

# Grass Growth and Regrowth for Improved Management

## Grass Structures

### Definition

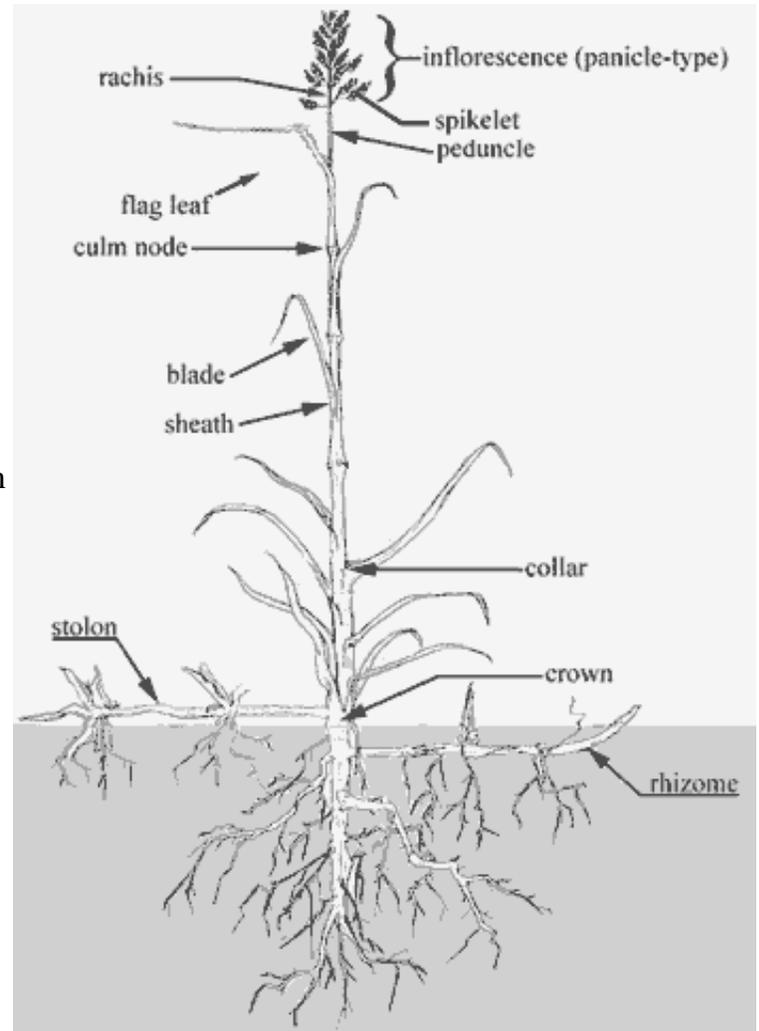
#### Nomenclature of Vegetative and Floral Structures

Knowing the names of specific plant parts will provide a foundation for in-depth discussions of mechanisms which account for growth and recovery following defoliation. The diagram and definitions are divided into three categories: vegetative, floral (reproductive), and collar. During early growth, while a grass plant is vegetative, identification is difficult. When floral structures are visible, identification is easier. The collar region is helpful for identification and it contains a band of intercalary meristem which, when properly safe-guarded, will account for regrowth following mowing or grazing.

#### *Vegetative Structures*

Notice the following labeled items on the drawing:

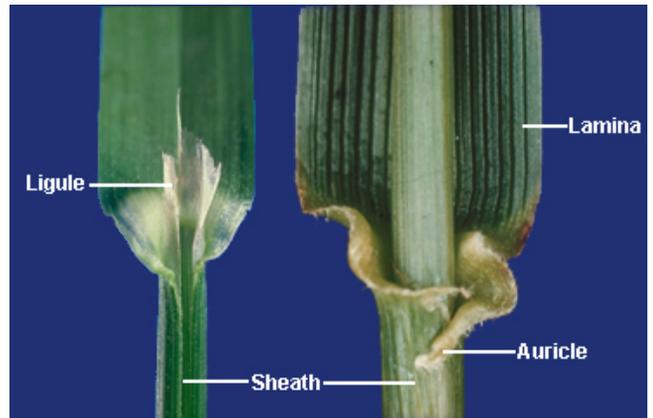
- **peduncle:** upper most culm segment supporting the seed head.
- **flag leaf:** uppermost leaf of the culm, enclosing the seed head during the boot stage.
- **culm node:** solid region on the culm which gives rise to a leaf sheath. On certain grass species, lower culm nodes may bear adventitious buds capable of producing new tillers.
- **culm:** central axis of the mature grass shoot, comprised of nodes and internodes; each node bearing a leaf.
- **leaf blade:** part of the leaf above the sheath, also known as the lamina.
- **leaf sheath:** lower section of a grass, enclosing its associated culm internode.
- **auricles:** short, often claw-like appendages at the base of the leaf blade which tend to clasp the sheath at the culm internode. The various shapes can be useful for identifying certain grasses.
- **ligule:** a variously modified extension of the sheath lying at the base of the blade; often a vertical membrane, and in certain cases, mere bristles.
- **crown:** basal zone of the shoot, the origin of which was tissue at the base of the coleoptile during the seedling stage. The crown is essential for the perennial growth of the plant as this zone is comprised of over-wintering tissues (basal internodes, rhizomes, stolons, corms) which produce new shoots the following spring. Annual grasses do not develop a crown.
- **stolon:** a prostrate or creeping, above-ground stem, rooting at the nodes; a means of vegetative reproduction.



