# Cambridge (CIE) IGCSE Biology

Your notes

## Reproduction in Plants & Humans

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- Asexual Reproduction
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- Sexual Hormones in Humans
- Sexually Transmitted Infections



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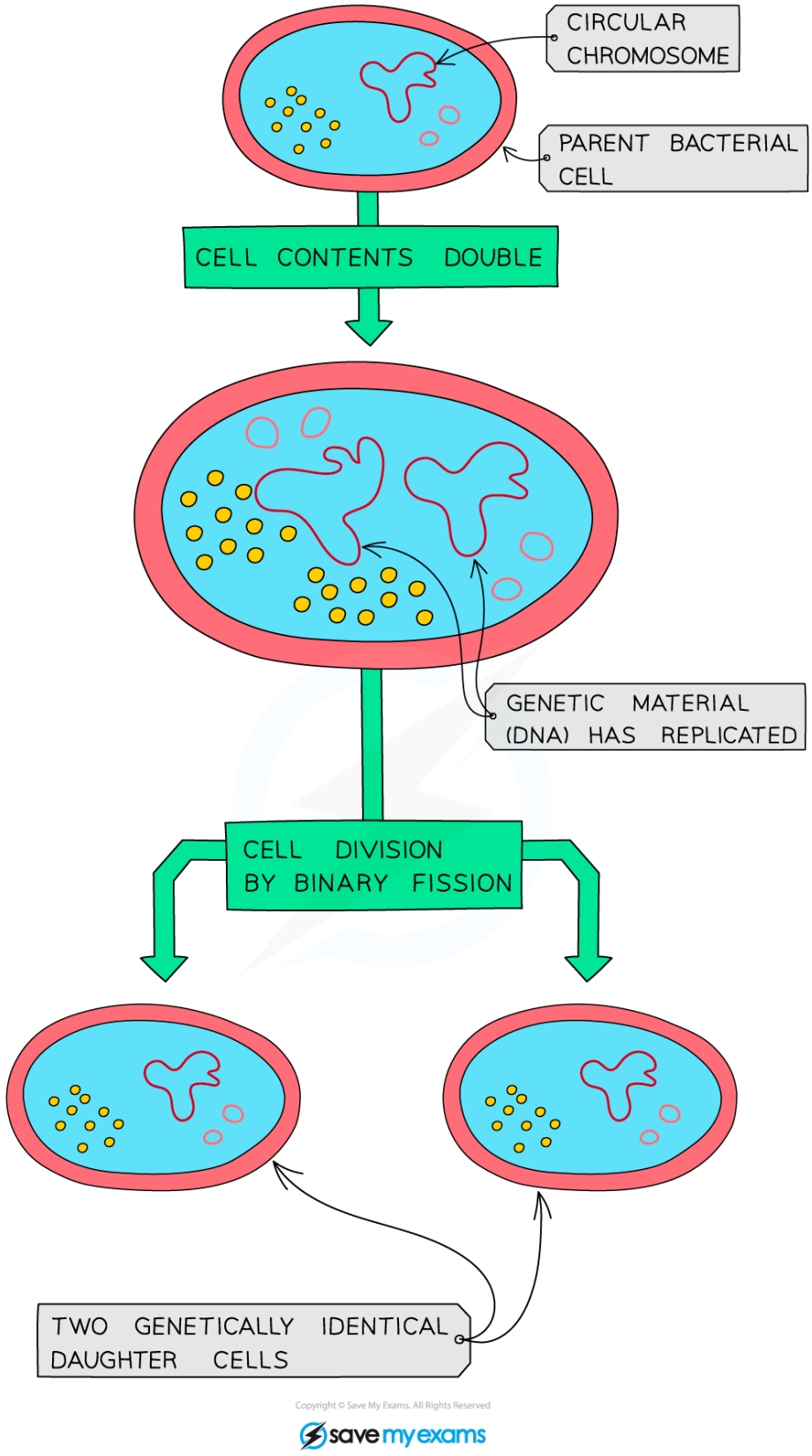
# Asexual reproduction

- Asexual reproduction does not involve sex cells or fertilisation
- **Only one parent is required** so there is no fusion of gametes and no mixing of genetic information
- As a result, the offspring are **genetically identical to the parent and to each other** (clones)
- Asexual reproduction is defined as **a process resulting in genetically identical offspring from one parent**

# Examples of asexual reproduction

- Bacteria produce exact genetic copies of themselves in a type of asexual reproduction called binary fission
- Binary fission produces two genetically identical daughter cells from the division of one parent bacterial cell


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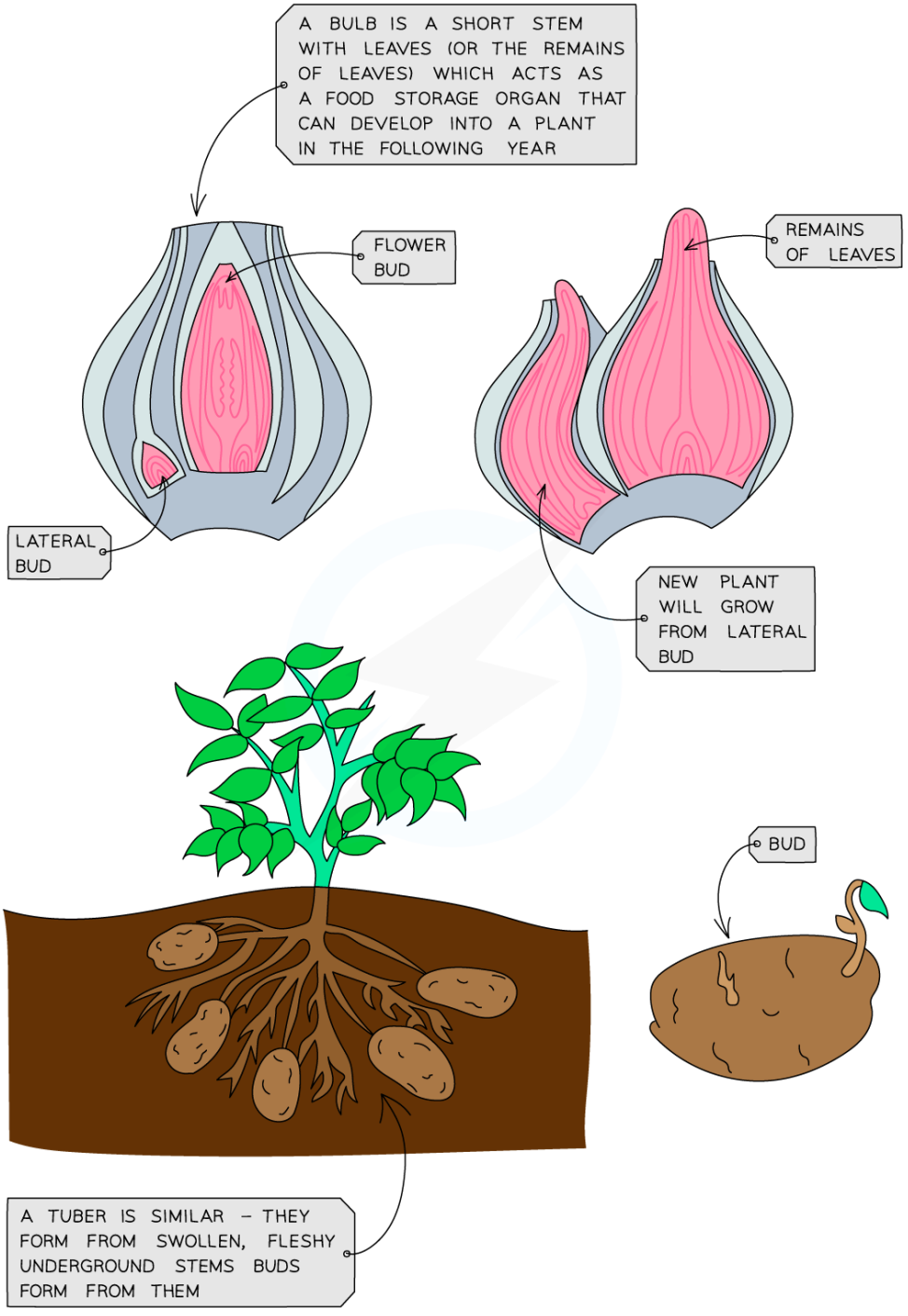



*Bacteria produce exact genetic copies of themselves in a type of asexual reproduction called binary fission*

Your notes

- Plants can reproduce asexually using bulbs and tubers; these are food storage organs from which budding can occur, producing new plants which are genetically identical to the parent plant:

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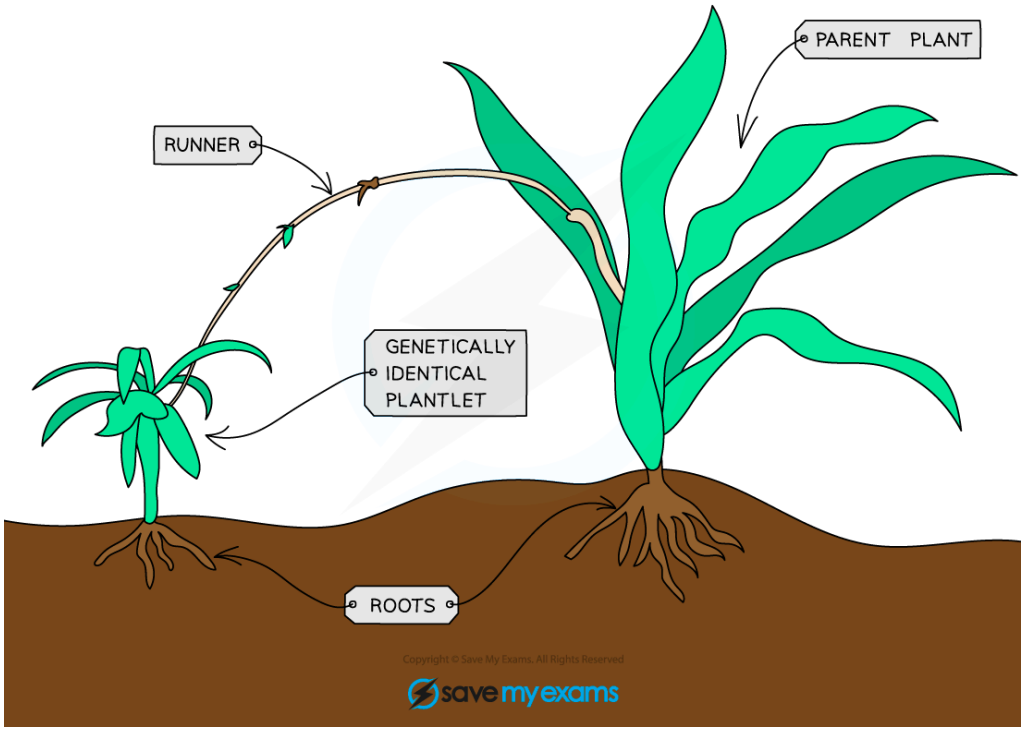
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***Some plants develop underground food storage organs that will develop into next year's plants – they can take different forms, such as bulbs or tubers***

- Some plants grow side shoots called runners that contain tiny plantlets on them

- Strawberry plants reproduce asexually in this way
- The plantlets grow roots and develop into separate plants, which are genetically identical to the parent plant

Your notes




*Some plants grow side shoots called runners that contain tiny plantlets on them. These will grow roots and develop into separate plants.*

# Advantages & disadvantages of asexual reproduction: Extended

| Species Type | Advantages | Disadvantages |
|---|---|---|
| Wild species | Rapid population growth | Limited genetic variation in population - offspring are genetically identical to their parents |
| | Can exploit suitable environments quickly | Vulnerability to habitat changes e.g. temperature changes, droughts or new predators |
| | More time and energy-efficient | Disease is likely to affect the whole population as there is no genetic variation |

| | | |
|---|---|---|
| | Reproduction is completed much faster than sexual reproduction | No recombination of genes means evolution is slow |
| Crop plants | Crops can be produced with desired characteristics e.g. high yield, disease-resistant, drought resistant | Crops will not adapt to changes in climate if produced asexually |
| | Crops can be produced with uniform characteristics necessary for commercial sale | The process of asexual reproduction in crops requires human input and management |
| | Production of crops can be faster | If a diseased parent plant is used in the reproduction process, the offspring will also be diseased |
| | The cost of production will be less than investing in seeds | Vulnerability to disease or pests may result in big financial losses for the farmer |



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# Gametes & zygotes

## Sexual reproduction

- Sexual reproduction is **a process involving the fusion of the nuclei of two gametes (sex cells) to form a zygote (fertilised egg cell) and the production of offspring that are genetically different from each other**
- Fertilisation is defined as the **fusion of gamete nuclei**, and as each gamete comes from a different parent, there is variation in the offspring

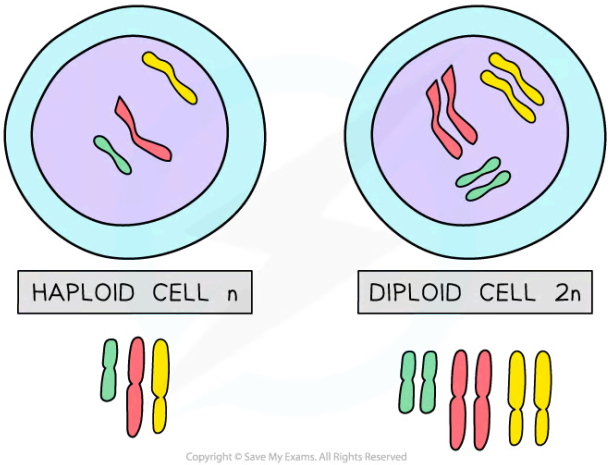
## Gametes

- A **gamete** is a sex cell (in animals: sperm and ovum; in plants pollen nucleus and ovum)
- Gametes differ from normal cells as they contain **half the number of chromosomes** found in other body cells - we say they have a **haploid nucleus**
- This is because they only contain **one copy of each chromosome**, rather than the two copies found in other body cells
- In human beings, a normal body cell contains **46 chromosomes** but each gamete contains **23 chromosomes**
- When the male and female gametes fuse, they become a **zygote** (fertilised egg cell)
- This contains the full **46 chromosomes**, half of which came from the father and half from the mother - we say the zygote has a **diploid nucleus**

# Haploid & diploid cells: Extended

- The nuclei of gametes are **haploid**
  - A haploid nucleus contain half the number of chromosomes of a normal body cell
  - In humans, a haploid cell has **23** chromosomes
- The nucleus of a zygote is **diploid**
  - A diploid nucleus contains the same number of chromosomes as a normal body cell
  - In humans, this is **23 pairs** of chromosomes
  - The zygote continues to stay diploid as it grows into a foetus and embryo during pregnancy


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*Haploid cells contain half the number of chromosomes as a diploid cell*

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# Advantages & disadvantages of sexual reproduction: Extended

- **Advantages of sexual reproduction**:
  - increases genetic variation within a population
  - this variation gives the population a better chance of adapting to a changing environment
  - a population with more variation is less likely to be wiped out entirely by a single disease, since some individuals may be resistant
- **Disadvantages of sexual reproduction**:
  - finding a mate costs time and energy
  - individuals that are isolated from others may struggle to find a mate at all
- Many crop plants reproduce sexually:
  - This is an advantage as it means **variation is increased** and a genetic variant may be produced which is better able to cope with weather changes, or produces significantly higher yield
  - The disadvantage is that the variation may lead to offspring that are **less successful** than the parent plant at growing well or producing a good harvest



Your notes

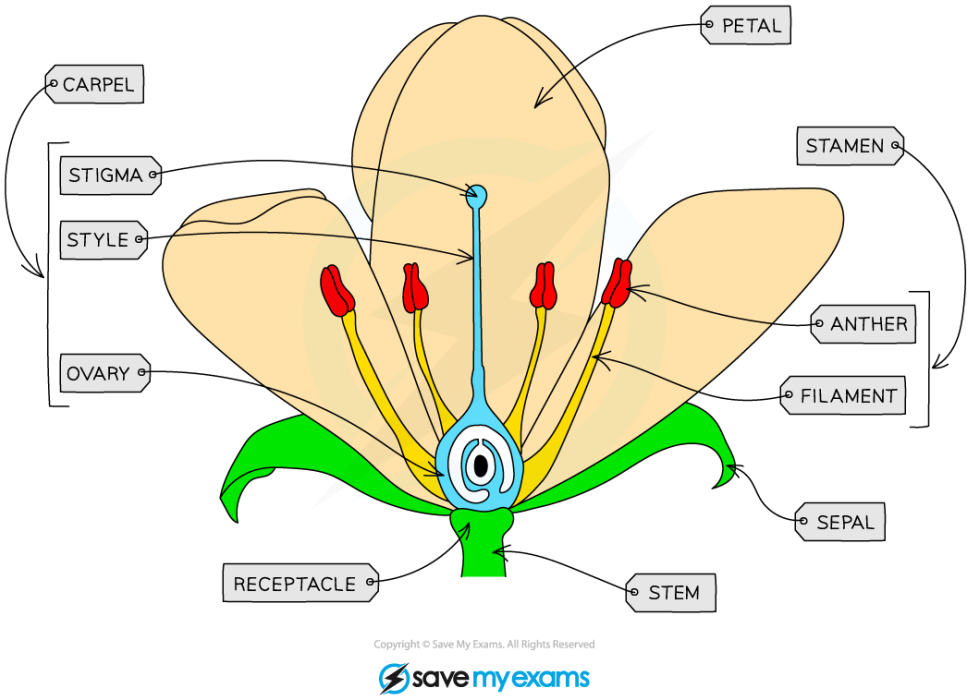
# Insect pollinated flowers

- Flowers are the **reproductive organs** of plants
- The role of flowers is to enable plant sex cells, or gametes to come together in **fertilisation**
  - The male gametes of plants are found in **pollen** grains
  - The female gametes of plants are in **ovules**
- The process by which pollen is transferred from the male part of a flower to the female part of a flower is known as **pollination**; this can be carried out in various ways, e.g. by insects or by wind

## Insect pollinated flower structure

- The most well known flower structure is that of the **insect pollinated flower**
- The parts of an insect pollinated flower include:
  - sepals
  - petals
  - stamens
  - filaments
  - anthers
  - carpel
  - style
  - stigma
  - ovary
  - ovules
- Insect pollinated flowers are adapted to **allow insects to collect pollen** from the male parts of the flower and easily **transfer it to the female parts** of another flower


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*Insect pollinated flowers are adapted to attract insects and aid insect pollination*

