Course: *Genetics* **Unit #2:** *Cellular Basis of Cancer*	**Year of Implementation:** 2024-2025

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Stage One - Desired Results

Link(s) to New Jersey Student Learning Standards for this course:
{provide all applicable links to standards here}
https://www.state.nj.us/education/cccs/2020/

Science and Engineering Practices
The content of this unit will strengthen student skills in the following SEPs.

- Practice 1 Ask Questions
- Practice 2 Developing and Using Models
- Practice 3 Planning and Carrying Out Investigations
- Practice 4 Analyzing and Interpreting Data
- Practice 5 Using Mathematics and Computational Thinking
- Practice 6 Constructing Explanations and Designing Solutions
- Practice 7 Engaging in Argument from Evidence
- Practice 8 Obtain, Evaluate and Communicate Information

LS1.A: Structure and Function

- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS -LS1-1.) (SEP 1, 2, 4)

LS3.A: Inheritance of Traits

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA . The instructions for forming species' characteristics are carried in DNA . All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known

function. (HS-LS3-1) (SEP 1, 2, 3, 4)

LS3.B: Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) (SEP 1, 2, 3, 4, 5)
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3) (SEP 1, 4)

LS4.A: Evidence of Common Ancestry and Diversity

- Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1) (SEP 1, 3, 4)

WHST.9-12.7

- Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. *(HS-LS4-6) (SEP 4, 6, 7, 8)*

WHST.11-12.8

- Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3) (SEP 4, 6, 8)

RST.11-12.1

- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1),(HS-LS1-6) (SEP 4, 6)

- **Unit Standards:** *(keep each of the following headings in place)*
  - ***Content Standards***
    - List all content-specific standards that apply to this unit here
  - ***21st Century Life & Career Standards***
    - A new chemotherapy treatment for cancer has been developed and before they consider using the treatment for use, the new drug must be extensively researched to determine toxicity level, side

effects, and the effective dosage. This information must be known prior to release of the new treatment to make sure the dosage is high enough to be effective, but low enough that it does not inhibit normal cellular processes or kill normal cells. Create a clinical trial that outlines the dosage of the new drug, and details the experimental set-up of how the trial will run for patients. (**9.4.12.CI.1:** Demonstrate the ability to reflect, analyze, and use creative skills and ideas **9.4.12.CT.1:** Identify problem-solving strategies used in the development of an innovative product or practice **9.4.12.TL.2:** Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data)

- ***English Companion Standards***
  - List grade-level appropriate companion standards for History, Social Studies, Science and Technical Subjects (CTE/Arts) 9-12. English Companion Standards are required only in these subject/content areas. This section can be deleted for all other content areas.
  - Grade 9-10 Companion Standards: https://www.nj.gov/education/standards/ela/Docs/2016NJSLS-ELA_Companion9-10.pdf
  - Grade 11-12 Companion Standards: https://www.nj.gov/education/standards/ela/Docs/2016NJSLS-ELA_Companion11-12.pdf
- ***Interdisciplinary Content Standards***
  - List any standards from other content areas that apply to this unit.
- ***NJ Statutes:*** NJ State law mandates the inclusion of the following topics in lesson design and instruction as aligned to elementary and secondary curriculum.

  Amistad Law: N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

  Holocaust Law: N.J.S.A. 18A:35-28 Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35 A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36) A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.

Diversity and Inclusion (N.J.S.A. 18A:35-4.36a) A board of education shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards.

Asian American and Pacific Islanders (AAPI) P.L.2021, c.410 Ensures that the contributions, history, and heritage of Asian Americans and Pacific Islanders (AAPI) are included in the New Jersey Student Learning Standards (NJSLS) for Social Studies in kindergarten through Grade 12 (P.L.2021, c.416)

For additional information, see

NJ Amistad Curriculum: ***https://www.nj.gov/education/amistad/about/***

Diversity and Inclusion: ***https://www.nj.gov/education/standards/dei/index.shtml***

- *(Sample Activities/ Lessons):* ***https://www.nj.gov/education/standards/dei/samples/index.shtml***

Asian American and Pacific Islanders:

- ***Asian American and Pacific Islander Heritage and History in the U.S.***
  A Teacher's Guide from EDSITEment offering a collection of lessons and resources for K-12 social studies, literature and arts classrooms that center around the experiences, achievements and perspectives of Asian Americans and Pacific Islanders across U.S. history.

Transfer Goal:
Students will be able to independently use their learning to analyze the genetic components and environmental triggers that negatively impact the cell cycle and lead to the genetic phenomenon of cancer and other genetic disorders.

