

## MYP/3D Science Unit Planner

### Marietta City Schools

<b>Grade &amp; Course:</b> 9th/10th Grade Biology	<b>Topic: Molecular Genetics:</b> DNA Replication, Protein Synthesis, and Biotechnology	<b>Duration:</b> 5 weeks
<b>Teachers:</b> Hunter Fisher, Heather Glazebrook, Mariah Sappington, Rosemary Kamau, O'Neal McRunells, Amber Carr, Ella Benton, Zakayo Ruoro, Ashanti Pilgrim		
<b>Georgia Standards and Content:</b> <b>SB2. Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.</b> <b>SB2a.</b> Construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation. <b>SB2b.</b> Construct an argument based on evidence to support the claim that inheritable genetic variations may result from: <del>new genetic combinations through meiosis (crossing over, nondisjunction);</del> non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or heritable mutations caused by environmental factors (radiation, chemicals, and viruses). <b>SB2c.</b> Ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture. (Clarification statement: The element is intended to include advancements in technology relating to economics and society such as advancements may include Genetically Modified Organisms.)		
<b>Narrative / Background Information</b>		
<b>Prior Student Knowledge: (REFLECTION – PRIOR TO TEACHING THE UNIT)</b> <b>S7L3. Obtain, evaluate, and communicate information to explain how organisms reproduce either sexually or asexually and transfer genetic information to determine the traits of their offspring.</b> a. Construct an explanation supported with scientific evidence of the role of genes and chromosomes in the process of inheriting a specific trait. b. Develop and use a model to describe how asexual reproduction can result in offspring with identical genetic information while sexual reproduction results in genetic variation. (Clarification statement: Models could include, but are not limited to, the use of monohybrid Punnett squares to demonstrate the heritability of genes and the resulting genetic variation, identification of heterozygous and homozygous, and comparison of genotype vs. phenotype.) c. Ask questions to gather and synthesize information about the ways humans influence the inheritance of desired traits in organisms through selective breeding. (Clarification statement: The element specifically addresses artificial selection and the ways in which it is fundamentally different from natural selection.)		
<b>Year-Long Anchoring Phenomena: (LEARNING PROCESS)</b> Sickle cell is a heritable genetic mutation that evolved in response to interactions in ecosystems.		
<b>Unit Phenomena (LEARNING PROCESS)</b> Malaria and sickle cell anemia - sickle cell disease is a genetic mutation that may be reversed by gene therapy.		
<b>MYP Inquiry Statement:</b> Your <b>identity</b> and <b>relationships</b> with other people are determined by genetic factors: scientific <b>evidence</b> has led to <b>models</b> that help to understand observed <b>patterns</b> of inheritance.		
<b>MYP Global Context:</b> Scientific and Technical Innovation: The Biological Revolution		

<b>Approaches to Learning Skills: ***</b> Communication Skills Collaboration Skills Research Skills	<b>Disciplinary Core Ideas: (KNOWLEDGE &amp; SKILLS)</b> <ul style="list-style-type: none"> <li>- DNA Structure &amp; Function</li> <li>- DNA Replication</li> <li>- DNA Mutations (insertions, deletions, substitutions)</li> <li>- Heritable mutations (caused by environmental factors)</li> <li>- Protein Synthesis (transcription and translation)</li> <li>- Advancements in biotechnology and their impact on economics and society (i.e. GMOs).</li> <li>- Ethical, societal, and economical considerations of biotechnology and genetic engineering.</li> </ul>	<b>Crosscutting Concepts: *** (KNOWLEDGE &amp; SKILLS)</b> Cause & Effect Structure and Function System and system models
		<b>MYP Key and Related Concepts: **</b>  Key Concept - Cause & Effect  Related Concepts Structure and Function System and system models Sciences - Form and Models

### GADOE Achievement Level Descriptors for Biology

**Disciplinary Core Content:** molecular genetics

**Focus Science & Engineering Practices:** developing and using models; constructing explanations

**Focus Crosscutting Concepts:** structure and function

**SB2a:** Construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation.

**SB2b:** Construct an argument based on evidence to support the claim that inheritable genetic variations may result from: non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or heritable mutations caused by environmental factors (radiation, chemicals, and viruses).

