Basic Genetics and Protein Synthesis

High School Level Biology STAAR Preparation Course

Instructional Design Document

TAP

Topic: Understanding the basic principles of modern genetics at a high school level as defined by the Texas Essential Knowledge and Skills for Science (TEKS Science). This includes being able to predict the statistical outcomes of various genetics crossings and understanding the basic molecular mechanisms that are behind them.

Audience: On-level 9th grade Texas biology students. Texas is a highly diverse state, with a wide range of students from different ethnic, socioeconomic, and linguistic backgrounds. While this course will not be able to accommodate every background, suggestions will be provided to the instructor for ESL, special education, and gifted and talented students.

Purpose/Problem: Genetics is one of the pillars of modern biology. Understanding the topic not only helps people make informed decisions about their health. Genetics isn't just a subject that opens the doors to many high skilled jobs. But, increasing the public's genetic literacy is critical in a time when momentous decisions about genetic engineering, cloning, and the environment are being made.

From an educational perspective, Biology, in Texas, is the only STAAR high school science subject tested. The STAAR Biology reporting category two is completely devoted to genetics. This course is designed to provide high-quality genetics instruction to biology students. While the STAAR test provides the objectives for the course, it also designed to enkindle and a passion for genetics and science in general.

Format:

This is a 100 percent online course built on the Canvas Learning Platform. Assignments will come from a combination of online readings and videos, audio, quizzes, and web activities. Assessment will heavily depend on writing assignments and online quizzes. Students will submit their work using Microsoft Word or Google Docs. They will also use the quizzes provided for them on the canvas platform.

Theoretical Basis of Design

This course will use a constructivist learning theory with a problem-based approach. The scaffolding model used in this lesson is the "predict, observe, explain, and evaluate (POEE)" model (Mamun, Lawrie, & Wright, 2020). Instead of merely introducing the topic, students will be presented with several real-world genetic questions. Real-life examples tend to be more engaging to students and help them "explore all dimensions of [a] problem" (Savery & Duffy, 1995). Essay questions and group discussion will allow students to self-evaluate allowing students to help clarify and crystalize their knowledge of what they have learned.

Learning Goals and Objectives

Goal 1. Describe the process Meiosis and how it leads to the independent assortment of genes.

O.1.1. The learner will be able to describe the phases of meiosis.

O.1.2. The learner can describe how the separation of homologous chromosomes and the process of crossing over can lead to genetic diversity.

Goal 2. Predict the outcomes of mendelian and non-mendelian genetic crosses using monohybrid and dihybrid crosses.

O.2.1. The learner can interpret a classical Mendelian monohybrid problem, and construct a Punnett square to determine the genetic outcomes using Punnett Squares

O.2.2. The learner can interpret a non-mendelian monohybrid problem, such as codominance, incomplete dominance, and linked genes and construct a Punnett square to determine the genetic outcomes using Punnett Squares

O.2.3. The learner can interpret a mendelian dihybrid cross and construct a dihybrid Punnett square to determine its genetic outcomes.

Goal 3. Determine the protein sequence that a DNA sequence. Describe how this process occurs in cells.

O.3.1 The learner can describe the molecular process of protein synthesis specifically the process of transcription and translation

O.3.2. The learner, using an mRNA chart, can decode a DNA sequence to determine the genetic sequence of a protein.

O.3.3 The learner can describe how the sequence of amino acids of a protein can determine the shape of a protein and determine its function

Goal 4. Explain how point and chromosomal mutations occur and their potential effects on an organism and its offspring.

O.4.1. The learner can describe what a point mutation is and a chromosomal mutation.

O.4.2. The learner can analyze how point mutations can affect the phenotype of an organism.

O.4.3. The learner can describe how chromosomal mutations can affect the phenotype of an organism

Goal 5. Interpret pedigree diagrams

O.5.1. The learner can interpret the symbols on a pedigree diagram, including what is a male or a female, and determine an organism's generation.

O.5.2. The learner can determine wither a trait is autosomal dominant, autosomal recessive, or sex-linked given a pedigree diagram.

O.5.3. The learner can make predictions about genotypes and phenotypes of organisms found on a pedigree diagram.

Goal 6 (GT students). Discuss real-life topic related to genetics

O.6.1. The learner can research and discuss a topic related to genetic diseases or biotechnology.

Technologies Required

- Modern browser and internet connection with the ability to access the following:
  - YouTube
  - Canvas
- Word processing program (Microsoft Word, Google Docs, Open Office)
- Scanner or Smartphone camera

Textbook Reading

No textbooks will be required for this course. Major YouTube concepts come from the following the Amoeba Sisters series:

Learning Activities

Each day will have 1.5 hours of instruction for 6 weeks.

