

## Topic 5 – Homeostasis and response

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## 5.1 Homeostasis

### What is homeostasis?

- Regulation of internal conditions of a cell or organism to maintain optimal conditions

### Why is homeostasis important in body? (1)

- Maintain optimal conditions for enzymes action & all cell functions

### In human body, these include control of:

- Blood glucose con
- Body temp
- Water levels

These automatic control systems may involve nervous or chemical responses

### All control systems include:

- **Receptors** - cells which detect stimuli (changes in environment)
- **Coordination centres** eg brain, spinal cord & pancreas - receive & process info from receptors
- **Effectors, muscles or glands** - restore optimum levels

## 5.2 The human nervous system

### 5.2.1 Structure and function

<b>Central nervous system (CNS)</b>	<ul style="list-style-type: none"> <li>• Brain &amp; spinal cord</li> <li>• Coordinates response of effectors eg muscles contracting / glands secreting hormones</li> </ul>
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Stimulus → receptor → coordinator (CNS) → effector → response

#### Describe the function of receptors. (2)

- Detect changes in surroundings
- Convert stimulus to impulse

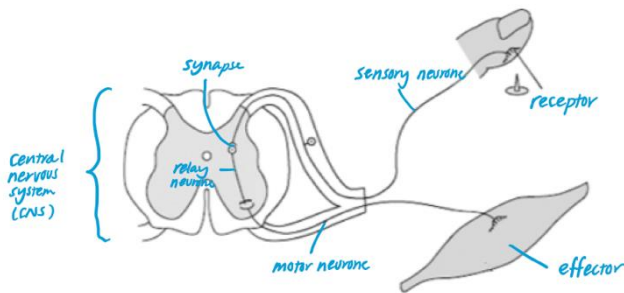
#### Describe the function of effectors. (2)

- Convert impulse to an action
- Eg muscle / gland

### Reflex action

- Automatic & rapid
- Over short period of time
- Don't involve conscious part of brain
- Involves nerve cells & impulses
- Affects only one part of body

### Structure in a reflex action



Type of effector	Response effector makes
muscle	contraction
gland	Produce chemical / enzyme

### Describe the stages that happened in a reflex action. (6)

Stimulus → receptor → sensory neurone (in peripheral) → synapse → relay neurone (in CNS) → synapse → motor neurone (in peripheral) → effector → response

1. Stimulus detected by receptor
2. Receptor sends electrical impulses along sensory neurons and reaches synapse
3. Chemical releases from sensory neurons
4. Chemical diffuses across synapse and attaches to relay neurone to stimulate electrical impulse
5. Impulse passes along relay neurone and reaches synapse
6. Chemical release from relay neurone
7. Chemical diffuses across synapse and attaches to motor neurone to stimulate electrical impulse
8. Impulse passes along motor neurone to an effector
9. Effector causes a response

### How can you tell that it's not a conscious action? (1)

- Not connected to brain
- Coordinated only by spinal cord

### Reflex actions like this are useful. Explain why. (2)

- Rapid response protects body from damage or pain

### Reflex action times investigation

1. Student A sits with his 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.
5. Steps 1 to 4 are then repeated.

### Give two variables the students controlled in their investigation. (2)

- Drop ruler from same height
- Use same weight of ruler

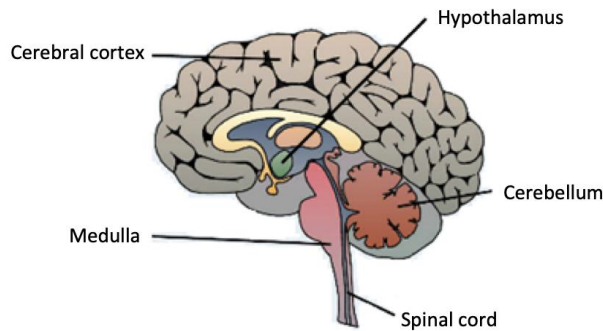
### What improvement could the students make to the method so the results are more valid? (1)

- Carry out more repeats

### Give a conclusion about the effect of caffeine on reflex actions & reaction time. (1)

- Caffeine speeds up reflex actions & decreases reaction time

## 5.2.2 The brain (biology only)



### Functions

**Cerebral cortex** - consciousness, intelligence, memory & language

**Cerebellum** - coordination of muscular activity & balance

**Medulla** - unconscious activities eg heartbeat & breathing

### Methods of finding out how much the brain is damaged

Neuroscientists map regions of brain to particular functions by...