As aligned with LRHSD Long Term Learning Goal(s):https://www.lrhsd.org/Page/6163

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- design, critique, and carry out experiments in order to investigate scientific questions and/or propose solutions
- collect, interpret, and analyze data in order to solve a defined problem
- apply mathematics to express relationships efficiently and accurately
- draw evidence-based conclusions from data in order to make informed decisions;
- construct, interpret, and refine models (scientific and mathematical) to explain the physical and natural world
- effectively communicate scientific ideas and evidence-based arguments to an appropriate audience through written and oral means
- evaluate for their validity arguments that rely on scientific reasoning presented in the popular press and informational sources

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<u>Enduring Understandings</u>
Students will understand that. . .

EU 1
Growth and development is highly regulated under genetic control.

EU 2
Cancer, a genetic disorder that can be caused by multiple modalities, can be diagnosed in a variety of ways.

EU 3
Lifestyle choices may play a role in the future development of cancer

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<u>Essential Questions</u>

- How does genetic regulation influence cancer development and progression?

- How does genetic predisposition and environmental exposure increase the risk of cancer development?

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<u>Knowledge</u>
Students will know . . .

EU1

- the phases of mitosis and meiosis during healthy cellular division. (LS3.B) (SEP 1, 2, 3, 4, 5)

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<u>Skills</u>
Students will be able to. . .

EU1

- differentiate between the phases of mitosis and meiosis. (LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5)
- explain the role of each checkpoint in normal cell

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● the function of the checkpoints throughout the cell cycle. (LS3.A) *EU2* ● that oncogenes and tumor suppressor genes regulate the cell cycle. (LS3.A) ● that disruption to these genes affect normal cellular division. (LS3.A) ● the predisposition for cancer development may be inherited. (LS1.A, LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● that cancerous cells look different microscopically. (LS1.A, LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● that blood antigens may signal the presence of cancer. (LS1.A, LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● that genes are expressed differently in cancer cells. (LS1.A, LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● that abnormal gene sequences can be identified and isolated. (LS1.A, LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) *EU3* ● the molecules in processed/synthetic food and the way food is prepared may disrupt and/or change genetic sequences. (LS1.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● exposure to UV light and x-ray can mutate DNA. (LS3.B) (SEP 1, 2, 3, 4, 5) ● environmental toxins in air and water can mutate DNA. (LS3.B) (SEP 1, 2, 3, 4, 5) ● temperate viruses can disrupt normal DNA sequences. (LS3.B) (SEP 1, 2, 3, 4, 5) ● regular exercise can promote healthy metabolism and cellular repair (LS3.B) (SEP 1, 2, 3, 4, 5)	division. (LS3.A) *EU2* ● compare and contrast the oppositional roles of oncogenes and tumor suppressor genes in cell cycle regulation. (LS3.A) ● predict the effects of mutation(s) in oncogenes and tumor suppressor genes. (LS3.B) (SEP 1, 2, 3, 4, 5) ● compare and contrast normal cells to cancer cells microscopically recognize the concept and evaluate the results of a blood-based screening for cancer. (LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● explain the effects of mutations in the p53 tumor suppressor gene and its role in familial cancers. (LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● explain how viral genomics can affect normal cell function (LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) *EU3* ● evaluate their own lifestyle for risk factors that may lead to cancer. (LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5) ● discuss the likelihood of developing cancer with an inherited predisposition. (LS3.A, LS3.B) (SEP 1, 2, 3, 4, 5)
Stage Two - Assessment	

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Stage Three - Instruction

Learning Plan: **Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.** *{place A, M and/or T along with the applicable EU number in parentheses after each statement} All knowledge and skills must be addressed in this section with a corresponding lesson/activity which teaches each concept. The following color codes are used to notate activities that correspond with interdisciplinary connections and 21st Century Life & Career Connections (which involves Technology Literacy): Red = Interdisciplinary Connection; Purple = 21st Century Life & Career Connection*

PHENOMENON: Why is Henrietta Lacks (cells) so special?
Link: https://www.hopkinsmedicine.org/henriettalacks/

GOAL: Students will discover the impact(s) of HELA cells on genetic-based cancer discoveries.

1. Activity 1: Show the following video: The Immortal Life of Henrietta Lacks (A) **(EU1, EU2, EU3)**
    a. Students list the pros and cons related to the case of Henrietta Lacks (A/M)
    b. Create a class T chart summarizing the pros and cons of the case. Include ethics of informed consent. (A/M)

2. Activity 2: Teacher-led discussion on the cell cycle, including checkpoints (A/M/T) **(EU1)**
    a. Relate back to phenomena- what went wrong with Henrietta Lacks' cells? (A/M/T)

3. Activity 3: Mitosis Lab (see Supporting Instructional Framework for examples of labs) (A/M) **(EU1)**

4. Activity 4: Teacher- led discussion on cancer (A/M/T) **(EU1, EU2, EU3)**

5. Activity 5: Labs to support understanding of cancer and cancer detection technologies. Students will be able to answer the following questions while completing these labs (A/M/T) **(EU1, EU2, EU3)**:
    a. What do cancer cells look like? (see Supporting Instructional Framework for examples of labs)
    b. What tests do we use to identify cancer? (see Supporting Instructional Framework for examples of labs)
    c. Relate back to phenomena- How were these diagnostic tools used in the discovery of HeLa cells? (T)

