OCR (B) Biology A-level

4.2 Mammalian Reproduction

Notes

4.2.1 Fertility and assisted reproduction

Male reproductive system:

- **Testes** - there are two testicles. This is where sperm cells are produced, as well as testosterone.
- **Scrotum** - Contains the testicles.
- **Sperm ducts** - Tubes that carry sperm from the testes to the urethra.
- **Prostate gland** - Secretes nutritive fluid which combines with sperm to form semen.
- **Urethra** - Tube which allows excretion of urine and semen from the body.

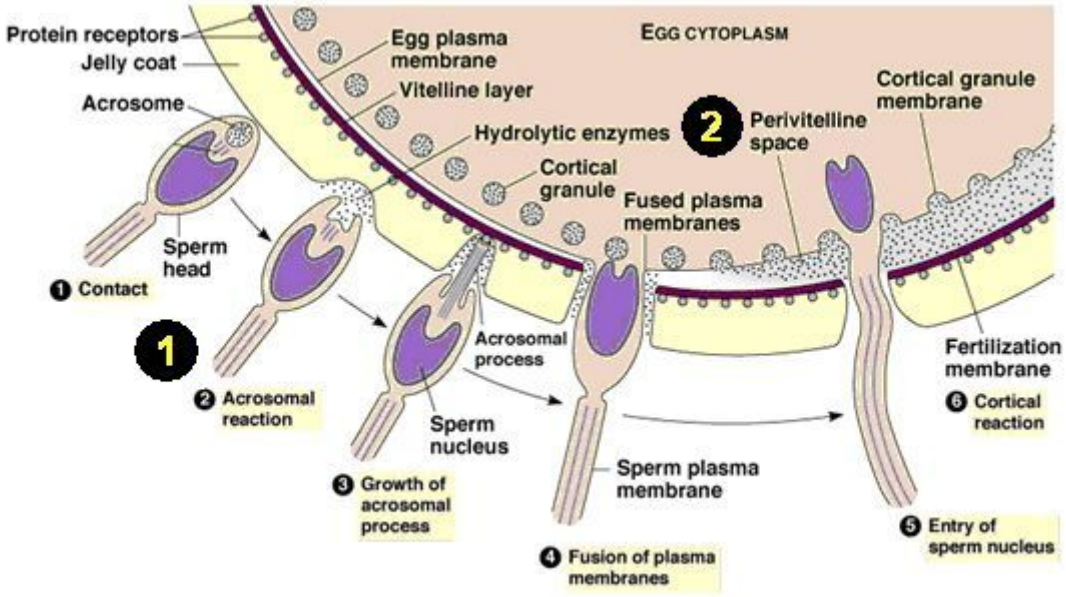
Female reproductive system:

- **Ovaries** - there are two ovaries. Their function is to develop egg cells. Woman have undeveloped egg cells from birth, whereas men produce new sperm throughout their lives.
- **Oviducts** - connect to each ovary and contain cilia to transport the egg cells through the tube. This is where fertilisation occurs.
- **Uterus** - this is where the foetus develops.
- **Cervix** - separates the vagina from the uterus, and also holds the baby in place during pregnancy. The cervix is made of muscular tissue.
- **Vagina** - Tube that leads from the cervix to outside of the body. Receives the penis during intercourse.

Fertilisation:

Fertilisation occurs when a **sperm** cell and an **egg** cell **fuse their nuclei** together. Sperm cells are male **gametes** produced in **large numbers** in the testes. They are adapted by having a tail-like **flagellum** which allows movement to the egg cell. Sperm cells also contain many **mitochondria** to produce energy for this movement. Eggs, in contrast, are much larger than sperm and are unable to move themselves. They are instead transported by **cilia** on the walls of the oviduct. When the sperm cell reaches the egg cell, it must **digest the wall of the cell** so that it can fuse their nuclei. This is done using **enzymes** located in the **acrosome.** The egg contains a **jelly coat**, which ensures that only one sperm cell can enter.

Once fertilisation has occurred, the **zygote** undergoes mitosis (cell-division) to produce many cells which make up an **embryo**. The egg cell contains **energy stores** to allow this to happen. The embryo is implanted into the wall of the **uterus,** where it grows. The process of fertilisation involves restoring the number of chromosomes and introducing genetic variation.



Sex hormones in humans

Two hormones are key to the **development of secondary sexual characteristics** during **puberty** and the subsequent **regulation** of these characteristics:

- **Testosterone** - Testosterone is produced in the **testes** of males, and in small amounts in the **ovaries** of females. It is responsible for muscle development and the deepening of the voice, amongst other things.

- **Oestrogen** - made in the **ovaries** of females. It leads to the development of widened hips, breasts, and plays a part in the menstrual cycle.

