GUIDELINES TO SCIENTIFIC PROCESS

Main Conceptual Flow	**Subconcepts**	**Biological Example: Moth Color**
1. Observe/Question		Moths are hard to see when they rest on certain backgrounds; they are cryptic.
2. Wonder/Speculate/Think		I wonder if cryptic coloration of moths hides them from predators.
3. Generate Biological Hypothesis **If** (hypothesis), **then** (prediction)	Deduction (if….then logic) testability assumptions	If cryptic coloration hides moths from predation, then number of survivors will be higher for moths with non-altered coloration than moths with altered coloration. Assumptions: 1) Predators can see altered coloration; 2) Investigators can see altered and non-altered equally.
4. Determine Experimental Design A. Independent Variable(s) Number of independent variables Number of treatments per variable	Experimentation: Creation of variation in independent variable Treatment – Control Observation: Use natural existing variation in independent variable	Experiment: alter wing coloration (with neon spray paint) = treatment; no alteration of wing coloration = control 1 independent variable = coloration; 2 treatments = altered and non-altered
B. Dependent Variable(s) Observation Measurements/Counts	Categorical variable Continuous variable	Dependent Variable = count of number of altered and non-altered moths recaptured and not recaptured
C. Replicates	Sample size per treatment Relation to probability	Sample size = 100 moths/treatment
5. Collect Data		
6. Analyze Data A. Create Data File		
B. Calculate Descriptive Statistics	Types of Distributions (Frequency distributions) 1. normal 2. skewed 3. bimodal	

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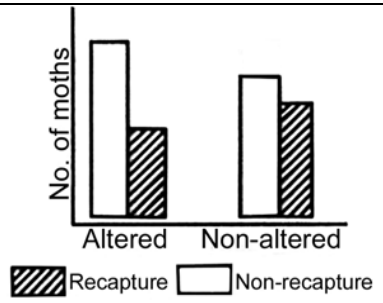
	Descriptors of Central Tendencies of Distributions 1. Mean 2. Dispersion a. range b. variance c. standard deviation $(SD) = \sqrt{variance}$ 34% x 2 = 68% of data within 1 SD of mean 47.7% x 2 = 95.5% of data within 2 SD of mean	
C. Graph Data	Horizontal axis (x, independent variable) Vertical axis (y, dependent variable) Types of graphs Box + Whisker ($\overline{X}$, SD, range) Bar (column) (independent variable = categorical) Histogram of Frequency Distribution (continuous classes; tally frequency/class)	
D. Calculate Analytical (Comparative) Statistics	What is question? What is hypothesis? Choice of statistical test	Difference between distributions → χ^2 contingency test
	Null H_o/Alternate H_1 [symbolic format]	H_o: # non-altered recaptured = # altered recaptured H_1: # non-altered recaptured > # altered recaptured
	Probability/Level of Significance Relate to SD + distributions Type I, II error	$\alpha = .05$ ($p<0.05$ of rejecting true H_o)
	Interpretation of statistical output	n.s. = non-significant; $p > 0.05$ Failure to reject null hypothesis (H_o)
7. Reach Conclusion	Fail to reject H_o; Support for H_1 No proof	No evidence that cyptic coloration hides moths from predators.
	Assumption may have been violated.	Predators may not see altered coloration as well as humans. Need to test that assumption.