Planning a Three-Dimensional Science Lesson

Based on template by Jeremy Peacock, Northeast Georgia RESA

Lesson to Redesign or Plan: Briefly describe a favorite or upcoming lesson that you would like to redesign or plan.

*Note, this is not a previously uploaded lesson, but one that I have been thinking about in order to show students that everything is related and can lead to a more complex system across units. I have adapted an old lesson plan that I use to add cystic fibrosis.

When talking about structure and function of macromolecules, I would like to add an illustrative example that we can use not only in this unit, but it could be overlapping into several future units. Cystic fibrosis can be used as we talk about protein folding, mutations in DNA, as well as human disease and immune responses maintaining homeostasis.

In the past, I would have built a model showing beads of different colors and their folding based on hydrophillic and hydrophobic interactions. I would mention cystic fibrosis and showed them the amino acid difference. However, I think it would be much more impactful to build it and then keep using the cystic fibrosis disease as a example through water movement, mutations, etc.

Motivating Phenomenon: What phenomenon or motivating problem displays, requires, or exemplifies the concepts your lesson will cover?

I would like the overarching phenomenon to be what cystic fibrosis is and how the non-functioning protein is different from a functioning protein and how it affects humans. I would start by showing students the HHMI video on Cystic Fibrosis: Mechanism and Treatment. https://www.youtube.com/watch?v=6IbP1ASGv9w

Core Ideas: What are the Disciplinary Core Ideas you want to cover in this lesson?

HS-L.S.1-1. Structure and Function

Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Science & Engineering Practices:
List the specific elements of 1-2 practices the lesson will emphasize.

Students will use models to build the amino acid sequence for a functioning CTFR protein and a non-functioning protein using 3D Molecular Designs models.

Crosscutting Concepts:
List the specific elements of 1-2 crosscutting concepts the lesson will emphasize

Structure and Function
Amino acid properties will determine how the protein folds, determining its structure.

Cause and Effect

Students will engage in argument from evidence. Students will make claims answering the question, “Does the structure of a non-functioning CTFR protein differ from a functioning protein?” Students will gather evidence from their model and have to explain the molecular interactions of the amino acids. How will you support students in developing understandings about the practice(s)? Students will have already used the 3D molecular design models to illustrate protein folding based on hydrophobic and hydrophillic interactions. They will use this knowledge to help them look at the cystic fibrosis example. How will you engage students in applying the practices(s) to make sense of the phenomena and/or design solutions to problems? I will engage students by having them build mental models on paper that they can add to every time we learn another piece of the puzzle. They will have this to add to all year long. We will also focus on Ion Channel Research by Michael Welsh in the next unit and treatments into future units. https://www.hhmi.org/research/cystic-fibrosis-and-ion-channel-research	A change in amino acid sequence is the cause for the change in protein folding. A different sequence, like in the case of the CTFR gene produces a different structure, leading to a non-functioning protein and disease. How will you support students in developing understandings about the crosscutting concepts? I will have students compare and contrast the shape of a normal protein and a mutated protein to clearly see the difference. We will spiral this concept in the next unit on how this changes water flow when we get to the cell unit. We can use the example, the chloride ion issues and water movement or lack of movement that leads to a mucous build up and possible infection. How will you engage students in applying the crosscutting concept(s) to make sense of the phenomena and/or design solutions to problems? A fundamental concept is the structure and function of working proteins or nonworking proteins. We will use this structure = function theme throughout biology. Students will be able to analyze treatments looking at the concept of structure and function to discuss how treatments work to help patients with cystic fibrosis.
Integration: Explain how the three dimensions will work together to support students in making sense of the phenomena and/or in designing solutions to the problem. I think that students need the idea of what they need to know - the core idea that they are focusing on. They perform experiments or complete tasks that help students gather data about the core idea using scientific practices. The cross cutting concepts are then used so	

that students can make connections of scientific work across all science phenomena. All of these dimensions interwoven to help students make meaning of their learning and they help them understand science as being part of a complex system rather than an idea in isolation.

