For each of the research scenarios below, identify the most appropriate statistical test or method be prepared to discuss it with the class.

1. Sex-Chromosome Gene Expression Bias

A student compares the proportion of *X-linked genes* that show male-biased expression in a species of beetle. Based on prior theory, 50% of X-linked genes are expected to be unbiased. In a dataset of 120 X-linked genes, 78 appear male-biased.

2. Habitat Preference in a Sky-Island Beetle

You survey three habitat types (oak, juniper, grassland) on Mount Graham and record the number of Chrysina beetles found in each habitat. You want to test whether beetles are distributed equally across the three habitats.

3. Stress Hormone Levels Under Heat Exposure

You measure plasma cortisol levels (ng/mL) from *C. elegans* cultures held at 25°C vs 30°C for 48 hours (n = 10 replicates per treatment). You want to know if mean cortisol level differs between the two temperatures.

4. Chromosome Number vs. Body Size Across Species

Across 42 related beetle species, you record the haploid chromosome number and mean adult body length. You want to know whether body size increases or decreases with chromosome number.

5. Predicting Probability of Mating Success

Across 250 experimental hybridization attempts, you record whether each trial produced successful mating (1) or no mating (0) along with the genetic divergence (My) between species pairs. You want to estimate how mating success changes with divergence.

6. Testing Whether Chromosome Fusion Rates Could Arise by Chance

In a clade of 90 species, you observe 11 independent X–autosome fusion events. You want to know whether this number is unusually high given that simulations under your null model predict fusion rates ranging from 4–10 events, depending on random drift and branch lengths.

For each of the research scenarios below, identify the most appropriate statistical test or method be prepared to discuss it with the class.

Dataset 1: The "Essential" X

You are investigating the "insulation" hypothesis in Tribolium castaneum. You have identified a set of 40 genes known to be essential for male fertility. You want to know if these genes are significantly under-represented on the X chromosome compared to the autosomes. You have the following data:

1. The specific genomic coordinates of the 40 essential genes.
2. The total physical size (bp) and total gene count of the X chromosome vs. all autosomes.

You do not trust a standard parametric approximation because gene density varies wildly across the chromosomes.

Dataset 2: Retrotransposon Clines

You are studying a specific transposable element (TE) insertion in a population of weevils distributed along a latitudinal gradient. You want to determine if the probability of having the TE insertion changes with latitude. You sample 100 weevils from Southern Texas up to Northern Oklahoma.

- Variable 1: Latitude (Continuous).
- Variable 2: Presence or Absence of the TE insertion (Binary: 0 for absent, 1 for present).

Dataset 3: Genome Size and Development

There is a long-standing hypothesis that larger genomes lead to slower cell division, and consequently, longer development times. You have collected data for 25 different species of Carabid beetles.

- Variable 1: C-value (Genome size in picograms, Continuous).
- Variable 2: Larval development time (Days from hatch to pupation, Continuous).

You want to see if genome size significantly predicts development time.

Dataset 4: Meiotic Drive in a Single Cross

You suspect a "selfish" sex chromosome system is operating in a specific line of darkling beetles, causing a distortion in the sex ratio. You set up a single pair cross and collect the offspring.

- Data: You count the offspring and find 18 Females and 4 Males.
- Expectation: Under Mendelian inheritance, you expect a 0.5 probability of females.

Dataset 5: Horn Length Differences

You are studying sexual dimorphism in a Scarab beetle species. You want to know if there is a difference in horn length between males reared on high-nutrient dung versus males reared on low-nutrient dung.

- Group A: 30 Males (High Nutrient).
- Group B: 30 Males (Low Nutrient).
- Measurement: Horn length in mm (Continuous).

Dataset 6: Host Plant Preference

You want to know if two closely related species of Chrysomelid beetles segregate by host plant. You go to a field site where both Plant A and Plant B are present. You count the number of individuals of Beetle Species 1 and Beetle Species 2 found on each plant type. You want to test if the choice of host plant is independent of the beetle species.