Development of female gametophyte and life cycle of *Pinus sp*

2. FEMALE GAMETOPHYTE —Female gametophyte i.e. embryo sac is monosporic i.e. of the four megaspores, only the lowermost is the functional megaspore which takes part in the development of the gametophyte. Development of the gametophyte takes place entirely within the megasporangium.

The functional megaspore enlarges in size, its nucleus divides and redivides repeatedly by free nuclear division forming numerous small nuclei (about 2,000) without walls (Fig. 3.20 C); these free nuclei are distributed in the cytoplasm of the megaspore i.e. embryo sac. A large central vacuole is formed pushing the protoplast towards the periphery. Then walls are formed between the nuclei; the formation of these walls starts from the periphery in a centripetal fashion. As a result a solid mass of gametophytic tissue, known as endosperm tissue is formed; this tissue is composed of one kind of cells.

Towards the micropylar end of the gametophyte 2 to 3 archegonia (Fig. 3.18, A) are formed from the superficial cells (archegonial initials) of the female gametophyte. At first the archegonial initial divides transversely to form an upper primary neck initial and a lower large central cell.

Each mature archegonium (Fig. 3.18, B) consists of a neck of eight cells (developed from the neck initial), one ventral canal cell and a large egg (developed from the lower central cell). Neck canal cell is absent.

Pollination —Pollen grains, after liberation from microsporangia, are carried by means of wind (anemophilous) at the 4-celled stage. The yellow coloured pollen grains are carried in a mass and they resemble dust of sulphur.

At the time of pollination, the scales of the female cone remain open for the reception of pollen grains, and pollens are caught in the mucilage drop oozing out of the micropyle. This pollination drop contains excess glucose and fructose. As the mucilage drop dries up, pollen grains are gradually drawn down the micropyle and are finally taken at the nucellus

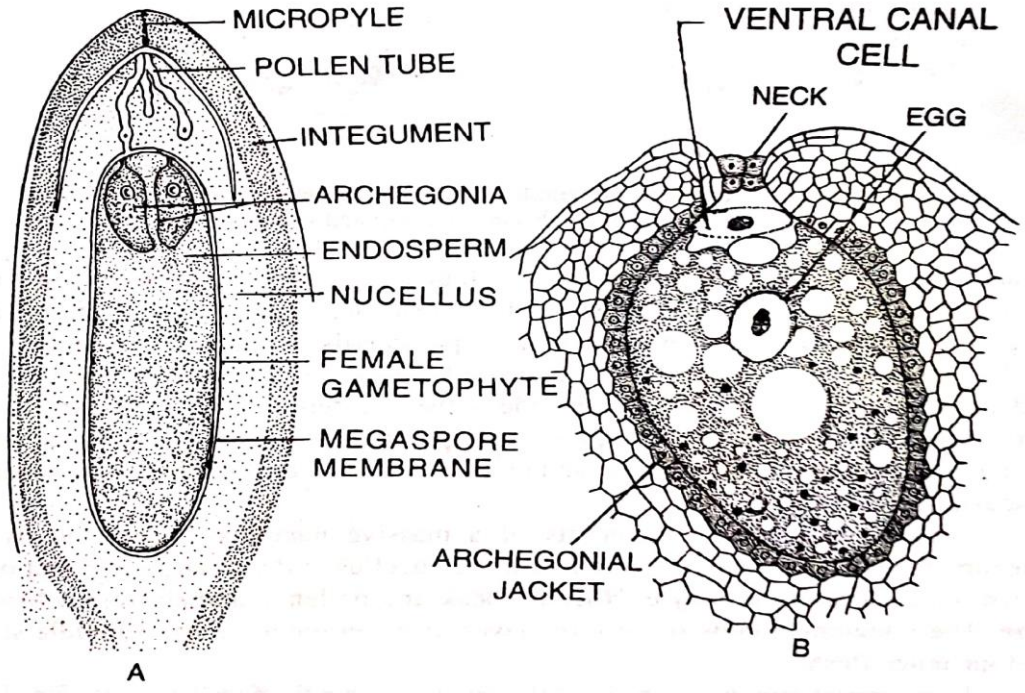


Fig. 3.18 —*Pinus* sp. A –Median longitudinal section of a mature ovule with the integument having three fused layers and a female gametophyte bearing archegonia ready for fertilization. B–Mature archegonium.

