CYCAS

Division : Cycadophyta

Class : Cycadopsida

Order : Cycadales

Family : Cycadaceae

Genus : Cycas

Gymnosperms are plants which produce naked seeds i.e., plants which lack ovary and hence do not produce fruits. Cycas belongs to this group of plants.

The genus **Cycas** is the most widely distributed genus of the order cycadales. There are about 20 species which grow in the wilderness in China, Japan, Australia, Africa, Nepal, Bangladesh, Burma and India. **C. circinalis, C. pectinata, C. rumphii** and **C. beddomei**, are found in the wilderness in India. **C. revoluta** is grown in gardens in India.

Species of Cycas are of considerable economic importance. Starch is extracted from several species of Cycas. Young succulent leaves are used as vegetable in some parts of India. Several species of Cycas are of medicinal value. The juice of young leaves of C. circinalis is used as a remedy for stomach disorders, flatulence, blood vomiting and skin diseases. The decoction of young seeds of this species is purgative and emetic. A tincture prepared from the seeds of C. revoluta is used to relieve headache, giddiness and sore throat.

Anatomy

Normal root: A cross section of normal root (fig) consists of epiblema, cortex and central vascular tissue.

Epiblema: It is composed of a single layer of thin-walled cells.

Cortex: It is a multilayered zone of thin-walled parenchymatous cells. These cells are filled with starch. Tannin cells and mucilage cells are also present in the cortex. The innermost layer of the cortex is endodermis. Pericycle is a multi-layered zone found next to endodermis.

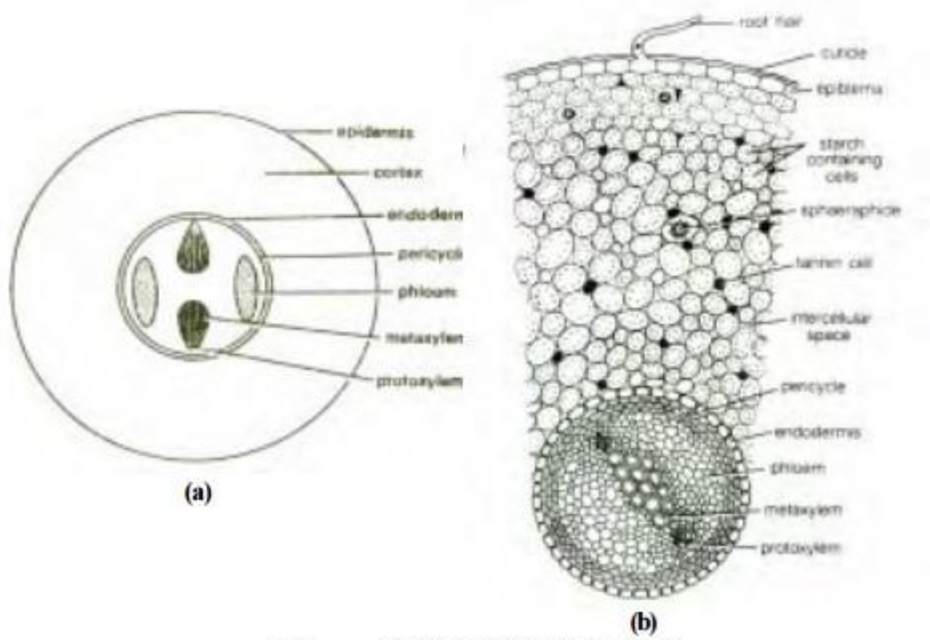


Fig. Cycas - Normal young root
(A) Ground plan TS (B) A portion enlarged

Vascular tissue: This tissue forms a central diarch stele. The diarch steel refers to the presence of two patches of protoxylem points. The xylem consists of xylem tracheids. A tracheid is one celled, non-living, elongated xylem element with thick lignified and pitted cell walls. The xylem is exarch i.e., the protoxylem is pointing towards the periphery while the metaxylem is located near the centre of roots. The pith is either reduced or completely absent.

The normal roots exhibit secondary growth, which starts by the formation of cambium strips that are formed inner to the primary phloem strands (fig). These cambium strips cut off secondary phloem towards the outer side and secondary xylem towards the inner side. Due to the development of secondary structures the primary phloem is crushed while the primary xylem is found in the centre. A distinct layer of cork cambium (phellogen) arises in the outer region of cortex which gives rise to cork (phellem) on its outer side and secondary cortex (phelloderm) on its inner side. Cork, cork cambium and cork cortex or secondary cortex are collectively known as periderm.

