# Scientific Hypothesis Structure

Hypothesis development is vital to scientific research, because hypotheses direct the entire research process. Hypotheses provide precise answers to research questions. Effective hypotheses are logical, clearly written, and make testable predictions. The following 3-part structure provides a template for writing effective hypotheses.

## If (premise), then (prediction), because (mechanism).

(1) The premise should state your assumption about the (an) important factor to your topic or system of interest.

(2) The prediction should follow logically from the premise. If the premise is true, then you should be able to find evidence for the prediction.

(3) The mechanism describes the link between the premise and prediction -- it helps ensure the prediction is likely, or at least plausible.

If your hypothesis(es) is(are) well-formulated, interpretation of your results becomes simpler. If the data are consistent with a prediction, then you have empirical evidence for validity (or importance) of the premise. If the data contradict the prediction, then you have evidence against the premise. Similarly, well-formulated hypotheses should help you learn something from your results: you can find evidence that your premise is valid (or important), or not.

These ideas imply you should develop your hypotheses thoughtfully, because they determine whether your results will be meaningful or interpretable. You should choose premises that are clear and informative. You should think carefully about logical implications of your premises: they will become your predictions. Try to make your predictions as specific or precise as you can, which will lead to more definitive results.

Example 1: Bird diversity

Hypothesis 1. "**If** most birds in Whatcom County specialize on a relatively small number of food types, **then** Bellingham's central business district will support fewer birds species than any comparable sized area in the county, **because** fewer kinds of avian foods are available in the central business district than anywhere else in the county."

Hypothesis 2. "**If** avian species diversity in Whatcom County is limited primarily by the variety of predators, **then** Bellingham's central business district will contain more bird species than any comparable area in the county, **because** predator control measures, habitat isolation and fragmentation, and low availability of predator den and nest sites reduces predator variety in the central business district relative to other areas.

Example 2: Douglas fir branch distribution (water, light, or nutrient limitation)

Hypothesis 1. **If** growth of Douglas fir branches is limited primarily by water availability, **then** living Douglas fir branches and foliage will be more dense and abundant on trees at the base of slopes, and less abundant on trees growing on ridge tops with thin soils or rocky substrates, **because** rainwater collects at the base of slopes and drains rapidly from ridgetops and rocky substrates.

Hypothesis 2. **If** growth of Douglas fir branches is limited primarily by light availability, **then** living Douglas fir branches will be abundant in spaces with high light exposure including the upper canopy, forest edges, and canopy gaps; branches will be absent or senescing the forest understory and other areas with low light availability, **because** photosynthetic rates of Douglas fir needles in high light environments are much greater than rates in understory locations and whole tree growth rates are greater with branches in the high light environments than if resources were allocated to branches in lower light environments.

Hypothesis 3. **If** growth of Douglas fir branches is limited primarily by nutrient availability, **then** Douglas fir trees growing adjacent to alders will have greater abundance of branches and higher foliage density than Douglas fir trees in monospecific stands, **because** alder leaf litter generates soil rich in nitrogen relative to soils associated with monospecific Douglas fir stands.

Many authors have written additional guidance about writing scientific hypotheses. Below are references for two sources you might find useful.

Penn State University Writing Center. The hypothesis in scientific writing. [online] https://berks.psu.edu/sites/berks/files/campus/HypothesisHandout_Final.pdf

Misra DP, AY Gasparyan, O Zimba, M Yessikepov, V Agarwal, and GD Kitas. 2021. Formulating hypotheses for different study designs. *J. Korean Med. Sci*. 36(50):e338. https://doi.org/10.3346/jkms.2021.36.e338 https://pmc.ncbi.nlm.nih.gov/articles/PMC8728594/