VIVEKANANDA COLLEGE

THAKURPUKUR

KOLKATA-700063

NAAC ACCREDITED 'A' GRADE

Topic:	GYMNOSPERMS
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Name of the Department:	Botany (Morning)

Gametophyte of Pinus

The spore is the first phase of gametophyte generation. The microspore or pollen grain represents the male gametophyte, while the megaspore represents the first stage of female gametophyte which develops into a female gametophyte.

❑ MALE GAMETOPHYTE:

i. Development of Male Gametophyte before Pollination:

- The pollen grains undergo endosporic development.
- The pollen nucleus divides mitotically to produce a small lens-shaped **first prothallial cell** towards the proximal end and **a large central cell** on the distal end (Fig. 1.65A).
- The **central cell again cuts off a second prothallial cell and an antheridial initial** (Fig. 1.65B).
- Both the prothallial cells are ephemeral and the second prothallial cell remains attached to the first prothallial cell.
- The **antheridial initial divides to form a small antheridial cell and a large tube cell** (Fig. 1.65C).
- The **pollen grains are released from the microsporangium at the 4- celled stage (2 prothallial cells, an antheridial cell and a tube cell)**

ii. Development of Male Gametophyte after Pollination:

- After pollination, the 4-celled pollen stores in the pollen chamber and remains ungerminated for about 11 months. The pollen develops the next spring.
- The **tube cell of the pollen comes out** through the pollen aperture **in the form of a pollen tube**.
- The pollen tube proceeds towards the archegonium, penetrating the nucellar tissue of the ovule.
- The **antheridial cell** within the pollen tube **divides to form a stalk cell and a spermatogenous (body) cell** (Fig. 1.65D).
- The **spermatogenous cell divides to form two male nuclei** just prior to fertilisation (Fig. 1.65E).
- The male nuclei are actually the **male gametes** which are **non-motile and ephemeral**.

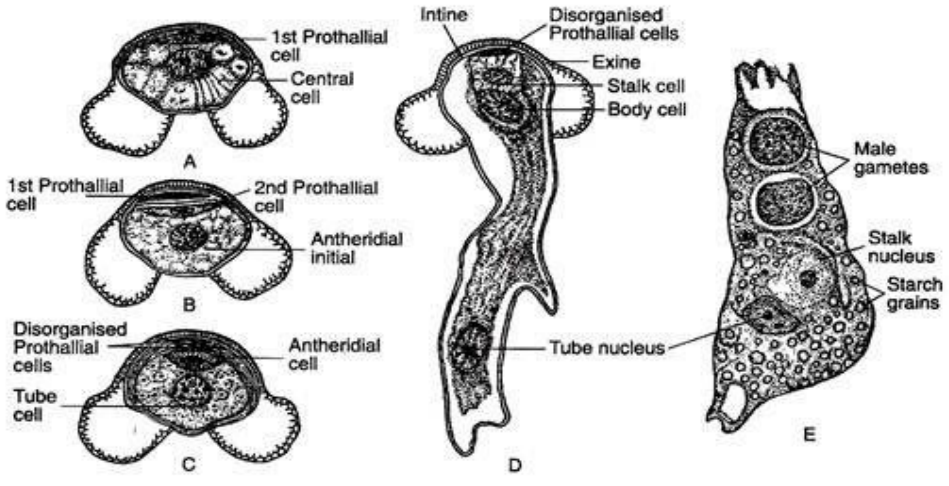
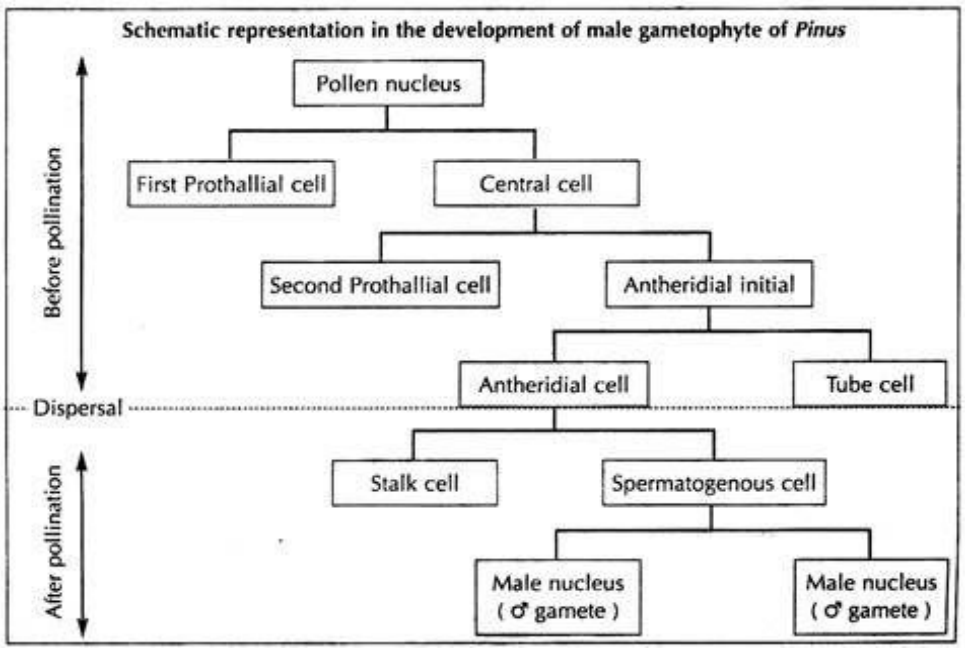


