Science Assessment System
Through Course Task

Hybrid Chickens

Grade Level:
9, 10, 11, 12

Phenomena:
Genetics of Hybrid Chickens

Science & Engineering Practices:
Analyzing and Interpreting Data
Engaging in Argument from Evidence

Crosscutting Concepts:
Stability and Change

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in collaboration with teachers from Kentucky schools and districts.

Preparing to implement Through Course Tasks in the Classroom

What is a TCT?

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal is for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

How do I facilitate a Through Course Task (TCT)?

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations.
   Success criteria include:
   - What is this task designed to get evidence of?
   - What is the task asking the students to do?
   - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:**
  - The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

    - Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
        - **Science and Engineering Practices**
        - *Disciplinary Core Ideas*
        - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

Hybrid Chickens Task Annotation

After **analyzing and interpreting the data** about *hybrid chicken characteristics*, **develop an argument** about *whether the hybrid chicken population of Kauai is more genetically similar to their domesticated ancestors or their red jungle fowl ancestors* **using evidence and reasoning** from the patterns observed in the data about change in the population over time.

Phenomenon within the task

The feral chickens in Kauai, Hawaii, are “hybrids” that have resulted from the interbreeding of wild red jungle fowl chickens and domesticated European chickens that have escaped captivity. These hybrid chickens have traits from both lineage; some traits are visible and others are not. This task asks students to explore whether the hybrid chickens are more genetically similar to one parent population over the other based on provided data from studies of the chickens.

How the phenomenon relates to DCI

- This task relates to LS3.A by looking at mitochondrial DNA from hybrid chickens.
- Variation in traits can be generated via sexual reproduction (LS3.B).
- The task also connects to LS4.A by comparing DNA and anatomical evidence to determine relatedness.

LS3.A: Inheritance of Traits

Grade 3: Many characteristics of organisms are inherited from their parents.

High School: Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species’ characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)

LS3.B: Variation of Traits

Grade 3: Offspring acquire a mix of traits from their biological parents. Different organisms vary in how they look and function because they have different inherited information.

Grade 8: Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.

High School: In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)

Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)

LS4.A: Evidence of Common Ancestry and Diversity

High School: Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.

What information/data will students use within this task?

Students are provided 4 sources of information in the task:

1) A short background text describing how the hybrid chickens of Kauai have developed from two parent populations - domesticated chickens (relatively recent arrivals) and red jungle fowl (estimated arrival ~7000 years ago). A third population (hybrids) has resulted due to interbreeding of these two populations. Students will need to “closely read” this text in order to get important information for the task.
2) The tabular results of a study of seasonal egg production for the hybrid population. Information from the introductory paragraph is relevant to interpreting the data in this table. Students are expected to analyze the data to support their argument.
3) The tabular results of a study indicating the physical characteristics of the hybrid population (leg color and plume comb height). Information from the introductory paragraph is relevant to interpreting the data in this table. Students are expected to analyze the data to support their argument.
4) An excerpt from *Conservation Magazine* provides additional information about the hybrid chickens, including the relationship between physical characteristics and their mitochondrial DNA, which is only passed to offspring by the mother. Students will need to “closely read” this paragraph to get important information for their argument.

In addition to the provided information, students will have to also have to access some basic background knowledge related to heredity and genetics:

- Students need to have the basic understanding that traits are passed from parents to offspring.
- Students need to understand that DNA determines traits, and similarities in DNA indicated relatedness. In this case, mitochondrial DNA data is given and is only passed via the mother to her offspring, although this level of specificity is not needed to engage with the task. It is simply the role of DNA in determining heredity that is needed at a general level.

Ideas for setting up the task with students

Students may be overwhelmed with analyzing the data so collaboration could be an effective strategy to support engagement and persistence. Collaboration will allow students to brainstorm and get clarification from their peers if there is any confusion or misconceptions. It might be helpful to guide students toward organizing and simplifying the mathematical data as an average (for comb height) or proportion (for leg color). This could be achieved by leading a think-pair-share on how they think data could be organized; explain how real scientists summarize or "boil down" their large amount of data into smaller, easier to understand pieces. Quantitative evidence will help bolster their argument, and there are various ways to analyze the data quantitatively. It is important to understand that students need to struggle with the data and this should not be taken away from them -- this is a skill to be developed. See below for an idea as to how this was presented in class using whiteboards.

