

Linkage

PP LL (purple flower, long pollen grain) X ppll (red, round)

PpLl
⊗

Phenotype	# Observed	# Expected (9:3:3:1)
Purple, long (P- L-)	284	215
Purple, round (P- ll)	21	71
Red, long (pp L-)	21	71
Red, round (pp ll)	55	24
	381	381

These two classes are larger than expected. Possibly due to excess of PL and pl gametes (i.e. original parental gametes).

Linkage *Drosophila*

$prpr\ vgvg$ (purple eye color, vestigial wings) X $pr^+pr^+\ vg^+vg^+$ (red eyes, normal wings)



$prpr^+\ vgvg^+$ X $prpr\ vgvg$

testcross

Phenotype of offspring represent the gametic contribution of the doubly heterozygous parent

Parental type	{	$pr^+\ vg^+$	1339	←	Expected ratio: 1 : 1 : 1 : 1
		$pr\ vg$	1195		
Non-parental type	{	$pr^+\ vg$	151		
		$pr\ vg^+$	154		
			2839		
			(/4=710)		Physical coupling between the genes

Linkage *Drosophila*

$pr^+ pr^+ vgvg$ X $prpr vg^+vg^+$



$prpr^+ vgvg^+$ X $prpr vgvg$

testcross

Phenotype of offspring represent the gametic contribution of the doubly heterozygous parent

Non-parental type	{	$pr^+ vg^+$	157
		$pr vg$	146
parental type	{	$pr^+ vg$	965
		$pr vg^+$	1067
			2335
			(/4=584)

