Modern Tools and Techniques

Content Area: **Science**
Course(s): **CP Genetics**
Time Period: **Marking Period 2**
Length: **2.5 weeks**
Status: **Published**

Course Pacing Guide

Unit	MP/Trimester	Weeks
• DNA and the Central Dogma- Structure and Replication	1	2
• DNA and the Central Dogma- Protein Synthesis	1	2
• Meiosis, Prenatal Screening, and Genetic Family History	1	3
• Mendelian Genetics	1	2
• Non-Mendelian Genetics	2	3
• Genetics of Cancer	2	2.5
• Modern Tools and Techniques	2	2.5
• Genetic Disease Eradication	2	1

Unit Overview

- The students will focus on modern tools and techniques in molecular biology, genetics and genomics. Students will begin by being taught Sanger sequencing of DNA, followed by the importance advancement of shotgun sequencing, and next gen sequencing (illumina). Students will also compare and contrast genomics, transcriptomics, exomics, and SNP databases. Students will discuss the importance, future, and ethics surrounding genome sequencing and information privacy.
- Students will investigate what GWAS studies are and convince me of their value by together proposing a GWAS study (they might write up an experimental proposal). Students will investigate a recent seminal paper using GWAS.
- Students will investigate CRISPR, learn about the CRISPR babies, and read recent studies using CRISPR to modify human cells.
- Students will self-select which group they want to be in (GWAS, CRISPR, or genomics) and create a presentation in which they discuss the technique and its potential for future use in the field of medicine and technology.

Key Terms: SNPs, Sanger sequencing, dideoxynucleotides, primers, chromatography, shotgun sequencing, nextgen sequence, genome coverage, genomics; GWAS, lod; CRISPR, Cas-9, homologous recombination, indels, PAM site

Enduring Understandings

- Students will investigate SNPs, Sanger sequencing, dideoxynucleosides, primers, chromatography, shotgun sequencing, nextgen sequence, genome coverage, genomics; GWAS, lod; CRISPR, Cas-9, homologous recombination, indels, PAM site

Essential Questions

- How is the sequence of nucleotides determines for a specific stretch of DNA?
- How was the first genome sequenced? Why was chromosome walking insufficient?
- What is shotgun sequencing and why was it such an important advancement in genomics?
- How is next gen sequencing an improvement over Sanger sequencing? In what scenario would it be a disadvantage compared to Sanger sequencing?
- What groups of individuals are studied in GWAS? How does GWAS help in identification of alleles associated with (and possibly the cause of) disease?
- How is the CRISPR/Cas-9 system used to modify genomes? Are there ethical concerns using this system moving forward?

New Jersey Student Learning Standards (No CCS)

9-12.HS-LS1-1	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.
9-12.HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
9-12.HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
9-12.HS-LS3-1	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Amistad Integration

Discuss the 23andMe-based study in which genomics has facilitated discovery of African American ancestory, and also provides insights into slave treatment/forced reproduction. This may or may not occur in this unit, but this may be covered at the appropriate time in the course.

Holocaust/Genocide Education

Students will have an ethics discussion about the concepts of hate-based discrimmination, and how genomics can play a role in reshaping the way we view each other. This may or may not occur in this unit, but this may be covered at the appropriate time in the course.

Interdisciplinary Connections

LA.RL.11-12.1	Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
LA.RL.11-12.2	Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
LA.RL.11-12.4	Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (e.g., Shakespeare as well as other authors.)
MA.S-CP.A.2	Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
MA.S-CP.A.3	Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

MA.S-CP.B.9	Use permutations and combinations to compute probabilities of compound events and solve problems.
MA.S-MD.B.6	Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).
MA.S-MD.B.7	Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).
SOC.6.1.12.A.16.b	Analyze government efforts to address intellectual property rights, personal privacy, and other ethical issues in science, medicine, and business that arise from the global use of new technologies.

Technology Standards

TECH.8.1.12.A.3	Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.
TECH.8.1.12.A.CS1	Understand and use technology systems.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.C.CS1	Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media.
TECH.8.1.12.C.CS2	Communicate information and ideas to multiple audiences using a variety of media and formats.
TECH.8.1.12.C.CS4	Contribute to project teams to produce original works or solve problems.
TECH.8.1.12.E.CS2	Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
TECH.8.1.12.E.CS3	Evaluate and select information sources and digital tools based on the appropriateness for specific tasks.

21st Century Themes/Careers

CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
CRP.K-12.CRP11.1	Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

Financial Literacy Integration

Students will address these standards through common health issues, such as funding allocation vs. disease commonality, healthcare costs vs. cost of new medicine, ethics of compassionate use in pharmaceuticals, and personalized medicine.

PFL.9.1.12.A.3	Analyze the relationship between various careers and personal earning goals.
PFL.9.1.12.A.6	Summarize the financial risks and benefits of entrepreneurship as a career choice.
PFL.9.1.12.B.1	Prioritize financial decisions by systematically considering alternatives and possible consequences.
PFL.9.1.12.G.1	Analyze risks and benefits in various financial situations.
PFL.9.1.12.G.3	Compare the cost of various types of insurance (e.g., life, homeowners, motor vehicle) for the same product or service, given different liability limits and risk factors.

