EDU 603 Final Project: Tenth Grade DNA and Protein Synthesis Unit

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**Part I: Statement of Educational Philosophy**

    The role of an effective science education is to engage the learner in active science by promoting problem solving and critical thinking skills. In doing so, scientific knowledge can be expanded by addressing learners’ misconceptions to their existing knowledge. The potential exists to provide students with improved understanding of the natural world and the skills necessary to succeed in a global workforce.

    Understanding the process of individual learning has been at the center of many educational discussions. Theories and philosophies have emerged over the years that have provided a scientific basis to explain the best approach to instruction. These theories have provided teachers with the tools to make instruction less random and more effective by providing an understanding of the learners’ capacity to learn (Walker, 2014). Teachers should always consider various approaches to instruction. Students are unique and so is how they process information. Wiggins & McTighe (2005) state that, “[w]hen choosing instructional approaches, think about what is needed for learning, not just what is comfortable for teaching” (p. 242). One theory that encourages successful science education, as stated, is the Constructivist Theory.

The Constructivist philosophy of education focuses on the idea that learners are not passive recipients of knowledge but construct knowledge based on unique interactions and experiences within ones environment (Takaya, 2008). The role of the teacher is to act as a guide and the students’ role is to actively engage in the learning process. Recognizing that students bring unique experiences and knowledge with them to class, teachers can guide students through a new construction of knowledge.

    Inquiry is central to science education. Students are engaged in learning when they are actively engaged rather than passively listening to instruction. Developmental psychologist Jerome Bruner would argue that there is a big difference between learning about science and learning to be a scientist (Lombardi, 2007). Encouraging students to use inquiry to construct new knowledge in science will give them the opportunity to develop stronger problem solving and critical thinking skills. The U.S. Department of Education has deemed problem solving and critical thinking to be important 21st century skills; these skills are necessary for the success of students in today's economy (Hagler, 2016).

     Engaging in hands on activities, describing, explaining, and testing those explanations are ways learners begin to develop or construct their knowledge. As learners use existing experiences to construct new knowledge, teachers can identify and adjust for misconceptions (Taber, 2010). By utilizing strategies such as cooperative learning, open ended inquiry, and authentic assessments, students will be able to use prior knowledge in an environment that is less threatening (Colburn 2000).

    The constructivist theory aligns with the development of curriculum using the Universal Design for Learning (UDL) and Understanding by Design (UbD) models. Both the UDL and UbD models require teachers and students to work together to set instructional goals. The focus is on how to teach rather than what to teach (Wiggins & McTighe, 2005). Teachers should utilize these instructional models when developing units so that goals can be designed clearly and learning can be more effective. The UDL model suggests that teachers develop learning profiles to understand students’ strengths, weaknesses, and interests. Once teachers evaluate students using learning profiles, instructional goals are designed and stated clearly so that learners know what the desired results are. This can improve student understanding as well as encourage students to be active in their learning. In addition, learning profiles can encourage a positive classroom climate where students feel they are part of the learning process and validated in their learning style and interests. Learning pyramids also help teachers to identify and address misconceptions in student knowledge and improve understandings of the natural world.

    An important component of the UbD model is the development and use of essential questions. Essential questions used in teaching science can stimulate student thinking and inquiry.  The essential questions are meant to spark meaningful connections to student experiences and cause students to rethink what they know. In addition to promoting inquiry, essential questions provide teachers with another opportunity to address misconceptions in science, therefore improving scientific understanding. When students truly understand, they can transfer knowledge (Wiggins & McTighe, 2005).

       Finally, to be competitive in a global job market, today’s students must become comfortable with 21st century skills such as problem solving and critical thinking. The greater the student’s exposure to inquiry, active participation, and authentic assessments, the better prepared the student will be to put these skills into practice (Lombardi, 2007).

**Part II: Rationale of Curriculum**

This instructional unit is designed for 10th grade biology students. The demographics of the student population consists of:

* approximately one hundred 10th grade biology students (15-16 years old).
* 2 honors classes (50 students).
* 2 college prep classes of heterogeneously mixed student ability (50 students).

Within the heterogeneous population there will be ELL students, special education students (with IEP), and several students with various learning disabilities. The students in the class have all had 9th grade Integrated Science and have had experience with the scientific method and other basis science skills necessary for Biology. Students are familiar with writing lab reports and using rubrics to evaluate their work. In addition, the majority of students have attended the district middle school where they have had Life Science in 7th grade along with basic instruction on DNA. The topics of DNA and Protein Synthesis are considered the central dogma in biology and will be necessary for students to understand in order to transfer knowledge to other units as well as other disciplines.