Expected ratio:
1 : 1 : 1 : 1

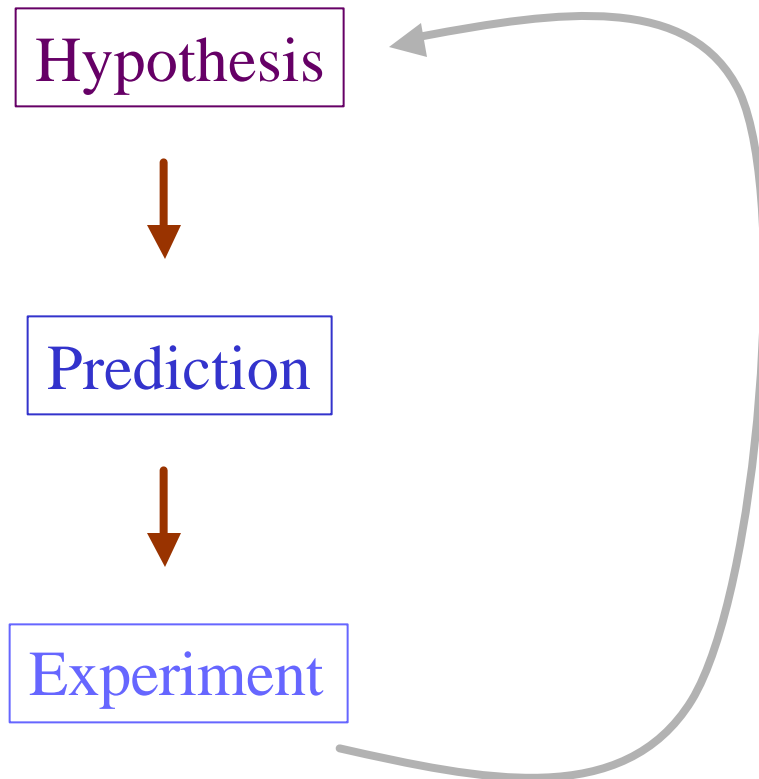


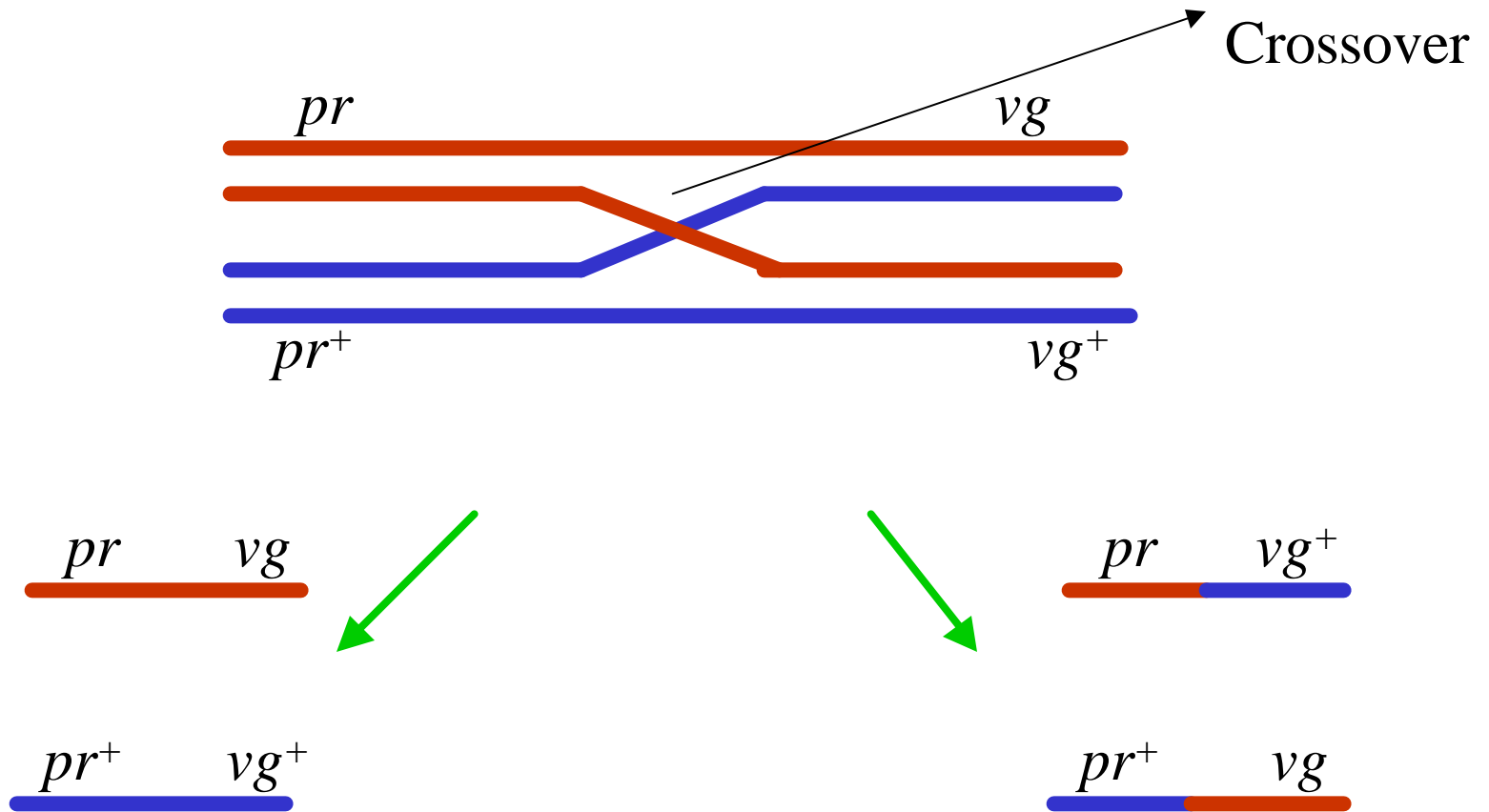
Physical repulsion
between the genes

Linkage

Drosophila (T. Morgan)

Morgan's hypothesis was that in coupling both pairs of genes being studied are **located on the same pair of homologous chromosomes**

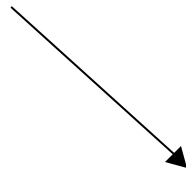




Diagrammatic representation of the process of crossing over during meiosis

Mendel's Laws of Genetics

1. Alleles are different forms of the same gene that segregate during gamete formation (Law of Segregation)
2. Alleles of different genes segregate independently (Law of independent assortment)

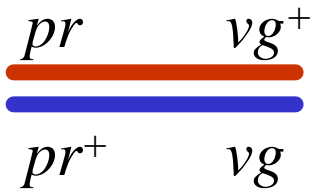


The second law only applies to gene pairs located on separate chromosome pairs or those gene pairs so far apart on the same chromosome pair that they behave independently.

Linkage

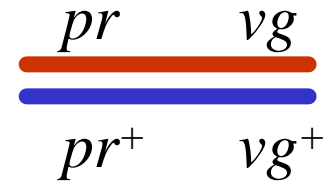
Drosophila (T. Morgan)

