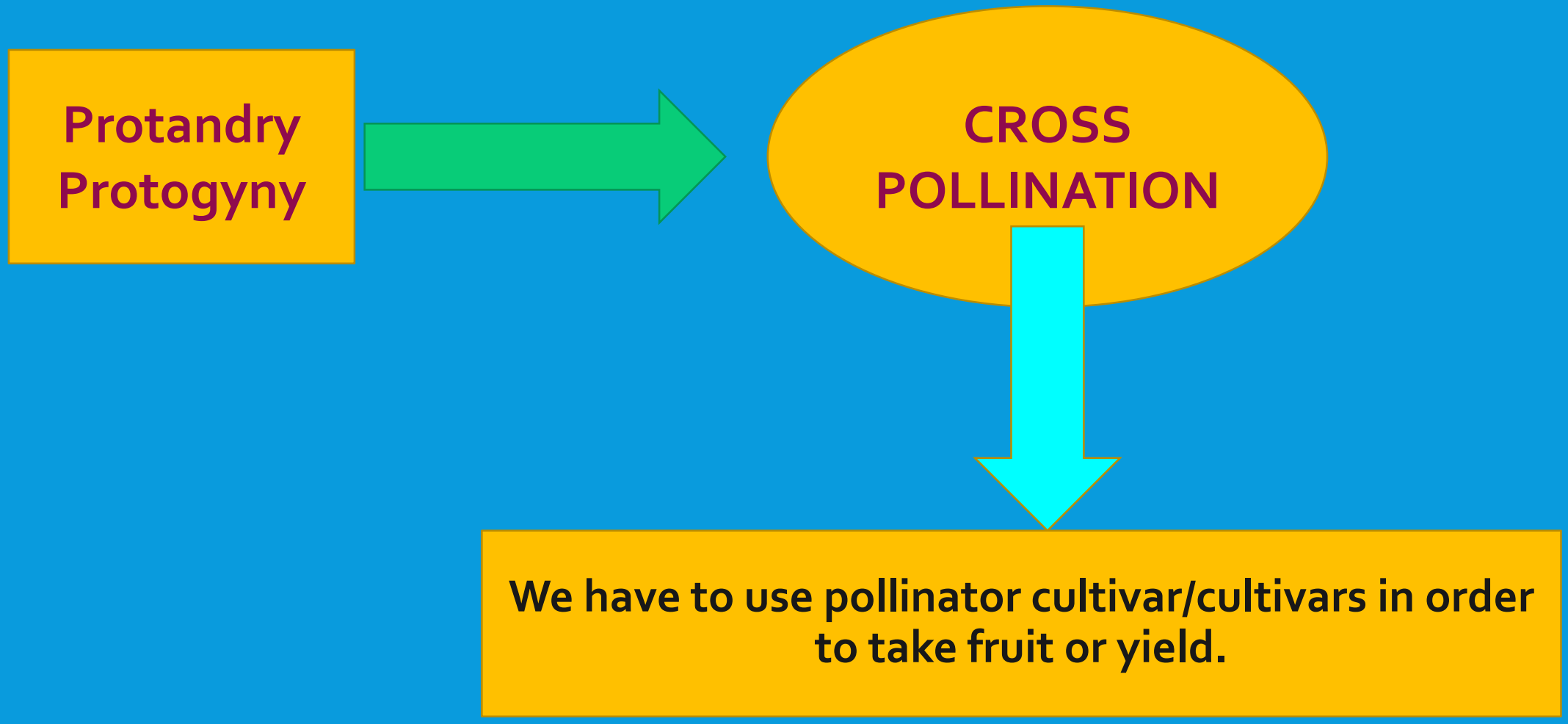
FACTORS AFFECTING POLLINATION TYPE

- Maturation time of female and male organs in the flowers.
- **Homogamy** is when the anthers and the stigma of a flower are being matured at the same time.
- **Dichogamy** is when anthers and the stigma of a flower are being matured at the different time. Dichogamy is divided into two different groups;
- **1- Protandry:** The process in which the anther mature before the maturation of pistil.
- **2- Protogyny:**The process in which the pistil mature before the maturation of anther.
- Dichogamy completely prevents self-fertility.
- If it is possible to see both protandry and protogyny in a species or in a cultivar, his situation is called as **Heterodichogamy.**


Protandry
Protogyny
CROSS
POLLINATION
We have to use pollinator cultivar/cultivars in order to take fruit or yield.

THE MOST IMPORTANT ENVIRONMENTAL CONDITION FOR ANEMOPHILY SPECIES IN ORDER TO OBTAIN PROPER POLLINATION

- **Weather conditions during flowering period or flowering time**

- In these kind of species (Anemophyle species),
- Long foggy and very humid weather conditions cause pollen to remain suspended in the air. It is a big problem in our country in Black Sea region especially on hazelnut cultivation. After such kind of season, the yield decreases because of fertilization problem.
- Hot and dry winds for a long time cause the stigma to dry out. It is a problem in pistachio nut cultivation in South-East Region of Turkey.

IN ENTOMOPHYLE SPECIES THE MOST IMPORTANT REQUIREMENT AFFCETING POLLINATION IS BEE

- Availability of insects especially **BEES**

- **When can bees not come out of their hive??**
- **At temperatures below 10°C**
- **In rainy and windy weather that blows faster 25-40 km**

Honeybees are the most important natural carriers of pollen. As the bee flies from flowers on one tree to those on another in the orchard, pollen sticks to its body hairs. The bee rubs off the pollen onto the stigma and transfers additional pollen from the anthers as it visits the flowers. A honey bee may visit 5,000 flowers a day. Home plantings of fruit crops generally have enough wild bees for adequate pollination.

Bambus bee

IF WE ARE CULTIVATING ENTHOMOPHILE SPECIES, HOW MANY BEEHIVES SHOULD WE PLACED IN THE ORCHARD???

- 2-5 beehives per hectare
- The distance between the hives should not be more than 250 m.

WHAT SHOULD BE DONE FOR FRUIT YIELD IN THE CULTIVATION OF SPECIES THAT CANNOT BE POLLINATED WITH SELF-POLLINATION?

- We have to use another cultivar in the orchard as **pollinator (Pollinizer) cultivar** in order to obtain pollination then fertilization.
- **How many pollinator cultivar should be placed in the orchard?**
- The number of pollinator cultivar should be one tree per 8 essential cultivar trees.
- If this pollinator cultivar can not be pollinated with the essential (main) cultivar, in this case we have to use another second cultivar to pollinate pollinator cultivar in order to obtain fruit.

