The Scientific Method. All science uses the scientific method, generally following these steps:

1. **OBSERVATIONS**: An initial phase, characterized by informal, preliminary observations, explorations, natural history – gives you ideas and direction for your question
2. **QUESTION**: Simple and answerable, typically derived directly from your observations
3. **HYPOTHESES**: All of the plausible, direct answers to your question

Types of hypotheses:

   a. Pattern Hypothesis: there is a pattern (or a particular pattern); Null Hypothesis: there is no pattern
   b. Process Hypothesis: "A" causes the pattern/phenomenon (a proposed explanation); Alternative Hypothesis: "B" causes the pattern; Null Hypothesis: Neither "A" nor "B" causes the pattern – the pattern is the result of chance
   c. Process Hypotheses include 4 different kinds of explanations for patterns or phenomena: (1) Ultimate, (2) Proximate, (3) Developmental, (4) Phylogenetic. These can be aligned with Tinbergen's 4 questions: How does it work (proximate/mechanism)? How does it develop (developmental/ontogenetic)? What is its evolutionary history (phylogenetic)? (Why) is it adaptive (ultimate)?

4. **PREDICTIONS**: Quantifiable, definitive assertions that lead directly from each hypothesis – "IF the hypothesis is true, THEN we predict ..." Diagnostic predictions that are not shared by multiple hypotheses are most useful (i.e., if the hypothesis is true, the predicted data must be observed, and no other plausible hypothesis predicts the same result).
5. **TESTS**: Collection of data to test the prediction(s). Experiments are often the most powerful approach, but other methods (correlative, comparative, meta-analytical) can be effective as well.
   a. Be a control freak – control for EVERYTHING ("controlled variables") except your one variable of interest ("independent variable"). Avoid observer bias.
   b. Replication – you want to be confident in your result, so ensure sufficient replication for a robust outcome. This can mean sampling a sufficiently large number of populations, species, or individuals and/or repeating your tests multiple times (possibly in different systems).
6. **RESULTS**: Compare your data to your predictions. Plotting can help (as can statistics):
   a. Independent variable (x-axis)
      i. Experiment: what you manipulated (manipulated variable)
      ii. Non-experiment: factor predicted to cause variation in the dependent variable
   b. Dependent variable (y-axis) – what you measured (response variable)
7. **CONCLUSIONS**: Interpretation of results:
   a. Which hypothesis is supported? Which can be rejected?
   b. Could something have biased your results? What can you NOT conclude from your data?
   c. Are there future experiments you would do?
   d. What broad conclusions can you draw from your study?

*NOTE: **Hypotheses cannot be PROVEN!** Experiments or observations may support or reject a hypothesis, but they never prove a hypothesis. Even if a hypothesis is well-supported, we must always be willing to modify or discard it as new information becomes available.