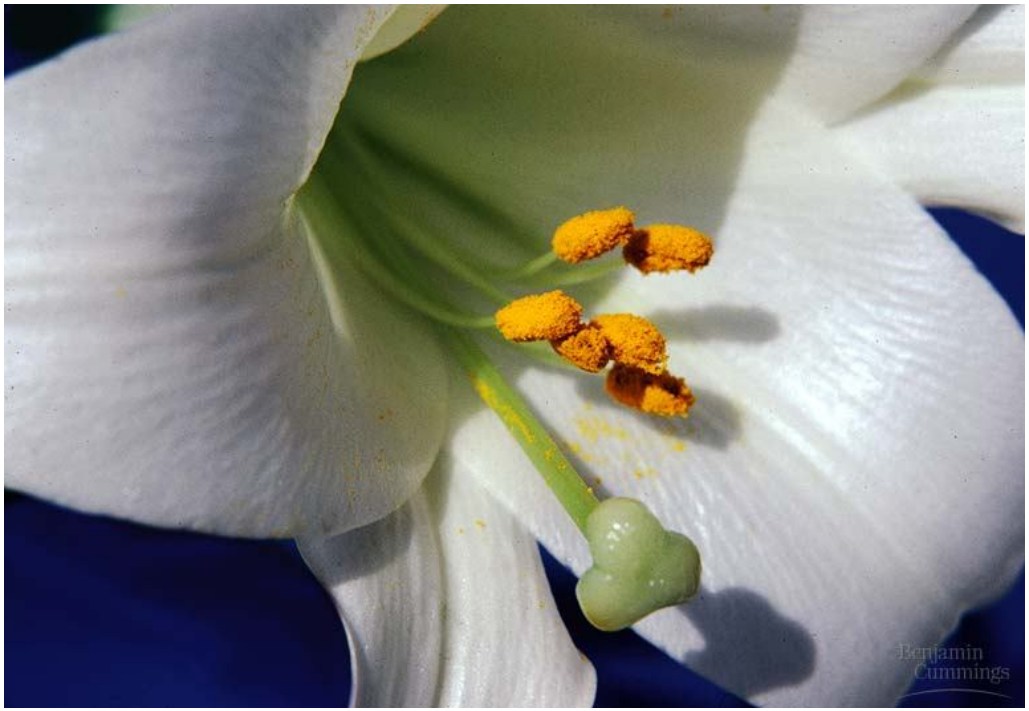
Chapter 38

Plant Reproduction & Biotechnology



Titan Arum (*Amorphophallus titanum*)

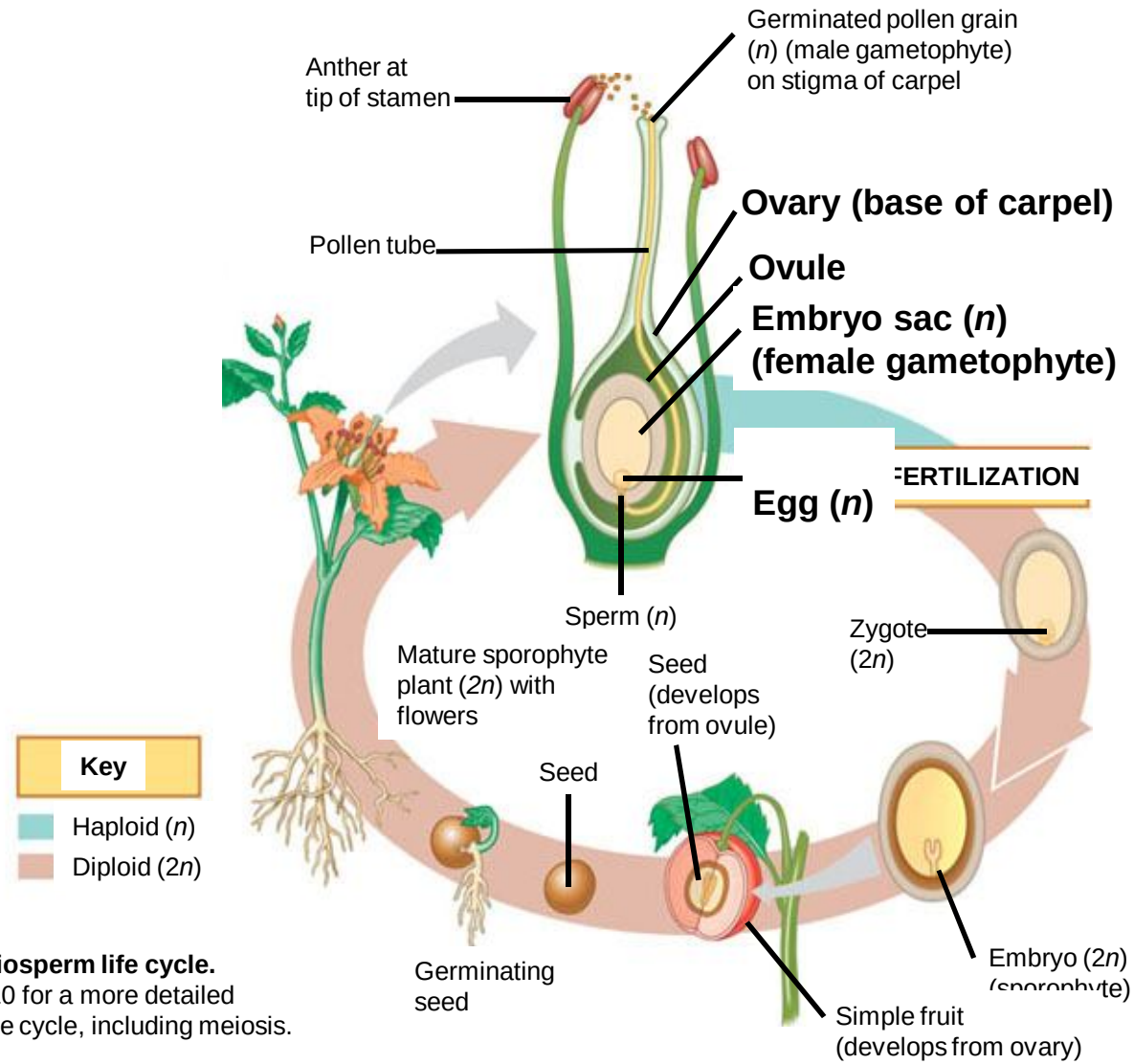
The Oakland Tribune / Annie Tritt

"corpse flower" Rafflesia arnoldii

Alternation of generations in angiosperms

- **dominant sporophyte generation (2n)**
  - **produces haploid spores (by meiosis) that develop within flowers (in anthers or ovaries)**
  - **haploid spores develop (by mitosis) into multicellular haploid gametophytes**
    - **male gametophytes = pollen grains**
    - **female gametophytes = embryo sacs**
- ***Pollination enables gametes to come together within a flower***

An overview of angiosperm reproduction



(b) Simplified angiosperm life cycle. See Figure 30.10 for a more detailed version of the life cycle, including meiosis.

Flower Structure

- **Flowers**

  -Reproductive shoots of the angiosperm sporophyte (highly modified leaves)

