SL IB Biology

Your notes

Reproduction

Contents

Sexual & Asexual Reproduction

Your notes

Comparing Sexual & Asexual Reproduction

- **Sexual reproduction** involves **two parents** and is the fusion of the nuclei of two gameteto form a zygoteand the production of **offspring that are genetically different** from each other
  - 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**
- There are number advantages and disadvantages to an organism carrying out sexual reproduction

Advantages & disadvantages of sexual reproduction table

ADVANTAGES	DISADVANTAGES
INCREASES GENETIC VARIATION	TAKES TIME AND ENERGY TO FIND MATES
THE SPECIES CAN ADAPT TO NEW ENVIRONMENTS DUE TO VARIATION, GIVING THEM A SURVIVAL ADVANTAGE	DIFFICULT FOR ISOLATED MEMBERS OF THE SPECIES TO REPRODUCE
DISEASE IS LESS LIKELY TO AFFECT POPULATION (DUE TO VARIATION)	

- **Asexual reproduction**
  - Asexual reproduction does **not** involve **gametes** 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** (they are clones)
  - Many **plants** reproduce via asexual reproduction
  - **Bacteria** produce exact genetic copies of themselves in a type of asexual reproduction called **binary fission**

Your notes

- There are a number of advantages and disadvantages to an organism carrying out asexual reproduction

Advantages & disadvantages of asexual reproduction table

ADVANTAGES	DISADVANTAGES
POPULATION CAN BE INCREASED RAPIDLY WHEN CONDITIONS ARE RIGHT	LIMITED GENETIC VARIATION IN POPULATION – OFFSPRING ARE GENETICALLY IDENTICAL TO THEIR PARENTS
CAN EXPLOIT SUITABLE ENVIRONMENTS QUICKLY	POPULATION IS VULNERABLE TO CHANGES IN CONDITIONS AND MAY ONLY BE SUITED FOR ONE HABITAT
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	

- The key differences between sexual and asexual reproduction include:
  - The **number of parent organisms**
  - **How** offspring are produced (the **type of cell division** required)
  - The **level of genetic similarity** between offspring
  - The possible **sources of genetic variation** in offspring
  - The **number of offspring** produced
  - The **time taken** to produce offspring

Comparing sexual & asexual reproduction table

Feature	Asexual Reproduction	Sexual Reproduction
Number of parent organisms	One	Two
Type of cell division required	Offspring are produced by mitosis	Offspring are produced from the fusion of two haploid gametes, which are produced by meiosis
Level of genetic similarity between offspring	Offspring are genetically identical to each other (and to the parent)	Offspring are geenetically unique (and genetically different from both parents)
Sources of genetic variation in offspring	Only one source: mutation	Three sources: the contribution of 50% of their DNA from each of the two parents, the production of gametes by meiosis (resulting in new combinations of alleles on the chromosomes), the random distribution of chromosomes into gametes during meiosis
Number of offspring produced	Usually relatively large numbers	Usually relatively limited numbers
Time taken to produce offspring	Usually relatively fast	Usually relatively slowly

Your notes

Sexual Reproduction

Your notes

Meiosis & Fertilisation in Sexual Reproduction

- Meiosis is a form of nuclear division that results in the **production of** haploid **cells from** diploid **cells**
- It produces **gametes** in plants and animals that are used in **sexual reproduction**
- It takes place in two successive divisions: **meiosis I** and **meiosis II**
- More information about meiosis can be found here
- During meiosis, **specific mechanisms occur to lead to genetic variation** within the resulting gametes, this breaks up parental combinations of alleles derived from the mother and father chromosomes
  - **Crossing over** - the process by which non-sister chromatids exchange alleles during meiosis I
  - **Independent assortment** - the production of **different combinations of alleles** in daughter cells due to the **random alignment of** homologous **pairs of chromosomes** during meiosis I
  - **Random fertilisation** - there are millions of combinations of sperm and egg cells and the fusion of these sperm and egg cell
- Within each division there are four stages; prophase, metaphase, anaphase and telophase
- Meiosis occurs:
  - In the **testes** of male animals and the **ovaries** of female animals
  - In the **anthers** and **ovaries** of flowering plants
- Meiosis leads to the production of the following haploid gametes:
  - **Spermatozoa,** or **sperm cells,** in male animals, **ova** (singular ovum) in female animals
  - Male plant gametes are carried in **pollen** grains and female plants gametes are held in the **ovules** within the plant ovary
- The **fusion of gametes during fertilisation** produces **new combinations of alleles** leading to genetic variation

Male & Female Differences in Sexual Reproduction

- The process of meiosis in males and females is identical, however the resulting gametes are very different
- This leads to a number of difference in the reproductive strategies in males and females

Comparison of male & female gametes table

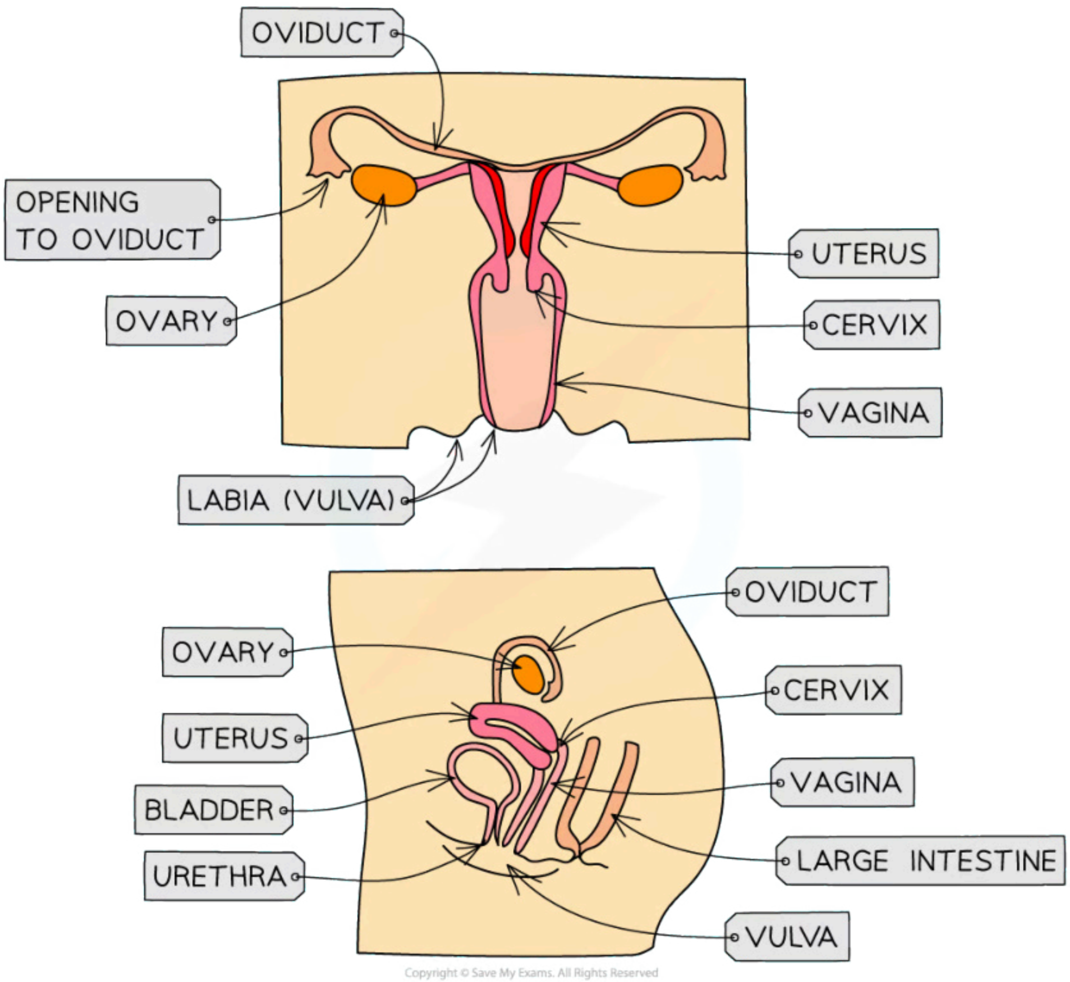
	SPERM	EGG
SIZE	VERY SMALL (45 µm)	LARGE (0.15 mm)
STRUCTURE	HEAD REGION AND FLAGELLUM, MANY STRUCTURAL ADAPTATIONS	ROUND CELL WITH FEW STRUCTURAL ADAPTATIONS, COVERED IN A JELLY COATING
MOTILITY	CAPABLE OF LOCOMOTION	NOT CAPABLE OF LOCOMOTION
NUMBERS	PRODUCED EVERY DAY IN HUGE NUMBERS (AROUND 100 MILLION PER DAY)	THOUSANDS OF IMMATURE EGGS IN EACH OVARY, BUT ONLY ONE RELEASED EACH MONTH

