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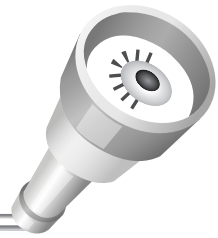

CYCLES

SYSTEMS

INTERACTIONS

ENERGY

Cycles

Every day, living things are being born, growing old and dying. Young, fit organisms which are better able to face the world continue to survive while the older generation gradually dies. Reproduction in both plants and animals ensures the continuity of the cycle of life. In chapter 1, we will study about some of the characteristics that parents pass on to their young when they reproduce. This process called heredity is also seen in plants as well. In chapters 2 and 3, we will study in greater detail how plants and animals ensure that their own species do not die out by means of reproduction.

Water is life, or the source of all life. Water exists in different states. These states can be converted from one to another and such changes of state play an important role to ensure a continuous supply of finite water for all living things on earth. This is the water cycle. Given the importance of water and its limited supply, water is indeed a precious resource that we must strive to conserve. Chapters 4 to 6 introduce us to the wonderful world of water, its uses and how we can save it to make it last longer.

Let us now plunge into the study of cycles in reproduction and water!

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CHAPTER 1
Heredity

Heredity And Genetics

Heredity is the passing of genetic factors from parent to young, or from one generation to the next.

Genetics is the study of how characteristics are passed down from parents to children.

Below are some characteristics that children can inherit from their parents or grandparents.

- shape of eyes / nose / face / body
- colour of eyes / hair
- skin complexion
- straight / curly hair
- overall appearance and build
- attached / detached ear lobes

- whether or not one can roll one's tongue

- whether or not one has dimples, and many others.

Children can also inherit certain diseases from their parents. Examples of such diseases are haemophilia (the inability of the blood to clot due to the lack of platelets), AIDS (Acquired Immune Deficiency Syndrome) and HD (Huntington's disease).

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Plants can also pass down characteristics to their offspring. Such characteristics include the quality of the fruit and the state of health of the plant during its lifetime.

However, not all of one's characteristics can be attributed to genetics. One's characteristics may be affected by environmental factors and lifestyle choices.

Example Despite having parents who are slim, you can risk gaining excessive weight and becoming fat if you are constantly overeating.

Consuming too much food can result to a weight gain.

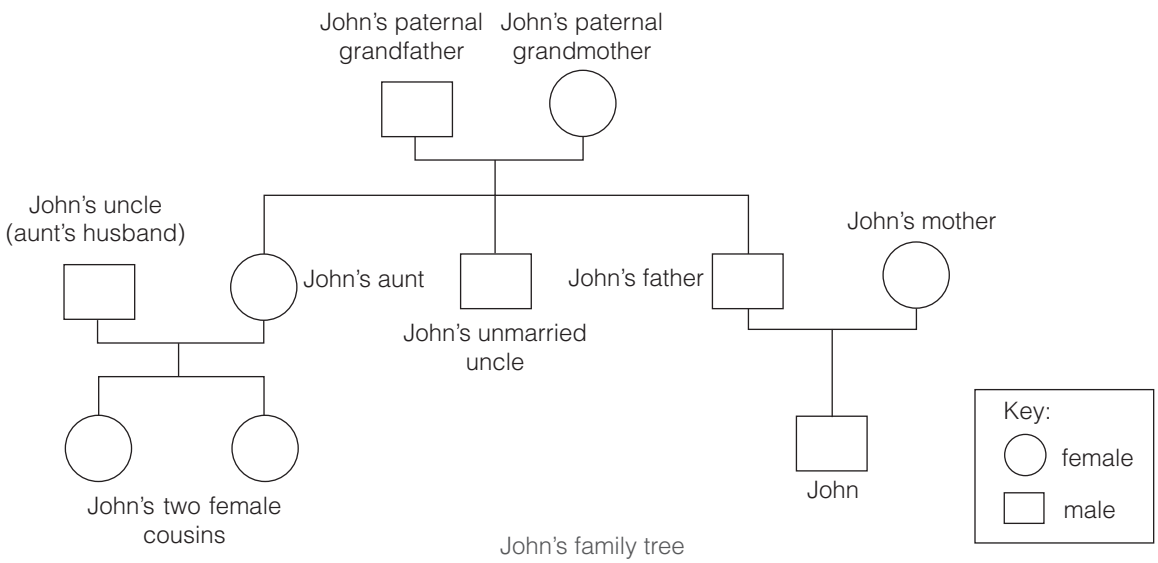
Genes determine the characteristics of organisms.

