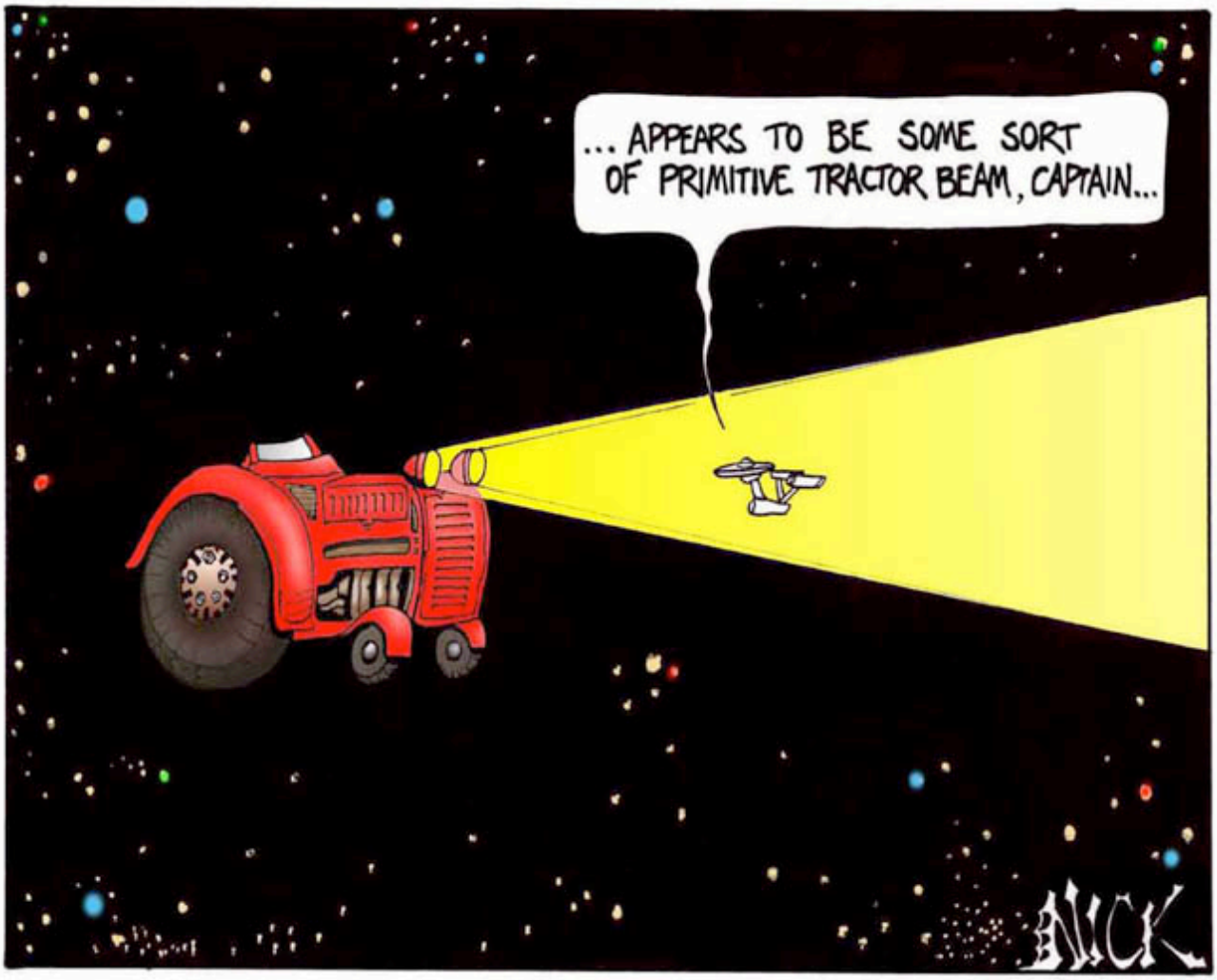
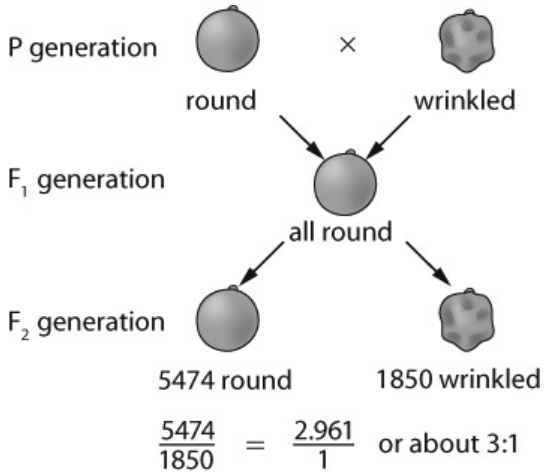
MENDEL'S CROSSES

