General Outcome 2
Students will explain the basic rules and processes associated with the transmission of genetic characteristics.

Specific Outcomes for Knowledge
Students will:

30-C2.1k describe the evidence for dominance, segregation and the independent assortment of genes on different chromosomes, as investigated by Mendel

30-C2.2k compare ratios and probabilities of genotypes and phenotypes for dominant and recessive, multiple, incompletely dominant, and codominant alleles

30-C2.3k explain the influence of gene linkage and crossing over on variability

30-C2.4k explain the relationship between variability and the number of genes controlling a trait;
e.g., one pair of genes, as for Rh factor, versus two or more pairs of genes, as for skin colour and height

30-C2.5k compare the pattern of inheritance produced by genes on the sex chromosomes to that produced by genes on autosomes, as investigated by Morgan and others.

30-C2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
design a plan for collecting data to demonstrate human inheritance

30-C2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
interpret patterns and trends of inheritance of traits and predict, quantitatively, the probability of inheritance of traits illustrated in monohybrid, dihybrid and sex-linked inheritance, using pedigrees and Punnett squares

perform experiments to record and explain predicted phenotypic ratios versus actual counts in genetic crosses to show a relationship between chance and genetic results

draw and interpret pedigree charts from data on human single-allele and multiple-allele inheritance patterns; *e.g., hemophilia, blood types*

analyze crossover data for a single pair of chromosomes to create a chromosome map showing gene arrangement and relative distance

identify limitations of data associated with phenotypic ratios for small populations in which the ratios may not conform with the theoretical ratios expected

30-C2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
work cooperatively with team members to investigate a monohybrid cross (tongue rolling, attached earlobes) and solve problems as they arise

Outcome 2
Topic 1 – Gregor Mendel and Heredity Terms
Pre-Class Reading Assign

1. Read pgs 596-600

2. Define the following terms

a. Progeny
b. Dominant trait
c. Recessive trait
d. Allele
e. Homozygous
f. Recessive
g. Genotype
h. Phenotype
i. segregation

3. Explain why, normally, an individual can only carry two alleles of a gene.

Topic 1 – Gregor Mendel and Heredity Terms
Notes

- Heredity – passing of traits from parents to offspring

- **Genes** – Units of instruction, located on chromosomes that produce a certain trait

- **Allele** – different versions of the same gene.
    - Ex. Type A blood allele, Type B blood allele

- Remember that we have two copies of every gene, one on the maternal chromosome, one on the paternal chromosome

- Gregor Mendel was a monk in Austria during the 1860's

- Worked with peas and studied their traits and inheritance of those traits

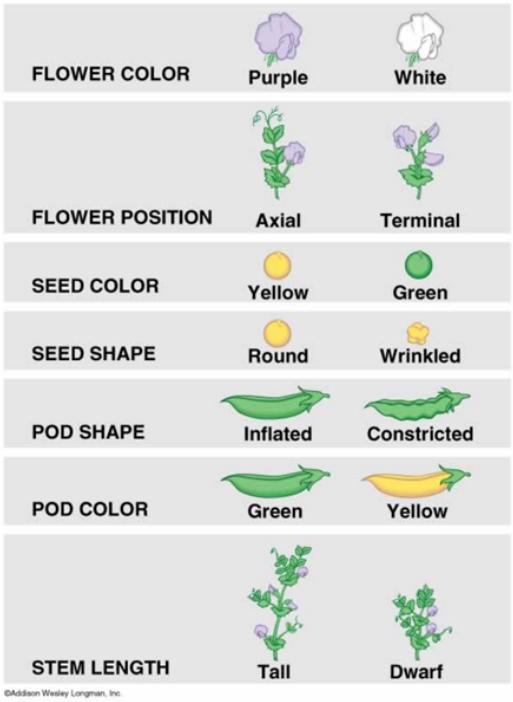
- He worked with peas because
    - They have a number of characteristics that can only be expressed in two different ways (ex. Green or yellow seeds)

    - Peas can cross fertilize
        - Means he could "mate" two different plants and observe the outcome

- Mendel studied 7 different traits and examined the patterns of inheritance

- He came up with the idea of dominant and recessive genes
    - Dominant genes determine which trait is expressed

