Morphology of Plant Organs : Flowers, Fruits and Seeds

I. Morphology of the flower

I. Flower

In angiosperms, a **flower** is : Like a highly modified stem with determined growth; it consists of the peduncle, the receptacle and 4 whorls (floral parts arranged in a circle).

These 4 whorls are: the **calyx** and the **corolla** (sterile parts), the androecium and the gynoecium (fertile parts);

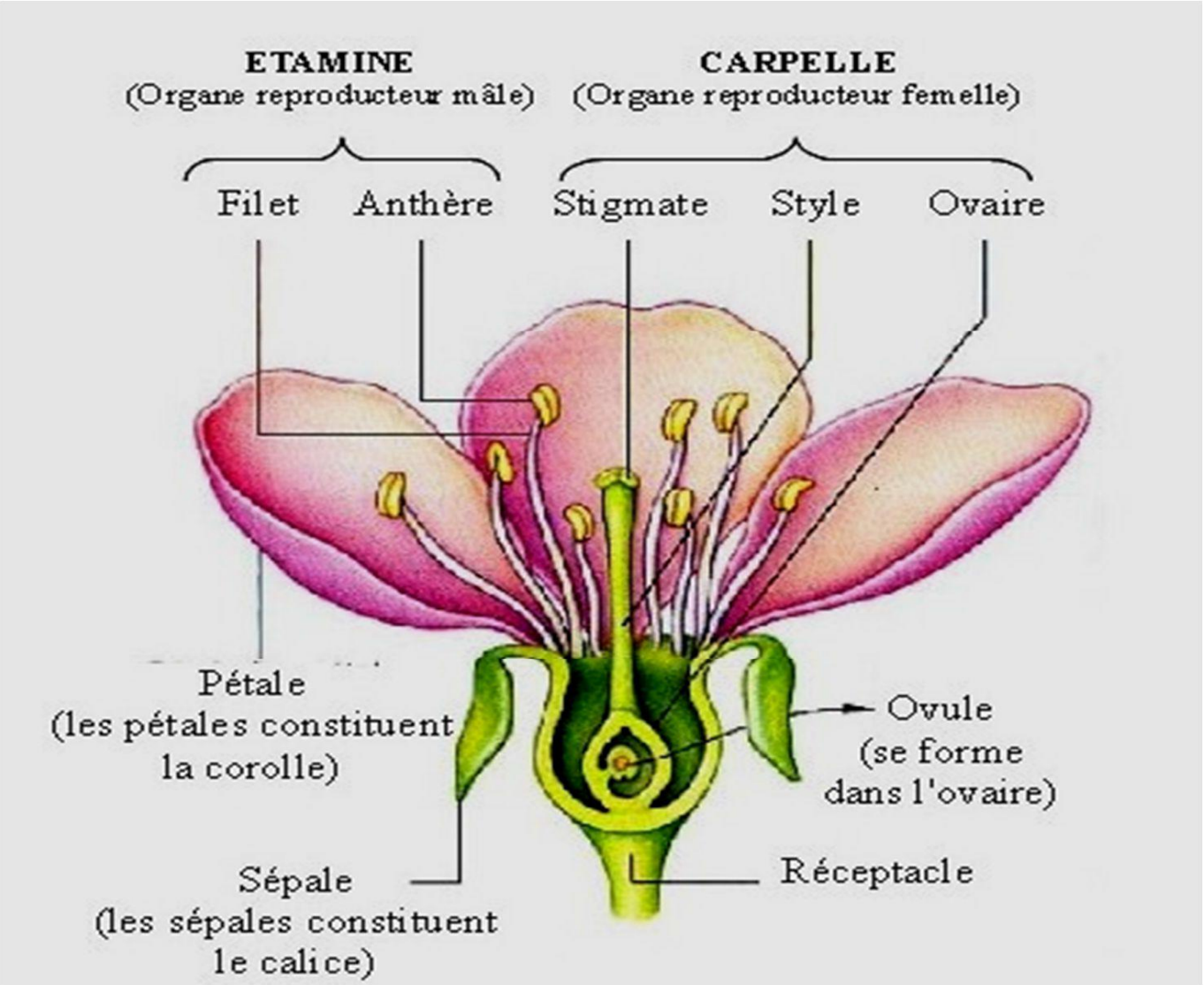
Some plants have an isolated (individual) flowers, but many have flowers in small ‘clusters’ called inflorescences:

- An isolated flower is borne on a peduncle;

- A sessile flower (no stalk);

- In an inflorescence, the axis carrying an individual flower is called the pedicel.

Schematic diagram of an angiosperm flower



1. The perianth

The **perianth** is the set of sterile parts, composed of 2 whorls: corolla and calyx.

1.1. The calyx : The calyx is made up of sepals, which are often greenish, foliaceous parts located at the base of the flower. The calyx takes different forms:

A dialepal calyx (the sepals are free);

A gamosepal calyx (the sepals are fused together).

The persistence of the calyx also varies:

- A calyx is deciduous when it falls as soon as the flower has opened;

- A calyx is persistent when it remains until the fruit ripens.

1.2. The corolla : The corolla is formed by the petals, which are larger than the sepals and often brightly coloured. The petals are situated above the sepals. When the petals and sepals have the same appearance (i.e. they are difficult to distinguish from each other), the floral part is called a tepal and all the tepals are called a perigone.

There are different types of corolla :

Dialypetal corolla (the petals are free);

Gamopetal corolla (the petals are fused together).

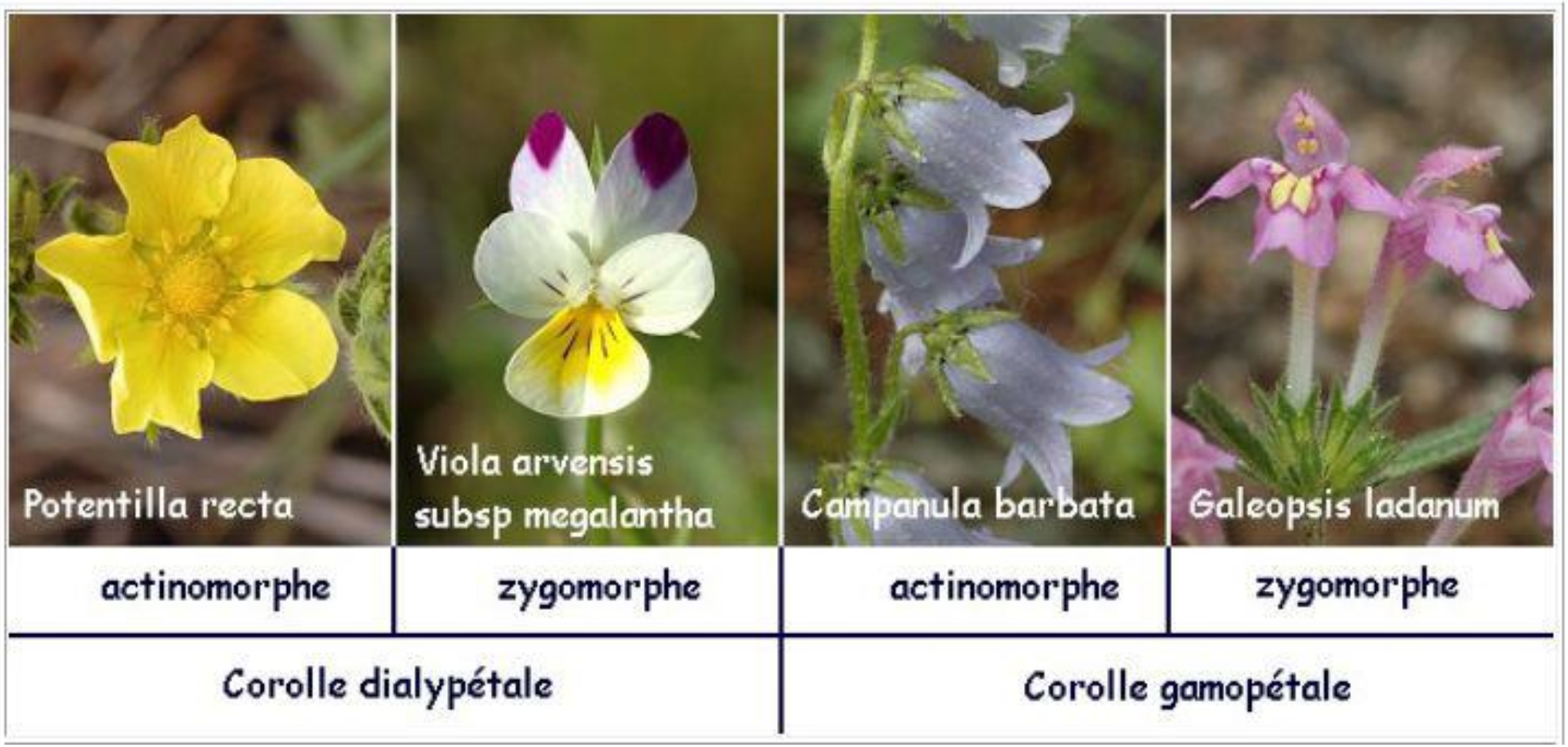
A flower is actinomorphic when the sepals and petals are radially symmetrical. A flower is zygomorphic when the sepals and petals are axially symmetrical,

Some definitions :

- **Radially symmetrical flower:** The flower's axis of symmetry is described as that of a star. The petals of its corolla, all similar, are arranged around the receptacle ‘like a star’.

-**Flower with axial symmetry:** A flower whose parts are arranged symmetrically in relation to its axis.

Actinomorphic and zygomorphic flower



2. Fertile parts (reproductive organs)

The fertile parts are the reproductive organs directly involved in reproduction. They consist of 2 whorls: the **androecium** and the **gynoecium**.

2.1. The **androecium** is the plant's male reproductive organ, formed by all the stamens arranged in spirals or whorls on the receptacle.

Each stamen consists of :

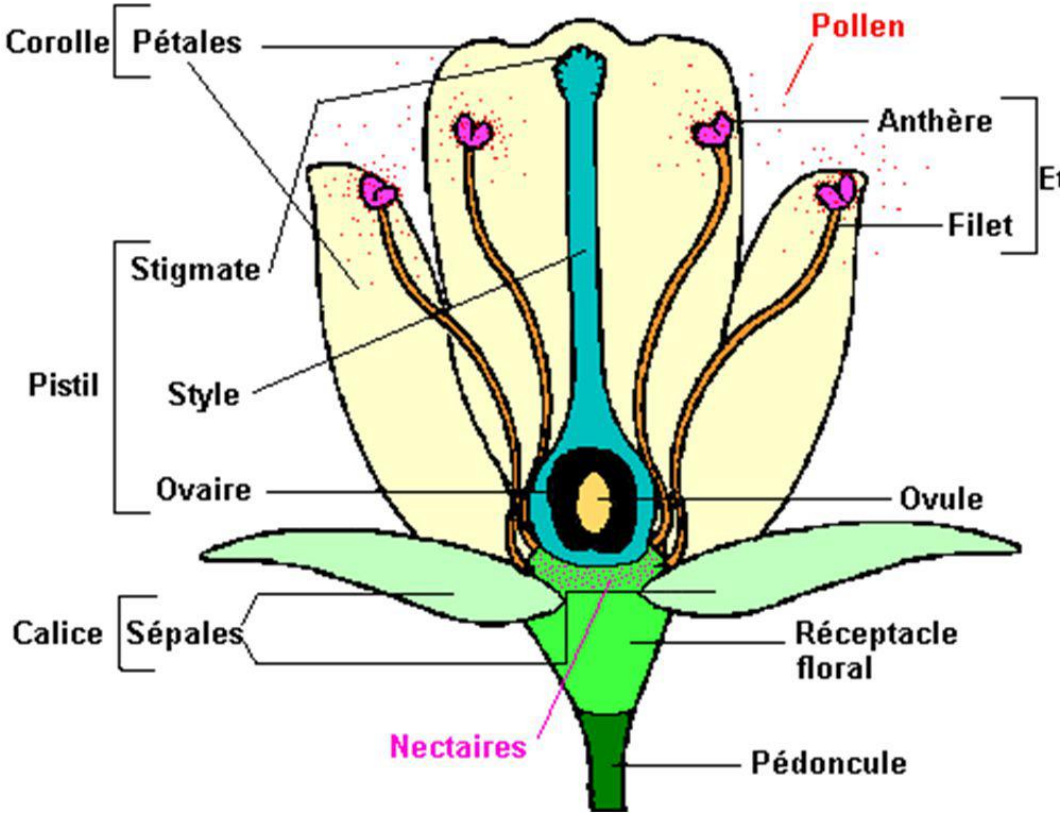
a. A lower part, usually cylindrical, small and elongated (=thread), which attaches the stamen to the receptacle.

b. An upper part of highly variable shape, called the anther.

