

REPRODUCTION

This is the formation of new separately existing individuals of a species from those already in existence.

It may also be defined as the continuation of life processes in new organisms.

Importances of reproduction

- A. Growth of a population
- B. Continuation of life in new individuals
- C. Continuation of the species

SEXUAL AND ASEXUAL REPRODUCTION

1. Asexual reproduction

It takes place when a new individual arises from part of a previously existing organism without fertilisation having taken place.

2. Sexual reproduction

This is when new individuals are formed by fusion of gametes from two different parents,

Differences between sexual and asexual reproduction

Sexual	Asexual
Two parents are involved	A single parent is involved
Male and female gametes are produced	No gametes produced
A diploid zygote is formed by fertilisation	No zygote formed
Meiosis essential for gamete formation	Mitosis is essential for spore formation and cell division
Variation occurs in the offspring leading to high hybrid vigor	Offspring is identical to the parent
Not rapid	It is rapid in favourable conditions
Occurs among all living organisms	Occurs among plants and some simple vertebrates
Occurs by sexual organs such as cones, flowers, testis and ovaries.	It occurs by fragmentation, budding, spores, and vegetative production.

SEXUAL REPRODUCTION

Sexual reproduction involves formation of new individuals by fusion of specialised cells called gametes resulting into fertilisation.

Advantages of sexual reproduction

1. New varieties are produced because characters from different parents are mixed in the offsprings
2. There is no or there's little competition among offsprings or between offsprings and parents
3. Advantageous characters may be enhanced in successive generations
4. Chance of colonising new areas is high as seeds are usually dispersed some distance away from the parents
5. Mass destruction of offsprings by epidemics is unlikely as the offsprings are genetically various
6. Seeds are able, often, to survive disasters such as fires and floods.

Disadvantages of sexual reproduction

1. It is a slow means of reproduction
2. Parental food supply to young ones is limited
3. Some offsprings may find unfavourable conditions which may prevent their growth
4. Agents for pollination and dispersal are often needed and these may not always be available
5. Unless self pollination occurs, two individuals are required.

CONJUGATION

This method involves formation of gametes within cells after which the gametes are transferred from one cell into another cell. It is found mainly in unicellular organisms e.g. bacteria, spirogyra and fungi.

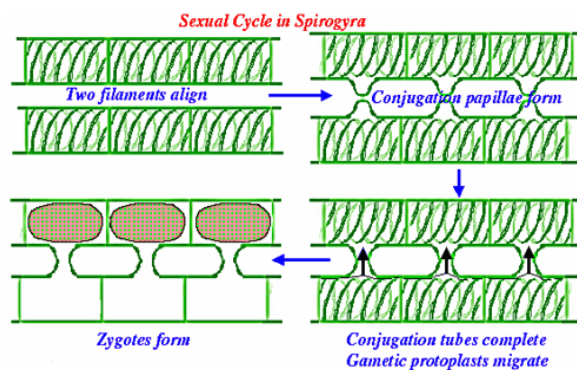
Although spirogyra normally reproduces asexually by binary fission and fragmentation, once in a while sexual reproduction occurs when gametes are formed within cells and they are exchanged. Conjugation may be lateral i.e. between adjacent cells within a filament

or it may be scalariform conjugation where gametes are exchanged between cells in different filaments.

Before conjugation takes place in *spirogyra*, the protoplasm within the cells of adjacent filaments transforms itself into a gamete. Projections then develop on the side walls of the cells which are to undergo conjugation. The projections then come into contact with each other and the walls separating the two projections dissolve away forming a continuous tube called a conjugation tube.

The protoplasm in one of the cells then migrates across the conjugation tube and one fuses with that in the opposite cell, leaving one cell empty while the other cell then contains a fused protoplasm. The cell then undergoes further development and it becomes a zygospore. The cyst enables the zygospore to withstand adverse environmental conditions e.g. drought.

The dry zygospore can also be dispersed by wind to colonise new habitats. When the zygospore finds appropriate environmental conditions, a new filament then germinates from the zygospore to live the normal life of an asexually reproducing *spirogyra*.



REPRODUCTION IN MAMMALS

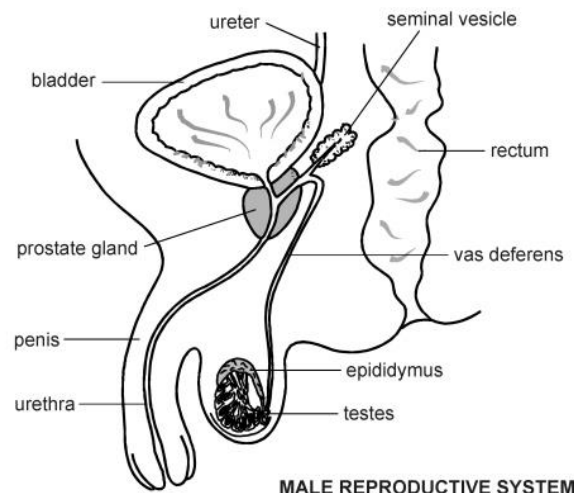
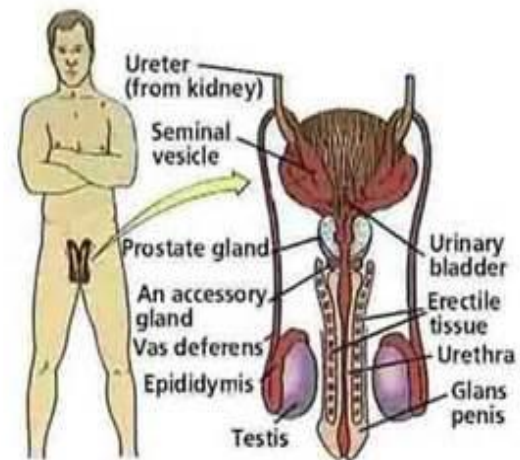
Mammals can only reproduce sexually and this reproduction takes when the male gamete fuses with the female gamete to form a zygote which eventually develops into a new individual.