IMPORTANT POINT WHEN PLANTING A POLLINIZER IN THE ORCHARD:

- **1. The flowering period of the pollinizer cultivar should be at the same time as the main cultivar in the orchard.**
- **2. The distance between the main and the pollinizer cultivars should be no more than 75 m in the orchard.**

THE POLLINIZER CULTIVAR IN THE ORCHARD SHOULD HAVE THESE CHARACTERISTICS:

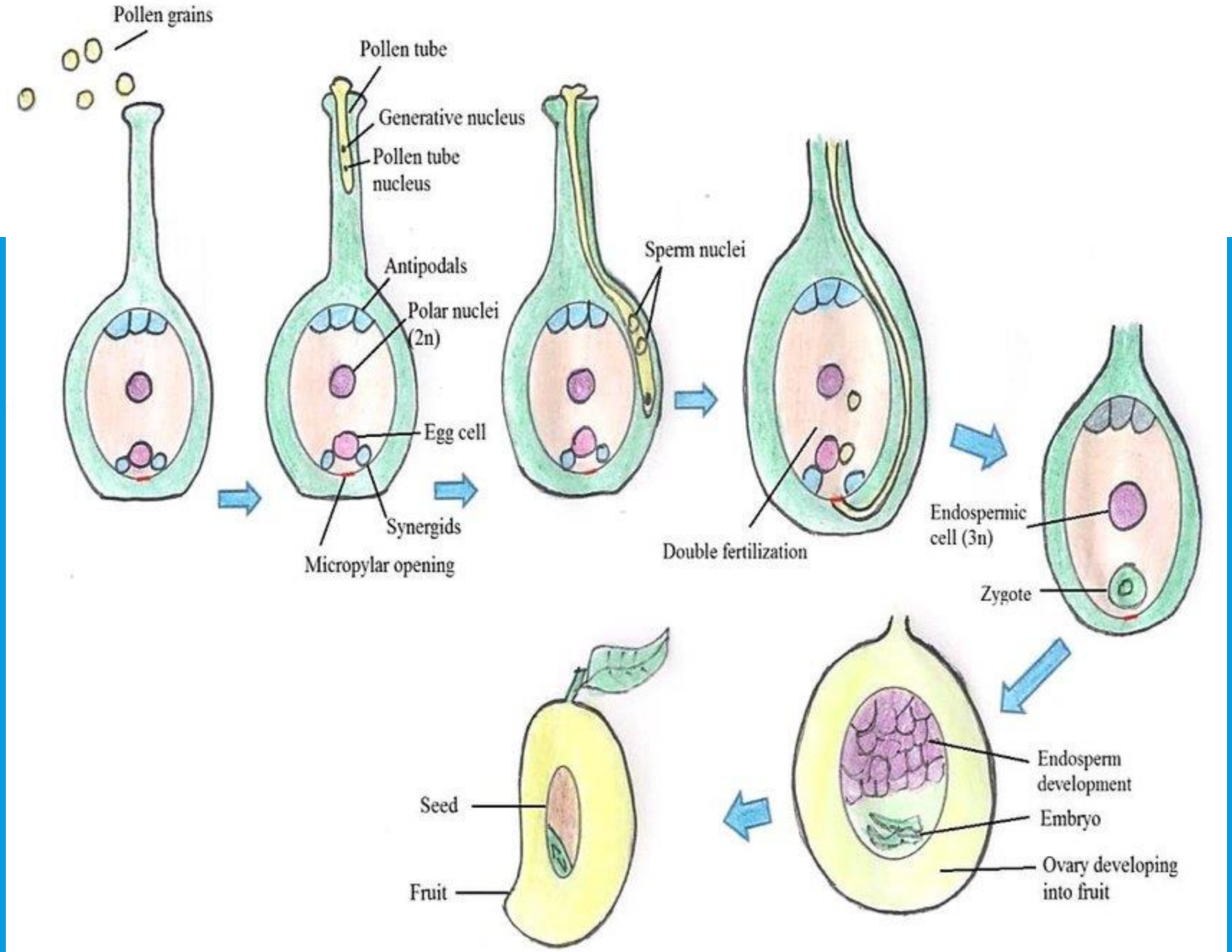
- It should form abundant pollen with high germination rate.
- Its flowering period should be at the same time as the main cultivar (pollinated cultivar) in the orchard.
- It has a long blooming (flowering) period.
- Its fruits should have a market value.
- It should have a hermaphroditic flower structure.

FERTILIZATION

- In plants, fertilization is a process of sexual reproduction, which occurs after pollination and germination.
- Fertilization can be defined as the fusion of the male gametes (pollen) with the female gametes (ovum) to form a diploid zygote. It is a physicochemical process which occurs after the pollination of the carpel. The complete series of this process takes place in the zygote to develop into a seed.
- In the fertilization process, flowers play a significant role as they are the reproductive structures of angiosperms (flowering plants). The method of fertilization in plants occurs when gametes in haploid conditions fuse to produce a diploid zygote.
- In the course of fertilization, male gametes get transferred into the female reproductive organs through pollinators (honey bees, birds, bats, butterflies, flower beetles) and the final product will be the formation of the embryo in a seed.