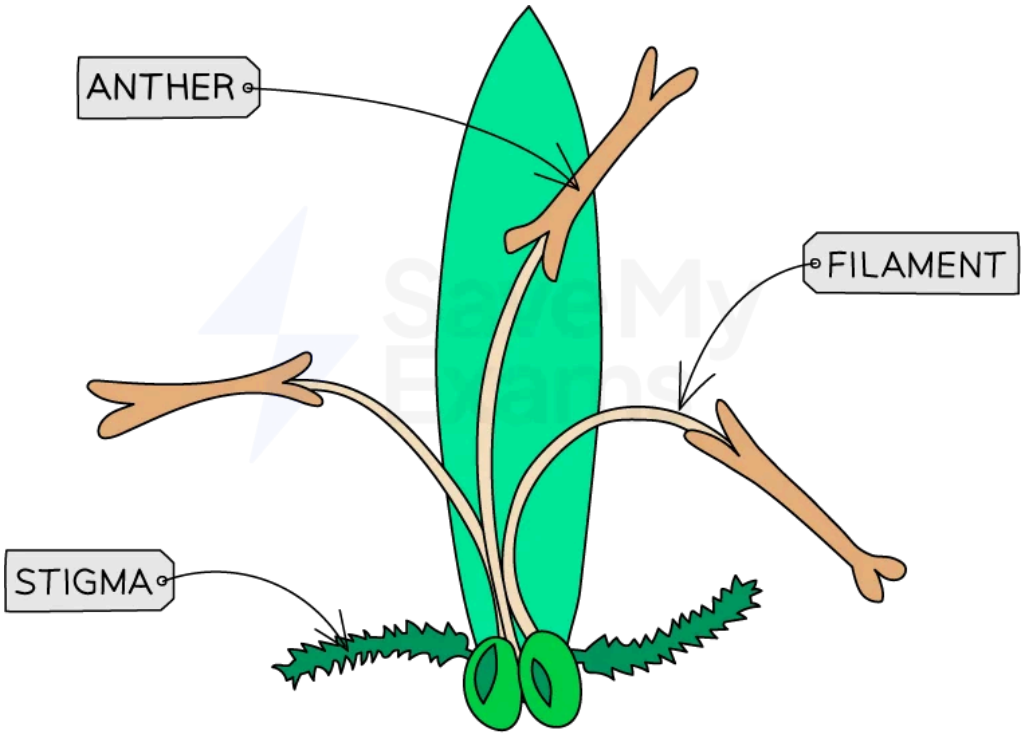
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## Flower structure and function table

| Structure | Description |
|---|---|
| Sepal | Protects unopened flower |
| Petals | Brightly coloured in insect-pollinated flowers to attract insects |
| Anther | Produces and releases pollen |
| Filaments | Provides support to the anther |
| Stigma | Sticky top of the female part of the flower which collects pollen grains |
| Style | A tube that connects the stigma and ovary |
| Ovary | Contains the ovules |
| Ovule | Structures inside the ovary that contain the female gametes |

# Wind pollinated flowers

- Wind pollinated flowers are adapted so that wind can easily catch pollen grains and carry them to the stigmas of other flowers
- The anthers and stigmas of wind pollinated flowers **hang outside the flower** so that:
  - pollen can easily be blown away by the wind
  - pollen can easily be caught by the stigmas of other flowers



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*Wind pollinated flowers have anthers that hang outside the flower on long filaments, and feathery stigmas that can catch pollen easily*

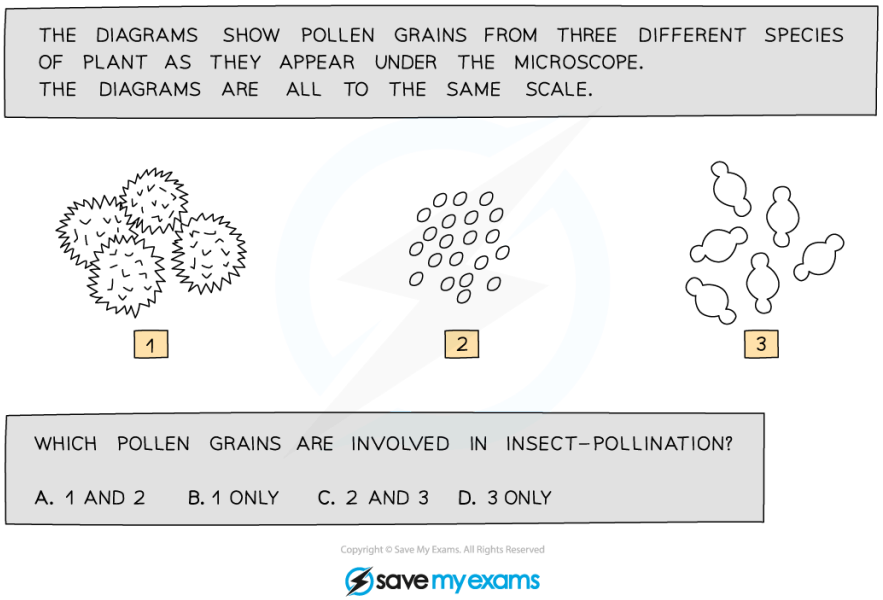
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# Pollination & fertilisation

## Pollen and pollination

- The pollen of different types of flower is adapted to aid pollination:
  - Insect-pollinated flowers produce **larger, heavier pollen grains** that often contain **spikes or hooks** on the outside so they are better able to stick to insects
  - Wind-pollinated flowers produce **small, lightweight pollen grains** that can be caught and carried easily by the wind

**Worked Example**




**Observe the features of the different pollen grains**

1. The pollen grains are large and have spikes around the outside
2. The pollen grains are small and smooth
3. The pollen grains are medium-sized and have wing-like structures on each side

**Consider how each feature may relate to the pollination method**

1. Large pollen grains are likely to be too heavy to be picked up by the wind, and spikes will mean that they can catch onto the bodies of insects
2. Small pollen grains will be light enough to be carried by the wind
3. Wing-like structures will catch the wind easily

**Answer:**

- **B** 1 only

# Pollination in insect and wind pollinated flowers

- Insect and wind pollinated flowers have structural adaptations which aid pollination:

## Structural adaptations of an insect pollinated flower table

| Feature | Insect pollinated flower |
|---|---|
| **Petals** | Large and brightly coloured to attract insects |
| **Scent and nectar** | Scent and nectar are produced to encourage insects to visit the flower and push past stamen to get to nectar |
| **Anthers** | Held on stiff filaments within the flower so that they brush against insects |

Your notes

| | |
|---|---|
| **Stigma** | Sticky stigmas within the flowers catch pollen grains when insects brush past |



Your notes

## Structural adaptations of a wind pollinated flower table

| **Feature** | **Wind pollinated flower** |
|---|---|
| **Petals** | Small and dull, often green or brown in colour |
| **Scent and nectar** | Scent and nectar are not produced; this would be a waste of energy |
| **Anthers** | Held on long filaments outside the flower to release pollen grains easily into the wind |
| **Stigma** | Feathery stigmas outside the flower catch airborne pollen grains |

# Pollination and fertilisation

- Pollination can be defined as:

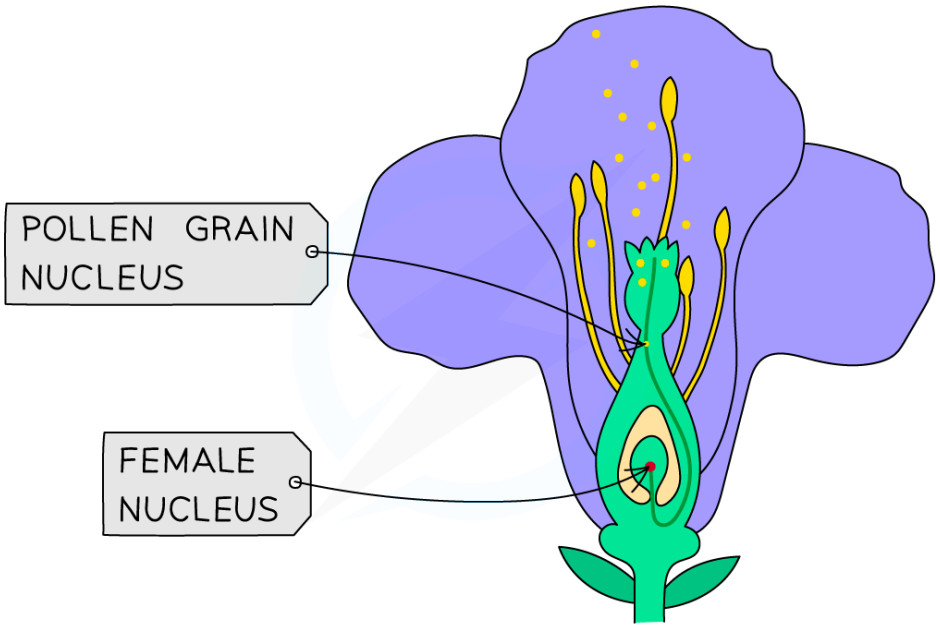
**The transfer of pollen grains from an anther to a stigma**

- This is distinct from fertilisation, which is:

**The fusion of a pollen nucleus with an ovum nucleus**

- After pollination, the pollen nuclei travel to the ovule and fuse with female gametes in a process called fertilisation


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*Pollen nuclei travel down a pollen tube in order to fuse with the female gametes inside the ovule; this is fertilisation*

### Examiner Tips and Tricks

It is easy to get confused between pollination and fertilisation in plants; remember that they are not the same thing!