Male reproductive system

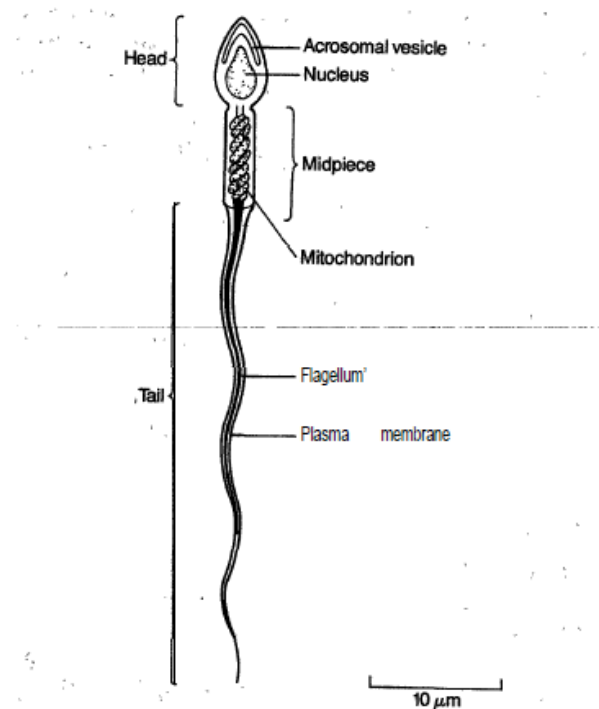
The male reproductive system of mammals consists of a pair of gonads called testis which are located in a sac called scrotum which is found outside the abdominal

cavity of the male. The testis consist of numerous coiled tubes called the male gametes (sperms) are manufactured. The seminiferous tubules unite to form large tubes which eventually unite to form the epididymis in which the mature spermatozoa are stored.

Leading from each testis is a sperm duct (vas deferens) which joins the urinary tract (urethra). There are a number of associated glands which include the Cowper's gland, the prostate gland and the seminal vesicle which pour their secretions into the urethra or vas deferens to facilitate the movement of spermatozoa.



MALE REPRODUCTIVE SYSTEM



1. Diagrammatic illustration of a spermatozoon.

Male sex hormones

The male reproductive system is influenced by a number of hormones called sex hormones. Some of these hormones are secreted by the pituitary glands while others are secreted by the gonads (testis).

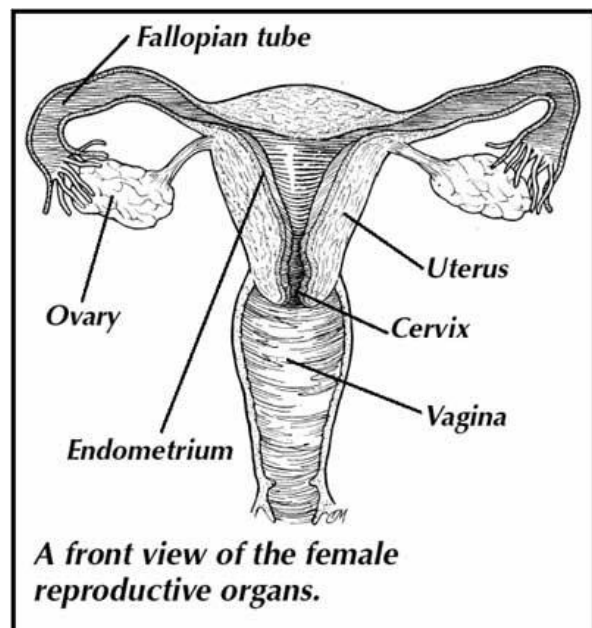
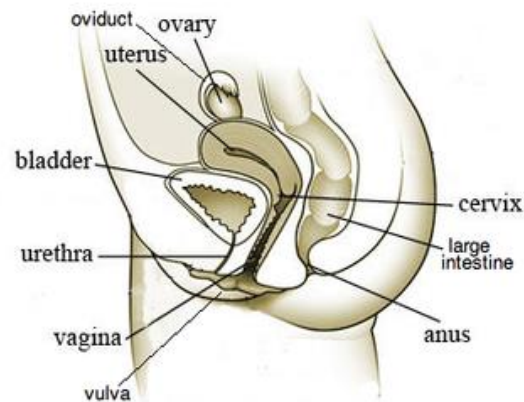
The anterior lobe of the pituitary gland secretes the follicle stimulating (FSH) which triggers the process of spermatogenesis (sperm formation).