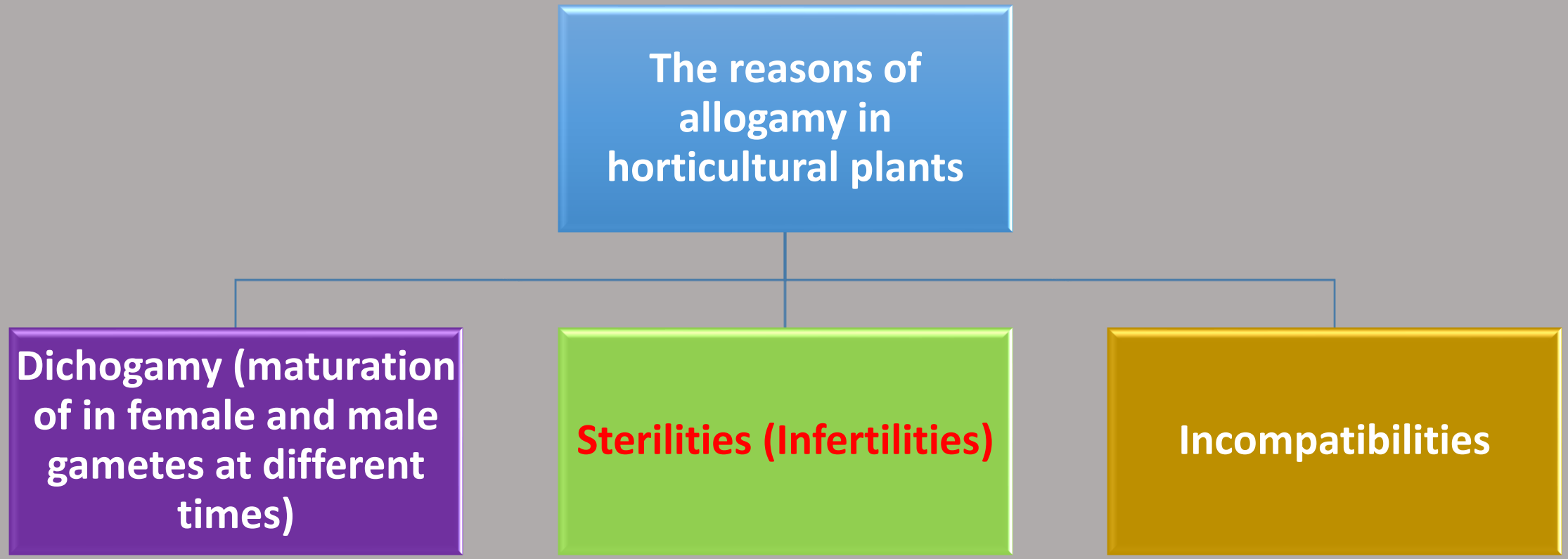
FERTILIZATION PROCESS

- In flowers, the pollen grain germinates after the pollination of the carpel and grows into the style by creating the pathway for the pollen grain to move down to the ovary.
- The pollen tube opens into the ovule through the micropyle and bursts into the embryo sac. Here, the male nucleus unites with the nucleus of an egg inside the ovule forming a diploid zygote, which later swells up and develops into a fruit.


Pollen grains
Pollen tube
Generative nucleus
Pollen tube nucleus
Antipodals
Polar nuclei (2n)
Egg cell
Synergids
Micropylar opening
Sperm nuclei
Double fertilization
Endospermic cell (3n)
Zygote
Endosperm development
Embryo
Ovary developing into fruit
Seed
Fruit

Fertilization can occur in two different ways in horticultural plants

- **Autogamy:** It is the process of self-fertilization in plants. The pollen of the plant is transferred to its own stigma or ovule and fertilization occurs. E.g., Apricot, peach, nectarine, quince, orange, pea, tomato, bean.
- **Allogamy:** It is the process of cross-fertilization in plants. The pollen of the plant is transferred from the flower of another cultivar. It is quite common in horticultural species. E.g., Apple, pear, cherry, plum, walnut, pecan, olive, banana, okra, fig date, avocado, blackberry, raspberry, strawberry, grape, watermelon, asparagus, carrot, celery, radish, spinach, cabbage, broccoli, onion , zucchini, lettuce etc.


The reasons of allogamy in horticultural plants
Dichogamy (maturation of in female and male gametes at different times)
Sterilities (Infertilities)
Incompatibilities

STERILITIES (INFERTILITIES)

1- Morphological infertilities:

Male and female organs have morphologically deficiencies. Formation and development of one of female or male gametes or both of them is somewhat prevented. In Washington Navel orange cultivar, the male gametes are not occurred.

2- Genetic and cytoplasmic infertilities

These kind of infertilities are common for male gametes (male sterility). It is possible to see in onion, tomato, bean.

INCOMPATIBILITIES

- Both male and female gametes are normal, pollination realizes but fertilization does not occur because of some genetical reasons and seed does not occur. The incompatibility occurs between pollen and stigma, or between pollen and style and ultimately, pollen grain does not germinate or does not proceed inside the style for proper fertilization. Some reasons prevent germination of the pollen grain on the stigma or proceeding in style after germination/

1. Self-incompatibility:

- Self-incompatibility (SI) refers to all genetic mechanisms in flowering plants that prevent self-fertilization through the recognition and rejection of self-pollen by the style of a flower.

2- Cross incompatibility:

Cross incompatibility (CI) has been defined as any relationship (or its absence) between pollen and pistil which prevents zygote formation in crosses between two fertile species. This phenomenon has been proposed to occur from a lack of genetic information in one of the partners of a given genotypic combination about either the structure or the physiology of the other partner, or for pistil recognition of pollen with a foreign origin.

- In plants, fertilization is defined as the fusion of the male and the female gamete to develop into a diploid zygote. After fertilization, a series of event occurs in the zygote to develop into a seed. Let us take an overview of the process of post-fertilization, endosperm and embryo formation.

- **What Is Post Fertilization? SEED FORMATION**

- Post-fertilization is a series of events that takes place after fertilization to develop a seed from an ovule and a fruit from an ovary.

- The following events occur in the post-fertilization.
  - Endosperm development
  - Embryogeny

ENDOSPERM

- The endosperm is a type of tissue, which is present in the seeds of flowering plants during the time of fertilization. Reserve food materials fill in the cells of endosperm tissue. It provides nutrition to the developing embryo in the form of starch. Endosperm development is classified into three types. These are as follows:
- Nuclear endosperm formation: In this process, the primary nucleus of endosperm undergoes a nuclear division repeatedly to produce free nuclei without wall formation.
- Cellular endosperm formation: During nuclear division, the formation of cell wall occurs and it leads to the cellular endosperm formation.
- Helobial endosperm formation: It is an intermediate type of endosperm formation between cellular and nuclear type endosperm formation.
- During seed maturation or in the mature seed, the developing embryo may either utilize the endosperm completely or it is used by seed during seed germination.

EMBRYOGENY

- Embryogeny is defined as the process of growth and development of an embryo from a zygote in the flowering plants. Embryo development stages are the same in both monocot and dicot plants.
- In dicot plant embryo, an embryonal axis and two cotyledons are present. Two parts are present in the embryonal axis. These are as follows:
- Epicotyl: It is located above the cotyledon level.
- Hypocotyl: It is located below the cotyledon level.
- A monocot plant embryo consists of only one cotyledon. The cotyledon is termed as scutellum in the grass family. Root cap of grass is covered with an undifferentiated sheath which is called as coleorhiza. A portion of the embryonic axis, which is located above the scutellum is called epicotyl. Epicotyl consists of shoot apex and coleoptiles.

FACTORS AFFCETING FERTILIZATION

- Pollination is very important.
- But each pollination does not result with fertilization.
- For pollination resulting with fertilization;
- 1. Stigma should be receptive
- 2. Pollen should germinate
- 3. Pollen tube should develop
- 4. During this period, the egg cell should remain alive

WHAT IS THE PERIOD BETWEEN POLLINATION AND FERTILIZATION???

