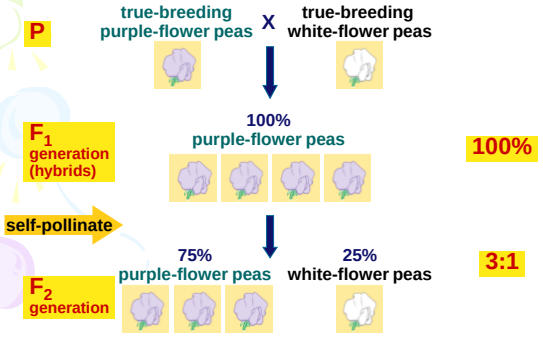
Gregor Mendel

- a monk named Gregor Mendel documented inheritance in peas in the mid-1800s
  - used experimental method
  - used quantitative analysis
    - collected data & counted them
  - excellent example of scientific method

Looking closer at Mendel's work

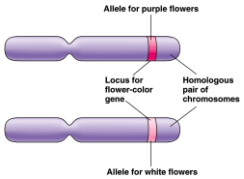


What did Mendel's findings mean?

- Traits come in alternative versions
  - purple vs. white flower color
  - alleles
    - different alleles vary in the sequence of nucleotides at the specific locations of a gene

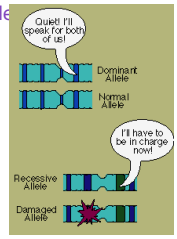
purple-flower allele & white-flower allele are 2 DNA variations at flower-color locus

different versions of gene on homologous chromosomes



What did Mendel's findings mean?

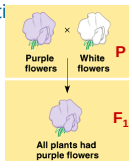
- Some traits mask others
  - purple & white flower colors are separate traits that do not blend
    - purple x white ≠ light purple
    - purple masked white
  - dominant allele
    - fully expressed
  - recessive allele
    - no noticeable effect
    - the gene makes a non-functional protein



Genotype vs. phenotype

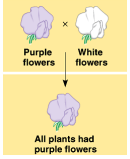
- difference between how an organism "looks" & its genetics
  - phenotype
    - description of an organism's trait
  - genotype
    - description of an organism's genetic

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



Making crosses

- using representative letters
  - flower color alleles → P or *p*
  - true-breeding purple-flower peas → PP
  - true-breeding white-flower peas → *pp*

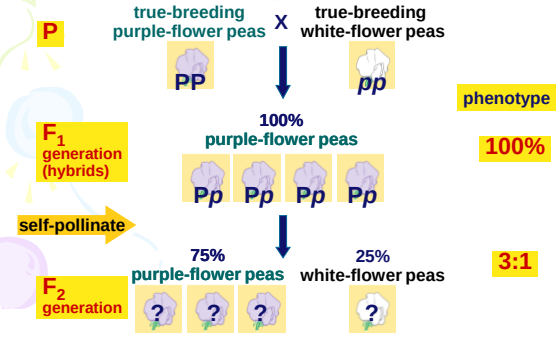


PP x *pp*

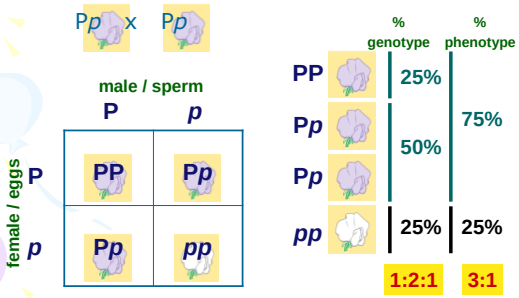
↓

P*p*

Looking closer at Mendel's work

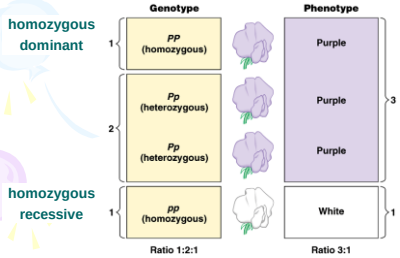


Punnett squares



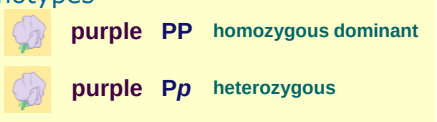
Genotypes

- Homozygous = same alleles = PP, *pp*
- Heterozygous = different alleles = P*p*



Phenotype vs. genotype

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



Dominant phenotypes

- It is not possible to determine the genotype of an organism with a dominant phenotype by looking at it.

