CHIMERA

Apical Origin, Ontogeny and Consideration in Propagation

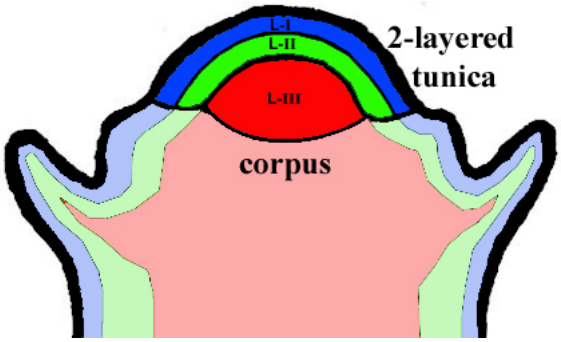
CHIMERA (ki' mer a)

Chimera - a plant or plant part composed of genetically different layers.

The most common example is a "variegated" plant where different regions of the leaf are yellow or white due to the lack of chlorophyll synthesis, i.e. these are chlorophyll mutants. However, there are many kinds of chimeras. Thornless blackberries are chimeras where the L-I epidermis lacks the ability to produce thorns. Some fruits have sweet and sour regions of flesh, which may be a chimera.

Tunica-Corpus Model of Apical Organization

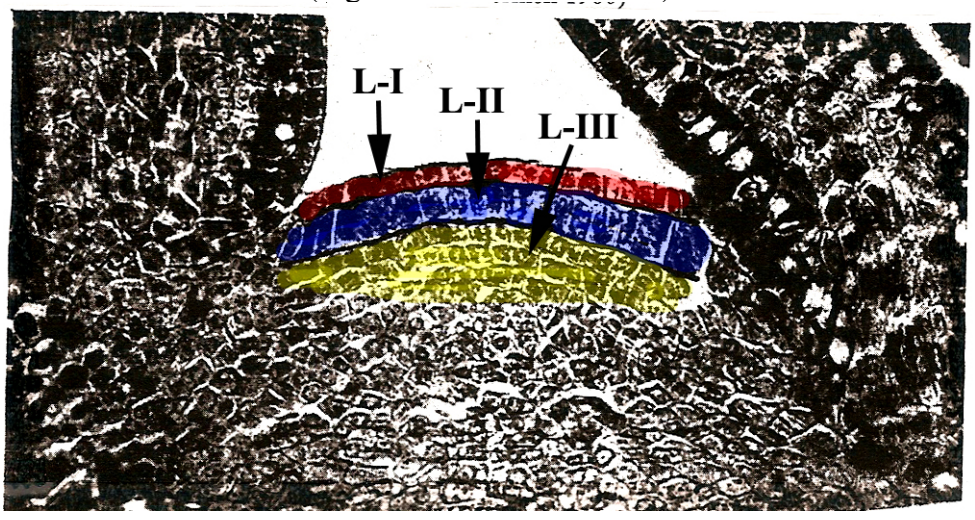
Stable chimeras usually occur in species that exhibit a tunica-corpus type of apical organization, which is common in many dicot and monocot species. The outer layer of the tunica gives rise to the L-I layer, the second layer of the tunica gives rise to the L-II layer, and the corpus gives rise to the L-III layer.