Coralloid roots: The internal structure of coralloid roots is similar to that of normal roots except in certain respects. The cortex of coralloid root is differentiated into i) outer cortex composed of polygonal cells, ii) inner cortex consisted of thin-walled parenchymatous cells and iii) middle cortex made up of a single layer of loosely connected thin-walled and radially elongated cells with blue green algal forms such as Anabaena or Nostoc. Coralloid roots show little or no secondary growth.

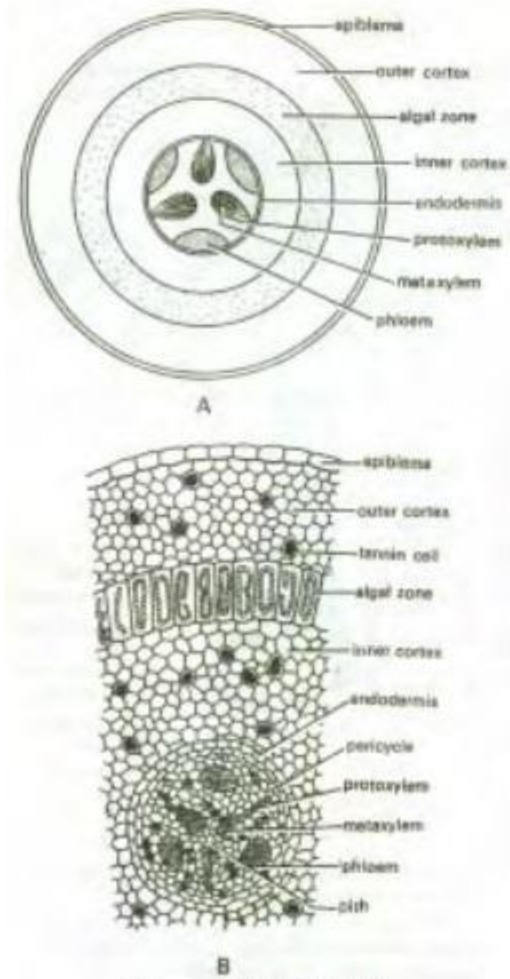


Fig. Coralloid root
A. Ground plan TS B. A portion enlarged

Stem : The stem is irregular in outline due to the presence of numerous persistent leaf bases. Its internal structure is similar to that of dicots of Angiosperms. Young stem of cycas is differentiated into epidermis, cortex and vascular cylinder (fig). The epidermis is the outermost layer of stem covered with a thick cuticle. Cortex forms the major part of the stem. It is composed of parenchymatous cells with rich starch grains. The cortex is traversed by several mucilagenous canals and many leaf traces. The inner most layer of cortex is endodermis which is followed by pericycle. However, these two regions are not distinctly seen.

In the young stem, vascular region is very small when compared to the cortical zone. There are several vascular bundles arranged in a ring. The vascular bundles are conjoint, collateral, endarch and open. The individual bundles are separated by parenchymatous medullary rays. The xylem consists of tracheids and paraenchyma. Xylem vessels are absent. The phloem consists of sieve tubes and phloem parenchyma. There are no companion cells.

There is a parenchymatous pith present in the centre of the stem. The pith cells are rich in starch and some cells contain tannin and mucilagenous substances.

Secondary growth i.e., the formation of secondary xylem and secondary phloem from cambium as found in dicot stems, is observed in old stems of C*ycas*. In addition to secondary xylem and secondary phloem, the cambium also forms parenchymatous medullary rays. A well developed stem of **Cycas** is called manoxylic because the wood is not compact due to well developed pith, cortex and broad medullary rays with limited vasculature.

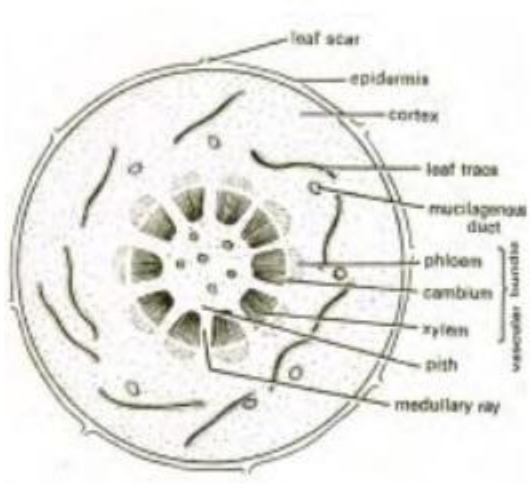


Fig. Young Stem TS

Rachis : Transverse section of rachis is more or less circular in outline. It has two rows of leaflets inserted on one side. The internal structure is differentiated into epidermis, hypodermis, ground tissue and vascular tissue (fig).