1. Studying patients with brain damage
2. Electrode stimulator - electrically stimulating different parts of brain
3. MRI scan

Name the technique a doctor would use to find out if the man's brain has been damaged. (1)

- MRI scan

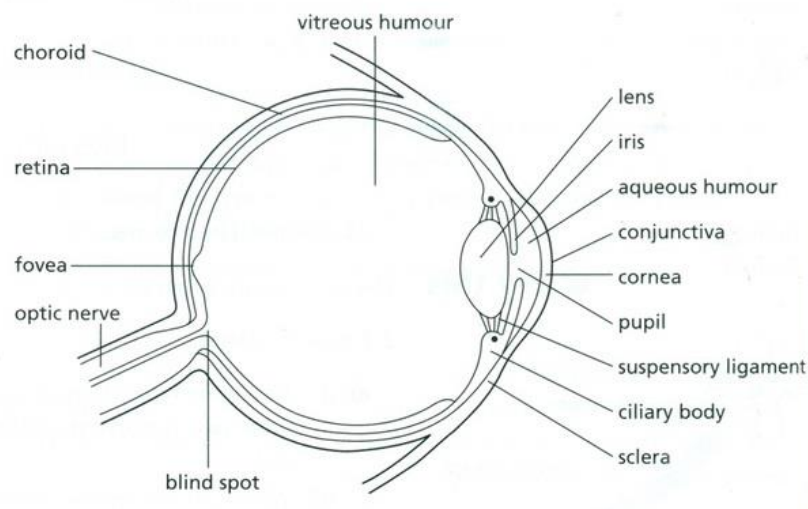
### Difficulties of brain investigation

Explain why it is difficult to treat brain damage. (1)

- High risk of causing more damage to brain
- It's complex & delicate
- Difficult to treat brain disorders

## 5.2.3 The eye (biology only)

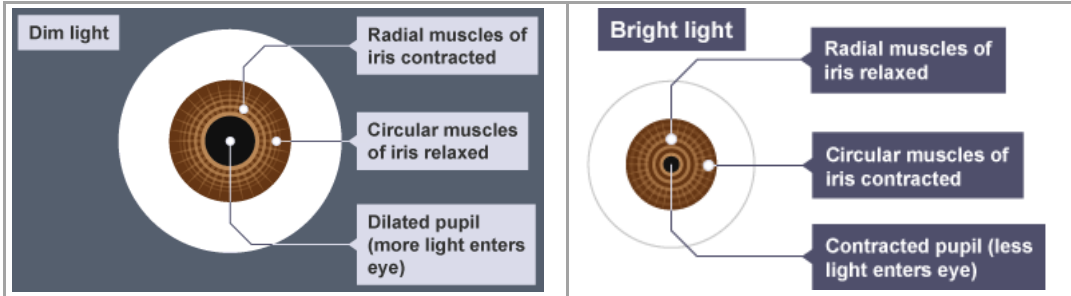
**Eye** - a sense organ containing receptors sensitive to light intensity & colour



### Functions

<b>Retina</b>	<ul style="list-style-type: none"> <li>contains light receptors, rods &amp; cones</li> </ul>
<b>Optic nerve</b>	<ul style="list-style-type: none"> <li>carries sensory neurons from retina to brain</li> </ul>
<b>Sclera</b>	<ul style="list-style-type: none"> <li>tough outer coat</li> </ul>
<b>Cornea</b>	<ul style="list-style-type: none"> <li>Focus light onto retina</li> </ul>
<b>Iris</b>	<ul style="list-style-type: none"> <li>controls amount of light entering eye</li> </ul>
<b>Ciliary muscles</b>	<ul style="list-style-type: none"> <li>controls shape of lens</li> </ul>
<b>Suspensory ligaments</b>	<ul style="list-style-type: none"> <li>attach lens to ciliary muscles</li> </ul>

