

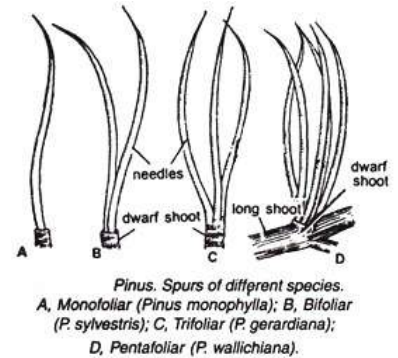
Pinus

Occurrence

1. The genus *Pinus* has about 90 species. It has world wide in distribution.
2. They are mostly present in the temperate regions.
3. Four species of pinus are found in Pakistan: *Pinus wallichiana*; *Pinus halepensis*; *Pinus roxburghil*; *Pinus gerardiana*.

General Structure

1. The plant body is **sporophyte**.
2. It is an **evergreen** tall tree.
3. Plant body is divided into root, stem and leaves
4. Stem: The main trunk is **unbranched**.
5. It has **branches** confined to the **apical region**.
6. These branches form a characteristic **canopy**.
7. It is covered with a **scaly bark**. Its branches are **dimorphic**.



(a) Branches of unlimited growth:

The main branches have an unlimited growth. They bear only scale leaves.

(b) Branches of limited growth:

1. Branches of limited growth or **dwarf branches** are produced in the axil of the scale leaves on the main branches.
2. These are about 1 -2cm long.
3. These are covered by one or two scale leaves.
4. These branches also bear **foliage leaves**.
5. A dwarf shoot with its foliage leaves is called **spur**.

Leaf

Pinus has two types of leaves: scale leaves and foliage leaves.

(a) **Scale leaves:** The scale leaves are small, membranous and brownish in colour. These are protective in function. They are present on the main and dwarf shoots.

(b) **Foliage leaves:** The foliage leaves are green and needle-like. They are found only on the dwarf shoots forming the **spur**.

Roots

Pinus has a well developed **tap root**. It remains short and grows on hard ground or rocks. The **lateral roots** are well developed. These roots spread over a large area. **Young roots** are diseased with a **fungus** to form **mycorrhizae**.

Internal Structure of the Stem

Stem is differentiated internally into epidermis, cortex, vascular tissue and central pith.

Epidermis:

- The surface is covered by an epidermis.
- It consists of a single layer of cells.
- Outer walls of these cells are highly **cutinized**.
- Below the epidermis is a **hypodermis** which is formed of layers of **lignified** cells.

Cortex:

- The cortex is formed of parenchymatous cells.
- Cortex has a large number of **resin canals**.
- Each resin canal is surrounded by a layer of resin secreting glandular epithelial cells.

Vascularbundler:

- The vascular bundles are **conjoint, collateral** and **open**.
- They form a ring around the **pith**.
- In each vascular bundle the **xylem** is towards the **inner** side and **phloem** towards the **outside**.
- A narrow strip of **cambium** is present between xylem and phloem.
- **Pericycle** is present outer to the ring of vascular bundles.
- A single layered thin walled endodermis is present outside the pericycle.
- **Secondary growth** takes place by the activity of **cambium ring**.
- There are distinct **annual growth rings** in the wood.

Bark:

- **Phellogen** originates in the deeper layers of the cortex.
- It is present in the form of strips.
- It produces characteristic scaly bark.

Internal structure of Leaf

A transverse section shows following internal parts of the leaf:

Epidermis:

- Leaf is covered by thick walled epidermis.
- Epidermis is covered by a thick layer of cuticle.

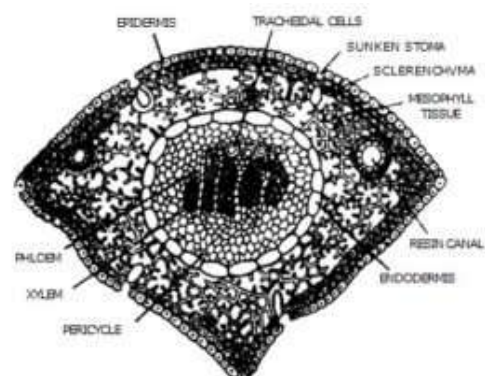
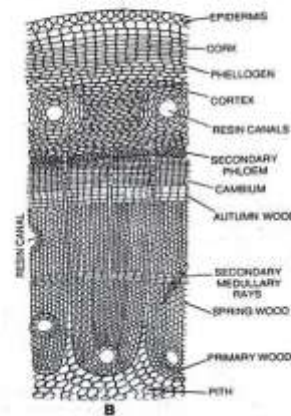
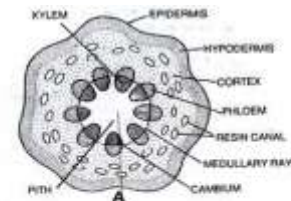


Fig. Section of leaf

- **Sunken stomata** are present below the general surface.
- Two or three layered **hypodermis** is present underneath the epidermis.
- Hypodermis is composed of **sclerenchymatous tissues**
- This hypodermis is the main **strengthening tissue** of the leaf.

