Angiosperms

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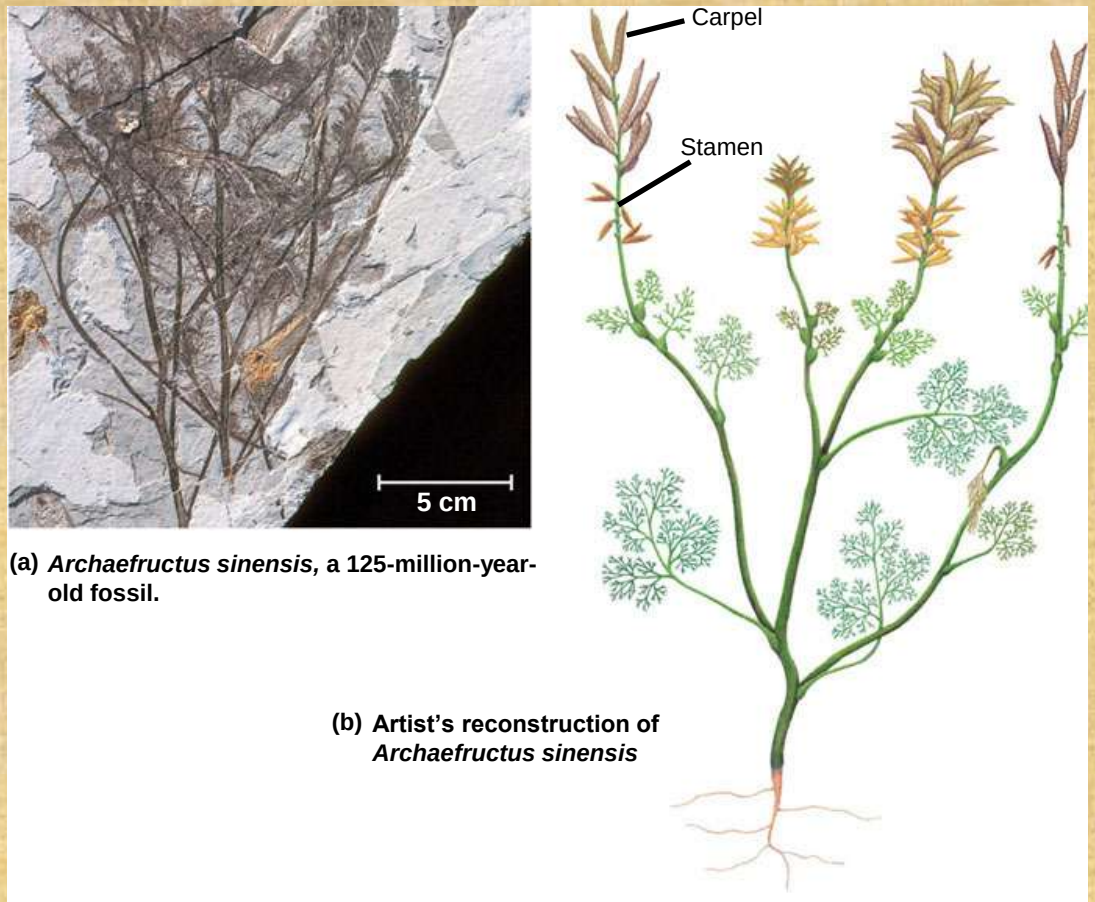
Magnoliophyta

Fossil Angiosperms

- Primitive fossils of 125-million-year-old angiosperms
  - Display both derived and primitive traits



(a) ***Archaefructus sinensis*, a 125-million-year-old fossil.**

(b) **Artist's reconstruction of *Archaefructus sinensis***

Angiosperm Evolution

- Clarifying the origin and diversification of angiosperms
  - Poses fascinating challenges to evolutionary biologists
- Angiosperms originated at least 140 million years ago
  - And during the late Mesozoic, the major branches of the clade diverged from their common ancestor

Angiosperm Diversity

- The two main groups of angiosperms
  - Are monocots and dicots
- Basal angiosperms
  - Are less derived and include the flowering plants belonging to the oldest lineages
- Magnoliids
  - Share some traits with basal angiosperms but are more closely related to monocots and eudicots

- Exploring Angiosperm Diversity

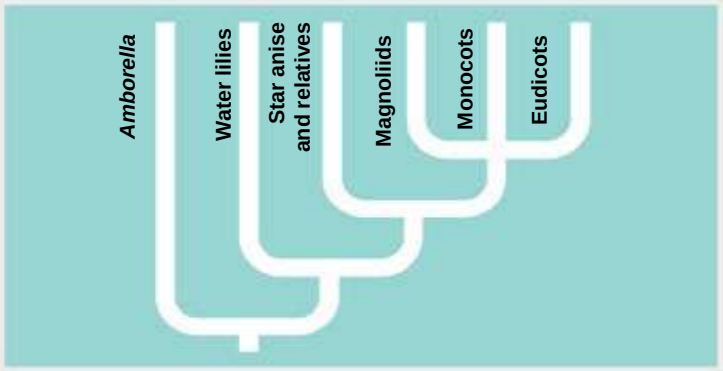
BASAL ANGIOSPERMS

Amborella trichopoda

Water lily *(Nymphaea "Rene Gerard")*

Star anise *(Illicium floridanum)*

HYPOTHETICAL TREE OF FLOWERING PLANTS



MAGNOLIIDS

Southern magnolia (*Magnolia grandiflora*)

Magnolia virginiana flower

Kindom Plantae

Division Magnoliophyta

Class Magnoliopsida - Dicots
Class Liliopsida - Monocots

Class Magnoliposida

The dicotyledons

Class Liliopsida

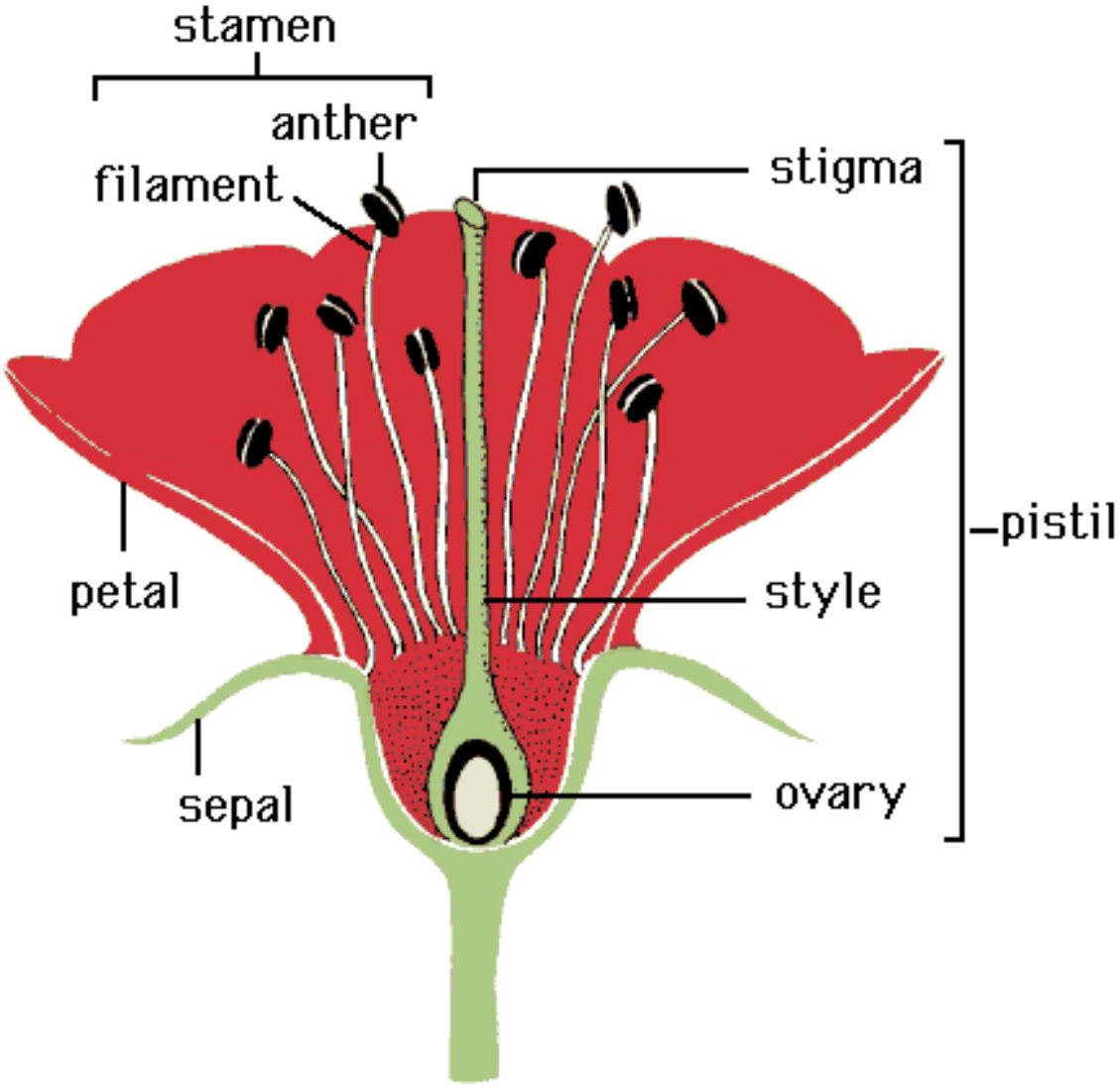
The monocotyledons

Characteristics of Angiosperms

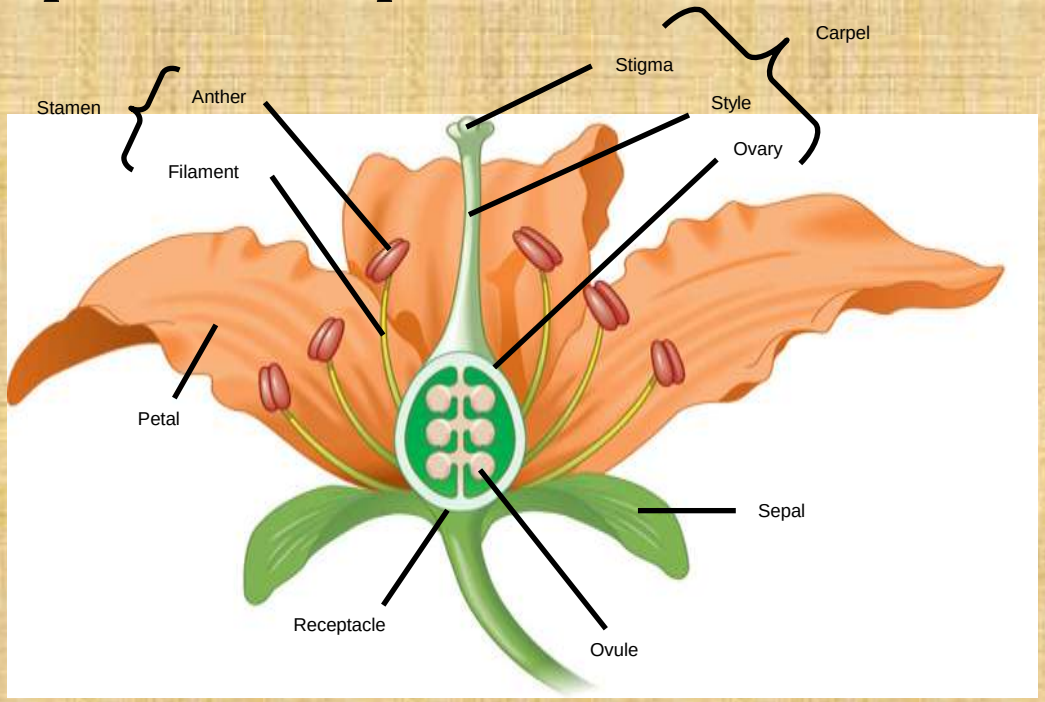
- The key adaptations in the evolution of angiosperms
  - Are flowers and fruits

