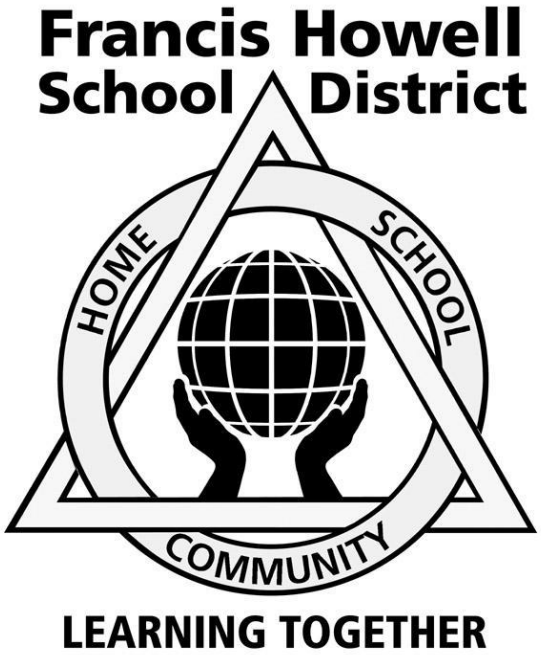
Genetics
Science Curriculum
Francis Howell School District



Board Approved: April 15, 2010

Francis Howell School District

Mission Statement

Francis Howell School District is a learning community where all students reach their full potential.

Vision Statement

Francis Howell School District is an educational leader that builds excellence through a collaborative culture that values students, parents, employees, and the community as partners in learning.

Values

Francis Howell School District is committed to:

- Providing a consistent and comprehensive education that fosters high levels of academic achievement for all
- Operating safe and well-maintained schools
- Promoting parent, community, student, and business involvement in support of the school district
- Ensuring fiscal responsibility
- Developing character and leadership

Francis Howell School District Graduate Goals

Upon completion of their academic study in the Francis Howell School District, students will be able to:

1. Gather, analyze and apply information and ideas.
2. Communicate effectively within and beyond the classroom.
3. Recognize and solve problems.
4. Make decisions and act as responsible members of society.

Science Graduate Goals

The students in the Francis Howell School District will graduate with the knowledge, skills, and attitudes essential to leading a productive, meaningful life.

Graduates will:

- Understand and apply principles of scientific investigation.
- Utilize the key concepts and principles of life, earth, and physical science to solve problems.
- Recognize that science is an ongoing human endeavor that helps us understand our world.
- Realize that science, mathematics, and technology are interdependent, each with strengths and limitations that impact the environment and society.
- Use scientific knowledge and scientific ways of thinking for individual and social purposes.

Course Rationale

Science education develops science literacy. Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. A sound grounding in science strengthens many of the skills that people use every day, like solving problems creatively, thinking critically, working cooperatively in teams, using technology effectively, and valuing life-long learning. Scientific literacy has become a necessity for everyone.

To accomplish this literacy, science courses will reflect the following:

- Develop scientific reasoning and critical thinking skills.
- Extend problem-solving skills using scientific methods.
- Include lab-based experiences.
- Strengthen positive attitudes about science.
- Incorporate the use of new technologies.
- Provide relevant connections to personal and societal issues and events.

Coding:

The Learner Objectives and the concepts are coded to the National Science Education Standards (NSES) and the Student To Do statements are coded to both NSES and the Concepts within the strand.

Example: (C1a; A)

"C1a" aligns to the National Science Education Standards
"A" aligns to the concept on the strand

Course Description

Biology III (Human Genetics) – Course #131275
Credit: 1 unit
Prerequisite: Completion of Biology with a grade of "C" or better recommended or teacher recommendation (Biology II is not required)

This is a rigorous course where students will study the science of genetics. Topics will include: human cellular processes, genetic inheritance with an emphasis on genetic abnormalities, immunity and cancer, human biotechnology, gene therapy, and microbiology. This course requires a high degree of independent initiative.