Mesophyll

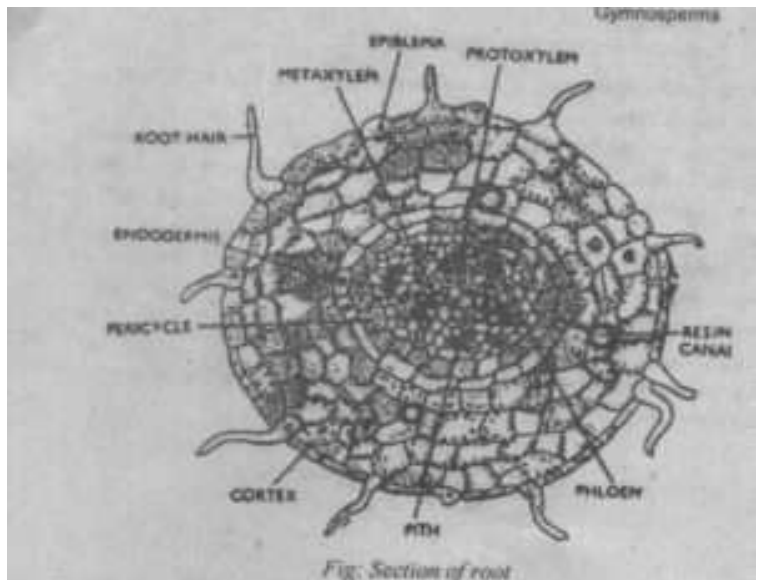
- The mesophyll of the leaf is **parenchymatous**.
- It is not differentiated into palisade and spongy parenchyma.
- Resin **canals** are present below the hypodermis.
- Each resin canal is lined by a layer of small epithelial cells.
- Each leaf is supplied by two unbranched veins.

Endodermis and vascular tissues:

- Endodermis is present outside the **pericycle**.
- Pericycle surrounds the xylem.
- Pericycle is formed of parenchymatous cells.
- Its cells adjacent to the phloem are called **aluminous cells**.
- The cells adjacent to the xylem are called **tracheidal cells**.
- These specialized cells form the **transfusion tissue**.
- They help in the lateral flow of nutrients.

Internal Structure of Root

- Young root is **di- to pentarch**.
- Xylem bundles are **Y-shaped**.
- parenchymatous pith may be present or absent in the centre. The ring of vascular bundles is surrounded by two to three layered pericycles.
- **Pericycle** is surrounded by **endodermis**.
- The cortex consists of a few layers of thin walled parenchymatous cells.
- Root **hairs** may be present or absent.
- Roots may be covered by **mycorrhizal** fungus.



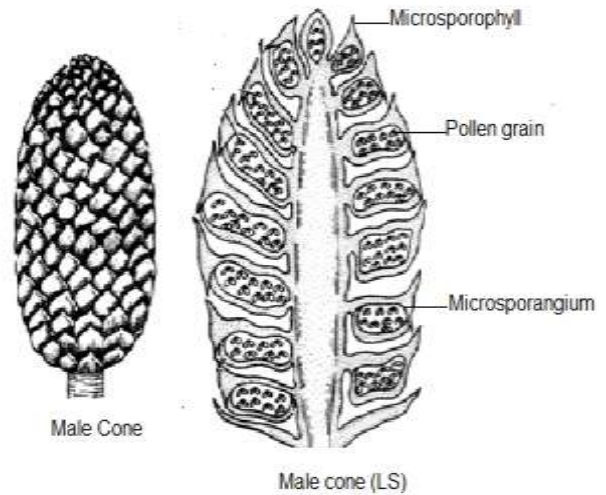
REPRODUCTION

- Pinus is **monoecious**. Plant develops both male and female strobili on the same plant.
- The strobili are **monosporous**. There is **no vegetative reproduction** in Pinus.

Male Cone:

Fig: Pinus male cones

1. The male cones are much **smaller**.
2. They are produced in **clusters** near the tip of the long shoots.
3. The male cones are produced in the **spring**.
4. Each male cone has a **central axis**.
5. It bears a number of spirally arranged **microsporophylls or stamens**.
6. Each microsporophyll has sac like **microsporangia** (pollen sacs) on the ventral side
7. Each microsporangium produces a large number of **microspores** (pollen grains).
8. The wall of each microspore (pollen grain) consists of an inner **intine** and an outer **exine**.
9. It has balloon like **wings**.
10. The wings help in the dispersal of spores by wind.