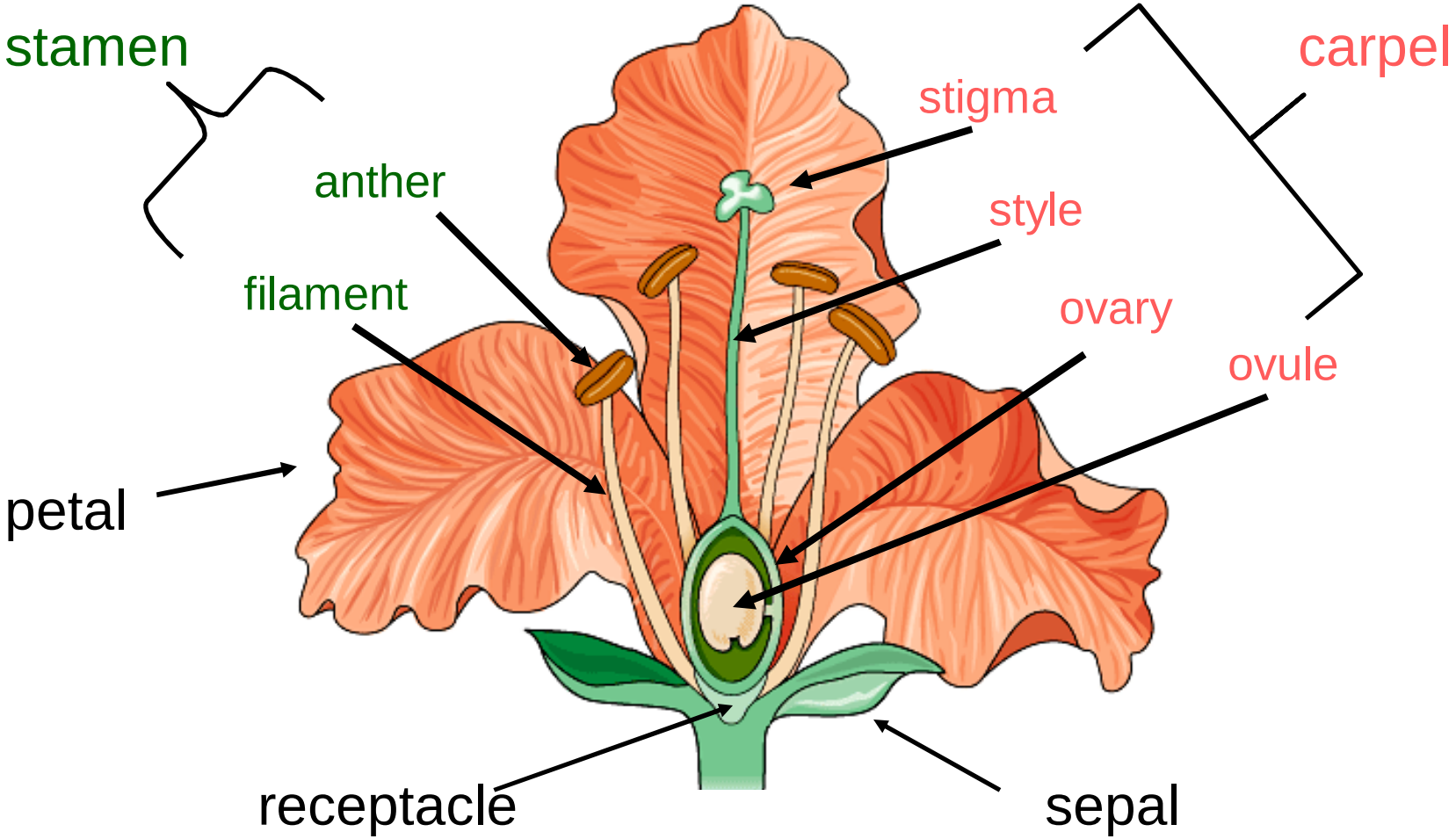
  -Composed of four floral organs:

  sepals

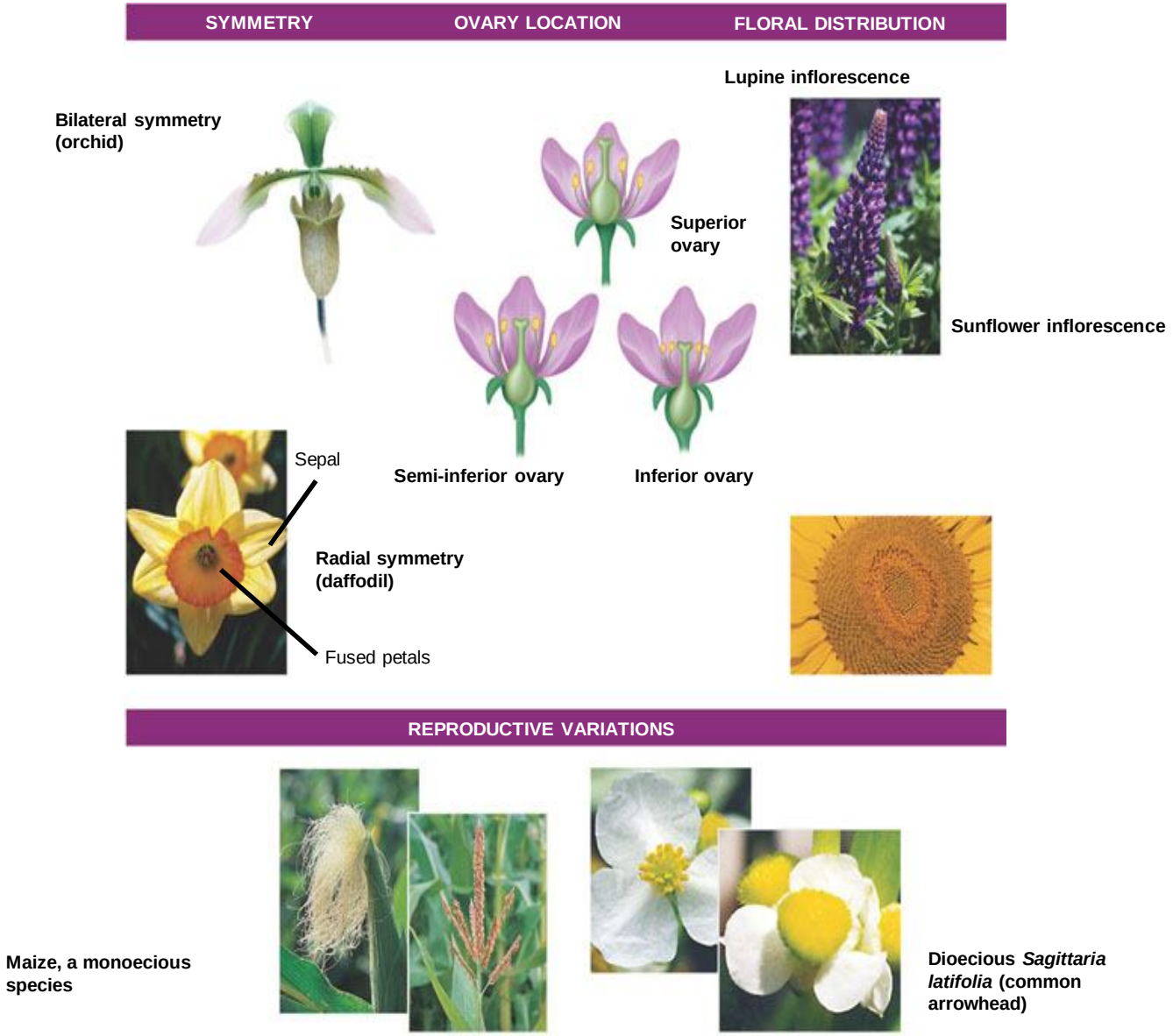
  petals

  stamens

  carpels



- Many variations in floral structure



Gametophyte Development and Pollination

- In angiosperms

Pollination is:

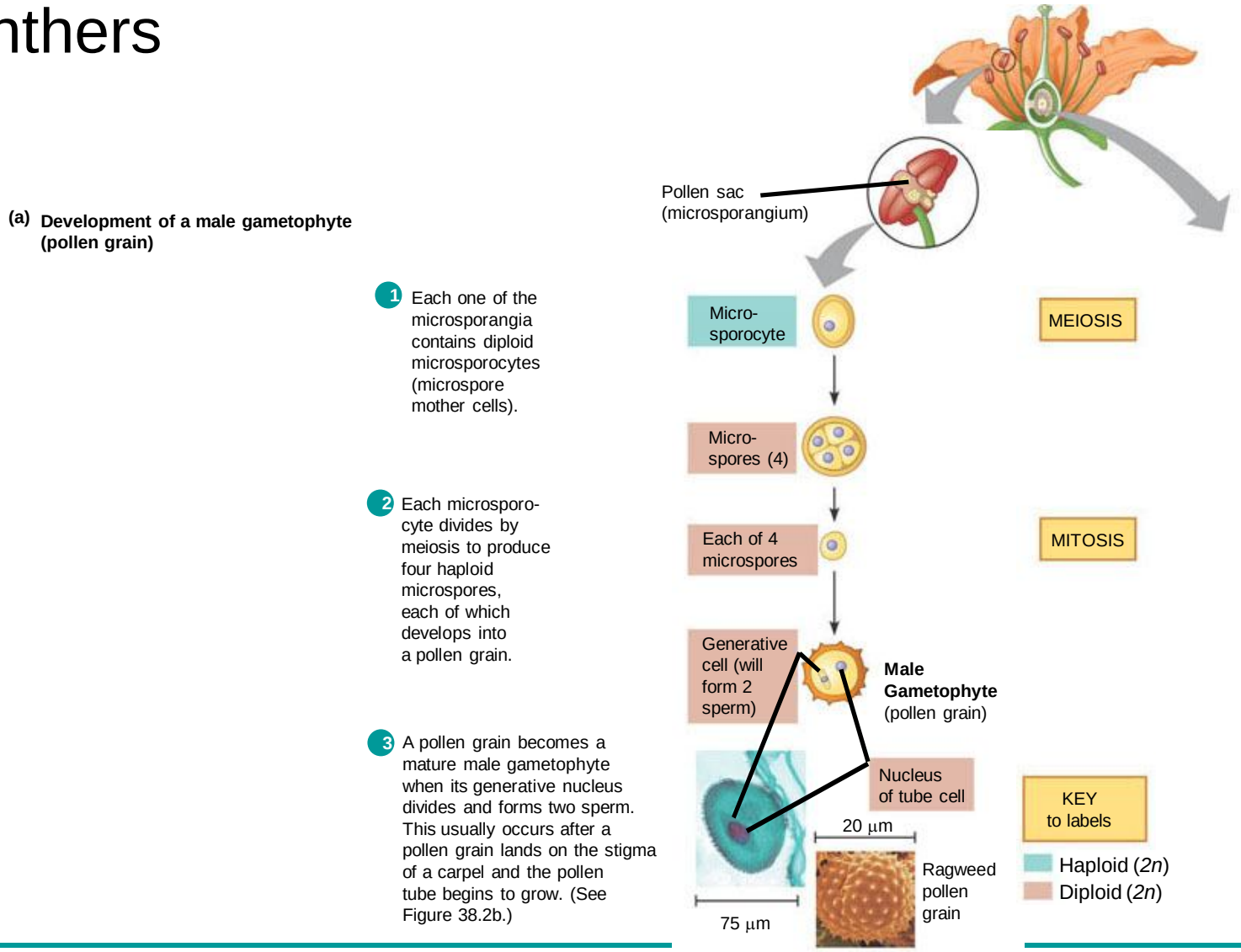
–the transfer of pollen from an anther to a stigma

