Mendel's lows

GE02: day 1 part 2

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Gregor J. Mendel (1822 – 1884)

- 1865: talk on "Experiments on Plants Hybridisation" at two meetings of the Natural History Society of Brunn

- Mendel, G., 1866, Versuche über Pflanzen-Hybriden. Verh. Naturforsch. Ver. Brünn 4: 3–47

Re-discovery of Mendel's lows

- Hugo de Vries (March 1900) Sur la loi de la disjonction des hybrides // Competes Redus, CXXX no. 13: pp. 845-847
- Hugo de Vries (March 1900) Das Spaltungsgsetz der Bastarde // Berichte der deutschen botanischen Gesellschaft, Bd XVIII: pp. 83-90
- Carl Correns (April 1900) G. Mendel's Regels ueber das Verhalten der Nachkommenschaft der Rassenbastarde // Berichte der deutschen botanischen Gesellschaft, Bd XVIII: pp. 158-168
- Erich Tschermak (June 1900) Ueber kuenstliche Kreuzung bei Pisum sativum // Berichte der deutschen botanischen Gesellschaft, Bd XVIII: pp. 232-239

Mendel’s Experiments

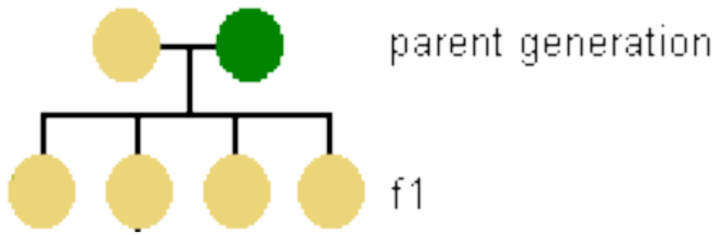
- The experimental plants must necessarily:
  - Possess constant differentiating characteristics
  - The hybrids of such plants must, during the flowering period, be protected from the influence of all foreign pollen, or be easily capable of such protection.
  - The hybrids and their offspring should suffer no marked disturbance in their fertility in the successive generations.

Traits studied

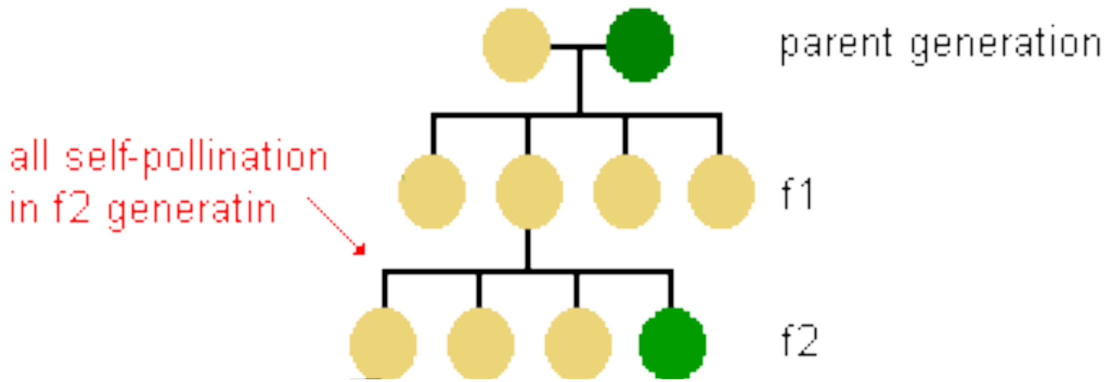
- Seed's form (round or wrinkled)
- Seed's color (yellow or green)
- Seed-coat's color (white or colored)
- Flower's position (axial or terminal)
- Length of stem (6-7 ft vs. ¾-1 ft.)
- … (7 in total)