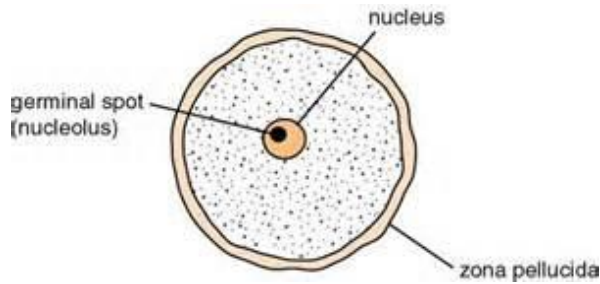
The anterior lobe of the pituitary gland also secretes another hormone called the leutenising hormone (LH) which stimulates the interstitial cells between the seminiferous tubules to start secreting another hormone called testosterone. Testosterone brings about the development of secondary sexual characteristics in male. These male secondary characteristics include;

- i. Development of a deep voice
- ii. Widening of the chest
- iii. Development of beards
- iv. Pubic hair
- v. Development of hair round the armpits
- vi. Interests in the opposite sex

Female reproductive system

The female gonads are the ovaries which are found inside the abdominal cavity. Close to each other, there's an opening of the fallopian tube (oviduct) which leads to the uterus. The uterus opens to the outside through the cervix and the tubular vagina which opens out to the external genitalia through the vulva.





Female sex hormones

Human females undergo a regular sexual cycle from the onset of puberty to the menopause. This cycle is controlled by hormones which are secreted by the pituitary gland and the ovaries.

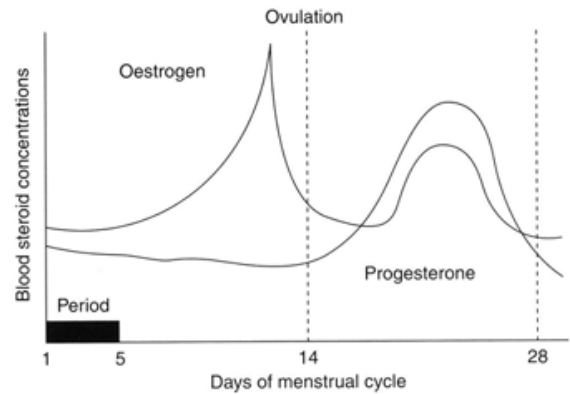
The pituitary gland secretes the Follicle Stimulating Hormone (FSH) and the leutenising hormone. The ovaries secrete oestrogen and progesterone. These four hormones interact to bring about the sexual cycle which in humans is called the menstrual cycle because it involves menstruation.

The menstrual cycle

The human menstrual cycle usually takes about 28 days with day 1 of the cycle being the first day of menstruation.

Menstruation occurs when the endometrium (inner lining of the uterus wall) breaks down due to failure of implantation of a previously released ovum. The wall breaks down due to lack of progesterone which sustains its thickening (proliferation)

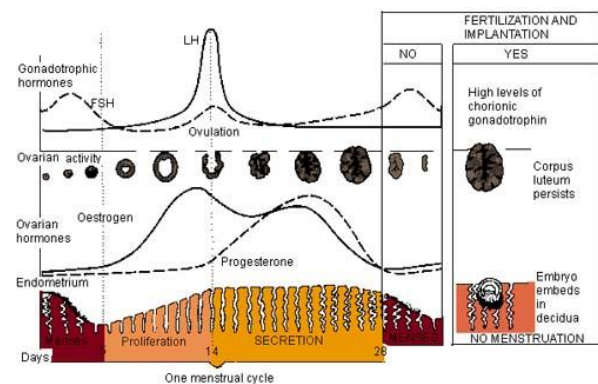
Menstruation takes place between days 3 and 5. During this time, the broken down endometrium is washed out of the reproductive track together with some blood. Mean while, during the same period, the pituitary gland secretes FSH which stimulates the grafian follicles to start undergoing maturation in one of the ovaries. FSH also stimulates the ovary to start producing another hormone, oestrogen.



Oestrogen brings about repair of the endometrium. When levels of the oestrogen rise up to a critical point, they inhibit the production of FSH by the pituitary gland and they trigger the production of LH. Because of the lack of production of FSH, the ovary also stops secreting oestrogen.

LH leads to ovulation, the release of an egg from the ovary, and it also sustains the existence of the corpus luteum (a temporary endocrine gland of the ovaries) which arises out of the discharge of the grafian follicles. The cells within the corpus luteum produce the hormone, progesterone, which brings about the thickening (proliferation) of the endometrium wall by increasing the blood supply and the thickness of the endometrium. This is done in anticipation of implantation in case the released egg is fertilised.

Increased levels of progesterone inhibit the production of LH and when this stops, the corpus luteum regenerates and no more progesterone is produced hence resulting into the breakdown of the endometrium due to absence of progesterone.



Fertilisation

Fertilisation is the fusion of the sperm with an ovum or an egg to form a zygote.

In humans this process occurs after copulation or coitus or sexual intercourse or mating. Mating takes place when the male's intermittent organ, the penis, is introduced into the vagina of the female in order for it to deliver the sperms into the female reproductive tracts.

Before copulation can take place, the penis must become erect, which is brought about by the blood filling the cavities in the erectile tissue of the penis during sexual arousal. This arousal or excitement is directed by the brain which brings about constriction of veins and dilation of arteries such that blood enters into the erectile tissue of the penis.

During copulation, the penis penetrates the muscular vagina, a process facilitated by the secretion of lubricating fluids by the cells which line the vaginal wall as well as the vulva. The movement of the penis within the vagina stimulates the nerve endings within the penis to send impulses to the brain to bring about a reflex action called ejaculation.

During ejaculation, the walls of the epididymis where the spermatozoa are stored, constrict to propel the spermatozoa through the vas deferens towards the urethra. At the point where the two sperm ducts from each testis join the urethra, there's a gland called a seminal vesicle. The seminal vesicle produces secretions which provide an environment suitable for the swimming movement of the spermatozoa. The Cowper's gland and the prostate gland also produce secretions, which together with the spermatozoa and the secretions from the seminal vesicle together form semen. The effect of the secretions from the accessory glands include;

- i. Providing a suitable pH for the sperms to swim in.
- ii. Provide a medium for the swimming action of the sperms
- iii. To provide nutrients (carbohydrates and vitamins) which are used by the mitochondria to produce energy as the spermatozoa swim towards the egg
- iv. The prostaglandins produced by the prostate have an effect of producing some peristaltic

movements mostly in the oviduct to help the spermatozoa along their journey towards the egg.