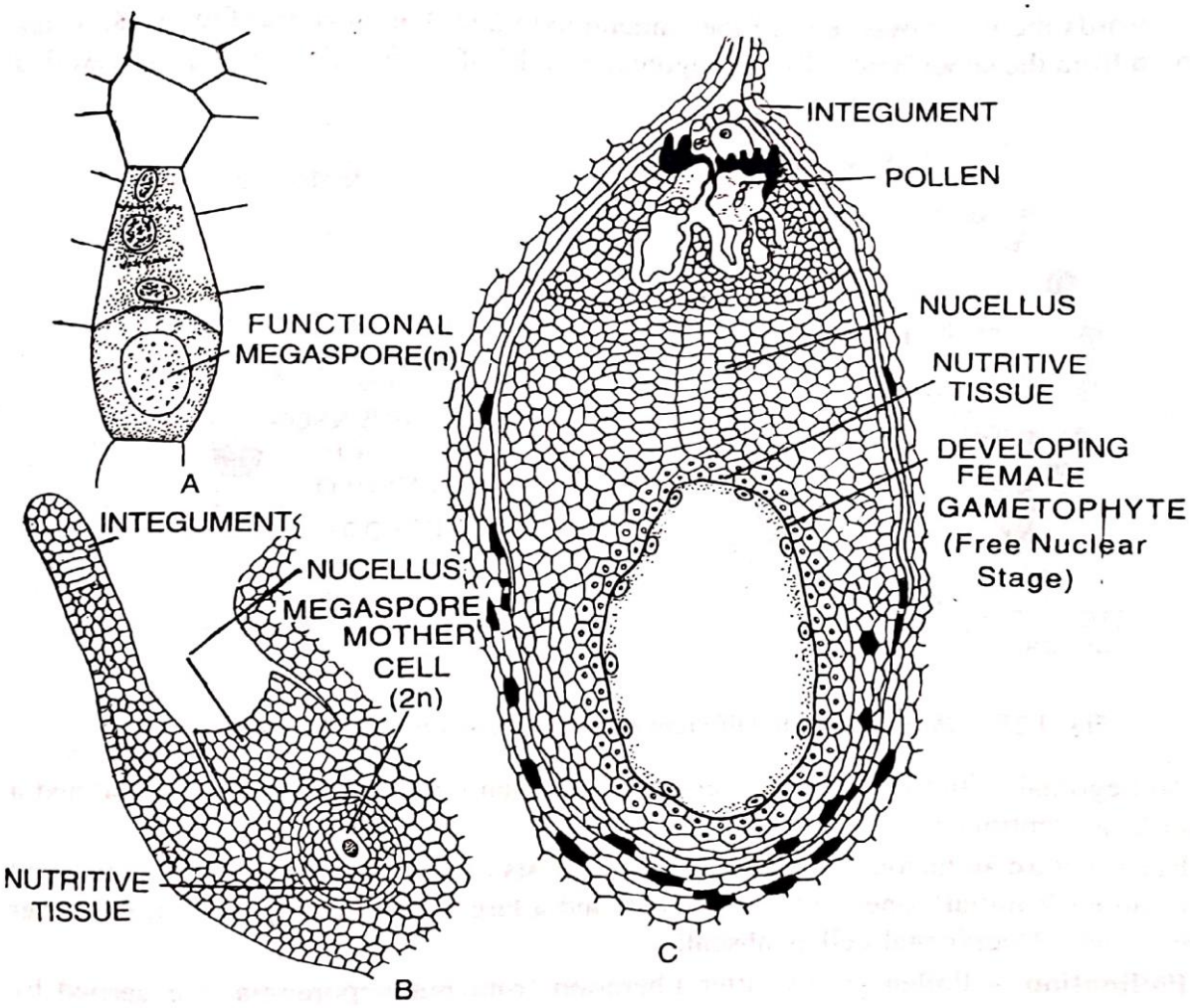


Fig. 3.20–*Pinus* sp. A–Formation of a megaspore mother cell. B–Formation of a linear tetrad of 4 megaspores, but only the lowermost one is functional. C–Development of a female gametophyte (free nuclear stage only).