Flowers

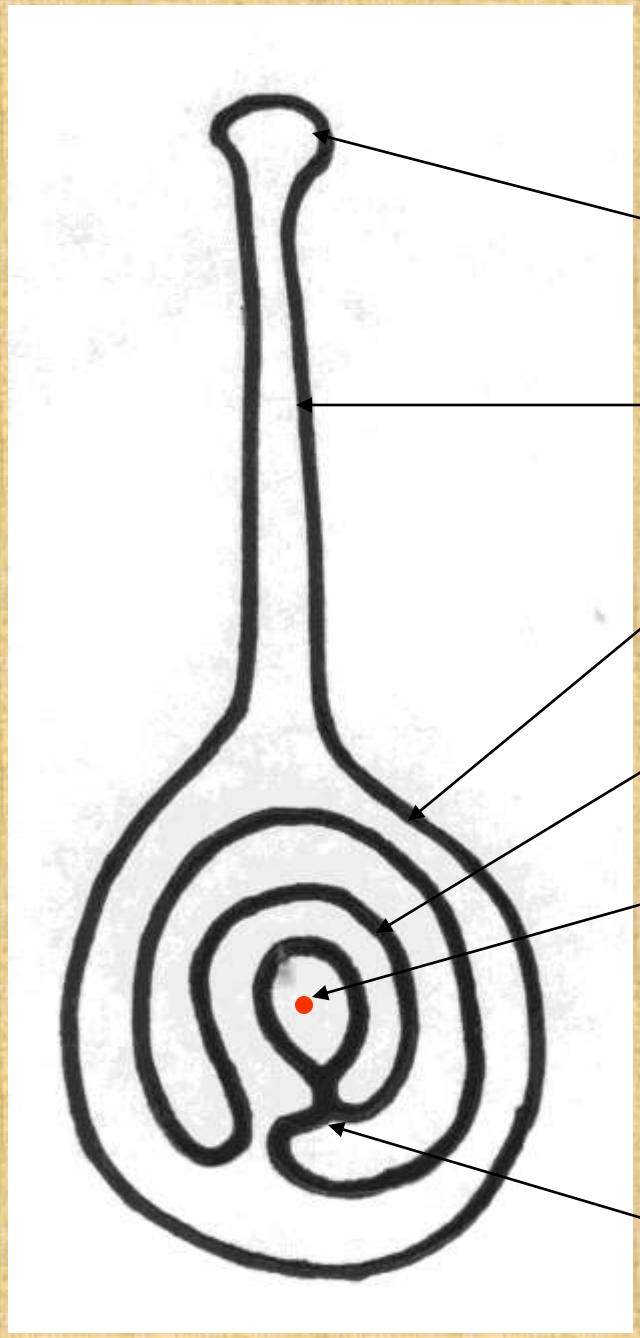
- The flower
  - Is an angiosperm structure specialized for sexual reproduction

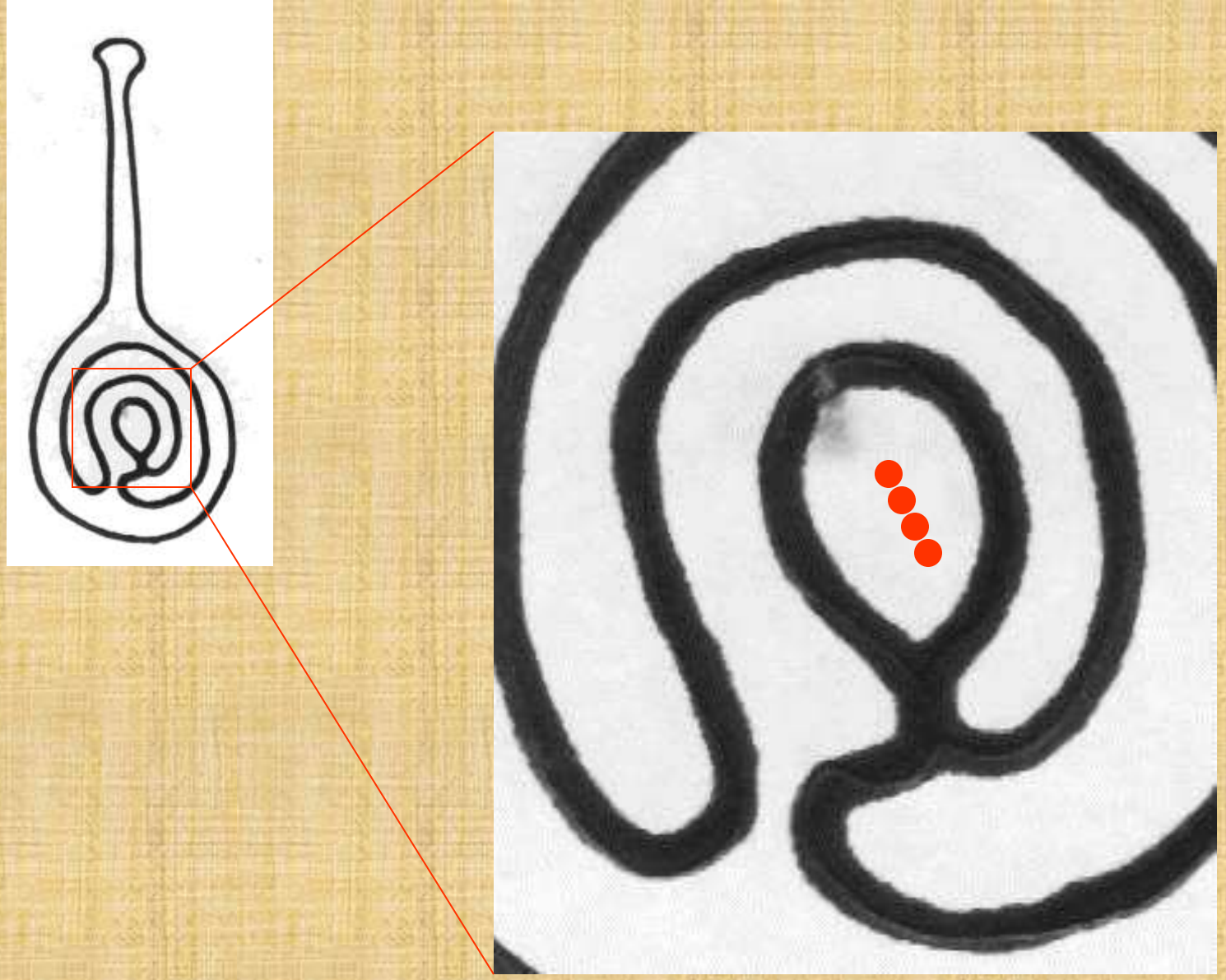

stamen
anther
filament
stigma
pistil
petal
style
sepal
ovary

- A flower is a specialized shoot with modified leaves
  - Sepals, which enclose the flower
  - Petals, which are brightly colored and attract pollinators
  - Stamens, which produce pollen
  - Carpels, which produce ovules

