SCIENCE TASK ANNOTATION

ANNOTATION KEY

EQUITY
Supporting a wide range of diverse students.

SCENARIOS
Information provided to elicit performances.

SEPs
Opportunities to demonstrate science and engineering practices.

DCIs
Opportunities to demonstrate understanding of disciplinary core ideas.

CCCs
Opportunities to demonstrate understanding of crosscutting concepts.

SENSE-MAKING
Opportunities for reasoning about phenomena and problems.

ASSESSMENT PURPOSE
Highlights how the task features connect to intended assessment use.

The scenario fits coherently with the associated unit, helping ensure that students are cued to apply their learning from the unit in this context.

EQUITY **CONNECTION TO ASSESSMENT PURPOSE**

HUMAN ADAPTATION ON THE TIBETAN PLATEAU

Tibet is a mountainous region in Asia. Archeologists believe people currently living in Tibet moved there from lower elevations about 3,000 years ago. It is likely that when they first moved, they experienced the same changes to their bodies as people today do when they travel to the mountains: faster breathing and producing more blood cells to help them deliver more oxygen to their cells.

This aspect of the scenario provides students with the necessary background information to be able to understand and engage with the task. Although there are many words here and throughout the rest of the scenario, it is important that students be provided with this information to ensure the task is accessible and engaging to all students.

SCENARIOS **EQUITY**

Using humans as the animals discussed in the performance expectation and DCI helps make this task more relevant and engaging for students--and helps make the relevance of the the science learning experiences clear as well.

SCENARIOS **EQUITY**

Tibetans today have bigger blood vessels than people who live at lower elevations which allows their blood to circulate easier (there is variation of blood vessel size in the population). Although human bodies can produce more red blood cells when we travel from low to high elevations, we can't make our blood vessels bigger. In Tibet, babies born to mothers with bigger blood vessels are more likely to survive than babies born to mothers with smaller blood vessels.

This describes a specific set of observations connected to 2 specific phenomena: 1) Tibetans today have bigger blood vessels than people who live at lower elevations, and 2) babies born to mothers with bigger vessels are more likely to survive than those born to mothers with smaller blood vessels. The specificity included here helps 1) ensure that students will be making sense of phenomena, and 2) require sense-making, because students will need to connect their understanding to this specific instance.

SCENARIOS **SENSE-MAKING**

1

HUMAN ADAPTATION ON THE TIBETAN PLATEAU (CONTINUED)

The table below summarizes differences between people who travel to the mountains and Tibetans whose ancestors have lived in the mountains for thousands of years.

Although presentation of information in a table form is a helpful way to reduce reading load and present complex information clearly, the task is very text-dependent and may disadvantage some students who struggle with reading and writing in English.

EQUITY

	People visiting the mountains	**Tibetans living at high elevations**
Resting heart rate	100 beats per minute (compared to 60 beats at sea level)	78 beats per minute
Speed of breathing	High	High
Blood cell production	Elevated when visiting	Similar rates as people who live at sea level

1. Using the information in the table about *people visiting the mountains* and *Tibetans living at high elevations*, construct an explanation for why, over many generations, the people of Tibet today are physiologically different from people living at lower elevations.

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Successfully responding to this question requires that students 1) analyze straightforward patterns of information in the chart ,and 2) connect that analysis to their understanding of how natural selection/adaptation leads to populations change over time to make sense of why people of Tibet today are physiologically different from people living at lower elevations. This most closely connects with:

- part of the 6-8 SEP#6 element "apply scientific ideas, principles, and/or evidence to construct...an explanation for real-world phenomena...". This is most closely aligned to the 6-8 expectations, rather than 9-12, because students are using a single source of evidence.

- part of the MS DCI element LS4.C "adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes." This is more closely connected to the MS DCI than related HS DCIs because student explanations need not explicitly include information about variation in genetic information and the expression of that genetic information (HS.LS4.B) or evolution as the consequence of the interaction of several factors (HS.LS4.C). While this explanation is clearly helping students progress toward the HS-level DCI understanding, the understanding elicited and required to respond to the question is at the MS level.

- While students are talking about cause and effect relationships (3-5 element "cause and effect relationships are...used to explain change", this is highly overlapping with the cause and effect relationships embedded in the DCI, and it is not clear that students need to understand cause and effect relationships at levels of sophistication expected of MS/HS to respond to this question.

SENSE-MAKING **DCIs** **SEPs** **CCCs**

2. If conditions in Tibet remain stable for the next 1,000 years…

    a) predict how the proportion of individuals with big blood vessels living in the area will change (increase, decrease) and

    b) justify your predictions using evidence from the text.

I predict the proportion of Tibetans with big blood vessels will (increase/decrease) because

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I predict the proportion of Tibetans with small blood vessels will (increase/decrease) because

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- This question explicitly asks students to make visible the DCI understanding that was targeted in question 1, resulting in similar MS DCI alignment.
- While the question specifically asks students to predict outcomes, at best this is connected to the 3-5 cause and effect CCC element "cause and effect relationships are… used to explain change". It should be noted that this is an example of the CCC being implicit in the student response because of its overlap with the DCI, rather than explicitly required to respond to the question.
- When students make an evidence-based prediction and defend it with reasoning, they have to are using a part of SEPs #7 at the MS level. This doesn't quite reach the HS level because of the limited sophistication of the evidence needed.

