Structure of female gametophyte, fertilization and life cycle of *Gnetum sp*

2. **Female gametophyte** —Female gametophyte i.e. the embryo sac is tetrasporic because all the four megaspore nuclei within a tetrasporic cell i.e. megaspore mother cell take part in the development of the gametophyte. The megaspore mother cell containing four megaspore nuclei thus form the female gametophyte (*i.e.* embryo sac). A number of female gametophytes may start developing but only a few attain full maturity. Development of the female gametophyte takes place entirely within the megasporangium.

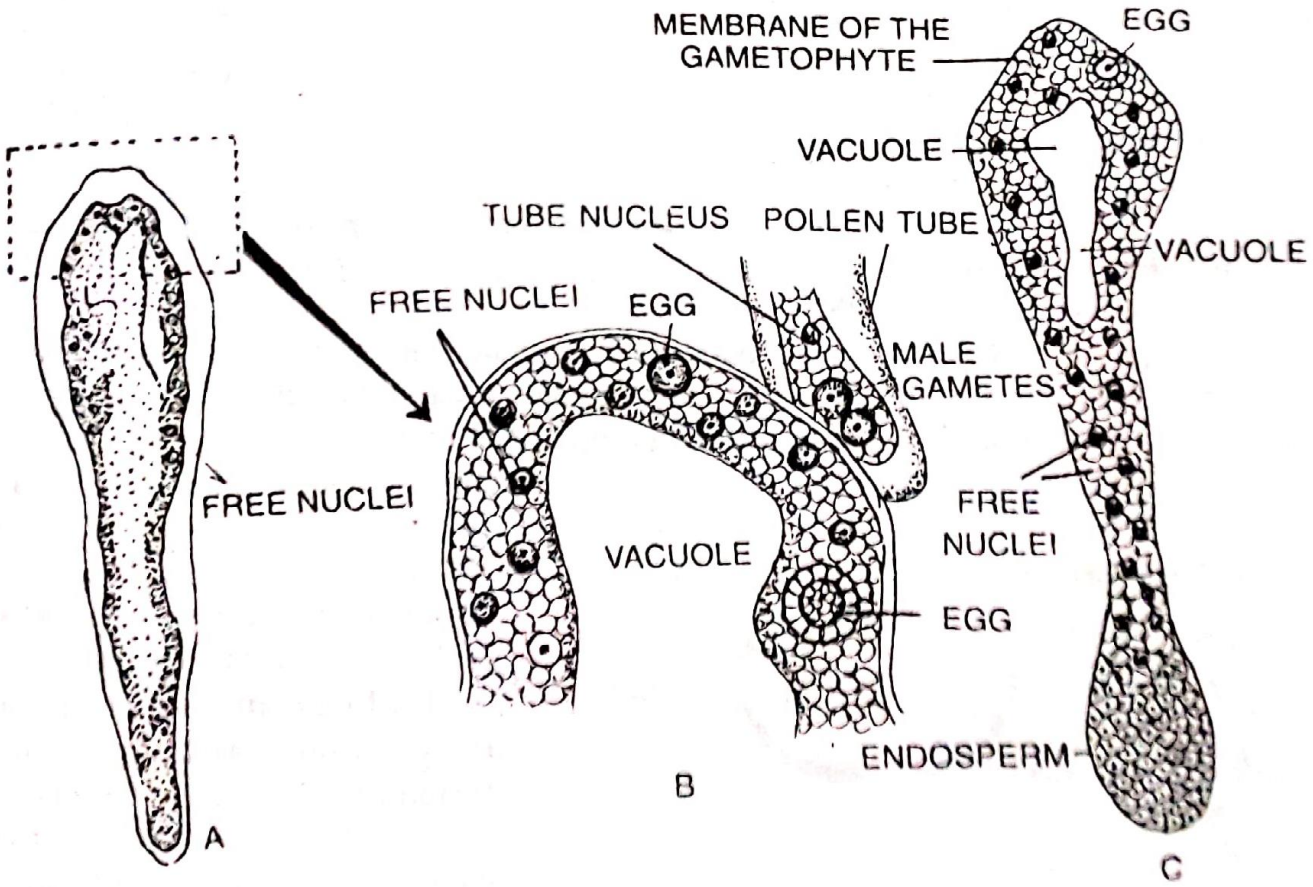


Fig. 3.43 —*Gnetum* sp. A —Female gametophyte in free-nuclear stage. B—Upper part of the female gametophyte showing eggs; a pollen tube containing male gametes is also seen adpressed to the wall of the female gametophyte. C—Later stage of the female gametophyte showing incipient type of endosperm formation before fertilization.

Four megaspore nuclei divide and redivide by free nuclear division into a large number of nuclei which are distributed in the cytoplasm of the embryo sac; then a large central vacuole appears in the centre of the embryo sac and the free nuclei are distributed in the peripheral cytoplasm (Fig.3.43A). The nuclear divisions continue and the upper part of

the embryo sac becomes gradually wider, this wider part contains the vacuole but the lower part contains a greater amount of cytoplasm. Gradually the embryo sac enlarges further, becomes elongated and takes the form of an inverted flask (Fig. 3.43, A).

