Angiosperms

VARIATION MEANS THAT THERE IS A RANGE OF CHARACTERISTICS SO IF WIPED OUT THERE IS A GREATER CHANCE OF SURVIVAL.

·Petals: collectively form the corolla, and are often coloured and scented. They attract insects that visit the flowers and collect nectar and pollen, pollinating the flowers as they do so. Small grooves or darker lines in the petals called 'nectar guides' are thought to direct the insect to the nectarines within the flower.
·Sepals: collectively called the calyx. They are usually green, but sometimes they are the same colour as the petals. They enclose and protect the rest of the flower while it is in bud.
·Nectary: plants produce a sugary liquid called nectar to attract insects to the flower.
·Receptacle: the swollen base of the flower, which sometimes forms the succulent tissue of the fruit.

Male structures (androecium)
The Stamen
·Consists of a filament and an anther.
·Anther: contains pollen grains in 4 spore sacs, which are each surrounded by a jacket of cells that nourish it. It is the top portion of the stamen.
·Filament: the slender stalk part of the stamen that supports the anther.
·Pollen grains: are immature male gametophytes, formed by meiosis in the microspore mother cells within the pollen sac. They contain the male reproductive cells (gametes). Different pollens vary in shape and pattern, and genera can be easily distinguished on the basis of their distinctive pollen. The species-specific nature of pollen ensures that only genetically compatible plants will be fertilised. Some species such as Primula (primrose) produce two pollen types and this assists in cross-pollination between different flower types.

Female structures (gynoecium)
The Pistil
·Consists of carpels. An entire female part is the carpel. There may be one or more carpels per flower.
·Stigma: the receptive part of the carpel. Pollen grains will germinate only if they land here.
·Style: the structure that supports the stigma.
·Ovary: the base of the carpel where the ovules develop. Once fertilised, the ovary becomes the fruit.
·Ovules: these are eggs and once fertilised they become seeds. The ovule skin becomes the seed coat (testa).

Monoecious
·Male and female parts on the same plant. Some of these plants self-pollinate, but most have mechanisms that make this difficult or impossible. The male and female parts may be physically separated in the flower, or they may mature at different times.
·Protandrous plants: the male matures first.
·Protogynous plants: the female matures first.
·Angiosperms are successful because they have mechanisms to avoid self pollination
·Monoecious plants do this by having the male and female parts physically separated or they mature at different times

Dioecious
·Carry the female and male flowers on separate plants. Different methods of pollination (animal, wind, water) help to ensure that cross-pollination occurs.
·Dioecious plants ensure cross pollination by having male parts and female parts on separate plants
·This is important because cross pollination provides variation within the species which promotes its survival

Gametophyte Generation
·Haploid or N phase.
·Produces gametes by mitosis.
·In angiosperms, the gametophyte generation is reduced in size to just a small number of cells.
·Anthers develop an immature gametophyte in the form of a pollen grain.

Sporophyte Generation
·Diploid or 2N phase.
·Produces spores by meiosis.
·In angiosperms, the sporophyte generation is clearly dominant.

The Angiosperm Life Cycle
·The primary method of reproduction for flowering plants is by seeds, which develop after the fertilisation of the female parts of the flower and contain the protected plant embryo together with a store of food.

·The typical life cycle of a flowering plant involves the formation of gametes (egg and sperm) from the haploid gametophytes, the fertilisation of the egg by a sperm cell to form the zygote, the production of fruit containing the seed, and the germination of the seed and its growth by mitosis.
·The eggs and sperm are contained within the female and male gametophytes(embryo sac and pollen grain).

Meiosis
·In the ovule, meiosis produces haploid megaspores (N), one of which gives rise to the female gametophyte (embryo sac).
·In anthers, meiosis produces haploid microspores (N), which give rise to the pollen grains.
·Pollen grains produce the sperm.

Pollination
·When the pollen is transferred from the anthers to the stigma it is called pollination.
·Cross-pollination is the transfer of pollen from the anthers of one flower to the stigma of another flower of the same species.
·Pollen grains cannot move by themselves and so are usually carried by wind (anemophily): chance air-currents carrying the pollen from one flower to the next, or animals (entomophily).
·Plants rarely self-pollinate, although they can be made to do so.
·Most often the stigma of one plant receives pollen from other plants in cross-pollination.
·Adaptations to ensure cross-pollination include structural and physiological mechanisms associated with the flowers themselves, and the reliance on wind and animal pollinators.
·Once pollination has occurred, the sperm nuclei can enter the ovule and fertilisation can take place.