1. In *Drosophila*, a gene for wing length is linked to a gene for eye color
2. An allele of one gene will always be linked to an allele of the other gene
3. The double heterozygote can exist in two conformations:



pr vg^+
 pr^+ vg

Repulsion conformation



pr vg
 pr^+ vg^+

Coupling conformation

AA BB

aa bb

A B

a b

Aa Bb

x

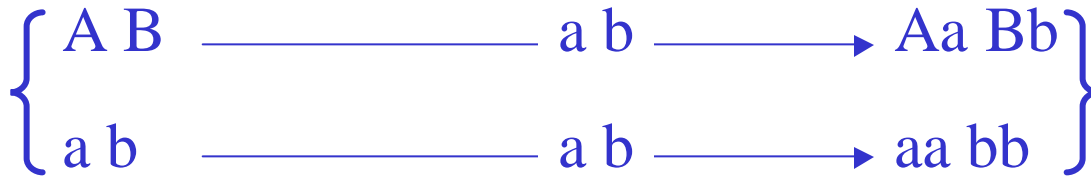
aabb

Meiosis

Meiosis

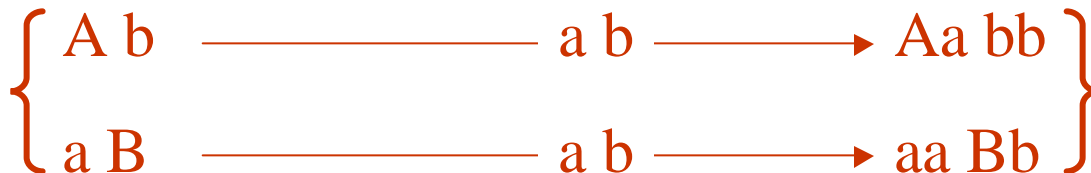
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Parental gametes

