CHAPTER 2

Reproduction of Flowering Plants

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Rafflesia arnoldii in Indonesia

Asexual Reproduction

Sexual Reproduction

Seeds and Fruits

Flower Plant Reproduction

- Many flowering plants clone themselves by asexual reproduction
- Many angiosperm species
  - Reproduce both asexually and sexually
- Asexual reproduction in plants
  - Is called vegetative reproduction
- Sexual reproduction
  - Generates the genetic variation that makes evolutionary(sự tiến hóa) adaptation possible

Asexual Reproduction

Sexual Reproduction

Seeds and Fruits

Asexual reproduction

- Does not involve meiosis(sự giảm phân), gametes(giao tử), and fertilization.(sự thụ tinh)
- New individuals form by mitotic cell division.
- A parent organism produces progeny(kết quả) that are genetically identical to it and to each other.

In nature

- Plants often reproduce vegetatively (asexually) by forming new plants from portions of their roots, stems, or leaves.
- From stems:
  - Rhizomes
  - Tubers
  - Stolons
  - Bulbs.(củ)
- From leaves:
  - Plantlets(cây non)

From Rhizome: Prayer plant (*Maranta leuconeura)*

From Rhizome: Prayer plant (*Maranta leuconeura)*

From tuber: Potato *(Solanum tuberosum)*

From Stolon

- **Strawberry *(Fragaria ananassa)***

Strawberry with stolon

From bulbs: Garlic *(Allium sativum)*

Garlic *(Allium sativum)*

From plantlets: Mother of Thousands

Apomixis(tiếp hợp vô tính)

Occurs in two forms:

- *Gametophytic(thể giao tử) apomixis* (Parthenogenesis):
  - the embryo arises from an unfertilized egg within a diploid embryo sac that was formed without completing meiosis.
- *Nucellar embryony:*
  - The embryo is formed from the diploid nucellus tissue surrounding the embryo sac.
  - Nucellar embryony occurs in some citrus seeds.

Apomixis in Taraxacum

Vegetative Propagation and Agriculture

- Humans have devised various methods for asexual propagation(nhân giống) of angiosperms

Clones from Cuttings

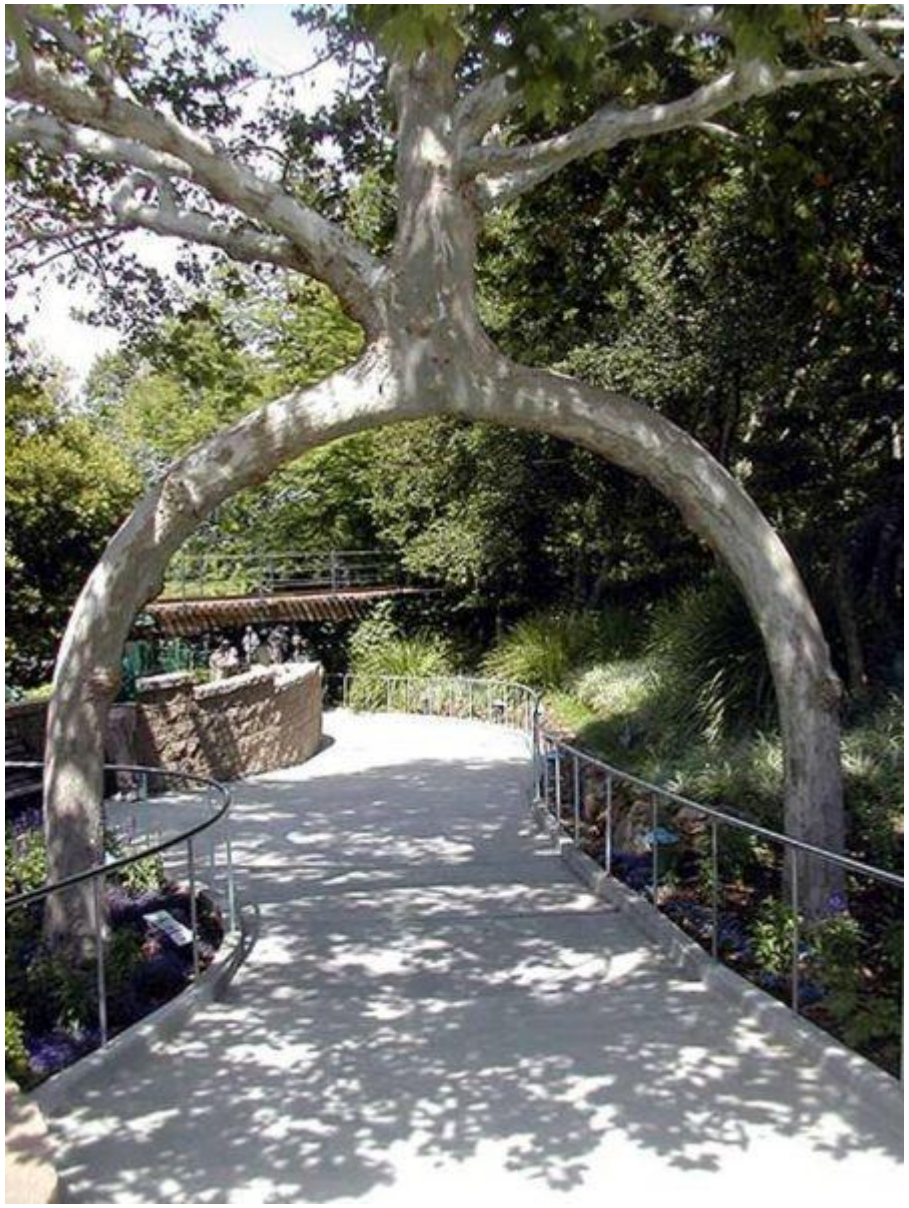
- Many kinds of plants
  - Are asexually reproduced from plant fragments called cuttings

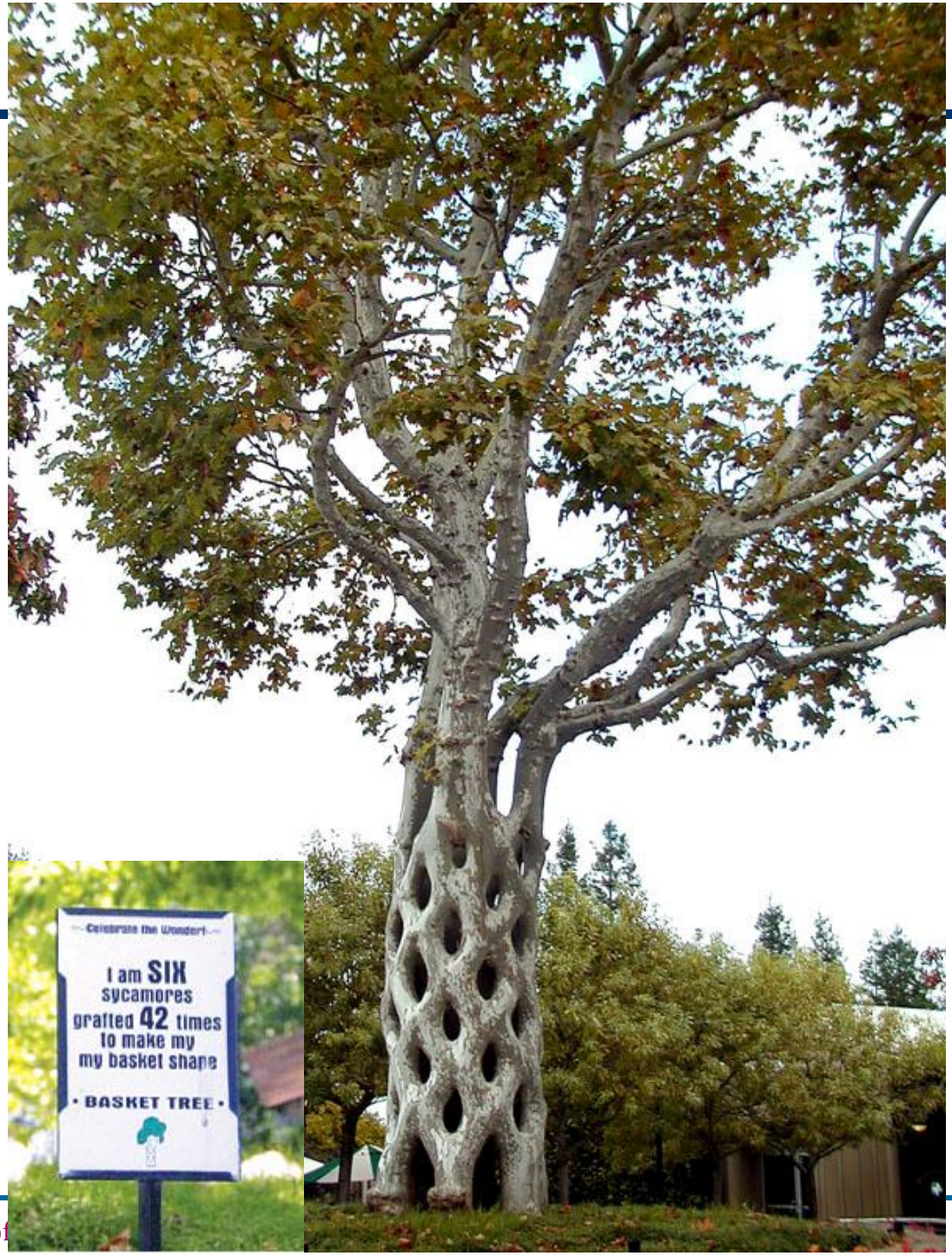
Grafting

- In a modification of vegetative reproduction from cuttings
  - 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

Grafting

Axel Erlandson's "Two Leg Tree"




Celebrate the Wonder!
I am SIX
sycamores
grafted 42 times
to make my
my basket shape
• BASKET TREE •

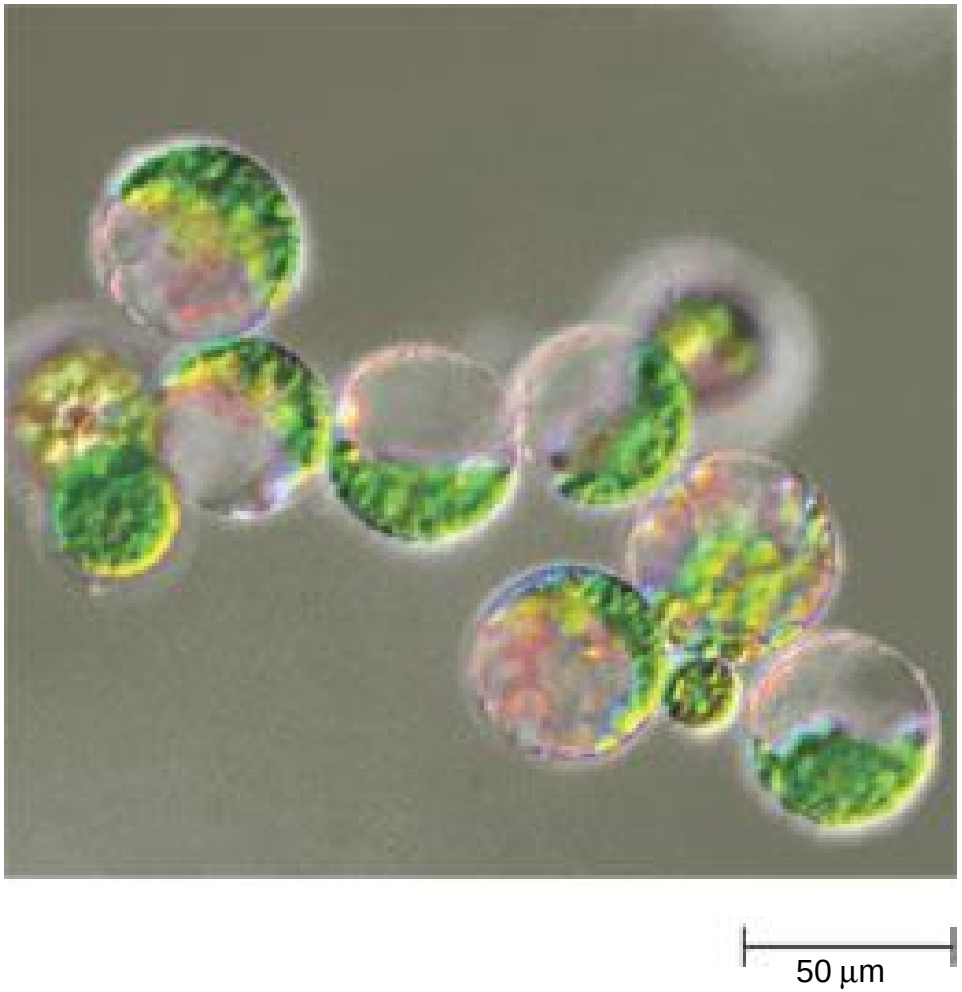
Test-Tube Cloning

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

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

Protoplast fusion

- Researchers fuse protoplasts, plant cells with their cell walls removed, to create hybrid(lai) plants