Animal Pollination
·Common animal pollinators include insects, bats, birds and small reptiles.
·Animals are able to transfer pollen between plants very effectively and often over large distances, so many plants have come to depend on one or two animal pollinators only.

Insect Pollinated flowers
·Flowers that are pollinated by insects typically offer an attraction such as nectar, scent or edible flower parts, and their pollen is relatively large and heavy.
·Petals form guides for insects that visit for nectar or pollen.
·In this way, wandering insects transfer pollen.
·Pollen can be transported from flower to flower on the hairs of insects.
·For plants that are insect pollinated, pollen grains are usually spiked or sticky to attach to insects.

Wind Pollinated flowers
·On wind-pollinated flowers the stigma are large and feathery and suspended clear of the flower by long styles.
·Large quantities of smooth, dry pollen are produced and no scent or nectar is produced.
·Anthers hang well clear of the flower and produce lightweight pollen, which is easily carried away.
·Wind pollinated flowers typically have many tiny flowers grouped on a stalk or spikelets.
·Most grasses are wind pollinated.
·The feathery appearance of their flowers is typical of wind-pollinated plants and they are often a dull colour.

Fertilisation
·After the pollen grain has landed on the sticky stigma, it is able to complete development, germinate, and grow a pollen tube that extends down to the ovary.
·To do this it absorbs substances secreted by the stigma, and the cytoplasm in the pollen grain grows out as a tube.
·This tube grows down through the style between the cells and is directed by chemicals such as calcium.
·On reaching the ovary it grows to one of the ovules and enters the ovule through the micropyle, a small gap in the ovule.
·The tip of the pollen tube breaks open in the ovule, and the male nucleus, which has been passed down the tube, enters the ovule and fuses with the female nucleus there.
·This produces a zygote.
·After this, the second sperm nucleus fuses with the two polar nuclei within the embryo sac to produce the endosperm tissue (3N).
·This process is known as a double fertilisation.
·The double fertilisation is a special feature of angiosperm reproduction.
·There are usually many ovules in an ovary; therefore many pollen grains are needed before the entire ovary can develop.
·Each egg cell of an ovule can only be fertilised by a male nucleus from a separate pollen grain.
·As the fertilisation of the egg and sperm involves gametes from different flowers, the new organism contains genetic material different to its parents
·The genetic variation therefore increases the chance of survival for the species of angiosperm as they may be able to survive environmental changes

Result of fertilisation
·After fertilisation, the petals, stamens, style and stigma wither and usually fall off.
·Food made in the leaves reaches the fertilised ovules and the ovary, which grow rapidly.
·Inside the ovule, cell division and growth produce a seed containing a potential plant or embryo.
·The zygote is dividing to develop into an embryo.
·The embryo consists of a plumule (young shoot), a radicle (young root) and one or two cotyledons.
·The integuments of the ovules become thicker and harder, forming the testa of the seeds.
·After this the water is withdrawn from the seeds, making them dry and hard.
·The ovary wall may become dry and hard, forming a capsule or pod, or it may become succulent and fleshy forming a fruit.

Fruits:
·Occur only in angiosperms and their development has been a central feature of angiosperm evolution.
·A fruit is a mature, ripened ovary.
·As a seed develops, the ovary wall around it enlarges and changes to become the fruit wall or pericarp, which has 3 sections.
·Fruits may open to release the seeds or they may retain the seeds and be dispersed whole.
·Succulent fruits are usually dispersed by animals and dry fruits by wind, water or mechanical means.
·Ovary may swell and form a fleshy fruit after fertilisation and this
high-energy fruit is attractive for animals as they eat the fruit and their undigested seeds, which are then passed through their systems in faeces.

Mitosis
·The seed holds the embryo, which develops by mitotic division from the zygote (2N).
·Eventually, the sporophyte matures to produce flowers (2N).

