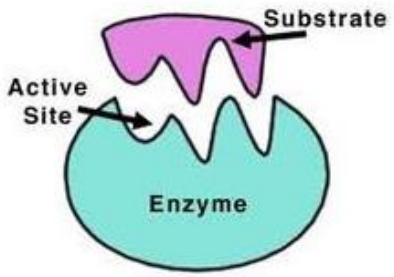
Biology Knowledge Organiser -
Homeostasis and Response

Homeostasis

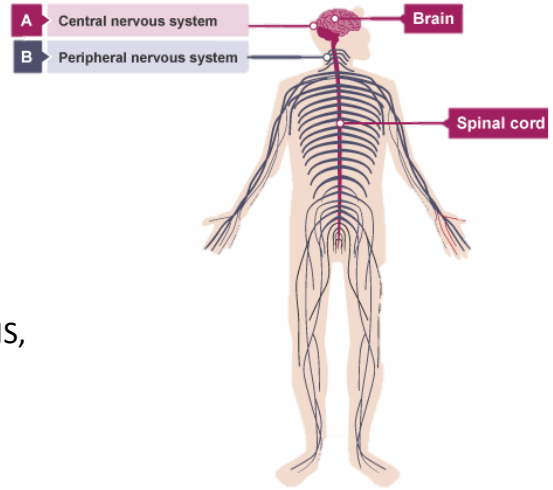
Regulation of the internal conditions of a cell or organism to maintain optimum conditions for function in response to internal and external changes.

Homeostasis is important for maintaining optimum conditions for enzyme action and all cell functions. For example, if our body temperature was to low reactions would happen to slowly and if it was to high enzymes could denature.



Human Nervous System Structure and Function

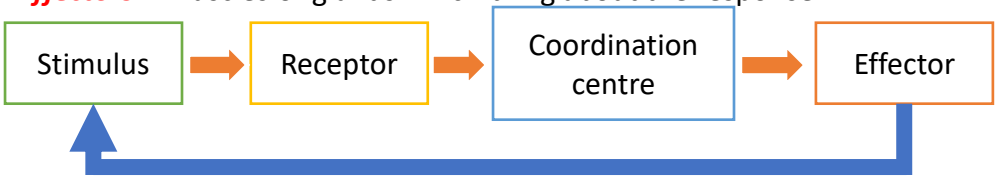
Our nervous system enables humans to react to their surroundings and coordinate their behaviour.



The central nervous system (CNS) consists of the brain and the spinal cord.
The peripheral nervous system (PNS) is the nerve cells that sit outside the CNS, the sensory and motor neurones.

Automated control

Homeostasis is controlled by autonomously (without conscious thought) by organs in the body, the hypothalamus in the brain, pancreas and pituitary gland.
These systems all have –
Receptors – cells which detect stimuli (changes in the environment).
Coordination centres – that receive and process the information from receptors. Examples are brain, spinal cord and pancreas.
Effectors – muscles or glands which bring about the response.

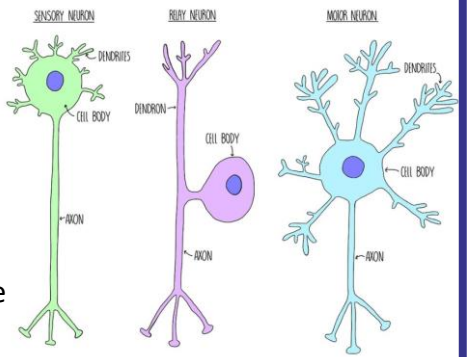


Inside the human body homeostasis keeps the blood glucose concentration, body temperature and water levels within fine limits using this method of control.

Neurone Cells

Information passes along neurones as electrical impulses.
The diagram below shows the three types of neurones.