- The differences between male and female gametes, not just in humans, means that there are differences in the strategies developed for reproductive success
  - **Human females release only one egg cell** (per menstrual cycle) whereas a **male will release many thousands of sperm cells** per ejaculation, this is because the majority of which will not reach the egg cell (only one sperm cell can fertilise an egg cell)

Male & Female Reproductive Systems

- You should be able to **draw** and **annotate diagrams** of the female and male **reproductive systems** to identify the different **structures**
- You should also be able to recall the **function** of each of these structures

Female reproductive system diagrams



Front and side view of the female reproductive system

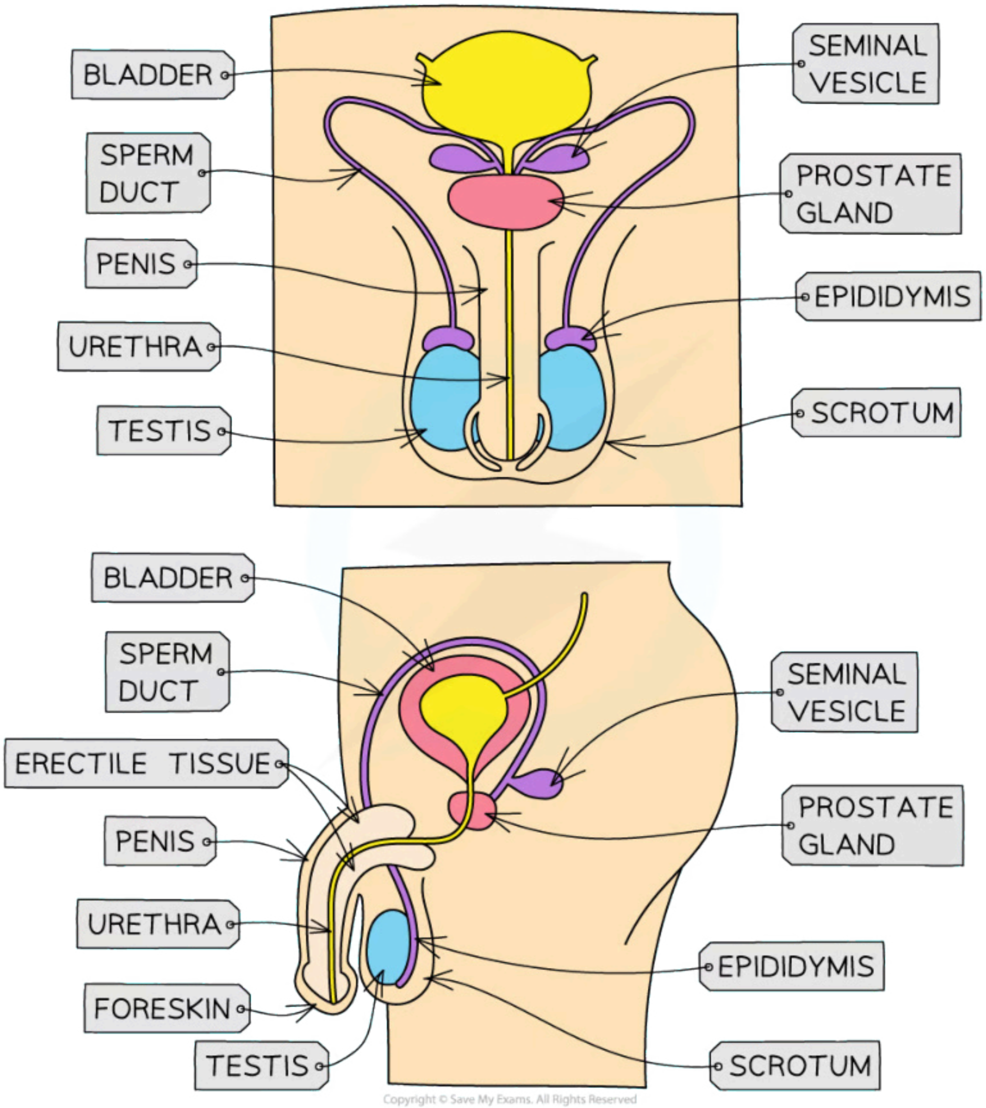
Female reproductive system table

Your notes

Your notes

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) willbe 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	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
Vulva	A collection of structures (including the pubic mound, labia, clitoris and hymen), one function of which is to protect the more internal parts of the female reproductive system

Male reproductive system diagram



Front and side view of the male reproductive system

Male reproductive system table

Structure	Function
Prostate gland and seminal vesicle	Produces fluid called semen that provide sperm cells with nutrients
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 carryout urine or semen, a ring of muscle in the urethra prevents the urine and semen from mixing
Testis	Contained in a bag of skin (scrotum) and produces sperm (male gamete) and testosterone (hormone)
Scrotum	Sac supporting the testes outside the body to ensure sperm are kept at 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
Epididymis	Coiled tubes that store sperm until ejaculation

Your notes

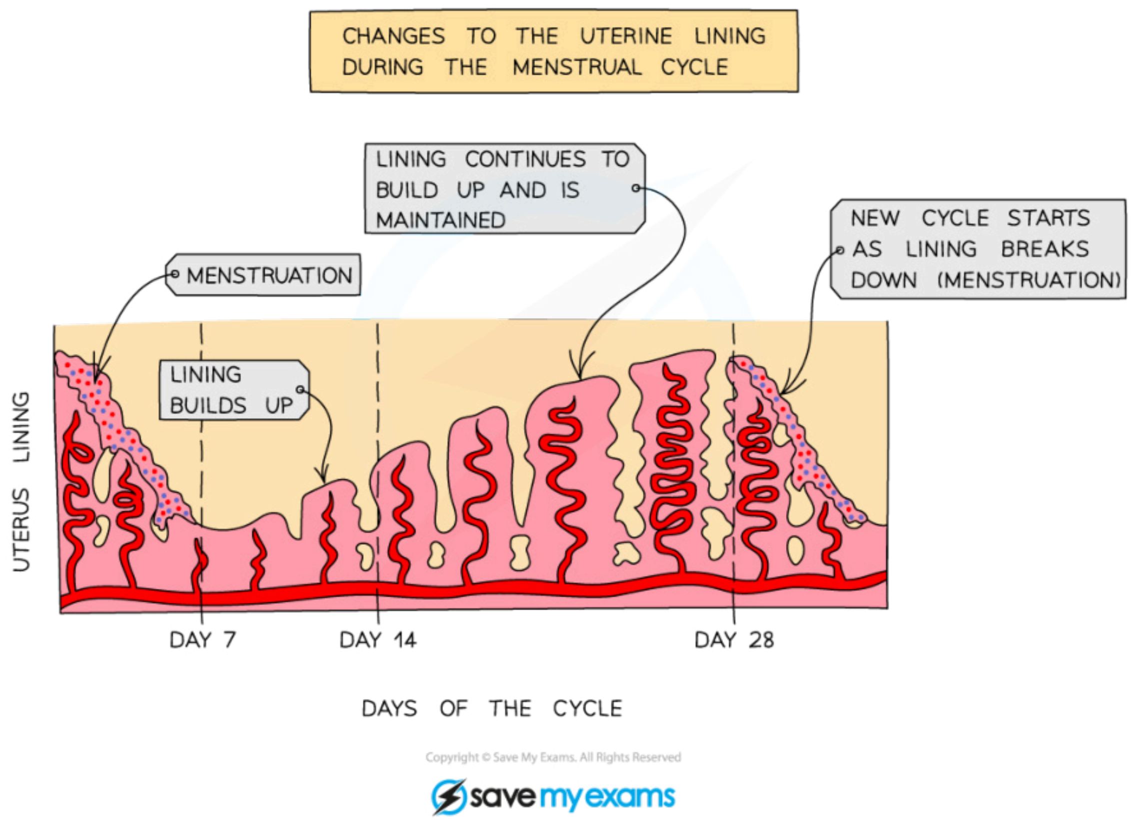
The Menstrual Cycle

The Menstrual Cycle

- The **menstrual cycle** is the series of changes that take place in the female body leading up to and following the release of an egg from the ovaries
  - It starts in early adolescence in girls and is controlled by **hormones**
  - The average menstrual cycle is **28 days** long
- The **uterus lining**, or **endometrium**, thickens from **day 7** through to **day 28** of the cycle in preparation for receiving a fertilised egg
- The release of an egg, or **ovulation**, occurs about **halfway** through the cycle on **day 14,** and the egg then travels down the oviduct to the uterus
  - Eggs develop inside fluid-filled sacs known as **egg follicles** inside the ovary
  - The follicle releases the egg at ovulation and becomes an empty follicle known as a **corpus luteum**
- Failure to fertilise the egg leads to **menstruation,** commonly known as a period
  - Menstruation involves the loss of menstrual blood via the vagina
  - This is caused by the **breakdown of the endometrium**
- Menstruation takes place roughly between **days 1–7** of the cycle
  - The number of days during which menstruation occurs can vary
- After menstruation finishes, the endometrium starts to **thicken again** in preparation for the **possible implantation** of a fertilised egg in the next cycle