Ejaculation results into the deposition of semen high up into the vaginal tube close to the cervix. This is done to reduce the distance which spermatozoa swim in order to reach the ovum. After the semen has been deposited, the sperm will swim through the oviducts. If there's a fertile egg within the upper third of the fallopian tube, the sperm will swim towards it and when they reach it, the acrosome, which is found at the tip of the spermatozoa, releases its contents onto the cells surrounding the ovum.

The acrosome contents digest these cells to break up this wall and finally one of the sperms penetrates the egg membrane with its head, after which the tails break off and it remains outside.

As soon as the head of a single sperm enters the cytoplasm of an ovum, a reaction is triggered to thicken the membrane surrounding the cell. The thickened membrane prevents any other sperm from entering the cytoplasm of the egg cell hence the name fertilisation membrane.

The nuclear wall of the sperm nucleus disintegrates and the nucleus of the ovum undergoes a second meiotic division and all chromosomes from both the ovum and the sperm lie along the equator forming complementary pairs of chromosomes of a diploid cell called a zygote.

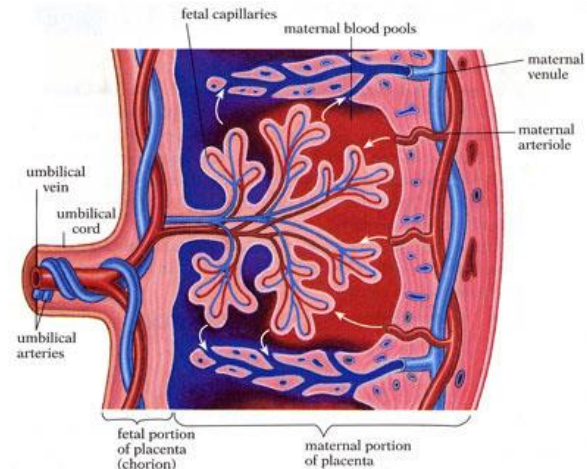
After formation of the zygote, the new cell starts to undergo a series of mitotic cell divisions eventually resulting into a mass of cells called a blastocyst. This mass of cells becomes embedded in the endometrium during the process of implantation. It is at this time that the female is said to have undergone conception.

Pregnancy

Pregnancy refers to the period between implantation and the birth of a fully developed baby. This period is referred to as the gestation period and during this time there are a number of changes which occur in the mother as well as the developing baby.

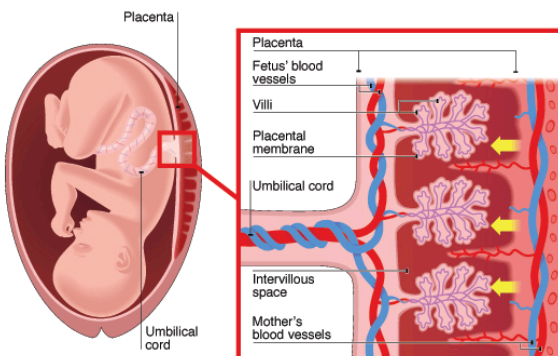
During the first few weeks the developing baby is referred to as an embryo before the tissue are formed. As the tissue form, it is referred to as a foetus up to the time when it leaves the mother's womb.

Soon after implantation, the mother and the foetus tissue, at the site of implantation, develop into a common organ consisting of numerous blood capillaries of the foetus embedded into sinuses of maternal blood, this region is known as the placenta which performs a number of functions during the gestation period.



Functions of the placenta

1. Passage of soluble food from maternal blood into the foetal blood
2. Passage for oxygen from maternal blood into the foetal blood
3. Passage for waste products from foetal blood into the maternal blood
4. It prevents entry of pathogens from maternal blood into the foetal blood
5. It prevents the mixing of maternal and foetal blood.
6. It prevents toxins from crossing into the foetal blood from the maternal blood.
7. It allows antibodies to cross from maternal blood into foetal blood hence enabling the baby to be born with some antibodies
8. It is an endocrine organ which produces hormones e.g. progesterone as well as Prolactin which stimulates the development of mammary glands.



After the establishment of the placenta, the embryo continues to develop slowly acquiring features of the adult human. During its development, the embryo is enclosed in a fluid filled membrane called the amnion, which secretes the amniotic fluid in which the developing foetus is suspended. The fluid cautions the features from mechanical injury which could result from movement from the mother. All through its stay in the uterus, the foetus is connected to the placenta by the umbilical cord which bears an artery and a vein. The artery brings in blood deficient in oxygen and rich in carbon dioxide and nitrogenous wastes from the heart of the foetus while the veins carry blood rich in oxygen and nutrients from the placenta towards the heart of the foetus. These materials are exchanged in sinuses found within maternal tissue which are penetrated by capillary networks from the umbilical artery and umbilical vein.

Towards the end of the gestation period, the foetus orients itself in such a way that it is the head which is adjacent to the cervix.

