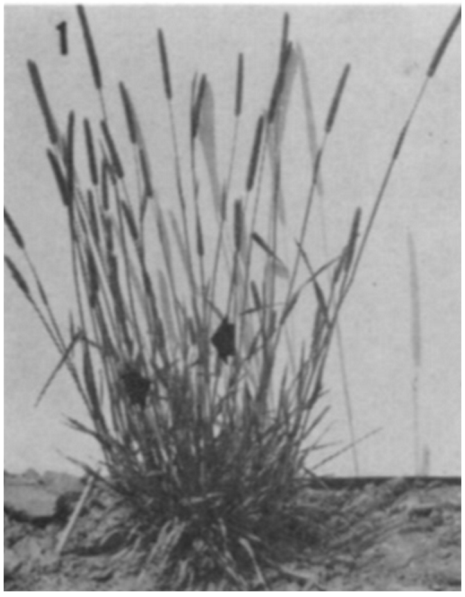
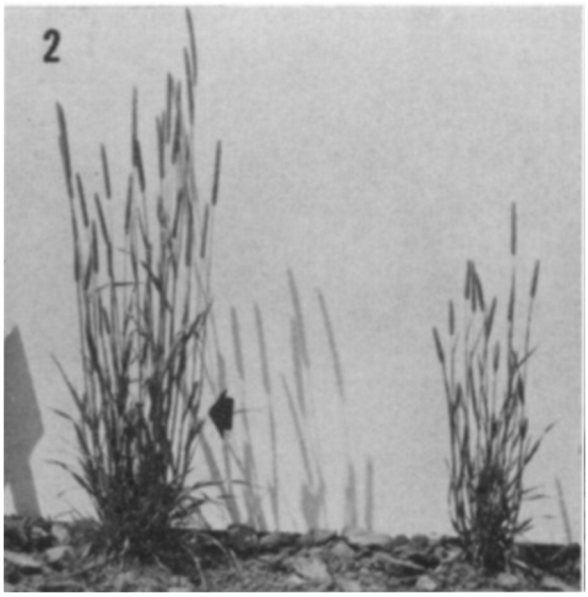
Somatic instability

Nielsen 1962 - 1968

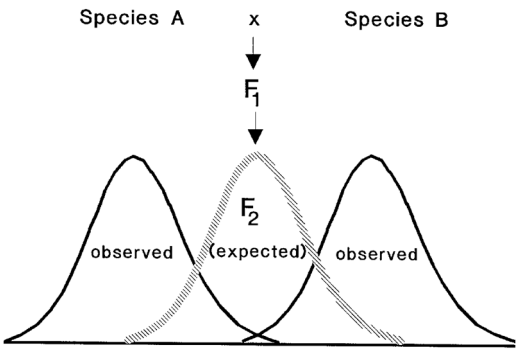


Different culms in a 5x hybrid of timothy (*Phleum pratense*)



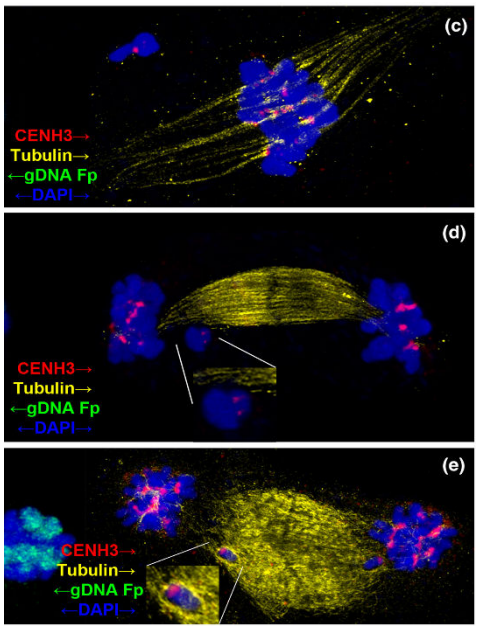
Plants from different corms of the hybrid plant

F2 segregation



Majka et al, 2023

Working with *Lolium* × *Festuca* (ryegrass × fescue) hybrids

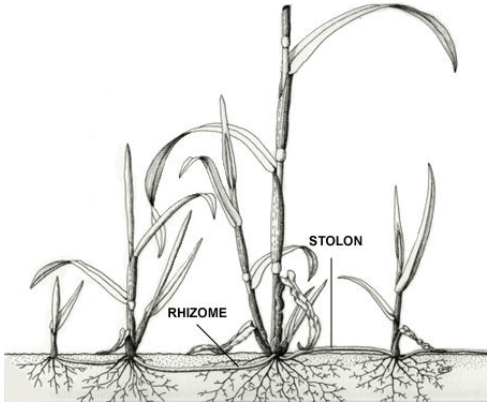


(c) Met I and (d) Ana I with fescue univalent not attached to the spindle. (e) Ana I with Lolium univalent attached to the spindle.