The menstrual cycle diagram

Your notes



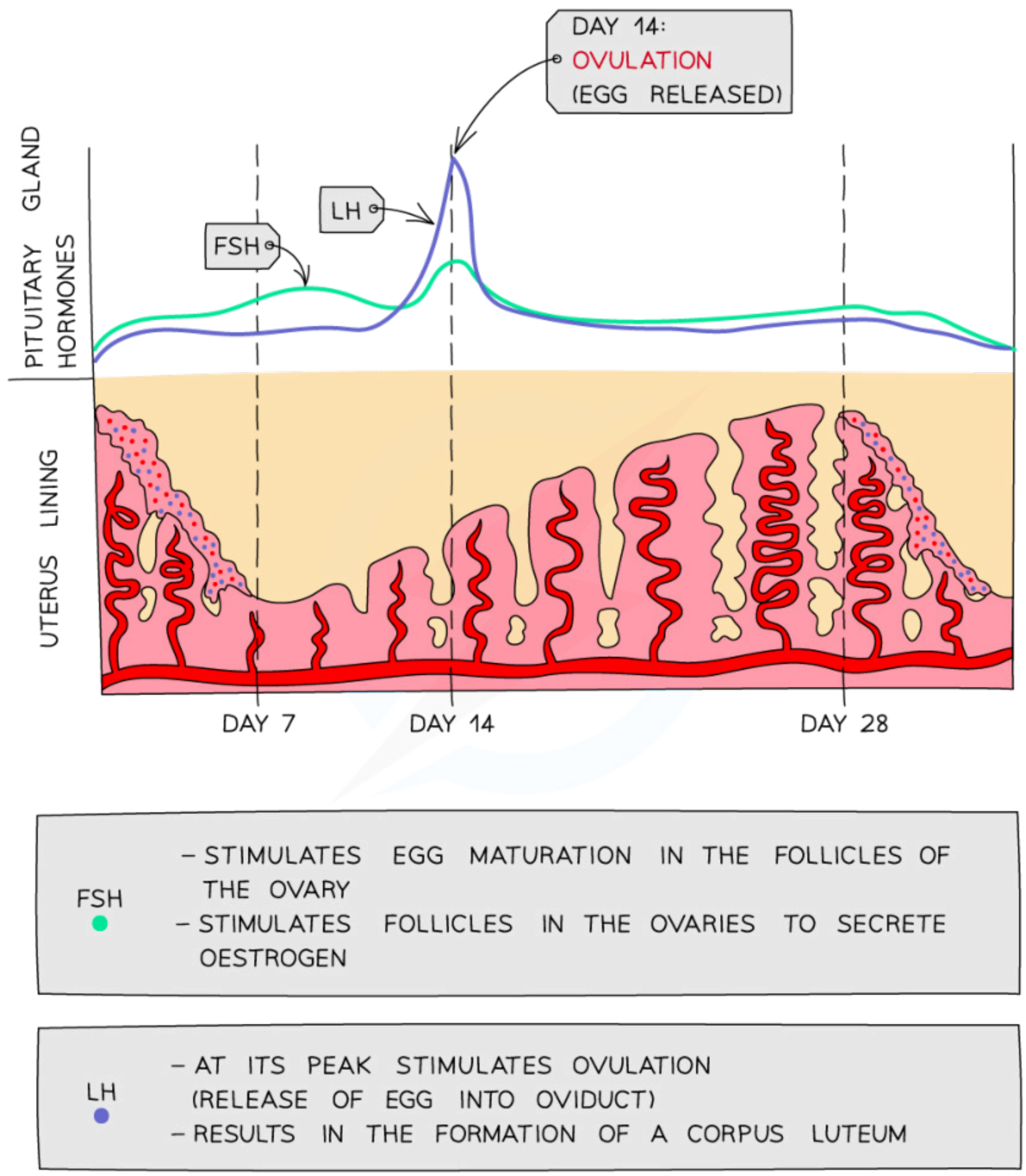
Changes in the endometrium during the menstrual cycle

How ovarian and pituitary hormones control the menstrual cycle

- **Four hormones** control the events that occur during the menstrual cycle:
  - Two of these hormones are produced by the **pituitary gland** in the brain
    - **F**ollicle-**s**timulating **h**ormone (**FSH**)
    - **L**uteinising **h**ormone (**LH**)
  - The other two hormones are produced in the **ovaries**
    - **Oestrogen** (also known as **oestradiol**)**;** produced by the **egg follicle,** and by the **corpus luteum** after ovulation
    - **Progesterone;** produced by the corpus luteum
  - The roles of FSH and LH:
    - FSH is secreted by the **pituitary gland** and stimulates the **development** of several immature **egg cells** in **follicles** in the **ovary**
    - FSH also stimulates the **secretion of oestrogen** by the **follicle wall**
    - The **pituitary gland** is stimulated to release LH when **oestrogen** levels have reached their **peak**
    - LH causes **ovulation to occur;** the shedding of the mature egg cell from the follicle and its release from the ovary

    - The shedding of the mature egg cell leaves behind an empty egg follicle called the corpus luteum
- LH also **stimulates** the production of **progesterone** from the corpus luteum

Diagram to show the impact of LH and FSH on the menstrual cycle



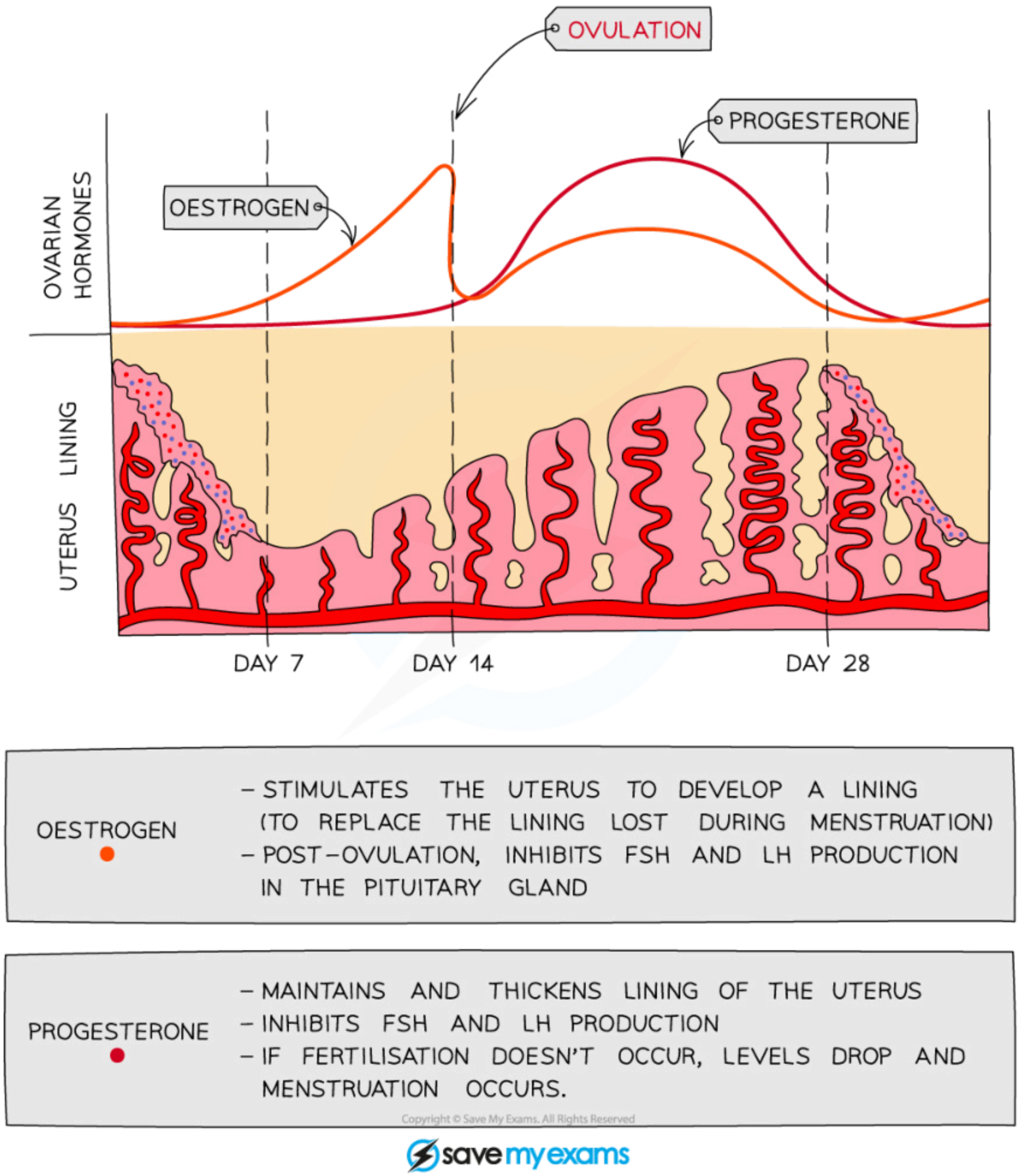
Changes in the levels of the pituitary hormones FSH and LH in the blood during the menstrual cycle