Chochicine-Induced Tetraploid Chimeras

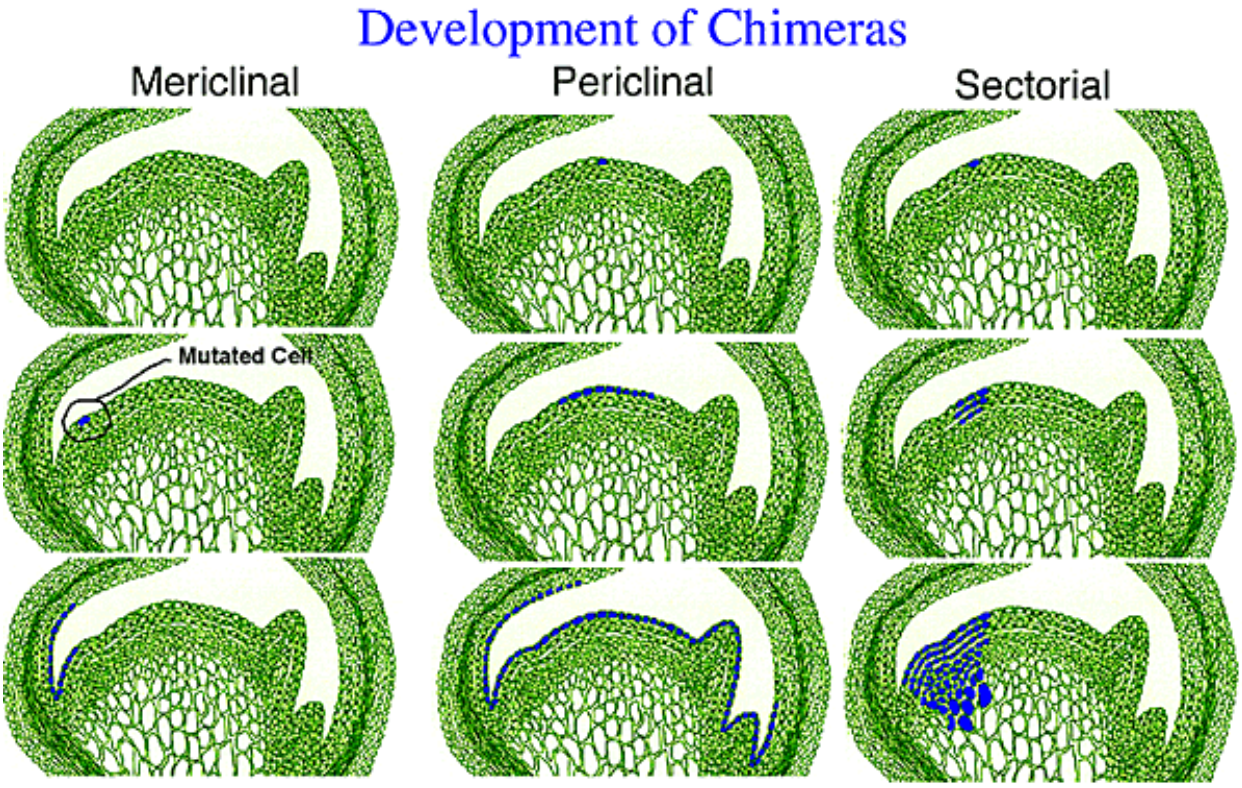
Chochicine is a chemical that allows doubling of the chromosomes, but not cytokinesis; thus, tetraploid cells are produced. If chochicine is applied to the apical dome, tetraploid cells can be induced to form. If only one layer of the apical meristem is receptive to the chochicine, then a distinguishable chimera is produced.

(Fig. 8a from Dermen 1960)



Types of Chimeras

(from Dan Lineberger,
aggie-horticulture.tamu.edu/syllabi/201h/lecoutlines/chimeralec/chimeras.html)



Mericlinal Chimera
A mutation occurs in one layer and along the side of the apex. Due to its position, the cell division products of those mutated cells occur as a layer on only one side of the plant. In other words, only a section of one of the layers is mutated. Mericlinal chimeras are not stable.

Periclinal Chimera
A mutation occurs in one (or more) layer at the top of the apex. Due to its position, the cell division products of the mutated cells spread and cover the entire layer of the apex. In other words, the entire layer is mutated. Periclinal chimeras are stable to very stable, and comprise the most common type chimeras in horticulture.

