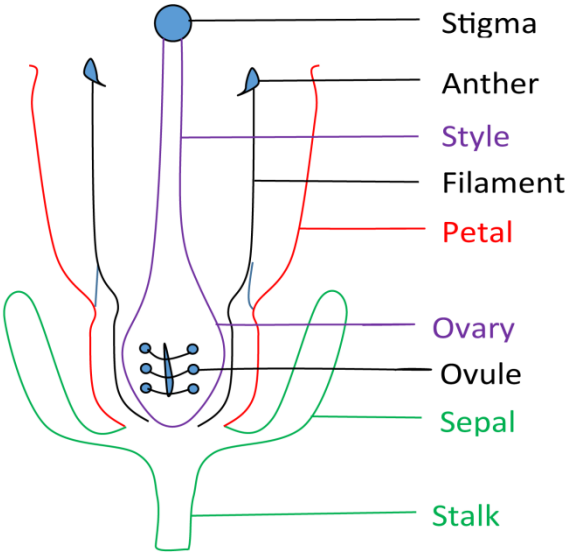
Theme: Reproduction in organism

S4 New Curriculum Biology-Chapter 2– Sexual reproduction in plants

The flower

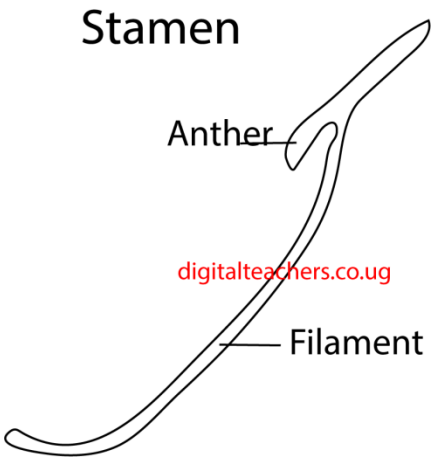
The flower is the sexual reproducing organ of the flowering plants.

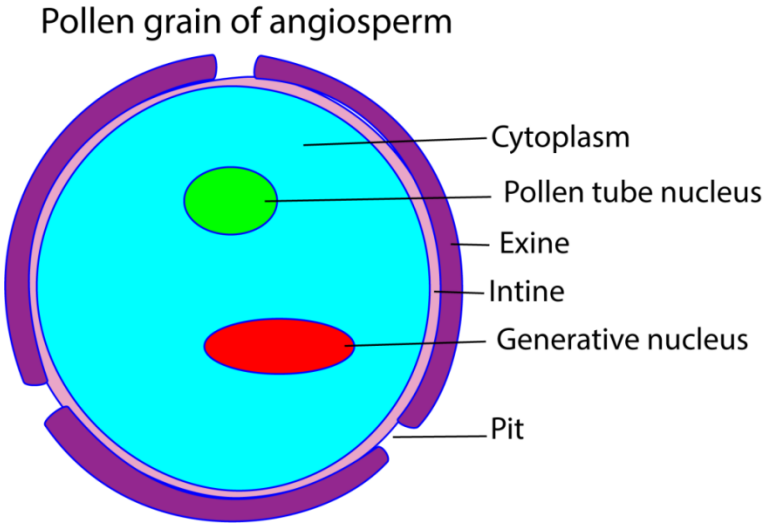
Diagram of a typical flower



Parts of flowers

1. Stalk joins a flower to the plant.
2. Sepals (**calyx**) protect floral parts during the bud stage. They may fused (joined longitudinally) or free (not joined)
3. Petals (**corolla**)are brightly coloured to attract pollinators. They may fused (joined longitudinally) or free (not joined)
4. Stamen or androecium the male part of the flower. It is made of anther that produce pollen grains and filament that supports the anthers.