Within the nucleus of our cells, there are chromosomes which store DNA (deoxyribonucleic acid). DNA is made up of genes.

Family Tree

A **family tree** provides a visual diagram of the members of a family and how they are related over a period of time.

Example In the family tree shown below, we can tell many things about John's family. John's father has two siblings, a brother and a sister. John's aunt (who is his father's sister) is married with two girls. The two girls are John's cousins.



John's family tree

Plants are also able to pass on their characteristics to their young. Characteristics such as colour, taste and size are passed on to the young plants when reproduction takes place in the parent plants.

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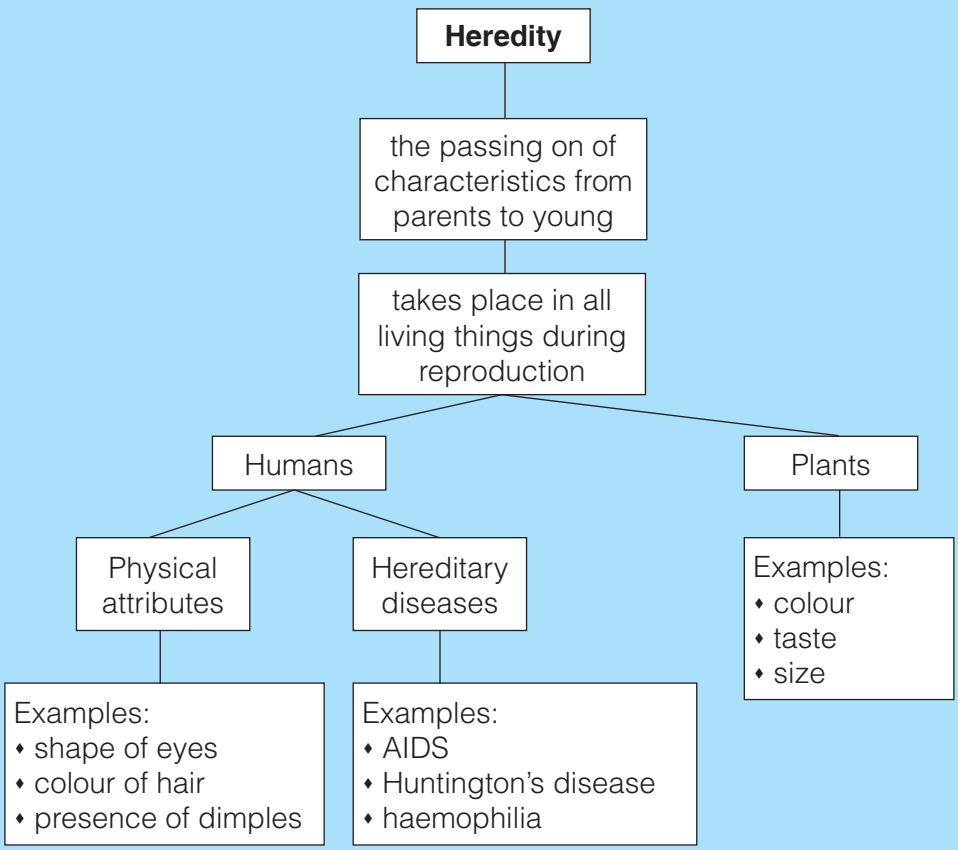
What I Have Learnt In This Chapter

- Living things reproduce to ensure continuity of their kind.
- Many characteristics of an organism are passed on from parents to offspring. This is called heredity.
- The study of how characteristics are passed down from one generation to the next is called genetics.
- Some characteristics are affected by environmental factors or lifestyle choices.
- A family tree provides a visual diagram of the members of a family over a long period of time. It gives information like the names of the family members and how they are related to one another.



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CHAPTER 2

Reproduction In Plants

Living things reproduce to ensure that there will be members of their own kind left on earth after they die. In other words, living things reproduce to ensure continuity of their species.

Reproduction In Plants

Plants can reproduce in different ways.

Flowering plants bear flowers. They reproduce from **seeds**.

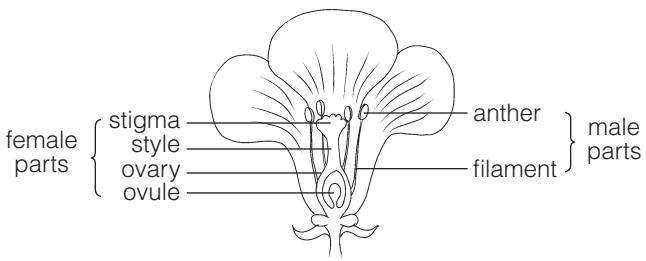
Some non-flowering plants reproduce from **spores**.