Lower part of the embryo sac i.e. chalazal region becomes cellular (Fig. 3.43,C) before fertilization. This cellular part is the primary endosperm tissue which serves the nutrition of the gametophyte. A portion of the upper part of the gametophyte remains free nuclear at the time of fertilization. A few free nuclei in this part become larger and differentiate as *eggs i.e.* female gametes (Fig. 3.43, B, C).

Archegonia are not formed at all and, in this regard *Gnetum* resembles an angiosperm female gametophyte.

Pollination —Pollen grains are liberated from the sporangia at the three-nucleate stage. Pollination takes place by the help of wind and insects.

Pollen grains after pollination are caught within the micropylar tube by the help of a drop of a sweet fluid exuded at the tip of the micropylar tube. With the drying up of this fluid-drop, the pollen grains are sucked in within the pollen chamber.

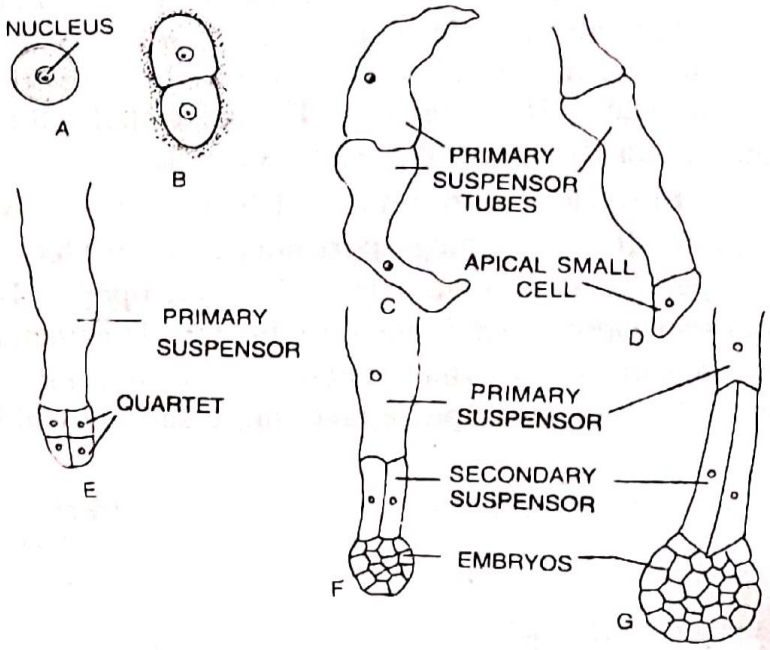


Fig. 3.44 —*Gnetum* sp. A—Zygote. B-G—Different stages in the development of embryo.

Fertilization —Pollen tube is found to lie close to one of the groups of eggs present in the upper part of the female gametophyte. Several pollen tubes after penetrating the nucellus reach the female gametophyte. Both the male cells (gametes) of a pollen tube can fuse with eggs, provided two eggs are present close to such a pollen tube. As a result of fertilization, several zygotes (oospores) are developed of which one matures ultimately and develops into an embryo.

