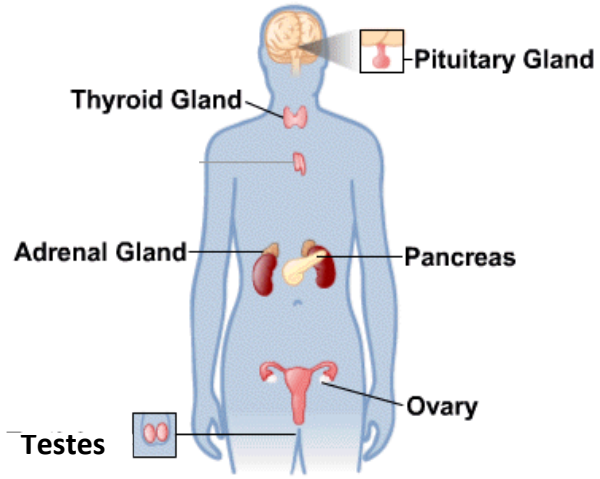
# Biology Knowledge Organiser
# B11 - Hormonal coordination

## The human endocrine system

**Hormones** are released by endocrine glands directly into the bloodstream so they can be transported to a target organ or tissue and cause an effect. In comparison with the nervous system, the effects caused by the endocrine system are slower but act for longer. The hormones themselves are large chemical molecules.

The most important endocrine gland is the **pituitary gland** – think of it as a master gland that secretes many hormones that act on *other endocrine glands*, which then release hormones of their own. Learn the positions of the endocrine glands indicated on the diagram.




## Diabetes

Diabetes is a group of disorders where blood glucose cannot be properly regulated by the body, which is potentially very dangerous. There are two types, with different causes and treatments. More on this in topic 13: how do organisms get sick?

## Controlling blood glucose concentration

The monitoring and control of blood glucose concentration are both carried out by the **pancreas**. When blood glucose concentration rises (for instance, soon after eating), the pancreas detects this and releases the hormone **insulin**. Insulin causes glucose to move out of the blood and into cells. In particular, muscle and liver cells take in glucose and convert it to a much bigger molecule called **glycogen** for storage, rather than keeping it as glucose in their cytoplasm. This, obviously, *lowers* the blood glucose concentration back down to what it should be.

**HT**: when blood glucose concentration drops too low, the pancreas detects this and releases a different hormone: **glucagon**. Glucagon causes muscle and liver cells to convert glycogen back into glucose and release it into the blood. This obviously *raises* the blood glucose concentration back up. Therefore, using insulin and glucagon, the pancreas can keep your blood glucose concentration within very tight limits – an excellent example of homeostasis.

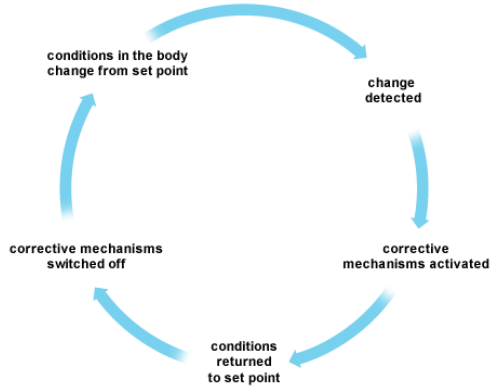
| Key Terms | Definitions |
|---|---|
| Hormone | A large chemical released by an endocrine gland; hormones have target tissues/organs and they produce an effect when they reach them. |
| Target organ/tissue | The destination of a hormone and the place where the effect caused by the hormone actually happens. |
| Secrete | The proper term for 'release' of a chemical in the body, such as a hormone from an endocrine gland. |
| Insulin | The hormone released by the pancreas that lowers blood glucose concentration, by making cells take in glucose from the blood. |
| Glycogen | Large chemical, made from glucose, that acts as a store of glucose in liver and muscle cells. |
| Pituitary gland | The 'master gland' of the endocrine system, since, through its hormone release, it can make other endocrine glands release hormones. |

## HT: negative feedback

Negative feedback is an important concept in homeostasis. Secretion of hormones is stimulated by a change from the normal level of a condition in the body. The hormone brings the condition back under control, so its release is no longer stimulated. In a round about way, hormones end up preventing their own release – this is called negative feedback. The diagram shows this in general. The level of many hormones can be controlled in this way.

Thyroxine, secreted by the thyroid gland, is controlled by negative feedback, for example. Thyroxine stimulates the **basal metabolic rate** – the baseline for the speed of chemical reactions in the body. This is important in growth and development.