Sensory neurones carry impulses from receptors to the central nervous system. They consist of one long dendron and a short axon.
Relay neurones carry impulses between the sensory and motor neurons and are found within the CNS. They have lots of short dendrites.
Motor neurones carry impulses from the CNS to an effector. They have lots of short dendrites and one long axon.
Neurones are bundled together in 100s or 1000s to form nerves



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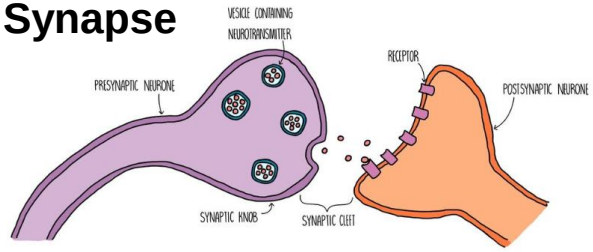
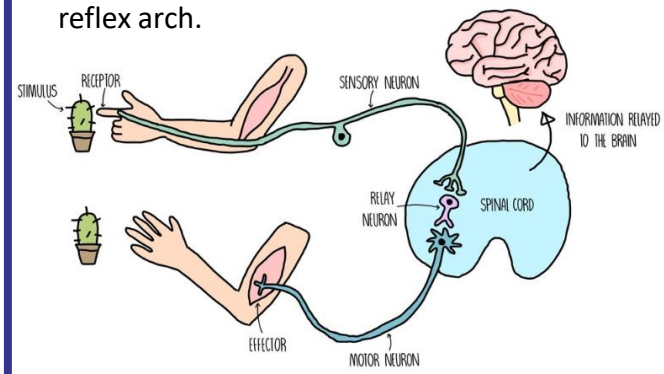
Synapse



A synapse is a gap between two neurones.
When an electrical impulse arrives at the presynaptic neurone it causes a chemical neurotransmitter to be released into the synaptic gap. The neurotransmitter diffuses across the synaptic gap and binds to complementary receptors on the post synaptic membrane which causes an electrical impulse to be triggered in the neurone.
Impulses travel much faster through the axons of neurones than they do crossing a synapse. This means having more synapses will slow down the rate of transmission of the impulse.
Synapses play an important role in our nervous system allowing impulses to only travel in one direction, learning and acclimatisation.

Reflex Actions

Reflex actions are automatic and rapid; they do not involve the conscious part of the brain. The diagram below show a reflex arch.



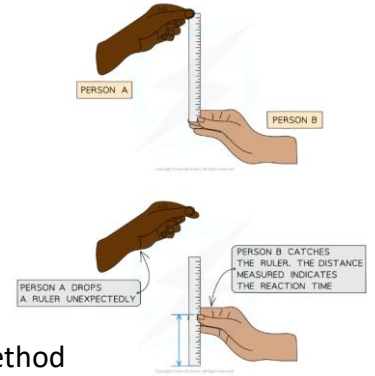
Reflex actions are important in protecting us from danger / damage. In a reflex arch the impulse travels as shown below (red) –

Stimulus → Receptor → Sensory neurone → Relay neurone → Motor neurone → Effector

Between each neurone is a synapse so the more neurones there are the slower the reflex.

After the reflex arch has been triggered a message is also sent to the brain to allow conscious recognition of the event.

RP – Investigating the effect of a factor on human reaction time.



Method
1. Have the subject sit down and rest their non dominant arm on the table with their hand over the edge.
2. The subjects hand which is held open with two fingers at the top and the thumb ready to stop the ruler.
3. A meter ruler is held above the subjects had ensuring the zero reading is inline with top of the subjects hand.
4. The ruler is dropped with no warning and the subject catches it and the distance the ruler has dropped is read from the top of the finger.
5. This is repeated five times and a average is taken.

Reaction Time

Reaction time is a measure of how much time passes between seeing something and reacting to it.
A human reaction time for someone that is alert is usually between 0.2 and 0.9 seconds.

Method –

Independent variable – distraction (i.e. doing mental maths, talking) caffeine levels, sleep levels.
Dependent variable – reaction time – measured either by distance a ruler has dropped before being caught and converted to a time using a conversion table or equation Or using computer software.
Control variables – Any of the independent variables not been tested, age, dominant hand, starting position of ruler, sitting position (i.e. non dominant hand resting on table), time of day.

