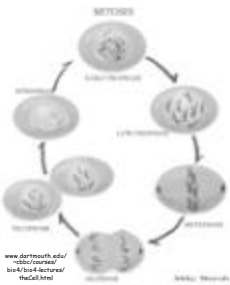


Mutations, Chimeras, and Variegation



Mitosis



- Cells divide to form 2 identical daughter cells
- Mitosis - division of the nucleus

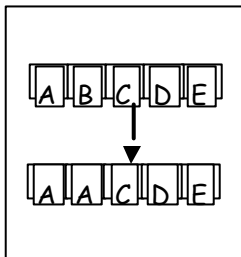
Mutations

Mutations



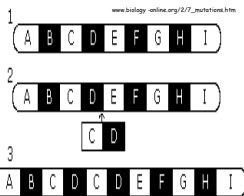
- Genetic modifications that produce permanent changes in the genotype of the plant
- Can be spontaneous or induced
- Chemicals, radiation

Point Mutation



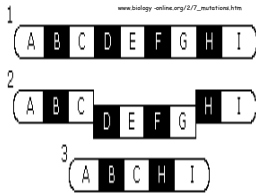
- Chance rearrangement of the four bases in the DNA structure

Duplication



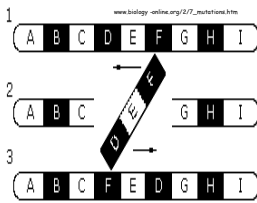
- An individual chromosome segment is duplicated and inserted in the chromosome set

Deletion



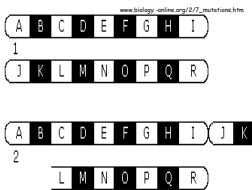
- Removal of an individual chromosome segment from the chromosome set

Inversions



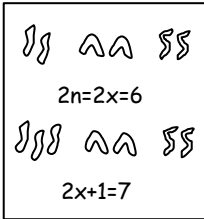
- Removal of a chromosomal segment
- 180° rotation
- Reinsertion in the same location

Translocations



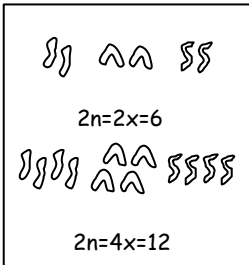
- Relocation of a chromosomal segment into a different position in the genome

Aneuploidy



- Chromosome number of a cell or cells differs from the normal chromosome number for a species
- Results from the addition or subtraction of a few chromosomes

Polyploidy



- Chromosome number of a cell or cells differs from the normal chromosome number for a species
- Results from multiplication of entire sets of chromosomes

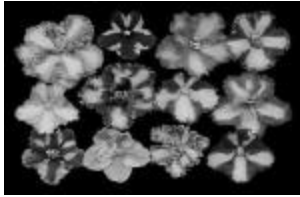
Mutations



- Most mutations are deleterious
- A few are aesthetically desirable

Genetic Mosaic

- Existence of cells of different genotypes coexisting in the same organism

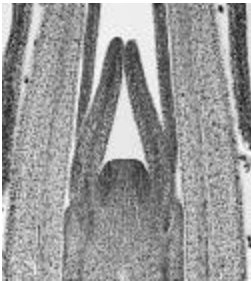


Plant Chimeras

- Specific type of genetic mosaic
- Two or more genotypes coexisting in the shoot apical meristem

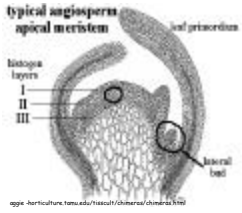


Shoot Apical Meristem

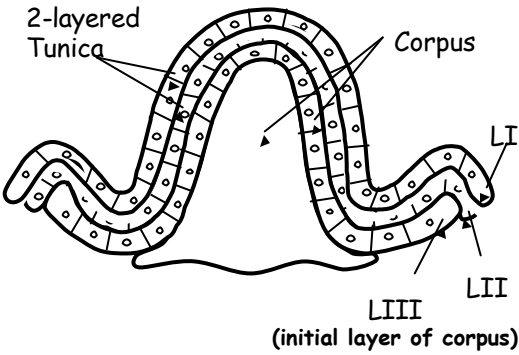


- Active cell division
- Origin of primary tissues for vegetative and reproductive structures
- Different arrangements