Another hormone you need to know about is adrenaline. This is released by the adrenal glands when you are scared or stressed. It increases the heart rate, increasing the delivery of oxygen and glucose to the brain and muscles. This prepares the body for 'fight or flight' – combat or running away.



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## Hormones and Human Reproduction

Hormones, those chemical messengers that travel in the bloodstream, control many aspects of reproduction, including the **menstrual cycle**, which is essential for sexual reproduction in humans (and other animals).

- During **puberty** the reproductive hormones (see key terms) cause the development of **secondary sex characteristics**. These are the distinctive features of men and women that develop during puberty (e.g. beards and breasts).
- **Testosterone** is the main male reproductive hormone. It is produced in the **testes** and it *stimulates sperm production* (sperm cells are also produced in the testes).
- **Oestrogen** is produced in the ovaries (in women), largely responsible for bringing about changes at puberty.

**The menstrual cycle** is not only the period, although this is where is usually considered to start. The average length of a menstrual cycle is 28 days. The whole purpose of the menstrual cycle is to ready the body for pregnancy, by:

- Shedding (releasing) the uterus lining from the previous cycle – causing the period (aka **menstruation**)
- Allowing an egg to **mature** in the ovary (this is stimulated by the hormone **FSH**).
- Thickening and maintaining the **uterus lining** in preparation for pregnancy (this is controlled by **oestrogen** and **progesterone**).
- Releasing an egg (**ovulation**), about two weeks after the period started (this is stimulated by the hormone **LH**).

## Contraception – preventing pregnancy

One class of contraceptive methods is **hormonal contraception**. Oral contraceptives ("the pill") contain hormones to inhibit FSH production so **no eggs mature**. Injections, implants of hormone-releasing devices, or skin patches can be used for slow-release progesterone, which inhibits the maturation and release of eggs for months or even years.

Non-hormonal methods include:

- **Barrier** methods, like condoms or diaphragms. These prevent sperm reaching the egg.
- **Intrauterine devices** (in the uterus) that prevent any embryos produced from implanting in the uterus. They may also release progesterone, like the hormonal methods above.
- **Spermicidal agents** – chemicals that kill or disable sperm. These are not very effective!
- **Abstinence** – obviously, there will be no pregnancy without sex. An ineffective method of contraception is attempting to time abstinence so you don't have sex while an egg is in the oviduct.
- **Sterilisation** with **surgery**: for men, this involves cutting and tying the sperm ducts so no sperm are included in the ejaculate. For women, the procedure is more invasive, involving cutting and tying the oviducts so no eggs reach the uterus, and no sperm can get to them.

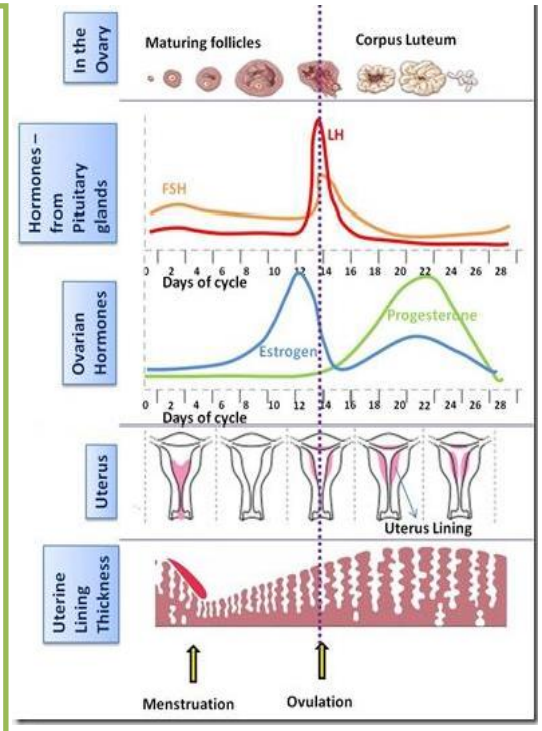
| Key Terms | Definitions |
|---|---|
| Reproductive hormones | Those hormones that control reproduction. Important examples: testosterone (in males); oestrogen and progesterone (in females). |
| FSH | Follicle Stimulating Hormone. This is released by the pituitary gland and causes maturation of an egg in the ovary. |
| LH | Luteinising Hormone. This is released by the pituitary gland and it causes release of a mature egg (ovulation). |
| Uterus lining | The inside of the wall of the uterus. This is where an embryo implants when it is only a few cells in size. |
| Maturation | Becoming mature. All a woman's eggs are in her ovary when she is born, but they must mature before they are released. |

## HT: Interactions of hormones in the menstrual cycle

The four hormones involved in the menstrual cycle affect each other. Key points:

- FSH stimulates the released of oestrogen
- High levels of oestrogen stimulate the release of LH
- High levels of oestrogen **inhibit** (reduce) the production of FSH
- Progesterone inhibits the production of both LH and FSH

The changing hormone levels throughout the cycle can be graphed as shown – make sure you are familiar with the sequence and changing hormone levels.