- Pollination is the **transfer of pollen**
- Fertilisation is the **fusion of gametes**

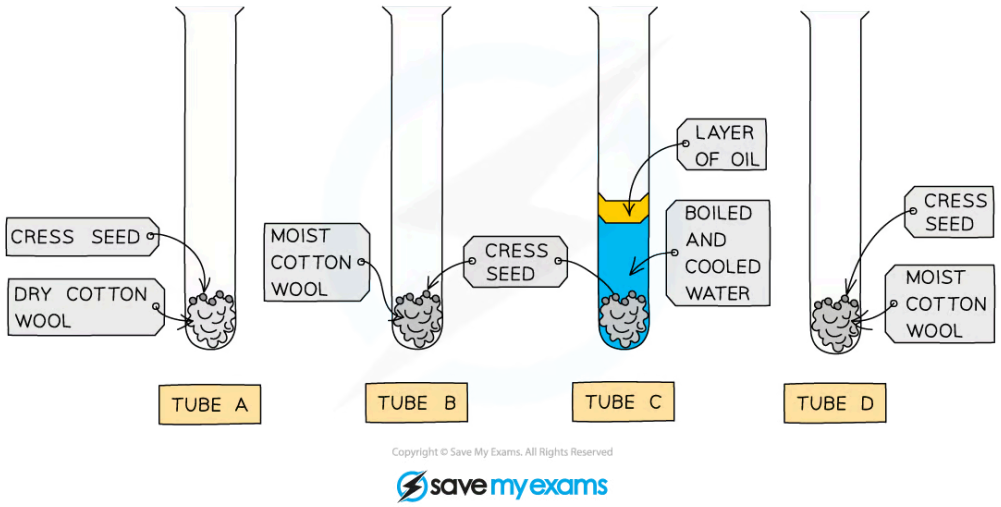
# Factors affecting germination of seeds

- **Germination** is the **start of growth in the seed**
- Three factors are required for successful germination:
  - **water** - allows the seed to swell up and the enzymes in the embryo to start working so that growth can occur
  - **oxygen** - so that energy can be released for germination
  - **warmth** - germination improves as temperature rises (up to a maximum) as the reactions which take place are controlled by enzymes
- As carbon dioxide is not necessary for germination but also does not inhibit it, it makes no difference whether it is present or not

## Investigating Germination

Your notes

- Set up 4 boiling tubes each containing 10 cress seeds on cotton wool
- Set each test tube as shown in diagram below
- Leave tubes in set environment for a period of time: A, B and C incubated at 20°C; D placed in a fridge at 4°C
- Compare results and see which tube has the greatest number of germinated seeds




*An investigation into the conditions required for germination of seedlings*

### Conditions required for germination results table

| Test tube | Factor being tested | Seeds germinated |
|---|---|---|
| A | Water / moisture | No |
| B | Control (all factors present) | Yes |
| C | Oxygen | No |
| D | Warm temperature | No |

- The results of this experiment prove that **all three factors are required** for the successful germination of the seeds and if any one factor is missing the seeds cannot germinate

# Self- & cross-pollination: Extended

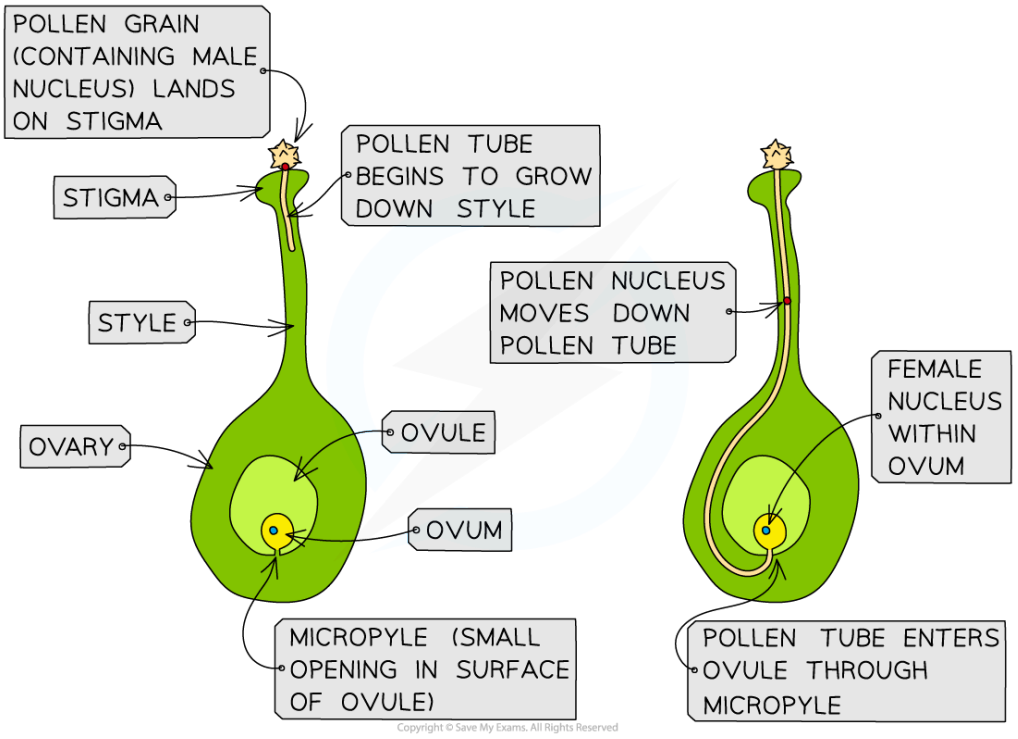
- Cross-pollination occurs when the **pollen from one plant** is transferred to the stigma of **another plant of the same species**
- This is the way most plants carry out pollination as it **improves genetic variation**

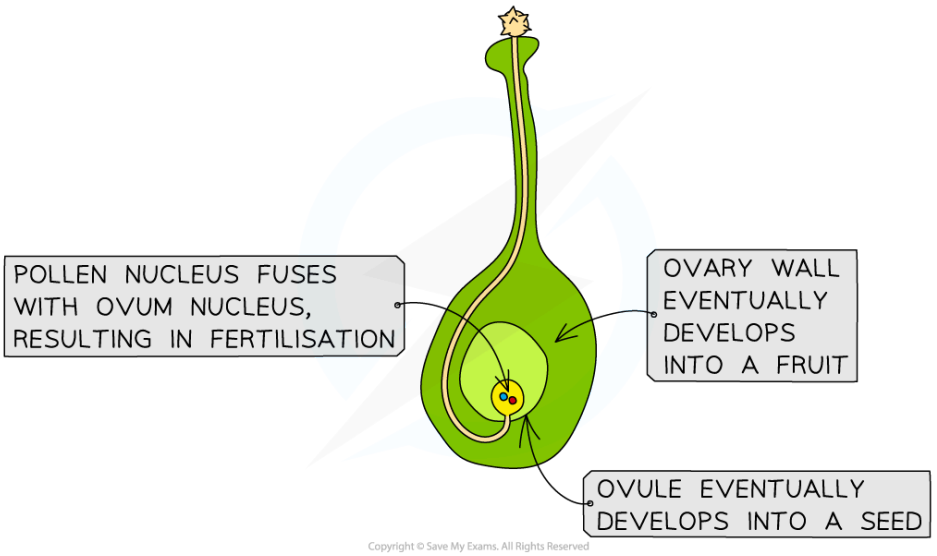
- Occasionally, the pollen from a flower can **land on its own stigma** or on the **stigma of another flower on the same plant** - this is known as self-pollination
- Self-pollination **reduces genetic variety of the offspring** as all the gametes come from the same parent (and are therefore genetically identical)
- Lack of variation in the offspring is a disadvantage if environmental conditions change, as it is **less likely that any offspring will have adaptations that suit the new conditions** well
- On the other hand, cross-pollination relies completely on the presence of **pollinators** and this can be a problem if those pollinators are **missing** (e.g. the reduction in **bee** numbers is of great importance to humans as bees pollinate a large number of food crops) - this doesn't apply to wind-pollinated plants

Your notes

## Pollen tube formation

- After pollination, the following sequence of events take place:
  - A **pollen tube** grows from the pollen grain down the style until it reaches the ovary
  - **Nuclei from pollen** travel down the tube
  - The nuclei enter the ovule and fuse with the nucleus of the female gamete (fertilisation)
  - After fertilisation the **ovules develop into seeds and the ovary develops into a fruit**






*Growth of the pollen tube and its entry into the ovule followed by fertilisation*

Your notes

## Examiner Tips and Tricks

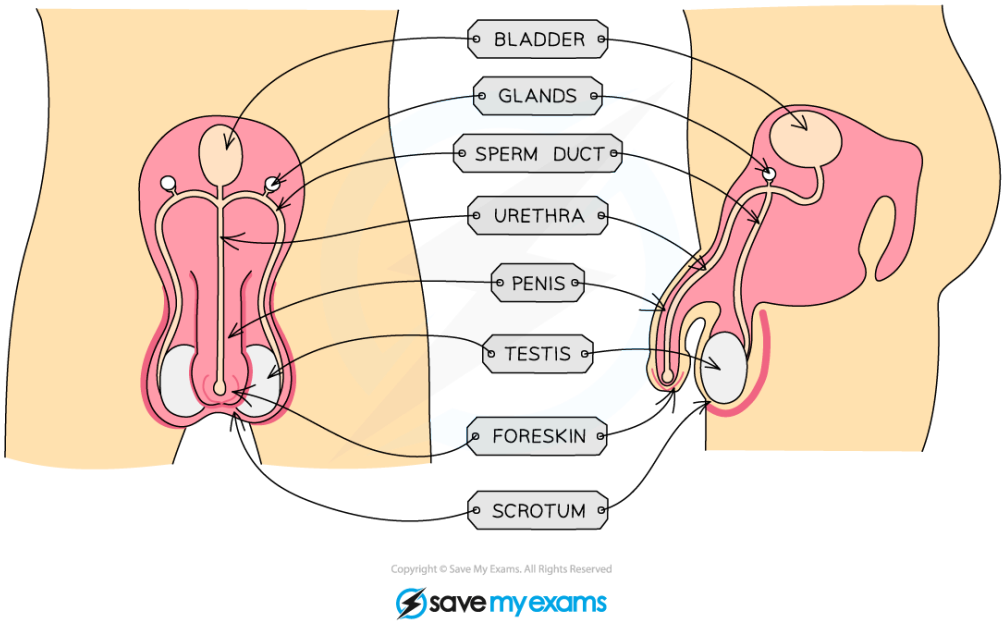
Remember that it is the **nucleus** of the pollen grain that travels down the pollen tube in the style for fertilisation and not the pollen grain itself. Make sure to be specific with your use of key words!