Francis Howell School District
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Francis Howell School District
Genetics Curriculum Map

First Semester: (First and Second Quarter)

Cells and Cancer	**Reproduction and Development**	**DNA Structure and Genomics**	**Proteins**	**Gene Expression and Mutation**
● Cell Structure and Function ● Cell Cycle ● Stem Cells ● Cancer **3 weeks**	● Reproductive Systems ● Meiosis ● Prenatal Development ● Birth Defects **3 weeks**	● DNA History ● DNA Structure ● DNA Analysis ● DNA Replication ● Genomics **3 weeks**	● Central Dogma ● Protein Function ● Protein Structure ● Protein Analysis **3 weeks**	● Gene Expression ● RNA Interference ● Gene Mutations **2weeks**

Second Semester: (Third and Fourth Quarter)

Mendelian Genetics & Exceptions ● Mendelian Laws ● Probability ● Punnett Squares ● Inheritance Patterns ● Pedigrees ● Gene Linkage **3.5 weeks**	**Gender & Multifactorial Traits** ● Gender Determination ● Sex-linked Inheritance ● Nature vs. Nurture ● Polygenetic Traits ● Correlational Studies **4 weeks**	**Cytogenetics** ● Karyotyping ● Chromosomal Mutations **2.5 weeks**	**Population Genetics** ● Hardy-Weinberg Principle ● Population Studies **3 weeks**	**GMOs & Gene Therapy** ● Biotechnology ● Transgenic Organisms ● Gene Therapy **4 weeks**

Content Area: Science	Course: Biology III (Genetics)	Strand: 1 - Cells & Cancer

Learner Objectives:
- Cells go through a natural progression of events to produce new cells. (C)

Concepts:
A. Cellular organelles work together to perform a specific function. (C1)
B. The cell cycle regulates cells during development, growth, and repair. (C1)
C. Errors in the cell cycle can lead to cancer. (C1)
D. All cells in the human body descend from stem cells. (C1)

Students Should Know	Students Should Be Able to
• Cells are the fundamental units of life which comprise the human body. • Inherited traits and illnesses can be understood at the cellular and molecular levels. • ~~All cells share certain features, but they are also specialized.~~ (This should have been covered in bio- review quickly if needed) • ~~Cells consist of primarily water and several types of macromolecules; carbohydrates, lipids, proteins, nucleic acids~~.(This should have been covered in bio- review quickly if needed) • Coordination of cell division (mitosis) and cell death (apoptosis) maintains cell numbers, enabling structures to enlarge during growth and development but preventing abnormal growth. • Mitosis proceeds in four stages; prophase, metaphase, anaphase, and telophase. (This should have been covered in bio- review quickly) • Cytokinesis separates cellular components into daughter cells. (This should have been covered in bio- review quickly) • Internal and external factors control the cell cycle. • Telomere size determines how many more cell divisions will occur. • Stem cells produce daughter cells that retain the ability to divide and specialize in particular ways. • Cancer is a loss of cell division control. • Cancer can be inherited (germline) or triggered by an environmental influence causing a mutation in a body cell (somatic). • Single genes (oncogenes and tumor suppressor genes), when mutated, can cause cancer.	• Describe how the organelles work together to coordinate basic life functions. (C1a; A) • Differentiate between different stages of the cell cycle. (C1d, C1f; B,C) • Demonstrate the process of mitosis. (C1f; B, C) (This should have been covered in bio- review quickly) • Predict changes that would result from errors at any checkpoint in the cell cycle. (C1c, C1f; C) • Differentiate between pluripotent, totipotent, and progenitor cells. (C1f; D) • ~~Explain how microarrays are used to diagnose and treat cancer.(C1f; C)~~ • Identify checkpoint genes in the cell cycle that if mutated can cause cancer. (C1d, C1f; B)) • Compare cancer cells with non-cancerous cells.(C1f; C) • Compare how oncogenes and tumor-suppressor genes cause cancer. (C1d, C1f; C)