Birth / parturition

At the end of the gestation period, the fully developed foetus produces substances which when detected in the expectant mother's brain, stimulates the posterior pituitary to produce a hormone called Oxytocin. The same substance brings about the inhibition of progesterone secretion. Oxytocin has the effects of bringing about contraction of the smooth muscles of the wall of the uterus. These contractions are initially weak but they increase in intensity and regularity as

time goes along, the expectant mother experiences some pain with these contractions, hence, labour pains.

These contractions together with the additional force created by forceful contraction of abdominal muscles will force the amnion to break, hence releasing the amniotic fluid. The cervical plug will become dislodged and the birth canal will become widened due to the opening up of pubis symphysis. The combination of these actions will lead to the baby being expelled out head first, through the vagina.

In humans the baby is expelled while the umbilical cord is still attached onto the placenta. The cord has to be physically cut and ligatured to prevent loss of foetal blood through the umbilical cord.

In humans, the placenta is later expelled as the 'after birth'. Oxytocin stimulates the release of milk by the mammary glands which provide milk which is the side diet of the young human being.

BIRTH CONTROL

Human population of recent time has undergone very rapid increase i.e. population explosion, due to a number of factors. Today some countries/regions are experiencing overpopulation i.e. failure of resources to support the population.

The increase in population has been brought about by a number of factors;

1. Improved agriculture
This has resulted into plentiful supply of food which eliminated death due to famine. This coupled with globalisation has resulted into relative elimination of starvation by transferring food from one region to another. Deaths due to malnutrition were eliminated resulting into the growth of majority of newly born children up to maturity.
2. Improved health services
3. Relative peace

Methods of controlling birth

1. Persuasion, persuade the population the need to exercise some form of birth control
2. Forcing couples to have one child

3. Transformation of social institutions e.g. decentralisation of government activities.

Contraceptive methods

1. Condoms

This method works by preventing the male and female gametes from coming into contact.

It is reliable if properly used.

This method involves the placing of a thin membranous rubber sheath over the penis to trap semen released in a single ejaculation. Today a female condom may be used; it bears 2 rings where one ring is placed inside the vagina while the other ring remains outside, lining the female external genitalia. The semen produced during intercourse is trapped within the tube. The female condom is also useful in controlling STD's since it limits contact between the external genitalia of both individuals.

2. Contraceptive pills

It involves taking pills containing hormones by mouth or injection. The hormones interfere with the reproductive cycle, having effects like prevention of ovulation.

3. Abortion

It may be dangerous to the life of the expectant mother, unless it is carried out by a fully qualified experienced medical officer.

4. Cervical cap

This method is reliable, especially if used in conjunction with chemical contraceptives.

5. Spermidal creams/jellies

These are chemicals which kill or disable sperms to prevent them from swimming to the egg. They are usually best used in conjunction with one of the barrier methods. It is a very efficient method of preventing conception since spermatozoa cannot reach the egg.

6. Water /hot pants

This method involves men wearing very tight rubber pants which retain heat around the testis making the sperms which are stored unable to swim efficiently.

It is not reliable.

7. Intra Uterine Device (IUD)

This is a mechanical method which uses mainly plastic coils or loops. The device is inserted into the uterus by qualified personnel. Its presence in the uterus prevents implantation of the blastocyst.

The method is reliable but it requires qualified personnel for its administration.

8. Natural rhythm

This method employs the observation of “safe days” periods of the woman’s natural cycle. Couples desist from sex during the “unsafe” days i.e. when there’s a live egg, within the female’s reproductive tract.

This method requires careful study of the female menstrual cycle.

Reliability can be improved upon by daily observation and recording of the female’s body temperature, since it’s known that ovulation results into a slight rise in temperature. Careful plotting of the observed temperature can make the method more reliable.

9. Sterilisation

This method is very reliable and permanent since the gametes are no longer released.

10. Coitus interruptus

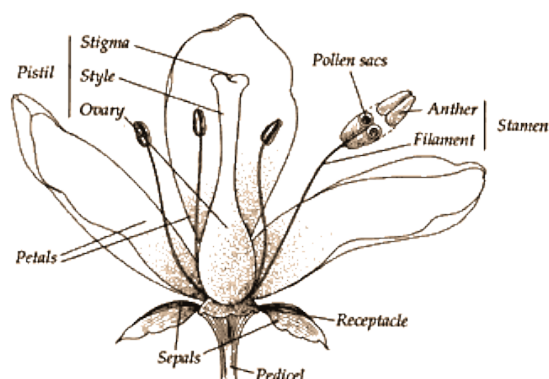
This involves withdraw of the penis from the female system just before ejaculation. It is highly very unreliable.

SEXUAL REPRODUCTION IN PLANTS

Flowers are organs of sexual reproduction in angiosperms

A complete flower has four whorls. The outermost being the **calyx** which is made up of sepals which protect the flower during the early stages of development. Just beneath the calyx is the **corolla** whose function is to attract pollinators. The next whorl is the **androecium** which produces male gametes within the pollen grains which are produced in the anthers of the stamen. The inner most whorl is the **gynoecium** in which the female gametes are produced by the ovules of the ovary of the stigma.

General structure of a flower



POLLINATION

This is the transfer of mature pollen grains from the anther heads to the stigma.

The process is usually carried out by agents such as wind, insects, birds and human beings. The table below shows the summary of typical differences between wind pollinated and insect pollinated flowers.