Your notes

# The male reproductive system

## Structures of the male reproductive system

- The male reproductive system has several key organs and structures




*The male reproductive system*

- The structure and function of these components can be seen in the table below

| Structure | Function |
|---|---|
| Prostate gland | Produces a fluid that mixes with sperm cells to form semen |
| Sperm duct | Sperm passes through the sperm duct to be mixed with fluids produced by the glands before being passed into the urethra for ejaculation |
| Urethra | Tube running down the centre of the penis that can carry out urine or semen, a ring of muscle in the urethra prevents the urine and semen from mixing |
| Testis | Contained within a bag of skin (scrotum) and produces sperm (male gamete) and testosterone hormone |


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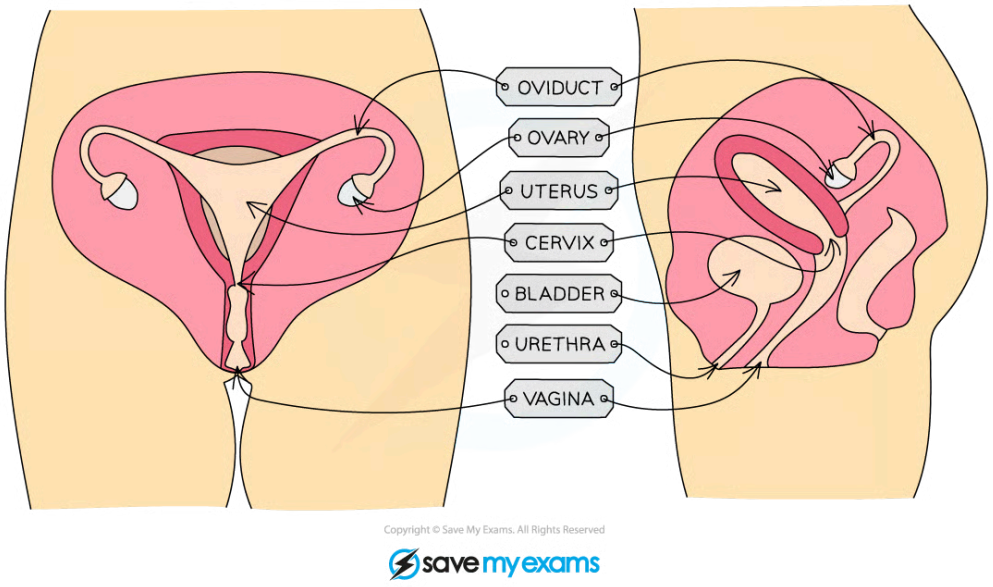
| | |
|---|---|
| Scrotum | Sac supporting the testes outside the body to ensure that sperm are kept at a temperature slightly lower than body temperature |
| Penis | Passes urine out of the body from the bladder and allows semen to pass into the vagina of a woman during sexual intercourse |

Your notes

# The female reproductive system

## Structures of the female reproductive system

- The female reproductive system has several key organs and structures




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*The female reproductive system*

- The structure and function of these components can be seen in the table below

| Structure | Function |
|---|---|
| Oviduct | Connects the ovary to the uterus and is lined with ciliated cells to push the released ovum down it. Fertilisation occurs here |
| Ovary | Contains ova (female gametes) which will mature and develop when hormones are released |
| Uterus | Muscular bag with a soft lining where the fertilised egg (zygote) will be implanted to develop into a foetus |
| Cervix | Ring of muscle at the lower end of the uterus to keep the developing foetus in place during pregnancy |

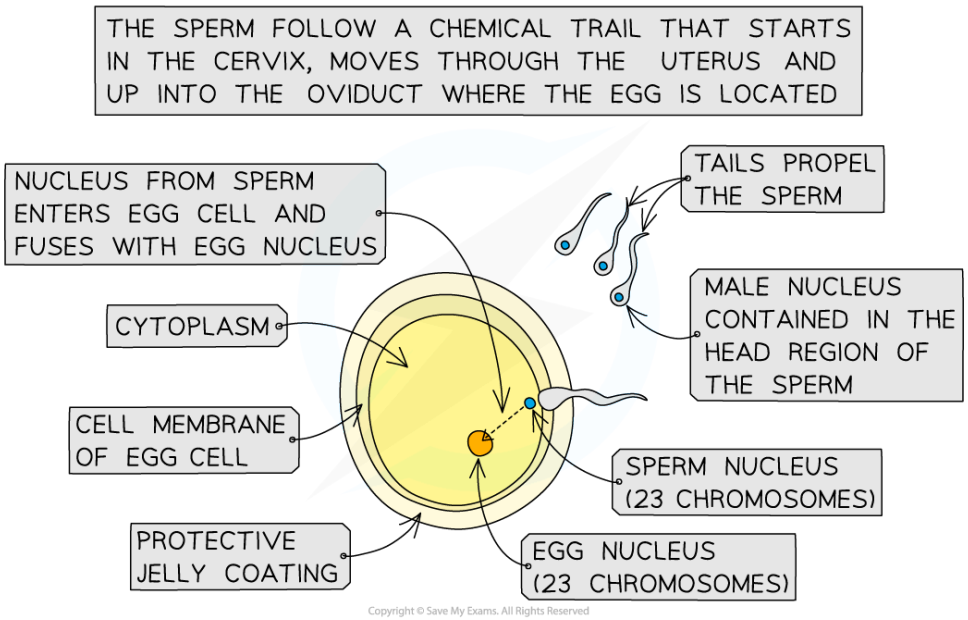
| | |
|---|---|
| Vagina | The muscular tube that leads to the inside of the woman's body where the male's penis will enter during sexual intercourse and sperm are deposited |

Your notes

# Gametes & fertilisation

## What is fertilisation?

- Fertilisation is the **fusion of the nuclei from a male gamete (sperm cell) and a female gamete (egg cell)**
- Fertilisation occurs in the **oviducts**
- Gametes have **adaptations** to increase the chances of fertilisation and successful development of an embryo

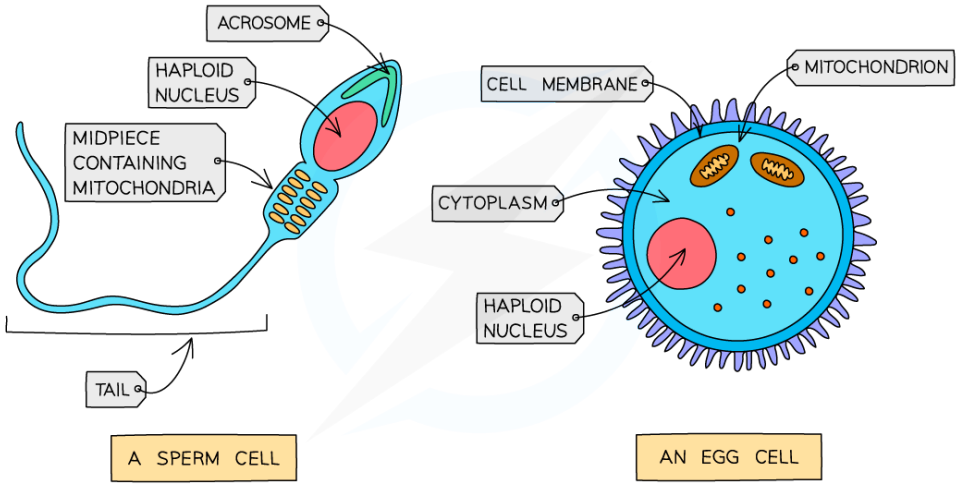



*The sperm enters the egg cell during fertilisation which usually occurs in the oviduct*

# Adaptations of gametes

## Human gametes

- The human gametes are the **egg** and the **sperm** cells




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*Comparing sperm and egg cells*

## Adaptive features of the gametes

- The gametes are **highly specialised cells** with adaptive features designed to maximise the chances of successful reproduction
- These **adaptive features** are compared in the table below

| Gamete | Adaptive feature | Function |
|---|---|---|
| Sperm | Has a flagellum (tail) | Allows the sperm to swim towards the egg |
| | Contains **enzymes** in the head region (acrosome) | To digest a route into the egg for fertilisation |
| | Contains many mitochondria | To provide energy for movement of the flagellum |
| Egg | Cytoplasm contains a store of energy | To provide energy for cell division in the developing zygote after fertilisation |
| | Jelly-like coating that changes after fertilisation | To make an impenetrable barrier after fertilisation to prevent more sperm entering the egg |

## Comparison of male and female gametes

| Comparative Feature | Sperm | Egg |
|---|---|---|

Your notes

| | | |
|---|---|---|
| Size | Very small (45 μm) | Large (0.15 mm) |
| Structure | Head region, flagellum, many structural adaptations | Round cell with few structure adaptations, covered in a jelly coating |
| Motility | Capable of locomotion | Not capable of locomotion |
| Numbers | Produced every day in huge numbers (around 100 million per day) | Thousands of immature eggs in each ovary, but only one is released each month |