If pollination is successful:

a pollen grain produces a structure called a **pollen tube**, which grows down into the ovary and discharges sperm near the embryo sac

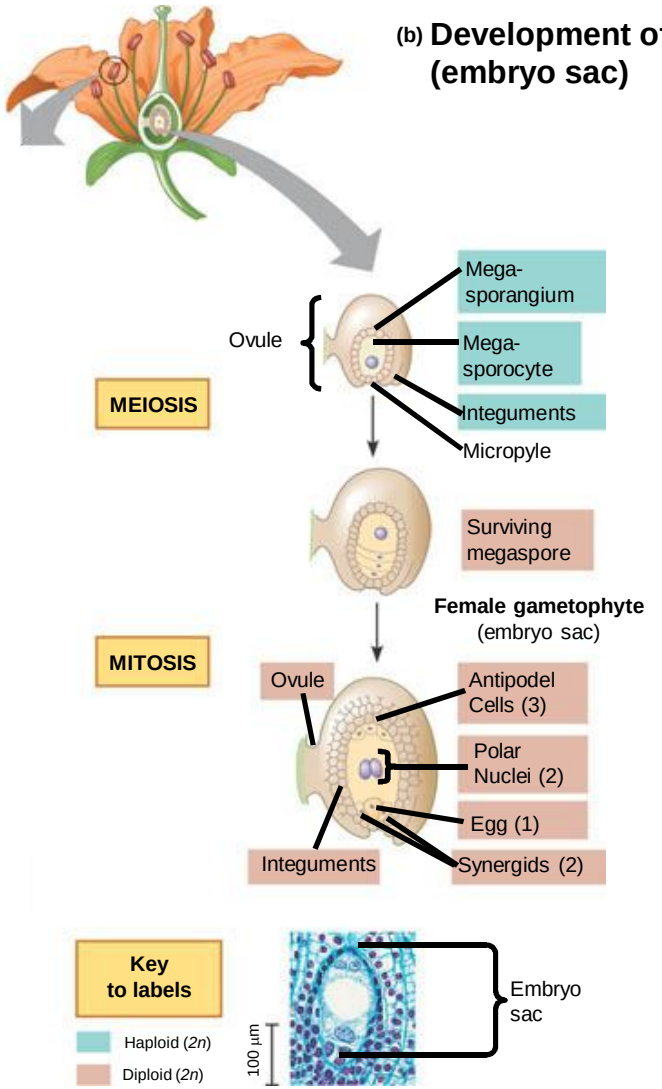
Pollen

- Develops from microspores within the sporangia of anthers



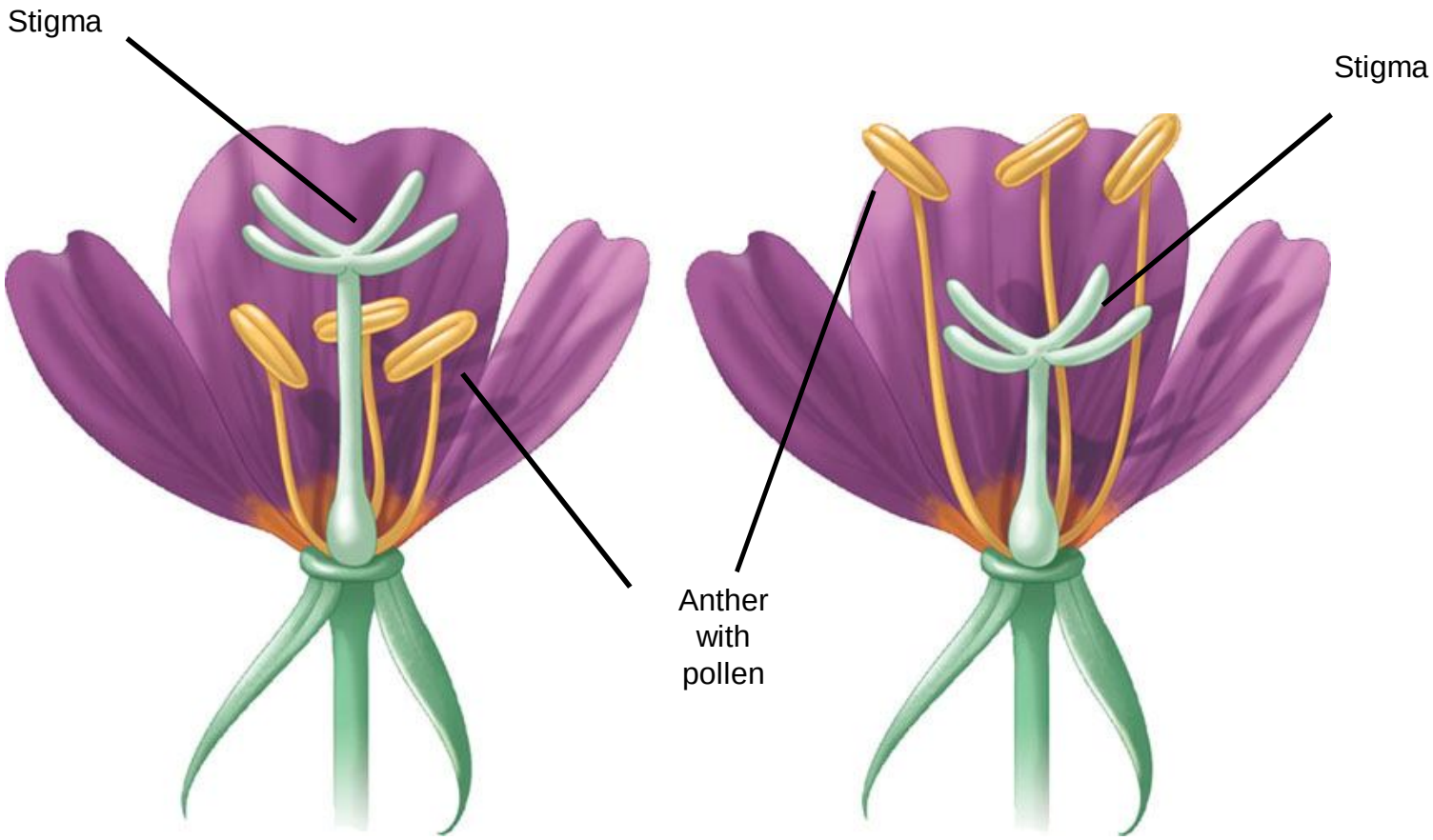
Embryo sacs

- Develop from megaspores within ovules



1. **Within the ovule's megasporangium is a large diploid cell called the megasporocyte (megaspore mother cell).**
2. **The megasporocyte divides by meiosis and gives rise to four haploid cells, but in most species only one of these survives as the megaspore.**
3. **Three mitotic divisions of the megaspore form the embryo sac, a multicellular female gametophyte. The ovule now consists of the embryo sac along with the surrounding integuments (protective tissue).**