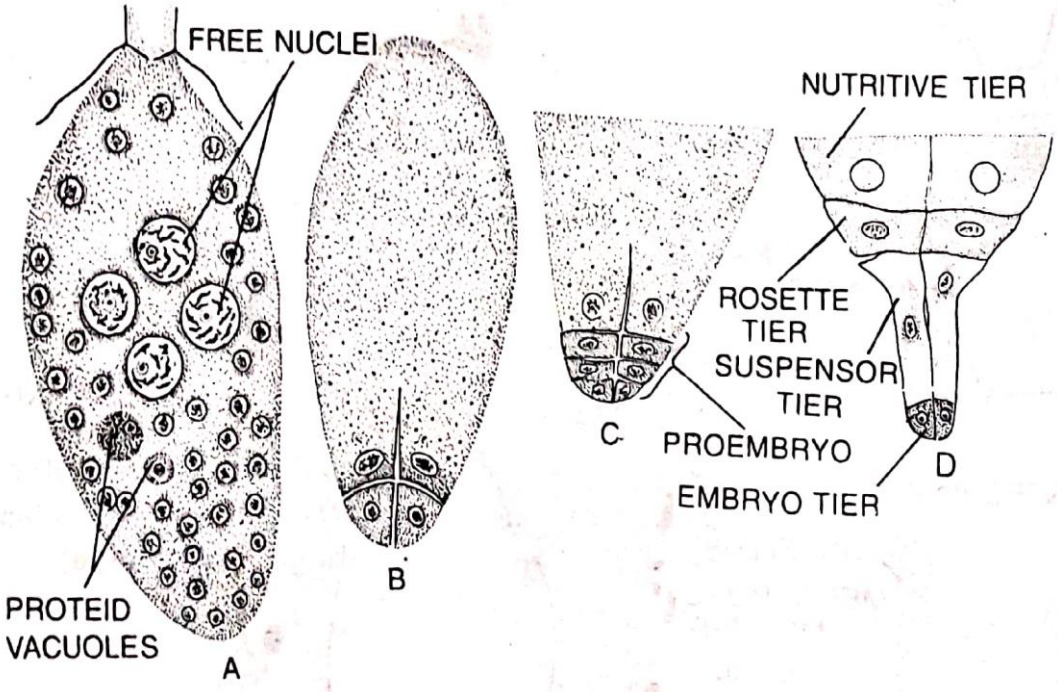


Fig. 3.21 —*Pinus* sp. A-D –Different stages in the development of proembryo.