- Some 28,000 pea plants tested

Uniformity of F_1



Uniformity of F_1, independent segregation in F_2



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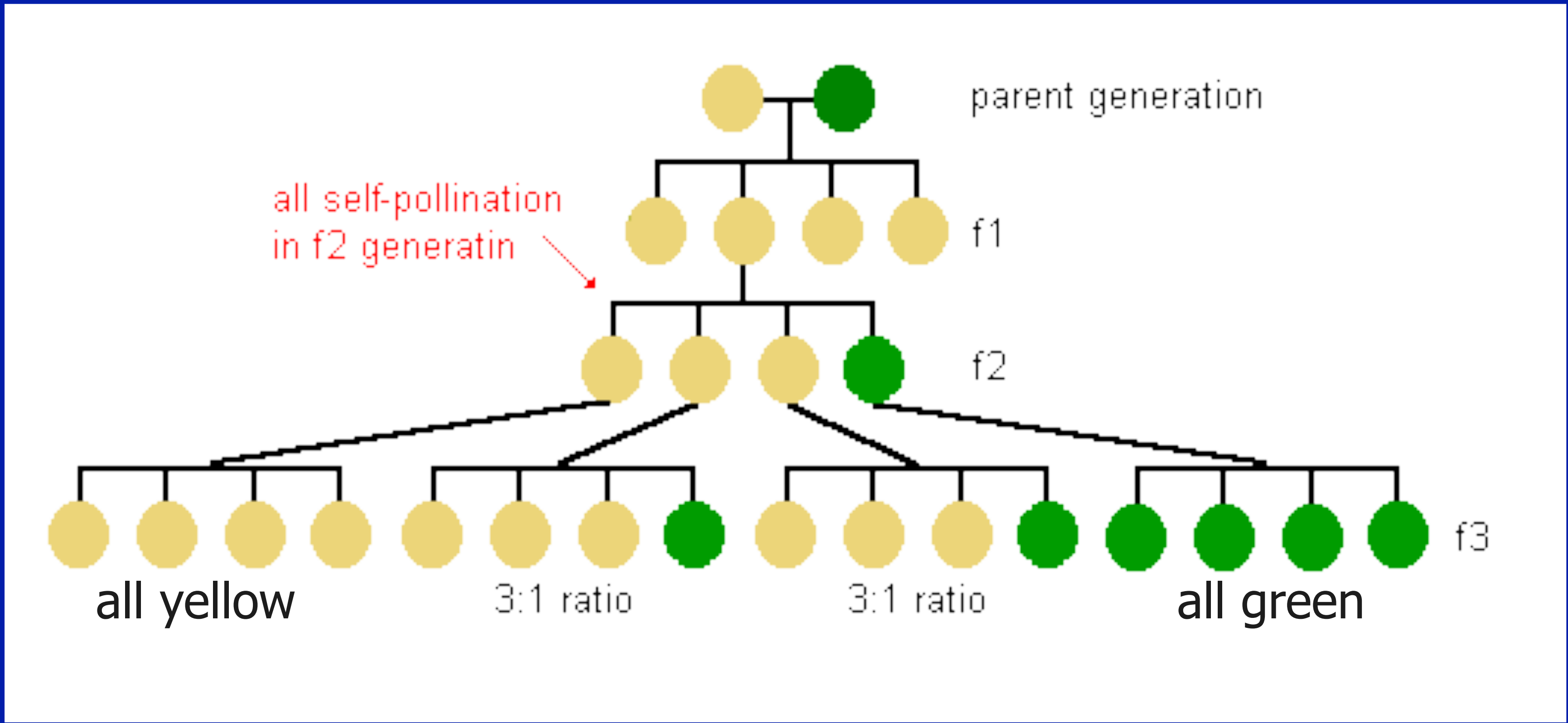


Mendel's low is based on one assumption

Concepts

- **Alleles : Y, G**
- **Y is dominant over G**
- **Genotype : Phenotype**
- **YY : Yellow**
- **YG or GY : Yellow**
- **GG : Green**

Assumption

- Alleles are transmitted to the next generation in random, independent manner

Uniformity of F_1

- **Yellow** parental form has genotype **YY**
- **Green** parental form has genotype **GG**
- In F_1 all plants have genotype **YG**
  - **Y** from **Yellow** parent and **G** from **Green** parent

- All F_1 will be **Yellow**.