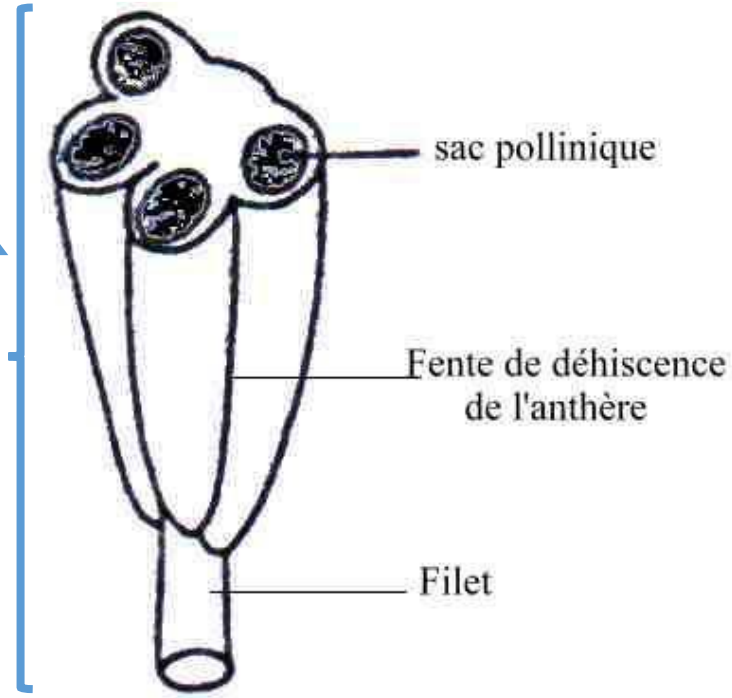
The anther generally consists of two chambers, joined by a connective tube; each chamber contains two pollen sacs.

Pollen is released by dehiscence of the anthers (opening of the anthers).The stamens are implanted directly on the receptacle. There are also sterile stamens, called staminodes.

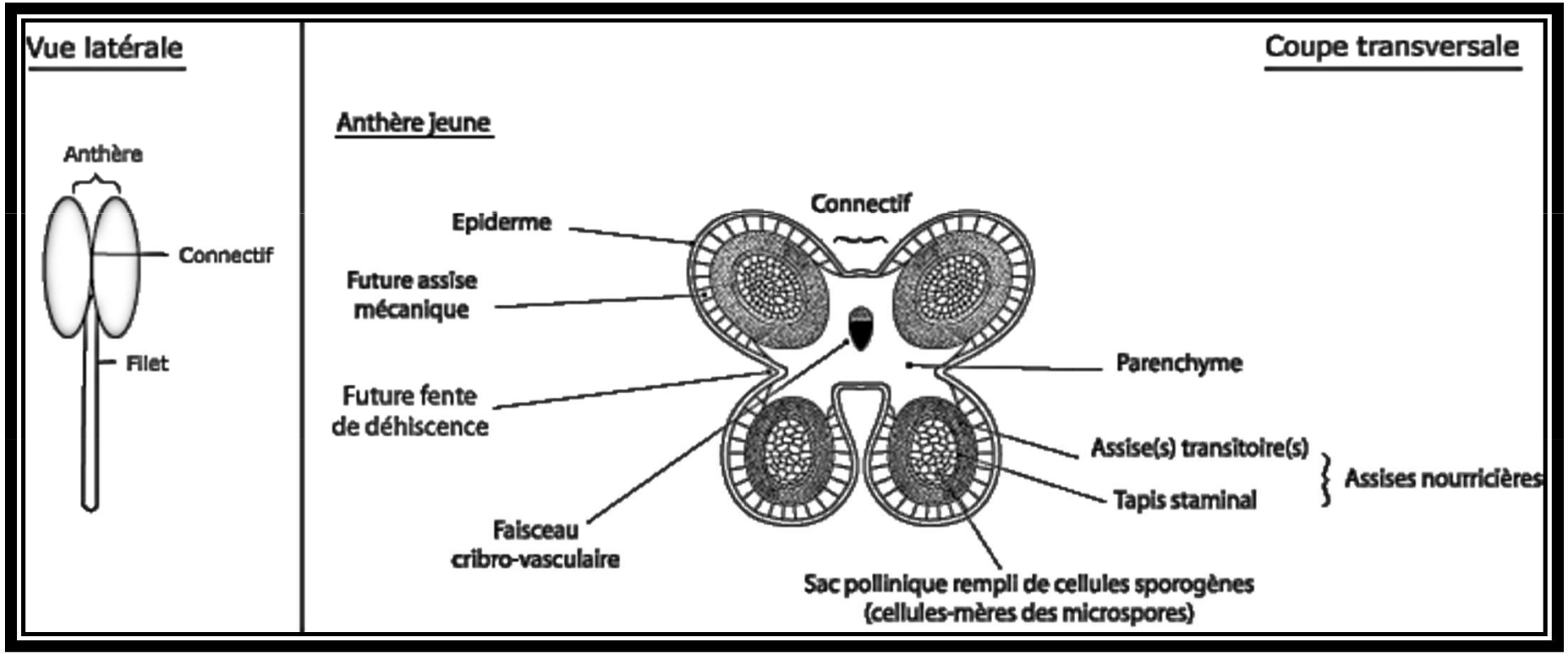
I. Morphology of the flower



A section of an angiosperma flower



Stamen



Stamen and transversal section of anthers

2.2. The gynoecium

The **gynoecium** or pistil, is the female reproductive organ of the plant, formed by one or more carpels of the same flower, free or fused together. The carpels contain one or more well-protected ovules in their lobes. The gynoecium is organised into :

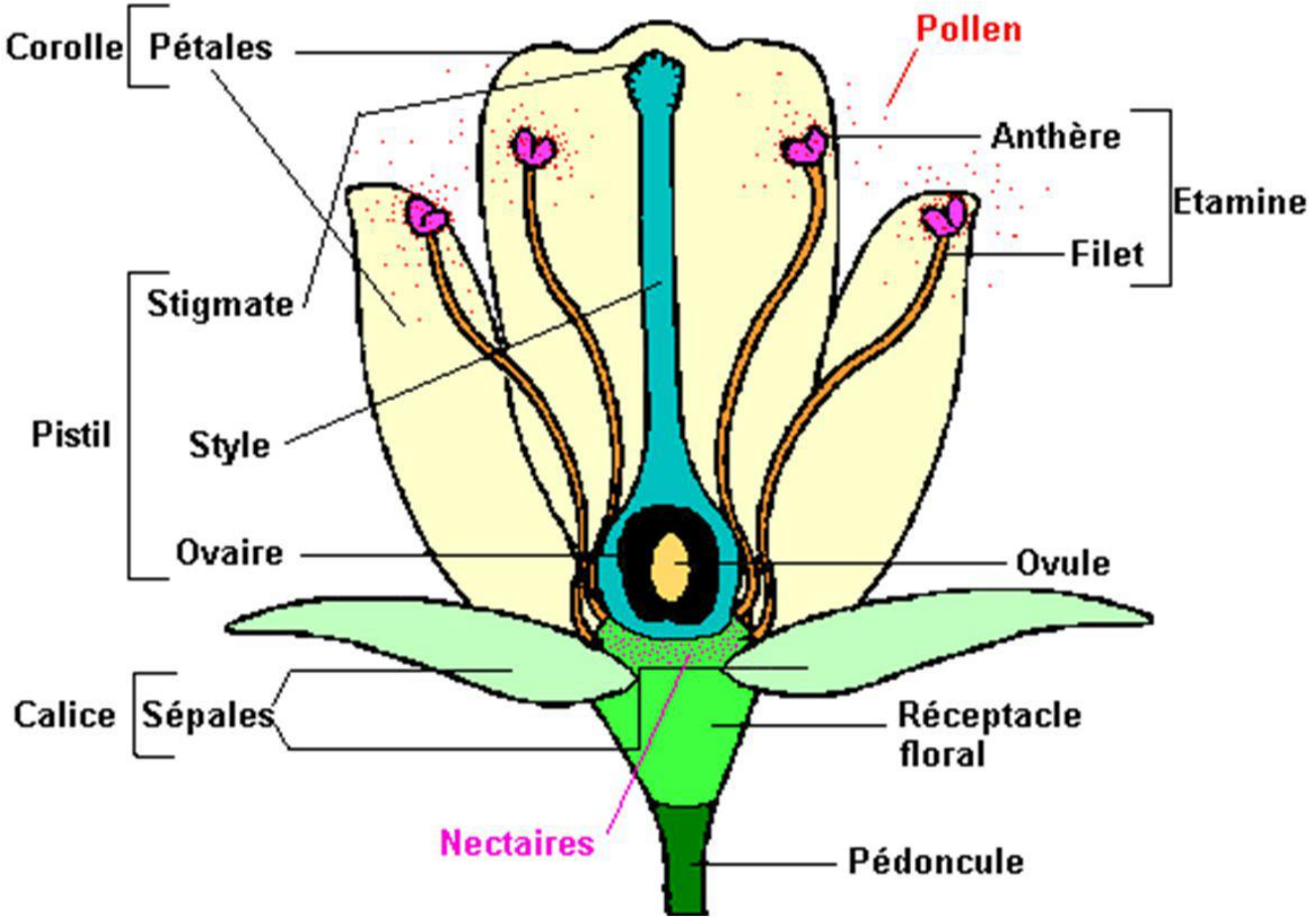
An enlarged, hollow base containing the ovules, called the ovary;

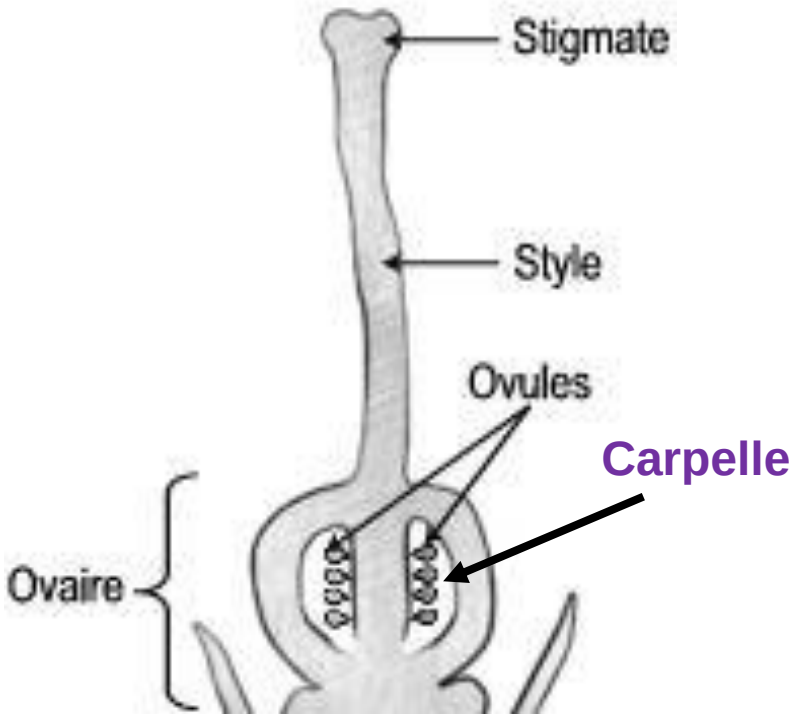
The **ovary** is extended by a narrow part called the style;

The **style** ends at the top with the stigma.