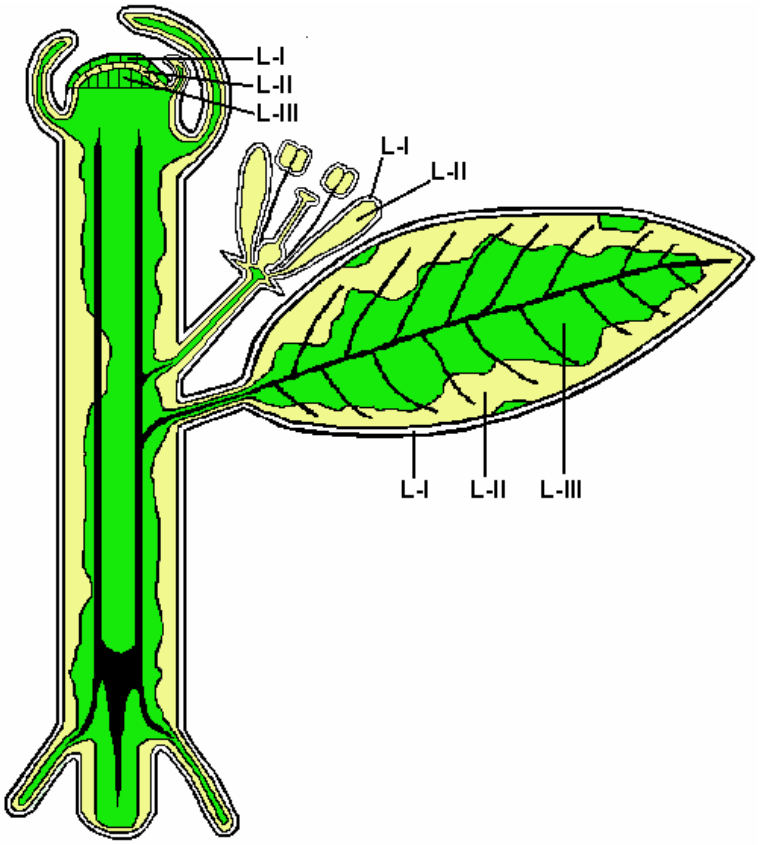
Sectorial Chimera
A mutation occurs in multiple layers at the top of the apex. Due to its position, the cell division products of the mutated cells give rise to a section of mutated cells. In other words, an entire section of the plant is mutated. Sectorial chimeras are stable to very stable, and comprise the most common type chimeras in horticulture.

Layering of Periclinal Chimeras

A periclinal chimera will have the mutated region(s) restricted to the layer(s) which was mutated in the apical meristem. If a plant is variegated because it is a periclinal chimera, the pattern of variegation should have a geometrical organization similar to the pattern below.

If the pattern is more of a mosaic, spots, blotches, or lateral stripping, it is probably not a chimera, but rather genetically determined. Or, the plant may be one of the other chimeral types, i.e. sectorial or mericlinal chimeras.

A chimeral pattern can also occur in flower petals, such as multi-colored African Violets or petunia flowers.



Nomenclature for Periclinal Chimeras

A periclinal chimera is described by a sequence of three letters with the first representing L-I, the second L-II and the third L-III. G is usually used to represent green or an un-mutated layer, and W is usually used to represent the non-green mutated layer. For example, if the center of the leaf around the midrib is white or yellow and the rest of the leaf is green, then it would be described as a GGW chimera. All combinations are possible.

Portions of Stems Derived from L-I, L-II AND L-III Layers of the Apical Meristem

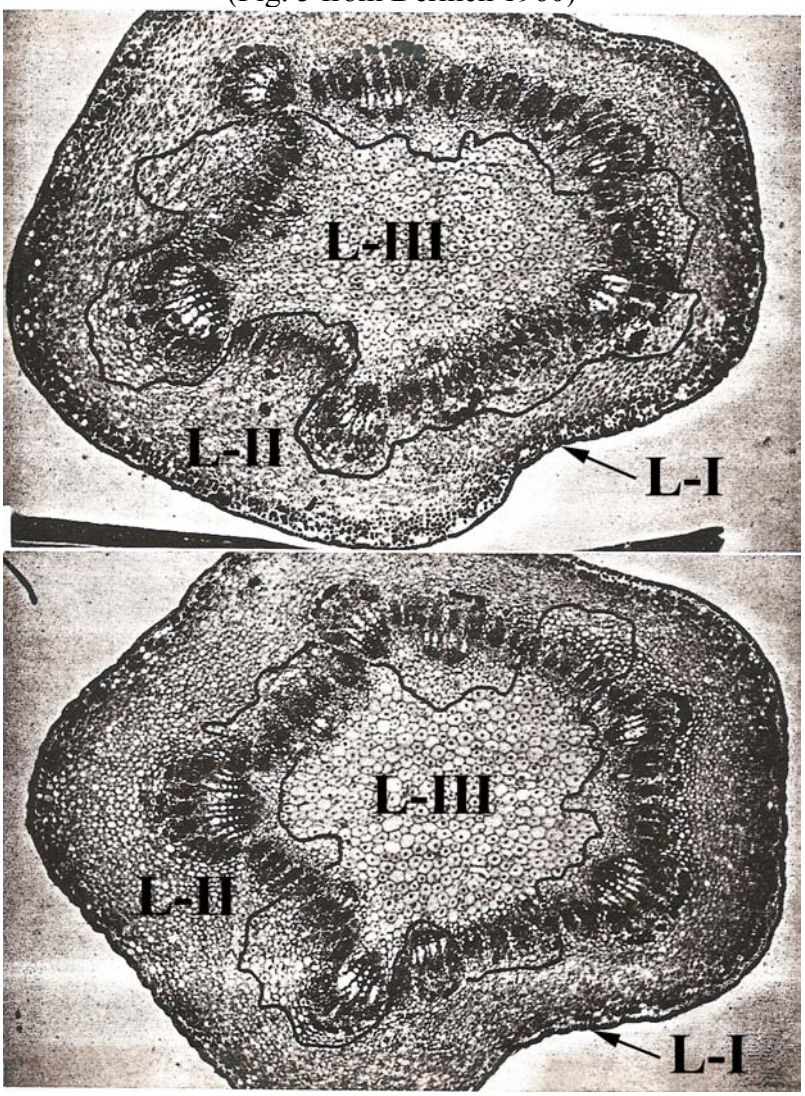
Cross-section of two peach stems. The epidermis is L-I. The wavy line denotes the border between L-II and L-III. L-III is differentiated by its larger chochicine-induced tetraploid cells.