Your notes

- The roles of oestrogen (also known as oestradile) and progesterone:
  - **Oestrogen** levels rise from **day 1** to **peak** just before **day 14**
  - This causes the **endometrium** to start **thickening** and the egg cell 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
    - Progesterone is produced by the corpus luteum
  - The increasing levels of progesterone cause the endometrium to continue to thicken
  - A fall in progesterone levels as the corpus luteum deteriorates causes the endometrium to **break down**, resulting in **menstruation**

Diagram to show the impact of oestrogen and progesterone on the menstrual cycle

Your notes



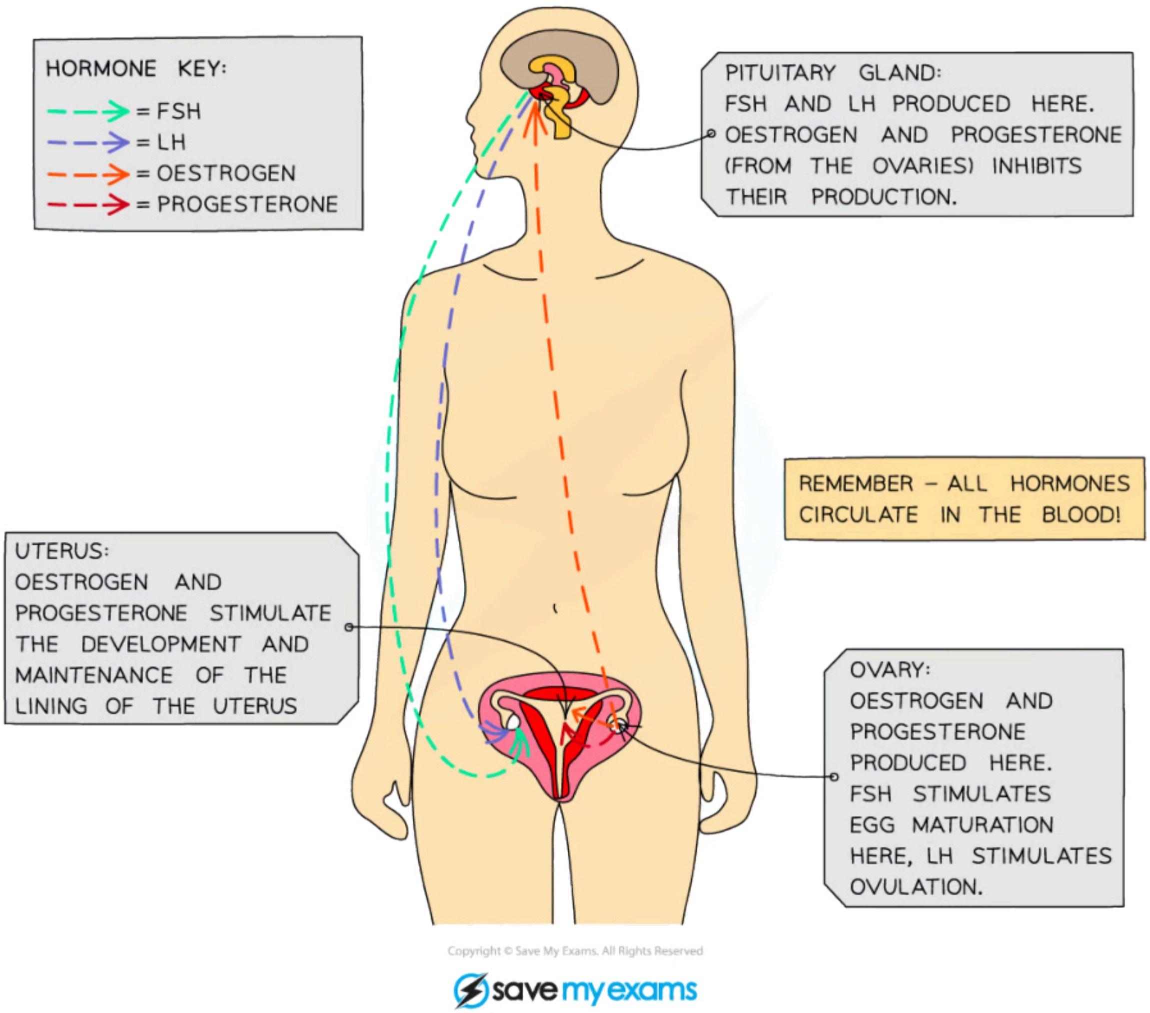
Changes in the levels of oestrogen and progesterone in the blood during the menstrual cycle

Negative and positive feedback mechanisms controlling the menstrual cycle

- The four hormones all **interact** to control the menstrual cycle via both negative and positive feedback

- FSH and oestrogen
  - FSH stimulates the development of a follicle, and the follicle wall produces the hormone oestrogen; it can be said that **FSH stimulates the production of oestrogen**
  - As well as causing growth and repair of the endometrium, oestrogen also causes an **increase in FSH receptors;** this makes the follicles **more receptive to FSH** which, in turn, **stimulates more oestrogen production**
    - This is **positive feedback**
  - When oestrogen levels are high enough, it **inhibits the secretion of FSH**
    - This is **negative feedback**
  - LH and oestrogen
    - When oestrogen rises to a high enough level, it **stimulates the release of LH** from the pituitary gland, causing ovulation on around day 14 of the cycle
    - After ovulation, **LH causes the wall of the follicle to develop into the corpus luteum,** which **secretes more oestrogen**
      - This is **positive feedback**
    - LH and progesterone
      - **LH** stimulates the wall of the follicle to develop into the **corpus luteum,** which **secretes progesterone**
      - Progesterone thickens and maintains the endometrium but also **inhibits the secretion of FSH and LH** from the pituitary gland
        - This is **negative feedback**

Glands and hormones of the menstrual cycle diagram



Where hormones involved in the menstrual cycle are made and act – remember that hormones travel around the body in the bloodstream but only have an effect on a target organ