- **rhizome:** a prostrate subterranean stem, capable of rooting at the nodes and becoming erect at the apex; a means of vegetative reproduction.
- **tiller:** a daughter plant, a shoot capable of producing a new plant.
- **meristem:** the cells capable of growth.

● **collar region:** The collar region of the leaf is the most useful area for identifying vegetative-stage grasses. Later on, after seed head emergence, floral structures may provide a more obvious means of identification. The collar region consists of the leaf blade, the leaf sheath wrapping around the stem, auricles (if present), a ligule, and connective tissue called the collar. Each species is unique with respect to the presence, size, and shape of the auricles and ligules in this leaf zone. The collar (connective tissue) is a narrow band of intercalary meristem (tissue capable of growth) which accounts for blade growth. With immature blades, this meristem provides for further blade growth following defoliation.

The first photographs show a collar with the blade (lamina), auricles, ligule, and leaf sheath.

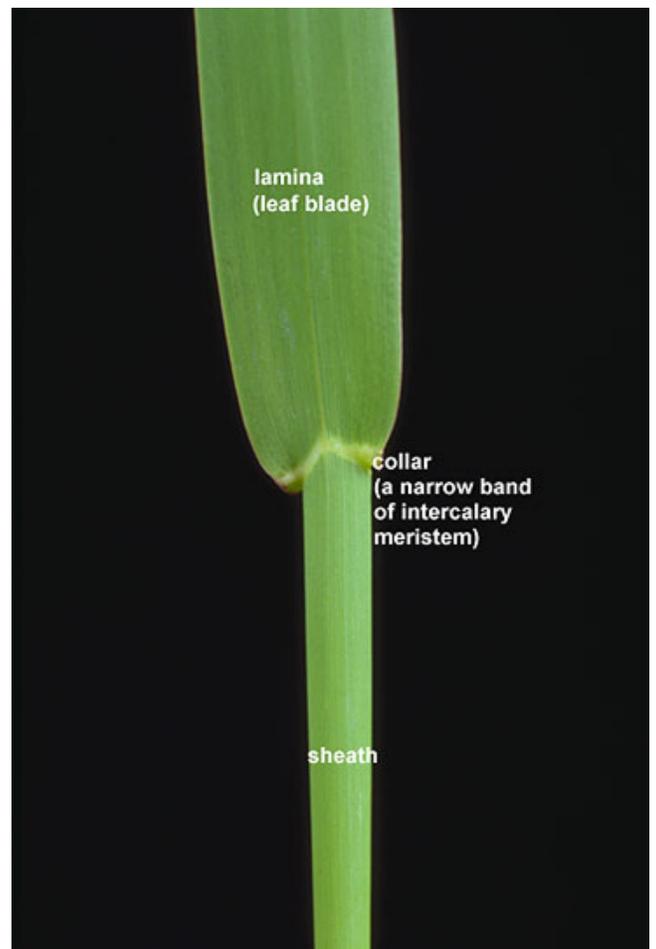


- **blade (lamina):** part of the leaf above the collar
- **collar:** a thin band of meristematic tissue at the junction of the leaf blade (lamina) and the sheath
- **auricles:** claw appendages at the base of the blade of some grasses (some grasses do not have auricles)
- **ligule:** outgrowth at the inner junction of the leaf sheath and blade, often membranous, sometimes a fringe of hairs
- **sheath:** lower part of the leaf that encloses the internode

The middle photograph shows the collar, where intercalary meristematic tissue is seen (lighter in color) just underneath the top leaf blade. The lower leaf blade is bent back showing the ligule but a portion of whitish collar can be seen at the edge of the fold.



