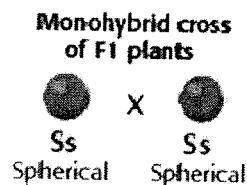


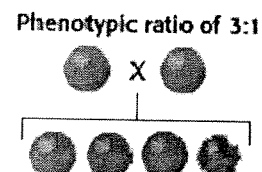
### Problem 1: The Monohybrid Cross

In pea plants, spherical seeds (S) are dominant to dented seeds (s). In a genetic cross of two plants that are heterozygous for the seed shape trait, what fraction of the offspring should have spherical seeds?



### Problem 2: Mendel's First Law

A phenotypic ratio of 3:1 in the offspring of a mating of two organisms heterozygous for a single trait is expected when:



### Problem 3: Mendel's "Experiment 1"

In Mendel's "Experiment 1," true-breeding pea plants with spherical seeds were crossed with true-breeding plants with dented seeds. (Spherical seeds are the dominant characteristic.) Mendel collected the seeds from this cross, grew F1-generation plants, let them self-pollinate to form a second generation, and analyzed the seeds of the resulting F2 generation. The results that he obtained, and that you would predict for this experiment are:

### Problem 4: A cross of F1-hybrid plants

A genetic cross between two F1-hybrid pea plants for spherical seeds will yield what percent spherical-seeded plants in the F2 generation? (Recall, spherical-shaped seeds are dominant over dented seeds.)

### Problem 5: Another F1-hybrid cross

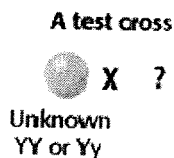
A genetic cross between two F1-hybrid pea plants having yellow seeds will yield what percent green-seeded plants in the F2 generation? Yellow seeds are dominant to green.

### Problem 6: Predicting the dominant allele

When true-breeding tall stem pea plants are crossed with true-breeding short stem pea plants, all of the \_\_\_\_\_ plants, and 3/4 of the \_\_\_\_\_ plants had tall stems. Therefore, tall stems are dominant.

### Problem 7: The test cross

To identify the genotype of yellow-seeded pea plants as either homozygous dominant (YY) or heterozygous (Yy), you could do a test cross with plants of genotype \_\_\_\_\_.



### Problem 8: Predicting the results of a test cross

A test cross is used to determine if the genotype of a plant with the dominant phenotype is homozygous or heterozygous. If the unknown is homozygous, all of the offspring of the test cross have the \_\_\_\_\_ phenotype. If the unknown is heterozygous, half of the offspring will have the \_\_\_\_\_ phenotype.

### Problem 9: Incomplete dominance

In Mendel's experiments, if the gene for tall (T) plants was incompletely dominant over the gene for short (t) plants, what would be the result of crossing two Tt plants?

### Problem 10: Disappearance of parental phenotypes in the F1 generation

A genetic cross of inbred snapdragons with red flowers with inbred snapdragons with white flowers resulted in F1-hybrid offspring that all had pink flowers. When the F1 plants were self-pollinated, the resulting F2-generation plants had a phenotypic ratio of 1 red: 2 pink: 1 white. The most likely explanation is:

### Problem 11: Codominant alleles: The human ABO markers

Human blood type is determined by codominant alleles. There are three different alleles, known as  $I^A$ ,  $I^B$ , and  $i$ . The  $I^A$  and  $I^B$  alleles are co-dominant, and the  $i$  allele is recessive.

The possible human phenotypes for blood group are type A, type B, type AB, and type O. Type A and B individuals can be either homozygous ( $I^A I^A$  or  $I^B I^B$ , respectively), or heterozygous ( $I^A i$  or  $I^B i$ , respectively).

A woman with type A blood and a man with type B blood could potentially have offspring with which of the following blood types?

### Problem 12: 2:1 segregation in Manx cats

Manx cats are heterozygous for a dominant mutation that results in no tails (or very short tails), large hind legs, and a distinctive gait. The mating of two Manx cats yields two Manx kittens for each normal, long-tailed kitten, rather than three-to-one as would be predicted from Mendelian genetics. Therefore, the mutation causing the Manx cat phenotype is likely a(n) \_\_\_\_\_ allele.