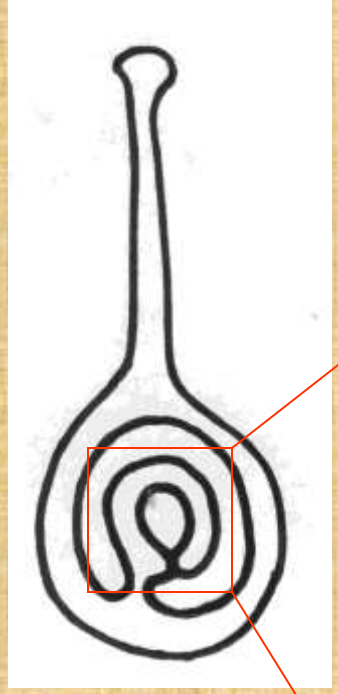


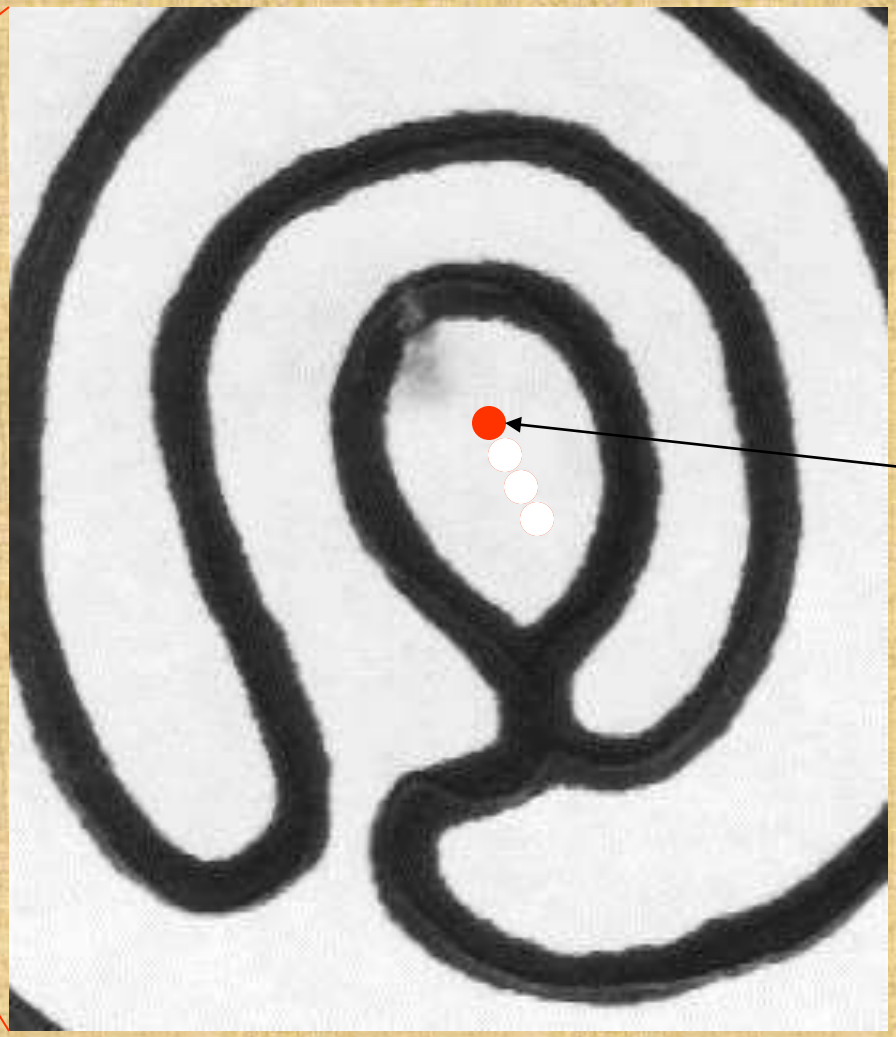
The carpel





Creation of the megaspore





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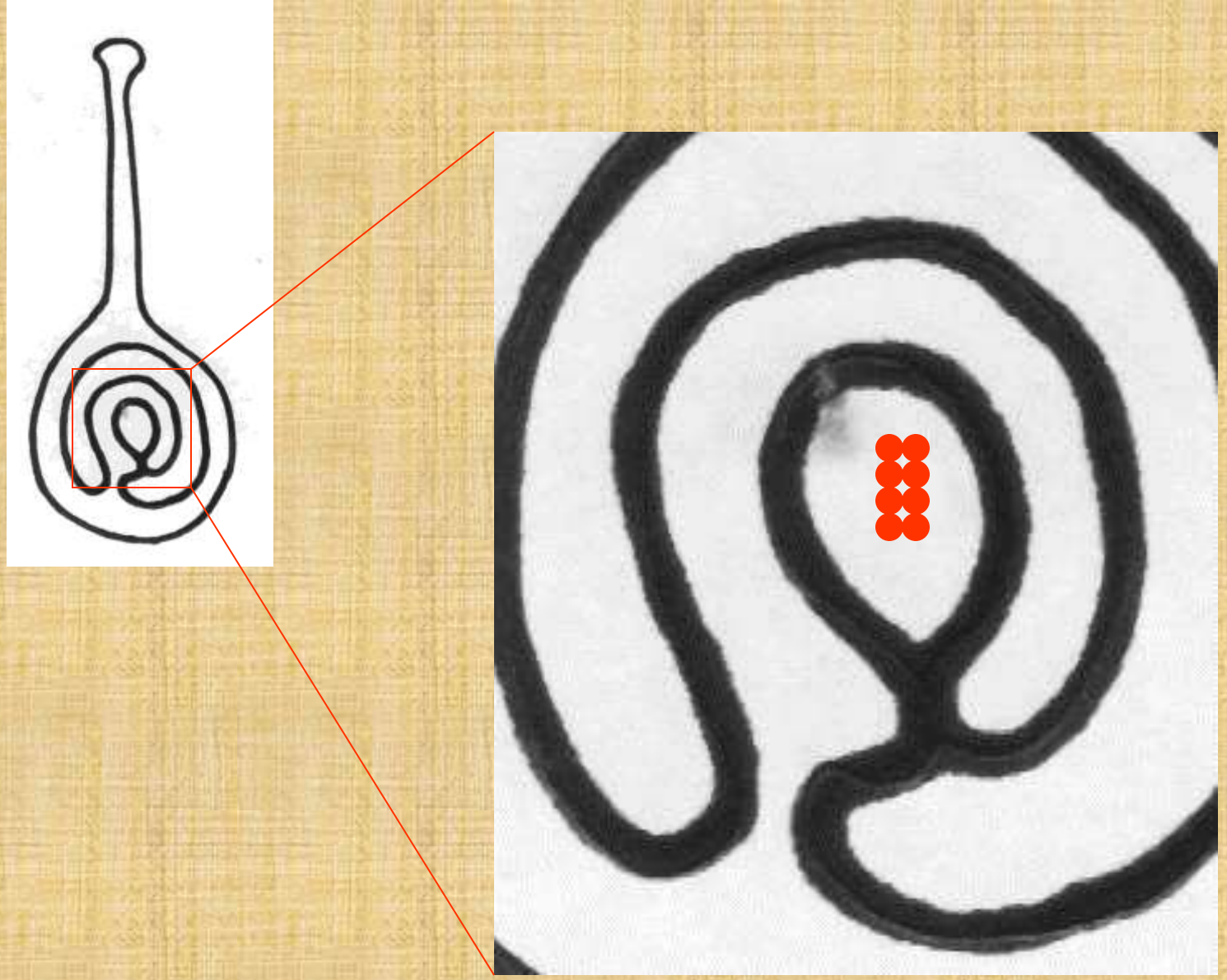
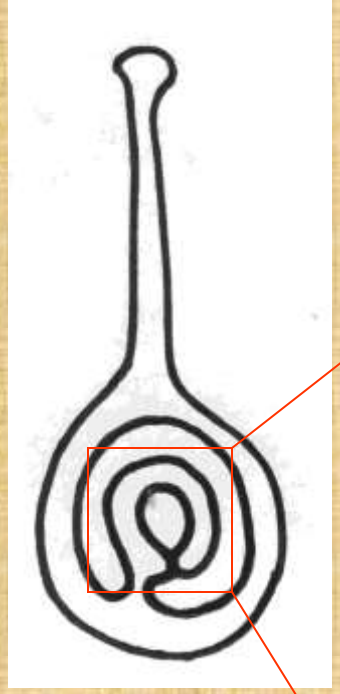
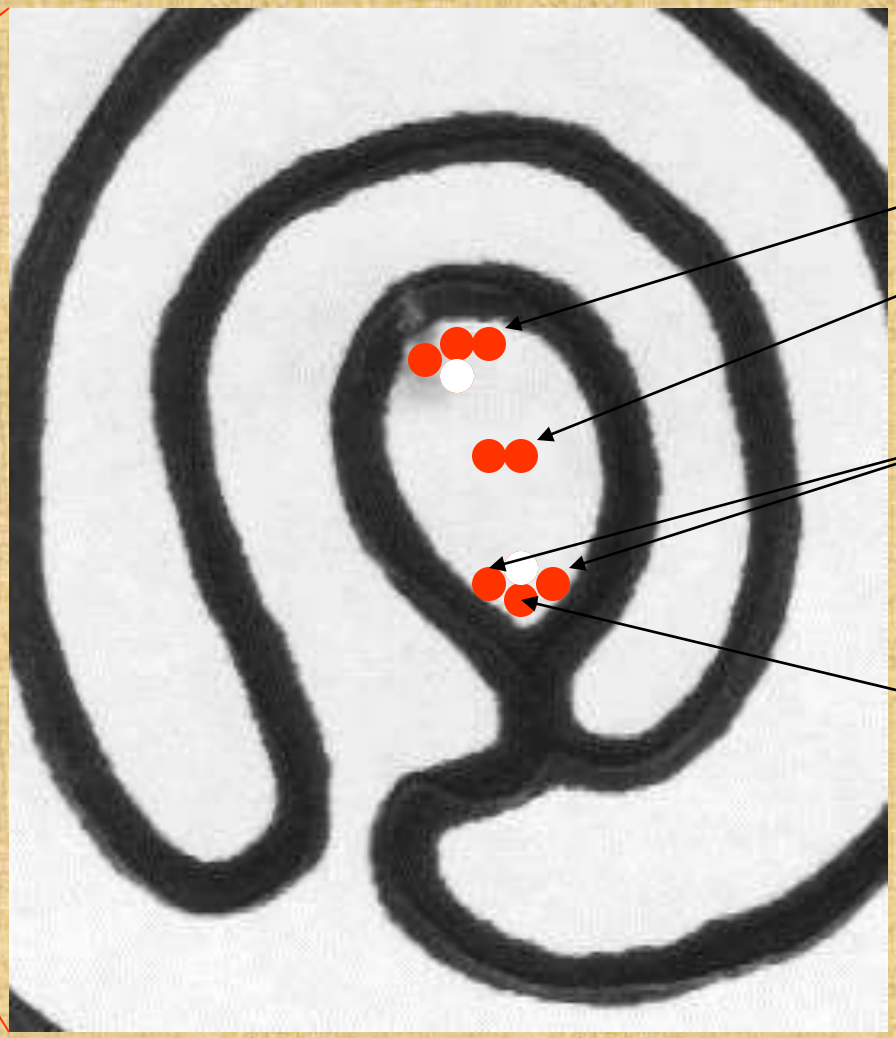