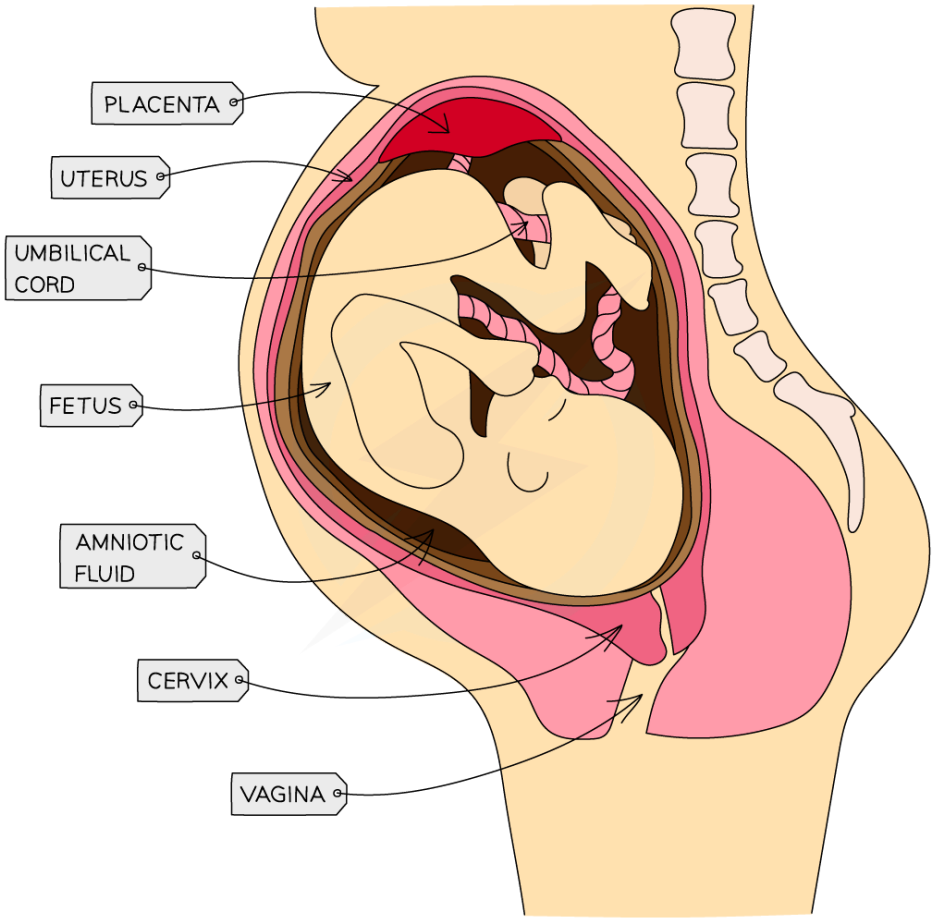


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# Pregnancy: growth & development of the fetus

- After fertilisation in the **oviduct**, the zygote travels towards the **uterus**
- After fertilisation, the zygote travels along the oviduct towards the uterus, **dividing repeatedly** to form a ball of cells called an **embryo**
- In the uterus, the embryo embeds itself in the thick lining (**implantation**) and continues to grow and develop
- The gestation period for humans is **9 months:**
  - major **development of organs** takes place within the **first 12 weeks**, during which time the embryo gets nutrients from the mother by **diffusion through the uterus lining**
  - after this point the organs are all in place, the **placenta** has formed and the embryo is now called a **foetus**
  - the remaining gestation time is used by the foetus to **grow bigger in size**
- The foetus is surrounded by an **amniotic sac** which contains **amniotic fluid** (made from the mother's blood plasma)
- Amniotic fluid protects the foetus during development by **cushioning it from bumps** to the mother's abdomen
- The **umbilical cord** joins the foetus's blood supply to the **placenta** for exchange of nutrients and removal of waste products


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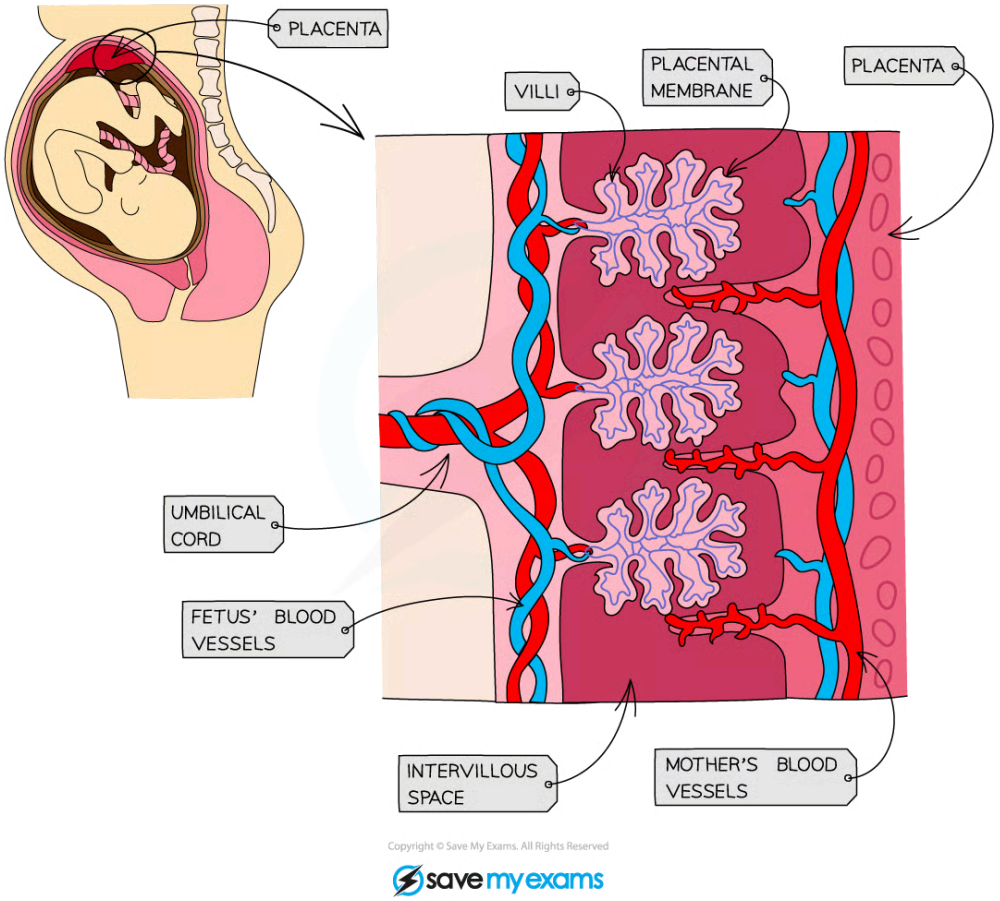

*The foetus in the uterus*

Your notes

# The placenta & umbilical cord: extended

## What are the placenta and the umbilical cord?

- During the gestation period the foetus develops and grows by gaining the **glucose, amino acids, fats**, **water** and **oxygen** it needs from the mother's blood
- The bloods run opposite each other, never mixing, in the **placenta**
- The foetus's blood connects to and from the placenta by the **umbilical cord**
- The mother's blood also absorbs the **waste** from the foetus's blood in the placenta; substances like **carbon dioxide** and **urea** are removed from the foetus's blood so that they do not build up to dangerous levels
- Movement of all molecules across the placenta occurs by **diffusion** due to **difference in concentration gradients**
- The placenta is adapted for this diffusion by having a **large surface area** and a **thin wall** for efficient diffusion




*The placenta*

Your notes

## Toxins and pathogens

- The placenta acts as a **barrier** to prevent toxins and pathogens getting into the foetus's blood
- Not all **toxin molecules** or **pathogenic organisms** (such as **viruses**, eg **rubella**) are stopped from passing through the placenta (this usually depends on the size of the molecule)
- This is why pregnant women are advised **not to smoke during pregnancy** as molecules like **nicotine** can pass across the placenta

### Examiner Tips and Tricks

It is worth learning at least two specific substances that move in either direction across the placenta – this is a common exam question and non-specific answers such as 'waste products' and 'nutrients' will not get any marks!


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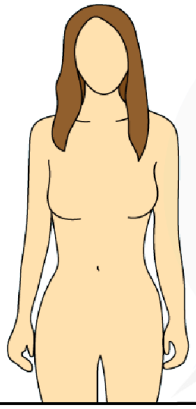
# Secondary sexual characteristics

- Secondary sexual characteristics are the **changes that occur during puberty** as children become adolescents
  - Primary sexual characteristics are present during development in the uterus and are the differences in reproductive organs between males and females
- They are controlled by the release of hormones - **oestrogen** in girls and **testosterone** in boys

## Human secondary sexual characteristics

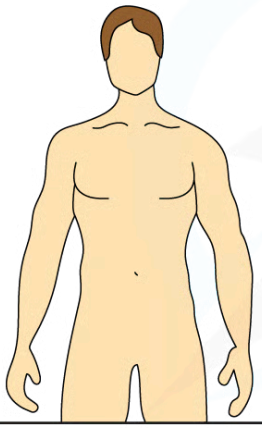
- Some changes occur to both boys and girls, including **growth of sexual organs** and **growth of body hair**
- **Emotional changes** also occur due to the increased levels of hormones in the body
- These include more interest in sex and increased mood swings

### Female secondary sexual characteristics

| FEMALE | EFFECTS OF OESTROGEN |
| --- | --- |
|  | BREASTS DEVELOP |
| | BODY HAIR GROWS |
| | MENSTRUAL CYCLE BEGINS |
| | HIPS GET WIDER |

### Male secondary sexual characteristics


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| MALE | EFFECTS OF TESTOSTERONE |
| --- | --- |
|  | GROWTH OF PENIS AND TESTES |
| | GROWTH OF FACIAL AND BODY HAIR |
| | MUSCLES DEVELOP |
| | VOICE BREAKS |
| | TESTES START TO PRODUCE SPERM |
| | |