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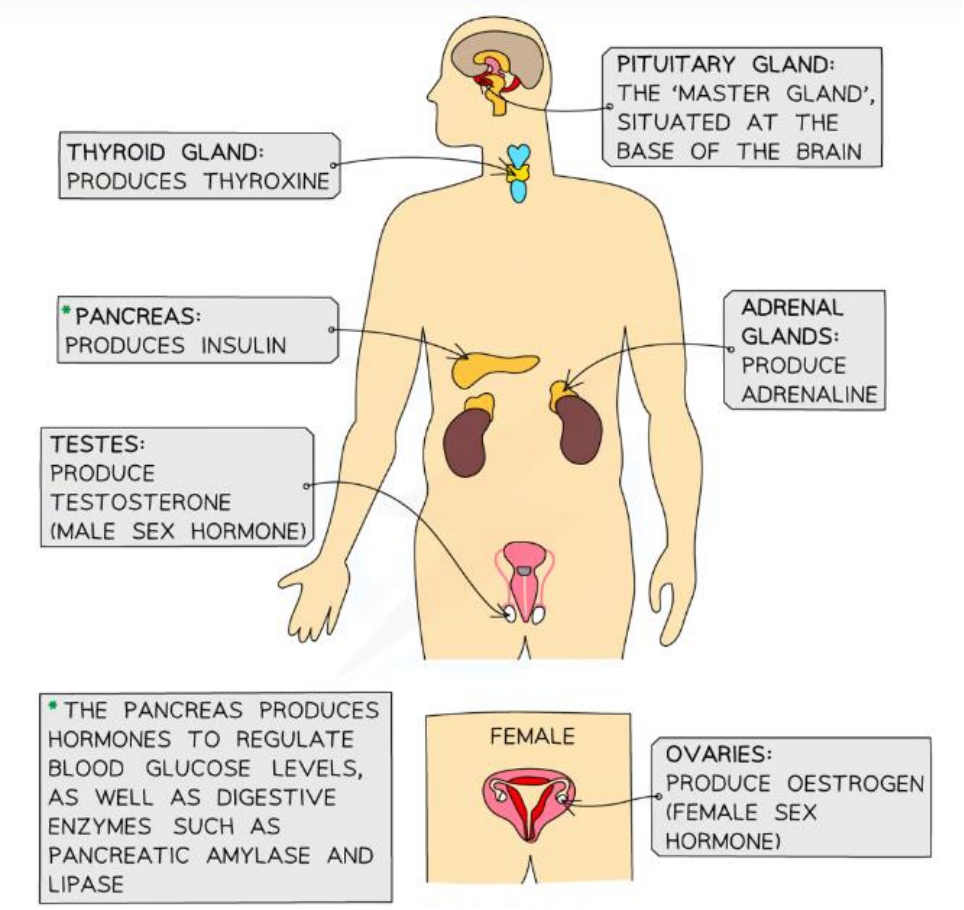
Endocrine System Structure & Function

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.



Important structures in the endocrine system are:

Pituitary gland - a 'master gland' making hormones such as **FSH** and **LH.**

Pancreas - produces **insulin** which regulates the blood glucose level.

Thyroid - produces **thyroxine** which controls metabolic rate and affects growth.

Adrenal glands - produces **adrenaline.**

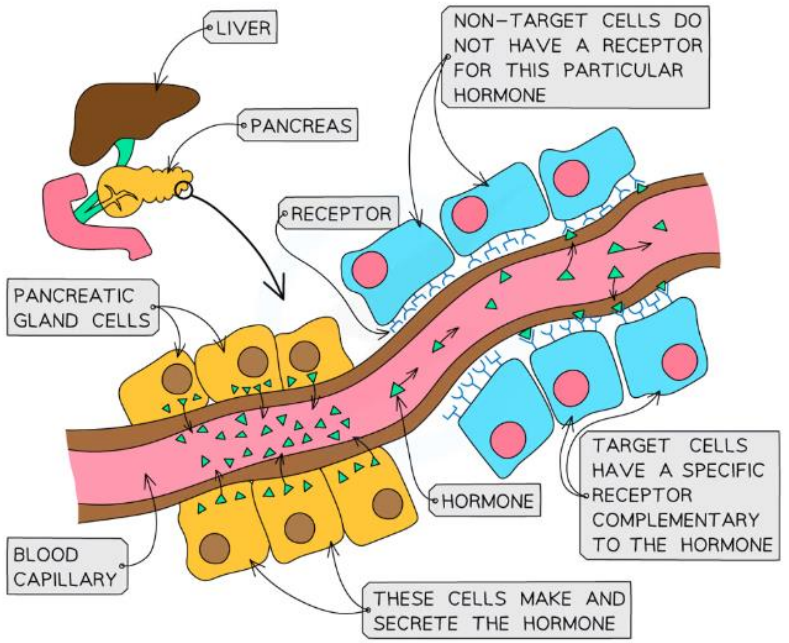
Ovaries (females) - produce **oestrogen.**

