ANATOMY OF THE STEM/SCAPE OBSERVATIONS
**Lilium longiflorum var. giganteum** (Fig. 17 a, b, c, d)

The epidermal cells are radially elongated rather thick-walled with thick cuticle. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are few and not sunken, with air chamber. Stomata are anomocytic. The guard cells are with outer ledges.

The epidermis is followed by two layered chlorenchyma. This is followed by two to three layered sclerenchyma. The remaining cortex is parenchymatous with intercellular spaces. The vascular bundles are scattered and unequal sized. They are collateral with endarch xylem. Xylem elements are in groups or U shaped. Bundle sheath is inconspicuous, thin-walled. Pith is small and parenchymatous.

**Lilium tigrinum** (Fig. 18 a, b, c, d, e).

The epidermal cells are rectangular, thick walled with thick cuticle. Some epidermal cells elongate radially into the conical shaped papillae which are thick-walled. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are few and not sunken and with air chamber. Stomata are anomocytic. Outer stomatal ledges are present.
The epidermis is followed by two to three layered chlorenchymatous and few layered parenchymatous cells. This is followed by two to three layered sclerenchyma. Rest of cortex is of parenchymatous cells. Vascular bundles are of unequal sized and are scattered. They are collateral with endarch xylem. Bundle sheath is conspicuous, thin-walled. Pith is broad and parenchymatous.

**Anatomy of scape**

*Scilla hyacinthina* (Fig. 19 a, b, c, d)

The epidermal cells are rectangular, thick-walled compactly arranged with thin cuticle. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are few and not sunken. Stomata are anomocytic. Outer and inner stomatal ledges are absent.

The epidermis is followed by two layered chlorenchyma and then two layered sclerenchyma. The remaining cortex is parenchymatous. Vascular bundles are unequal in size. Large bundles are alternating with smaller bundles and are arranged in a ring. Vascular bundles are with thin-walled parenchymatous sheath. Vascular bundles are collateral with endarch xylem. Pith is broad and parenchymatous. Starch grains are present in the cortical cells.
**Scilla violacea** (Fig. 20 a, b, c, d)

The epidermal cells are small radially elongated, thick-walled with thin cuticle. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are few and not sunken. Stomata are anomocytic. Outer and inner ledges are absent.

The epidermis is followed by two to three layered hypodermal chlorenchyma and four to five layered parenchymatous cells and then one to two layered sclerenchyma. Rest of cortex is parenchymatous. Vascular bundles are of unequal sized and scattered. They are collateral with endarch xylem. Xylem elements are in groups. Bundle sheath is inconspicuous. Pith is parenchymatous and broad. Starch grains are present in the cortical cells.

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**Ornithogalum thyrsoides** (Fig. 21 a, b, c, d)

The epidermal cells are small, thick-walled, with thick cuticle. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are few and not sunken and with large air chambers. Stomata are anomocytic. Outer stomatal ledges are present.
The epidermis is followed by three to four layered chlorenchyma and few layered parenchymatous cells, which follow three to four layered sclerenchymatous cells. Remaining cortex is parenchymatous. The vascular bundles are unequal sized and are scattered. The outer are smaller and are many in number and some are lying just within or outside the sclerenchymatous ring. The inner vascular bundles are larger. The vascular bundles are collateral with endarch xylem. Xylem is linear or 'V' shaped or in groups of 3-5 elements. Bundle sheath is of thin-walled cells. Pith is narrow and parenchymatous.

*Urgineae congesta* (Fig. 22 a, b, c, d)

The epidermal cells are radially elongated, thick-walled with thick cuticle. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are few in number and sunken with larger air chamber. Stomata are anomocytic. Outer stomatal ledges are present.

The epidermis is followed by few layered chlorenchymatous and few layered parenchymatous cells and then five to six layered thick-walled sclerenchymatous cells. The rest of cortex is parenchymatous. Vascular bundles are scattered and unequal sized. The outer are smaller and many in number. They are collateral with endarch xylem.
Bundle sheath is of thin-walled parenchymatous cells. Xylem elements are in linear rows or Y shaped. Pith is parenchymatous and broad.

_Urginea goiindappae_ (Fig. 23 a, b, c, d)

The epidermal cells are rectangular thick-walled with thick cuticle. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are very few and not sunken with air chambers. Stomata are anomocytic. Outer stomatal ledges are present.