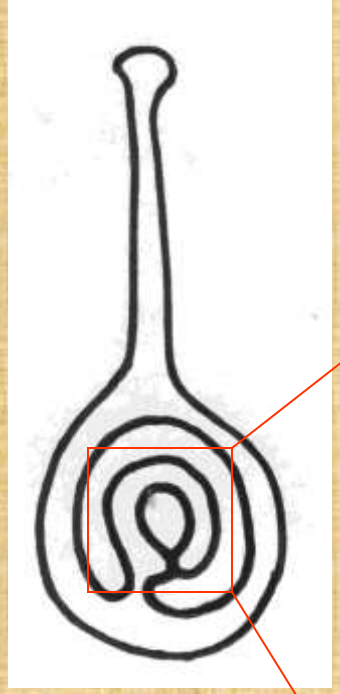


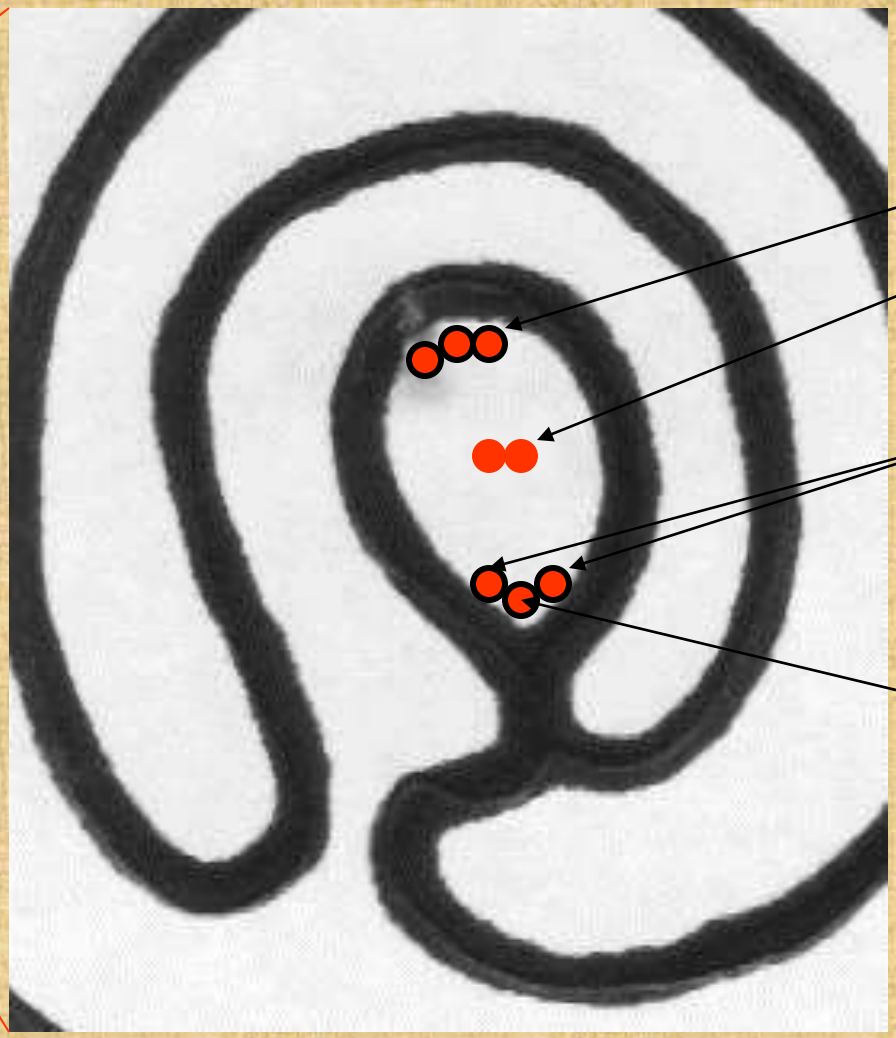
Creation of the female gametophyte





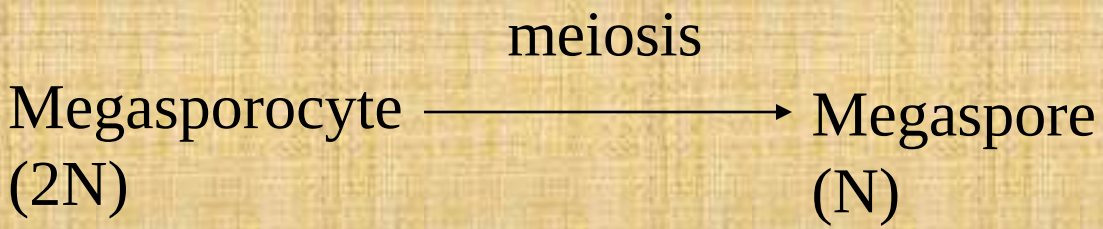
Creation of the female gametophyte

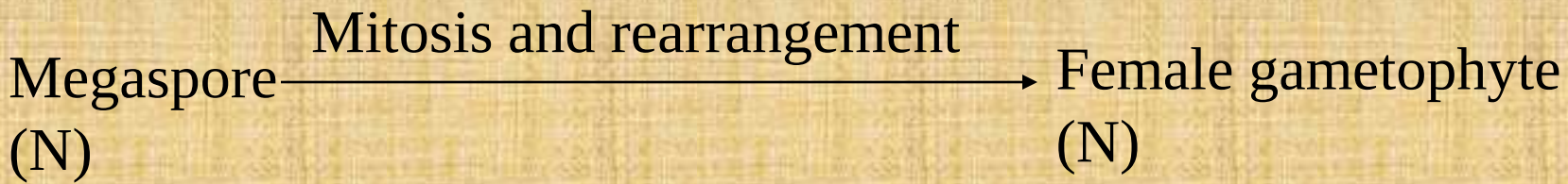




Mature female gametophyte = embryo sac

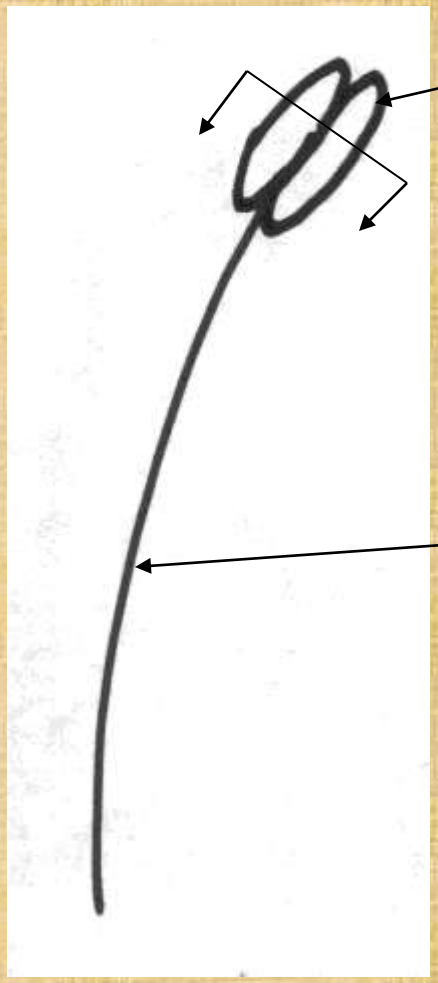
Review:

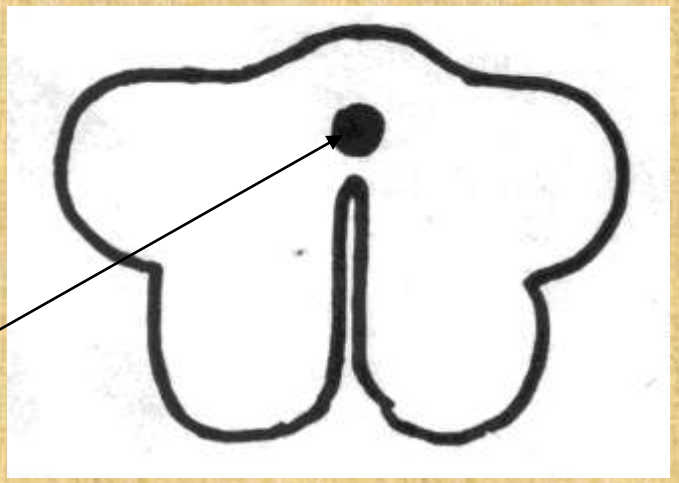


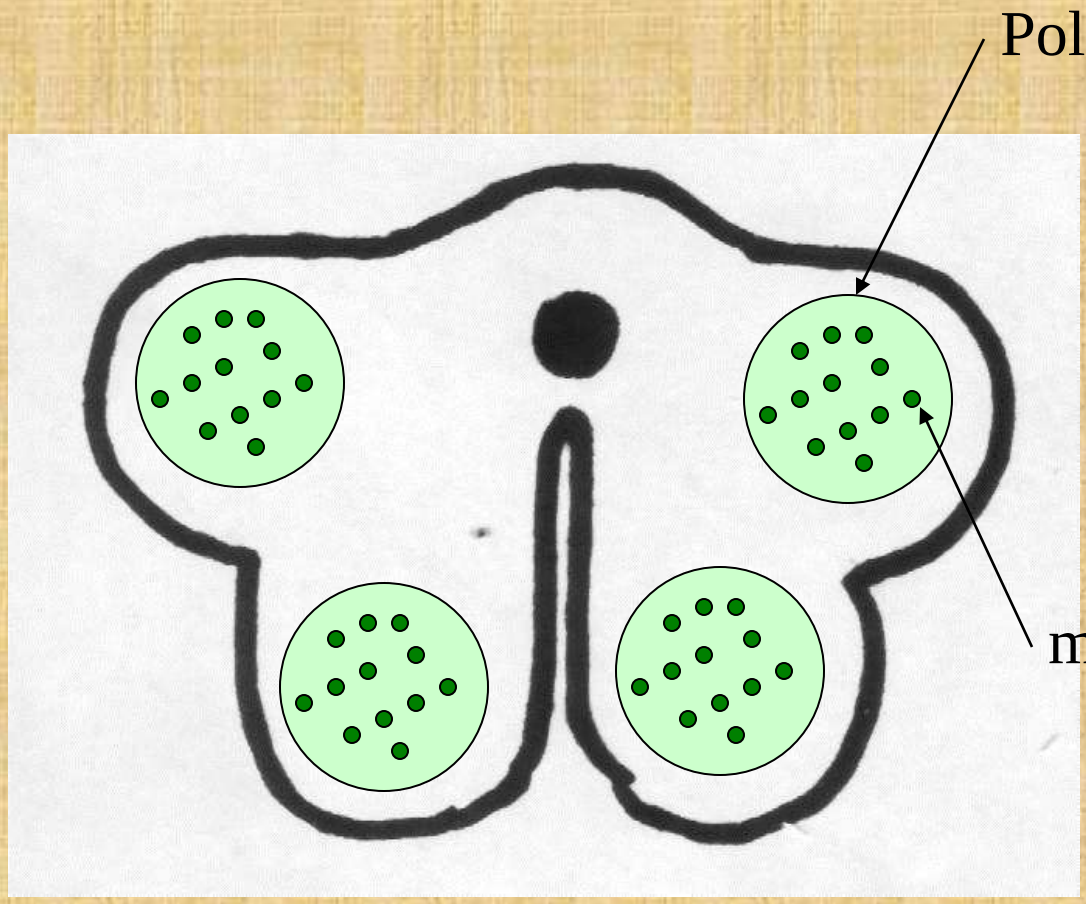


Female gametophyte contains the egg cell

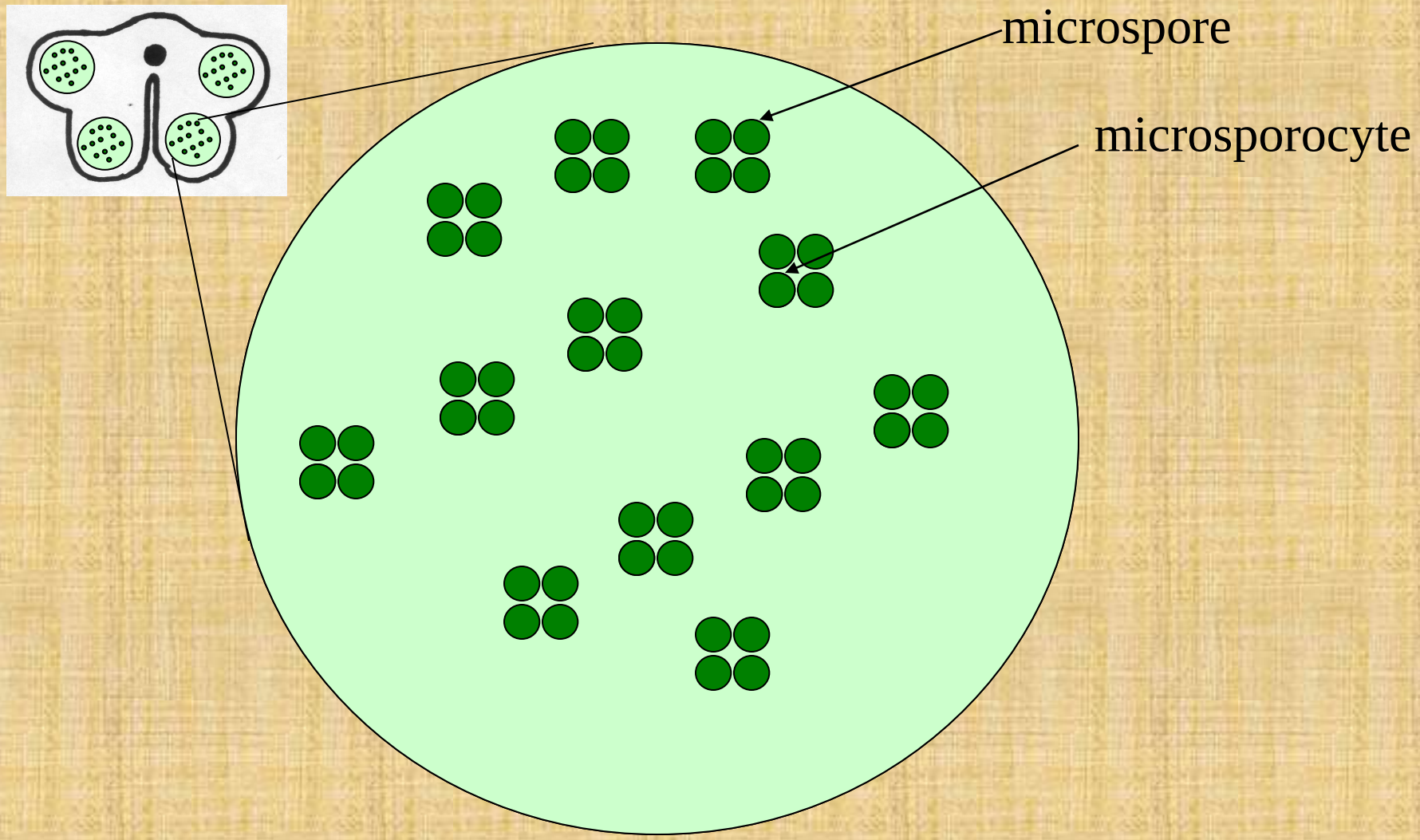
Stamen





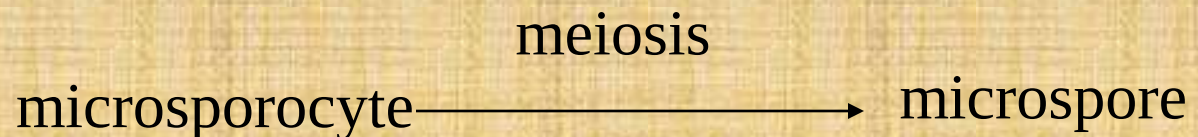


Cross section of an anther



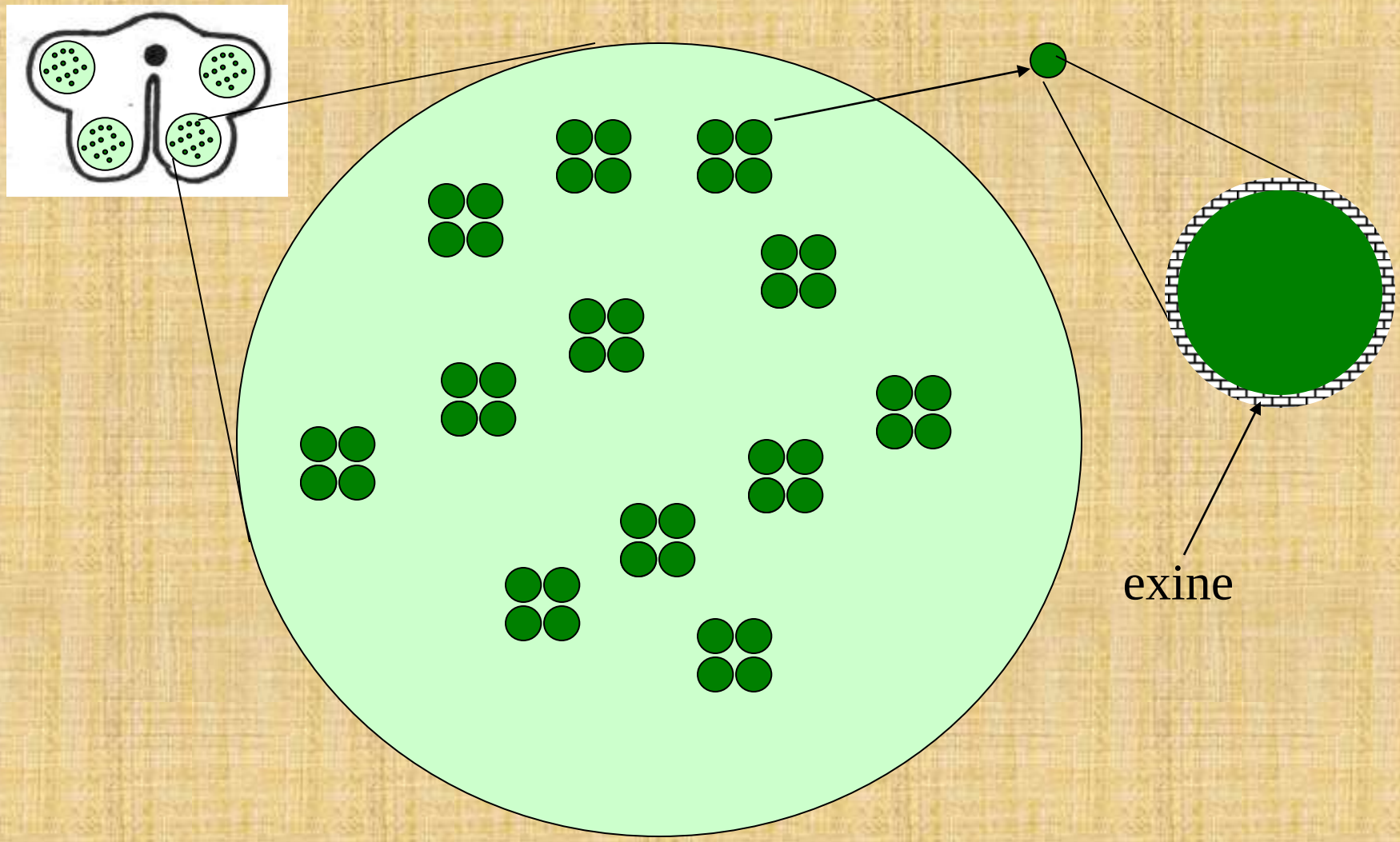
Creation of microspores

Review:



Creation of microspores

Next step: creation of male gametophyte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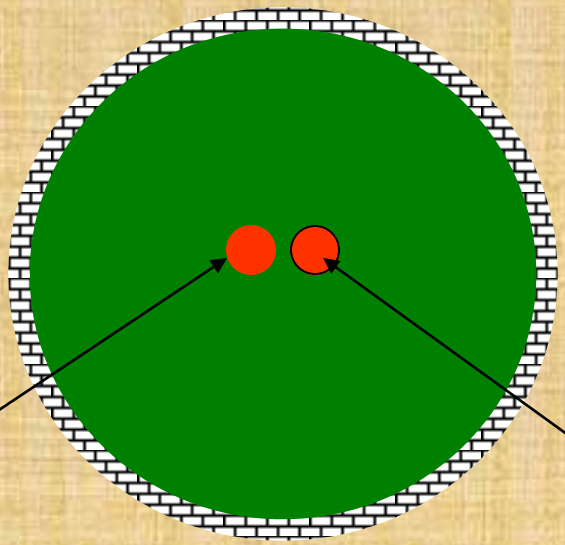
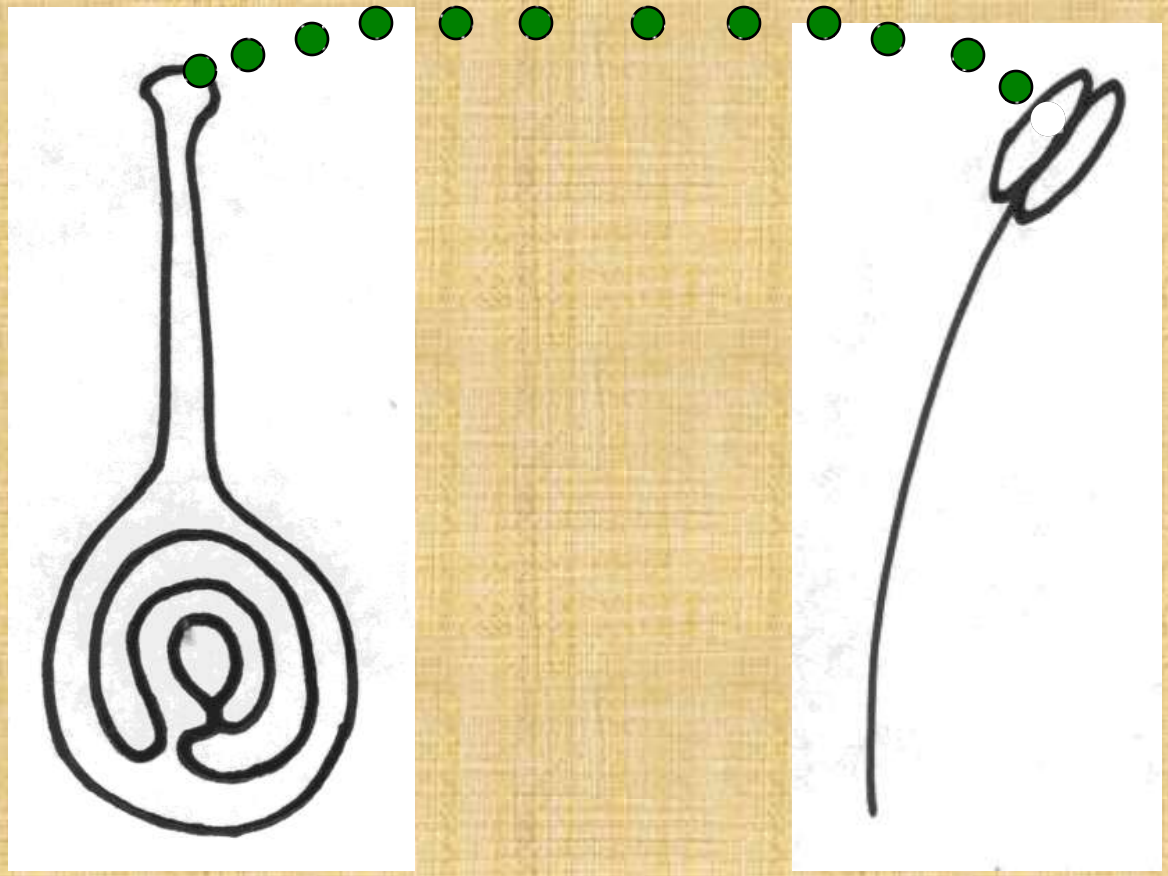
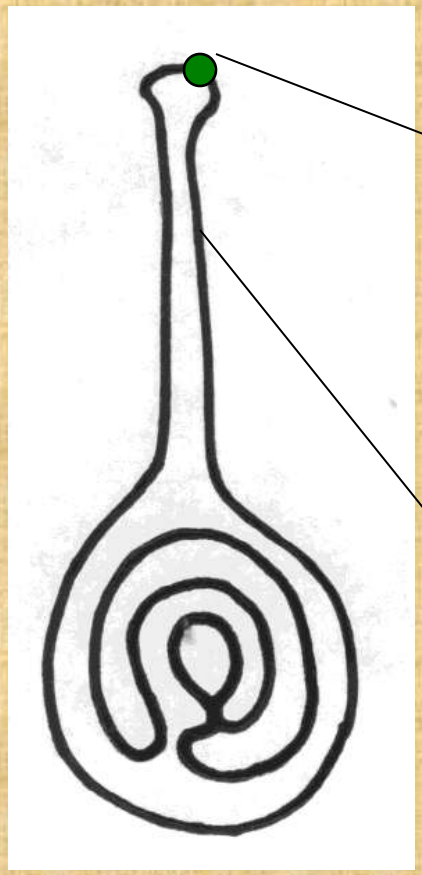