**SB2c:** Ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture. (Clarification statement: The element is intended to include advancements in technology relating to economics and society such as advancements may include Genetically Modified Organisms.)

The beginning learner can...	The developing learner can...	The proficient learner can...	The distinguished learner can...
recognize the role of cellular reproduction in maintaining genetic continuity;  identify features in the structures of DNA;  identify considerations related to the use of biotechnology in forensics, medicine, and agriculture	recognize models used to explain the role of cellular reproduction in maintaining genetic continuity;  recognize that the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation;  gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture;	develop and use models to explain the role of cellular reproduction (i.e., binary fission and mitosis) in maintaining genetic continuity;  construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation  ask questions to gather and communicate information	refine models to explain the role of cellular reproduction in maintaining genetic continuity;  refine an explanation of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation;  refine questions used to gather and communicate information about the use and ethical considerations of biotechnology in forensics,

		about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture;	medicine, and agriculture;
<p>As a <b>beginning learner</b>, I can...</p> <ul style="list-style-type: none"> <li>identify the structure of DNA and RNA</li> <li>identify the function of DNA and RNA</li> <li>state the rules of base pairing for DNA</li> <li>identify the semiconservative nature of DNA replication</li> <li>recognize that the process of protein synthesis involves transcription of DNA and translation of mRNA to an amino acid sequence</li> <li>recognize that genetic variations may result from non-lethal errors occurring during replication</li> <li>define and recognize examples of insertions, deletions, and substitutions</li> <li>recognize that genetic variations may result from heritable mutations caused by environmental factors (radiation, chemicals, and viruses)</li> <li>identify or recognize basic ways that biotechnology is used in forensics, medicine, and agriculture</li> </ul>	<p>As a <b>developing learner</b>, I can...</p> <ul style="list-style-type: none"> <li>compare and contrast, using existing models, how the structure of DNA and RNA are different</li> <li>differentiate between the function of DNA and the function of RNA (overview)</li> <li>explain, using existing models, how the structure of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation</li> <li>select an argument that could be used to support the claim that inheritable genetic variations may result from: non-lethal errors occurring during replication (insertions, deletions, substitutions);</li> <li>select an argument that could be used to support the claim that inheritable genetic variations may result from heritable mutations caused by environmental factors (radiation, chemicals, and viruses).</li> <li>gather information for myself and communicate about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture;</li> </ul>	<p>As a <b>proficient learner</b>, I can...</p> <ul style="list-style-type: none"> <li>use mathematics and computational thinking to examine the structure of DNA using the rules of base pairing;</li> <li>construct an explanation of how the structure DNA leads to the expression of information within the cell via replication</li> <li>construct an explanation of how the structure of DNA leads to the expression of information within the cell via transcription and translation</li> <li>construct an explanation of how the structure of RNA leads to the expression of information within the cell via transcription and translation</li> <li>construct an argument based on evidence that could be used to support the claim that inheritable genetic variations may result from: non-lethal errors occurring during replication (insertions, deletions, substitutions);</li> <li>construct an argument based on evidence that could be used to support the claim that inheritable genetic variations may result from heritable mutations caused by environmental factors (radiation, chemicals, and viruses).</li> <li>apply learning and academic vocabulary to indicate my understanding of how the structure of DNA/RNA supports its</li> </ul>	<p>As a <b>distinguished learner</b>, I can...</p> <ul style="list-style-type: none"> <li>refine my own explanations of how the structures of DNA and RNA lead to the expression of information within the cell via the processes of replication, transcription, and translation.</li> <li>refine my own arguments, based on evidence, that could be used to support the claim that inheritable genetic variations may result from: non-lethal errors occurring during replication (insertions, deletions, substitutions);</li> <li>refine my own arguments, based on evidence, that could be used to support the claim that inheritable genetic variations may result from heritable mutations caused by environmental factors (radiation, chemicals, and viruses).</li> <li>extend learning and academic vocabulary to obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.</li> <li>refine my own questions about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture;</li> </ul>