Fig. 1.65 : *Pinus* : A–E. The stages in the development of male gametophyte



❑ FEMALE GAMETOPHYTE:

Development of Female Gametophyte:

- The female gametophyte of *Pinus* develops from the functional megaspore which enlarges considerably (Fig. 1.66A).
- The nucleus of the megaspore divides mitotically forming a large number of nuclei unaccompanied by wall formation.
- The number of free nuclei is constant for a particular species, say for example, it is 2,000 for *P. gerardiana* and 2,500 for *P. roxburghii* and *P. wallichiana*.
- With the increase in size, the megaspore develops a vacuole at the centre which forces by cytoplasm along with nuclei towards the periphery.

- Thus, the nuclei lie in a thin film of cytoplasm around the vacuole (Fig. 1.66B). Thereafter, the cell wall formation starts in a centripetal fashion, from periphery inwards.
- At this stage, numerous radially elongated multinucleate tube-like cells called alveoli are formed and the wall formation takes place through alveoli.
- Each alveolus containing a nucleus at its mouth directs its growth.
- Then, cross-walls are laid down on each alveolus to form uninucleate cells. In this way, the entire gametophyte becomes cellular and the tissue thus formed represents endosperm or female prothallus (Fig. 1.64).

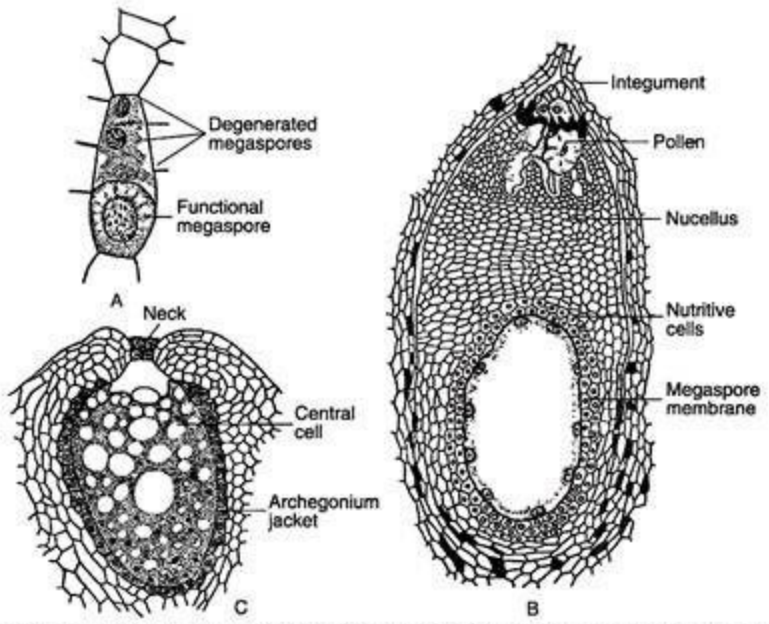
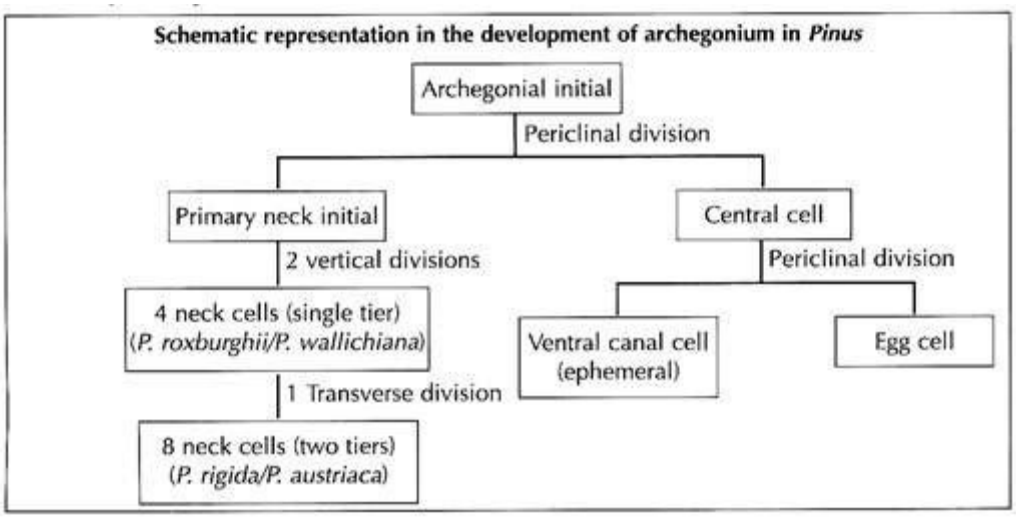