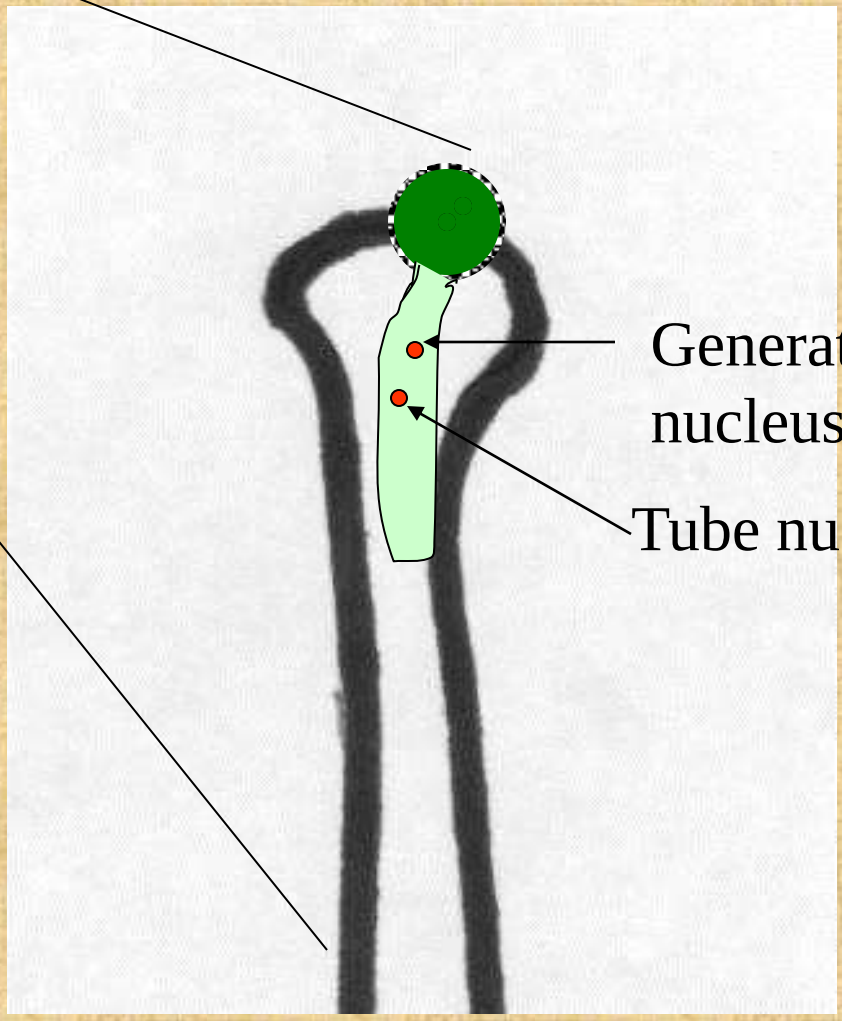
Pollen grain

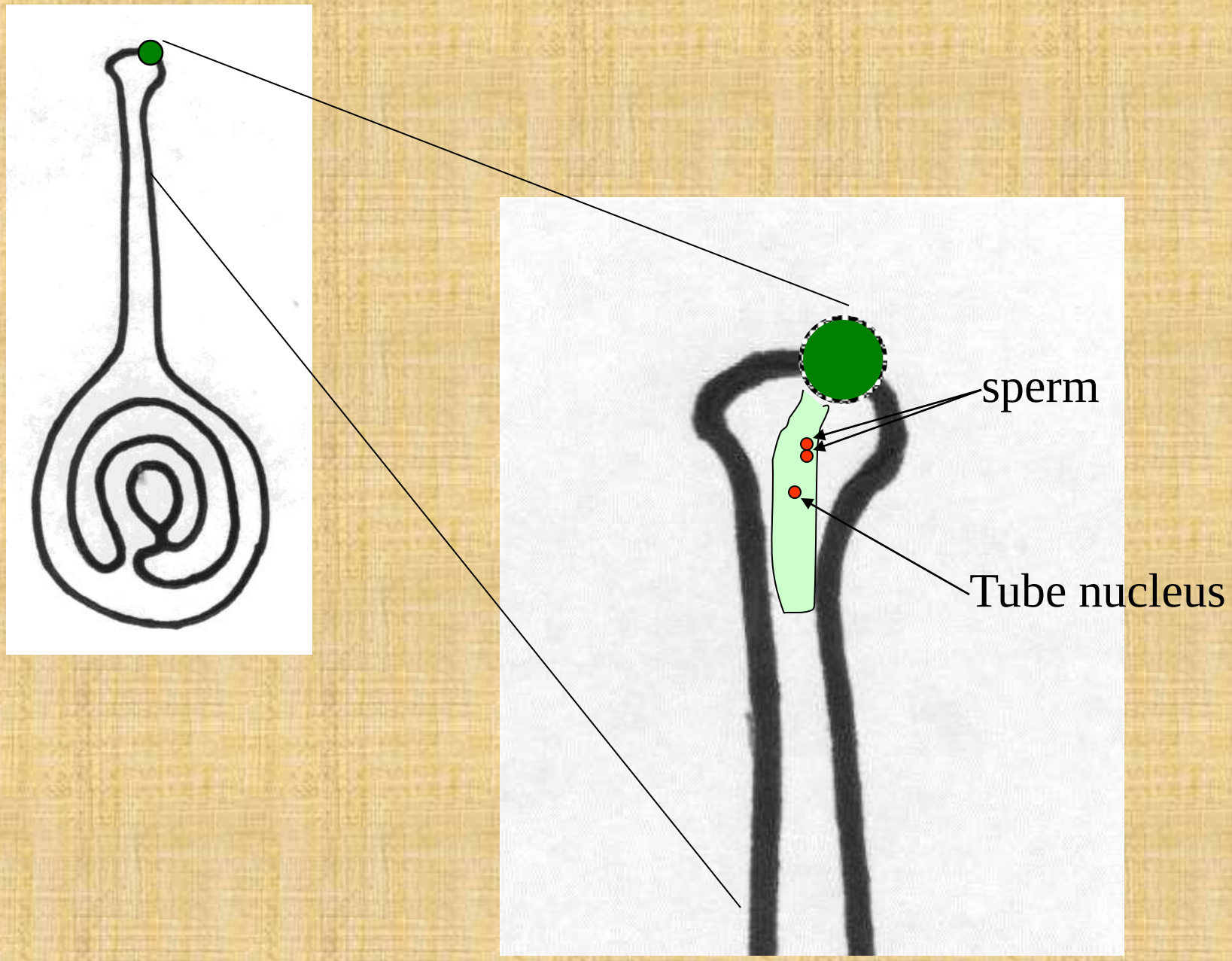


pollination

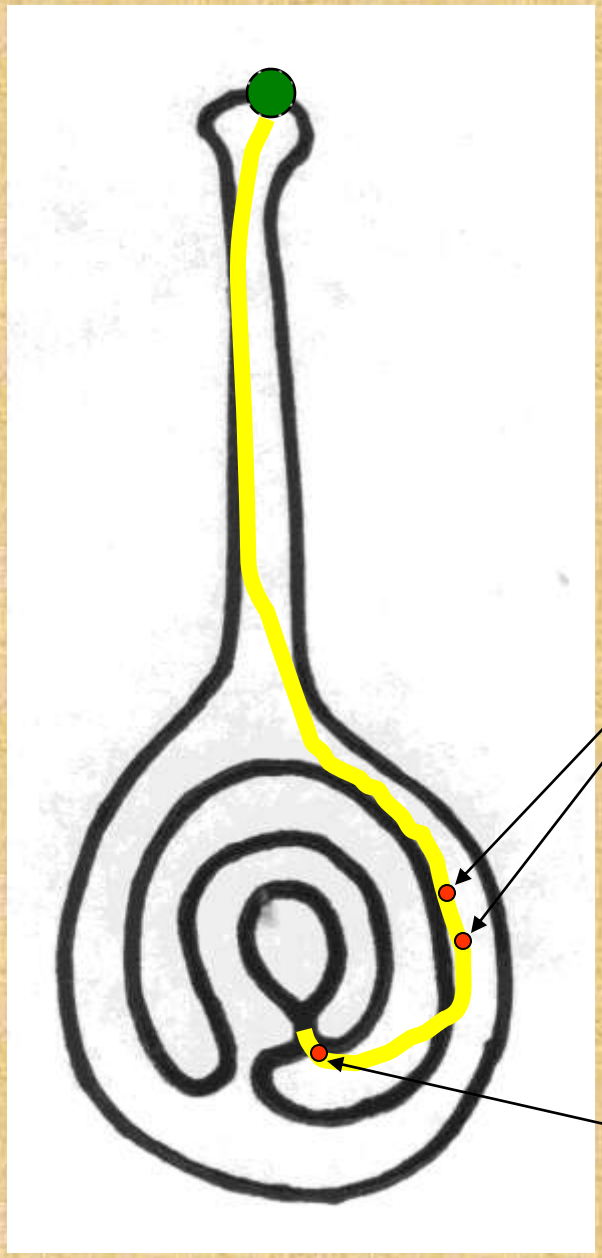
Pollen germination






sperm
Tube nucleus

Mature
Male gametophyte



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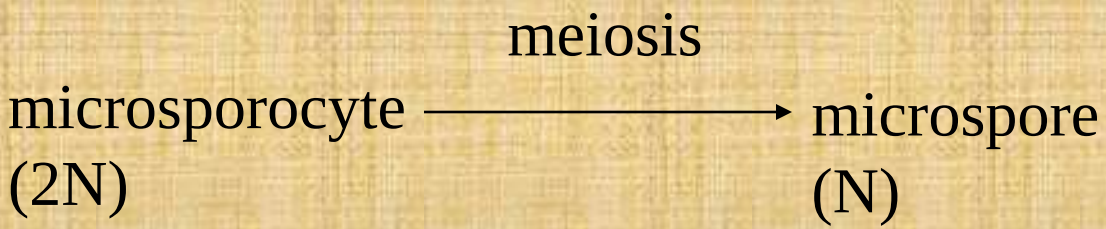
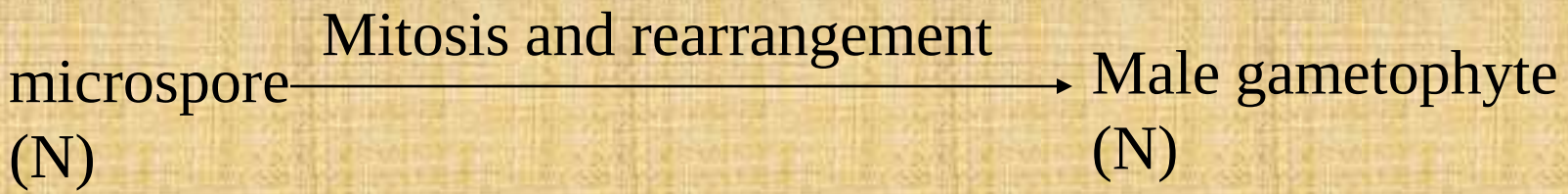
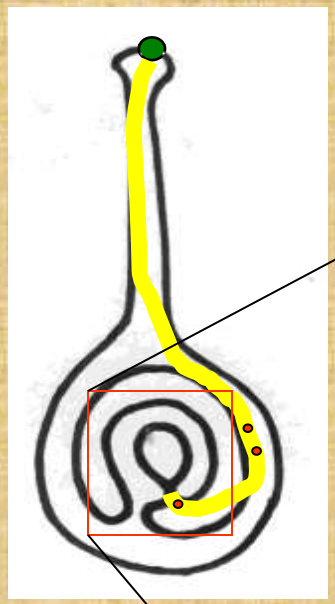
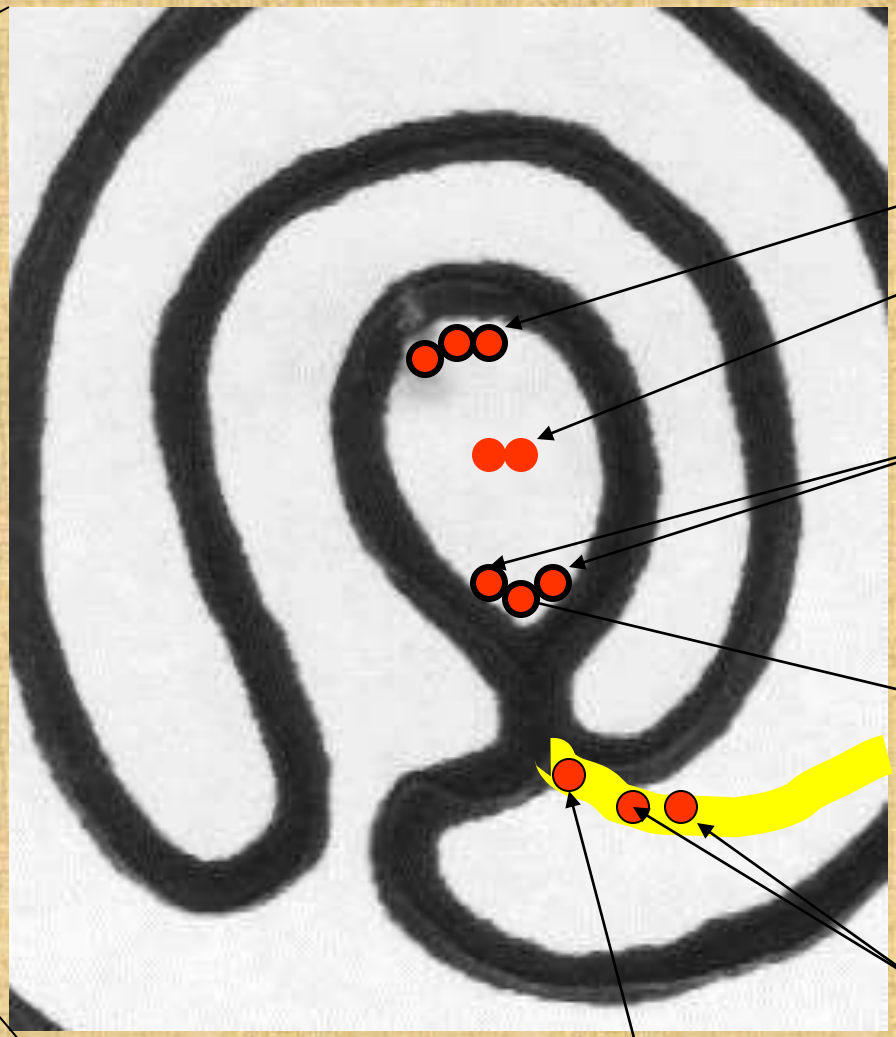




