Supplemental Material

CBE—Life Sciences Education

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Cell Membrane Interview Protocol

Thank student for participating
Introduce yourself as a student (or researcher) working with a research team interested in developing and improving biology assessments.

Explain that you

- *will not indicate whether the student's answer to a particular question during the interview is right or wrong,*
- *emphasize that we just want to understand the student's thinking*
- *note that if the student has any questions about content and the end, you can definitely go over it with him/her.*

Briefly review consent form and ask again for permission to record.
Have participant sign a copy of the consent form which you will keep. Give participant a copy for their records.

Additional Notes/Reminders for the whole interview

- If you don't understand, ask the student to elaborate
- Make sure the student knows what you are asking
- Ask students to go deeper to get a better idea of conceptions they have
- See if the students have any questions
- Remember that an acceptable probe is always "Why?"

Step 1: Answering the Origin of Alleles Questions

Each student will be prompted separately to answer the "origin" and the "spread" portions of the Origin of Alleles question and given time to answer aloud.

Script: "Here is a question related to the material you've been studying in class. Please read the question and answer it to the best of your ability. Feel free to use the pencil/pen and paper provided as your work through the question. As you formulate your answer, talk me through how you answered this question.

There are two parts to the question: Please talk through your answer to the first part, and then the second part."

<u>Origin of Alleles Stem:</u>

How would you explain the origin and spread of a new trait in a population. Enter your explanations in the boxes below, but limit "origin" to one box and "spread" in the other.

Have the students first talk through the "origin" part, and then the "spread" part

<u>Considerations for BOTH the "Origin" part AND the "Spread" part:</u>

- Explanations that students may give, based on the current version of Hailey Cockerill's Origin of Alleles Rubric (rubric bin names in purple). The origin and/or spread of the allele:
    - Is Random
    - Is a Mutation
    - Is Natural Selection
    - May be a Dominant or Recessive Allele
    - Is due to a Sexual Mechanism
    - Is due to a Sexual Mechanism
    - Is due to Genetic Drift
    - Is due to a Small Population
    - Is due to Speciation
    - Is due to Geography/Geographic features (such as the population being isolated by an island, mountains, etc.)
- If the students mention any of the above rubric bins, ask them to explain further.

- If students mention "natural selection", "sexual selection", or "evolution", ask them to explain these terms
    - When students talk about "natural selection", we would ideally like students to mention both *advantageous traits* AND *increased reproduction*. If students only mention one of these, probe them for the additional component WITHOUT leading them
        - § If the student mentions "advantageous", "beneficial", or similar synonyms ask them to explain further and/or provide examples
    - If they mention "fitness" or "increased fitness", ask them to define the terms

- [ADDED AFTER FIRST INTERVIEW] Ask the student how natural selection relates to the origin and spread of new traits, if at all?

Step 2: Stem Probes

We will return to your response shortly.

Let's talk a bit about the question itself. What are the parts of the question that you felt are ***most relevant*** *to your attempts to answer it?*

- Ask participants to highlight them in yellow or orange

*Are you having any **problems** with any parts of the question? Are there any parts that are **confusing**?*

- Ask participants to circle them

*Are there any parts that you feel are unnecessary, that is, parts that you consider **irrelevant** to the question that you can simply ignore?*

- Ask participants to ~~Strikethrough~~ these items.
- If students circle parts of the question, ask them to propose another wording of the question in their own words.

Is there any way you would rephrase the question to make it more clear?

Step 3: Content Probes

NOTE: THE FOLLOWING TEXT AND PROBE 1) IN THIS SECTION ARE SKIPPED IF THE STUDENT DID NOT PREVIOUSLY ANSWER THE "ORIGIN OF ALLELES" QUESTION FOR HOMEWORK

Thanks! Let's now talk more about your answers.

1) What changes, if any, do you notice in your written and verbal answers. Please describe why your explanations for the question differed?

2) Have them follow up and define key words they used in their answer
    a. Ask students to elaborate and explain the words they use to confirm that they know what they are saying rather than just regurgitating key words

Step 4: Student habits

How and when do you normally study for this class? How many hours per week?
How often do you attend this class lecture?
How did you prepare for exams?
Year in school?
Major?
Semester and name of last biology class taken?

Thank you for taking the time to participate in this interview. Your responses will help us improve biology assessments for future classes.

Pay the student for his/her time, have she/he sign the receipt