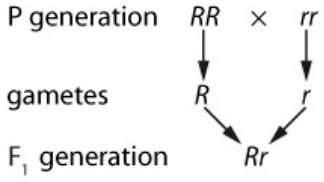


Mendel's Monohybrid Crosses

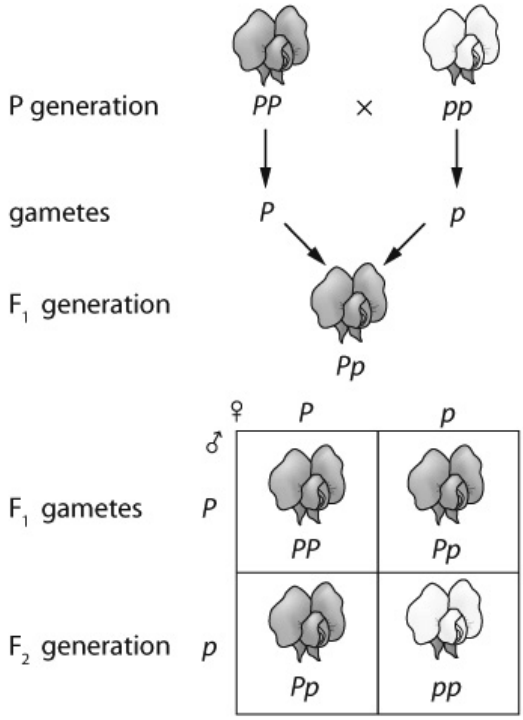
The ratio of plants with round seeds to plants with wrinkled seeds in the F_2 generation is 5474:1850 or 2.96:1. This is very close to a 3:1 ratio.



Representation of a monohybrid cross between two true breeding parent plants. One parent plant is homozygous for round seeds (*RR*), and the other parent plant is homozygous for wrinkled seeds (*rr*). The F_1 generation is heterozygous for round seeds (*Rr*).



For each trait that he tested, Mendel observed the same types of results and inferred the same pattern. This illustration shows a cross between true breeding purple-flowered plants and true breeding white-flowered plants. The ratio of phenotypes in the F_2 generation is 3:1.



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.

3. Short hair is dominant (H) over long hair (h) in cats. If a homozygous dominant female mates with a homozygous recessive male, give the phenotype ratio of the second filial generation.

4. 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.

5. A cross between a tall pea plant and a short pea plant produces offspring of which roughly half are tall and half are short. What are the genotypes of the parental plants? Support your answer with a Punnett square. Which of the parental genotypes is true breeding?

_____

_____

6. Assume that, in humans, the allele for brown eyes (B) is dominant to the allele for blue eyes.

   a) What is the probability that the first child of two heterozygous brown-eyed parents will be blue-eyed? Support your answer with a Punnett square.

   b) If the first child is blue-eyed, what is the probability that the second child will be blue-eyed?

   _____

   c) What is the probability that, if the couple has two children, they will both be blue eyed? (Note: This question differs from (b).)

   _____

7. In some cases, you can determine the genotype of an organism by examining the phenotype alone. In the case of Mendel's pea plants, you know that round seeds (R) are dominant over wrinkled seeds (r).

   a) Identify the genotypes for seed shape that you can determine by inspection alone. Explain.