Asexual Reproduction

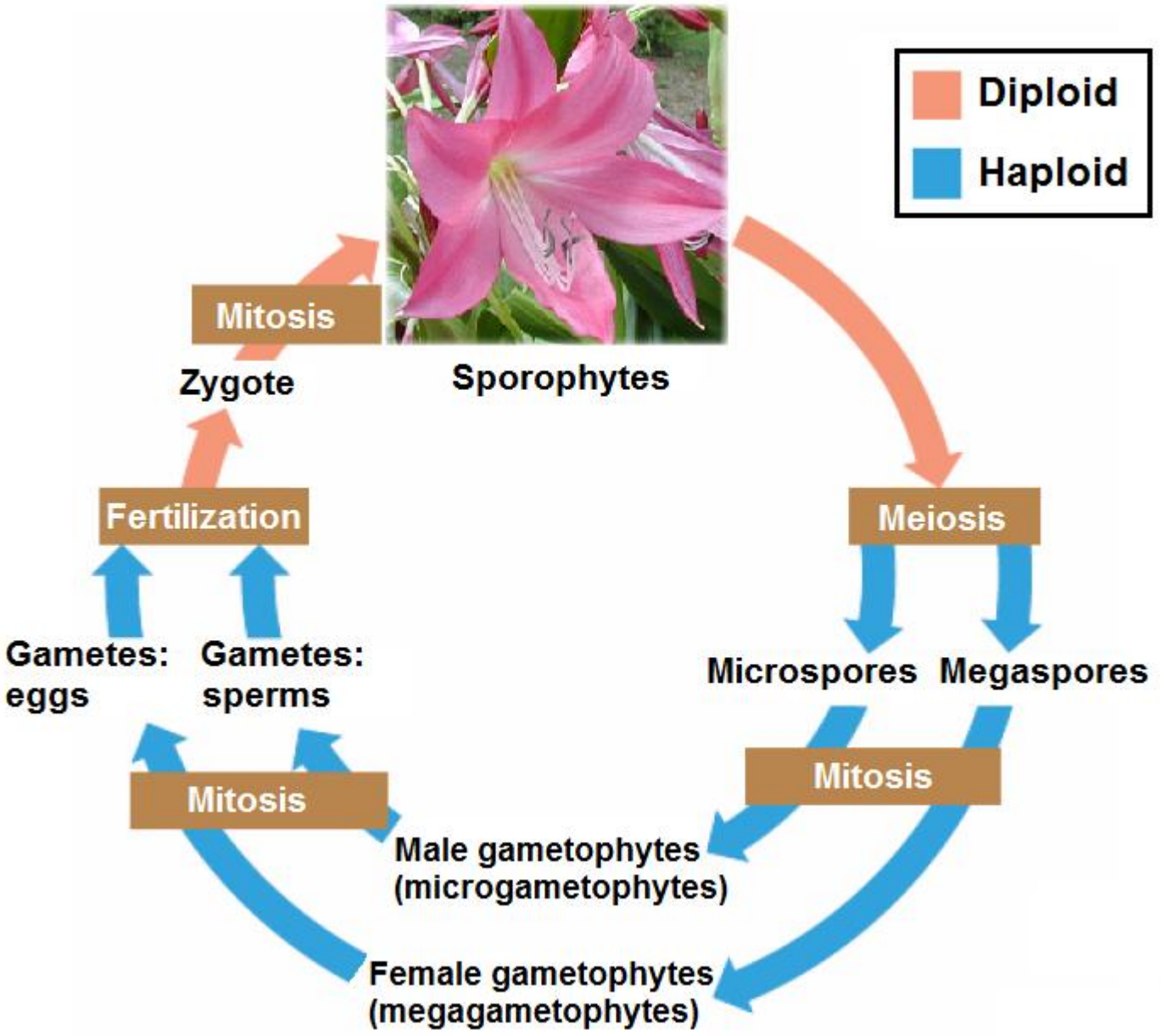
Sexual Reproduction

Seeds and Fruits

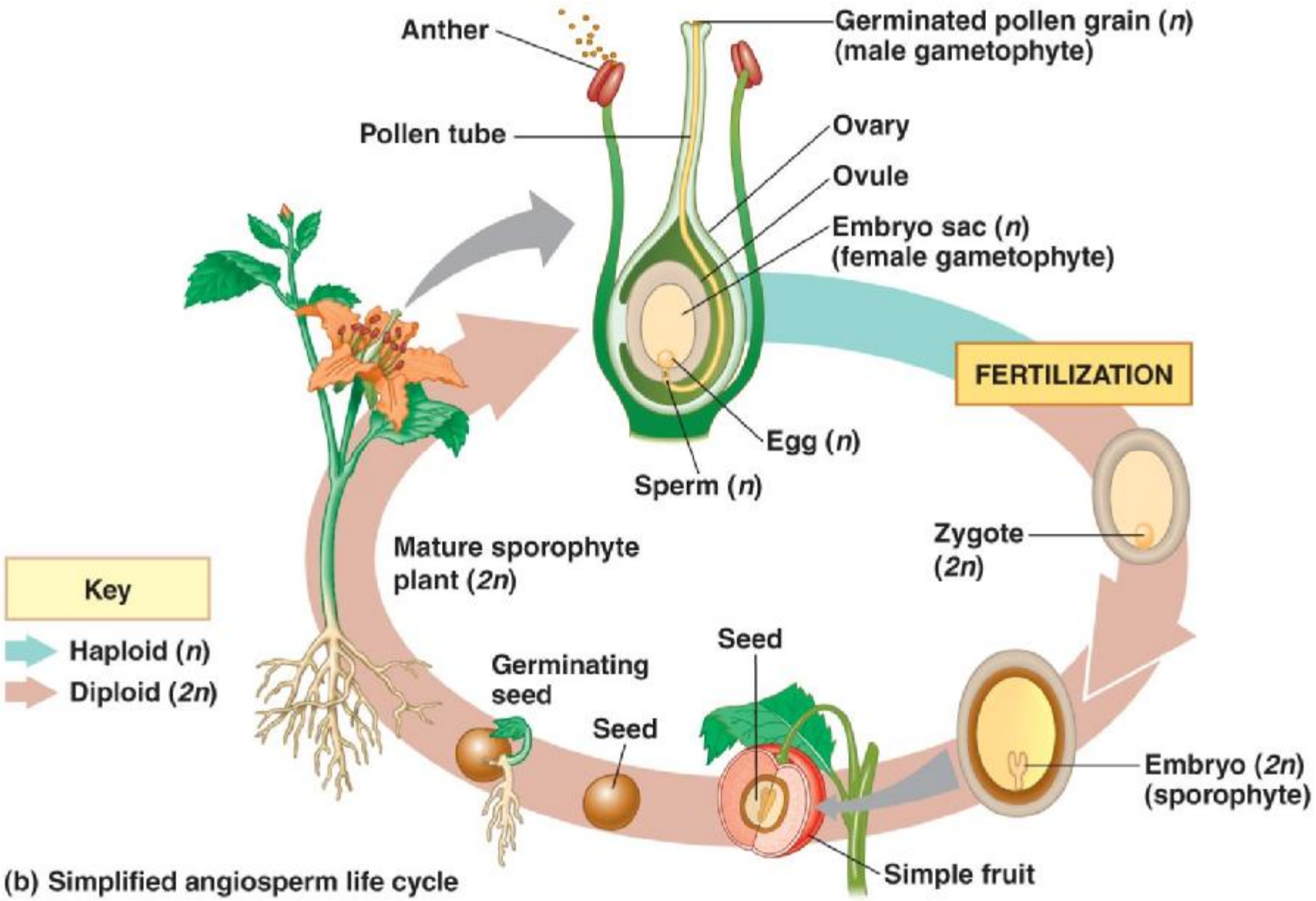
Sexual Reproduction

- **Sporophyte(thể bào tử)**, the diploid generation, produces *haploid spores(bào tử)* through meiosis.
- The haploid spores divide mitotically to produce a multicellular *haploid gametophyte*.
- **Gametophyte(thể giao tử)** produces haploid eggs or sperm (*gametes*) by mitosis.
- These haploid gametes fuse to form a *diploid zygote.*
- The zygote grows and develops, eventually becoming a mature sporophyte.

Alternation of Generations in Flowering Plants

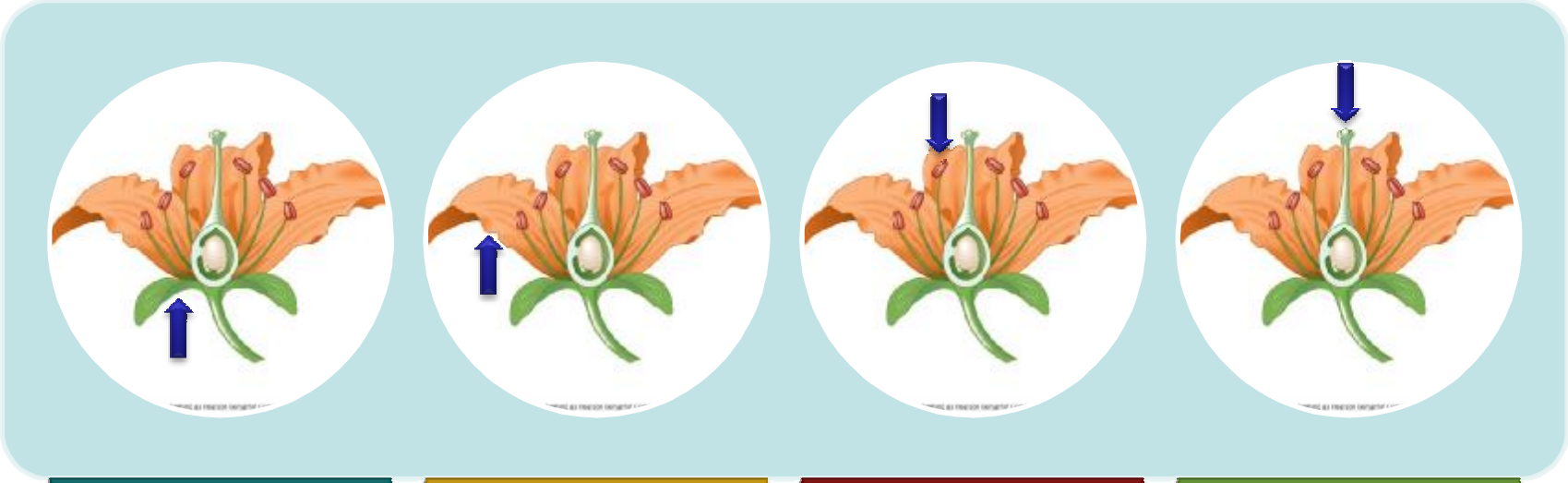


Alternation of Generations in Angiosperms



Flowers are Reproductive Organs

Flower Structure



Sepal

Petal

Stamen

Anther

Filament

Carpel

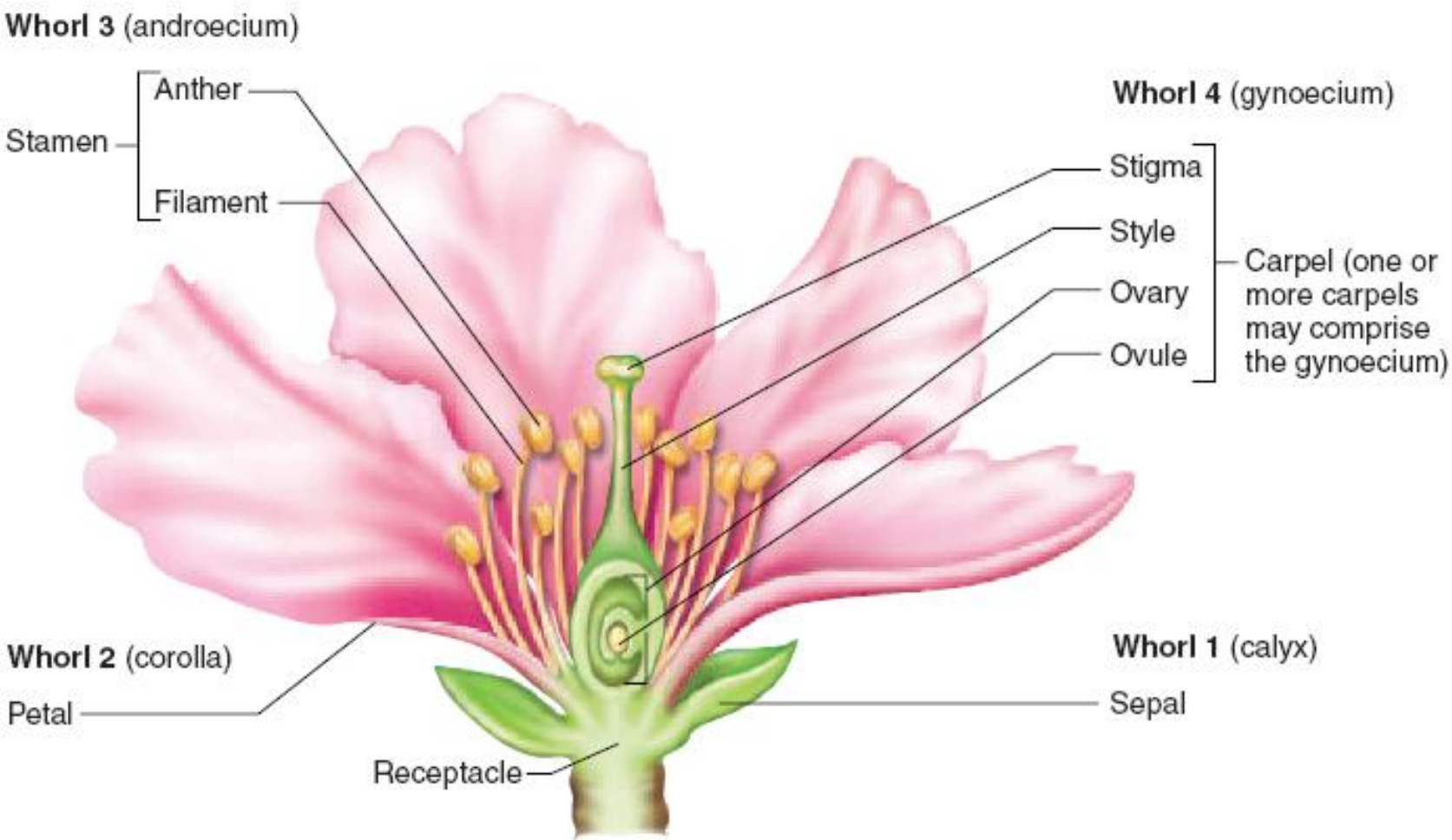
Stigma

Style

Ovary

Ovule

Flower structure



Papayas flower

- Papaya plants occur in one of three sexual forms: male, female, or hermaphrodite. These forms are expressed in the plant's flower.
- Male flowers have no ovary and do not produce a fruit. They contain stamens bearing pollen.
- Female papaya flowers have an ovary and are born in the axil of the leaf petiole.
- Hermaphrodite flowers have both an ovary and stamens bearing pollen. They can pollinate themselves.

