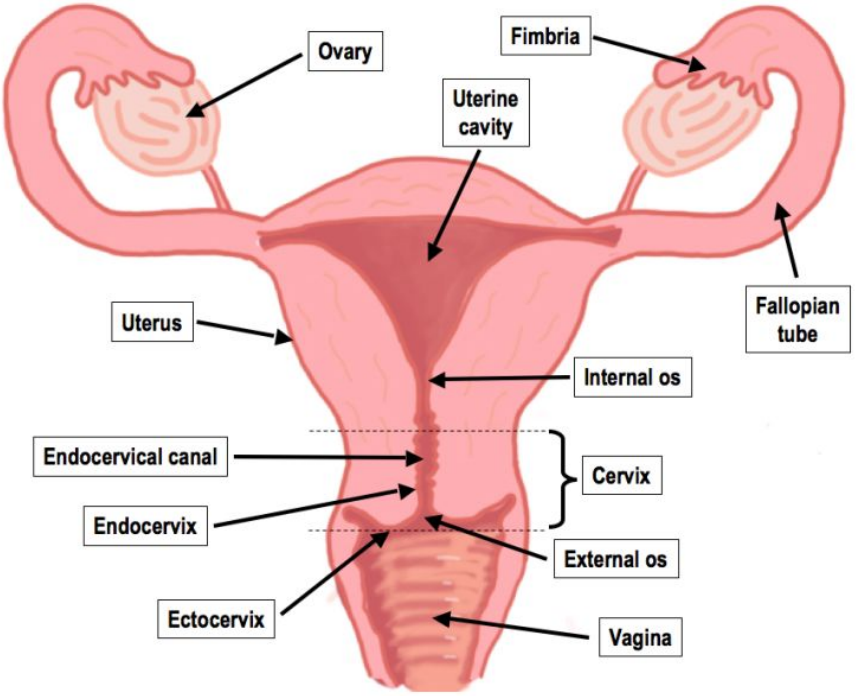
WJEC (England) Biology A Level
Topic 2.3: Sexual Reproduction in Humans

Notes

Female Reproductive System

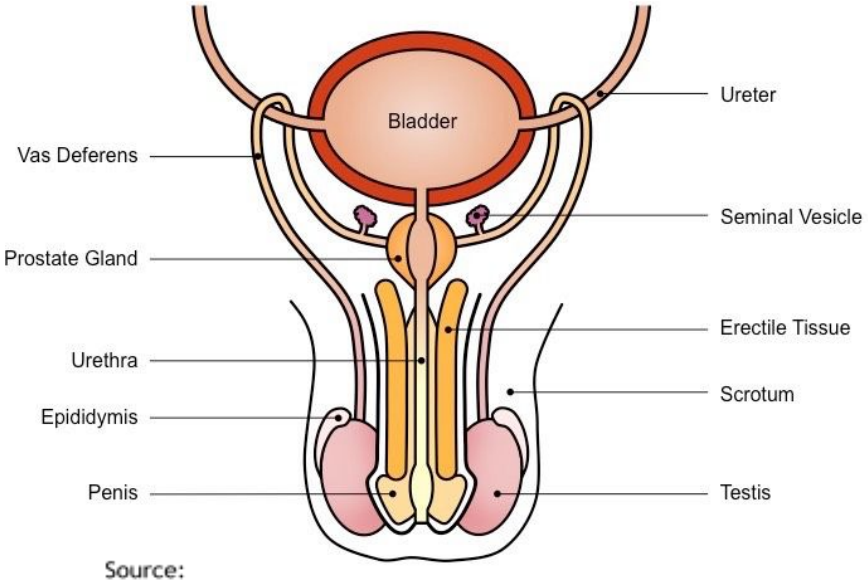


Source:
https://histologyblog.com/2013/01/20/histoquarterly-cervix/female-reproductive-system-2/`

- **Vagina** - a canal linking the cervix of the uterus to the outside of the body. Birth canal, accommodates penis during sexual intercourse.
- **Cervix** - opening through which the foetus exits during childbirth.
- **Uterus** - organ which provides protection and support for the embryo and foetus prior to birth.
- **Fallopian tube** - tubes connecting the ovaries and the uterus. The ovum travels down the fallopian tube during ovulation.
- **Ovaries** - organs which produce ova and secrete hormones. Homologous to the testis.
  - The ovaries are made up of the **cortex** (the outermost layer, made up of stroma - background - and developing follicles), the **medulla** (made up of

stroma, blood vessels, and nerves) and the **hilum** (the innermost layer, made up of blood vessels and nerves).

Male Reproductive System



Source:
http://ib.bioninja.com.au/standard-level/topic-6-human-physiology/66-hormones-homeostasis-and/male-reproductive-system.html

- **Penis** - an organ which delivers sperm to the vagina during sexual intercourse.
- **Scrotum** - provides protection for the testis.
- **Epididymis** - storage for spermatozoa.
- **Vas deferens** (sperm duct) - duct which connects epididymis and ejaculatory duct.
- **Testis** - glands which produce spermatozoa and hormones. Homologous to the ovaries.
  - The testis are divided into sections called **lobules** divided by tissue called **septa**. Each lobule contains several **seminiferous tubules** (and background stroma). These tubules are where the spermatozoa are manufactured.