Hormones Involved With In Vitro Fertilisation Treatment

Your notes

- A couple may find it difficult to conceive a baby **naturally**
- This can be due to **insufficient levels of reproductive hormones** affecting the development of egg and sperm cells, or as a result of **issues with the reproductive system of the male or female**
- One possible treatment is for eggs to be fertilised by sperm **outside the body** in carefully controlled laboratory conditions
    - This is known as ***i**n **v**itro* **f**ertilisation, or **IVF**
- Although the process can vary, it normally follows the same main steps:
    - The first step involves stopping the normal secretion of hormones; the woman takes a drug to **inhibit the secretion of FSH and LH** from the pituitary gland
        - This also causes oestrogen and progesterone secretions to stop
    - This **temporarily halts the menstrual cycle**, allowing doctors to control the **timing** and **quantity** of **egg production** in the woman's ovaries
    - The woman is then given **injections of FSH and LH to stimulate the development of follicles;** as the injection gives a much higher FSH concentration than is present during a normal menstrual cycle, '**superovulation**' occurs
        - Many more follicles than normal begin to mature
    - The eggs are then collected from the woman and fertilised by sperm from the man in **sterile conditions in the laboratory**
    - The fertilised eggs develop into **embryos**
    - At the stage when they are tiny balls of cells, about **48 hours after fertilisation**, one or more embryos are inserted into the mother's uterus
    - Finally, **extra progesterone** is normally given to the woman to ensure the **endometrium** is **maintained**
- The success rate of IVF is low (~30%) but there have been many improvements and advancements in medical technologies which are helping to increase the success rate

Fertilisation

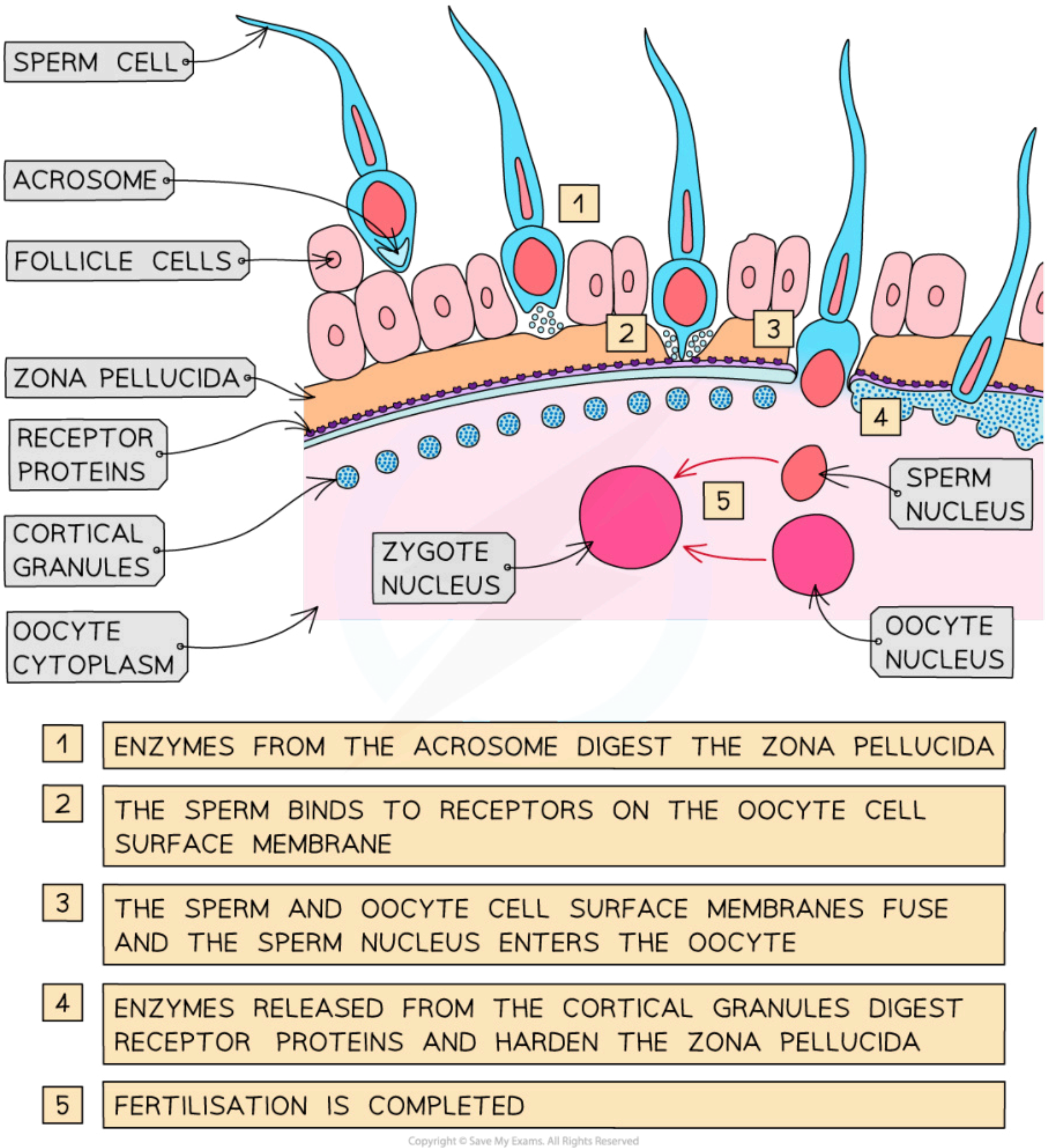
Your notes

Human Fertilisation

- Fertilisation is the **fusion** of **one sperm cell** and **one ovum** (egg cell); this fusion of two haploid nuclei gives rise to a diploid zygote
- During sexual reproduction, **many sperm are released**, and the sperm cells are attracted towards the secondary oocyte by chemical signals
- When the sperm cells reach the secondary oocyte, the process that takes place at its cell surface **prevents more than one sperm from passing through its cell surface membrane**
  - The entry of more than one sperm into a single oocyte is known as **polyspermy**
- When the first sperm cell digests its way through the zona pellucida, it reaches the oocyte cell surface membrane; **complementary receptors on the head of the sperm bind with proteins on the oocyte cell surface membrane**, enabling the cell surface membranes of the two gametes to **fuse together** and the sperm nucleus to enter the oocyte
  - At this point **vesicles released from the egg destroy the sperm flagellum (tail) and its mitochondria**
- Inside the ovum haploid sets of chromosomes from the sperm and egg cell are both within the cytoplasm of the oocyte
- The paternal and maternal chromosomes form a pronucleus within which **DNA undergoes replication to prepare for mitosis**
  - The two haploid pronuclei come together and the temporary membranes dissolves to create a **diploid cell**, the zygote, fertilisation is now complete
  - Chromosomes undergo the first mitotic division of the now diploid cell, subsequent mitotic divisions take place to form a blastocyst

Fertilisation diagram

Your notes



Mechanisms during the process of fertilisation destroy the sperm tail and polyspermy is prevented