● ~~New diagnostic approaches monitor expression of many genes.~~ ● Cancer cells have specific characteristics. ● Cancer cells are heritable, transplantable, and dedifferentiated, and lack contact inhibition. ● Proto-oncogenes can become oncogenes when they mutate. ● RB, p53, and BRCA1 genes encode tumor suppressors. ● Some cancers may be the culmination of a series of mutations in several genes. ● Lower cancer risk is associated with certain behaviors such as eating healthy and exercising. ● ~~Population, case-control, and prospective studies can reveal correlations between environmental exposures and the development of certain cancers, but usually cannot establish cause and effect.~~	

Instructional Support

Student Essential Vocabulary					
Eukaryotic	Peroxisome	Cell cycle	Chromosomes	Progenitor cells	Telomerase
Prokaryotic	Mitochondria	Interphase	Centrioles	Cancer	Somatic mutation
Organelles	Plasma membrane	Prophase	Chromatids	Benign	Germline mutation
Ribosome	Cytoskeleton	Metaphase	Telomere	Malignant	Proto-oncogenes
Nucleus	Mitosis	Anaphase	Necrosis	Metastasis	Retinoblastoma
Endoplasmic reticulum	Somatic cell	Telophase	Stem cells	Carcinogens	P53 gene
Golgi apparatus	Germ cell	Cytokinesis	Totipotent	Oncogenes	BRCA1 gene
Lysosome	Apoptosis	Centromere	Pluripotent	Tumor suppressor genes	

Sample Learning Activities

Learning Activity #1 : (See Appendix AA)

p53 Gene and Cancer - Students will learn about two tumor suppressor genes as they answer questions about a family with p53 related cancers. Students draw and analyze simple pedigrees and answer some ethical "what if" type questions. Takes one class period.

Activity's Alignment	
NSES	C2b, C2c, F6d
CONTENT	SC3, SC8
PROCESS	1.7- Evaluate information 1.8- Organize data and ideas 3.6- Examine solutions from many perspectives 3.8- Assess consequences
DOK	3-Stategic Thinking

Sample Assessments

Assessment #1: (See Appendix A)

Inheritance of Cancer Exit Card -

Students are asked to analyze a pedigree to determine a reason for reduced fertility in a family with inherited p53 mutations. They must be able to factually justify their answer.

Scoring Guide:

Jan and Greg both carry a mutated p53 gene. They are experiencing reduced fertility due to zygotes produced with 2 copies of the mutation. Answer should include a understanding that with two mutated copies of the gene, all cells would lack control of the cell cycle, would become cancerous, and would not perform their normal function. This is incompatible with life.

Assessment's Alignment	
NSES	C2c
CONTENT	SC3

INSTRUCTIONAL STRATEGIES	Nonlinguistic representations Generating and Testing Hypotheses
ISTE	

Learning Activity #2: (See Appendix B)
U.V. Light - In this activity, students use a strain of yeast that is missing DNA repair enzymes, so it is easily mutated. Students design their own investigation to determine the effect of sunscreen on the growth of these yeast cells. Takes from 2 to 5 days. Students prepare a laboratory report at the conclusion of the activity.

Activity's Alignment	
NSES	C2c, A1b, A1f
CONTENT	SC3, SC7
PROCESS	1.1- Develop research questions/ideas 1.2- Conduct research 1.3- Design/conduct investigations 3.5- Reason logically (inductive/deductive) 2.2- Revise communications 2.6- Apply communication techniques
DOK	4-Extended thinking
INSTRUCTIONAL STRATEGIES	Cooperative learning Generating and testing hypotheses
ISTE	

PROCESS	3.8- Assess consequences
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level – 85%
ISTE	

Assessment #2:
UV Light Constructed Response Question -
Design a procedure of at least five essential steps to test the effect of tanning booths on the mutation rate of UV light sensitive yeast.

Scoring guide:
Three points total; must include
(1) Steps are quantitative; another student could carry out the procedure
(1) Controls are included. Student is specific about how they would set up the independent variable and how the dependent variable would be measured.
(1) Procedure is logical and appropriate to answer the question.