Development of Microsporangium (Stamen)

1. A number of **hypodermal cells** act **sporangial initials**. The sporangial initials divide to form outer **wall initials** and the inner **archesporial initial**.
2. The wall initials divide to form a many layered **wall of the sporangium**.
3. The archesporial initials also increase in number by the repeated divisions. The **peripheral cells** of the archesporium form the **tapetum**.
3. Some of the archesporial cells are transformed into **microspore mother cells**. The **remaining** archesporial cells and the tapetal layer provide **nourishment** to the developing microspore mother cells.
4. The microspore mother cell divides by **meiosis** to form four **microspores** or pollen grains.
5. The **exine of spore forms wings**.

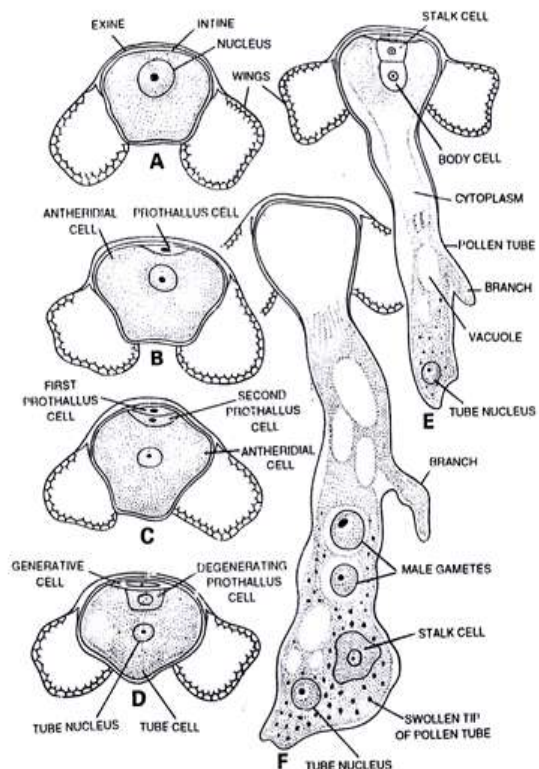


Fig. Pinus spp. Development of male gametophyte. A, a pollen grain; B-D, successive stages in the development; E, pollen tube with nucleus; F, two unequal male gametes, stalk nucleus, tube within pollen tube.

6. The pollen grain divides in to **smaller** and **larger** cells.
7. The **smaller** cell again divides to form **two small prothallial cells**.
8. The larger cell becomes **antheridial cell**.
9. The sporangium splits and microspores are released from the microsporangia at this stage.

Male Prothallus

1. The **pollen grain** has two **prothelial cells** and an **antheridial cell**. These cells soon **disintegrate**. Further development of the pollen grain takes place at the **surface of the nucellus**.
2. The **antheridial cell cut off second prothelial cell**.
3. It also cut off **generative** cell adjacent to the prothelial cells.
4. The remaining large cell is known as the **tube cell**. Its nucleus is called **tube nucleus**. Tube nucleus controls the growth of the pollen tube.
5. **Exine** of the pollen grain **ruptures**.
6. **Intine** grows out to form the pollen tube. It grows through the nucellus. But its activity stops till spring.
7. Female cone enlarges very much in size after pollination.
8. Outer ends of the **ovuliferous** scales increase very much. They meet each other to close the gaps in between them.
9. The cone is covered with a lot of resinous secretions.

Female Cone

Fig: Female cone of Pinus

1. Female cones are produced in the **axils of the scale leaves**.
2. The production of female cones is initiated in the **winter**.
3. These become ready for pollination during the following spring.
4. Each young female cone has a **central axis**.
5. It bears **spirally arranged** scales.
6. The scales are of two types. Some are **thin membranous** and are directly attached to the central axis. They are called **bract scales**.
7. Woody **ovuliferous** scales are present on the **ventral surface** of each bract scale.
8. The **broad end** of the ovuliferous scale has **projection** called the **umbo**.
9. Each ovuliferous scale bears **two ovules**.
10. They are situated side by side on upper side.
11. Each ovule (megasporangium) has a mass of **nucellar tissue**.
12. They are surrounded by a **single integument**.
13. The micropylar end of the ovule is directed towards the central axis.
14. A single **megaspore mother cell** is differentiated in the nucellus near the micropylar end.