Plants can also reproduce from other plant parts.

Parts Of A Flower

The petals of a flower are usually brightly coloured. This attracts insects to come to it and help in the pollination.

The flower is made up of many different parts. Its most basic parts are divided into male and female parts.



Parts of a flower		Function
female parts	stigma	This is where the pollen grains enter as they travel downwards towards the style.
	style	The stalk which supports the stigma and holds it in a position which enables the pollen grains to enter the stigma.
	ovary	This is where the ovule is formed and once fertilization takes place, it will become the fruit.
	ovule	It contains an egg cell. The ovule will eventually develop into a seed.
male parts	anther	The place where pollen sacs are found. Pollen sacs produce pollen grains.
	filament	It is the stalk which supports the anther.

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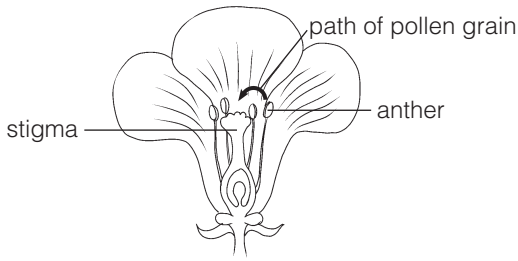
A pollen grain (produced in the anther) is the male sex cell required for reproduction to take place.

Pollination

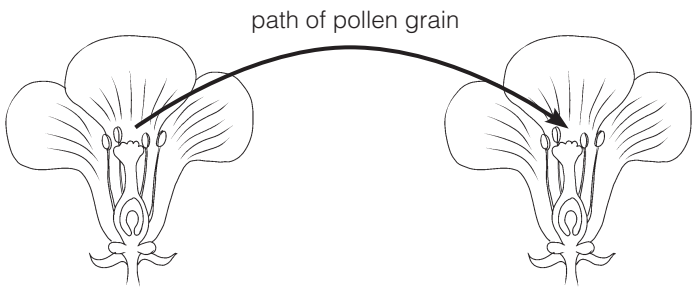
Pollination is the process when pollen grains from the anther are transferred to the stigma of a flower of the same species.

If the pollen grains come from the same flower as the stigma, it is known as **self-pollination**. This can occur in flowers which have both male and female parts on the same flower.



Self-pollination

If the pollen grains are transferred to the stigma of another flower, this is known as **cross-pollination**.



Cross-pollination

Most of the time, the process of pollination requires agents (organisms that assist in transferring the pollen grains to the stigma). There are three ways in which pollination can take place.

① Help Of Insects And Animals

Flowers can be pollinated by insects. The insects are attracted by the flower's petals, scent and sweet nectar. When the insect lands on the flower to feed on the nectar, the pollen sticks to its body. The pollen is deposited into the stigma of another flower when the insect lands on it. Birds and even some mammals such as bats can help in the pollination process in a similar way.

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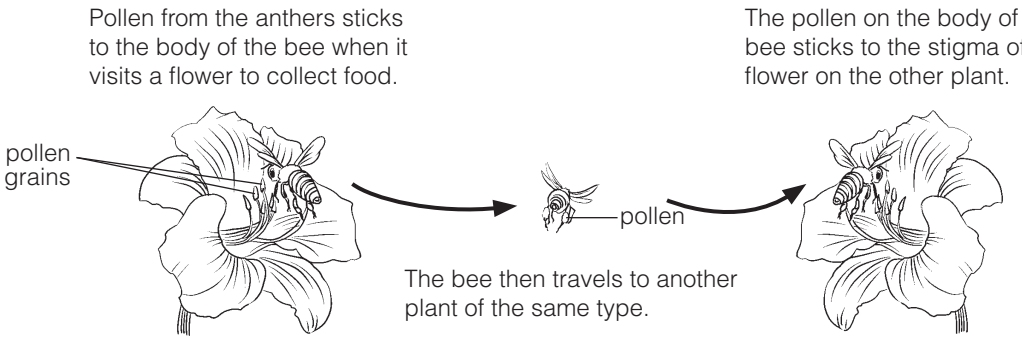


Cross-pollination with the help of an insect

Flowers that are pollinated by insects and other animals usually have brightly coloured petals, fragrant scents and produce nectar.