   _____

   _____

   b) How could you determine the genotypes that you cannot determine by inspection?

   _____

   c) With what would you cross each of your unknowns?

   _____

   _____

   d) Use a Punnett square to show the results for test crosses performed on all unidentified genotypes for seed shape. Explain how each test cross can show which genotype you had in each case.

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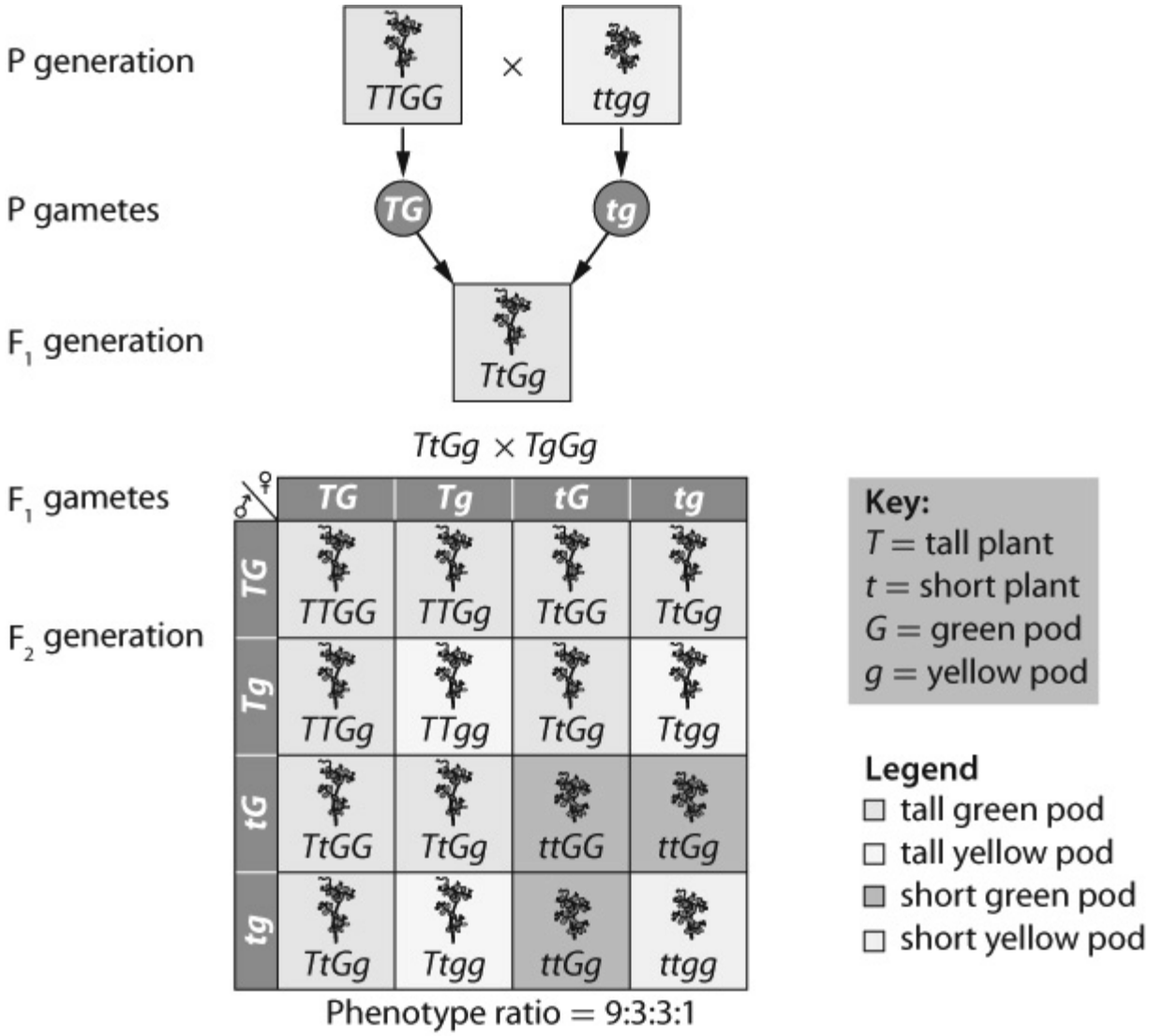
Mendel's Dihybrid Cross