Mechanisms That Prevent Self-Fertilization



Mechanisms That Prevent Self-Fertilization

Self-incompatibility:

– the ability of a plant to reject its own pollen

- Some plants reject pollen that has an *S*-gene matching an allele in the stigma cells

•Recognition of self pollen triggers a **signal transduction pathway** leading to a block in growth of a pollen tube

Double Fertilization

- **After landing on a receptive stigma**
  - **pollen grain germinates and produces a pollen tube that extends down between the cells of the style toward the ovary**

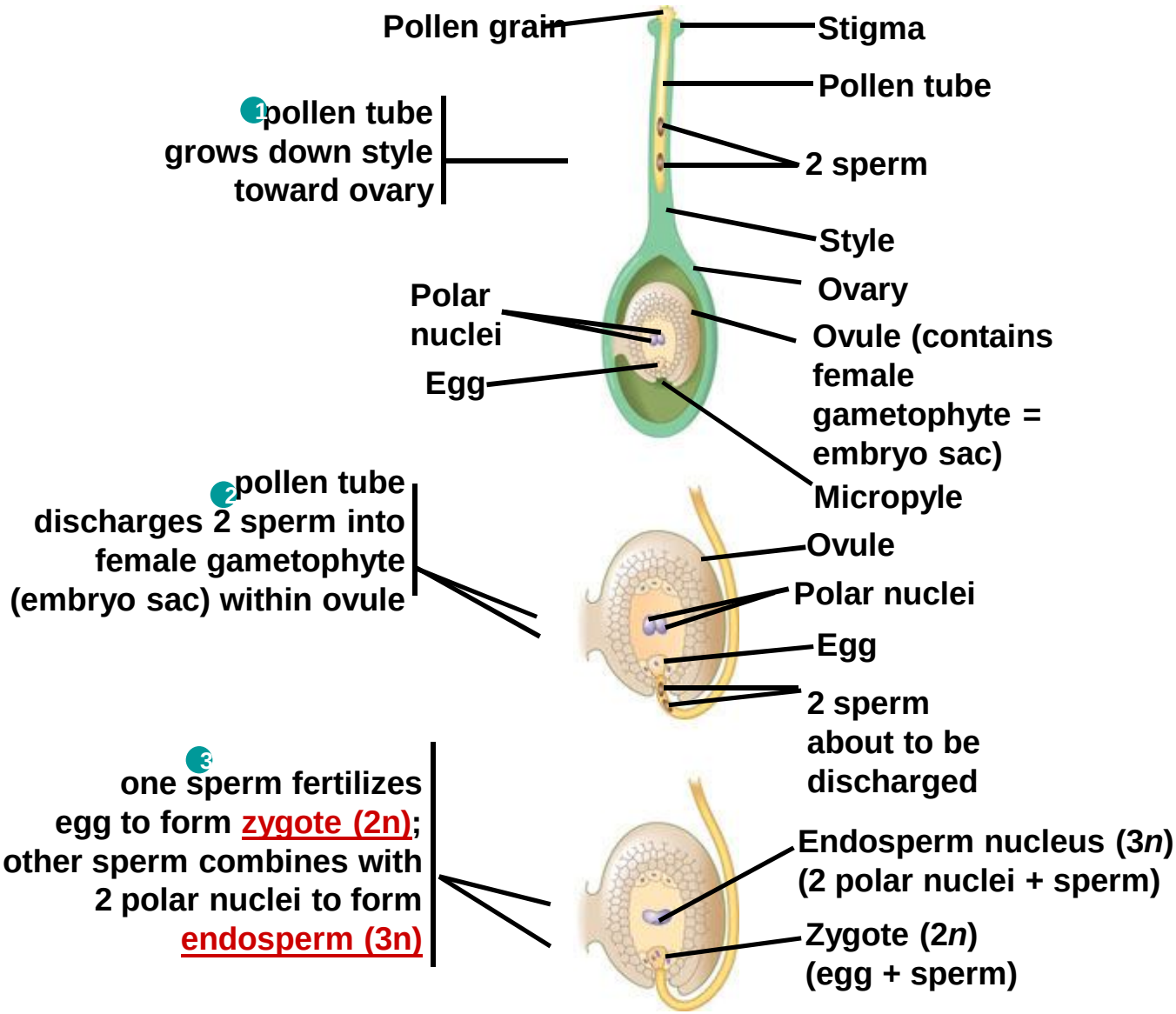
pollen tube discharges two sperm into the embryo sac

- **In double fertilization**

  One sperm fertilizes the egg (2n)

  The other sperm combines with the polar nuclei, giving rise to the food-storing endosperm (3n)

Growth of the pollen tube & double fertilization



From Ovule to Seed

- **After double fertilization**
  - **Each ovule develops into a seed**
  - **The ovary develops into a fruit enclosing the seed(s)**

Endosperm Development

- **Endosperm development**
  - ***Usually precedes embryo development. Why?***

In most <u>monocots</u> (and some eudicots):

The endosperm stores nutrients that can be used by the seedling after germination

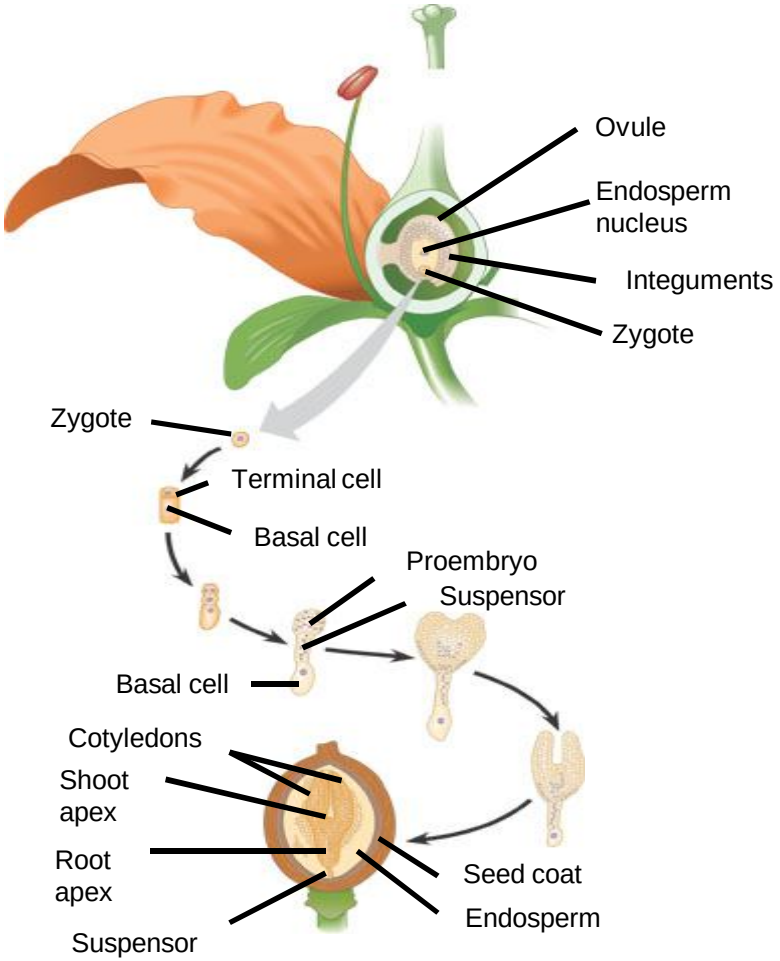
In other <u>eudicots</u>:

The food reserves of the endosperm are completely exported to the cotyledons

Embryo Development

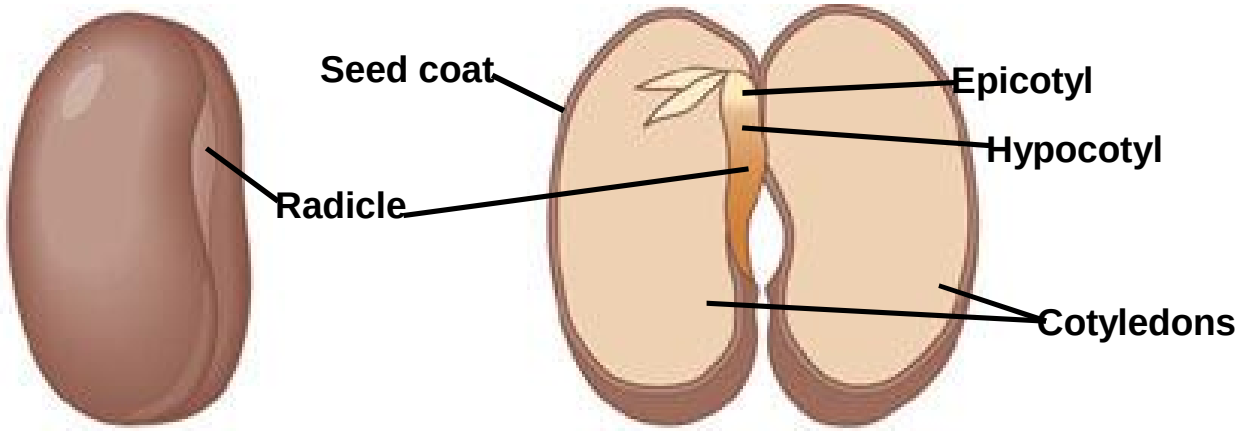
- The first mitotic division of the zygote is transverse; establishes polarity