Epidermis is covered with a thick cuticle. The epidermis is interrupted by sunken stomata. The epidermis is followed by hypodermis. The hypodermis consists of outer thin-walled chlorenchymatous cells (2-3 layers) and the inner thick walled sclerenchymatous cells (4-5 layers). The ground tissue consists of parenchymatous cells with mucilage canals.

The vascular bundles are arranged in an inverted omega-shaped manner. The bundles are conjoint, collateral, open and diploxylic. Diploxylic condition refers to the presence of centrifugal and centripetal xylem.

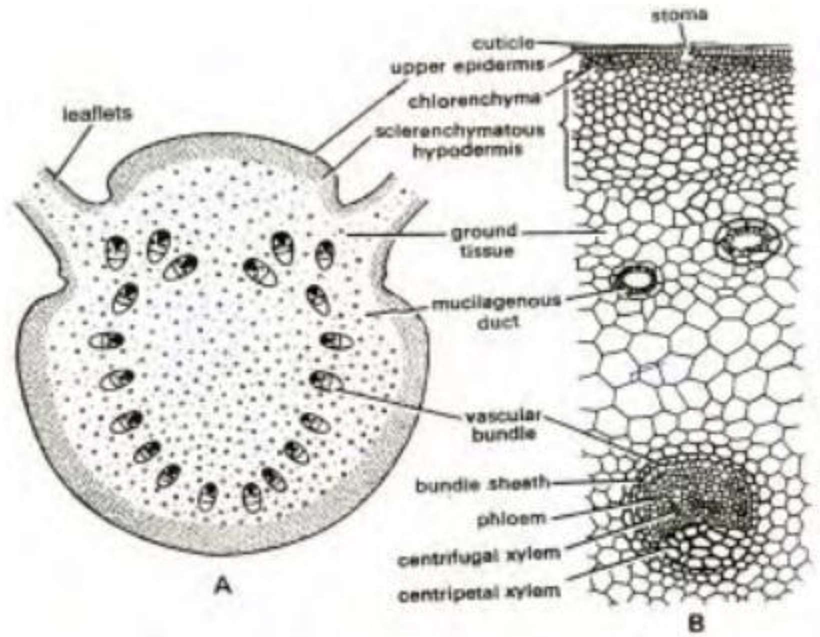


Fig. **Rachis A. Ground plan B. A portion enlarged**

Leaflet : Transverse section of **C***ycas* leaflet shows the following tissues i) upper and lower epidermis, ii) hypodermis, iii) mesophyll, iv) transfusion tissue and v) vascular bundles.

1. The upper and lower epidermis are the outermost cellular layers (one celled thick) of the upper and lower sides respectively of the leaflets. Both of them are covered by thick cuticle. The upper epidermis is continuous, whereas the lower epidermis is interrupted by sunken stomata.

2. Hypodermis : This layer is made up of sclerenchymatous cells. The hypodermal layer protects the plant from over-heating and excessive transpiration.

3. Mesophyll : This tissue consists of palisade and spongy parenchyma cells. The palisade layer is a single continuous layer of column-like cells. The spongy parenchyma consists of several layers of loosely arranged oval or

irregular cells. Both palisade and spongy parenchyma cells are rich in chloroplasts.

4. Transfusion tissue : This tissue consists of two small groups of short and wide tracheid-like cells with thickenings / pits on their walls. A few layers of transversely elongated cells are present in both the wings between palisade and spongy parenchyma cells. These layers are called accessory transfusion tissue or secondary transfusion tissue.

6. Vascular bundle : There is only one vascular bundle present in the midrib region of the leaflet. It is conjoint, collateral, open and diploxylic. The triangular centrifugal xylem is well-developed with endarch protoxylem. Phloem is arc-shaped and remains separated by cambium. Phloem consists of sieve tubes and phloem parenchyma. Companion cells are absent.