For any dihybrid cross, individuals in the largest group (9) have at least one dominant allele for each gene (*T_G_*), where the underscore represents any one of the four alleles. In the intermediate groups (3), the individuals have at least one dominant allele for one gene but two recessive alleles for the other gene (*T_gg* or *ttG_*). The smallest group (1) is homozygous recessive for both traits (*ttgg*).

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

1. Fruit fly traits are represented with the following letters: L = long wings, l = short wings, G = grey body colour, g = black body colour. What is the phenotype of a fly with the genotype *LLGg*?

   _____

2. The organism with the genotype *LLGg* will produce how many type(s) of gamete(s)? Show how you came to this conclusion.

   _____

3. In fruit flies, normal wing shape (V) is dominant to vestigial (v) and grey body colour (G) is dominant to black body colour (g).
   a) What is the phenotype of a fly whose genotype is *VVGG*? List the possible gametes of this fly.

   _____

   b) What is the phenotype of a fly whose genotype is *VvGg*? List the possible gametes of this fly.

   _____

4. In guinea pigs, black hair colour (B) is dominant to brown hair colour (b). Long hair (L) is dominant to short hair (l).
   a) What are the phenotypes of the parents in the cross BbLl × BbLL?

   _____

   b) Construct a Punnett square for the offspring of the cross in part (a).

c) List the genotypes and phenotypes of the offspring of the cross in part (a) along with the genotype and phenotype ratios.

5. In peas, T = tall stems, t = short stems, G = green pods, and g = yellow pods. A cross between a plant that is homozygous for tall stems and heterozygous for pod colour is crossed with a plant with short stems and yellow pod characteristics. Identify the genotypes and phenotypes of the F_1 generation. Show your work using the Punnett square.

6. About 70 percent of Canadians get a bitter taste from the drug phenylthiocarbamide (PTC), while the other 30 percent do not. The ability to taste this drug (T) is dominant, while the inability to taste the drug is recessive (t). Tongue rolling ability is dominant (R), while the inability to roll the tongue is recessive (r). A tongue-rolling woman who cannot taste PTC has a father who could not roll his tongue but could taste the PTC chemical. She marries a man who can taste PTC but cannot roll his tongue. His mother was unable to taste the chemical. Show the possible children this couple could produce. Use a Punnett square to illustrate your answer. Provide the genotype and phenotype ratios of the offspring.

7. A botanist is trying to create a pea plant that is homozygous for green pod colour and round seed shape. Both of these genes are dominant over yellow pod colour and wrinkled pea shape. The botanist has collected a group of pea plants that produce round peas and green pods. He crosses these plants with a group of plants that have wrinkled peas and yellow pods.

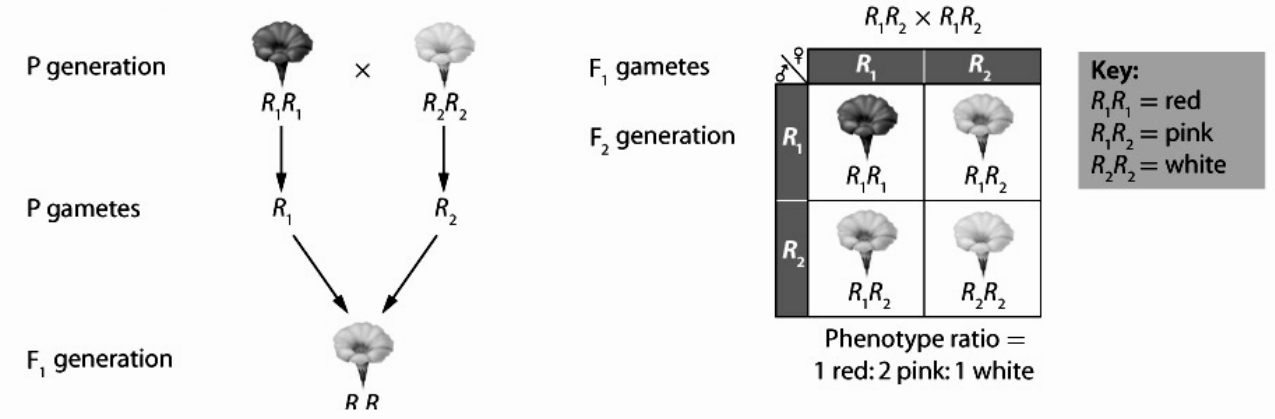
   a) Show all the possible combinations that may result from this cross and provide the phenotype ratios for the offspring. Explain how the botanist could determine the genotype of the parent with round peas and green pods.