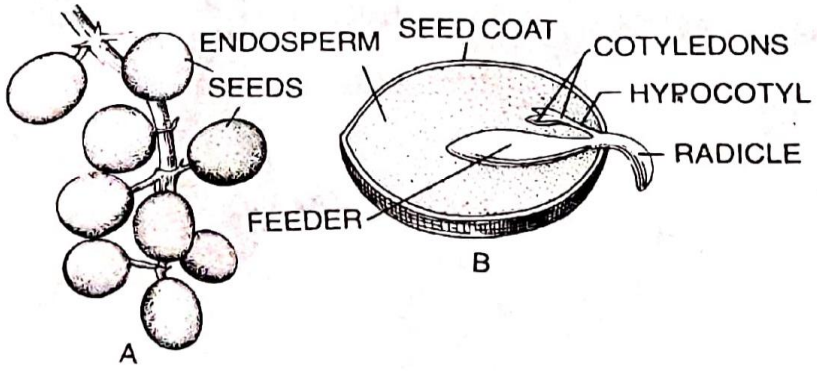


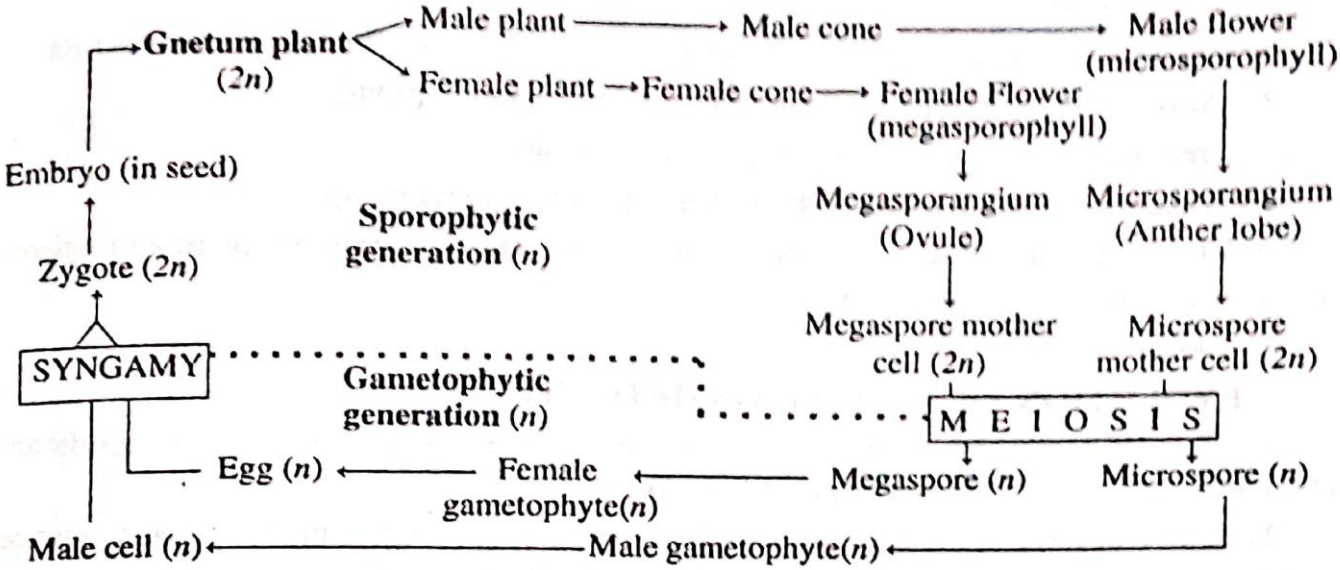
Fig. 3.45—*Gnetum* sp. A—Bunch of seeds. B—L.s. of the seed showing different parts.