Wind pollinated	Insect pollinated
Small petals or petals absent	Large petals
Nectarines are absent	Nectarines are present
They have no scent	They have a scent
Large quantities of pollen are produced	Few pollen grains are produced
Large branched and feathery stigma	Small stigma which is sticky and
Stigma is hanging outside the flower	Stigma is enclosed within the flower
They have light pollen grains which are small	Pollen grains are relatively heavy and large
Pollen grains are dry and often with smooth walls	Pollen grains have spiny and sticky walls

There are two types of pollination, self pollination and cross pollination

a. Cross pollination

This is the type of pollination where pollen is transferred from anthers of a flower on one

plant to the stigma of a flower on another plant of the same species.

b. Self pollination

This is the transfer of pollen from anthers to stigma of a flower on the same plant

Avoiding self-pollination

1. The stamens ripen before the stigmas, e.g. butter cup. Such flowers are referred to as **protandrous flowers**.
2. The stigmas ripen before the stamens, e.g. plantain. Such flowers are referred to as **protogynous flowers**.
3. The flowers are of more than one kind, the length of the style in each case being different, thus causing the position of the stigma to vary in relation to that of the stamens e.g. primrose
4. The flower has a stigma onto which its own pollen will not develop, e.g. sweet peas.
5. Some flowers lack stamens, others on the same plant lack carpels, e.g. hazel and maize i.e. male and female flowers are separated on the same plant. Such plants are referred as **monoecious plants**
6. All the flowers on some plants lack stamens, on other plants they all lack carpels e.g. holly. Such plants are referred as **dioecious plants** e.g. pawpaw
7. The stigma is at times borne above the anthers, thus removing the possibility of pollen falling onto the stigma of the same flower

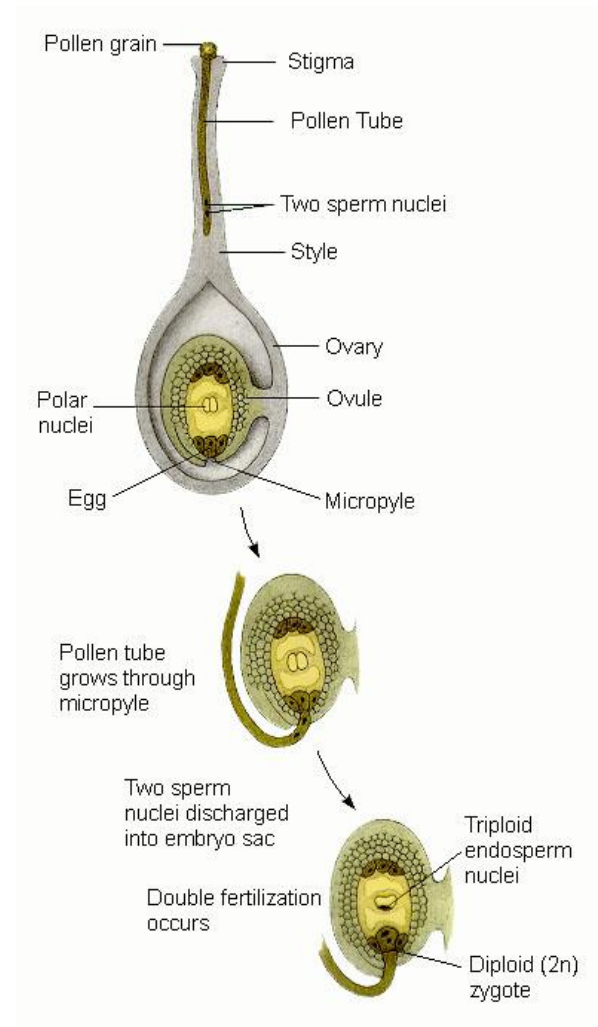
FERTILISATION

When mature pollen lands on the stigma, a pollen tube germinates out of the grain into the tissue off the stigma. While deriving nourishments from the stigma tissue, the tube grows through the style into the ovary and finally to the ovule.

During its growth, the nuclei (tube nucleus and generative nucleus) follow close to the tip of the growing tube. On reaching the ovule, the tube enters it through the micropyle and it eventually the embryo sac. In the embryo sac, the tube nucleus degenerates and the tip bursts open.

The generative nucleus meanwhile divides into two nuclei, one of these nuclei fuses with the egg cell (female gamete) to form a diploid zygote which gives rise to the embryo. The other male nucleus fuses with the polar nuclei to form a triploid endosperm nucleus which is the precursor of the seed endosperm.

After fertilisation, the integuments surrounding the ovule become the seed coat while ovule becomes the fruit.



ASEXUAL REPRODUCTION

Advantages

1. More offsprings are produced
2. The offsprings are identical to the parent
3. It is a quick means of reproduction
4. Only one parent is required

Diadvanges

1. Leads to overcrowding
2. There's no variation
3. It reduces hybrid vigor
4. Diseases can easily be transmitted from parents to offsprings

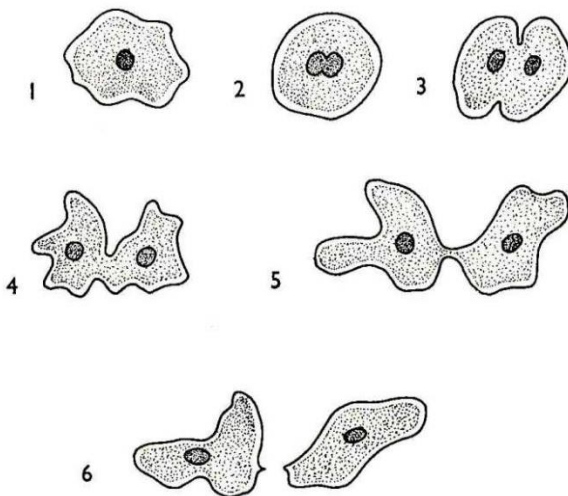
ASEXUAL METHODS OF REPRODUCTION

These produce organisms whose cells are genetically identical to one another and are known as clones.

a. Binary fission

It involves the splitting of one parent cell to form two (2) daughter cells.

