Cytoplasmic mutations, Cell autonomy

Maternal inheritance

Strictly maternal inheritance is expected when a mutation occurs in a gene encoded by the chloroplast or mitochondria. Both organelle genomes are genetically redundant, with several genomes (~5-10) per organelle and upwards of 100 organelles of each type in any given cell. Somatic segregation can result in the 'homoplasmic' state such that mutant phenotypes can be studied. Essential genes cannot be made homoplasmic, i.e remain heteroplasmic.

1. A classic example is variegated Four O' Clock. Only when crossed as a female is the white phenotype transmitted.
2. Another very similar example is the NCS6 mutant of maize, a yellow-striped mutation. The gene affected is the *cytochrome oxidase subunit 2* encoded in the mitochondria. NCS6 shows this segregation in crosses (Gu et al., 1993, Plant Cell 5 963-971):

Cross	# mutant	# normal
NCS6 X WT	39	0
WT X NCS6	0	83
NCS6'nd' X WT	0	22

'nd' = normal derivative, i.e. a nonstriped plant that arose by somatic segregation from a mutant

3. Most chloroplast genetics in higher plants is done in tobacco, where chloroplast reverse genetics is possible. The approach is to use biolistic transformation to transform the chloroplasts with a mutant gene that contains a selectable marker. The mutant gene/selectable marker can replace the wild type gene by homologous recombination (this is called gene replacement). Homologous recombination events such as this occur naturally once the construct is in a chloroplast. The new mutant alleles can be selected for over several plant generations to recover the homoplasmic state. Even essential genes can be made homoplasmic because the plants can be grown on sucrose.

Cell autonomy

The *Antirrhinum deficiens* mutation transforms petals into sepals. In an unstable mutation, sectors of petal tissue are formed on the mutant sepal tissue.

Partial Cell autonomy

1) Camelia example – non-cell autonomy drives much of plant form

2) A good example comes from a McClintock experiment. On kernels of the genotype Ds Bz CI/ bz C (Ac), Bz and CI are lost to expose the bz phenotype. At the border between (C-I, Bz) and (C, bz) a purple line occurs. Conclude that Bz product from C-I region moves into bz sector. The anthocyanin intermediate made by the Bz1 locus is *partially cell autonomous*.

3) Another example of a partially autonomous character: *Knotted.* The Knotted mutation causes protrusions on the epidermis; but where is the gene product made that conditions this phenotype? [to

understand this analysis, you must understand that plants have meristematic cell layers, designated LI, LII, LIII. Each cell layer contributes in a unique way to organ formation]

Data shown from Sinha et al., who X-irradiated plants of the constitution *Lw Kn*/*lw kn.* The authors conclude that Kn is required in the lateral vein and/or the middle mesophyll bundle sheath layer of the leaf to form knots on the epidermis.

Non-cell autonomy

Other gene products are non non-cell autonomous, e.g. gene involved in synthesizing phytohormones.