② By Wind

Some flowers are pollinated by wind. The pollen grains are carried by wind to be deposited in the stigma of another flower.

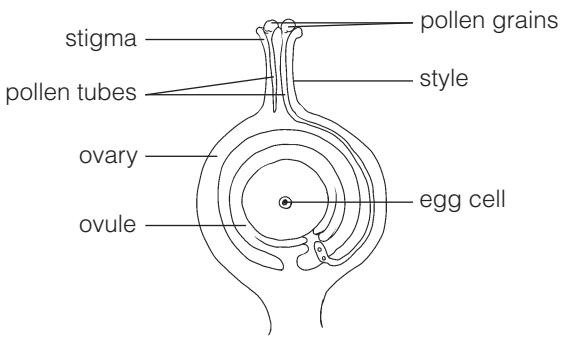
Flowers that are pollinated by wind have smaller, dull-coloured petals and are not fragrantly scented. An example of such a plant is the grass.

③ By Water

Some water plants are pollinated by water. The water carries the pollen grains to the stigma of another flower.

Fertilization

When the pollen grain lands on a stigma, it produces a tiny tube that grows down the style until it reaches the ovule.



The tiny tube formed from the pollen grain travels down to the ovule.

The fusion of the pollen grain with the female egg cell in the ovule is known as **fertilization**.

After fertilization, the ovary swells and develops into a fruit. The petals will wither and drop off.

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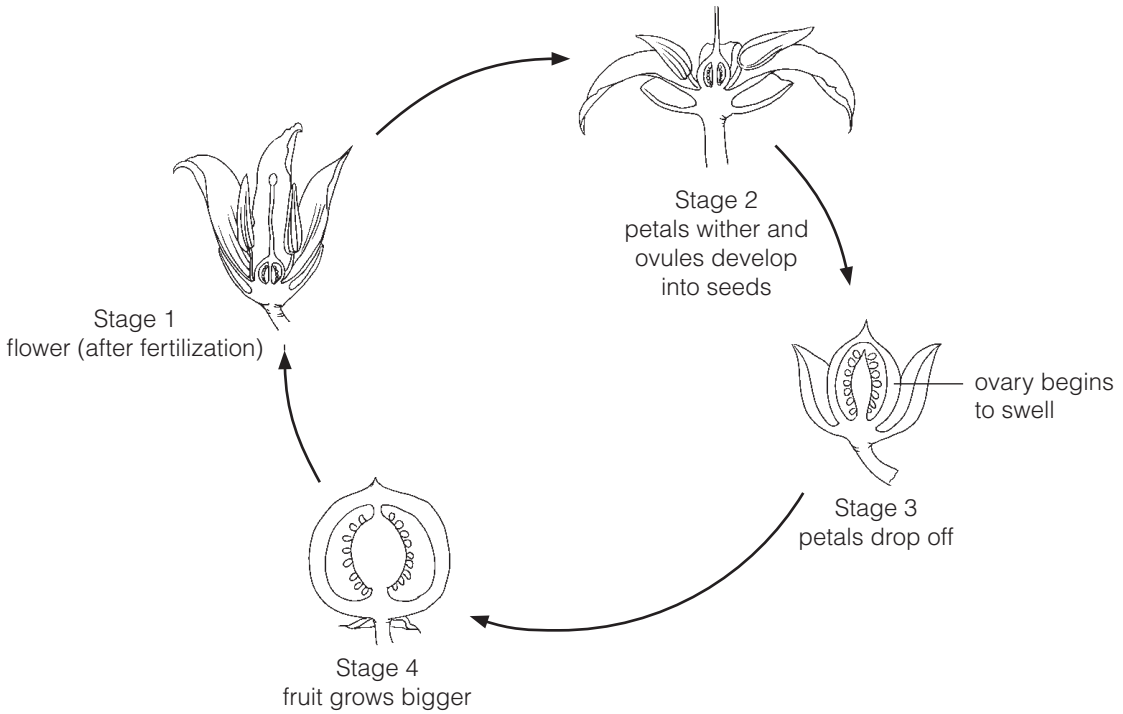
The ovules in the ovary develop and become the seeds.

The seeds in the fruit will eventually develop into new plants.



To produce new plants from seeds, both the male and female cells are needed. Therefore, **sexual reproduction** takes place in plants. In order for new plants to grow and develop well, the seeds have to be scattered away from the parent plant.

If seeds are not scattered, they will grow very close to the parent plant. This will lead to **overcrowding**. The new plants will not be able to grow well because they have to compete with one another for space, air, sunlight, minerals and even water.