    The curriculum development will consider backwards design in creating lessons. Backwards design is shifting the current thinking of curriculum development from identifying what to teach and how to teach it to developing learning objectives first. It provides a clear focus on objectives and what students need to know. This type of design can eliminate the two issues of traditional design which are aimless coverage of material in an attempt to cover everything required and use of engaging activities that do not have a clear connection to goals but merely engage students in the activity (Wiggins & McTighe, 2005). The unit design focused on aligning all components to the instructional goals.

    To differentiate instruction to meet the need of learners in class the three principles of the Universal Design for Learning Instructional Model will be implemented. The teacher will offer the student a variety of ways to cover instruction. For example, students will have materials to read, video’s to watch, and models to build in order to understand the concept of DNA as the molecule of heredity. Visual, Auditory, and Kinesthetic learners can benefit from one of these methods. In this unit, multiple tools for learning will be used to increase student understanding. Students will use technology to communicate lab results, rubrics to self-evaluate, small groups to research DNA discovery and to deliver presentations. Finally to improve student engagement, students will be given choices on how they present information for assessment. For example, with small group presentations students will have a choice of using PowerPoint, developing a play or skit, or a writing a report to present information (Wiggins & McTighe, 2005).

     In developing this unit plan, the distinctions between understanding, knowledge, and skills were important to consider. Understanding and knowledge are different from each other. Understanding is what the human mind does to make sense of and process information; knowledge is when evidence of understanding can be shown (Wiggins & McTighe, 2005).  For example, students will be able to understand that DNA is the heritable molecule and will demonstrate this understanding by answering the question “How do we know what we know?” Students will be able to explain using historical experiments, how scientists discovered that DNA was the heritable molecule. Students will also understand that the structure of DNA dictates the proteins that are made. They will know this by demonstrating that the genetic information flow from nucleotides in a gene to the sequence of amino acids into a protein. The planning pyramid for this unit describes what some, most, and all students should know (see appendix C).

In addition, Wiggins & McTighe (2005), advocate that developing and using Essential Questions (EQ) in the curriculum design will keep focus on the unit’s big ideas and provide effective teaching and learning. In this unit, the big idea is: Living systems store, retrieve, transmit, and respond to information essential to life processes. EQ’s were written to frame the big idea of the unit in order to provide a deep understanding (Wiggins & McTighe, 2005). Good questions will spark meaningful connections to experiences and prior classes causing students to rethink what they know and understand. The EQ’s should stimulate inquiry, be relevant to the student, and encourage students to transfer knowledge to promote connections (Wiggins & McTighe, 2005). All lessons align with the EQ’s and big idea of the unit.

Finally, learner profiles were considered when creating this unit (See appendix D for an example). Learning profiles support learning and inclusion because they emphasize the individual student. In developing learner profiles, teachers will be able to access what learning style will work for the student, what barriers student may have to learning, and what motivates and engages them to learn (Wojcik, 2016). Learner profiles can help inform instruction for this unit by revealing students prior knowledge and identifying and addressing misconceptions. Many students have basic knowledge of DNA and revealing their prior knowledge would be beneficial to inform instruction.