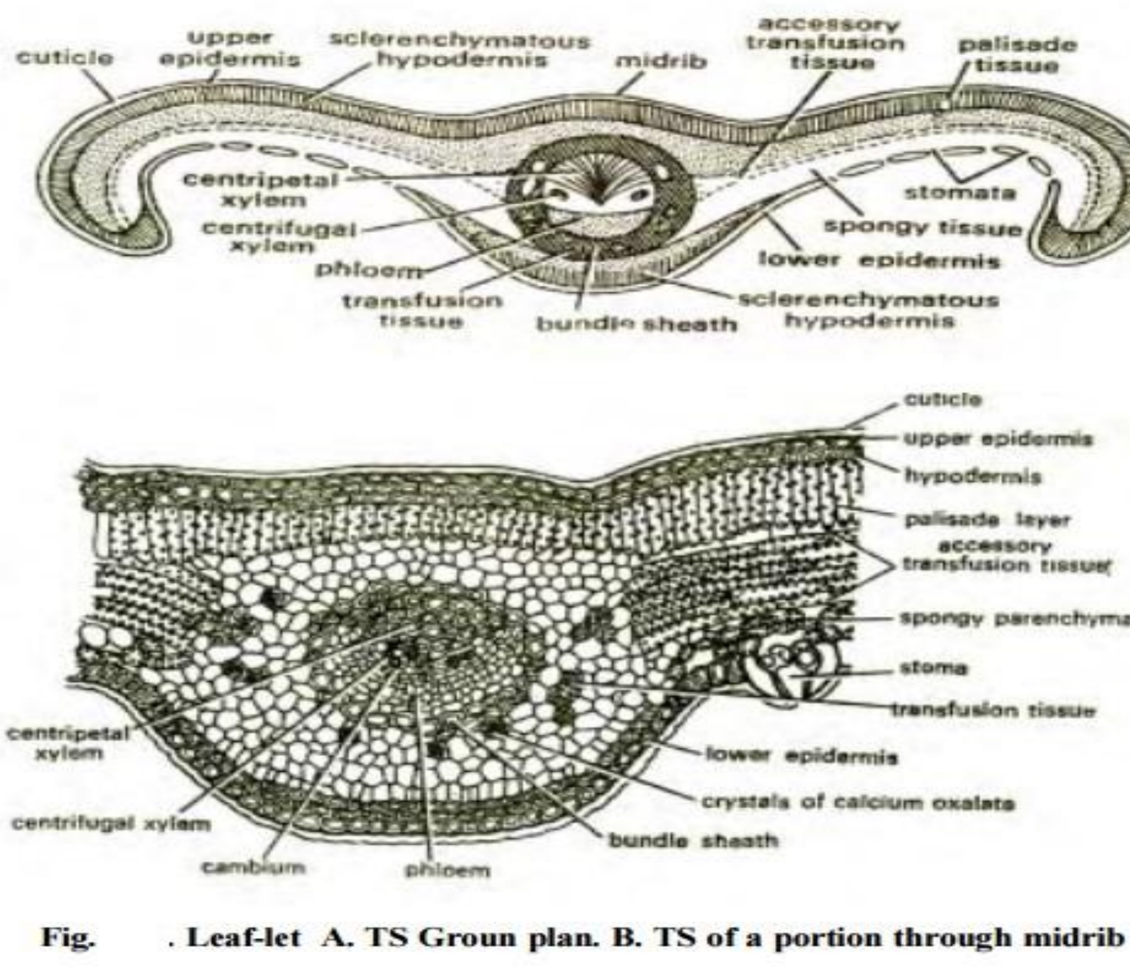


Fig. . Leaf-let A. TS Groun plan. B. TS of a portion through midrib

Reproduction : **Cycas** reproduces by vegetative and sexual means.

Vegetative reproduction

Vegetative reproduction is by the formation of adventitious buds or bulbils . The bulbils develop from the basal part of stem especially from cortical cells. They are found between the persistent leaf bases. They are more or less oval shaped. Several scale leaves are arranged spirally and compactly over a dormant stem in a bulbil. Upon detachment from the stem, a bulbil germinates to produce a new plant. A bulbil from male plant produces a new male plant while a bulbil from female plant produces a new female plant.

Sexual Reproduction : Cycas is strictly dioecious i.e., male and female plants are distinctly different from each other.