The **stigma** retains the pollen, which is a passageway from the pollen tube to the ovary cavity.

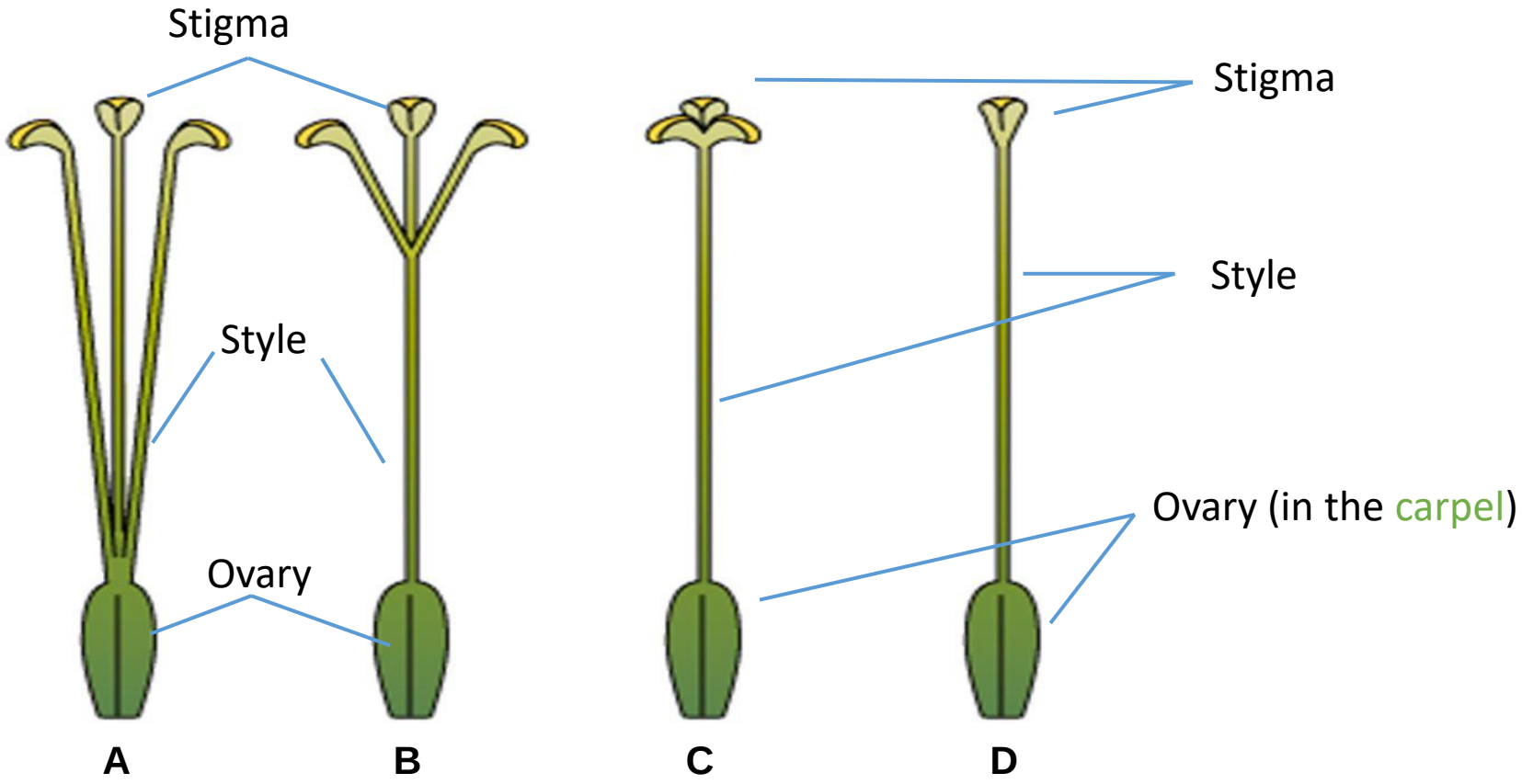
Gynoecium and longitudinal section in the carpels





Gynécée

Types of gynoecium composed of partially and totally fused carpels



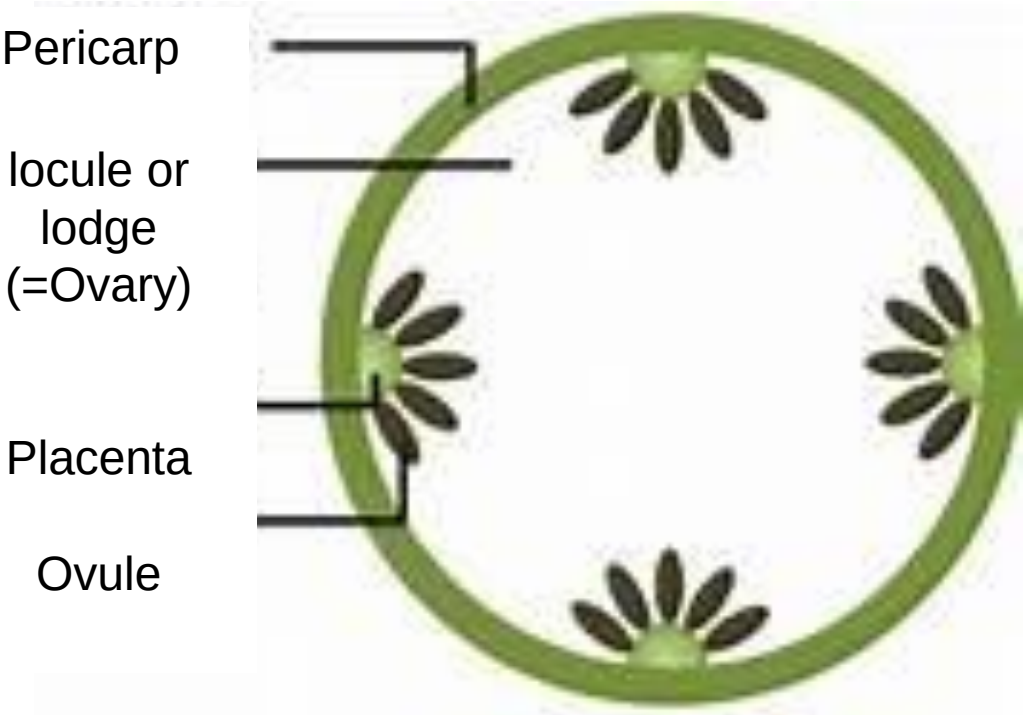
A. Total union of ovaries, styles remain independent - **B.** Total union of ovaries, partial union of styles - **C.** Total union of ovaries and styles - **D.** Total union of ovaries, styles and stigmas

- In most cases, the **flower** has both an androecium and a gynoecium: it is called bisexual or hermaphroditic.
- There are **unisexual species** that have only a gynoecium (pistillate flowers), or only an androecium (staminate flowers).
- There are also **sterile flowers** that have neither stamens nor carpels.
- A plant is **monoecious**: when male and female flowers are produced on the same individual;
- A plant is **dioecious**: when male and female flowers are produced on separate individuals.

Type of Placenta

The fused edges of the carpel or carpels are known as the placenta. When the gynoecium is composed of several fused carpels, the weld between the carpels can take different forms (3 different types of placentation):

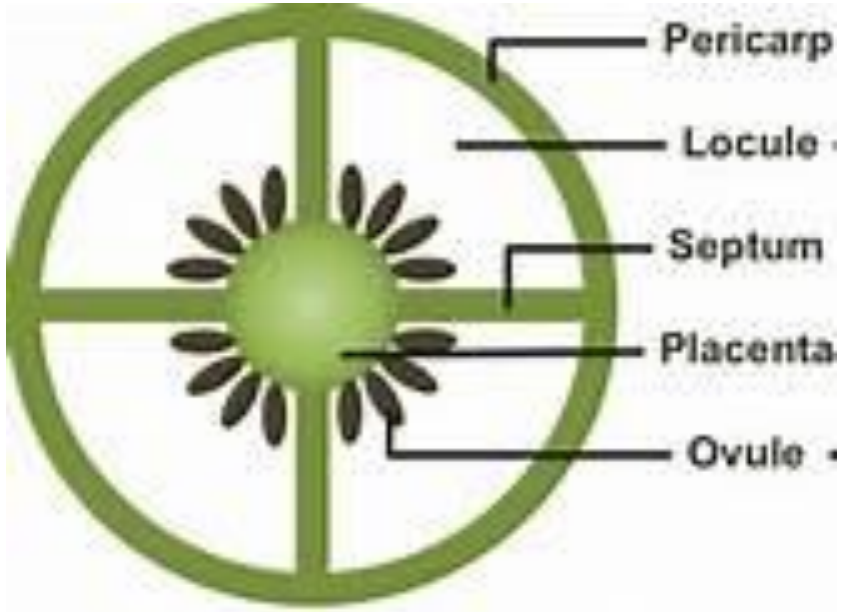
1. Parietal placentation : The gynoecium consists of a single carpel with a unilocular ovary (a single chamber). The ovules are inserted into the peripheral wall of the ovary.



Transversal section of an ovary :
Parietal placentation

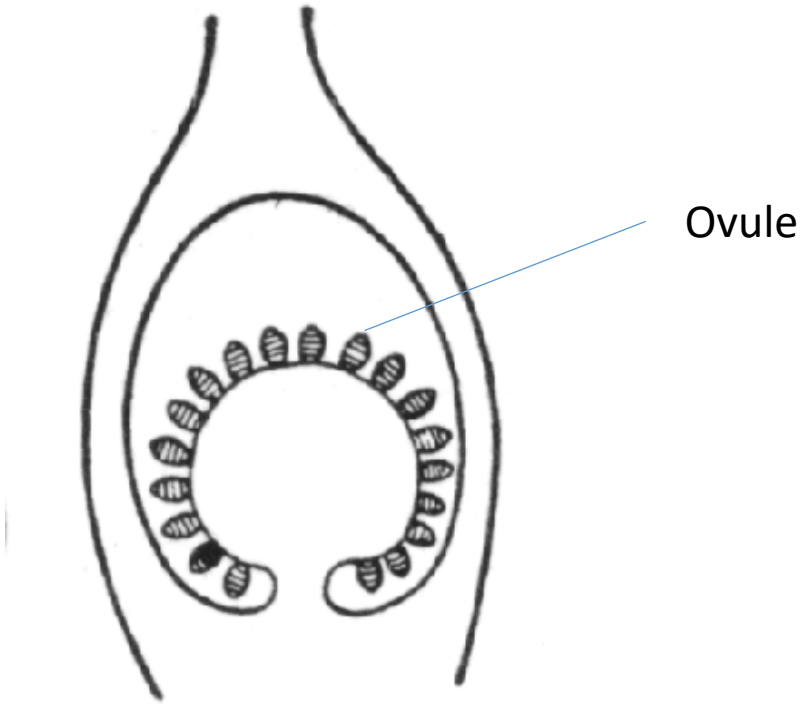
2. Axial placentation: The gynoecium is formed by several closed carpels (several ovaries) fused together to form partitions. The ovules are inserted into the central zones. The ovules are carried by the axis of the ovary.