Endosperm —Endosperm is cellular, although cell formation generally begins at the chalazal region of the gametophyte before fertilization but the upper part (micropylar region) of the gametophyte remain free nuclear at the time of fertilization. This indicates that endosperm tissue formation takes partly before and partly after fertilization.

Embryo and Seed—Zygote becomes larger and densely cytoplasmic with a prominent nucleus. The first division of the zygote-nucleus is accompanied by a wall formation (Fig. 3.44, B)—as a result two daughter cells are formed; both the daughter cells then elongate to form tube like structures, known as *primary suspensor* tubes (Fig. 3.44, C). Further development may not occur in both the primary suspensor tubes *at the same*

time but one may develop earlier than the other. A small cell is cut off at the tip of each primary suspensor tube (Fig. 3.44, D) which divides transversely and then longitudinally to form a quartet (Fig. 3.44, E). From the apical two cells of the quartet, a globular mass of cell i.e. embryo proper (Fig. 3.44, F) develops, while the cells situated towards the primary suspensor elongate and divide further to form a long secondary suspensor (Fig. 3.44, G) which pushes the embryo deep within the endosperm. The mature embryo consists of a root protected by the large root cap, two cotyledons, the stem tip and large feeder (Fig. 3.45,B). The feeder is developed from the hypocotyl base. It absorbs nourishment from the endosperm. The phenomenon of polyembryony is noted in *Gnetum*.

Life cycle of Gnetum (in word diagram) :—



Seeds (Fig. 3.45, A) are large, oval or elongate, green or red in colour. The seed is provided with a seed coat of three layers—an outer fleshy layer, a middle stony layer and an inner papery layer. Inside the seed there is a copious endosperm, the embryo is a dicotyledonous type—a feeder is formed from the base of the hypocotyl and this takes nourishment from the endosperm. The radicle comes out first at the time of germination. The process of germination of the seed is hypogeal.

Angiospermic characters of *Gnetum* : *Gnetum* resembles angiosperms due to the presence of following features :—

(*a*) In habit, *Gnetum* presents a remarkable resemblance to a dicotyledonous plants like lianes, shrubs or small trees.

(*b*) The shoot apex of *Gnetum* is similar to that of angiosperms in having tunica and corpus.

(*c*) Like dicot leaves, the leaves of *Gnetum* are broad with reticulate venation, and arranged in opposite decussate manner.

(*d*) Like angiosperms, the xylem of *Gnetum* is composed of true vessels (tracheae) in addition to tracheids with bordered pits.

(*e*) Cones of *Gnetum* look like the catkin type of inflorescences of some earlier angiosperms.

(*f*) In the presence of perianth in male and female flowers, *Gnetum* resembles angiosperms. The well developed micropylar tube (formed by the elongation of the inner envelope of the ovule) of the female flower is looked upon as the 'style' of angiosperm flower.

(*g*) Megasporogenesis in *Gnetum* is like that of angiosperms. Female gametophyte is tetrasporic i.e., female gametophyte develops from four functional megaspore nuclei.

(*h*) Like angiosperms, female gametophyte is without archegonia. Secondly, like angiosperms, at least a portion of the upper part of the gametophyte remains free nuclear at the time of fertilization where differentiation of egg takes place.

(*i*) Complete endosperm tissue formation takes place after fertilization—a character like those of angiosperms.

(*j*) Male gametophyte is much more reduced, and without stalk cell like angiosperms.

(*k*) Like angiosperms, the first division of the zygote-nucleus is accompanied by laying down a wall.

Gymnospermic characters of *Gnetum* : *Gnetum* resembles gymnosperms in the following characters :

(*a*) The composition of phloem of *Gnetum* is typically like that of gymnosperms.

(*b*) Presence of prothallial cell (one) in the male gametophyte.

(*c*) Free nuclear divisions in the female gametophyte.

(*d*) Presence of rudimentary pollen chamber at the nucellus tip.

(*e*) The nature of endosperm tissue and the formation of incipient type of endosperm tissue at chalazal region before fertilization.

(*f*) Naked seeded condition.