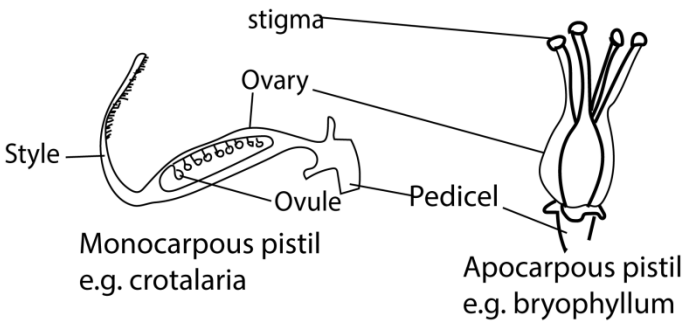


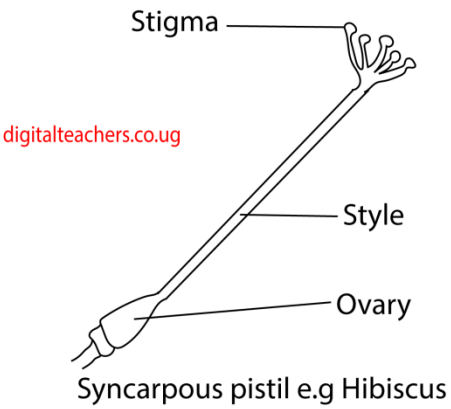


5. Pistil/gynoecium
   This is the female part the flower. It is made of
   (a) Ovary containing ovules
   (b) The style connecting the ovary to
   (c) Stigma which receives the pollen grain
   Types of pistil

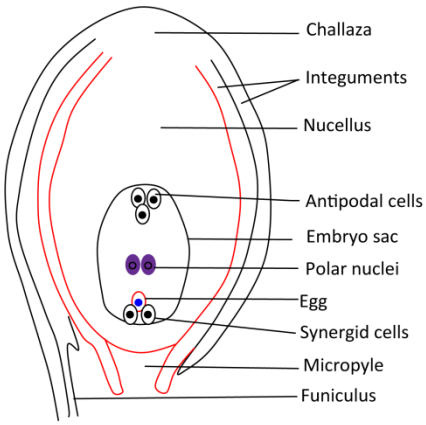
   (i) **Monocarpous** pistil consist of only one carpel (e.g. Crotalaria)
   (ii) **Apocarpus** pistil has entirely separate carpels on the same receptacle e.g. bryophyllum.
   (iii) **Syncarpous pistil** has fused carpels e.g. hibiscus.

Types of stigmas





Plant egg cell/ovum



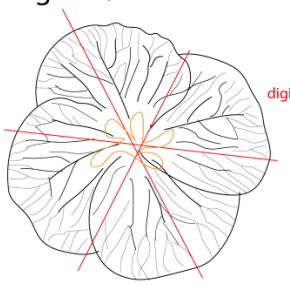
Functions of parts ovum

- Stalk/funiculus allows passage of food and water to the growing ovary
- Ovary wall protects the ovule
- Egg cell develop into seed
- Embryo sac protects the embryo
- Integument protect the embryo and develop into seed coat
- Micropyle allow entry of pollen nuclei.

Terms used to describe flowers

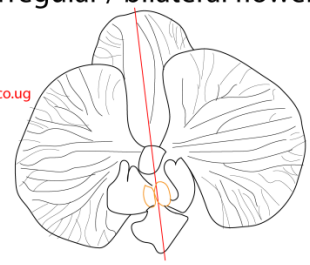
(a) A complete flower is a flower that sepals, petals, stamen and pistil.
(b) Incomplete flower lacks one or more of the following i.e. Sepals, petals, stamen and/or pistil
(c) Non-essential parts of flower are those not directly involved in sexual reproduction of a flower, i.e. sepals and corolla.
(d) Essential **parts** of the flower are those directly involved in sexual reproduction i.e. stigma, style, ovary, ovule, anthers.
(e) **A regular flower** has more than one line of symmetry e.g. hibiscus, sweet potato, promrose and morning glory flowers while **irregular flowers** have only one line of symmetry, e.g. bean and orchid flowers.

Regular / radial flower



Primrose

Irregular / bilateral flower



Orchid

(f) Hermaphrodite flower has both male (androecium) and female (gynoecium) parts.

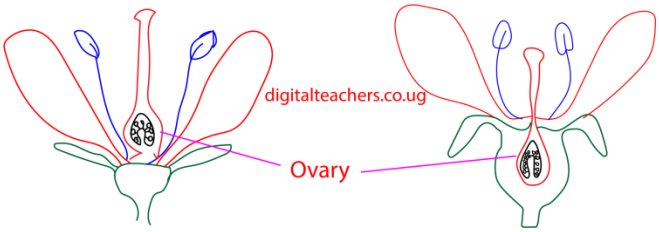
(g) Unisexual flower has either stamen or pistil. Plants that has stamen only is called **staminate**, while that that has pistil only is **pistillate**.

(h) Monoecious plant has both pistillate and staminate on the same plant, e.g. maize plant, palm plant.

(i) Dioecious **plant**, the pistillate and staminate are borne on separate plant, e.g. paw paw.

(j) Inferior **ovary** is one where the sepals, petals and anthers are borne on top of ovary, e.g. banana, canna lily and sun flower; while in **superior ovary**; stamen, petals and sepals are borne below the ovary, e.g. hibiscus, cassia and bean flower.