carpel = locule = lodge renferme an ovary

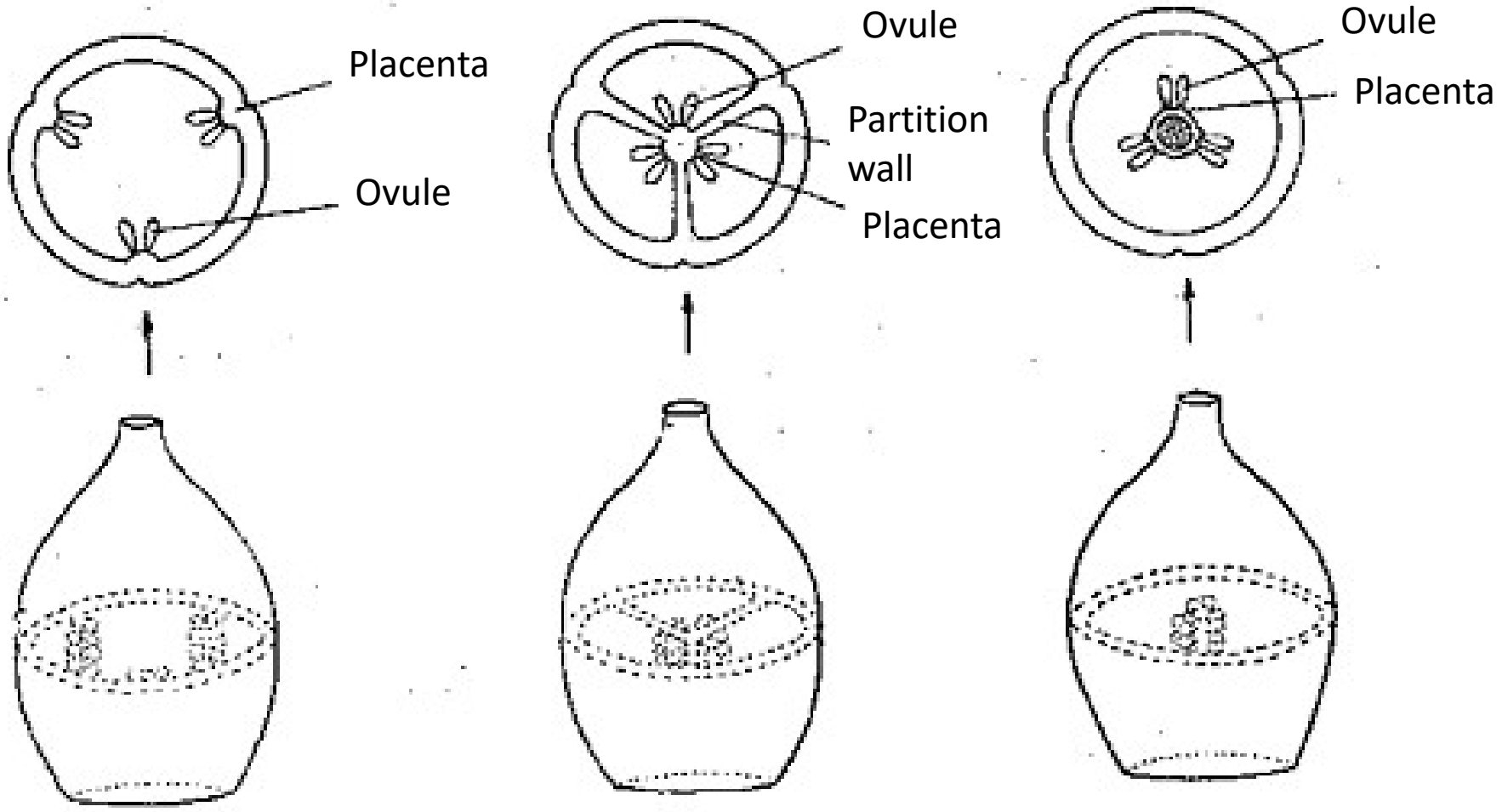


Transversal section of an ovary :
Axial placentation

3. Central placentation : The gynoecium consists of several closed carpels whose partitions have resorbed (there is a unilocular ovary), leaving only a central column to which the ovules are attached.



Summary of the three types of placentation :



Placenta : **Parietal** **axial** **central**

3. Position and number of flowers

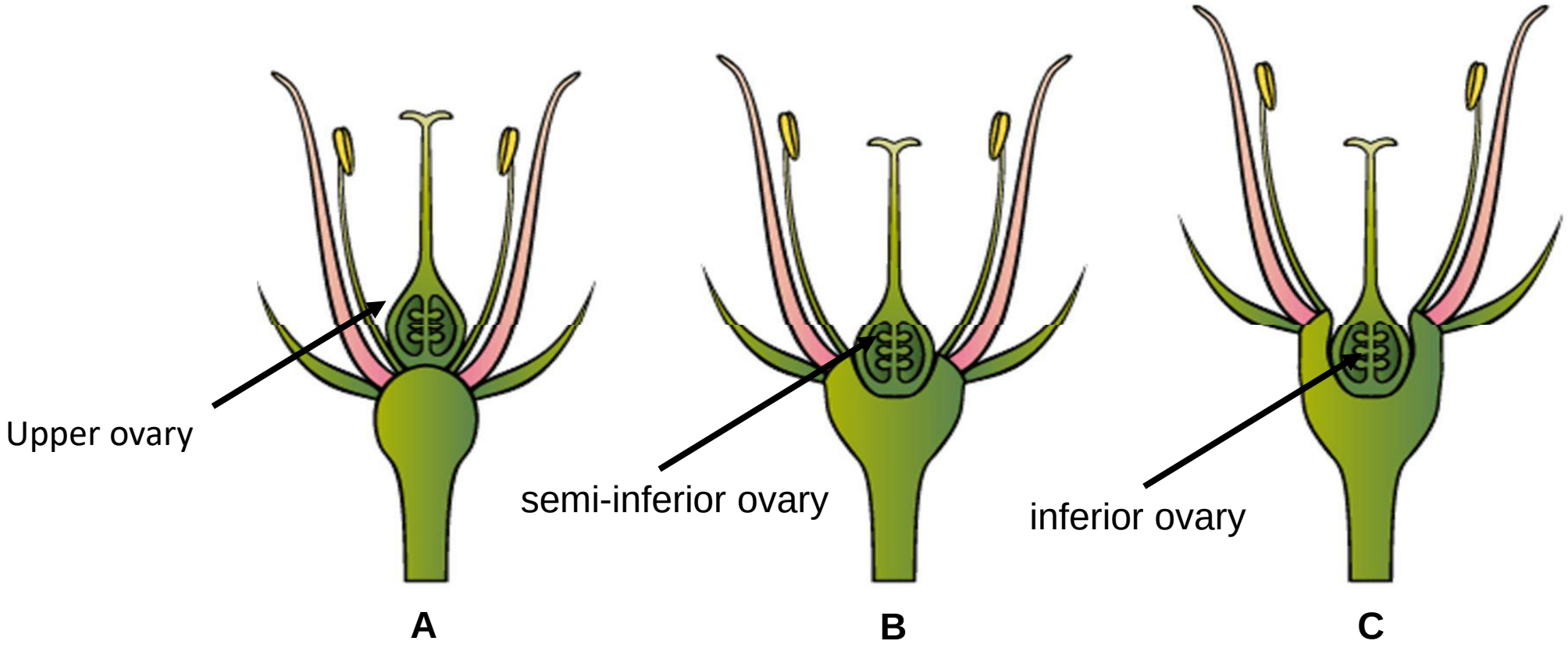
3.1. Position of the ovary and floral parts

- The flower is hypogynous when the perianth and stamens are inserted lower than the ovary, which implies a cylindrical, conical receptacle (see A).

- The flower is perigynous when the perianth and stamens are inserted higher than the level of insertion of the semi-inferior ovary, which is partially fused into the receptacle (see B).

- The flower is epigynous when the perianth and stamens are inserted higher than the inferior ovary, which is fully inserted and fused into the receptacle (see C).

I. Morphology of the flower



(A) Upper ovary (hypogynous flower) – **(B)** Semi-lower ovary (perigynous flower) – **(C)** lower ovary (epigynous flower)

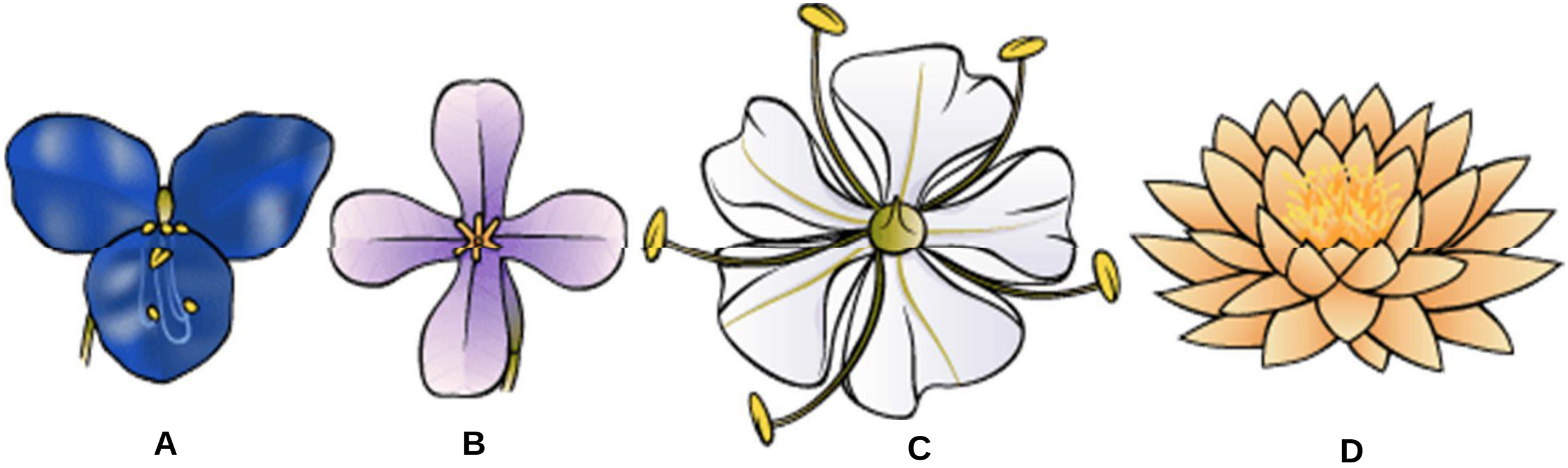
3.2. Number of flowers

The number of flowers per whorl varies and there are three main types:

- Trimerous flowers or flowers composed of successive whorls of 3 parts each. Example of monocotyledons;

- Tetrameric, pentameric or polymeric flowers: Example of dicotyledons.

I. Morphology of the flower



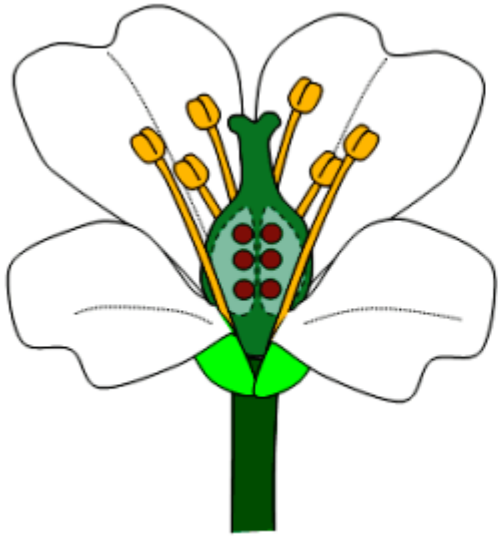
A **B** **C** **D**

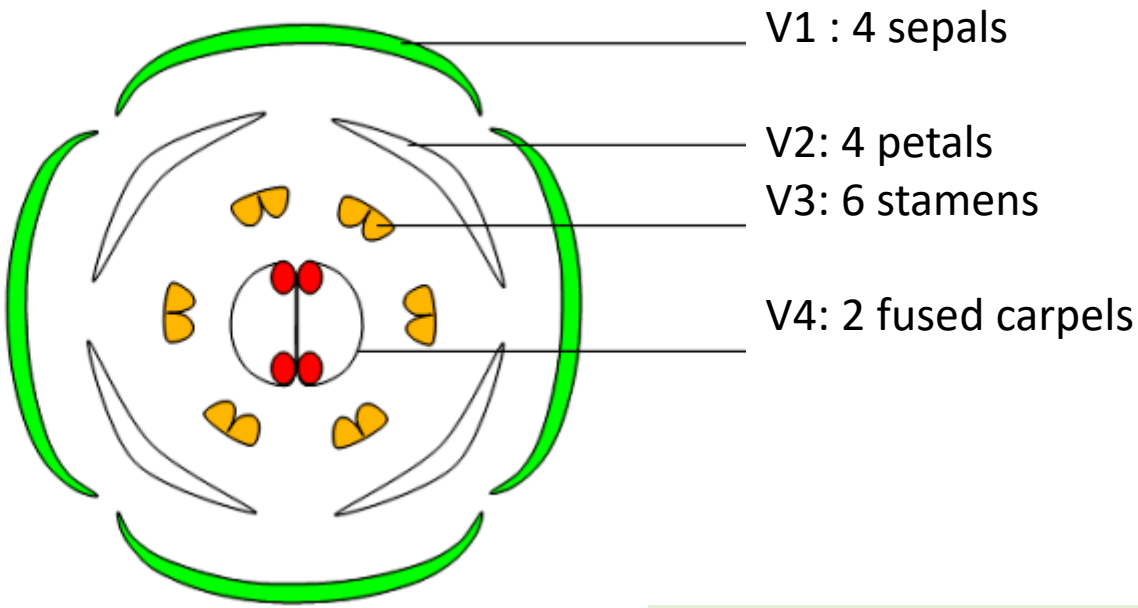
Number of floral parts per whorl :

A. trimeric - **B.** tetrameric - **C.** pentameric - **D.** polymeric

3.3. Floral diagram

This is a diagram showing the arrangement of all the floral parts in cross-section. Each floral part has its own conventional representation (see PW n°5).