		function in maintaining genetic continuity • ask my own questions about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture;	
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The intent of standard SB1b is for students to develop and use models to investigate mitosis and the purpose of cell division in cellular growth and repair. The *details* of the sub processes of the cell cycle and mitosis are beyond the scope of the HS Biology course. Calculations for SA to V ratio (if used to illustrate a need for cellular division) should be limited to square cell models to meet the intent of the HS Biology standard.

For standard SB2a, historical scientific discoveries related to DNA and the scientists responsible are outside the scope of the course. The details of the specific enzymes involved in replication, transcription, and translation are beyond the scope of the HS Biology course. The detailed processes of transcription and translation in protein synthesis is limited to a conceptual understanding.

#### Student Friendly Learning Targets

1. I can describe the general structure of DNA: double helix, base pairs, sugar/phosphate backbone, nitrogenous bases, hydrogen bonds, twisted.
2. I can state the base pairing rules for DNA (Chargaff's Rule).
3. I can explain the basic steps involved in DNA replication (exact copy, uses multiple enzymes, strands unwind and unzip, bonds break between base pairs, each half used a template for new identical strand, attachment of free nucleotides).
4. I can state why DNA replication is referred to as "semi-conservative".
5. I can communicate that genetic information, expressed by the transcription and translation of a gene, results in a protein.
6. I can define a chromosome as a long DNA molecule consisting of hundreds of genes that code for proteins.
7. I can explain how the structure of DNA allows it to store genetic information, direct the production of proteins, and pass the data to new cells (base pairing, order of nucleotides, weak bonding between bases, supercoiled when not replicating, relaxed when replicating).
8. I can communicate that the central dogma of genetics explains the conversion of DNA (cellular instructions) into a functioning product (protein), and that genetic information flows from the genetic code of DNA, to RNA, to functional proteins expressed as traits.
9. I can explain that DNA carries information to produce proteins in a triplet code (codon), and that each sequence of three nucleotides either codes for a particular amino acid or the sequence's beginning or end.
10. I can support the claim that the unique arrangement of nucleotides on a gene leads to differences in organisms.
11. I can explain why DNA does not leave the nucleus, but RNA can.
12. I can describe the differences between the structure and function of DNA compared to RNA.
13. I can state the function of mRNA, rRNA, and tRNA in protein synthesis.
14. I can explain the basic steps of how transcription transcribes the genetic code of DNA into a segment of RNA.
15. I can explain the basic steps of explaining how translation converts the information of MRNA into a sequence of amino acids to make a protein.
16. I can transcribe and translate a gene into an amino acid sequence.
17. I can explain that there is redundancy in the codon table (that there are multiple codons that code for each amino acid).
18. I can explain how a change in the nucleotide sequence of a DNA molecule can become a genetic mutation.
19. I can explain that exposure to agents such as ultraviolet light, radiation, substances in tobacco products, and other chemical compounds can cause mutations.
20. I can explain that spontaneous mutations during DNA replication can cause mutations.
21. I can state the difference between a gene mutation and a chromosomal mutation.
22. I can describe substitution mutations, insertion mutations, and deletion mutations, and explain how the outcome of the mutation depends on the changes it causes to the protein created.
23. I can provide evidence to support the claim that not all mutations are bad, and that some produce advantageous new phenotypes.
24. I can define the term biotechnology, and state simple examples of how it is used in forensics, medicine, and agriculture.
25. I can define the term genetic engineering, and state simple examples of how it is used in agriculture.
26. I can provide a basic definition of each of the following techniques used to manipulate DNA: restriction enzymes, PCR, gel electrophoresis, DNA fingerprinting, bacterial plasmids, and cloning.