Epidermis is followed by two layers of chlorenchymatous cells and then a layer of parenchyma. This is succeeded by a sclerenchymatous ring of three to four layers. The remaining cortex is parenchymatous. The vascular bundles are in two rings and unequal in size. The outer ones are smaller. The vascular bundles are collateral with endarch xylem. Xylem is linear and 'U' shaped or in groups. The pith is broad and parenchymatous.

_Urginea indica_ (Fig. 24 a, b, c, d)

The epidermal cells are rectangular, thick-walled with thick cuticle. The cells in surface view are elongated and
the anticlinal walls are straight. Stomata are few and not sunken and with large air chambers. Stomata are anomocytic. Stomatal ledges are absent.

The epidermis is followed by two to three layered chlorenchymatous cells which again followed by eight to ten layers of sclerenchymatous cells. The rest of cortex is parenchymatous. Vascular bundles are in a ring. They are collateral with endarch xylem. Bundle sheath is of thin-walled cells. Pith is parenchymatous and broad.

_Urginea maritima_ (Fig. 25 a, b, c, d)

The epidermal cells are small, thick-walled with thick cuticle. The cells in surface view are elongated. The anticlinal walls are straight. Stomata are few and sunken with large air chambers. Stomata are anomocytic. Outer stomatal ledges are present.

The epidermis is followed by three layers of chlorenchyma, two layers of parenchymatous cells and then by ten to twelve layers of sclerenchymatous cells. The rest of cortex is parenchymatous. The vascular bundles are many and are arranged in three rings. The bundles of the two outer rings are smaller and are many in number. These are embedded in sclerenchymatous ring. The bundles of the inner
ring are larger and are capped by sclerenchyma. The vascular bundles are collateral with endarch xylem. The xylem is 'U' or 'V' shaped. The bundle sheath is of thick or thin walled cells. Pith is parenchymatous and broad.

**Urginea paniculata** (Fig. 26 a, b, c, d)

The epidermal cells are small, thick-walled, with thick cuticle. The cells in surface view are elongated. The anticlinal walls are straight. Stomata are few and sunken with large air chamber. Stomata are anomocytic. Outer stomatal ledges are present.

The epidermis is followed by two to three layered chlorenchymatous cells. This is succeeded by eight to ten layered sclerenchymatous cells. The rest of cortex is parenchymatous. The vascular bundles are in four rings. The outer smaller bundles of two rings are embedded in sclerenchymatous ring. The bundles of the inner ring are larger. Sclerenchymatous caps occur at both ends or one end of larger vascular bundles. Vascular bundles are collateral with endarch xylem. Xylem is linear 'V' or 'U' shaped. Bundle sheath is thin-walled, Pith is broad and parenchymatous.
**Urginea polyantha** (Fig. 27 a, b, c, d)

The epidermal cells are smaller, thick-walled with thin cuticle. The cells in surface view are elongated and the anticlinal walls are straight. Stomata are few and not sunken with large air chambers. Stomata are anomocytic. Stomatal ledges are absent.

The epidermis is followed by one-layered chlororenchyma and then by five to six layers of sclerenchymatous cells and again followed by parenchymatous cells. The vascular bundles are in two rings. The outer one is of small bundles. Vascular bundles are collateral with endarch xylem. Xylem is linear or in groups. Bundle sheath is of thin-walled cells. Pith is parenchymatous and broad.

**Urginea razii** (Fig. 28 a, b, c, d)

The epidermal cells are small and thick-walled with thin cuticle. The cells in surface view are elongated. The anticlinal walls are straight. Stomata are few and not sunken with air chamber. Stomata are anomocytic. Guard cells are without ledges.

The epidermis is followed by two to three layered chlorenchymatous cells and then four to five layered sclerenchymatous cells. The remaining cortex is
parenchymatous. Vascular bundles are arranged in two to three rings. The outer ring is of smaller bundles. They are collateral with endarch xylem. Bundle sheath is thin-walled. Xylem elements are in linear row. Pith is parenchymatous and broad.

Diplocaulon concamense (Fig. 29 a, b, c, d)

The epidermal cells are rectangular and thick-walled. Cuticle is thin. The cells in surface view are elongated. The anticlinal walls are straight. Stomata are many and not sunken. Stomata are anomocytic. Guard cells are with outer ledges.

