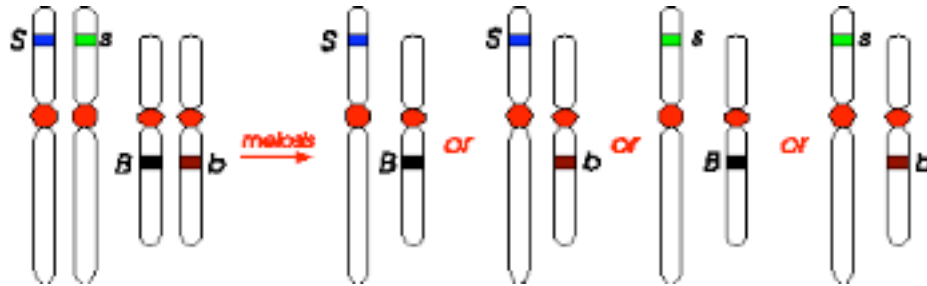


## GENETICS PRACTICE PROBLEMS II

### Dihybrid crosses:

Remember to consider the chromosomes and how they are sorted into the gametes in meiosis when doing dihybrid crosses! It's easy to get lost in the symbols and create Punnet squares that are biologically impossible.



### Steps for solving dihybrid cross problems using Punnet squares:

- Step 1: Figure out the genotypes of the parents.
- Step 2: Figure out what kinds of gametes the parents can produce.
- Step 3: Set up a Punnett Square for your cross. Remember that what you put at the head of each column and row represents what can go in the gametes, so you have to account for both chromosomes in each row or column.
- Step 4: Fill in the offspring inside the table.
- Step 5: Figure out the genotypic ratio for your predicted offspring.
- Step 6: Figure out the phenotypic ratio for your predicted offspring.
- Step 7: Answer the question you've been asked.

### Steps for solving dihybrid cross problems using probability (easier once you get the math):

- Step 1: Figure out the genotypes of the parents.
- Step 2: Treat each trait separately as a monohybrid cross problem.
- Step 3: Determine the decimal percentage of each phenotype for trait A, and for trait B. (For example, 75% BB or Bb and 25% bb translates to 0.75 BB or Bb and 0.25 bb)
- Step 4: Multiply the decimal percentage for the desired phenotypes to get the probability of inheriting both phenotypes. (example: If the odds of inheriting the dominant trait A is 0.75 and the odds of inheriting the dominant trait B is 0.75, then the odds of inheriting both traits is  $0.75 \times 0.75 = .56$ , or 56% which can also be expressed as 9/16)

1. In summer squash, white fruit color (W) is dominant over yellow fruit color (w) and disk-shaped fruit (D) is dominant over sphere-shaped fruit (d).
  - a. If a squash plant true-breeding for white, disk-shaped fruit is crossed with a plant true-breeding for yellow, sphere-shaped fruit, what will the phenotypic ratios be for their offspring (the F1 generation)?
  
  - b. if two individuals from the F1 generation are crossed, what will the phenotypic ratios of the next generation (the F2 generation) be?

2. In Guinea pigs the allele for short hair (**S**) is dominant over the allele for long hair (**s**). (*Note that although short hair is "little hair" the allele symbol is "big S" because it's dominant.*) The allele for black hair (**B**) is dominant over the allele for brown hair (**b**). (*Note: please don't try this at home. The chance of death for Guinea pig sows and their pups during pregnancy and birth is between 20 and 25%, and too many unwanted Guinea pigs are euthanized in animal shelters already.*)

a. Suppose two Guinea pigs, both heterozygous for both traits, are mated. What are the odds of any one of their pups being

short-haired and black?

short-haired and brown?

long-haired and black?

long haired and brown?

b. Suppose that a Guinea pig boar that is heterozygous for both traits is mated with a sow that is heterozygous for fur (**Ss**), but whose fur is brown (**bb**). What are the odds of any one of their pups being:

short-haired and black?

short-haired and brown?

long-haired and black?

long haired and brown?

### **Incomplete dominance and co-dominance**

Some pairs of alleles aren't fully dominant or recessive. In these special cases, the heterozygotes seem to have both inherited traits or a blend of both traits. This is because both alleles are expressed equally. "Incomplete dominance" is where the traits appear to blend. An example is the Four-o'clock flower, where white-flowered plants crossed with red-flowered plants can produce pink-flowered plants. An example of co-dominance is the color "roan" in horses and other animals, where a red-coated horse crossed with a white-coated horse can produce a foal with a roan coat (both white and red hairs). The underlying genetics in both cases are the same. Instead of **A** or **a** to express dominant or recessive alleles, we usually use two small letters. For example, the allele for red flowers in Four-o'clocks is often expressed as **r**, and the allele for white flowers is **w**.

1. A purebreeding red-flowered Four-o'clock (**rr**) is crossed with a purebreeding white-flowered Four-o'clock (**ww**). What colors will be seen in the resulting offspring? What will their genotypes be?

2. If two offspring from the above cross are crossed with each other, what colors will be seen in the resulting offspring? What will be the genotypes of the resulting offspring?

3. A black cat breeds with a tan cat and their kittens are all black-and-tan tabby (striped or mottled) cats. Set up a Punnett square that shows how this could happen. Is this incomplete dominance or co-dominance?
4. If two black-and-tan tabby cats, with genotypes that are like the kittens in problem 3, are bred, what are the odds of any one of their kittens being tabby? All black? All tan?

### **X-linked traits**

An X-linked trait is one that is controlled by a gene on the X chromosome. Because men inherit only one X chromosome while women inherit two, the patterns of X-linked inheritance are a little different than the patterns for normal monohybrid crosses. To track the inheritance of X-linked traits, it is important to use symbols for the X and Y chromosomes themselves, and attach the symbol for the gene in question to the X.

1. Color blindness is also a recessive X-linked gene. Let's denote the normal and mutant alleles as  $X^{b+}$  and  $X^b$  respectively. A woman with genotype  $X^{b+}/X^b$  marries a man of genotype  $X^b/Y$ . They have four sons and two daughters.
- What are the odds that any one of their sons will be color blind?
  - What are the odds that any one of their daughters will be color blind?
  - What are the odds that any one of their will be carriers for the  $X^b$  allele?
2. Duchene Muscular Dystrophy (DMD) is a severe form of muscular dystrophy that is caused by a recessive allele on the X chromosome. Children who inherit this disorder usually die in childhood. Suppose that a woman who is a carrier for the disease marries a man who is normal.
- From which parent did the boy inherit the DMD allele?
  - What are the odds that any of their next sons will have DMD?
  - What are the odds that any one of their daughters be a carrier for DMD?
  - Why is it virtually impossible for a girl to be born with DMD?
3. In fruit flies, sex linkage works very much like it does in humans. Normal flies have red eyes. A recessive gene that causes white eyes is found on the X chromosome. (The gene codes for an enzyme that is one of a series of enzymes that makes red pigment. If the enzyme is defective, the pigment can't be made.) If a white-eyed male is mated to a female that is red-eyed but a carrier for the white-eye gene, what proportion of their offspring would be:
- red-eyed males
  - red-eyed females
  - white-eyed males
  - white-eyed females