L-I: encompasses the epidermis

L-II: usually encompasses most of the cortex, a variable portion of the vascular tissue, and some of the pith.

L-III: usually encompasses most of the pith, a variable portion of the vascular tissue, and some of the cortex.

2-2-4 Chimera - Chochicine-Induced Tetraploid L-III
(Fig. 5 from Dermen 1960)



Portions of Flower Derived from L-I, L-II AND L-III Layers of the Apical Meristem

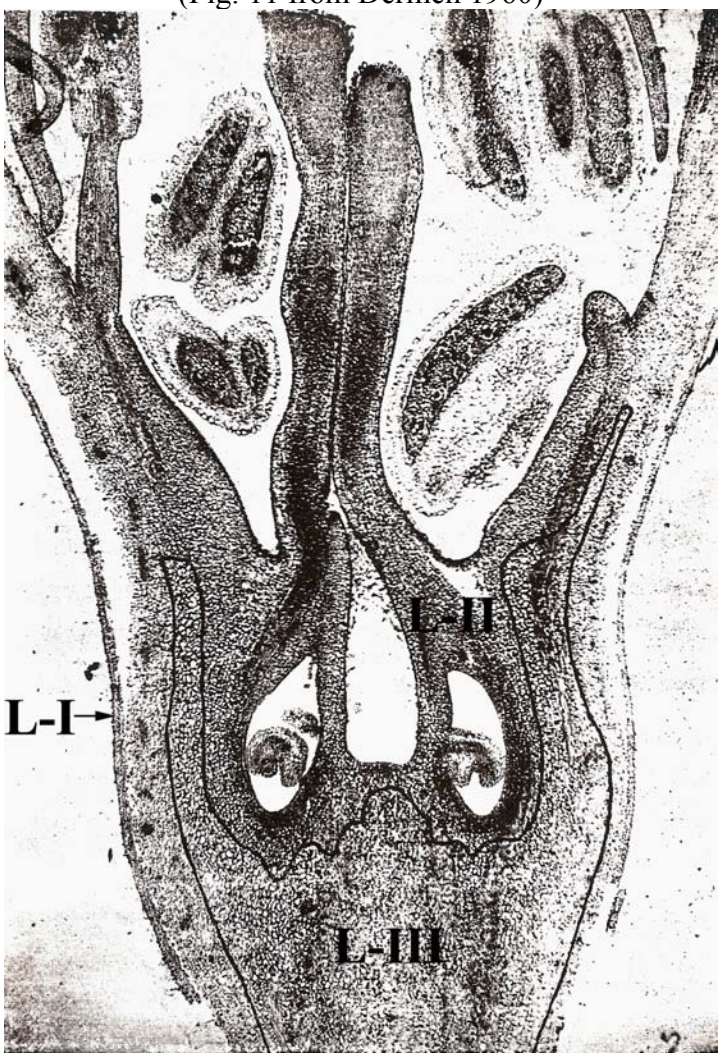
Longitudinal section through an apple flower just before opening. The epidermis is L-I. The wavy line denotes the border between L-II and L-III. L-III is differentiated by its larger chochicine-induced tetraploid cells.