**Part III: Unit Plan**

**Stage I**

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| **Gr****ade 10 Biology: DNA and Protein Synthesis** | |
| In this unit, 10th grade high school Biology students will identify DNA as the molecule that transmits genetic information. Students will know how DNA produces proteins and understand the role of DNA as the essential molecule for all life processes. By using historical data, the student will identify how scientists concluded that DNA was the molecule responsible for heredity. Students will be able to apply prior knowledge of the scientific method to analyze and evaluate scientific experiments. Students will know how genetic material from one organism can be manipulated to create new products. | |
| **STAGE 1- STANDARDS/GOALS** *What should students understand, know, and be able to do? Stage one identifies the desired results of the unit including the related state content standards and expected performances, enduring understandings, essential questions, knowledge and skills.* | |
| **Content Standard(s)**  Generalizations about what students should know and be able to do. | |
| **Content Standards** | **Primary Expected Performances** |
| CT Grade 10, Strand IV  10.1 - Fundamental life processes depend on the physical structure and the chemical activities of the cell.  CT Grade 10, Strand V  10.3 - Similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another. | Students will describe the general role of DNA and RNA in protein synthesis.  Students will be able to identify the basic unit of the DNA structure.  Students will be able to outline the central dogma of molecular biology starting with the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.  Students will be able to describe in general terms, how the genetic information of one organisms can be altered to make them produce new materials such as new foods and medicines in biotechnological processes.  Students will explain the risks and benefits of altering the genetic composition and cell products of existing organisms. |
| *Scientific Literacy:*  Scientific literacy includes the ability to read, write, discuss and present coherent ideas about science. | Students will read, interpret and examine the credibility and validity of scientific claims in different sources of information. |
| **Enduring Understandings**  *Insights learned from exploring generalizations via the essential questions (Students will understand THAT…)*  *K-12 enduring understandings are those understandings that should be developed over time, they are not expected to be mastered over one unit or one year.* | **Essential Questions**  *Inquiry used to explore generalizations* |
| ***Overarching Enduring Understandings:***   * Students will understand that DNA is responsible for transferring genetic information from one generation to another * Students will understand that all living things are composed of a universal genetic code that drives all life processes. * Students will understand that the DNA molecule could be edited to alter an organism’s genome. Students can transfer this knowledge to authentic discussions related to designing babies, eliminating genetic disorders, and genetically modified foods.   ***Unit Specific Enduring Understanding***   * Students will understand that the chemical components that make up a molecule of DNA and the role the structure has in producing proteins. * Students will be able to describe how mutations can alter the genetic information. | * What is DNA? * How do we know that DNA is responsible for transmitting genetic information? * How do the unique properties of DNA and proteins support the essential processes of life? * How can DNA be altered and should human genes be edited to alter the human genome? * How can DNA be altered to form new organisms? |
| **Knowledge and Skills***What students are expected to know and be able to do* |  |
| *Knowledge*  The students will know…   * The molecular structure of DNA * How the structure of DNA dictates its function in transmitting genetic information. * How DNA codes for a protein. * Historical experiments and scientists that contributed to the understanding of DNA as the genetic material.     *Skills*  *The students will be able to…*   * Build a model of DNA and explain its properties. * Review, analyze, and evaluate scientific experiments and explain their importance in the discovery of DNA as the genetic material. * Perform lab experiments and effectively communicate results. * Transcribe and translate a DNA sequence into a protein- Protein synthesis. * Illustrate types of mutations using DNA sequences. |  |

**Stage 2**

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| **Stage 2 – Assessment Evidence** | | |
| **Performance Task: Should genetically modified foods be labeled**  In this performance task, students will work in small groups to create a persuasive brochure that supports or refutes the mandatory labelling f GMO foods. Students will present their brochure during a simulated Public Health Committee meeting. | | |
| **GRASPS Elements of the Performance Task** | | |
| ***G*** *– Goal*  *What should students accomplish by completing this task?* | Goal  Your group's goal is to create a persuasive brochure that supports your position on whether genetically modified foods should be labeled.  Role  You are a group of food scientists working for a Connecticut company.  Audience  You will be addressing the Public Health Committee of Connecticut at their monthly meeting in Hartford.  Situation   1. The Public Health Committee of Connecticut will be deciding if GMO’s should be labeled in Connecticut. You have been hired by the American Seed Trade Association to present a persuasive brochure that you will share with the committee to prevent the mandatory labeling of foods in Connecticut. 2. The Public Health Committee of Connecticut will be deciding if GMO’s should be labeled in Connecticut. You have been hired by the Concerned Citizens Organization to present a persuasive brochure that you will share with the committee to support the mandatory labeling of foods in Connecticut.   Product/Performance  You will create a persuasive brochure with references and present your stance to a simulated public health committee. | |
| ***R*** *– Role*  *What role (perspective) will your students be taking?* |
| ***A*** *– Audience*  *Who is the relevant audience?* |
| ***S*** *– Situation*  *The context or challenge provided to the student.* |
| ***P*** *– Product, Performance*  *What product/performance will the student*  *create?* |
| ***S*** *– Standards & Criteria for Success*  *Create the rubric for the Performance Task* | See Appendix A. | |
| **Other Evidence**  Through what other evidence (work samples, observations, quizzes, tests, journals or other means) will students demonstrate achievement of the desired results? Formative and summative assessments used throughout the unit to arrive at the outcomes. | | **Student Self-Assessment**  How will students reflect upon or self-assess their learning? |
| Throughout the unit, students will be providing multiple pieces of evidence to demonstrate achievement. These will include: class discussions mediated and evaluated by the teacher, oral quizzes, written quizzes, and demonstrations using manipulatives (DNA model), lab exercises with lab reports, presentations, and online activities with assessments. | | Students will be provided with rubrics to self-assess their learning prior to completing assignment on evaluating historical experiments and creating a persuasive brochure on the mandatory food labeling of GMO’s. Students will be given the opportunity to receive feedback and revise work prior to turning in final projects. |