Menstrual cycle:

The menstrual cycle happens approximately every **28 days**. During each cycle, an **egg cell is released** from the ovaries. The **uterus wall thickens** by filling with blood capillaries in preparation for a pregnancy, which would occur if the egg is fertilised. If this egg is not fertilised, the egg dies and **menstruation** occurs, where the dead egg cell and old uterus lining is expelled from the body in a **period**.

The menstrual cycle is regulated by four hormones:

- **FSH** - Follicle stimulating hormone triggers the development of an egg cell in the ovary, and also stimulates oestrogen production in the ovaries. This is produced in the pituitary gland.
- **LH** - Luteinising hormone triggers an egg to be released, as well as stimulating progesterone production in the ovaries.
- **Progesterone** - Progesterone is responsible for maintaining the thick uterus lining in the cycle and during pregnancy. It also decreases FSH production.
- **Oestrogen** - Stimulates LH production, whilst decreasing FSH production.

At the beginning of the cycle, levels of **FSH and LH are high** to stimulate egg production and cause the production of oestrogen which thickens the uterus lining. When the egg is released, the levels of **LH, FSH and oestrogen decrease**, whilst **progesterone is released** to maintain the uterus lining. If the egg is **not fertilised**, **progesterone levels decrease** and the uterus lining breaks down, causing menstruation.

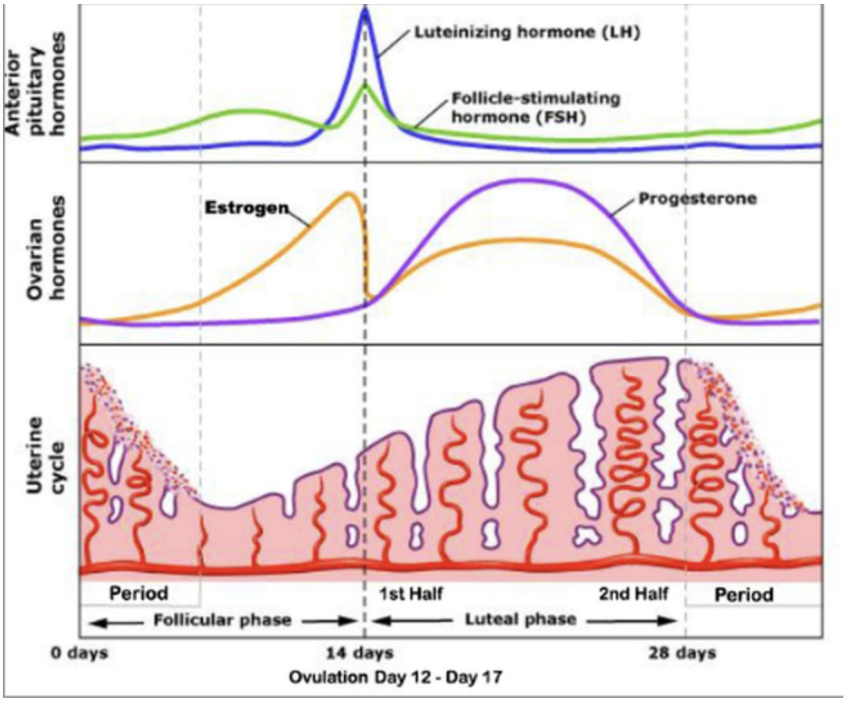
Summary

There are 3 **feedback loops** to take note of:

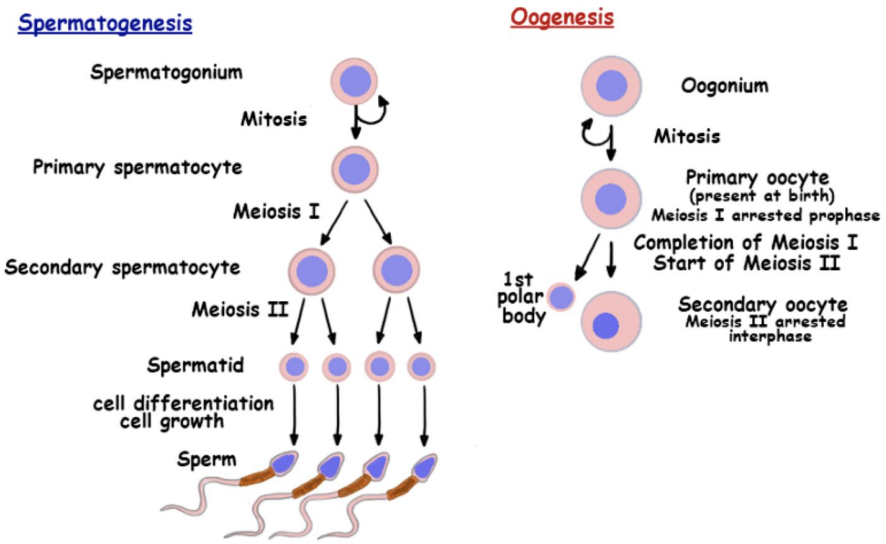
1. Negative feedback from oestrogen to FSH – 'Hey FSH, I'm oestrogen and I know that you stimulated me in the first place, but how about you lay low now that I'm around. Until I get a bit more abundant! My presence means your absence for the time being, so tell that pituitary gland to be quiet.'