L-I: comprises the epidermis

L-II: comprises the mesophyll of the petals, and the non-epidermal portions of the stamens, and most of the pistil and ovary tissue; i.e. the reproductive portions.

L-III: comprises the center of the peduncle and receptacle.

2-2-4 Chimera -Chochicine-Induced Tetraploid L-III
(Fig. 11 from Dermen 1960)



Ontogeny of Chimeras

Each layer of the tunica corpus gives rise to specific anatomical regions of the plant body. There are key differences between dicots, monocots and gymnosperms.

Dicots and monocots - developmentally they are similar, with the most pronounced differences expressed in the leaves as detailed below.

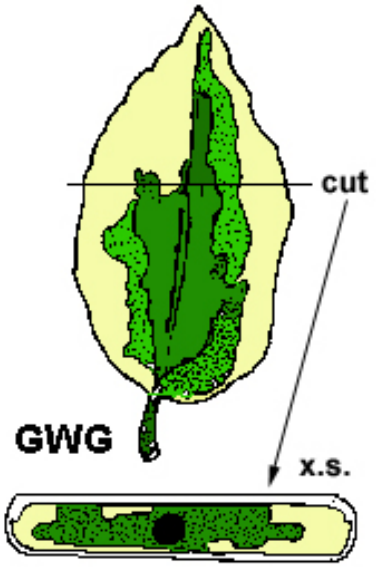
Gymnosperms – most gymnosperms do not follow a strict tunica-corpus organization; rather have a mantle-core arrangement. Anticlinal cell divisions are less strictly followed in the mantle. Thus, typically, gymnosperm chimeras are less stable.

Layer	Region of Tunica-Corpus	Gives Rise To
L-I	**first (outer) cell layer of tunica**	**epidermis** - of all organs **dicot leaf** - L-I usually gives rise to only the epidermis. Epidermal cells usually are colorless (i.e. lack chlorophyll), thus an L-I mutation in dicots usually cannot be seen. In some species, L-I may give rise to small islands of tissue along the margin. You can verify a L-I chlorophyll chimera by looking for chloroplast in the guard cells **monocot leaf** - L-I contributes to the outermost region of the leaf mesophyll giving rise to a strip along the leaf margin. **gymnosperm leaf** – L-I and L-II may have anticlinal and periclinal cell divisions, thus L-I L-II contribute to a variable amount of the epidermis and subepidermal tissue. For this reason, chimeras of gymnosperms typically are not very stable. **flower, fruit and seed** – L-I gives rise to the epidermis.
L-II	**second cell layer of tunica**	**stem and root -** outer and inner cortex and some of vascular cylinder. **leaf -** mesophyll in outer region or perimeter of leaf. **flower, fruit and seed** – L-II gives rise to the mesophyll of petals and sepals, and the internal tissue of the stamens and pistil and resultant pollen and seeds.
L-III	**corpus**	**stem and root -** inner cortex, vascular cylinder and pith **leaf** - mesophyll in central region of leaf. **flower, fruit and seed** – L-III typically does not contribute to any part of the flower, fruit or seeds.

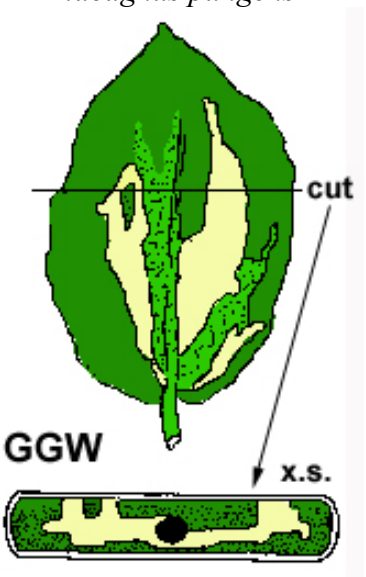
Periclinal Chimeras

(from R.A.E. Tilney-Bassett. 1986, and Stewert and Dermen 1979)