6. Activity 6: Cancer research project (A/M/T) **(EU2, EU3)**

7. Activity 7: HBO Documentary Video and/or excerpts from book The Immortal life of Henrietta Lacks by Rebecca Skloot - (A) **(EU1, EU2, EU3)**
    a. Relate back to phenomena- Why is Henrietta Lacks so special? (T)
    b. Discuss specific genetic-based cancer discoveries made using HeLa cells.
    c. Engage students in a class discussion or small group activity to analyze and interpret the impact of HeLa cells on cancer research.

8. Culminating Activity: Synthesis and Reflection (M/T) **(EU1, EU2, EU3)**
    a. Assign an individual or group project where students synthesize their learning from the previous activities.
    b. Engage students in a class discussion on the ethical considerations related to the use of HeLa cells and human tissue in research.
    c. Encourage students to reflect on the balance between scientific progress and ethical considerations.
    d. Have students present their reflections or engage in a debate/discussion to further explore the topic.
    e. Incorporate reflective prompts to encourage students to analyze their own perspectives and insights gained throughout the learning process.

Interdisciplinary Connections:
Language Arts: Read and analyze excerpts from the book "The Immortal Life of Henrietta Lacks" by Rebecca Skloot, focusing on the ethical and social implications of the case. Write a persuasive essay or argumentative speech discussing the importance of informed consent in medical research.
Social Studies: Investigate the historical context of medical research and the treatment of minority populations, exploring issues of ethics, justice, and inequality. Analyze the impact of the Henrietta Lacks case on medical ethics and informed consent practices. Engage in discussions or debates on the ethical considerations surrounding the use of human tissue in scientific research. Examine the concepts of informed consent, privacy, and ownership of biological materials in the context of medical research.

Supporting Instructional Framework:
- Presentation overview of cellular division (mitosis and meiosis), cell cycle, and checkpoints - A
- Carolina Biological - Onion Mitosis (primary growth) - M

- Presentation overview of the hallmarks of cancer - A
- Edvotek #990 - Morphology of Cancer Cells Lab – A, M, T
- Pedigree case study review – A, M
- Edvotek #115 - Cancer Gene Detection Lab – A, M, T
- Edvotek #314 - In Search of the Cancer Gene – A, M, T
- Carolina Biological - DNA Damage: Studying the impact of UV Light – A, M, T
- Carolina Biological – DNA Chips and/or Edvotek #235 - Microarray– A, M, T

- Edvotek #141- Blood Based Cancer Diagnostics – A, M, T
- Cancer Research Project/presentation – A, M, T
- Create a healthy lifestyle poster that could be marketed as a PSA for the NIH - A, M, T
- Insidecancer.org - see activities on website/teacher webquest resources – A, M
- HELA cells and Henrietta Lacks – HBO Documentary Video and/or excerpts from book The Immortal life of Henrietta Lacks by Rebecca Skloot - A
- NOVA video – Curing Cancer – A

- Discussion of Sanger sequencing techniques and the Human Genome Project - A
- Sequencing the Human Genome Lab and/or Principles of DNA Sequencing Lab - Ready to load DNA Sequencing Lab – A, M, T

Pacing Guide

{This chart will be identical in all of the units for this course.}

Unit #	***Title of Unit***	***Approximate # of teaching days***
1	*Fundamental Concepts, Bioethics, and Applications for the Modern Geneticist*	33
2	*Cellular Basis of Cancer*	34
3	*Gene Expression, Inheritance and Statistical Analysis*	34
4	*Applying Modern Technology, Lab Skills, and Bioinformatics to Investigate Current Genetic Issues*	34

Instructional Materials

- *Micropipettes and tips (various sizes)*
- *Gel electrophoresis machine(s) and consumables*
- *PCR/thermal cyclers and PCR tubes*
- *Microwave*
- *Melt & pour agarose*
- *Buffer(s)*
- *e-Gels*
- *Graduated cylinders*
- *Various lab kits/perishables (*see learning plan for specific kit numbers/vendors)*
- *Large Post-It Note Presentation boards*
- *Genome book by Matthew Ridley*

Accommodations

Special Education: The curriculum will be modified as per the Individualized Education Plan (IEP). Students will be accommodated based on specific accommodations listed in the IEP.

Students with 504 Plans: Students will be accommodated based on specific accommodations listed in the 504 Plan.

English Language Learners: Students will be accommodated based on individual need and in consultation with the ELL teacher.

Students at Risk of School Failure: Students will be accommodated based on individual need and provided various structural supports through their school.

Gifted and Talented Students: Students will be challenged to enhance their knowledge and skills through acceleration and additional independent research on the subject matter.