\[ \chi^2 = \sum \frac{(O - E)^2}{E} \]

1. A newly identified fruit fly mutant, cyclops eye (large and single in the middle of the head), is hypothesized to be autosomal dominant. The experimenter started with homozygous wild type females and homozygous cyclops males. The data from the F2 generation was 44 wild type males, 60 wild type females, 110 cyclops males and 150 cyclops females. Does this data support or reject the hypothesis? Use chi square to prove your position.

- **C** = cyclops
- **c** = normal

\[ \begin{align*}
C \times CC & \rightarrow F_1 = Ce \\
F_2 & \rightarrow \left\{ CC, 2 Ce, 1 cc \right\} \\
& \text{Observed: } 60 \text{ wild, 110 cyclops} \\
& \text{Expected: } 91 \text{ wild, 273 cyclops} \\
\end{align*} \]

\[ \frac{(110-91)^2}{91} = 1.86 \]

\[ \frac{(260-273)^2}{273} = .62 \]

\[ \chi^2 = 2.48 \]

2. Another fictitious mutant, bloodshot eyes, is hypothesized to be autosomal recessive. Again the experimenter used homozygous wild type females but this time the males had homozygous blood shot eyes. The F2 data was 75 wild type males, 60 wild type females, 31 bloodshot males and 45 bloodshot females. Does this data support or reject the hypothesis? Use chi square to prove your position.

- **N** = normal
- **n** = bloodshot

\[ \begin{align*}
N \times nn & \rightarrow F_1 = Nn \\
F_2 & \rightarrow 3:1 \text{ Expected} \\
\end{align*} \]

\[ \begin{align*}
\text{Observed: } & 158 \text{ N-} \\
& 53 \text{ nn} \\
\text{Expected: } & 135 \text{ N-} \\
& 76 \text{ nn} \\
\end{align*} \]

\[ \begin{align*}
\frac{(135-158)^2}{158} & = 3.348 \\
\frac{(76-53)^2}{53} & = 9.18 \\
\end{align*} \]

\[ \chi^2 = 13.33 \]
3. Still another imaginary trait, bristles-with-split-ends, is hypothesized to be X-linked dominant. As before, the P1 females were homozygous wild type however this time the males had bristles-with-split-ends. The F1 84 males were all wild type while the 90 females all had split-ends. In addition, the data for the F2 generation revealed 26 wild type males, 35 wild type females, 29 split-end males and 40 split-end females. Does this data support or reject the hypothesis? Use chi square to prove your position.

\[
\begin{array}{c|c|c|c}
\text{XX} & \text{X}^b \text{X}^b & \text{X}^b \text{Y} \\
\hline
\text{F1} & \text{X}^b \text{X}^b \times \text{X} \text{Y} & \text{X}^b \text{X}^b \times \text{X} \text{Y} \\
\hline
\text{1:1:1:1 expected} & (26 - 32.5)^2 & 1.3 \\
\text{32.5 each} & (35 - 32.5)^2 & 0.19 \\
\text{32.5} & (29 - 32.5)^2 & 0.37 \\
\text{32.5} & (40 - 32.5)^2 & 1.73 \\
\end{array}
\]

Accept: 3.59 is smaller than 7.82

4. Bow-legs is hypothesized to be X-linked recessive in Drosophila melanogaster. The P1 females were, once again, homozygous wild type but the males were bow-legged. There were 52 wild type males and 67 wild type females in the F1 generation. The F2 generation contained 30 wild type males, 75 wild type females, 40 bow-legged males and no bow-legged females. Does this data support or reject the hypothesis? Use chi square to prove your position.

\[
\begin{array}{c|c|c|c}
\text{XX} & \text{X}^b \text{X}^b & \text{X}^b \text{Y} \\
\hline
\text{F1} & \text{X}^b \text{X}^b \times \text{X} \text{Y} & \text{X}^b \text{X}^b \times \text{X} \text{Y} \\
\hline
\text{1:1:1:1 expected} & (15 - 7.25)^2 & 0.9 \\
\text{7.25 each} & (7.25 - 3.6)^2 & 1 \\
\text{36 wild} & (40 - 36)^2 & 0.44 \\
\text{36 bow-legged} & (80 - 36)^2 & 1.53 \\
\end{array}
\]