Segregation in F_2

- According to random transmission assumption **YG** plants will produce 50% **Y** and 50% **G** gametes. These will randomly aggregate to give F_2:

  - P(**Y** & **Y**) = P(**Y**) P(**Y**) = ½ ½ = ¼ (**Yellow**)
  - P(**Y** & **G**) = P(**Y**) P(**G**) = ½ ½ = ¼ (**Yellow**)
  - P(**G** & **Y**) = P(**G**) P(**Y**) = ½ ½ = ¼ (**Yellow**)
  - P(**G** & **G**) = P(**G**) P(**G**) = ½ ½ = ¼ (**Green**)

- Thus ¾ will be **Yellow** and ¼ will be **Green**
- 3:1 established

Problem

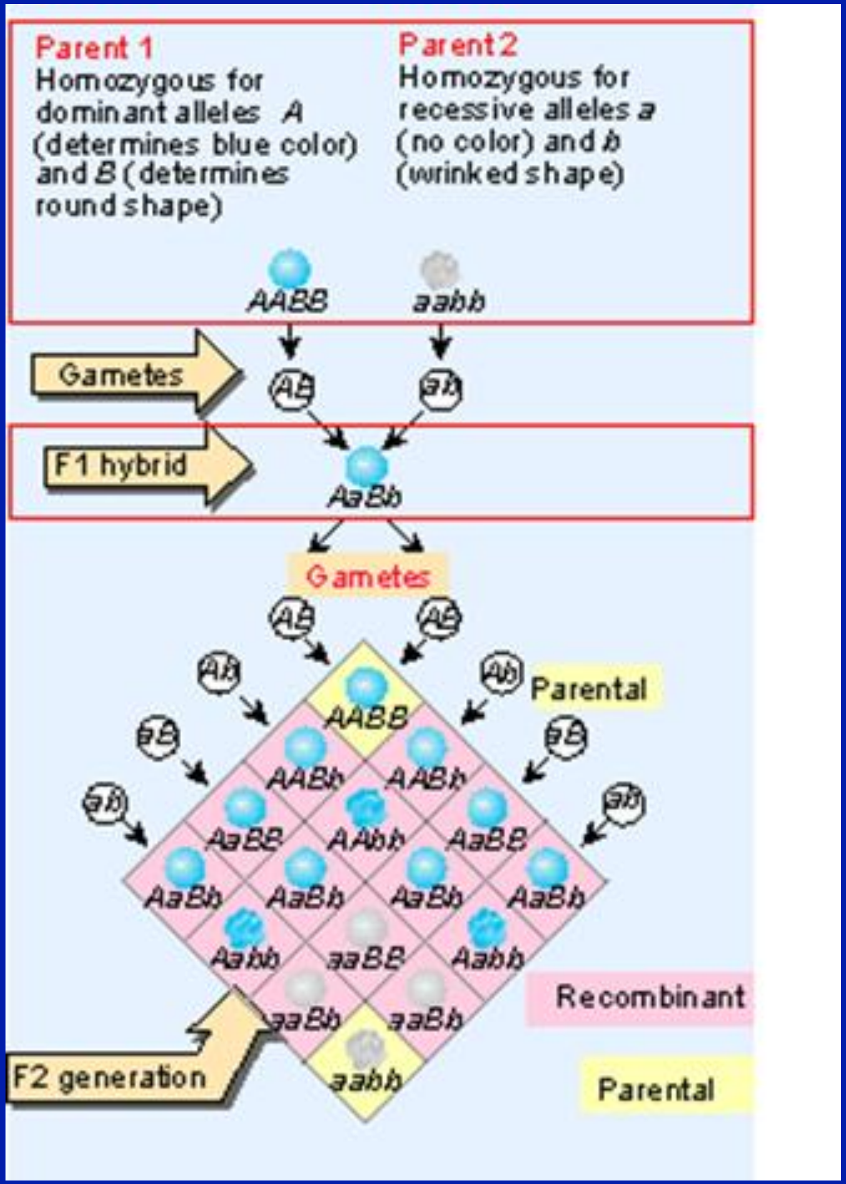
- Consider two independent traits
  - Seed’s color, as in previous example and
  - Seed’s shape (wrinkled or smooth), which is controlled by alleles W and S, with S being dominant