Testes (males) - produce **testosterone.**

Pituitary Gland

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



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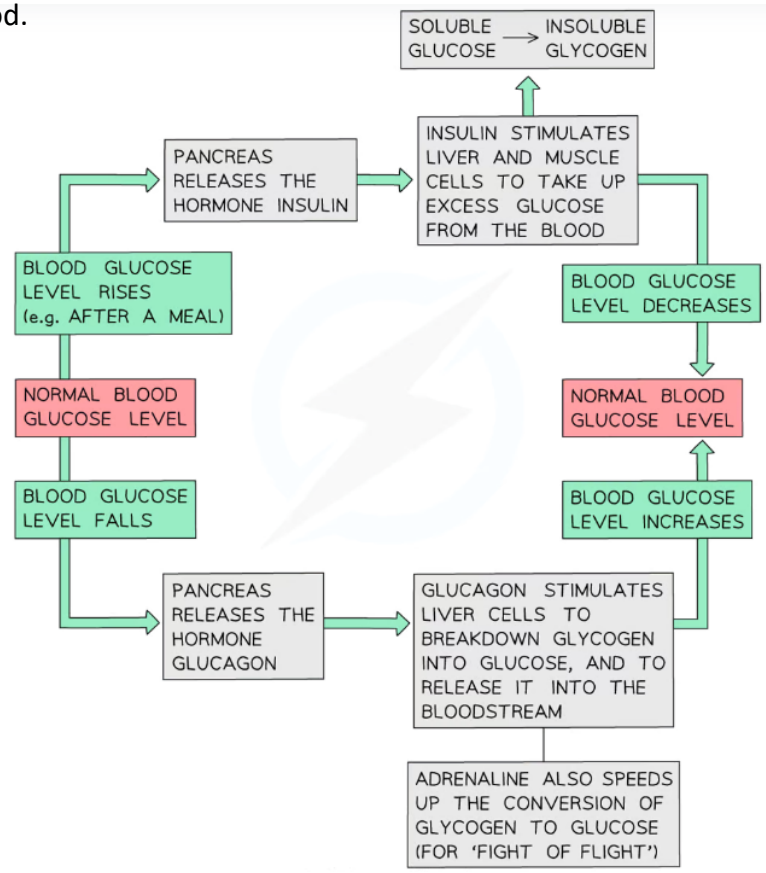
Control of blood glucose

Blood glucose concentration is monitored and controlled by the pancreas.

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.

(HT only) 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.

Negative feedback control of blood glucose



Diabetes

Type 1 diabetes is a disorder in which the pancreas fails to produce sufficient insulin to control blood glucose levels.

Type 2 diabetes the body cells no longer respond to insulin produced by the pancreas - the person still makes insulin but their cells are resistant to it and don't respond as well as they should.

	Type 1	Type 2
Cause	Inability of pancreas to produce insulin	Cells of the body become resistant to insulin produced by the pancreas
Treatment	Monitoring blood glucose levels and injecting human insulin throughout the day	Maintain a low carbohydrate diet and regular exercise to reduce need for insulin

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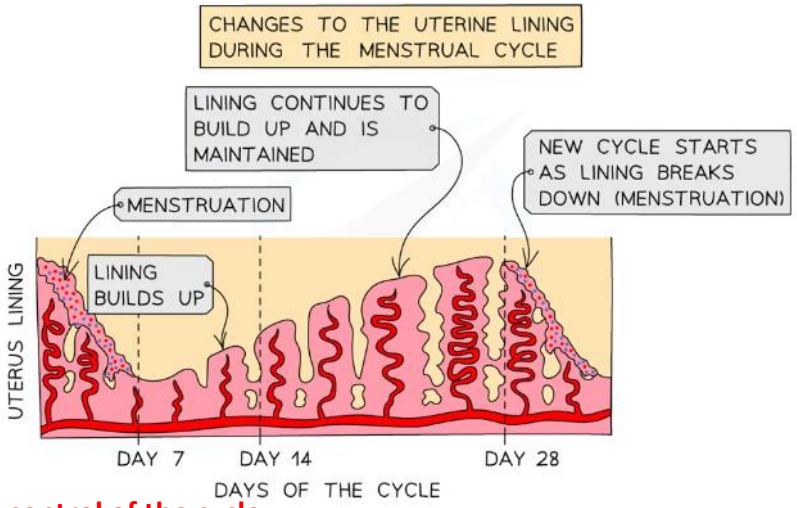
Menstrual Cycle