Accept: 1.53 is smaller than 5.99

5. In 1901, Bateson reported the first post-Mendelian study of a cross involving two characters. White leghorn chickens, having white feathers and large "single" combs, were crossed to Indian Game Fowl, having dark feathers and small "pea" combs. The F1 were white with pea combs, and the F2 distribution was: 111 white pea, 37 white single, 34 dark pea, and 8 dark single. What phenotypic ratio would you expect? Test your prediction using chi-square.

\[
\begin{align*}
W = \text{white} & \quad \text{w} = \text{dark} \\
P = \text{pea combs} & \quad p = \text{single}
\end{align*}
\]

\[
\begin{array}{c|c|c}
\text{WW} & \text{Ww} & \text{WW} \\
\hline
\text{P}^2 \times \text{P}^2 & \text{P}^2 \times \text{pp} & \text{PP} \times \text{Pp} \\
\hline
111 & 36 & 36 \\
\end{array}
\]

Accept: 1.62 is smaller than 7.82

6. In the garden pea, yellow cotyledon color is dominant to green, and inflated pod shape is dominant to the constricted form. Considering both of these traits jointly in self-fertilized dihybrids, the progeny appeared in the following numbers:

\[
\begin{align*}
\text{193 green, inflated} & \quad 0.26 \\
\text{184 yellow constricted} & \quad 0.22 \\
\text{556 yellow, inflated} & \quad 0.16 \\
\text{61 green, constricted} & \quad 0.16 \\
\end{align*}
\]

Do these genes assort independently? Support your answer using Chi-square analysis.
6. A mutation causing short wings in fruit flies is thought to be autosomal recessive. A homozygous wild type female is crossed with a homozygous short winged male. All the offspring are long winged. The F2 generation is 102 longwinged females, 34 short winged females, 113 long winged males and 45 short winged males. Given that information, can we accept the null hypothesis?

$$\text{LL} \times \text{LL} \rightarrow \text{F1 LL, Ll} \rightarrow \text{F2 3:1 LL: Ll}$$

3/4 of 294

$$\frac{(73.5-72)^2}{72} = 0.12$$

5/4 of 294

$$\frac{(220.5-215)^2}{215} = .137$$

smaller than 3.84

7. A mutation in rabbits causing crooked back legs is thought to be autosomal dominant. A homozygous wild type female is crossed with a homozygous crooked legged rabbit. All the offspring have crooked back legs. The F2 is 38 crooked legged females, 28 crooked legged males, 19 straight legged females and 14 straight legged males. Given that information can we accept the null hypothesis?

$$\text{cc} \times \text{CC} \rightarrow \text{F1 Cc} \\ \text{3:1 Cc: cc}$$

3/4 total

$$\frac{(24.75-33)^2}{33.75} = .341$$

7/4 total

$$\frac{(74.25-66)^2}{74.85} = 3.67$$

smaller than 3.84

8. A mutation in cats causing notched ears is believed to be autosomal recessive. An old lady has a male cat with notched ears and a female cat that is homozygous for normal ears. They have 5 litters of kittens all with normal ears. If the next generation of cats numbers 1248 in the old lady’s house when the film crew from A&E's Horders shows up, how many of them would you expect to have notched ears?

$$\text{NN} \times \text{nn} \rightarrow \text{F1 all Nn} \rightarrow \text{3:1 normal to notched}$$

$$1248 \div 4 = 312$$

9. The film crew mentioned in question #8 captures all 1248 cats and 512 of them have notched ears. Can you accept the null hypothesis?

$$\frac{(512-312)^2}{512} = 78.125$$

$$\frac{(736-936)^2}{936} = 42.73$$

$$\frac{120.855}{120.855}$$

No

120.8 is well above 3.67