Week 1.

- Week 1 discussion question
- Week 1 worksheet/writing assignment
- Introduction, with synchronous online introduction section.
- Genetics vocabulary Quizlet assignment (O.1.1, O.1.2, O.2.1, O.2.2, O.2.3, O.3.1, O.3.2. O.3.3, 0.4.1, O.4.2)
- Class poll genetic traits/ dragon genetics activity
- *Alleles and Genes*, Amoeba sisters video:
- Set up Geniverse account
- Meiosis Onion Root Activity
- Week 1 vocabulary quiz
- Introduction to genetics topic report (GT students) (O.5.1)

Week 2

- Week 2 discussion question
- Week 2 worksheet/writing assignment

- *Meiosis*, Amoeba sisters video
- Bioman game- Snurfle Meiosis and Genetics
- Geniverse Cases 1-10
- Genetics how to create a Punnett Square introduction screencast
- *How Mendel's pea plants helped us understand genetics*, Ted Ed video
- *Monohybrids and the Punnett Square Guinea Pigs*, Amoeba Sisters
- Meiosis Square Quiz

Week 3

- Week 3 Discussion Question
- Week 3 worksheet/writing assignment
- *Incomplete Dominance, Codominance, Polygenic Traits, and Epistasis!* Amoeba Sisters (O.2.2)
- *Multiple Alleles (ABO Blood Types) and Punnett Squares,* Amoeba Sisters (O.2.2)
- Blood type activity
- Punnett squares quiz (O.2.1-2)
- Punnett Squares optional help simultaneous chat

Week 4

- Week 4 Discussion Question
- Week 4 Worksheet/Writing Assignment
- Dihybrid cross screen cast (O.2.3)
- Dihybrid cross, Amoeba sisters (O.2.3)
- Punnett Square Calculator (O.2.1, 2, 3)
- Bioman game- Snurfle Meiosis and Genetics 2: Diversity and Dihybrid Crosses
- Review Kahoot
- Midterm Review
- Midterm Exam

Week 5

- Week 5 Discussion Question
- Week 5 worksheet/writing assignment (O.3.1-3)
- Protein Synthesis Screencast- Process (O.3.1-3)
- Protein Synthesis- Decoding screen cast (O.3.1-3)
- Bioman game- Protein Synthesis Race (O.3.1-3)
- Protein Synthesis discussion (O.3.1-3)
- Protein Synthesis Amoeba Sisters video (O.3.1-3)
- Protein Synthesis quiz (O.3.1-3)
- Turn in genetics topic report (GT) (O.6.1)

Week 6.

- Week 6 Discussion Question (O.4.1-2, O.5.1-3)
- Week 6 worksheet/writing assignment (O.4.1-2, O.5.1-3)
- Mutations screencast (O.4.1-2)
- Mutations Amoeba Sisters (O.4.1-3)
- Pedigree Amoeba Sisters (O.5.1-3)
- Pedigree screencast (O.5.1-3)
- Mutations Amoeba Sisters video (O.5.1-3)
- Final Review
- Review Kahoot
- Final Exam

Assessment

Assessment will take place with a combination of weekly online quizzes and free-response short-answer assignments. Online quizzes will be used to measure basic vocabulary and concepts. They also will be good STAAR test practice. Free-response questions, done with paper and pencil and scanned or photographed will be used to determine gaps in learner procedural knowledge that cannot be measured by a multiple-choice quiz. This is most evident when it comes to Punnett Squares and Protein Synthesis.

Evaluation

Each non-exam week will end with a 10-question multiple-choice quiz. During week four students will have a mid-term exam with a two-hour time limit with essay and multiple-choice sections. During the final week, the students will also have a comprehensive final exam with a two-hour time limit and free-response essay questions. Some of the questions from the final exam will come from past STAAR Biology exams.

Timeline

This course is designed to be completed in 6 weeks, the length of a standard grading period. Each day will have 1.5 hours of instruction for a total of 45 hours of instruction.

Week 1. Introduction activities. Gregor Mendel and Genetics Vocabulary,

Week 2. Meiosis, Start Mendelian Genetics, Monohybrid cross activities

Week 3. Non-Mendelian Genetics, Start Dihybrid crosses.

Week 4. Finish Dihybrid Crosses, Mid-Course Examination.

Week 5. Protein Synthesis

Week 6. Mutations, Pedigrees, and End of course examination.

References

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