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## Germinating seed

When the seed germinates in well-drained and well-aerated soil, the **coleorhiza**, a covering enclosing the radicle or primary root, protrudes first.

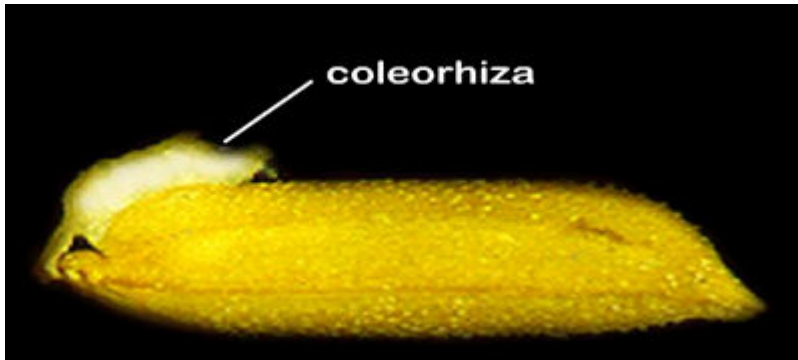


Fig. 1 - The **coleorhiza** protrudes first.

Shortly after the coleorhiza appears, the **radicle** or **primary root** breaks through the covering.

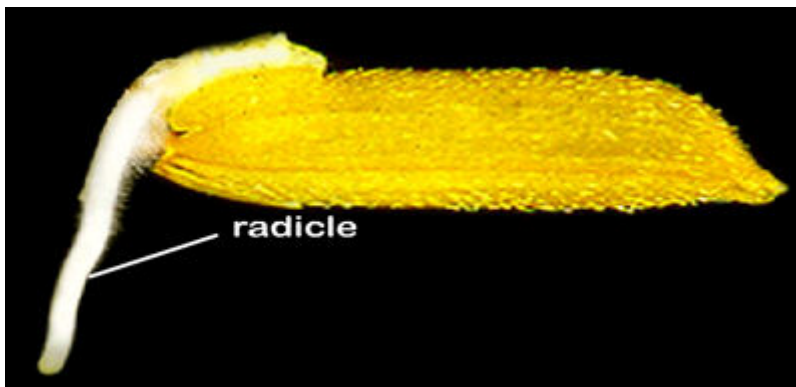


Fig. 2 - Radicle or primary root breaks through the covering.

Two or more sparsely branched **seminal roots** follow. These roots eventually die and are replaced by many **secondary adventitious roots**.

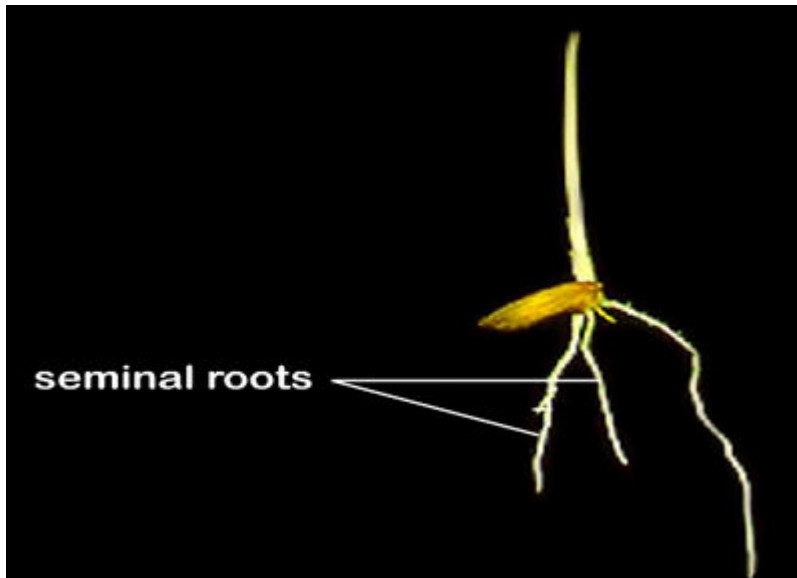


Fig. 3 - Seminal roots

If the seed germinates in water, the **coleoptile**, a covering enclosing the young shoot, emerges ahead of the coleorhiza. The coleoptile emerges as a tapered cylinder.

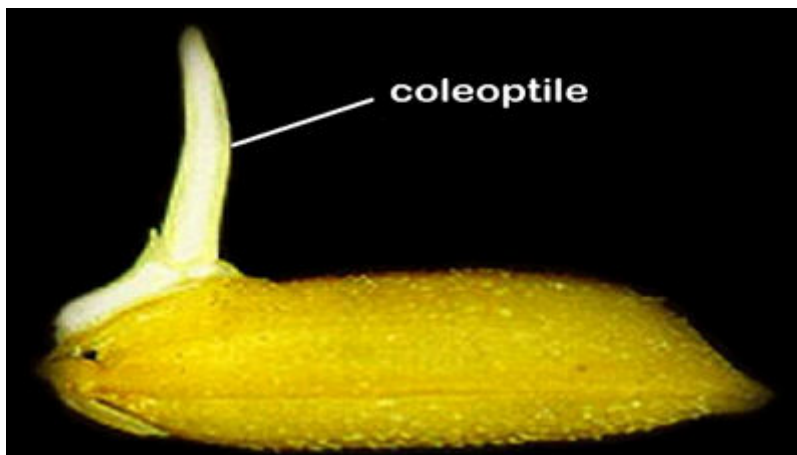


Fig. 4 - Coleoptile emerging as a tapered cylinder.

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## Seedling

The **mesocotyl** or basal portion of the coleoptile elongates when the seed germinates in soil, and in darkness. It pushes the coleoptile above the soil surface.

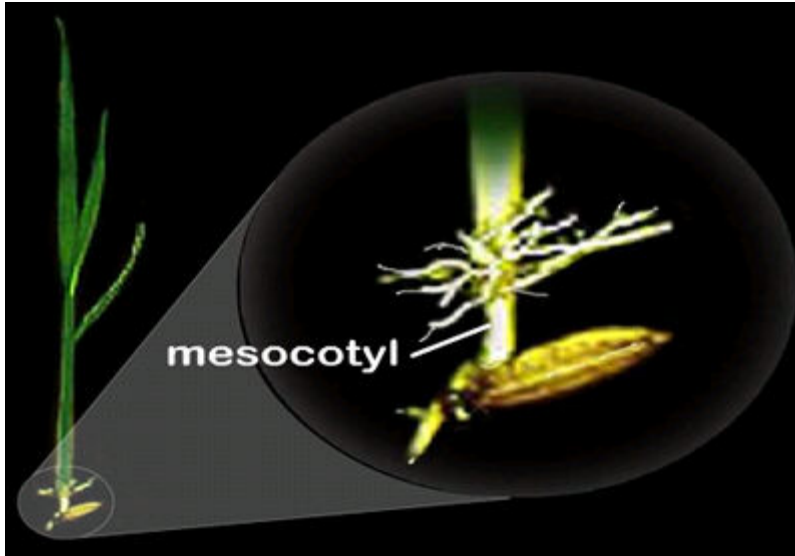


Fig. 5 - Mesocotyl pushing the coleoptile above the soil surface.

The first seedling leaf, or **primary leaf**, emerges from the growing seed. It is green and shaped like a cylinder. It has no blade. The second leaf is a complete leaf. It is differentiated into a leaf blade and a leaf sheath.

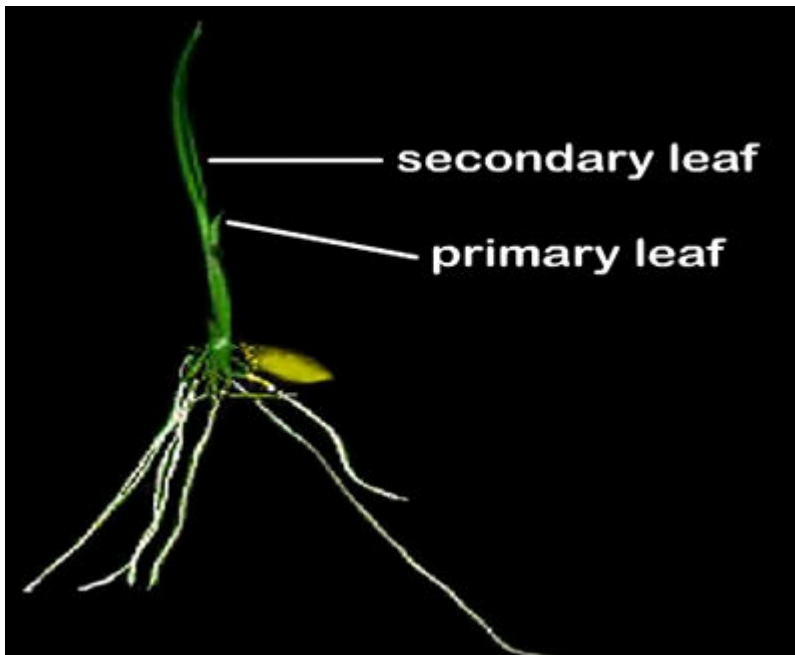


Fig. 6 - First and second seedling leaf.

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## Tiller

The seedling will grow and develop branched tillers. Parts of the rice tiller include the **roots**, **culm** and **leaves**. Mature roots of the rice plant are fibrous and produce smaller roots called **rootlets**. All roots have root hairs to absorb moisture and nutrients.

