**Punnett Squares: Terminology and Solving Monohybrid Crosses**

**For all peas, green is recessive and yellow is dominant. They are autosomal traits.**

**P1. A heterozygous yellow pea is crossed with a homozygous green pea. What are the phenotypes and genotypes of the offspring? What is the probability of having a fully homozygous offspring?**

**P2. A disease is inherited as autosomal dominant. A male who is heterozygous for the disease marries a homozygous recessive female. What is the chance that their child will be unaffected by the disease?**

**P3. Colorblindness is inherited as a sex-linked recessive disease. If a normal male marries a carrier female, what is the chance that their sons will be affected? What about daughters?**

**Background:**

Punnett squares are often confusing because their purpose is not completely explained. Once you understand what a Punnett square is for, understanding how to solve it becomes much easier. They key to understanding most things in biology is to understand the terms, so that is where we start. There are a lot of terms here and you may know some or all of them. You can skip the terms you do know.

**Definition:**

A Punnett square is just a diagram that biologists use to determine or predict the outcome of breeding (mating) two organisms (two pea plants, to dogs, etc.) The diagram is used to keep track of the alleles for the genes that are of interest.

**Terms:**

Gene – A gene is a unit of heredity. It is a section of DNA on a chromosome that controls a specific outward trait (phenotype).

Allele – In most organisms, there are two copies of every gene. Each copy is referred to as an allele. One allele is found on the maternal chromosome and one allele is found on the paternal chromosome. Together these alleles determine the genotype and phenotype of an organism for a specific trait.

Genotype – A genotype refers to the specific alleles that an organism has. For instance, the genotype Yy in pea plants tells us that the pea plant has one dominant allele (Y for yellow) and one recessive allele (y for green).

Phenotype – An organism’s phenotype refers to the outward manifestation of a genotype. For instance Yy and YY will both produce yellow pea plants while yy will produce a green pea plant. The phenotypes are yellow and green while the genotypes are Yy, YY, and yy.

Parent Generation – This is the generation that is crossed (bred or mated) in an experiment to produce a daughter generation.

Daughter (Filial or F) Generation – Filial just means daughter. This generation is the outcome of a cross or breeding (mating) experiment. It is often designated as F1 (filial 1) for the first daughter generation and F2 (filial 2) for the second daughter generation and so forth. The term son is not used. Daughter is used as a convention, regardless of whether the offspring are girls or boys.

Homozygous – This literally means “same yolk.” It refers to an organism that has identical alleles for a trait. YY and yy are homozygous while Yy is heterozygous. Homozygous is further subdivided into homozygous dominant, which means the organism has two dominant alleles (like YY), and homozygous recessive, which means the organism has two recessive alleles (like yy).

Heterozygous – This mean “different yolk.” It refers to an organism that has different alleles for a trait. As above Yy is a heterozygote for pea pod color.

Dominant Allele – An allele that, when present, will mask the recessive allele in the phenotype. In other words, Yy is not green and yellow, it is only yellow because the dominant Y masks the recessive y. Dominant alleles are written using upper case letters.

Recessive Allele – An allele that can be masked by a dominant allele in the phenotype. The only way to see a recessive allele in a phenotype is if there is no dominant allele. Yy is yellow, but yy is green because there is not dominant Y to mask the recessive y.

Sex-linked (X-linked): The term “sex-linked” can be confusing because it isn’t specific. In most cases, it means that a gene is passed down on the X chromosome and is therefore X-linked. Unless a problem states otherwise, you can assume that sex-linked and X-linked mean the same thing.

Autosomal – This means the gene is not on the X or Y chromosome, but on any other chromosome that does not determine gender.