Winslow Township School District
Human Genetics Lab CP (Semester Course)
Unit 3: Gene Expression, Inheritance, and Statistical Analysis

Overview: In this unit students will develop a conceptual understanding of gene expression, inheritance, and statistical analysis using hands-on instruction, interactive note booking, observations of and interactions with natural phenomena and the use of engineering and design processes to identify problems, plan, test and revise possible solutions. Students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data. Students are also expected to use these practices to demonstrate understanding of the core ideas while independently use their learning to predict gene expression and quantify probability of inheritance using statistical analysis.

Overview	Standards for Science	Unit Focus	Essential Questions
Unit 3 **Gene Expression, Inheritance, and Statistical Analysis**	• **HS-LS1-1** • **HS-LS3-3** • **HS-LS4-3** • **HS-ETS1-1** • **WIDA 1, 4**	• build a model of DNA. • illustrate the processes of DNA replication and protein synthesis. • model gene expression in prokaryotic and eukaryotic cells. • algebraically solve multifactorial probability using binomial expansion and chi square analysis. • predict the outcome of Neo-Mendelian traits (codominance, incomplete dominance, sex-linkage, polygenetic inheritance, epistasis). • calculate the impact of lethal alleles on offspring probability.	• How is DNAs structure related to its function? • How does the central dogma relate foundational understanding of DNA and gene expression? • Why are certain genes expressed, while other genes are suppressed? • How are genes turned on and off in prokaryotes and eukaryotes? • How and why are prokaryote and eukaryote gene expression mechanisms different?

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Unit 3: Enduring Understandings	• DNA structure is essential to its function as the template for protein synthesis. • Genes are selectively turned on and off in both prokaryotic and eukaryotic cells. • Probability of inheritance of genetic traits can be quantified. • Dominant and recessive inheritance is only one type of transmission of traits. • Mutation(s) can affect gene expression.	• Why does inheritance follow a mathematical model? • How can the simultaneous inheritance of different traits be determined mathematically? • How has our understanding of Neo-Mendelian genetics changed the calculations and analysis of predicted outcomes? • Do all mutations have the same effect on gene expression?

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Curriculum Unit 3	Standards		Pacing	
			Days	Unit Days
Unit 3: **Gene Expression, Inheritance, and Statistical Analysis**	**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.	5	22
	HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	5	
	HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.	6	
	HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	4	
	Assessment, Re-teach and Extension		2	

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Unit 3 - Human Genetics Lab CP		
Disciplinary Core Ideas	**Indicator #**	**Indicator**
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. (HS -LS1-1.)	**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.
LS3.B: Variation of Traits 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-LS3-3)	**HS-LS3-3**	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
LS4.B: Natural Selection Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-3) The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)	**HS-LS4-3**	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
LS4.C: Adaptation Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3) Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3) **ETS1.A: Defining and Delimiting Engineering Problems** Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)	**HS-ETS1-1**	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

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Unit 3 – Human Genetics Lab CP	
Assessment Plan	
• Exploratory activities • Warm-up/Ticket Out activities • Class discussions • Student Participation • Teacher Observations • Virtual/Hands-On Labs • Self-Test Assessments • Scientist Timeline Activity • Clinical Case Study Analysis	• Quizzes and Tests (Chapter 16, 17 and 24 of Textbook, "Genetics: A Conceptual Approach, 6th edition by Benjamin A. Pierce) • Authentic assessments and projects • Exploratory activities • Presentations • Lecture Notes • Think-Pair-Share • Graphic Organizers • Study Questions at the end of each chapter • Multiple Choice and Critical Thinking at the end of each chapter
Resources	**Activities**

- Chromebooks
- Textbook ("Genetics: A Conceptual Approach, 6th ed by Benjamin A. Pierce)
- Web Quests
- Virtual Field Trips
- Video Streaming
- BrainPOP
- Puzzlemaker: Game Based Learning | Discovery Education