Fig. 1.66 : *Pinus* : A. Linear tetrad showing large functional megaspore, B. Free nuclear stage of female gametophyte, C. An archegonium

Development of Archegonia:

- Two to four cells of the female gametophyte at the micropylar end enlarge in size and have dense cytoplasm and prominent nuclei. These cells function as **archegonial initials**.
- Each **archegonial initial divides** periclinally **to form** an outer **small primary neck initial** and a **large central cell**.
- The **primary neck initial divides** by two vertical walls at right angles to each other **forming a neck of four cells**.
- Thus, the four neck cells are arranged in a single tier as in *P. roxburghii* and *P. wallichiana*. However, in *P. rigida, P. austriaca* the four neck cells again divide transversely to form eight cells which are arranged in two tiers.
- The central cell enlarges very rapidly and its cytoplasm becomes vacuolated (Fig. 1.66C).
- The **nucleus of the central cell divides into an upper ephemeral ventral canal cell and a large egg cell**.
- A nutritive layer called an **archegonial jacket** is differentiated **around the archegonium**.
- The nucellar tissue above the archegonia disorganises to form an archegonial chamber.



Pollination:

- *Pinus* is anemophilous i.e., wind-pollinated. The pollen grains are dispersed and remain suspended in the air for some time.
- At the same time, the nucellar breaks in the ovule disorganises forming a viscous sugary liquid containing glucose, fructose and sucrose.
- This fluid comes out in a cyclic phenomenon (24 hr. cycle) through the micropyle in the form of a **pollination drop** either at night or in the early hours of morning.
- The pollen grains are caught in the pollination drop and are collected in the pollen chamber as a result of drying off the fluid.
- The mouth of the micropyle is then sealed from the outer environment.

Fertilisation:

- The fertilisation takes place after one year of pollination.
- The pollen tube enters the tip of the archegonium by forcing itself between the cells of the nucellus.
- The pollen tube wall is disintegrated by the enzymes secreted from the egg and eventually two male nuclei are released.
- One of the male nuclei fuses with the egg cell and thus a zygote is formed.

Development of Proembryo:

➢ The zygote nucleus divides by two mitotic divisions forming four nuclei which move to the base of zygote (Fig. 1.67A).

➢ All the four nuclei are arranged in one plane and only two nuclei are thus visible in lateral view.

➢ A synchronous division gives rise to eight nuclei arranged in two tiers of four each (Fig. 1.67B).

➢ Thus, the upper group of four cells forms the primary upper tier (these cells have no wall towards the upper side) and the lower group of four cells forms the primary embryonic tier (these cells are bounded by wall all around).

➢ The internal division in both the tiers forms four tiers of four cells each (Fig. 1.67C), and the proembryo thus consists of 16 cells.

➢ The lowest tier is known as **embryonal tier,** (Fig. 1.67D) which further divides **to form embryos**.

