

## Dihybrid/Multihybrid Crosses; Independent Assortment

Dihybrid Cross (see fig. 14.7b)

A dihybrid cross is a cross between parents differing in two characters

Using the examples of seed color and seed shape from the previous lecture, the possible genotypes and phenotypes of pea plants with regard to these two characters are:

<u>Genotype</u>	<u>Phenotype</u>
YYRR (Homo. Dom./Homo. Dom.)	Yellow, Round (Dom./Dom.)
YYRr (Homo. Dom./Hetero.)	Yellow, Round (Dom./Dom.)
YyRR (Hetero./Homo. Dom.)	Yellow, Round (Dom./Dom.)
YyRr (Hetero./Hetero.)	Yellow, Round (Dom./Dom.)
YYrr (Homo. Dom./Homo. Rec.)	Yellow, Wrinkled (Dom./Rec.)
Yyrr (Hetero./Homo. Rec.)	Yellow, Wrinkled (Dom./Rec.)
yyRR (Homo. Rec./Homo. Dom.)	Green, Round (Rec./Dom.)
yyRr (Homo. Rec./Hetero.)	Green, Round (Rec./Dom.)
yyrr (Homo. Rec./Homo. Rec.)	Green, Wrinkled (Rec./Rec.)

In this example, the alleles for seed color are on one pair of homologous chromosomes, and the alleles for seed shape are on a different pair of homologous chromosomes; therefore, the alleles will be independently assorted to sex cells during meiosis (see fig. 14.7b)

What kind of sex cells can these plants make?

YYRR	→	100% YR
YYRr	→	50% YR and 50% Yr
YyRR	→	50% YR and 50% yR
YyRr	→	25% YR, 25% Yr, 25% yR, and 25% yr (see fig. 14.7 b)
YYrr	→	100% Yr
Yyrr	→	50% Yr and 50% yr
yyRR	→	100% yR
yyRr	→	50% yR and 50% yr
yyrr	→	100% yr

A few examples of crosses:

Example 1	<u>Parent A</u> YYRR	<u>Parent B</u> YYRR	
			A's Sex Cells 100% YR
	B's Sex Cells	100% YR	100% YYRR Yellow/Round

Example 2

Parent A  
YYRR

Parent B  
yyrr

A's Sex Cells  
100% YR

B's Sex Cells 100% yr

100% YyRr Yellow/Round
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Example 3

Parent A  
yyrr

Parent B  
yyrr

A's Sex Cells  
100% yr

B's Sex Cells 100% yr

100% yyrr Green/Wrinkled
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Example 4

Parent A  
YYRR

Parent B  
YYRr

A's Sex Cells  
100% YR

B's Sex Cells  
50% YR  
50% Yr

50% YYRR Yellow/Round
50% YYRr Yellow/Round

Example 5

Parent A  
YYRr

Parent B  
YYRr

A's Sex Cells  
50% YR      50% Yr

B's Sex Cells  
50% YR  
50% Yr

50% YR	25% YYRR Yellow/Round	25% YYRr Yellow/Round
50% Yr	25% YYRr Yellow/Round	25% YYrr Yellow/Wrinkled

Example 6

Parent A  
YyRR

Parent B  
YYRr

A's Sex Cells  
50% YR      50% yR

B's Sex Cells

50% YR

50% Yr

25% YYRR Yellow/Round	25% YyRR Yellow/Round
25% YYRr Yellow/Round	25% YyRr Yellow/Round

Example 7

Parent A  
YYRr

Parent B  
YyRr

A's Sex Cells  
50% YR      50% Yr

B's Sex Cells

25% YR

25% Yr

25% yR

25% yr

12.5% YYRR Yellow/Round	12.5% YYRr Yellow/Round
12.5% YYRr Yellow/Round	12.5% YYrr Yellow/Wrinkled
12.5% YyRR Yellow/Round	12.5% YyRr Yellow/Round
12.5% YyRr Yellow/Round	12.5% Yyrr Yellow/Wrinkled

Example 8

Parent A  
YyRR

Parent B  
YyRr

A's Sex Cells  
50% YR      50% yR

B's Sex Cells

25% YR

25% Yr

25% yR

25% yr

12.5% YYRR Yellow/Round	12.5% YyRR Yellow/Round
12.5% YYRr Yellow/Round	12.5% YyRr Yellow/Round
12.5% YyRR Yellow/Round	12.5% yyRR Green/Round
12.5% YyRr Yellow/Round	12.5% yyRr Green/Round

Example 9      Parent A              Parent B              See fig. 14.7 b  
                          YyRr                      YyRr

In a dihybrid cross of heterozygous/heterozygous x heterozygous/heterozygous with independent assortment (such as that in example 9 and fig. 14.7b), the result is always a phenotypic ratio of offspring of 9:3:3:1

- 9 Dominant/Dominant (Yellow/Round)
- 3 Dominant/Recessive (Yellow/Wrinkled)
- 3 Recessive/Dominant (Green/Round)
- 1 Recessive/Recessive (Green/Wrinkled)

### Probability

As crosses get more complex (looking at 3, 4, 5, etc. characters at the same time), it is much more convenient to use probability rather than drawing boxes

In the cross AA x AA, the probability of getting AA offspring is 1.0 (=100%)

In the cross AA x aa, the probability of getting Aa offspring is 1.0 (100%)

In the cross AA x Aa, the probability of getting AA offspring is 0.5 (=50%) and the probability of getting Aa offspring is 0.5 (=50%)

In the cross aa x Aa, the probability of getting Aa offspring is 0.5 (=50%) and the probability of getting aa offspring is 0.5 (=50%)

In the cross Aa x Aa, the probability of getting AA offspring is 0.25 (=25%), the probability of getting Aa offspring is 0.5 (=50%), and the probability of getting aa offspring is 0.25 (25%)

Homozygous x Homozygous is always 1.0 (100%) for the one possible genotype

Homozygous x Heterozygous is always 0.5 (50%) for each of the two possible genotypes

Heterozygous x Heterozygous is always 0.25 (25%), 0.5 (50%), and 0.25 (25%) for of the three possible genotypes AA, Aa, and aa, respectively

Example: in the cross AABb x aaBb, what is the probability of getting an offspring with the genotype Aabb? The probability of getting Aa is 1.0 (see above - there are no other possibilities) and the probability of getting bb is 0.25 (see above). Therefore, the probability of getting Aabb is  $1.0 \times 0.25 = 0.25$  (25%)

Example: In the cross AaBbCcDdEeFf x AabbCcDdEEff, the probability of getting an offspring with the genotype aaBbCCDdEeff is:

$$0.25 \times 0.5 \times 0.25 \times 0.5 \times 0.5 \times 0.5 = 0.00390625$$