Courtesy of PETNET in Australia

### Problem 13: Predicting human blood types

What are the possible blood types of the offspring of a cross between individuals that are type AB and type O? (Hint: blood type O is recessive)

## Genetic Problems - Monohybrid Crosses

Work out the crosses and answer the questions for each problem below on a separate sheet of paper. Make sure you do all parts of each problem.

- In peas, the gene for tallness (T) is dominant over the gene for shortness (t). Given the genotypes of the parent plants, give the possible genotype(s) and phenotype(s) of the offspring of each cross:
  - Tt x Tt
  - Tt x TT
  - TT x tt
  - tt x tt
  - Tt x tt
  - TT x TT
- In humans, the ability to roll one's tongue (R) is dominant to the non-rolling condition (r).
  - Can two tongue rolling parents have a non-roller child?
  - Can two non-rollers have a child that is a tongue roller?
  - Can a roller and a non-roller have a child who is a tongue roller?
  - Can a roller and a non-roller have a child who is a non-roller?
- White fruit color is dominant over yellow in squash. In a cross between a heterozygous white-fruited plant and a yellow-fruited plant:
  - What are the possible genotypes and phenotypes of the offspring?
  - What are the genotypic and phenotypic ratios of the offspring?
- In humans, polydactyly (extra fingers and toes) is dominant over the normal number of digits. Suppose a man with the normal number of digits has children with a woman with polydactyly whose father had the normal number of digits. What proportion of their children would be expected to have polydactyly?
- Free or unattached earlobes is dominant over attached earlobes. If a man with free earlobes and a woman with attached earlobes have ten children, all with free earlobes, can we be certain the man is homozygous for the trait? If their eleventh child has attached earlobes, does that prove the father's genotype? Why or why not?
- Huntington disease is a serious and ultimately fatal nervous system disorder in humans. The symptoms don't develop until after age 30 and the disorder is caused by a dominant gene. A man with Huntington disease had a father who was also afflicted and a mother who was not. His wife does not have the disease, although both her parents did. The couple have a daughter who develops the disease and a son who does not. For which of the people mentioned can we be sure of their genotype? What are their genotypes? What genotypes are possible for the others?
- From a cross involving two fruit flies, both of which had normal wings, there were 79 normal-winged and 27 dumpy-winged offspring produced:
  - Is the gene for normal wings dominant or recessive? How can you tell?
  - What is the genotype of each parent?

## *Dihybrid Cross*

**Problem 1: Predicting combinations of alleles in gametes of plants heterozygous for two traits.**

A pea plant is heterozygous for both seed shape and seed color. S is the allele for the dominant, spherical shape characteristic; s is the allele for the recessive, dented shape characteristic. Y is the allele for the dominant, yellow color characteristic; y is the allele for the recessive, green color characteristic. What will be the distribution of these two alleles in this plant's gametes?

**Problem 2: When does a phenotype ratio of 9:3:3:1 occur?**

A phenotype ratio of 9:3:3:1 in the offspring of a mating of two organisms heterozygous for two traits is expected when:

**Problem 3: A genetic cross yielding a 9:3:3:1 ratio of offspring.**

Which of the following genetic crosses would be predicted to give a phenotypic ratio of 9:3:3:1?

**Problem 4: Predicting gametes of an SsYy plant.**

The gametes of a plant of genotype SsYy should have the genotypes:

**Problem 5: A SsYy x ssyy test cross.**

Which of the following genotypes would you not expect to find among the offspring of a SsYy x ssyy test cross:

**Problem 6: Offspring of a SsYy x ssyy test cross.**

The expected phenotypic ratio of the progeny of a SsYy x ssyy test cross is:

**Problem 7: Homozygous offspring of a dihybrid cross.**

In a dihybrid cross, AaBb x AaBb, what fraction of the offspring will be homozygous for both recessive traits?

**Problem 8: Heterozygous offspring of a dihybrid cross.**

Following a SsYy x SsYy cross, what fraction of the offspring are predicted to have a genotype that is heterozygous for both characteristics?

