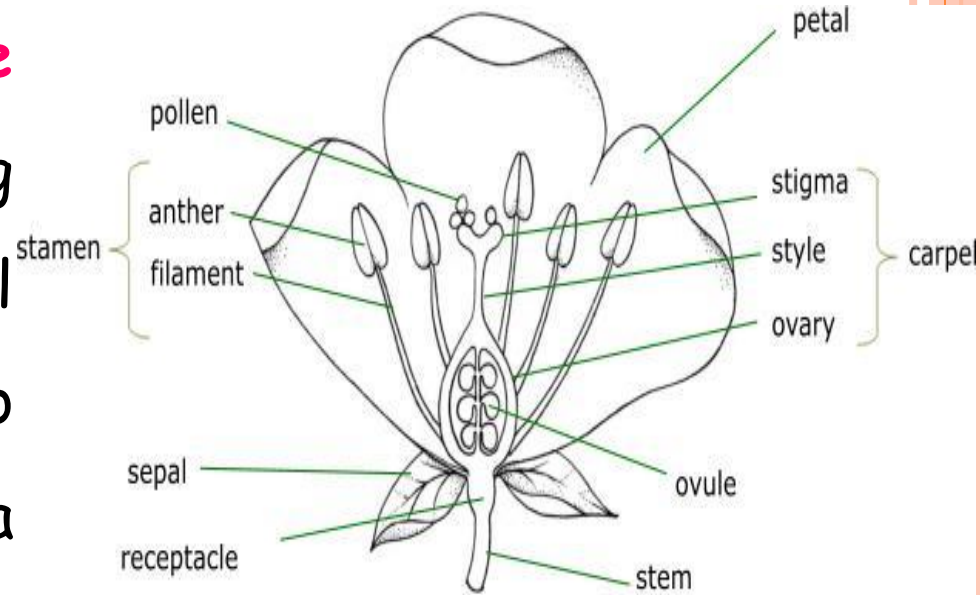




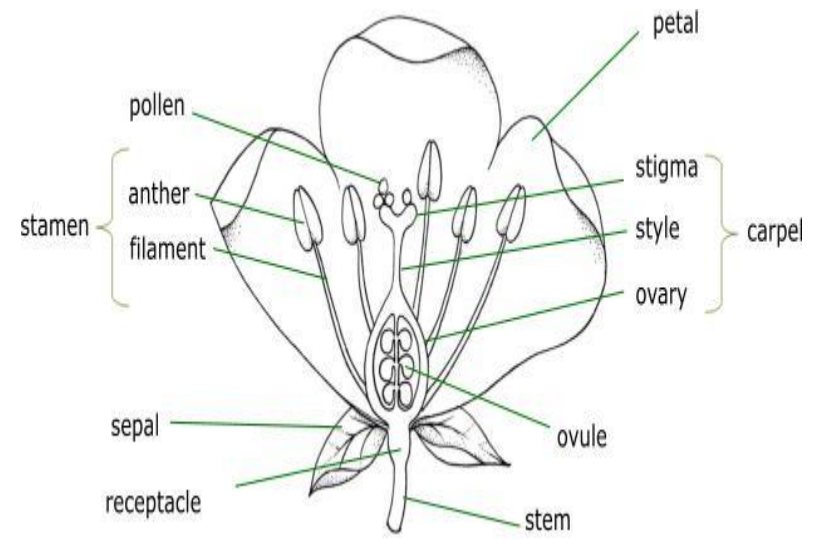
PLANT ORGANS - FLOWERS AND FRUITS

FLOWER

- A flower is the **reproductive structure** found in flowering plants. The biological function of a flower is to provide **reproduction**, a mechanism for the **union of sperm with eggs**. Flowers give rise to fruit and seeds.



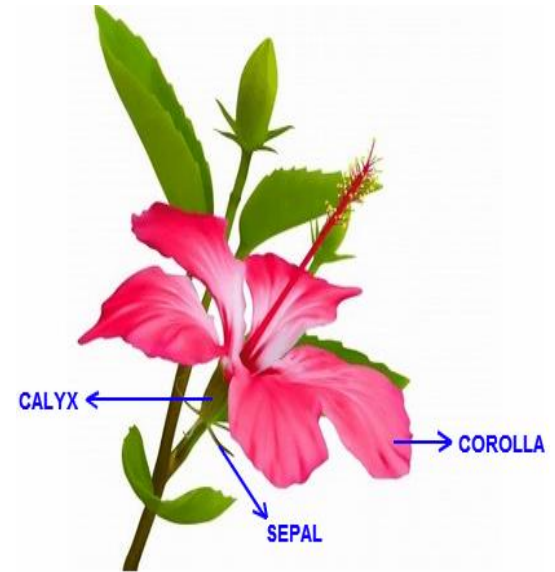
FLORAL PARTS



- The essential parts of a flower can be considered in two parts: **the vegetative part**, consisting of **petals** and associated structures in the **perianth**, and the reproductive or sexual parts.
- A stereotypical flower consists of **four kinds of structures attached to the tip of a short stalk**. Each of these kinds of parts is arranged in a whorl on the **receptacle**.

THE FOUR MAIN WHORLS ARE AS FOLLOWS:

- Vegetative (Perianth)
- 1. Calyx and 2. Corolla form the perianth.

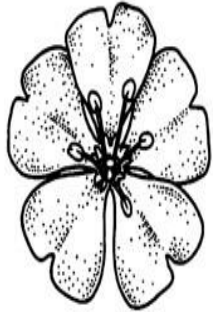


1. **Calyx:** the outermost whorl consisting of units called sepals; these are typically green and enclose the rest of the flower in the bud stage, however, they can be absent or prominent and petal-like in some species.

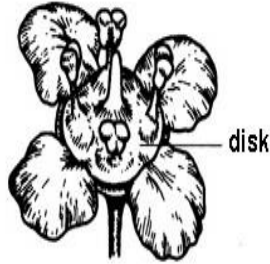
2. **Corolla:** the next whorl toward the apex, composed of units called petals, which are typically thin, soft and colored to attract animals that help the process of pollination.