Male Papayas *(Carica papaya)*

Male Papayas *(Carica papaya)*

Female Papayas

Female Papayas

Hermaphrodite flowers

Hermaphrodite flowers

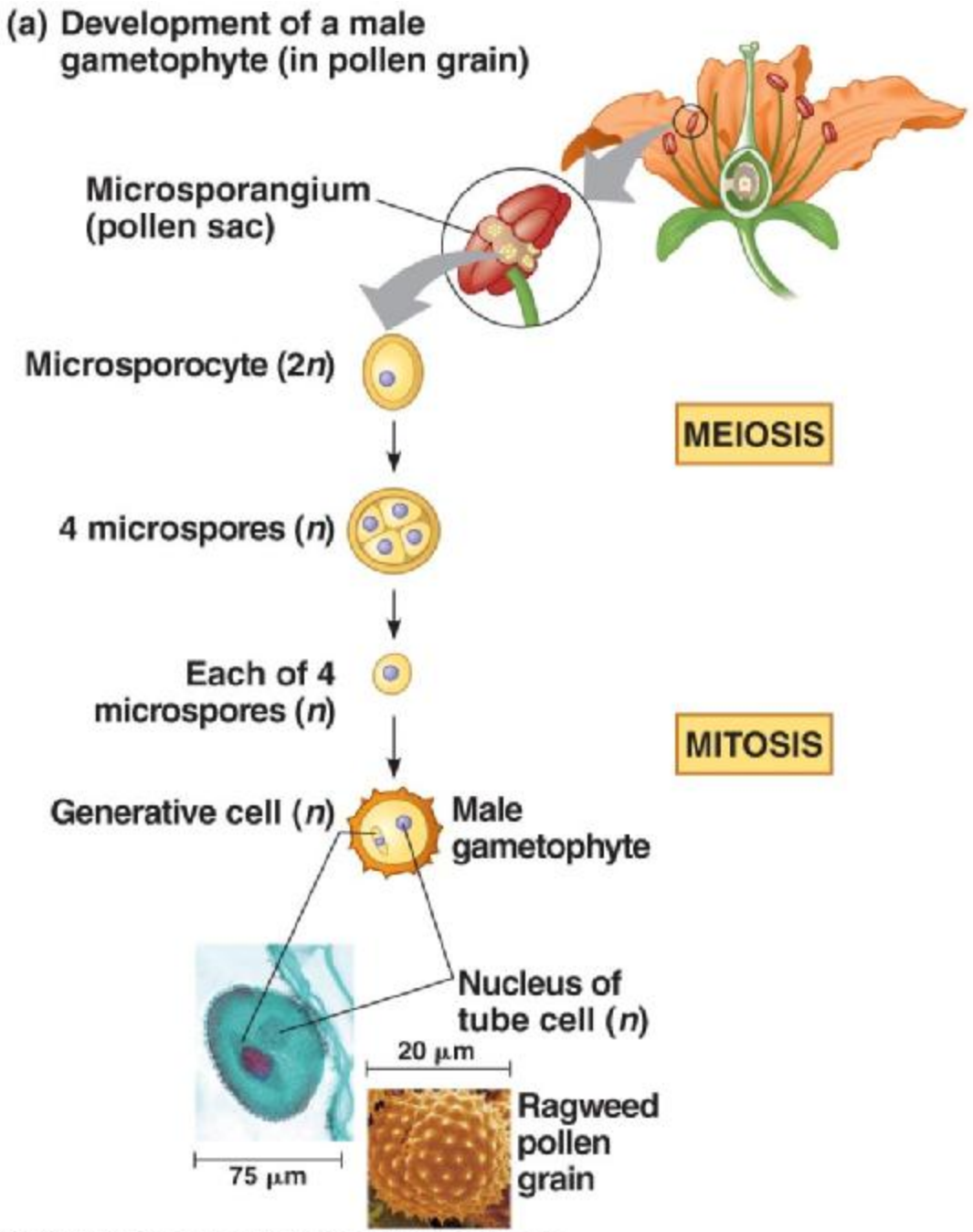
Gamete Formation

Keywords

- megagametophytes/ microgametophytes
- megaspores/ microspores
- pollen sacs/ pollen grains(hạt)
- polar nuclei
- embryo sac

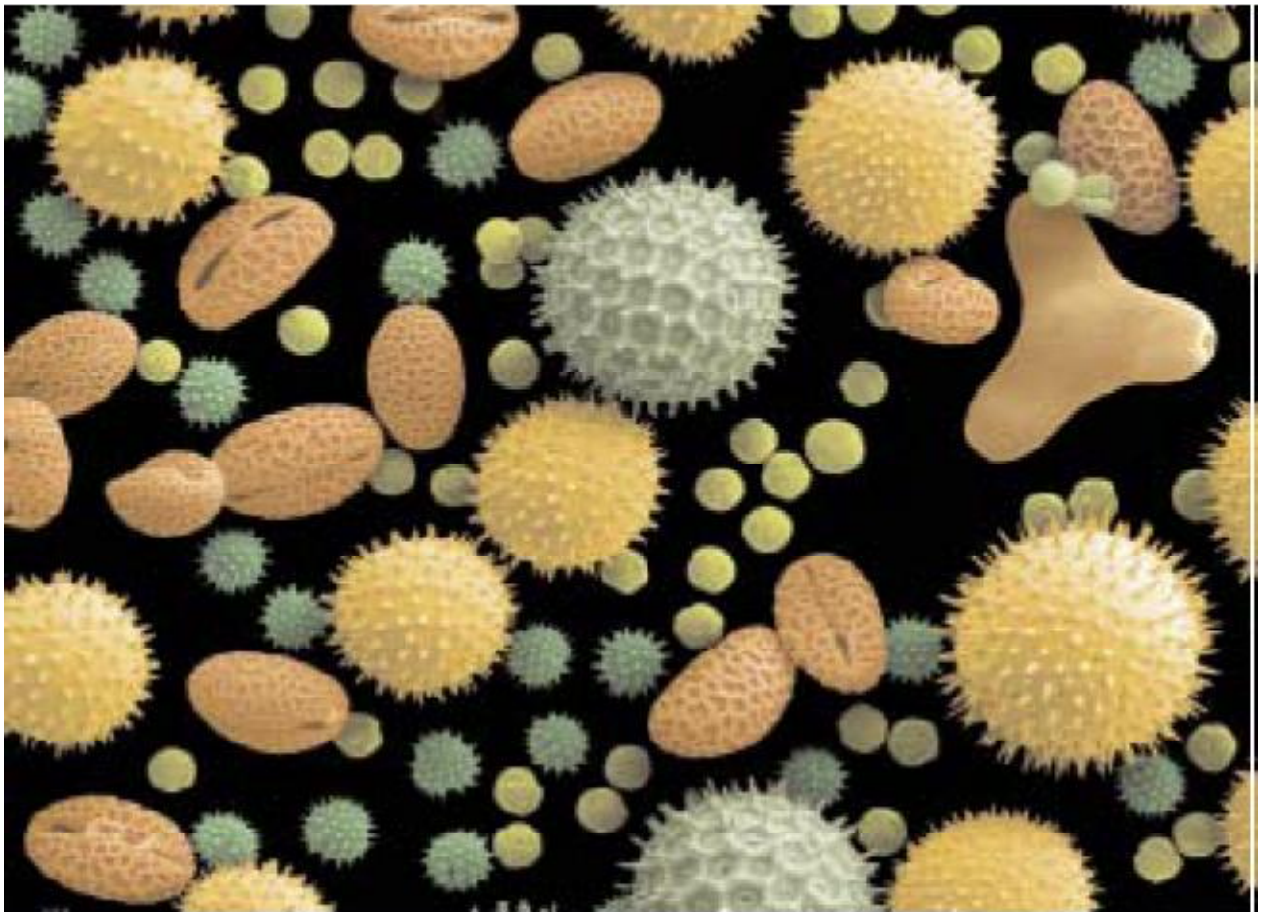
Gamete Formation

- In angiosperms
  - Pollination is the transfer of pollen(phấn hoa) 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

