose solution was given to two people.

- Person with Type 1 diabetes.
- Person without Type 1 diabetes.

The figure below shows how the blood glucose concentration of these two people changed after they each drank a glucose solution.




Look at the figure above. Compare the blood glucose concentrations of the two people. Include similarities and differences in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(d) People with diabetes may be asked to control their diet. Explain how this can help to reduce the risk of developing health problems.

_____

_____

_____

_____

_____

_____

**(3)**

**(Total 9 marks)**

## PPQ 2

**Q2.** (a) **List A** gives the names of three hormones. **List B** gives information about the three hormones. Draw a line from each substance in **List A** to the correct information in **List B**.

| List A Hormone | List B Information |
|---|---|
| | Used in some contraceptive pills to stop eggs maturing |
| FSH | |
| | Used as a fertility drug to make eggs mature |
| LH | |
| | Causes the lining of the womb to break down |
| Oestrogen | |
| | Stimulates the release of eggs in IVF |

**(3)**

(b) The table gives information about three methods of giving hormones to stop a woman becoming pregnant.

| | The 'pill' | The 'patch' | The 'implant' |
|---|---|---|---|
| **How the hormone is given** | Swallowed each day for 21 days out of every 28 days. | Stuck onto the skin. Each patch lasts three weeks. There is a one week gap between each patch. | Needs an operation to put it under the skin. Lasts for up to 5 years. |

Use the information in the table to answer these questions.

(i) Which of the three methods is likely to be the most reliable?

_____ **(1)**

(ii) Explain why you chose this method.

_____

_____ **(1)**

(iii) Give **one** disadvantage of the method you have chosen.

_____ **(1)**

**(Total 6 marks)**

## PPQ 3

**Q3.**

Our bodies control the concentration of glucose in the blood.

Draw a ring around the correct answer to complete each sentence.

(a) The concentration of glucose in the blood is controlled by a

hormone called

| |
|---|
| carbohydrase. |
| insulin. |
| protease. |

**(1)**

(b) This hormone is produced by the

| |
|---|
| intestine. |
| stomach. |
| pancreas. |

**(1)**

(c) If the body does not produce enough of this hormone,

the person develops

| |
|---|
| diabetes. |
| cystic fibrosis. |
| Huntington's disease. |

**(1)**

**(Total 3 marks)**

---

## PPQ 4

**Q4.**

Internal conditions in the body are controlled.

Use words from the box to complete each of the following sentences.

| | | |
|---|---|---|
| **blood** | **FSH** | **glands** |
| **hormones** | **LH** | **white blood cells** |

Many processes in the body are controlled by chemical substances called

_____ .

The chemicals are secreted by _____ .

They are transported to their target organs in _____ .

One of these chemical substances stimulates the release of an egg from a woman's ovary.

This chemical substance is called _____ .

**(Total 4 marks)**

---

## PPQ 5

**Q5.**

In Vitro Fertilisation (IVF) treatment helps infertile women to become pregnant.

(a) Use words from the box to complete each sentence.

| ovary | pituitary gland | sperm | uterus |
|---|---|---|---|

The eggs are collected from the mother's _____

Each egg is fertilised by a _____ .

Each fertilised egg develops into a ball of cells called an embryo.

One or two of these embryos are inserted into the mother's _____ .

**(3)**

(b) The table shows the effectiveness of IVF treatment in one clinic in 2010.

| Age of women in years | Under 35 | 35 – 37 | 38 – 40 | Over 40 |
|---|---|---|---|---|
| **Number of IVF treatments** | 130.0 | 100.0 | 29.0 | 20.0 |
| **Average number of embryos transferred** | 2.6 | 2.8 | 3.3 | 3.6 |
| **Percentage of successful pregnancies** | 43.0 | 30.0 | 21.0 | 13.0 |

(i) How does the age of the women affect the average number of embryos transferred?

_____

_____

**(1)**

(ii) Look again at the information in the table.

Suggest **one** ethical reason why many people are against IVF treatment.

_____

_____

**(1)**

**(Total 5 marks)**

## Standard demand

## PPQ 6

**Q6.**

The pancreas is involved in digestion and controlling the internal conditions of the body.

(a) Name **two** digestive enzymes produced by the pancreas.

1. _____

2. _____

**(2)**

(b) Diabetes may be caused by a lack of insulin.

Part of the treatment for someone with diabetes is to pay careful attention to the diet.

(i) Give **one** symptom of diabetes.

_____

_____

**(1)**

(ii) Give **one** way in which a diabetic may be advised to change their diet.

_____

_____

**(1)**

(iii) How does this change in diet help the diabetic?

_____

_____

**(1)**

(iv) State **one** other way in which the symptoms of diabetes may be treated.

_____

**(1)**

(c) Many of the cells in the pancreas contain large numbers of ribosomes.

What is the function of ribosomes in a cell?

_____

_____

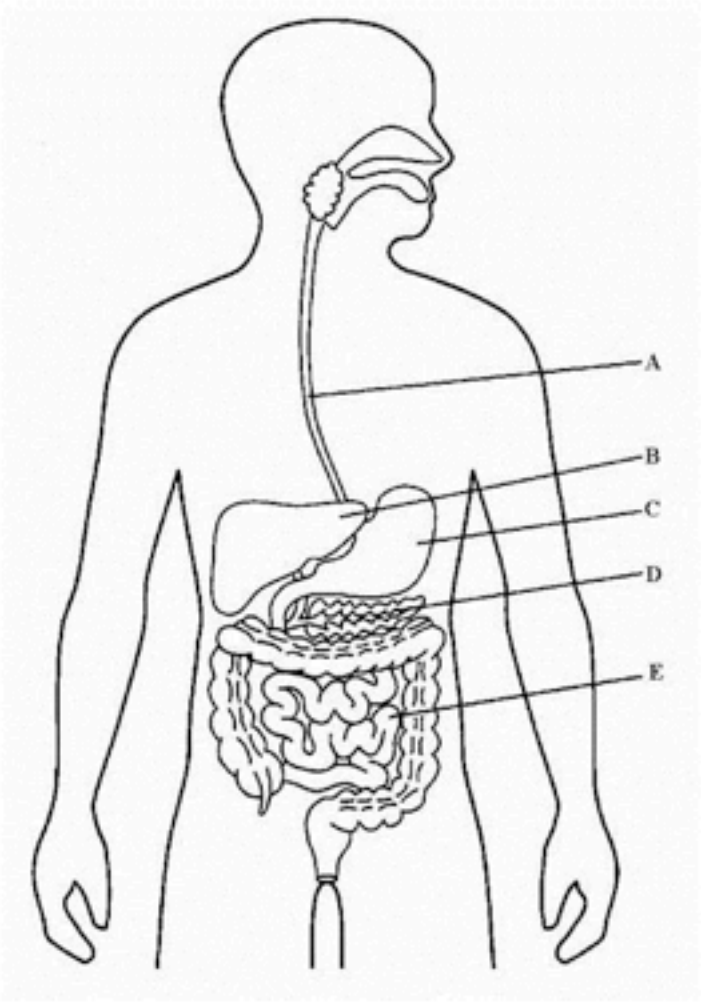
**(1)**

**(Total 7 marks)**

## PPQ 7

**Q7.**

The diagram shows part of the human digestive system.




(i) Name part **B**.

_____

**(1)**

(ii) Describe the role of **B** and **D** in reducing blood sugar levels.

_____

_____

_____

_____

_____

**(2)**

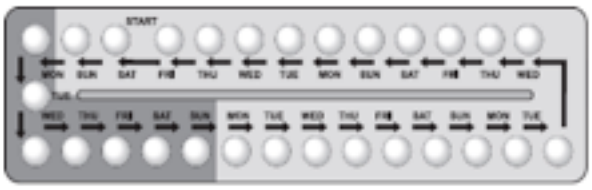
**(Total 3 marks)**

## PPQ 8

**Q8.**

Hormones can be used to control human fertility.

Many women take the oral contraceptive pill so they do not become pregnant.




(a) Name **two** hormones used in contraceptive pills.

1. _____

2. _____

**(2)**

(b) Explain how these hormones stop a woman from becoming pregnant.

_____

_____

_____

_____

**(2)**

**(Total 4 marks)**

## PPQ 9

**Q9.**

This question is about hormones.

(a) (i) Hormones carry messages.

What type of messenger is a hormone?

Draw a ring around the correct answer.

**chemical** **electrical** **environmental**

**(1)**

(ii) Which part of the brain secretes hormones?

Draw a ring around the correct answer.

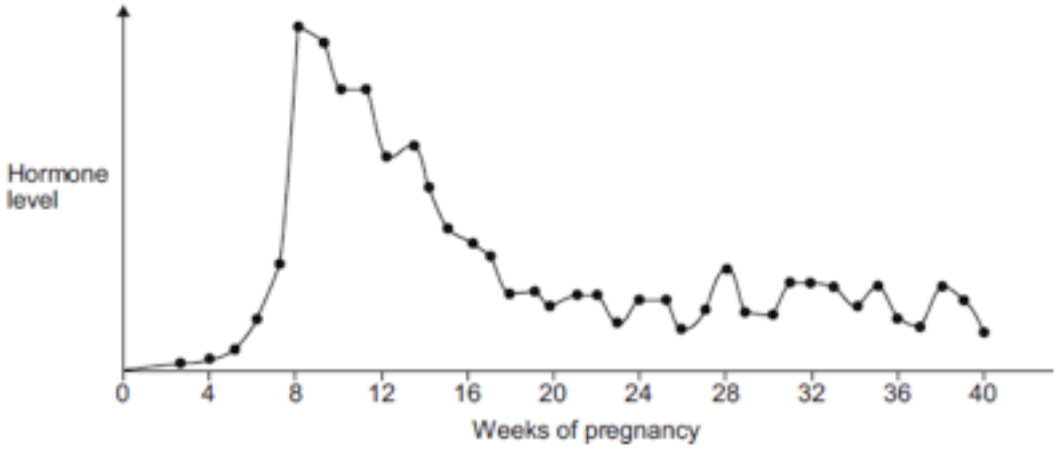
**cerebellum** **medulla** **pituitary gland**

**(1)**

(b) **Figure 1** shows the level of a pregnancy hormone over a 40-week pregnancy.

This hormone can be detected in a pregnancy test.

**Figure 1**




A woman takes a pregnancy test.

In which week of pregnancy is the test most likely to give a positive result?

Use information from **Figure 1**.

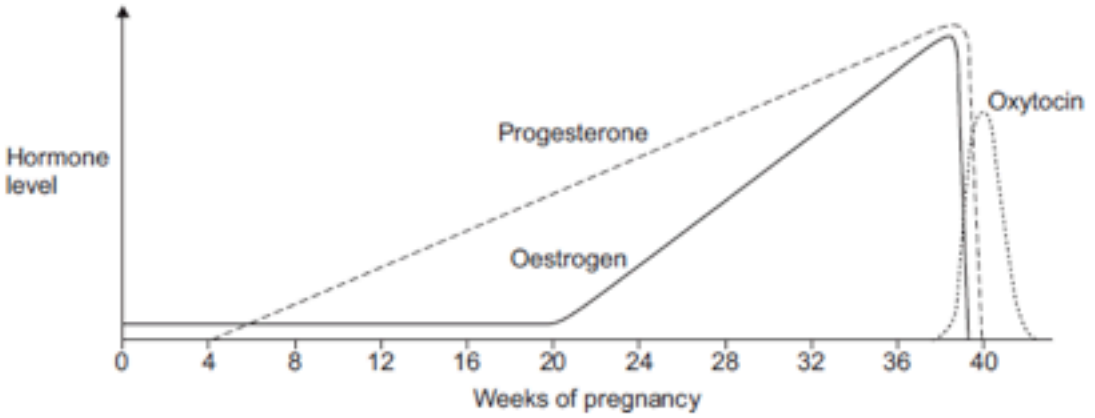
Write the correct answer in the box.

**(1)**

(c) **Figure 2** shows the levels of three other hormones during pregnancy.

The baby is usually born at about 40 weeks.

