## Hypothesis Testing: discussion questions set A

Discuss in pairs the answers to the following questions:

**1. What is the null and alternative hypothesis?**

In hypothesis testing, the **null hypothesis (H₀)** is a statement that there is no effect, no difference, or no relationship between variables. The **alternative hypothesis (H₁)** is a statement that contradicts the null hypothesis, indicating that there is an effect, difference, or relationship.

**Example in agriculture:**

Let's say we want to test whether a new type of fertilizer increases crop yield.

* **Null Hypothesis (H₀)**: The new fertilizer has no effect on crop yield. In other words, the crop yield with the new fertilizer is equal to or the same as with the old fertilizer.
  + **Mathematical form**: µ₁ = µ₂ (The mean crop yields for both fertilizers are equal).
* **Alternative Hypothesis (H₁)**: The new fertilizer increases crop yield compared to the old fertilizer.
  + **Mathematical form**: µ₁ > µ₂ (The mean crop yield for the new fertilizer is greater than that of the old fertilizer).

**2. What do we need to do in order to test the null hypothesis?**

To test the null hypothesis, we follow a series of steps:

1. **Formulate Hypotheses**: Clearly state the null and alternative hypotheses (as shown above).
2. **Collect Data**: Gather relevant data through experimentation or observation. For example, apply both the new fertilizer and old fertilizer to separate groups of crops and record the yield.
3. **Choose a Significance Level (α)**: This is often set at 0.05 (5%), meaning you are willing to accept a 5% chance of incorrectly rejecting the null hypothesis.
4. **Select an Appropriate Test**: Depending on the data, we would use statistical tests such as t-tests (for comparing means) or chi-square tests (for categorical data). For example, if we're comparing mean crop yields between two groups (new fertilizer vs old fertilizer), a t-test might be appropriate.
5. **Compute the Test Statistic**: Use the selected test to calculate the test statistic (e.g., t-value or z-value) based on your data.
6. **Make a Decision**: Compare the p-value to your chosen significance level (α). If the p-value is less than α, reject the null hypothesis; otherwise, fail to reject it.

**3. What does the p-value tell you? – what conclusion would you draw if the p-value = 0.010 and how would your conclusion change if the p-value = 0.234?**

The **p-value** represents the probability of observing the data (or something more extreme) if the null hypothesis is true. A low p-value indicates strong evidence against the null hypothesis, while a high p-value suggests weak evidence.

**Interpretation of p-values:**

* **If p-value = 0.010**: This is smaller than the typical significance level of 0.05. So, we would **reject the null hypothesis**. There is statistically significant evidence to suggest that the new fertilizer increases crop yield compared to the old fertilizer.
* **If p-value = 0.234**: This is much greater than 0.05. So, we would **fail to reject the null hypothesis**. There is insufficient evidence to suggest that the new fertilizer has a significant effect on crop yield.

In summary, the p-value helps us decide whether to reject or fail to reject the null hypothesis based on the strength of evidence in the data.

**4. How would you define the null and alternative hypothesis when you are comparing two samples? Think of an example of what these could be in your area of study.**

When comparing two samples, the null hypothesis typically asserts that there is no difference between the two groups or populations. The alternative hypothesis asserts that there is a difference.

**Example in agriculture:**

Imagine we want to compare the effectiveness of two different irrigation methods (e.g., drip irrigation vs. flood irrigation) on crop yield.

* **Null Hypothesis (H₀)**: There is no difference in crop yield between the two irrigation methods. In other words, the mean yield for drip irrigation equals the mean yield for flood irrigation.
  + **Mathematical form**: µ₁ = µ₂ (The mean crop yield for both irrigation methods is the same).
* **Alternative Hypothesis (H₁)**: There is a difference in crop yield between the two irrigation methods. In other words, the mean yield for drip irrigation is not equal to the mean yield for flood irrigation.
  + **Mathematical form**: µ₁ ≠ µ₂ (The mean crop yields for both irrigation methods are different).

In this case, you would collect data on crop yield using both irrigation methods and then conduct a statistical test (such as a t-test) to see if there is significant evidence to support the claim that the irrigation methods yield different results.