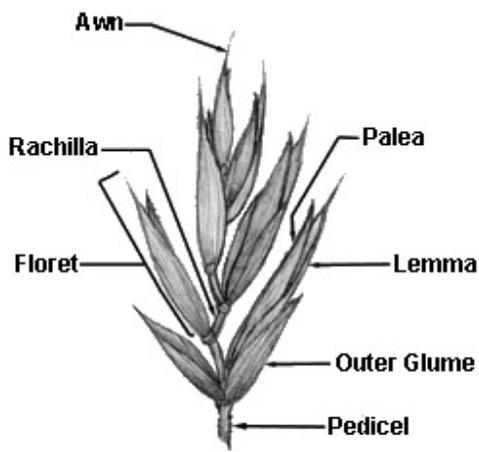
The bottom photograph shows the collar, the narrow band of meristematic tissue of a timothy plant.



The collar region is also important in grass management. When properly safe-guarded, this band of intercalary meristem will account for continued blade growth following mowing or grazing of immature leaf blades.

### *Floral Structures*

- **inflorescence:** flower head terminating the stem, consisting of a collection of flowers arranged on a common axis. There are three main grass inflorescence types: 1. panicle, 2. spike, 3. raceme.
- **rachis:** central axis of seed head.
- **spikelet:** a flowering unit comprised of one or more florets enclosed by two glumes (bracts). When the spikelets are attached directly to the rachis the inflorescence is called a spike (wheat, rye, barley, ryegrass). When the spikelets are attached to the rachis with short pedicels, the inflorescence is termed as raceme. When the spikelets are attached by means of a branch the inflorescence is said to be a panicle.



## Spikelet

- **pedicel:** in grasses, a short stem segment supporting a spikelet. Such spikelets are said to be pedicellate.
- **glume(s):** bracts which enclose the floret(s). A spikelet can be described as a "pair" of glumes with the enclosed floret(s). The outer (lower) glume is always the largest of the pair. In some species (Paniceae family) the uppermost glume is greatly reduced and is largely replaced by the lemma of a sterile floret contained within.
- **floret:** small flower; the reproductive unit of a grass spikelet consisting of a lemma and palea and the small flower they contain (see spikelet).
- **rachilla:** the segmented central axis of a spikelet is prominent in spikelets which bear two or more fertile florets. Each rachilla segment bears a floret, thus in threshed form, a single seed usually retains a rachilla segment or joint. The presence or absence of a rachilla segment provides a means of recognizing many seeds. Further, the shape and size of the segment is widely contrasted among species.
- **lemma:** the larger, outer, bract which, along with the palea, serves to contain the floret(s) held within. The lemma and palea provide a protective covering for the developing floret as well as for the seed after ripening.
- **awn:** a fibrous bristle (often called a beard) which is an extension of the midrib of the lemma. It may arise from the tip of the lemma or from the abaxial (outer) surface below the tip.
- **beard:** common term for awn.
- **palea:** the shorter, upper, bract which, along with the lemma, serves to contain the floret(s) held within (see lemma).
- **stamens:** the male organ of a flower supporting anthers which produce pollen.
- **anther:** the pollen bearing portion of a stamen, composed of one or two pollen sacs.
- **pollen:** the structures that result from the maturation of a microspore.
- **pistil:** the female organ of the flower comprised of the stigma, style, and ovary. The stigma receives pollen grain, which upon germination, produces a pollen tube which passes through the stigma into the ovary.

## Function

The following review of grass plants is intended to describe the functions of various plant parts that will be important in studying grass growth and regrowth.

### *Seeds*

Grasses are herbaceous (nonwoody) plants with jointed stems, slender, sheathing leaves and flowers borne in spikelets. The grass family (Poaceae, formerly Gramineae) is divided into subfamilies. Most grasses in the United States are in the Pooideae, Panicoideae, and Chloridoideae subfamilies. Though grasses are herbaceous, with jointed stems, the categorization into subfamilies is made by more intricate plant anatomy.

Grasses are monocotyledonous because the seeds contain only one cotyledon (seed leaf, also called the scutellum) ([Fig. 1, corn kernel diagram](#)). The coleoptile is enclosed in the cotyledon, a sheath which develops in the seed then breaks away and pushes upwards to the soil surface. This coleoptile is leaf-like in appearance and develops from the seed shortly after the radicle (root) appears ([Fig. 2, coleoptile](#)). In contrast, legumes, such as clovers, are dicotyledonous. Their seeds have two cotyledons. This difference means that grass seedlings emerge from the soil with only one leaf-like structure ([Fig. 3, germination and emergence of monocots](#); [Fig. 4, monocot](#)). Legumes emerge from the soil with two cotyledons ([Fig. 5, dicotyledons](#)).