    - Recessive genes are overruled by the dominant genes



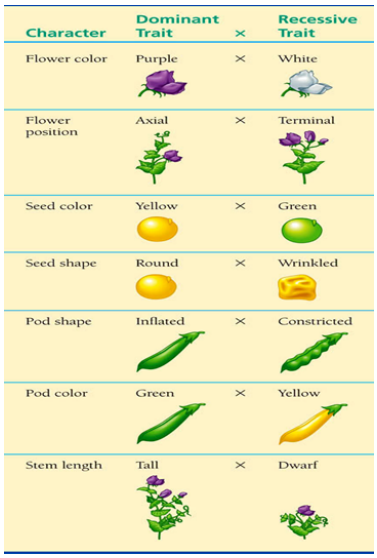
Mendel's Laws of Heredity
- Inherited characteristics are controlled by factors known as genes that occur in pairs.

- One gene masks the effect of another
    - Known as the **principle of dominance**
    - Dominant gene is indicated by an uppercase letter
    - Recessive gene is indicated with a lowercase letter

- A pair of genes separate or segregate during meiosis in the formation of sex cells

- **Mendels first law: The Law of Segregation**
    - All individuls have two copies of each factor (gene). These copies segregate randomly during gamete formation and each gamete receives one copy of each factor

- **Mendels second law: The law of independent assortment**
    - The two alleles for one gene segregate (assort) independently of eth alleles for other genes during gamete formation



Genetic Terms

- **genotype** – the genes that an organism contains
    - Diploid organisms have two copies of each gene
    - One copy of each gene from each parent
    - A tall stem pea plant could have the genotype TT or Tt

- **phenotype**– observable traits of an organism
    - Since a pea plant can only be tall or short, there are only two possible phenotype for this characteristic
    - But, the tall phenotype can have two different genotypes, TT or Tt

- **Homozygous** –a genotype in which both genes in the pair are identical
    - Ex. A homozygous tall pea plant has the genotype TT

- **Heterozygous** – a genotype in which the genes pairs are different
    - Ex. A heterozygous tall pea plant has the genotype Tt
    - **Allele** – two or more alternate forms of a gene
    - Ex. For the tall trait, the pea can have the tall (T) allele or the short (t) allele

- **Parental** generation (P) - The parents of a mating, involving contrasting genotypes

- First filial generation (F_1) – the offspring of parents of contrasting genotypes

- Second filial generation (F_2) - the offspring of two F1 individuals

Topic 2 – Monohybrid Cross, Punnet Squares and Probability
Pre-Class Reading Assignment

1. Read pgs 601-604

2. Define the following terms

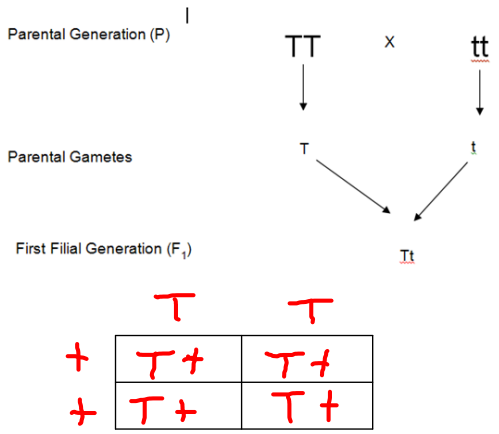
    a. Phenotypic ratio
    b. Punnet square
    c. Genotypic ratio
    d. Test cross

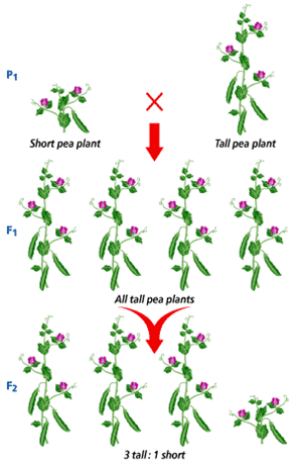
Topic 2 – Monohybrid Cross, Punnet Squares and Probability
Notes

- **Monohybrid cross** – combining of single contrasting traits
  - Ex. A TT tall pea plant and a tt short pea plant

- **Punnett Square** – a special chart that helps geneticists organize the results of a cross between the sex cells of two individuals
  - Resembles and X's and O's chart
  - Punnett square shows every possible combination when combining one maternal allele with one paternal allele

Example: A homozygous tall pea plant is bred with a homozygous short pea plant (Tall gene is dominant)

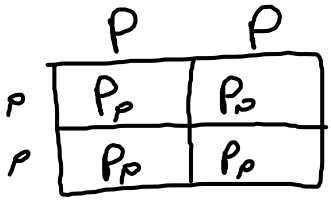




All offspring produced in this breeding will be tall.

