Big Science, Big Data, Big Impact!

Overview:
Students will utilize *The Progress of Science Timeline* to learn more about several "Big Science Projects" that have been conducted in the last thirty years. Students will then evaluate common evidence types generated by these projects and determine to which project they belong. Teachers will then examine how these pieces of evidence contribute to our understanding of structure, function and variation present within the TAS2R38 gene resulting in various sensitivities to bitter taste molecules.

2015 Alabama Course of Study: Science Alignment
To obtain, evaluate and communicate information that explains how advancements in genetic technology (Human Genome Project, Encyclopedia of DNA Elements (ENCODE) project, 1000 Genomes Project) have contributed to our understanding as to how a genetic change at the DNA level may affect proteins and in turn influence the appearance of traits. (*AL COS 3b)*

Materials:
Big Science Big Data Student Worksheet
Access to computers (*timeline.hudsonalpha.org*)
Big Science Big Data Educator Slides

Estimated Time Frame:
1 class period for introduction and timeline work
1 class period for evidence examination

Instructor Protocol:

1. Place the following statement on a screen visible to all students.
   A DNA change is identified at position 141972906 on chromosome 7. What evidence would determine if this DNA change leads to increased sensitivity to the taste of bitter foods like Brussels sprouts?
2. Allow students 1-2 minutes to generate a list of possible evidence they think would be needed.
3. Then have students work in pairs for 4 minutes to compare and discuss the lists of evidence they each came up with.
   Teacher Note: How are they similar? Can they combine the similar ones into one umbrella statement? Are there pieces missing?
4. Lead the students to create a class-wide listing of all of the evidence types.
   Teacher Note: While the evidence statements are being gathered from the class, as similar evidence statements are given, condense/revise the statement to reflect the whole thought being expressed into a singular encompassing statement.
   (refer to the 6 types of evidence)
5. Once the list is generated, ask clarifying questions and address student misconceptions surrounding evidence pieces given.
6. Provide a summary list of the accepted evidence pieces.
7. Lead a conversation discussing that researchers came up with the same types of evidence when faced with a question similar to this.
8. Highlight where the students list is "on target" with the scientist list.
9. Prompt students when possible to get the rest of the evidence types listed on the worksheet.
10. Distribute the Big Science, Big Data worksheet.
11. Students should list additional evidence types they brainstormed in the blank box.
12. Direct students to the Progress of Science Timeline (timeline.hudsonalpha.org) for exploration of the "Big Science Projects." Students write a brief description of each project, based on information gleaned from the Timeline. They then review each evidence type and determine which project likely generated the data associated with that evidence. The evidence type is written on the corresponding project line.
13. After students have completed placing all pieces of evidence discuss the following concerning each of the "Big Science Projects": *(see Teacher Key for answers)*
    a) What was/is the project?
    b) What types of evidence could you obtain from the project?
    c) Would that information help answer our original question? If so, how?

14. Following this discussion wrap up "the rest of the story." Describe the Big Science Projects and how the data from those projects provides insight into the impact of our DNA change in the TAS2R38 gene. A recommendation for this conversation is to establish the pattern of:
    a) Asking the students what evidence was obtained from the project? Allow response
    b) Telling the students what data researchers found.
    See summary table below. Slides to support this discussion are available.

Summary of evidence and data findings as discussed in slides:

Project	Evidence type	Data
Human Genome Project	Occurs within a gene	TAS2R38 gene; Chromosome 7
ENCODE	Alters the amount of RNA and/or protein produced	Identified transcription factors that bind at the TAS2R38 promoter
Human Genome Project	Alters the sequence of amino acids	DNA change identified G->A which results in amino acid change from ala -> val
Hap Map	Is somewhat common across the population, is present in people who can taste bitter, and absent in people who cannot	Somewhat common across 4 major global populations studied. Three DNA changes identified in gene of interest.
1000 Genomes Project	Is somewhat common across the population	Somewhat common across 26 global populations studied. 21 DNA changes identified in gene of interest

15. Help the students to recognize the "big science" projects we have discussed brought us a long way in determining the answer to our original question, but further work was required to determine how that DNA change resulted in "increased sensitivity to bitter taste."
    Use the remaining slides to discuss the research that brought us the rest of the way to answering our question.
16. In conclusion:
    A DNA change is identified at position 141972906 on chromosome 7. Does this DNA change lead to increased sensitivity to the taste of bitter foods like Brussels sprouts?
    This position is involved with increased sensitivity to the taste of bitter foods. The DNA change discussed at this site results in an ala-> val substitution and a decreased sensitivity to taste bitter.