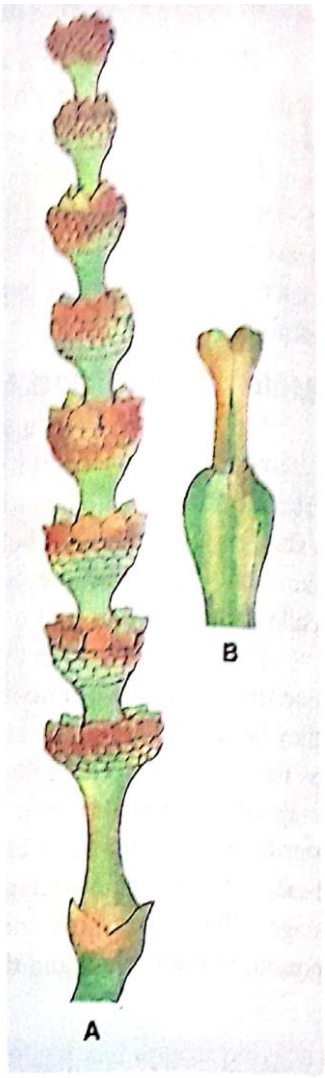


Fig. 16.15. (A-B) *Gnetum gnemon*. A male cone bearing an ovular ring above the male flowers above each collar; B. A male flower (After Vasil).

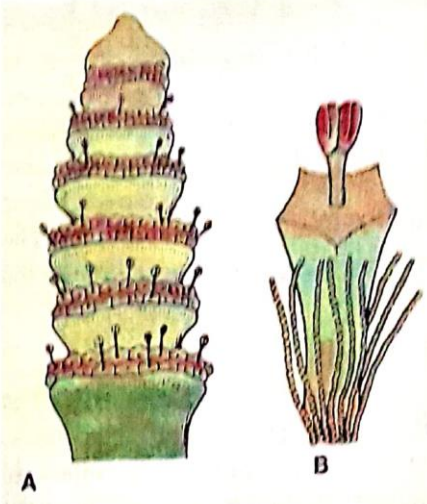


Fig. 16.14. (A-B) *Gnetum ula*. A. portion of male strobilus; B. Single male flower.

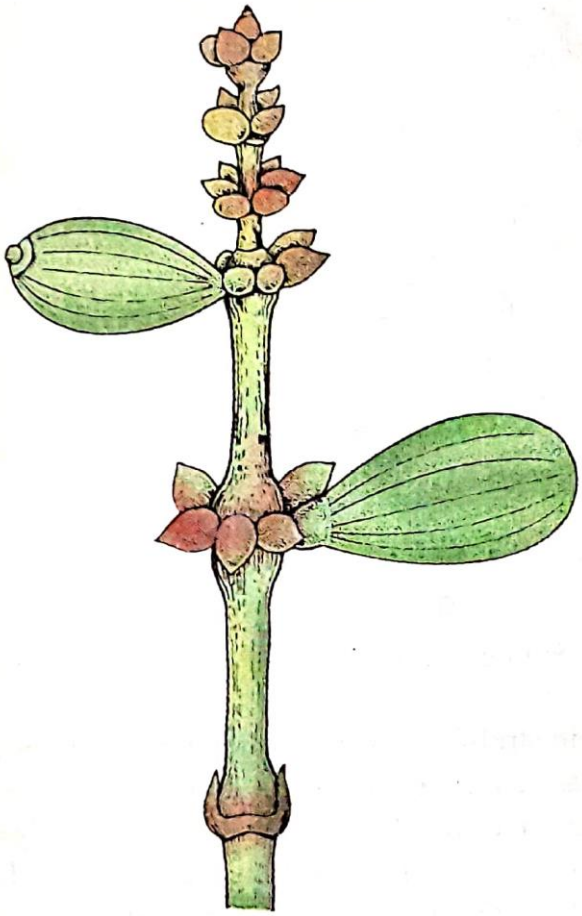


Fig. 16.21. *Gnetum gnemon.* A female strobilus bearing two seeds.