**Pupil reflex in response to light**



**Accommodation**

- process of changing the shape of the lens to focus on near or distant objects

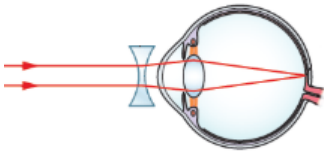
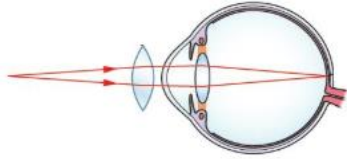
To focus on near object	To focus on a distant object
<ul style="list-style-type: none"> <li>ciliary muscles contract</li> <li>suspensory ligaments loosen</li> <li>lens is then thicker &amp; refracts light rays strongly</li> </ul>	<ul style="list-style-type: none"> <li>ciliary muscles relax</li> <li>suspensory ligaments are pulled tight</li> <li>lens is then pulled thin &amp; only slightly refracts light rays</li> </ul>

**Eye defects**

- Occur when light doesn't focus on retina

Types	<b>Myopia (short sightedness)</b>	<b>Hyperopia (long sightedness)</b>
	<ul style="list-style-type: none"> <li>Lens too curved</li> <li>Distant objects appear blurry</li> </ul>	<ul style="list-style-type: none"> <li>Lens too flat</li> <li>Cannot refract light enough</li> </ul>

**Treatments**

<b>1. Spectacle lenses</b>	<ul style="list-style-type: none"> <li>Refract light rays so they focus on retina</li> </ul>	
	<b>Myopia</b>  Concave lens bends light so light focuses on the retina	<b>Hyperopia</b>  Convex lens bring rays together
<b>2. Contact lenses</b>	<ul style="list-style-type: none"> <li>Hard or soft last for different lengths of time</li> </ul>	
<b>3. Laser surgery</b>	<b>Myopia</b>	<b>Hyperopia</b>
	<ul style="list-style-type: none"> <li>Reduce thickness of cornea</li> <li>So it refracts less light</li> </ul>	<ul style="list-style-type: none"> <li>Change its curvature</li> <li>So it refracts light more strongly</li> </ul>
<b>4. Replacement lens</b>	<ul style="list-style-type: none"> <li>Treat hyperopia by replacing it with artificial lens</li> <li>Could damage retina</li> </ul>	

### 5.2.4 Control of body temperature (biology only)

Describe what happens in the body to keep the body temperature constant. (6)

- Body temp monitored by thermoregulatory centre (TC)
- TC contains thermoreceptor
- Thermoreceptor in skin send nervous impulses to TC, giving info about skin temp

If core body temp too **high**

- Blood vessels supplying blood to skin dilate
- So more blood flows near skin surface
- More heat loss
- Sweat glands release more sweat to cool body

If core body temp too **low**

- Blood vessels supplying blood to skin constrict
- Less blood flows near skin surface
- Less heat loss
- Muscles may shiver to release heat energy

Why it is important to control body temperature. (1)

- Enzymes work best
- So chemical reactions are fastest
- Prevent damage to cells