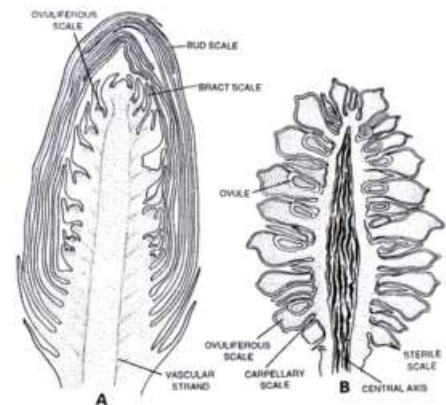
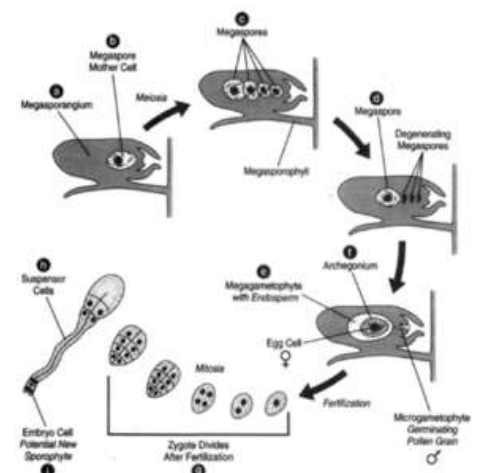


Fig. 4.31. A, L.S. of young female cone of *Pinus wallichiana* showing well developed bract scales and developing ovuliferous scales; B, V.S. mature female cone of *P. roxburghii*



15. This megaspore mother cell undergoes **meiosis** to form four megaspores.
16. Only the **lower most** megaspore remains functional. The others disintegrate.
17. Functional megaspore (embryo sac) **increases** in **size**. It occupies the major part of the nucellus.
18. Pollination takes place at this stage.

Female Prothallus

1. The megaspore **divides** many times to form **female prothallus**.
2. Megaspore wall encloses the female prothallus.
3. **Three archegonia** are produced towards the micropylar end.
4. Each archegonium develops from a **single prothallial cell**.
5. Archegonia consist of a large **venter** and a **short neck**.
6. The **oosphere or egg is very large**.
7. It is bounded by the prothallial cells.
8. There is a small ventral canal cell below the neck.
9. **The neck is without any neck canal cells**.
10. The prothallial tissue enlarges very much in size.
11. It crushes all nucellar tissue except a small amount near the micropylar end.

Pollination

1. Each ovule secretes a **mucilaginous** drop at the micropylar end.
2. A gap is produced between the ends of the ovuliferous scales.
3. It forms a passage for the entry of pollen grains. Wind carried pollen grains.
4. The mucilage drop entangles the pollen grain.
5. Pollen grain is carried through the micropyle to the surface of the nucellus.

Formation of Embryo and Seed

1. Diploid nucleus divides thrice to form eight cells.
2. The lower four cells becomes **proembryonal cells**.
3. The upper four nuclei are separated by incomplete cell walls.
4. Four proembryonal divides to produce three tiers of cells:

1. Embryonal cell

- The cells of the **lower tier** become **embryonal** cells.
- The **four embryonal cells** separate from each other.
- Each develops into a **separate embryo** independently.
- Each embryonal cell forms **secondary suspensor** cells.
- The formation of more than one embryo from a single fertilized oosphere is called **polyembryony**.
- Only one embryo reaches maturity. The rest are aborted.

2. Suspensor cells

- The cells of the middle tier become suspensor cells.
- Suspensor cells elongate very much.
- It pushes the developing embryos into the prothallial tissue for nutrition.

3. Rosette cells

- The cells of the upper most tiers are called the rosette cells.
- These cells do not take part in the development of the embryo.
- A fully developed embryo is in the form a short straight axis.
- Its **radicle** is present towards the micropylar end.
- **Plumule** is present towards the inner side.
- Plumule is surrounded by ten **cotyledons**.
- The unutilized prothallial tissue forms the **endosperm**.
- The persistent nucellus tissues near the micropylar end form the **perisperm**.
- The integument becomes hard testa.
- Some part of the ovuliferous scale fuses with the developing seed.
- It makes a large wing for dispersal of seed.
- The axis of the female cone rapidly increases.
- It produces gaps in ovuliferous scales.
- The cone becomes woody for the dispersal of seeds.

Germination of Seed

- The radicle grows out.
- It splits the testa at the micropylar end.
- This radicle grows down into the soil and forms the **primary root**.
- The hypocotyl elongates to form a loop.
- Then it becomes straight. It carries with it the plumule and the cotyledons.
- The testa is also carried up with the cotyledons.