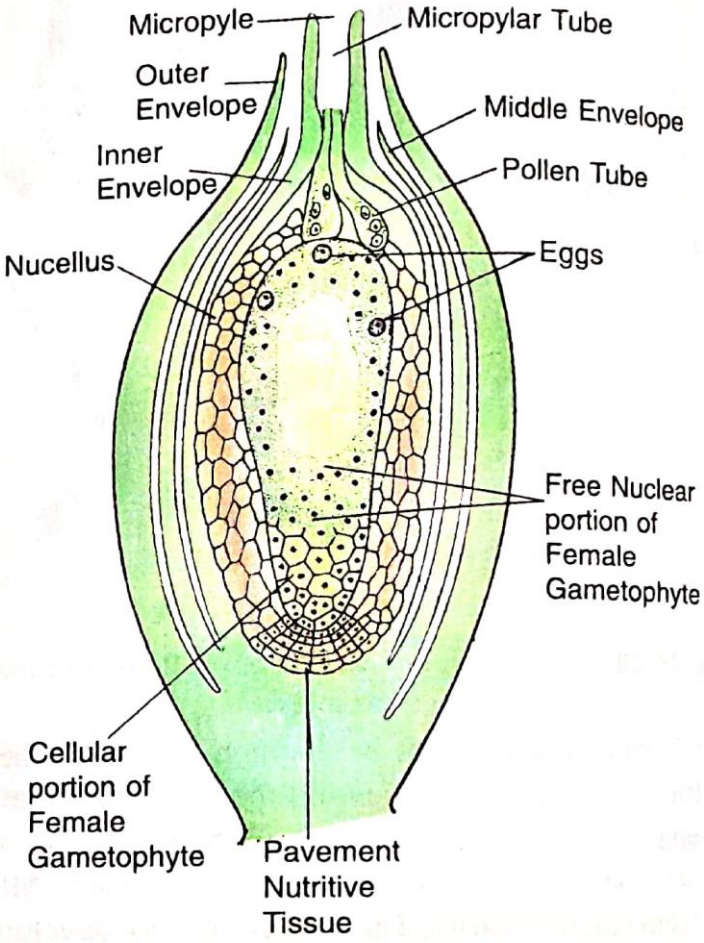


Fig. 16.22. L.S. of ovule of a *Gnetum sp.*

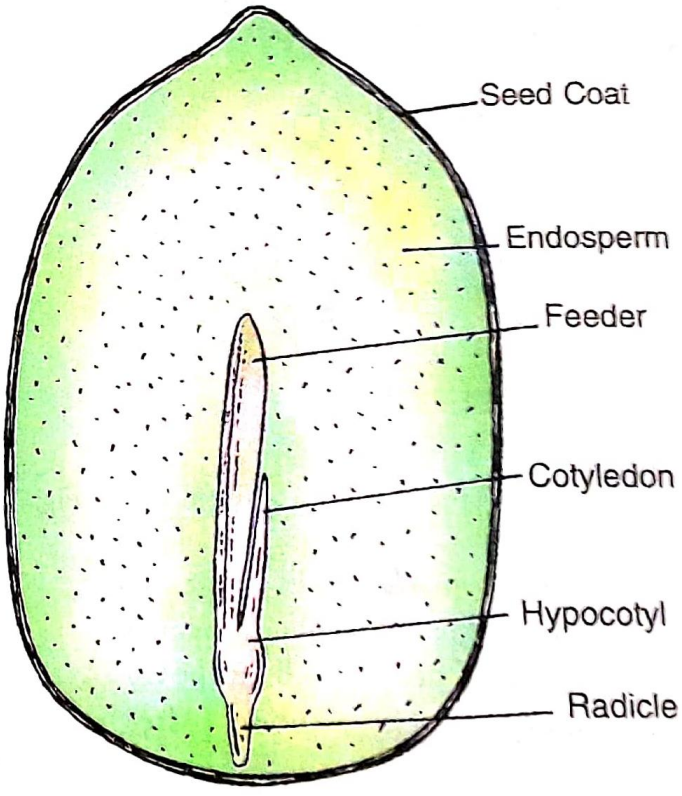


Fig. 16.40. L.S. Seed of *Gnetum* sp.