- This period depends on;
- 1. the weather conditions,
- 2. Genetical structure of the plant (Species and cultivar characteristics).

Especially the air temperature at the time of flowering (The fertilization period is prolonged at temperatures below and above the optimum temperature.)

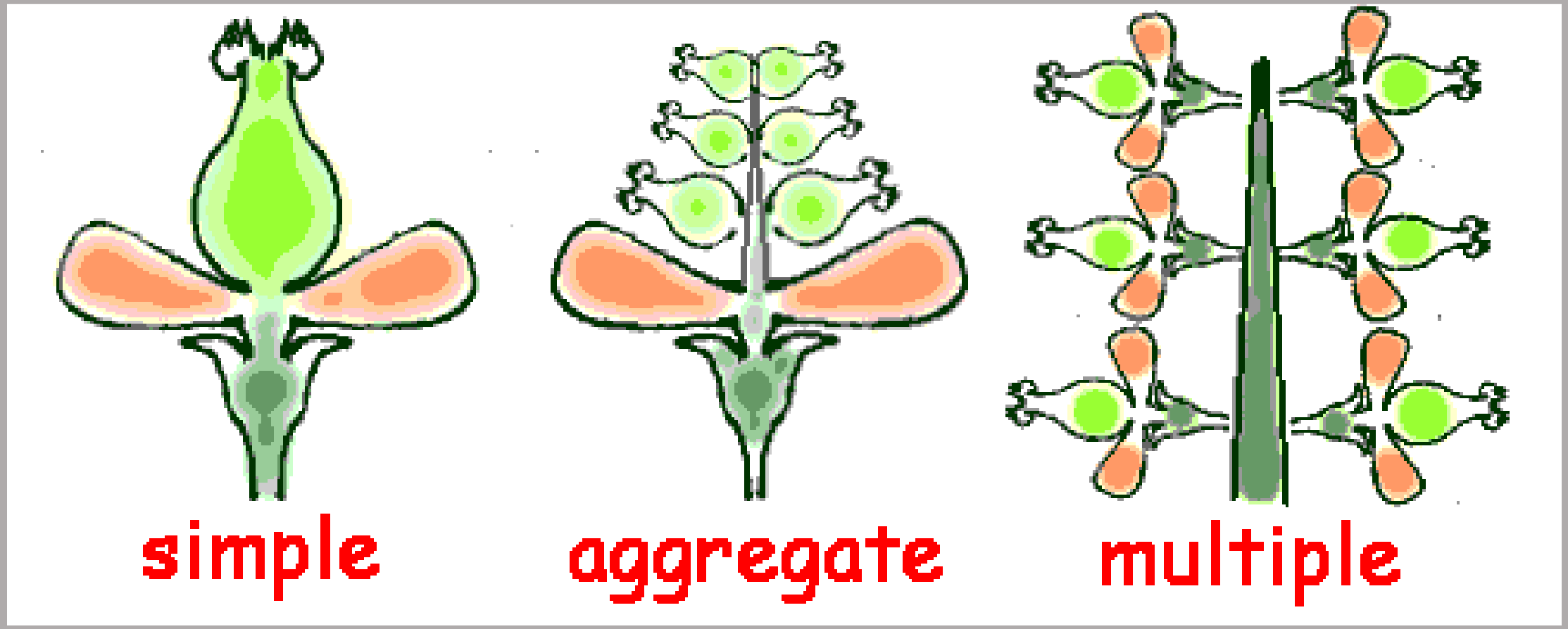
FRUIT AND FRUIT GROWTH

- After pollination and fertilization, embryo is formed and then fruit set occurs. While seeds are developing from the ovules, the ovary of the flower is developing into a fruit, which protects enclosed seeds and aids in dispersal by wind or animals. Fertilization triggers hormonal changes that cause the ovary to begin transformation into a fruit. During fruit development, the ovary walls become the pericarp, the thickened wall of the fruit. Meanwhile, other parts of the flower usually wither and are shed.

The Fruit

- The botanical term fruit refers to the mature ovary and other flower parts associated with it. Thus it may include the receptacle as well as the withered remnants of the petals, sepals, stamens and specific portions of the pistil. It also includes seeds contained in the ovary.
- The structure of the fruit is related to the structure of the flower. Fruits are classified into several types depending on their developmental origin.