PP?

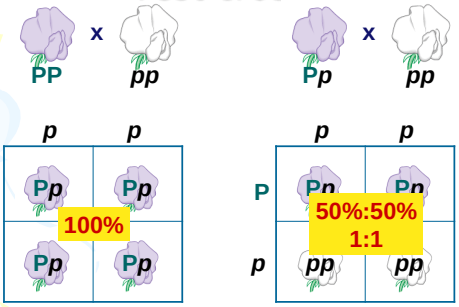
Pp?

Test cross

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

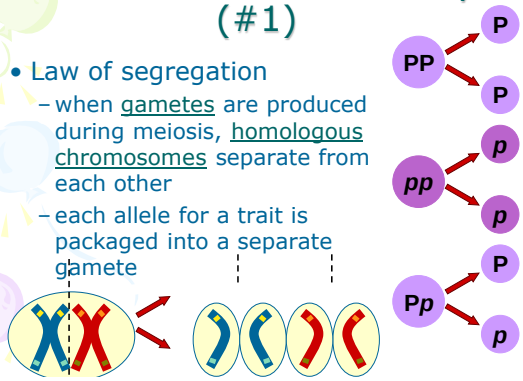
is it PP or P*p*? x ***pp***

Test cross



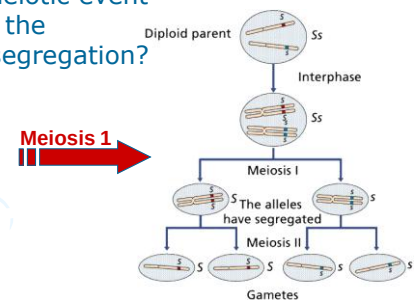
Mendel's laws of heredity (#1)

- Law of segregation
  - when gametes are produced during meiosis, homologous chromosomes separate from each other
  - each allele for a trait is packaged into a separate gamete



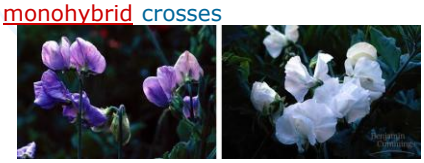
Law of Segregation

- What meiotic event creates the law of segregation?



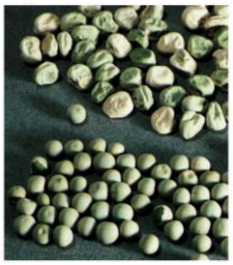
Monohybrid cross

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

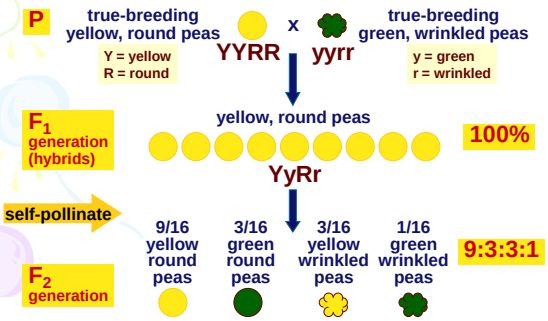


Dihybrid cross

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



Dihybrid cross



Dihybrid cross

YyRr x YyRr

	YR	Yr	yR	yr
YR	YYRR	YYRr	YyRR	YyRr
Yr	YYRr	YYrr	YyRr	Yyrr
yR	YyRR	YyRr	yyRR	yyRr
yr	YyRr	Yyrr	yyRr	yyrr