Experiment **Let's find out what the effects of plant overcrowding are.**

Three similar flowerpots are used to conduct the experiment. The number of seeds planted in each flowerpot is different.

For flowerpot A, one seed is placed in it. Flowerpot B has three seeds and flowerpot C has nine seedlings. All three pots are watered daily.

Seedling has a thick stem when there is no competition.

Flowerpot A

Seedlings have thick stems when there is less competition.

Flowerpot B

Overcrowding can cause seedlings to grow tall and thin because they compete for space, sunlight, water and minerals.

Flowerpot C

Overcrowding results to seedlings that have thin stems.

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When the seeds grow into seedlings, observations can be made about them. Flowerpots A and B have seedlings with a larger, thicker and shorter root system than the seedlings found in flowerpot C. The seedlings in flowerpot C have thinner root mass and long thin roots.

The stems of the seedlings in flowerpots A and B are thicker than those in flowerpot C. The stems of the seedlings in flowerpot C are tall and thin. They look weak and fragile.

There are many large flat leaves on the seedlings in flowerpots A and B. The leaves are also dark green in colour. Although the seedlings in flowerpot C have more leaves, they are smaller in size. They are of a lighter shade of green as compared to those found in flowerpots A and B.

This experiment goes to show that when given a limited space, the seedlings are forced to compete with one another to survive. Plant growth is healthier when there is no overcrowding.

Method Of Dispersal

Fruit and seeds may be scattered (dispersed) in different ways depending on their environment and characteristics.

① By Wind

- Characteristics
  - light and dry
  - may have wing-like structures so that the seeds / fruit can be easily carried away by the wind

Examples


angsana


shorea


lalang


yellow flame

② By Water

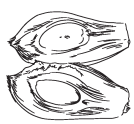
- Characteristics
  - has a fibrous husk that traps air, enabling it to float on water and be carried over long distances
  - has a waterproof covering

Examples


coconut


pong pong


lotus


nipah


mangrove

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③ By Animals

- Characteristics
  - may have hook-like structures which hook on to the fur of animals and drop off at another location
  - may have thick, juicy flesh which is eaten by animals, leaving the seed behind
  - some edible fruit may have small, indigestable seeds that are swallowed by animals and passed out in their waste later

Examples

- edible fruit


mango

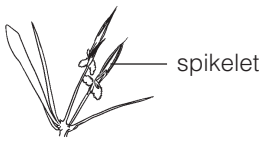

rambutan


apple


orange

- fruit with hook-like structures


mimosa



love grass

④ By Explosive Action

- Characteristics
  - fruit split open forcefully (explosive action) when they are ripe, scattering the seeds

Examples


balsam


cotton


lady's finger


rubber


saga


flame of the forest

Alert

The African tulip fruit have pods that split open, but not forcefully enough for the seeds to be dispersed on their own. The seeds are small and light so that they can be carried away by the wind.

Another example is the kapok.


African tulip and seed


kapok

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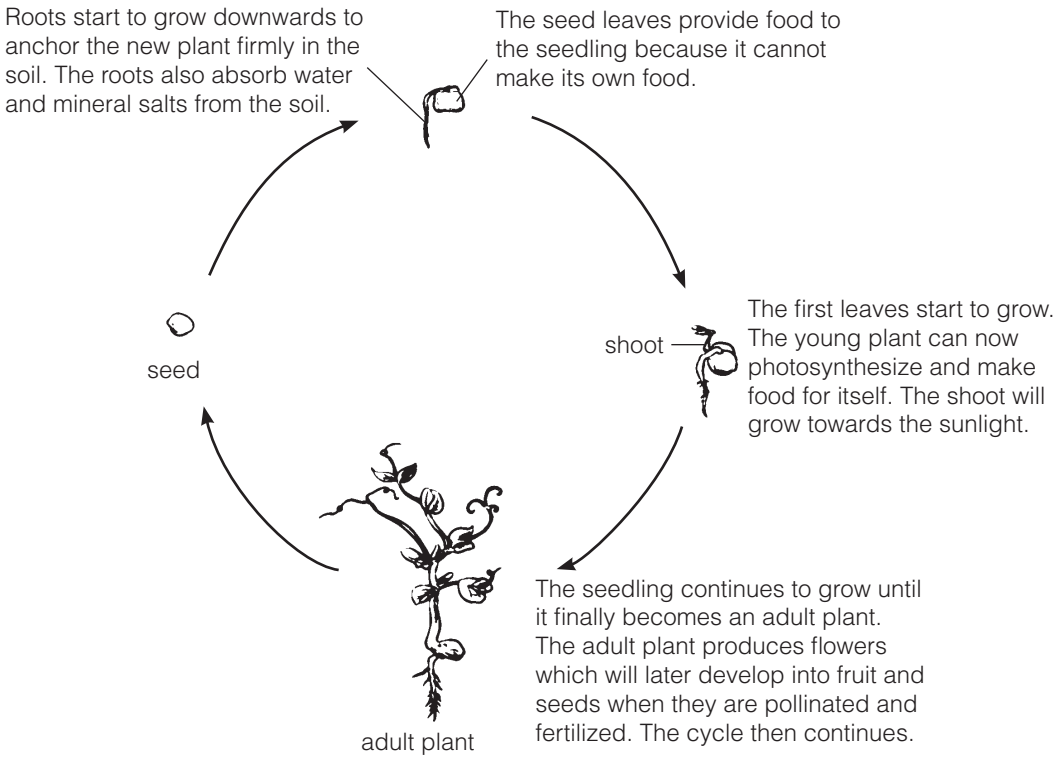
Germination