**Figure 2**




Adaptation by kind permission of Biozone International

(i) Describe the patterns in the levels of oestrogen and progesterone from 0 to 36 weeks.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(ii) Which hormone is likely to stimulate contractions of the uterus (womb) when the baby is born?

Use information from **Figure 2** to give a reason for your answer.

_____

_____

_____

_____

**(2)**

**(Total 9 marks)**

## PPQ 10

**Q10.**

The human body produces many hormones.

(a) (i) What is a *hormone*?

_____

_____

**(1)**

(ii) Name an organ that produces a hormone.

_____

**(1)**

(iii) How are hormones transported to their target organs?

_____

**(1)**

(b) Describe how the hormones FSH, oestrogen and LH are involved in the control of the menstrual cycle.

_____

_____

_____

_____

_____

_____

_____

_____

**(3)**

**(Total 6 marks)**

## High demand

## PPQ 11

**Q11.**

Read the following passage which is from an advice book for diabetics.

### Insulin Reactions

Hypoglycaemia or 'hypo' for short, occurs when there is too little sugar in the blood.
It is important always to carry some form of sugar with you and take it immediately you feel a 'hypo' start. A hypo may start because:

- you have taken too much insulin, or
- you are late for a meal, have missed a meal altogether, have eaten too little at a meal, or
- you have taken a lot more exercise than usual.

The remedy is to take some sugar.

An insulin reaction usually happens quickly and the symptoms vary – sweating, trembling, tingling of the lips, palpitations, hunger, pallor, blurring of the vision, slurring of speech, irritability, difficulty in concentration.

Do not wait to see if it will pass off, as an untreated 'hypo' could lead to unconsciousness.

(a) Many diabetics need to take insulin.

(i) Explain why.

_____

_____

_____

_____

**(2)**

(ii) Explain why there is too little sugar in the blood if too much insulin is taken.

_____

_____

_____

_____

**(3)**

(iii) Explain why there is too little sugar in the blood if the person exercises more than usual.

_____

_____

_____

_____

**(3)**

(b) Suggest why sugar is recommended for a 'hypo', rather than a starchy food.

_____

_____

_____

_____

**(3)**

(c) Explain how the body of a healthy person restores blood sugar level if the level drops too low.

_____

_____

_____

_____

**(3)**

(d) Explain, using insulin as an example, what is meant by negative feedback.

_____

_____

_____

_____

**(3)**

**(Total 17 marks)**

## PPQ 12

**Q12.**

*In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Homeostasis keeps conditions in the body relatively constant.

The amount of water in the body is controlled by homeostasis.

Kidney function is controlled by a gland in the brain.

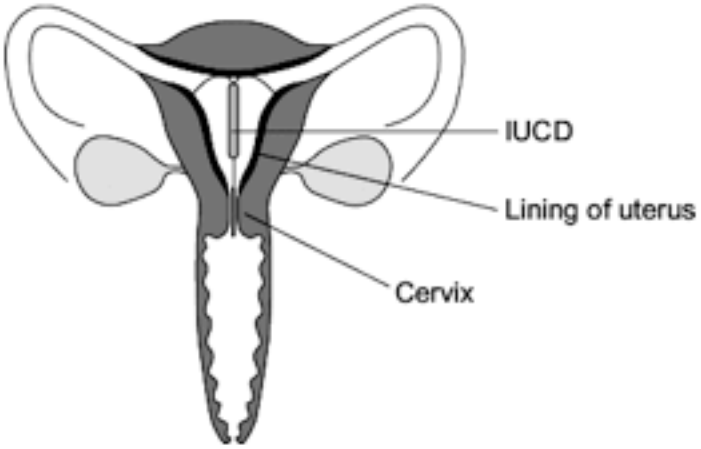
Describe how the water content of the blood is controlled.

**(Total 6 marks)**

## PPQ 13

**Q13.**

The diagram shows an intra-uterine contraceptive device (IUCD).




The IUCD is put inside the uterus (womb). The IUCD contains a hormone. The hormone diffuses directly into the uterus. The supply of hormone in the IUCD lasts for about five years.

The hormone works by:

- causing the cervix to produce a thick plug of mucus
- causing the lining of the uterus to become very thin.

For every 1000 women using the IUCD for one year about 2 women become pregnant. There are about 10 pregnancies for every 1000 women using the contraceptive pill for one year.

Evaluate the use of the IUCD compared with the contraceptive pill.

Use the information in this question and your own knowledge and understanding.

Remember to give a conclusion to your evaluation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

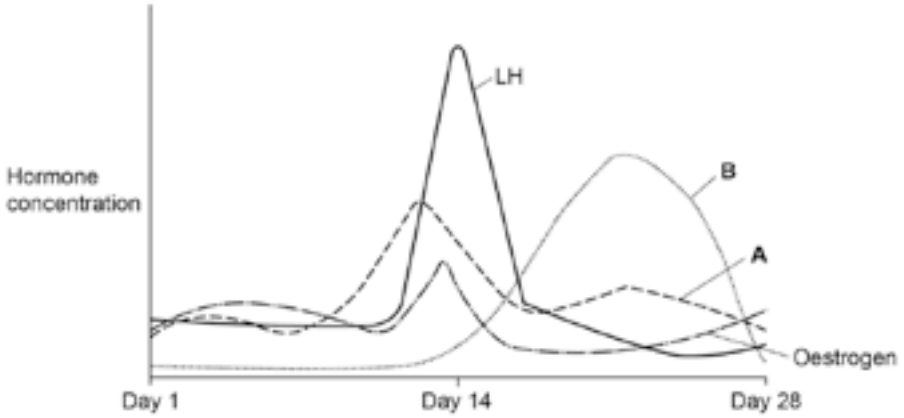
_____

**(4)**

**(Total 4 marks)**

## PPQ 14

**Q14.** The figure below shows how the concentrations of the reproductive hormones in the blood of a woman change over 28 days.




(a) Name hormones **A** and **B**.

**A** _____

**B** _____

**(2)**

(b) Use information from the figure above to explain what happens on Day 14.

_____

_____

_____

_____

**(2)**

(c) In Vitro Fertilisation (IVF) treatment can be used to help women become pregnant. IVF uses some of the hormones shown in the figure above. Explain why IVF increases the chance of some women becoming pregnant.

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**

**(Total 10 marks)**

## PPQ 15

**Q15.** People with Type 1 diabetes cannot control the concentration of glucose in their blood.

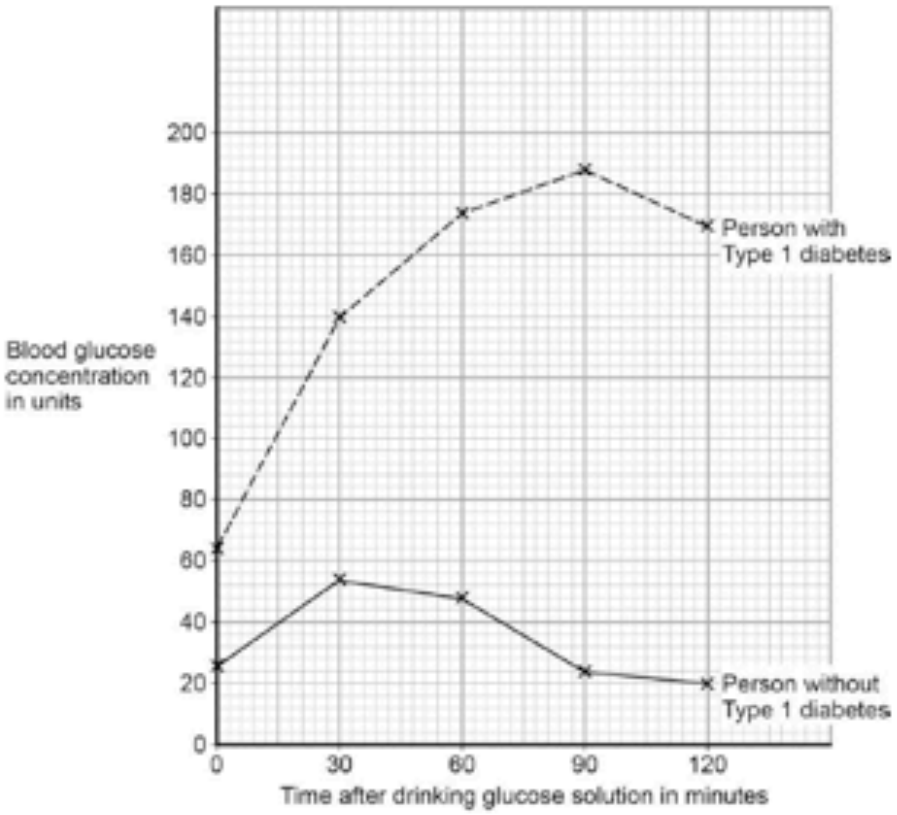
This is because they do **not** produce the hormone insulin.

The same concentration and volume of glucose solution is given to two people.

- Person with Type 1 diabetes.
- Person without Type 1 diabetes.

**Figure 1** shows how the blood glucose concentration of these people changes after they each drink a glucose solution.

**Figure 1**




(a) The blood glucose concentration increases at a faster rate in the person with diabetes compared to the person without diabetes.

Calculate how much faster the rate of increase in blood glucose concentration is in the person with diabetes.

Give the rate of increase for the first 30 minutes after drinking the glucose solution.

Give your answer in units / h.

_____

_____

_____ Units / h

**(2)**

(b) The blood glucose concentration of the person without diabetes starts to change 30 minutes after drinking the glucose solution.

Explain why the blood glucose concentration changes.

_____

_____

_____

_____

**(2)**

(c) People with diabetes should try to keep their blood glucose concentration within the same range as a person without diabetes.

Most people with Type 1 diabetes regularly check their blood glucose concentration using a meter, as shown in **Figure 2**.

The meter reading is used to estimate how much insulin they need to inject.

**Figure 2**

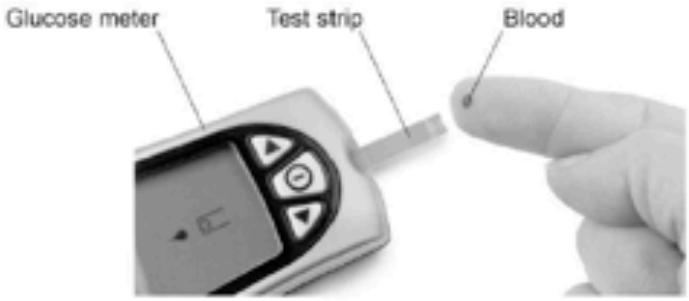
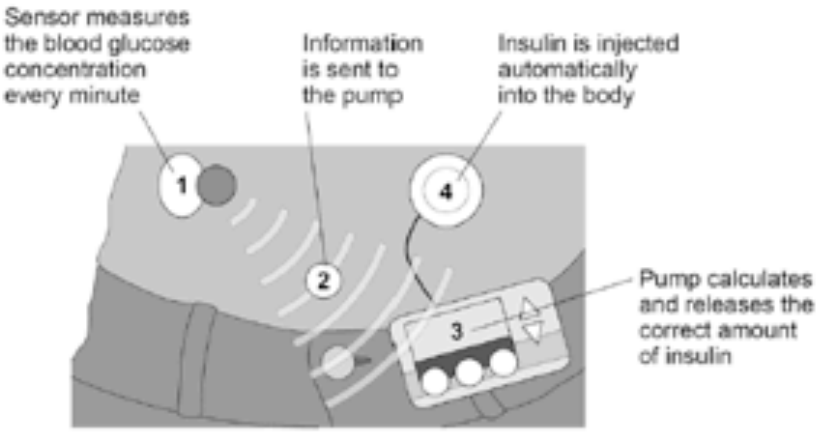





**Figure 3** shows a new system.

It is connected to the person all the time.

**Figure 3**




The new system:

_____

- gives better control of blood glucose concentration
- reduces the number of times the glucose concentration falls too low.

Evaluate the two systems as methods for controlling blood glucose concentrations for people with Type 1 diabetes.

Give a justified conclusion to your evaluation.

**(4)**

(d) How does the body respond if slightly too much insulin is injected into the body.

**(5)**

**(Total 13 marks)**

**PPQ 16**

## Q16.

Conditions inside the body must be kept constant.