Classification of fruit

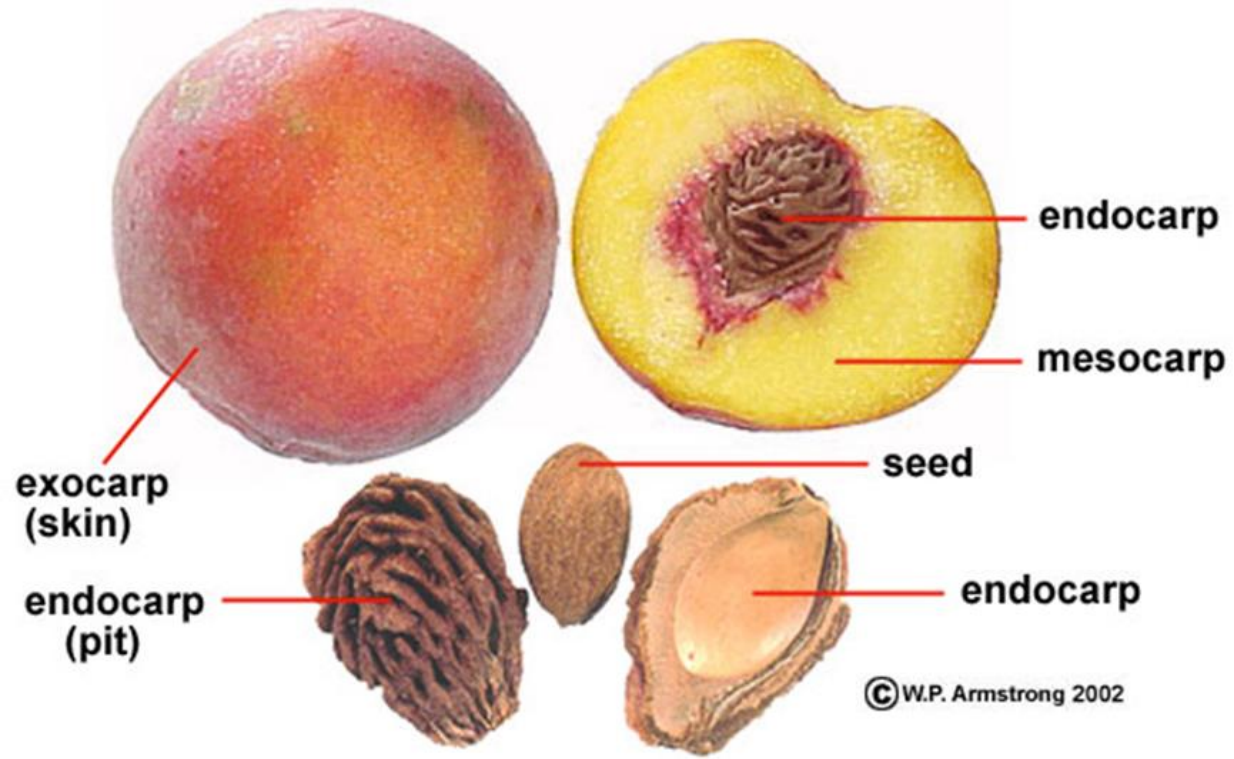


Classification of fruit

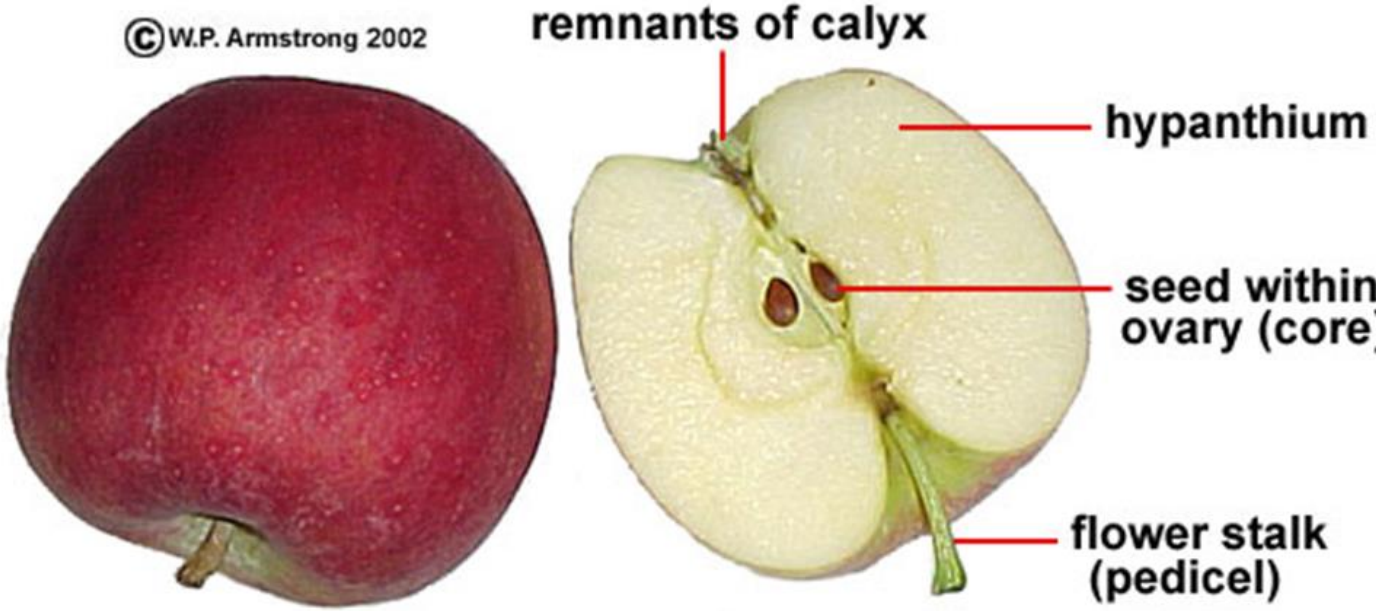
1. Simple fruit:

Fruits composed of a single ovary.

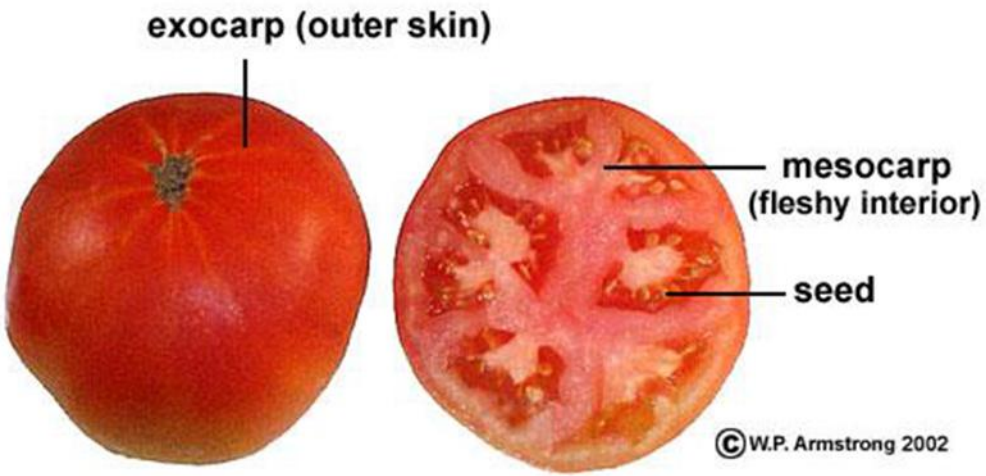
Simple fleshy fruits having **a stony endocarp** (such as peach, cherry, plum and olive) are known as drupes or stone fruits. The skin of these fruits is the exocarp; the fleshy edible portion is the mesocarp. Simple fleshy fruits in which the inner portion of the pericarp forms a dry paper like “core” are known as pomes (e.g., apple, pear, quince).