Stages of the menstrual cycle

•During the menstrual cycle, the lining of the uterus builds up and ovulation occurs

•The average menstrual cycle is 28 days long and there are four overall stages:

- **Menstruation** – loss of lining from the uterus, occurs at the start of the cycle if no fertilisation has occurred
- The **lining** starts to thicken
- **Ovulation** occurs around the middle of the cycle (about day 14), the egg travels down the oviduct towards the uterus
- The lining is **maintained** ready to accept a fertilized egg



Hormonal control of the cycle

•Four hormones control the events that occur during the menstrual cycle

•Two of these hormones are produced by the pituitary gland in the brain:

- Follicle-stimulating hormone **(FSH)** causes maturation of an egg in the ovary
- Luteinising hormone **(LH)** stimulates the release of the egg

•The other two hormones, **oestrogen** and **progesterone** are involved in maintaining the uterus lining with oestrogen being made by the ovaries and progesterone specifically by an empty egg follicle called the corpus luteum

Hormones in the menstrual cycle (HT only)

There are several hormones are involved in the menstrual cycle of a woman:

FSH – produced in the pituitary gland.

• Tells an egg to start maturing in an ovary follicle

•Stimulates the ovary to produce oestrogen.

Oestrogen – produced in the mature follicle in the ovary

•Starts build-up of uterus lining

• Inhibits FSH

• Causes release of LH.

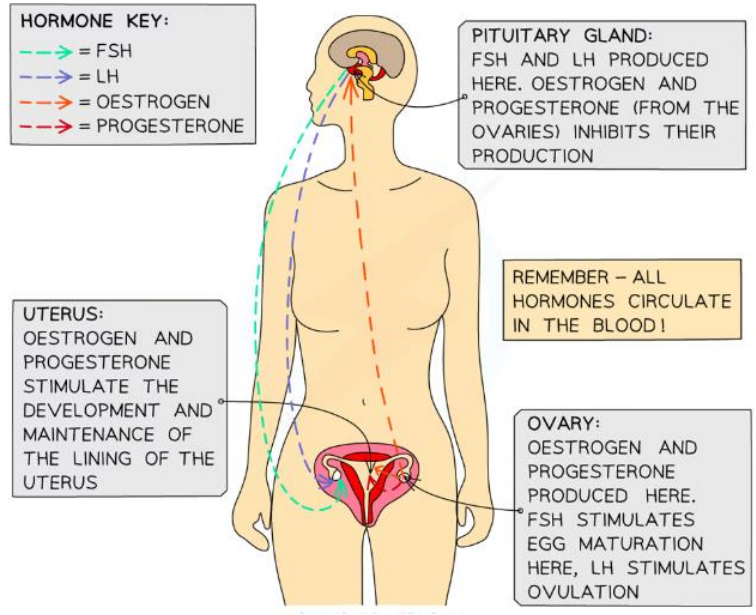
LH – produced in the pituitary gland.

•Triggers ovulation (egg released)

Progesterone - produced in the ovary

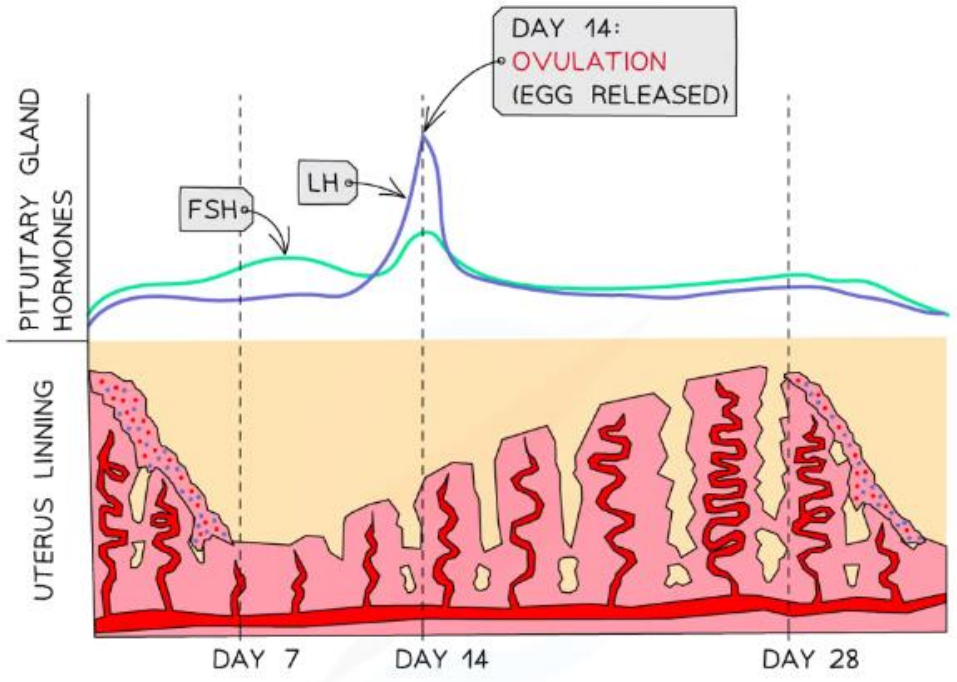
• Maintains the lining of the uterus for ~10 days