Teachers may want to pre-plan questions to stimulate student thinking when analyzing the data. It is likely that some ways students analyze the data does not provide useful interpretation of the evidence. They should be encouraged not to give up, but rather think of different ways to look at the data. For example, if the proportion of hens with chicks is evaluated monthly, then the patterns appear random (no pattern?), but if the same data are evaluated seasonally (winter, spring, summer and fall) then the data seem more consistent. It can be debatable which analysis is "better" or more valid to support an argument, but evaluating data in different ways does provide a different perspective on the data. The point is that students should be encouraged to use information provided in the task when considering how to evaluate the results of numerical studies, and realize that looking at the same data from different mathematical or graphical representations might provide different insight. This is a skill that scientists develop with experience.

Intent of the Task for Assessment

The intention of this task was to get evidence of students' ability to analyze and interpret authentic, yet limited, data to develop an argument about how an animal population has changed genetically, using patterns and an understanding of change over time via genetic transfer as evidence and reasoning in their arguments.

The data provided (text and collected data) could be challenging to analyze and synthesize for many students, and engaging in this part of the task may best be done collaboratively with intentionally scaffolded teacher support. Thus, the evidence of student performance during this collaborative part of the task should be collected by the teacher as it occurs. Students would then use their collaboratively synthesized evidence to develop their arguments. The arguments should be developed independently, and students may want to continue to evaluate their data as they develop their arguments. The written arguments (supported with evidence of patterns in the data, scientific reasoning, as well as identifying any evidence that does not support their argument) are the student product for this task. Keep in mind that evidence of a student's ability to synthesize the data is somewhat implicit in the argument if data analysis was completed collaboratively.

The background knowledge about heredity and genetics needed to make sense of the task is not extensive and should not be a barrier to student engagement with the task. In fact, a teacher could ensure that all students have this basic understanding with a pre-task discussion in a different context. This would not compromise the evidence the task is intended to elicit.

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

Analyzing and interpreting data

- Compare and contrast various types of data sets to examine consistency of measurements and observations.
- Analyze data in order to make valid and reliable scientific claims.

Engaging in argument from evidence

- Construct a written argument based on data and evidence
- Make and defend a claim based on evidence from the natural world that reflects scientific knowledge

Stability and Change - Conditions that affect stability and factors that control rates of change are critical to elements to consider and understand.

- Much of science deals with constructing explanations of how things change and how they remain stable.

Patterns

- Mathematical representations are needed to identify some patterns.
- Empirical evidence is needed to identify patterns.

"Patterns figure prominently in the science and engineering practice of Analyzing and Interpreting Data. Recognizing patterns is a large part of working with data."

Success Criteria

- The student analyzes and interprets data from four sources, using mathematical representations as needed to identify patterns, to support synthesis of the information. (This criterion is gray text as this part of the task may be done collaboratively.)
- The student develops an argument by making a claim about how the hybrid chicken population is evolving (to which ancestor is the hybrid more genetically similar), and supporting that claim with their synthesized data analysis and scientific reasoning.
- The student identifies any evidence in the data that does not support their argument and explains whether this evidence weakens or has no effect on their argument and why.

Possible Student Responses

- Egg production was observed year round for hybrid chickens which is more similar to that of domesticated chickens.
- Grey and yellow leg color was observed almost evenly in the hybrid population. 11 of the 20 observed had yellow legs which matches the trait seen in domesticated chickens while 9 out of 20 had grey legs which resemble the legs of jungle fowl.
- Only 3 out of 20 hybrid chickens had combs measuring larger than 4 cm which is a trait seen in domesticated chickens to attract mates. 17 out 20 hybrid chickens had combs measuring less than 4 cm which is commonly seen in the jungle fowl.
- 20 out of 23 birds in the mitochondrial DNA study aligned with domesticated chickens and only 3 aligned with the jungle fowl.
- Three out of four pieces of data presented in this task support the idea of red jungle fowl evolving to be more like their domesticated ancestors'- egg production, leg color, mDNA. The leg color evidence was not as strong because the proportion of yellow to grey legs was almost even in the hybrid population. DNA evidence could be seen as a stronger piece of evidence as it will inevitably control the traits of the hybrid chickens.

Other information teacher teams might find useful when preparing to use this task in the TCT process

When implementing this task students, pairs of students were given whiteboards. They divided the whiteboard into four sections as there are four pieces of data with this task (egg production, leg color, comb height and mitochondrial DNA). For each piece of data they determined if it was suggesting the hybrid was more similar to the domesticated chicken or jungle fowl. This helped students organize their thoughts. Once each piece of data had been categorized as supporting domesticated or jungle fowl, student then wrote their responses- weighing pieces of evidence as they wrote. For example, some students may put more emphasis on DNA over leg color.