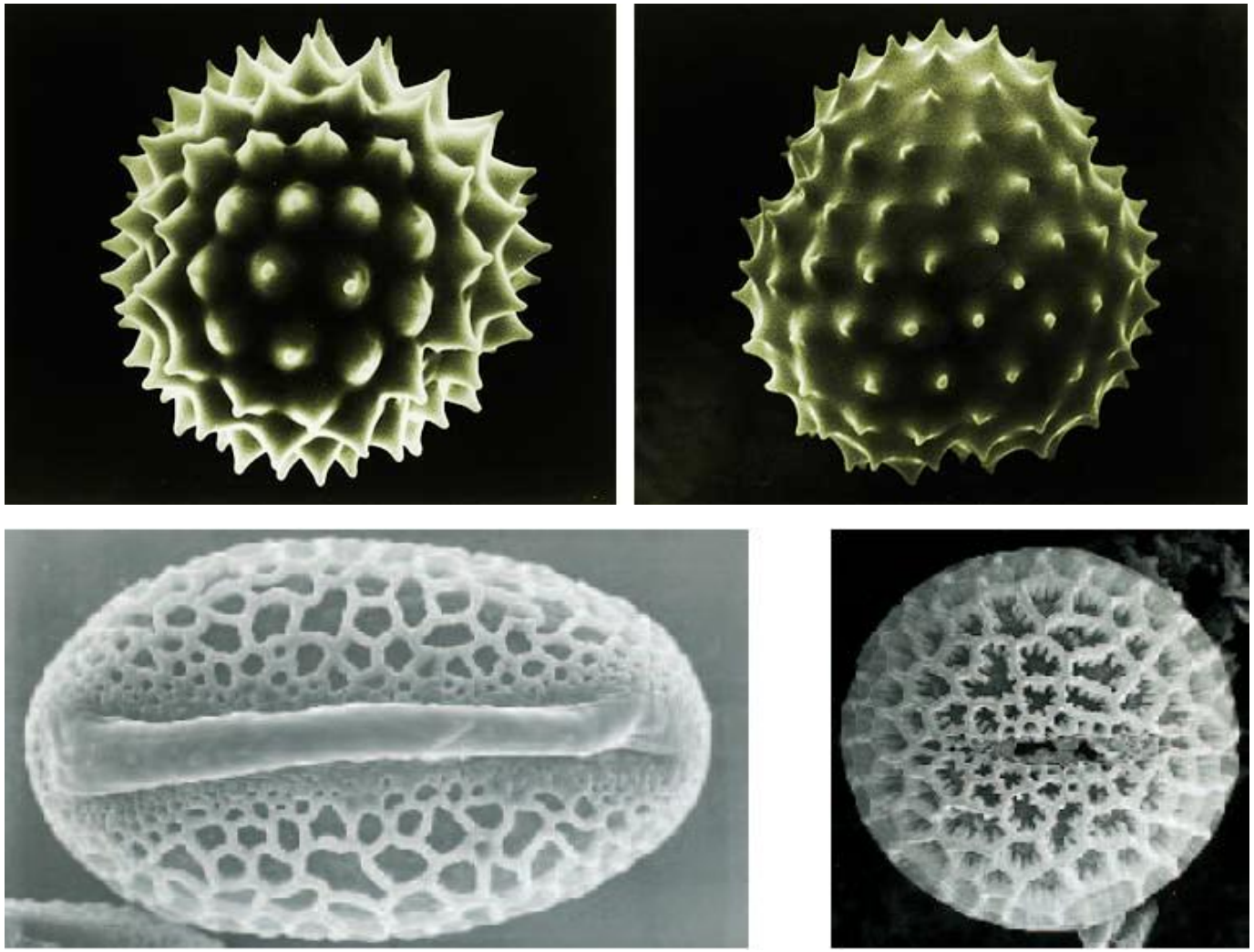


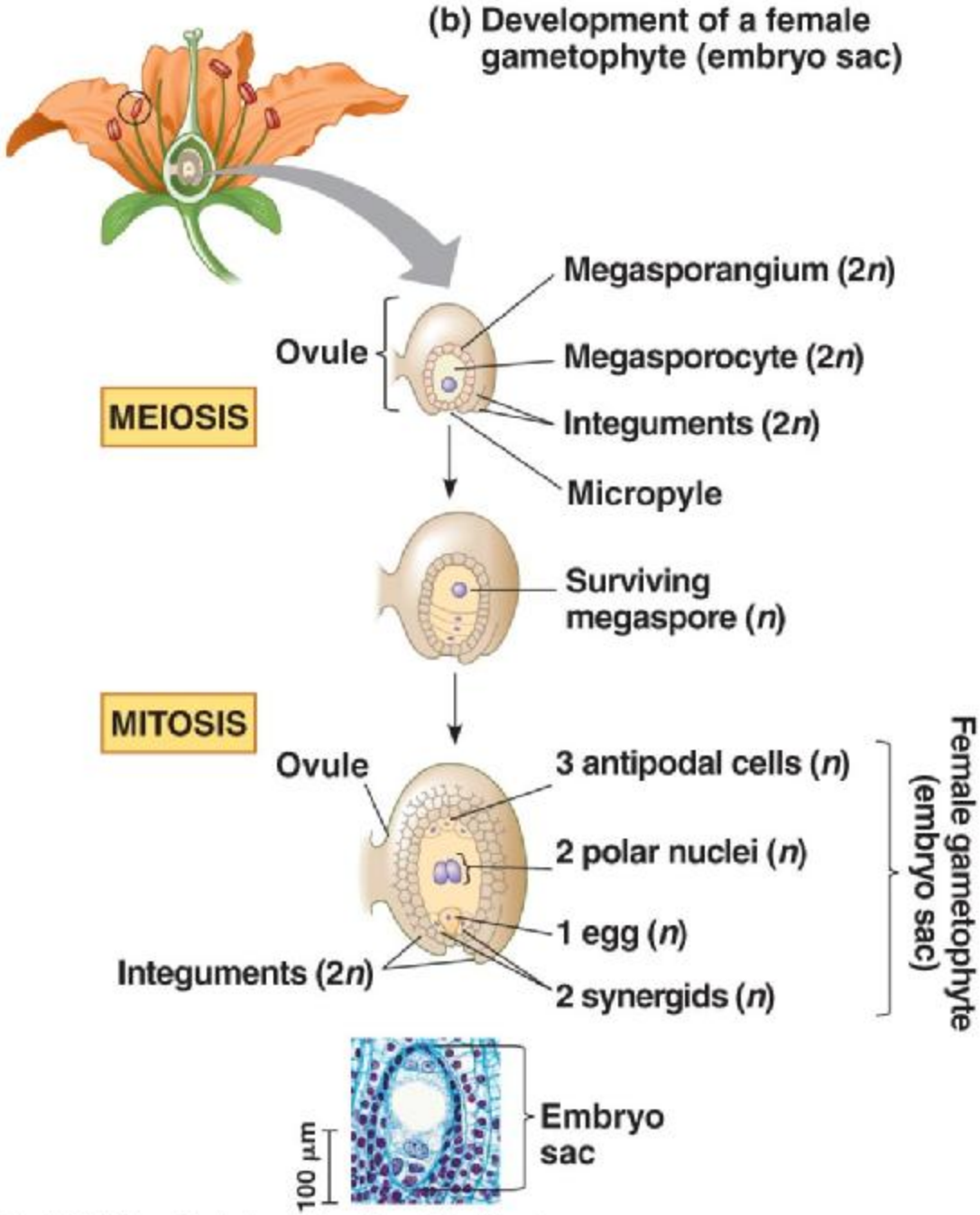
Pollen Grains

- Each species' pollen has a characteristic size, shape, and cell wall structure.