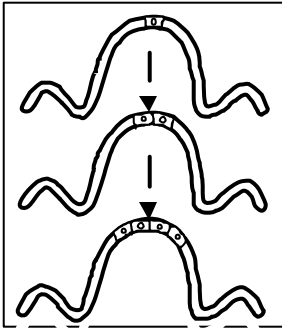
Tunica Corpus Arrangement



- Schmidt, 1924
- Angiosperms
- Dicots - 3 apical cell layers
- Monocots - 2 apical cell layers

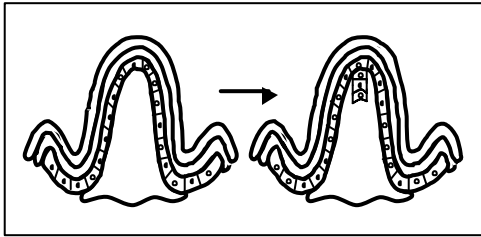


Anticlinal Division

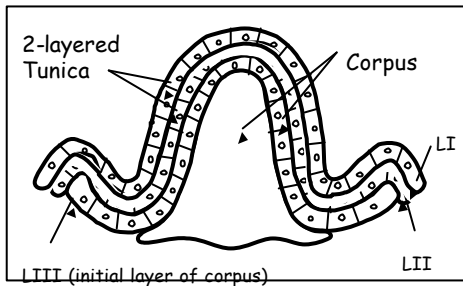


- Cells divide perpendicular to the surface

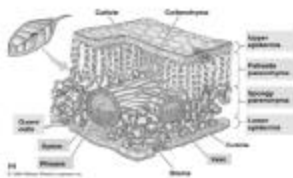
Periclinal Division



- Cells divide parallel to the surface



- LI - outer layer of stem
- LII - cortex, vascular tissue, reproductive structures
- LIII - pith, some vascular tissue



- LI - epidermis
- LII - palisade parenchyma, spongy parenchyma of the leaf margin
- LIII - upper and middle layer of the spongy parenchyma, but no contribution to the blade margin

Variegation

Variegation

- Presence of distinct markings or different colors on a portion of the plant or the entire plant
- Manifested as streaks, stripes, blotches, or differences between the leaf or petal margins and the leaf or petal mid-region

Variegated Chimeras



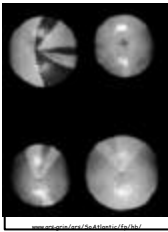
- Cells of one color are clonally related
- Cell division planes regulate the patterns
- Rate and duration of cell division determines the size and shape of the streak, stripe, or blotch

Origin of Plant Chimeras



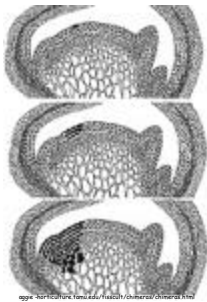
- Genetic mutations in the nuclear or chloroplast genome
- Transposable genetic elements
- Tissue culture
- Semigamy
- Graft chimeras

Types of Plant Chimeras



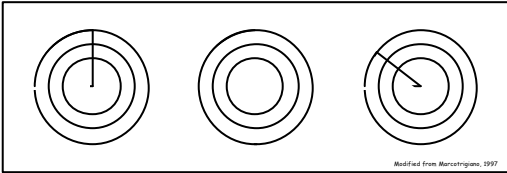
- Sectorial
- Mericlinal
- Periclinal

Sectorial Chimeras



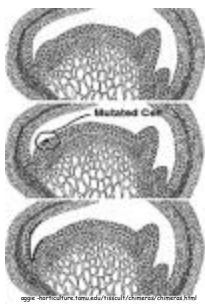
- A segment of all apical cell layers is genetically different

