Dominance and Haplosufficiency

Introduction to Dominance:

Dominance refers to a relationship between two or more alleles of the same gene. A dominant allele will be expressed over a recessive allele that is masked. In mendelian genetics, an allele will either be dominant or recessive.

Only one dominant allele is required to express a dominant phenotype. This means heterozygous individuals (with one dominant and one recessive allele for a given gene) will express a dominant phenotype. An individual with two dominant alleles (homozygous dominant for the given gene) will also have a dominant phenotype. In contrast, in order for a recessive allele to be expressed, an individual must be homozygous recessive. This is because any dominant allele will mask the recessive allele.

Traditionally, a dominant allele is defined by an uppercase letter while a recessive allele is defined by a lowercase letter. Because these are alleles of the same gene, the letter choice must be the same.

Example: Red fur is dominant to black fur in red foxes.

A-Red fur; a- black fur

Practice:

1. Long leaves are dominant to round leaves. Define the alleles and then state what the phenotype would be for plants with the following genotypes:

   Alleles:

   Genotype of AA:

   Genotype of Aa:

   Genotype of aa:

2. When I breed two heterozygous plants together (Dd x Dd), I see mostly green stems and only a few orange stem plants. Define the alleles for the stem color gene and explain why I see the difference the ratio of stem colors on my plants.

Introduction to Mutations:

Mutations are changes in the structure of a gene that results in a variant. This can result in a new allele that can be expressed as a new phenotype. The new variant is called a mutant allele and the old, un-mutated version is called the wildtype allele. Mutations can be good or bad or make no difference in the survivability of an individual. Mutations can be dominant or recessive. Haplosufficiency is used to describe a mutation in respect to the wildtype phenotype.

When a wildtype allele is dominant to a mutant allele, the mutation is considered haplosufficient. Another way this can be said is only one wildtype allele is required to show the wildtype phenotype. A heterozygous individual will express the wildtype phenotype. Only a homozygous recessive (homozygous mutant) individual will show the mutant phenotype.

When a mutant allele is dominant to a wildtype allele, the mutation is considered haploinsufficient. Another way this can be said is one wildtype allele is not enough to show the wildtype phenotype. A heterozygous individual will express the mutant phenotype. Only a homozygous recessive (homozygous wildtype) individual will show the wildtype phenotype.

*Hint for success in your course: Never state that something is a mutation unless you are told it is. There are lots of alleles that you will not state are mutations. *

Practice:

1. If a mutation is haplosufficient, would a heterozygous individual have a wildtype or mutant phenotype?

2. Long fins arose due to a mutation in Plecostomus. When I cross two long-fin Plecostomus, I got the following offspring:

Phenotype	Number of offspring
Short Fins	90
Long fins	310

   a. Is the mutation for long fins haplosufficient or haploinsufficient?

   b. Underline all true statements:
      i. The long-fin parents were heterozygous.
      ii. All short fin Plecostomus will be homozygous dominant.
      iii. All short fin Plecostomus are healthier than all long fin Plecostomus.
      iv. All long-fin Plecostomus must be heterozygous.

3. I know that a mutation in scale color is haplosufficient in guppies.
    a. Is the mutation dominant or recessive?

    b. What is/are the possible genotype(s) of guppy with a wildtype phenotype?

    c. If I was to breed two guppies that show a mutant phenotype, what would the expected offspring phenotype(s) be? How many of each phenotype do you expect?