PLATE 9. FLORAL MORPHOLOGY

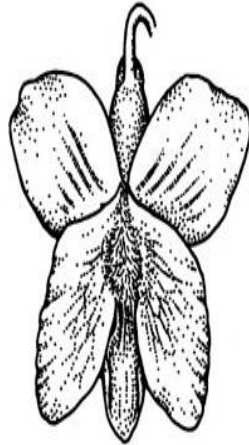
SYMMETRY



ACTINOMORPHIC / RADIAL SYMMETRY



ZYGOMORPHIC / BILATERAL SYMMETRY



OVARY POSITION



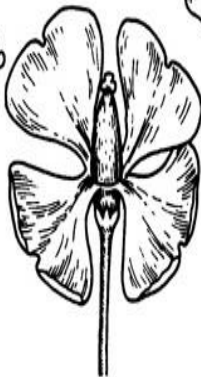
SUPERIOR

HYPOGYNOUS



SUPERIOR

PERIGYNOUS



1/2 INFERIOR



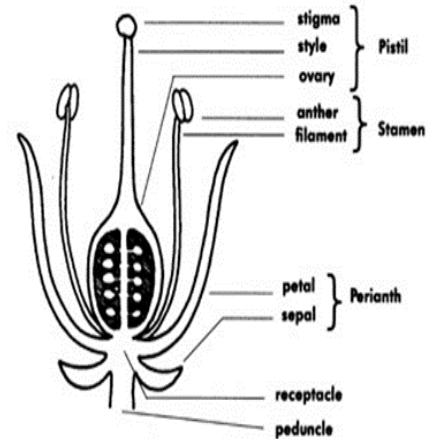
INFERIOR

EPIGYNOUS

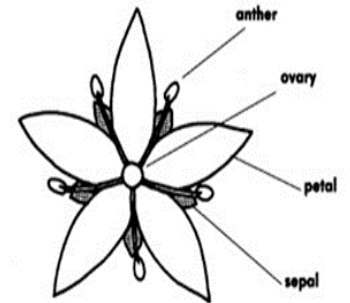


INFERIOR

COMPONENTS



FLOWER LONGITUDINAL SECTION



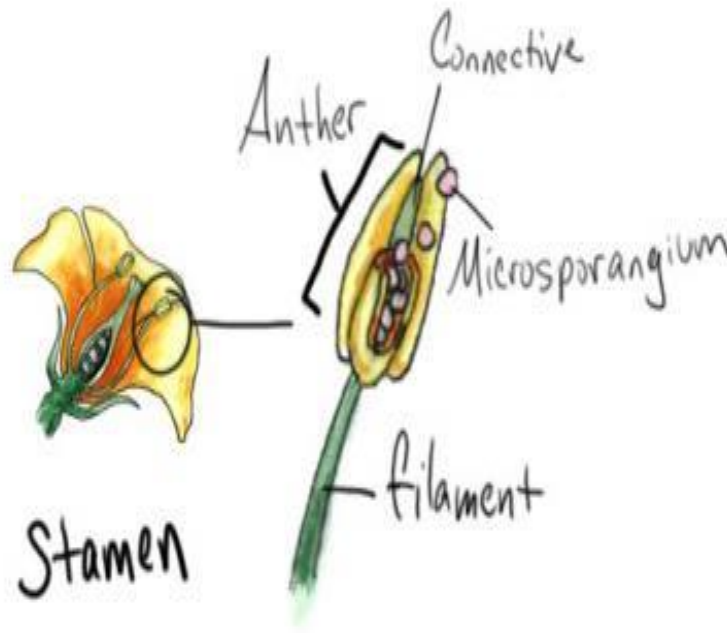
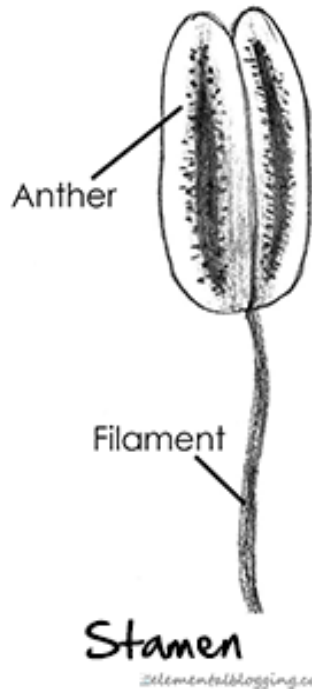
FLOWER TOP VIEW

modified from Swink, F. and G. Wilhelm. 1994. *Plants of the Chicago region*. 4th ed. Indianapolis: Indiana Academy of Science.



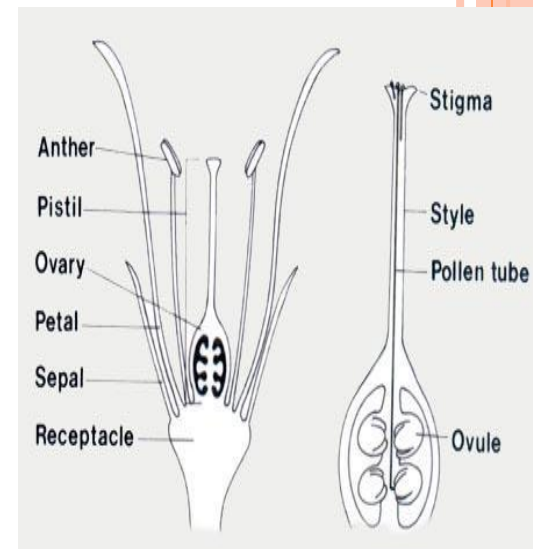
REPRODUCTIVE

- 3. Androecium: the next whorl (sometimes multiplied into several whorls), consisting of units called **stamens**. Stamens consist of **two parts**: a stalk called a **filament**, topped by an **anther** where pollen is produced by meiosis and eventually dispersed.

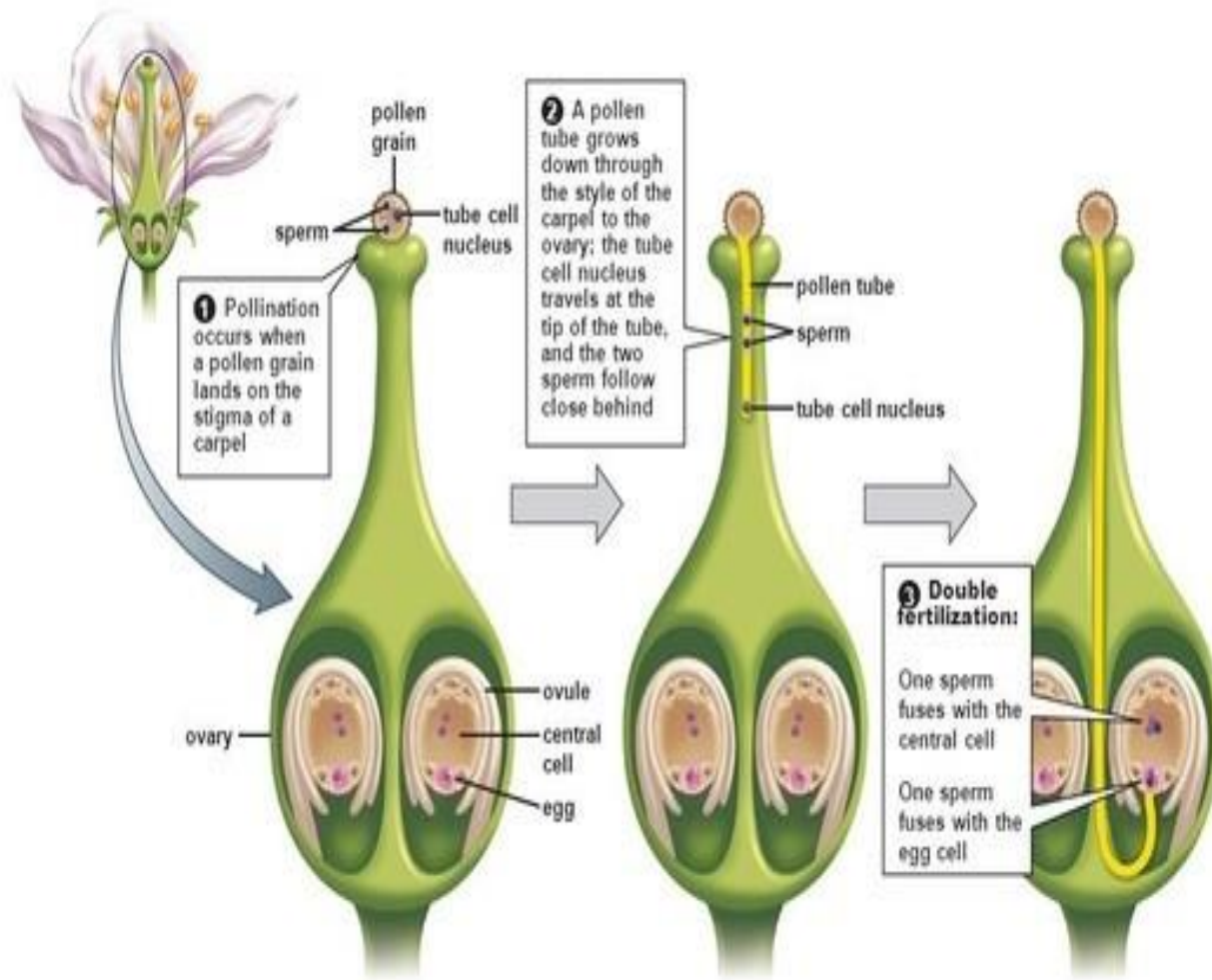


- 4. Gynoecium: The gynoecium, innermost whorl (consisting of an ovary, style and stigma) is called a **pistil** and is composed of one or more units called **carpels**. The **carpel or multiple fused carpels form a hollow structure called an ovary, which produces ovules internally**. Ovules are megasporangia and they in turn produce megaspores by meiosis which develop into female gametophytes. These give rise to egg cells.