Assessment's Alignment	
NSES	C2c, A1b
CONTENT	SC3, SC7
PROCESS	1.3- Design/conduct investigations 3.5 – Reason logically (inductive/deductive)
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 75%
ISTE	

Student Resources	Teacher Resources
Human Genetics, McGraw Hill, ©2005 Textbook website: www.mhhe.com/lewisgenetics6 Biotechnology: Science for the New Millennium, First Edition.	Human Genetics, McGraw Hill, ©2005 Textbook website: www.mhhe.com/lewisgenetics6 Biotechnology: Science for the New Millennium, First Edition.

Paradigm Publishing, 2008	Paradigm Publishing, 2008

Identity Equity and Readiness			
Gender Equity		Technology Skills	
Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	

Content Area: Science	Course: Biology III (Genetics)	Strand: 2 - Reproduction and Development

Learner Objectives:

- Organisms progress through a series of stages as they grow and develop. (C)

Concepts:

A. The male and female reproductive systems include paired gonads and networks of tubes in which sperm and oocytes are manufactured. (C1)
B. Meiosis is a form of cell division that has the two genomes of a somatic cell to produce haploid gametes. (C1)
C. Nearly all human prenatal development occurs during the first eight weeks; during the remaining months of gestation structures grow and specialize. (C1)
D. The type of birth defect is dependent upon which structures were forming at the time of environmental exposure. (C2)

Students Should Know	Students Should Be Able to
• A sperm cell goes through different developmental stages: spermatogonia, primary spermatocyte, secondary spermatocyte, spermatid, and sperm. • An egg cell goes through different developmental stages: oogonium, primary oocyte, secondary oocytes, and ovum. • Meiosis is the process of reducing the cell's chromosome number from diploid to haploid.(This should have been covered in bio- review quickly) • ~~The three primary germ layers (ectoderm, mesoderm, and endoderm) will develop into specific structures.~~ • Critical period is the time of development that a particular structure is susceptible to damage.	• Trace the path of development of a spermatogonia and oogonia through the reproductive tract. (C1d; A) • Describe the two events in meiosis, independent assortment and crossing over, which cause genetic variation. (C1d; B) • Differentiate between oogenesis and spermatogenesis. (C1d; B) • Model all steps of meiosis. (C1d; B) (This should have been covered in bio- review quickly) • Identify the major stages and events of embryonic and fetal development. (C1f; C) • ~~Differentiate between the formation of monozygotic and dizygotic twins. (C2b; C)~~ • Identify environmental agents that have an effect on human development. (C2c; D)

Instructional Support

Student Essential Vocabulary					
Gamete	Homologous pairs	Meiosis	Polar body	Crossing over	Critical period
Gonad	Haploid	Independent assortment	Chorionic villi	Notochord	Teratogens
Oocyte	Diploid	Acrosome	Primitive streak	Neural tube	Organogenesis
Allantois	Gastrula	Tropoblast	Blastocyst	Morula	Capacitation
Fetus	Embryo				

Sample Learning Activities

Learning Activity #1 : (See Appendix CC)
Personal Development Story – Students trace the pathway of their own personal development in a story in which they must highlight the major events of development in the womb. Students must relate the events to themselves, present a picture, and a description of each event.

Activity's Alignment	
NSES	C1f
CONTENT	SC3
PROCESS	1.2 Conduct Research 2.1 Plan and make presentations
DOK	2 – Skill/Concept
INSTRUCTIONAL STRATEGIES	Nonlinguistic representation Summarizing and Note Taking
ISTE	3c – Use digital tools to complete specific tasks

Sample Assessments

Assessment #1: (See Appendix C)
Personal Development Assessment
A set of questions are given that determines if the students have understood the development process and how environmental factors can affect that development.