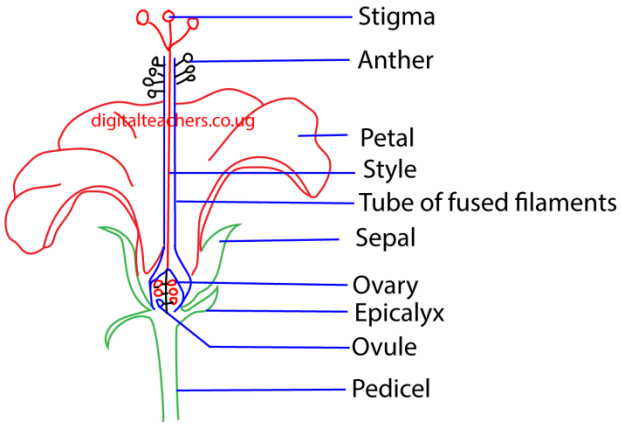
Superior and inferior ovaries



Common flowers

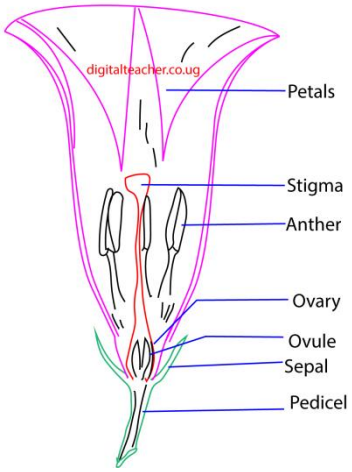
Parts of hibscus flower

Longitudinal section of hibscus flower

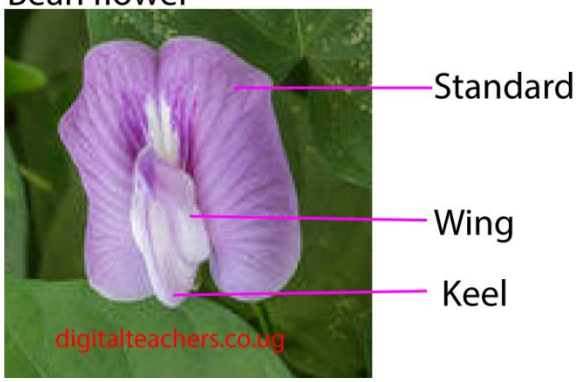


Sweet potato flower

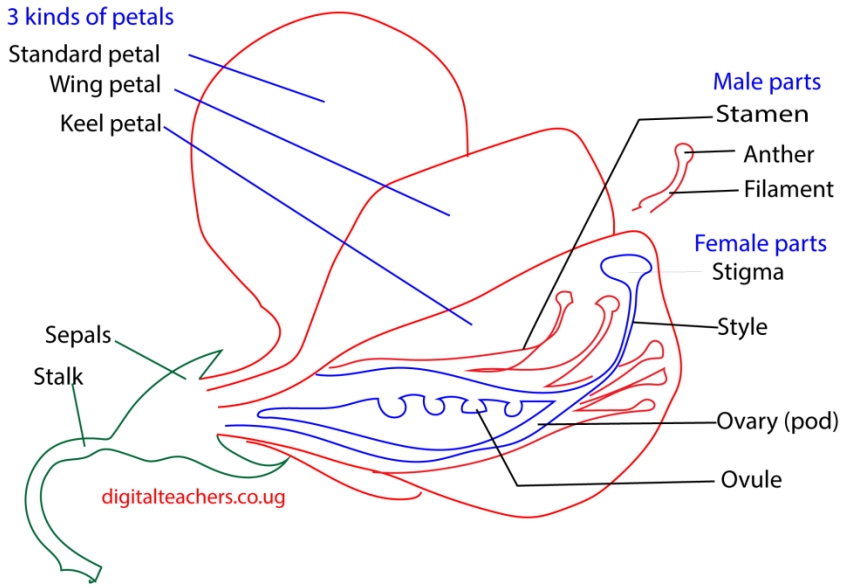
Cross section of potato flower



Bean flower



Cross section of bean flower



Differences between hibiscus an potato flowers

	Hibiscus flower	**Potato flowers**
1.	Lobed stigma	fused stigmas
2.	Free petals	Fused petals
3.	Many anthers	Five anthers
4.	Has epicalyx	Has no epicalyx
5.	Fused sepals	Free sepals
6.	Fused filament	Free filamant

