Teacher Instructions for Extension Using the 5E Model for Punnett Squares and Chi-Squares

Standards:

- **HS-LS3-1**: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits.
- **HS-LS3-3**: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Objectives:

Students will be able to:

- Use Punnett squares to predict possible offspring genotypes and phenotypes from GloFish crosses.
- Explain how dominant, recessive, and incompletely dominant traits affect glow color.
- Use chi-square analysis to evaluate whether observed results support a genetic hypothesis.
- Understand gene transfer between species through genetic engineering.

Materials:

- Student worksheet (you provided)
- Colored pencils or highlighters
- Blacklight image of GloFish (optional visual support)
- Chi-square reference table
- Calculators

Vocabulary:

- Gene
- Allele
- Dominant / Recessive
- Incomplete dominance
- Genotype / Phenotype
- Punnett square
- Genetic engineering
- Chi-square analysis

Engage (Bell Ringer):

Prompt:
"Some GloFish glow red, yellow, or green—but others don't glow at all. What could be causing this difference? How might these traits be inherited?"

Students share out ideas briefly and are introduced to genetic engineering and reminded about how the GloFish were created.

Explore (Activity - Part 1):

Predicting Inheritance with Punnett Squares

1. Students work through guided crosses:
    - Red × Yellow (all offspring = orange)
    - Red × Wildtype (expected 50% red, 50% wildtype)
    - Red × Orange (more complex ratio)
2. Students complete Punnett squares for each, then:
    - Identify genotypes and phenotypes
    - Calculate phenotype percentages

Class Discussion:
Highlight incomplete dominance (e.g., red + yellow = orange).

Explain (Mini-Lesson):

Review:

- Dominant vs. recessive traits
- Incomplete dominance
- How genetic switches determine glow color
- Importance of genotype in predicting inheritance

Elaborate (Part 2 - Data Analysis):

Chi-Square Test

1. Students analyze a cross between a **blue GloFish and wildtype**:
    - 7 blue, 6 grey offspring
    - Predict expected results assuming dominance
    - Use the chi-square formula to compare observed vs. expected
    - Calculate df and look up p-value
2. Students answer conclusion questions:
    - Does the data support their hypothesis?
    - Is blue glow likely dominant or recessive?
    - Alternate explanations?

Evaluate (Assessment):

- Completion and accuracy of Punnett squares and phenotype predictions
- Chi-square calculation and interpretation
- Exit Ticket:
    - What's one trait you'd genetically engineer into an organism and why?
    - How do scientists use data to test genetic predictions?

Extensions & Differentiation:

For Advanced Learners:

- Have students simulate additional crosses using 2 or 3 glow genes (tri-hybrid crosses)
- Introduce real-world CRISPR or transgenic examples

For Support/ELL Students:

- Use color-coded cards for alleles
- Offer sentence stems (e.g., "The offspring will be ___ because...")
- Pair with a peer for the chi-square portion

Optional Visual Aid:

Include projected images or a short video of GloFish under UV light to spark interest and provide context.