If a seed is scattered and lands at a place where it is able to obtain sufficient **air**, **water** and **warmth**, it will start to grow and develop into a seedling. We call this **germination**.

Germination is the process where a seed develops into a seedling.



Cycle of a plant

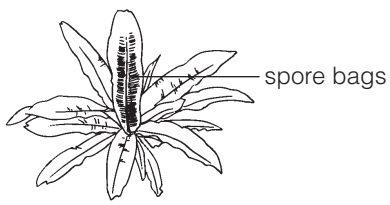
Other Methods Of Reproduction In Plants

Non-flowering plants, as the term implies, do not have flowers. Thus, they cannot reproduce seeds to make new plants.

Non-flowering plants reproduce in a different way.

① By Spores

Non-flowering plants such as ferns have tiny spore bags on the underside of their leaves. The spore bags in these ferns contain numerous spores which are released by the plant. Some of the spores which land in places with suitable conditions (i.e. having sufficient air, water and warmth) will develop into new plants.



bird's nest fern

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All ferns such as the bird's nest fern, bracken fern, maidenhair fern, soft tree fern, ladder fern and log fern reproduce by spores. The arrangement of spore bags on the leaves of the ferns may differ from plant to plant.

Mushrooms and other fungi also reproduce by spores, although they do not come under the category of plants.

② By Underground Storage Roots

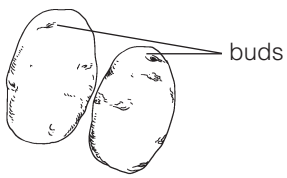
The roots of these plants are underground. The roots are swollen because the food made by the plant is stored in them, hence the name underground storage root. The roots can also grow into new plants.

Some examples of underground storage roots are the tapioca, radish, carrot, sweet potato and taro.

③ By Underground Stem

The underground stems of these plants store food. There are buds on them which can develop into new plants.

Some examples of underground stems are yam, ginger, water chestnut, potato and onion.



potato

④ By Suckers

The shoots of these plants grow upright from the base of the parent plant.

Some examples of plants that reproduce by suckers are the banana plant, pineapple plant, heliconia, sugarcane and sealing wax palm.

banana

pineapple

heliconia

sugarcane

pygmy date palm

⑤ By Leaves

The shoots grow from the leaf of the parent plant. The new plant formed is identical to the parent plant.

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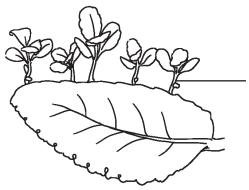

bryophyllum

Some examples of plants that reproduce by leaves are the bryophyllum, African violet, begonia, sansevieria, peperomia and santpaulia.

bryophyllum

African violet

begonia

sansevieria

peperomia

santpaulia

⑥ By Cuttings

Although plants can reproduce by other natural means, e.g. by seeds or by any of the above-mentioned methods, man sometimes cuts the leaves or stems of plants and places them in either soil or water so that they can grow into new plants. The new plants will have identical characteristics to their parent plants.

