

Plant Physiology

Topic 5: Seed Formation and Development

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Topic outline

- Seed Formation
- Seed Development



Seed Formation

Formation of a seed begins with the development of an ovule, dome-shaped mass of undifferentiated cells on the surface of the placenta of the ovary wall (ovule primodia)

Plant with simple ovaries

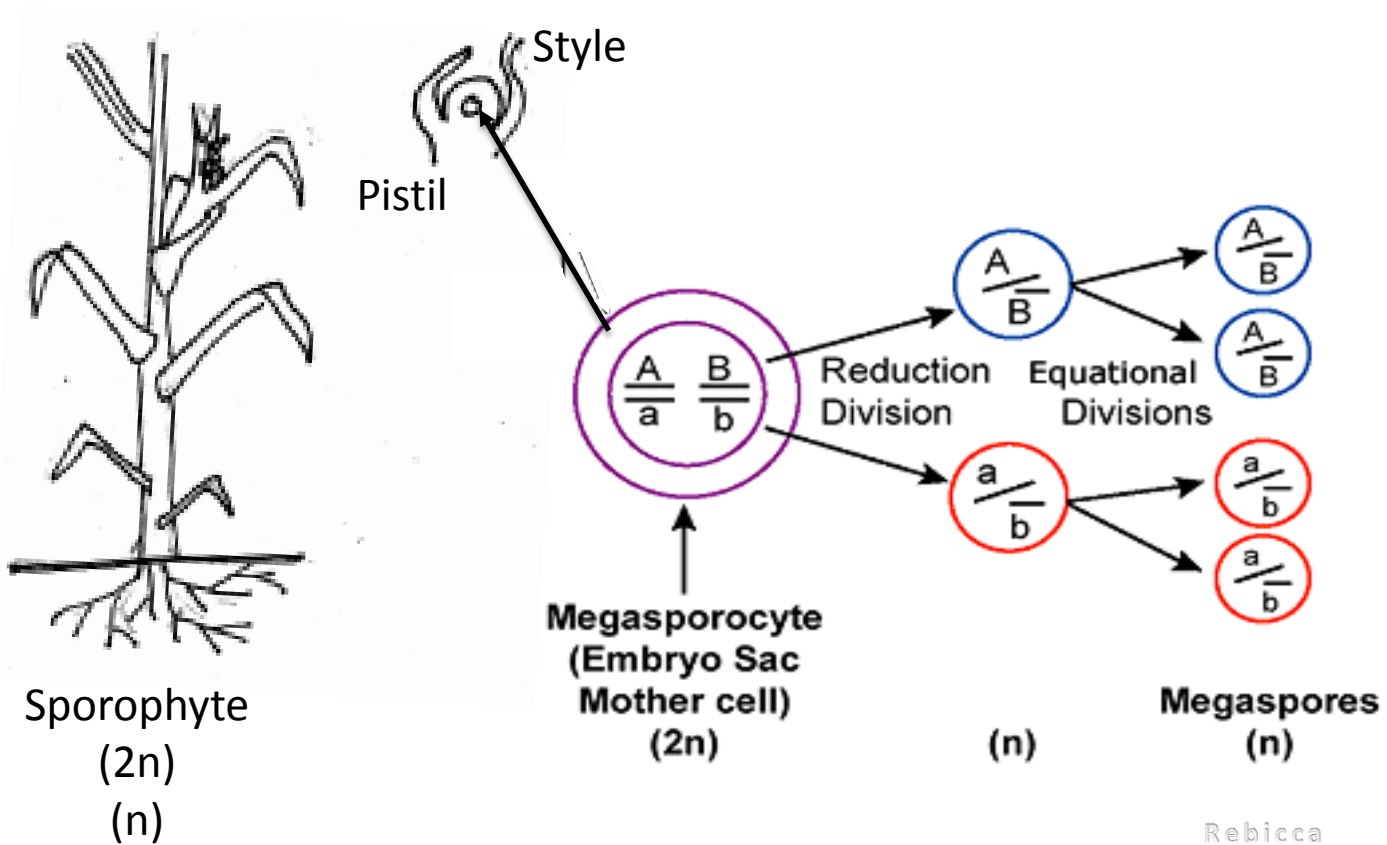
- primodia are located near the suture of the ovary wall where the carpel is fused

