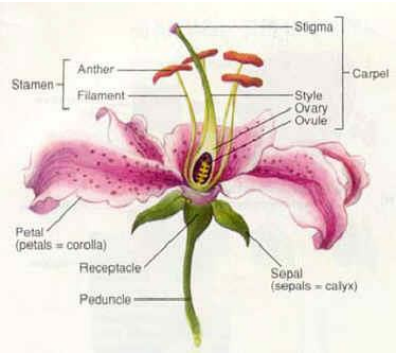
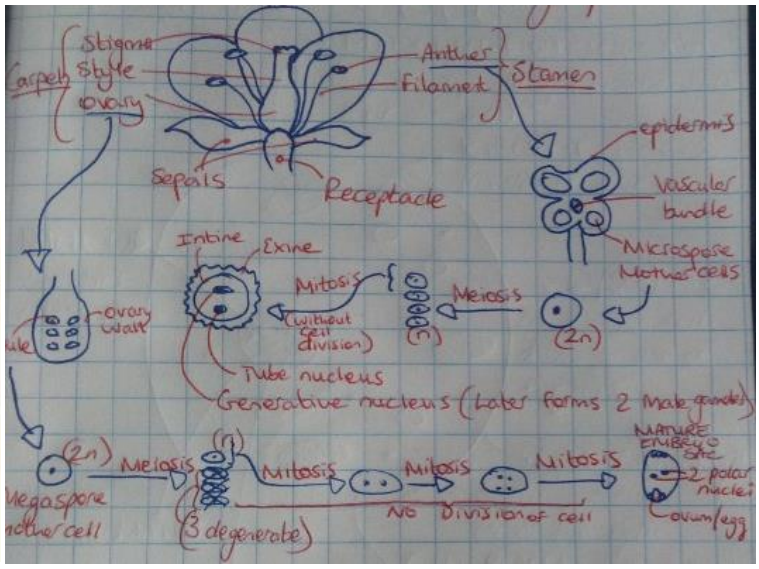
Plant Reproduction | Topic Notes

Sexual reproduction is the fusion of male and female gametes to produce a diploid zygote. (The new individual is genetically different from both parents). Advantages include ***genetic variation***, ***reduced competition*** (between parent & offspring) and good ***chance of surviving harsh winter***. A disadvantage is that there's a ***long period of growth required.***

Structure of flowering plant:



Megaspore (egg) formation & microspore (pollen) formation:



- The **carpel** (female part of the flower) is composed of the **stigma** (sticky to trap pollen grains), **style** (supports stigma in best position to trap pollen grains) and **ovary** (contains 1 or more ovules which following fertilisation will develop into seeds).
- The **stamen** (male part of the flower) is composed of the **anther** (produces pollen grains) and **filament** (supports anther in best position to transport pollen grains).
- **Sepals** support the developing flower before it blooms.
- **Petals** may be bright coloured in insect pollinated plants (to attract them).
- The **receptacle** is the organ from which the flower develops and functions in supporting it.
- **Pollination** is the transfer of pollen from the anther to the stigma of a flower of the same species. It may be:
    1. **Self-pollination**: the transfer of pollen from the anther to the stigma in the same plant.
    2. **Cross-pollination**: the transfer of pollen from the anther to the stigma of a different plant but of the same species.