Diversity, Equity & Inclusion Educational Resources
https://www.nj.gov/education/standards/dei/

- Use various forms of expository writing-procedural writing, narrative writing, descriptive writing, labeling, as well as to create visuals, graphs, tables, diagrams and charts.
- Use scientific argumentation with exercises on writing claims, using evidence to support your claim and explaining the reasoning behind their claim.
- Mini-lessons
- Independent reading
- Films
- Website exploration
- Discussions, dialogues
- Debates
- Laboratory experiments
- Partner or small group work
- Student presentations, reports, journals, reflections
- In-class assessments
- Written reports, essays, research, and homework

Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.
- Intro to Gene regulation/Gene Expression [modeling kits] – A, M
- Probability/Statistics/Chi Square Problems – A, M, T
- Chi Square Lab/ Probability Labs (m&m lab or equivalent) – A, M, T
- Carolina Biological - Mendelian Genetics of Corn Lab – A, M, T
- Carolina Biological - Natures Dice: A Genetics Screening Simulation (Sex linked traits) – A, M, T
- Fly Lab and/or Brassica Rapa Fast Plants Lab (through 2 generations to demonstrate Mendelian Genetics and x2) – A, M, T
- Punnett Squares – A, M, T
- Forked Line Method problems – A, M
- Neo-Mendelian Genetic problems – A, M
- Binomial Expansion problems – A, M

- Epistasis problems – A, M
- Edvotek #118 – Hypocholesteremia Lab– A, M, T
- Edvotek #346 - In Search of the Alcohol Gene– A, M, T
- Carolina Biological - Alcohol Tolerance in Fruit Fly– A, M, T
- Edvotek #S-49 – In Search of my Father – A, M, T
- Edvotek #S-51 – Who's DNA was left behind? – A, M, T
- Chromosome Mapping and Gene/Genetic Disorder project – A, M
- Romanovs (dnai.org activities) – A, M
- Genetic Origins (dnai.org activities) – A, M
- mtDNA lab and/or ALU lab and/or DS180 lab– A, M, T
- Carolina Biological – Using SNP to predict bitter tasting ability (PTC) or Edvotek #345 – Exploring the Genetics of Taste– A, M, T
- NOVA video – Ghost in your Genes - A
- Philadelphia Zoo Behind the Scenes Breeding/Genetics Tour– A, M, T
- Dr. Mutter's Marvels by Christin O'Keefe Aptowicz – A, M
- The Sports Gene Inside the Science of Extraordinary Athletic Performance by David Epstein– A, M
- Video - Race for the Double Helix – A

Instructional Best Practices and Exemplars	
1. Identifying similarities and differences	6. Cooperative learning
2. Summarizing and note taking	7. Setting objectives and providing feedback
3. Reinforcing effort and providing recognition	8. Generating and testing hypotheses
4. Homework and practice	9. Cues, questions, and advance organizers
5. Nonlinguistic representations	10. Manage response rates

9.1 Personal Financial Literacy, 9.2 Career Awareness, Exploration, Preparation and Training & 9.4 Life Literacies and Key Skills

The implementation of the 21st Century skills and standards for students of the Winslow Township District is infused in an interdisciplinary format in a variety of curriculum areas that include, English language Arts, Mathematics, School Guidance, Social Studies, Technology, Visual and Performing Arts, Science, Physical Education and Health, and World Language.

Additional opportunities to address 9.1, 9.2 & 9.4:

Philadelphia Mint

https://www.usmint.gov/learn/kids/resources/educational-standards

Different ways to teach Financial Literacy.

https://www.makeuseof.com/tag/10-interactive-financial-websites-teach-kids-money-management-skills/

- 9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.
- 9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
- 9.4.12.DC.1: Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content (e.g., 6.1.12.CivicsPR.16.a).
- 9.4.12.DC.2: Compare and contrast international differences in copyright laws and ethics.
- 9.4.12.DC.7: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society (e.g., 6.1.12.CivicsPD.16.a).