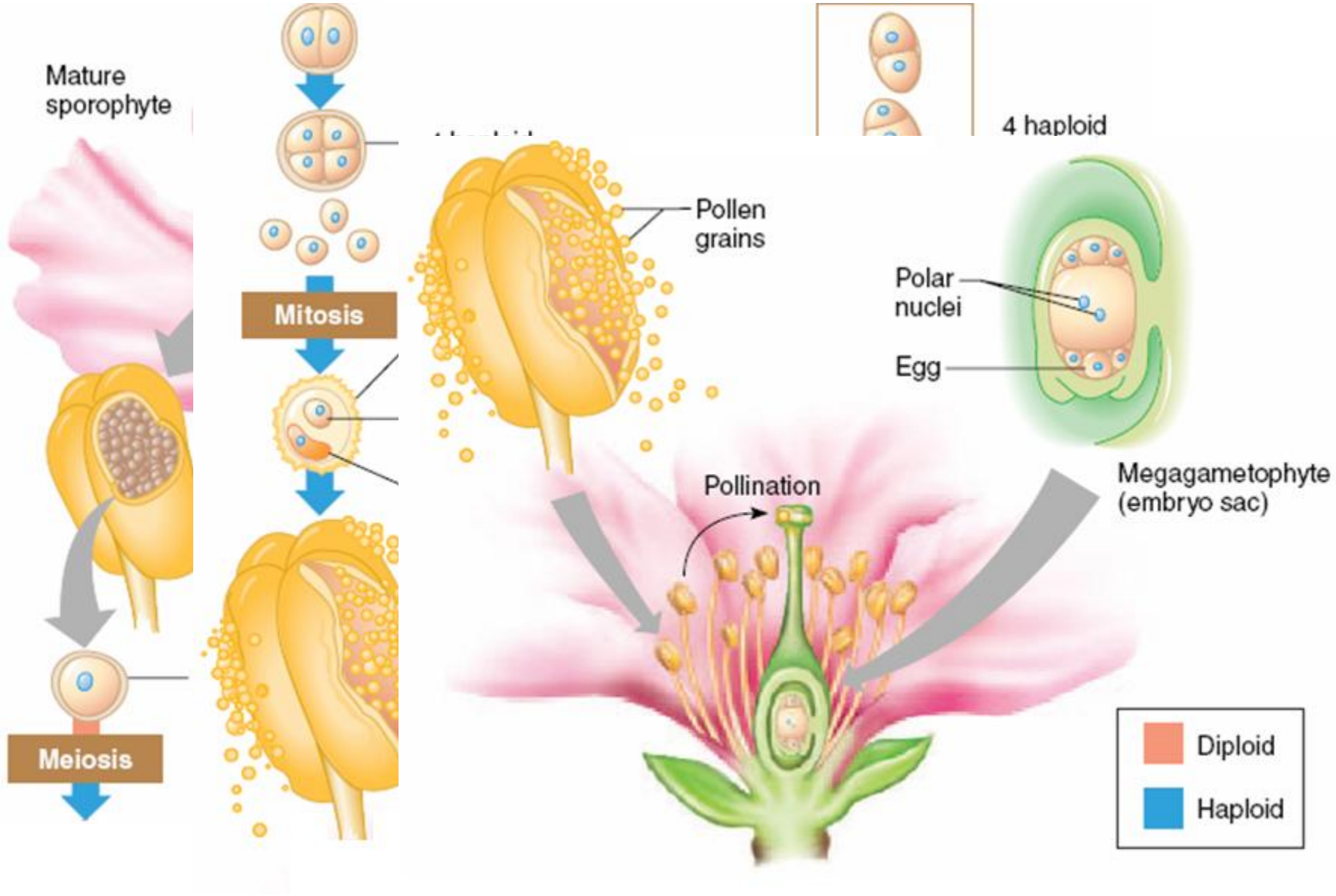


Pollen Grains





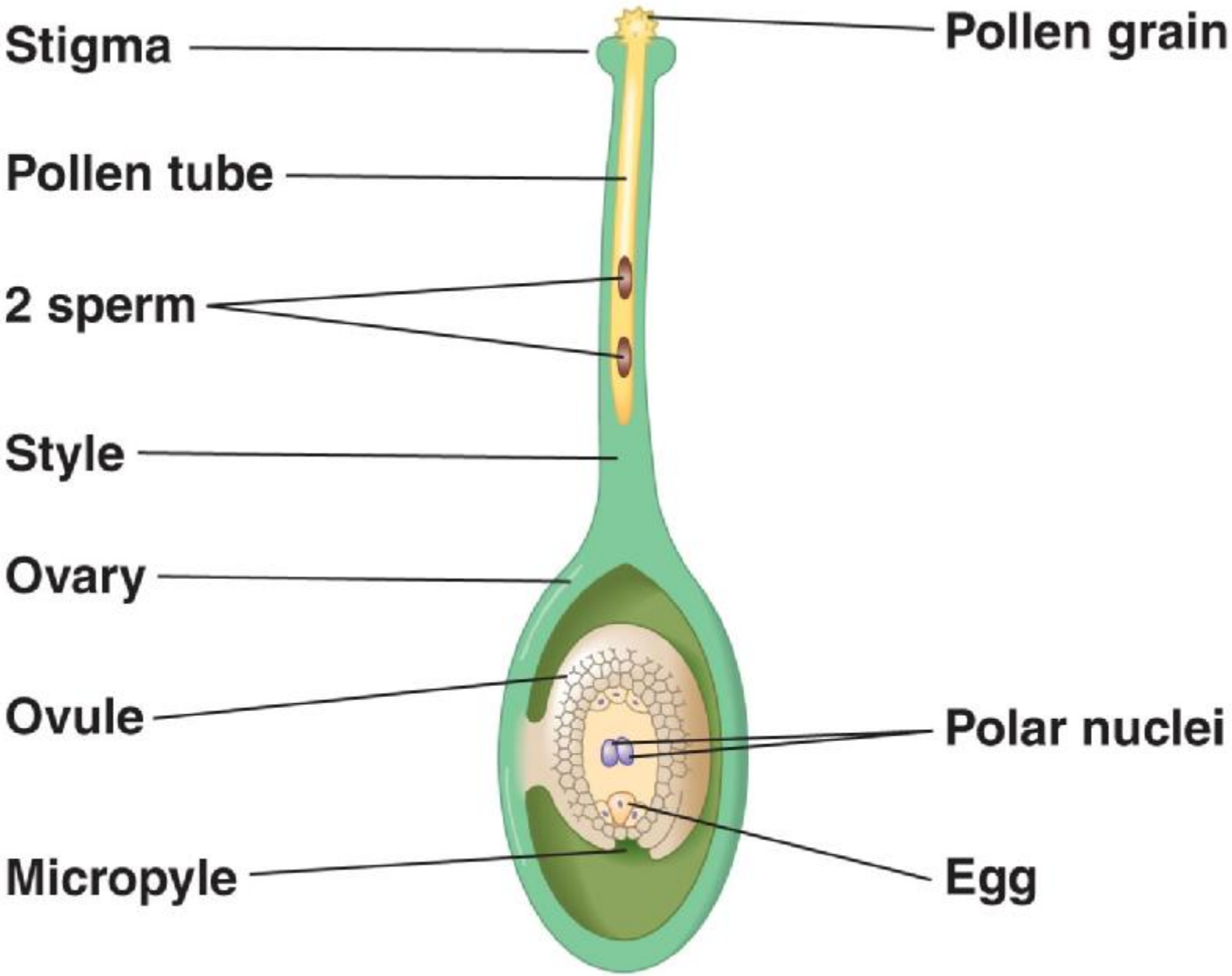
Gamete Formation



Pollination – Animals are pollinators

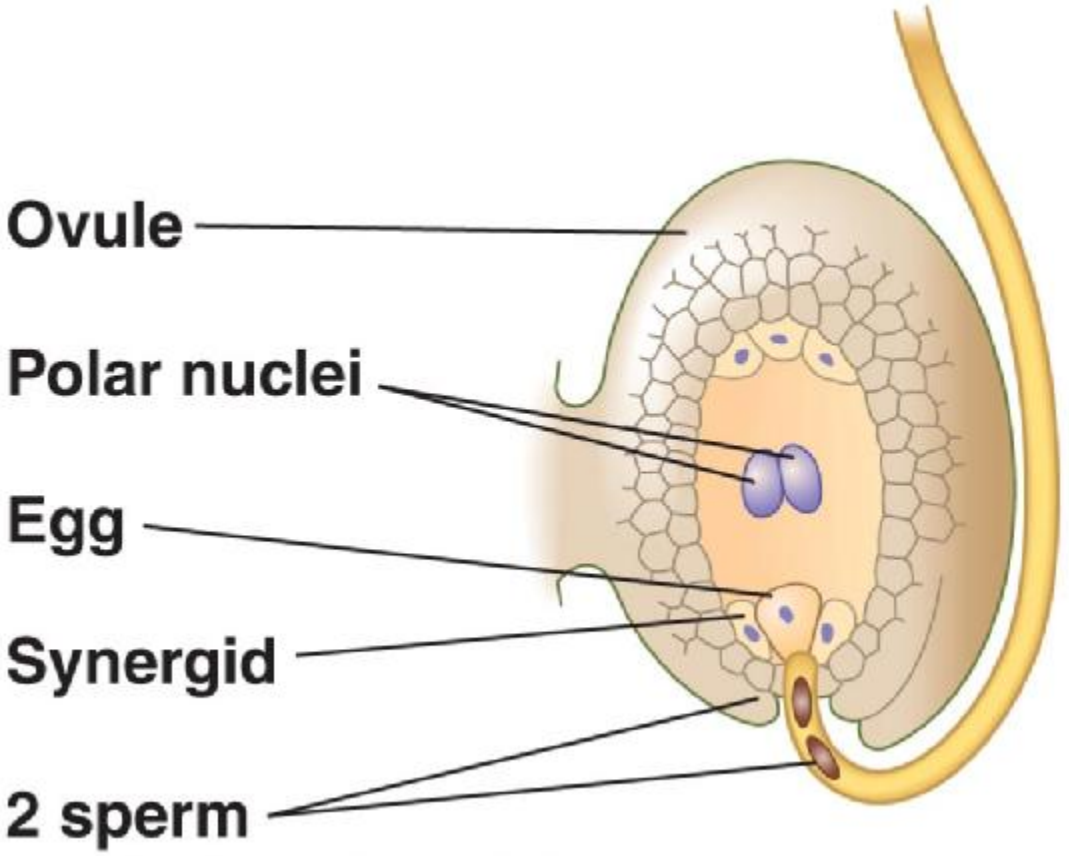
Double Fertilization

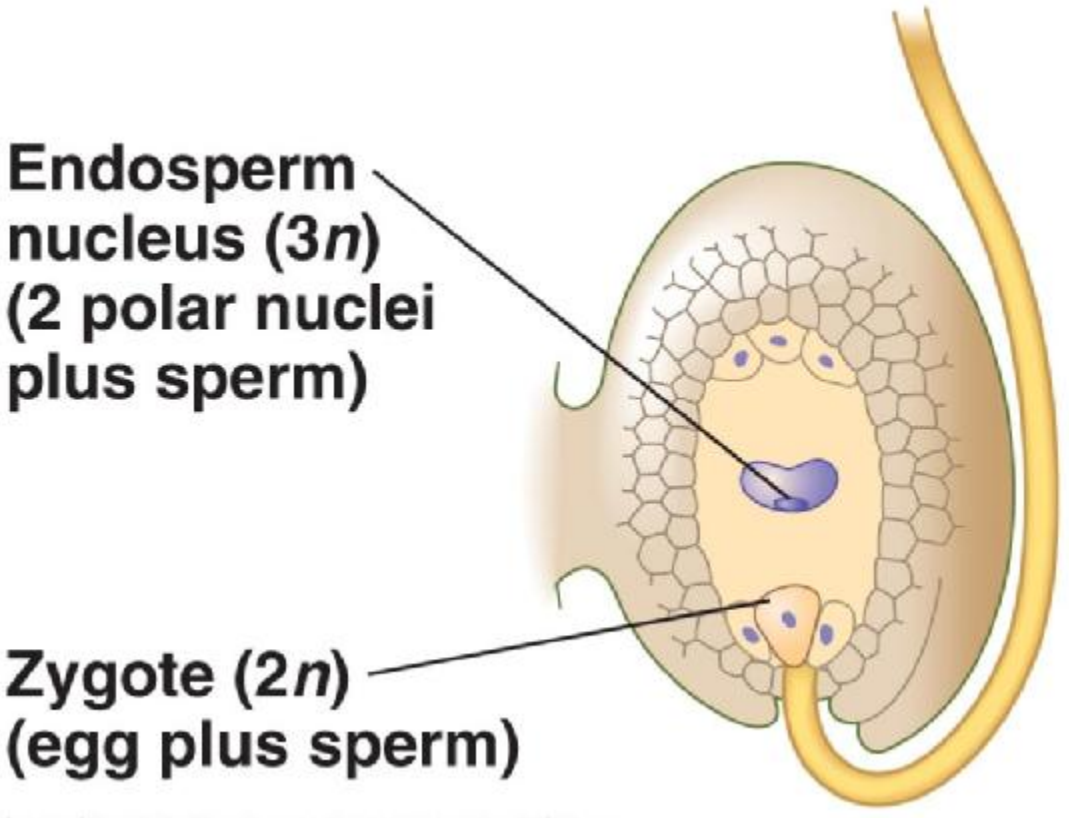
- After landing on a receptive stigma
  - A pollen grain germinates and produces a pollen tube that extends down between the cells of the style toward the ovary
- The pollen tube
  - Then discharges two sperm into the embryo sac


Stigma
Pollen grain
Pollen tube
2 sperm
Style
Ovary
Ovule
Polar nuclei
Micropyle
Egg

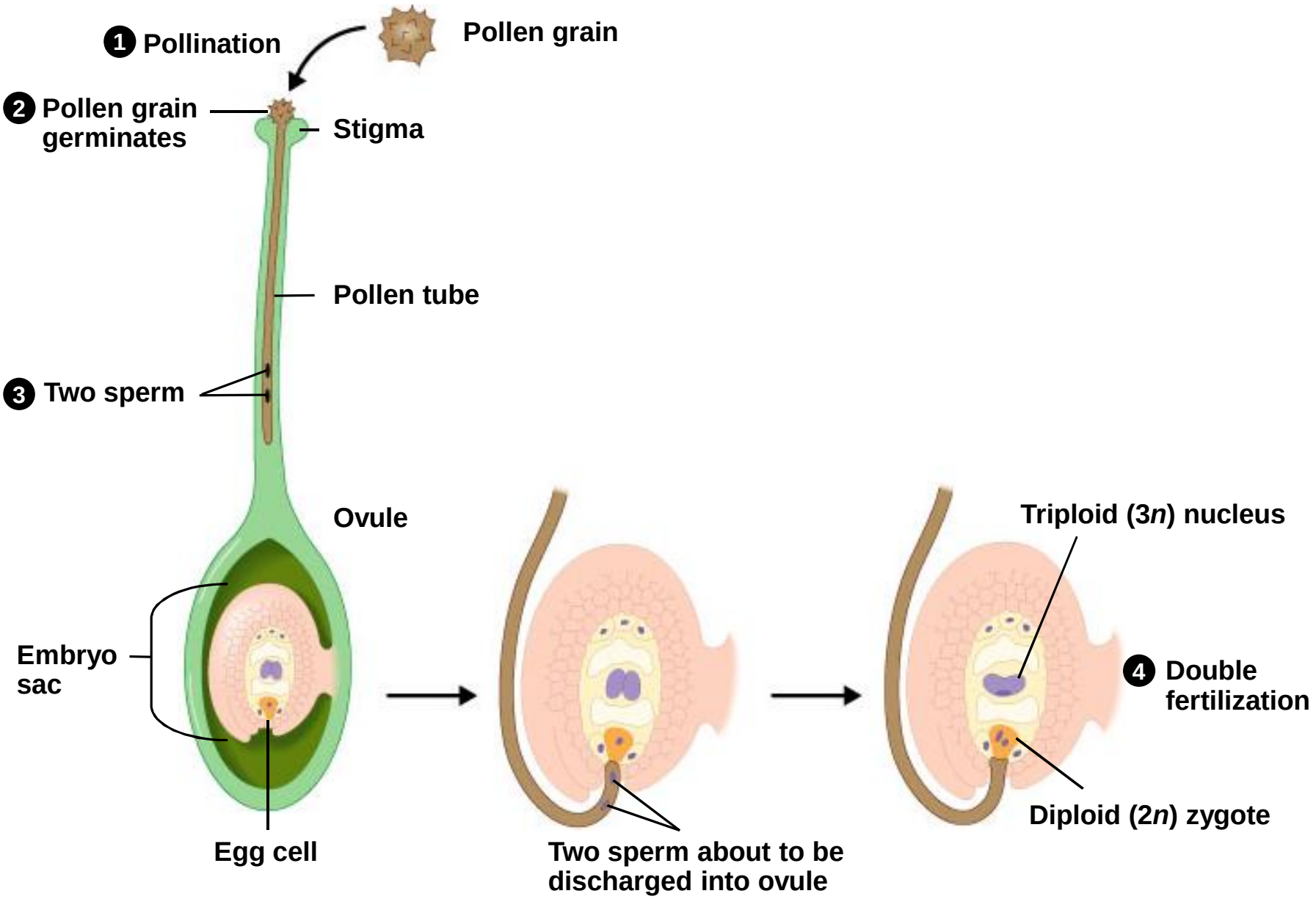
Double Fertilization

- In double fertilization
  - One sperm fertilizes the egg
  - The other sperm combines with the polar nuclei, giving rise to the food-storing endosperm


Ovule
Polar nuclei
Egg
Synergid
2 sperm


Endosperm nucleus (3n) (2 polar nuclei plus sperm)
Zygote (2n) (egg plus sperm)