   b) The botanist determines that phenotype ratio of the offspring is 1 round, green: 1 round, yellow. What was the genotype of the round seed, green pod parent plant?

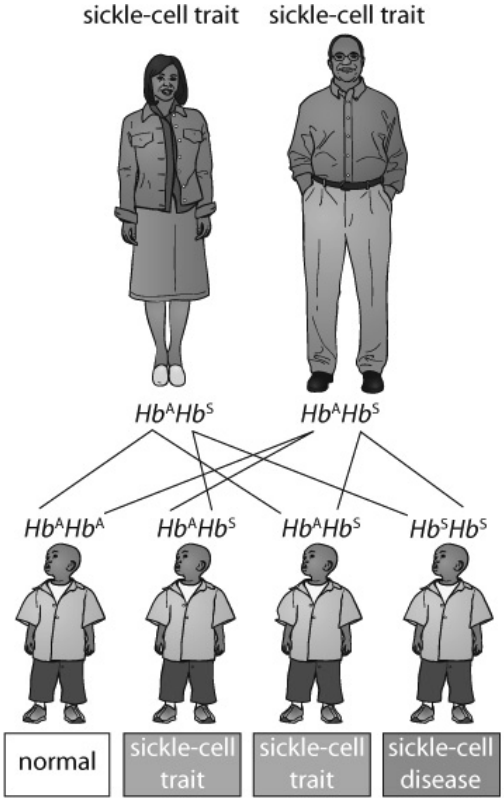
   _____

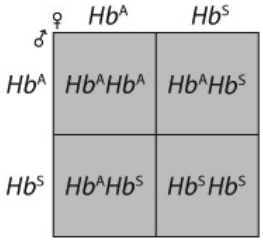
Incomplete Dominance and Co-dominance

The allele for red flowers in the four o'clock plant directs the synthesis of red pigment. When only one allele is present, the flower cannot make enough pigment to make the flowers red, resulting in incomplete dominance (pink flowers).



When a man and a woman are both heterozygous for the sickle cell gene, there is a one in four chance that they will have a child with sickle cell disease.





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

1. A white flowering, true breeding four-o'clock plant (*Mirabilis jalapa*) is crossed with a true breeding, red flowering plant of the same species. The result of this cross is an F_1 generation of all pink flowers. What form of dominance does this plant exhibit? What is the genotype of the F_1 offspring? The F_1 offspring are then crossed to produce an F_2 generation. Draw a Punnett square illustrating this cross and determine the resulting phenotype ratio.

2. A horse breeder near Calgary breeds a black mare and a white stallion. She is hoping that the offspring will have a roan coat of mixed black and white hairs. What mode of inheritance would result in this outcome?

   _____

3. Use Punnett squares to explain your answers where appropriate.

   a) A man with has sickle cell disease marries a woman with the sickle cell trait. Can they have a child without sickle cell?

   b) What is the chance that they will have a child with sickle cell disease?

c) If the family lives in a part of Africa that is endemic for malaria, which genotype would provide a heterozygote advantage? Explain.

_____

_____

_____

_____

d) The man remarries a woman who does not carry the sickle cell allele. What is the chance that they will have a child with the disease?