- **Fertilisation** is the union of a haploid male gamete with a haploid female gamete, to produce a diploid zygote.
- Once a **pollen grain** has landed on the **stigma**, the **tube nucleus** moves down through the **stigma** and **style** forming a **pollen tube** and enters the **ovule** at the **micropyle**, guided towards the egg by **chemotropism**, the tube nucleus then degenerates. The **generative nucleus** enters the pollen tube, as it travels through the pollen tube **mitosis** occurs to form **two sperm nuclei (n)**. Upon entering the **embryo sac,** double fertilisation occurs. The first sperm nucleus fertilises the **egg cell** to become a **(2n) zygote**. The second sperm nucleus fuses with the **two polar nuclei** to form a **(3n) endosperm**.
- The **radicle** (1st to emerge) is the embryonic root, the **plumule** is the embryonic shoot.
- The **cotyledons** may absorb all of the endosperm to give what is called a **non-endospermic** seed (e.g. broad bean plants), otherwise they're known as **endospermic** seeds (e.g. corn).
- The walls of the ovule (**integuments**) dry out and become the wall of the seed (**testa**).
- **True fruits** are fruits that are formed by the **ovary** swelling with food and sometimes water. (Fruits that swell with water as well as food are called **succulent** fruits as opposed to **dry** fruits).
- The ovary wall becomes the fruit wall, called the **pericarp.**
- **False fruits** develop from the **receptacle** swelling with food and water. (E.g. apples)
- **Advantages of fruit formation** include protecting the seeds until they are ready to germinate and attracting animals which eat the fruit, and disperse its seeds away from the parent plant.
- **Seedless fruits** are nicer to eat and have a longer shelf life. They are formed in two ways:
    1. **Genetic manipulation** may occur naturally, or can be artificially induced. Changes in the chromosome numbers cause the egg cell or pollen grain to become unviable and seeds do not develop.
    2. **Auxin treatment** is where the horticulturist or farmer sprays the plants (e.g. tomatoes) with auxins. This stimulates the ovary to swell with food before fertilisation has occurred, and also produces much larger fruits.
- **Ethene** gas ripens fruit by making cell walls less rigid.
- **Dispersal** is the transfer of seeds and fruit away from the parent plant. It prevents competition between the parent plant and offspring, and allows the plant to colonise new habitats.
    1. **Wind**- dandelion plants
    2. **Water**- coconut trees
    3. **Self**- pea pods
    4. **Animal**-blackberries

- **Dormancy** is a resting period for the seed when it undergoes no growth. It allows the plant to avoid harsh winter conditions and maximises the survival of plants from each seed.
- **Germination** is the regrowth of a plant embryo after a period of dormancy, when environmental conditions are suitable.(the embryo must be alive, factors maintaining dormancy must be overcome and H_2O, O_2 and a suitable temperature must all be present).
- Gardeners and farmers often carry out certain procedures on the seeds to maximise germination such as **Pre-chilling** or **treatment with growth regulators.**
- Germination begins with the **digestion of food reserves** in the cotyledons and/or endosperm. (Lipids → fatty acids + glycerol, starch → glucose, protein → amino acids). Digestion (a catabolic reaction requiring water), allows for the embryo to grow. Once above soil level **photosynthesis** can take over as the source of food.
- The **dry weight** of a seed is the mass of the seed minus the water.
- There are two types of seedling growth:
    1. **Epigeal:** the cotyledon(s) move above ground during germination and start to photosynthesise. The part of the embryo just below the cotyledon(s) but above the radicle is called the ***hypocotyl.*** The part of the embryo above the cotyledon(s) but below the plumule is called the ***epicotyl.***
    2. **Hypogeal:** the cotyledon(s) remain below the soil. (The epicotyl grows rapidly and pushes the plumule above the soil leaving the cotyledon(s) behind.

Vegatitive Propagation

Asexual reproduction (AKA vegetative propagation) is the production of a new individual from one parent. The new individual is genetically identical to the parent. (All angiosperms reproduce sexually, some also reproduce asexually). Advantages include that it has a ***fast reproductive rate*** and ***shorter period of growth***. A disadvantage is that the plants will all be ***susceptible to the same diseases.***

Natural vegetative propagation:

1. **Stem**- ***strawberry*** plants send out '***runners'.*** When sufficiently far away from the parent plant, roots and shoot emerge.
2. **Root**- ***raspberry*** plants roots grow away from the parent plant and send up a '***sucker'.***
3. **Leaf**- ***plantlets*** develop on the edges of the ***devils backbone*** plant and drop off when mature.
4. **Bud**- ***onion bulbs*** often produce ***axillary buds*** which become swollen with starch and develop into a new plant.