Dicot - GWG Chimera
L-II mutation
Elaeagnus pungens

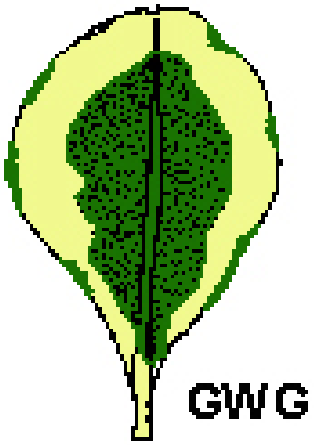


Dicot - GGW Chimera
L-III mutation
Elaeagnus pungens



Dicot - GWG Chimera
L-II mutation
Peperomia obtusifolia

Note islands of green tissue along the margin of the leaf indicating a normal L-I



Monocot Chimeras
Chlorophytum comosum (left & right) and *Dracaena deremensis* (center)

Asexual Propagation of Chimeras

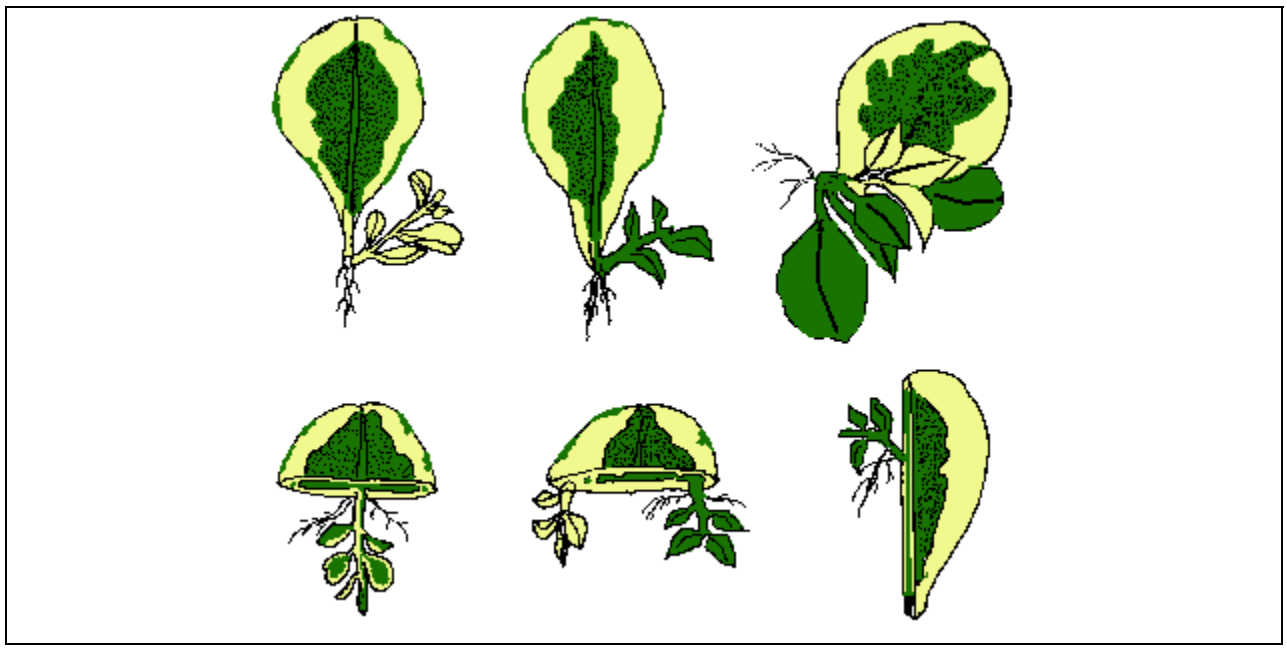
Stem Cuttings

Stable periclinal chimeras can be propagated true-to-type by stem cuttings, because the lateral buds are reproduced identical to the original mutated apical bud. Sectorial or mericlinal chimeras cannot be propagated true-to-type, because the lateral buds will have the properties of the side of the shoot from which they originated.

Leaf or Root Cuttings

If you take leaf or root cuttings from chimeras the plantlets that form are never true-to-type to the parent variegation or mutation. The reason is simple. The adventitious shoots that form will have the properties of the region of the leaf or root from which they regenerate. For this reason, chimeras are never propagated true-to-type by cutting types or methods that require adventitious shoot formation.

Adventitious Shoot Formation on Leaf Cuttings of a GWG Periclinal Chimera of *Peperomia*
(Modified from: R.A.E. Tilney-Bassett. 1986)



SEED PROPAGATION

Chimeras cannot be propagated true-to-type from seed. Look at the previous figures on location of the layers in the flower to determine why. Or, think about the cellular origin of an embryo.