Bermudagrass

Caetano-Anollés, 1998

Heterogeneity from seed mixtures gives the same appearance as from somaclonal variation



Turfgrass grows horizontally from rhizomes and stolons and can propagate asexually through mitosis alone (thelawninstitute.org)

Cultivar Breakdown/Decline

Jensen, 1965

Suarez & Favret, 1986

	Aneuploidy		
	Present	Absent	Percentage
Tall plants	19	6	76%
Tall plants with short dent glumes	2	1	67%
Early plants	4	13	23%
Short plants	2	-	100%
Spikes from tall plants	1	-	100%
Short spikes	1	1	50%
Spikes with high sterility	2	1	67%
Spikes with supernumerary spikelets	1	1	50%

Fernandes et al., 1991

	Cultivar		
PMCs with:	IAS 55	Londrina	Sonora 64
Unpaired chromosomes	11%	4%	28%
Broken chromosomes	4%	4%	4%
Lagging chromosomes	2%	5%	13%
Aneuploidy	7%	0%	4%
Normal tetrads	95%	98%	89%

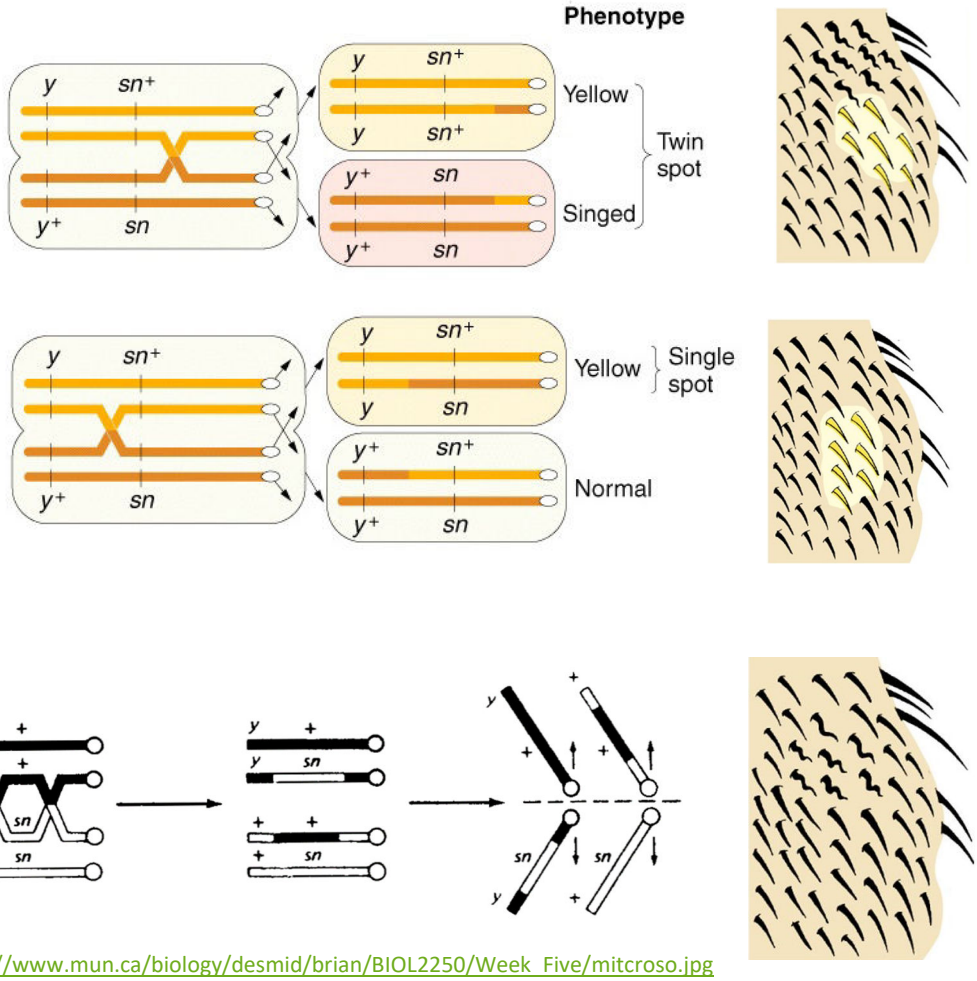
Norin 10 germplasm

"Veteran in a New Field" (1865) Winslow Homer

"You know in the song 'America the Beautiful,' we talk about amber waves of grain? That was not written about modern wheat. Rather than sway in the wind, the shorter modern wheat stalks only nod." --Thom Leonard, Flagpole Magazine 27 Jul 2016