**Problem 9: Homozygous offspring of a dihybrid cross, again.**

In a dihybrid cross, SsYy x SsYy, what fraction of the offspring will be homozygous for both traits?

**Problem 10: Exceptions to the 9:3:3:1 ratio of offspring?**

If Mendel's crosses between tall, spherical-seeded plants and short, dented-seeded plants had produced many more than 1/16 short, dented-seeded plants in the F<sub>2</sub> generation, he might have concluded that:

**Problem 11: Incomplete dominance in a dihybrid cross.**

In Mendel's experiments, the spherical seed character (SS) is completely dominant over the dented seed character (ss). If the characters for height were incompletely dominant, such that TT are tall, Tt are intermediate and tt are short, what would be the phenotypes resulting from crossing a spherical-seeded, short (SStt) plant to a dented-seeded, tall (ssTT) plant?

**Problem 12: What is the genotype of the agouti parent?**

Two unlinked loci effect mouse hair color. **CC** or **Cc** mice are agouti. Mice with genotype **cc** are albino because all pigment production and deposition of pigment in hair is blocked. At the second locus, the **B** allele (black agouti coat) is dominant to the **b** allele (brown agouti coat). A mouse with a black agouti coat is mated with an albino mouse of genotype **bbcc**. Half of the offspring are albino, one quarter are black agouti, and one quarter are brown agouti. What is the genotype of the black agouti parent?

**Problem 13: AaBb dihybrid cross involving epistasis.**

Two unlinked loci effect mouse hair color. **AA** or **Aa** mice are agouti. Mice with genotype **aa** are albino because all pigment production is blocked, regardless of the phenotype at the second locus. At the second locus, the **B** allele (agouti coat) is dominant to the **b** allele (black coat). What would be the result of a cross between two agouti mice of genotype AaBb?

## Genetic Problems - Dihybrid Crosses

Work out the crosses and answer the questions for each problem below on a sheet of notebook paper. Make sure you show all of your work.

- In peonies, straight stamens ( $S$ ) are dominant over curved stamens ( $s$ ), and plain petals ( $P$ ) are dominant over striped petals ( $p$ ). If a plant that is homozygous for both dominant traits ( $SSPP$ ) is crossed with a plant that is homozygous for both recessive traits ( $sspp$ ):
  - What are the genotypes of their offspring?
  - What are the phenotypes of their offspring?
  - If two members of the  $F_1$  generation are later crossed, what would be the expected phenotypic ratio of their offspring?
- In mice, the gene for colored coat ( $C$ ) is dominant over the gene for albino coat ( $c$ ), and the gene for straight whiskers ( $S$ ) is dominant over the gene for bent whiskers ( $s$ ). In a cross between two mice that are both heterozygous for both traits ( $CcSs \times CcSs$ ):
  - What proportion of all the offspring would be expected to be albino?
  - What proportion would be expected to have bent whiskers?
  - What is the expected phenotypic ratio of all the offspring?
- In maize plants, normal size ( $N$ ) is dominant over pigmy size ( $n$ ), and smooth leaves ( $S$ ) are dominant over crinkly leaves ( $s$ ). If two maize plants, both heterozygous for plant size and leaf texture ( $NnSs$ ) are crossed and produce 160 offspring, how many of each of these would we expect to be produced?
  - Crinkly leaves
  - Normal size
  - Normal size and smooth leaves
  - Pigmy size and smooth leaves
- In fruit flies, hairy body ( $H$ ) is dominant over hairless body ( $h$ ), and large wings ( $L$ ) are dominant over small wings ( $l$ ). In a cross between a fly that is heterozygous for hairy body and large wings ( $HhLl$ ) and a fly that has a hairless body and short wings ( $hhll$ ):
  - What are the genotypes of the offspring?
  - What is the phenotypic ratio of the offspring?

# Genetic Problems

**Directions:** Work out the problems on a sheet of notebook paper show all of the crosses and answer all of the questions.

