Name: **Date:** **Section:**

Chi-Square Activity: Statistical Analysis in Biology

Testing Genetic Predictions with Statistics

Phase 1: ENGAGE (5 minutes)

Getting Started:

Open peebedu.com and navigate to Chi-Square Test Practice

Click through the introduction to learn about the chi-square test.

The Challenge:

You're a genetics researcher studying inheritance patterns. Sometimes observed data doesn't perfectly match predictions. How do you know if the difference matters? _____

Initial Question:

If you expect a 3:1 ratio and observe 78:22, is this "close enough"? _____

Key Understanding:

The chi-square test helps us decide if differences are due to random chance or something important!

Phase 2: EXPLORE (18 minutes)

Investigation 1: Your First Test

The simulation presents a random dataset. Examine it carefully.

Before Testing:

1. What type of cross is shown? _____

2. Do the numbers look close? Yes / No _____

Using the Simulation:

1. Follow the prompts to enter expected values
2. Let the simulation calculate χ^2
3. Record:

- Critical value: _____
- Conclusion: Accept / Reject the hypothesis

What This Means:

If accepted, the data _____ the expected pattern.

If rejected, something _____ is happening.

Investigation 2: Exploring Patterns

Click "New Problem" or try different scenarios.

Compare Different Datasets:

For each scenario you try:

Pattern Discovery:

- When is χ^2 usually LOW? _____

Investigation 3: Making Predictions

Before running each new test, predict:

- Will this data "pass" the test? _____

Then check if you were right!

Phase 3: EXPLAIN (15 minutes)

Making Sense of Chi-Square

1. **The Decision Process:**

Complete this flowchart: _____

Calculate χ^2 → Compare to critical value → If χ^2 is less → _____ hypothesis

→ If χ^2 is greater → _____ hypothesis

1. **What Results Tell Us:**

Match the result to its meaning:

- Small χ^2 value: _____

1. **Biological Explanations:**

When genetic ratios don't match expectations, consider:

- Genes might be _____ (on same chromosome)

- Environmental factors affecting _____

1. **Pattern Practice:**

Without calculating, predict if χ^2 will be high or low:

Scenario A: Expected 1:1, Observed 50:50

Prediction: χ^2 will be _____ because _____

Scenario B: Expected 1:1, Observed 75:25

Prediction: χ^2 will be _____ because _____

Phase 4: ELABORATE (10 minutes)

Applying Your Knowledge

1. **Design Challenge:**

Create data that would FAIL the chi-square test:

- Expected ratio: 3:1
- Why would this fail? _____

1. **Linked Genes Mystery:**

Two traits usually show 9:3:3:1 ratio but you observe 12:1:1:2

- What does the strange ratio suggest? _____

1. **Evolution in Action:**

A moth population was 50% light, 50% dark. After pollution, it's 20% light, 80% dark.

- Would χ^2 be high or low? _____

Data Detective:

Use the simulation to test different scenarios. Find one where:

- The hypothesis is rejected
- Explain why it failed: _____

Phase 5: EVALUATE (7 minutes)

Check Your Understanding

1. **Quick Check:**

$\chi^2 = 1.5$, Critical value = 3.84

This means: _____

[ ] Data matches prediction well

[ ] Data doesn't match prediction

[ ] Test didn't work

[ ] Need more information

1. **Interpret Results:**

A plant breeder expects 3:1 ratio but gets 60:40

The chi-square test shows $\chi^2 = 5.33$

This suggests: _____

[ ] The plants follow simple Mendelian genetics

[ ] Something else is affecting inheritance

[ ] The sample size is perfect

[ ] Random chance explains everything

1. **Real-World Application:**

You're studying antibiotic resistance in bacteria.

Expected ratio of resistant:sensitive is 1:3

Observed is 1:1

What would a high χ^2 value tell you? _____

What might be happening biologically? _____

1. **Concept Connection:**

Final Reflection:

Why do scientists need statistical tests instead of just "eyeballing" data? _____