Free Handout: Core Elements of Experimental Design

1. Treatment / Experimental Groups

Definition: The group(s) in an experiment that receive the intervention or manipulation being tested.
Example: A group of patients receiving a new drug, or peanut samples modified using CRISPR-Cas9.

IMAGE Needed

2. Control Groups

Definition: Groups that do not receive the experimental treatment. They serve as a baseline.
Types: Placebo, no treatment, or standard treatment.
Why It Matters: Helps determine if observed effects are due to the experimental manipulation.

IMAGE Needed

3. Replication

Definition: Repeating the experiment or treatment to verify results and reduce random error.
Types:

- *Technical replicates*: Same sample/condition repeated
- *Biological replicates*: Independent samples or trials
  Why It Matters: Supports statistical reliability and generalization of results.

IMAGE Needed

4. Randomization & Blinding

Randomization Definition: Assigning subjects randomly to groups to eliminate selection bias.
Blinding Definition: Preventing participants or researchers from knowing group assignments to reduce bias.

- **Single-Blind:** Only participants don't know
- **Double-Blind:** Neither participants nor researchers know
- **Triple-Blind:** Even analysts are blinded

Image Suggestion:
"Double-blind Randomized Controlled Trial"

IMAGE Needed

5. Blocking

Definition: Grouping units with shared characteristics to reduce known variation, and randomizing within blocks.
Example: Blocking by sun exposure, gender, or baseline skill level.
Why It Matters: Increases precision by accounting for confounding variables.
Image Suggestion:
"Blocking in Experimental Design"
Source: Scribbr
https://www.scribbr.com/methodology/blocking-in-experiments/

Summary Table

Concept	Definition	Purpose
Treatment Group	Group receiving intervention	Test the effect of the independent variable
Control Group	Group used for baseline comparison	Isolate the effect of the intervention
Replication	Repeating trials or samples	Increase reliability

Randomization	Random assignment to groups	Minimize bias
Blinding	Concealing group identity	Prevent bias in observation or analysis
Blocking	Grouping by shared traits before assignment	Control known confounding variables

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Additional Resources:

- **UC Davis Experimental Design in Science:**
  https://chemsite.chem.uci.edu/experimental-design/
- **HHMI BioInteractive – Scientific Method Resources:**
  https://www.biointeractive.org/classroom-resources/scientific-method
- **Scribbr – Types of Experimental Design:**
  https://www.scribbr.com/methodology/experimental-design/
- **Journal of Emerging Investigators (JEI):**
  https://www.emerginginvestigators.org/
- **Khan Academy – Controlled Experiments:**
  https://www.khanacademy.org/science/ap-biology/cellular-energetics/experimental-design/v/controlled-experiments