Somatic crossing over

Stern, 1936. Somatic crossovers in the Drosophila X chromosome which was heterozygous for the yellow (y) and singed (sn) loci. Figure credit: Alamy



http://www.mun.ca/biology/desmid/brian/BIOL2250/Week_Five/mitcroso.jpg
Peter J. Russell, iGenetics
Strickberger

Evans & Paddock, 1976

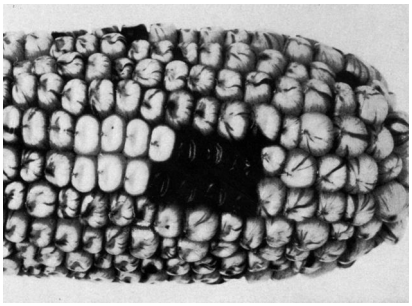
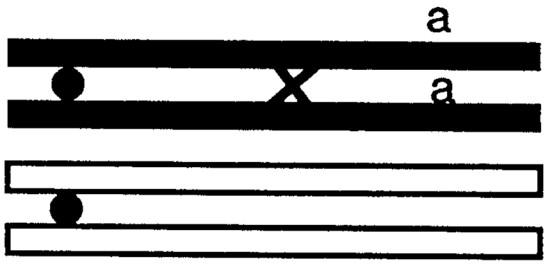
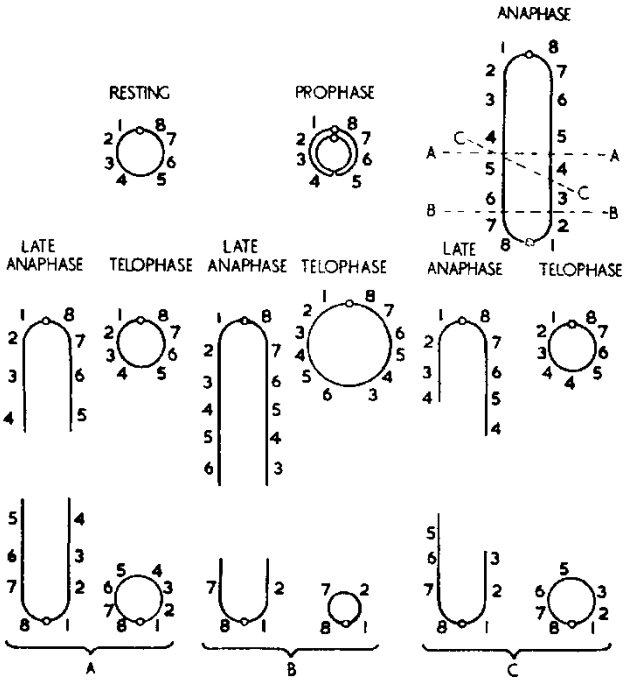


Figure 1 Twin spots in maize. Brink & Nolan, 1952

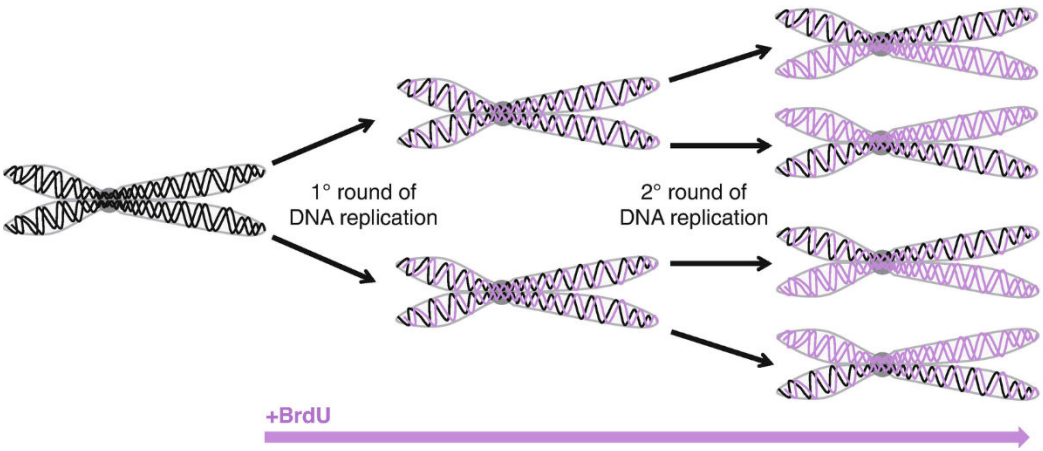
Sister Strand Crossovers



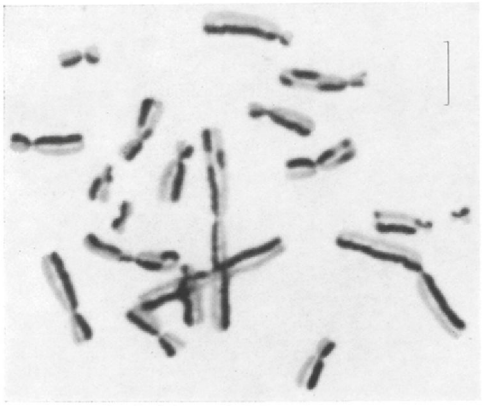
McClintock, 1938; 1941



Schubert, 1994



Tumini E., Aguilera A. (2021) The Sister-Chromatid Exchange Assay in Human Cells. In: Aguilera A., Carreira A. (eds) Homologous Recombination. Methods in Molecular Biology, vol 2153. Humana, New York, NY. https://doi.org/10.1007/978-1-0716-0644-5_26