Plant with polycarpellate ovaries

- seeds are formed at the fusion of the carpels or along the septa or central carpel axes, depending on the types of placentation



Megasporogenesis



Rebicca



Megasporogenesis: Development of the haploid (1N) megaspores from the diploid (2N) archesporial cell within the nucellus of the ovary wall of the flower

Megaspore mother cell undergoes a two-step meiosis division


Process of meiosis gives rise to four megaspores

Each having one-half of the chromosomes number of the mother plant and the four megaspores are haploid (1N) cells

Three of these megaspores degenerated, leaving only one functional megaspore

Megagametogenesis: Development of the female gametophyte/embryo sac from the functional megaspore

Process of successive nuclear divisions (mitosis) within an enlarging cell that becomes the embryo sac



Three successive mitosis division occur, culminating in eight haploid ($1N$) nuclei

Megagametogenesis cont.

- These nuclei arrange themselves within the enlarging embryo sac and cell wall is formed;
 - Resulting in three antipodal cells at one end
 - Two polar nuclei (nucleus without cell wall) located near the center
 - Egg apparatus (composed of the egg between two synergid cells) at the other end, opposite to the antipodal cells

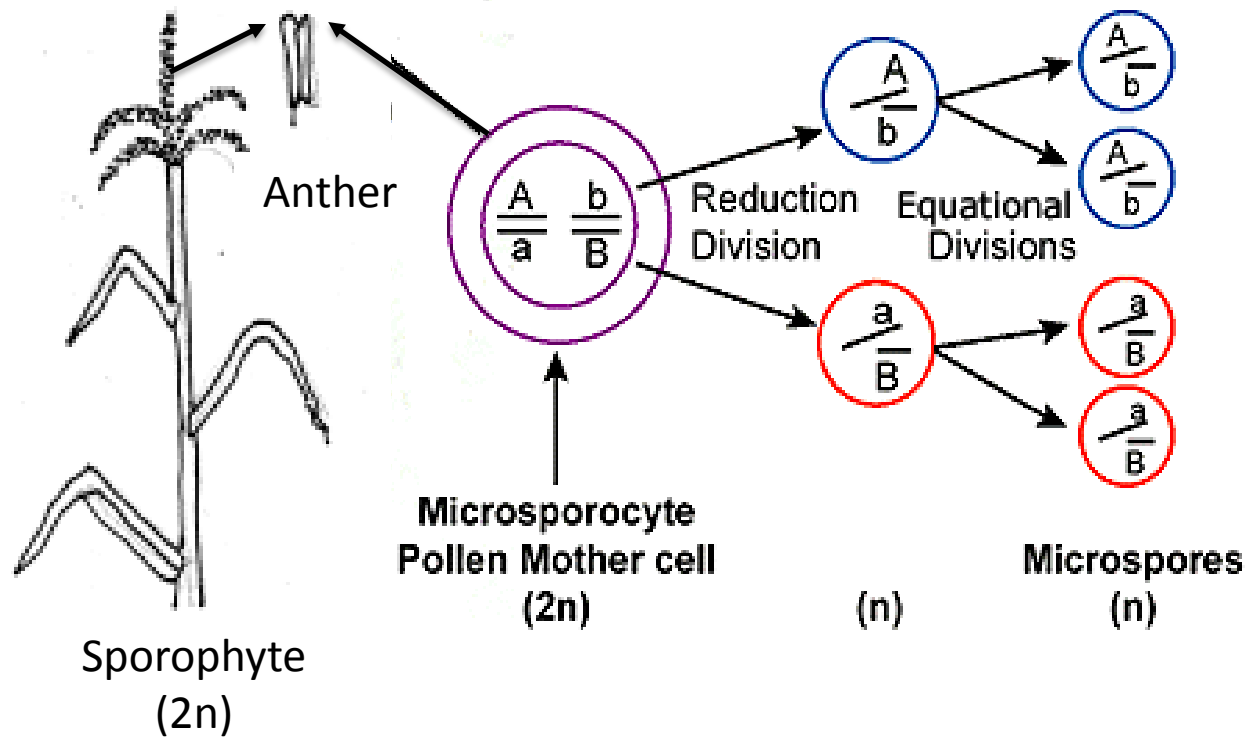


Megagametogenesis cont.