Differences between hibiscus and bean flower

	Hibiscus flower	Bean flower
1.	Lobed stigma	Single stigma
2.	All filaments fused	Nine of the filament are fused one free
3.	Many anthers	Ten anthers
4.	Regular flower	Irregular flower
5.	Fused carpel	One carpel
6.	Fused sepals	Free sepals
7.	Has epicalyx	Has no epicalyx
8.	All petals are free	Two of the five petals are fused
9.	All petals are similar	Petals dissimilar

Differences between bean and potato flowers

	Potato flower	Bean flower
1.	Fused carpel	One carpel
2.	Regular flower	Irregular flower
3.	Fused petals	Two of the five petals are fused
4.	Five anthers	Ten anthers
5.	Free filament	Nine of the ten filaments are fused

Pollination

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

Self-pollination is the transfer of pollen grains from the anther to the stigma of the same flower or another flower of the same plant.

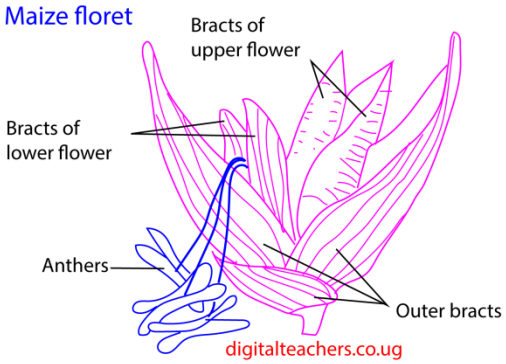
Cross pollination is the transfer of pollen grains from the anther of one flower to the stigma of another flower on a different plant of the same species.

Agents of pollination

1. Wind
2. Insects
3. Water

Characteristics of wind pollinated flowers

a. Large production of pollen grains.
b. Flowers are not attractive and scent emitting.
c. Feathery and sticky stigma.
d. The pollen grains are light and non-sticky so that they can be transported in wind currents.
e. Flowers do not possess nectar.
f. Anthers is well exposed e.g. maize flower.



Characteristics of insect pollinated flower

(i) brightly colored petals
(ii) scented
(iii) Have nectar
(iv) Flowers have nectar
(v) Flower have sticky pollen grains

Adaptations of Insects pollinated flowers

- brightly colored petals to attract pollinators
- scented to attract pollinators
- Have nectar to attract pollinators

- Flowers have nectar to attract pollinators
- Have sticky stigmas to pick pollen from pollinators
- Flower have sticky pollen grains to stick on pollinators and the stigma

Adaptations of wind pollinated flowers

1. Large production of pollen grains to to increase chance of pollination.
2. Feathery and sticky stigma to increase chance of receiving pollen
3. Produce light pollen grains that can be transported by wind.
4. Anthers is well exposed e.g. maize flower to scatter pollen

Development after pollination

(i) As soon as a mature pollen grain fall on a receptive stigma. The pollen grain then absorbs the sugary fluid and increase in size and volume.
(ii) The exine burst open and the entine grows into a long narrow tube called the pollen tube. The pollen tube nucleus occupies the position at the tip and controls it growth.
(iii) The generative nucleus again divides mitotically into 2 male nuclei.
(iv) On reaching the ovary the pollen tube enters, usually through the micropyle to the embryo.
(v) One male nucleus fuses with egg cell to forma diploid zygote.
(vi) The second male nucleus fuse with both polar nuclei to form a triploid nucleus which give rise to **endosperm**. The endosperm in cereals is where food reserves are stored. In seed of other plants (dicotyledonous plants) endosperm is absorbed by the developing cotyledon which then provides the main food reserve.

NB. Plants are therefore said to undergo **double fertilisation** because two male nuclei fuse within the ovum; one with the egg cell to form a zygote while another with the polar two polar cells to form an endosperm.

After fertilization

1. The zygote divides mitotically, growing and developing into the embryo. The embryo consists of a radicle (young root) plumule (young shoot) and either on cotyledon or two cotyledons (seed leaves). The embryo is attached to the wall of the expanding embryo sac by a suspensor which acts as passage of food to the embryo.
2. The primary endosperm nucleus (triploid) divides into a mass of nuclei which are separated from one another by thin cell walls. It becomes food storage for the seed.
3. The ovule develops into the seed. The integuments of the ovule become the seed coats. The outer integument is called the Testa while the inner is called tegmen. Bothe of these layers are tough and protective.
4. The ovary develops into a fruit.

Parthenogenesis

This is the development of a new offspring from unfertilised egg. Haploid parthenogenesis, the egg is produced by meiosis whereas in diploid parthenogenesis the egg is produced by mitosis; e.g. production of wingless aphids.

Parthenocarpy

This is the development of a fruit without fertilization such fruits cart be artificially produced for commercial purpose by spraying with auxins.