Plant Reproduction

Your notes

Sexual Reproduction in Flowering Plants

Production of Gametes

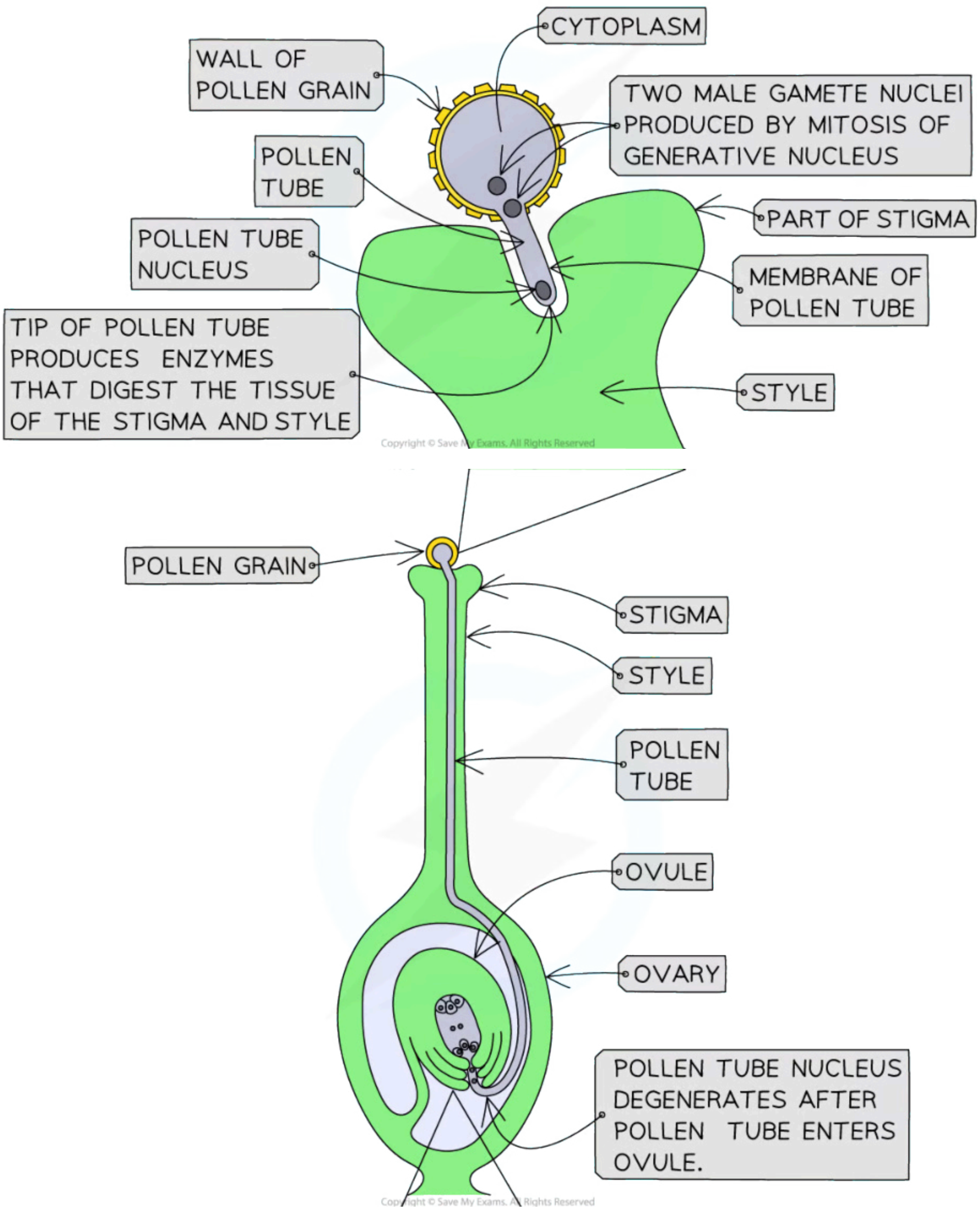
- In flowering plants, **male and female gametes are produced in the anther and ovule** (see diagram below for position of these structures), **respectively**
  - **Male gametes are contained within pollen grains**, which are released from the anthers
    - The anther contains pollen sacs
    - Each pollen sac contains a **diploid mothercell which undergoes meiosis** to form four haploid pollen grains (the gametes)
    - **Mitosis occurs** to produce more haploid male gametes
  - **Female gametes are made in the ovules**
    - A **single diploid cell within the ovule undergoes meiosis** to produce four haploid egg cells
    - Only one of these cells survives which undergoes **mitosis to produce female gametes**

Pollination and Fertilisation

- **Pollination** is the process of transferring pollen from the **anther** of one flower to the **stigma** of another
  - Some flowering plants are **hermaphroditic** which means they **contain both male and female parts**
    - **Self pollination** can occur in some of these species when pollen is transferred between different flowers on the same plant, or even from anther to stigma within the same flower
  - **Cross pollination** is the transfer of pollen from one plant to another
    - Flowers make use of a variety of methods, such as shape, colour and scent, to attract pollinators to aid with pollination
  - All pollination methods are forms of **sexual reproduction because the gametes are produced by meiosis so there is fusion of gametes** to form a diploid nucleus
- After pollination has occurred, a **pollen tube** grows from the **pollen grain** down the **style** to the **ovary** of the plant
- The **male nuclei** travel down the pollen tube to the female ovule
  - Two male nuclei travel down the pollen tube to the ovule; one will fuse with an ovule nucleus to form the zygote while the other will go on the form the plant embryo's food store
- **Fertilisation** occurs when the **haploid** male and female nuclei fuse and a **diploid zygote** is formed
  - After fertilisation, the **ovule** becomes a **seed** and the **ovary** develops into the **fruit**

Fertilisation in flowering plants diagram

Your notes


CYTOPLASM
WALL OF POLLEN GRAIN
TWO MALE GAMETE NUCLEI PRODUCED BY MITOSIS OF GENERATIVE NUCLEUS
POLLEN TUBE
PART OF STIGMA
POLLEN TUBE NUCLEUS
MEMBRANE OF POLLEN TUBE
TIP OF POLLEN TUBE PRODUCES ENZYMES THAT DIGEST THE TISSUE OF THE STIGMA AND STYLE
STYLE
Copyright © Save My Exams. All Rights Reserved
POLLEN GRAIN
STIGMA
STYLE
POLLEN TUBE
OVULE
OVARY
POLLEN TUBE NUCLEUS DEGENERATES AFTER POLLEN TUBE ENTERS OVULE.
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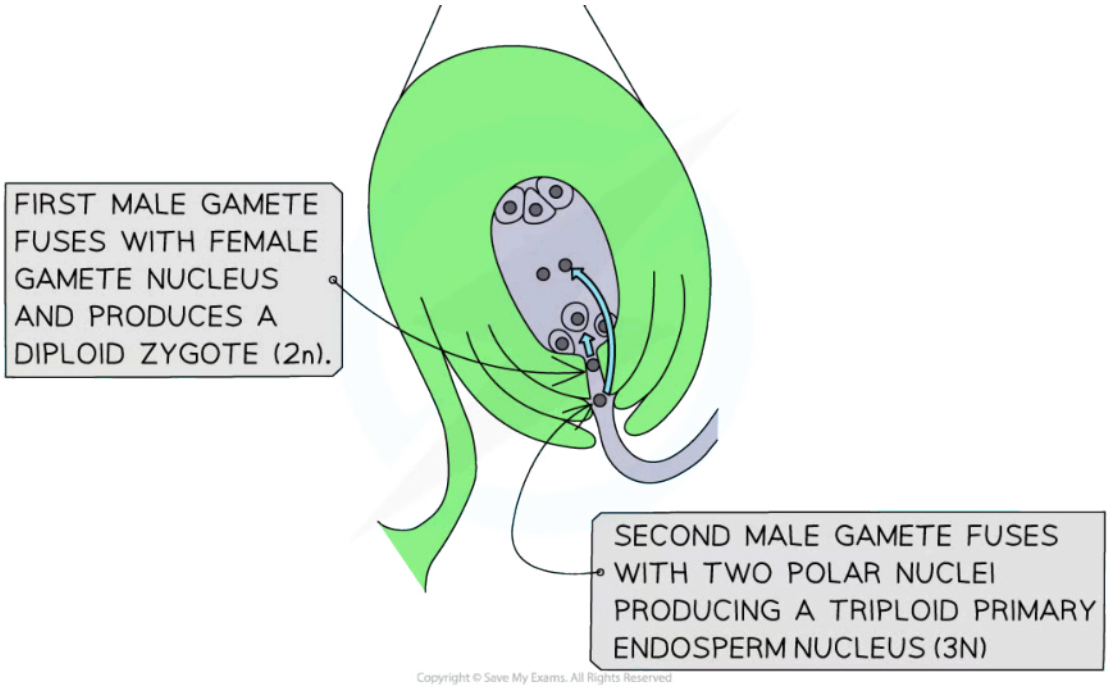