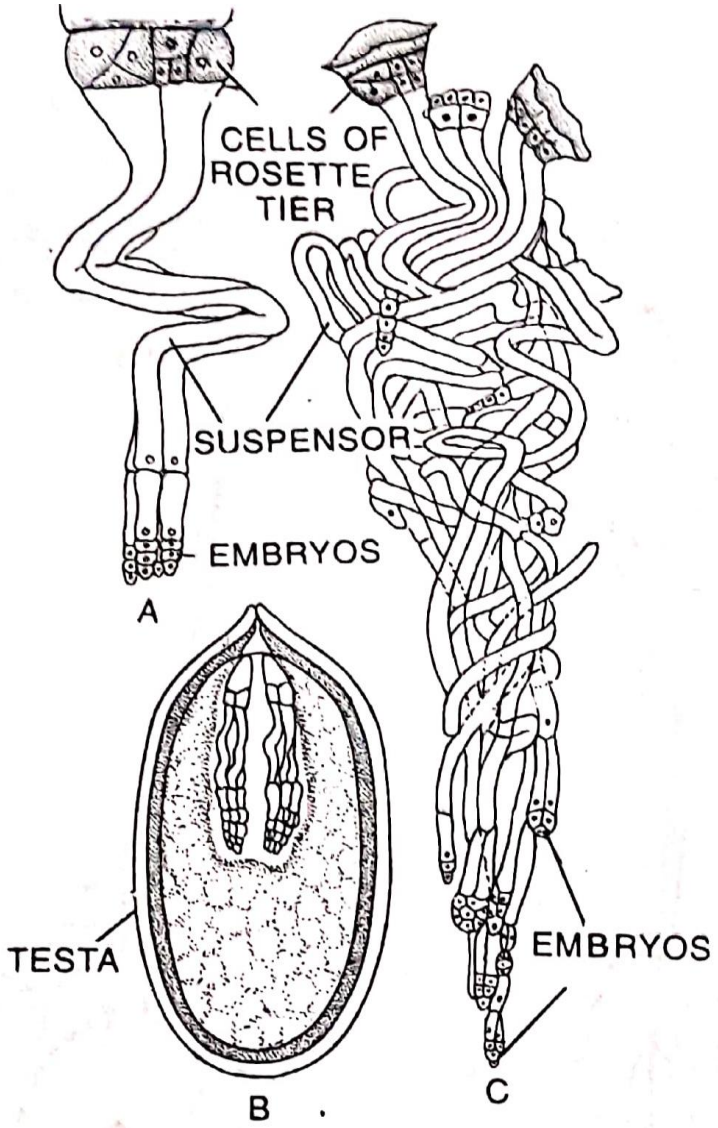


Fig. 3.22 –Different stages in the development of proper embryos. A–Formation of 4 embryos, each of their respective suspensor. B–Several embryos are pushed down within the endosperm tissue of the seed. C–About 12 embryos with their respective suspensors developing from three zygotes of three archegonia.

tip.

Fertilization : Fertilization takes place after an year of pollination. Pollen tube makes its way down until it reaches the neck of the archegonium, the neck is penetrated and the tip of the pollen tube bursts. The contents of the pollen tube are then discharged and of the two male cells, only one unites with the egg i.e. oosphere, as a result a diploid zygote i.e. oospore is formed.

Endosperm is cellular and is formed before fertilization from the megaspore nucleus due to repeated divisions. Endosperm tissue is therefore haploid (n).

Embryo and the Seed : First division of the zygote is not accompanied by a transverse or vertical wall; instead, free nuclear divisions of the zygote-nucleus take place.

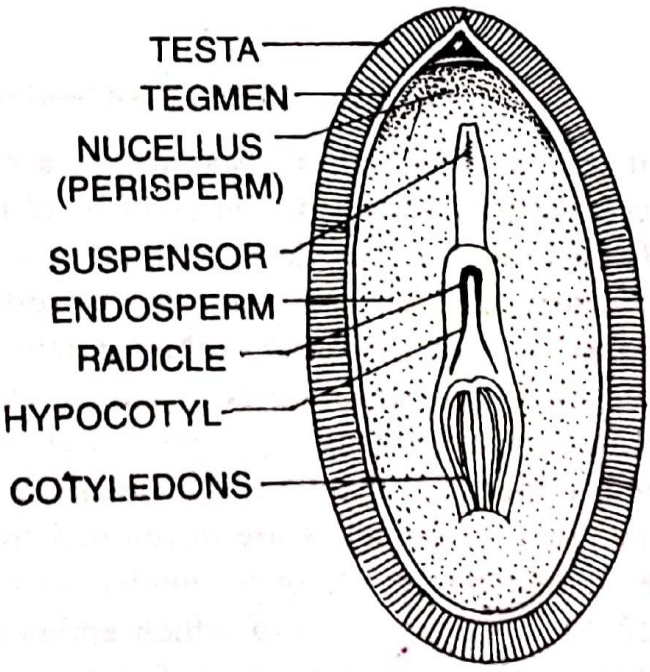


Fig. 3.23 —*Pinus* sp. Longitudinal section of a seed.

The zygote-nucleus passes towards the lower end, then divides twice. The resultant four free nuclei (Fig. 3.21, A) now move to the bottom. Then another