Cross and self-fertilization

1. Self-fertilization is the union of gametes from the same individual flower.

   Advantage:

a. it increases the chances of fertilization and formation of new organism.

b. only one parent is required, and that beneficial qualities are more likely to be passed on to the offspring since all offspring are genetically identical to the parent.

   Disadvantage:

a. it reduces genetic variability, so the organism will be less adapted to changes in the environment.
b. It may transfer diseases to the offspring

2. Cross fertilization: is the union of gametes from the different individual or flower of the same species. This brings in genetic mixing and genetic variability which increase the hybrid vigour.

   Advantages of sexual reproduction
   - Genetic mixing
   - Seeds can go through adverse conditions in a dormant stage.
   - Allow genetic improvement.

Means employed by plants to limit self-fertilization in plants

(a) Dichogamy: anthers mature and stigma become receptive at different times
   (i) Protandry: anther mature before the stigma

(ii) Protogyny: stigma mature before the anther

(b) Self-incompatibility: the pollen grain fails to develop on the stigma of the same flower.

(c) Special floral structure: most hermaphrodite flowers have structural features that favour cross pollination; e.g. stigma may be above the anthers thus removing the possibility of pollen falling on the stigma of the same flower. Other have nectar and good scent to attract pollinator.

(d) Inflorescence: having many flowers in close proximity on the same stalk favours cross pollination.

(e) Some plants have monoecious flower, i.e. separate male and female flowers on the same plant. e.g. maize and coconut.

(f) Some plants are **dioecious**, separate male and female flower of different plants. Despite the advantage of cross fertilization, dioecious plants are not many because only half of the plants are able to produce seeds and there is waste of pollen grains in wind dispersal.

Adaptations promoting self-fertilization

1. Bisexual, hermaphrodite flowers e.g. marigold.
2. Anther and stigma ripen at the same time. E.g. tomato.
3. Flowers remain enclosed until fertilization has taken place. E.g. garden pea
4. The flowers are buried in ground e.g. G. nuts.

Advantages and disadvantages of reproduction by seed

Advantages

1. The plant is independent of water for sexual reproduction and therefore better adapted for land environment.
2. The seed protects the embryo
3. The seed contains food for embryo either in cotyledon or in endosperm
4. The seed is adapted for dispersal
5. The seed remain dormant and survive adverse condition
6. The seed as a product of sexual reproduction has advantages genetic variation

Disadvantage

1. Seeds are relatively large structure because of extensive food reserves which makes dispersal more difficult than spores
2. Seeds are often eaten by animals for their food reserves.
3. There is reliance on external agent such as wind, insects and water for pollination which is a risk
4. There is large wastage of seed because the chances of survival of a given seed are limited
5. The food supply in a seed is limited as compared to vegetative reproduction
6. Two individuals are required in dioecious species making the process risky than reproduction in which only one parent is involved.

Fruits and seed

Differences between fruits and seeds

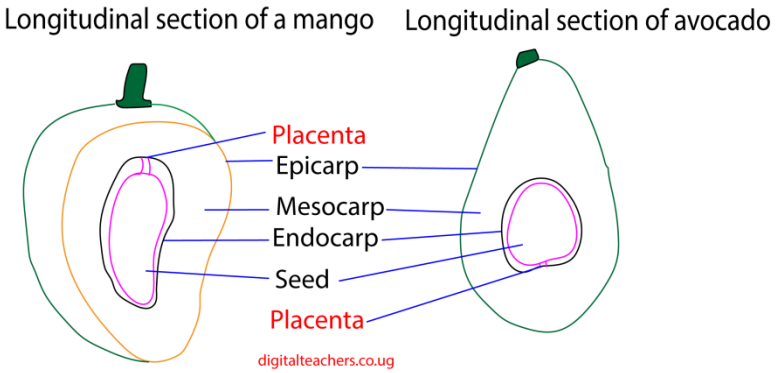
Fruits	Seeds
Formed from ovary	Formed from ovule
Has two scars, one attachment to the plant and the other to the style	One scar which is attachment to the fruit
Contains seed(s)	Contain embryo
Protects seeds	Found in fruit