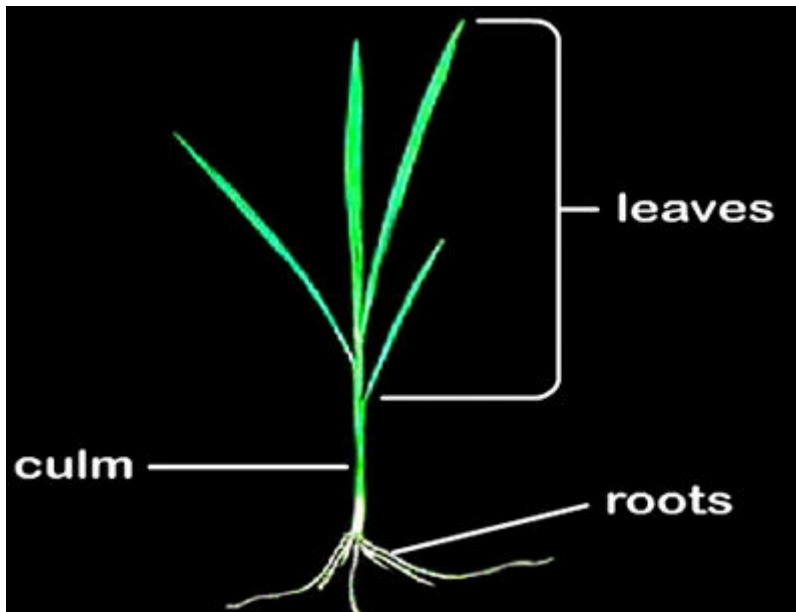


Fig. 7 - Parts of the rice tiller.

There are two kinds of mature roots:

1. secondary adventitious roots
2. adventitious prop roots.

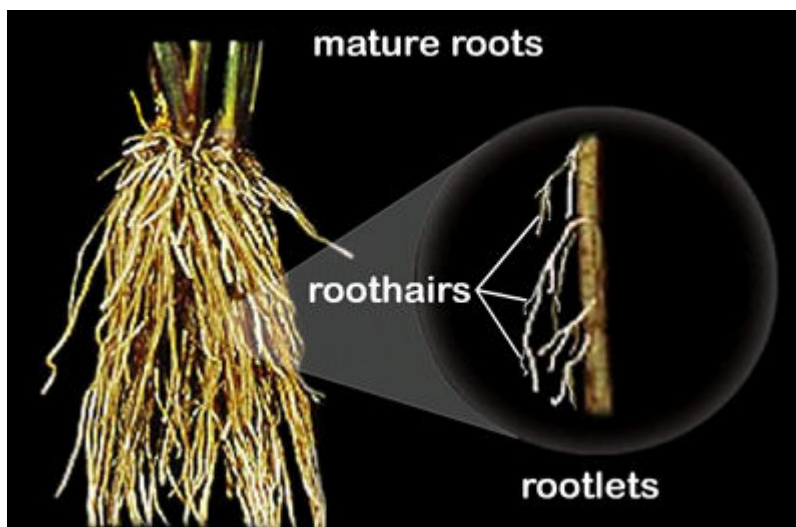


Fig. 8 - Types of roots.

**Secondary adventitious roots** are produced from the underground nodes of young tillers.

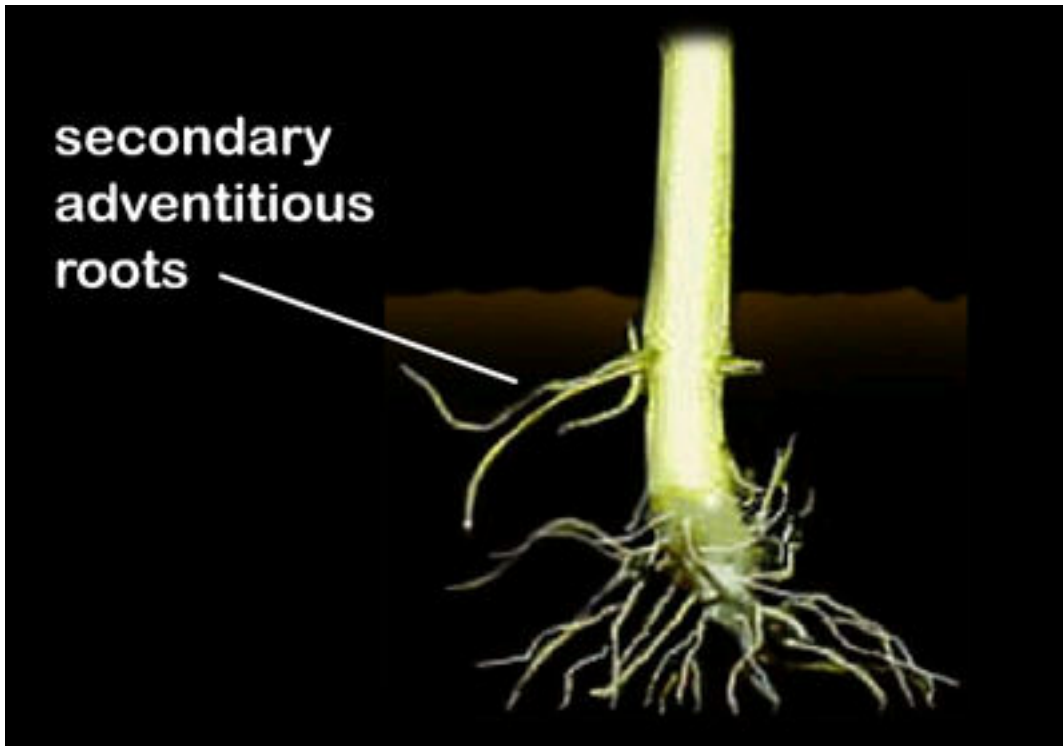


Fig. 9 - Secondary adventitious roots.

As the plant grows, coarse **adventitious prop roots** often form above the soil surface in whorls from the nodes of the culm.

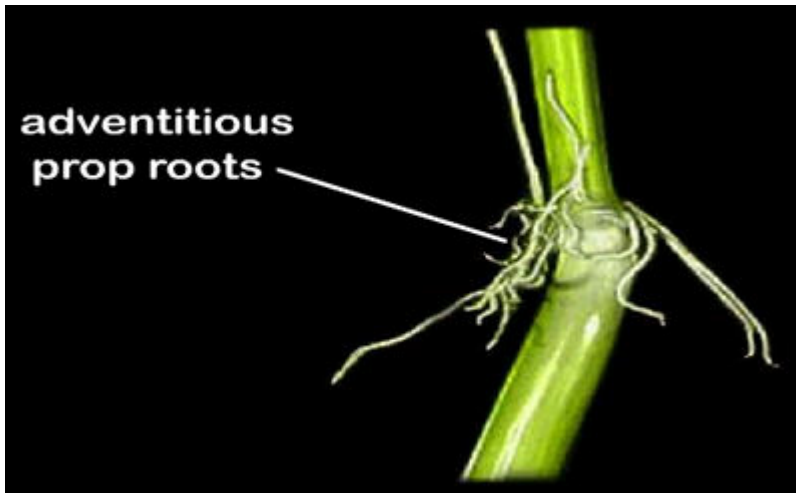


Fig. 10 - Adventitious prop roots.

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## Culm

The **culm**, or jointed stem of the rice, is made up of a series of **nodes** and **internodes**.

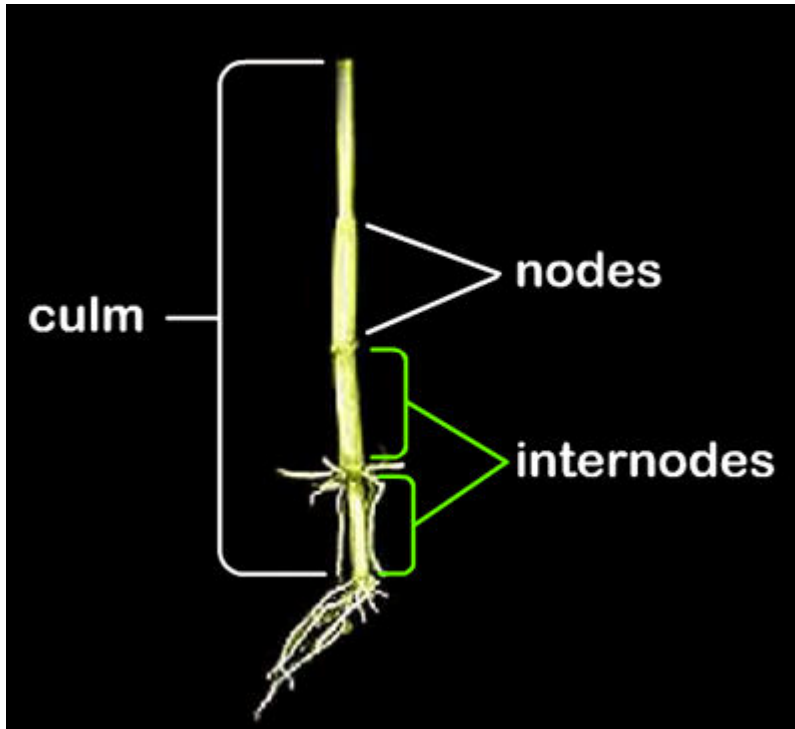


Fig. 11 - Culm, nodes, and internodes.