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What I Have Learnt In This Chapter

- Most flowers have male and female parts.
- The stigma, style, ovule and ovary are the female parts of a flower.
- The anther and filament are the male parts of a flower.
- Sexual reproduction occur in flowering plants. The processes are
  - pollination
  - fertilization (seed production)
  - seed dispersal
  - germination
- Pollination can take place with the help of insects and animals, wind and water.
- The process of pollination occurs when pollen grains fall on the stigma.
- Fertilization takes place when the pollen tube fuses with the egg cell in the ovule.
- Plants reproduce in various ways, i.e.
  - by spores
  - seeds
  - by other plant parts such as underground stems, suckers and leaves
- Plants disperse their seeds to avoid overcrowding and competition for nutrients, water, air and sunlight.
- Plants may disperse their seeds by wind, water, animals or explosive action.

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CHAPTER 3

Reproduction In Humans

Sexual reproduction does not only occur in plants. It also occurs in humans where the female reproductive cell and the male reproductive cell unite to form a new individual.

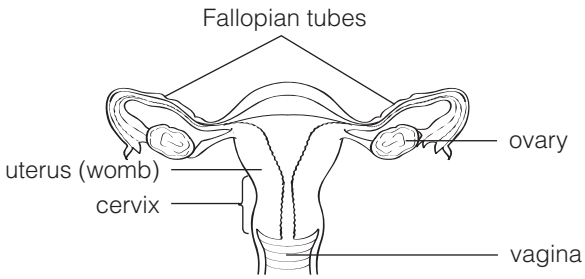
Female Sex Organs

The ovary is part of the female sex organ. There are two ovaries in each woman's body.

Ova (singular ovum) or **eggs** are the female sex cells. The ova are stored in the ovaries of a female.

A female is born with all the unripe eggs (or ova) she will ever have in her lifetime. When she reaches puberty, an egg will start to mature in the ovary. Every month, an egg will be released by the ovary into one of the Fallopian tubes. This is called **ovulation**.

Extra On average, a female is born with approximately one million eggs but they decline in number and quality as she grows older. In fact, a girl is only left with about 400,000 eggs by the time she reaches puberty. Only a few hundred are released during ovulation.



Female reproductive system

Male Sex Organs

A male has two sex organs. They are the **testis** and the **penis**.

Sperms are the male sex cells. They are produced in the testes.

When a boy reaches puberty, his testes will start to produce sperms.

It takes about 72 days for a sperm to grow.

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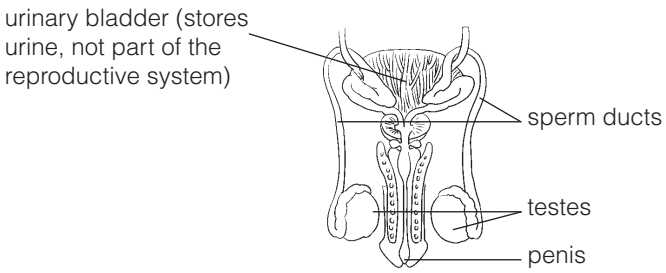
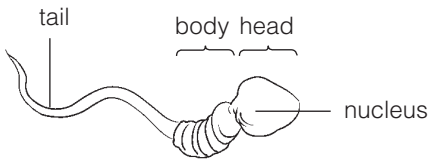


Male reproductive system

Extra A sperm cell consists of a head (where the nucleus lies), the midpiece (which is the motor of the sperm) and a tail which helps it to swim.



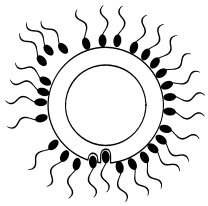
A sperm cell (magnified)

From the testes, sperms swim in a liquid known as **semen**. The sperms travel through the sperm ducts (which are the tubes that carry the sperms) to the penis.

How A Human Life Begins

During sexual intercourse between an adult male and female, the male deposits the sperms into the vagina of the female. The millions of sperms then travel up the vaginal canal through the cervix and into the uterus until they reach the Fallopian tubes.

If an egg has just been released by an ovary and is travelling through the Fallopian tube, the sperms will surround it and try to enter it.



Sperms trying to enter an egg

Once one sperm enters the ovum, no other sperms can enter it any more. The other sperms will die very quickly.

The joining together or fusion of a sperm and an ovum is called **fertilization**.

The fertilized egg then travels through the Fallopian tube until it reaches the uterus. It implants itself in the wall of the uterus. The wall of the uterus contains nutrients and is richly supplied with blood vessels so that the fertilized egg can grow and develop well.

The fertilized egg in the uterus is called an **embryo**.