(a) Urea must be removed from the body.

(i) Name the organ which makes urea.

_____ **(1)**

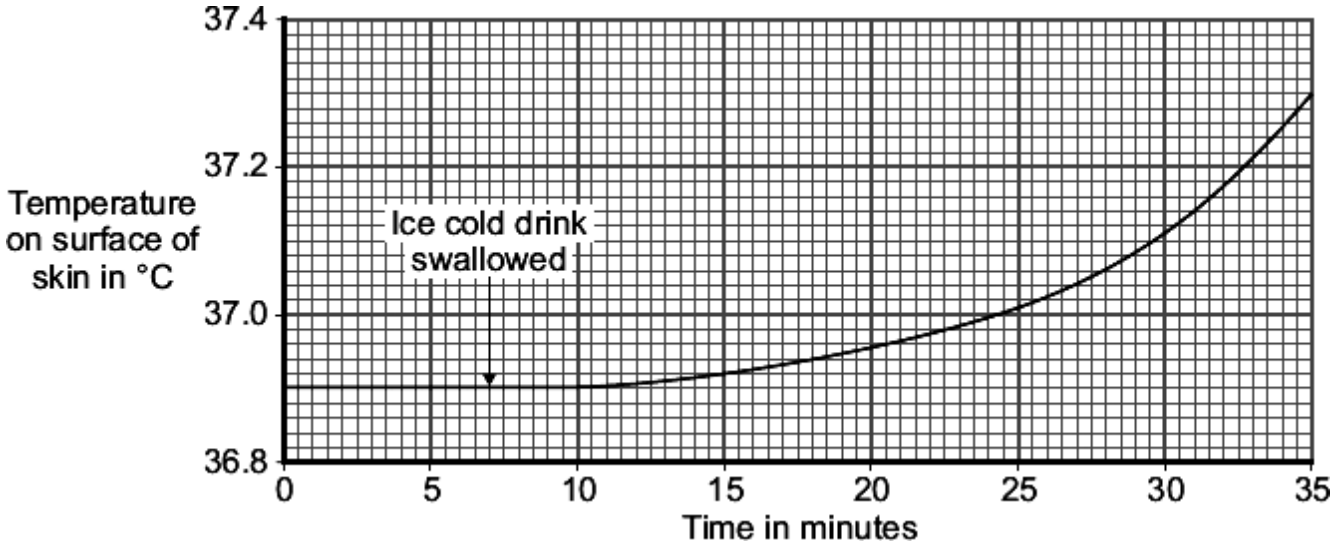
(ii) Which organ removes urea from the body?

_____ **(1)**

(iii) What is urea made from?

_____ **(1)**

A man sat in a room where the temperature was maintained at 40 °C. The temperature on the surface of his skin was monitored for 35 minutes. He swallowed an ice cold drink at the time indicated on the graph.




(b) The sweat glands contribute to the change in the temperature on the surface of the skin shown on the graph.

Explain how.

_____

_____

_____

_____

_____

_____

**(2)**

(c) The blood vessels near the surface of the skin also contribute to the changes in skin temperature shown on the graph.

(i) How do the blood vessels in the skin change when the core body temperature falls?

_____

_____

**(1)**

(ii) How does this change in the blood vessels explain the change in the skin temperature shown on the graph?

_____

_____

**(1)**

**(Total 7 marks)**

**PPQ17.**

**Q17.** Homeostasis keeps conditions in the body relatively constant. The amount of water in the body is controlled by homeostasis. Kidney function is controlled by a gland in the brain. Describe how the water content of the blood is controlled.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(Total 6 marks)**

## 4.5.3 Hormonal control in humans PPQ answers

## Low demand

## PPQ MS1

### Q1.

(a) pancreas

1

(b) (in the) blood(stream)

*allow in the (blood) plasma*

1

*ignore dissolved* ***or*** *in solution*

(c) any **two** from:

- concentration rises and falls in both people
- concentration is higher at start / always in person with diabetes
- concentration rises higher in person with diabetes

*allow correct use of figures*

2

plus any **two** from:

- concentration rises more rapidly in person with diabetes
- concentration stays high for longer in person with diabetes
- concentration does not return to starting level during test in person with diabetes,
  yet concentration returns to starting concentration by 90 minutes in person without diabetes
- concentration goes below starting concentration only in person without diabetes

2

(d) reduce carbohydrate / glucose / sugar in diet

1

(so) blood glucose concentration does not increase as much

1

(so) there is reduced named effect (of prolonged high blood glucose)

*allow reduced short or long term consequences such as tiredness*

***or***

*increase urination*

***or***

*thirst*

***or*** *eye / kidney / nerve / heart disease*

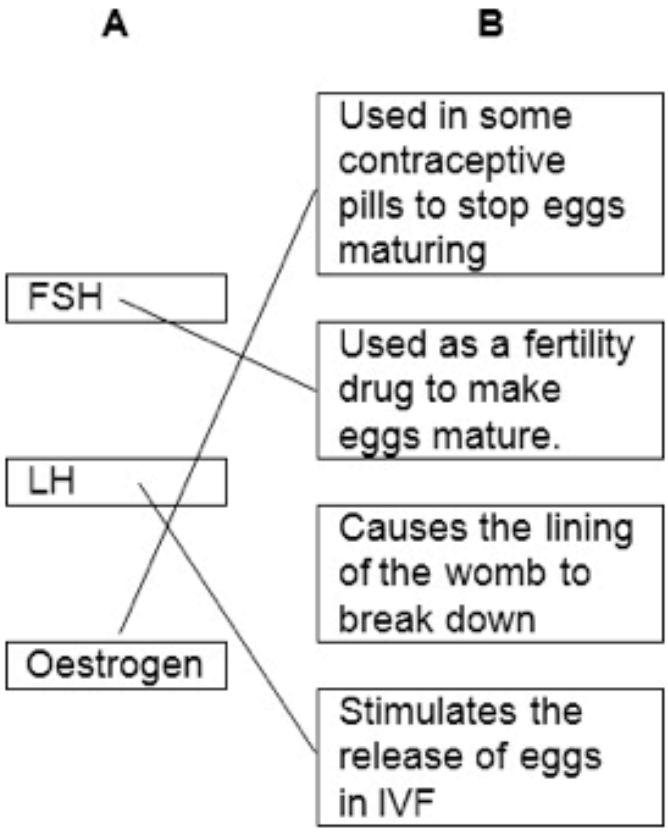
1

**[9]**

**PPQ MS2**

**Q2.**

(a)




*mark each line from left hand box*

*two lines from left hand box cancels mark for that box*

3

## Q2.

(b) (i) implant

1

(ii) any **one** from:

*allow explanation for their method in (b)(i)*

- lasts for 5 years / long(est)
- cannot forget to take / replace it / lose it
- (hormone) there all the time

*ignore expense*
*ignore STDs*
*ignore side effects*

1

(iii) any **one** from:

*accept correct disadvantage for wrong method in (b)(i)*

- needs surgery / operation

*allow it could go wrong*

- painful
- infection
- have to wait five years for a child or more difficult to have a change of mind

*ignore expense*
*ignore STDs*
*ignore side effects*

1

**[6]**

---

**PPQ MS3**

## Q3.

(a) insulin

*extra ring drawn cancels the mark*

1

(b) pancreas

*extra ring drawn cancels the mark*

1

(c) diabetes

*extra ring drawn cancels the mark*

1

**[3]**

---

## PPQ MS4

### Q4.

hormones

*words must be in correct order*

1

glands

1

blood

1

LH

1

**[4]**

---

## PPQ MS5

### Q5.

(a) ovary

1

sperm

1

uterus

1

*must be in correct order*
*accept phonetic spelling – see marking guidance 3.6*

(b) (i) more embryos transferred in older women / average increases with age
*ignore chance of pregnancy / number of treatments*

1

(ii) *answer must relate to data in table*

(many) embryos die / destroyed / do not survive
*allow low success rate / often does not work*
*allow could lead to multiple births*
*ignore less successful in older women*
*ignore older women should not have babies*
*ignore not natural / finance*
*ignore religion / 'against God's will'*

1

**[5]**

---

**Standard demand**

**PPQ MS6**

**Q6.**

(a) any **two** from:

- amylase / carbohydrase
- protease
  *allow trypsin*
- lipase

2

(b) (i) high / above normal blood sugar
**or** cannot control blood sugar
*allow other symptoms*
*eg frequent / plentiful urination **or** sugar in urine **or** thirst **or** weight loss **or** coma*
*ignore consequential effects eg blood pressure / circulation / glaucoma / tiredness*

1

(ii) any **one** from:

- small / regular meals
- low sugar (meals) or low GI / GL **or** carbohydrates as starch
  *allow high fibre*
  *ignore reference to low carbohydrate*

1

(iii) any **one** from:

- keep constant( blood) sugar **or** prevent high (blood) sugar **or** reduces surge / rush of sugar into blood
- reduce the need for insulin

1

(iv) (take) insulin
*allow pancreas transplant*

1

(c) protein / hormone / enzyme synthesis **or** synthesis of named example **or** combine amino acids

1

**[7]**

## PPQ MS7

### Q7.

(i) liver

1

(ii) liver **or** B stores glycogen
**or** pancreas **or** D makes insulin

1

clear description of link

1

**[3]**

---

## PPQ MS8

### Q8.

(a) oestrogen

*in either order*
*allow phonetic spellings*

1

progesterone

*accept progestin / progestogen*
*do **not** allow proestrogen*

1

(b) (oestrogen / progesterone) inhibits FSH production

*if no hormones mentioned credit any effect listed in mark scheme*

1

(so) no eggs mature

*ignore for oestrogen: no eggs mature*
*do **not** accept oestrogen*
*inhibits ovulation*
*accept (progesterone) thickens mucus around cervix*
***or***
*inhibits maturation / ovulation of egg*

1

**[4]**

---

**PPQ MS9**

**Q9.**

(a) (i) chemical

1

(ii) pituitary gland

1

(b) 8

*allow 9 or 10*

1

(c) (i) any **four** from:

- progesterone starts being produced at 4 weeks / no progesterone before 4 weeks
- and then / from 4 weeks increases
- oestrogen at constant / low level (from 0) to 20 weeks
- and then / from 20 weeks increases
- from 20 − 36 weeks level of O rises more steeply than that of P

**or**

- P is always higher than 0 from 6 to 36 weeks

*if no other marks awarded, allow progesterone and oestrogen both increase / rise for **1** mark.*

4

(ii) oxytocin

1

level of oxytocin increases just before birth

1

**[9]**

**PPQ MS10**

## Q10.

(a) (i) any **one** from:

- chemical messenger / message
  *allow substance / material which is a messenger*
- chemical / substance produced by a gland
  *allow material produced by a gland*
- chemical / substance transported to / acting on a target organ
- chemical / substance that controls body functions

1

(ii) gland / named endocrine gland
*brain alone is insufficient*
*allow phonetic spelling*

1

(iii) in blood / plasma **or** circulatory system **or** bloodstream
*accept blood vessels / named*
*do **not** accept blood cells / named*

1

(b) *each hormone must be linked to correct action*
*apply list principle*
*ignore the gland producing hormone*

FSH stimulates oestrogen (production) / egg maturation / egg ripening
*ignore production / development of egg*

1

oestrogen inhibits FSH
*allow oestrogen stimulates LH / build up of uterine lining*

1

LH stimulates egg / ovum release / ovulation
*accept LH inhibits oestrogen*
*accept LH controls / stimulates growth of corpus luteum*
*ignore production of egg*

1

**[6]**

**Q11.**

(a) (i) blood sugar rises because insufficient insulin secreted by body

*for 1 mark each*

2

(ii) increase in rate of conversion of glucose to glycogen in liver

*for 1 mark each*

3

(iii) muscles use more glucose from blood in respiration to release energy needed for exercise

*for 1 mark each*

3

(b) 3 of

sugar soluble
therefore absorbed
quicker than starch
which has to be digested

*any 3 for 1 mark each*

3

(c) increased secretion of glucagons by pancreas
results in increases rate of conversion of glycogen into glucose

*for 1 mark each*

3

(d) 3 of eg

higher blood sugar level results in increased secretion of insulin
effect of insulin is to lower blood sugar
which in turn reduces rate of insulin secretion
overall result is to keep fluctuations in sugar level to a minimum

*any 3 for 1 mark each*

3

**[17]**

## Q12.

Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

**0 marks**
No relevant content.

**Level 1 (1 – 2 marks)**
There is a brief description of kidney function including a mention of pituitary gland **or** hormones but roles may be confused.