Dispersal of fruits and seeds
·When flowering is over and the seeds are mature the whole ovary, or the individual seeds, fall from the parent plant to the ground, where if conditions are suitable germination will occur.
·In many plants, the fruits or seeds are adapted in such a way that they are distributed away from the parent plant and this helps to reduce overcrowding among and competition between members of the same species for light, air, water and mineral salts.
·It also results in the colonisation of new areas.
Wind dispersal
·Censer mechanism: the ovary becomes a dry capsule that partially opens at the top. The capsule is at the end of a long stalk that is shaken to and fro by the wind. The seeds that have become detached from the placenta are shaken out and scattered.
·'Parachute' fruits and seeds: feathery hairs projecting from the fruit or seed increase its surface area so much that air resistance to its movement is great. As a result it sinks to the ground slowly and is likely to be carried great distances from the parent plant by air currents.
·Winged seeds: some seeds have papery extensions formed from the placenta or testa making wing-like structures. The extra surface area of these wings offers increased air resistance, so delaying the fall of the seed and increasing its chances of being blown away from its parent by the wind.

Animal Dispersal
·Mammals: hooked fruits. The hooks that develop on some seeds catch in the fur of passing mammals or in the clothing of people. The seeds may fall from the fruit during the animal's movements or the whole fruit may be brushed off or scratched off some distance from the parent plant. If the seeds fall in a situation where there is adequate soil, moisture and light, they will germinate.
·Mammals and birds: succulent fruits. The succulent texture and sometimes the bright colour of fruits attract birds and mammals. Sometimes the fleshy part of the fruit is eaten and the seeds with their resistant seed coats pass undigested through the animal's alimentary canal, to be dropped with the faeces some distance from the parent plant. In other cases, the fruit is carried away from the parent tree, the flesh is eaten and the seed discharged.

Self-dispersal
·The pods formed by flowers dry and shrivel.
·The tough fibres in the pericarp shrink and set up a tension.
·When the pod splits in half, the two halves twist up trapping the seed between the coils.
·As the coils tighten the seeds are squeezed out and projected away from the parent, like an explosion.

Dormancy
·The embryo inside a seed is in a state of dormancy where the metabolic processes have almost ceased.
·The seed remains dormant until conditions are suitable for germination.
·This is an advantage to the seed as it enables it to survive over winter and ensures that it does not germinate until conditions are ideal.

Ferns
·Environmental: occurs in shady, damp areas
·The sporophyte generation is dominant

Alternation of generations concept
·Alternation of generations: haploid (n) and diploid (2n) generations alternate in reproducing each other. The gamete producing plant alternates with a spore producer. The spore producer is a large conspicuous plant
·There are two plants: the large, familiar fern which is a spore producing plant and a very small gamete producing plant
·The sporophyte is always diploid and forms spores through meiosis while the gametophyte is always haploid and forms gametes by mitosis

Diploid spore-producing plant (sporophyte)
·Sporophyte: the diploid plant (generation) which produces haploid (n) spores by meiosis
·The diploid stage in the life cycle is now the large predominant plant
·It produces spores adapted for dispersal in dry conditions
·Have cells with two sets of chromosomes and forms sporangia (a spore case)which contain the spores, on their leaves

Spore formation
·Reduction division takes place in the production of spores (meiosis)
·This takes place within special called (sporocytes) within the spore case
·Meiosis halves the chromosome number to produce spore cells with one set of chromosomes
·As a result of meiosis, the chromosomes in the spore cells are likely to contain new combinations of genetic material
·Spore cells are surrounded by thick protective walls so are able to withstand periods of exposure to the elements and be widely dispersed with no negative effects

Spore release
·Spore release is the result of the loss of water from a band of cells called the annulus, which encircle the spore case
·The force is strong enough to pull the delicate outer wall of the band inwards, hence shortening it
·When too much water is lost, the remaining water molecules are unable to hold together and water goes from the liquid to gas phase
·Water is unable to pull on the adjacent walls and they are instantly released and free to return to their original place
·The annulus returns to its original length and the sporangium close so fast that the spores are thrown out
·Small filaments called rhizoids attach it to the substrate
·Sex organs are formed on the under-surface, where the moist environment and their sterile jackets help protect them from desiccation
·Haploid spores released from sporangia are carried by the wind
·If they land in a moist area they can grow into a haploid prothallus, which is up to 1cm across
·Developing spores are produced meiosis of spore mother cells

Haploid gamete plant (gametophyte)
·Gametophyte: the haploid generation. Formed by mitotic division of spores resulting in a multicellular male/female gametophyte. The gametophyte produces sperm/eggs (gametes) by mitosis
·The spore will germinate into a tiny gamete plant called the prothallus
·The prothallus is haploid
·This plant requires protection from exposure to full sunlight as it is
susceptible to drying out