Classification of fruits

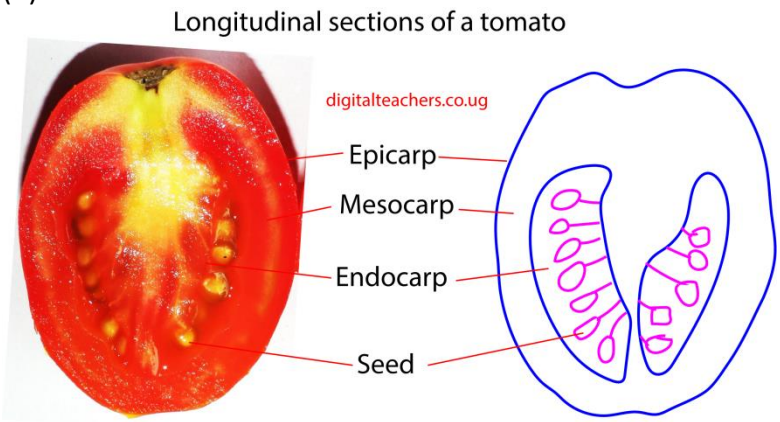
Fruits are classified as succulent/fleshy fruits and dry fruits

1. Succulent fruits
   They are divided into **drupe**, e.g. mango and avocado and **berries** e.g. orange, tomato, passion fruits