## Incomplete Dominance and Codominance

- Incomplete dominance can be observed in short-tailed cats. The cats have two alleles for tail length - one for long tail ( $T^L$ ) and one for no tail ( $T^N$ ). A long-tailed cat is homozygous for long tail ( $T^L T^L$ ), a short-tailed cat is heterozygous ( $T^L T^N$ ), and a Manx cat is homozygous for no tail ( $T^N T^N$ ).
  - Show a cross between a Manx and a long-tailed cat. Give the phenotype of the kittens.
  - When two short-tailed cats are crossed, what % of the offspring can be expected to have long tails? Short tails? No tails?
  - Would a breeder who breeds only Manx cats ever get any short or long tailed cats?
- In certain breeds of cattle, the gene for red coat color ( $R$ ) is codominant to the gene for white ( $W$ ) coat color. The heterozygous cattle are called roan ( $RW$ ) which is a mixture of red and white hairs.
  - Show a cross between a roan bull and a white cow. What are the phenotypes of the offspring?
  - If a farmer wanted to produce a herd of only roan cattle, what color cattle should he buy for his breeding stock? Show a cross that supports your answer.
  - The results of a cross show an equal number of red and roan offspring. What are the probable genotypes of the parents? Show a cross to support your answer.

## Blood Type

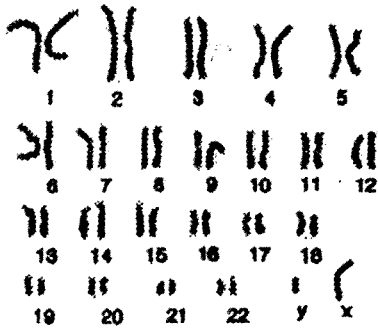
- Blood type in humans is a trait controlled by multiple alleles. There are three alleles,  $I^A$ ,  $I^B$ , and  $i$ . In addition,  $I^A$  and  $I^B$  are codominant and both are dominant over the  $i$  allele. Work out the following crosses. Next to each cross, give the possible blood types of the children.
  - Both parents are type AB.
  - Both parents are type A.
  - One parent is type B, the other parent is type O.
  - One parent is type A, the other parent is type AB.

4. A woman with type A blood has a baby with type O blood. The man she claims is the baby's father has type B blood. Can he be the father of her baby? Show a cross that supports your answer.
5. Is it possible for parents who are both type O to have a child who has type A or type B blood? Show a cross that supports your answer.

### Sex-linked Traits

6. In humans, hemophilia B is a recessive sex-linked disorder characterized by the inability of the blood to clot properly, resulting in excessive bleeding. Use "H" to represent the normal dominant gene and "h" to represent the recessive gene for hemophilia. Remember, since this is a sex-linked trait, you must show the sex chromosomes of each individual along with the gene on each X chromosome. Work out the following crosses and next to each one, write the possible phenotypes of the children.
  - a. The mother is a carrier and the father does not have hemophilia.
  - b. The mother has both dominant genes and the father has hemophilia.
  - c. Both parents have only dominant genes.
7. A mother who does not have hemophilia gives birth to a daughter who has hemophilia. What is the mother's genotype and also that of the father? Show a cross to support your answer.
8. Red-green color-blindness is another recessive sex-linked trait in humans. Use "C" to represent the dominant gene for normal color vision and "c" to represent the gene for color-blindness. Show a cross between a man who is color-blind and a woman who is homozygous dominant.
  - a. Can they have a color-blind daughter?
  - b. Can they have a color-blind son?
  - c. Can they produce daughters who are carriers?
9. Show a cross between a woman who is a carrier and a man who is not color-blind.
  - a. What are the chances (%) of them having a color-blind daughter?
  - b. What are the chances (%) of them having a color-blind son?
  - c. Why do recessive sex-linked traits occur more often in males than in females?

## Genetics Presentation – due



The Genetics Presentation this year should consist of the following items:

1. Should be in a PowerPoint presentation
2. Should be at least 10 slides long.
3. Should have at least 3 pictures, can have more.
4. Should include the following items about your disorder:
  - a. Define what it is.
  - b. What type of genetic disorder is it?
  - c. How is it transferred/transmitted?
  - d. How does the disorder affect the patient?
  - e. What types of treatments are available?
  - f. What is the prognosis of the patient?
  - g. What types of diagnostic tests are there?