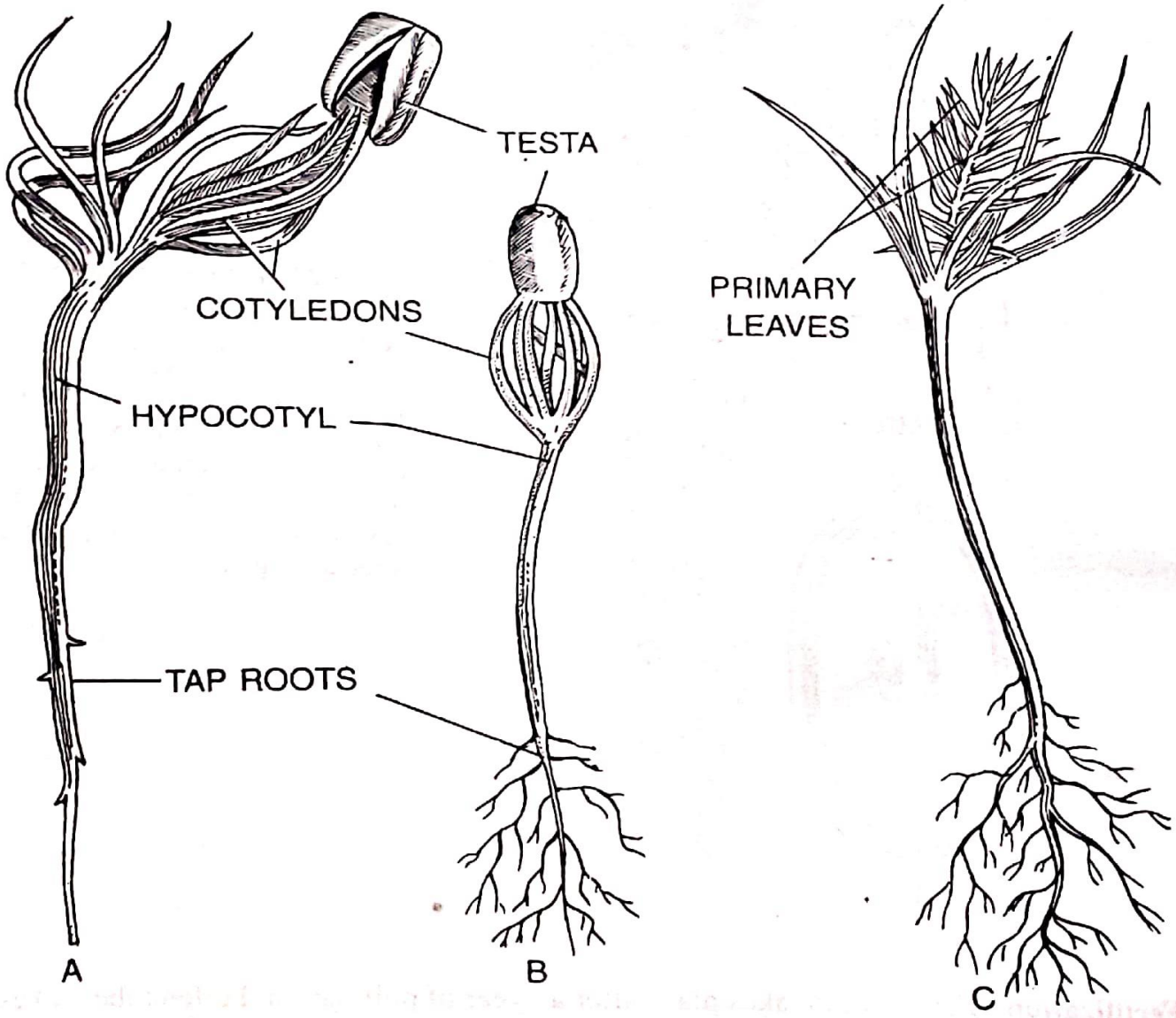


Fig. 3.24 —*Pinus* sp. A-C —Different stages in germination of seed.