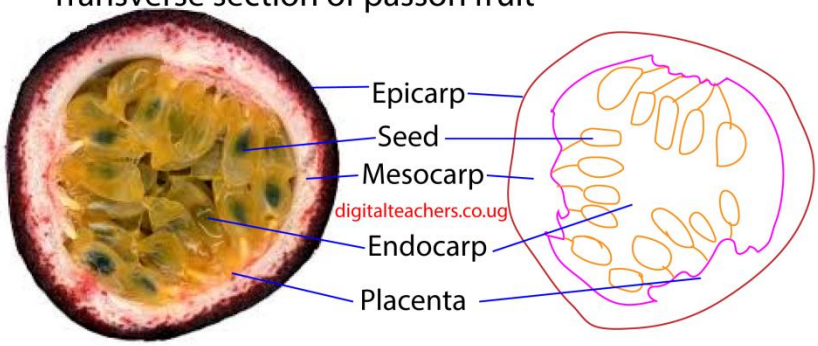
(a) Drupes



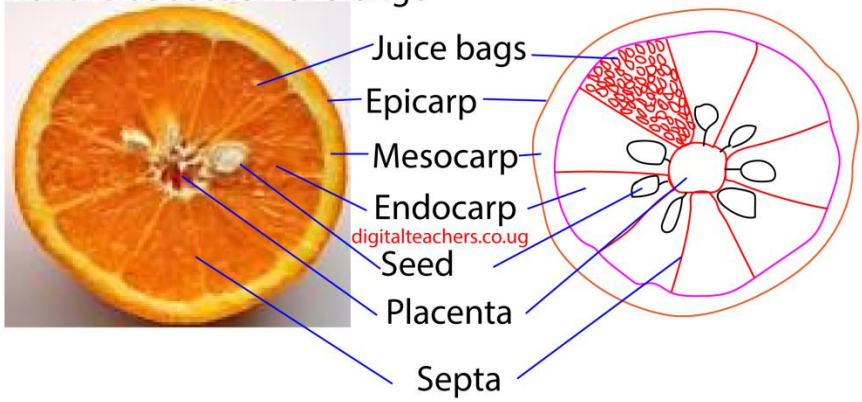
(b) Berries



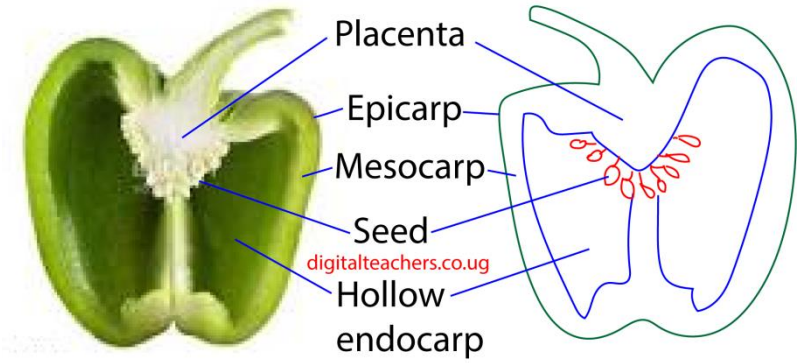
Transverse section of passon fruit



Transverse section of orange



Longitidinal section of green pepper



Differences between drupes and berries

Drupes	Berries
One seed	Many seeds
Woody endocarp	Fleshy/hollow endocarp

2. Dry fruits

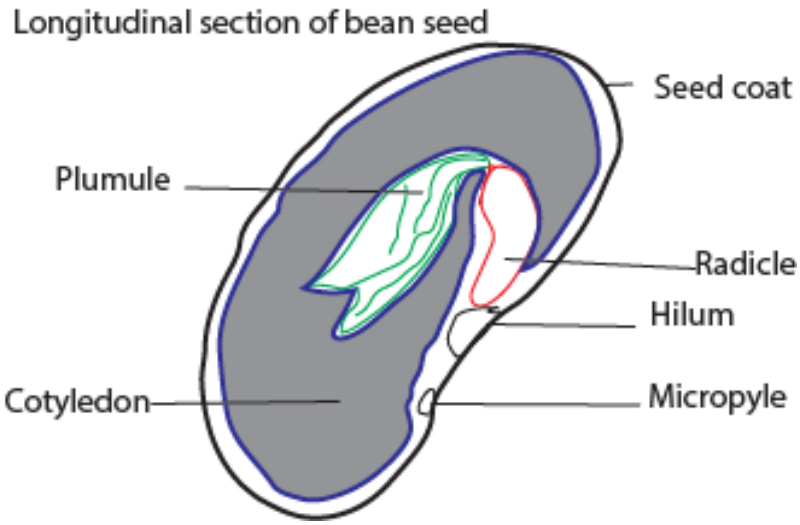
Can be classified as dehiscent fruits (when they break to release their seed) or indehiscent fruits those that do not break to release their seed.

(i) Dehiscent Fruits

Dry fruits which at maturity open by definite natural means to shed the contained seeds. They are classified according to line of sutures.

(a) Follicle A dry dehiscent fruit developed from 1 carpel and at maturity splitting along only one suture. (larkspur, delphinium)

(b) Legume A dry dehiscent fruit developed from 1 carpel and at maturity splitting along both the dorsal and ventral sutures, e.g. beans, peas.



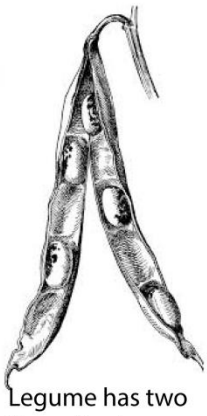
Uses of parts of bean seed

- seed coat protects inner parts of the seed
- Plumule grows into shoot system
- Radicle grows into root system
- cotyledon stores food reserves and protects the embryo
- Micropyle allows in pollen nucleus during fertilization and water during germination
- Hilum attachment of to plant during development

(c) Capsule A dry dehiscent fruit developed from several carpels e.g. Dutchman's capsule.

Dehiscent fruits

Follicle has one line of suture e.g. larkspur, columbine



Legume has two lines of suture e.g. bean and peas

Capsule has many lines of suture e.g. dutchman's capsule

(ii) Indehiscent fruits

Dry fruits which do not open when mature to shed their seeds. Many of this group are one seeded fruits.

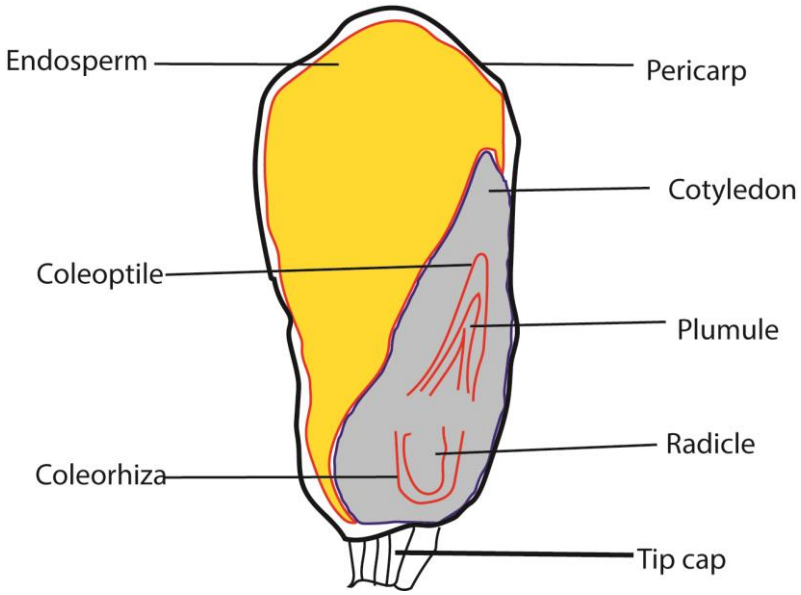
(a) **Achene** - A one-seeded, dry, indehiscent fruit; the one seed is attached to the fruit wall at a single point. (buttercups, dandelion, sunflower).

(b) **Nut** - A dry, indehiscent, one seeded fruit similar to an achene but with the wall greatly thickened and hardened. (beech, chestnut, oak, hazel; walnut and hickory - note: because of extrafloral bracts, or "husk", the latter two fruits are sometimes called "drupes").