**Stage 3:**

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| **Learning Plan (Stage 3)** | |
| **Where are your students headed? Where have they been? How will you make sure the students know where they are going?** | Students are headed to a deeper understanding of DNA as the molecule responsible for heredity. Students have had only basic instruction of DNA and know that it controls our traits but will expand their knowledge to include how scientists used experiments to prove DNA is the molecule of heredity, how DNA produces proteins that are responsible for life processes, and how DNA can be altered to produce new organisms and products. Students will be guided through each of these discoveries by referencing essential questions along the way. |
| **How will you hook students at the beginning of the unit?** | Students will be engaged in the unit by providing them with the following: brainstorm ideas in small groups, watch a video that walks them through the historical discovery of DNA, use manipulatives to build a DNA molecule, extract DNA from a strawberry to visually see the molecule, and complete authentic performance task that relates to a current real life issue. |
| **What events will help students experience and explore the big idea and questions in the unit? How will you equip them with needed skills and knowledge?** | Students will explore the big ideas by brainstorming in groups while guided by the teacher and unit resources. Teacher will present videos and PowerPoints to students to help them explore the big ideas. Students will use online resources to learn how DNA produces proteins and perform protein synthesis using worksheets and online activities. Students will build models, perform lab experiments, research topics, create persuasive brochures and conduct research and present information to help them explore and equip them with the knowledge and skills necessary for this unit. |
| **How will you cause students to reflect and rethink? How will you guide them in rehearsing, revising, and refining their work?** | Students will be given rubrics to evaluate work and will be offered the opportunity to receive feedback and revise work before turning it in for final grade. Students will be given graphic organizers to help them refine their work. |
| **How will you help students to exhibit and self-evaluate their growing skills, knowledge, and understanding throughout the unit?** | Students will be given a self-assessment rubric for the authentic performance task to evaluate their progress. Students will exhibit understanding by presenting authentic performance task. |
| **How will you tailor and otherwise personalize the learning plan to optimize the engagement and effectiveness of ALL students, without compromising the goals of the unit?** | To help personalize learning a Spanish version of a video used in this unit is provided for ELL students. Extra practice activities will be provided for students that are struggling. Students that have mastered content will be asked to assist peers that are struggling. Students will also be provided with choices for assessment. |
| **How will you organize and sequence the learning activities to optimize the engagement and achievement of ALL students?** | Students will be given graphic organizers/checklists to help organize their work and to optimize achievement. (see appendix E). |

The Learning Plan considers the elements WHERETO when the unit was being developed. The acronym description is outlined below.

* W: WHERE is the unit headed and WHAT is expected of the learner.
* H: How will you HOOK the student and HOLD their interest throughout the unit.
* E: How will you EQUIP your students to help them EXPERIENCE and EXPLORE the big ideas being studied.
* R: How will students be able to RETHINK, REVISIT, or REVISE their work to show growth and improvement.
* E(2): Provide students with means to EVALUATE and self-assess their work.
* T: How will you TAILOR learning the meet the diverse needs of the learners.
* O: What tools will students be offered to help them stay ORGANIZED.