The sticky tip of the pistil, the **stigma**, is the receptor of pollen. The supportive stalk, the **style**, becomes the pathway for pollen tubes to grow from pollen grains adhering to the stigma. The relationship to the gynoecium on the receptacle is described as **hypogynous** (beneath a **superior** ovary), **perigynous** (surrounding a superior ovary), or **epigynous** (above inferior ovary).

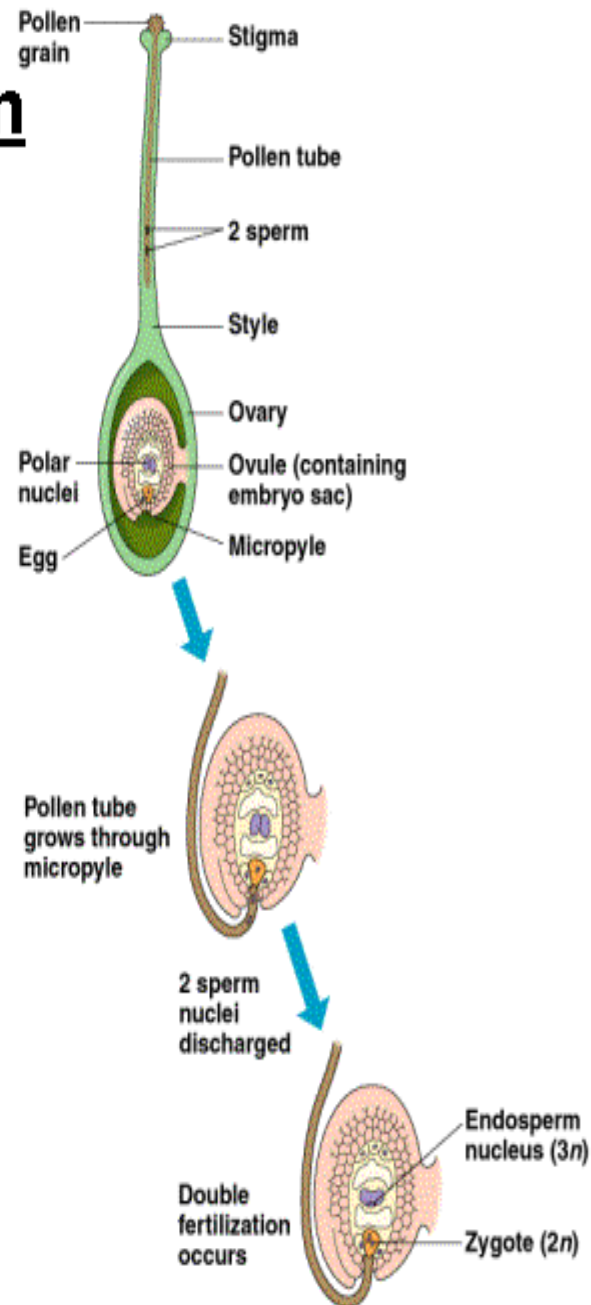


Pollination and Fertilization of a Flower



Summary of Fertilization

1. A **pollen tube** grows from pollen grain, down the style, through the **micropyle** and into the **ovule**.
2. Two **sperm nuclei** are discharged into the **embryo sac** resulting in **double fertilization**.
3. The fertilized egg (**zygote**) will develop into the **embryo**.
4. The fertilized **central cell** will develop into **endosperm**.
5. The **ovule** develops into a **seed**.
6. The **ovary** develops into a **fruit** containing one or more seeds.



Insertion of Floral Parts

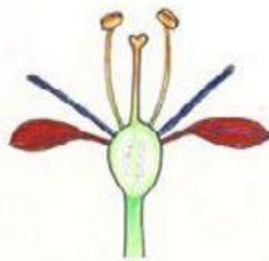
- Hypogynous: the sepals, petals, and stamens are inserted under the carpel
 - Ovary is said to be *superior*



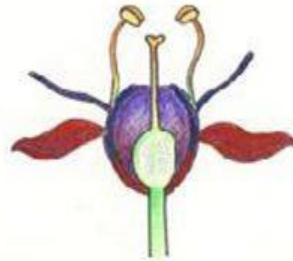
Hypogynous



Ovary Position



Epigynous



Perigynous



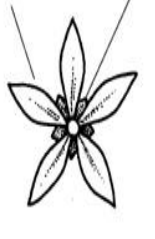
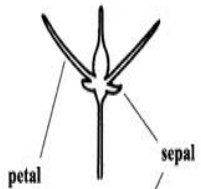
Hypogynous

Depending upon its position the ovary may be

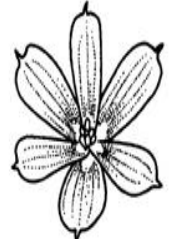
- i) Inferior: When all the floral parts arise from above the ovary as in epigynous flowers.
- ii) Semi-inferior: Where the floral parts are seen developing from about the middle of ovary as in perigynous flowers.
- iii) Superior: When all the floral parts arise from the base of the ovary as in hypogynous flowers.