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## HT: Hormones to treat infertility

Hormones can be used not only to prevent pregnancy, but to improve the chances of getting pregnant in cases of infertility. Fertility drugs contain FSH and LH, which may help a woman to get pregnant, as the cause of infertility may be low levels of these hormones. Failing this, **In Vitro Fertilisation (IVF)** can be used. Here's how it works:

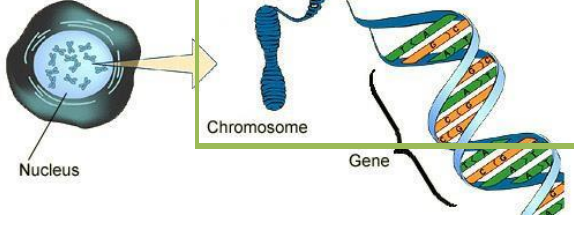
1. The mother is given **FSH** by injection to stimulate eggs to mature – a high dose is given so many eggs mature. **LH** is also given, getting eggs ready for ovulation.
2. Once eggs have had time to mature and are ready for ovulation, but before they actually get released into the oviduct, they are **collected** from the **ovaries**.
3. In a lab ('in glass' – a Petri dish: this is what in vitro means), the eggs are **fertilised** by sperm from the father. The mother can use a sperm donor at this point.
4. Still in the lab, in a Petri dish, these fertilised eggs grow into **embryos** of a few cells.
5. As tiny balls of cells, ready for implantation, one or two embryos are **inserted** into the mother's **uterus**. They used to insert more than this, to increase the chances of pregnancy, but as effectiveness increased the number of *multiple births* (twins, triplets etc.) increased, which are a bit more risky than pregnancies with one baby.

So, IVF has allowed many people to have children who couldn't otherwise. It is stressful though – physically uncomfortable and emotional, because it still only works far less than half of the time. Also, the success rate drops with age. As mentioned, multiple births are more likely in IVF, and these are more risky to mother and baby.

## DNA

DNA is a chemical, a compound made of elements you know – carbon, hydrogen, nitrogen, oxygen, phosphorus. It is a polymer – meaning a very long molecule with units that repeat over and over. Each molecule of DNA is in fact made of two strands that run opposite one another and join in the middle (see diagram). These two strands form a spiral we call a **double helix** – double because there are two strands, and helix is just another word for spiral.

DNA is contained in **chromosomes**, where each chromosome contains one molecule of DNA – one long double helix each (there are also protein molecules as part of chromosomes). Short (compared to the whole molecule) sections of DNA called **genes** code for *proteins* (see diagram). This is how DNA gives you characteristics – the genes inherited from the parents, on the chromosomes they pass on to you, code for the *sequence of amino acids to make specific proteins.*




| Key Terms | Definitions |
|---|---|
| Infertility | Problems conceiving (getting pregnant). Treatments for female infertility given left (HT only). |
| IVF | In Vitro Fertilisation. This means 'in glass' fertilisation – meaning fertilisation happens in a lab. |
| DNA | The chemical that makes up the genetic material in all cells. DNA is a polymer and arranged as a double helix. |
| Chromosome | Structure in cells containing one molecule of DNA. Body cells contain two copies of each chromosome – one from each parent. |
| Genome | The entire genetic material of an organism. |
| Gene | A section of DNA. Each gene is a code for a sequence of **amino acids**, so each gene codes for a specific protein. |

## The genome

The genome is the word to describe all the genetic material of an organism. The human genome has been fully sequenced, so we know exactly the order of genes on each chromosome. (Note: in genetic terms, humans are extremely similar so we do have a general human genome. Everyone will vary slightly from it, but by less than 1%.) The micrograph shows the 23 pairs of chromosomes found in human cells, where pair 23 is the sex chromosomes (XY in this person).

Understanding the human genome is very useful for all sorts of reasons, including:

- Helping the search for genes linked to specific diseases
- Understanding inherited disorders (more on these later)
- Using the tiny differences in genetic information between people to track how humans have migrated all over the planet.