**Each learning plan will have a letter that corresponds to one of the elements described.**

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| **#** | **Lesson Title** | **Lesson Activities** | **Resources** |
| 1 | Introduction and brainstorming | Provide each pair of students with white boards and ask them to brainstorm the question, “What is DNA?” Discuss results as a class and introduce the unit and essential questions. (W), (E), (H). | White board, markers |
| 2 | The discovery of DNA. | View the short film: “DNA , The Discovery of the Double Helix” by HHMI to hook students into how scientists discovered that DNA was the molecule responsible for heredity. Spanish version of film available [here](https://www.youtube.com/watch?v=FMIsQlrtg_w) for ELL students (H), (T). | Internet access, projector, computer |
| 3 | DNA and proteins | Inform students that the DNA code is the code for protein production and remind students of the importance and functions of proteins function of DNA. (W) | Projector, computer, PowerPoint |
| 4 | Protein Synthesis | Demonstrate protein synthesis and use online resources from Howard Hughes Medical Institute to transcribe and translate a DNA sequence into a protein. Teacher will offer extra help to students that are struggling and provide extra practice examples. Students that grasp content quickly will be asked to help students that need assistance. (E), (W), (T). | Computers, PowerPoint, worksheets. |
| 5 | Historical experiments leading to the discovery of DNA as molecule of heredity | Arrange students into groups and assign each group a different scientist from the film. Each group will research the contribution of each scientist to the discovery of the structure of DNA. Students will evaluate each experiment for the steps of the scientific method (identify variables and controls, evaluate possible sources of error, summarize conclusion) and relate the importance of the work on the discovery of DNA. Students will use rubric provided to evaluate their work. Students can turn in a draft for review and revise work. (E) (W), (R), (E-2). | Computer access, |
| 6 | DNA Extraction Lab | Perform DNA extraction to offer students a visual of DNA and appreciate the complexity of the structure. Use scientific method to conduct experiments and communicate results.(H),(E). | Strawberries, dish soap, salt, ethyl alcohol, extraction equipment, internet access, introduction video, lab handout. Assignment handout with rubric. |
| 7 | Building DNA | Construct a DNA molecule using molecule kits. Students demonstrate understanding of structure and replication of DNA by verbally explaining to the teacher (Oral quiz). (H), (E). | Model kits, instructions, oral quiz requirement outline. |
| 8 | Altering DNA to create new organisms | Discuss technologies that can alter DNA to create new organisms and products. Have students briefly research in small groups’ examples of organisms and products that have been created by altering DNA. Conclude lesson with a discussion of results from search. Students will have a choice of write an essay, creating a video, or creating a presentation on the benefits and drawbacks to the use of the technology. (W), (E) (T). | Internet access, computers, articles. |
| 9 | GMO and food labeling | Provide students with the authentic performance task on GMO mandatory fool labeling issue. Students will work in groups to create a persuasive brochure and presentation to a simulated health committee meeting. Students will be given a graphic checklist/ organizer and guiding questions to help students outline their brochure and presentation. (E) (R), (O). | Computer access, examples of work, template, videos, articles, rubrics, Checklist and organizer (appendix E). |
| 10 | GMO and food labeling | Students will work with their groups to research benefits and consequences of labeling GMO’s. Students will consult with peers and teacher to review and revise work using graphic organizer or checklist. (E), (R), (W) | Computer access, graphic/checklist organizer (appendix E). |
| 11 | GMO brochure and presentation | Students will be give self-assessment rubric for authentic performance task on GMO labelling. (E-2). | See appendix A |
| 12 | Presentation to Committee | Students present authentic performance task and present persuasive brochure. (W), (E). | Simulated conference and related resources. Rubric for assessing. (See appendix A). |

**Checking for UDL Principles**

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| Assess and Reflect State (Stage 4) | |
| **Considerations** | **Comments** |
| **Required Areas of Study:**  **Is there alignment between outcomes, performance assessment and learning experiences?** | The outcomes, performance assessment and learning experiences all center on the big idea: Living systems store, retrieve, transmit, and respond to information essential to life processes. Students will learn the structure of DNA and its function in storing, transmitting and responding to information related to protein synthesis. The specific purpose of this unit is for students to understand DNA as the molecule of heredity. This knowledge could be transferred to authentic scenarios related to altering DNA to produce new products. |
| **Adaptive Dimension:**  **Have I made purposeful adjustments to the curriculum content (not outcomes), instructional practices, and/or the learning environment to meet the learning needs and diversities of all my students?** | For struggling students: Support can be given by:   * Working in small collaborative groups * Individual assistance by teacher when working in groups * Peer mentoring * Use Introduction videos to support activities and visual learners. * Spanish version of video to support ELL students * Provide resources to special education teacher and paraprofessionals to assist students with tasks such as researching scientists, protein synthesis, and authentic performance task. Work with special education teacher to incorporate any assistive technology into the class.   For students who need a challenge:   * Act as peer mentors to help struggling students * Using multimedia to communicate results * Additional protein synthesis practice with increased challenge * Offer additional challenges for the authentic performance task. Allow students to communicate with local community partners or government agencies to add to authenticity of task. |
| **Instructional Approaches:**  **Do I use a variety of teacher directed and student centered instructional approaches?** | There are multiple teacher and student centered instructional approaches Students will receive direct instruction to cover content before delving into deeper understandings of DNA and protein synthesis. Students will work in small groups to conduct research. The research will offer students the option of choosing a stance on GMO labelling of foods. Students can express their interests and opinions while using supporting evidence. Students will be able to perform an experiment which would benefit hands -on learners. |
| **Resource Based Learning:**  **Do the students have access to various resources on an ongoing basis?** | Students will have access to computer labs as available as well as cell phones, tablets and text resources in the classroom. |
| **FNM/I Content and Perspectives/Gender Equity/Multicultural Education:**  **Have I nurtured and promoted diversity while honoring each child’s identity?** | In researching historical experiments leading to the discovery of DNA as the genetic molecule, students will be understand how the life experience of scientists influenced their work. This is especially true of female scientists that were instrumental in the field.  Students will be encouraged to think about how their cultural identity influences the way they learn.  Spanish speaking students will have video resources in Spanish as well as text resources that offer Spanish versions. |