## 5.3 Hormonal coordination in humans

### 5.3.1 Human endocrine system

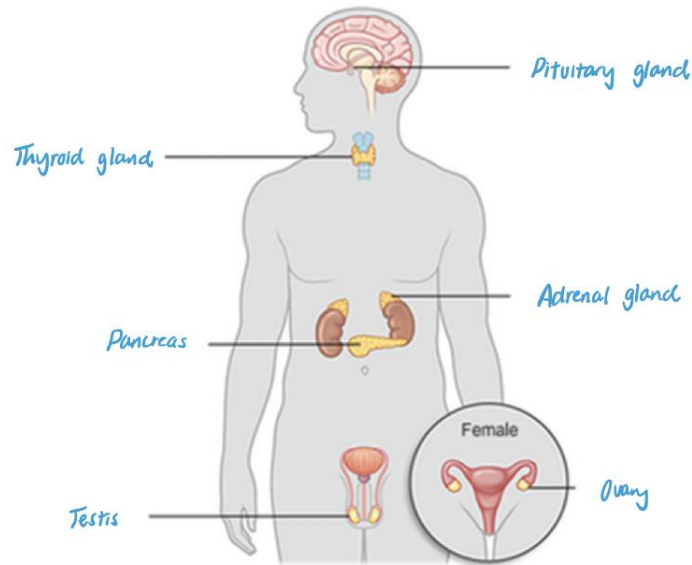
**Endocrine system**

- Composed of gland which secrete chemicals called **hormones** into bloodstream
- Hormone transported in bloodstream to target organ where it produces an effect
- Effect slower but longer compare to nervous system

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**What is a hormone? (1)**

- Chemical messenger produced by endocrine gland



<b>Pituitary gland</b>	<ul style="list-style-type: none"> <li>• Acts as 'master gland'</li> <li>• Secretes hormones into blood in response to body conditions</li> <li>• (Some hormones act on other glands to stimulate other hormones to produce different hormones)</li> <li>• In men - stimulate ovaries</li> <li>• In women - stimulate testes</li> </ul>
<b>Thyroid gland</b>	<ul style="list-style-type: none"> <li>• Produce thyroxine</li> <li>• Controls metabolic rate</li> <li>• Controlled by negative feedback</li> </ul>
<b>Adrenal gland</b>	<ul style="list-style-type: none"> <li>• Produce adrenaline</li> <li>• Prepares body for stressful situations / 'fight or flight' response</li> <li>• Increase heart rate &amp; delivery of O<sub>2</sub> &amp; glucose to brain &amp; muscles</li> </ul>
<b>Pancreas</b>	<ul style="list-style-type: none"> <li>• Secretes insulin</li> <li>• Controls level of glucose in blood</li> </ul>
<b>Ovary</b>	<ul style="list-style-type: none"> <li>• Produce &amp; release eggs</li> <li>• Produce oestrogen</li> <li>• Causes changes at puberty &amp; control menstrual cycle</li> </ul>
<b>Testis</b>	<ul style="list-style-type: none"> <li>• Produce sperm</li> <li>• Produce testosterone</li> <li>• Cause changes at puberty &amp; stimulates sperm production</li> </ul>

**Hyperthyroidism** - caused by an overactive thyroid gland

**Suggest what would happen in the body of a person with hyperthyroidism. (3)**

- Too much thyroxine is released into blood
- Which raises basal metabolic rate (BMR)
- Causing increase formation of glycogen, rate of respiration, breakdown of proteins

### 5.3.2 Control of blood glucose concentration

Which organ in the body monitors the concentration of glucose (sugar) in the blood? (1)

- Pancreas

Explain how insulin controls blood glucose levels in body (3)

- If too high, pancreas produces insulin to cause glucose move from blood into cells
- In liver & muscle cells, excess glucose is converted to glycogen for storage
- If too low, pancreas produces glucagon to break down glycogen to convert into glucose & released into blood in a negative feedback cycle

During the race, the cyclist's blood glucose concentration began to decrease. Describe how the body responds when the blood glucose concentration begins to decrease. (3)

- Pancreas detects low blood glucose
- Produces glucagon
- So glycogen is converted to glucose

	Description	Treatment
<b>Type 1 diabetes</b>	<ul style="list-style-type: none"> <li>• Pancreas fails to produce sufficient insulin</li> <li>• Characterized by uncollected high blood glucose levels</li> </ul>	<ul style="list-style-type: none"> <li>• Insulin injections to replace insulin that isn't made</li> <li>• Pancreas transplant</li> <li>• (Dis - pancreas could be rejected)</li> </ul>
<b>Type 2 diabetes</b>	<ul style="list-style-type: none"> <li>• Body cells no longer respond to insulin produced</li> <li>• Risk - obesity</li> </ul>	<ul style="list-style-type: none"> <li>• Carbohydrate controlled diet</li> <li>• Exercise</li> </ul>

Insulin cannot be taken as a tablet. Why? (1)

- It digested / broken down

Other than using drugs or insulin, give two methods of treating diabetes. (2)

- Control or change diet
- Exercise
- Pancreas transplant

Give one symptom of diabetes (1)

