Genetics – Scales

Teacher's Guide

1.0 Summary

The *Scales* activity follows the *Dihybrid Cross* core activity and is designed to last approximately 45-50 minutes.

2.0 Learning Goals

Driving Question: How do you investigate the inheritance of a new trait?

Scales is a puzzle designed to teach students to reason like geneticists. Students conduct breeding experiments and perform pedigree analyses to determine the mode of inheritance for a new trait.

Learning Goals

- Students will know that factors that determine biological inheritance pass from one generation to the next.
- Students will demonstrate their understanding of the basic principles of independent assortment in solving the puzzles.
- Students will know that the basic principles of Mendelian genetics can be used to calculate the probability of a trait being inherited.
- Students will demonstrate their understanding of the principle of probability by predicting the outcome of several genetic crosses throughout the *Scales* puzzle.
- Students will know that the alleles of different genes segregate independently of one another.
- Students will know that chromosomes assort independently, not individual genes.

Additional Teacher Background

This activity requires students to use the models and reasoning that they have learned in the previous activities such as *Monohybrid*, *Dihybrid Crosses and X-Linkage*. These puzzles are more advanced and require abstract reasoning. A student must be able to analyze specific data and form conclusions based on prior knowledge and the given factors of each problem within the puzzle.

The logic goes something like this:

If a cross with Ji-Yan, the scaly dragon, and a dragon without scales produces more than one scaly offspring, then scales must be a genetic trait.

If crossing two dragons without scales produces a dragon with scales, then having scales must be recessive, otherwise having scales is dominant.

Having scales is autosomal if:

- crossing parents without scales produces a daughter with scales or
- crossing a scaly female with a male without scales produces a son without scales.

3.0 Standards Alignment

Alignment to National Math and Science Standards (NCTM or NSES)

Objective	Standards
Students will learn strategies for investigating a new trait.	Students should demonstrate appropriate procedures, a knowledge base, and a conceptual understanding of scientific investigations.
Students will reason with probabilities to determine inheritance patterns.	Students should learn how to analyze evidence and data.
Student will be able to determine the modes of inheritance for a new trait.	The students will focus on questions that can be answered by using observational data, the knowledge base of science, and processes of reasoning.

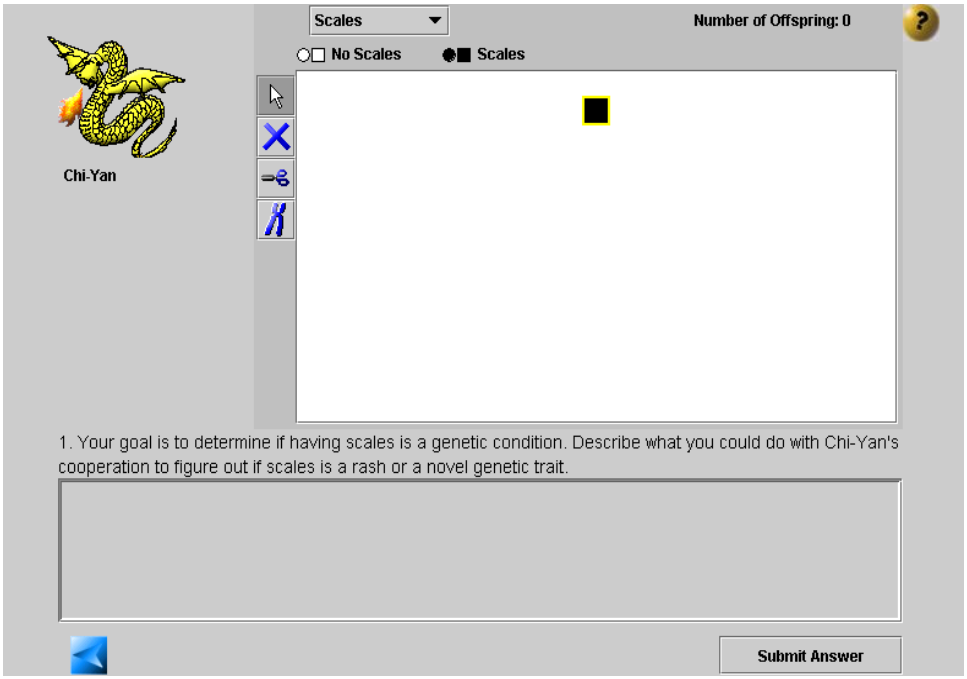
4.0 Activity Sections

In the *Scales* activity, students look for evidence that a previously unrecognized trait is genetic in origin. Then they must determine through breeding experiments whether the trait is dominant, recessive, or incompletely dominant; whether it is autosomal or sex-linked; and finally the chromosome of which it is part.