27. I can ask my own questions to gather information about the ethical use of biotechnology and genetic engineering in forensics, medicine and agriculture, including societal, economical, and environmental benefits and risks.

### **Possible Preconceptions/Misconceptions: (REFLECTION – PRIOR TO TEACHING THE UNIT)**

All organisms have the same number of chromosomes; DNA is different than chromosomes; mutations in somatic cells are passed along to future generations; mutations are not random; all mutations are negative; nucleus is the “brain” of the cell, but students don’t have a true understanding of why; proteins are just the nutrients found in meats- not aware of the true function and variety of proteins found in organisms; structure of proteins are the same; cancer is caused by environmental factors only; all mutations are harmful; DNA can leave the nucleus; GMOs have negative effects on our health

### **Key Vocabulary: (KNOWLEDGE & SKILLS)**

- |                        |                                 |                      |
|------------------------|---------------------------------|----------------------|
| • Amino Acid           | • DNA Fingerprinting            | • Insertion Mutation |
| • Artificial Selection | • Double Helix                  | • Inversion Mutation |
| • Base Pair Rule       | • Ethics                        | • Karyotype          |
| • Biotechnology        | • Gamete                        | • Meiosis            |
| • Carcinogen           | • Gel Electrophoresis           | • Mitosis            |
| • Central Dogma        | • Gene Mutation                 | • mRNA               |
| • Codon                | • Gene Therapy                  | • Mutagen            |
| • Chromosomal Mutation | • Genetic Engineering           | • Nitrogenous Base   |
| • Chromosome           | • Genetic Variation             | • Nondisjunction     |
| • Clone                | • Genetically Modified Organism | • Point Mutation     |
| • Crossing Over        | • Homologous Chromosomes        | • Polypeptide        |
| • Deletion Mutation    |                                 | • Protein            |
| • DNA                  |                                 | • Protein Synthesis  |
| • RNA                  | • Ribosome                      | • Translation        |
| • rRNA                 | • Selective Breeding            | • Trisomy            |
| • Recombinant DNA      | • Transcription                 | • tRNA               |
| • Replication          | • Transgenic Organism           |                      |

### **Inquiry Questions:**

#### **Factual:**

- What is DNA?
- What are the roles of organelles involved in protein synthesis?
- What are the phases of mitosis and what are their functions?
- Which types of cells undergo mitosis?
- What are the three parts of a nucleotide?
- What are the similarities and differences between DNA and RNA?
- What is the central dogma of biology?
- What are the functions of the processes of transcription and translation?
- Which molecules are involved in both transcription and translation?
- Where do the processes of transcription and translation take place in the cell?
- What are the different types of genetic mutations and what effect do these mutations have on organisms?
- What are the advantages and disadvantages of sexual and asexual reproduction?

#### **Conceptual:**

- What does the structure of DNA reveal about its function?
- What does the structure of RNA reveal about its function?
- How are DNA and RNA utilized in the process of transcription?
- How are mRNA, rRNA, and tRNA utilized in the process of translation?
- Why do cells perform mitosis?
- How are protein synthesis and mutations related?
- How is the function of a protein affected if the shape of the protein is changed (due to a mutation)?
- Why do cells undergo the cell cycle, and what are the functions of each phase and subphase?
- How do cells undergo the process of mitosis, and how do the daughter cells relate to the parent cells?
- How does mitosis maintain genetic continuity?
- Why is DNA replication referred to as “semiconservative”?
- How is the structure of DNA and RNA different ?
- How do the ethical implications of different types of DNA technology influence society?

**Debatable:**

To what extent should humans manipulate human reproduction and genetic characteristics?  
Should GMOs be used in foods for human or livestock consumption?