Instructional Strategies & Learning Activities

- Students will be reminded of DNA replication (with focus on primase), instructed of what dideoxynucleotides are, and then asked to figure out how Sanger sequencing works.

- Students will be given an autoradiograph, have to determine the sequence, and then determine which gene the sequence is from.

- Students will analyze a chromatogram and discuss the improvements in Sanger sequencing.

-Students will be taught next gen sequencing by direct instruction.

- Students will summarize the different types of "omics," and state the pros and cons of each.

- Students will brainstorm, hypothesize and propose how the molecular nature of disease can be discovered today with "omics"

- Students will review an article using GWAS and draw conclusions.

- Students will propose their own GWAS study, and indicate what disease they are attempting to understand.

- Student will be taught CRISPR/Cas-9 by direct instruction, have a conversation regarding ethics, and propose one disease that can be treated/alteration that can be made with this system (specific nucleotide changes must be given and justified).

Differentiated Instruction

Favored strategies:

- Inquiry/Problem-Based Learning
- Learning preferences integration (visual, auditory, kinesthetic)
- Meaningful Student Voice & Choice
- Relationship-Building & Team-Building
- Self-Directed Learning
- Mastery Learning (feedback toward goal)
- Grouping
- Socratic Seminar
- Jigsaws
- Concept Attainment
- Mentoring
- Assessment Design & Backwards Planning

Formative Assessments

Informal conversation

Questioning

Small scale homeworks

Summative Assessment

Mini-proposals for each mini-topic

Benchmark Assessments

Final examination

Alternate Assessments

None

Resources & Technology

Students will access a wide vartiety of online resources, including the free open stax biology text (https://openstax.org/details/books/biology-2e). Online resources include, but are not limited to NCBI, OMIM, Sequence alignment tools, GWAS studies, etc. Students will investigate recent technological advances in genome sequencing, gene editing, and gene therapy mechanisms.

BOE Approved Texts

Closure

Includes:

- Sequence It - create timelines of major events discussed
- Ask a question. Give students ten seconds to confer with peers before you call on a random student to answer. Repeat.
- Have kids orally describe a concept, procedure, or skill in terms so simple that a child in first grade would get it.
- Direct kids to raise their hands if they can answer your questions.
- Have students confer with each other, and have each group summarize a main concept, or ask a question.
- Smaller assessments like a "quest" or presentation
- Turn and Talk- present a situation, students discuss, then present

ELL

Includes:

- Alternate Responses
- Teacher Modeling
- Simplified Written and Verbal Instructions
- E-Dictionaires
- Google Translate

Special Education

List is not inclusive but may (as the IEP document indicates):

- Shorten assignments to focus on mastery of key concepts.
- Shorten spelling tests to focus on mastering the most functional words.
- Substitute alternatives for written assignments (clay models, posters, panoramas, collections, etc.)
- Reduce visual distractions in the classroom (mobiles, etc.).
- Provide a computer for written work.
- Seat the student close to the teacher or a positive role model.
- Provide an unobstructed view of the chalkboard, teacher, movie screen, etc.
- Keep extra supplies of classroom materials (pencils, books) on hand.
- Maintain adequate space between desks.
- Give directions in small steps and in as few words as possible.
- Number and sequence the steps in a task.
- Have student repeat the directions for a task.
- Provide visual aids.
- Go over directions orally.
- Provide a vocabulary list with definitions.
- Divide tests into small sections of similar questions or problems.
- Allow the student to complete an independent project as an alternative test.
- Give progress reports instead of grades.
- Grade spelling separately from content.
- Stand near the student when giving directions or presenting a lesson.
- Use a pass-fail or an alternative grading system when the student is assessed on his or her own growth.

504

Examples of accommodations in 504 plans include but are not limited to:

- preferential seating
- extended time on tests and assignments
- reduced homework or classwork
- verbal, visual, or technology aids
- modified textbooks or audio-video materials
- pre-approved nurse's office visits and accompaniment to visits

- occupational or physical therapy

At Risk

Examples may include:

- Use of mnemonics
- Have student restate information
- Provision of notes or outlines
- Concrete examples
- Use of a study carrel
- Assistance in maintaining uncluttered space
- Weekly home-school communication tools (notebook, daily log, phone calls or email messages)
- Peer or scribe note-taking
- Lab and math sheets with highlighted instructions
- Graph paper to assist in organizing or lining up math problems
- Use of manipulatives
- No penalty for spelling errors or sloppy handwriting
- Follow a routine/schedule
- Teach time management skills
- Verbal and visual cues regarding directions and staying on task
- Adjusted assignment timelines
- Visual daily schedule
- Immediate feedback
- Work-in-progress check
- Pace long-term projects
- Preview test procedures
- Film or video supplements in place of reading text
- Pass/no pass option
- Cue/model expected behavior
- Use de-escalating strategies
- Use peer supports and mentoring
- Have parent sign homework/behavior chart
- Chart progress and maintain data

Gifted and Talented

Foster student interest in science, promote development of critical thinking and problem-solving skills, model and encourage transparency in thinking, and encourage risk-taking.