Artificial vegetative propagation

1. **Cutting** is a process of removing a small piece of a parent plant and encouraging it to grow into an independent plant.
2. **Layering** is a process in which a stem of a parent plant is bent down into the soil and encouraged to grow into an independent plant.
3. **Grafting** is a process in which the shoot system (***scion***) of one plant is joined to the root system (***stock***) of another.
4. **Tissue culturing** (also called micropropagation) is the growth of a large number of plantlets in a nutrient medium from small tissue samples.

Plant Growth Experiments

To Investigate the effect of IAA growth regulator on plant tissue.

Serial Dilution

1. Prepare stock solution by dissolving 100mg IAA in 2-3ml ethanol. When fully dissolved make up to 1L with distilled water.
2. Label 8 petri dishes A-H.
3. Pipette 9ml of distilled water into dish B-H. Pipette 10ml of stock solution into dish A. Then pipette 1ml of this stock solution into dish B and 1 ml of dish B into dish C. When you reach dish G remove 1ml and dispose in sink, leave dish H as control with 9ml water. **This produces a range of IAA solutions each one is 1/10 the concentration of the previous.**

Dish	A	B	C	D	E	F	G	H
IAA conc. (mg/l)	100	10	1	0.1	0.01	0.001	0.0001	0

Investigate

1. Photocopy a sheet of graph paper onto acetate sheets *to measure length of roots and shoots.*
2. Place a circular acetate grid in lid of each petri dish
3. Place 5 cress seeds evenly spaced on same line in grid
4. Cover with filter paper
5. Add 1/4 IAA solution of each to the filter paper
6. Cover with cotton wool layers and add remaining IAA solution to each corresponding wool covered dish.
7. Tape shut. Cut a slot in a large plastic bottle and stand the 8 petri dishes on their edge *to ensure root grows down and shoot grows up.*
8. Incubate dishes at 25 degrees for 2-3 days.

Examine

1. The roots and shoots in the control dish grew due to IAA produced by seeds themselves.

2. The roots in dishes with high concentration didn't grow much (or at all) where as the shoots in these dishes grew more.
3. The shoots in dishes with low concentration didn't grow much (or at all) where as the roots grew more.

$$\%\text{increase} = \frac{\text{average length} - \text{average length of control}}{\text{average length of control}} \times \frac{100}{1}$$

To investigate the effect of water, oxygen and temperature on germination.

1. Label 4 test tubes, A, B, C and D.
2. Add water to B and D, leave tube A dry and fill C with boiled cooled water..
3. Place 6 radish seeds in each tube.
4. Place tube B in the fridge to create an environment of low temperature.
5. Remember to put boiled water in C and cover with a layer of oil to create anaerobic conditions.
6. Place A , D and C in an incubator at 25 degrees.
7. D is the control.

Use starch agar plates to show digestive activity during germination

1. Soak 4 broad been seeds in water for 1-2 days.
2. Boil 2 of these to kill them and wash the bench with disinfectant.
3. Use a backed blade to split each bean in half. Cut away from you to prevent injury.
4. Sterilize the half seeds by soaking them in disinfectant for 10 minutes. Wash this off then with water.
5. Flame a forceps and allow it to cool to sterilize it.
6. Using the forceps barely open the petri dish to prevent the entry of unwanted micro organisms.
7. Label Dish A and place 4 unboiled half seeds face down on the starch agar.
8. Label dish B and place 4 boiled half seeds face down on the starch agar.
9. Place the covered dishes in a warm place for 2 days. Remove the seeds and add dilute iodine solution in their place.

In dish A, the iodine is clear, this means that the starch has been digested by the seeds to maltose using the enzyme amylase.

In dish B, the iodine turns blue black meaning starch is still present and has not been digested by the boiled, dead seeds. The seeds are dead and the enzyme amylase no longer works, hence the starch remains as is.