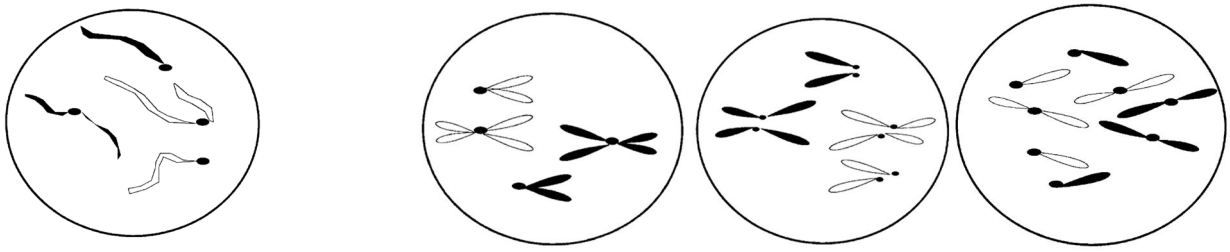


Harlequin chromosomes. Wolff S & P Perry. 2004. Differential giemsa staining of sister chromatids and the study of sister chromatid exchanges without autoradiography. DOI:10.1007/BF00290991

Species		SCE frequency/ chromosome
Allium cepa	2n=16	44.8
Allium sativa	2n=16	104.0
Hordeum vulgare	2n=14	20.6
Secale cereal	2n=14	11.06
Tradescantia paludosa	2n=12	43.5
Triticum aestivum	2n=6x=42	15.2
Zea mays	2n=20	3.7
Crepis capillaris	2n=6	4.96
Solanum tuberosum	X=12	0 to 8
Vicia faba	2n=12	20.6
Nicotiana plumbaginifolia	2n=20,40	7.7, 5.4
Picea abies	2n=24	36.9
Pinus sylvestris	2n=24	36.2

Frequency of sister chromatid exchanges in plants varies greatly

C-mitosis



As with regular mitosis, starts with chromosome condensation in prophase. There is no pro-metaphase. Then you have C-metaphase, C-anaphase, and C-telophase. No nuclear or cell division.

C-mitotic agents

https://www.imdb.com/

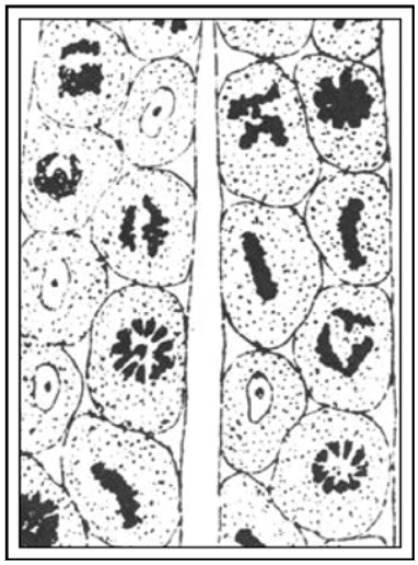
Colchicine

Eigsti, 1955; Weismann, 2009

Colchicum autumnale from Dictionnaire de botanique by Henri Ernest Baillon. Route map from http://www.argonauts-book.com/maps.html

Pernice, 1889

Eigsti, 1938



Pernice 1889 drawing of c-mitosis in dog intestinal cells

Why autotetraploids?

Auto4x and 2x perennial ryegrass (*Lolium perenne*)

http://www.greenkeepingeu.com/greenkeeping-feature-tetraploid-perennial-ryegrass-technology-explained/

Inbreeding at the tetrasomic level

Random mating in 2x: $F = \frac{3\alpha}{2+\alpha}$

Selfing a 2x: $F = \frac{1}{2}(1 + F')$

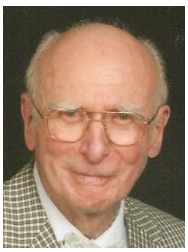
Selfing an auto4x: $F = \frac{1}{6}[1 + 2 \propto (5 - 2 \propto)F']$

Somatic chromosome doubling

Analytic breeding

Chase 1962

Chase 1963



Sherrett Spaulding Chase
1918 - 2021

$$A_1A_1A_1A_2$$
$$\downarrow$$
$$A_1A_2 \text{ Breeding} \quad F = 0$$