- After the two polar nuclei fused to form a diploid (2N) nucleus,
 - Seven celled structure is known as the mature female gametophyte / mature embryo sac / mature megagametophyte
 - Ready to receive the mature male gametophyte / pollen tube
- The egg is positioned near the small opening or micropyle of the ovule formed by the surrounding integuments
- A small vacuole may be present near the point of attachment away from the micropyle



Microsporogenesis



Microsporogenesis: process whereby the microspore mother cells are produced in the sporangia and undergo a two-step reduction division (or meiosis)

Pollen is produced usually in four sacs / microsporangia of the anther

As the anther matures, a certain group of meristematic cells within the sporangia develop

Four diploid ($2N$) microspore mother cells are produced that is one microspore mother cell in each sporangium


Each microspore mother cell ($2N$) divides meiotically to produce four haploid ($1N$) microspores

Each containing half of the number of chromosomes of the parent cell




Microgametogenesis: each of the four haploid (1N) microspores is functional and undergoes two mitosis cell division, give rise to a microgametophyte/mature pollen grain

A mature pollen grain usually has two nuclei, the tube nucleus and the generative nucleus



The generative nucleus subsequently divides to produce two male gametes or sperm cells



before the pollen is shed or transferred onto the stigma of the flower during pollination

Seed Development

- Some terminologies associated or involved in the stages of seed development:
 - Anthesis
 - Pollination
 - Fertilization
 - Seed maturation



Anthesis

- **Anthesis:** period in flower development when the stigma is ready to receive the pollen
- The time when the pollen is matured and is ready to be blown
 - Many people show allergic reactions to pollens during this period

Pollination

- **Pollination:** process by which pollen is transferred from the anther of the stamen where it is produced to the stigma or pistil of the flower
- Occurs irrespective of whether the stigma may or may not be receptive to the pollens



crossed-pollinated crops

- accomplished through the transfer of pollens by the insects / wind, by dropping of the pollens / by other means / by direct transfer onto the stigma

self-pollinated crops

- accomplished by direct transfer of the pollens by dropping pollens onto the stigma of the flower containing the ovule

Fertilization

- **Fertilization / syngamy:** the fusion between one of the sperm nucleus of the male gametophyte/pollen with the egg of the female gametophyte/ovule
- When the pollen grain is shed from the anther onto the stigma,
 - the protoplasmic contents consist of a small amount of cytoplasm and the two tube and generative nuclei



Fertilization cont.

- On the stigma, the shed pollen grain germinates,
 - the protoplasm of the pollen grain absorbs water and swells
 - eventually breaks the outer membrane
- The inner membrane extends through the break in the outer wall and forms the limiting membrane of a protoplasm-lined tube (pollen tube)



Fertilization cont.

- The pollen tube penetrates the tissue of the stigma,
 - grows down the style and enters the ovary, usually through the micropyle
- The tip of the pollen tube then ruptures,
 - the two sperm nuclei are discharged into the embryo sac
- One of the sperm nucleus moves toward the egg and fuses with it causes fertilization and forming the diploid (2N) zygote



Seed Maturation

- After fertilization of the ovule,
 - the embryo and endosperm continue to grow and differentiate and ultimately forming the seed
- During the development of the embryo and endosperm of the seed,
 - part of the nucellar tissue is digested and used to supply nutrients for the growth of the embryo



Seed Maturation cont.

- Nucellus in a mature seed (if present) usually consists of a thin layer of cells (perisperm),
- Maturation phase in seed development is a rapid growth and differentiation



At maturation, the various parts of a matured embryo sac or seed will give rise to the different parts of a fruit, as indicated below:

Before maturation	After maturation
2 Polar Nuclei (1N+1N) + 1 Sperm Cell (1N)	Endosperm (3N)
Egg (1N) + 1 Sperm Cell (1N)	Embryo (2N)
Ovule	Seed (2N)
Ovary	Fruit (2N)
Integument	Testa (2N)
Micropyle	Micropyle (2N)
Funiculus	Hilum (2N)
Nucellus	Perisperm (2N)

What have you learned today?



Further reading

- Taiz, L. and Zeiger, E. (2010) Plant physiology 5th ed. Sunderland, MA : Sinauer Associates.



End of Topic 5

Thank you