-Splitting the fertilized egg into a **basal cell** and a **terminal cell**



Structure of the Mature Seed

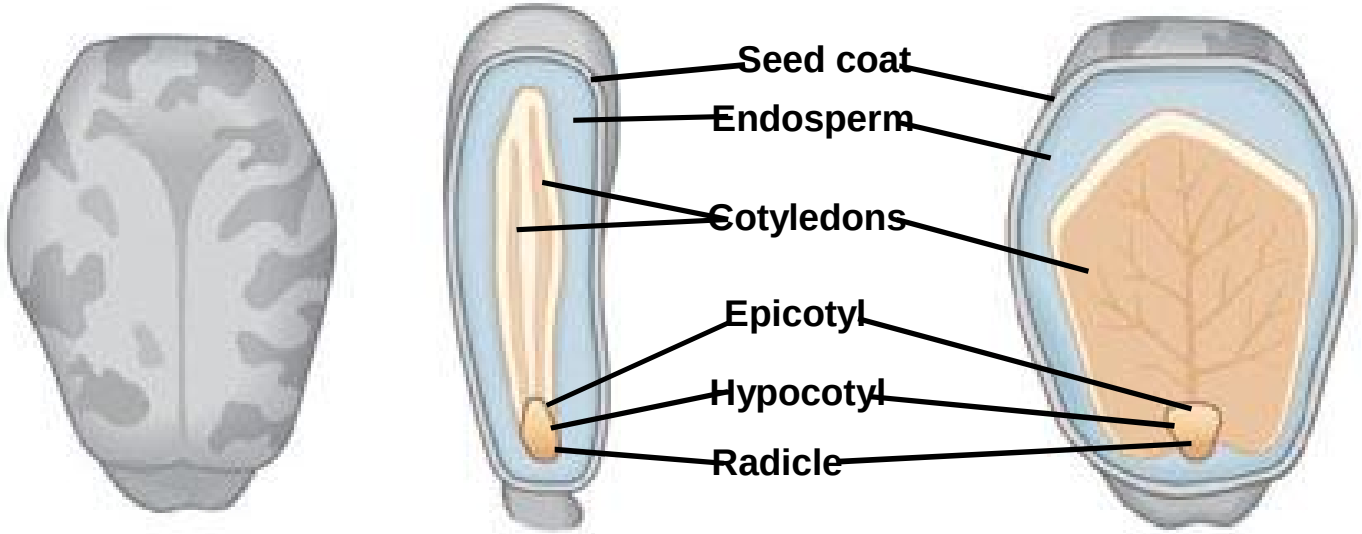
- **In a common garden bean, a eudicot, embryo consists of the hypocotyl, radicle, and thick cotyledons**



Food stored in cotyledons:

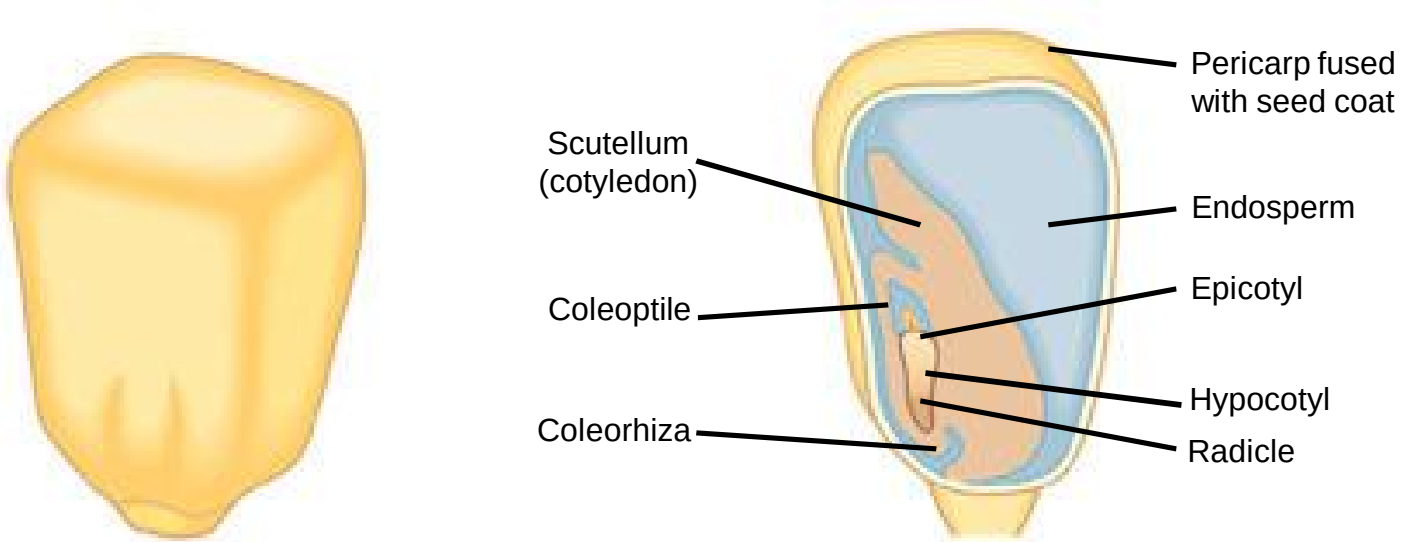
- **cotyledons absorb food from endosperm before seed germinates; become thick & fleshy**

- **The seeds of other eudicots have similar structures, but with thin cotyledons**
  - **Ex. castor beans**



Food stored in endosperm:
- **thin, membranous cotyledons absorb food from endosperm when seed germinates**

- **The embryo of a monocot**
  - **Has a single cotyledon, a coleoptile, and a coleorhiza**



(c) Maize, a monocot. Like all monocots, maize has only one cotyledon. Maize and other grasses have a large cotyledon called a scutellum. The rudimentary shoot is sheathed in a structure called the coleoptile, and the coleorhiza covers the young root.