It is observed in amoeba and bacteria. The cytoplasm is divided to parts followed by division of the nucleus.

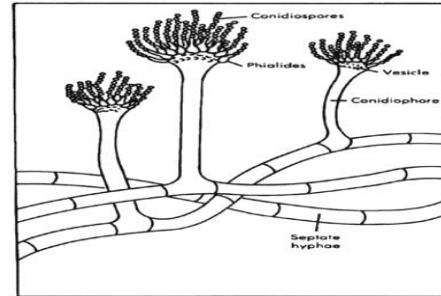


b. Multiple fission

It is similar to binary fission of amoeba. The cytoplasm divides into three or more equal parts.

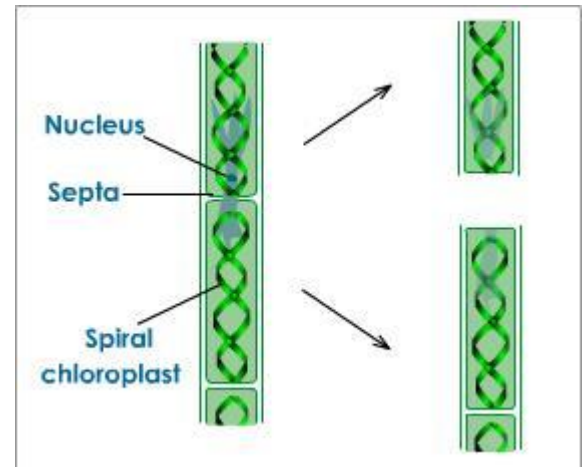
c. Septation

This is observed in spirogyra and algae. It occurs when a parent divides by forming a new cell wall or septum to separate the daughter cells



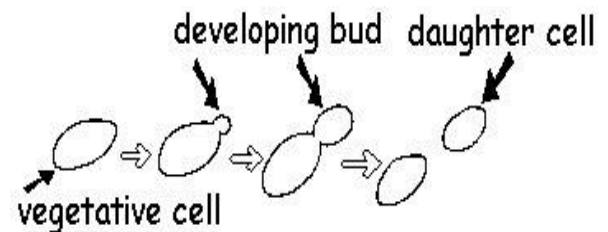
d. Fragmentation

This is the separation of the daughter cells which occurs in the transverse plane. The separation occurs due to increased mechanical stress on a greatly elongated filament



e. Budding

This is seen in the simplest form in yeast when the cell forms a small bulge into which the cytoplasm and the nucleus pass. The bud is smaller than the parent cell and it becomes detached

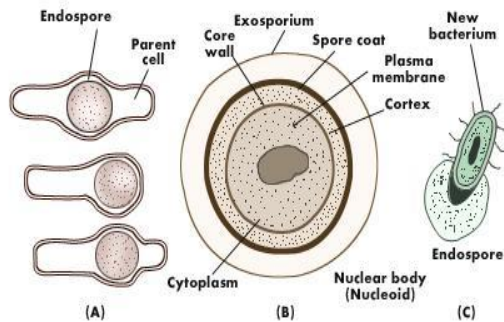


It also occurs in hydra and in the tapeworm. The tapeworm shows budding when the proglottids breaks away from the neck of the scolex.

f. Spore formation

Fungi, bacteria, mosses and ferns reproduce by means of spores.

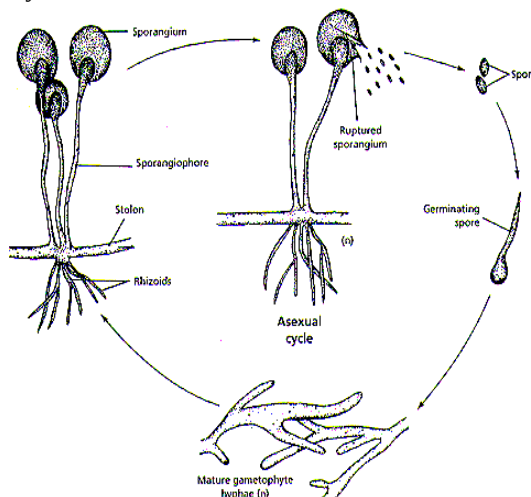
Bacterial spores: certain bacteria form a small thick walled spore inside the bacterial cell wall. This, like most spores, can resist unfavourable conditions of drought and extreme heat. Many bacterial spores survive cooking temperatures to cause food poisoning. Light spores are carried by air currents to infect exposed food.



Endospore formation. A, Endospores according to their position in parent cell. B, An endospore in cross-section. C, Germination of endospore.

Spore producing sporangia: Mucor or the pin mould found on decaying bread and fruit is able to produce a single hyphae from its body or mycelium. These erect hyphae develop a swelling at its top to form a sporangium, separated from the rest of the body mycelium by a columella.

A great number of spores are produced by mitosis and they are liberated on bursting the sporangium and are carried over great distances by air currents. Each spore germinates on a suitable medium to form small hyphae which produces an extensive mycelium.