PLATE 10. COROLLA TYPES



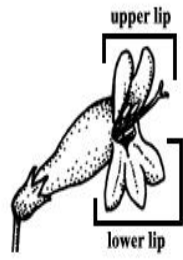
SEPALS & PETALS



TEPALS



ROTATE



BILABIATE



CRUCIFORM



HOOD & HORN



LIGULATE



PALATE



PAPILIONACEOUS



CARINATE



CORONATE



CAMPANULATE



FUNNELFORM



GALEATE



GIBBOUS



SACCATE



SALVERFORM



SPURRED



TUBULAR

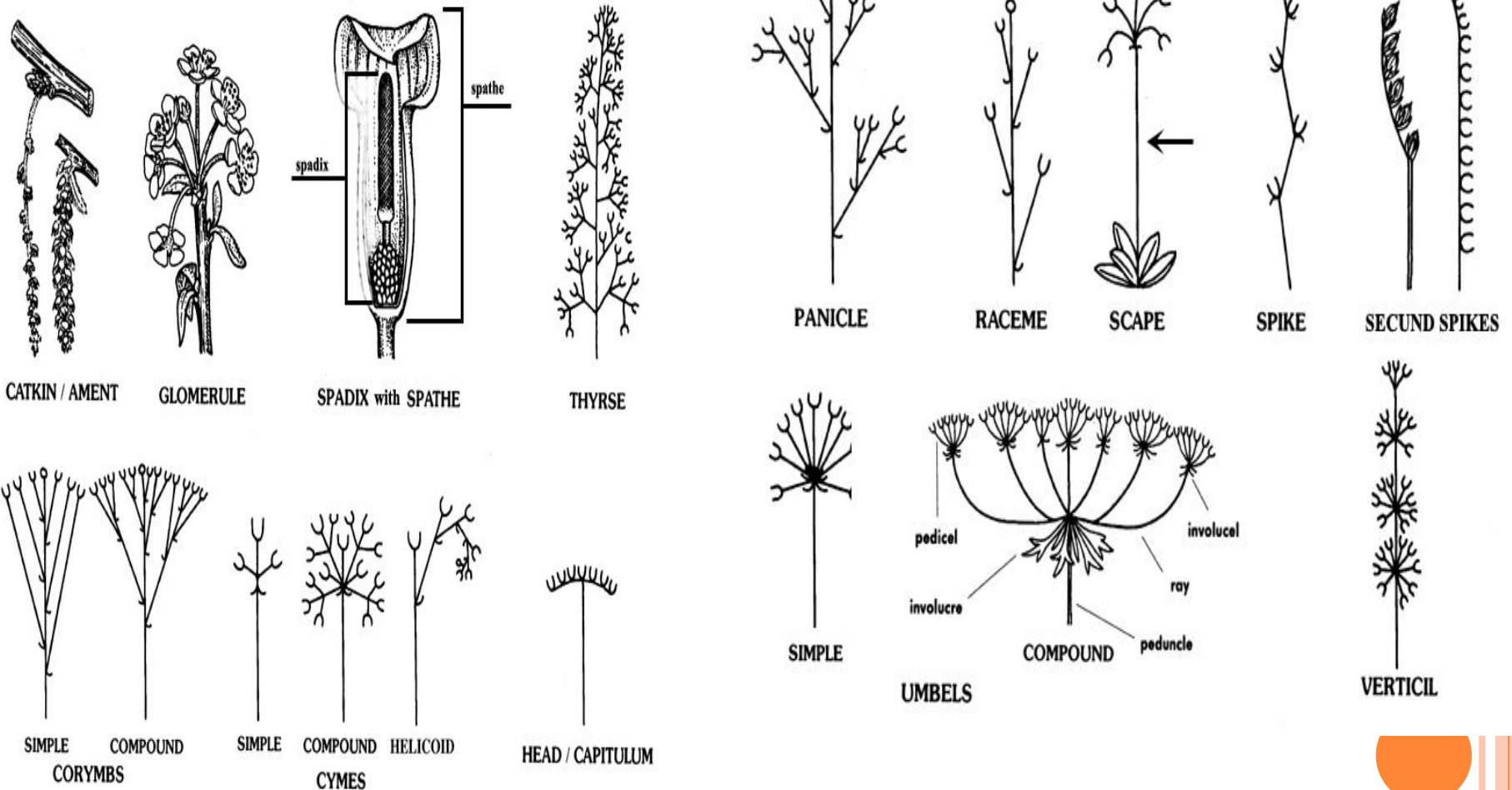


URCEOLATE



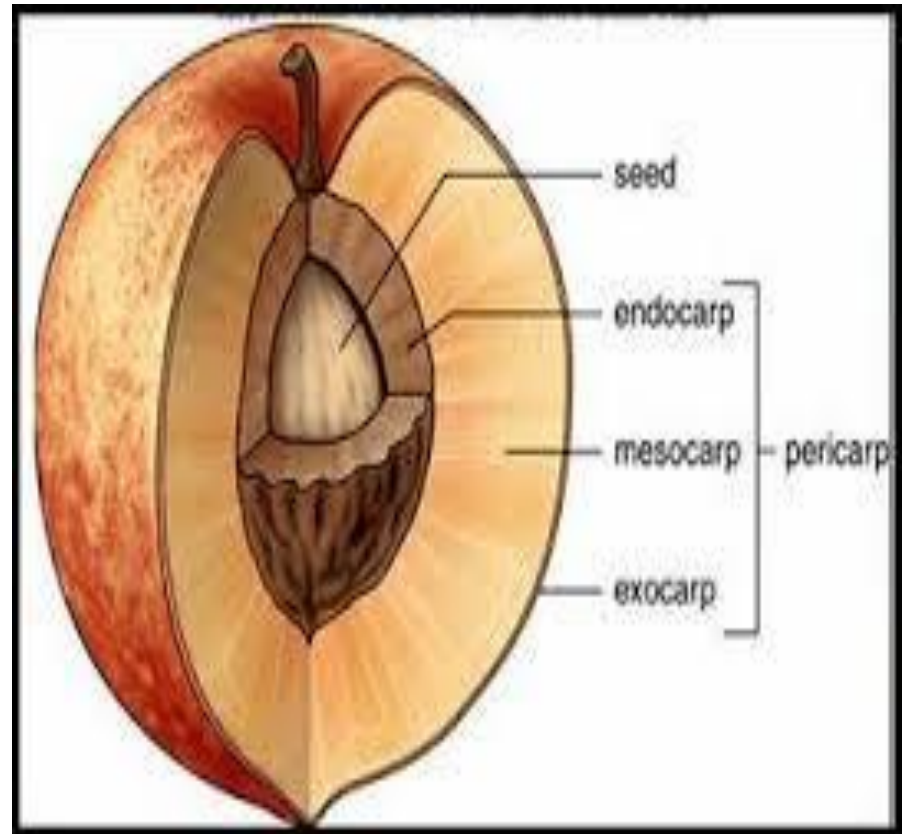
INFLORESCENCE: It is actually an inflorescence of tiny flowers pressed together on a central stalk that is surrounded by a large petal-like bract.

PLATE 8. INFLORESCENCE TYPES



FRUIT

- A fruit results from **maturation of one or more flowers**, and the **gynoecium of the flower(s) forms all or part of the fruit**.
- Inside the ovary/ovaries are **one or more ovules** where the **megagametophyte contains the egg cell**. After double fertilization, these **ovules will become seeds**. The **ovules are fertilized in a process that starts with pollination**, which involves the movement of **pollen from the stamens to the stigma of flowers**.



- After pollination, a tube grows from the pollen through the stigma into the ovary to the ovule and two **sperms are transferred from the pollen to the megagametophyte**. Within the megagametophyte one of the two sperm unites with the egg, forming a zygote, and the second sperm enters the central cell forming the endosperm mother cell, which completes the double fertilization process. Later the **zygote will give rise to the embryo of the seed**, and the **endosperm** mother cell will give rise to endosperm, **a nutritive tissue used by the embryo**.



THERE ARE THREE GENERAL MODES OF FRUIT DEVELOPMENT:

- **Apocarpous fruits** develop from a single flower having one or more separate carpels, and they are the simplest fruits.
- **Syncarpous fruits** develop from a single gynoecium having two or more carpels fused together.
- **Multiple fruits** form from many different flowers.

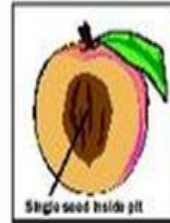


Types of Fruits

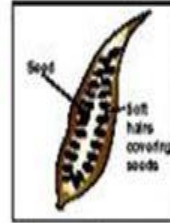
- **Simple Fruits:** These fruit types are produced by flowers containing one pistil, the main female reproductive organ of a flower.
- **Aggregate Fruits:** These fruits types are developed from flowers which have more than one pistils. They consist of mass of small drupes that develops from a separate ovary of a single flower.
- **Multiple Fruits:** These fruit types are developed not from one single flower but by a cluster of flowers.
- **Accessory Fruits:** These fruit types are developed from plant parts other than the ovary.



