The use of a statistical test allows us to say with a certain amount of confidence (e.g., 95%) whether the means of data obtained for different treatments are significantly different from each other or not. More specifically, a statistical test assesses the evidence against H_o, i.e., that there is no effect of the factor on the organism, by asking the question, "What is the probability that the observed differences between the means could have occurred by chance alone if the factor has no effect on the organism?". Differences are considered statistically significant if the probability is very small (in Biology, very small is less than 5%) that the results obtained could have occurred by chance. This means there is some evidence against the hull hypothesis, H_o, and you can then reject H_o as a false statement and lend support to the alternate hypothesis, H_a, that the factor does have an effect on the organism. Observed differences in the means are not statistically significant if there is a greater than 5% probability, $p = .05$, that the results could have occurred by chance alone; these results are not convincing enough to enable you to reject H_o.

- If the data **are in agreement with** statistical values predicted for no effect of different treatments on experimental organisms, you fail to reject H_o.

- If the data **deviate from** the statistical values predicted for no effect of different treatments on experimental organisms, you reject H_o and provide support for H_a.

Student t-tests

This statistical test is useful for determining if sample means from two populations (e.g., two treatments in an experiment) are significantly different from each other. It is used when sample sizes are small (less than or equal to 30 in one or both groups. This statistic is called student's t-test, or t-test.

For small samples (≤ 30), $t = \dfrac{\bar{x}_1 - \bar{x}_2}{s\sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$

Where $\overline{x_1}$ and $\overline{x_2}$ are the means of the two samples, n_1 and n_2 are the number in each sample and s is the combined standard deviation of the two samples, which is calculated by taking the square root of the combined variance calculated as follows:

$$s^2 = \frac{\sum(x-\bar{x}_1)^2 + \sum(x-\bar{x}_2)^2}{n_1+n_2-2}$$

Since this is not a statistics course, you do not have to worry about the actual formula for calculating the t value. All you have to do is download the Excel file, t-test calculator and enter your data as directed.

The calculated value is compared with theoretical values, using the number of degrees of freedom ($n_1 + n_2 - 2$). The program will then calculate a p value for the difference between the means of the two samples, i.e. the probability of rejecting a true null hypothesis (the null hypothesis in a two-sample t-test is that the means are equal).

- If the calculated *p* is ≤ 0.05, you reject H_o and provide support for H_a.
- If the calculated *p* is > 0.05, you fail to reject H_o.

You need to examine the means to confirm the direction of the difference is as stated in your prediction.

In case you are interested, the program uses a two-tailed t-test. This considers the effect of differences in the means in either direction.