- You cross smooth yellow to wrinkled green

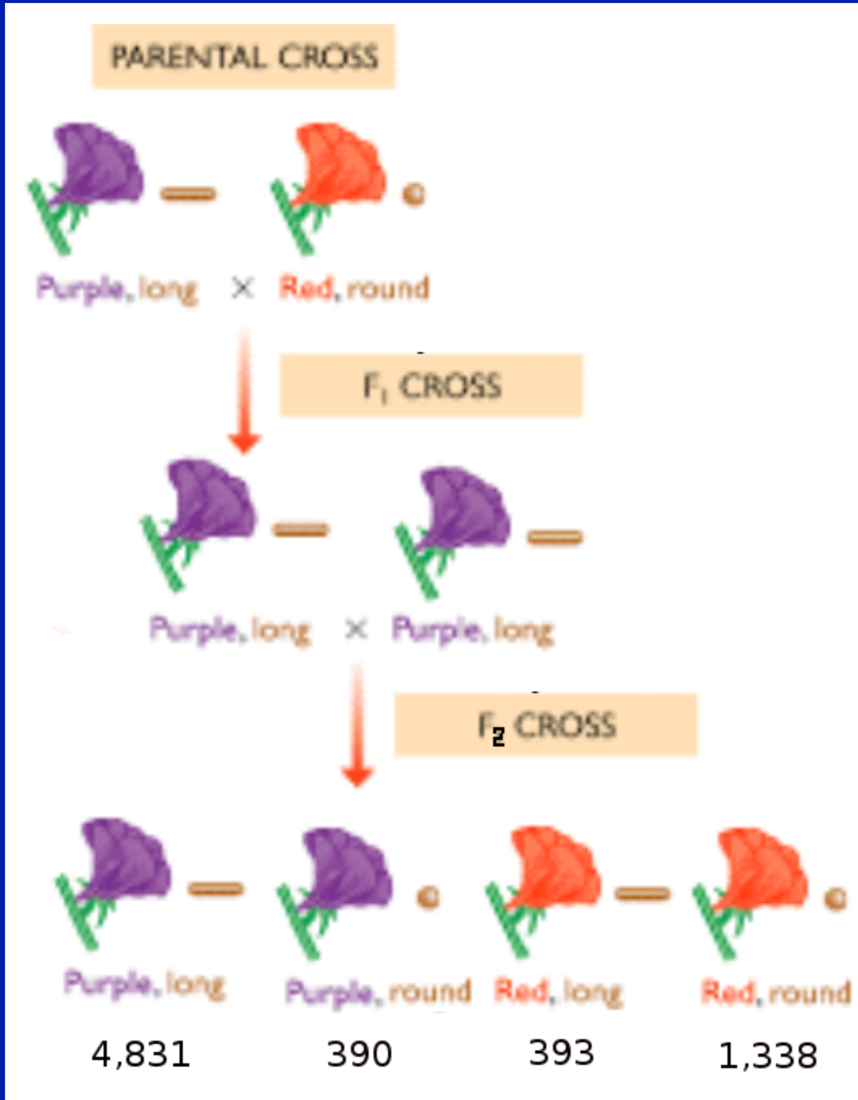
- What is expected trait distribution in F_1 and F_2?

Low of independent assortment

9:3:3:1



Bateson & Punnett (1905)



