

Mitosis and Meiosis

Shui-zhang Fei
Department of Horticulture
Iowa State University

Different types of cultivars

- Vegetative cultivars – clonal cultivars such as potato, ornamentals.
- Seed cultivars
 - Soybean – naturally self-pollinated. Cultivars breed true and are referred to as pure line cultivars.

Alfalfa – naturally open-pollinated. Cultivars do not breed true and are referred to as synthetic cultivars.

Before we discuss mitosis and meiosis in details, we need to know two ideas

Idea 1: Chromosome sets

- Chromosome sets: Each plant species has a unique chromosome number. Corn has 20 chromosomes, consisting of two sets with one set (10) from the pollen (tassel) and the other from the egg cell (ear).
- While the corn plant has 20 chromosomes, its gametes, i.e. pollen in the tassel or eggs in the ear contain only one half of the 20 chromosomes.

Idea 2: Homologous chromosomes

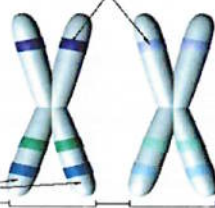
- When pollination occurs, the 10 chromosomes from the pollen parent (A, B, C,J) and the other 10 from the egg parent (A', B', C',J') come together as pollen and egg unite.
- The 20 chromosomes in a corn plant are thus made of 10 homologous chromosome pairs.

This idea is particularly useful in understanding the meiosis.

Figure B-11: Homologous Chromosomes

Homologous chromosomes contain DNA that codes for the same genes. In this example, both chromosomes have all the same genes in the same locations (represented with colored strips) but different 'versions' of those genes (represented by the different shades of each color).

Homologous regions code for the same gene



Sister chromatids are exact replicas, but homologous chromosomes are not

Genes at corresponding locations do not have to be different; when they are different, it's called heterozygous, as in an F1 hybrid.

When they are the same, it's called homozygous, as in a soybean pure line cultivar

Why potato plants of a particular cultivar are identical?

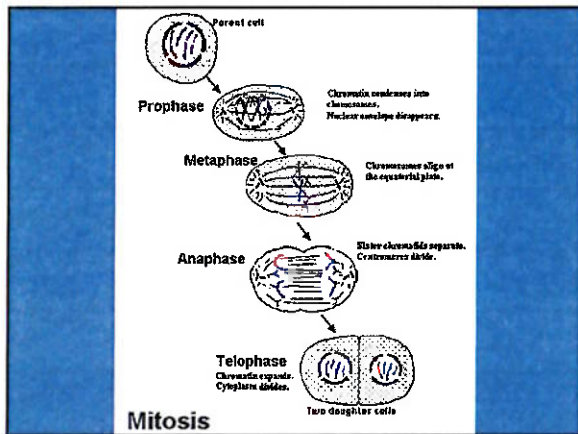
Plant growth require dramatic increase of cell numbers and volume which can only be achieved through cell division and cell expansion.

Fact: chromosome number is constant from cell to cell within an organism (with the exception of reproductive cells), how does this happen?

A mechanism must exist to maintain this consistency.

Mitosis

- **Mitosis** is the nuclear division associated with the division of *somatic cells* – cells that are not destined to become sex cells.
 - Cells in leaves, stems and roots are all somatic cells
- Mitosis produces two identical daughter cells (with exactly the same number and kind of the chromosomes) in one division.



Meiosis

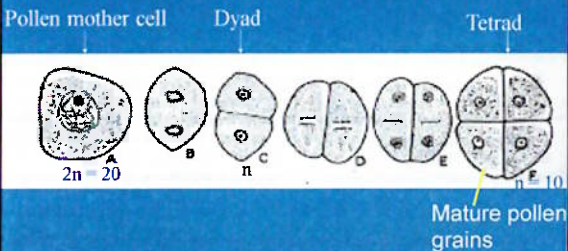
- Chromosome number is constant from generation to generation within a species.
- Recall that during fertilization, male and female gametes unite to form seed.
- So how a species can maintain chromosome number constant between generations.

A mechanism must exist to reduce the chromosomes in gametes.

Meiosis

- **Meiosis** is the nuclear division occurs only in special cells destined to produce gametes (sex cells).
 - For example, corn tassel (produce male gametes - pollen) and ear (producing the female gametes - eggs).
 - Unlike clonal varieties which involve only mitosis, seed production for seed cultivars requires meiosis.
- Meiosis produce 4 cells in two successive divisions, chromosome numbers in each of the final cells is reduced to half of the original number.

Development of pollen grains



Important features of meiosis

- 1) Meiosis results in male and female gametes with halved chromosome number.
- 2) Random assortment of chromosomes during meiosis results in gametes that may contain varied combinations of genes.
If the parent has chromosomes of ABC/A'B'C', the pollen may carry A, B' and C or A'B' and C
- 3) Pairing of homologous chromosomes causes exchange between them which results in recombination of linked genes.

- For alfalfa, genes at corresponding locations in the homologous chromosome pair are often different, which results in gametes carrying different combinations of genes. In addition, open-pollination generates more variation.
– Not breed true
- For soybean, genes at corresponding locations in the homologous chromosome pair are the same, which results in gametes carrying same combinations of genes. In addition, soybean do not open-pollinate with others – breed true.