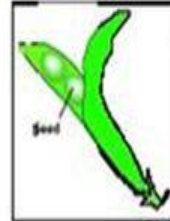
Berry
A simple, fleshy fruit in which the fruit wall is soft throughout.
Tomato (*Lycopersicon lycopersicum*)



Drupe
A simple, fleshy fruit in which the inner wall of the fruit is hard and stony (the pit).
Peach (*Pearus persica*)



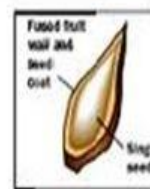
Follicle
A simple, dry fruit that splits open along one suture to release its seeds.
Milkweed (*Asclepias speciosa*)



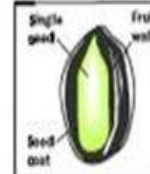
Legume
A simple, dry fruit that splits open along two sutures to release its seeds.
Green bean (*Phaseolus vulgaris*)



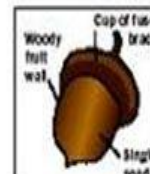
Capsule
A simple, dry fruit that splits open along three or more sutures or pores to release its seeds.
Lily (*Lily sp.*)



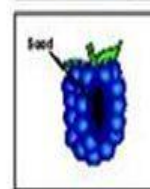
Grain
A simple, dry fruit in which the fruit wall is fused to the seed coat.
Wheat (*Triticum sp.*)



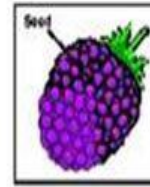
Achene
A simple, dry fruit in which the fruit wall is separate from the seed coat.
Sunflower (*Helianthus annuus*)



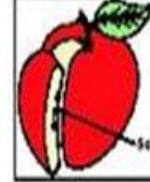
Nut
A simple, dry fruit that has a stony wall, is usually large, and does not split open at maturity.
Oak (*Quercus sp.*)



Aggregate fruit
A fruit that develops from a single flower with several to many pistils (i.e., carpels are not fused into a single pistil).
Blackberry (*Rubus sp.*)



Multiple fruit
A fruit that develops from the ovaries of a group of flowers.
Mulberry (*Morus sp.*)



Accessory fruit
A fruit composed primarily of tissue (such as the receptacle) other than ovary tissue.
Apple (*Malus domestica*)



Fruits

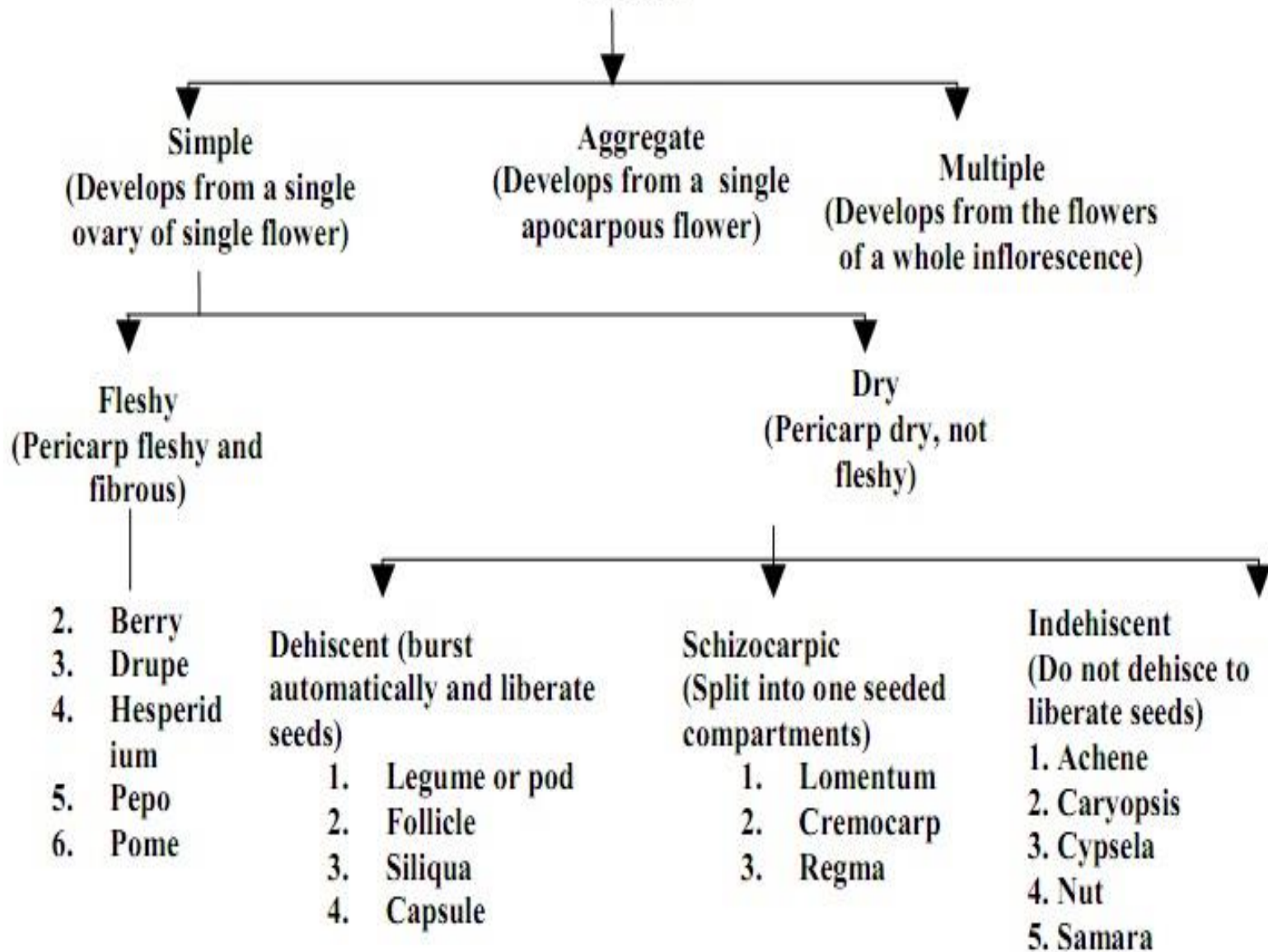
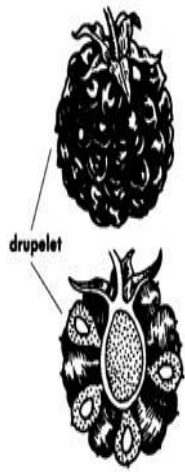


PLATE 11. FRUIT TYPES

FLESHY

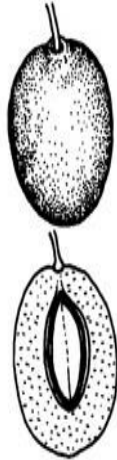


drupelet

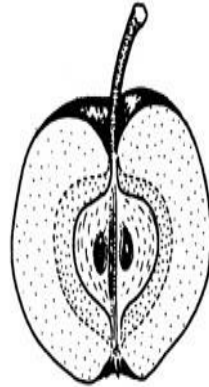
AGGREGATE



BERRY



DRUPE



POME



CIRCUMSCISSILE



FOLLICLE



LEGUME



LOMENT

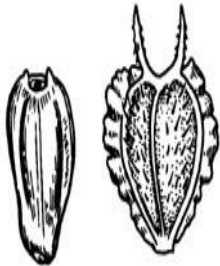


ACORN

DRY



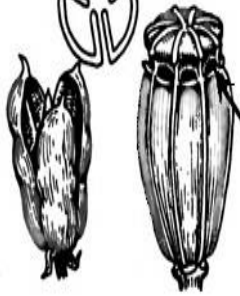
ACHENES



LOCULICIDAL



SEPTICIDAL
CAPSULES



PORICIDAL



SAMARAS



SCHIZOCARP



SILICLE



SILIQUE



SIMPLE FRUIT

- Simple fruits can be either dry or fleshy, and result from the ripening of a simple or compound ovary in a flower with only one pistil. Dry fruits may be either dehiscent (opening to discharge seeds), or indehiscent (not opening to discharge seeds).