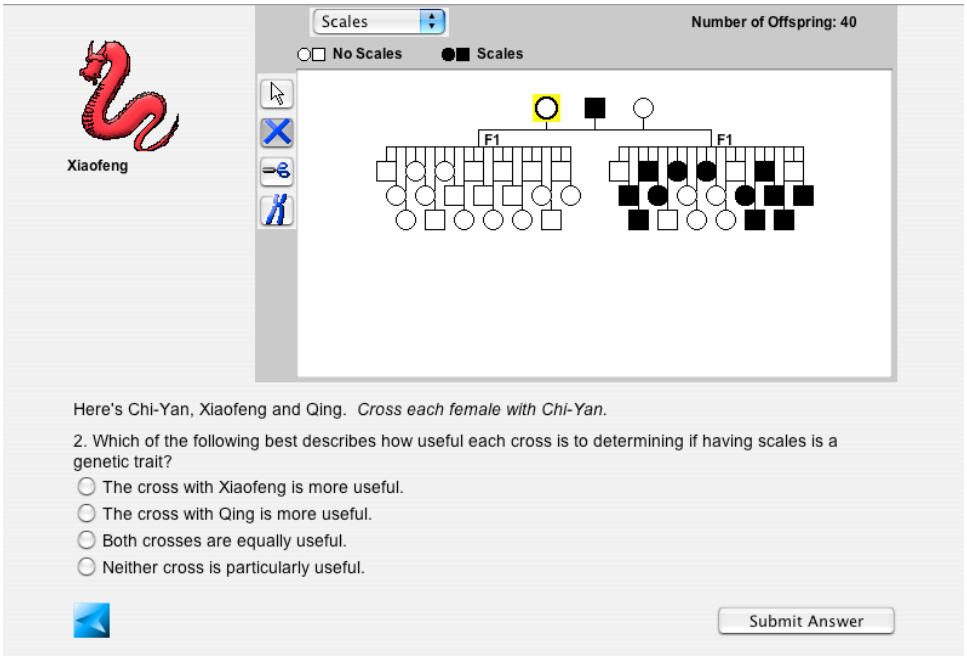
Step 1: Meet Chi-Yan, a dragon covered in scales.
Step 2: Cross Chi-Yan with two female dragons, (no scales).
Step 3: Analyze the pedigree chart and answer the questions.
Step 4: Make additional crosses as needed to determine if Scales is dominant or recessive.
Step 5: Follow the same procedure to determine whether the trait is autosomal or sex-linked.
Step 6. Cross Chi-Yan and a new female dragon in order to determine which chromosome contains the Scales gene.
Step 7: Complete the Punnett Squares to determine all possible traits of the offspring
Step 7: Take the Quiz

4.1 The Puzzle Begins

Students are asked how they will determine if having scales is a genetic trait, which it is.



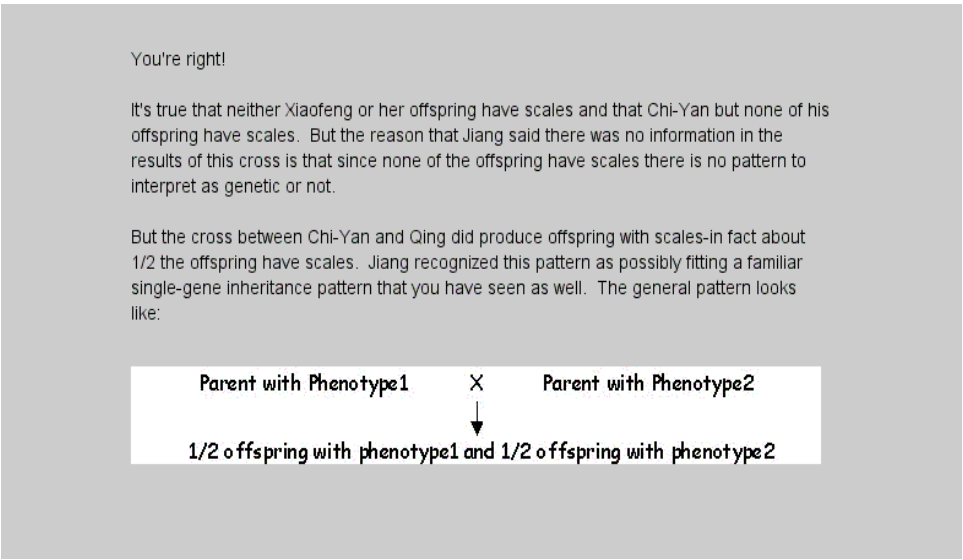
Is it genetic?