Teacher: C. High	**Subject: Biology**
Lesson: Two day plan	
Essential Questions: How does the amino acid sequence change lead to cystic fibrosis?	
Content Standard Alignment: (Framework Domain 1c: Setting Instructional Goals) *Outline the concept, knowledge, skill, or application students can demonstrate upon lesson completion. This may be the same as or very similar to the content standard; however, it could be narrower or perhaps broader. Objectives may be stated in the form of critical questions students should be able to answer.* Students will take information from a previous lesson on amino acid molecular interactions to build a normal protein and a cystic fibrosis protein on models to visually compare how the interactions will change the structure and therefore the function of the protein.	
Dailey Objective: (Framework Domain 1e: Designing Coherent Instruction) *How does this lesson support the unit goals / enduring understandings? How does this lesson build on the previous lesson in this instructional sequence? How does this lesson support the next lesson in this instructional sequence?* Today students will use previous knowledge to build functioning proteins and cystic fibrosis proteins to compare to one another.. Students will be able to: - fold their model based on amino acid properties. -explain how the difference in amino acids led to a different structure and ability to function.. -identify patterns in data to make claims answering the question "Does the structure of a non-functioning CTFR protein differ from a functioning protein?" -justify claims based on evidence and reasoning of data.	
Cross Cutting Concepts -Structure and Function -Cause and Effect **Science and Engineering Practices** -Students will use models	

-Engaging in Argument from Evidence

Methods and Instructional Strategies (Framework Domain 1a: Demonstrating Knowledge of Content and Pedagogy)

Cue Set: In table groups (groups of 4 people) : Students will be shown the video https://www.youtube.com/watch?v=6IbP1ASGv9w . From that video, they will then be asked to create a model on paper of what they saw in the video clip showing the difference between a functioning and non-functioning protein. We will build on this model in the next few units. Every time we learn a little more, we will add to the model using a different colored writing utensil.

Best Shot: The instructor will go over the lecture burst discussing primary, secondary, tertiary, and quaternary structure of proteins. The instructor will have a bead model (beads of different colors) to show how a "string" of amino acids will fold based on hydrophilic and hydrophobic interactions.

Guided Practice: The instructor will hand out 3D molecular design models to student groups. They will build a model together given the following sequence. **MET — ALA — VAL — PHE — LEU — LYS — THR — GLU — ASN — TRP** Students can use the student hand out to answer questions about the amino acids as they build them.

https://www.3dmoleculardesigns.com/3DMD-Files/AASK/PDFs/Student-Handouts/AASKStudentHandout1.pdf?

Independent Practice: Students are given one of two amino acid sequences (just a section) one normal and one with the mutation for cystic fibrosis. Students will build and fold each model in order to note similarities and differences at the level of molecular interaction. They will photograph how they folded them and compare them with other student groups. Students will make claims answering the question, "Does the structure of a non-functioning CTFR protein differ from a functioning protein?"

They will provide evidence from their model and use it to explain their reasoning on a piece of chart paper that they post in the room. (Including their picture of their model) Students will then do a gallery walk to look to see how other groups answered the question.

Formative Assessment: Students are asked to write a claim and evidence and reasoning to answer the question they have been working on by themselves. They can be used as an exit ticket.

Wrap Up Synthesis/Closure: The instructor will wrap up by showing similarities and differences between each group's gallery walk display before doing the CER formative assessment. Students will be given feedback on their responses and any misconceptions will be discussed with the class the following day.

Supplies: (Framework Domain 1d: Demonstrating Knowledge of Resources)
List all materials and resources required by teacher and/or students, include preparation or other special instructions; e.g. paper based materials such as textbooks, technology equipment, science equipment or supplies, art materials or equipment.

Projector, PPT, Student Sheet for amino acid starter kit, amino acid list for regular and mutated CTFR protein, chromebook to enter CER, chart paper, markers.

Anticipated Student Misconceptions:
Students will often answer the claim well, noting a difference in the evidence. The instructor needs to look for specific evidence, actual amino acid differences. Students will mostly not explain their reasoning well. The instructor may have to link the difference back to folding differences and therefore, structure/ function differences.

Concept Prerequisites: *List all key concepts and terminology necessary for students to understand the concepts as well as meet the standards, goals and objectives of the lesson.*

Students will need to understand that amino acid chains make proteins.

Differentiation According to Student Needs: (Framework Domain 1b: Demonstrating Knowledge of Students) Address diverse student needs including students with an IEP or 504, cultural or linguistic needs.

For students with disabilities, the questions are seen visually and stated orally during instruction. All students are given the notes in the learning management system. Students with disabilities are provided typed copies.. The lecture is also posted on Edmodo for students to review at their own pace.