Expected under 9:3:3:1

- 3911 : 1303 : 1303 : 435

Observed is rather

- 11 : 1 : 1 : 3

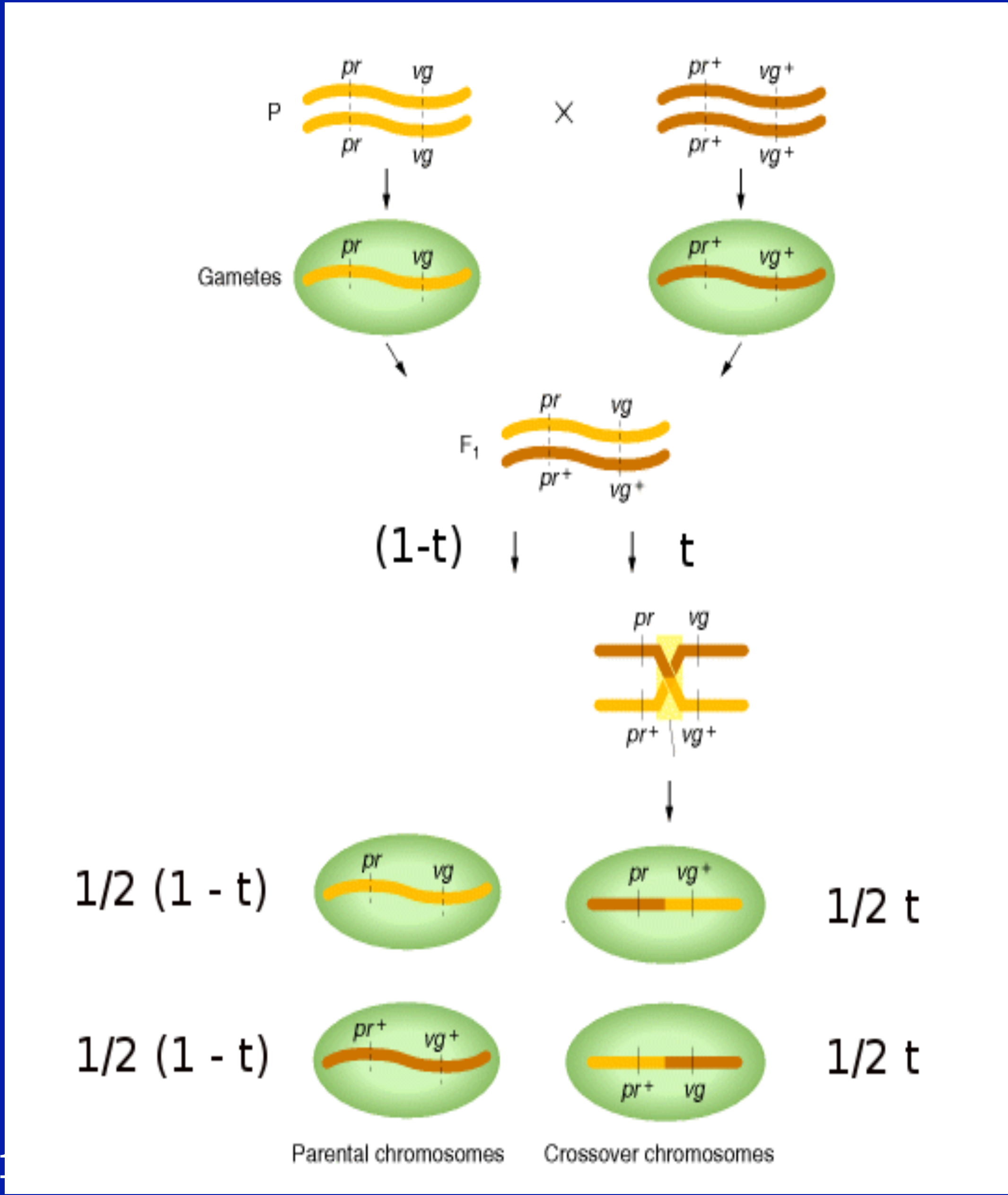
Compared to expected

- More parental
- Less recombinant

Morgan's extension (1911): linkage

- Genes are located on chromosomes (Sutton, 1902)
- Low of independent assortment is violated when two genes are located on the same chromosome
- The closer two genes are, the smaller is the chance for recombination

Mendel’s lows under linkage



Inheritance of linked genes

	Gamete	PRP-LNG	PRP-rnd	red-LNG	red-rnd
Gamete	Freq	½ (1-t)	½ t	½ t	½ (1-t)
PRP-LNG	½ (1-t)				
PRP-rnd	½ t				
red-LNG	½ t				
red-rnd	½ (1-t)				

$t=\frac{1}{2}$: **9/16 : 3/16 : 3/16 : 1/16**

$\frac{1}{4}(3 - 2t - t^2) : \frac{1}{4}t(2-t) : \frac{1}{4}t(2-t) : \frac{1}{4}(1-t)^2$