**Level 2 (3 – 4 marks)**
There is a clear description of kidney function in relation to fluctuations in blood water levels and the roles of the pituitary gland **or** hormone is mentioned with correct role.

**Level 3 (5 – 6 marks)**
There is a clear and detailed scientific description of kidney function in relation to fluctuations in blood water levels and of the roles of the pituitary gland and ADH.

**examples of biology points made in the response:**

- if water content too low, ADH released
- from pituitary gland
- into the blood
- (causing) kidney reabsorbs more water
- more concentrated / small volume urine produced
- if water content too high, ADH lowered / not produced
- less water reabsorbed by kidney
- more dilute / larger volume urine produced

*full marks may be awarded for detailed description of either water loss or gain*

**[6]**

**Q13.**

any **three** from:

*max **2** if only advantages **or** only disadvantages discussed*
*ignore 'side effects' unqualified*
*ignore side effects produced by hormones*

**advantages of IUCD over pill eg**

- can't forget to take it / have to take pill every day
  *do **not** allow last 5 years unless qualified*
- effect much longer than pill
- more effective in preventing pregnancy
  *do **not** allow reference to figures unless qualified*
- stops sperm entering uterus

**disadvantages of IUCD over pill eg**

- pain / uncomfortable / risk of infection / may damage uterus
- prevents fertilised egg developing / 'embryo rights'
  *allow kills embryo*
- needs replacement by doctor / nurse / professional
  **or** access to IUCD is more difficult than pill
  **or** IUCD is harder to come off than pill

3

argued conclusion

*must include a preference and a reference to **both** advantages and disadvantages*
***or** one is better in a given situation but the other is better in a different situation*

1

**[4]**

## Q14.

(a) **A** FSH

*allow follicle stimulating hormone*

1

**B** Progesterone

1

(b) LH peaks

*allow luteinising hormone*

1

which causes an egg to be released.

1

(c) **Level 3 (5–6 marks):**
A detailed and coherent explanation is given, which logically links the role of different hormones to their use in IVF and a clear explanation of how IVF increases the chance of
a successful pregnancy.

**Level 2 (3–4 marks):**
An attempt is made to link the role of hormones to their use in IVF. The logic used in explaining how IVF increases the chance of a successful pregnancy may not be clear or linked to the hormones.

**Level 1 (1–2 marks):**
Discrete relevant points made. The logic may be unclear and links may not be made.

**0 marks:**
No relevant content

---

**Indicative content**

Identification of hormones used in IVF:
- FSH
- LH.

Role of hormones in IVF:
- FSH causes eggs to mature
- LH causes the eggs to be released.

Effect on chance of successful pregnancy:
- high levels of hormones cause many eggs to be matured and released
- sperm and eggs are collected and eggs are fertilised (so increased probability
of fertilisation)
- fertilised eggs are given time to develop into a small ball of cells
- some are transferred into the mother (uterus), to increase the probability of
one successfully implanting.

6

**[10]**

---

## Q15.

(a) (76 − 28) × 2

1

96 (units / h)

*allow 96 (units / h) with no working shown for **2** marks*

1

*allow 1.6 units / min for **1** mark*

*allow answer in range of 94–104*

*(units / h) for **1** mark*

(b) increased blood glucose concentration causes insulin release from pancreas

1

which stimulates cells to absorb glucose / sugar from the blood, so blood glucose concentration decreases

1

(c) any **three** from:

*at least one advantage **and** one disadvantage of the system(s) must be given for full marks*

*allow responses phrased in terms of the meter and injection systems*

---

**advantages of the new system:**

- better control so reduces risk of future health problems
  *allow fewer low / high blood glucose periods so safer*
- no need to estimate dose of insulin
- less chance of giving too much / little insulin
- system works automatically / continuously so no need to test / inject

**disadvantages of the new system:**

- system is always attached so may restrict activities
  *allow pump is difficult to hide*
- pump has to be carried somewhere
  *allow risk of discomfort*
- pump will need re-filling
- risk of infection
  **or**
  risk of tissue damage (at injection site)
- line might come out
  *accept new system more expensive*

3

---

qualified conclusion: a statement as to which system is better with reference to at least
one advantage and one disadvantage

*for example, the new system is better because although it is more expensive, it works automatically*

1

(d) blood glucose concentration goes too low

1

blood glucose concentration detected by pancreas

1

pancreas releases glucagon

1

(glucagon causes) cells to convert to glycogen into glucose

1

glucose released into blood

1

**[13]**

---

**PPQ MS16**

## Q16.

(a) (i) liver

1

(ii) kidney

*allow urethra / bladder, ignore ureter*

1

(iii) (excess) protein / named / amino acids

*accept amino / ammonia*

1

(b) less / no sweating

*allow ideas of how sweat glands change in order to reduce sweating*

1

less heat lost / evaporation

1

(c) (i) become narrower / constrict

*allow contract / get smaller etc allow less blood flows through vessels do **not** allow capillaries become narrower **or** reference to movement of vessels*

1

(ii) reduced / no heat loss

*allow heat gained from room*

PPQ MS17

## Q17.

Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

**0 marks**
No relevant content.

**Level 1 (1 – 2 marks)**
There is a brief description of kidney function including a mention of pituitary gland **or** hormones but roles may be confused.

**Level 2 (3 – 4 marks)**
There is a clear description of kidney function in relation to fluctuations in blood water levels and the roles of the pituitary gland **or** hormone is mentioned with correct role.

**Level 3 (5 – 6 marks)**
There is a clear and detailed scientific description of kidney function in relation to fluctuations in blood water levels and of the roles of the pituitary gland and ADH.

**examples of biology points made in the response:**

- if water content too low, ADH released
- from pituitary gland
- into the blood
- (causing) kidney reabsorbs more water
- more concentrated / small volume urine produced
- if water content too high, ADH lowered / not produced
- less water reabsorbed by kidney
- more dilute / larger volume urine produced

*full marks may be awarded for detailed description of <u>either</u> water loss or gain*

**[6]**

## 4.5 Homeostasis and Response Knowledge

### 4.5.4 Plant hormones (biology only)

#### 4.5.4.1 Control and coordination

In order to survive, plants require light and water for **photosynthesis**. They have developed responses called **tropisms** to help ensure they grow towards adequate sources of light and water.

There are two main types of tropisms:

- positive tropisms – the plant grows towards the **stimulus**
- negative tropisms – the plant grows away from the stimulus

**Phototropism** is a response to the stimulus of light.

**Responses to stimuli of different parts of the plant**

In the plant stem, responses to light are known as a **positive phototropism**, which means the stem grows towards the light

In the plant root, responses to light are known as a **negative phototropism**, which means the root grows away from the light

**Auxins**

**Auxins** are a family of plant hormones. They are mostly made in the tips of the growing stems and roots, which are known as apical meristems, and can **diffuse** to other parts of the stems or roots.

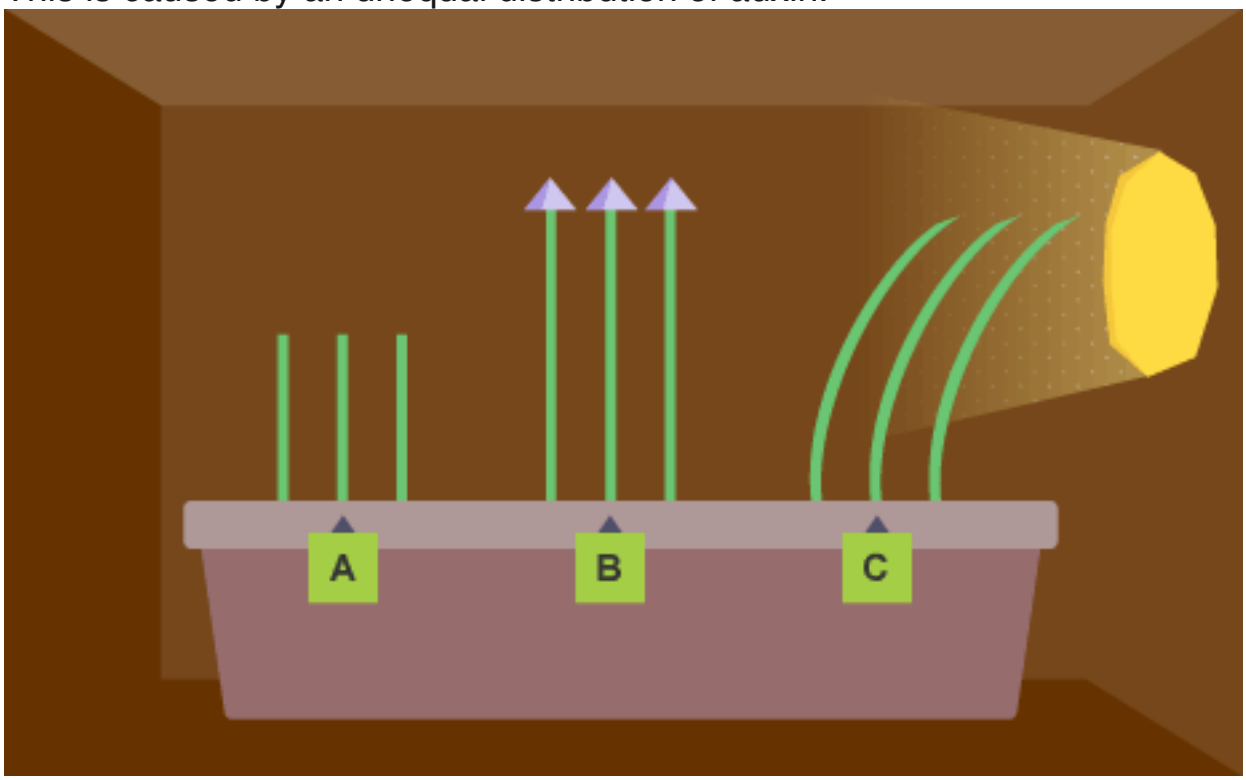
Auxins control the growth of plants by promoting cell division and causing elongation in plant cells (the cells get longer).

Stems and roots respond differently to high concentrations of auxins:

cells in stems grow more

cells in roots grow less

**Phototropism**
This is caused by an unequal distribution of auxin.




Typical results shown by oat seedlings grown in a box with a light source
**In a stem**, the shaded side contains more auxin and **grows longer**, which causes the stem to grow towards the light. It is vital to note that the plant does **NOT** bend towards the light.

| | Seedling A | Seedling B | Seedling C |
|---|---|---|---|
| **Treatment** | The tips have been removed | No light reaches the tips | More light reaches one side of the tips |
| **Effect on auxin concentration** | No auxin is produced | Equal concentration of auxin on both sides | Greater concentration of auxin on the shaded side |
| **Result** | The stems do not grow longer | The stems grow evenly and longer on both sides | The cells on the darker side of the stems grow longer |

Auxins have the opposite effect on root cells. **In a root**, the shaded side contains more auxin and **grows less** - causing the root to bend away from the light.

**Auxin and geotropism**

**Geotropisms**

**Phototropism** is a response to the stimulus of light, whereas **geotropism** (also called gravitropism) is a response to the stimulus of **gravity**.