Young internodes are smooth and solid. Mature internodes are hollow and finely grooved with a smooth outer surface. Generally, internodes increase in length from the lower to the upper portions of the plant. The lower internodes at the plant base are short and thick.



Fig. 12 - Young and mature internodes.

The **node** is the solid portion of the culm. The node or nodal region bears a leaf and a bud. The bud is attached to the upper portion of the node and is enclosed by the leaf sheath. The bud may give rise to a leaf or a tiller.

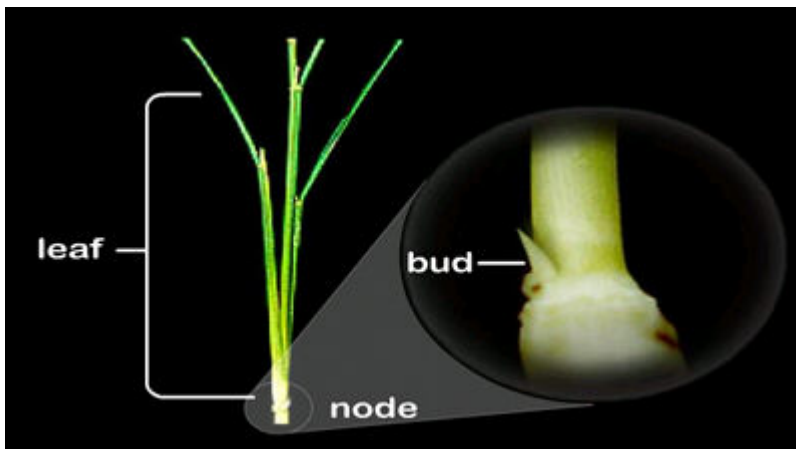


Fig. 13 - Leaf, node, and bud.

Early tillers arise from the main culm in an alternate pattern. Primary tillers originate from the lowermost nodes and give rise to secondary tillers. Secondary tillers produce tertiary tillers.

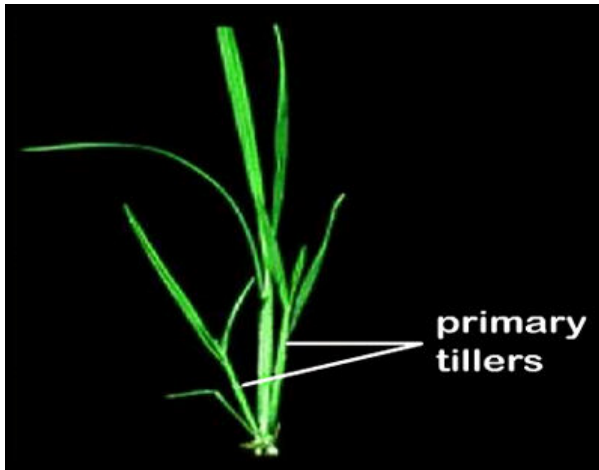


Fig. 14 - Primary tillers.



Fig. 15 - Secondary tillers.

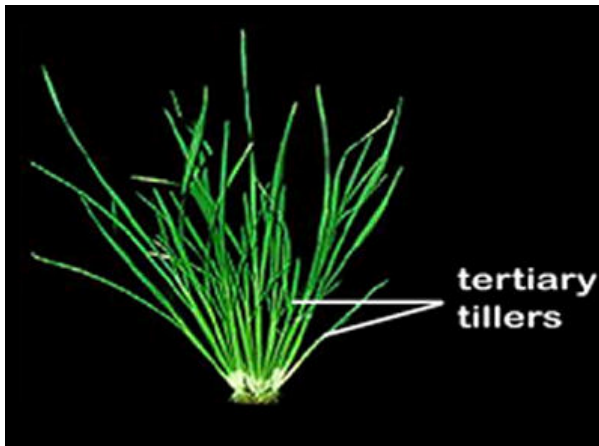


Fig. 16 - Tertiary tillers.



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## Leaf

The node or nodal region of the culm will bear a **leaf**.

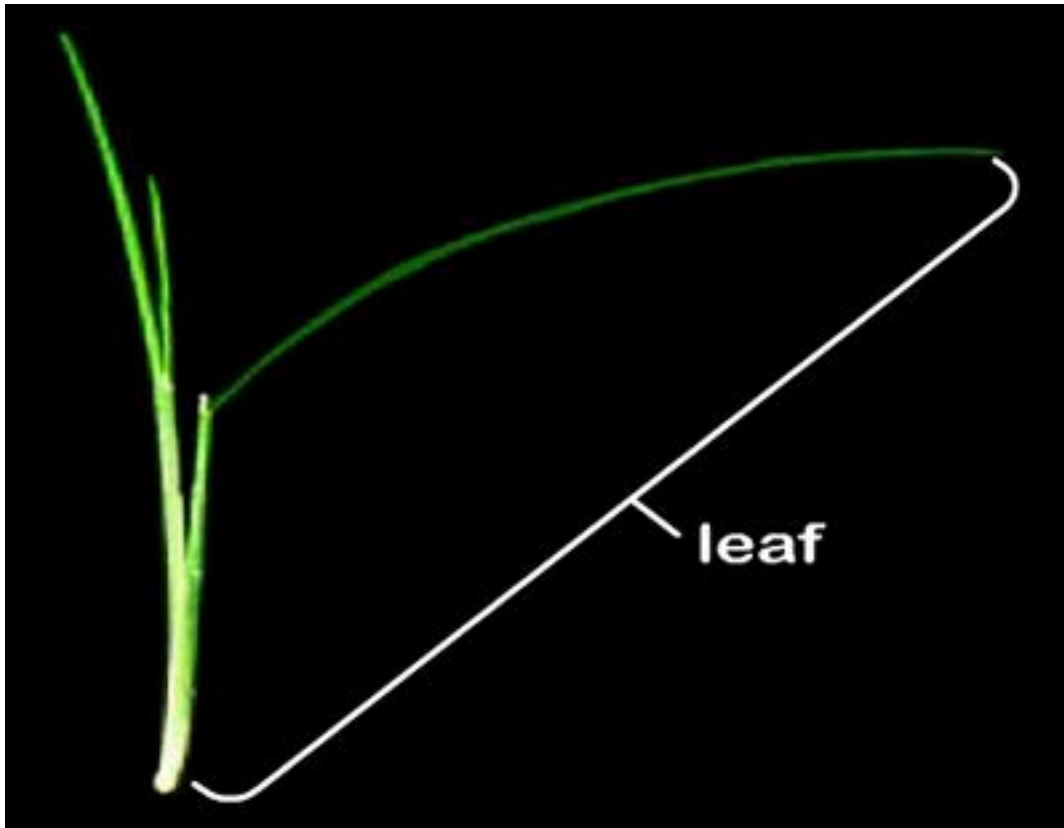


Fig. 17 - Leaf.

Leaves are borne alternately on the culm in opposite directions. One leaf is produced at each node. Varieties differ in the number of leaves produced.

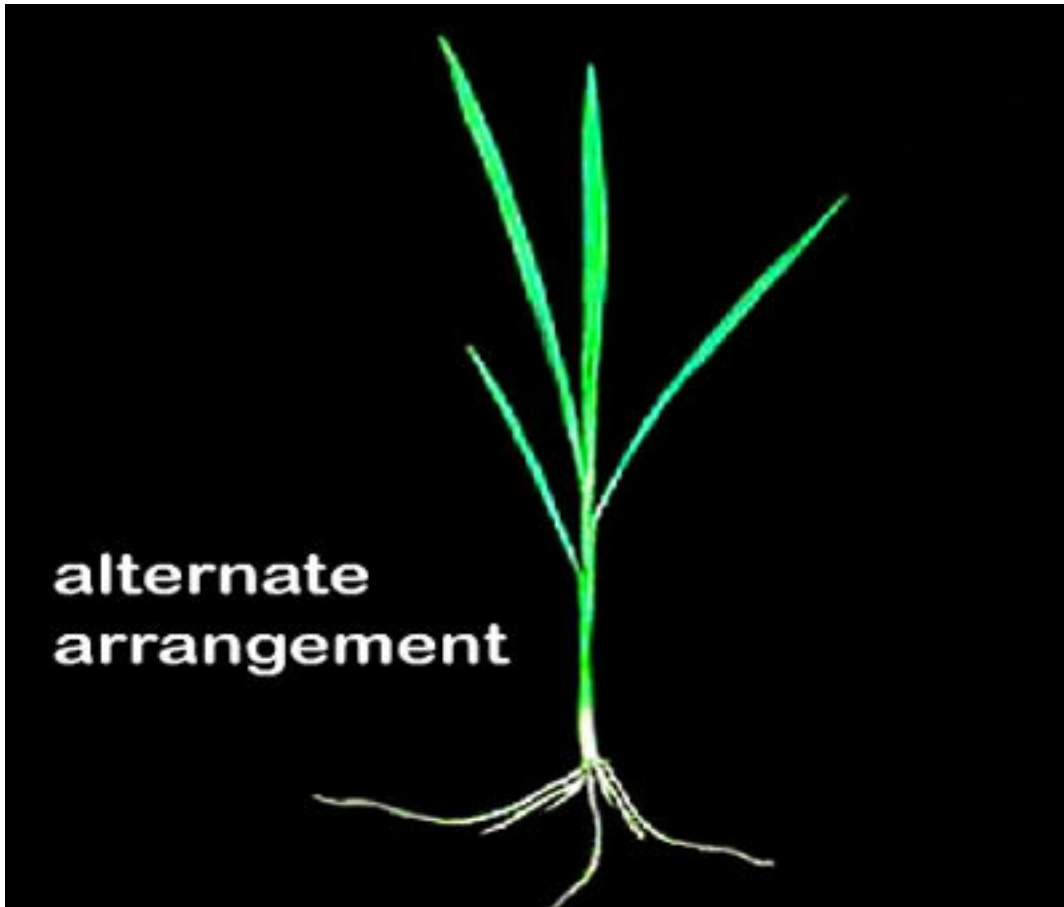


Fig. 18 - Leaves alternate on the culm in opposite directions.