2. Positive feedback from oestrogen to LH – 'Hey LH, I'm oestrogen and I want more of you. See how abundant I am? You want to be here with me, don't you? Come on, come closer.'

3. Negative feedback from progesterone to LH – 'Hey LH, I'm progesterone and you're making too much noise partying like that with oestrogen, so here's the deal. Go away. Thank you in advance.'



Gametogenesis:



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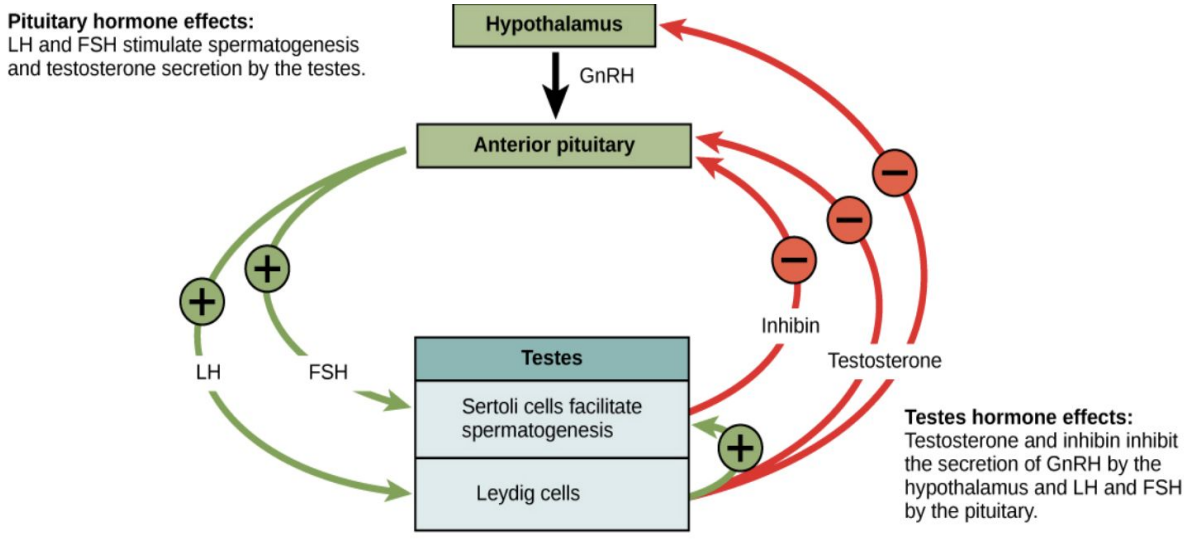
Hormonal control of spermatogenesis [males]:



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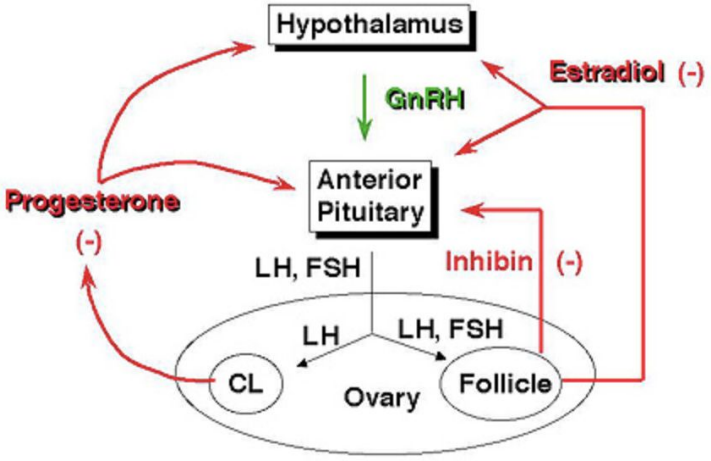
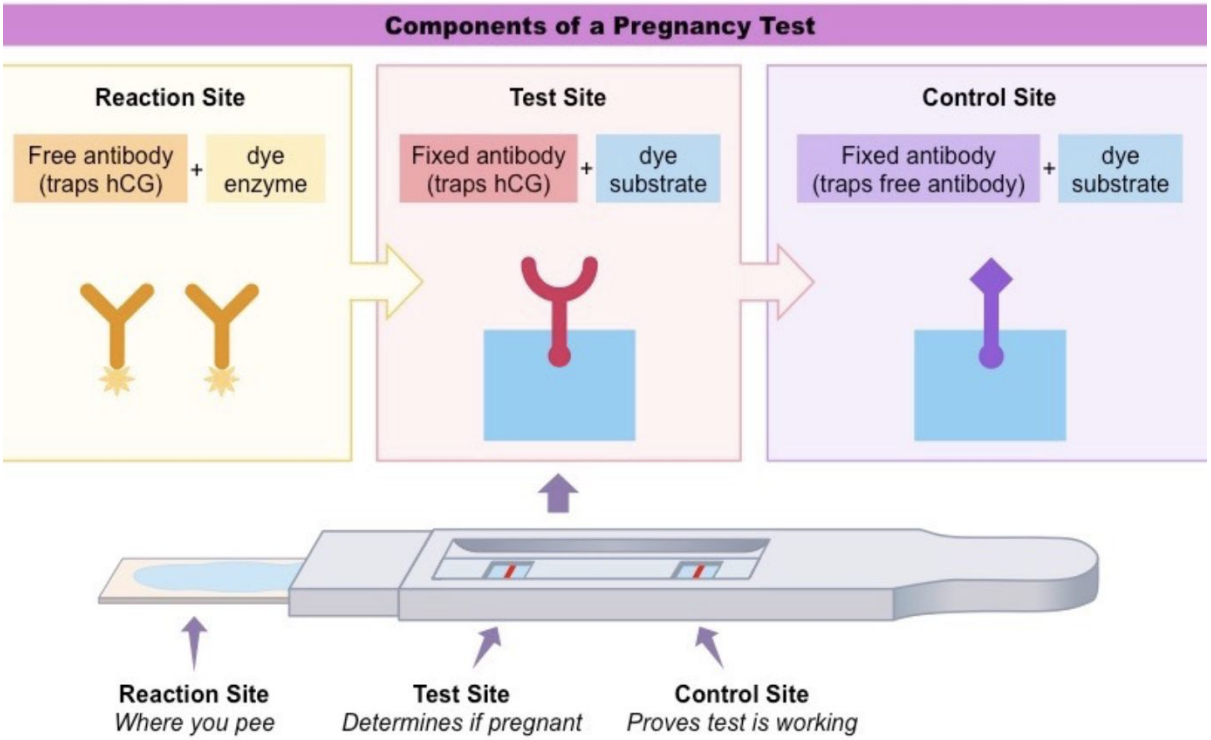
Hormonal control of oogenesis [females]:



CL = corpus luteum; Inhibin inhibits the release of LH/FSH from the pituitary gland. Progesterone is secreted from the corpus luteum and also has an inhibitory effect on the pituitary and hypothalamus.

Image source: www.ansci.wisc.edu

Pregnancy testing



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The presence of hCG [human chorionic gonadotropin] in urine is a sign of pregnancy.

Fertility treatments:

On the other hand, there are also people who would like to have children who have difficulty becoming pregnant. **In vitro fertilisation** (IVF) and **artificial insemination** (AI) are two fertility treatments which can solve this:

- **IVF** - If fertilisation cannot occur due to the sperm count or quality being too low, the egg cell can be fertilised outside of the body and then be implanted back into the uterus.
- **AI** - sperm is directly inserted into the uterus. This sperm can be from the partner, or from a sperm bank if their sperm is not of a high enough quality.

Social implications of contraception and fertility treatments:

Some people believe that fertility treatments, such as IVF, and genetic screening of embryos may lead to '**designer babies**', where parents will discard eggs which do not have **desired characteristics**, for example a certain hair colour or gender. In addition, they may avoid having a child with an inherited disease.

Some **religious groups** do not agree with artificial methods of contraception. This is because they believe that they are **preventing a life** that otherwise would have been created, which goes against their beliefs. Fertility treatments are also contentious as during IVF, **multiple eggs** are taken and fertilised at once, leading to **spare embryos** which are afterwards frozen and stored or destroyed.

4.2.2 Ageing and reproductive system

- Decrease in production of hormones such as oestrogen [ovaries] and testosterone [testes]
- Low levels of testosterone may lead to decreased libido, decreased muscle mass and erectile dysfunction
- Sudden cessation in women [menopause], usually occurring around the age of 51
- Menopause:
    - No eggs released, oestrogen levels falls
    - Hot flushes, atrophy of vagina, decreased libido, osteoporosis [brittle bones, prone to fractures], cardiovascular problems, stroke risk. **Hormone replacement therapy** may be used. This increases the levels of oestrogen; other medication may be used to control hot flushes and night sweats. May increase risk of certain types of cancer – i.e. breast. Lifestyle changes are also advised such as cutting down on caffeine, smoking and alcohol reduction.
- Prostate: a gland found in men. May enlarge with age. Results in urinary dysfunction. Difficulty initiating urination, and retention of urine [incomplete emptying].