(c) **Samara** - A one- or two-seeded dry, indehiscent fruit in which part of the fruit wall grows out into a wing. (elm, maple, ash).

(d) **Caryopsis** - A one-seeded dry, indehiscent fruit in which the fruit wall and the seed coat are fused. (wheat, corn, grasses).

Longitudinal section of maize fruit



Functions of parts of maize fruit

Pericarp protects the internal parts

Endosperm stores food reserves

Cotyledons protect and nourishes the embryo

Coleoptile protects the plumule

Plumule grows into shoot system

coleorhiza protects the radicle

Radicle grows into root system

(e) **Schizocarp** - A fruit formed from several carpels, each carpel of this pistil enclosing a single ovule, at maturity the carpels separate as separate indehiscent fruits. (mallow, wild carrot, dill).

Indehiscent fruits

Achene of sunflower | Cashew nut | Caryopsis of maize | Cypsela of tridax | Samara of Norway maple | Schizocarp of Desmodium

(iii) Aggregate Fruit

A fruit formed by the development of a number of pistils from the same flower. The individual units may be berries or other specific types. (raspberry, strawberry).

(iv) Multiple Fruit

A fruit formed by the development of a number of pistils often with accessory parts, the pistils being from a number of flowers. (mulberry, fig, pineapple).

Fruits and seed dispersal

This is the scattering of seed and fruits from the parent.

Why dispersal?

- To avoid overcrowding
- To increase the distribution of plants so that they can colonise better places
- To preserve species by spreading them and preventing them from extermination by natural hazard e.g. fire.

Dispersal agent

1. Wind
   Fruits and seed dispersal by wind have the following features.
   - They are small and light
   - They have, flattened wing like structures e.g. Tecoma or a parachute of fine hair e.g. Tridax to increase their surface area and air resistance.
2. Animal
   Fruits and seed dispersal by animal have the following features
   - May have sticky hairs e.g. Desmodium
   - May have hooks to stick on fur e.g. black jack
   - Some fruits have attractive colour, scent and sweet mesocarp when ripe, e.g.
   - May have small indigestible seed which are deposited in faeces, e.g. passion fruit.
   - Some plants have seed enclosed in woody endosperm that cannot be chewed, e.g. mango
3. Water
   Fruits dispersed by water
   - Have floating devices, e.g. the seeds of the water lily have aril, small float, that have in air. The seed can float on water until the aril decays, then it sinks to the bottom and germinate
4. Explosive mechanism of dispersal

e.g. balsam, bean

Seed Dormancy

It is the state in which a seed that is viable will not germinate even if the conditions that are necessary for germination are provided?

Dormant seed are usually dry, their metabolic activity is much reduced and they respire anaerobically.

Importance of seed dormancy

- Seed are able to withstand adverse external conditions such as very cold or very dry whether.
- It allows seed and fruits to disperse

Causes of seed dormancy

The main factors that causes the seed dormancy are:

1. **Seed coats impermeable to water**: The seed of certain family have very hard seed coats which are impermeable to water. This dormancy remains until the testa layer decay by soil **microorganisms**. The impermeable seed coats are found in the family **leguminosae, Malvaceae, convolvulaceae.**
2. **Seed coat impermeable to oxygen**: This type of dormancy is because of the **impermeability of the seed coats to oxygen**. But later seeds become more permeable to oxygen so that it germinates afterwards. This type of dormancy in found in the **family compositae.**
3. **Mechanically resistant seed coat**: In certain **seeds of weeds have hard seed coats** that prevent the expansion of embryo.
4. **Immaturity of the embryo:** In the seeds of plants like **the Orchids, Ginkgo** etc. The immaturity of the embryo is due to the **failure of the embryo to develop** when the seeds are shed.
5. **Due to the effect of germination inhibitors**: The inhibition caused due to the presence of the **inhibitor substances in the seed coat, endosperm, embryo or any structure**. Some of the important germination inhibitors are; **Coumarin, Phythalids, Ferulic acid, Abscisic acid, Dehydracetic acid and parasorbic acid.**

6. **Low temperature:** In certain plants the seeds **remain dormant after harvest because they require low temperature for germination.** The seeds germinate in the spring season.
7. **Light sensitive seeds:** In certain seed the germination is affected by the light so the absence of light results in the seed dormancy. These seeds which are **sensitive to sunlight** are termed as the **photoblastic seeds**, where as in some other seeds the light inhibits the seed germination so they are **negatively photoblastic.**

Thanks

Dr. Bbosa Science