The topmost leaf below the panicle is the **flag leaf**. The flag leaf contributes largely to the filling of grains because it supplies photosynthetic products, mainly to the panicle.



Fig. 19 - Flag leaf.

The leaf sheath and leaf blade are continuous.

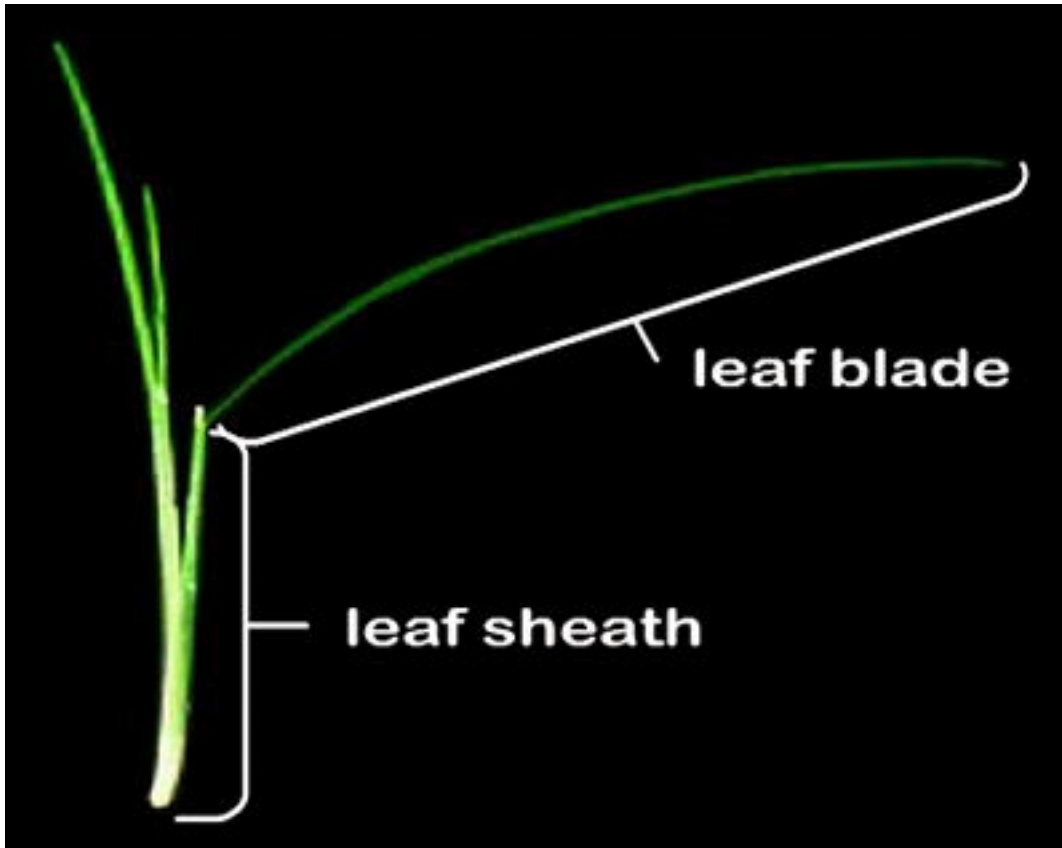


Fig. 20 - Leaf sheath and blade.

A circular collar joins the leaf blade and the leaf sheath.

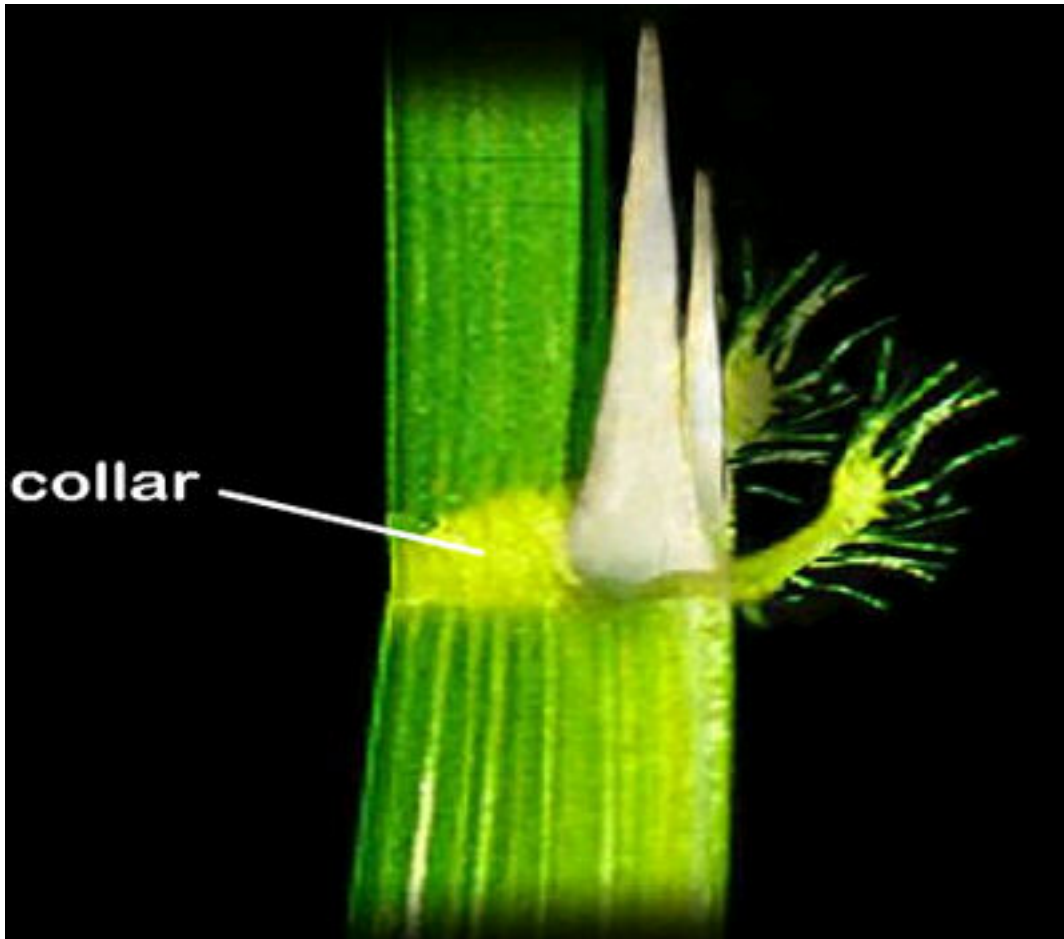


Fig. 21 - Leaf collar.

The leaf sheath is wrapped around the culm above the node.

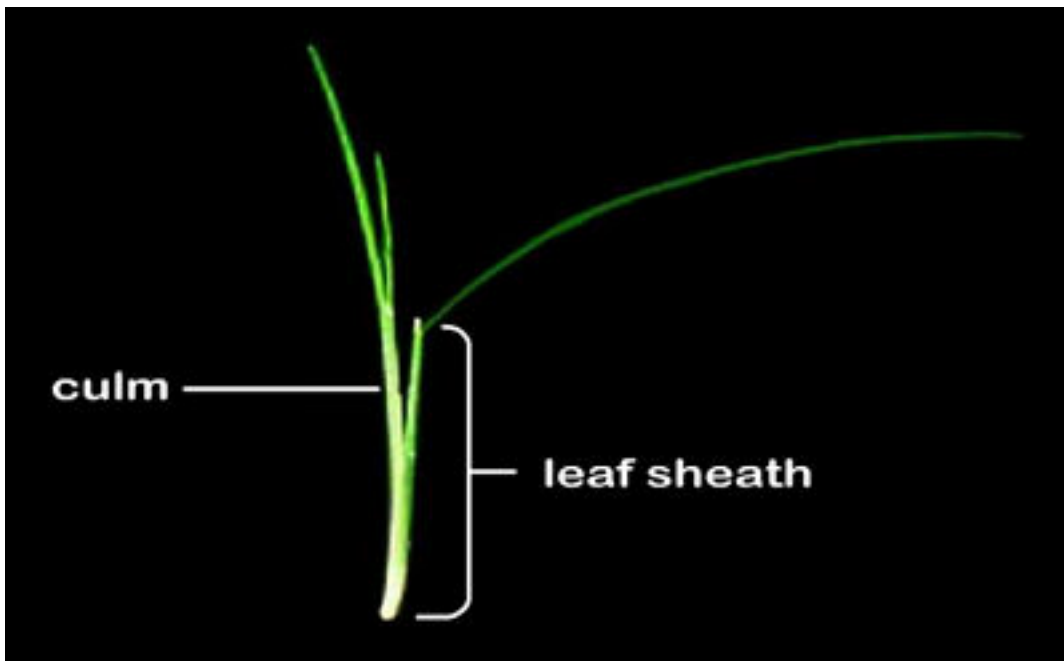


Fig. 22 - Leaf sheath and culm.