Cross the females with Chi-Yan and look at the offspring. Students are asked about their reasoning. Note: You can find the names of the females by using the Arrow tool to click on the circle in the pedigree.

4.2 Determine a Pattern

Students work to establish a pattern of inheritance for the trait of scales.



Single gene inheritance pattern

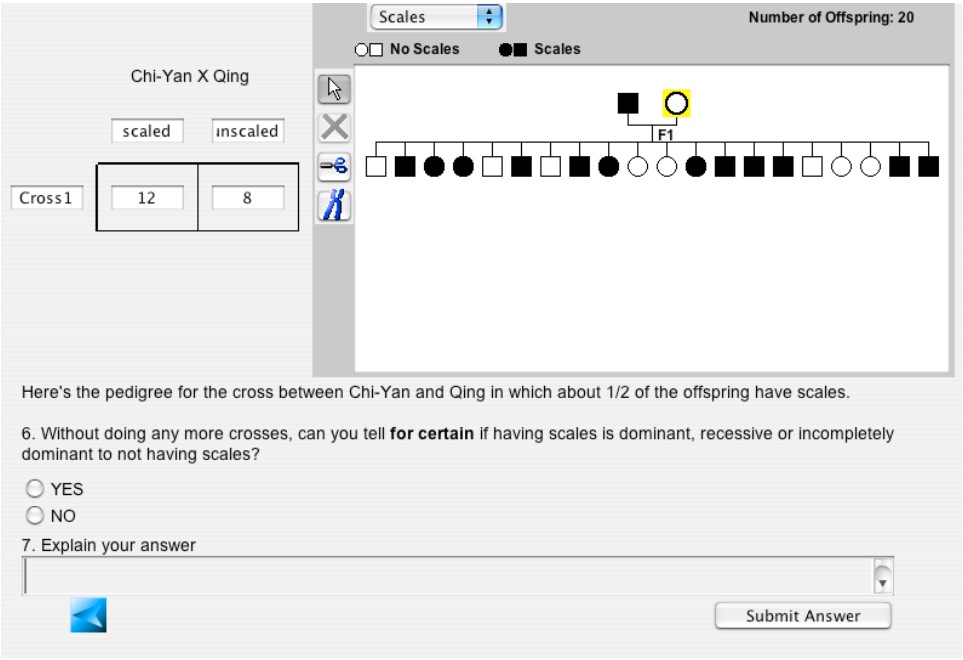
You and Jiang now have a hypothesis that Scales is a single-gene characteristic based on your understanding of single-gene inheritance patterns. Since this is the simplest hypothesis that fits the data, you decide to assume that it's "true" and that there is a single Scales gene. If the single-gene hypothesis isn't true, the results of additional crosses you make will not turn out the way the hypothesis predicts.

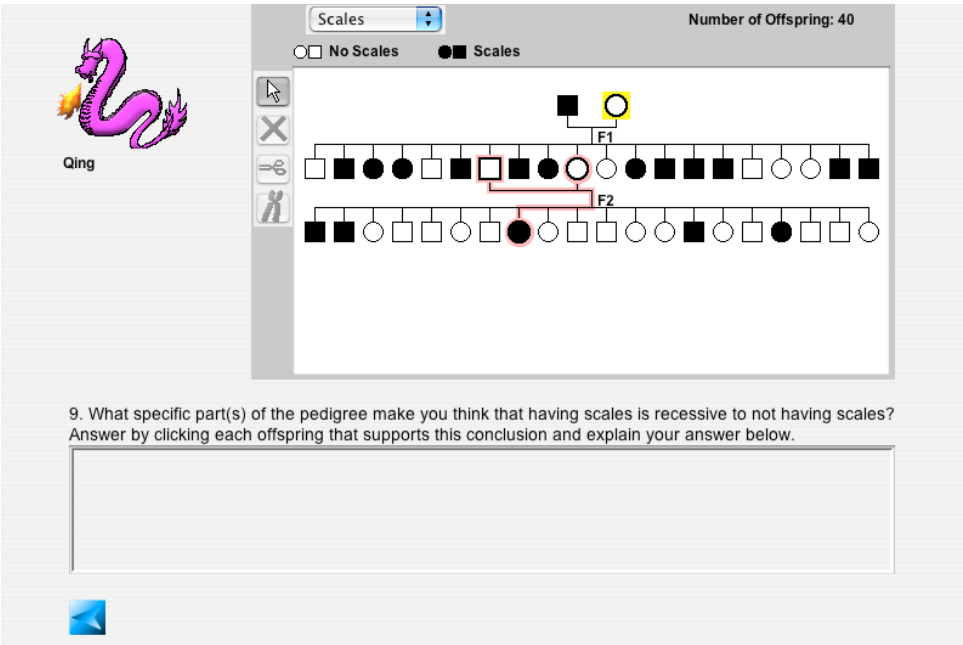
Given the single-gene hypothesis, the next step is to figure out how the proposed Scales gene is inherited. In other words, you need to figure out