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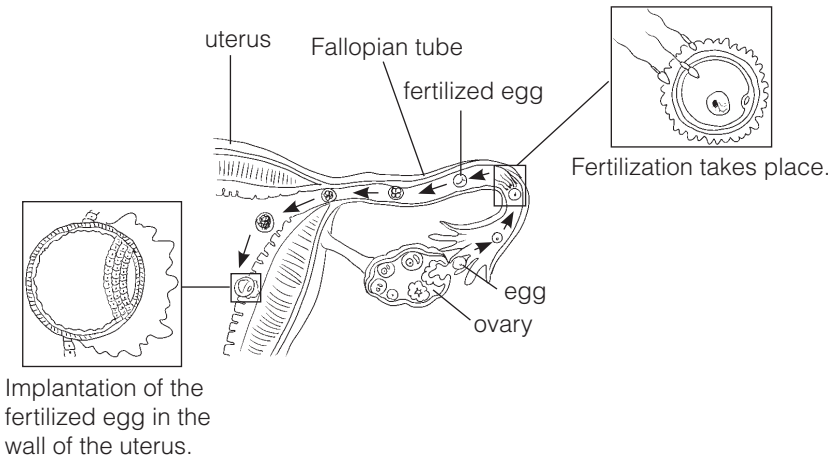


The passage taken by a fertilized egg

The fertilized egg cell divides very rapidly as the embryo develops. At 3 months (12 weeks), the embryo has developed arms, legs and most of the internal organs. It is now called a **foetus**.

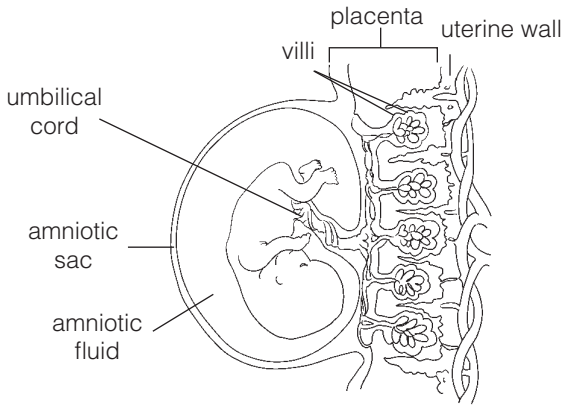
The time the foetus takes to develop inside its mother's uterus (or womb) is known as **pregnancy** or **gestation**.

In humans, the gestation period is about 40 weeks.

Sometimes, babies may be born earlier. A baby who is born after 28 weeks of gestation is able to survive, but it has to spend some time in an incubator to develop and grow more fully before it can leave the hospital to begin its new life. Babies born earlier than they are supposed to are called **premature** babies.

In the uterus, the foetus is attached to the **placenta** by an **umbilical cord**. The placenta is attached to the uterus. The foetus receives oxygen and nutrients from its mother and gives out its waste products through the placenta.

The foetus remains in a watery environment inside the uterus. The fluid is known as **amniotic fluid**. It protects the foetus from shock or sudden movements which may be made by the mother.



The foetus is attached to the placenta by the umbilical cord.

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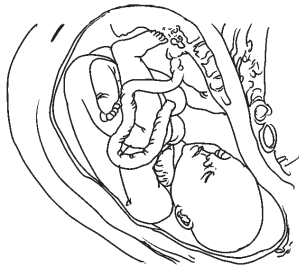
When the foetus is ready to be born, it comes out of the mother's body through the vagina.



Eight-month-old foetus

The umbilical cord will be tied and cut. The newborn baby can now breathe on its own, take in milk and water from its mouth and pass out waste from its excretory organs. As such, it no longer needs the umbilical cord in the outside world. The place where the umbilical cord was now exists as the **belly button**.

The placenta is also delivered out through the vagina after the baby is born.

Sometimes, the baby may not be able to be delivered through the vagina. A surgery will then be performed to extract the baby from the mother's uterus. This is known as a **caesarean section**.

A mother may deliver two or more babies at a time. Identical twins are two babies who look alike. They develop from a single fertilized egg which later divides into two embryos. Fraternal or non-identical twins develop when two eggs are released into the Fallopian tube and these two eggs are fertilized by two different sperms.

Apart from humans, all mammals (except the platypus and spiny anteater) undergo sexual reproduction in a similar manner and give birth to their young alive, although the period of gestation varies.

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What I Have Learnt In This Chapter

- There are similarities in terms of fertilization in the sexual reproduction of flowering plants and animals.
- In humans, the ovaries in females produce eggs and the testes in males produce sperms.
- When a sperm fertilizes an egg, a human life is formed.
- The fertilized egg develops in the womb.

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