Modifications for Special Education/504

Students with special needs: The students' needs will be addressed on an individual and grade level using a variety of modalities. Accommodations will be made for those students who need extra time to complete assignment. Support staff will be available to aid students related to IEP specifications. 504 accommodations will also be attended to by all instructional leaders. Physical expectations and modifications, alternative assessments, and scaffolding strategies will be used to support this learning. The use of Universal Design for Learning (UDL) will be considered for all   students as teaching strategies are considered.

- Small group instruction

- Audio books/ Text-to-speech platforms

- Leveled texts/Vocabulary Readers

- Leveled informational texts via online

- Modeling and guided practice

- Read directions aloud

- Repeat, rephrase and clarify directions

- Extended time as needed

- Break down assignments into smaller units

- Provide shortened assignments

- Modify testing format

- Repeat directions as needed

- Graphic organizers

- Study Guides, Study Aids and Re teaching as needed

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Modifications for At-Risk Students

Formative and summative data will be used to monitor student success. At first signs of failure, student work will be reviewed to determine support. This may include parent consultation, basic skills review and differentiation strategies. With considerations to UDL, time may be a factor in overcoming developmental considerations

- Audio books and Text-to-speech platforms

- Leveled texts/Vocabulary Readers

- Leveled informational texts via online

- Extended time as needed

- Read directions aloud

- Assist with organization

- Use of computer

- Emphasize/highlight key concepts

- Recognize success

- Provide timelines for work completion

- Break down multi-step tasks into smaller chunks

- Provide copy of class notes and graphic organizer

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English Language Learners	Modifications for Gifted Students

All WIDA Can Do Descriptors can be found at this link:
https://wida.wisc.edu/teach/can-do/descriptors
Grades 9-12 WIDA Can Do Descriptors...
Listening…
• Process <u>recounts</u> by…
  ○ Categorizing perspectives of multiple speakers
  ○ Identifying important information on specific event & concept from lecture/presentation
• Process <u>explanations</u> by…
  ○ Recognizing specific language used to enhance clarity and precision
  ○ Recognizing and following language related to the same event or phenomenon throughout presentations
• Process <u>arguments</u> by…
  ○ Identifying strengths, limitations, and potential biases from oral presentations
  ○ Organizing claims and counter claims presented in debates
Speaking…
• <u>Recount</u> by…
  ○ Adjusting presentation style, degree of formality, word choice, tone, and information to the context and audience
  ○ Presenting information that follows discipline specific organization (e.g., orientation to topic, sequence of events, conclusion)
• <u>Explain</u> by…
  ○ Providing precision and accuracy in classifications, procedures, processes, and accounts using abstraction, technical language, and a variety of active/passive verb forms
  ○ Following discipline-specific organization (e.g., orienting the reader, details, conclusion) and supporting presentations with graphs, formulas, quotes or other media
• <u>Argue</u> by…
  ○ Organizing claims and counter claims in debates with evidence from multiple sources
  ○ Negotiating differing cultural perspectives in pairs or small groups
Reading…
• Process <u>recounts</u> by…
  ○ Analyzing and comparing how authors use language for specific purposes and audiences
  ○ Identifying how authors develop and maintain cohesion by connecting ideas or events in extended texts
• Process <u>explanations</u> by…
  ○ Recognizing discipline-specific patterns (e.g., orienting the reader, part-whole classification, neutral/ authoritative tone)
  ○
	Students excelling in mastery of standards will be challenged with complex, high level challenges related to the topic.
	• Raise levels of intellectual demands
	• Require higher order thinking, communication, and leadership skills
	• Differentiate content, process, or product according to student's readiness, interests, and/or learning styles
	• Provide higher level texts
	• Expand use of open-ended, abstract questions
	• Critical and creative thinking activities that provide an emphasis on research and in-depth study
	• Enrichment Activities/Project-Based Learning/ Independent Study
	