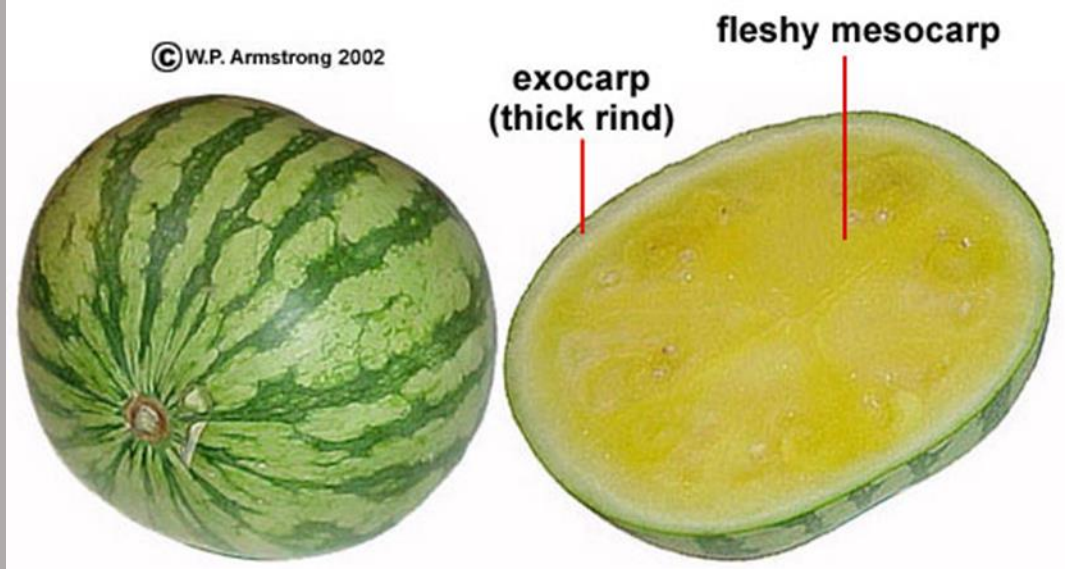
Drupe (fleshy fruit with a stony endocarp)



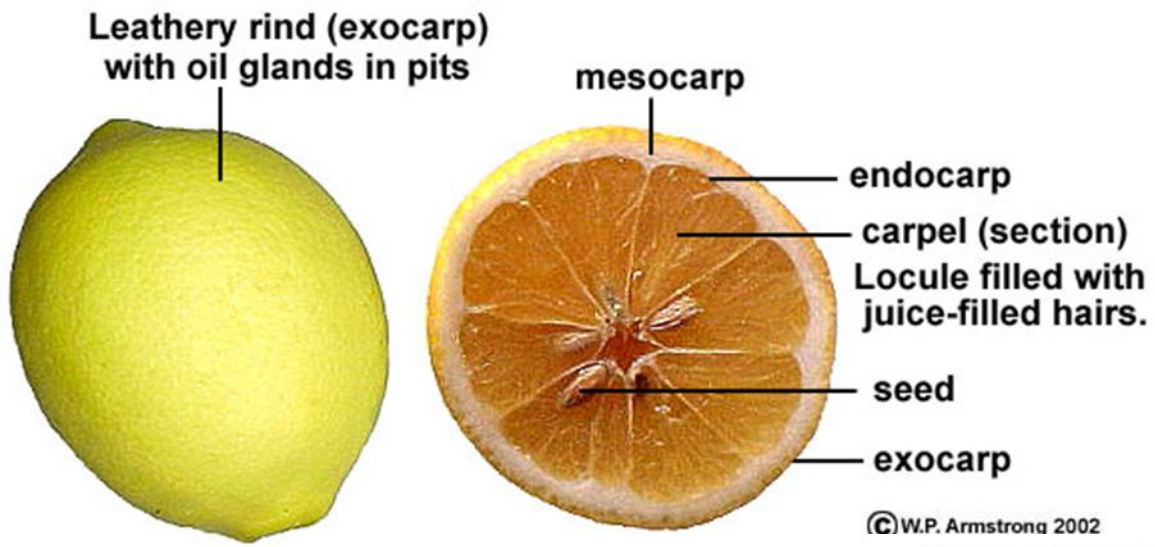
Pome (ovary surrounded by fleshy hypanthium)
e.g. apple (*Malus domestica* cv. *'gala'*)



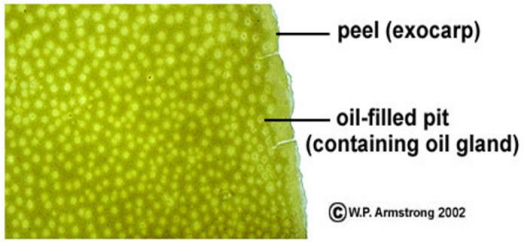
Berry (All of most of pericarp is fleshy)
e.g. tomato (*Lycopersicon esculentum*)



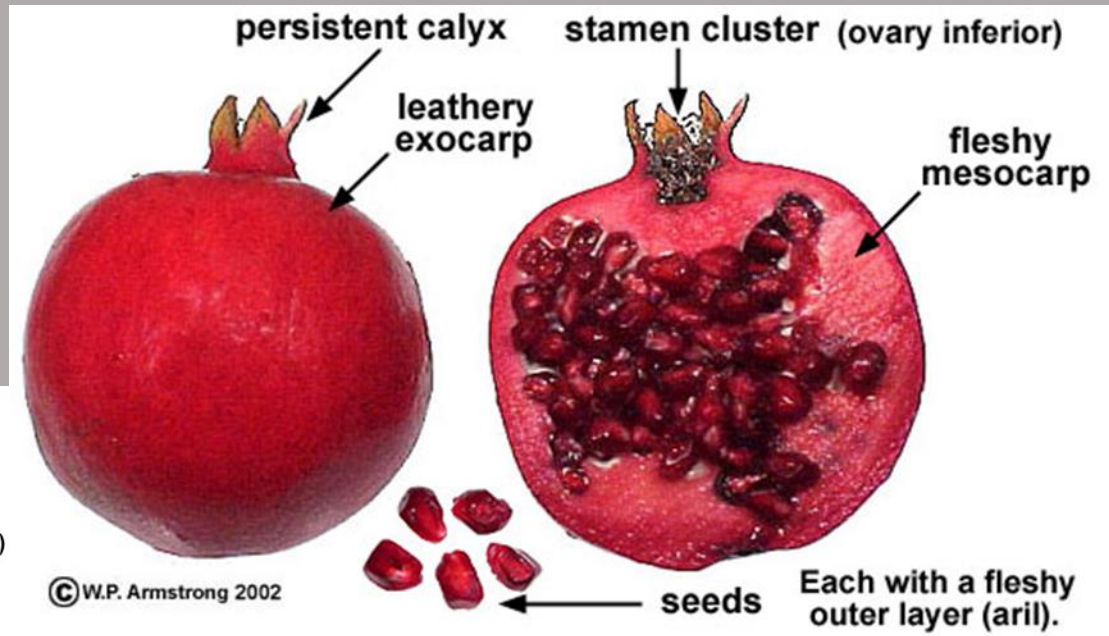
Pepo (a berry with a hard, thick rind)
e.g. watermelon (*Citrullus lanatus* var. *lanatus*)