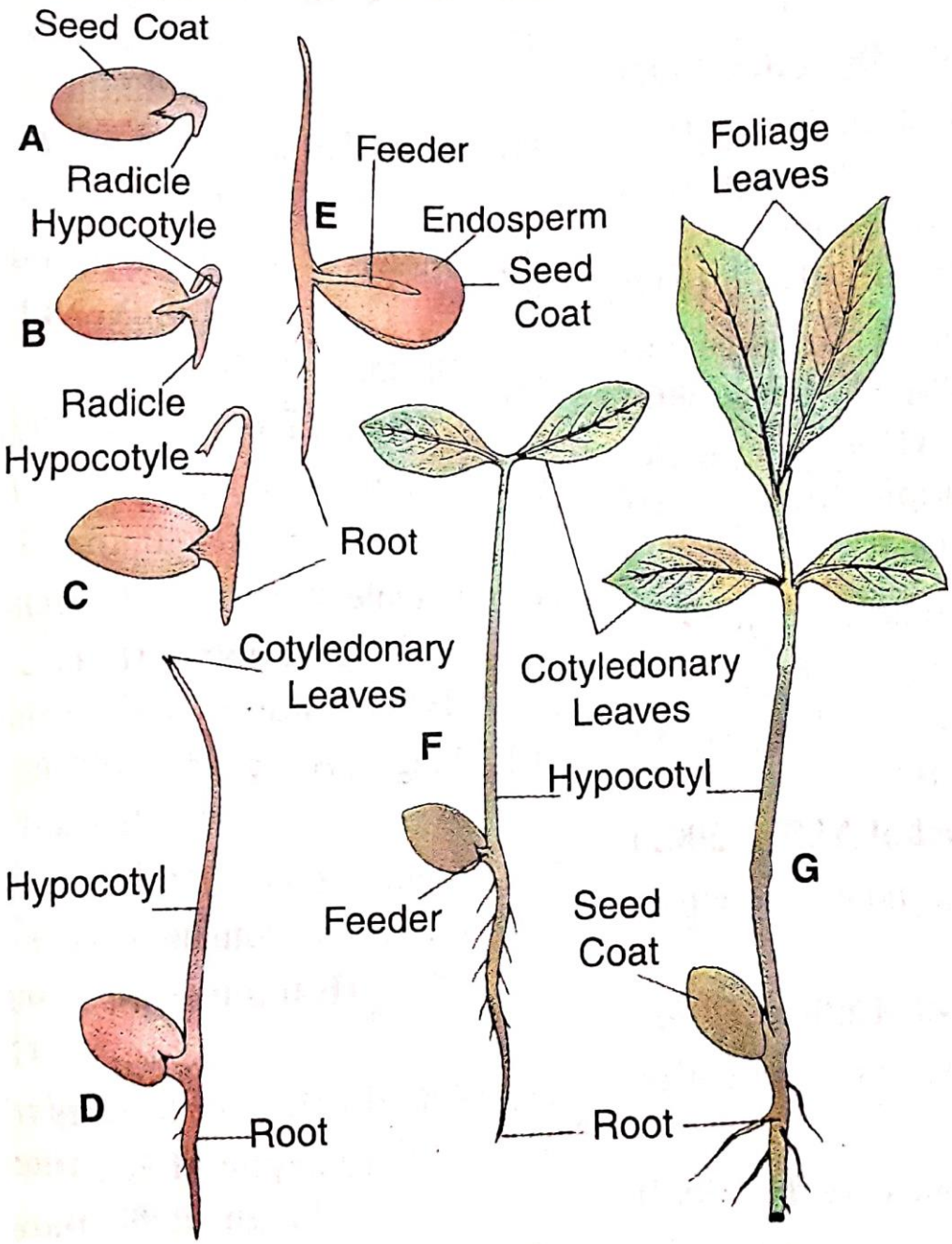


Fig. 16.41. (A-G) Various stages in the germination of seed in *Gnetum* sp.