DCIs **CCCs** **SEPs** **SENSE-MAKING**

This scaffolding may support student thinking by ensuring that all students make complete predictions that include predictions and evidence-based reasoning for both parts of the population.

DCIs **EQUITY**

3. Recent scientific studies have documented variation in the alleles of Tibetan women. The alleles being studied are indicated as A and B below and represent alternative versions of a trait that affects oxygen content in the blood of the women. High oxygen content is important for survival at high altitudes.

Describe two pieces of evidence from the table below that support the claim that allele B is affected by selection pressure.

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This is a nice example of the scenario coherently building to include more complex information as the task progresses, providing students with information as they need it. This helps the task itself grow coherently while also providing students with some cueing to help them attend to the most relevant aspects of the scenario as well as some on-ramping to new information.

DCIs **SEPs** **SENSE-MAKING**

This requires students to 1) know what a selection pressure and how that interacts with genetic and phenotypic variation, and use that understanding to 2) analyze and interpret a relatively simple data table to make sense of the provided claim. This elicits students understanding and use of:

- MS SEP #4 Analyzing and Interpreting Data element "analyze and interpret data to provide evidence for phenomena"

- Part of the MS SEP #7 Engaging in Argument from Evidence element "use...written argument supported by empirical evidence and scientific reasoning to support...[a claim].

- Part of the MS DCI element LS4.C "...traits that support successful survival and reproduction become more common; those that do not become less common..." While the table includes information that more clearly connects to the HS DCI (the confluence of genetic and phenotypic variation), students do not need to understand that both must exist for natural selection to act because the information is given—as a result, this question elicits MS level understanding of the DCIs.

SCENARIOS **EQUITY**

	Average for Mothers with "AA" genotype	Average for Mothers with "AB" genotype	Average for Mothers with "BB" genotype
Number of live births	4.45	4.76	4.62
Number of infant deaths	1.69	0.62	0.32
Proportion of live births that died during infancy	40%	10%	6%
Proportion of live births that died before 15 years of age	43%	11%	8%

[whole table] when students are analyzing and interpreting data, they must use their understanding of patterns to determine that 1) the number of live births is not dramatically different across the genotypes, but number and proportion of deaths varies substantially—as a result, student responses are an example of the 6-8 CCC element "patterns in...numerical relationships can provide information about natural...systems." However, it should be noted that while student responses might be an example of patterns, it isn't clear that students had to have a deep understanding of this concept to answer the question —more likely, they were just looking for patterns in the table (3-5 element).

CCCs   **SENSE-MAKING**

HUMAN ADAPTATION ON THE TIBETAN PLATEAU (CONTINUED)

4. What do you predict will happen to the relative frequency of Allele B in the population of Tibetan women over many generations? Explain why and cite data from the table above as evidence.

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Answering this question requires that students understand 1) that allele B confers an adaptive advantage because children born to mothers with the AB or BB genotype are more likely to survive infancy and childhood (and as a result, more of those children are able to survive and reproduce), 2) the B allele will be passed on to their more-likely-to-survive offspring, and 3) because offspring of AB and BB mothers are more likely to survive than AA and more than 50% of them will inherit a B allele, the frequency of the B allele among the population will increase. To do so, students need to connect evidence from the provided chart to reasoning based in scientific principles about adaptation and natural selection to make a reasoned and justified prediction. This is an example of students sense-making using SEPs and DCIs, with implicit CCC connections.

Specifically, this question elicits student understanding of:

- — 6-8 SEP #6 constructing explanations element "construct...a written argument that is supported by empirical evidence and scientific reasoning to support [a claim about] a phenomenon". This is closer to the 6-8 element than HS because students are using a single source of data.

- parts of the following DCIs:
    o MS.LS1.B "organisms...transfer their genetic information to their offspring"

    o MS. LS3.B "in sexually reproducing organisms, each parent contributes...genes acquired by the offspring. Individuals have two of each chromosome and hence 2 alleles of each gene, one acquired from each parent..."

    o Initial understanding of HS.LS4.B "natural selection occurs...if there is both variation in the genetic information of organisms in the population and variation in the expression of genetic information – that is, trait variation—that leads to differences in performance among individuals."

- the 3-5 CCC element "patterns can be used to make predictions" [note: there is limited data driving the observed patterns, keeping this at a lower level of sophistication—however, using patterns as evidence for prediction is necessary to respond to this question.]

Finally, it is important to note that this question elicits deep student understanding, but this is not supported by the scoring guidance—indeed, the scoring guidance does not actually require students to answer the question [discusses "people with allele B will survive" without addressing allele frequency explicitly].

SEPs **CCCs** **DCIs** **SENSE-MAKING**