The swelling at the base of the leaf sheath, just above the node, is the **sheath pulvinus**. It is sometimes incorrectly referred to as the node.

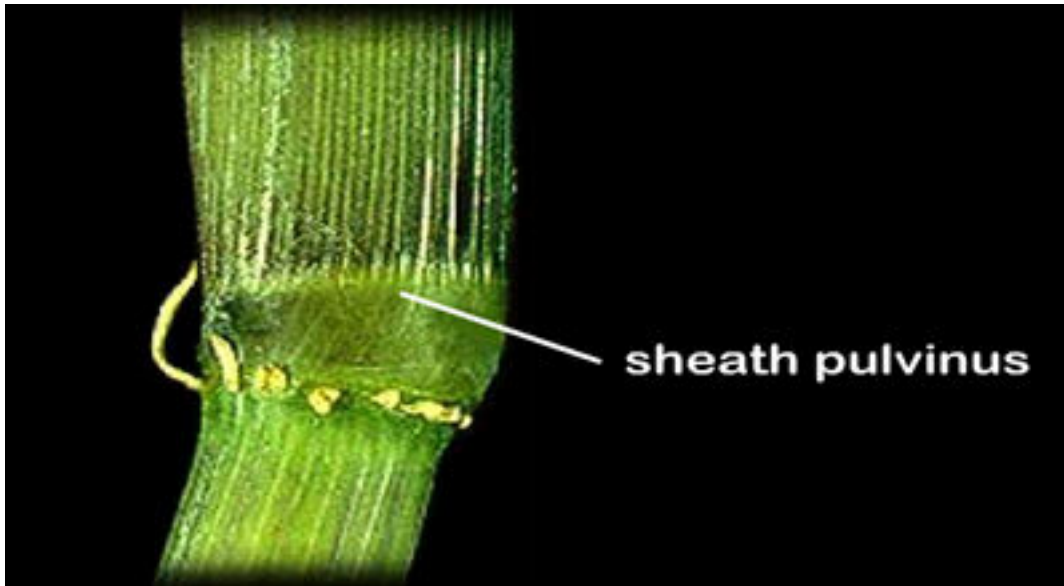


Fig. 23 - Sheath pulvinus.

Leaf blades are generally flat. Varieties differ in blade length, width, thickness, area, shape, color, angle and pubescence.

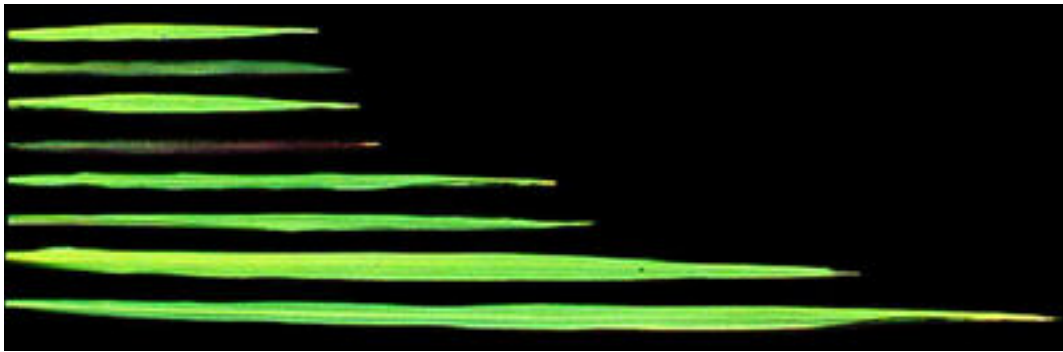


Fig. 24 - Different varieties with varying blade characteristics.

With many parallel veins on the upper surface of the leaf, the underside of the leaf blade is smooth with a prominent ridge in the middle; the **midrib**.

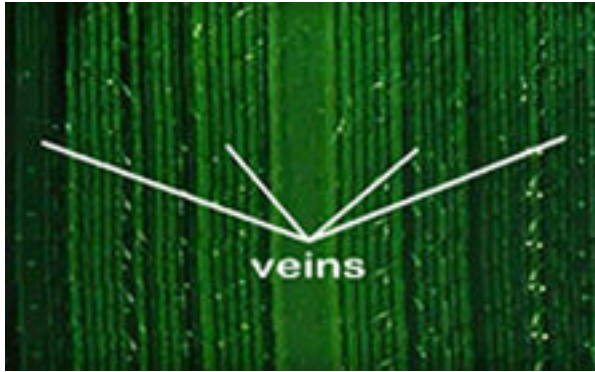


Fig. 25 - Parallel veins on upper surface.

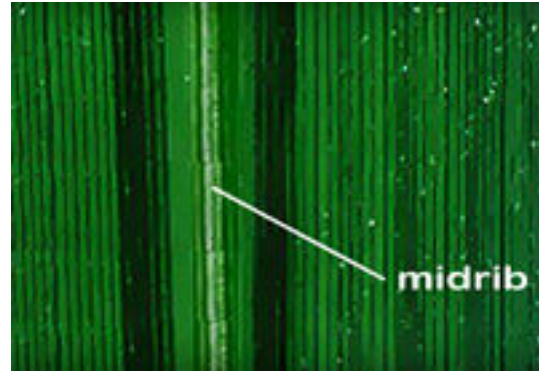


Fig. 26 - Leaf midrib.

Most leaves possess small, paired ear-like appendages on either side of the base of the blade. These appendages are called **auricles**. Auricles may not be present on older leaves. Another leaf appendage is the **ligule**, a papery membrane at the inside juncture between the leaf sheath and the blade. It can have either a smooth or hair-like surface. The length, color, and shape of the ligule differ according to variety.

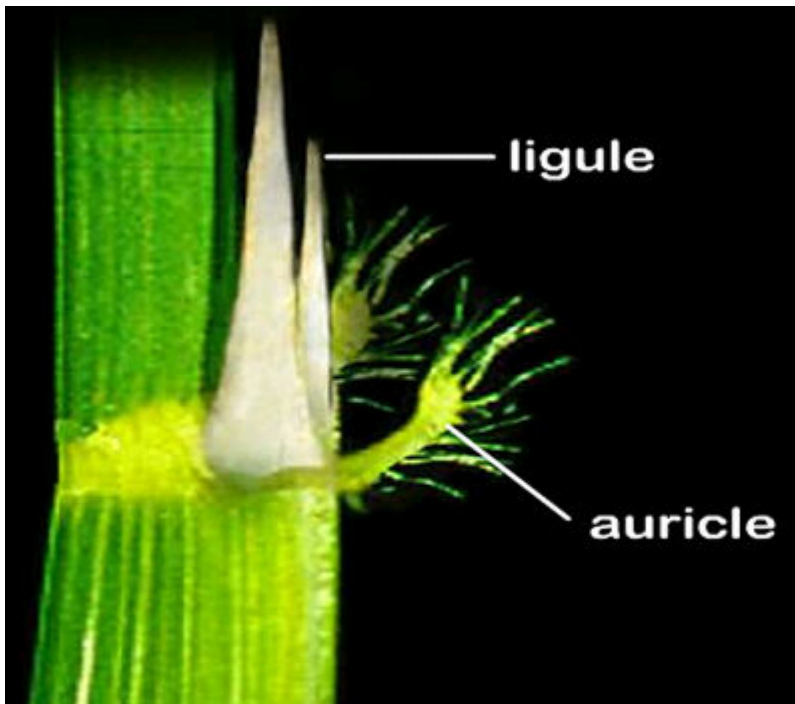


Fig. 27 - Ligule and auricle.

Although similar, rice seedlings are different from common grasses. While rice plants have both auricles and ligules, common grassy weeds found in rice fields normally do not have these features. These characteristics are often helpful in identifying weeds in rice fields when the plants are young.

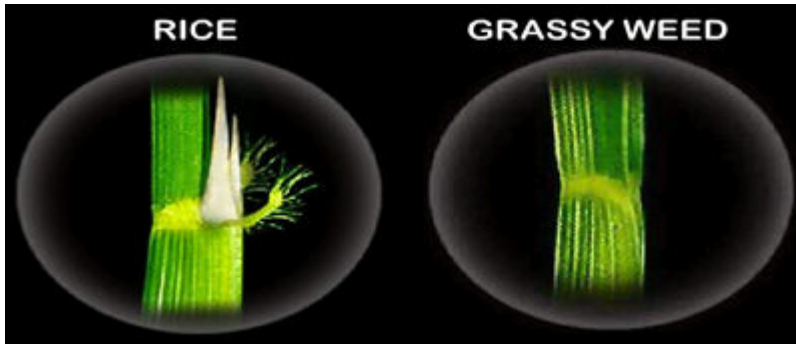


Fig. 28 - Rice and grassy weed comparison.

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## Panicle and Spikelets

The terminal component of the rice tiller is an inflorescence call the **panicle**. The inflorescence or panicle is borne on the uppermost internode of the culm. The panicle bears rice spikelets, which develop into grains.



Fig. 29 - Rice panicle.

The panicle base often appears as a hairlike ring and is used as a dividing point in measuring culm and panicle length. The panicle base is often called the **neck**.