### ***Roots***

Initially, there are two root systems which support a grass seedling: 1) the seminal root which arises from the root itself and 2) the adventitious or secondary roots which arise from the crown node located at the base of the coleoptile. Seminal roots are called primary roots because they develop first. The seminal roots function until adventitious roots become established. There are no roots on the mesocotyl. The mesocotyl is an underground stem segment often called the subcrown internode or real stem. It elongates in a manner that helps push the coleoptile upward through the soil crust. This is important because the leaf enclosed within the coleoptile might unfurl beneath the soil surface and thus fail to emerge.

The first results of germination are the enlargement of the coleoptile and coleorhiza, a sheath that protects the primary root. This is followed by elongation of the primary root and the mesocotyl. Within days, additional mesocotyl roots develop. Roots developing in the crown area are called adventitious roots. Adventitious roots are the roots of the mature grass plant. The seminal roots will disappear. The roots anchor the plant to the ground, absorb nutrients and water from the soil, and function as carbohydrate storage tanks ([Fig. 6, root diagram](#)).

### ***Crown***

The crown is the base of the grass plant. It is the connecting tissue between the roots and the shoots. The crown produces buds that are the source of new tillers, adventitious roots, rhizomes, and stolons. This area is critical in understanding the regrowth of grass plants because it is the area to find buds which determine if regrowth will be successful ([Fig. 7, crown](#)). Some grass species have storage organs called corms that develop in the crown area ([Fig. 8, corm](#); [Fig. 9, corm at the base of the plant](#)).

### ***Stems***

The flowering stem (culm) of grasses is comprised of nodes and internodes yielding a characteristic "jointed" stem ([Fig. 10](#)). Grass stems have solid joints at the nodes with hollow or pith-filled internodes. In contrast, rushes and sedges are without nodes and internodes and have a triangular stem shape ([Fig. 11, common yellow sedge](#); [Fig. 12, yellow nutsedge stem without nodes and internodes](#); [Fig. 13, the tri-leaf formation of sedges](#)).

### ***Leaves***

A grass leaf consists of a blade, collar, and supporting sheath ([Fig. 14, Fig. 15](#)).

Sheaths arise from each node. Blades are displayed alternately on opposite sides of the culm ([Fig. 16](#)).

Monocot leaf blades have parallel veination while dicots have netted veination ([Fig. 17, grass veination](#); [Fig. 18, dicot veination](#)).

Species are often distinguished by variation in the size and shape of ligules and auricles, appendages located at the collar which joins the blade to the sheath ([Fig. 19](#) and [Fig. 20](#)).

### ***Inflorescences***

Grasses have three main inflorescence (seed head) types: panicle, spike, and raceme ([Fig. 21](#)). Each is unique as to how the individual flowering units, called spikelets, are attached to the central axis. The central axis of an inflorescence is called a rachis ([Fig. 22](#)).

Panicle inflorescences have spikelets individually supported by pedicels attached to **panicle branches**, not directly to the main axis (rachis) ([Fig. 23](#)). Panicles are the most common grass inflorescence but can have two forms: spreading and compact.

- Spreading panicles are common among forage grass species and have varying branch lengths. Examples include switchgrass, proso millet, bromegrass, reed canarygrass, and bluegrasses ([Fig. 24](#)).
- Compact panicles have extremely short panicle branches. Close examination shows that the pedicels supporting the spikelet appears to be branched thereby forming a racemose (raceme-like) inflorescence. Examples include species of foxtails (*Setaria*), timothy (*Phleum*), and meadow foxtails (*Alopecurus* spp.). With such short pedicels they are often mistaken as spike inflorescences and sometimes referred to as "spike-like" ([Fig. 25, a drawing of an \*Alopecurus\* species](#); Meadow foxtail compact panicle, [Fig. 26](#)).

Spike inflorescences have spikelets that are sessile (attached directly to) the rachis without pedicels or branches. Spike inflorescences may exist in three forms:

- 1) Solitary spikes have one rachis of spikelets (*Agropyron*, *Lolium*, *Hordeum* species [Fig. 27](#), [Fig. 28](#), ryegrasses).
- 2) Digitate spikes have more than one rachis of spikelets and form from a central point like the fingers on a hand (*Bouteloua*, *Eluesine*, *Cynodon*; [Fig. 29](#), bermudagrass).
- 3) Multiple spikes have more than one rachis and they form from various points (side-oats grama).