Is the offspring heterozygous or homozygous for this trait?

Example: A pea plant that is homozygous for the white flower (pp) is bred with a pea plant that is homozygous for the purple flower (PP). Purple flower is the dominant trait.



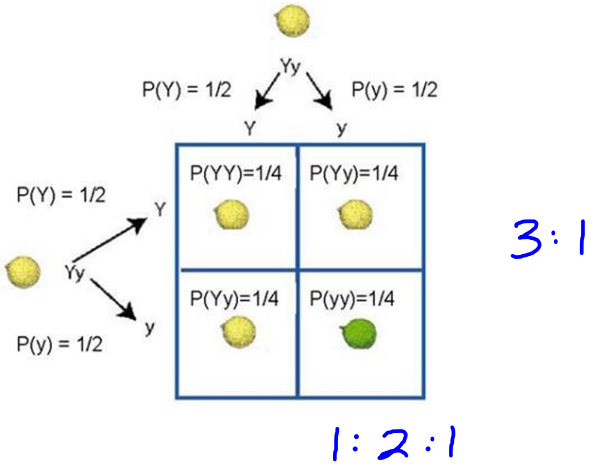
All offspring produced in this breeding will have purple flowers.

Is the offspring heterozygous or homozygous for this trait?

Probability

Probability – the likelihood that a specific outcome will occur

We can use Punnet squares to help us predict the probability of a given phenotype or genotype in a cross between two individuals.



What is the chance that an offspring from this cross will have yellow seeds?

What is the chance that an offspring from this cross will have green seeds?

Genotypic ratio – the ratio of offspring with each possible allele combination from a particular cross

- should always be written as –

Homozygous dominant :heterozygous :homozygous recessive

Phenotypic ratio – the ratio of offspring with a dominant trait to the alternative, recessive trait

Practice Problems

Seed Color: yellow (Y) is dominate, green (y) is recessive.

Solve the following: Show a Punnett square then calculate genotype and phenotype ratios

YY x yy

	Y	Y
y	Yy	Yy
y	Yy	Yy

0:4:0

4:0

Yy x Yy

	Y	y
Y	YY	Yy
y	Yy	yy

1:2:1

3:1

Yy x yy

	Y	y
y	Yy	yy
y	Yy	yy

0:2:2

2:2

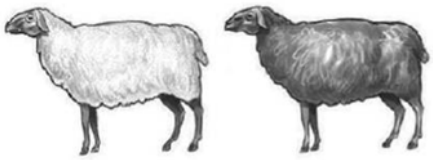
Test Cross

- A test cross is done to determine the genotype of a dominant phenotype

- A test cross determines whether a particular characteristic that a plant or animal expresses is homozygous dominant or heterozygous dominant

- Test cross is always performed between the unknown genotype and a homozygous recessive genotype

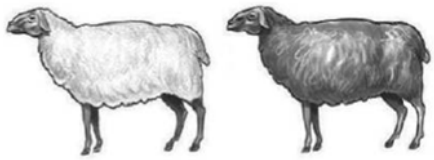
Example:
A farmer has a white sheep (W?) and wants to breed that sheep to another white sheep to get more white sheep. The white allele (W) is dominant to the black allele (w). The farmer performs a test cross by using a homozygous black sheep to determine the genotype of the unknown white sheep.



W? × ww

	W	w
w	Ww	ww
w	Ww	ww

Half of the offspring are black and half are white.



Ww × ww

	W	w
w	Ww	Ww
w	Ww	Ww

All of the offspring are white.

Practice Questions

In humans, brown eyes (B) are dominant over blue (b). A brown-eyed man marries a blue-eyed woman and they have three children, two of whom are brown-eyed and one of whom is blue-eyed. Draw the Punnett square that illustrates this marriage. What is the man's genotype? What are the genotypes of the children?