Double Fertilization



Asexual Reproduction

Sexual Reproduction

Seeds and Fruits

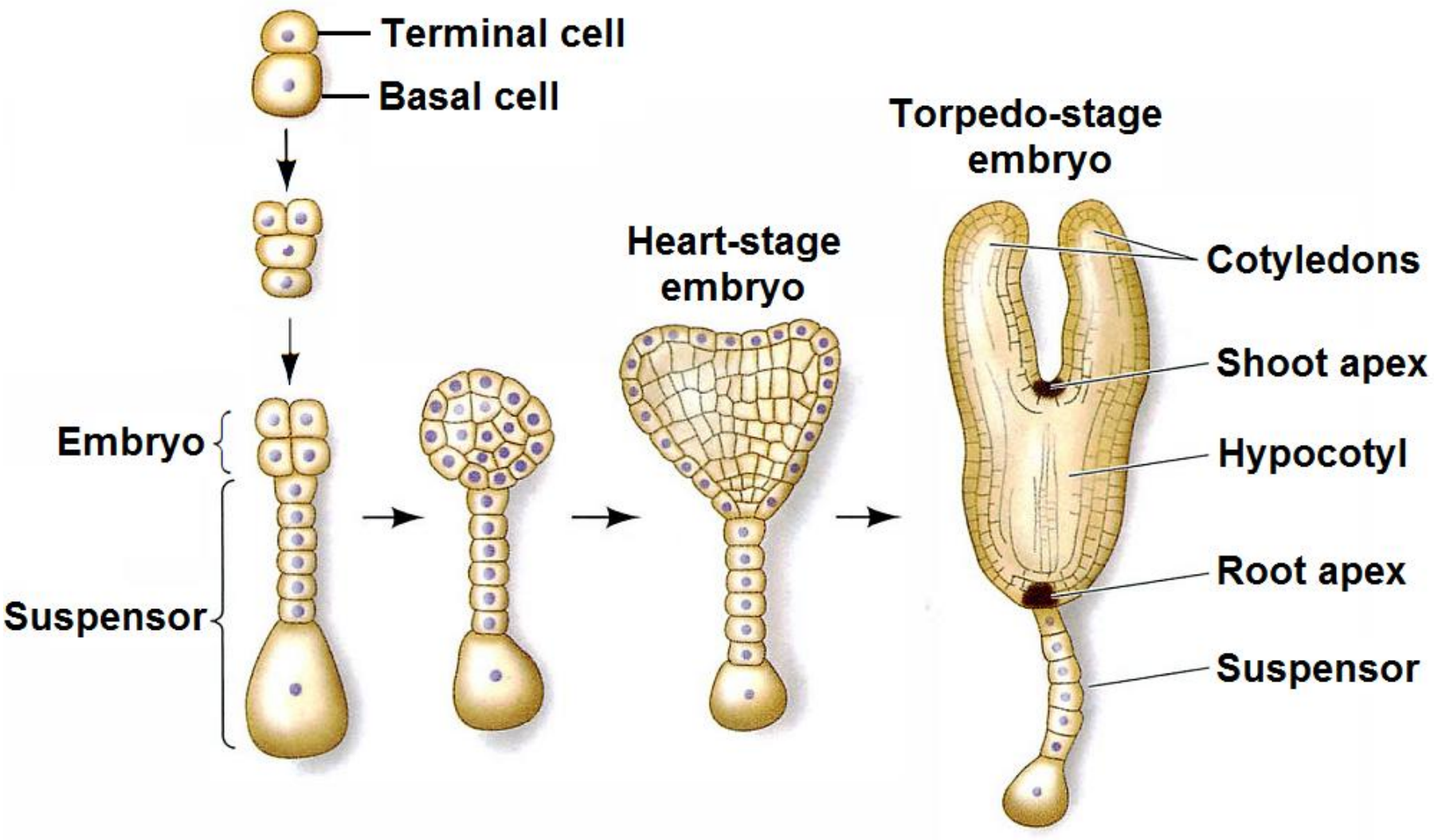
From Ovule to Seed

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

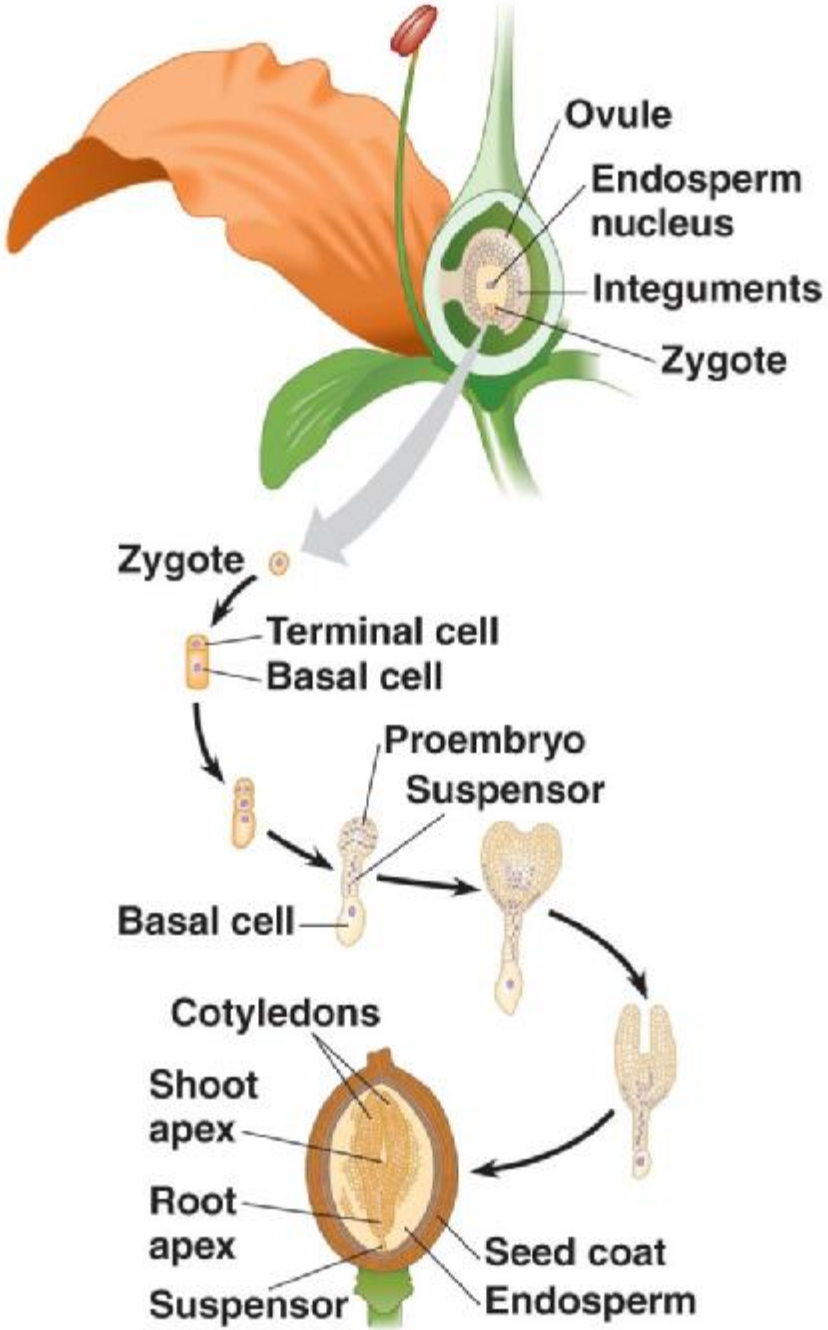
Endosperm (nộ̣i nhũ)Development

- Endosperm development
  - Usually precedes embryo development
- In most monocots and some eudicots
  - The endosperm stores nutrients that can be used by the seedling after germination
- In other eudicots
  - The food reserves of the endosperm are completely exported to the cotyledons

Embryo development in eudicot



- The result of embryonic development is a mature seed with a tough protective seed coat

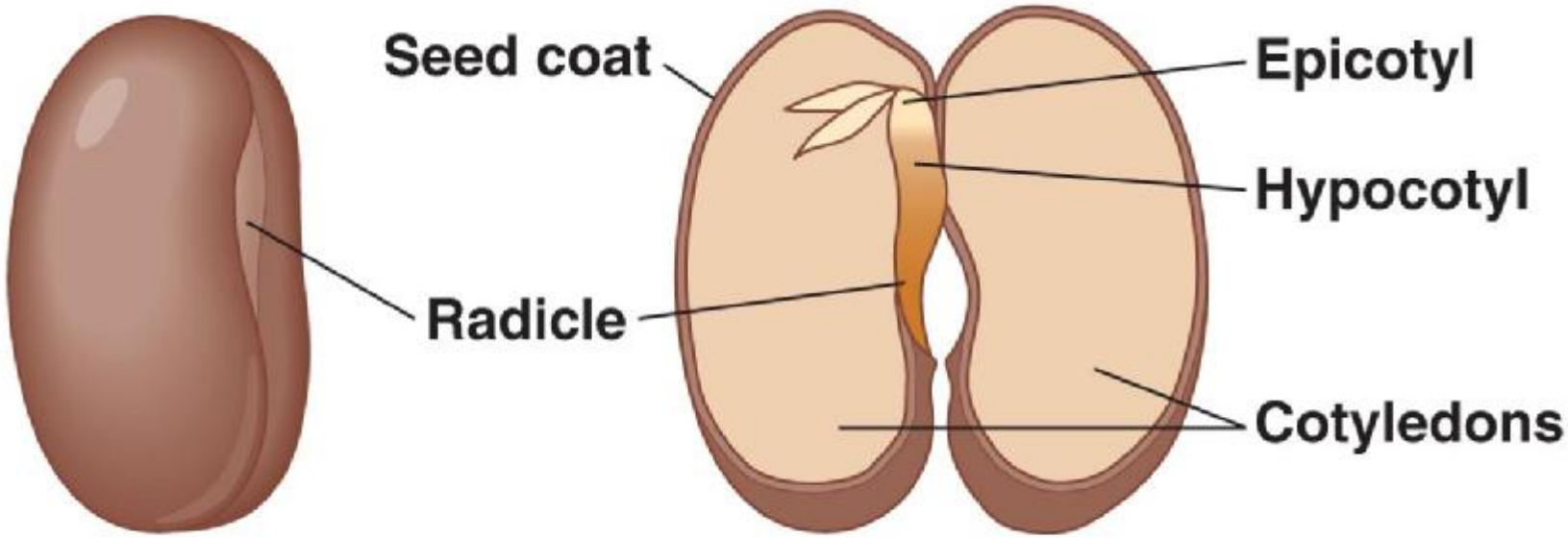


Structure of the Mature Seed

- The embryo and its food supply
  - Are enclosed by a hard, protective seed coat

Embryos in Dicots and Monocots

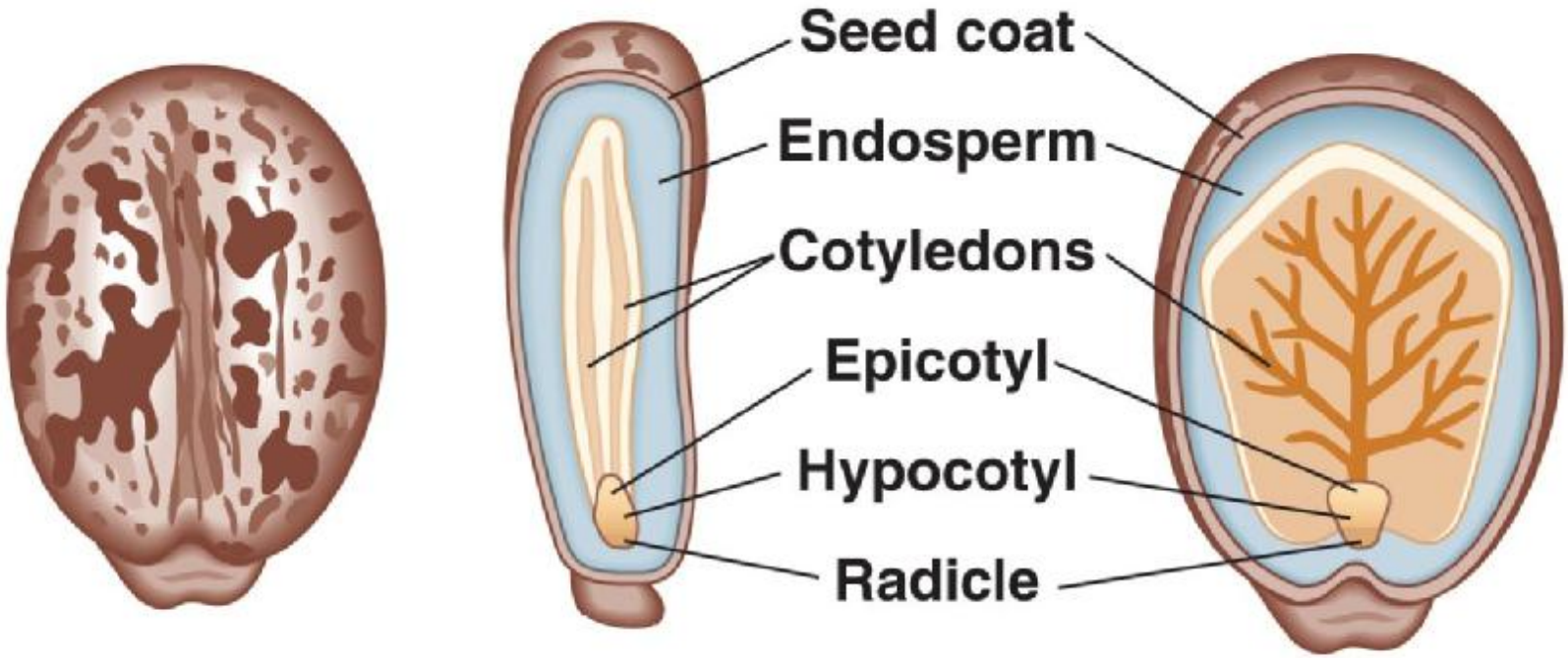
- In a common garden bean, a eudicot
  - The embryo consists of the hypocotyl, radicle, and thick cotyledons



(a) Common garden bean, a eudicot with thick cotyledons

Embryos in Dicots and Monocots

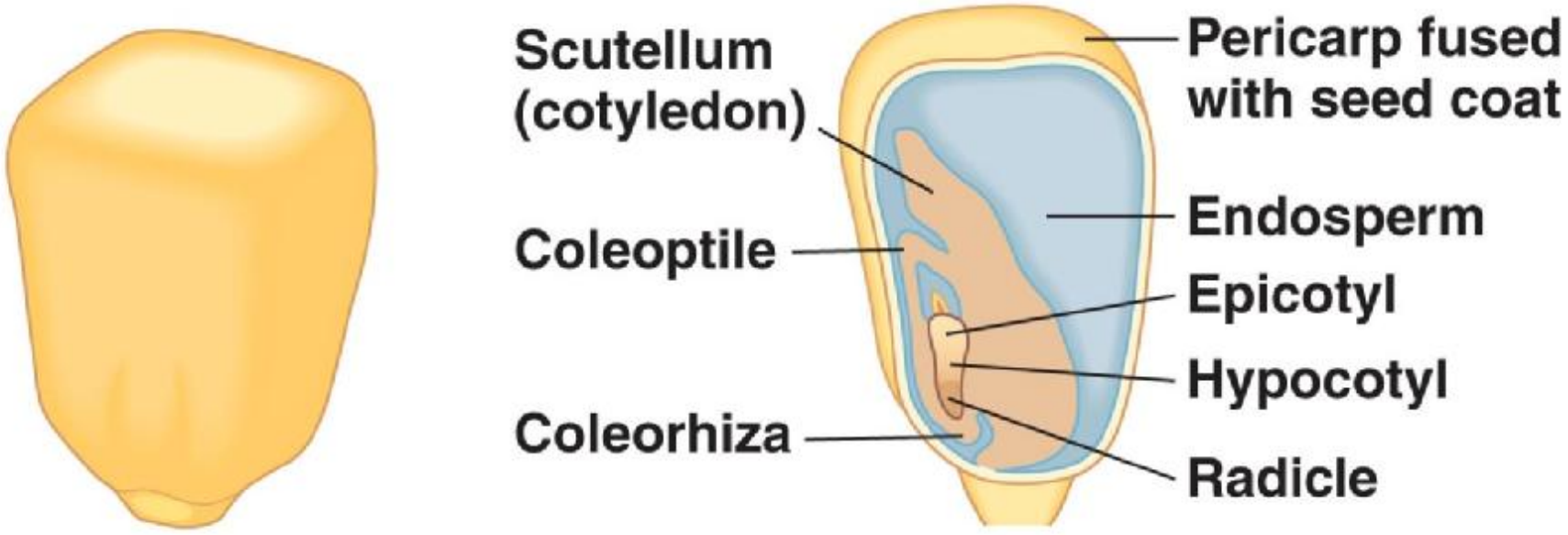
- The seeds of other eudicots, such as castor beans
  - Have similar structures, but thin cotyledons