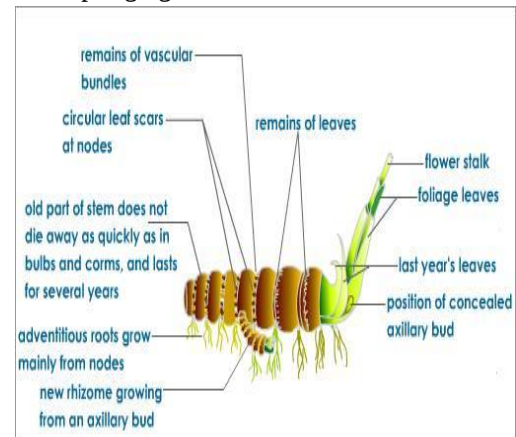


g. Vegetative reproduction

This is an asexual method in which specialised multicellular organs form and become detached from the parent, giving rise to new individual plants.

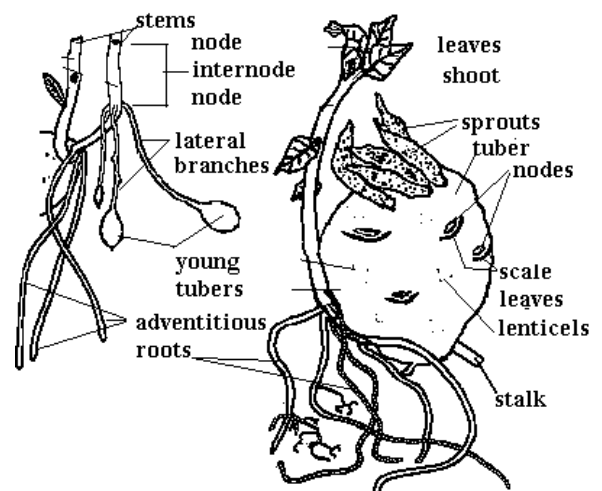
The organs include bulbs, tubers, rhizomes and runners.

Rhizomes are horizontal underground stems e.g. ginger. They form a branching network by vegetative propagation with adventitious roots springing from the stem.

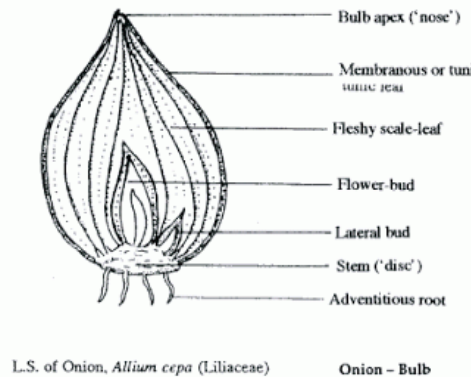


A tuber is either a swollen underground stem e.g. Irish potato, yam or a swollen underground root e.g. cassava and sweet potato.

9.85 Potato



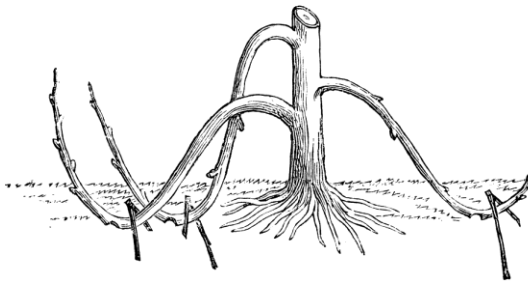
A bulb is a leafy swollen underground structure similar to a large swollen bud as seen in onions and lilies.



h. Artificial propagation methods

1. Layering

Layering involves pegging down of a stem into the soil structure. New daughter plants develop adventitious roots e.g. sweet potato

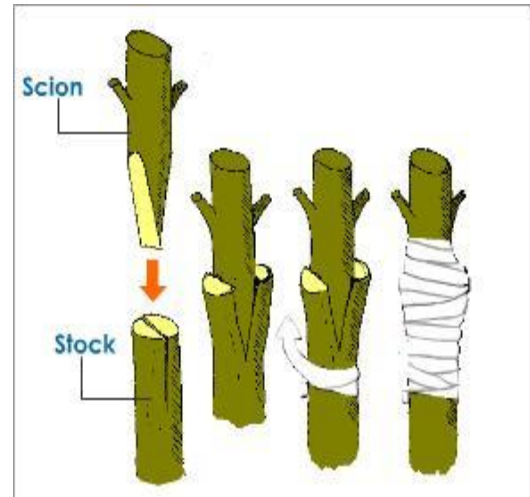


2. Cutting

A piece of root, stem or a complete leaf is dipped in a rooting mixture composed of plant hormones and allowed to grow in a rooting composite or soil.

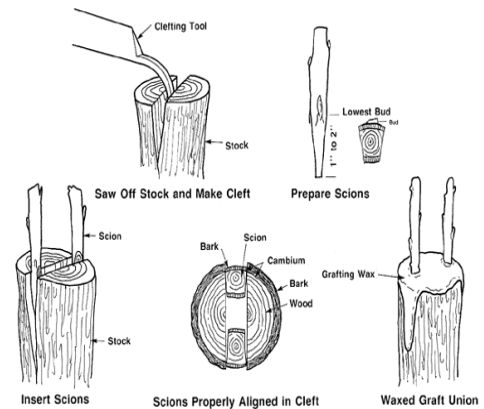
3. Budding

This is where by a dormant bud, taken from one woody plant (scion) is made to grow on a well established root system of another (stock).



4. Grafting

Grafting involves inserting a scion, bud or stem into another closely related species or stock. It involves union of stem vascular bundles and the exposed cambium of the two plants must be in contact e.g. stem grafting.



5. Tissue culturing

This is the growth of pieces of plant or animal tissue in a sterile solution of nutrients maintained at 35°C

Advantages of asexual reproduction

- Many offsprings are produced
- Only one parent is required
- It does not require fertilisation
- It is a quick means of reproduction
- Offsprings are identical to the offsprings