➢ The next tier, called **suspensor tier**, elongates considerably **to form the embryonal suspensor.**

➢ The third tier is known as dysfunctional suspensor (earlier known as **rosette tier**) which **shows abortive meristematic activity.**

➢ The uppermost or the fourth tier is called upper tier or **nutritive tier which provides nutrition.**

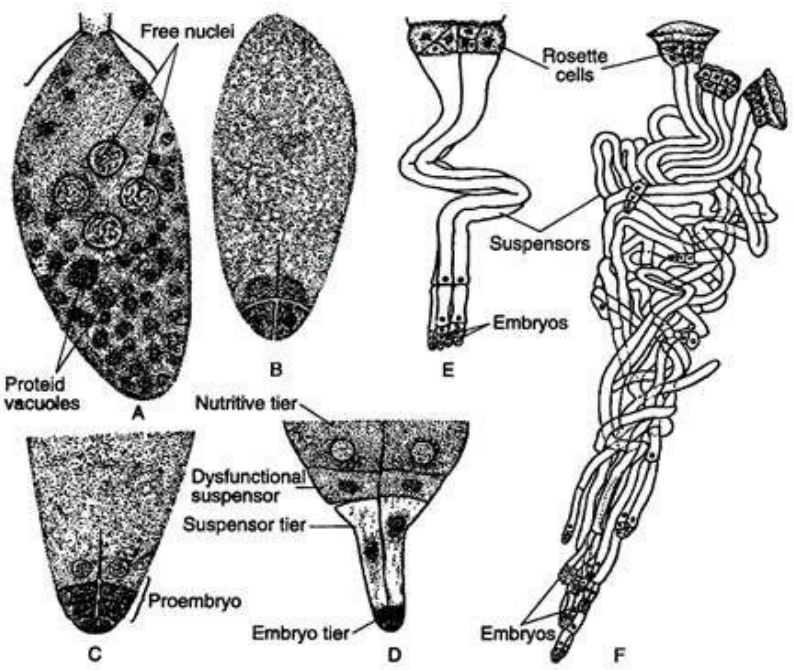


Fig. 1.67 : *Pinus* : A–D. The stages of development of proembryo, E–F. The stages of development of embryo

Embryogeny:

- The developing embryonal cells are deeply embedded into the gametophyte by the sevenfold elongation of embryonal suspensor (Fig. 1.67E).
- Thus the several embryonal suspensors (designated as Es_1, Es_2, Es_3 and so on) are formed.
- Proximal cells of the embryonal mass elongate unequally to form embryonal tubes.
- The cells of the embryonal tier are separated from each other at the time of embryonal suspensor elongation, thus four independent embryos are formed (Fig. 1.67E). This phenomenon is known as **polyembryony**, because more than one embryo is formed from a zygote (Fig. 1.67F).
- As the polyembryony occurs due to the splitting of a zygote, it is called **cleavage polyembryony**.
- Only a single deep-seated proembryo develops into an embryo and the growth of other embryos is arrested at different stages of development.
- The proembryo divides transversely to form two cells which by further repeated divisions form an embryo.

- The embryo consists of 3- 18 cotyledons, a distinct epicotyl root axis and a hypocotyl shoot axis with remnants of suspensor (Fig. 1.68A).

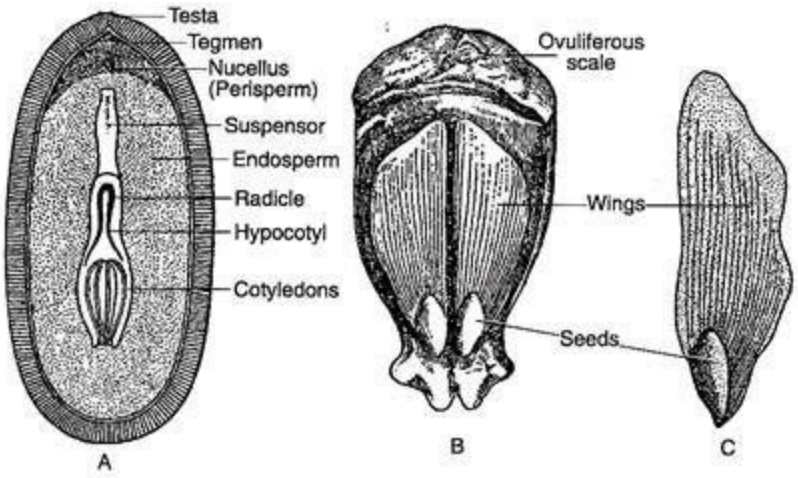


Fig. 1.68 : *Pinus* : A. L.S. of seed, B. An ovuliferous scale bearing seeds, C. A seed with wing

Seeds of Pinus:

The seeds are endowed with a well-developed wing which is thin and papery and is easily detachable at maturity (Fig. 1.68B). The outer fleshy layer of integument and part of ovuliferous scale contribute to the wing formation (Fig. 1.68C). The seeds are usually dispersed by wind. The embryo remains embedded within the endosperm.