Assessment's Alignment	
NSES	C1f
CONTENT	SC3
PROCESS	1.10 Apply information and ideas
DOK	2 – Skill/Concept
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Learning Activity #2: (See Appendix DD)
Simulation of Meiosis - Students read passages that describe the events of meiosis and as they move through each passage they draw what is happening either on a large piece of paper, chalk on the table, or markers on their desks. After students have completed the simulation, they will erase all of the drawings and discuss questions related to the process.

Activity's Alignment	
NSES	C2b
CONTENT	SC3
PROCESS	1.6 Discover and evaluate relationships
DOK	2 – Skill/Concepts
INSTRUCTIONAL STRATEGIES	Nonlinguistic representation Identifying Similarities and Differences
ISTE	

Assessment #2: (See Appendix D)
Meiosis Assessment - Assesses the student's knowledge of the significant events of meiosis and when they occur.

Assessment's Alignment	
NSES	C2b
CONTENT	SC3
PROCESS	1.6 Discover and evaluate relationships
DOK	2 – Skill/Concepts
LEVEL OF EXPECTATION	Mastery Level – 90%
ISTE	

Student Resources	Teacher Resources
• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008	• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008

Identity Equity and Readiness			
Gender Equity		Technology Skills	
Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	

Content Area: Science	**Course: Biology III (Genetics)**	**Strand: 3 - DNA Structure & Genomics**
Learner Objectives: ● Traits in living things are encoded in molecules of DNA. (C)		

Concepts:

A. The work of many scientists led to the characterization of the structure and function of the DNA molecule (G)
B. DNA is an alpha helix that resembles a ladder with sugar-phosphate rails and nitrogen base rungs. (C2)
C. DNA is made up of monomers called nucleotides; these are made of a five carbon sugar, a phosphate group, and a nitrogen containing base. (C2)
D. ~~DNA can be separated and analyzed using agarose gel electrophoresis. (A)~~
E. DNA makes exact copies of itself in a process called DNA replication during interphase of the cell cycle. (C2)

Students Should Know	Students Should Be Able to
● DNA is an alpha helix that resembles a ladder with sugar-phosphate rails and nitrogen base rungs. The two rails of the molecule are antiparallel. ● DNA replication is semiconservative. ● DNA encodes information that the cell uses to synthesize proteins. ● DNA copies itself in a way that passes its information to the next generation. ● DNA is made up of monomers called nucleotides; these are made of a five carbon sugar, a phosphate group, and a nitrogen containing base. ● DNA is highly coiled and complexed with protein to form chromatin. ● DNA replication proceeds in a 5' to 3' direction so the process is continuous on one strand (leading) and discontinuous on the other (lagging) ● ~~Agarose is a gel with molecular sized pores that separates molecules by size and charge.~~ (this works in second semester instead- DNA profiling and electrophoresis is discussed in Ch 14)	● Describe and identify the levels of DNA coiling, including: chromatin, histones, nucleosomes. (C2a; C) ● ~~Compare and contrast: semiconservative, conservative, and dispersive models of DNA replication. (C2a; E)~~ Just know that DNA replication is semiconservative and illustrate semiconservative replication. . ● Outline and diagram the steps in DNA replication. (C2a; E) ● Identify the job of each of the following enzymes: helicase, binding proteins, primase, DNA polymerase, ligase. (C2a; E) ● Build a model of DNA structure and label each of the following terms: (C2a; B, C) 3', 5' ends nucleotide deoxyribose sugar phosphate nitrogenous base (adenine, thymine, cytosine, guanine) leading strand

~~• Micropipettes are used to transfer very small quantities of liquid for molecular analysis.~~ (this works in second semester instead- DNA profiling and electrophoresis is discussed in Ch 14) ~~• Micropipettes measure quantities in microliters; one mililiter is equal to 1000 microliters.~~(this works in second semester instead- DNA profiling and electrophoresis is discussed in Ch 14) ~~• DNA has a negative charge, which allows it to move when electrophoresed.~~ (this works in second semester instead- DNA profiling and electrophoresis is discussed in Ch 14)	lagging strand hydrogen bond Okazaki fragment replication fork • Distinguish purines from pyrimidines. (C2a; B) • Describe experiments that contributed to present day knowledge of the structure of DNA. (G3b; A) ~~• Extract DNA from biological tissue, cut it into fragments using restriction enzymes, and analyze the DNA fragments with the use of gel electrophoresis. (A1b, A1c; D)~~(this works in second semester instead- DNA profiling and electrophoresis is discussed in Ch 14) ~~• Select and correctly use the appropriate sized micropipette for a specific task. (E1c; D)~~ (this works in second semester instead- DNA profiling and electrophoresis is discussed in Ch 14)

