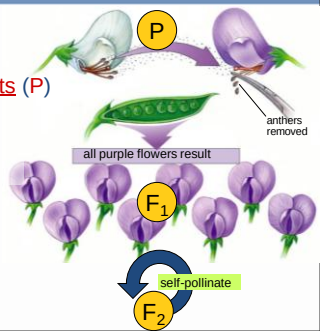
Genetics & The Work of Mendel

Gregor Mendel

- Modern genetics began in the mid-1800s in an abbey garden, where a monk named Gregor Mendel documented inheritance in peas
  - used experimental method
  - used quantitative analysis
    - collected data & counted them
  - excellent example of scientific method

Mendel's work

- Bred pea plants
  - cross-pollinate true breeding parents (P)
    - P = parental
  - raised seed & then observed traits (F_1)
    - F = filial
  - allowed offspring to self-pollinate & observed next generation (F_2)



Mendel collected data for 7 pea traits

Table 13.1 Seven Characters Mendel Studied and His Experimental Results

Character	Dominant Form	×	Recessive Form	F_2 Generation Dominant:Recessive	Ratio
	Purple flowers	×	White flowers	705:224	3.15:1
	Yellow seeds	×	Green seeds	6022:2001	3.01:1
	Round seeds	×	Wrinkled seeds	5474:1850	2.96:1
	Green pods	×	Yellow pods	428:152	2.82:1
	Inflated pods	×	Constricted pods	882:299	2.95:1
	Axial flowers	×	Terminal flowers	651:207	3.14:1
	Tall plants	×	Dwarf plants	787:277	2.84:1

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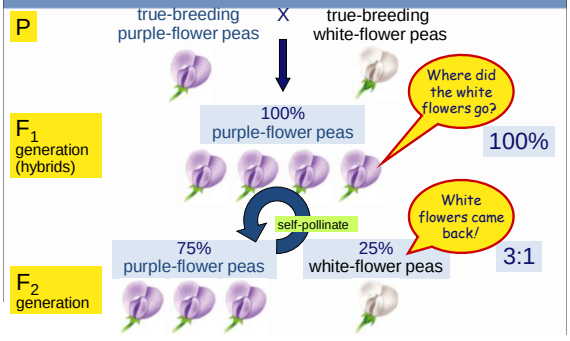
Looking closer at Mendel's work

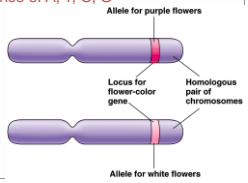


What did Mendel's findings mean?

- Traits come in alternative versions
  - purple vs. white flower color
  - alleles
    - different alleles vary in the sequence of nucleotides at the specific locus of a gene
      - some difference in sequence of A, T, C, G

purple-flower allele & white-flower allele are two DNA variations at flower-color locus

different versions of gene at same location on homologous chromosomes



Traits are inherited as discrete units

- For each characteristic, an organism inherits 2 alleles, 1 from each parent
  - diploid organism
    - inherits 2 sets of chromosomes, 1 from each parent
    - homologous chromosomes

What are the advantages of being diploid?

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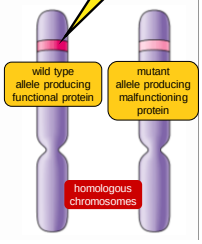
What did Mendel's findings mean?

- Some traits mask others
  - purple & white flower colors are separate traits that do not blend
    - purple x white ≠ light purple
    - purple masked white
  - dominant allele
    - functional protein
  - recessive allele

I'll speak for *both* of us!



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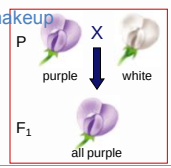
Genotype vs. phenotype

- Difference between how an organism "looks" & its genetics
  - phenotype
    - description of an organism's trait
    - the "physical"
  - genotype
    - description of an organism's genetic makeup

Explain Mendel's results using
…dominant & recessive
…phenotype & genotype



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Punnett squares

Aaaaah, phenotype & genotype can have different ratios

F_1 generation (hybrids)

Pp x Pp

male / sperm

female / eggs	P	p
P	PP	Pp
p	Pp	pp

	% genotype	% phenotype
PP	25%	75%
Pp	50%	
Pp		
pp	25%	25%
	1:2:1	3:1

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Phenotype vs. genotype

- 2 organisms can have the same phenotype but have different genotypes

purple	PP	homozygous dominant
purple	Pp	heterozygous

Can't tell by lookin' at ya!