(b) Castor bean, a eudicot with thin cotyledons

Embryos in Dicots and Monocots

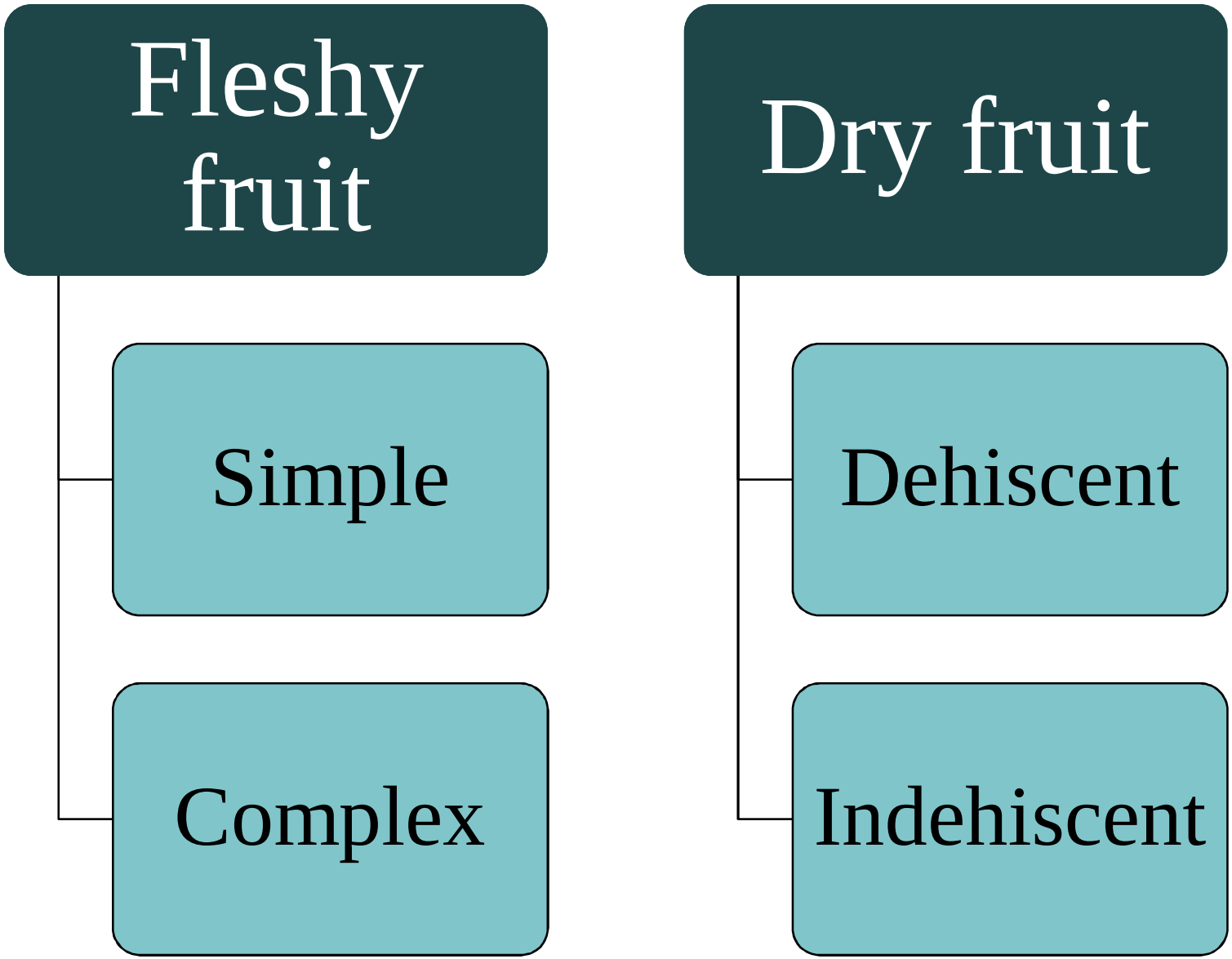
- The embryo of a monocot
  - Has a single cotyledon, a coleoptile, and a coleorhiza

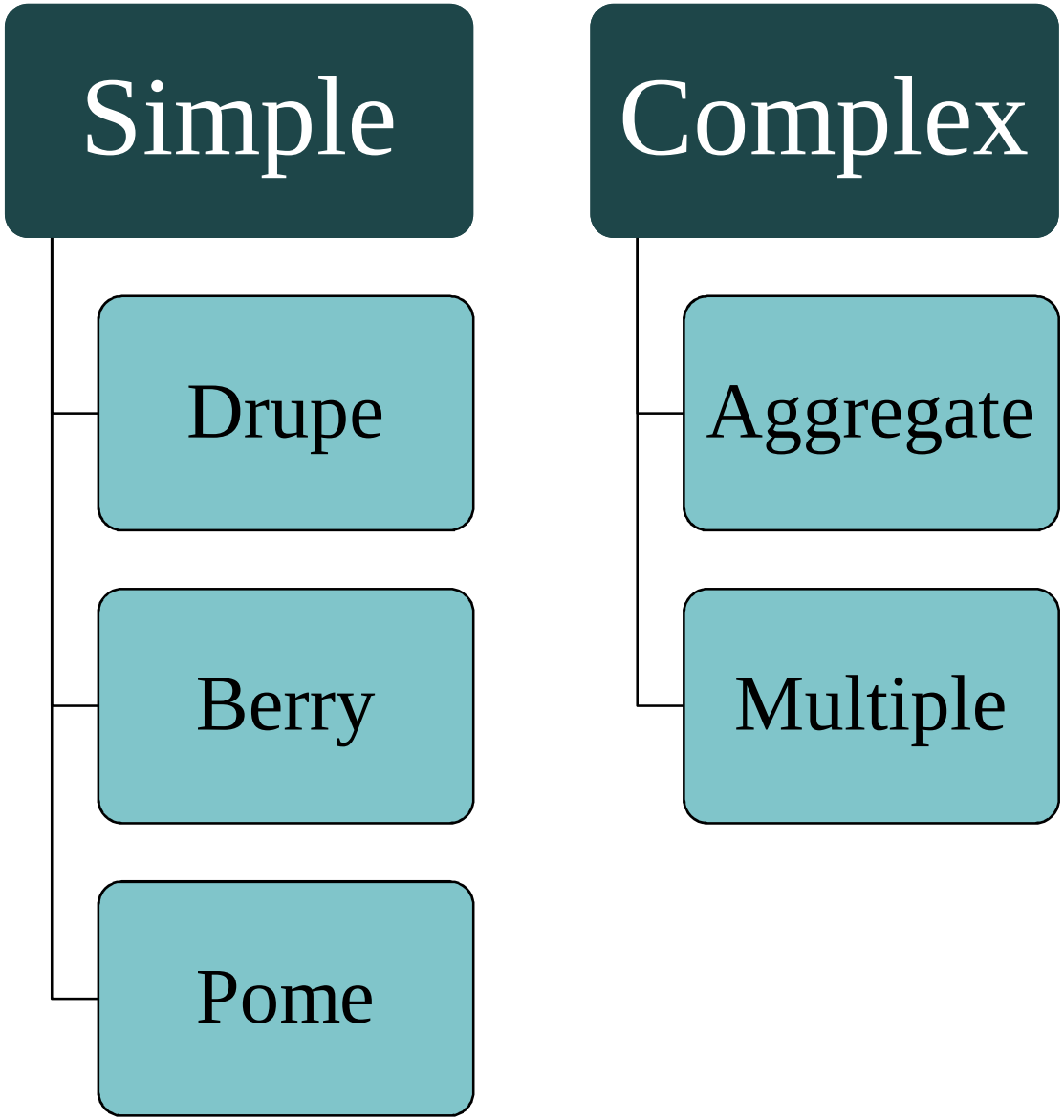


(c) Maize, a monocot

Fruit formation

- A fruit
  - Develops from the ovary
  - Protects the enclosed seeds
  - Aids in the dispersal of seeds by wind or animals


Fleshy fruit
Simple
Complex
Dry fruit
Dehiscent
Indehiscent


Simple
Drupe
Berry
Pome
Complex
Aggregate
Multiple

Types of Fruits

Fleshy fruits	Characteristics	Examples
Simple	One or more united carpels	
Drupe	Fleshy fruit; hard pit; one or more carpels with single seed each	Olive Cherry Peach Plum Coconut
Berry	One or more carpels, each with many seeds; inner part fleshy	Grape Tomato Pepper Eggplant
Pome	Tough core is derived from carpel walls; pulp derived from ovary wall and enlarged receptacle (hypanthium)	Apple Pear

Complex	Multiple separate carpels		
Aggregate	Derives from one flower with many separate carpels	Blackberry Strawberry Raspberry Magnolia	
Multiple	Develops from tight clusters of flowers whose ovaries fuse as the fruit develops	Pineapple	

Dry fruits	Characteristics	Examples	
Dehiscent	Mature fruit splits and releases seeds	Bean Pea Radish Milkweed	
Indehiscent	Mature fruit remains around seed(s)		
	Hard, thick pericarp	Hickory Acorn Chestnut	
	Thin pericarp	Parsley Carrot Maple Sunflower	