Floral diagram

V = spiral

II. Morphology of fruits

II. THE FRUIT

1. Structure of the fruit:

The fruit is the result of fertilisation of the ovary of a flower. The fruit contains the seeds resulting from the evolution of the ovules. The wall of the fruit (or pericarp), which originates from the wall of the ovary, has 3 parts :

- The exocarp (epicarp)
- The mesocarp
- The endocarp

Parts of the flower, such as the inflorescence, undergo a major change and become part of the fruit:

The fate of the various components of the ovary after fertilisation

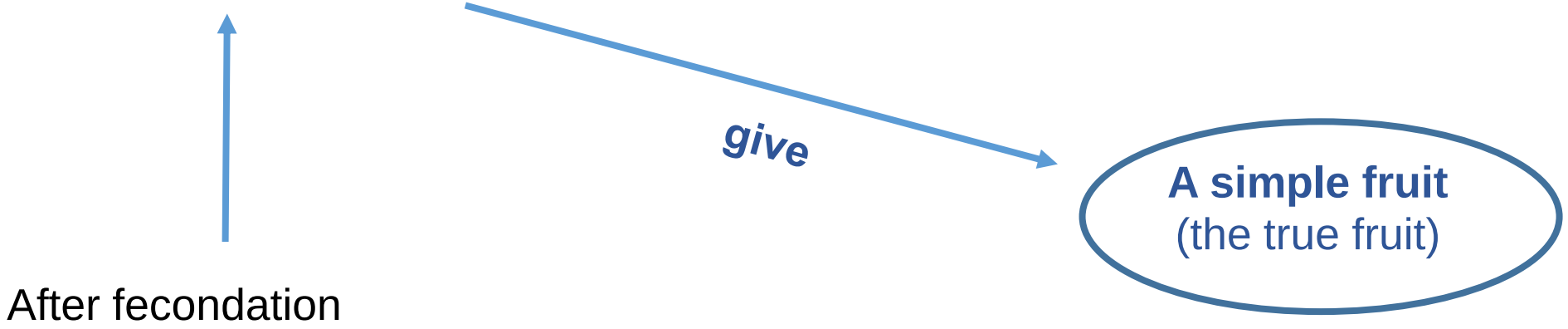
Ovary		future	Fruit	
Ovarian wall (or envelope)	Outer epidermis	→	Epicarp	Pericarp
	Chlorophyll parenchyma	→	Mesocarp	
	Internal epidermis	→	Endocarp	
Fertilised egg(s)		→	Seed(s)	

2. Types of fruits

2.1. **Simple fruit** (true fruit):

The **gynoecium** of a flower is composed of a single carpel or several fused carpels.

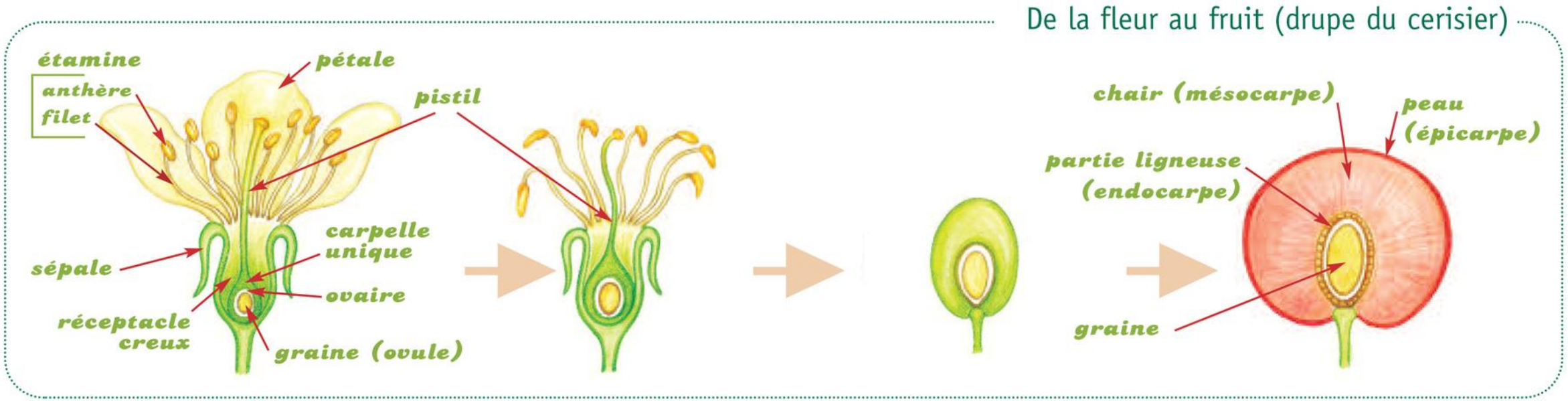
The transformation of the gynoecium of a single flower



Depending on the consistency of the pericarp, 2 types of single fruit are distinguished:

Dry single fruit and **fleshy single fruit.**

An example of the transformation of the ovule into a seed and the ovary into a fruit.



The ovary become a Fruit (The cherry)

a. Dried single fruit

The pericarp of the fruit dries out and becomes more or less hard or sclerotized (woody). This type of fruit can be divided into two categories:

a.1. Dehiscent dried fruit: These are dried fruits that open through slits or dehiscence pores to release seeds. Each fruit contains several seeds (polysperms). These fruits are produced from :

Monocarpellate gynoecium : Follicle: Fruit that opens through a single dehiscence slit. **E.g.** some species of the Ranunculaceae family;

Pod: Fruit that opens through 2 slits. **E.g.** the pea pod.

Two-celled gynoecium: This fruit is called a silique and opens through 4 para-placental dehiscence slits. **E.g.** the fruit of the cabbage plant (Brassica).

➢ **Pluricarpellate gamocarpellate gynoecium:** This fruit is called a capsule and opens in several ways and through several slits: with poricidal dehiscence (e.g. poppy (poppy) or eucalyptus fruit); with septicidal dehiscence (e.g. castor fruit), with loculicidal dehiscence (e.g. chestnut, cotton and castor fruit) and with septifragous dehiscence (e.g. castor fruit).

Définition de Gynécée gamocarpellé : ovaire obtenu suite à la fermeture d'un seul carpelle ou la soudure de plusieurs carpelles;

II. Morphology of fruit

Dehiscent dried fruit

Follicule

Gousse

Silique

Capsule

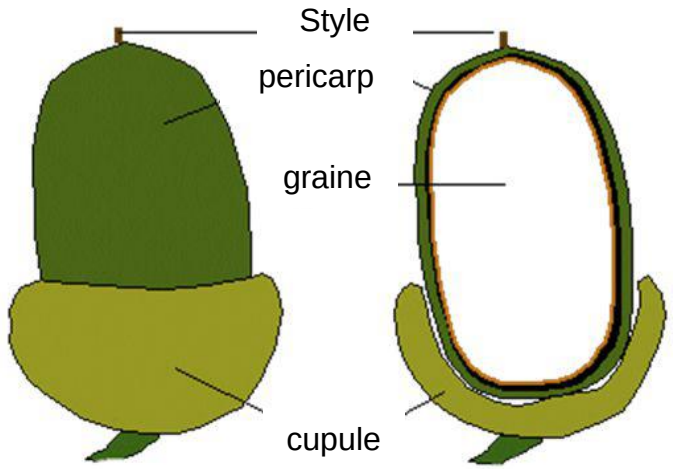
a.2. Indehiscent dried fruit: These are dried fruits that do not open spontaneously to release their seeds. Inside the fruit, the seed is generally free. There are different types of indehiscent dried fruit:

Achenes, which have a single seed. Achenes are often protected by a cup (e.g. hazelnut, chestnut, fruit of the Asteraceae);

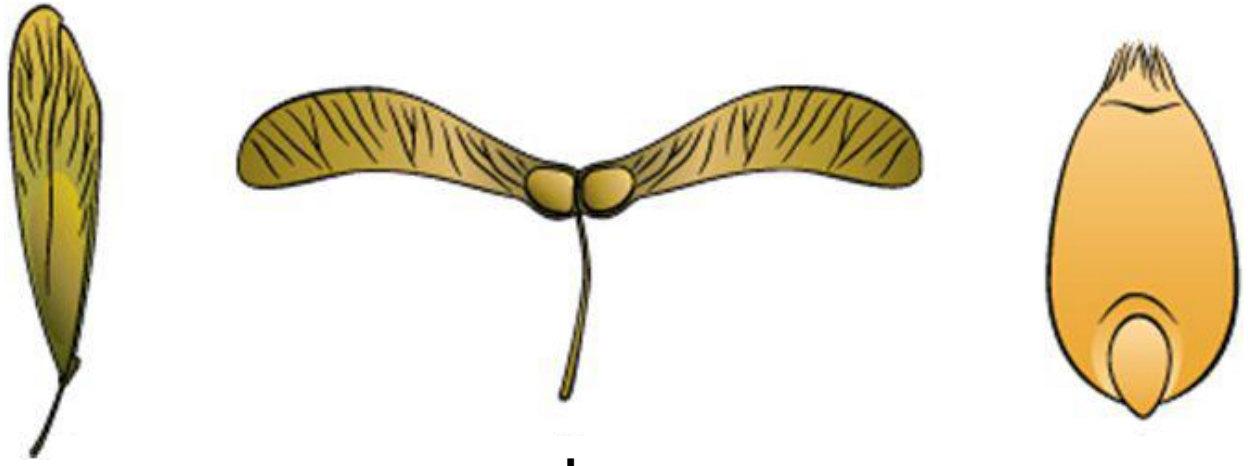
Samaras, which are special achenes with wings that allow them to be carried by the wind (e.g. ash). The disamara has two wings (e.g. maple);

Le caryopse which is specific to the grass family. It is characterised by the welding of the seed coat to the pericarp.