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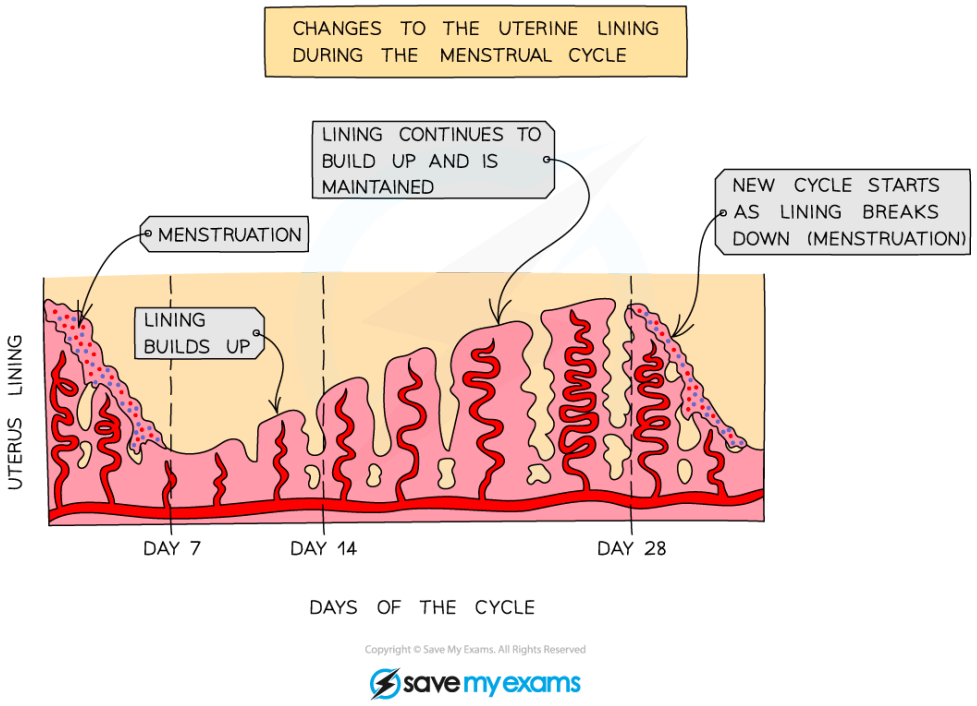
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Your notes

# The menstrual cycle

- Starts in early adolescence in girls (around age **12**) and is controlled by **hormones**
- The average menstrual cycle is **28 days** long
- **Ovulation** (the release of an egg) occurs about **halfway** through the cycle (day **14**) and the egg then travels down the oviduct to the uterus
- Failure to fertilise the egg causes **menstruation** (commonly called a period) to occur - this is caused by the **breakdown of the thickened lining of the uterus**
- Menstruation lasts around **5 – 7 days** and signals the beginning of the next cycle

  After menstruation finishes, the lining of the uterus starts to thicken again in preparation for possible implantation in the next cycle




*Changes in the lining of the uterus during the menstrual cycle*

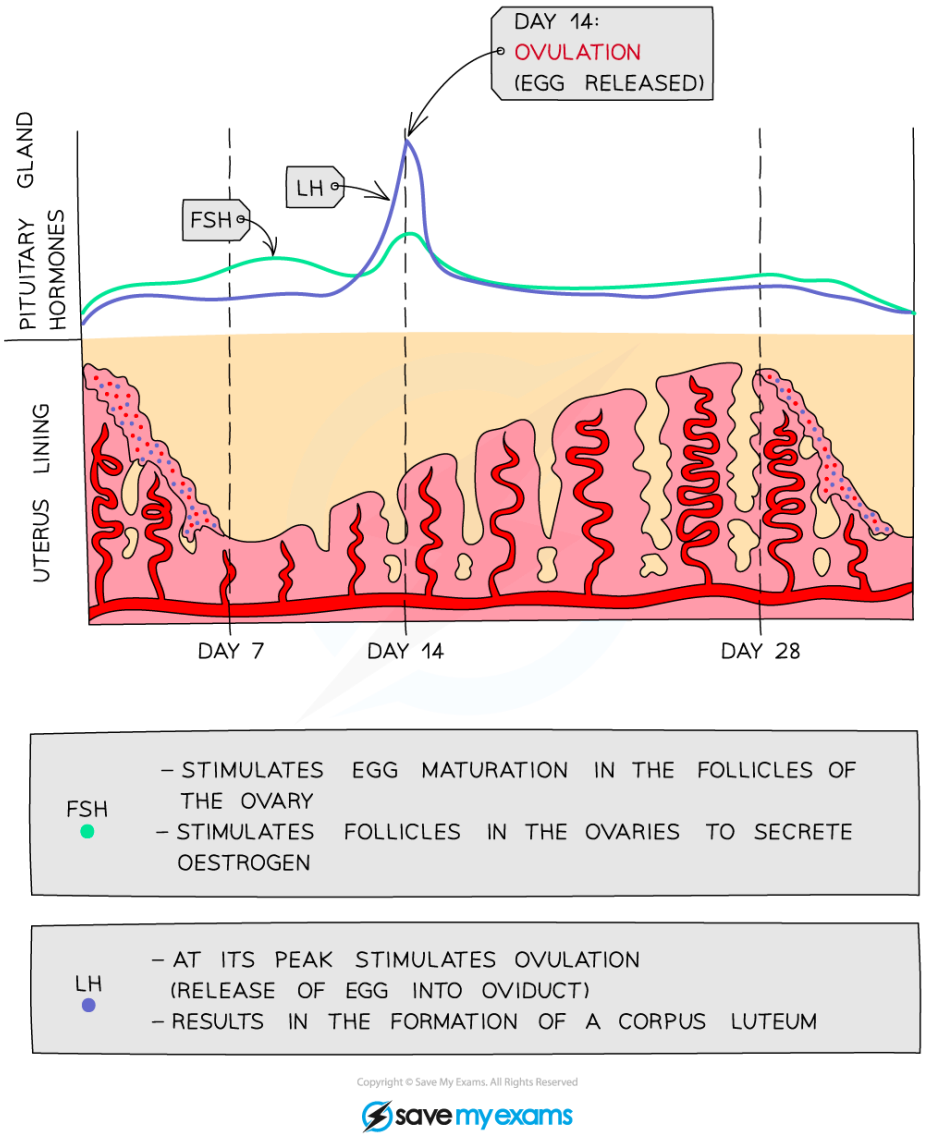
*Changes in the lining of the uterus during the menstrual cycle*

# Hormones of the menstrual cycle: Extended

- The menstrual cycle is controlled by hormones released from the **ovary** and the **pituitary gland** in the brain

## The roles of FSH and LH

- **FSH** (**f**ollicle-**s**timulating **h**ormone) is released by the **pituitary gland** and causes an **egg to start maturing** in the ovary
- It also **stimulates the ovaries** to start releasing **oestrogen**
- The **pituitary gland** is stimulated to release **l**uteinising **h**ormone (**LH**) when **oestrogen** levels have reached their peak
- **LH** causes **ovulation to occur** and also **stimulates the ovary** to produce **progesterone**

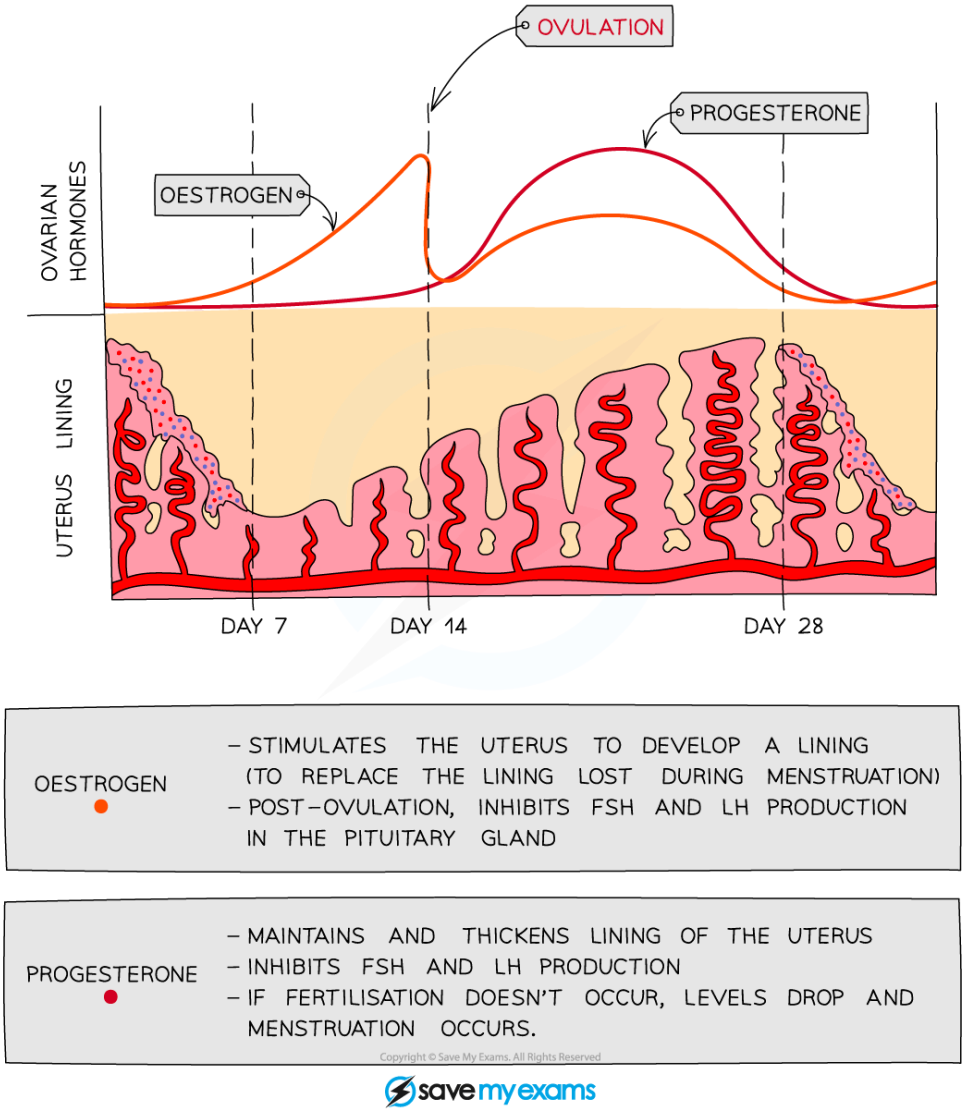



*Changes in the levels of the pituitary hormones FSH and LH in the blood during the menstrual cycle*