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

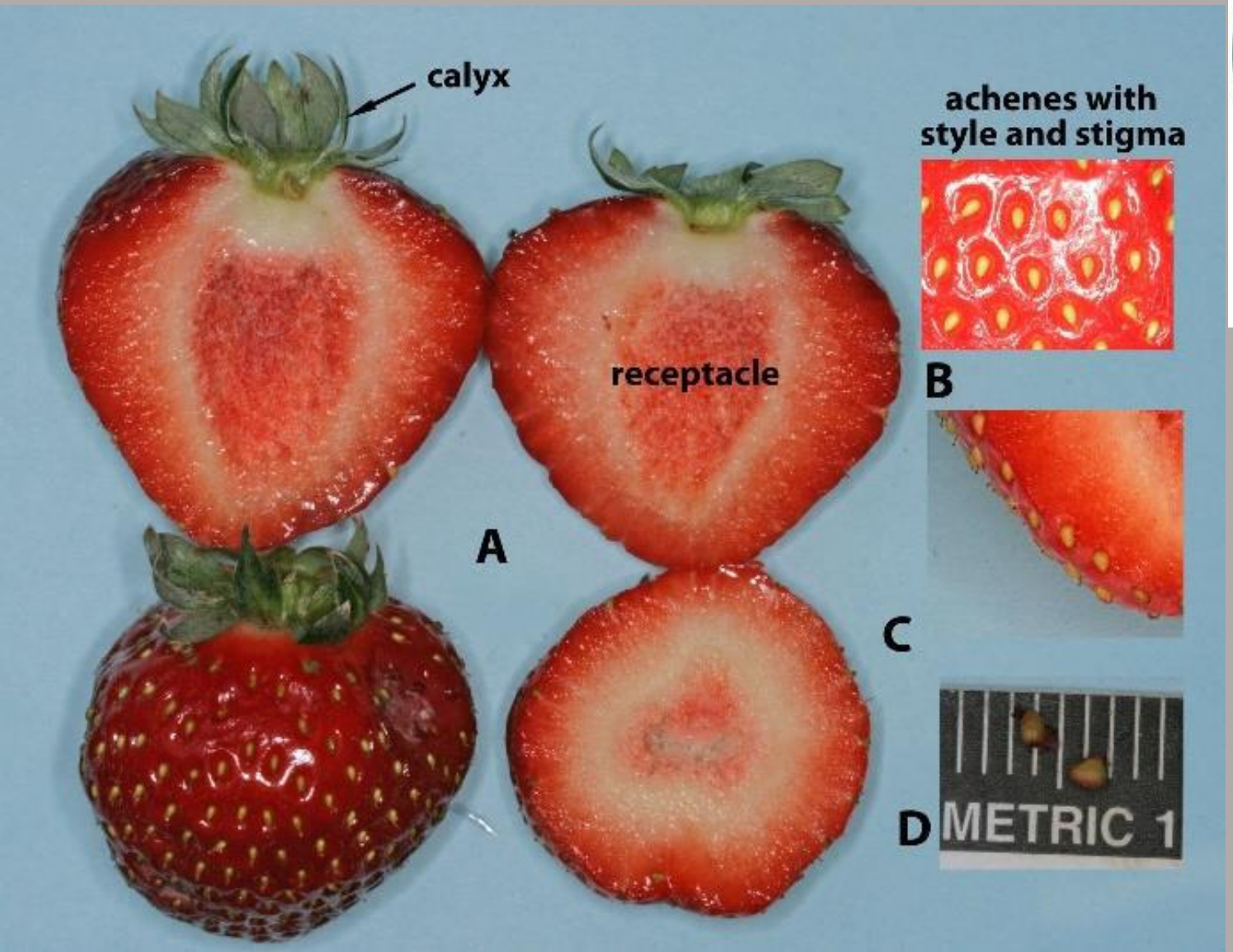


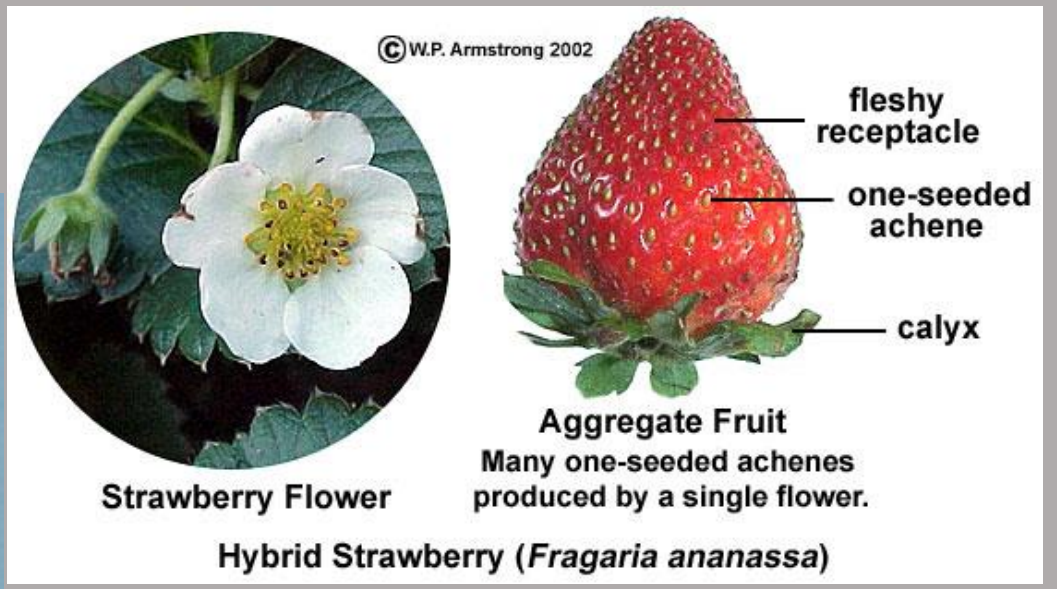
Magnified View Of The Surface Of A Lemon Peel



Pomegranate (*Punica granatum*): A many-seeded berry.