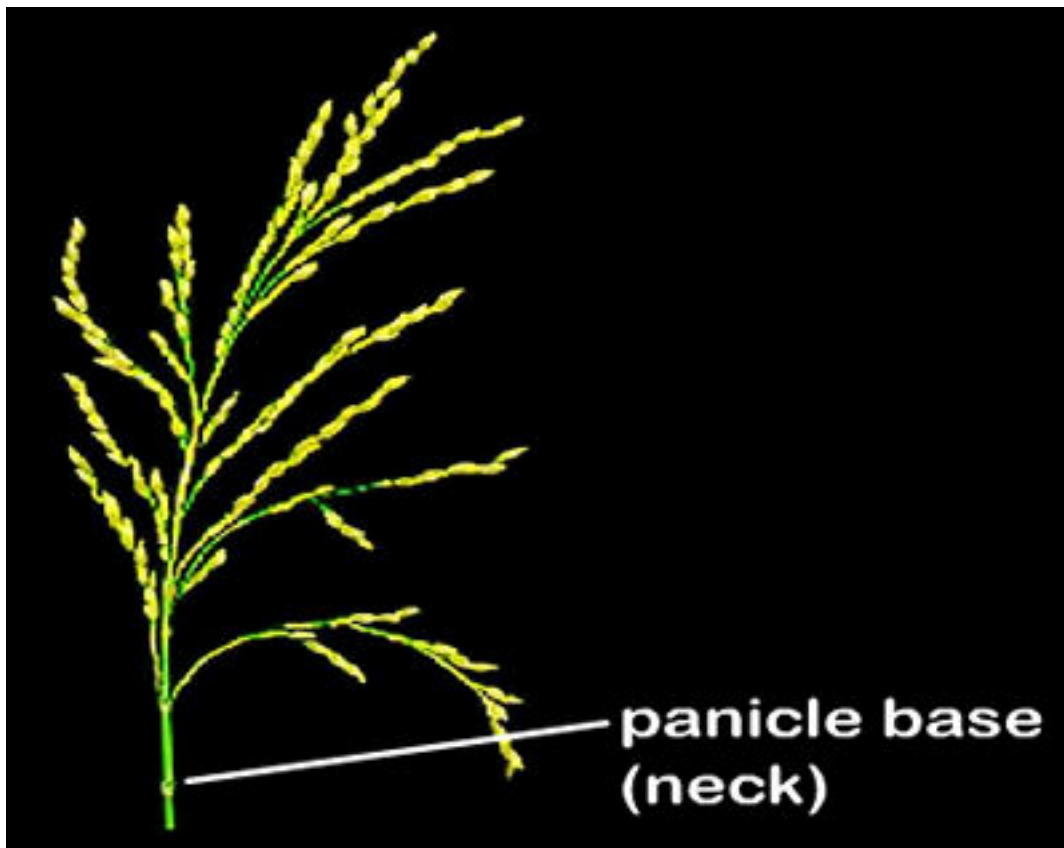


Fig. 30 - Panicle base (neck).

The **panicle axis** is continuous and hollow except at the nodes where branches are borne.

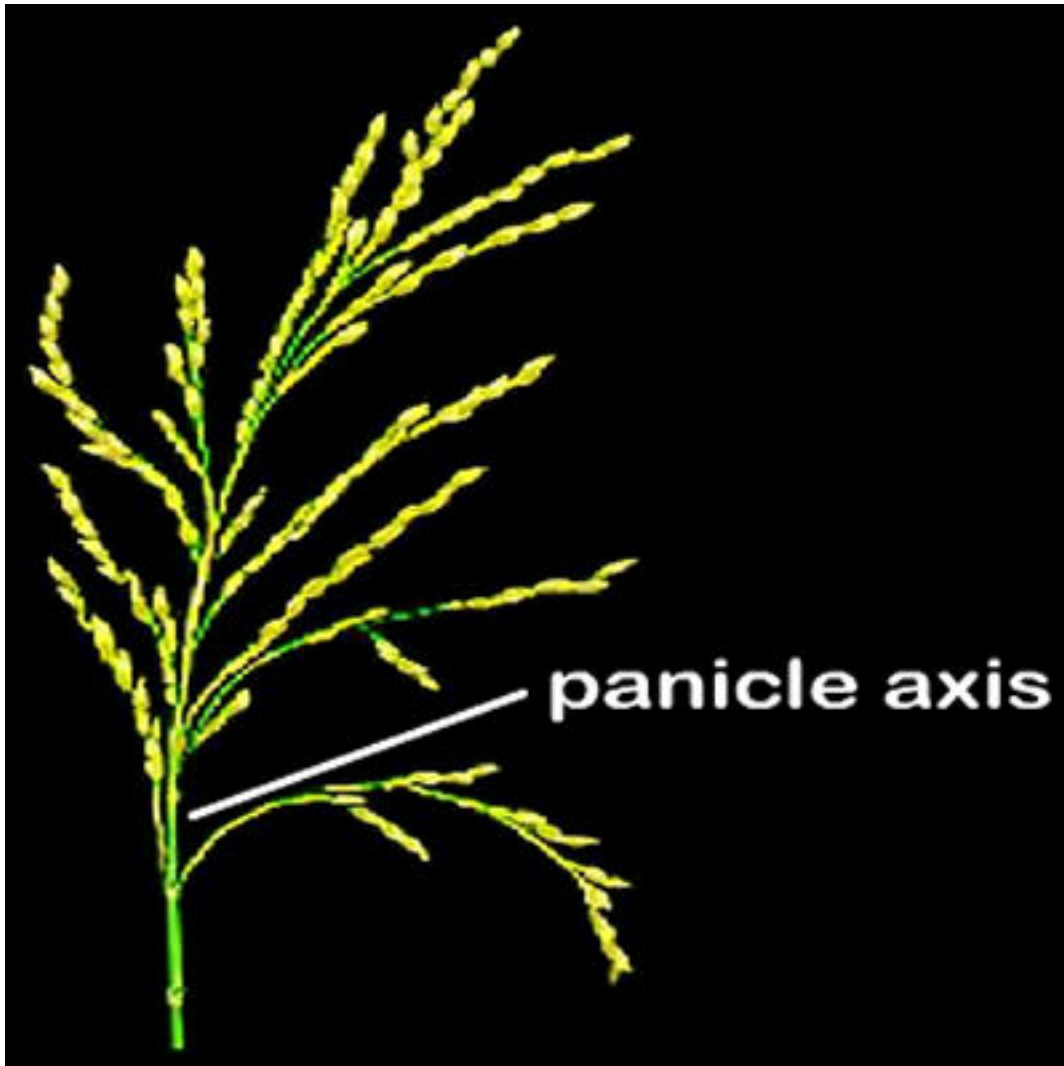


Fig. 31 - Panicle axis.

The swellings at the panicle axis where the branches are borne are referred to as the **panicle pulvinus**.

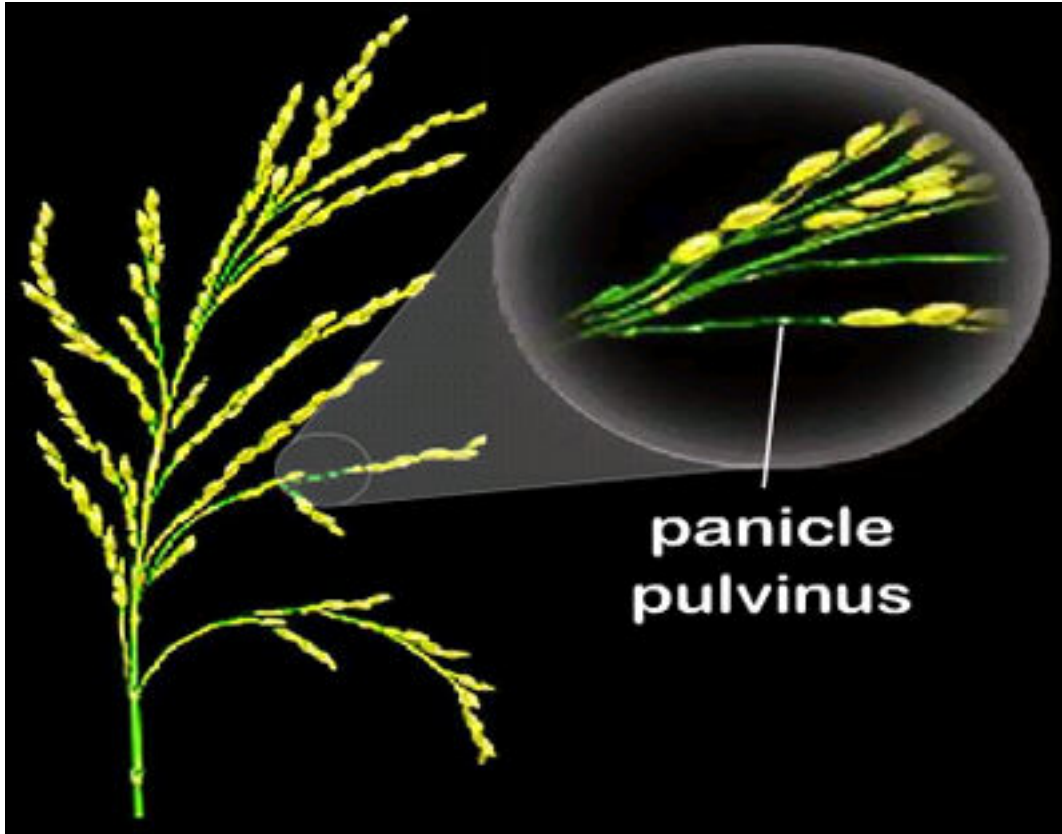


Fig. 32 - Panicle pulvinus.