Instructional Support

Student Essential Vocabulary					
Gene	Pyrimidine	Replication fork	Primase	Histone	Polymerase chain reaction
Nucleotide	Antiparallel	DNA polymerase	Ligase	Nucleosome	Semiconservative
Purine	Complementary base pairing	RNA primer	Endonuclease/restriction enzyme	Chromatin	Helicase
Genome					

Sample Learning Activities

Learning Activity #1 : (See Appendix EE)
Model of DNA
Students work in cooperative groups to construct a model of DNA from pop-beads. Students construct the model in nucleotides, and then replicate it eventually creating two identical strands of DNA. Three and five prime ends are emphasized. This activity generally takes three days to complete.

Activity's Alignment	
NSES	C2a
CONTENT	SC3

Sample Assessments

Assessment #1: (See Appendix E)
DNA Assessment – Students will draw a portion of a DNA molecule that is 6 nucleotides in length and label items such as the parts of the nucleotide, the hydrogen bonds, the 5' and 3' ends.

Assessment's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	1.10 – Apply information, ideas, and skills
DOK	2 – Skill/Concept

PROCESS	1.10 - Apply information, ideas and skills 3.5 - Reason logically (inductive/deductive)
DOK	2 – Skill/Concept
INSTRUCTIONAL STRATEGIES	Nonlinguistic representations Cooperative learning
ISTE	

Learning Activity #2: (See Appendix FF)
Restriction Enzyme Packet - This series of activities takes approximately 4 class periods. Students will learn how restriction enzymes are used to move genes from one species into a bacterial vector. Students will read plasmid maps and analyze electrophoresis results from restriction digests. Knowledge of bacterial transformation and the basic structure of DNA are necessary. A Power point presentation is available to guide students through each activity.
Restriction Enzyme Power Point – (See Appendix F)

Activity's Alignment	
NSES	A1c, A2c, C2a
CONTENT	SC3, SC8
PROCESS	3.5- Reason logically (inductive/deductive)
DOK	3-Strategic thinking
INSTRUCTIONAL STRATEGIES	Generating and testing hypotheses
ISTE	

LEVEL OF EXPECTATION	Mastery Level - 85%
ISTE	

Assessment #2: (See Appendix G)
Restriction Enzyme Assessment
This is an essay question released from an AP Biology Exam. The essay should take 20 minutes for students to complete. The scoring guide is attached.

Assessment's Alignment	
NSES	C2a
CONTENT	SC3, SC8
PROCESS	3.5- Reason logically (inductive/deductive) 1.10 – Apply information, ideas, and skills
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 75%
ISTE	

Student Resources	Teacher Resources

• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008	• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008 • Images and models of DNA; kits are well made http://www.3dmoleculardesigns.com/ • The above DNA kits can be checked out here; quantities are limited, so order early http://cbm.msoe.edu/teachRes/library/index.html • DNA animations form HHMI BioInteractive http://www.hhmi.org/biointeractive/dna/animations.html

Identity Equity and Readiness			
Gender Equity		Technology Skills	
Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	

Content Area: Science	Course: Biology III (Genetics)	Strand: 4 - Proteins

Learner Objectives:

- Proteins are synthesized from genes and have a specific structure and function in organisms. (C)

Concepts:

A. The central dogma states that DNA is transcribed into RNA and translated into a protein which is observed as the organism's phenotype. (C2)
B. The function of a protein is dependent on its shape. (C2)
C. Proteins have different levels of structural organization. (C2)
~~D. Proteins can be separated and analyzed using polyacrylamide gel electrophoresis. (A1)~~ Could be done during the second semester if needed (biotechnology unit).