- High normal blood sugar & remains high

Give one way in which a diabetic may be advised to change their diet. (1)

- Small meals

How does this change in diet help diabetic? (1)

- Prevent high blood sugar

A high concentration of glucose in blood can harm body cells as a result of osmosis. Explain why. (4)

- Water movement out of cell from dilute to concentrated solution through partially permeable membrane
- Cell shrink



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

- Water leaves body through lungs during exhalation
- Water, ions & urea lost from skin in sweat
- Excess water, ions & urea are removed through kidneys in urine

#### What happens to body cells if kidneys produce very little urine? (1)

- Cells swell

If body cells lose/gain too much water by osmosis, they don't function efficiently

#### The digestion of proteins from diet

- Excess amino acids deaminated & form ammonia
- Ammonia is toxic so converted to urea in liver
- Urea filtered by kidney & released into blood
- Urea in urine stored in bladder for safe excretion

#### How urine is produced by kidneys. (5)

- Urea filtered by kidney & released into blood
- Reabsorption of all glucose, some ions by active transport & water by osmosis as needed by body back into blood
- Urea present in urine

#### Functions of kidneys in maintaining water balance of body

- **Filtration** - high pressure in blood forces small molecules (glucose, urea, ions, water) out of blood into tubules
- **Selective reabsorption** - all glucose for respiration & enough water & ions to make con in body constant, no urea reabsorbed
- **Formation of urine** - anything remaining in tubules forms urine & passes down into bladder

#### How to keep water concentration constant?

If water concentration in blood too **high**

- Detected by osmoreceptor in hypothalamus
- Less ADH (anti-diuretic hormone) released by pituitary gland
- Less water reabsorbed from kidney tubules to blood
- Less water in blood

If water concentration in blood too **low**

- Detected by osmoreceptor in hypothalamus
- More ADH released by pituitary gland
- More water reabsorbed from kidney tubules to blood
- More water in blood

#### Treatments for kidney failure

Organ transplant		Use kidney dialysis
Advantages	Disadvantages	How it work <ul style="list-style-type: none"> <li>• Unfiltered blood taken from blood vessel in arm</li> <li>• Blood pump keep blood moving</li> <li>• Mixed with blood thinners / anti-coagulant to prevent clotting</li> </ul>

GCSE/IGCSE Biology notes

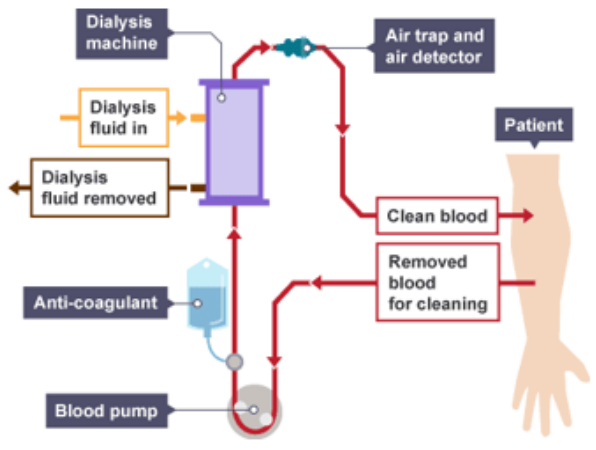
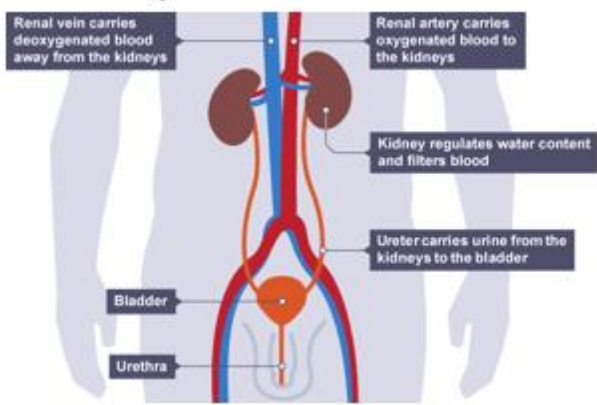
Homeostasis and response