Extensions and/or other uses after the task is implemented

- Selected samples of student work (names removed) can be used to look for characteristics of stronger and weaker arguments. This analysis could be done in student groups. What patterns do students notice for arguments that they identify as "strong?"
- Selected samples of the analysis/synthesis of the task provided data could be analyzed by student groups. Which data presentations were useful and why? Could the data be analyzed in a different way to provide better evidence to support the argument?
- After a meaningful class discussion that may or may not include the two ideas above, the original student arguments could be returned so that students could improve their arguments, and identify their own areas of strength and weakness with respect to argumentation.
- This task may lead to conversations about evolution and natural selection as well as the concept of a species.

Through Course Task – Hybrid Chickens

Background Information: Domesticated chickens live on the island of Kauai, Hawaii. These chickens tend to have white feathers with yellow legs and feet. Domesticated chickens (European descent) have been bred by humans to produce eggs all year round. As a result of domesticated chickens being such prolific breeders, their combs have become quite large (greater than 4 cm) to attract mates.

Red junglefowl are a wild type of chicken that also live on the island of Kauai. They are estimated to have arrived approximately 7,000 years ago. These chickens are very colorful with green, black and red plumage with gray legs. They tend to lay fewer eggs than the domesticated chicken and only in the spring. The combs of the red junglefowl tend to be smaller than those of the domesticated chickens (3 cm or less).

The red junglefowl have recently started interbreeding with domesticated chickens that are considered feral. Feral refers to domesticated animals that have escaped into the wild. Kauai now has a third population of chickens that are considered to be hybrids, which are a mix of feral domesticated and the red jungle fowl.

The studies presented below show data collected on the hybrid chicken population of Kauai over one year.

Study 1: *Seasonal Egg Production of Hybrid Chickens in Kauai**

Note: If a hen is observed with chicks, this means she has recently mated and hatched eggs because chicks only stay with their mothers for a few weeks.

Month	Time of Year	Total number of hens observed	Hens that were observed with chicks
December	Winter	24	3
January	Winter	11	4
February	Winter	14	1
March	Spring	42	8
April	Spring	4	3
May	Spring	18	7
June	Summer	12	3
July	Summer	12	2
August	Summer	3	2
September	Fall	12	2
October	Fall	5	3
November	Fall	14	4

*Collected from Eben Gering from Michigan State University

Study 2: *Physical Characteristic of Hybrid Chickens in Kauai*

Chicken Number	Leg Color	Comb Height (cm)
1	Yellow	1.2
2	Yellow	.7
3	Gray	3.0
4	Yellow	5.6
5	Gray	1.4
6	Yellow	1.2
7	Yellow	2.3
8	Yellow	2.7
9	Gray	1.4
10	Gray	.9
11	Gray	.9
12	Gray	2.2
13	Yellow	4.3
14	Gray	2.8
15	Yellow	2.0
16	Yellow	2.2
17	Yellow	1.5
18	Yellow	4.8
19	Gray	1.6
20	Gray	1.5

Study 3: *Mitochondrial DNA for Hybrid Chickens on Kauai*

"In a study published last month in *Molecular Ecology*, researchers turned to DNA to illuminate the debate. They analyzed genetic material of 23 chickens from eight different areas of the island, and made notes on plumage, leg color, and vocalizations of 21 additional birds. While most of the birds on the island look like wild red junglefowl [...], genetics tells a more complex story. Analysis of the birds' mitochondrial DNA, which is inherited only from the mother, reveals that two different lineages of chickens are present on the island. The researchers identified 20 birds that belong to a tribe called haplogroup E, similar to European-derived domestic chickens. Only 3 belong to haplogroup D, allied with red junglefowl from Asia and similar to specimens from archaeological sites dating prior to European contact."

Gering, E., Johnsson, M., Willis, P., Getty, T., Wright, D. Mixed-ancestry and admixture in Kauai's feral chickens: invasion of domestic genes into ancient Red Junglefowl reservoirs. Mol Ecol. 2015; 24(9): 2112–24 (https://onlinelibrary.wiley.com/doi/abs/10.1111/mec.13096)

TASK: After analyzing and interpreting the data about hybrid chicken characteristics, develop an argument about whether the hybrid chicken population of Kauai is more genetically similar to their domesticated ancestors or their red jungle fowl ancestors using evidence and reasoning from the patterns observed in the data about change in the population over time. Identify any evidence in the data that does not support your argument and explain whether you think this evidence weakens or has no effect on your argument and why.