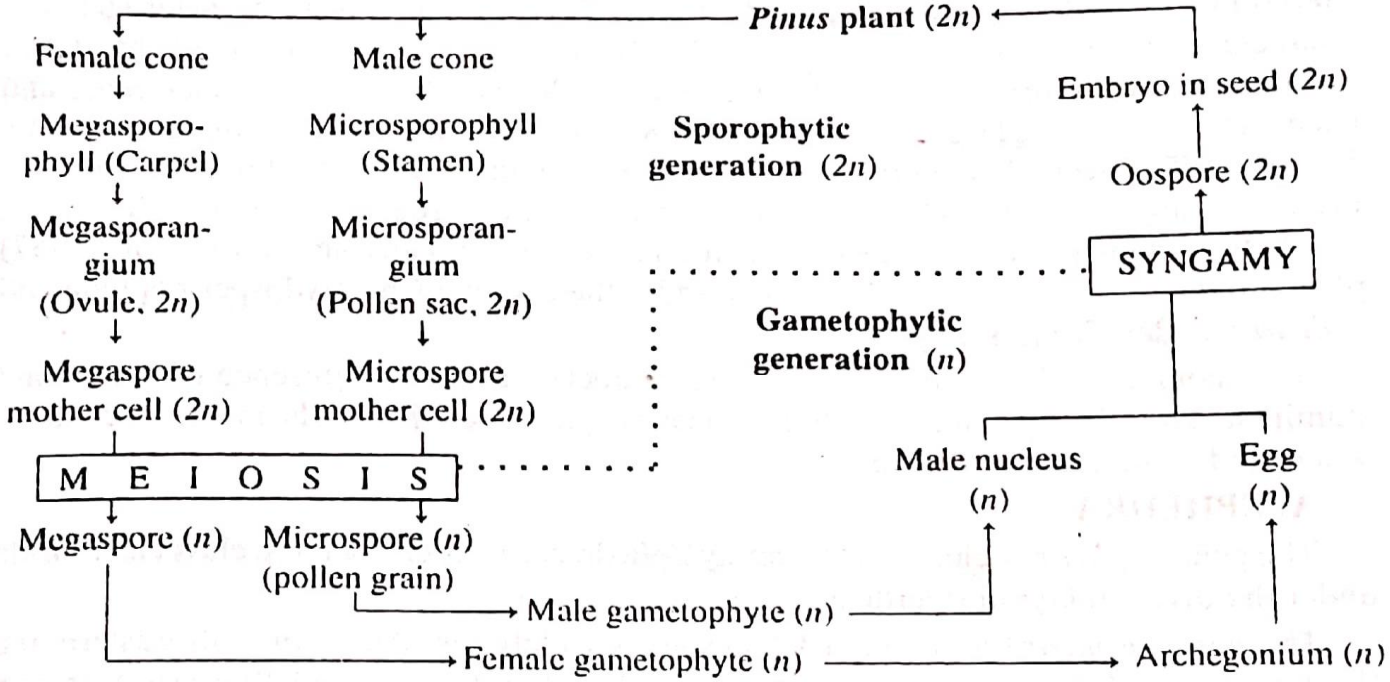
nuclear division takes place and as a result eight nuclei are formed. These eight nuclei arrange themselves in two tiers of four cells each (Fig. 3.21B). Again four cells of the lower tier divide by a transverse wall, the result is the formation of twelve cells arranged in three tiers. Next another division takes place in the cells of the lowermost tier, the result is the formation of sixteen cells in four tiers (Fig. 21, C). This 16-celled structure is called *proembryo* and the four tiers, beginning from below, are known as (a) embryo tier, (b) suspensor tier, (c) rosette tier and (d) open, upper or nutritive tier respectively (Fig. 3.21, D). As each tier contains four cells, so four embryos are developed from four cells of the embryo tier. Cells of the suspensor tier elongate rapidly forming spirally twisted long suspensors (Fig. 3.22,A), by the growth of which embryos are pushed down within the endosperm tissue. Cells of other tiers are functionless. In *Pinus* polyembryony occurs as four potential embryos are developed although only one of them matures ultimately.

The embryo matures and forms the seed. The seed coat is formed from the integument of the megasporangium. The testa is formed from the middle stony layer of the integument and forms the outermost covering of the seed. The outer fleshy layer of the integument is dried up. The innermost layer of the integument is sometimes present as a thin membrane.

The mature seed (Fig. 3.23) also contains perisperm and kernel. Perisperm is a thin, membranous and reddish-brown structure; it is a nutritive tissue and forms a remnant of the nucellar tissue and hence possesses diploid chromosome number. Kernel is also a kind of nutritive tissue which surrounds the embryo; this tissue is composed of cells with haploid chromosome number.

The embryo consists of a radicle, the hypocotyl, 3 to many cotyledons and a plumule. After a period of rest the seed germinates by epigeal means (Fig. 3.24) to form a new sporophytic plant.

Life cycle of *Pinus* (in word diagram)



Economic Importance of *Pinus* –Most of the species of *Pinus* have economic value. The seeds of *P. gerardiana* are edible and commercially known as 'chilgoza' *P. roxburghii* and *P. wallichiana* are timber yielding plants; the timber is used for making furnitures, poles, match boxes, building materials etc. Some species e.g. *P. roxburghii* and *P. insularis* are important sources of resin and turpentine.

Morphology of the Ovuliferous scale of *Pinus* —Various morphological interpretations have been offered by different authors regarding the morphological nature of the ovuliferous scale of *Pinus*. Some of the interpretations given by different authors are discussed as follows :—

1. Robert Brown (1827)—Ovuliferous scale is an exposed carpel developing in the axil of the bract and which bears two naked ovules.

2. Schleiden (1829) —Interpreted the ovuliferous scale as an axial placenta which arises in the axil of the leaf bearing two ovules. The bract scale is the true carpel.