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|--|--|
| <ul style="list-style-type: none"> <li>• Keep blood concentration constant</li> <li>• Prevent high blood pressure</li> <li>• Cheaper in long term</li> </ul> | <ul style="list-style-type: none"> <li>• Long term drug use</li> <li>• Hazards of operation</li> <li>• Shortage of donors</li> </ul> |
|--|--|

- Inside dialysis machine, blood & dialysis fluid separated by partially permeable membrane. Blood flows in opposite direction to dialysis fluid, allowing exchange occur
- Excess ions & water diffuse across partially permeable membrane
- Clean blood flows through bubble trap to get rid of bubbles
- Clean blood returns to blood vessel in arm

- Dialysis fluid**
- Same concentration of glucose & ions - no net movement of glucose out of blood
  - No urea - steep concentration gradient from blood down to fluid - more urea leaves blood

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Available to all patients</li> <li>• No need for immune-suppressant drugs</li> </ul>	<ul style="list-style-type: none"> <li>• Limit salt &amp; protein intake</li> <li>• Risk of blood clot</li> <li>• Regular dialysis sessions</li> </ul>



**Explain why transplanted organ may be rejected. (3)**

- WBC produce antibodies, which attack antigens on transplanted organ

**How to prevent kidney from being rejected? (1)**

- Tissue typing donor kidney

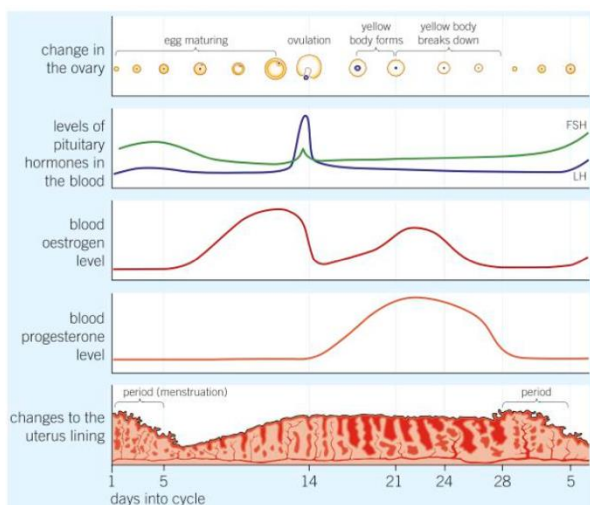
**5.3.4 Hormones in human reproduction**

During puberty reproductive hormones cause secondary sex characteristics to develop.

### What is ovulation? (1)

- Release of egg from ovary
- At puberty eggs begin to mature & one is released every 28 days

<b>Follicle stimulating hormone (FSH)</b>	<ul style="list-style-type: none"> <li>• Stimulates egg maturation in ovary</li> <li>• Stimulates ovary to produce oestrogen</li> </ul>
<b>Oestrogen</b>	<ul style="list-style-type: none"> <li>• Stimulate release of eggs</li> </ul>
<b>Luteinising hormone (LH)</b>	<ul style="list-style-type: none"> <li>• Inhibits FSH</li> <li>• Stimulates release of egg</li> <li>• Causes uterus lining to develop, while progesterone maintains it</li> </ul>
<b>Progesterone</b>	<ul style="list-style-type: none"> <li>• Maintain uterus lining</li> <li>• Inhibits release of FSH &amp; LH</li> </ul>



### Describe how FSH, LH & oestrogen are involved in control of menstrual cycle. (3)

- FSH - stimulate egg maturation
- LH - stimulate egg release
- Oestrogen - inhibits FSH

**The mini-pill is a contraceptive that only contains progesterone hormone.**

### Explain why missing a dose of mini-pill would reduce success rate of mini-pill. (4)

- Missing a dose cause drop in progesterone level
- So FSH & LH not inhibited anyone
- Egg is matured & released

## 5.3.5 Contraception

### How oral contraceptives / hormonal methods of contraception prevent eggs mature?

- **Contraceptive pill** contains oestrogen (stop FSH) & progesterone (stop FSH & LH) - stop ovulation
- **Injection, implant or skin patch** release progesterone - inhibit maturation & egg release for a no of months/years (how long and how effective?)