- **AGGREGATE FRUIT:**
- Each aggregate fruit is derived from a flower having many pistils on a common receptacle. The individual fruits of the aggregate may be drupes (stony), as in blackberries, or achenes (that is, one-seeded, dry fruits attached to the receptacle at the single point), as in strawberries. Aggregate fruits result from a single flower that has more than one separate carpel which each form a small fruit. In the strawberry, the fleshy edible part is the receptacle.


calyx
receptacle
A
achenes with
style and stigma
B
C
D
METRIC 1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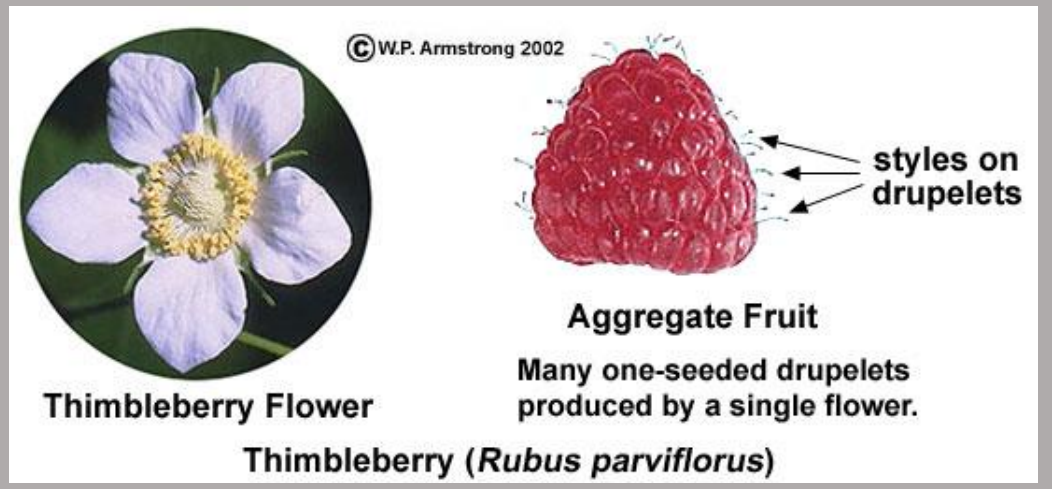
fleshy
receptacle
one-seeded
achene
calyx
Strawberry Flower
Aggregate Fruit
Many one-seeded achenes
produced by a single flower.
Hybrid Strawberry (*Fragaria ananassa*)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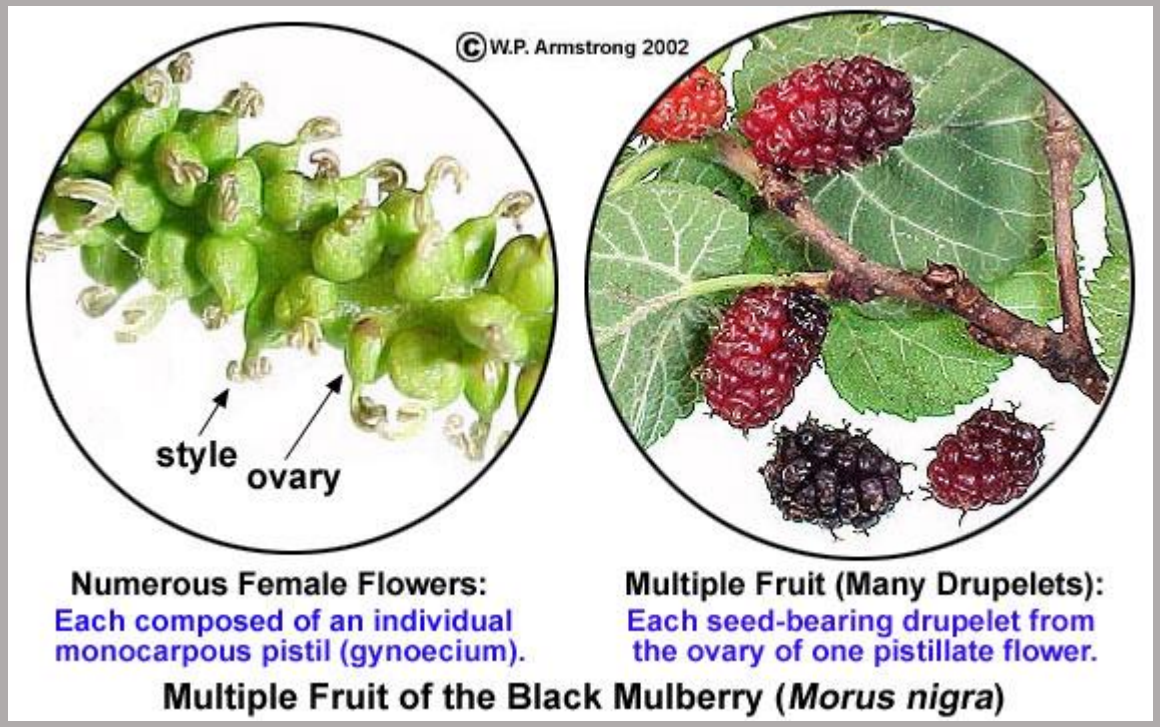
styles on
drupelets
Thimbleberry Flower
Aggregate Fruit
Many one-seeded drupelets
produced by a single flower.
Thimbleberry (*Rubus parviflorus*)

- **MULTIPLE FRUITS:**
- Multiple fruits develop from an inflorescence, a group of flowers tightly clustered together. Each multiple fruit is derived from many separate but closely clustered flowers. When the walls of many ovaries start to thicken, they fuse together and become incorporated into one fruit, such as a pineapple, fig, mulberry.



Does each fruit have seed/seeds???

- **PARTHENOCARPY (APIRENY) - PARTHENOCARPIC FRUIT**
- Many species and cultivars produce fruit that either lack seeds or have no viable seeds. The production of such seedless fruits is known as parthenocarpy and is common for banana, pineapple, cucumber, tomatoes, figs, oranges, grapes, kiwi, blackberry, pepper, etc.

Parthenocarpy results from one of three causes

- (i) lack of pollination,
- (ii) pollination occurs but fertilization does not (Stimulative parthenocarpy),
- (iii) fertilization is followed by embryo (seed) abortion (Stenospermocarpy)
- Hormones, auxins, gibberellins, and cytokinins, especially the first two, are well known to induce parthenocarpy.
- **Parthenocarpy is undesirable in nut crops, such as pistachio, for which the seed is the edible part.**

Amphimixis

- 1. It is sexual reproduction (Formation of the fruit with seed)
- 2. The union of a male and female gamete.
- 3. Sexual reproduction involving the fusion of two different gametes to form a zygote.

Apomixis

- Formation of fruit with seed without fertilization.
- Apomictic reproduction has traditionally been separated into 2 mechanisms:

Polyembryony and gametophytic apomixis:

Ployembryony (nucellar embryony) refers to the formation of embryos from ovule tissues outside of the embryo sac