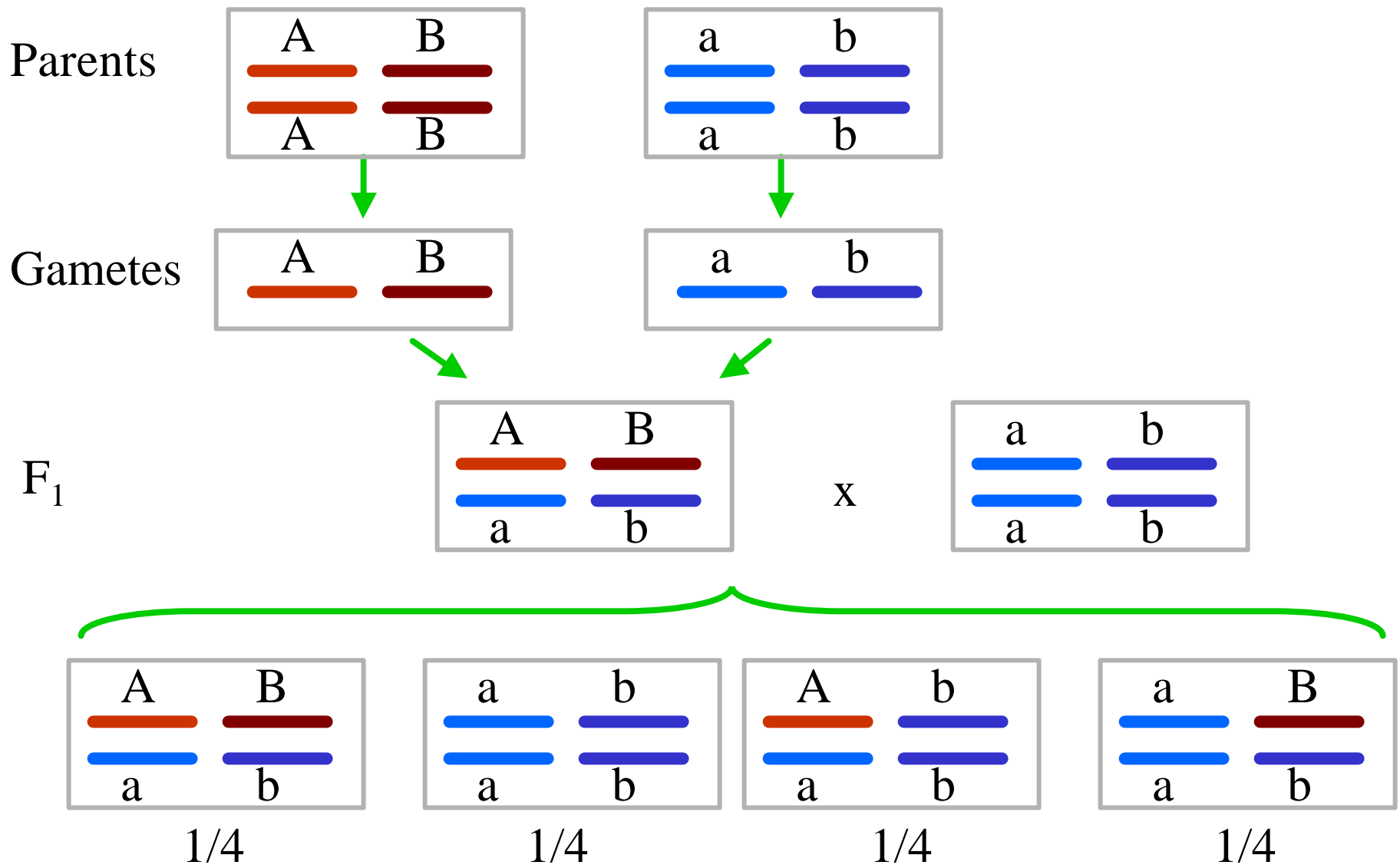


Parental-type individuals

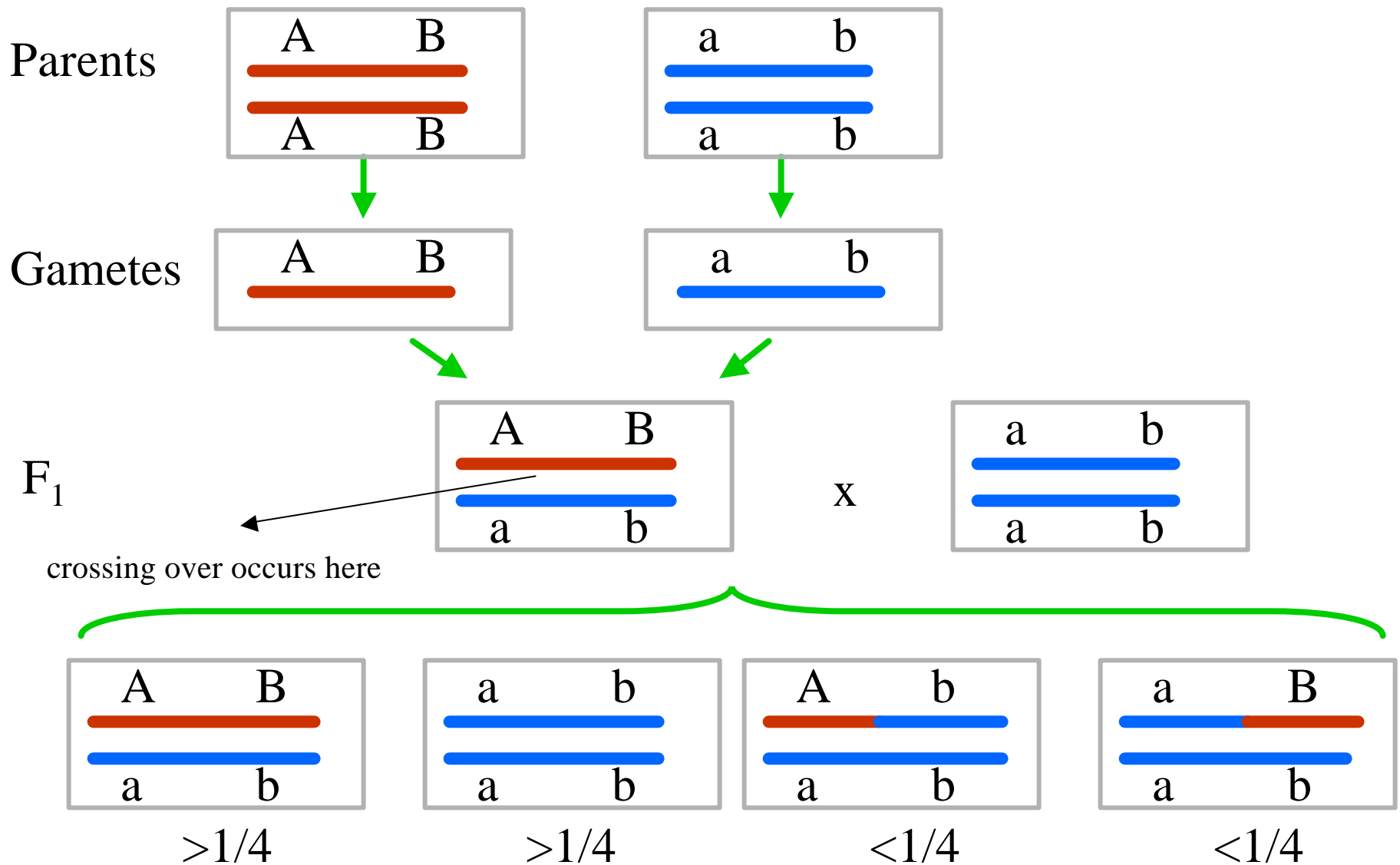
Recombinant gametes



Recombinant-type individuals



Genes on different chromosomes always produce equal number of recombinant and parental type individuals (i.e. frequency of recombination is 50%)



Genes on the same chromosome produce a recombination frequency equal to or usually less than 50%