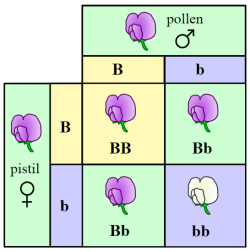
How to Solve Genetics Problems - Chapter 3

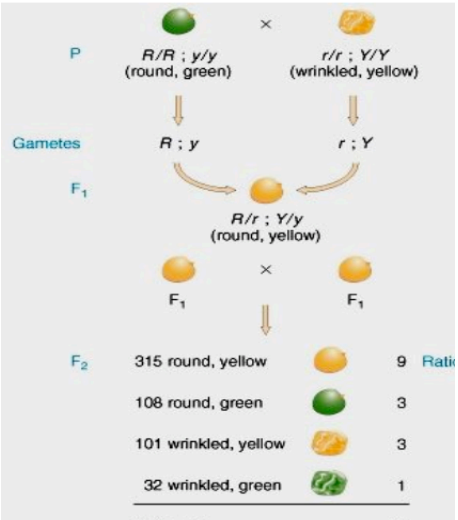
1. Read the problem.
2. Determine what traits are dominant and which are recessive. Write a *key*. ex: KEY: T = tall t = short
3. If letters are not already assigned, make them up.. We usually take the dominant characteristic and use the first letter of that word. For example, if polydactyly (extra fingers) is dominant over the normal five–fingered condition , we would pick P for the dominant gene, and small p for the recessive normal allele.
4. Determine, if possible, the genotypes of the parents. Sometimes you have to deduce it from other information given. Write it down by your key so that you can remember what it is,
5. Determine all the possible kinds of gametes that can be made by each parent. Be careful, remember that a gamete can ordinarily receive only one gene of a pair of alleles. This is the part that most people have trouble with!
    a. You can use the formula **2^n to determine the number of possible gametes** where n = the number of heterozygous pairs
        i. The 2 comes from the two possible outcomes (you get only one allele or another)
        ii. ex: Genotype = AaBbCc would be 2^3 or 8 (ABC, ABc, AbC, AbC, Abc, aBC, aBc, abC
    b. If a pair is not heterozygous you don't count it
        i. ex: AaBbcc = 2^2 or 4 (ABc, Abc, aBc, abc)
6. Make a Punnett square (or forked line). Write genotypes in the squares.
    a. You can use a similar formula to the one above to determine the **number of possible *genotypes*, 3^n** where n = the number of heterozygous pairs in *both parents*. Again, only count it if it is heterozygous.
        i. The 3 comes from the 3 possible outcomes from crossing heterozygotes (Tt x Tt : TT, Tt and tt)
        ii. ex: parents: AaBbCc x AaBbcc = 2^2 (Aa and Bb are heterozygous in both, but cc is not)
    b. You can also use a formula to determine **the number of *phenotypes*, 2^n** where n = the number of heterozygous pairs in *both parents*, to determine possible genotypes of offspring. Again, only count it if it is heterozygous.
        i. The 2 comes from the 2 possible outcomes from crossing heterozygotes (Tt x Tt : tall or short)
        ii. ex: parents: AaBbCc x AaBbcc = 3^2 (Aa and Bb are heterozygous in both, but cc is not)
7. Work the cross carefully.
8. Now read the problem again. Find out exactly what it is asking for. Don't assume too much. This is another place where many people get lost.
9. If a parent is unknown you may assign that parent something like A_ or __ genotype and see if that helps.
10. The actual genetic information you need to solve these problems may need to be implied by the wording of the problem. Learn to translate such a sentence, "Mary is normally pigmented but had an albino father", into its logical consequence: "Mary is heterozygous for albinism" and then into "Mary is Cc". Notice that, in this kind of a problem you may need to solve several subsidiary problems before you can proceed with the final solution.

Useful Information

- Mendel's crosses always begin with the purebred P generation, yielding a completely heterozygous F1 generation
- When you cross heterozygous pairs there is an outcome the you will see every time
  - Monohybrids
    - Phenotypic ratio = 3:1 (3 purple and 1 white)
    - Genotypic ratio = 1:2:1 (1 PP, 2 Pp, 1pp)



  - Dihybrids
    - Phenotypic ratio = 9:3:3:1



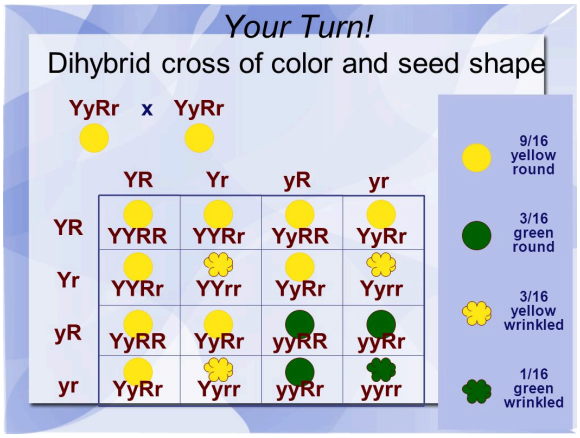
  - Trihybrids
    - Phenotypic ratio = 27:9:9:9:3:3:3:1

Generation of F_2 trihybrid phenotypes

A or *a*	*B* or *b*	*C* or *c*	Combined proportion		
3/4 *A*	3/4 *B*	3/4 *C*	(3/4)(3/4)(3/4) *ABC*	= 27/64	*ABC*
		1/4 *c*	(3/4)(3/4)(1/4) *ABc*	= 9/64	*ABc*
	1/4 *b*	3/4 *C*	(3/4)(1/4)(3/4) *AbC*	= 9/64	*AbC*
		1/4 *c*	(3/4)(1/4)(1/4) *Abc*	= 3/64	*Abc*
1/4 *a*	3/4 *B*	3/4 *C*	(1/4)(3/4)(3/4) *aBC*	= 9/64	*aBC*
		1/4 *c*	(1/4)(3/4)(1/4) *aBc*	= 3/64	*aBc*
	1/4 *b*	3/4 *C*	(1/4)(1/4)(3/4) *abC*	= 3/64	*abC*
		1/4 *c*	(1/4)(1/4)(1/4) *abc*	= 1/64	*abc*

Dihybrids

- Consider two traits for pea: – Color: Y (yellow) and y (green) – Shape: R (round) and r (wrinkled)
  - Each dihybrid plant produces 4 gamete types of equal frequency. – YyRr (adult) four gamete types: YR, Yr, yR or yr
    - You can use the FOIL method to find your gametes
  - Each single trait still gives 3:1 ratio - combined, the overall ratio is 9:3:3:1
  - If you draw a Punnett square to determine the outcome of a dihybrid cross, your box must be 4 x 4 (16 squares) Place a gamete (with only **one of each of the traits**)



Probability and the Forked Line Method

- Probability can make complicated genetics problems much easier!
- The probability of independent events occurring together is the product of probabilities of the individual events.
  - Ex: probability of an offspring that has the genotype Rryy
    - Rr = 2/4 -- yy = ¼
    - (2/4)(1/4) = 1/8

probability of an outcome = # of times event is expected to happen / # of opportunities (trials)