9/16 yellow round

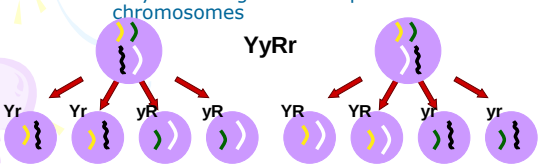
3/16 green round

3/16 yellow wrinkled

1/16 green wrinkled

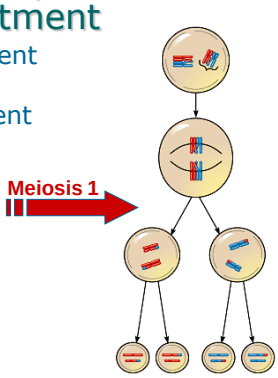
Mendel's laws of heredity (#2)

- Law of independent assortment
  - each pair of alleles segregates into gametes independently
    - 4 classes of gametes are produced in equal amounts
      - YR, Yr, yR, yr
    - only true for genes on separate chromosomes



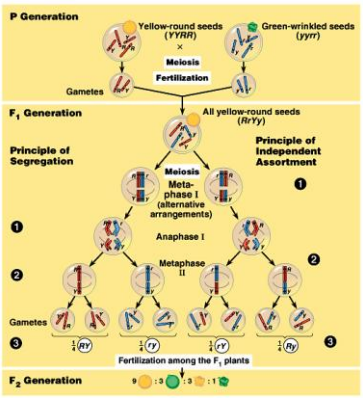
Law of Independent Assortment

- What meiotic event creates the law of independent assortment?



The chromosomal basis of Mendel's laws…

Trace the genetic events through meiosis, gamete formation & fertilization to offspring



Review: Mendel's laws of heredity

- Law of segregation
  - monohybrid cross
    - single trait
  - each allele segregates into separate gametes
    - established by Meiosis 1
- Law of independent assortment
  - dihybrid (or more) cross
    - 2 or more traits
  - each pair of alleles for genes on separate chromosomes segregates into gametes independently
    - established by Meiosis 1

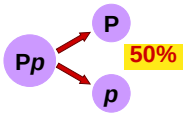
Genetics & Probability

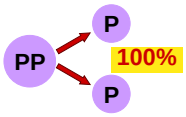
- Mendel's laws:
  - segregation
  - independent assortment

reflect same laws of probability that apply to tossing coins or rolling dice

Probability & genetics

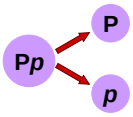
- Calculating probability of making a specific gamete is just like calculating the probability in flipping a coin
  - probability of tossing heads? 50%
  - probability making a P gamete…





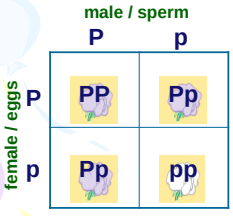
Probability & genetics

- Outcome of 1 toss has no impact on the outcome of the next toss
  - probability of tossing heads each time? **50%**
  - probability making a P gamete each time? **50%**



Calculating probability

Pp x Pp



sperm	egg	offspring
P 1/2	x P 1/2	= PP 1/4
P 1/2	x *p* 1/2	= *Pp* 1/4
p 1/2	x P 1/2	= 1/4
		1/2
p 1/2	x *p* 1/2	= *pp* 1/4

Rule of multiplication

- Chance that 2 or more independent events will occur together
  - probability that 2 coins tossed at the same time will land heads up

1/2 x 1/2 = 1/4

  - probability of Pp x Pp → pp

1/2 x 1/2 = 1/4

Calculating dihybrid probability

- Rule of multiplication also applies to dihybrid crosses
  - heterozygous parents — YyRr
  - probability of producing yyrr?
    - probability of producing y gamete = 1/2
    - probability of producing r gamete = 1/2
    - probability of producing yr gamete = 1/2 x 1/2 = 1/4
    - probability of producing a yyrr offspring = 1/4 x 1/4 = 1/16

Rule of addition

- Chance that an event can occur 2 or more different ways
  - sum of the separate probabilities
  - probability of Pp x Pp → Pp

sperm	egg	offspring
P 1/2	x p 1/2	= Pp 1/4
p 1/2	x P 1/2	= Pp 1/4

→ 1/4 + 1/4 = 1/2