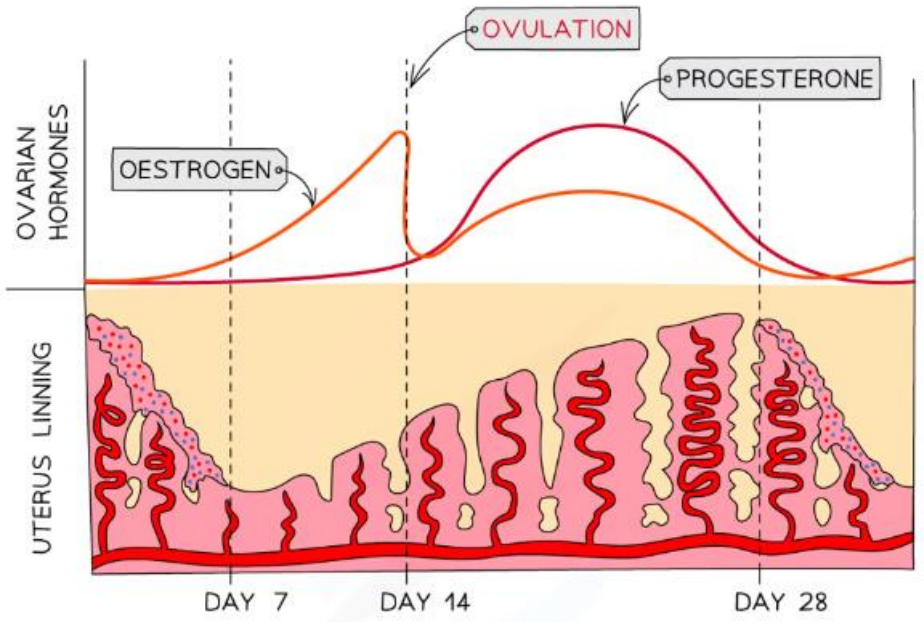
•Inhibits FSH & LH



Hormone level graphs

You need to be able to extract and interpret data from graphs showing hormone levels during the menstrual cycle:





FSH
- STIMULATES EGG MATURATION IN THE FOLLICLES OF THE OVARY
- STIMULATES FOLLICLES IN THE OVARIES TO SECRETE OESTROGEN

LH
- AS ITS PEAK STIMULATES OVULATION (RELEASE OF EGG INTO OVIDUCT)
- RESULTS IN THE FORMATION OF A CORPEUS LUTEUM

OESTROGEN
- STIMULATES THE UTERUS TO DEVELOP A LINING (TO REPLACE THE LINING LOST DURING MENSTRUATION)
- POST-OVULATION, INHIBITS FSH AND LH PRODUCTION IN THE PITUITARY GLAND

PROGESTERONE
- MAINTAINS AND THICKENS LINING OF THE UTERUS
- INHIBITS FSH AND LH PRODUCTION
- IF FERTILISATION DOESN'T OCCUR, LEVELS DROP AND MENSTRUATION OCCURS

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Control of Fertility – Contraception