Sectorial Chimeras



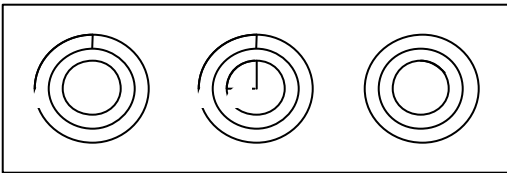
- Unstable
- Revert to mericlinal or periclinal
- Occur at early embryonic stages

Mericlinal Chimeras



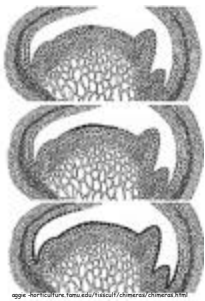
- A segment of one or more layers is genetically different

Mericlinal Chimeras



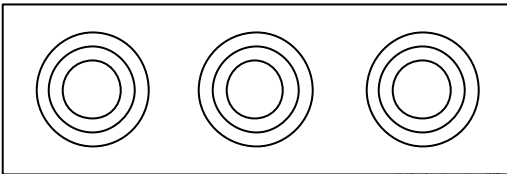
- Unstable
- Revert to periclinal or non-chimeral
- Often appear as sectorial
- Size of segments varies

Periclinal Chimeras



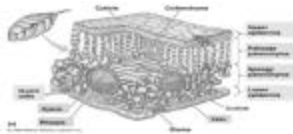
- One or more apical layers is genetically distinct from another apical layer

Periclinal Chimeras

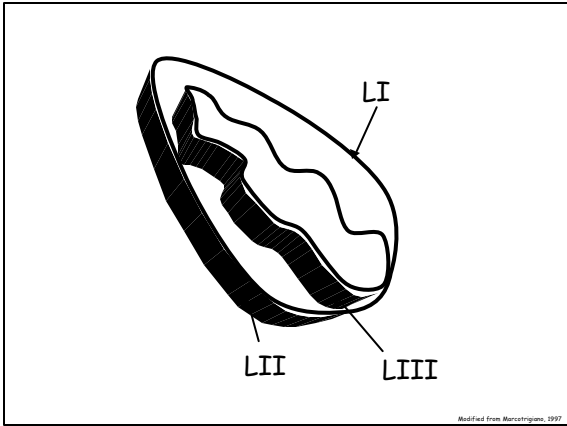


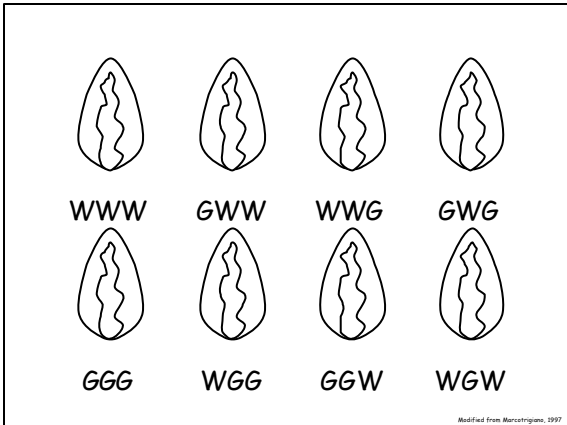
- Most stable
- Stability dependent on tunica-carpus arrangement
- Green and white - most common

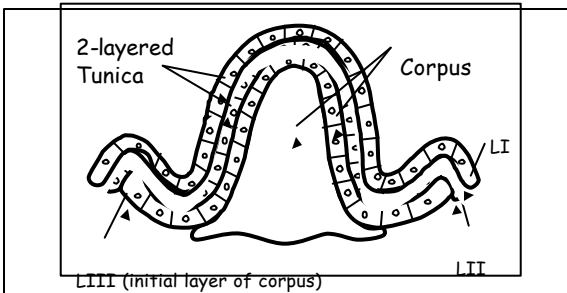
Periclinal Chimeras



- LI - epidermis
- LII - palisade parenchyma, spongy parenchyma of the leaf margin
- LIII - upper and middle layer of the spongy parenchyma, but no contribution to the blade margin

