Reproduction

Chromosomes, mitosis and meiosis, stem cells and cancer, asexual and sexual reproduction, flowers, pollination, fertilisation, seeds and germination, and human reproduction including the menstrual cycle and the placenta.

17.2 Nuclear division: mitosis and meiosis

Chromosomes are made of **DNA** and carry genetic information in the form of **genes**. They are found in the **nucleus**.

- A **haploid** nucleus contains a **single set** of chromosomes (as in gametes).
- A **diploid** nucleus contains **two sets** of chromosomes (as in body cells).
- In a diploid cell, there is a **pair of each type of chromosome**. In a **human** diploid cell there are **23 pairs**, which makes 46 chromosomes in total.

Mitosis

Mitosis is nuclear division that gives rise to genetically identical cells, in which the chromosome number is maintained (the details of the stages are not required).

Roles of mitosis: growth, **repair of damaged tissues**, **replacement of dying cells** and **asexual reproduction**.

Stem cells are **unspecialised** cells that divide by mitosis to produce daughter cells, which can become **specialised** for specific functions (for example nerve cells, muscle cells).

Meiosis

Meiosis is a reduction division in which the chromosome number is halved from diploid to haploid, resulting in genetically different cells. It is involved in the production of gametes (sex cells).

Note Academy

	Mitosis	Meiosis
cells made	two	four
chromosome number	stays the same (diploid)	halved (haploid)
genetically	identical	different
used for	growth, repair, asexual reproduction	making gametes

Cancer

Cancers form as a result of **uncontrolled cell division**, which makes a mass of cells called a **tumour**.

16.1 Asexual and sexual reproduction

> **Asexual reproduction is a process that produces genetically identical offspring from one parent. Sexual reproduction is a process involving the fusion of haploid nuclei (fertilisation) to form a diploid zygote, and it produces genetically different offspring.**

Examples of asexual reproduction: **bacteria** dividing, **yeast** budding, and **potato tubers** and **strawberry runners** (in plants).

	Asexual	Sexual
parents	one	two
offspring	genetically identical (clones)	genetically different (variation)
advantages	only one parent needed; fast; many offspring; no need to find a mate; useful in a stable environment	**variation**, so some offspring may survive a change in the environment or a new disease; can adapt (evolve)
disadvantages	no variation, so all can be killed by one disease or a change	needs two parents and time and energy to find a mate; slower; fewer offspring

16.3 Sexual reproduction in plants

The flower

Note Academy

Part	Function
sepals	protect the flower when it is in bud
petals	in insect-pollinated flowers, large and brightly coloured to **attract insects**
stamen	the male part: **anther** (makes **pollen**, containing the male gametes) and **filament** (holds the anther up)
carpel	the female part: **stigma** (receives pollen), **style** (holds the stigma up) and **ovary** (contains the **ovules**, which contain the egg cells)

Insect-pollinated and wind-pollinated flowers

	Insect-pollinated	Wind-pollinated
petals	large, brightly coloured, scented	small or absent, dull
nectar	present	absent
anthers	inside the flower	**hang outside** the flower, so wind can blow the pollen away
stigma	inside, **sticky**	**feathery** and hangs outside, to catch pollen
pollen	**sticky or spiky**, relatively little	**smooth and light**, produced in **large amounts**

Pollination

Pollination is the transfer of pollen from an anther to a stigma. Self-pollination is when the pollen is transferred to a stigma of the same plant. Cross-pollination is when it is transferred to a stigma of a different plant of the same species.

	Self-pollination	Cross-pollination
variation	little: offspring are similar	more variation
response to environmental change	poorer: all may be affected	better: some offspring may survive
reliance on pollinators	less (can happen without insects or wind)	more

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Fertilisation

After pollination, a **pollen tube** grows from the pollen grain down the style, into the ovary and **into the ovule**. The nucleus of the male gamete travels down the tube and **fuses with the nucleus of the egg cell**: this is **fertilisation**. It produces a **zygote**.

After fertilisation, the **ovules develop into seeds** and the **ovary develops into a fruit**.

Seeds

A seed contains an **embryo** (**radicle**: the future root; **plumule**: the future shoot), **cotyledons** (the food store, or seed leaves) and a protective **testa** (seed coat).

Dispersal

Seed and fruit dispersal by wind and by animals spreads the offspring to colonise **new areas** and **reduces competition** with the parent plant (and between seedlings) for light, water and minerals.

	Wind-dispersed	Animal-dispersed
features	light, with a **wing or a parachute** of hairs (for example sycamore, dandelion)	**hooks** that catch on fur, or **brightly coloured, fleshy, edible fruits** with seeds that pass through the gut (for example berries)

Germination

> **A seed needs water, oxygen and a suitable temperature to germinate. It does not need light.**

- **Water** is absorbed, and activates the **enzymes** in the seed.
- **Oxygen** is needed for **aerobic respiration**, which releases the energy for growth.
- A **suitable temperature** is needed for the enzymes to work.