Each node on the main panicle axis gives rise to primary branches which in turn bears secondary branches. Primary branches may be arranged singly or in pairs.

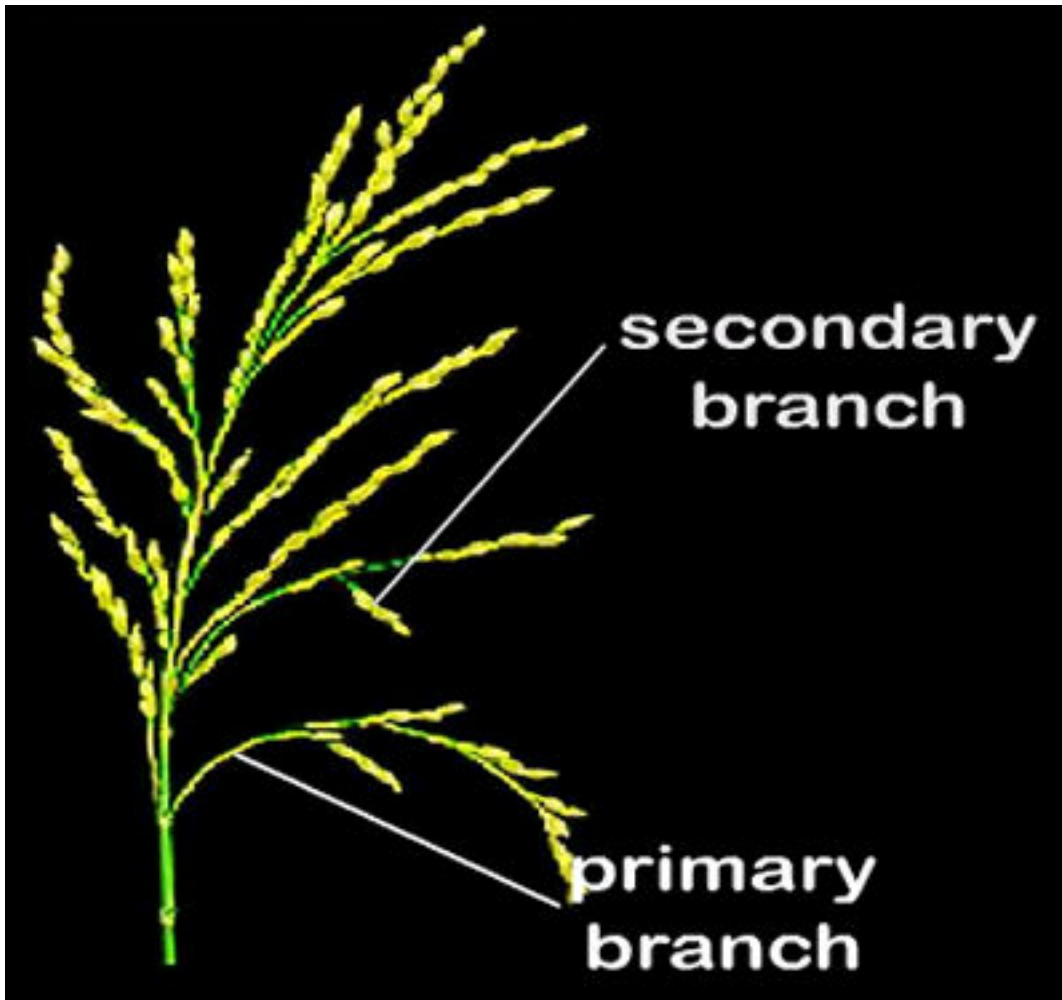


Fig. 33 - Secondary and primary branch.

The panicles bear spikelets, most of which develop into grains. These spikelets are borne on the primary and secondary branches. The spikelet is the basic unit of the inflorescence and panicle. It consists of the **pedicel** and the **floret**.



Fig. 34 - Spikelets.

The floret is borne on the pedicel.

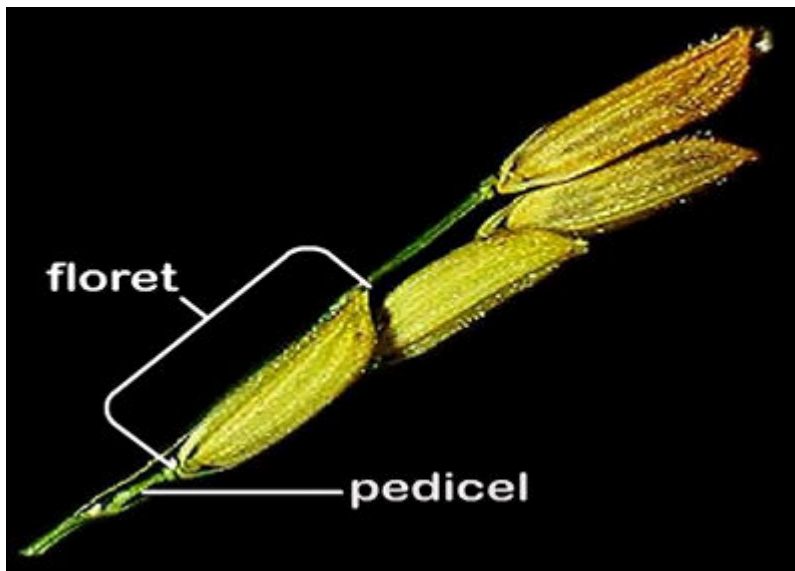


Fig. 35 - Floret and pedicel.

The **rudimentary glumes** are the laterally enlarged, cuplike apex of the pedicel. The rudimentary glumes are the lowermost parts of the spikelet. During threshing, the rudimentary glumes are separated from the rest of the spikelet.

The sterile lemmas are small, bractlike projections attached to the floret. The **rachilla** is a small axis that bears the single floret. It is between the sterile lemmas and the floret.

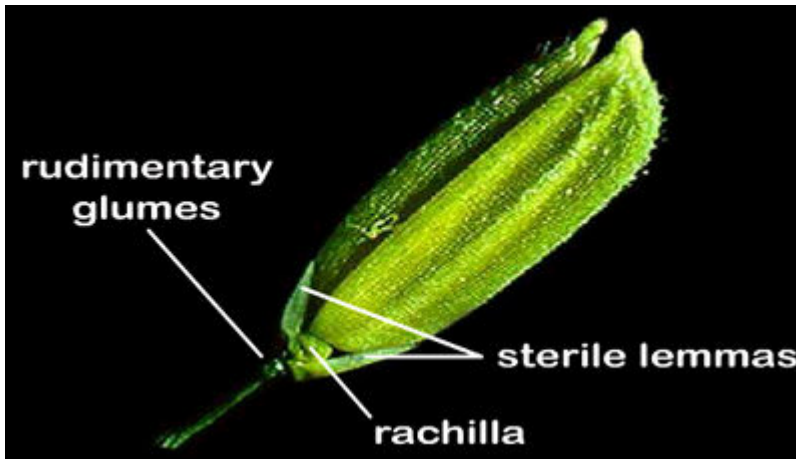


Fig. 36 - Rudimentary glumes, sterile lemmas, and rachilla.

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## Floret

The rachilla, sterile lemmas and the rudimentary glumes all support the floret. The floret includes the lemma, palea, and the flower.

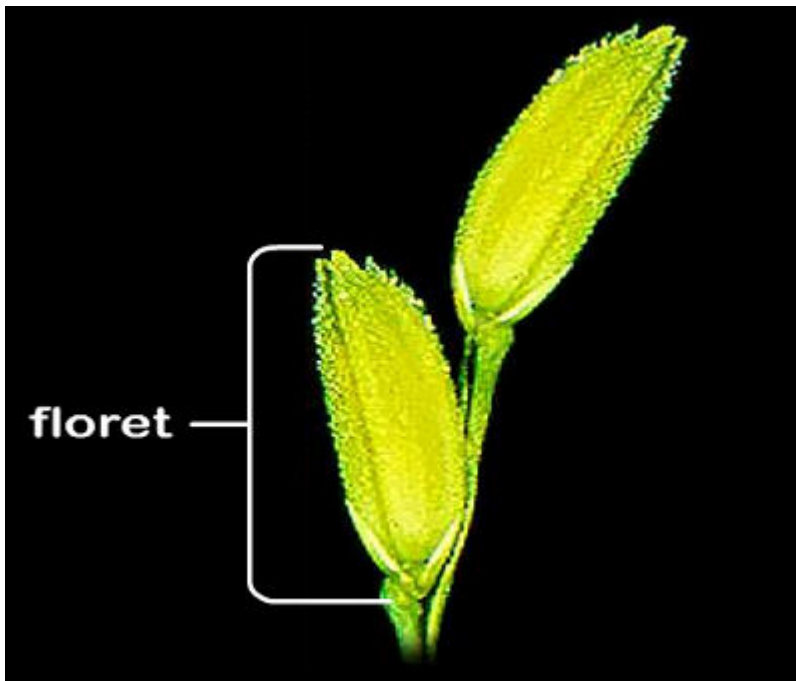


Fig. 37 - Floret

The larger protective glume covering the floret is called the **lemma** and the smaller one is referred to as the **palea**.