Advantage - reliable

Disadvantage - doesn't protect against STDs

### How can non-hormonal methods of contraception control fertility?

- **Barrier methods** eg **condoms & diaphragms** - prevent sperm reaching egg
- **Spermicidal agents** - kill or disable sperm
- **Intrauterine devices (IUD)** - prevent implantation of embryo or release of hormone
- **Abstaining** from intercourse when egg is in oviduct (natural method)
- **Sterilisation** (surgical methods)

In women - **female sterilisation** - oviducts are cut to prevent egg from reaching uterus

In men - **vasectomy** - sperm tubes are cut to prevent sperm from leaving penis

Disadvantage - x prevent STDs

### Why issues around contraception cannot be answered by science alone?

- The Catholic church teaches that all contraception is unethical, except natural methods

**Condom prevents STDs**

**Describe benefits & possible problems that may result from use of hormones to regulate human reproduction. You should refer to fertility drugs & contraceptives in your answer. (4)**

	Advantages	Disadvantages
<b>Oral contraceptives</b>	<ul style="list-style-type: none"> <li>Prevent egg release</li> <li>Regulate menstrual cycle</li> </ul>	<ul style="list-style-type: none"> <li>Prolonged use may prevent later ovulation</li> <li>Cause headache</li> </ul>
<b>Fertility drugs</b>	<ul style="list-style-type: none"> <li>Can stimulate egg release</li> </ul>	<ul style="list-style-type: none"> <li>Multiple births</li> </ul>

There are **mechanical, chemical, surgical and natural** contraceptive methods used to prevent a pregnancy.

**Mechanical**

Example	Method	Advantage	Disadvantage
Male condom	A barrier that prevents sperm entering the vagina.	Easily obtained. Protects against STIs (e.g. HIV).	Unreliable if not used properly.
Female condom	A barrier that prevents sperm passing up the female reproductive system.	Easily obtained. Protects against STIs (e.g. HIV).	Unreliable if not used properly.

**Chemical**

Example	Method	Advantage	Disadvantage
Contraceptive pill	Taken regularly by the female. Prevents ovulation by changing hormone levels.	Very reliable.	Female needs to remember to take the pill. Side effects include weight gain, mood swings or an increased risk of blood clots. Does not protect against STIs.
Contraceptive implant	A small tube placed under the skin of the upper arm. Releases hormones slowly over a long period of time. Prevents ovulation.	Very reliable. Can work for up to 3 years.	Does not protect against STIs. Can prevent menstruation.

**Surgical**

Example	Method	Advantage	Disadvantage
Vasectomy	Sperm tubes are cut preventing sperm entering the penis.	Virtually 100% reliable.	Difficult or impossible to reverse.
Female sterilisation	Oviducts are cut preventing fertilisation.	Virtually 100% reliable.	Difficult or impossible to reverse.

**Natural**

Example	Method	Advantage	Disadvantage
Rhythm method	Sexual intercourse is avoided around the time of ovulation.	No chemicals are used.	Not as reliable as other methods, especially if the menstrual cycle is irregular.

Source: <https://www.bbc.co.uk/bitesize/guides/zpwjk2p/revision/7>

**5.3.6 The use of hormones to treat infertility (HT only)**

**Name 2 hormones used in IVF treatment. (2)**

- FSH & LH

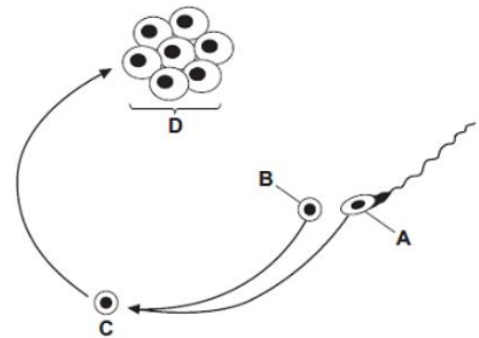
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**Why are fertility drugs given to some women? (1)**