Process. The enzymes (such as amylase) **break down the stored food** (starch) in the cotyledons or endosperm to **sugar**, which is used in respiration and to build new cells. The **radicle** grows first, down into the soil, then the **plumule** grows upwards.

Investigating the conditions. Set up tubes of seeds with: water, air and warmth (germinates); no water (does not); no oxygen (water boiled and covered with oil: does not); and low temperature (a refrigerator: does not).

Note Academy

16.4 Sexual reproduction in humans

The male reproductive system

Part	Function
testes	make **sperm** and the hormone **testosterone**
scrotum	holds the testes outside the body, where it is slightly cooler (better for sperm)
sperm ducts	carry sperm from the testes to the urethra
prostate gland	makes fluid that nourishes the sperm (semen)
urethra	carries sperm (or urine) through the penis
penis	places sperm inside the vagina during sexual intercourse

The female reproductive system

Part	Function
ovaries	make **eggs** and the hormones **oestrogen** and **progesterone**
oviducts (fallopian tubes)	carry the egg to the uterus; **fertilisation** takes place here; lined with cilia
uterus (womb)	where the embryo implants and the fetus develops
cervix	a ring of muscle at the opening of the uterus
vagina	receives the penis and sperm; the birth canal

Note Academy

The gametes

	Sperm	Egg cell
size	small	large (the largest human cell)
numbers	millions	one released a month
motility	**swims** by its tail (flagellum)	does not move itself: carried along the oviduct by cilia
structure	**flagellum** (tail), many **mitochondria** to supply energy, **enzymes in the acrosome** to digest the egg's jelly coat	**energy stores** (food) in the cytoplasm; a **jelly coat** that changes at fertilisation so that no more sperm can enter

> **Fertilisation is the fusion of the nuclei of a male gamete (sperm) and a female gamete (egg cell).**

Puberty and secondary sexual characteristics

At puberty, **testosterone** (from the testes) causes the development of male secondary sexual characteristics (for example facial and body hair, a deeper voice, broader shoulders), and **oestrogen** (from the ovaries) causes female characteristics (breast development, widening of the hips, body hair, the start of the menstrual cycle).

The menstrual cycle

The cycle is about 28 days. Each month an egg is **developed and released (ovulation)** from an ovary, and the **lining of the uterus** thickens to prepare for a pregnancy. If there is no pregnancy, the lining breaks down and is lost in **menstruation** (a period).

Hormone	Made by	Role
FSH (follicle-stimulating hormone)	pituitary gland	makes a **follicle** (an egg) develop in the ovary; stimulates the ovary to make oestrogen
oestrogen	ovary	makes the **uterus lining thicken**; stimulates the release of LH
LH (luteinising hormone)	pituitary gland	triggers **ovulation** (release of the egg), at about day 14
progesterone	ovary (the empty follicle)	**maintains** the lining of the uterus; inhibits FSH and LH

Note Academy

Early development

After fertilisation, the **zygote** divides to form a **ball of cells** (an **embryo**), which moves down the oviduct and becomes **implanted in the lining of the uterus**.

- The **amniotic sac** surrounds the embryo and contains **amniotic fluid**, which **protects the fetus** from knocks and **supports** it, and allows it to move.
- The **placenta** grows into the wall of the uterus and is joined to the fetus by the **umbilical cord**.

Functions of the placenta and umbilical cord. The **mother's blood and the fetus's blood** come close together but **do not mix**. Dissolved **nutrients (glucose, amino acids) and oxygen** diffuse from the mother's blood to the fetus's blood, and **excretory products** (urea) and **carbon dioxide** diffuse from the fetus to the mother's blood. The **umbilical cord** carries blood between the fetus and the placenta.

Some **viruses** (for example HIV and rubella) can pass across the placenta and affect the fetus. Harmful substances such as nicotine and alcohol can too.

> TRY IT
>
> State two features of a sperm cell that help it to fertilise an egg.

A **flagellum** (tail) for swimming, and **enzymes in the acrosome** to digest the jelly coat of the egg (also **many mitochondria** to release energy).

16.5 Sex hormones in humans

At **puberty** the sex hormones cause the **secondary sexual characteristics**.

- **Testosterone** is made in the **testes**. It causes deeper voice, facial and body hair, and muscle growth in boys.
- **Oestrogen** is made in the **ovaries**. It causes breast development and wider hips in girls, and it is involved in the **menstrual cycle**.
- **Progesterone** keeps the **lining of the uterus** thick and ready for a fertilised egg.

> **Testosterone and oestrogen are sex hormones. They are released into the blood and act on target organs, just like other hormones.**

16.6 Sexually transmitted infections

A **sexually transmitted infection (STI)** is an infection that is passed on during **sexual contact**. **HIV** is the example to know: it is a **virus** that infects and destroys white blood cells, so the immune system weakens. It can lead to **AIDS**.

Note Academy

HIV is passed on by **sexual contact**, by **blood** (for example shared needles) and from mother to baby. It is **not** spread by touching, sharing food or insect bites.

> **The spread of an STI can be controlled by using a condom, by having fewer partners, by not sharing needles and by testing and treating infections.**

Note Academy