The process of fertilisation in a flowering plant to produce an embryo

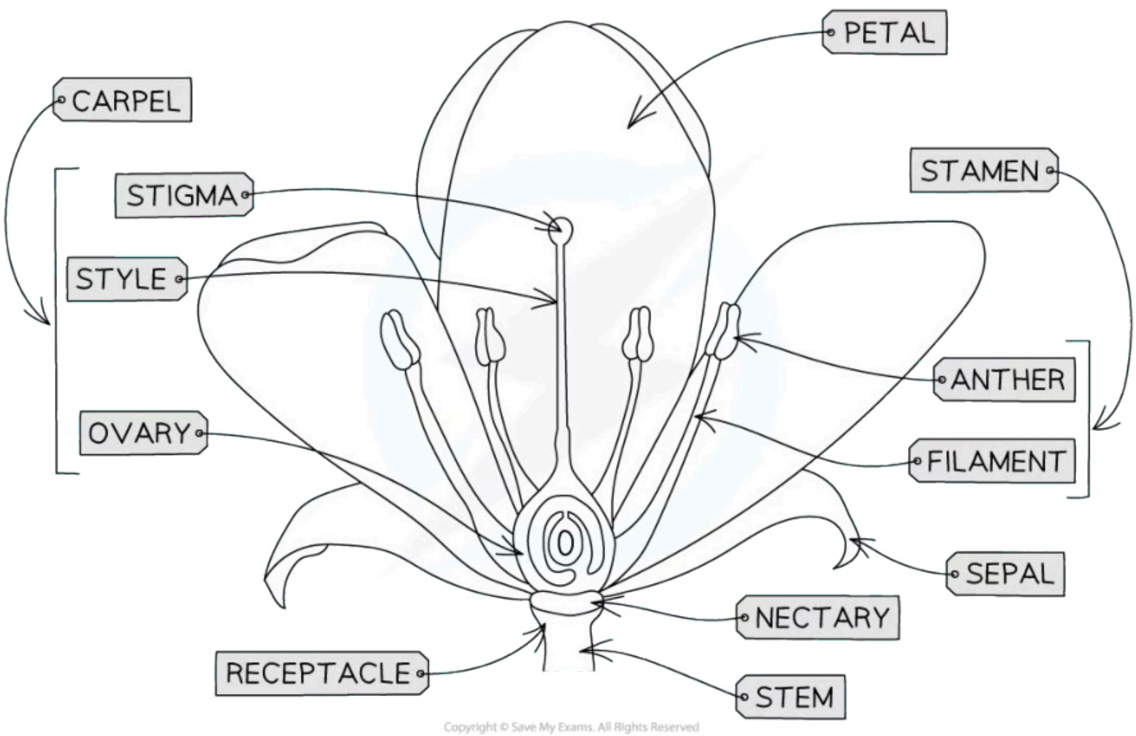
Your notes

Anatomy of an Insect-Pollinated Flower

Your notes

- The development of flowers occurs in the **reproductive stage** of the plant life cycle
- Flowers contain all the necessary organs and tissues required for **sexual reproduction** by **pollination**
- Key structures of the flower include
  - The **anther** - where the male gamete, pollen, is found
  - The **stigma** - part of the female reproductive organ which receives the pollen
  - The **ovary** - where the female gametes are located

Insect pollinated flower diagram



The structure of an insect pollinated flower

Examiner Tip

You should be able to draw diagrams annotated with names of structures and their functions of insect pollinated plants.

Flower structures and their functions table

Structure	Function

Sepal	Protecting the developing flower whilst inside the bud
Petal	Colourful to attract pollinators
Anther	Part of the stamen that produces the male gametes
Pollen	Contains the male nuclei for fertilisation
Filament	The stalk of the stamen that hold up the anther
Stigma	The top of the carpel, the female part of the flower, pollen lands here
Style	The part of the carpel that supports the stigma
Ovary	Contains the ovules
Ovule	The chamber within the ovary where female gametes develop

Your notes

Your notes

Pollination

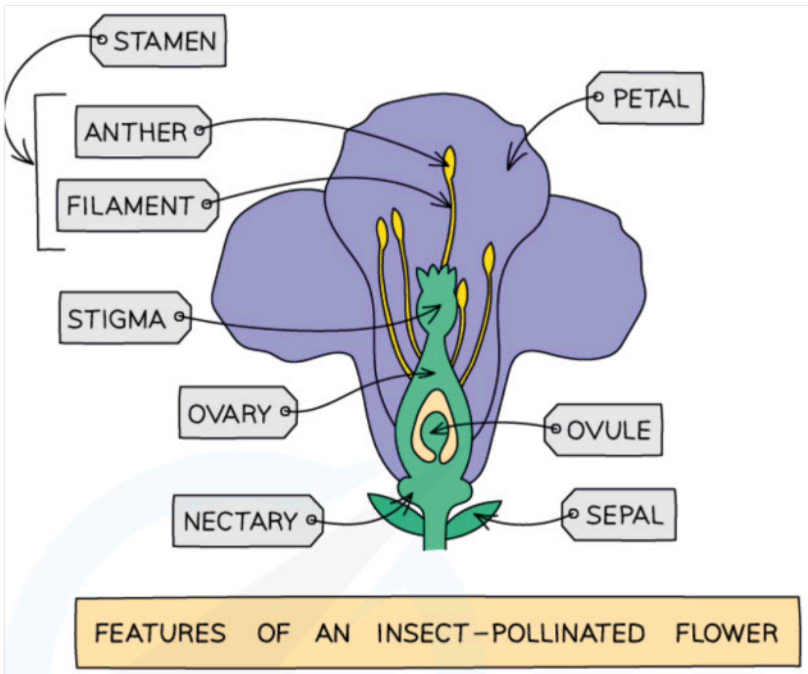
Promoting Cross-Pollination

- Flowers are the **reproductive organ** of the plant
- They usually contain both male and female reproductive parts
- Plants produce **pollen** which contains a nucleus inside that is the **male gamete**
- Unlike the male gamete in humans (sperm), pollen is **not capable of locomotion** (moving from one place to another)
- This means plants have to have mechanisms in place to **transfer pollen from the anther to the stigma**
- This process is known as **pollination** and there are two main mechanisms by which it occurs: transferred by **insects** (or other animals like birds) or transferred by **wind**
- The structure of insect and wind-pollinated flowers are slightly different as each is adapted for their specific function

Insect-pollinated flower features

- For the flowers of many plant species, the **pollinating agents** are **insects** (e.g. bees)
- Insects often visit these flowers to collect **nectar** (a sugary substance produced by insect-pollinated flowers and the base of their petals, which provides the insects with **energy**)
- As an insect enters the flowers in search of nectar, it often brushes against the **anthers**, which deposit **sticky pollen** onto the insect's **body**
- When the insect visits another flower, it may brush against the **stigma** of this second flower and in the process, may **deposit** some of the pollen from the **first flower**, resulting in **pollination**
- The structures of an insect-pollinated flower ensure that the flower is well-adapted for pollination by insects

Your notes

FEATURE	INSECT–POLLINATED
	 FEATURES OF AN INSECT–POLLINATED FLOWER
PETALS	LARGE AND BRIGHTLY COLOURED TO ATTRACT INSECTS
SCENT AND NECTAR	PRESENT – ENTICES INSECTS TO VISIT THE FLOWER AND PUSH PAST STAMEN TO GET TO NECTAR
NUMBER OF POLLEN GRAINS	MODERATE – INSECTS TRANSFER POLLEN GRAINS EFFICIENTLY WITH A HIGH CHANCE OF SUCCESSFUL POLLINATION
POLLEN GRAINS	LARGER, STICKY AND / OR SPIKY TO ATTACH TO INSECTS AND BE CARRIED AWAY
ANTHERS	INSIDE FLOWER, STIFF AND FIRMLY ATTACHED TO BRUSH AGAINST INSECTS
STIGMA	INSIDE FLOWER, STICKY SO POLLEN GRAINS STICK TO IT WHEN AN INSECT BRUSHES PAST

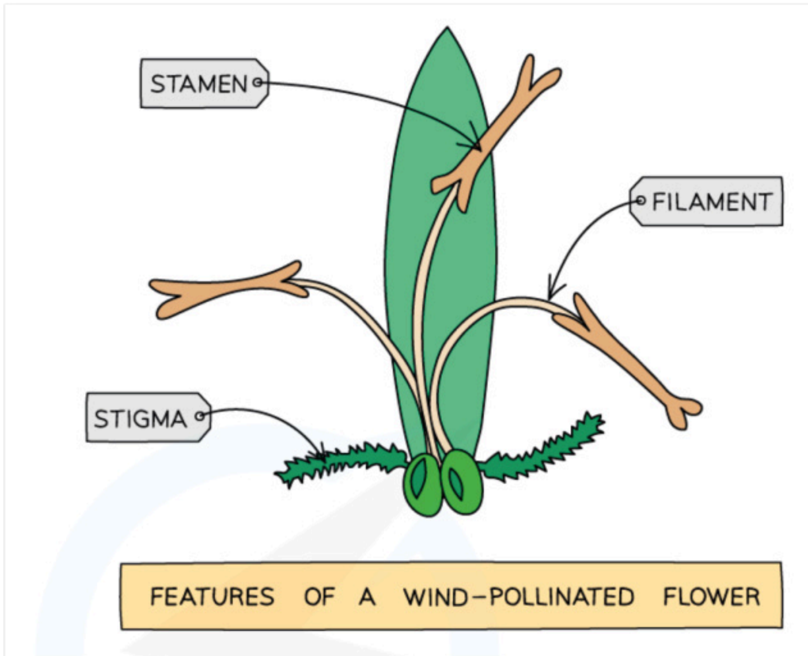
	WHEN AN INSECT BRUSHES PAST

Your notes

Wind-pollinated flower features

- For wind-pollinated flowers, the process of pollination is more **random** than it is for insect-pollinated flowers
- When ripe, the **anthers open** and **shed their pollen** into the open air
- The pollen is then either blown by the wind or carried by air currents until it (by chance) lands on the **stigma** of a plant of the same species, resulting in **pollination**
- The structures of a wind-pollinated flower ensure that the flower is well-adapted for pollination by the wind