Male gametophyte contains the sperm





antipodals

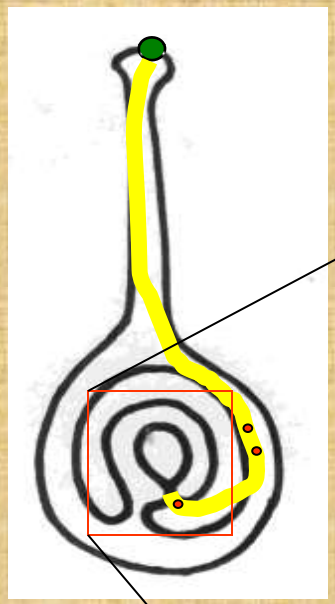
Polar nuclei

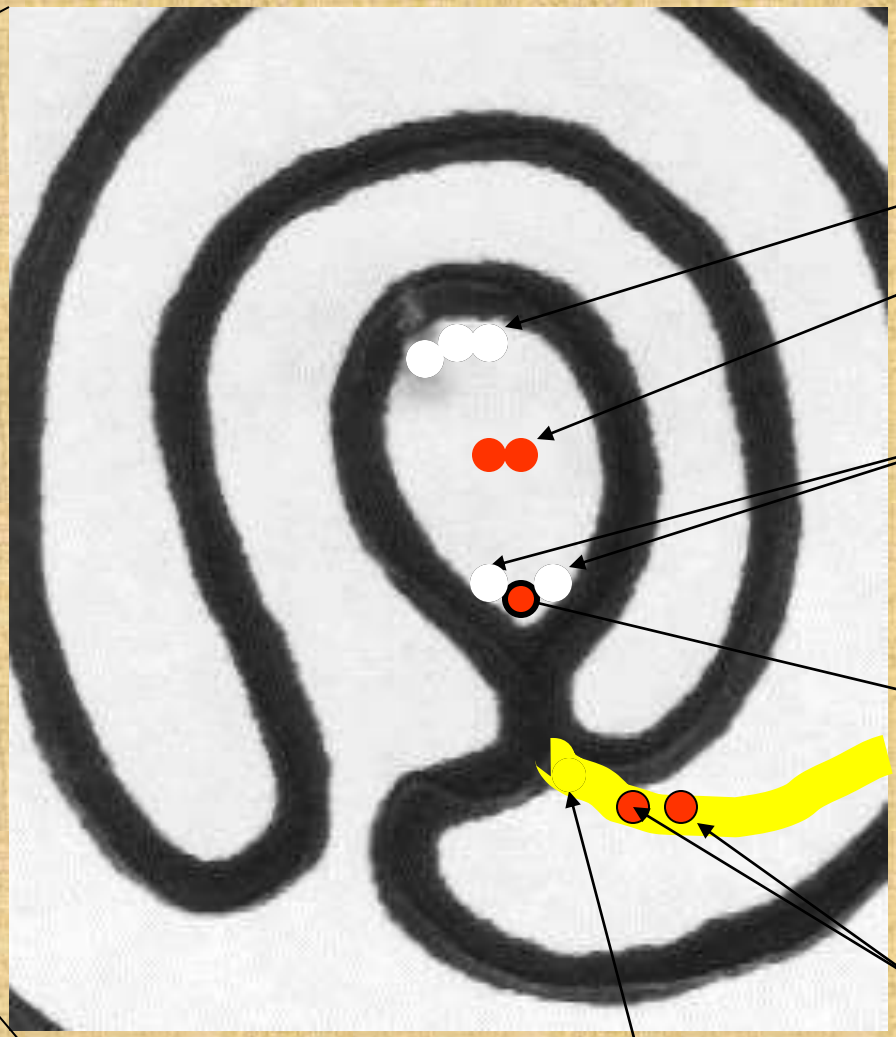
synergids

Egg cell

sperm

Tube nucleus





antipodals

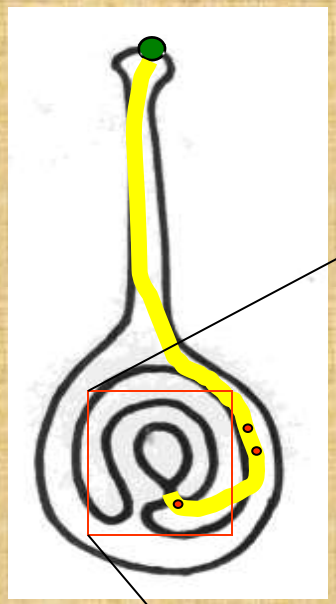
Polar nuclei

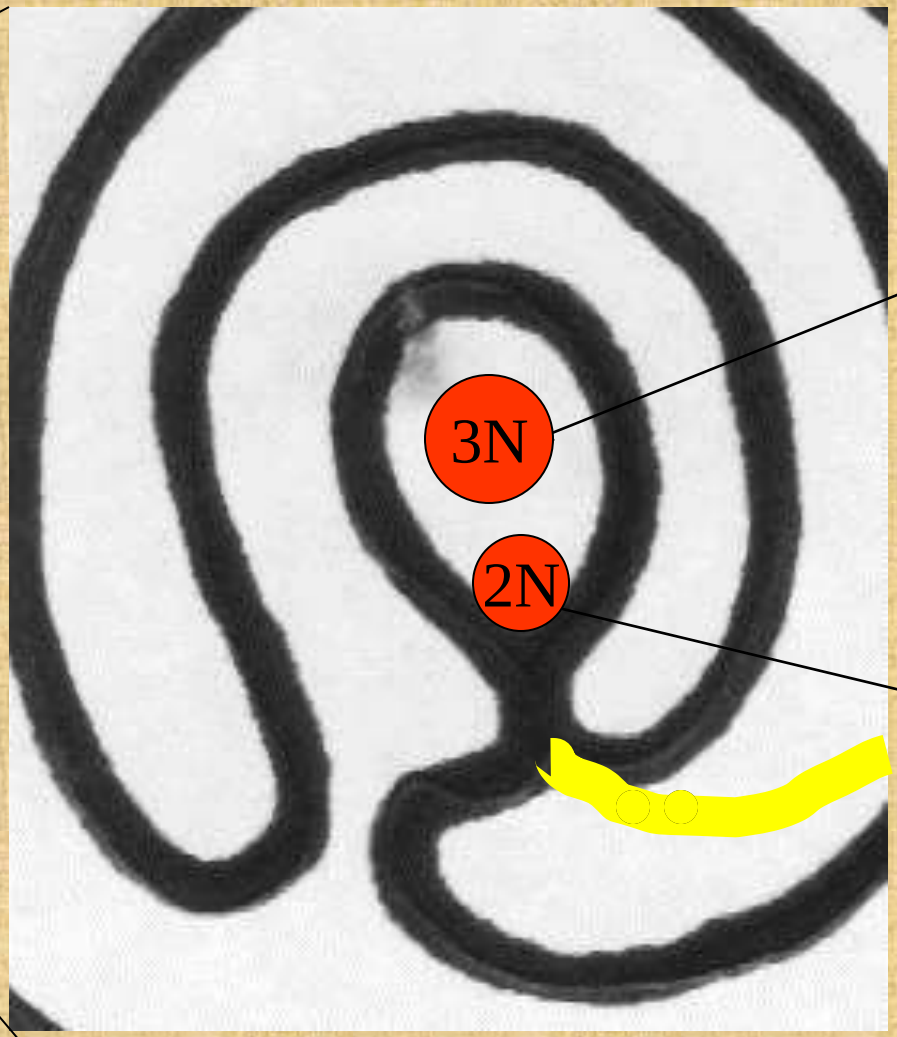
synergids

Egg cell

sperm

Tube nucleus

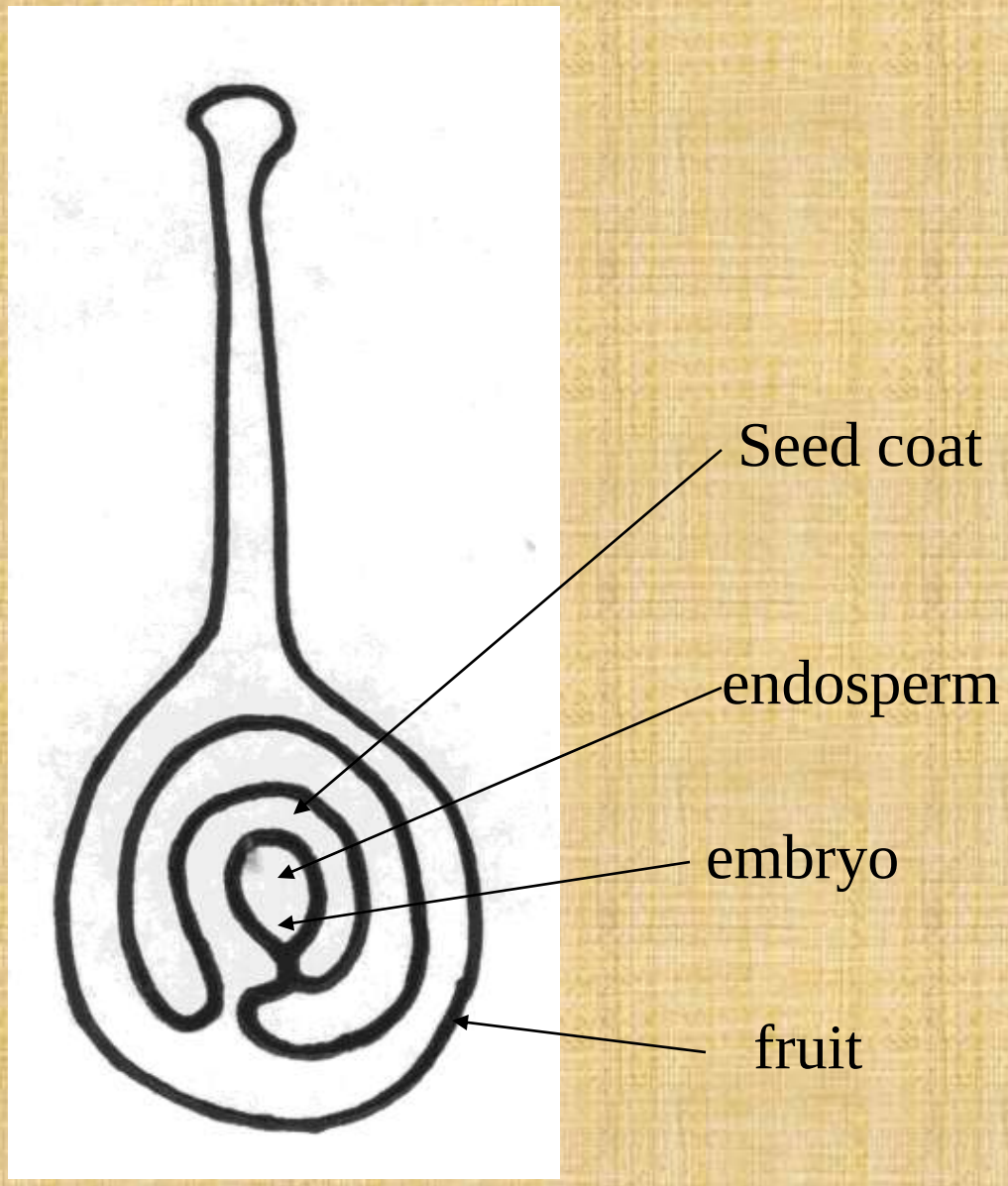




Primary endosperm nucleus

Zygote

Double Fertilization

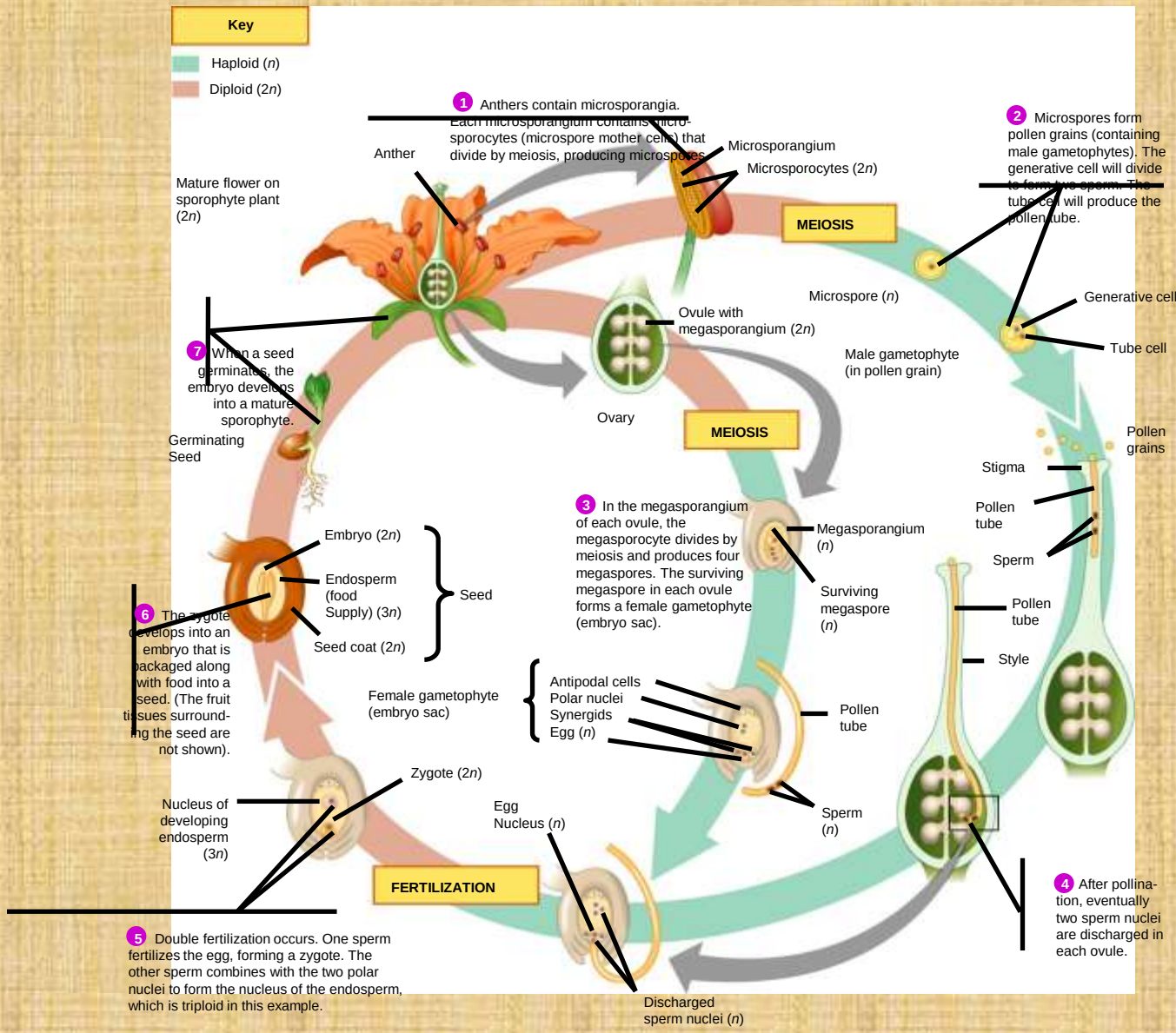

Seed coat
endosperm
embryo
fruit

The Angiosperm Life Cycle

- In the angiosperm life cycle
  - Double fertilization occurs when a pollen tube discharges two sperm into the female gametophyte within an ovule
  - One sperm fertilizes the egg, while the other combines with two nuclei in the center cell of the female gametophyte and initiates development of food-storing endosperm
- The endosperm
  - Nourishes the developing embryo

- The reduced gametophytes of seed plants are protected in ovules and pollen grains
- In addition to seeds, the following are common to all seed plants
  - Reduced gametophytes
  - Heterospory
  - Ovules
  - Pollen

- The life cycle of an angiosperm



The Evolutionary Advantage of Seeds

- A seed
  - Develops from the whole ovule
  - Is a sporophyte embryo, along with its food supply, packaged in a protective coatThe reduced gametophytes of seed plants are protected in ovules and pollen grains
- In addition to seeds, the following are common to all seed plants
  - Reduced gametophytes
  - Heterospory
  - Ovules
  - Pollen

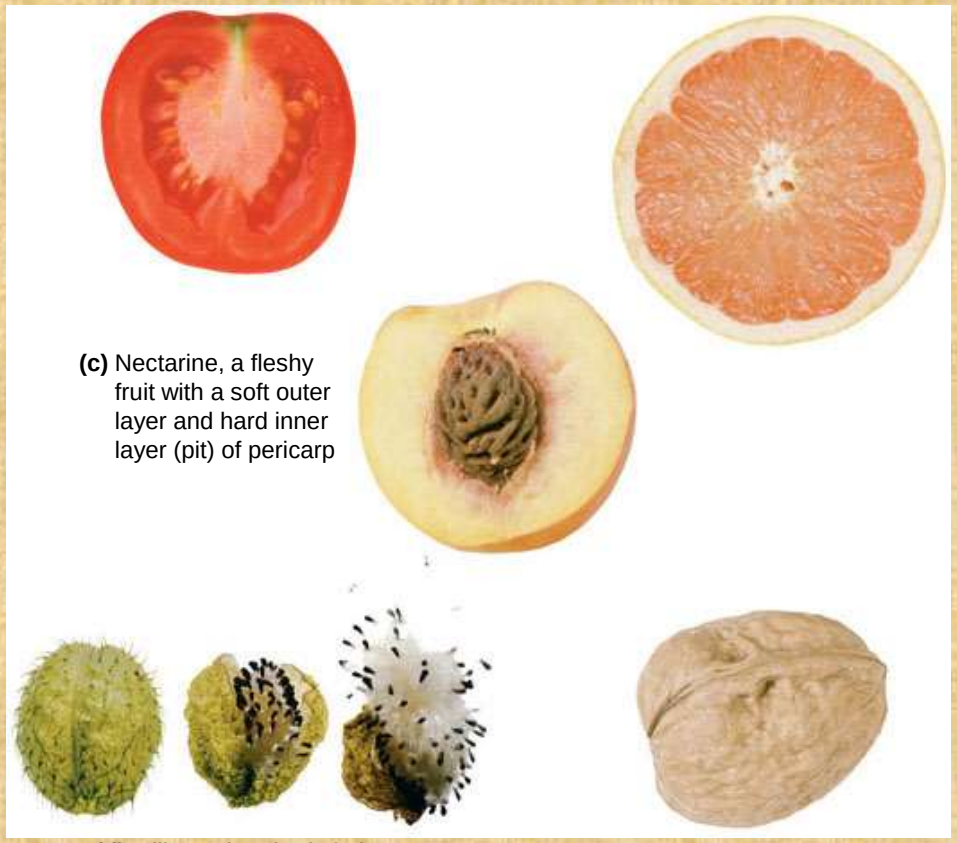
- Seeds changed the course of plant evolution
  - Enabling their bearers to become the dominant producers in most terrestrial ecosystems

Fruits

- Fruits
  - Typically consist of a mature ovary

(a) Tomato, a fleshy fruit with soft outer and inner layers of pericarp

(b) Ruby grapefruit, a fleshy fruit with a hard outer layer and soft inner layer of pericarp



(c) Nectarine, a fleshy fruit with a soft outer layer and hard inner layer (pit) of pericarp

(d) Milkweed, a dry fruit that splits open at maturity

(e) Walnut, a dry fruit that remains closed at maturity

KEY TO FRUIT TYPES

AND DISPERSAL

- Can be carried by wind, water, or animals to new locations, enhancing seed dispersal