TYPES OF DRY, SIMPLE FRUITS, WITH EXAMPLES OF EACH, ARE:

- **achene** - Most commonly seen in aggregate fruits (e.g. strawberry)
- **capsule** - (Brazil nut)
- **caryopsis** - (wheat)
- **Cypsela** - An achene-like fruit derived from the individual florets in a capitulum (e.g. dandelion).
- **fibrous drupe** - (coconut, walnut)
- **follicle** - is formed from a single carpel, and opens by one suture (e.g. milkweed). More commonly seen in aggregate fruits (e.g. magnolia)
- **legume** - (pea, bean, peanut)
- **loment** - a type of indehiscent legume
- **nut** - (hazelnut, beech, oak acorn)
- **samara** - (elm, ash, maple key)
- **schizocarp** - (carrot seed)
- **silique** - (radish seed)
- **silicle** - (shepherd's purse)



Types of FLESHY, simple fruits (with examples of each):

- Fruits in which part or all of the **pericarp (fruit wall)** is fleshy at maturity are **simple fleshy fruits**.
- **berry** - (redcurrant, gooseberry, tomato, cranberry)
- **stone fruit or drupe** (plum, cherry, peach, apricot, olive)



- An aggregate fruit develops from a single flower with numerous simple pistils.
- Schizocarp fruits form from a syncarpous ovary and do not really dehisce, but split into segments with one or more seeds; they include a number of different forms from a wide range of families. Carrot seed (Apiaceae) is an example.



AGGREGATE FRUIT

- Aggregate fruits form from **single flowers that have multiple carpels which are not joined** together, i.e. each pistil contains one carpel.
- Four types of aggregate fruits include **achenes, follicles, drupelets, and berries**.
- The raspberry, whose pistils are termed drupelets because each is like a small drupe attached to the receptacle. In some bramble fruits (such as blackberry) the receptacle is elongated and part of the ripe fruit, making the blackberry an aggregate-accessory fruit. The strawberry is also an aggregate-accessory fruit, only one in which the seeds are contained in achenes. **In all these examples, the fruit develops from a single flower with numerous pistils.**

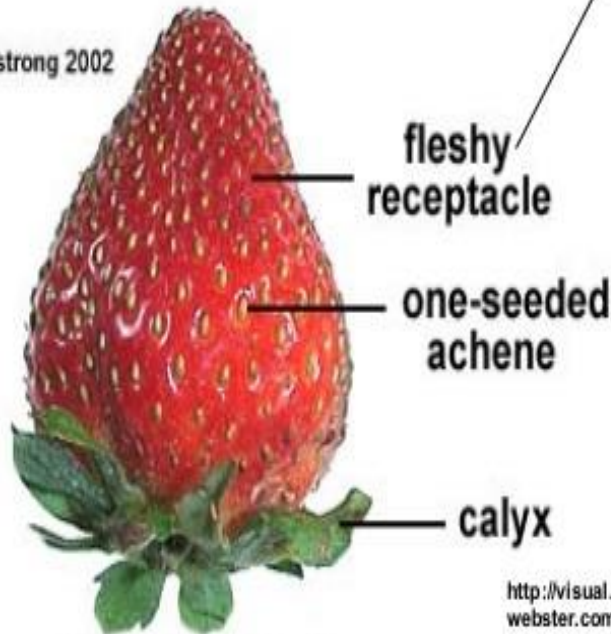


Strawberry = Aggregate-accessory fruit

This accessory "fruit" is actually an enlarged receptacle.



Armstrong 2002



www.visualdictionaryonline.com

<http://waynesword.palomar.edu/termfr4.htm>

http://visual.merriam-webster.com/plants-gardening/plants/fruits/fleshy-fruit-berry-fruit_3.php

+ section of a strawberry



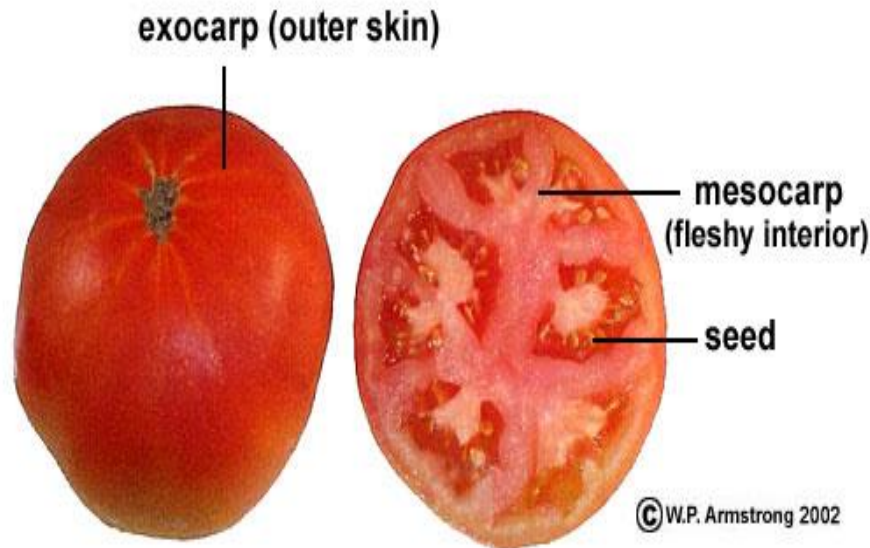
MULTIPLE FRUITS

Aggregating fruits are formed from a cluster of



Berries

- Berries are another type of fleshy fruit; they are simple fruit created from a single ovary. The ovary may be compound, with several carpels.



Berry (All of most of pericarp is fleshy)
e.g. tomato (*Lycopersicon esculentum*)

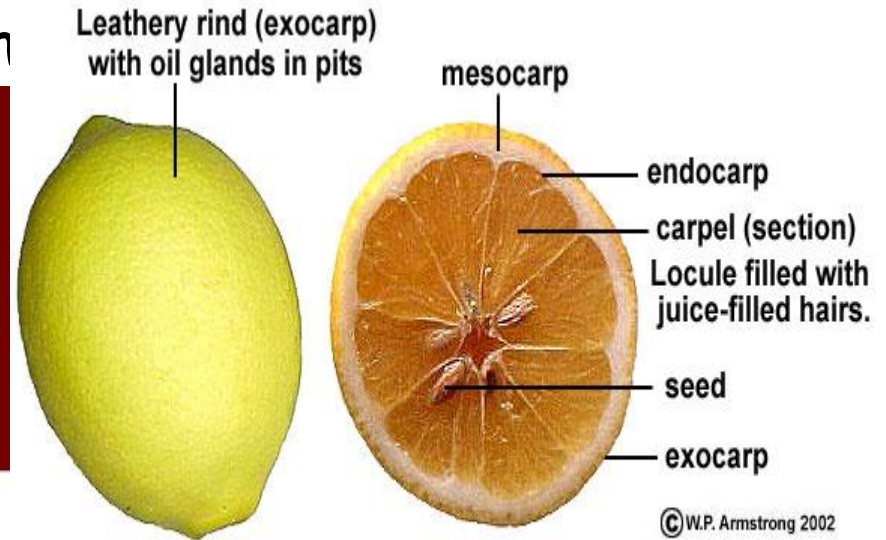
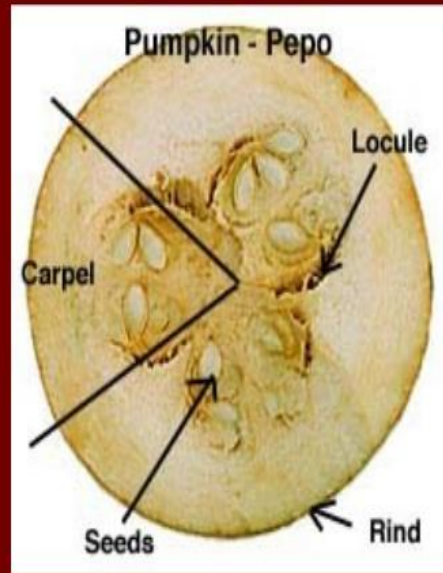
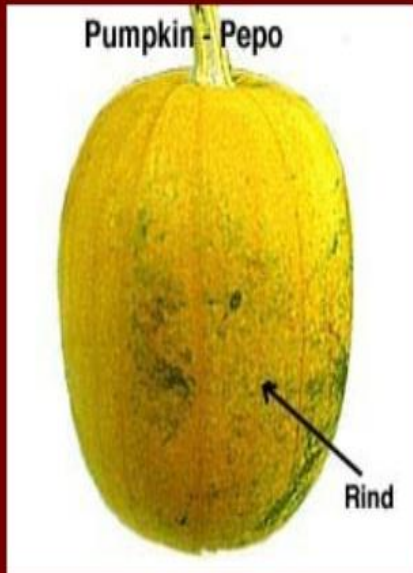