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Appendix A

Student GMO brochure and presentation rubric

Top of Form

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| --- | --- | --- | --- | --- | --- |
| **GMF Labelling** | | | | | |
|  | **Needs Improvement** **5 pts** | **Satisfactory** **10 pts** | **Good** **15 pts** | **Excellent** **20 pts** |  |
| **Persuasive Content** | Student made an attempt to take a position in support of or against labeling foods as genetically modified but was not successful. Gave information but did not help to support position. | Student took a position in support or against the labeling of GMF. Position was not clear and weak support was provided. | Student took a clear stand in support or against the labeling of GMF. Gave 2 or less supporting pieces of evidence. | Student took a clear stand on the position and fully supported the position with 3 or more supporting pieces of evidence. |  |
| **Accuracy and Support** | Less than 50% of information on GMO are accurate and not supported by research. Includes less than 3 details that support the position. Data not from reliable sources | 50% of the facts on GMO are accurate and are supported by research. Includes 3 or more details that support the position. Data from 1 reliable source. | 75% of the facts on GMO are accurate and are supported by research. Includes 4 or more details that support the position. Data from at least 2 reliable sources. | All the information on GMO is accurate and is supported by research. Includes 5 or more details that support the positions. Data from at least 3 reliable sources. |  |
| **Design and Appearance** | The brochure is not visually appealing. It is illegible and not organized.  Graphics do not support the text. Appear randomly chosen. | The brochure has three or more areas that are not visually attractive.  Includes at least 2 relevant graphics, | The brochure has 1 or 2 areas that are not visually attractive. Includes at least 3 relevant graphics | The brochure is neat, organized and visually attractive. Includes 4 or more relative graphics that support the text. |  |
| **Grammar and Spelling** | Major grammatical and spelling errors. Work was not checked. | Several grammatical and spelling errors. | Minor grammatical and spelling errors are present. | No grammatical or spelling errors. Proof reading is evident. |  |
| **Scientific Knowledge** | Student does not demonstrate understanding of GMO creation.  Does not present risks or benefits of genetically modifying organisms. | Student demonstrates limited understanding of GMO creation.  Student presents at least one benefit and risk of genetically modifying organisms. Provides no supporting evidence. | Student demonstrates adequate understanding of GMO creation.  Student presents 2 or more benefits and risks of genetically modifying organisms. Provides little supporting evidence. | Student demonstrates exemplary understanding of GMO creation.  Student presents 3 or more benefits and risks of genetically modifying organisms. Provides supporting evidence. |  |
| **Communication** | Inadequate communication. Does not effectively convey stance. Demonstrates little preparation and not able to answer questions from audience | Poor communication. Attempts to communicate stance. Demonstrates adequate preparation. Able to answer limited questions from audience. | Good communication. Effectively communicates stance. Demonstrates adequate preparation and can answer most questions from audience. | Exemplary communication of project. Effectively conveyed stance Well prepared for presentation and able to answer questions from audience with support. |  |