The male plant of Cycas produces male strobilus (cone) at the apex of the stem in between the crown of foliage leaves. Each male cone is a shortly stalked compact, oval or conical woody structure. It is 40-80 cm in length, perhaps the largest among plants. Each male cone consists of several microsporophylls which are arranged spirally around a central axis. Each microsporophyll is a woody, brown coloured and more or less horizontally flattened structure with a narrow base and an expanded upper portion. The upper part is expanded and becomes pointed at its tip. Pollen grains or microspores are produced at the end of meiotic division of microspore mother cells found in the microsporangium.

Male gametophyte

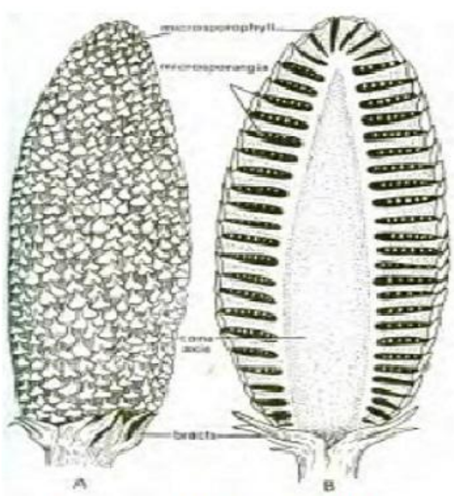
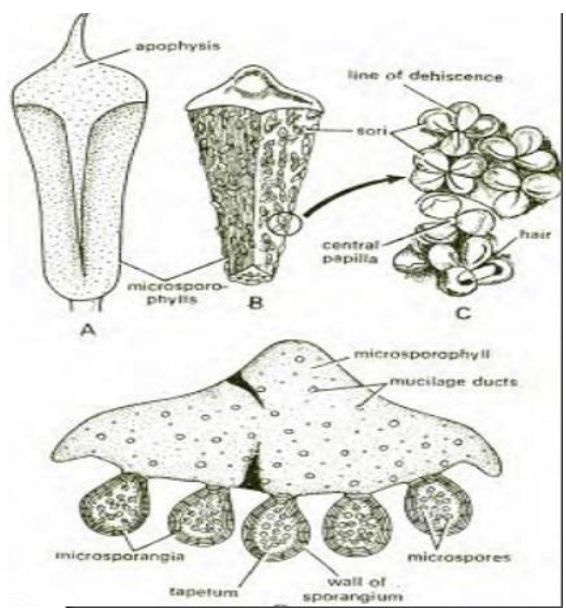


Fig. Microsporophyll
A. Entire, cone B. longitudinal section



Each microspore on pollen develops into male gametophyte partly even before the release of pollens from microsporangium. The transfer of pollens from male plant to the female plant is called pollination. At this stage, the male gametophyte has a prothallial cell, a generative cell and a tube cell. Dispersal of pollens is effected by wind (anemophyllous). Further development of male gametophyte starts only after the pollen reaches nucellar surface of the ovule where the pollen germinates to produce pollen tube. The pollen tube carries two top-shaped sperms. Each sperm contains thousands of cilia . By means cilia, the sperms move freely in the pollen tube.

The pollen tube penetrates the nucellar region of the ovule and subsequently delivers the male gametes into the archegonial chamber.

The female plant produces megasporophylls that are not organised into cones and instead they occur in close spirals in acropetal succession around the stem apex (fig). New megasporophylls are produced in large numbers every year. The megasporophylls of a year occupy the region between the successive whorls of leaves. The growth of the female plant is monopodial; the axis contines to grow as it produces foliage leaves and megasporophylls.

Each ovule consists of a large nucellus surrounded by a single integument. The integument remains fused with the body of the ovule except at the apex of the nucellus where it forms a nucellar beak and an opening called micropyle. The opposite end of the microphyle is called chalaza. The integument is very thick and is differentiated into three layers - the outer and inner fleshy layers and a hard and stony middle layer. Some cells in the nucellar beak dissolve to form a pollen chamber. The young ovule is green and hairy whereas the mature one is red or orange without hairs.

One of the deeply situated cells in the nucellus differentiates into megaspore mother cell and divides meiotically to produce 4 linearly arranged haploid megaspores. Of the four megaspores, the upper three cells degenerate while the lowermost acts as functional megaspore.