Students Should Know	Students Should Be Able to
• RNA is transcribed from the template strand of DNA. The other strand is the coding strand. • RNA is a single stranded nucleic acid similar to DNA but containing uracil and ribose rather than thymine and deoxyribose. • Several types of RNA participate in protein synthesis, including messenger RNA, ribosomal RNA, and transfer RNA. • Operons control gene expression. (this can be presented as additional information if there is time) • Transcription begins when transcription factors help RNA polymerase bind to a gene's promoter. • After a gene is transcribed, the mRNA receives a cap of modified nucleotides at the 5'end and a poly A tail at the 3' end. • Many genes do not encode information in a continuous manner; segments called exons are translated into protein, but introns are removed. • A protein must fold into a particular shape to be active and functional.	• Explain the "central dogma" of DNA. (C2a; A) • Compare and contrast DNA with RNA; give the function and structure for each type of RNA. (C2a; A) • Describe and diagram the processes of transcription and translation. (C2a; A) • Explain control of gene expression by operons and transcription factors. (C2a; C) • Distinguish between introns and exons. (C2a; C) • Describe RNA processing. (C2a; A) • Discuss the function of chaperone proteins. (C2a; C) • Model the primary, secondary, tertiary and quaternary structure of a protein. (C2a; C) • ~~Demonstrate how certain properties can cause a protein to fold into its proper shape. (C2a; B)~~ • ~~Extract proteins from biological samples and analyze the proteins using polyacrylamide gel electrophoresis. (A1b; D)~~ (this works in second semester instead during biotechnology)

Instructional Support

Student Essential Vocabulary					
Transcription	Coding strand	Promoter	Alternate splicing	Chaperone proteins	Transcription initiation
Translation	Codon	Introns	Genetic code	Ubiquitin	Transcription elongation
Template strand	Anticodon	Exons	Initiation complex	Proteasome	Transcription termination

Sample Learning Activities

Learning Activity #1 : (See Appendix H)

Protein Synthesis Investigation – Students will complete a multipart activity that will lead them through the process of protein synthesis. This activity will have the students transcribe DNA into RNA, then mRNA into proteins. The students will then look at the effects of mutations on the amino acid chain.

Activity's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	1.6 – Discover/ evaluate relationships
DOK	3 – Strategic Thinking
INSTRUCTIONAL STRATEGIES	Nonlinguistic representation
ISTE	

Sample Assessments

Assessment #1:

Protein Synthesis Exit Questions –

1. What happens <u>immediately</u> after a second tRNA enters the ribosome?
   a. empty tRNA drops off
   b. a peptide bond forms between the amino acids
   c. translation begins
   d. ribosome moves one codon further

2. Fill in the following table:

DNA	mRNA	tRNA	Amino Acid
TAC			
		CAG	

3. In the sequence: AUG-UGC-UAC-UUC-CAA- CGA-GGA-UAG, would there be a problem with the protein that was supposed to be made if the cytosine in codon #3 was replaced with a adenine? Justify your answer.

Answer Key

1. *b*
2. *AUG, UAC, Methionine*
   CAG, GUC, Valine
3. *Yes, there would be a problem. The mutation would cause the codon to code for 'stop'. This would end the production of the protein.*

Assessment's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	1.7 Evaluate information
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Assessment #2: (See Appendix I)

Learning Activity #2: (See Appendix II)
Evolutionary Relationship of Fish – Protein Profiling -
Students will extract proteins from a group of related fish muscle tissue and separate them using protein electrophoresis. The gels are photographed and analyzed using a standard curve. Discussions of evolutionary relationships are encouraged in order to see the relationships between species.