The epidermis is followed by two to three layered chlorenchyma and few layered parenchymatous cells. This is followed by two to three layers of sclerenchymatous cells. Rest of cortex is parenchymatous. Vascular bundles are many and arranged in two to three rings. The smaller bundles of the outer ring lie outside the sclerenchymatous tissue. The larger bundles lie in the inner cortex. Vascular bundles are collateral with endarch xylem. Bundle sheath is conspicuous. Xylem elements are linear. Pith is broad and parenchymatous.
**Dipcadi montanum** (Fig. 30 a, b, c, d)

The epidermal cells are small rather thick-walled. Cuticle is thin. The cells in surface view are elongated. The anticlinal walls are straight. Stomata are many, and not sunken with large air chamber. Stomata are anomocytic. The guard cells are with outer ledges.

The epidermis is followed by two to three layers of chlorenchymatous cells and two layers of parenchymatous cells. This is followed by four to five layers of small, thick walled sclerenchymatous cells. Rest of cortex is parenchymatous. Vascular bundles are scattered. They are collateral with endarch xylem. Bundle sheath is inconspicuous. Xylem elements are in linear rows. Pith is broad and parenchymatous.

**Dipcadi saxorum** (Fig. 31 a, b, c, d)

The epidermal cells are small and thick-walled with thick cuticle. The cells in surface view are elongated. The anticlinal walls are straight. Stomata are more and not sunken with air chamber. Stomata are anomocytic. Guard cells are with outer ledges.

The epidermis is followed by two to three layers of chlorenchymatous cells and few layers of parenchymatous
cells and then by three to four layers of sclerenchymatous cells. Rest of cortex is parenchymatous.

The vascular bundles are in two to three rings. The outer smaller bundles occur outside the sclerenchymatous ring and few remain embedded in the tissue of ring. The bundles of inner ring are large. The vascular bundles are collateral with endarch xylem. Xylem elements are in group or linear rows. Pith is parenchymatous and broad.

*Dipcadi ursulae* (Fig. 32 a, b, c, d)

The epidermal cells are small, rather thick-walled with thin cuticle. The cells in surface view are elongated. The anticlinal walls are straight. Stomata are less in number and not sunken with air chamber. Stomata are anomocytic. Guard cells are with outer ledges.

The epidermis is followed by two to three layers of chlorenchymatous cells and three to five layers of parenchymatous cells and then by three to four layers of sclerenchymatous cells. Rest of cortex is parenchymatous. Vascular bundles are many and are scattered. They are collateral with endarch xylem. Pith is parenchymatous.
**Lilium longiflorum var. giganteum**

**FIG 17**

SCAPE T.S. AND EPIDERMIS
FIG 18  SCAPE T.S.  AND EPIDERMIS

Lilium tigrinum
FIG 19  SCAPE T.S. AND EPIDERMIS

*Scilla hyacinthina*
FIG 20  SCAPE T.S. AND EPIDERMIS
FIG 21  SCAPE T.S. AND EPIDERMIS
FIG 22  SCAPE T.S.  
AND EPIDERMIS
Urginea govindappae

FIG 23 SCAPE T.S. AND EPIDERMIS
FIG 24  SCAPE T.S. AND EPIDERMIS

Urginea indica
FIG 25  
SCAPE T.S.  
AND EPIDERMIS  

Urginea maritima
FIG 26  SCAPE T.S. AND EPIDERMIS

SCAPE T.S. AND EPIDERMIS

0.5 mm

0.5 mm

0.1 mm

Cl
Sc

Urginea pancracion
FIG 28  SCAPE T.S. AND EPIDERMIS

Urginea razii
FIG 29  SCAPE T.S.
AND EPIDERMIS

Dipcadi concanense
FIG 30  SCAPE T.S. AND EPIDERMIS
FIG31  SCAPE T.S. AND EPIDERMIS

Dipcadi saxorum
Dipcadi ursulae

FIG 32  SCAPE T.S.  
AND EPIDERMIS

Cl  
Sc
ANATOMY OF THE STEM/SCAPE DISCUSSION
An aerial erect, cylindrical, unbranched and short-lived stem from a bulb occurs in *Lilium*.

The epidermal cells are thick-walled, radially elongated in *L. longiflorum* var. *giganteum* and rectangular in *L. tigrinum*. In the latter species, these cells elongate radially into conical, thick-walled papillae. The stomata are few and anomocytic. The guard cells develop an outer ledge.