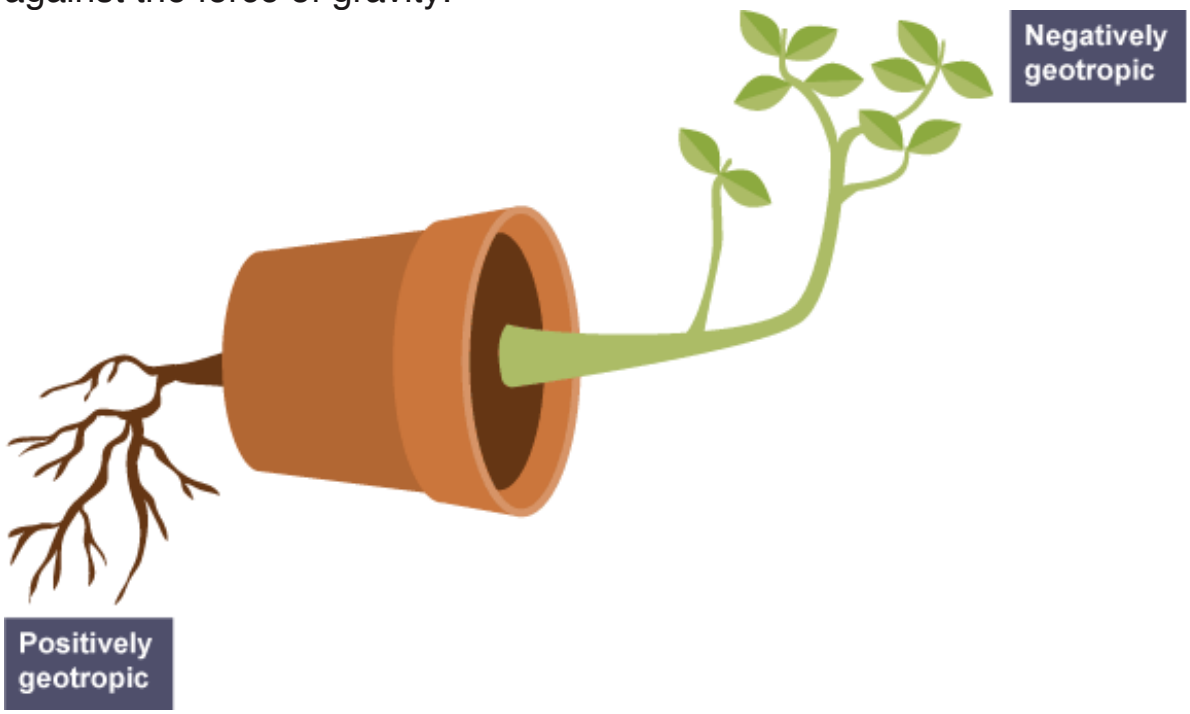
Plants responses to gravity:

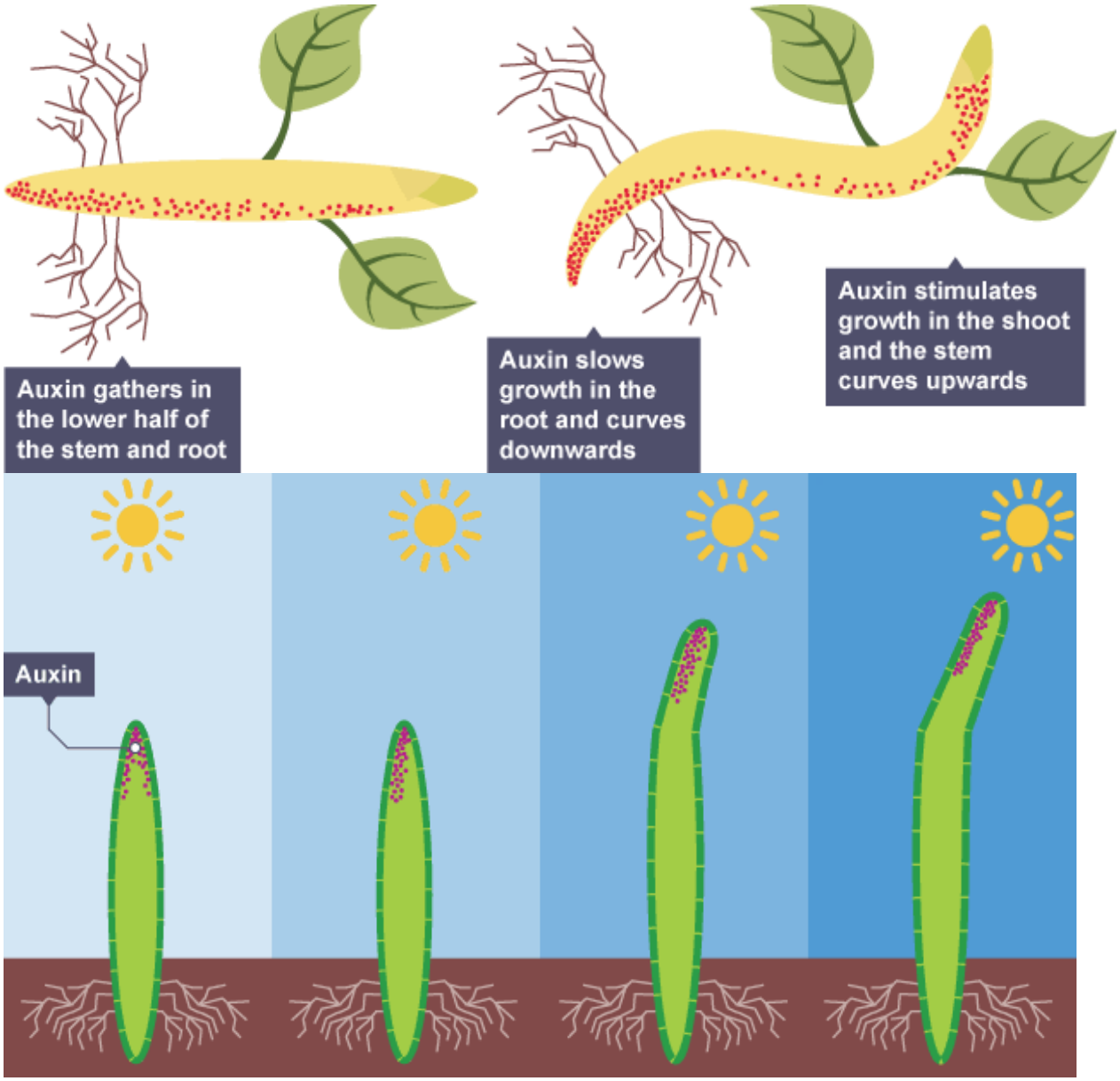
- when the stem grows against the force of gravity, this is known as a negative geotropism
- when a root grows in the direction of the force of gravity, this is known as a positive geotropism

Just like phototropism, geotropism is also caused by an unequal distribution of auxin.

In a **root placed horizontally**, the bottom side contains more auxin and **grows less** - causing the root to grow in the direction of the force of gravity.

The opposite happens in a stem. When a **stem placed horizontally**, the bottom side contains more auxin and **grows more** - causing the stem to grow upwards against the force of gravity.






## 4.5.4.2 Plant hormones

### Other plant hormones – Higher

Gibberellins, which are a group of plant hormones responsible for growth and development, are important for initiating seed **germination**. Low concentrations can be used to increase the speed of germination, and they stimulate cell **elongation** and cause plants to grow taller.
They are naturally produced by seeds.

Gibberellins are responsible for seed germination Gibberellins can be used to:

- end seed dormancy
- promote flowering
- increase fruit size

Seed **dormancy** must be broken for seeds to germinate, and this can be done by using gibberellins.

## Controlling fruit ripening

**Ethene** is a **hydrocarbon** gas which speeds up ripening in bananas and other fruit. It also controls cell division during plant growth.
In the food industry fruit is often picked unripe and then transported. This prevents fruit from over-ripening on the journey. It is ripened during storage by adding ethene and then taken to the shops.

The effect of ethene released from bananas is clearly visible if you keep them in a bowl with other fruit, as it causes other fruits to ripen very quickly.

## Use of plant hormones – Higher

There are many **plant hormones**, and there are a number of different groups. They are used in **agriculture** and **horticulture** to have a specific effect.
**Auxins** were the first class of plant hormones to be discovered. Their main function is to help plants grow and auxin stimulates plant cells to **elongate**. The tips of the growing stems and roots (apical meristem) of a plant is one of the main places where auxin is produced. The apical meristem is also the location that all other parts of a plant grow from - the stem, leaves and flowers.
**Auxins** are one specific group of hormones that are used:

- as weed killers
- as rooting powders
- for promoting growth in tissue culture

## Weedkillers

Selective weedkillers kill some plants, but not others. This can be useful for getting rid of dandelions in a lawn without killing the grass or weeds that compete with crops such as wheat. The selective weedkiller contains a growth hormone that causes the weeds to grow too quickly and die. Because most weeds have broader leaves than grass or wheat, the weedkiller is absorbed in larger quantities by the weeds.
Selective weedkillers kill plants that some species of animals rely on as a food source. This can result in a reduction of biodiversity.

## Rooting powder

Plant cuttings can be dipped in hormone rooting powder before planting.
Synthetic plant hormones are used to control plant growth. For example, rooting powder contains growth hormones that make stem cuttings develop roots quickly.

## Promoting growth in tissue culture

Tissue culture is a technique used to grow whole new plants from small sections of a parent plant.
Hormones are used to stimulate cell division and elongation.

## 4.5.4 Plant hormones PPQ's

## Low demand

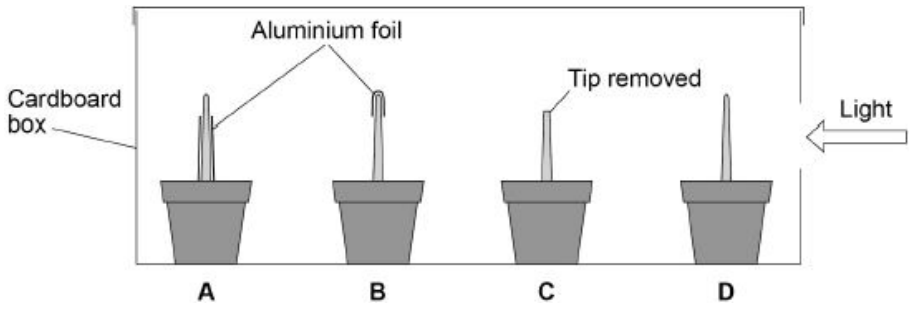
## PPQ 1

**Q1.** Some students investigated phototropism in plant seedlings. This is the method used.

1. Measure the lengths of the shoots of 20 seedlings.
2. Set up four groups of seedlings as follows:
   - **A** − bottom of shoot covered in aluminium foil
   - **B** − tip covered in aluminium foil
   - **C** − tip removed
   - **D** − no changes.
3. Put the seedlings in a cardboard box.
4. Use a lamp to shine a light into the box through a hole in one side.
5. After one day, re-measure the lengths of the shoots.
6. Make a drawing of the appearance of one seedling from each group.

**Figure 1** shows the appearance of one seedling in each group at the start of the investigation.

**Figure 1**




(a) Which **two** conditions should the students have kept constant for each group of seedlings? Tick **two** boxes.

The length of the roots ☐

The number of seedlings in each group ☐

The temperature ☐

The thickness of the aluminium foil ☐

The volume of water added to the soil ☐

**(2)**

(b) What is the purpose of the aluminium foil?

Tick **one** box.

To hold the shoot straight ☐

To keep the shoot warm ☐

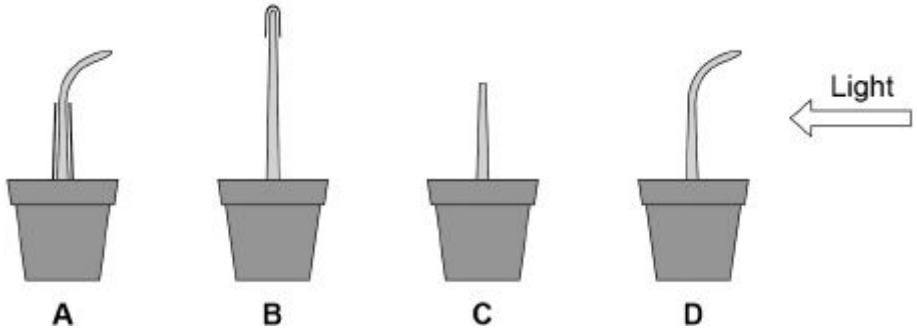
To remove the effect of gravity ☐

To stop light reaching the shoot ☐

**(1)**

**Figure 2** shows the students' results.

**Figure 2**




| | A | B | C | D |
|---|---|---|---|---|
| Mean length of shoot at start in mm | 23 | 24 | 21 | 25 |
| Mean length of shoot after 1 day in mm | 28 | 30 | 23 | 30 |
| Mean change in length of shoot in mm | 5 | 6 | 2 | 5 |

(c) Suggest how the students measured the lengths of the curved shoots of seedlings **A** and **D** at the end of the investigation.