Total: \_\_\_\_\_\_\_/12

Appendix B

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| Self- assessment Rubric for Curriculum Design | | | |
|  | Fully Present (2pts) | Somewhat Present (1pt) | Not Present (0 pts.) |
| STAGE 1: Identifying Desired Results: Essential Questions and Enduring Understandings | Essential questions promote and stimulate inquiry.  Essential questions encourage students to transfer knowledge to other disciplines or real-world.  Enduring understandings are aligned with essential questions. | Essential questions promote some inquiry.  Transfer of knowledge to other disciplines or the real world is limited.  Some of the Enduring understandings align with the essential questions. | Essential questions do not promote inquiry.  Essential questions do not encourage transfer of knowledge.  Enduring understandings do not align with the essential questions. |
| Stage 2: Determining Acceptable Evidence: Authentic Performance Tasks | The authentic performance task aligns with the big ideas of the unit and assures a high level of understanding.  The authentic performance task uses the GRASPS tools and is clear and understandable for students.  The unit considers variability among students and offer 3 or more ways for students to demonstrate understanding. | The authentic performance task aligns with the big idea of the unit but does not show a high level of understanding for the unit.  The authentic performance task uses the GRASPS tools but the task is not clear and understandable for students.  The unit considers variability among students and offers at least 2 ways for students to demonstrate understanding. | The authentic performance task does not align with the big idea of the unit.  The authentic performance task does not use the GRASPS tools.  The unit does not consider variability among students. |
| Stage 3: Planning Learning Experiences and Instruction: | Student expectations are clearly communicated to students. Students have the opportunity to rethink and revise work and receive feedback. | Student expectations are somewhat clearly communicated.  Students have the opportunity to rethink and revise work but do not receive feedback. | Student expectations are not clearly communicated.  Students do not have opportunity to rethink and revise work. |
| Learning Experiences | All activities align with the unit goals. One or more of the activities apply to the WHERETO elements. | Most activities align with the unit goals.  One or more of the activities apply to the WHERETO elements. | Few activities align with the unit goals.  The WHERETO elements are not present in the activities. |
| Revision and self-assessment | Students are given opportunities to revise and rethink their work prior to final grade.  Teacher offers feedback to students | Students are given opportunities to revise work prior to final grade.  Teacher does not offer feedback to students prior to final grade. | Students are not given opportunities to revise work prior to final grade.  Teacher does not offer feedback. |
| Differentiation | Unit offers multiple approaches to student instruction.  Approaches include: small group, whole group, use of technology, and peer collaboration, lab activities, and presentations. | Unit offers limited approaches to student instruction.  Approaches include at least 3 of the following approaches to instruction:  Small group, whole group, use of technology, and peer collaboration, lab activities, and presentations. | Unit offer limited approaches to student instruction.  Approaches include 2 or less of the following approaches to instruction:  Small group, whole group, use of technology, and peer collaboration, lab activities, and presentations. |

Appendix C

Planning Pyramid: Some, Most, All Students

**Some Students Will Know:**

* The significance of each historical experiment in the discovery of DNA as the genetic material.
* Changes in the nucleotide sequence will affect the three dimensional structure of a protein and prevent the interaction of specific parts of amino acids.
* Mutations provide the variation necessary for life to exist. Some mutations are harmful and some are helpful.

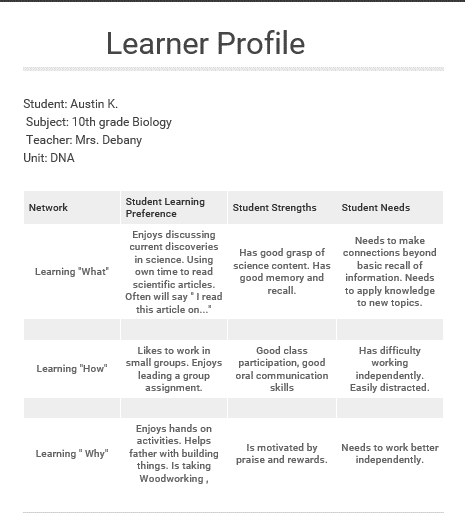
**Most Students Will Know:**

* That changes in the nucleotides sequence cause mutations that affect the structure of the protein and therefore its function.
* How mutations occur providing specific examples.
* The scientists and their experiments that contributed to the discovery DNA and its function as the genetic material.
* The complementary pairing of DNA bases using the words to represent bases (Ex. Adenine-Thymine and Guanine-Cytosine).
* The importance of sharing/publishing scientific data with other scientists.
* How to describe the process of producing GMO’s.
* That understanding DNA structure and replication makes genetic engineering possible.

**All Students Will Know:**

* That the basic unit of DNA is a three part nucleotide.
* The complementary pairing of DNA bases using letters to represent bases (Ex. A-T and G-C).
* That Watson and Crick were credited for the discovery of DNA.
* Many scientists contributed to the discovery of the structure of DNA and its function as the genetic material.
* The DNA codes for the synthesis of proteins.
* The role of RNA in protein synthesis.
* How to extract DNA from plant cells and describe what it looks like.
* DNA is replicated and copied during reproduction to produce egg and sperm cells.
* How to transcribe and translate a genetic code into a specific protein.
* How to demonstrate DNA replication using models.
* Mutations occur when the DNA code is altered.
* How mutations occur.
* Technology exists to alter DNA and produce GMO’s.