From Ovary to Fruit

- **A fruit**

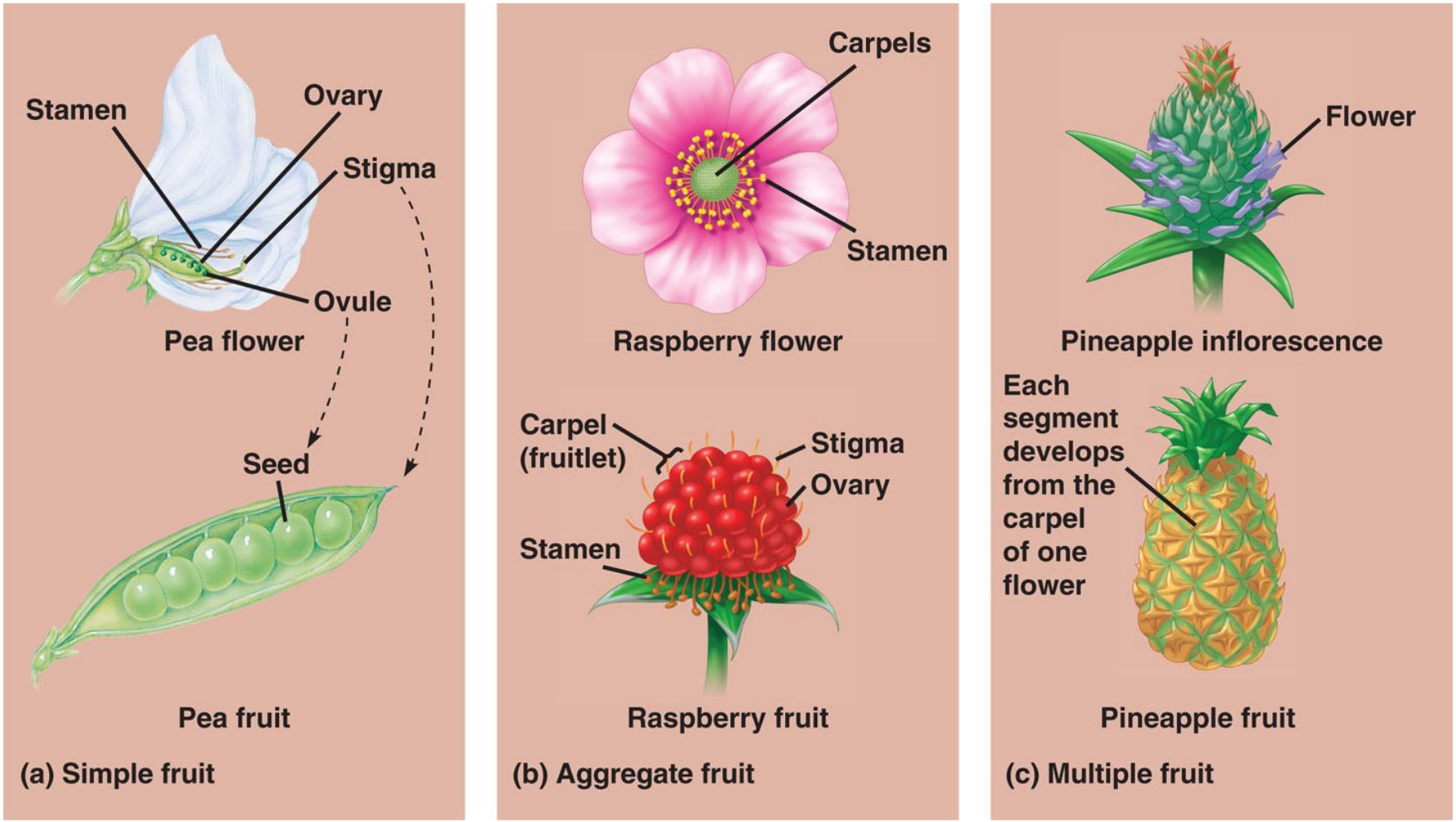
  Develops from the ovary

  Protects the enclosed seeds

  Aids in the dispersal of seeds by wind or animals

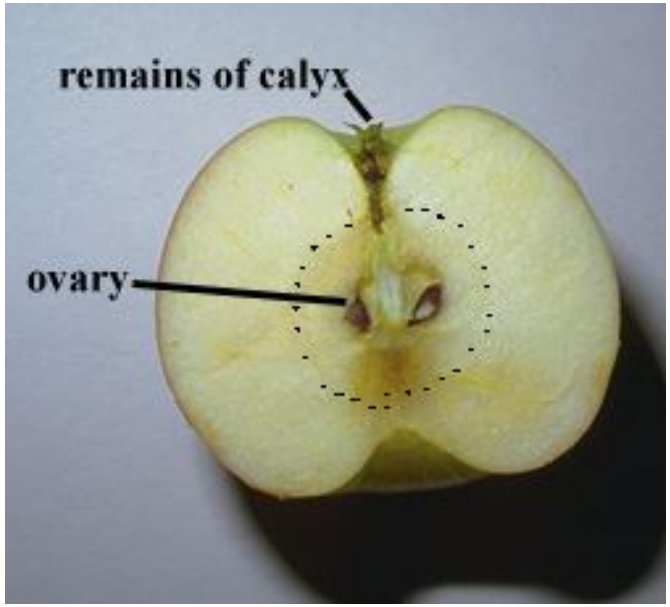
Types of fruits

- **Fruits are classified based on developmental origin**



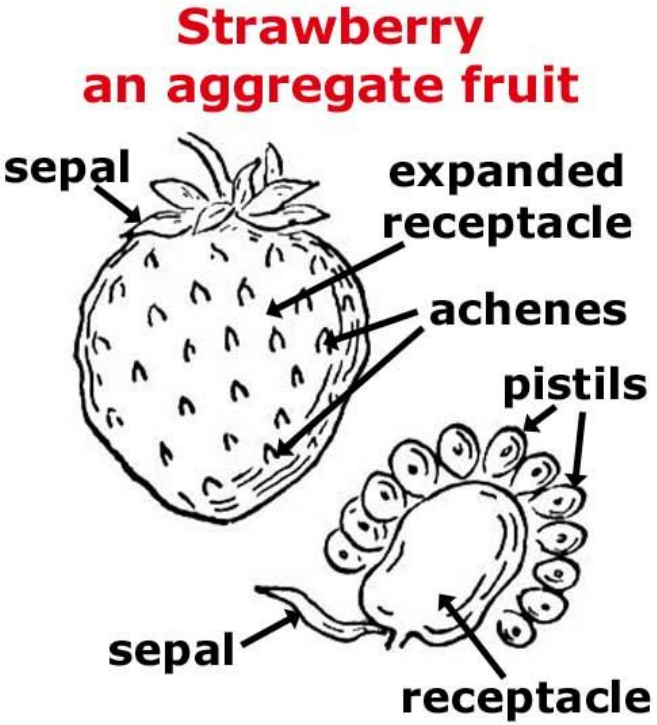
Types of fruits

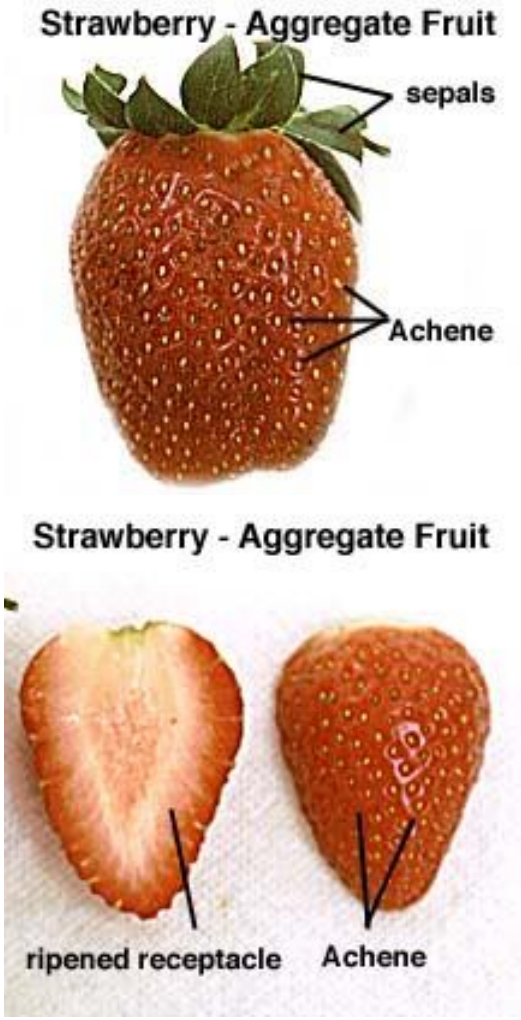
- **Simple fruit (one flower; one carpel (or fused carpels)**



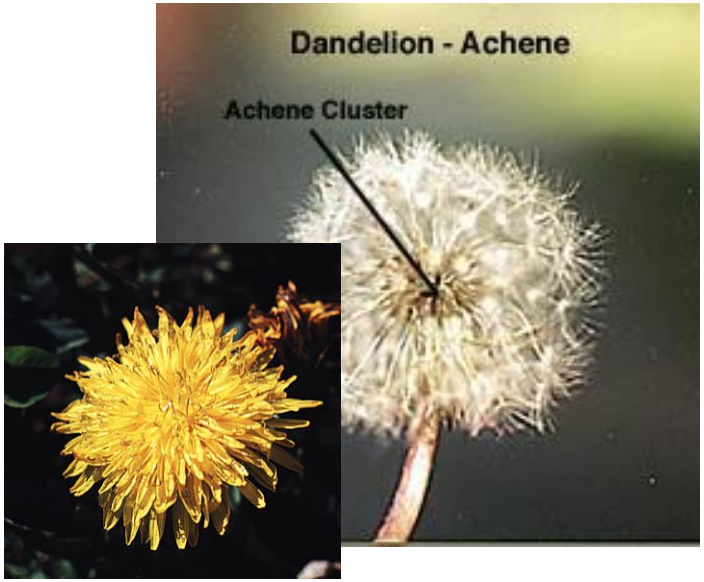
Types of fruits

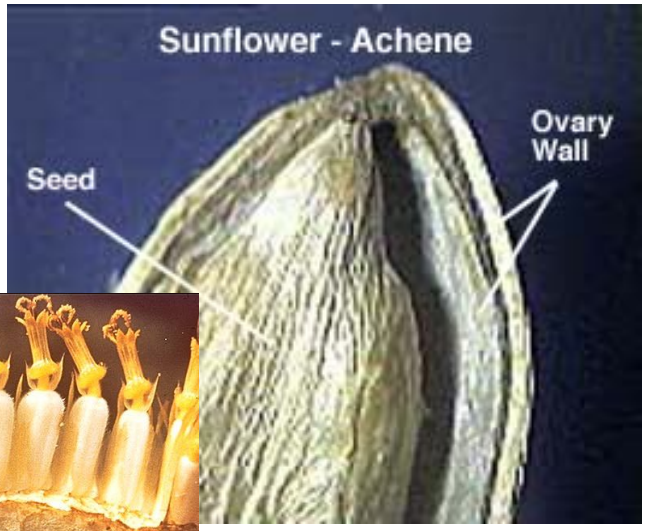
- **aggregate fruit (one flower; many carpels)**