## The roles of oestrogen and progesterone

- **Oestrogen** levels rise from day 1 to peak just before **day 14**
- This causes the **uterine wall to start thickening** and the **egg to mature**
- The peak in oestrogen occurs just before the egg is released
- **Progesterone** stays low from day 1 – 14 and starts to rise once ovulation has occurred
- The increasing levels **cause the uterine lining to thicken further**; a fall in progesterone levels causes the uterine lining to break down (**menstruation / 'period'**)

Your notes

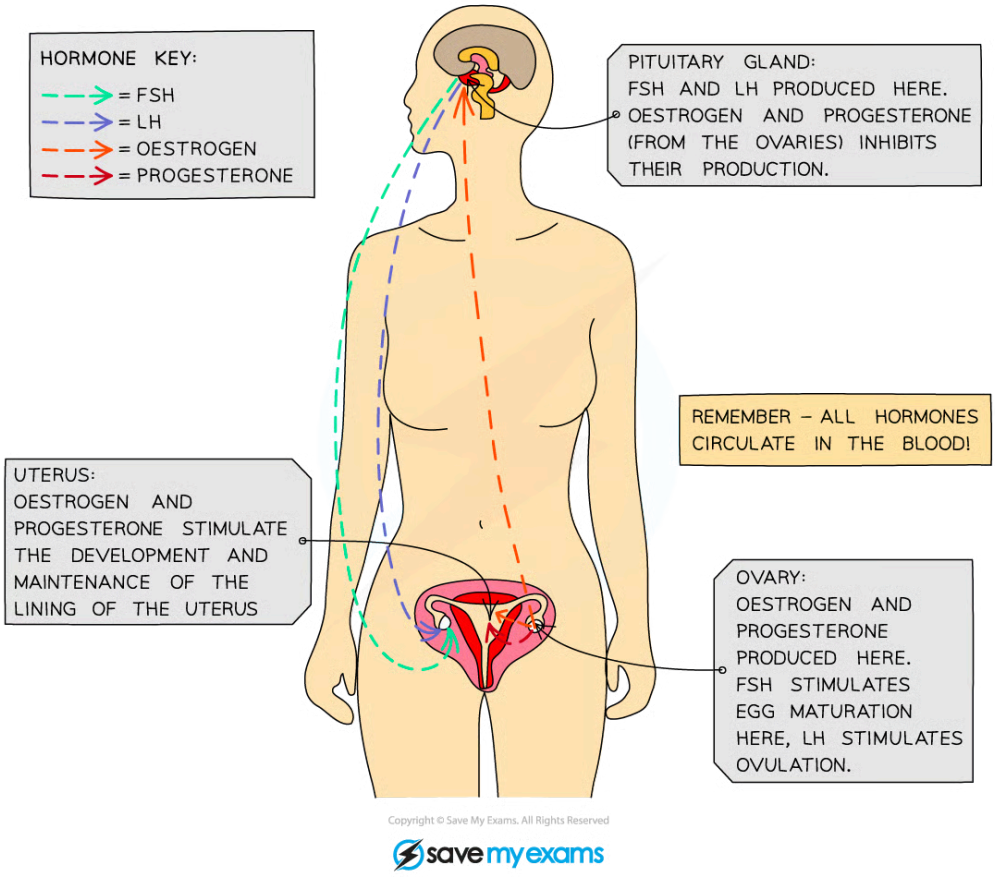



*Changes in the levels of oestrogen and progesterone in the blood during the menstrual cycle*

## Interaction between all four of the menstrual cycle hormones

- The pituitary gland produces **FSH** which stimulates the development of a **follicle** in the ovary
- An egg develops inside the follicle and the follicle produces the hormone **oestrogen**
- Oestrogen causes **growth and repair of the lining of the uterus wall** and inhibits production of **FSH**
- When oestrogen rises to a high enough level it stimulates the release of **LH** from the pituitary gland which causes **ovulation** (usually around day 14 of the cycle)
- The follicle becomes the **corpus luteum** and starts producing **progesterone**

- Progesterone **maintains the uterus lining** (the thickness of the uterus wall)
- If the ovum is not fertilised, the corpus luteum breaks down and progesterone levels drop
- This causes **menstruation**, where the uterus lining breaks down and is removed through the vagina - commonly known as having a period
- If pregnancy does occur the corpus luteum **continues to produce progesterone**, preventing the uterus lining from breaking down and **aborting** the pregnancy
- It does this until the **placenta** has developed, at which point it starts secreting progesterone and **continues to do so throughout the pregnancy**




*Where hormones involved in the menstrual cycle are made and act*

Your notes



Your notes

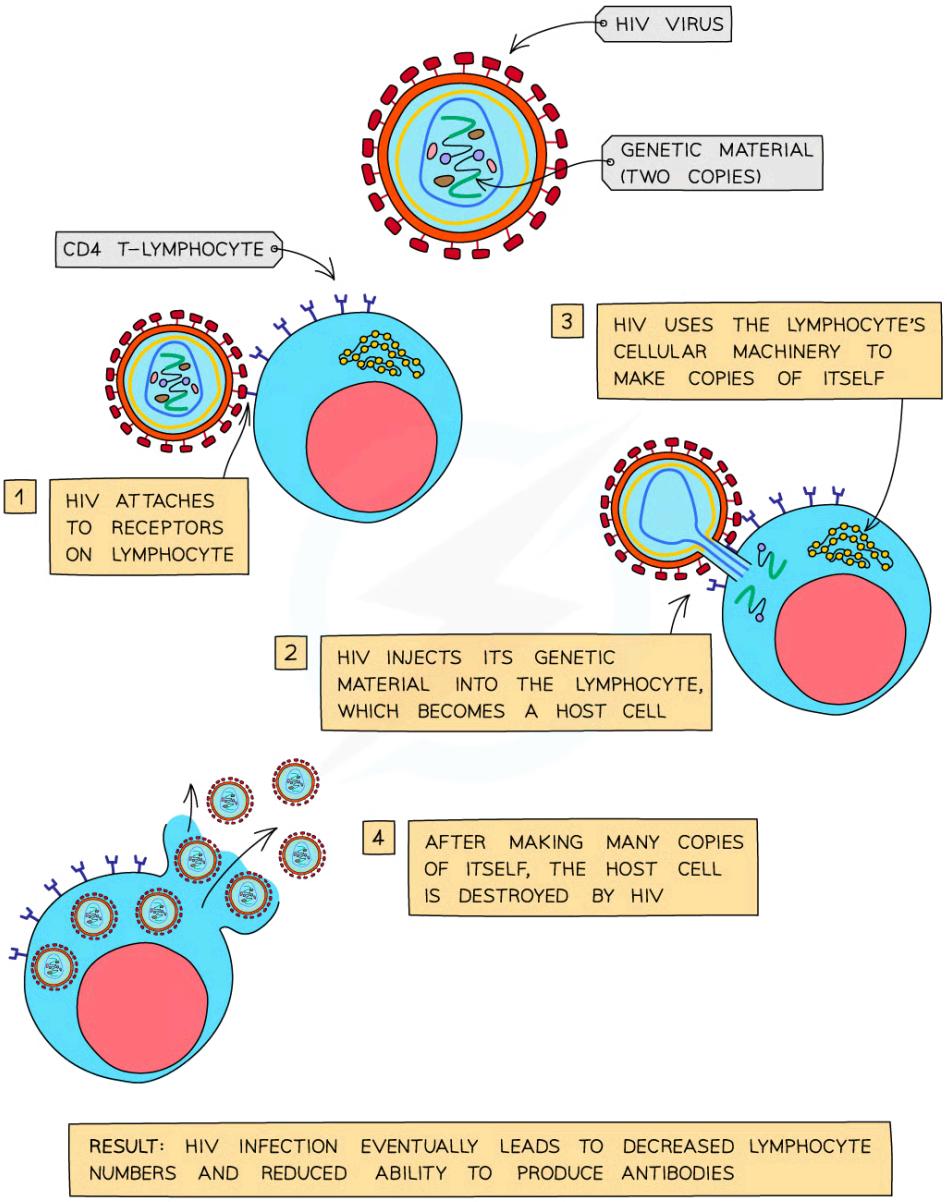
# STIs & HIV/AIDS

- Unprotected sexual intercourse can lead to the transfer of pathogens via exchange of body fluids
- Infections passed on in this way are known as sexually transmitted infections (STIs)
- An example of an STI is **HIV** (**H**uman **I**mmunodeficiency **V**irus), the virus that usually leads to the development of **acquired immunodeficiency disease** (**AIDS**)
- HIV can also be spread via sharing needles with an infected person, blood transfusions with infected blood and from mother to foetus through the placenta and mother to baby via breastfeeding

# How HIV affects the immune system

- Immediately after infection, people often suffer **mild flu-like symptoms**
- These symptoms pass and for a period of time **infected people might not know they are infected**
- The virus infects a certain type of **lymphocyte** of the body's immune system
- Normally lymphocytes **seek out and destroy pathogens** that enter the body, producing antibodies that attach to pathogens, enhancing phagocytic activity
- However HIV avoids being recognised and destroyed by lymphocytes by repeatedly **changing its protein coat**
- It then infects a certain type of lymphocyte and **uses the cells' machinery to multiply**
- This **reduces the number of lymphocytes** of the immune system, and also **the number of antibodies** that can be made
- This decreases the body's ability to fight off infections, eventually leading to **AIDS (Acquired immunodeficiency)**


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*How HIV infects lymphocytes*

# Controlling the spread of STIs

- The spread of STIs such as HIV are best controlled by:
  - **limiting the number of sexual partners** an individual has
  - **not having unprotected sex**, but making sure to always use a **condom**
  - **getting tested** if unprotected sex or sex with multiple partners has occurred
  - raising awareness by **education programmes**