_____

_____

_____

_____

**(2)**

(d) The students concluded that the **tip** of the shoot is needed for the plant to respond to light.

Give evidence for this conclusion from **Figure 2**.

_____

_____

_____

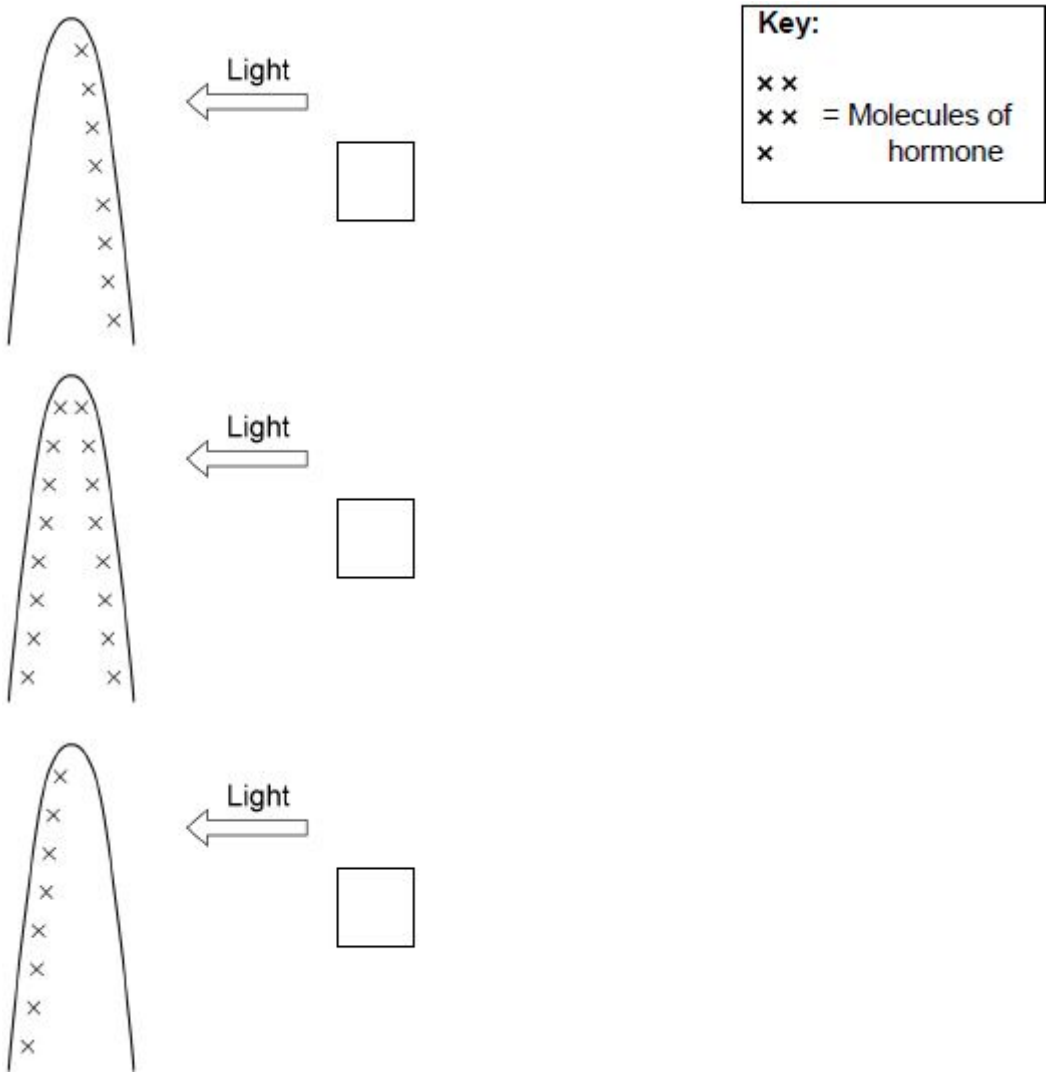
_____

**(2)**

(e) A hormone stimulates growth in shoots.

Which distribution of the hormone would cause the results seen in shoot **D**?

Tick **one** box.




**(1)**

**(Total 8 marks)**

**PPQ 2**

## Q2.

Hormones called auxins control plant growth. A student investigated plant growth responses in roots.

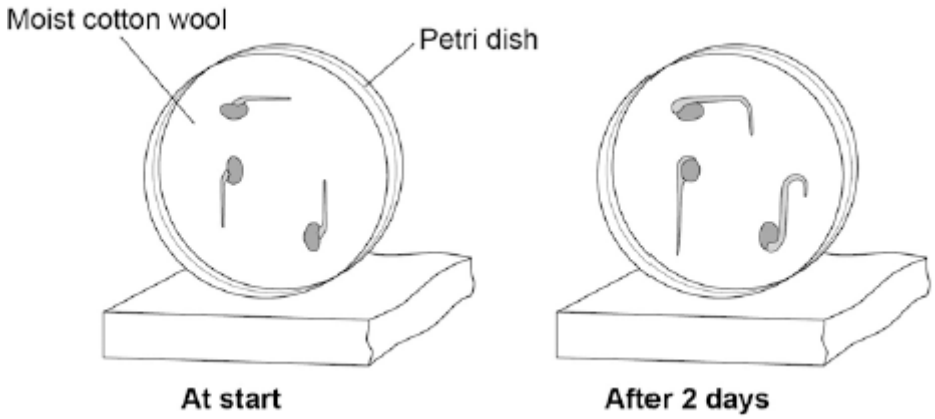
This is the method used.

1. Grow three bean seeds until their roots are 1 cm long.
2. Attach the three bean seeds to moist cotton wool in a Petri dish.

   Each bean seed root should point in a different direction.
3. Fix the Petri dish vertically for 2 days in the dark.

**Figure 1** shows the results.

**Figure 1**




(a) Describe the direction of growth of the bean **roots** after 2 days.

Give **one** reason for this growth response.

Direction of root growth _____

Reason _____

_____

**(2)**

(b) The student then noticed the shoots growing from the seeds. He then:

1. put a light above the Petri dish but did not move the seeds
2. allowed the seeds to grow for 2 **more** days.

Predict the direction of growth of the bean **shoots** after 2 days.

Give **one** reason for your prediction.

Direction of root growth _____

Reason _____

**(2)**

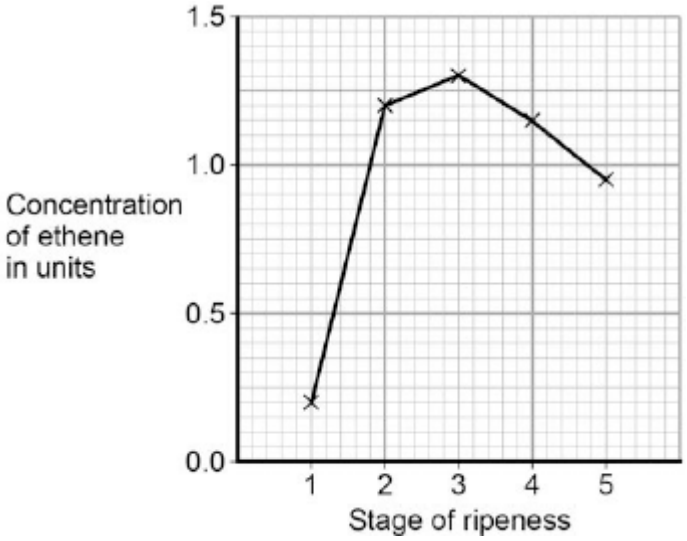
(c) Ethene is a plant hormone.

Ethene causes fruit to ripen.

Scientists measured the concentration of ethene found in fruit at different stages of ripeness.

**Figure 2** shows the results.

**Figure 2**




At which stage of ripeness is there most ethene?

Tick **one** box.

Stage **1** ☐

Stage **2** ☐

Stage **3** ☐

Stage **4** ☐

Stage **5** ☐

**(1)**

(d) Suggest how the scientists can find out if the result for Stage **1** was an anomaly.

_____

_____

**(1)**

(e) Gibberellins are a different type of plant hormone.

Farmers growing cotton plants in cold climates sometimes soak their seeds in a solution of gibberellins before planting the seeds.

Suggest an advantage of soaking seeds in a gibberellin solution in cold climates.

_____

_____

**(1)**

**(Total 7 marks)**

**PPQ 3**

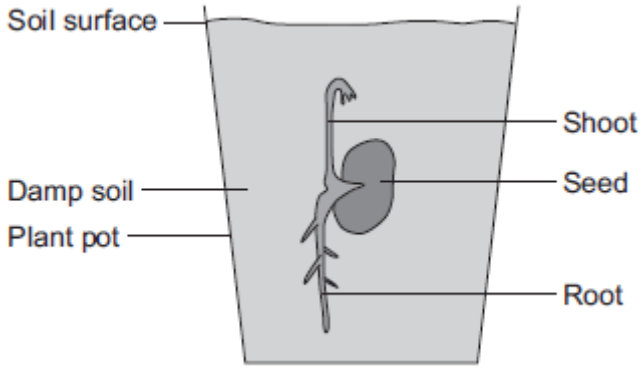
## Q3.

A student investigated growth in plants.

The student:

- planted a seed in damp soil in a plant pot
- put the plant pot in a dark cupboard.

The image below shows the result after 5 days.




(a) Draw a ring around the correct answer to complete each sentence.

(i) After the 5 days, the root had grown

| |
|---|
| away from water. |
| in the direction of the force of gravity. |
| towards light. |

**(1)**

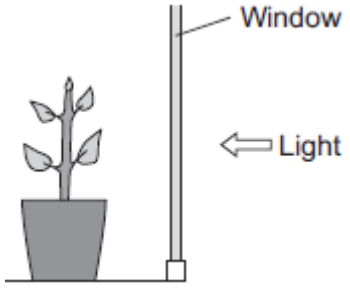
(ii) After the 5 days, the shoot had grown

| |
|---|
| against the force of gravity. |
| away from light. |
| towards water. |

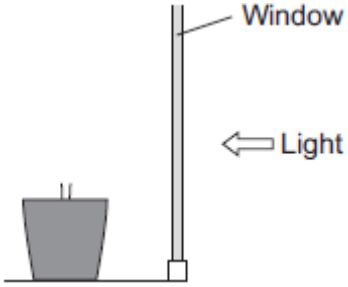
**(1)**

(b) After the plant had grown, the student put the plant pot by a window with lots of light.

The illustration below shows this.




(i) Complete the diagram below to show the appearance of the student's plant after 20 days by the window.




**(1)**

(ii) Explain the advantage to the plant of growing in the way that you have drawn in part (b)(i).