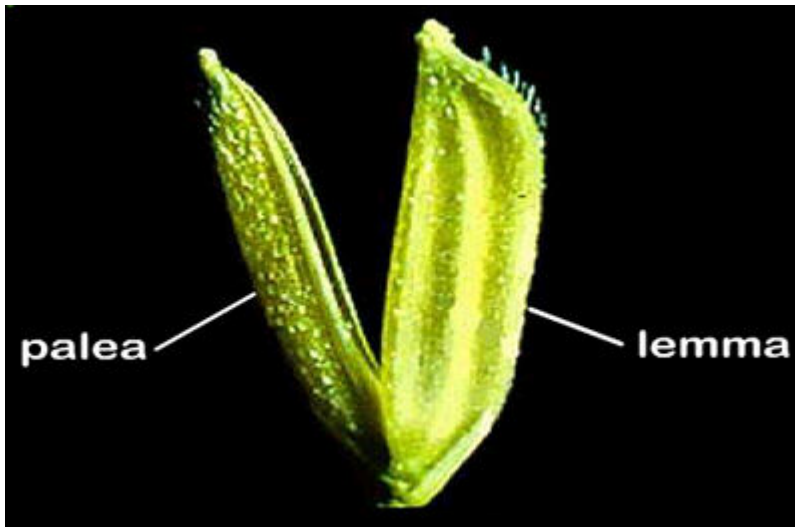


Fig. 38 - Palea and lemma.

Both the lemma and palea have ridges referred to as **nerves**. The lemma has five while the palea has three. The middle nerve of the lemma can be either smooth or hairy.



Fig. 39 - Nerves.

The lemma has a constricted structure at its end called the **keel**. In some varieties, the keel is elongated into a thin extension, the **awn**.



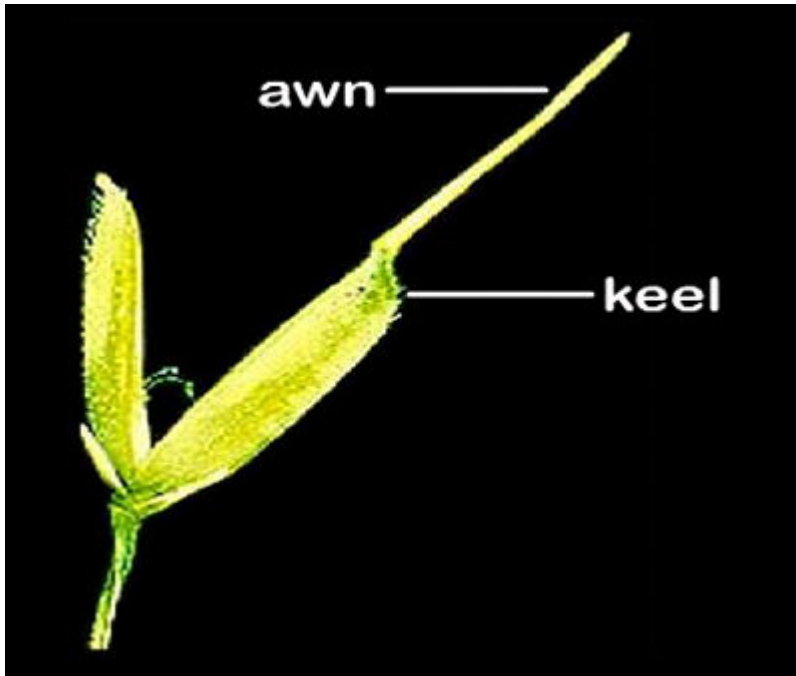


Fig. 40 - Awn and keel.

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## Flower

The floret contains a flower. The flower consists of a **pistil** (female organ) and six **stamens** (male organs).



Fig. 41 - Pistil.





Fig. 42 - Stamens.

The stamens have two-celled anthers borne on slender filaments.



Fig. 43 - Anthers and filaments.

The pistil contains one ovule and bears a double-plumed stigma on a short style.

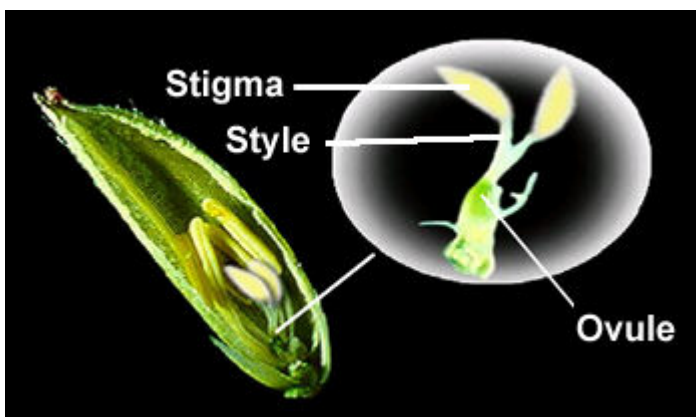


Fig. 44 - Stigma, style, and ovule.

At the flower's base near the palea are two transparent structures known as **lodicules**. The lodicules thrust the lemma and palea apart at flowering to enable the

elongating stamens to emerge out of the open floret. The lemma and palea close after the anthers have shed their pollen.



Fig. 45 - Lodicule.

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## Rice grain

The rice grain is the ripened ovary, with the lemma, palea, rachilla, sterile lemmas and the awn firmly attached to it.



Fig. 46 - Rice grain.

The rice hull includes the lemma and palea and their associated structures – the sterile lemmas, rachilla, and awn.



Fig. 47 - Rice hulls.

The dehulled rice grain is called **caryopsis**, commonly referred to as brown rice because of three brownish **pericarp** layers that envelope it. Next to the pericarp layers are the two **tegmen** layers and the **aleurone** layers.

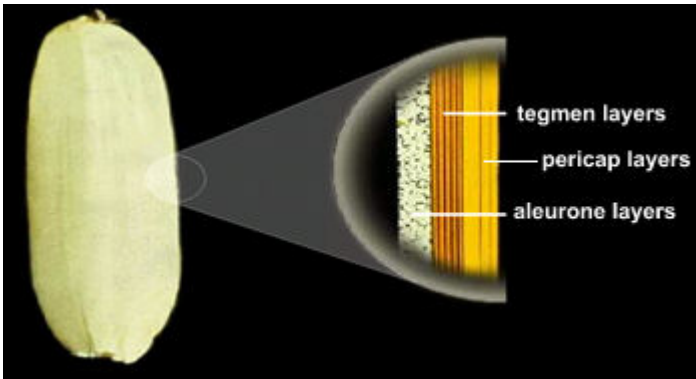


Fig. 48 - Tegmen, pericarp, and aleurone layers.

The remaining part of the grain consists of the **endosperm** and the **embryo**. The endosperm provides nourishment to the germinating embryo. The embryo lies on the belly side of the grain and is enclosed by the lemma. It is the embryonic organ of the seed.

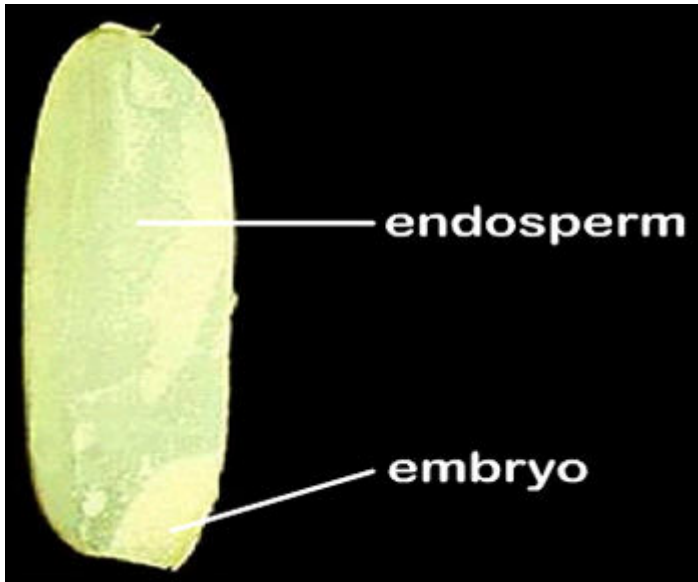


Fig. 49 - Endosperm and embryo.

The embryo contains the **plumule** (embryonic leaves) and the **radicle** (embryonic primary root).

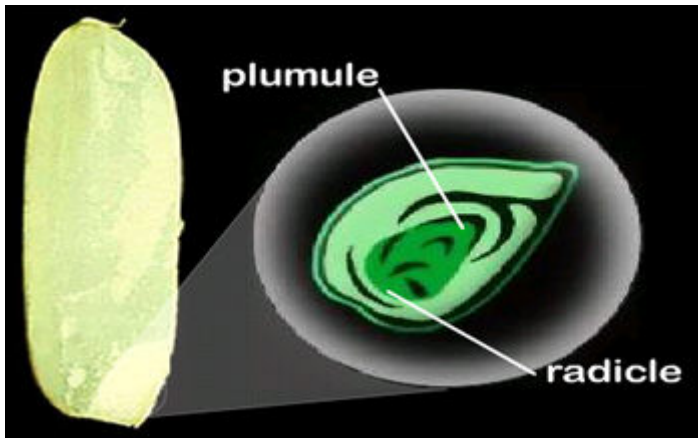


Fig. 50 - Plumule and radicle.