- **Pepo** - Berries where the skin is hardened, cucurbits

- **Hesperidium** - Berries with

Pepo

- Berry with a relatively hard rind (watermelon, gourds, squash).



Hesperidium (berry with a leathery rind)
e.g. lemon (*Citrus lemon*)



Accessory fruit

- The fruit of a **pineapple** includes tissue from the sepals as well as the pistils of many flowers. It is an **accessory fruit** and a **multiple fruit**.
- **Accessory fruit** can be **simple**, **aggregate**, or **multiple**, i.e., they can include **one or more pistils** and **other parts from the same flower**, or the **pistils** and **other parts of many flowers**.



"Sir, we've found this and we need you to name it. Most other countries call..."

"Pineapple."

"OK, but we thought we might as well just call it 'anasas' since the majority of the world refers to it--"

"Pineapple."

"But sir..."

"PINE. APPLE."



Arabic	أناناس	Indonesian	nanas
Armenian	անան	Irish	anann
Azerbaijani	ananas	Italian	ananas
Basque	anana	Latvian	ananas
Belarusian	ананас	Lithuanian	ananasas
Bulgarian	ананас	Macedonian	ананас
Croatian	ananas	Malay	nanas
Czech	ananas	Maltese	ananas
Danish	ananas	Norwegian	ananas
Dutch	ananas	Polish	ananas
English	pineapple	Portuguese	ananas
Esperanto	ananaso	Romanian	ananas
Estonian	ananas	Russian	ананас
Finnish	ananas	Serbian	ананас
French	ananas	Slovak	ananas
Georgian	ანანასი	Slovenian	ananas
German	Ananas	Swahili	mananasi
Greek	ανανάς	Swedish	ananas
Haitian	anana	Turkish	ananas
Hungarian	ananasz	Ukrainian	ананас
Icelandic	ananas	Yiddish	אָנאַנאַס

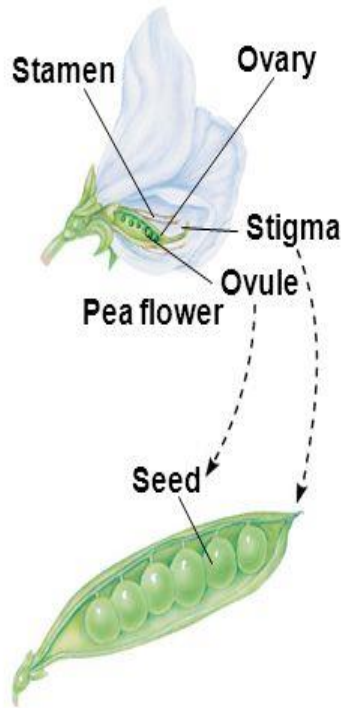


EXAMPLES FOR EACH GROUP:

- **True berry:** Blackcurrant, Redcurrant, Gooseberry, Tomato, Eggplant, Guava, Lucuma, Chili pepper, Pomegranate, Kiwifruit, Grape, Cranberry, Blueberry.
- **Pepo:** Pumpkin, Gourd, Cucumber, Melon.
- **Hesperidium:** Orange, Lemon, Lime, Grapefruit.
- **Aggregate fruit:** Blackberry, Raspberry, Boysenberry.
- **Multiple fruit:** Pineapple, Fig, Mulberry, Hedge apple.
- **Accessory fruit:** Pineapple, Apple, Strawberry, Stone fruit.

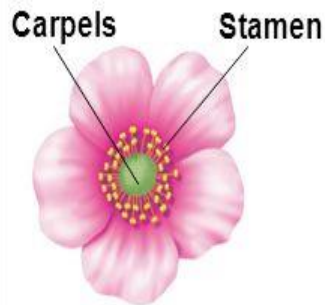


What do you eat?

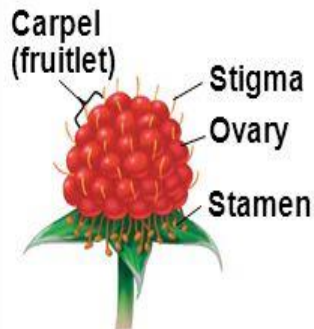


Pea fruit
(a) Simple fruit

© 2011 Pearson Education, Inc.



Raspberry flower



Raspberry fruit
(b) Aggregate fruit

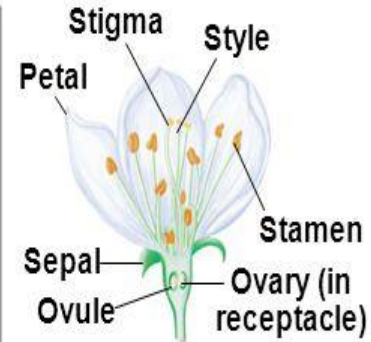


Pineapple inflorescence

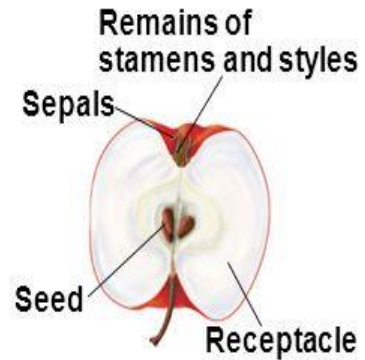
Each segment develops from the carpel of one flower