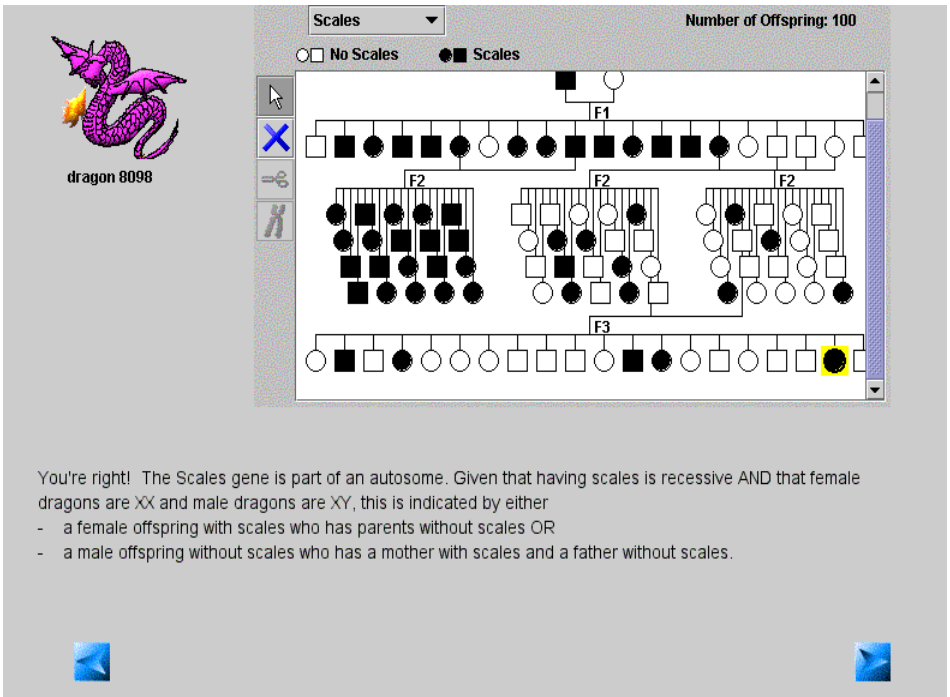
- if having scales is dominant, recessive or incompletely dominant to not having scales and
- if the Scales gene is part of an autosome (autosomal), the X chromosome (X-linked) or the Y chromosome (Y-linked)?

Single Gene Model Directions

As students work their way through the breeding experiments needed to answer these questions, they are asked questions about what they know and why.