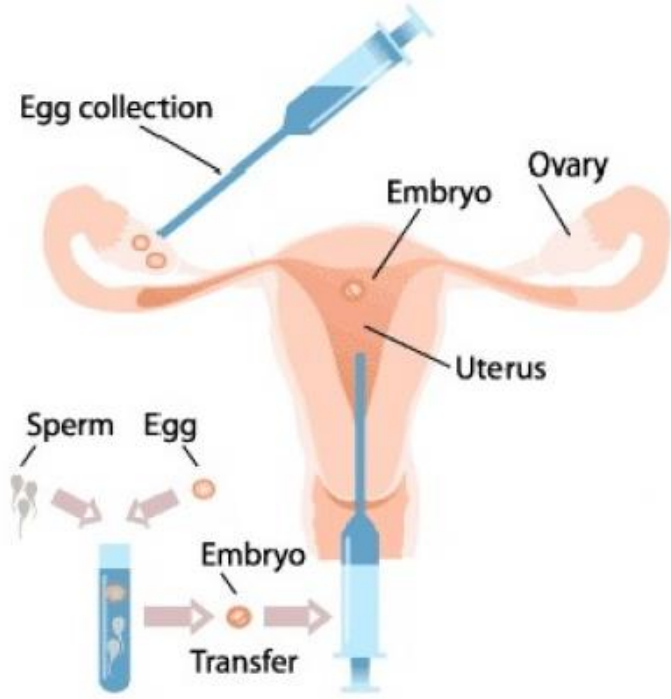
Fertility can be controlled by a variety of hormonal and non-hormonal methods of contraception

Contraception	Description
Pill (Oral)	Contains hormones that inhibit FSH production so no eggs mature.
Injection, implant, skin patch	Slowly releases progesterone – inhibits maturation and release (ovulation) of eggs.
Condoms or diaphragms	Barrier methods which prevent the sperm from meeting the egg
Intrauterine devices (IUD)	Prevent implantation of egg in uterus or release a hormone
Spermicides	Chemicals that kill sperm
Abstinence	Not have sex around the time of ovulation
Surgery	Both male and female sterilisation operations possible

Using hormones to treat infertility (HT only)

In Vitro Fertilisation (IVF) treatment.

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



Although fertility treatment gives a woman the chance to have a baby of her own, it is very emotionally and physically stressful. The success rates are not high. It can lead to multiple births which are a risk to both the babies and the mother

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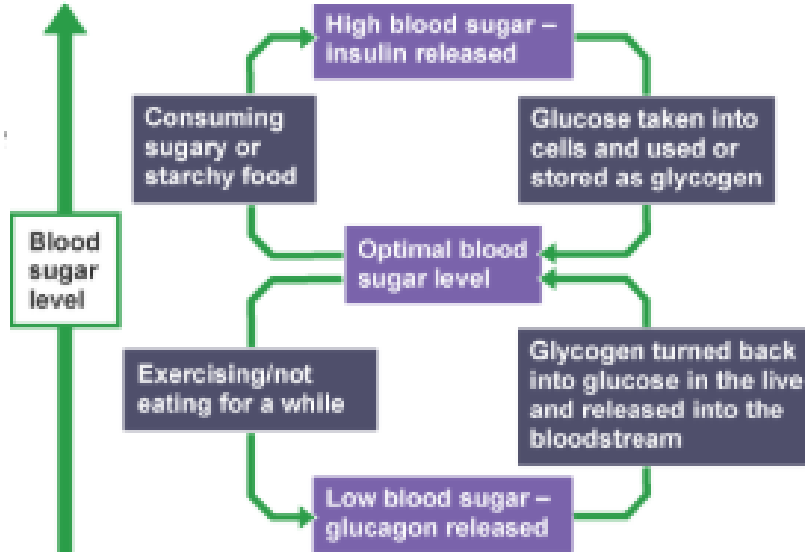
Negative feedback – (HT)

Control of blood glucose is an example of a negative feedback loop.



Negative feedback is where the body takes steps to **reverse** a change (an increase or decrease) to the body's normal levels to bring them back to the optimal level.

ADRENALINE: Adrenaline is produced rapidly 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'.
When the stress has ended, levels fall back to normal. This is **NOT** a negative feedback loop.

Thyroxine (HT)

Thyroxine is secreted by the thyroid gland.

Thyroxine stimulates the basal metabolic rate and is important for growth and development. This is a negative feedback loop

Thyroxine too low	Thyroxine too high
Pituitary gland secretes more TSH	Pituitary gland secretes less TSH
TSH stimulates thyroid to secrete thyroxine	Thyroid not stimulates to secrete thyroxine
Thyroxine increases metabolic rate.	Less thyroxine decreases metabolic rate.