Punnett Squares

A Punnett's Square is a charting method used to determine the probability of an offspring having a particular genotype. You fill in the possible alleles of the parent sperm and egg across top and left side, then combine those possible parent's alleles to predict the offspring genotypes & phenotypes.

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>BB</td>
<td>BB</td>
</tr>
<tr>
<td>b</td>
<td>Bb</td>
<td>Bb</td>
</tr>
</tbody>
</table>

EXAMPLE:

If the letter B stands for fur color, Uppercase B is the Dominant version of the trait = brown fur
Lowercase b is yellow fur, the recessive version of the trait = brown pigment not made. Upper case letters are dominant, lower case letters are recessive.

#1  BB  then Phenotype = Brown Genotype = homozygous (both alleles same)
#2  Bb  then Phenotype = Brown Genotype = heterozygous (one B, one b)
#3  bb  then Phenotype = yellow Genotype = homozygous recessive (both b)

In the square above, both parents (#1 & #2) are brown (phenotype) but one is homozygous and one is heterozygous (genotype).

In the example below, both parents are brown and both are heterozygous brown.
Which pairs of brown dogs produce yellow offspring? What is the ratio of brown to yellow pups in the example below?

<table>
<thead>
<tr>
<th></th>
<th>B</th>
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<tbody>
<tr>
<td>B</td>
<td>BB</td>
<td>Bb</td>
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<tr>
<td>b</td>
<td>Bb</td>
<td>bb</td>
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TEST CROSS: The genotype is not always known – just as in Mendel's experiments. Test crosses can reveal the genotype.
EXAMPLE: a yellow mom is mated to an unknown father. Two brown littermates and two yellow littermates result.
What is the likely genotype of the parents?
What is the likely genotype of the offspring? Can you be certain?
Dihybrid Squares – begin by defining the traits and parent genotypes. Then determine the possible gametes. Remember, each gamete contains one allele for trait #1 and one allele for trait #2. Always place them in the same order, trait #1 and then trait #2. Follow all steps as for a monohybrid cross. Use the FOIL method to determine gametes.

\[ RrYy \]

- **B** = black fur, **b** = brown fur
- **S** = short fur, **s** = long fur

**F**\(_1\) guinea pigs:
- Male **BbSs** X female **BbSs**

<table>
<thead>
<tr>
<th>Guinea pig female</th>
<th>Gametes</th>
<th>BS</th>
<th>Bs</th>
<th>bS</th>
<th>bs</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS</td>
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After filling in the squares, count up the number of each genotype and phenotype. Determine the ratios. Double check that you have 16 squares in your count.
Vocabulary:

**Allele** — one of a pair of genes coding for a particular trait

**Crossing over** — recombination of genetic material between from homologous chromosomes; results in new combinations of traits

**Diploid** — cell with two copies of each chromosome

**Dominant** — version of allele results in an observed trait

**Egg** — haploid female sex cell produced by meiosis

**Epigenetics** — the study of modifications to chromosomes that doesn't effect DNA code

**Fertilization** — fusion of male and female gametes

**Gamete** — sex cells, sperm and eggs, haploid cells

**Gene** — a pair of alleles, located on a chromosome, that code for a protein or RNA

**Genetic recombination** — major source of genetic variation among organisms caused by re-assortment or crossing over during meiosis

**Genetics** — branch of biology that studies heredity

**Genotype** — combination of genes in an individual organism

**Haploid** — cell with one copy of each kind of chromosome (gamete)

**Heredity** — passing on of characteristics from parents to offspring

**Heterozygous** — when the two alleles for a trait code for different variations in that trait

**Homologous chromosomes** — a matching set of paired chromosomes with genes for the same traits arranged in the same order

**Homozygous** — when the two alleles for a trait code for the same version of that trait

**Hybrid** — offspring formed by parents having different forms of a specific trait.

**Meiosis** — type of cell division where one cell produces four gametes, each containing half the number of chromosomes in a parent's body cells.

**Phenotype** — outward appearance of an organism, regardless of its genes.

**Recessive** — allele version that does not produce the observed trait

**Recombination** — a genetic exchange between homologous chromosomes

**Sexual reproduction** — pattern of reproduction that involves the production and subsequent fusion of haploid cells to make a fertilized egg or zygote

**Sperm** — haploid male sex cells produced by meiosis

**Trait** — characteristic that is inherited – not necessarily expressed

**Zygote** — diploid cell formed when a sperm fertilizes an egg