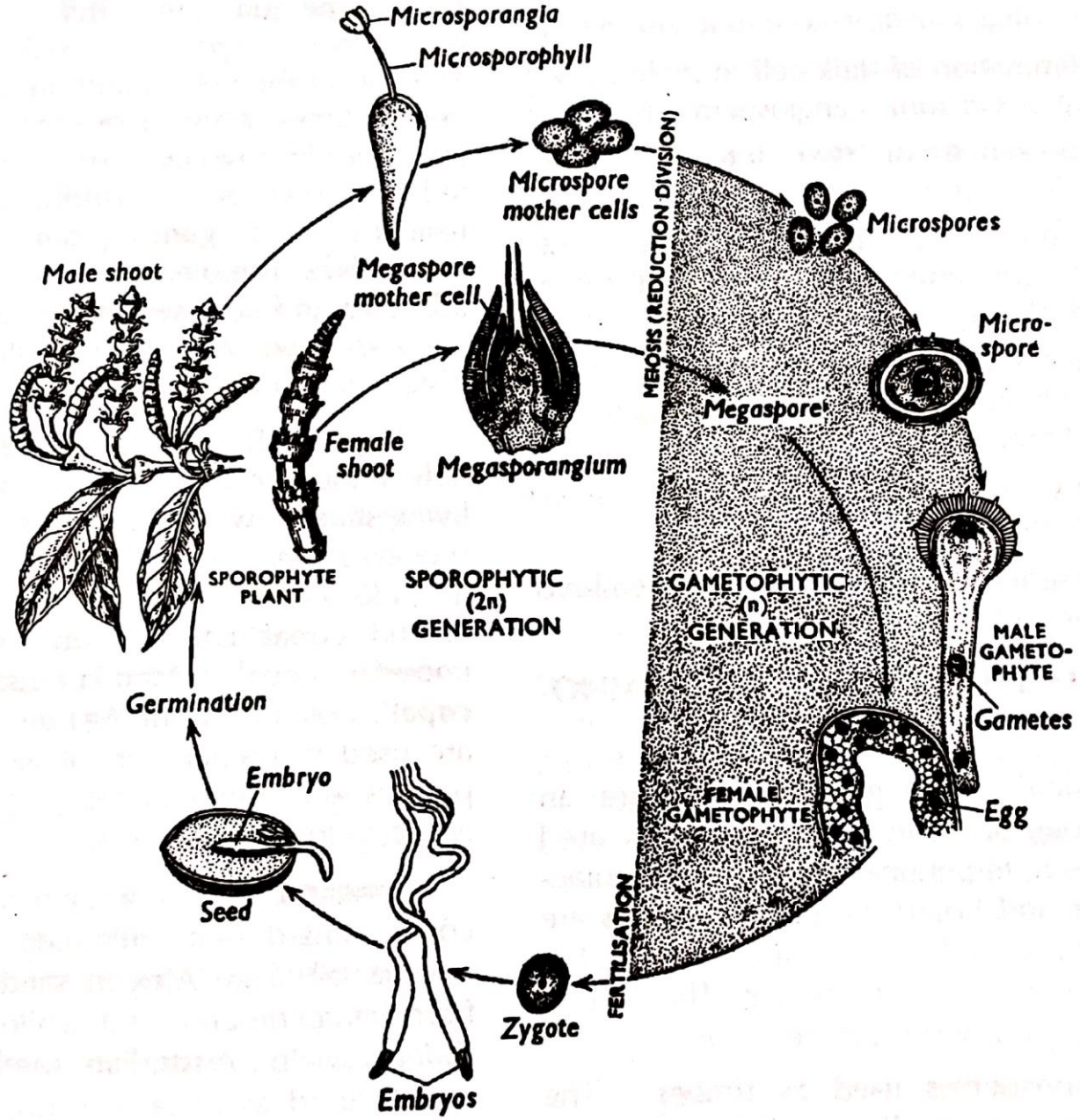


Fig. 1.82 : Life cycle of *Gnetum*