Appendix D



Appendix E

Guiding questions for APT

**GMO Brochure Guided Question**

Complete these questions to help you complete your brochure. These questions should be used as a guide to completing your brochure.

1.)  What is Genetic engineering?

2.)  Define and discuss Biotechnology. Provide specific examples of how it is used. is the method of using living organisms to create products that improve the quality of human life.

3.) What is Selective Breeding? What is transgenic? Describe an example of each.

5.) Outline the positive and negative consequences of  producing genetically modified foods. Be specific and provide references.

6.)Outline the positive and negative consequences associated with the mandatory labeling of genetically modified foods.

GMO Brochure and Presentation

Checklist for Success

|  |  |  |  |
| --- | --- | --- | --- |
|  | YES | ALMOST | NOT YET |
| Did I use 3 or more supporting pieces of evidence from research to support my position? |  |  |  |
| Did I verify that my information is accurate. Did I verify information with research or with my instructor? |  |  |  |
| Did I use enough details or examples to support my position? Did I refer to the rubric to make sure I have enough? |  |  |  |
| Did I use images that are appropriate and appealing in my brochure? |  |  |  |
| Does my brochure include information on how GMO’s are created? |  |  |  |
| Did I check my grammar and spelling? |  |  |  |
| Does my presentation address the audience I will be presenting to? |  |  |  |

Appendix F

Example of Historical experiment analysis

Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_            Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Genes to Protein

Identify the Essential Question related to this topic:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Objective:**  To investigate key historical experiments to identify *the* source of genetic information: DNA or Protein.

**Background Information**

Once T. H. Morgan and his co-researchers showed that Mendel’s traits (genes) are located on

chromosomes, the two chemical components of chromosomes—DNA and protein—became

the candidates for *the* genetic material. Until the 1940s, the case for protein seemed more

likely (Campbell and Reece 2005, 293). Why? Because scientists had previously discovered

that polypeptides contain a “language” based on a 20-letter amino acid alphabet from which

myriad proteins could be synthesized. Furthermore, little was known about the structure

and function of nucleic acids. Even after Rosalind Franklin produced the X-ray diffraction

photograph that Watson and Crick used to model the structure of DNA, it could be argued

that the helical shape of Franklin’s molecule supported protein (Campbell and Reece, 293).

Students often have this same misperception, confusing the alpha helix secondary structure

of protein with the double helix of DNA.

**Pre-Activity Questions**:

1. Describe the four structures of a protein and use a visual representation to describe how interactions between R-groups can determine the countless three-dimensional shapes of proteins.

2. Why could Franklin’s X-ray diffraction photograph been interpreted as a secondary structure, alpha helix protein?   Describe the effects of increased temperature or low pH on protein structure and enzymatic activity?

**Activity Background:**

In 1928, Frederick Griffith, who was studying *Streptococcus pneumoniae* to

find a vaccine for pneumonia, made a startling observation. Griffith had two strains of the

bacterium, a pathogenic or disease-causing strain and a second harmless one. Bacteria of

the “S,” or “smooth,” strain are pathogenic because a protein capsule protects them from

an animal’s defense system; bacteria of the “R,” or “rough,” strain lack a capsule and are

nonpathogenic. When Griffith killed the pathogenic bacteria with heat and then mixed

the cell remains with living “R” bacteria, he made a startling discovery (described in

Figure 1). Griffith called this phenomenon *transformation* (Campbell and Reece, 294).

Little did Griffith know that his work in 1928 would provide a foundation for genetic

engineering and recombinant DNA technology in the twenty-first century.

**Inquiry: Students will inquire about how Griffith’s experiment with Streptococcus pneumonia supports the idea that heritable material transformed living, nonpathogenic bacteria into pathogenic bacteria.**

**Experimental Analysis:**

In groups of two, analyze the diagram of Griffith’s experiment and answer the following questions.  Be prepared to discuss your answers with other groups and the entire class.

1. Form inferences about each of Griffith’s four experiments.

a.

b.

c

d

1. Draw conclusions regarding each of the two bacterial strains from your experimental inferences.

1. How does information resulting from Griffith’s experiments with *Streptococcus*

*pneumoniae* support the idea that a heritable material (the identity of which was unknown

in 1928) transformed living, nonpathogenic “R” bacteria into pathogenic “S” bacteria?