Gametogenesis

Spermatogenesis

1. **Primordial germ cells** (diploid cells which are the precursors to gametes) divide several times by mitosis to form **spermatogonia**.
2. Spermatogonia grow without further division to form **primary spermatocytes**.
3. Primary spermatocytes undergo the first meiotic division to form **secondary spermatocytes** (diploid).
4. Secondary spermatocytes undergo the second meiotic division to form **spermatids** (haploid, but without a flagellum, acrosome etc.).
5. Spermatids differentiate and grow to form **spermatozoa**.

Oogenesis

1. **Primordial germ cells** divide several times by mitosis to form **oogonia**.
2. Only one oogonium continues to grow to form a **primary oocyte**.
3. The first meiotic division forms one **secondary oocyte** and one **polar body** (small cells that bud off the oocyte, stick to the oocyte and do not develop into gametes).
4. The second meiotic division of the secondary oocyte forms one haploid **ootid** and one polar body. The second meiotic division of the polar body forms two more polar bodies. They degenerate and die as the ootid develops. This meiotic division starts in utero but is halted at prophase and occurs only in response to fertilisation to form the **mature ovum**.

Fertilisation

1. Several sperm cluster around the ovum. One penetrates the **zona pellucida** (waxy layer) of the ovum.
2. This triggers the **acrosome reaction**. The acrosome (secretory vesicle) bursts and the zona pellucida and follicle cells are digested.
3. **Membranes fuse** and the haploid spermatozoa nucleus enters the egg cytoplasm.

4. This triggers the **cortical reaction**. The cortical granules fuse with the cell membrane and release their contents via exocytosis into the zona pellucida. The zona pellucida hardens and thickens. Ion channels open/close to change the charge across the membrane. This makes the egg cell impermeable and prevents polyspermy.

5. **Meiosis II** takes place and the secondary oocyte matures into an ootid and then a mature ovum (this process takes only a few minutes).

6. The **chromosomes combine** to form a **diploid zygote**.

Implantation

1. The zygote undergoes **cleavage** (mitosis without interphase) and divides to produce a hollow ball of cells called a blastocyst.

2. The blastocyst develops **villi**, which grow into the tissue of the uterus and **implant** the developing blastocyst into the uterine lining, where it **attaches and absorbs nutrients**.

Hormonal Control

Menstruation, birth and lactation are controlled by **endocrine glands** - glands which secrete hormones directly into the bloodstream (as opposed to exocrine glands, which secrete hormones into ducts etc.).

Menstrual Cycle

1. Day One - **Menstruation**

   - **Oestrogen and progesterone** levels are low. This causes the uterus to shed its lining, causing menstruation. The unfertilised egg also passes out during this phase.

   - Levels of **follicle-stimulating hormone** produced by the pituitary gland increase. This stimulates the growth of several follicles in the ovary. Each follicle contains an ovum.

   - The follicles secrete oestrogen.

   - As oestrogen levels increase, this suppresses the growth of any more follicles.

2. Day Fourteen - **Ovulation**

   - Level of **luteinising hormone** increases rapidly.

   - Level of follicle-stimulating hormone also increases.

- LH stimulates the follicle to produce enzymes, which cause the follicle to rupture and release the ovum.

- The ovum travels into the fallopian tube.

3. Day Fifteen - **Luteal**

   - The ovum travels along the fallopian tube.

   - The ruptured/'dead' follicle (now referred to as the **corpus luteum**) secretes oestrogen and progesterone. This causes the lining of the uterus to thicken and fill with nutrients.

   - LH and FSH levels decrease.

4. Day Twenty-Eight

   - If the egg is not fertilised, the corpus luteum shrinks and stops secreting oestrogen and progesterone. Levels of oestrogen and progesterone fall.

   - If the egg is fertilised, the cells surrounding the embryo begin to produce **human chorionic gonadotropin**. This prevents the shrinking of the corpus luteum, so levels of oestrogen and progesterone are maintained. It therefore also maintains the lining of the uterus.

Birth

1. Because the foetus is fully grown, the walls of the uterus start to stretch.

5. This stretch is registered by baroreceptors, which triggers the release of **oestrogen** from the ovaries.

6. Oestrogen increases the sensitivity of the uterus to **oxytocin**. Oxytocin is released from the pituitary gland and binds to receptors on the walls of the uterus.

7. Oxytocin causes the smooth muscle in the walls of the uterus to contract, which then leads to the release of more oxytocin. This is one of the few mammalian examples of a **positive feedback loop** (where a change in conditions stimulates an increase in those conditions).

8. Oxytocin inhibits the release of **progesterone**, which previously prevented the uterus from contracting.

9. After birth, oxytocin levels remain high and the uterus continues to contract. This prevents excessive blood loss and helps to detach the placenta.

10. After birth, levels of prolactin (already increased throughout pregnancy) peak. Prolactin promotes lactation and enables breastfeeding.

Placenta

During pregnancy, the placenta enables **substances** (e.g. nutrients, water, oxygen and antibodies from mother to foetus, carbon dioxide and urea from foetus to mother) **to be transferred between the mother and the foetus**. The placenta is large, thin, and has a rich countercurrent blood supply to maximise diffusion of these substances.

The placenta (initially the cells surrounding the embryo, which later develop into the placenta) is responsible for **secreting human chorionic gonadotropin**, which is responsible for the maintenance of the corpus luteum and therefore of oestrogen and progesterone levels in pregnancy. This is important because progesterone inhibits uterine contractions and therefore prevents premature childbirth.