Female gametophyte : The functional megaspore develops into a large, haploid multicellular tissue called female prothallus or endosperm. The nucellus is used up as the female gametophyte develops. At this stage, some superficial cells of the female gametophyte at the micropylar end enlarge and develop into 2-8 archegonia. Each archegonium has a large egg nucleus and venter canal nucleus. The arehegonial chamber is found above the archegonia.

The megasporophylls are considered to be modified leaves. They are flat, dorsiventral and measuring 15-30 cm in length. A megasporophyll is differentiated into a basal stalk and an upper pinnate lamina. Ovules are formed on the lateral sids of the stalk. The number of ovules per megasporophyll varies from 2-10 depending upon the species.

Ovule : The ovule of Cycas is orthotropous and unitegmic. It is sessile or shortly stalked.

Fig.1.70. Structure of ovule LS the largest ovule (about 6 cm length and 4 cm width) in the plant kingdom.

Fertilization : The fusion of male and female gametes is called fertilization. The pollen tube of the pollen releases sperms or male gametes into the archegonial chamber. Normally, only one male gamete enters each archegonium and fuses with the egg thus resulting in the formation of zygote. Only one egg, in any one of the archegonia, is fertilized. The diploid zygote develops into embryo. The embryo takes about one year for its complete development. The ovule ultimately gets transformed into seed.

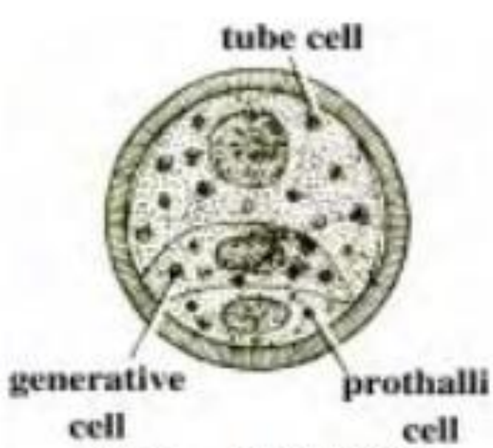


Fig. Pollen grain

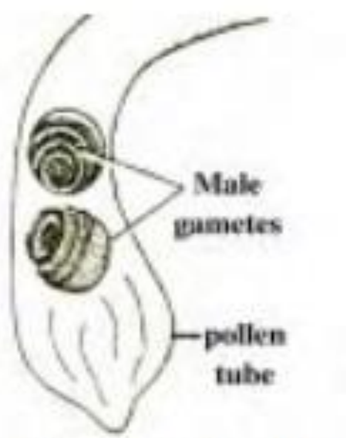


Fig. Pollen tube with male gametes

A **B**

Fig. Cycas

A. Cluster of megasporophylls at the apex of the stem B. Single megasporophyll

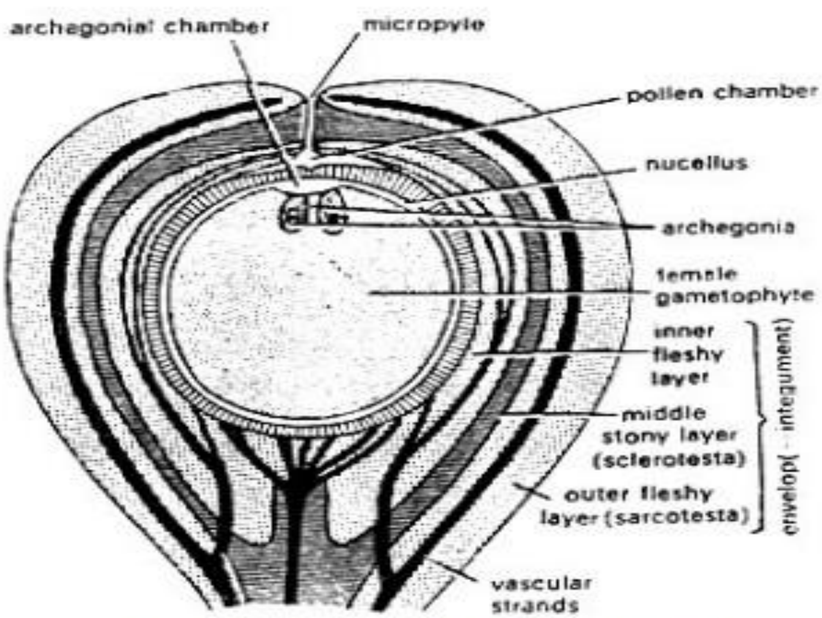


Fig. Structure of ovule LS