The hypodermis is parenchymatous and is followed by a ring of sclerenchyma. The ring is narrow in *L. longiflorum* var. *giganteum*. The vascular bundles are many and scattered. The xylem is 'U'- or 'V'-shaped or may be even linear (Cheadle and Uhl, 1948).

**Anatomy of scape**

The scape is erect, cylindrical, and unbranched. In some plants, the upper portion of the scape becomes pendent. The length varies in different plants. The scape has ridges and furrows in *U. maritima*. Kamble and Ansari (1977) find ridges and furrows in *U. indica* and only furrows in *U. razii*. However, in the material of same species studied for the present account such a feature is not observed.

It is interesting to note that in many species of *Urginea*, the scape appears first before the leaves; very
few species develop scape along with the leaves, e.g., *U. comosa*, *U. beccarii* and *U. congesta*.

The epidermis is generally of thick-walled and small, rectangular or radially elongated cells. In some plants, it is thin-walled. In surface view, the epidermal cells are elongated. The anticlinal walls are straight and comparatively thick. The cuticle is generally thick and smooth. The stomata are anomocytic. In *Dipcadi* the number of stomata is more. In the rest of plants the stomata are very few. The guard cells develop an outer ledge in *U. congesta*, *U. govindappae*, *U. maritima*, *U. pancratia*, *O. thyrsoides* and in the species of *Dipcadi*.

The type and distribution of mechanical tissue is rather interesting. The hypodermis is parenchymatous. The outermost layers of hypodermal parenchyma become chlorenchymatous in all the plants. The hypodermis is followed by sclerenchyma. It is usually in the form of a ring and not interrupted by the parenchymatous tissue. *D. concanense* and *Scilla* have narrow ring of sclerenchyma, while in the rest of the plants it is broader. Kamble and Ansari (1977) describe that sclerenchymatous content in *U. indica* and *U. govindappae* is nearly the same, but less when compared to those of *U. polyantha* and *U. razii*. This study on these species however indicate that the *U. razii* and *U. govindappae* have comparatively less sclerenchyma in scape.
The scape also functions as a photosynthetic organ. Generally, the hypodermal chlorenchymatous cells are involved in this function. No hypodermal collenchymatous cells are noted in the present taxa studied. Even in the rachis of *Zephyranthes taxana* the collenchymatous cells contain chloroplast and perform the twin functions of providing strength and food (Bansod, 1986).

The vascular bundles are generally numerous and mostly scattered. The outer bundles are generally smaller, while the inner ones are comparatively large. In certain plants, these bundles may be arranged in one or two rings. In *U. indica* and *S. hyacinthina* the bundles are in a single ring. In a latter plant, large bundle alternate with the smaller bundles. In *U. polyantha*, *U. razii* and *U. govindappae* these bundles are in two rings. In the remaining plants, they are in more than two rings. Furthermore, it is to be noted that some vascular bundles remain embedded in the sclerenchymatous ring or they may lie outside the ring. In *D. concanense*, *D. saxorum* and *O. thyrsoides* vascular bundles lie outside the ring, while *U. maritima*, *U. pancratium* many bundles remain embedded in the sclerenchymatous ring. Again, in the latter two species, the inner bundles are capped with sclerenchyma. The vascular bundles may show different shapes of xylem 'V'- or 'U'- or 'Y'-shaped or may be even linear (Cheadle and Uhl, 1948).
It may be noted that the scapes in general in these plants are not as massive as those in *U. maritima* and *U. panicration*. In the latter species, the development of sclerenchyma is more on account of the increased demand for strength and rigidity for the large scape.

Rendle (1930) finds that the scape anatomy can be used as a parameter for taxonomic delineations amongst the amaryllids. According to him, the presence or absence of a continuous ring of sclerenchyma in the cortex can be employed for this categorisation of the amaryllid genera into two groups. The present study however indicates that the sclerenchymatous ring occurs in all the plants studied. It is either narrow or broad. It encloses the vascular bundles inside or in some cases the vascular bundles are embedded within itself as in *U. maritima*, *U. panicration* or in still others, some bundles lie outside the ring. One may at best say that the variation in thickness of the sclerenchymatous ring and the distribution of vascular bundles in the scape of the lilies studied have to be looked at more from the mechanical standpoint. They may help incidentally in taxonomic grouping as in the amaryllids. That may not be the case always as is seen from the present study on the lilies.