How do you determine the genotype of an individual with with a dominant phenotype?

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Test cross

- Breed the dominant phenotype — the unknown genotype — with a homozygous recessive (*pp*) to determine the identity of the unknown allele

x

is it PP or Pp?

pp

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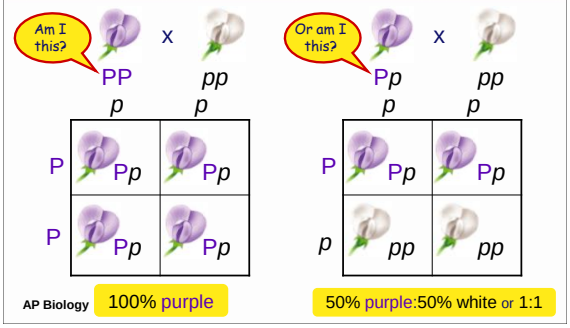
How does a Test cross work?



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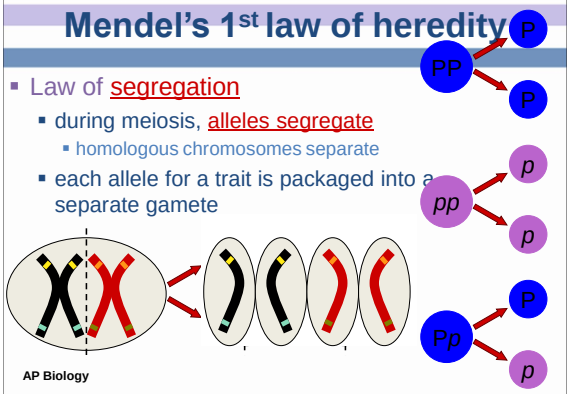
100% purple

50% purple:50% white or 1:1

Mendel's 1st law of heredity

- Law of segregation
  - during meiosis, alleles segregate
    - homologous chromosomes separate
  - each allele for a trait is packaged into a separate gamete



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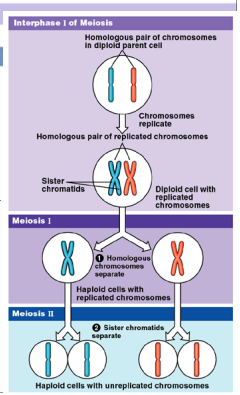
Law of Segregation

- Which stage of meiosis creates the law of segregation?

Metaphase 1

Whoa! And Mendel didn't even know DNA or genes existed!



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Monohybrid cross

- Some of Mendel's experiments followed the inheritance of single characters
  - flower color
  - seed color
  - monohybrid crosses

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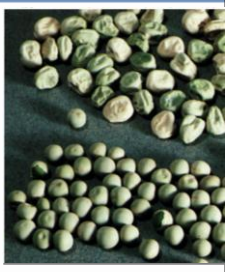
Dihybrid cross

- Other of Mendel's experiments followed the inheritance of 2 different characters
  - seed color and seed shape
  - dihybrid crosses