For each of the above types, spikelets are attached directly to the rachis without pedicels or panicles branches.

Raceme inflorescences have spikelets born individually on short pedicels or stalks attached directly to the rachis. There are no branches. There are two forms.

- 1) Digitate (like the fingers on a hand), as in *Paspalam* ([Fig. 30](#)).
- 2) Multiples, as in the *Echinochola* spp. ([Fig. 31](#)).

### ***Spikelet***

The most obvious unit of the grass inflorescence is the spikelet, comprised of a pair of glumes which enclose one or more florets. The number of florets per spikelet varies widely among the grass tribes ([Fig. 32](#)). This figure shows a pedicellate spikelet of the tall fescue panicle inflorescence. Notice that with multiple florets, each floret is born on a segmented central axis called the rachilla. In threshed form, each seed retains its rachilla segment (often called the rachilla joint). This segment is useful when identifying seeds ([Fig. 33](#)).

A floret is the reproductive unit of a spikelet.

In multifloreted spikelets, the florets are attached to a central axis called the rachilla. Figure 34 shows a floret ([Fig. 34](#)). Figure 35 shows a cross section of spikelets ([Fig. 35](#)).

At maturity, each floret (seed) of multi-floreted species retains its uniquely shaped rachilla segment. The unique shape and size of the rachilla segment is useful for identifying grass seeds (i.e. perennial vs. annual ryegrass; wedge-wise vs. cylindrical).

With single-floreted spikelets, like red top, reed canarygrass, meadow foxtail, and timothy, there is no rachilla and therefore, no rachilla segment on the threshed seeds as shown on figure 36, a meadow foxtail seed ([Fig. 36](#)).

### ***Florets***

The reproductive unit within a spikelet is called a floret. A floret is so named because it is a reduced (or modified) flower. It has no calyx or corolla as is found on most dicotyledonous flowers. The reproductive organs of the floret are enclosed by two bracts: the larger of the two is called the lemma, the smaller is called the palea ([Fig. 37](#)). For cross pollination to occur, the lemma and palea must become separated. This separation occurs when spongy cells called lodicules, located in the base of the floret swell, due to the absorption of water spreading the floral bracts. Stamens within the floret extend, exposing the anthers to the wind and other spreading agents such as bees and insects ([Fig. 38](#)).

This process of pollen shedding is called anthesis ([Fig. 39](#)).

## **References (citations and links)**

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## **Mechanisms for Growth**

There are several ways that grasses can grow or grow back after defoliation, winter freezes, or other stresses. There are 5 different structures that enable a grass plant to grow. The five are the apical meristem (meristem=tissues capable of growth), the intercalary meristem, basal buds, stolons, and rhizomes. Not all grass species have all five.

### ***The Growing Point: apical and intercalary meristems***

Many texts refer to "the growing point" of grasses. The growing point consists of two growth mechanisms. Within the growing point there is an apical dome containing the apical meristem and the primordium which will develop intercalary meristem. The apical dome contains apical meristems which push new leaves upward causing the grass plant to increase height and foliage. Intercalary meristems begin in the primordium and are pushed upward to become the base of each leaf blade. Much growth of a leaf is actually the expansion of the cells in the intercalary meristem. This expansion is conducive for photosynthesis and, if a leaf tip is removed, the intercalary cells continue to increase the leaf blade although the leaf tip will not regrow.

## ***Buds***

Buds are the sites for tillering. In the various texts there are many terms that refer to buds. Terms like sprouts, shoots, daughters, and tillers are used. Adjectives can also make the word buds more confusing. The literature refers to aerial buds, adventitious buds and basal buds. Basically, all buds are adventitious with basal buds referring to those new tillers arising from the base or crown area. Aerial buds, appearing at the lower nodes of the plant, occur in certain species.

## ***Rhizomes***

Some species have extravaginal tillering. This means they send out lateral, underground growth which can root at the nodes and develop daughter plants. Grass species with rhizomes (underground stems) are sod forming and can be invasive.

## ***Stolons***

Another type of extravaginal tillering produces lateral, above-ground growth which can root at the nodes' stolons. Grass species with stolons (above ground stems) are sod forming and can be invasive. It is possible that a species may have both rhizomes and stolons but, generally, a species will have one or the other. Many species, called bunchgrasses, have neither rhizomes nor stolons. Tall fescue is considered a bunch grass but has short rhizomes.