Your notes

FEATURE	WIND-POLLINATED
	
PETALS	SMALL AND DULL, OFTEN GREEN OR BROWN IN COLOUR
SCENT AND NECTAR	ABSENT – NO NEED TO WASTE ENERGY PRODUCING THESE AS NO NEED TO ATTRACT INSECTS
NUMBER OF POLLEN GRAINS	LARGE AMOUNTS – MOST POLLEN GRAINS ARE NOT TRANSFERRED TO ANOTHER FLOWER SO THE MORE PRODUCED, THE BETTER THE CHANCE OF SOME SUCCESSFUL POLLINATION OCCURRING
POLLEN GRAINS	SMOOTH, SMALL AND LIGHT SO THEY ARE EASILY BLOWN BY THE WIND
ANTHERS	OUTSIDE FLOWER, SWINGING LOOSE ON LONG FILAMENTS TO RELEASE POLLEN GRAINS EASILY
STIGMA	OUTSIDE FLOWER, FEATHERY TO CATCH DRIFTING POLLEN GRAINS

- 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**
- 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
- In addition to the mechanisms described above for insect and wind pollinated plants, plants also have a variety of other **methods to ensure successful cross-pollination**
  - **Different maturation times** for the pollen and ovules of the same flower. This prevents self-pollination from occurring
  - **Self-incompatibility mechanisms** are used in some species that ensure if pollen lands on the stigma from the same plant the plant produces chemicals that ensure a pollen tube does not grow
  - Plants can produce flowers that only have **either male or female parts** or the whole plant is either male or female
  - Wind-pollinated plants are less likely to self-pollinate due to the **wind carrying the pollen far from the parent plant**

Preventing Self-Pollination

- 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 results in **less genetic variation in the offspring** in comparison to cross-pollination
  - No new alleles are introduced into the offspring from other individuals
- 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
- **Genetic mechanisms** in many plant species ensure male and female gametes fusing during fertilisation are from different plants
  - Each plant has a **set of genes that controls the growth of a pollen tube** so that when pollen lands on the stigma of a flower of the same plant protein interactions occur that **prevent the growth of a pollen tube**
  - This is an example of a **self-incompatibility mechanism**
  - The mechanism may include
    - A pollen grain fails to germinate into a pollen tube
    - A pollen grain germinates but does not enter the style
    - The pollen nuclei enters the ovule but it degenerates before fertilisation can occur
    - Fertilisation occurs but the embryo degenerates before growth is established

Seed Dispersal & Germination

Your notes

Seed Dispersal & Germination

Seed dispersal

- **Seed dispersal** is then required in order to distribute the seeds away from the parent plant and **reduce competition** between the offspring and the parent plant
  - Methods of seed dispersal include
    - **Wind or water**
      - Parachute or wing shaped lightweight seeds will travel on the wind or float in water
    - **Animals**
      - Fleshy fruit is eaten by animals and seeds distributed through egestion
      - Sticky or hooked seeds catch on to the fur or feathers of passing animals
    - **Explosions**
      - Some pods explode propelling the seeds away from the parent plant
- Seed dispersal can often be confused with pollination
  - Pollination is the **transfer of pollen from anther to stigma**, while seed dispersal is the **distribution of mature seeds**. Both processes can involve wind, water, or animals.

Seed germination

- Once a seed has formed within the ovary of a flower they undergo a period of dormancy
- When conditions become favourable the seed may germinate
  - **Germination** is the **start of growth in the seed**

Requirements for germination

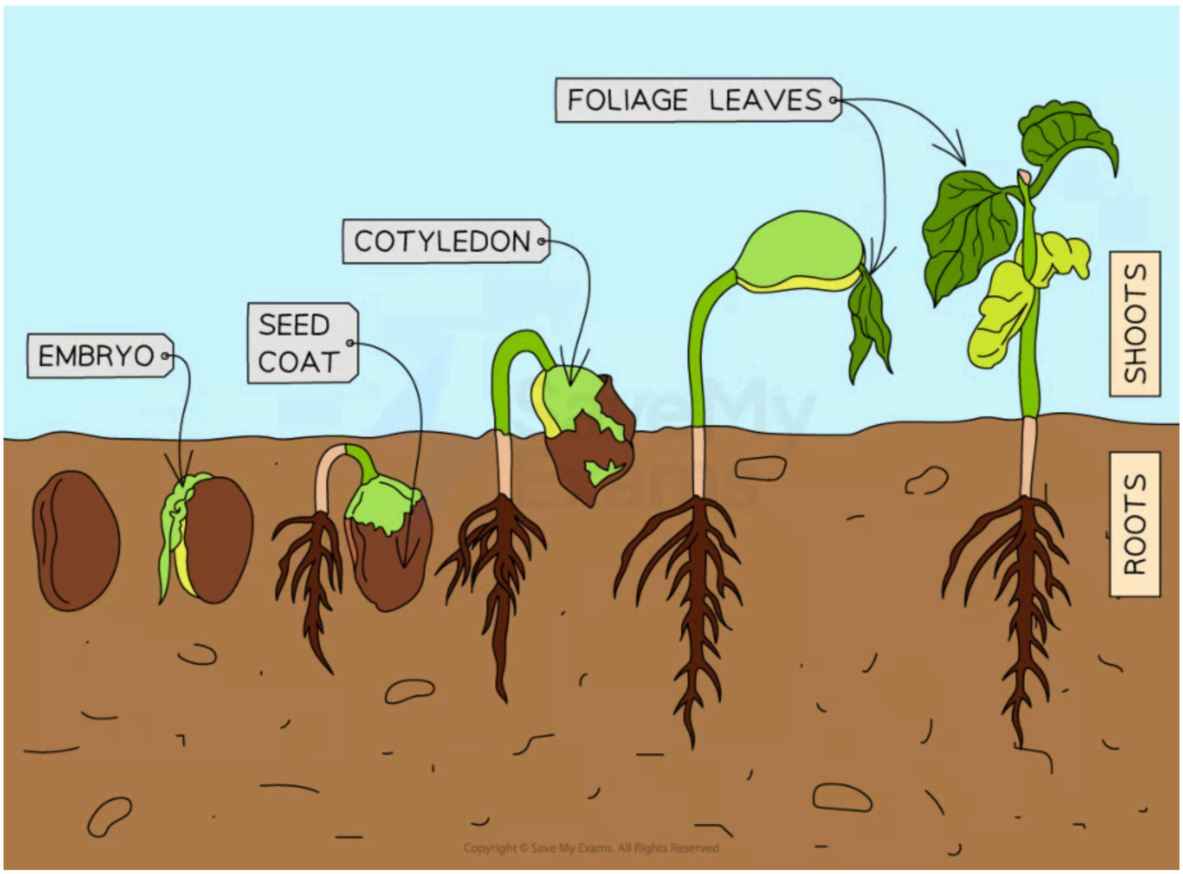
- Three factors are required for **successful germination**:
  - **Water** - allows the seed to **swell up**, which causes the **seed coat** (testa) to **burst**, allowing the growing embryo plant to exit the seed. Water also allows the enzymes in the embryo to start working so that growth can occur (**increases metabolic activity**)
  - **Oxygen** - required for **respiration**, so that **energy** can be released for germination
  - **Warmth** - germination improves as temperature rises (up to a certain point) as the reactions which take place are controlled by **enzymes**, which cannot function effectively when temperatures are **too low**

The process of germination

- A seed contains a plant embryo and **food reserves for its growth**
- The food reserves contain endosperm tissue which are transferred to the embryo through early leaf structures called **cotyledons**
- Seeds needs to **replenish water lost during dormancy and does so through a process called imbibition** which activates the biochemistry of the embryo
- The **rate of respiration and protein synthesis increases** and the embryo can prepare to emerge through the seed coat

- A **structure called the radicle is the first to emerge** and forms the initial root structure which responds to gravity and **grows downward** into the soil
- The **first structure to appear above ground is called the hypocotyl**, this is a curved portion of the plant shoot found below the cotyledons and **grows upwards**
- As the shoot grows the **first leaves begin to appear from the cotyledon and photosynthesis can begin**
- The root structure is also established and full plant growth can occur

Stages of germination diagram



The process of germination in flowering plant showing the development of roots and shoots

Your notes