Bb × bb

bb

	B	b
b	Bb	bb
b	Bb	bb

In dogs, there is an hereditary deafness caused by a recessive gene, "d." A kennel owner has a male dog that she wants to use for breeding purposes if possible. The dog can hear, so the owner knows his genotype is either DD or Dd. If the dog's genotype is Dd, the owner does not wish to use him for breeding so that the deafness gene will not be passed on. This can be tested by breeding the dog to a deaf female (dd). Draw the Punnett squares to illustrate these two possible crosses. In each case, what percentage/how many of the offspring would be expected to be hearing? deaf? How could you tell the genotype of this male dog? Also, using Punnett square(s), show how two hearing dogs could produce deaf offspring

	D	D
d	Dd	Dd
d	Dd	Dd

100%
0% deaf

	D	d
d	Dd	dd
d	Dd	dd

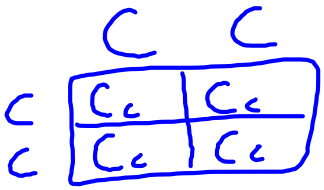
Curly hair is dominant (C) over straight hair (c) in humans. Is it possible for a curly haired man to produce curly haired children if his wife has straight hair? Explain using Punnett squares.

	C	_
c	Cc	
c	Cc	

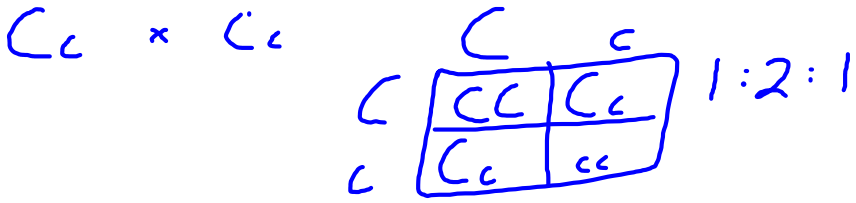
Topic 2
Review Sheet

Answer the following questions. Use a Punnett square as required to illustrate your answer.

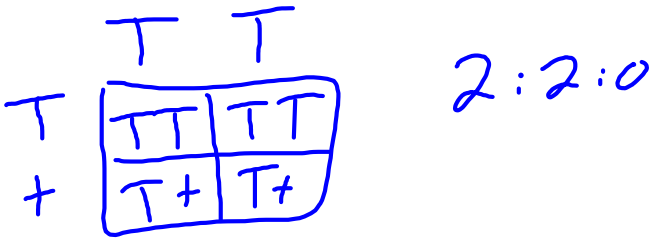
1. Inflated pea pods are dominant (C) over constricted pea pods (c).
a) Use a Punnett square to determine the genotypes and phenotypes of a cross between a plant that is homozygous dominant and a plant that is homozygous recessive.



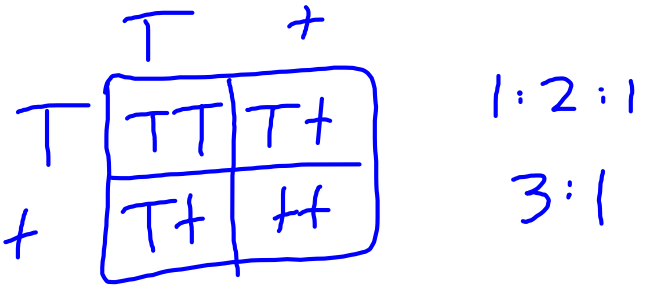
b) Cross two plants from the first filial generation, and determine the ratio of genotypes and phenotypes of the offspring that result.



2. Tall pea plants are dominant (T) over short pea plants (t).
a) Use a Punnett square to determine the genotypes and phenotypes of a cross between a plant that is homozygous dominant and a plant that is heterozygous for plant size.



b) Cross two heterozygous plants from the first filial generation, and determine the ratio of genotypes and phenotypes of the offspring that result.



Farmers who raise sheep for wool try not to produce offspring with black wool. Black wool is very brittle and difficult to dye; therefore, white wool is more desirable. If a farmer purchases a white ram, he will generally carry out a test cross to determine whether the ram is heterozygous or homozygous for white wool. White wool (*W*) is dominant to black wool (*w*).

If the ram is heterozygous for white wool, the expected phenotypes of the offspring of the farmer's test cross would be

A. all black

B. all white

C. $\frac{1}{2}$ black and $\frac{1}{2}$ white

D. $\frac{3}{4}$ black and $\frac{1}{4}$ white