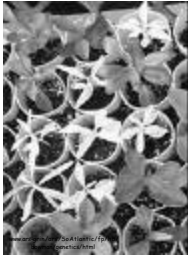






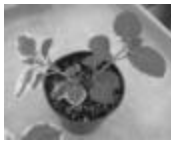
LI - outer layer of stem
LII - cortex, vascular tissue, reproductive structures
LIII - pith, some vascular tissue

Propagation

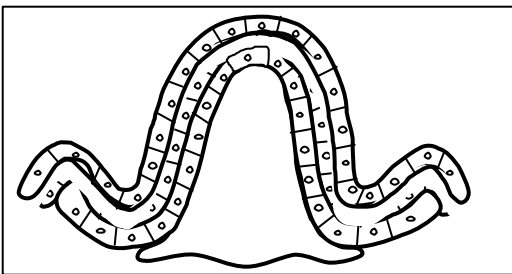


- LII - reproductive layer
- One genotype
- Variegation is not transmittable through the seed
- Stem cuttings, grafting, leaf-bud cuttings, division

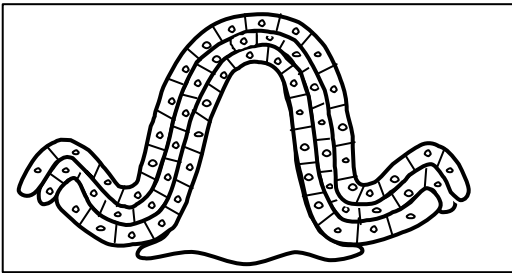
Bud Sports



- Sudden appearance of a branch or whole plant with marked changes in a specific characteristic
- Often result from displacement or replacement of cell layers in chimeras



- Replacement - periclinal division of a cell in an outer layer invades an inner layer



- Displacement - cells from an inner layer take over the position of cells in an outer layer

POP QUIZ

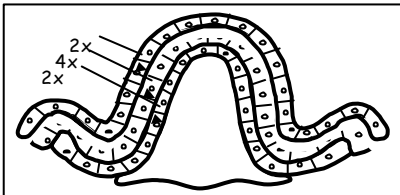
- A. All chimeras are variegated
- B. All variegation is due to chimeras
- C. All of the above
- D. None of the above

ANSWER D

Other Chimeras

- Thornless blackberries
- Sweet and sour apples
- Cytochimeras

Cytochimeras



- Different ploidy levels coexisting in shoot apical meristem
- Cells with higher ploidy levels are larger

Categories of Variegation



- Cell lineage type
 - ✓ Genetic mosaics
- Noncell lineage type
 - ✓ Differential gene expression
 - ✓ Leaf blisters
 - ✓ Viruses

Noncell Lineage

- All cells in the organism have the same genotype
- Genes in only certain cells are expressed
- The variegated phenotype is dependent on the geographic location of the cell in the organism

Differential Gene Expression



- Most common
- Most misunderstood
- All cells are genetically identical

Differential Gene Expression



- Genes responsible for pigment synthesis or destruction are only in expressed in certain cells
- Seed transmitted

Leaf Blisters



- All cells are genetically identical
- Cells separate from the underlying cells
- Seed transmitted

Viruses



- Do not severely impair growth
- Seed or graft transmitted

Conclusions

- Sexual propagation is dependent on the mechanism controlling the trait of interest
- Asexual propagation is necessary to maintain chimeras and bud sports

References

- Esau, K. 1977. *Anatomy of Seed Plants*. 2nd ed. John Wiley & Sons., New York.
- Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin, & N.M. Gelbart. 1996. *An Introduction to Genetic Analysis*. 6th ed. W.H. Freeman & Co., New York.
- Marcotrigiano, M. 1997. Chimeras and variegation: patterns of deceit. *HortScience*. 32:773-784.
- Tilney-Bassett, R.A.E. 1986. *Plant Chimeras*. Edward Arnold, London.