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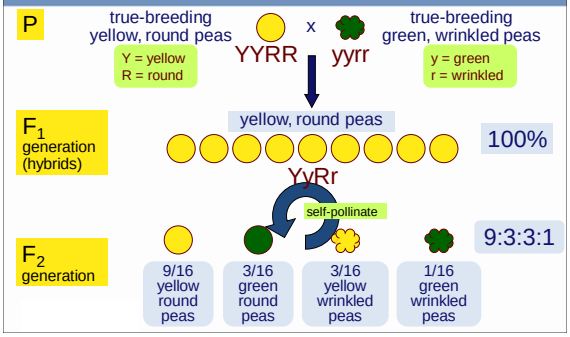
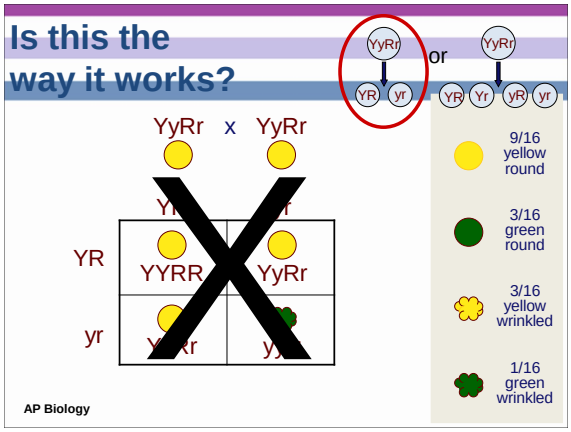
Dihybrid cross




Is this the way it works?
YyRr
or
YyRr
YR
yr
YR
Yr
yR
yr
YyRr x YyRr
YR
yr
YYRr
YyRr
9/16 yellow round
3/16 green round
3/16 yellow wrinkled
1/16 green wrinkled
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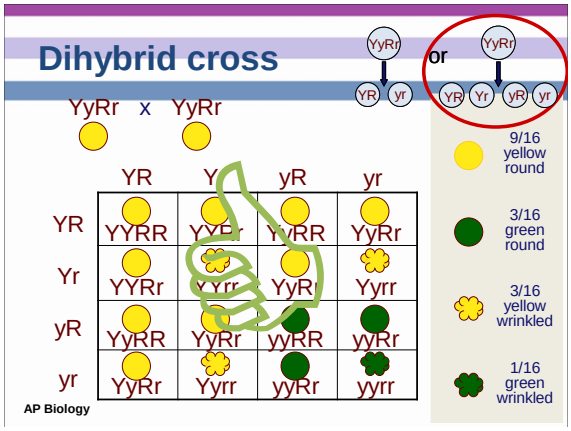
Dihybrid cross
YyRr
or
YyRr
YR
yr
YR
Yr
yR
yr
YyRr x YyRr
YR
Yr
yR
yr
YR
Yr
yR
yr
YYRR
YyRR
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YYRr
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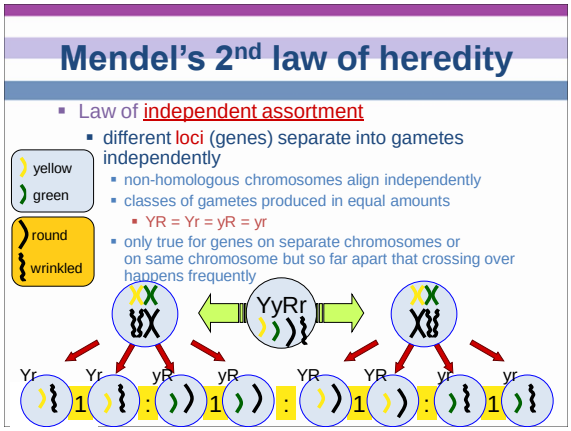
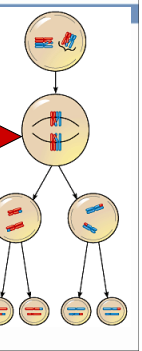

Mendel's 2nd law of heredity
Law of independent assortment
different loci (genes) separate into gametes independently
non-homologous chromosomes align independently
classes of gametes produced in equal amounts
YR = Yr = yR = yr
only true for genes on separate chromosomes or on same chromosome but so far apart that crossing over happens frequently
yellow
green
round
wrinkled
YyRr
Yr
Yr
yR
yR
YR
YR
yr
yr
1
:
1
:
1
:
1

Law of Independent Assortment

- Which stage of meiosis creates the law of independent assortment?

Metaphase 1



Remember Mendel didn't even know DNA —or genes— existed!

EXCEPTION

- If genes are on same chromosome & close together
  - will usually be inherited together
  - rarely crossover separately
  - "linked"

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