Peach

Plum

Plum

Eggplant

Blackberry

Strawberry

Raspberry

Mulberry = dâu tằm

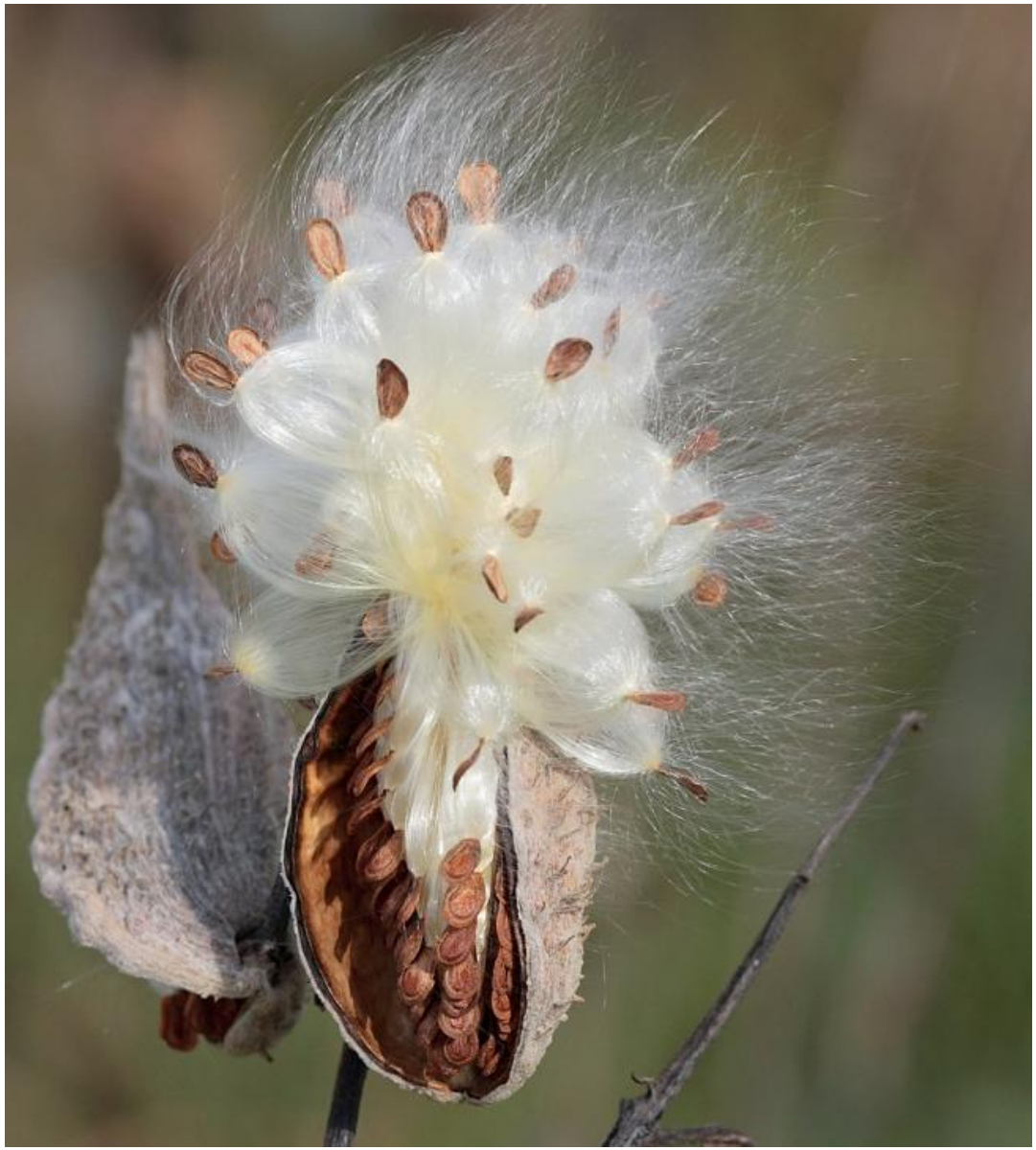
Magnolia


Magnolia grandiflora
Magnolia Seed "Cone"
Jack Scheper
© 2002 Floridata.com

Custard apple

Pineapple

Milkweed



Bastard poom

Bastard poom

Durian

Durian

Pea

Silk cotton tree

Hickory = mại châu

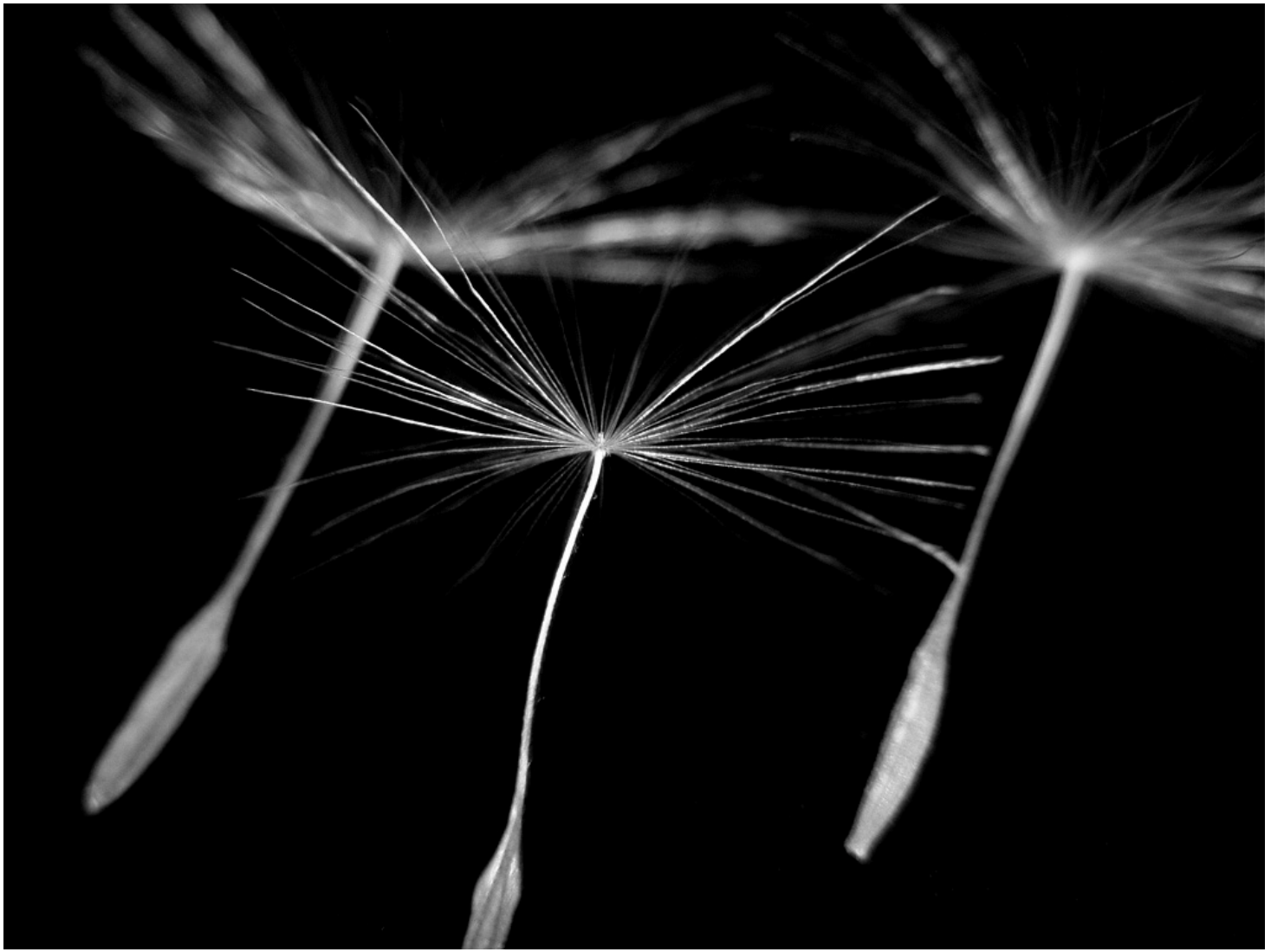
Acorn

Chesnut

Dispersal by wind

- Dandelion seed

- dandelion seed parachutes



Dispersal by wind

- Winged fruit of maple

Dispersal by wind

- Winged fruit of Dipterocarp

Dispersal by water

Dispersal by animal

- Spines on the fruits of puncture vine (*Tribulus terrestris*)

Dispersal by animal

- In feces

Dispersal by animal

- By ant

Dispersal by animal

- By bird

Dispersal by animal

- By bat

Dispersal by animal

- By mammal

Seed Germination

- As a seed matures
  - It dehydrates and enters a phase referred to as dormancy

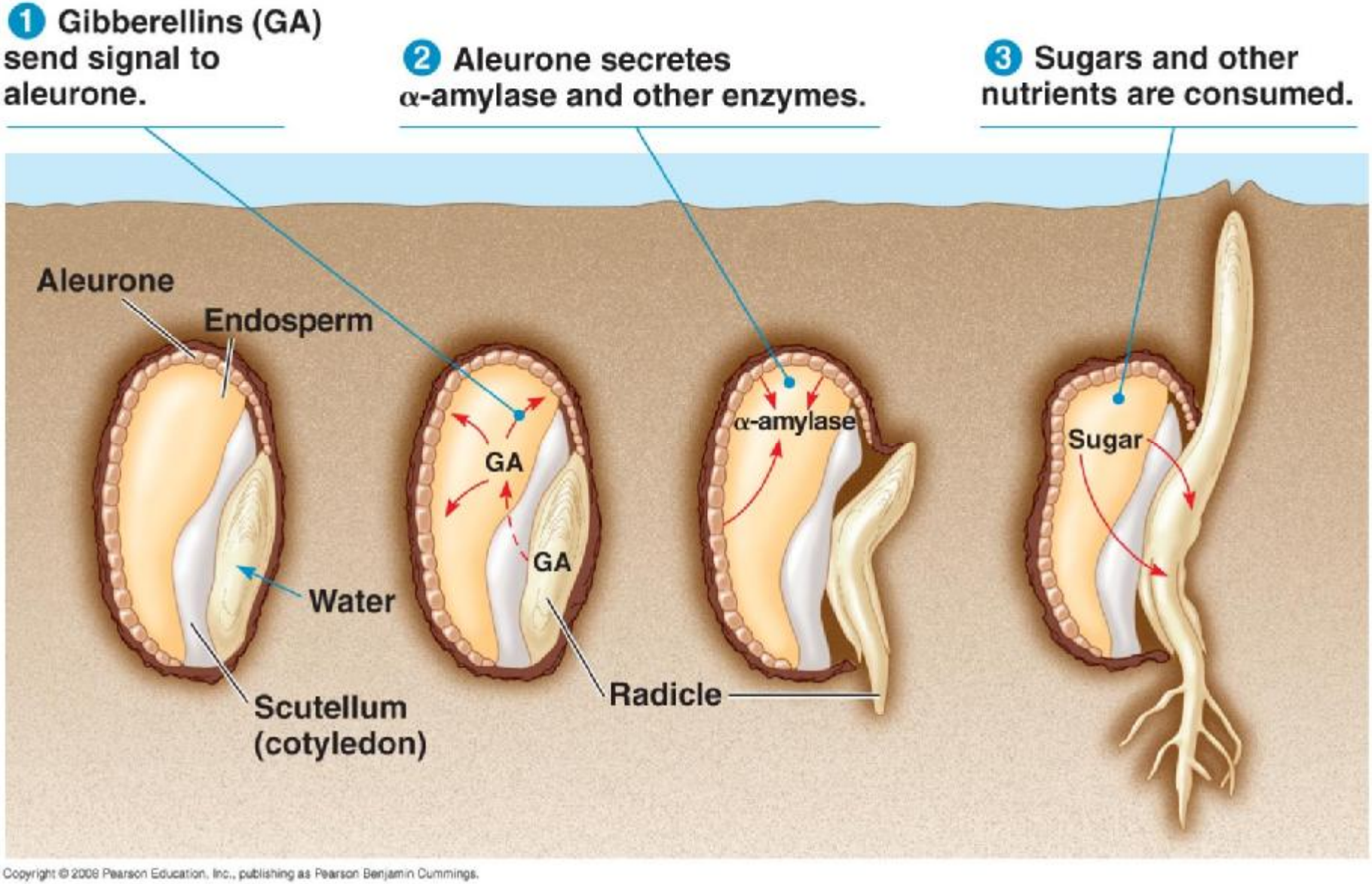
Seed Dormancy: Adaptation for Tough Times

- 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

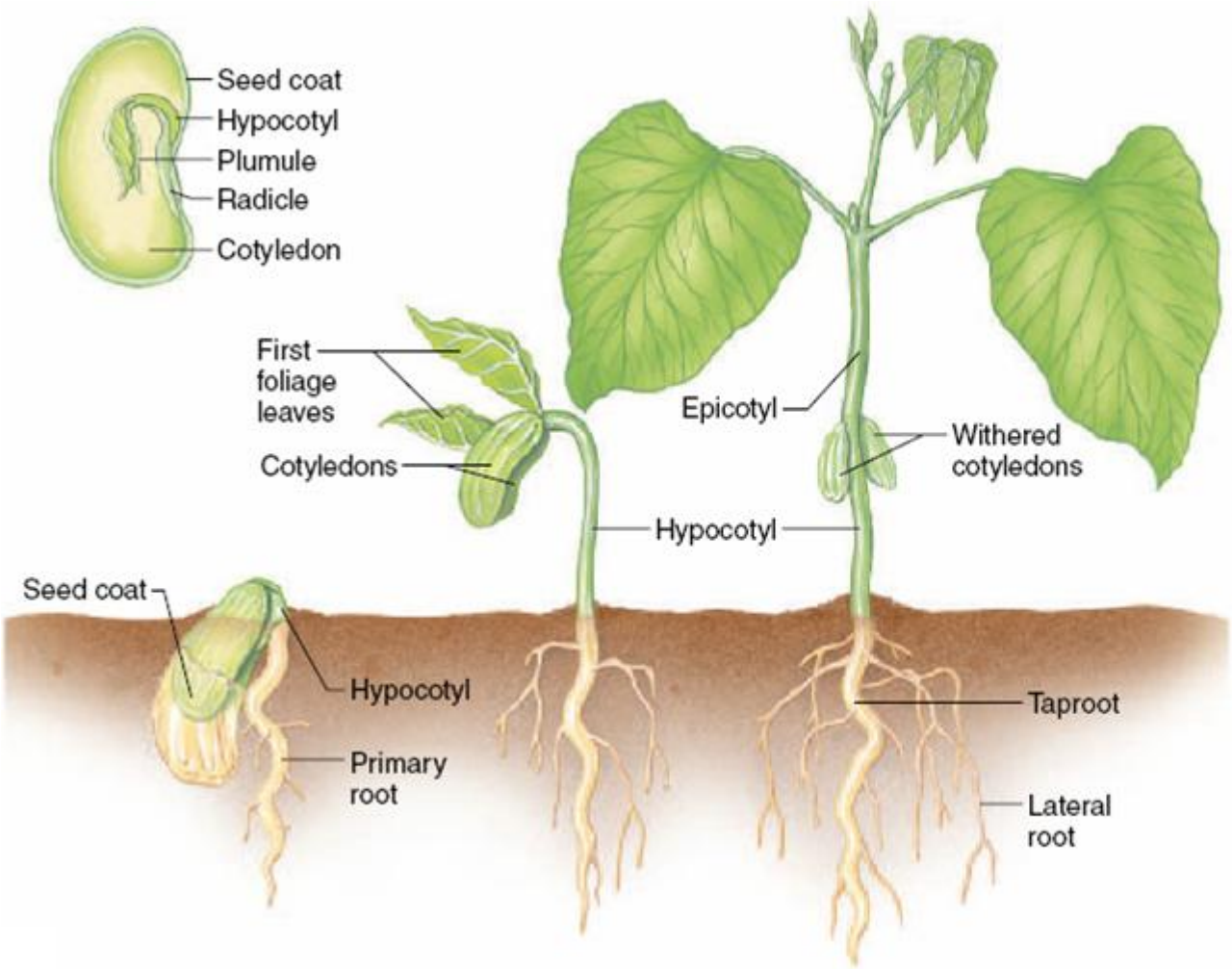
- Germination of seeds depends on the physical process called imbibition
  - The uptake of water due to low water potential of the dry seed

From Seed to Seedling



- The radicle
  - Is the first organ to emerge from the germinating seed
- In many eudicots
  - A hook forms in the hypocotyl, and growth pushes the hook above ground

Germination



- Monocots
  - Use a different method for breaking ground when they germinate
- The coleoptile
  - Pushes upward through the soil and into the air

Germination