- To stimulate egg production to help them get pregnant

**Describe the process of IVF. (4)**

- FSH & LH given to mother to matures & release eggs
- Egg collected from mother's ovary & mixed by sperm from father in the lab. Fertilisation occurs.
- Fertilised egg divides & develop into embryos
- When they're tiny balls of cells, one or two embryos are inserted into mother's uterus



**Disadvantages of IVF treatment (4)**

- Low success rate / more likely to have faulty chromosome if too old
- Emotionally & physically stressful
- Multiple births cause possible harm to mother & babies
- Expensive

**The committee which regulates IVF treatment now advises that only one embryo is used in each treatment. Suggest one reason for this. (1)**

- So fewer multiple births
- Multiple births cause possible harm to mother & babies

**5.3.7 Negative feedback (HT only)**

Details in...

5.3.2 Control of blood glucose concentration

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

**5.4 Plant hormones (biology only)**

**5.4.1 Control and coordination**

**Where is the plant hormone made?**

- In the root tip

**Which hormone and how does it control the responses of plants to light and gravity?**

Auxin

- Unequal distributions of auxin cause unequal growth rates in plant roots & shoots
- Higher con of hormone causes faster growth in shoot but slower growth in roots

**Why do plant produce hormones?**

- To coordinate & control growth and responses to light (phototropism) & gravity (gravitropism or geotropism)

**Describe how light affect the direction of growth of shoots. (4)**

When shoot tip is exposed to light

- More auxin accumulates on shaded side
- This causes cells elongate faster on shaded side as it has a higher con of auxin

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Homeostasis and response

- Shoot grow towards light (**phototropism**)
- This is a **+ve tropism** (plant grows towards stimulus)

**Explain how phototropism helps plant to survive. (3)**

- Plant can get as much light as possible
- More photosynthesis takes place
- Allow more energy to be generated

**Describe how gravity affect the direction of growth of roots & shoots. (4)**

When shoot grow sideways

- More auxin on lower side due to gravity
- This causes cells elongate faster on lower side as it has a higher con of auxin
- Shoot bends upwards (**-ve gravi/geotropism**)

When root grow sideways

- More auxin on lower side due to gravity
- Extra auxin inhibits growth
- Cells on top elongate faster
- Root bends downwards (**+ve gravi/geotropism**)

**Describe how moisture affect the direction of growth of roots & shoots. (4)**

- Roots grow towards moisture (**hydrotropism**)

**Explain how the hormone causes the appearance of the seedlings in Figure 7 to be different. You should refer to both seedlings in your answer. (3)**

Figure 7



Seedling from Apparatus A

Seedling from Apparatus B

- Uneven distribution of hormone in A (more auxin at bottom)
- So top grows faster than bottom in A
- Even distribution of hormone in B
- Equal growth in B

**What happen if shoot is removed?**

- No auxin available
- Shoot stop growing

### Practical

**Control variables**

- Type of plant
- Amount of water poured to Petri dish

**Method**

1. Set up 3 Petri dishes containing cotton wool soaked in equal amounts of water.
2. Put 10 mustard seeds in each dish.

3. Measure the length from the base of the shoot to the tip. Write your measurements in your result table.
4. Make accurate labelled drawings of the seed.
5. Place one Petri dishes into position.
  - Inside the box with the lid closed in darkness
  - Inside the box which is cut one side of the box in partial light
  - On a windowsill in full sunlight
6. Put a lamp above the box which is cut to make sure some light is reaching inside the box. Don't move the dish.
7. Water daily with equal amounts of water to each dish.
8. Measure length from base of shoot to tip, for at least 5 consecutive days.
9. Record your measurements in a result table, one for each light condition and calculate a mean.

### 5.4.2 Use of plant hormones (HT only)

#### Where are plant growth hormones used?

- In agriculture & horticulture

#### Why is **auxin** used?

- As weed killers
- As rooting powders
- To stimulate growth in tissue culture

#### How **weed killers** has an effect on biodiversity?

- Kills plants that some species rely on as food source

#### Why are **ethene** used in food industry?

- To reduce time of ripening of fruit during storage & transport

#### Why is **gibberellin** used?

- To promote seed germination / flowering
- Increase fruit size
- End seed dormancy