_____

_____

_____

_____

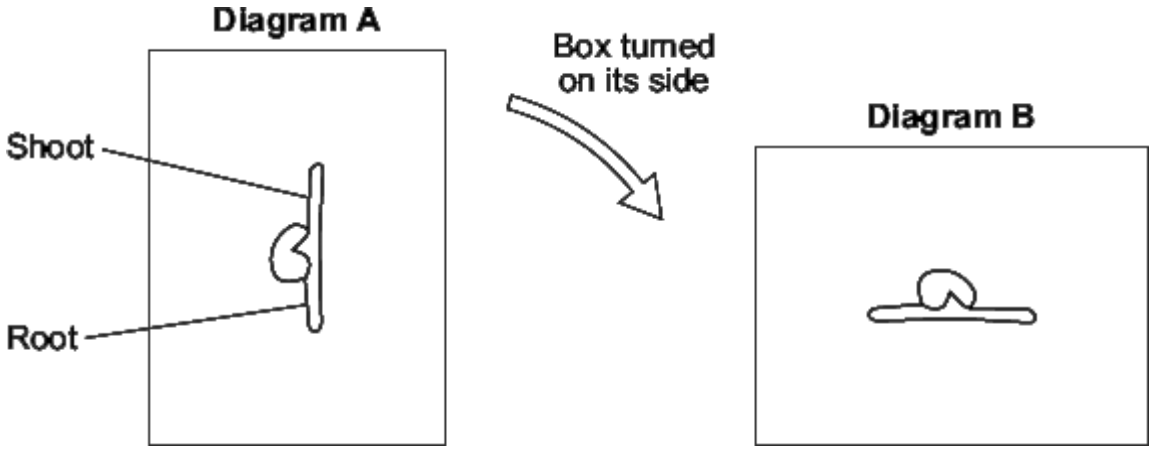
**(2)**

**(Total 5 marks)**

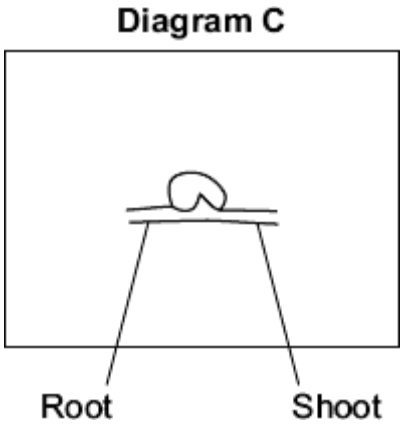
## Q4.

A student investigated growth responses in plants.

The student grew a bean seed in a box filled with moist soil, as shown in **Diagram A**. After the seed had started to grow, the box was turned onto its side and placed in a dark room, as shown in **Diagram B**.




(a) Complete **Diagram C** to show what the root and shoot will look like three days later.




**(2)**

(b) Draw a ring around the correct answer to complete the sentence.

The results of the investigation show that the root is sensitive to

| |
|---|
| light. |
| moisture. |
| gravity. |

**(1)**

(c) A hormone in the plant causes the growth responses.

What is the name of this hormone?

Tick (✓) **one** box.

Auxin ☐

Statin ☐

Steroid ☐

**(1)**

(d) Gardeners can use some plant hormones as weed killers.

(i) Give **one different** use of plant hormones by gardeners.

_____

_____

**(1)**

(ii) Selective weed killers only kill some plants in a garden.

Killing weeds in a garden reduces competition between plants.

Give **three** factors that plants compete for.

1. _____

2. _____

3. _____

**(3)**

**(Total 8 marks)**

## Standard demand

## PPQ 5

## Q5.

(a) When a seed starts to grow, the young root grows downwards towards gravity. The young shoot grows upwards, away from gravity.

(i) Name this type of plant response to gravity.

_____

**(1)**

(ii) Give **two** reasons why it is useful for a young root to grow towards gravity.

1. _____

_____

2. _____

_____

**(2)**

(iii) The root grows towards gravity due to the unequal distribution of a substance in the root.

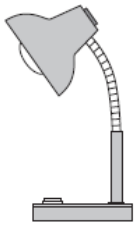
Draw a ring around the correct answer to complete the sentence.

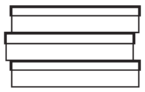
This substance is

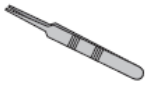
| |
|---|
| auxin. |
| chlorophyll. |
| sugar. |

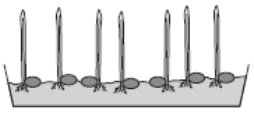
**(1)**

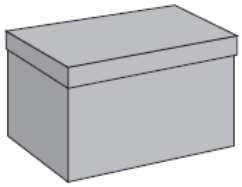
(b) The drawings show some apparatus and materials.

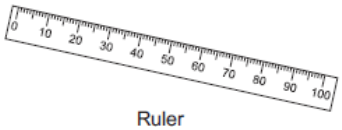

Lamp


Petri dishes


Forceps


50 maize seedlings on damp cotton wool


Supply of cardboard boxes with lids



Ruler


Scissors

Describe how the students could use some or all of the apparatus and materials shown in the drawings to investigate the growth response of maize seedlings to light shining from one side. You should include a description of the results you would expect.

**(6)**

**(Total 10 marks)**

**PPQ 6**

**Q6.**

Gardeners sometimes use weed killers to control the growth of plants.

(a) A gardener wanted to get rid of daisy plants growing in a lawn.

The gardener investigated the use of a weed killer.

The gardener:

- recorded the number of daisy plants growing in different 10 $m^2$ areas of the lawn
- made solutions of the weed killer (each solution had a different concentration)
- put 5 $dm^3$ of each solution on different 10 $m^2$ areas of the lawn
- recorded the number of daisy plants growing in each area after 2 weeks.

The table shows the results.

| **Concentration of weed killer in arbitrary units** | **Number of daisy plants per 10 $m^2$** | |
|---|---|---|
| | **Before using weed killer** | **2 weeks after using weed killer** |
| 0 (water) | 8 | 8 |
| 20 | 6 | 8 |
| 40 | 9 | 6 |
| 60 | 5 | 2 |
| 80 | 4 | 0 |
| 100 | 8 | 0 |

(i) To make the investigation fair, the gardener controlled some variables.

Give **one** variable the gardener controlled in the investigation.

_____

_____

**(1)**

(ii) The gardener decided that the result for a concentration of 20 arbitrary units of weed killer was anomalous.

Suggest why the gardener decided this result was anomalous.

_____

_____

**(1)**

(iii) Why did the gardener put 0 arbitrary units of weed killer on one area of the lawn?

_____

_____

**(1)**

(iv) The gardener concluded that the best concentration of weed killer to use all over a lawn is 100 arbitrary units.

Suggest why the gardener cannot be sure about this conclusion.

_____

_____

**(1)**

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Plants respond to different environmental factors.

Describe how different environmental factors affect:

- the direction of growth of roots
- the direction of growth of shoots.

In your answer you should refer to the role of plant hormones.

Do **not** refer to the artificial use of plant hormones by gardeners or scientists.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**

**(Total 10 marks)**

**PPQ 7**

**Q7.**

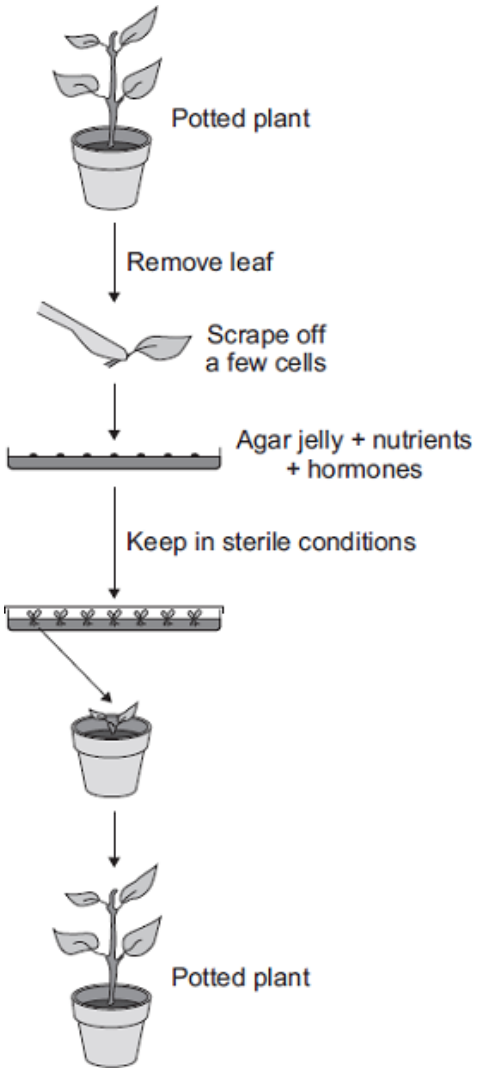
Plant hormones are used in horticulture.

(a) Name **one** plant hormone.

_____

**(1)**

(b) The diagram shows how new plants are produced using tissue culture.




(i) Tissue culture is a type of *asexual reproduction* .

Give the main features of *asexual reproduction* .

_____

_____

_____

_____

_____

**(3)**

(ii) Another method of producing new plants is by taking cuttings.

Suggest **one** advantage of using tissue culture and **not** using cuttings to produce plants.

_____

_____

_____

**(1)**

**(Total 5 marks)**

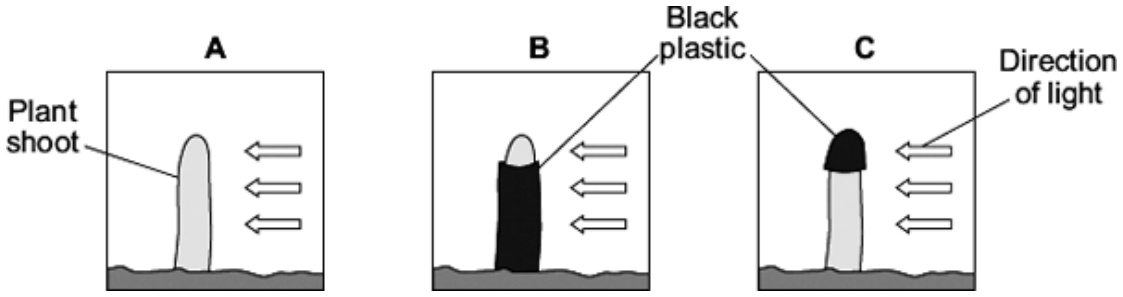
## PPQ 8

## Q8.

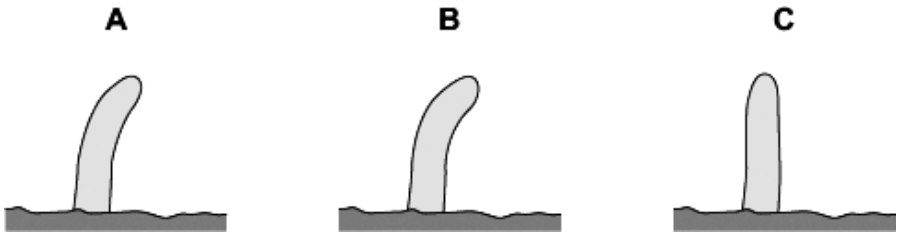
Charles Darwin investigated tropisms in plants. Some students did an investigation similar to Darwin's investigation. The students:

- grew seeds until short shoots had grown
- used black plastic to cover parts of some of the shoots
- put the shoots in light coming from one direction
- put boxes over the shoots to keep out other light.

The diagrams show how the investigation was set up.




Two days later the students took off the black plastic covers and looked at the shoots. The diagrams show the results.




(a) Give **two** variables that the students should control in this investigation.

_____

_____

_____

_____

**(2)**

(b) Shoot **A** bent towards the light as it grew.

Explain how.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(c) What conclusions can be drawn from the results about:

(i) the detection of the light stimulus

_____

_____

**(1)**

(ii) where in the shoot the response to the light takes place.

_____

_____

**(1)**

**(Total 8 marks)**

## High demand

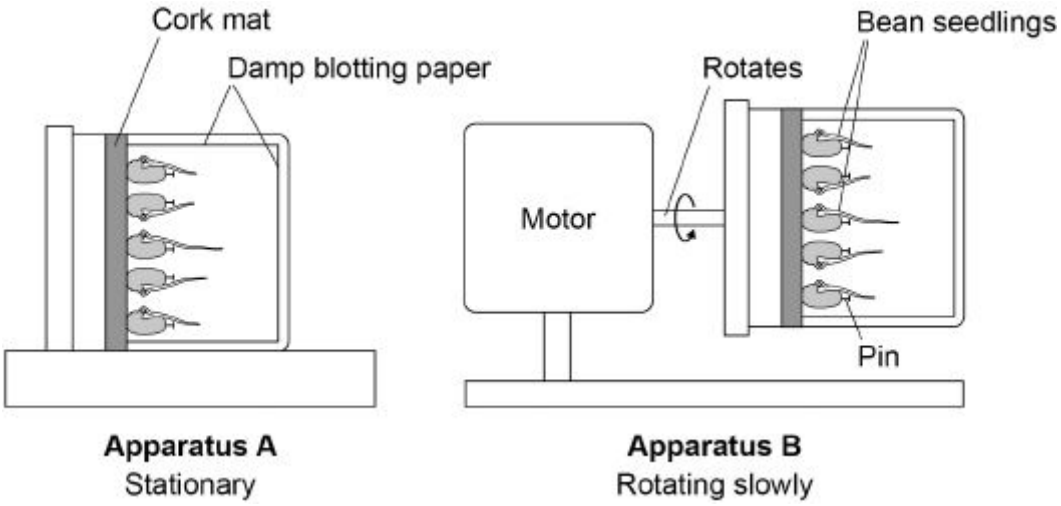
## PPQ 9

## Q9.

Some students investigated geotropism in the roots of bean seedlings.