The seeds of *Pinus* remain viable for a long time. The germination of seed is epigeal.

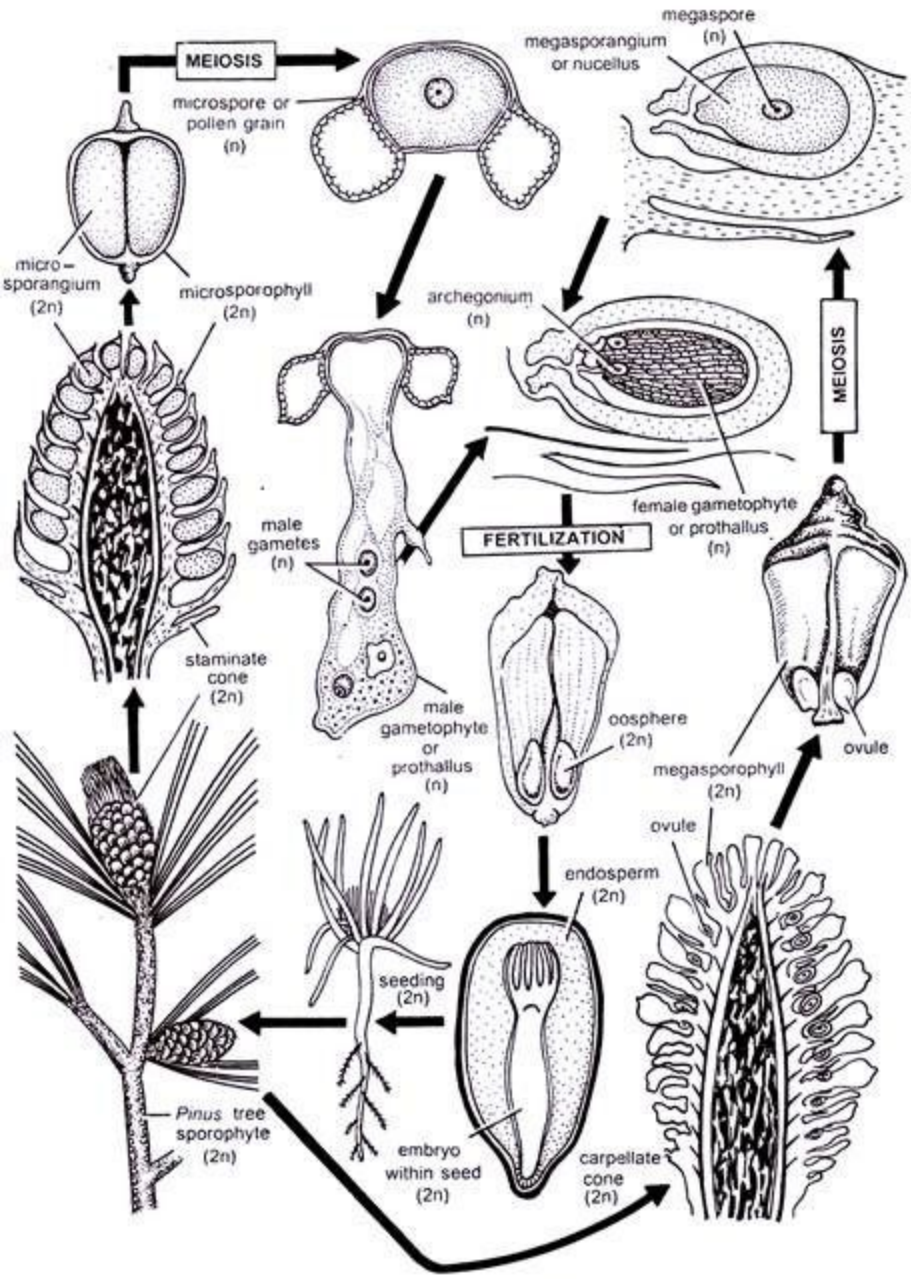


Fig. 11.46. Life cycle of *Pinus*.