Evolutionary Links Between Angiosperms and Animals

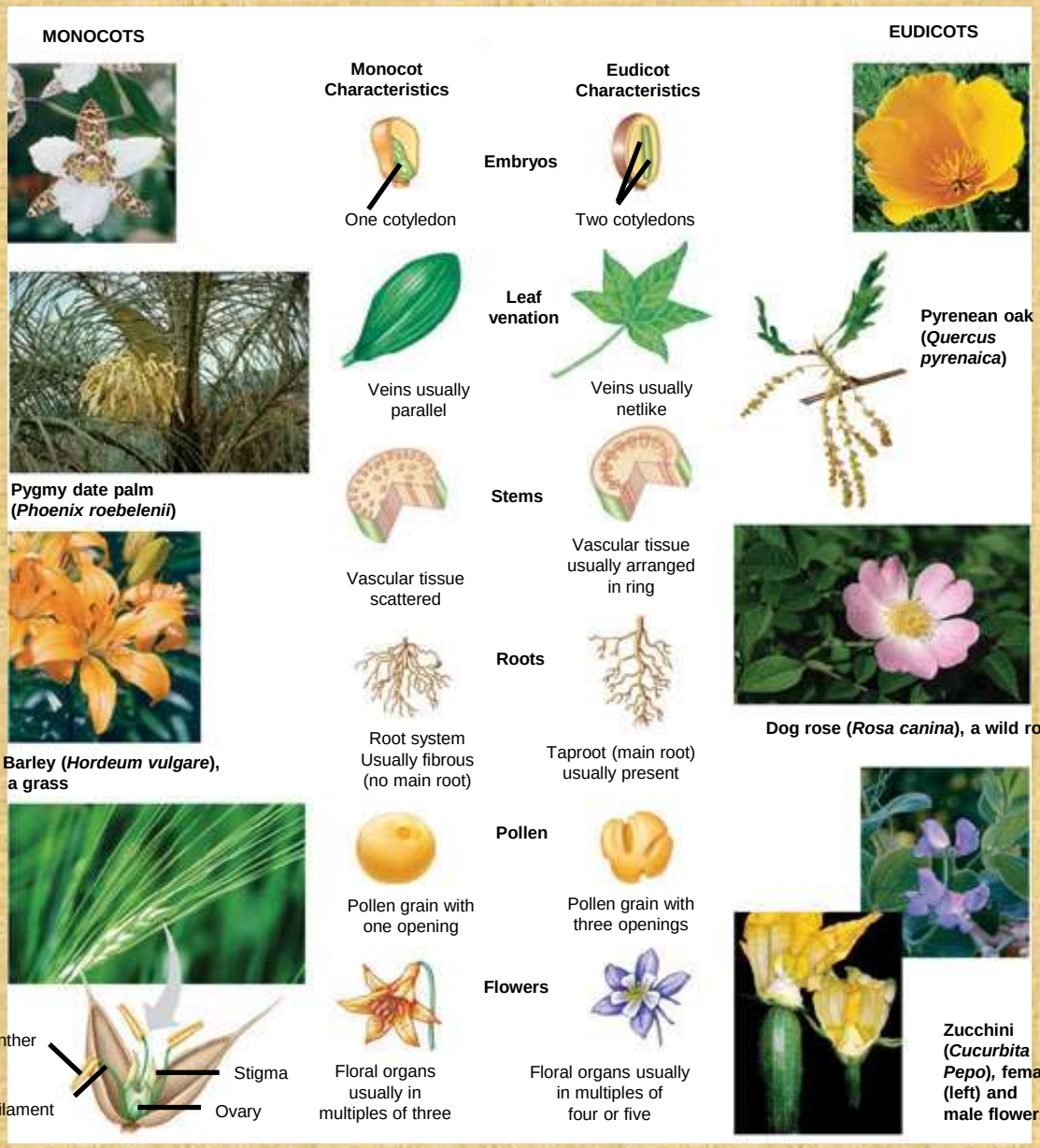
- Pollination of flowers by animals and transport of seeds by animals
  - Are two important relationships in terrestrial

(a) A flower pollinated by honeybees. This honeybee is harvesting pollen and nectar (a sugary solution secreted by flower glands) from a Scottish broom flower. The flower has a tripping mechanism that arches the stamens over the bee and dusts it with pollen, some of which will rub off onto the stigma of the next flower the bee visits.

(b) A flower pollinated by hummingbirds. The long, thin beak and tongue of this rufous hummingbird enable the animal to probe flowers that secrete nectar deep within floral tubes. Before the hummer leaves, anthers will dust its beak and head feathers with pollen. Many flowers that are pollinated by birds are red or pink, colors to which bird eyes are especially sensitive.

(c) A flower pollinated by nocturnal animals. Some angiosperms, such as this cactus, depend mainly on nocturnal pollinators, including bats. Common adaptations of such plants include large, light-colored, highly fragrant flowers that nighttime pollinators can locate.

• Exploring Angiosperm Diversity



Food for Thought

- Human welfare depends greatly on seed plants
- No group is more important to human survival than seed plants

Products from Seed Plants

- Humans depend on seed plants for
  - Food
  - Wood
  - Many medicines

Table 30.1 A Sampling of Medicines Derived from Seed Plants

Compound	Example of Source	Example of Use
Atropine	Belladonna plant	Pupil dilator in eye exams
Digitalin	Foxglove	Heart medication
Menthol	Eucalyptus tree	Ingredient in cough medicines
Morphine	Opium poppy	Pain reliever
Quinine	Cinchona tree (see below)	Malaria preventative
Taxol	Pacific yew	Ovarian cancer drug
Turbocurarine	Curare tree	Muscle relaxant during surgery
Vinblastine	Periwinkle	Leukemia drug

Cinchona bark, source of quinine

Threats to Plant Diversity

- Destruction of Habitat
  - Is causing extinction of many plant species and the animal species they support
- Disruption of Habitat
  - Introduction of invasive and exotic species (competitors, predators, and pathogens)