MYP Objectives		Summative assessment	
<b>Sciences</b>  <b>Design</b>	Common Assessments: <ul style="list-style-type: none"><li>Common formative assessment on DNA Structure and Replication / Protein Synthesis</li><li>Common summative assessment on Molecular Genetics</li><li>MYP Essay Prompt</li></ul>	Relationship between summative assessment task(s) and statement of inquiry:  The CFAs help to monitor and determine student progress as we move through the unit. This data informs the teacher of which students to accelerate, and which to remediate prior to the unit summative.  The summative assessments serve to test students' mastery of the learning targets at the proficient and distinguished level of the Achievement Level Descriptors for Biology.	
Unit Objectives: Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.			
Learning Activities and Experiences	Obtain:	Evaluate:	Communicate:
<b>Week 1:</b>  Topic 1: DNA Replication <ul style="list-style-type: none"><li>purpose of DNA replication</li><li>steps of DNA replication</li></ul>	<a href="#">Common Openers &amp; Closers for Unit 5: Molecular Genetics</a>  <a href="#">Molecular Genetics PPT 1: DNA Replication</a> (Honors) Molecular Genetics PPT (On-Level)	<a href="#">DNA Modeling Error Analysis</a>  <a href="#">DNA Replication Practice</a>  <a href="#">Modeling DNA Schoology Lab</a>  <a href="#">DNA Extraction Lab</a>  <a href="#">DNA Extraction Lab V2</a>  <a href="#">Bioman DNA Replication Interactive</a>  <a href="#">HHMI Biointeractive: DNA Missions</a>	<a href="#">Unit 5 Study Guide</a>
<b>Week 2/3:</b>  Topic 2: Protein Synthesis <ul style="list-style-type: none"><li>central dogma of genetics</li><li>purpose of protein synthesis</li><li>transcription</li><li>translation</li></ul>	<a href="#">Molecular Genetics PPT 2: Protein Synthesis</a> (Honors)  <a href="#">Transcription &amp; Translation Notes</a> (On-Level)	<a href="#">Protein Synthesis Race</a>  <a href="#">How Genes Work Exploration</a> <ul style="list-style-type: none"><li><a href="#">Protein Synthesis Simulation</a></li><li><a href="#">Transcribe &amp; Translate a Gene Simulation</a></li><li><a href="#">HHMI Biointeractive: DNA Missions</a></li></ul>	Common Formative Assessment (Topics 1 & 2)

		<a href="#">Snork Amino Acid Activity</a>  <a href="#">Codon Bingo</a> and <a href="#">Codon Bingo Student Worksheet</a>	
<b>Week 3/4:</b>  <b>Topic 2: DNA Mutations</b> <ul style="list-style-type: none"> <li>types of DNA mutations</li> <li>causes of DNA mutations</li> <li>connection between DNA mutations and evolution</li> </ul>	<a href="#">Molecular Genetics PPT 2: Protein Synthesis</a> (Honors continued)	<a href="#">DNA Mutations Consequences Lab</a>  <a href="#">The Genetics of Sickle Cell Anemia</a>  <a href="#">Mutations Practice</a>  <a href="#">Mutations Practice Worksheet</a>	<a href="#">Genetics 3D Model</a>
<b>Week 4/5:</b>  <b>Topic 4: Biotechnology</b> <ul style="list-style-type: none"> <li>use and ethical considerations of biotechnology in forensics, medicine, and agriculture</li> </ul> <b>Assess &amp; Remediate</b> <ul style="list-style-type: none"> <li>Common Summative Assessment &amp; Unit Remediation</li> </ul>	<a href="#">Molecular Genetics PPT 2: Protein Synthesis</a> (Honors continued)  <a href="#">Biotechnology Nearpod - Student Paced Lesson</a>  <a href="#">Genetic Engineering Nearpod - Student Paced Lesson</a>	<a href="#">Biotech Ethics Scenarios</a> with <a href="#">Biotech Ethics Work Tasks</a>	Common Summative Assessment  MYP Essay <a href="#">MYP D - Biotechnology</a>  CK12 Unit Remediation
<b>Resources (hyperlink to model lessons and/or resources):</b> All resources are available on schoology.			
<b>Reflection: Considering the planning, process and impact of the inquiry</b>			
<b>Prior to teaching the unit</b>		<b>During teaching</b>	<b>After teaching the unit</b>