**Figure 1** shows the apparatus used.

**Figure 1**




This is the method used.

1. Measure the length of the root of each of 10 bean seedlings.
2. Pin 5 seedlings to the cork mat in apparatus **A**.
3. Pin 5 seedlings to the cork mat in apparatus **B**.
4. Leave **A** and **B** in a dark cupboard for 2 days.
5. After the 2 days:
   - make a drawing to show the appearance of each seedling
   - measure the length of the root of each seedling.

(a) Why did the students surround the seedlings with damp blotting paper?

Tick **one** box.

To prevent light affecting the direction of root growth ☐

To prevent photosynthesis taking place in the roots ☐

To prevent the growth of mould on the roots ☐

To prevent water affecting the direction of root growth ☐

**(1)**

Apparatus **B** is a control.

Apparatus **B** rotates slowly.

(b) How does apparatus **B** act as a control?

_____

_____

**(1)**

The table below shows the students' results.

| | **Apparatus A** | | | | | **Apparatus B** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Seedling number** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| **Length at start in mm** | 35 | 41 | 32 | 33 | 39 | 30 | 33 | 29 | 28 | 31 |
| **Length after 2 days in mm** | 49 | 57 | 43 | 45 | 54 | 45 | 45 | 44 | 29 | 44 |
| **Length change in mm** | 14 | 16 | 11 | 12 | 15 | 15 | 12 | 15 | 1 | 13 |
| **Mean length change in mm** | 14 | | | | | 11 | | | | |

(c) One student stated:

'The mean length change for the seedlings in apparatus **B** is **not** valid.'

Suggest the reason for the student's statement.

_____

_____

**(1)**

(d) Suggest **one** improvement the students could make to obtain a more valid mean length change for the seedlings in apparatus **B**.

_____

_____

**(1)**

(e) **Figure 2** shows the students' drawings of two seedlings at the end of the 2 days.

Seedling from Apparatus A  Seedling from Apparatus B

A plant hormone is made in the root tip. The hormone diffuses from the tip into the tissues of the root. Explain how the hormone causes the appearance of the seedlings in **Figure 2** to be different. You should refer to **both** seedlings in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

**(3)**

(f) In horticulture plant hormones are used for controlling plant growth. Draw **one** line from each plant hormone to the correct use of that hormone.

| **Plant hormone** | **Use of hormone** |
|---|---|
| | To reduce the time taken for tomatoes to ripen |
| Auxin | |
| | To slow down the growth of plant stems |
| Ethene | |
| | To promote seed germination |
| Gibberellin | |
| | To stimulate root growth in plan cuttings |

**(3)**

**(Total 10 marks)**

## 4.5.4 Plant hormones PPQ answers

## Low demand

## PPQ MS1

### Q1.

(a) the temperature

**1**

the volume of water added to the soil

**1**

(b) to stop light reaching the shoot

**1**

(c) piece of thread (along shoot and mark length)

*allow straighten the shoot*

**1**

transfer to ruler / mm-scale

*allow use of (flexible) tape measure for **2** marks*

**1**

(d) tip covered / B / removed / C grows straight up **or** does not bend (towards light)

*allow tip covered / B / removed / C does not respond (to light)*

**1**

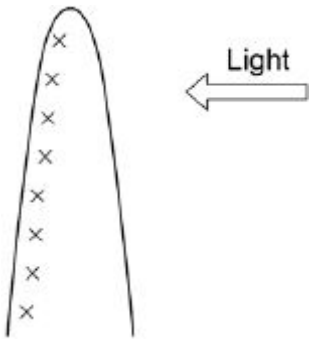
tip exposed / A / not covered / D bends (towards light)

*tip exposed / A / not covered / D does respond (to light)*

*allow only the ones with exposed tips or only A **and** D bend towards the light for **2** marks*

**1**

(e)




**1**

**[8]**

## PPQ MS2

## Q2.

(a) grown down

*allow longer*

1

towards gravity / gravitropism

*allow geotropism*

1

(b) grow up

1

towards the light

*allow phototropism*

1

(c) 3

1

(d) repeat the experiment

1

(e) seeds germinate sooner so growing season is longer

1

**[7]**

## PPQ MS3

## Q3.

(a) (i) in the direction of the force of gravity

1

(ii) against the force of gravity

1

(b) (i) diagram completed to show stem bending / leaning towards the window

*the bend / lean can be at / from any point above pot level*

*ignore any leaves*

1

(ii) more light (for leaves)

*ignore heat*

1

more photosynthesis / biomass / glucose

*ref to 'more' needed once only, eg 'more light for photosynthesis' = 2 marks*

*if no other marks given allow 1 mark for 'to get light for photosynthesis'*

1

**[5]**

## Q4.

(a) diagram to show root growing down

*allow single lines **or** not attached **or** open ends for both marks*
*all branches must go down*

**1**

diagram to show shoot growing up

*all branches must go up*

**1**

(b) gravity

**1**

(c) Auxin

**1**

(d) (i) rooting / cuttings

*accept other suggestions, eg fruit set / ripening*
*do **not** accept weed killers*

**1**

(ii) any **three** from:

- light
  *ignore sun / energy*
- water / moisture
- nutrients / ions / minerals
  *accept one named mineral*
  *ignore nutrition / food*
- space / area
  *ignore soil / land / territory / volume*
  *ignore reference to gases*

**3**

**[8]**

## Standard demand

## PPQ MS5

## Q5.

(a) (i) gravitropism / geotropism

*not '…trophism'*

*ignore 'positive' or 'negative'*

**1**

(ii) any **two** from:

- anchorage
- takes in water
- takes in ions / minerals / salts / correct named example

*allow nutrients*

*do not accept food*

**2**

(iii) auxin

**1**

(b) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response.
Examiners should also refer to the information on page 5, and apply a best-fit approach to the marking.

**0 marks**
No relevant content.

**Level 1 (1 – 2 marks)**
There is a basic description of a simple method involving seedlings and light.

**Level 2 (3 – 4 marks)**
There is a description of a method involving seedlings in 1-sided light, and a control, with a correct observation.

**Level 3 (5 – 6 marks)**
There is a description of a method involving groups of seedlings in 1-sided light, and in control conditions. It includes some correct measurements or observations.

**examples of Biology points made in the response:**

- use of scissors to cut tips from some shoots / cut hole in box
- use of forceps for handling seedlings
- use of ruler to measure lengths of shoots at start and at end
- other factors controlled – eg temperature / water
- use of lamp + box re. one-sided lighting
- repetitions – each treatment ≥ 3 times
- control in total darkness / all-round light
- time taken = several hours to a few days
- sample results: tip exposed to 1-sided light→bend to light, tip removed→vertical, control→vertical

**6**

**[10]**

## PPQ MS6

## Q6.

(a) (i) any **one** from:

*ignore references to same lawn / weather / soil, which are not given in the question.*

- (same) (type of) weed killer
- (same) volume / 5dm$^3$ of solution used (on each area)

*allow amount of solution used*

*do **not** allow amount / volume / concentration of weed killer*

*do **not** allow number of daisy plants*

- effect on daisies (not other weeds / plants)
- (same) area / 10m$^2$
- (same) time **or** (effect after) two weeks.

**1**

(ii) more (daisies) growing after use of weed killer **or** after two weeks

*allow it does not fit pattern (of other results)*

**1**

(iii) any **one** from:

*ignore to see if it / water has an effect*

- as a control

*do **not** allow as a control variable*

- to compare (to the other areas)
- to check other factor(s) are not affecting the results / daisies.

**1**

(iv) 80 (arbitrary units of weed killer) also killed all the daisies

*allow ref to possible experimental design flaws such as 'only tested once' or 'not repeated' or 'different number of daisies in each area at first'*

*allow idea that other weed species may not respond in the same way as daisies*

*allow idea that 100 (units) may also kill wanted species / grass*

**1**

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best-fit' approach to the marking.

**0 marks**
No relevant content.

**Level 1 (1−2 marks)**
Reference to at least one environmental factor plants respond to
**or**
at least one response
**or**
a named hormone

**Level 2 (3−4 marks)**
Reference to at least one environmental factor plants respond to
**and**
at least one associated response

**or**
reference to a named hormone
**and**
at least one associated response

**Level 3 (5−6 marks)**
Reference to at least one environmental factor plants respond to
**and**
at least one associated response
**and**
reference to a named hormone

**Examples of biology points made in the response:**
*environmental factors*
- light

  *allow phototropism*
- (direction of the force of) gravity

  *allow gravi / geotropism*
- moisture / water.

  *allow hydrotropism*

*effects on direction of growth*
- shoots grow upwards
- shoots grow towards light
- shoots grow against (the force of) gravity
- roots grow downwards
- roots grow towards moisture
- roots grow towards (the force of) gravity.

  *allow reference to 'positive' and 'negative' in terms of tropisms as indicating direction of growth*

*hormone*
- reference to auxin

  *allow other named hormone(s)*
- unequal distribution of hormone causes unequal growth (rates).

  *allow higher concentration of hormone causes faster growth in shoots*

  *allow higher concentration of hormone causes slower growth in roots*

**6**

**[10]**

## PPQ MS7

## Q7.

(a) auxin

*accept other named plant hormones*

**1**

(b) (i) any **three** from:

- no (fusion of) gametes / fertilisation

  *allow no meiosis **or** new cells only produced by mitosis*

- only one parent

  *allow not two parents*

- no mixing of genetic material
- no genetic variation **or** genetically identical offspring
  *allow clones*

**3**

(ii) more / many offspring / plants (produced from one parent plant)
*allow less damage to parent plant*
*ignore speed / cost*

**1**

**[5]**

**PPQ MS8**

## Q8.

(a) any **two** control variables for **1** mark each:

- age / size of shoots
- species **or** type of plant / seeds
- light intensity
  *accept amount of light / colour of light*
- (other) named condition eg temperature / water

**2**

(b) *ignore reference to phototropism*

ref to auxin / hormone

**1**

unequal (lateral) distribution

**1**

more hormone on dark side

**1**

causes growth on dark side

**1**

(c) (i) (detection) in tip / top / end

**1**

(ii) (response) behind tip
*allow at tip / end / top half*

**1**

**[8]**

**High demand**

**PPQ MS9**

## Q9.

(a) to prevent water affecting the direction of root growth

**1**

(b) gravity acts evenly on all sides

*allow cancel out the effect of gravity*

*do **not** accept there is no gravity*

**1**

(c) (mean) includes the (anomalous) result for seedling 4

*allow (mean) includes the (anomalous) result which only grew 1 mm*

**1**

(d) calculate (mean) from just seedlings 1, 2, 3 and 5

**or**

repeat the investigation **and** recalculate (a new mean)

*allow omit seedling 4 from (mean) calculation*

**1**

(e) uneven distribution of hormone in (root / seedling of) A

*allow reference to auxin*

*allow more hormone at bottom*

*do **not** accept more hormone at the top*

**1**

even distribution of hormone in B

*allow B does not have an uneven distribution of hormone*

**1**

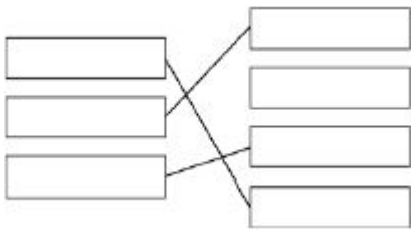
(so) top grows fast(er) (than bottom) in (root / seedling of) A (and equal growth in B)

*allow (more) cell elongation or cell division on top of A*

*allow converse for lower surface*

**1**

(f)



*extra line for a hormone cancels mark for that hormone*

**1**
**1**
**1**

**[10]**