Pineapple fruit
(c) Multiple fruit



Apple flower

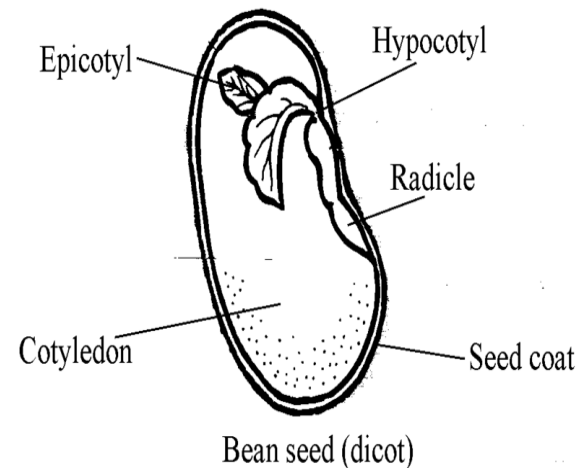
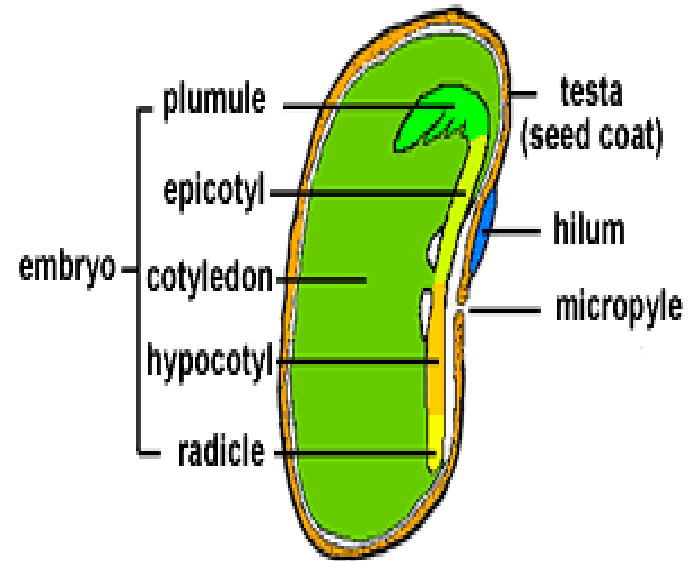


Apple fruit
(d) Accessory fruit



SEED

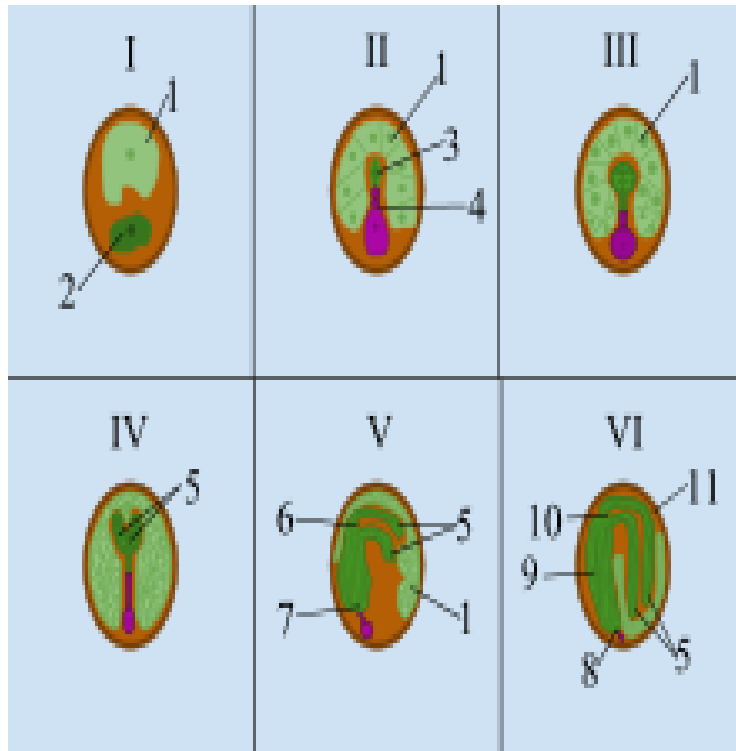
- A seed is an embryonic plant enclosed in a protective outer covering known as the **seed coat (=testa)**.
- It is a characteristic of spermatophytes (gymnosperm and angiosperm plants) and the product of the ripened ovule which occurs after fertilization and some growth within the mother plant. The formation of the seed completes the process of reproduction in seed plants (started with the development of flowers and pollination), with the embryo developed from the zygote and the seed coat from the integuments of the ovule.



- Seeds have been an important development in the reproduction and spread of gymnosperm and angiosperm plants, relative to more primitive plants such as **ferns** and **mosses**, which do not have seeds and use other means to propagate themselves. This can be seen by the success of seed plants (both gymnosperms and angiosperms) in dominating biological niches on land, from forests to grasslands both in hot and cold climates.
- Many structures commonly referred to as "seeds" are actually dry fruits.



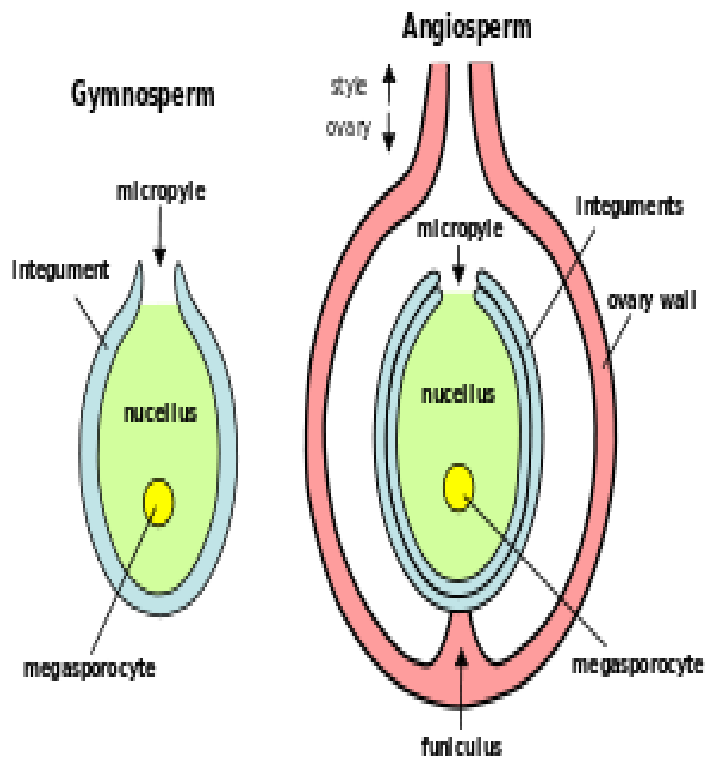
OVULE



Stages of seed development:

Key: 1. Endosperm 2. Zygote 3. Embryo
4. Suspensor 5. Cotyledons 6. Shoot Apical Meristem 7. Root Apical Meristem
8. Radicle 9. Hypocotyl 10. Epicotyl 11. Seed Coat





Plant ovules: Left: Gymnosperm ovule;
Right: angiosperm ovule (inside ovary)

After fertilization the ovules develop into the seeds. The ovule consists of a number of components:

The **funicle** (*funiculus*, *funiculi*) or **seed stalk** which attaches the ovule to the placenta and hence ovary or fruit wall, at the pericarp.

The nucellus, the remnant of the megasporangium and main region of the ovule where the megagametophyte develops.

The micropyle, a small pore or opening in the apex of the integument of the ovule where the pollen tube usually enters during the process of fertilization.

The chalaza, the base of the ovule opposite the micropyle, where integument and nucellus are joined together).



EMBRYO

- The main components of the embryo are:
- **The cotyledons**, the seed leaves, attached to the embryonic axis. There may be one (Monocotyledons), or two (Dicotyledons). The cotyledons are also the source of nutrients in the non-endospermic dicotyledons, in which case they replace the endosperm, and are thick and leathery. In endospermic seeds the cotyledons are thin and papery. Dicotyledons have the point of attachment opposite one another on the axis.
- **The epicotyl**, the embryonic axis above the point of attachment of the cotyledon(s).
- **The plumule**, the tip of the epicotyl, and has a feathery appearance due to the presence of young leaf primordia at the apex, and will become the shoot upon germination.
- **The hypocotyl**, the embryonic axis below the point of attachment of the cotyledon(s), connecting the epicotyle and the radicle, being the stem-root transition zone.
- **The radicle**, the basal tip of the hypocotyl, grows into the primary root.