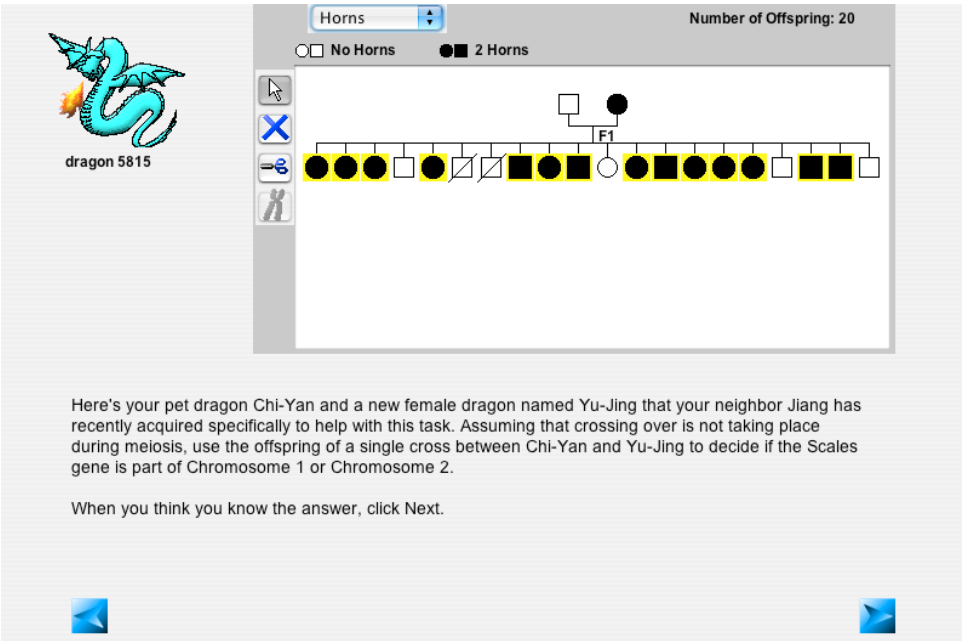




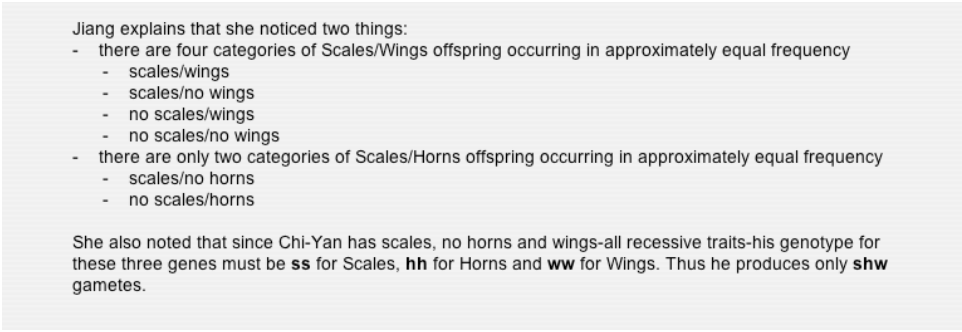
Scales are a recessive, autosomal trait.

4.3 Where is the gene for scales located?

Students must compare the patterns of offspring with scales to those of the other characteristics. If the Scales pattern matches another characteristic, then the gene for Scales is most likely on the same chromosome.

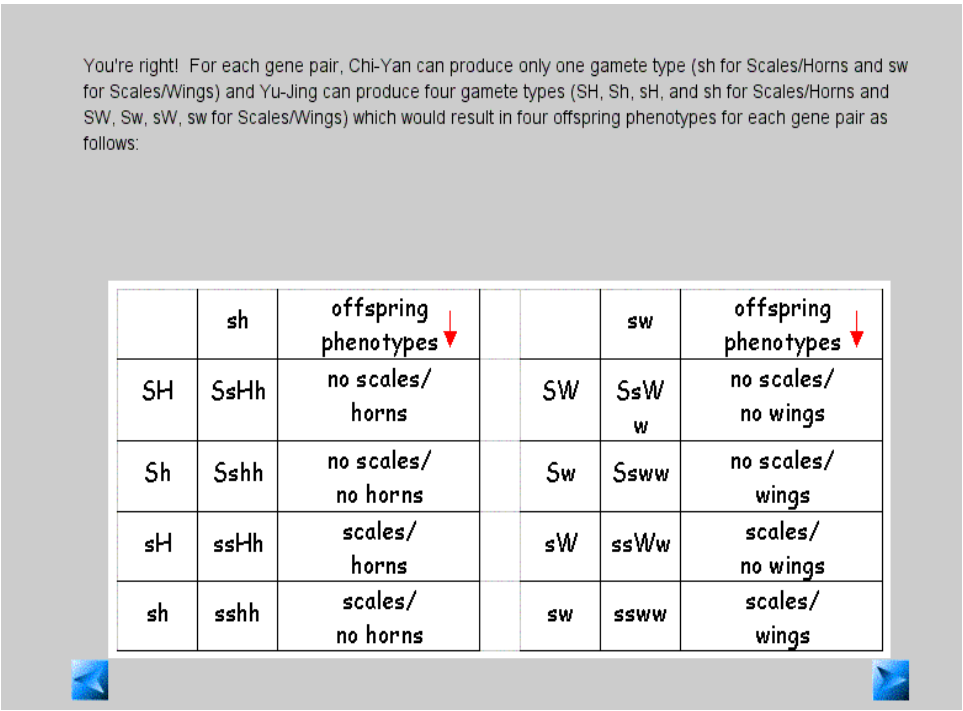


Use the pull down menu to view the pedigrees of different traits. Using the Arrow tool to select offspring with specific traits helps to make sense of the patterns.



Explanation of the evidence that Scales are part of Chromosome 1.

Students then work through some dihybrid reasoning about crossing a different female with Chi-Yan.



Possible phenotypes from crossing Chi-Yan and Yu-Jing

The assessment at the end of the activity involves Juvenile Parkinson's Disease, linked to a recessive allele on a single gene.

5.0 Student Reports

Your students' work with Scales is logged and viewable on the MAC Project Web Portal at http://mac.concord.org. For each student, you can view a report containing questions and answers.

Offering less guidance, *Plates* is a similar puzzle that involves an incompletely dominant, X-linked trait.