Fertilisation
·Zygote: the diploid (2n) stage, formed by fertilisation of sperm and egg
·Archegonia: each produce a female gamete (oosphere or egg) by mitosis
·Antheridia: produce male gametes (antherozoid or sperm) by mitosis
·Mature antherozoids swim towards the archegonia in the water film found between the lower surface of the prothallus and the ground
·Sperm are attracted by chemical recognition
·The female gamete is stationary and the male gamete has to move
·Fertilisation is external which prevents ferns from becoming established in dry habitats as they rely on water for fertilisation
·This is a disadvantage for plants living in terrestrial habitats
·The sexual part of their life cycle is restricted to water, which limits their habitats
·The release of sperm and opening of the egg case are triggered by a water film
·Sperm contain flagella and swim towards the source of a sperm attractant released by the egg cases
·Many fern gametophytes are bisexual or hermaphroditic but self fertilization is discouraged by having the maturation of sperm and egg cases at different times
·Bisexual gamete pants can enter into a female phase and induce neighbouring plants to form sperm sacs, thereby encouraging cross fertilisation
·This introduces another opportunity for recombination of genetic material when two sets of chromosomes are combined in the fertilised egg cell

Embryo and new spore plant

·The fertilised egg is held within the egg case and nourished by the gamete plant until it has formed an embryo spore plant with root, shoot, and first leaf
·As the zygote develops into an embryo it is protected by the gametophyte
·After fertilisation a sporophyte plant grows out of an archegonium
·The diploid fern plant produces large fronds, which carry out photosynthesis
·There is an extensive root system which absorbs mineral nutrients and water from the soil
·The spore plant grows and enlarges while the gamete plant withers and dies

The life cycle of a fern
·The fronds are divided into leaflets called pinnae
·Spores are produced on the underside of the fronds in structures called sporangia
·Sporangia are found in clusters called sori, and each sorus is covered by a protective hood called an indusium
·Inside the sporangia, diploid spore mother cells divide by meiosis to produce haploid spores
·Spores are released in dry conditions as a strip of cells called the annulus, in the wall of the sporangium curls back and ruptures the sporangium
·The spores are carried away on air currents
·They germinate in moist conditions, dividing by mitosis to form a haploid structure called a prothallus
·The prothallus has no cuticle and no supportive or specialised conducting tissue, so it can only grow in moist conditions
·The prothallus is the gametophyte generation in the fern's life cycle
·Male gametes and female gametes are produced by mitosis inside antheridia and archegonia, both on the underside of the prothallus
·The zygote remains inside the archegonium as it divides repeatedly by mitosis
·It develops into a new sporophyte
·At first, the embryo sporophyte obtains its nutrients from the prothallus, but once it has formed its first leaves it can photosynthesise for itself
·The gametophyte then dies, and the sporophyte continues to grow to form a new fern plant

Comparisons
Similarities
·Both form gametes by meiosis
·Both have plants that are monoecious and dioecious
·Both alternate between sporophyte and gametophyte generations but they have different reliance on them
·Both use sexual reproduction
·Fertilisation is followed by mitosis in both
·Spores and seeds have protective cases
·Both have chemicals to ensure fertilisation occurs. E.g. attraction of gametes to each other- synchronisation
·Both have food stores for the embryo but: -ferns- the growing embryo is nourished by the gamete plant until new plant is able to sustain itself
·Both have mechanisms of dispersal to avoid competition with parent plant but mechanisms are different
·Both have male and female parts
·In both the sperm is mobile

Differences
Fertilisation:
·Ferns- it is external. Occurs in the gametophyte plant. Less evolved, less efficient; don't need flowers, less energy cost, as there is no nectar, petals, etc. need water. Chances are less as abiotic factors affect them to a greater extent in their reproductive cycle. Sperm have flagella to reach egg.
·Angiosperms-it is in the ovary. Occurs in the sporophyte plant. Have become more adapted to allow them to suit more environmental conditions. Have double fertilisation.

Pollination:
·Ferns- doesn't have pollination, forms spores. Angiosperms- use wind, animals, and insects. Rely on pollinating agents and growth of pollen tube for pollination and fertilisation.

Different structures:
·Greater diversity of structures in angiosperms enabling them to exploit wider ranges of habitats- they are higher order plants

Spore formation:
·Angiosperms- 2 spore types each forming either male or female gamete
·Ferns- one spore forms gametophyte plant which form both male and femalegametes

Dispersal:
·Ferns- spore case, annulus cells shrink, case bursts
·Angiosperms- rely on wind, water, animals etc for dispersal