	Additional Strategies may be located at the links:
	❖ Gifted Programming Standards
	❖ Webb's Depth of Knowledge Levels and/or Revised Bloom's Taxonomy
	❖ REVISED Bloom's Taxonomy Action Verbs

- o Identifying authors' precision and accuracy in classifications, comparisons, accounts, or procedures as a result of clear language choices
- Process <u>arguments</u> by…
  - o Evaluating word choice and nuance as tools for distinguishing facts, claims, reasoned judgment, and opinions
  - o Identifying the logical connections among claims, counterclaims, reasons, and evidence

Writing…
- <u>Recount</u> by…
  - o Summarizing content-related notes from lectures or readings
  - o Producing research reports using multiple sources of information
- <u>Explain</u> by…
  - o Developing ideas about phenomena with relevant and sufficient facts, extended descriptions, concrete details, or quotations
  - o Maintaining discipline-specific patterns that bridge across key uses (e.g., explanation to argument in history, explanation to recount for information reports)
- <u>Argue</u> by…
  - o Evaluating positive and negative implications associated with various positions (e.g., historical events, scientific discoveries, individuals)
  - o Organizing information logically and coherently to represent contrasting views

Oral Language…
- <u>Discuss</u> by…
  - o Identifying and reacting to subtle differences in speech and register (e.g., hyperbole, satire, comedy)
  - o Producing coherent oral discourse appropriate to task, purpose, and audience
  - o Synthesizing and sharing information from a variety of sources and perspectives

Students will be provided with accommodations and modifications that may include:

- Relate to and identify commonalities in Social Studies and science in student's home country
- Assist with organization
- Use of computer
- Emphasize/highlight key concepts
- Teacher Modeling
- Peer Modeling
- Label Classroom Materials - Word Walls

Interdisciplinary Connections

English Language Arts/Literacy

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. **RST.11-12.1** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6)
2. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. **RST.11-12.7** (HS-LS2-6)
3. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. **RST.11-12.8** (HS-LS2-6)
4. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. **RST.11-12.9** (HS-ETS1-1),(HS-ETS1-3)
5. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. **WHST.9-12.2** (HS-LS2-1),(HS-LS2-2)
6. 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. **WHST.9-12.7** (HS-LS1-3)
7. 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. **WHST.11-12.8** (HS-LS1-3)
8. Draw evidence from informational texts to support analysis, reflection, and research. **WHST.9-12.9** (HS-LS1-1)
9. **WIDA Standards 1** English language learners communicate for social and instructional purposes within the school setting
10. **WIDA Standards 4** English language learners communicate information, ideas, and concepts necessary for academic success in the content area of science
11. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. **SL.11-12.5** (HS-LS1-2)

Mathematics
1. Reason abstractly and quantitatively. **MP.2** (HS-LS2-1),(HS-LS2-2),(HS-LS2-6)
2. Model with mathematics. **MP.4** (HS-LS2-1),(HS-LS2-2)
3. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays**. HSN.Q.A.1** (HS-LS2-1),(HS-LS2-2)
4. Define appropriate quantities for the purpose of descriptive modeling. **HSN.Q.A.2** (HS-LS2-1),(HS-LS2-2)
5. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. **HSN.Q.A.3** (HS-LS2-1),(HS-LS2-2)
6. Represent data with plots on the real number line. HSS-ID.A.1 (HS-LS2-6)
7. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. **HSS-IC.A.1** (HS-LS2-6)

Integration of Computer Science and Design Thinking NJSLS 8

8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
8.1.12.DA.2: Describe the trade-offs in how and where data is organized and stored.
8.2.12.ITH.1: Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.
8.2.12.ITH.3: Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.
8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment.
8.2.12.EC.1: Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
8.2.12.EC.2: Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
8.2.12.EC.3: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
8.2.12.ETW.4: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.