Indehiscent dried fruit



An achene (oak acorn)



a **b** **c**

a. **Samara** from an ash tree / **b.** Maple **disamara** / **c.** Wheat **caryopsis**

b. Fleshy single fruit

The pericarp of simple fruit becomes fleshy when ripe. This is because the pericarp is waterlogged and accumulates organic acids (e.g. citric acid), sugars and a number of vitamins. There are two types of fleshy fruit:

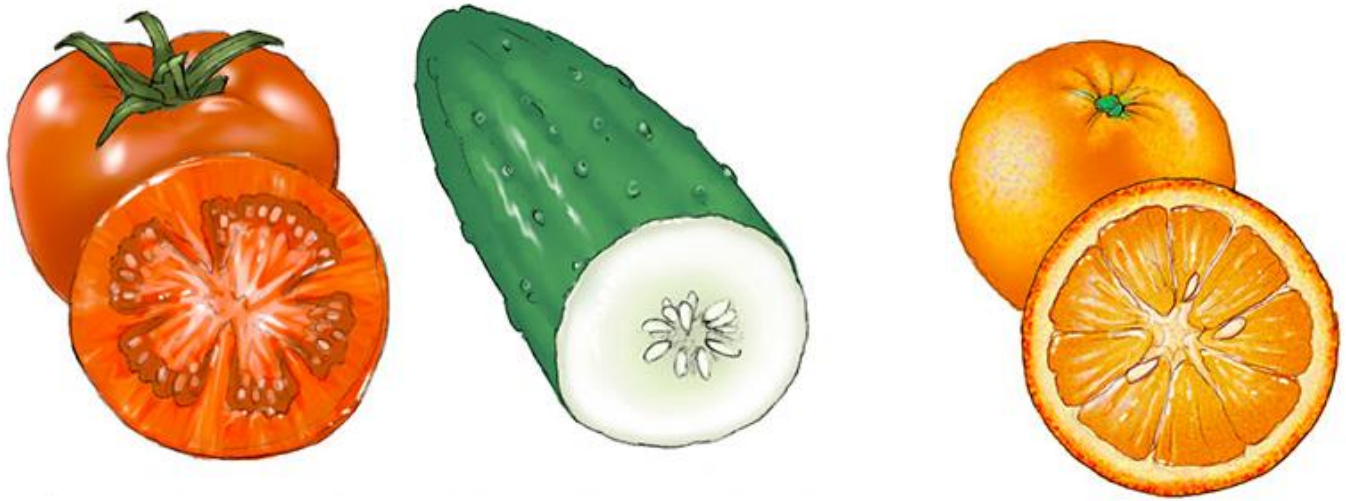
b.1. The berry (= succulent seeded fruit) This is a fleshy fruit with a fleshy endocarp. The endocarp is composed of : a thin exocarp - a mesocarp - a fleshy endocarp.

The seeds are free in the flesh of the fruit. E.g. orange, tomato, cucumber.

Berries have several seeds (polysperm = several ovaries). Oranges are special berries because their endocarp forms fleshy hairs rich in reserves. The mesocarp is white and underdeveloped.

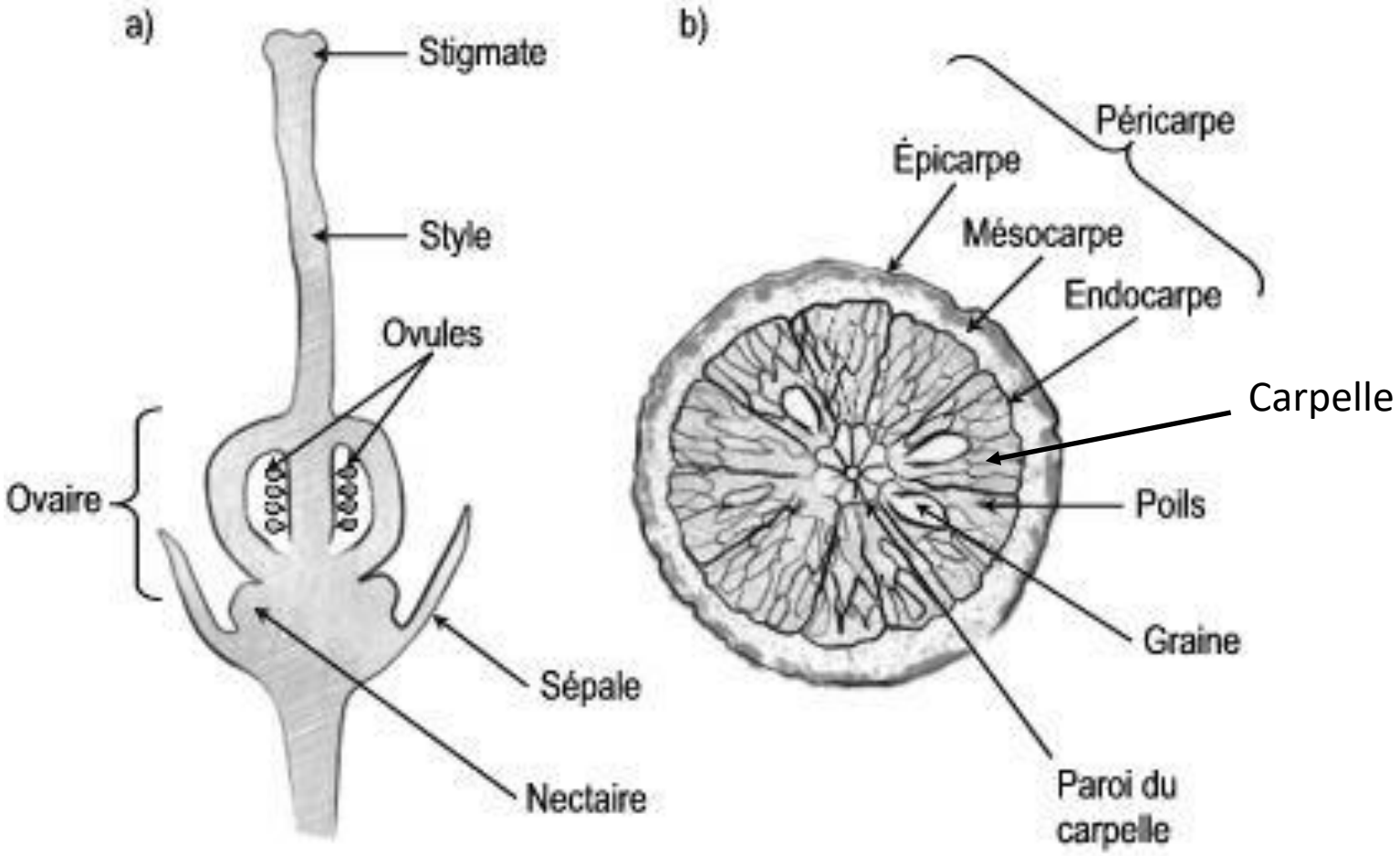
II. Morphology of fruit

Some examples of simple fleshy fruits (Berries)



Tomatoes Cucumber Orange

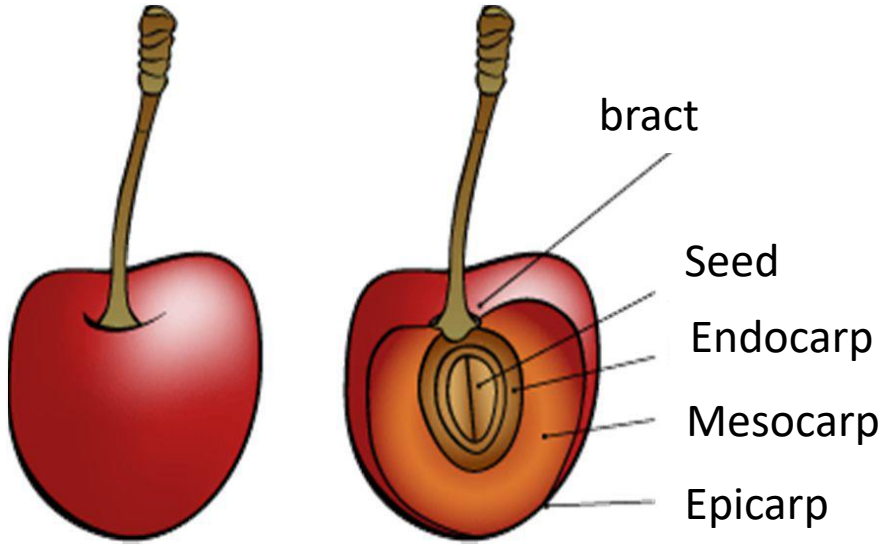
II. Morphology of fruit



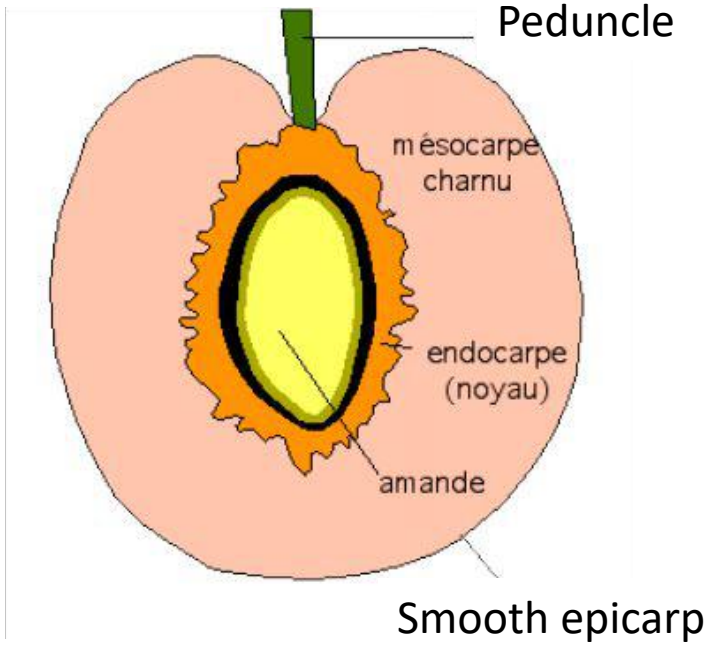
A section from an orange berry :
a. Gynoecium - b. fruit

b.2. The drupe (= stone fruit): The drupe is a fruit whose epicarp and mesocarp are fleshy, while the endocarp is hard (lignified). The endocarp envelops the single seed (monosperm). The nucleus = endocarp + seed. For example Cherries, peaches, olives

Cherries



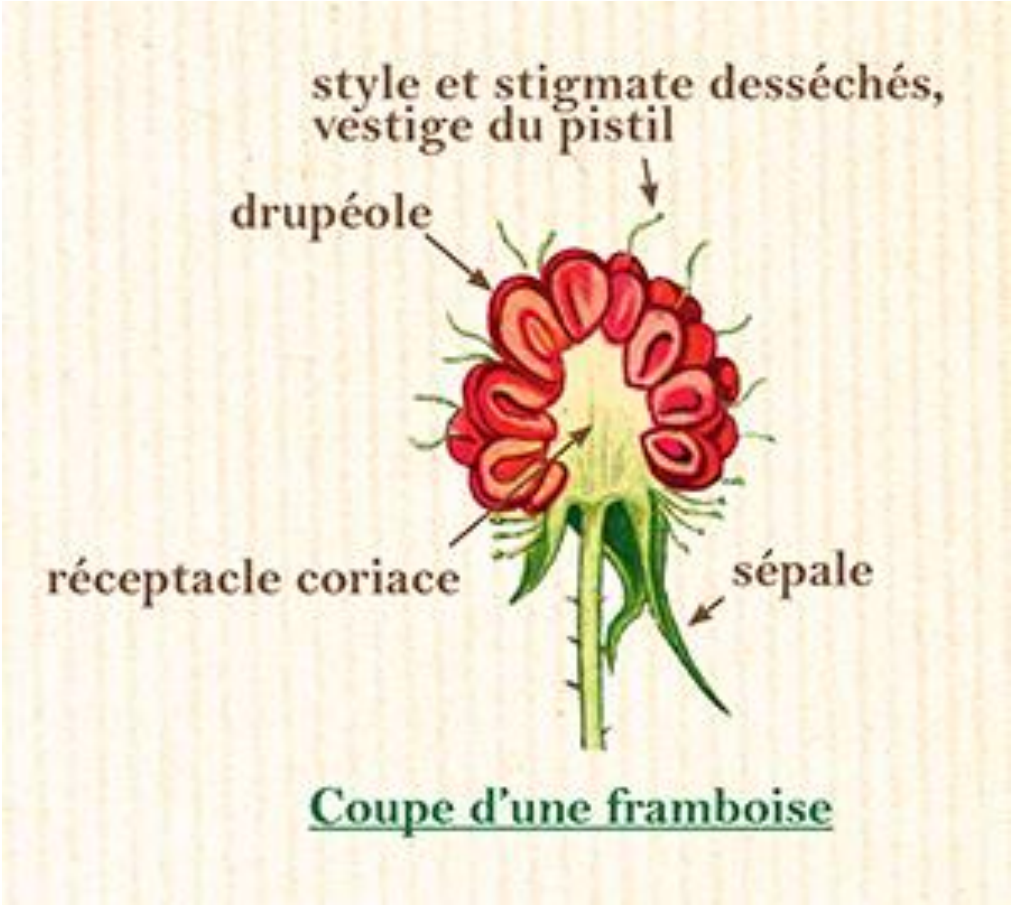
A peach



2.2. Multiple fruit

The **multiple fruit** is the whole of single fruits. It is formed from an ovary of a dialycarpellate multi-carpellate gynoecium of a single flower. The number of single fruits composed of the multiple fruit depends on the number of free carpels in the gynoecium. There are 2 types of multiple fruits:

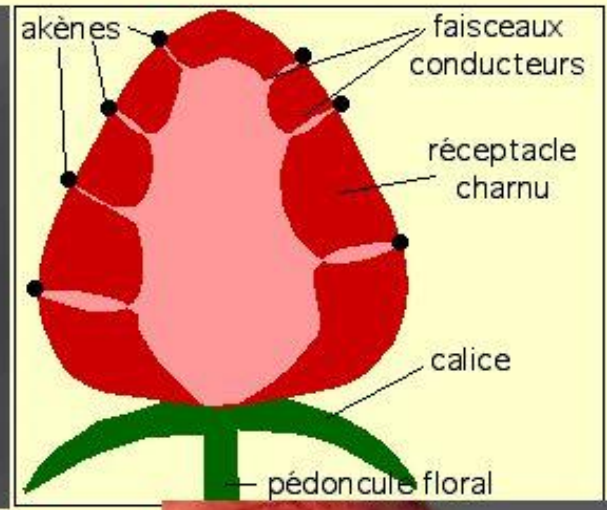
a. Fleshy: The fleshy multiple fruit is composed of numerous small drupes or drupelets, each containing a tiny stone. E.g. raspberry



Définition de Gynécée dialycarpellé : gynécées composés de plusieurs carpelles clos, libres et non soudés entre eux.

b. Dry indehiscent : The multiple dry indehiscent fruit is composed of numerous single dry indehiscent fruits or achenes. This polyakene fruit is forme by the hypertrophied, fleshy receptacle of the flower. E.g. strawberry (this species can be classified as a complex fruit).

La FRAISE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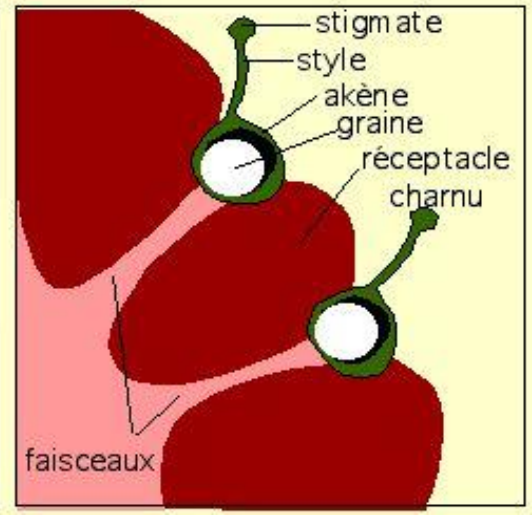
stigmate
style
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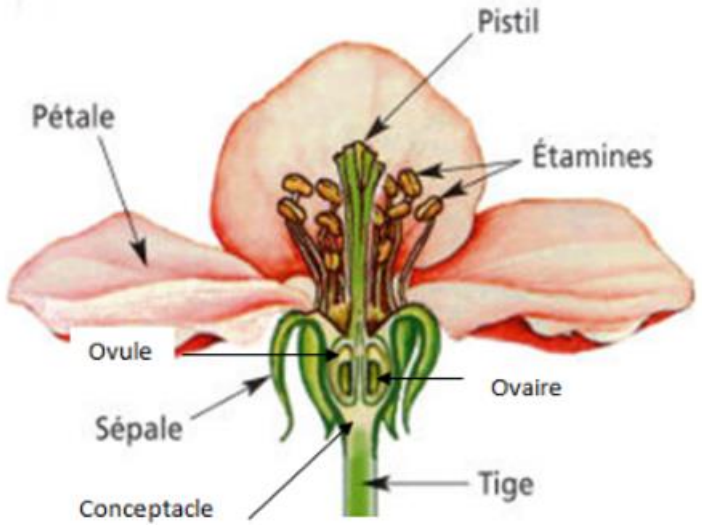
2.3. Complex fruit : The complex fruit consists of the ovary of a gamocarpellate or dialycarpellate multi-carpellate gynoecium and other parts of the flower.There are 2 types of complex fruit:

a. Complex fruit from a superect ovary with a receptacle: The gynoecium is multi-carpellate and diallycarpellate. The receptacle becomes very fleshy and participates with the gynoecium in the formation of the fruit. Example. In the strawberry, the receptacle forms the main edible part of the fruit.

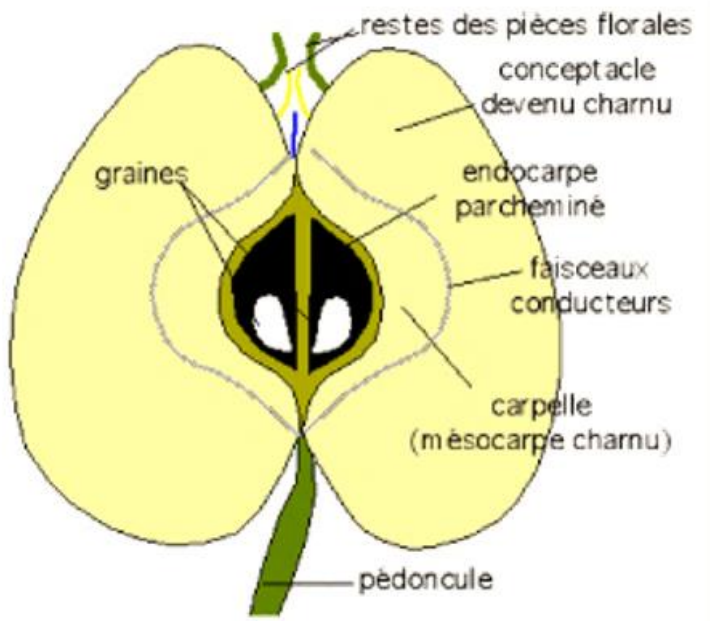
b. Complex fruit formed from an ovary inferior to the conceptacle: The complex fruit may be formed from a gynoecium that is adherent or non-adherent to the conceptacle:

Gynoecium adherent to the conceptacle: The conceptacle is highly developed and is fused to the epicarp and mesocarp, while the endocarp becomes cartilaginous and surrounds the seeds. The conceptacle itself becomes very fleshy and forms the largest edible part of the fruit. This type of fruit is called a piridion. **E.g. apple, pear**

• The example of the apple or pear: The infertile ovary is fused to the floral receptacle. The fruit consists of : A fleshy mesocarp made up of 2 parts (the hypertrophied receptacle and the outer wall of the carpels). A leathery endocarp formed from the inner wall of the 5 old carpel lodges.



Fleur du pommier



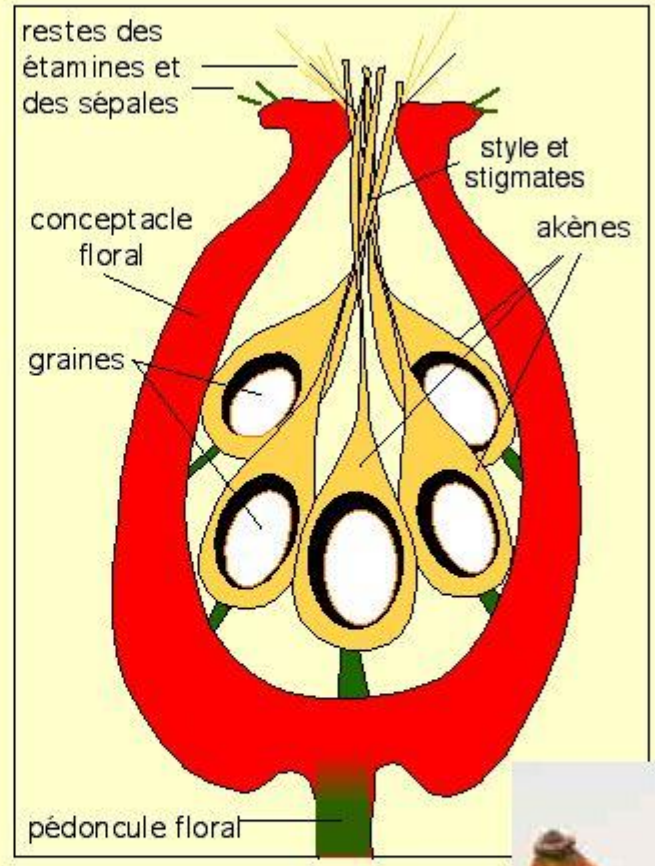
Fruit du pommier (pomme)

-**Gynoecium not adherent to the conceptacle** (the gynoecium is multi-carpellate di-allycarpellate and not adherent to the conceptacle). The conceptacle becomes fleshy and contains numerous free, hairy achenes.

E.g. rose hips, fruit or the false fruit of the rose.

Receptacle: contains the vegetative organs (floral parts)
Conceptacle: contains the reproductive organs

Le CYNORRHODON



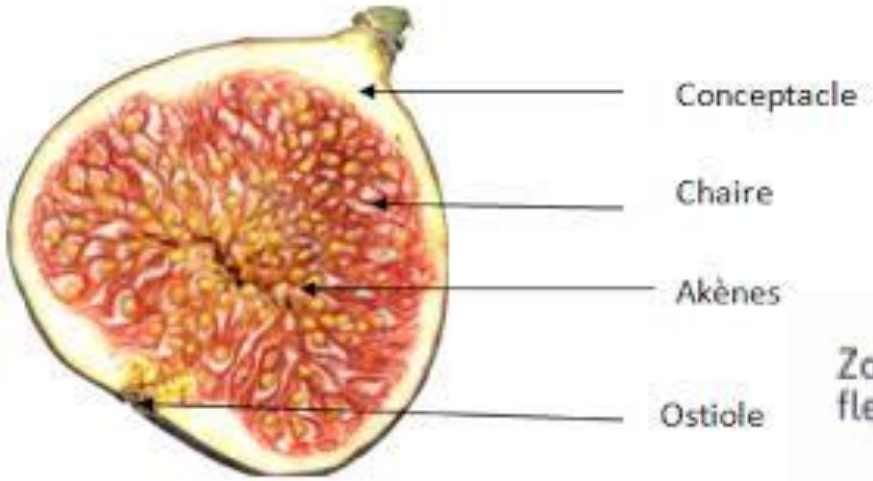
2.4. Compound fruit or infrutescence

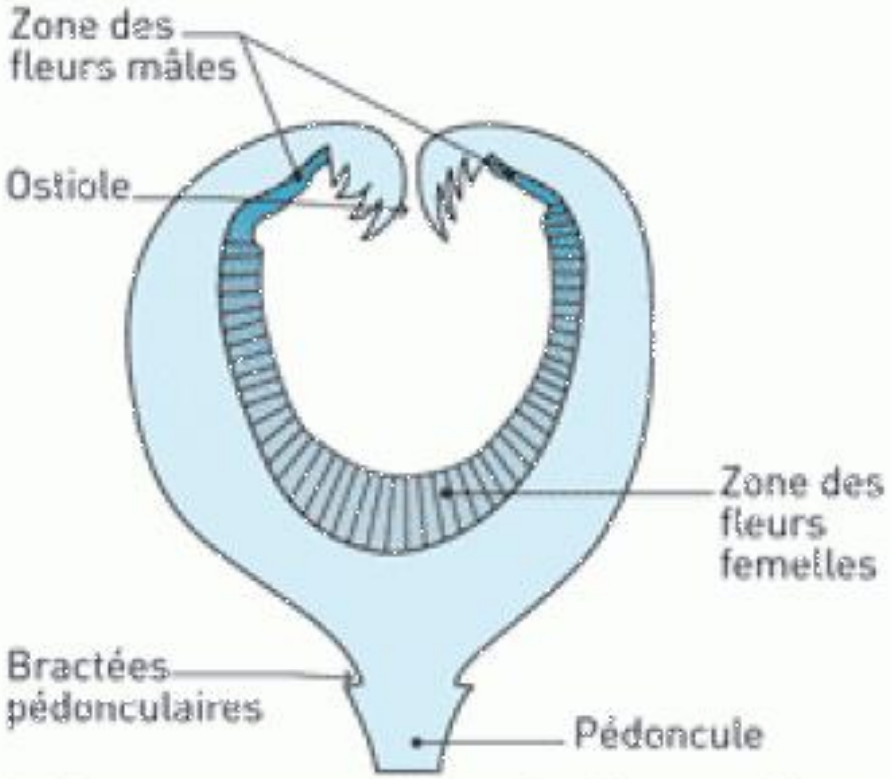
This is a fruit formed from an entire infrutescence. It is derived from the ovary to which may be added the receptacle of each flower, the axis of the inflorescence and sometimes even the bracts of the flowers and those of the inflorescence. E.g. the fig