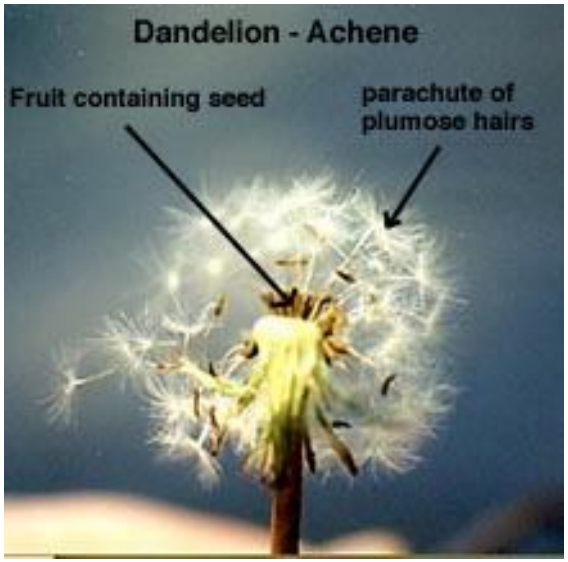


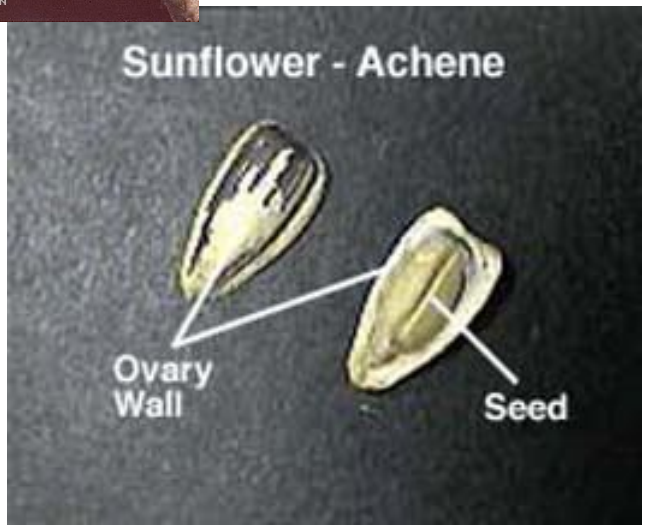


Types of fruits



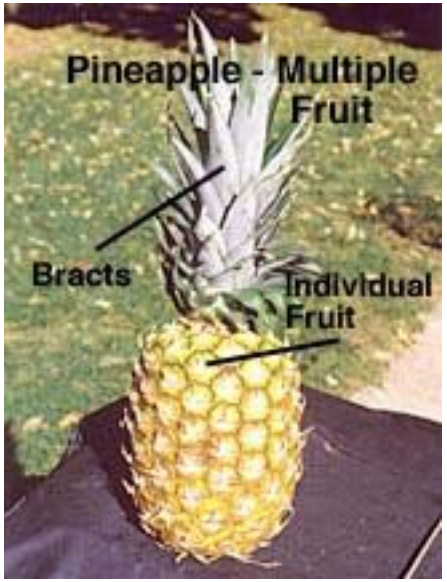


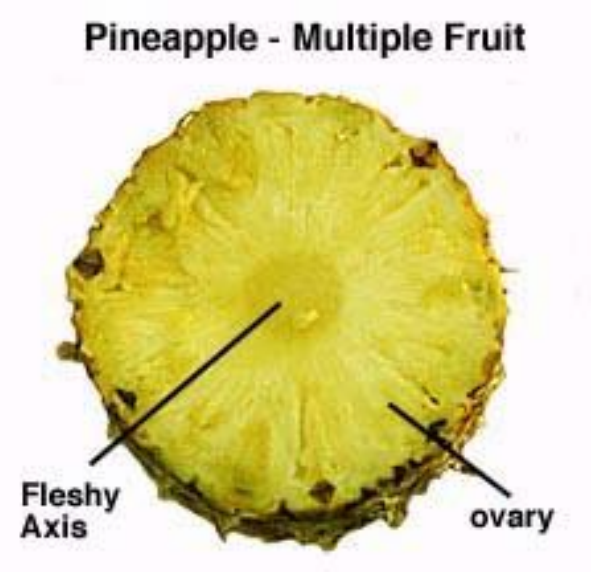




Types of fruits

- **multiple fruit (many flowers)**





Seed Dormancy: Adaptation for Tough Times

- **Seed dormancy**

-Increases the chances that germination will occur at a time and place most advantageous to the seedling

The breaking of seed dormancy:

–Often requires environmental cues, such as temperature or lighting cues

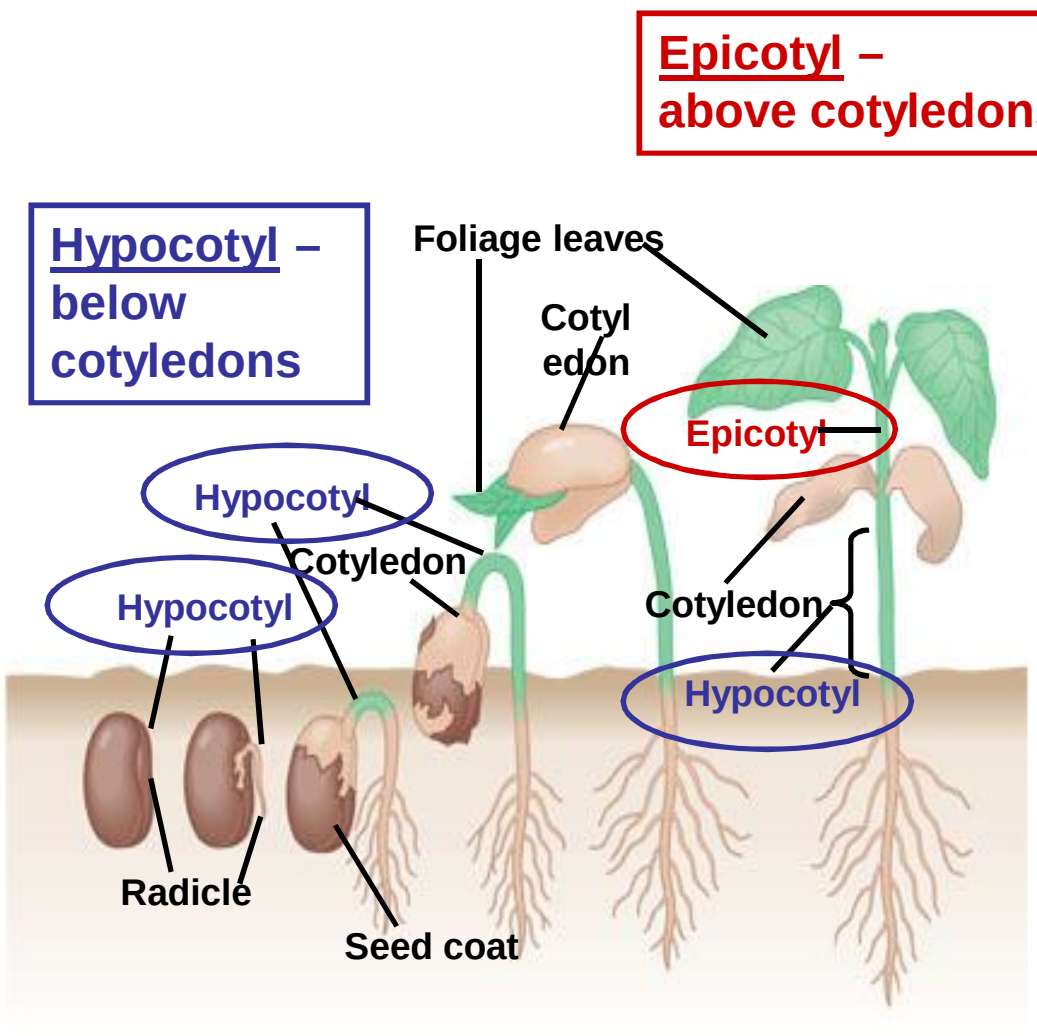
From Seed to Seedling

- **Germination of seeds depends on the physical process called imbibition**
  - **uptake of water due to low water potential (Ψ) of the dry seed**