3. A. Brown (1842)—The ovuliferous scale represents the first two leaves of an axillary shoot which are fused by their posterior margins.

4. Baillon (1863)—The ovuliferous scale is regarded as an axillary shoot bearing two bicarpellary ovaries.

5. Eichler (1868)—Bract is a carpel and the ovuliferous scale is a ligular outgrowth from the upper surface.

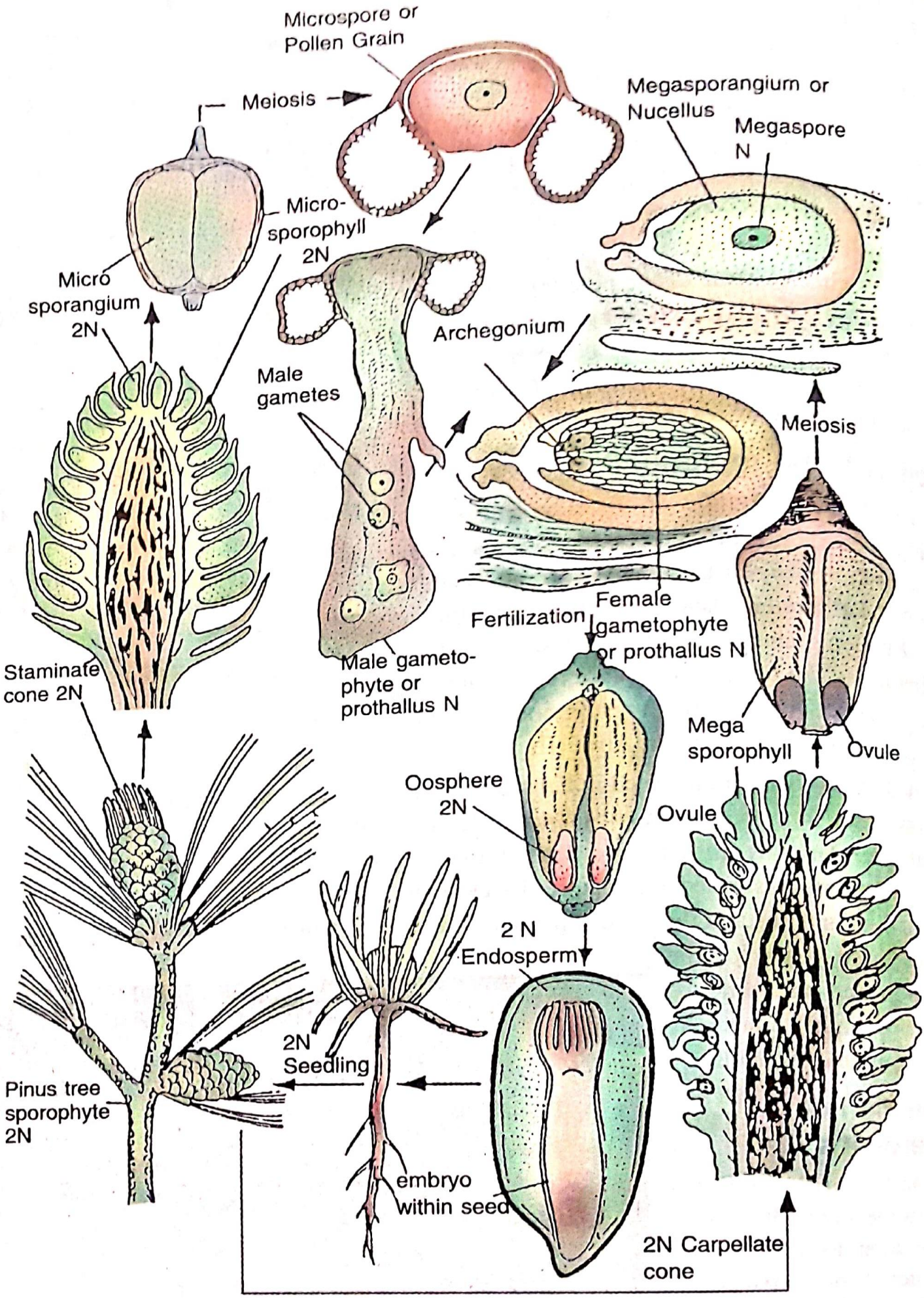


Diagram of Life cycle of *Pinus sp*