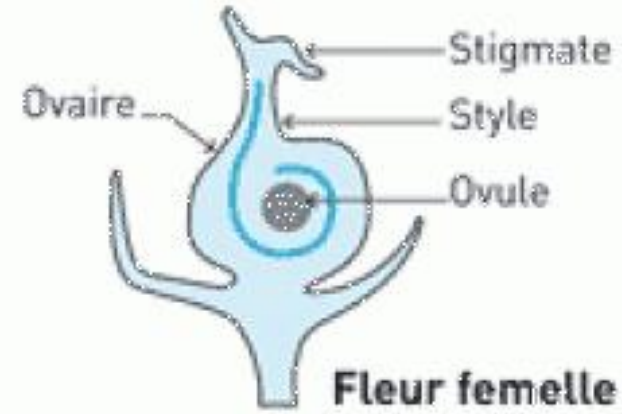
The fig consists of the fleshy inflorescence axis, which forms the greenish or purplish outer part of the fruit, and the whitish fleshy inflorescence conceptacle, which is stuck to the axis. The ovary of the uni-carpellar gynoecium of each of the flowers of the inflorescence is transformed into a small drupe or drupeole.

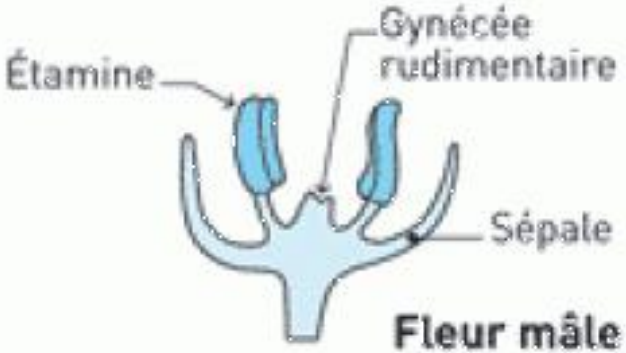
The drupeoles together form the internal granular flesh of the fig.

II. Morphology of fruit









III. Morphology of the seed

III. The seed

1. Seed structure :

The structure of the seed is directly related to that of the ovule. After fertilisation, the ovules are develop into seeds. The size, shape, hairiness and consistency of seeds vary considerably depending on the species and the means of dissemination.

A seed is composed mainly of : A **tegument**: which may be single or double. The surface of the tegument may be smooth, with ridges or hairs all over (cotton plants). This tegument protects or disseminates the seeds.

- A **kernel** is composed of = an embryo + reserve tissue (or albumen): The embryo is the essential part of the kernel. It comprises a radicle and a tigella (or gemmule) which bears the cotyledons (1 single cotyledon for monocotyledons and 2 cotyledons for dicotyledons).

Reserves accumulate in the albumen, allowing the plant to be self-sufficient until the first leaves appear, when photosynthesis takes over.

III. Morphologie de la graine

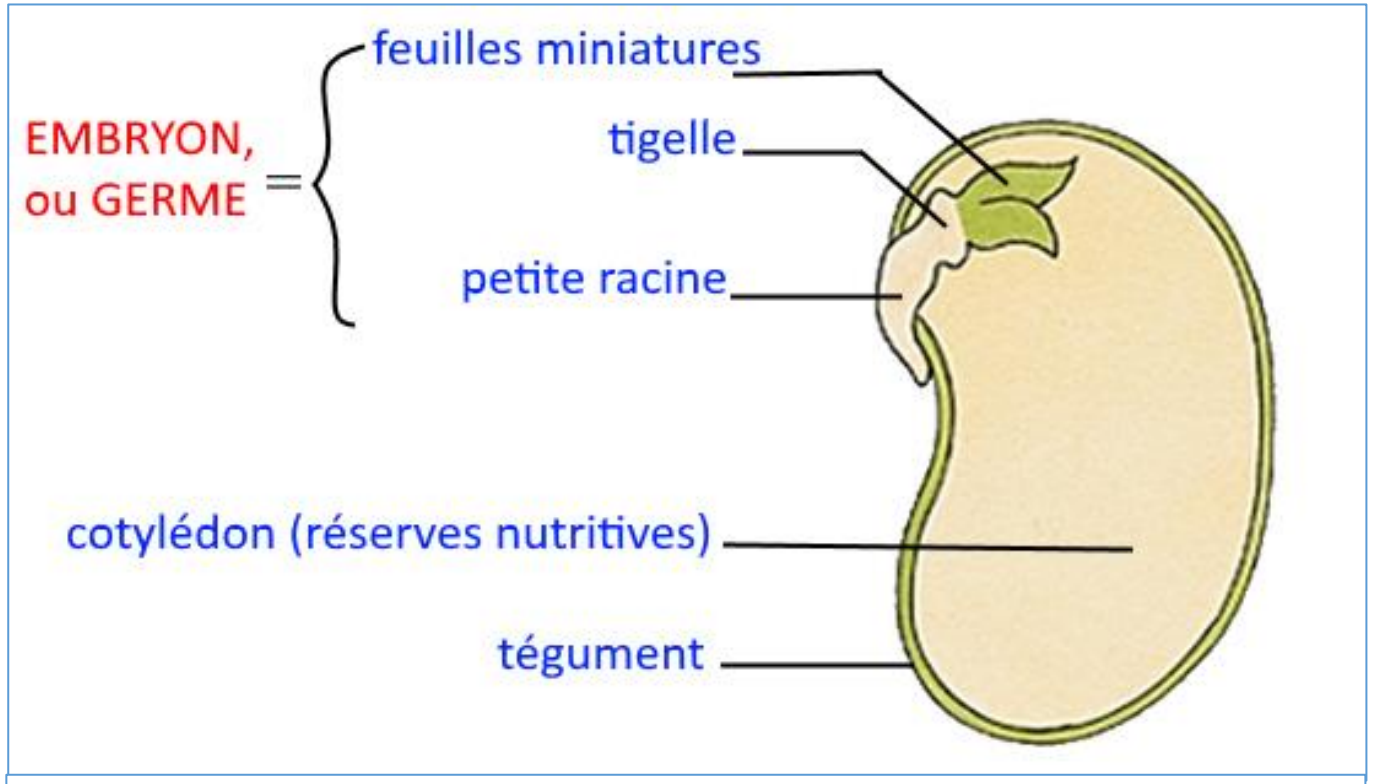


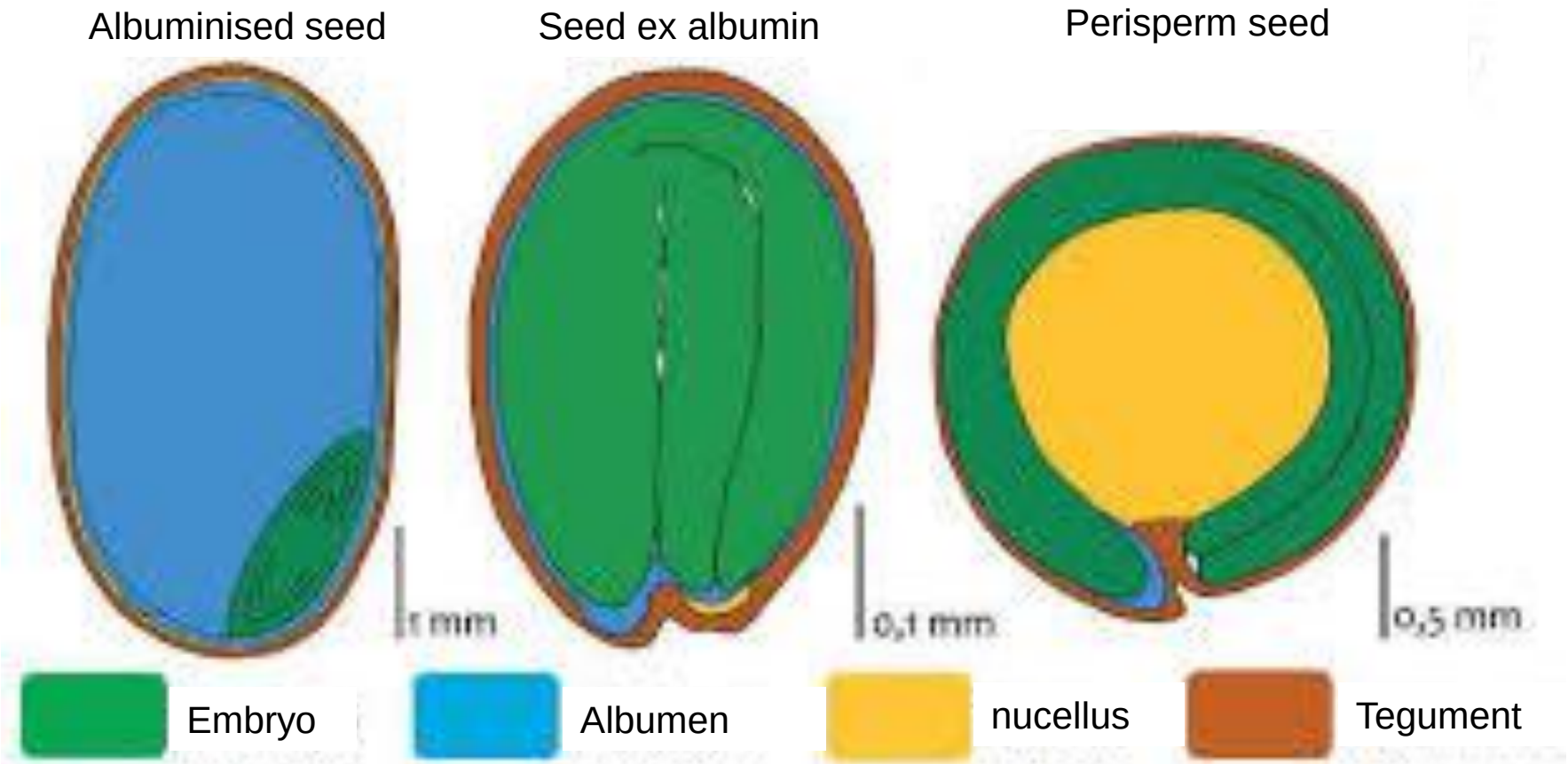
Schéma d'une moitié de grain d'haricot

2. Types of seed: Seeds are classified into 3 categories according to the presence or absence of albumen:

- **Albumenised seeds** : The nucellus is completely digested by the albumen. The albumen becomes abundant and is the seed's only nourishing tissue (e.g. castor seed); - **Exalbuminous seeds** : The nucellus is completely digested by the albumen. During its development into a seedling, the embryo completely digests the albumen. The nutrient reserves are stored in the cotyledons, which become large and occupy the whole of the seed (e.g. sunflower seed);

- Perisperm seeds: Part of the nucellus persists and is transformed into the perisperm, which is a nourishing tissue that accumulates reserves. The albumen is reduced because a large part of it is digested by the embryo during its development (pepper seed).

Types of seeds



The **nucellus** is a diploid plant tissue forming the interior of the ovule.