Germination in Dicots

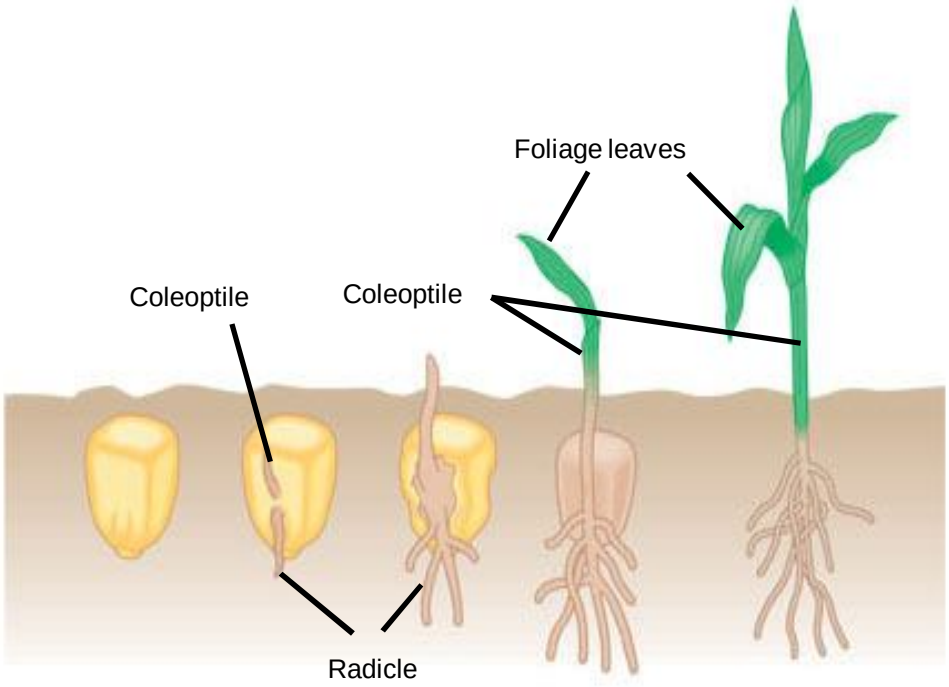
Radicle – first organ to emerge from germinating seed

- **In many eudicots a hook forms in the hypocotyl, and growth pushes the hook above ground (which *pulls* cotyledons from soil)**



Germination in monocots

- **The coleoptile**
  - **Pushes upward through the soil and into the air**

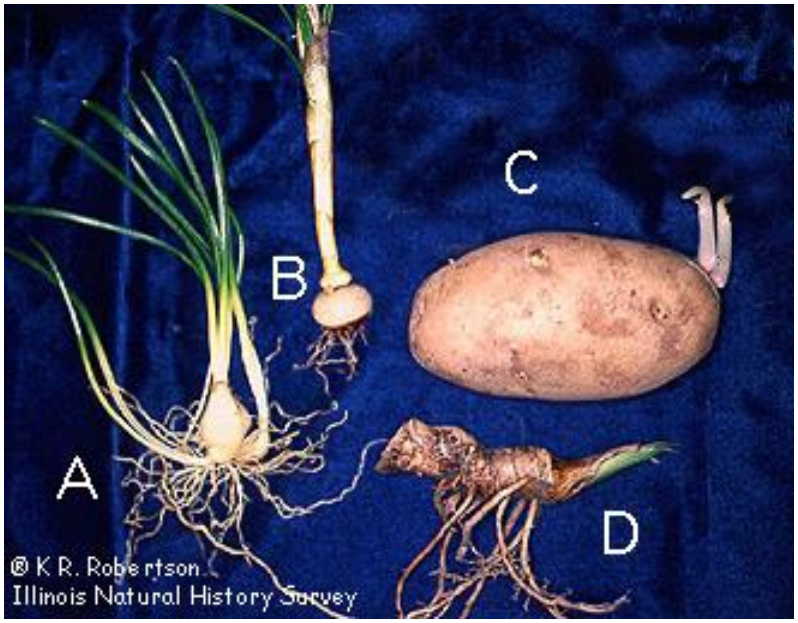


(b) Maize. In maize and other grasses, the shoot grows straight up through the tube of the coleoptile.

Asexual reproduction

Asexual reproduction in plants
Is called vegetative reproduction

Involves roots, stems, or leaves



Mechanisms of Asexual Reproduction

- **Fragmentation**

  –separation of a parent plant into parts that develop into whole plants

  -one of the most common modes of asexual reproduction

Natural vegetative reproduction

- In some species
  - The root system of a single parent gives rise to many adventitious shoots that become separate shoot systems

Aspen clones

Vegetative Propagation and Agriculture

- ***Clones from Cuttings***

- ***Grafting***
- A twig or bud from one plant can be grafted onto a plant of a closely related species or a different variety of the same species

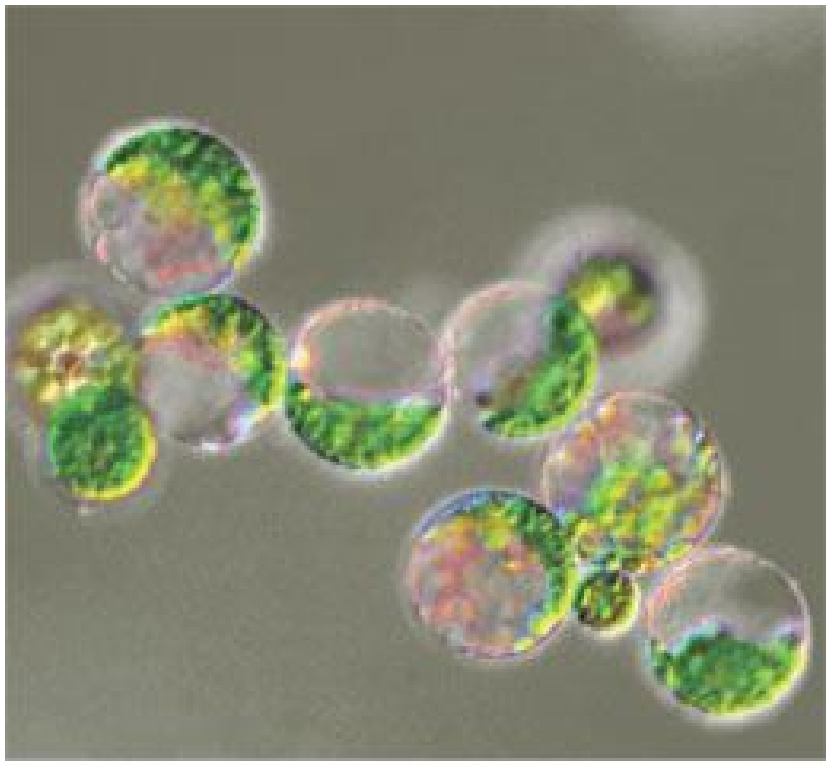
Test-Tube Cloning and Related Techniques

- Plant biologists have adopted *in vitro* methods
  - To create and clone novel plant varieties

Just a few parenchyma cells from a carrot gave rise to this callus, a mass of undifferentiated cells.

The callus differentiates into an entire plant, with leaves, stems, and roots.

- **In a process called protoplast fusion**
  - **Researchers fuse protoplasts, plant cells with their cell walls removed, to create hybrid plants**



Plant biotechnology

- **innovations in the use of plants to make products of use to humans**
  - ***use of genetically modified (GM) organisms in agriculture and industry***

- **Maize**
  - **Is a product of artificial selection by humans**
  - **Is a staple in many developing countries, but is a poor source of protein**

Reducing World Hunger and Malnutrition

- **Genetically modified plants**
  - **Have the potential of increasing the quality and quantity of food worldwide**

The Debate over Plant Biotechnology

- ***Issues of Human Health***

  May transfer allergens from a gene source to a plant used for food

- ***Possible Effects on Nontarget Organisms***

- ***Transgene Escape***

  The possibility of the introduced genes escaping from a transgenic crop into related weeds through crop-to-weed hybridization