Activity's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	1.3 – Design/Conduct investigations

DOK	3 – Strategic Thinking
INSTRUCTIONAL STRATEGIES	Generating and testing hypotheses
ISTE	

Protein Electrophoresis Assessment – Students will analyze 5 bean plants with a copy of the protein electrophoresis bands and answer questions accordingly.

Assessment's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	1.7 - Evaluate information 3.5 – Reason logically (inductive/deductive)
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level -75%
ISTE	

Student Resources	Teacher Resources
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Identity Equity and Readiness			
Gender Equity		Technology Skills	
Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	

Content Area: Science	Course: Biology III (Genetics)	Strand: 5 - Control of Gene Expression & Mutation

Learner Objectives:

- A cell transcribes and translates only a subset of its genome. (C)

Concepts:

A. Gene expression is evident at several levels, from molecular to the development of an organ or gland, to sweeping changes over a lifetime. (C1)
B. RNAi causes disruptions in normal transcription. (C1)
C. The "central dogma" of DNA-encoding-RNA- encoding protein is only a small part of the story in the human genome. (C1)
D. A mutation changes a gene's sequence, which may or may not disrupt the encoded protein in a way that causes a mutant phenotype. (C2)
E. DNA replication is routinely checked for errors and the damage is repaired. (C2)

Students Should Know	Students Should Be Able to
• Histone proteins control the start of transcription; small interfering RNAs sabotage transcripts already made. • By switching genes off when they are not needed, cells can prevent resources from being wasted. • In RNA interference, short double-stranded RNA molecules locate and bind to specific mRNAs, marking them for destruction, and also add methyl groups to DNA in the nucleus, blocking transcription. • Altering chromatin by adding or removing chemical groups can be passed on when DNA replicates. • The number of proteins encoded in the human genome exceeds the number of genes by a factor of at least six. • When noncoding sections of DNA (introns) are removed from a gene, the coding portions that remain (exons) can rearrange to code for many different proteins. • Some mutations exert no noticeable effect, because they do not occur in a part of the protein that is crucial to function. • The genetic code protects against mutation, because many changes result in a codon that specifies the same or a structurally similar amino acid.	• Identify why gene regulation is necessary. (C1c; C) • Describe how RNAi can be used to regulate gene expression. (C1d; B) • Describe chromatin remodeling. (C1d; A) • ~~Illustrate how 25,000 genes encode 200,000 proteins, using exon shuffling. (C1d; C)~~ discuss briefly • Describe how the genetic code protects against mutation. (C2c; D) • Differentiate between the different types of gene mutations. (C2c; D) • Differentiate between the different methods of DNA repair. (C2c; E)

Instructional Support

Student Essential Vocabulary					
Homeobox	Sonic hedgehog homolog	Proteomics	Histone code	Chromatin remodeling	Enhanceosomes
Epigenetics	RNAi	siRNA	Introns	Exons	Exon Shuffling
Transposons	Mutations	Mutant	Mutagens	Mutational hot spots	Excision Repair

Sample Learning Activities

Learning Activity #1 : (See Appendix JJ)
Gene Regulation in Bacteria
Students analyze and compare the lac operon and the trp operon in bacteria by observing and coloring pictures of them, answering questions, and drawing some conclusions regarding the way in which they operate.

Activity's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	3.5 Reason logically 1.7 Evaluate information
DOK	3 – Strategic Thinking
INSTRUCTIONAL STRATEGIES	Nonlinguistic information Identifying Similarities and Differences
ISTE	

Sample Assessments

Assessment #1: (See Appendix J)
Assessment of Gene Regulation in Bacteria
Students are evaluated on the mechanism of gene expression in bacteria and are asked to predict the outcome of mutations in specific genes in each of the operons.

Assessment's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	3.5 Reason logically 1.7 Evaluate information
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Learning Activity #2: (See Appendix KK)

Mutation Invasion - This is a short, introductory activity to get students to focus on types of gene mutations. Each partner is given a list of five sentences made up of only three letter words. The student changes the sentences and challenges the partner to determine the type of mutation. Activity does not take a full class period.

Activity's Alignment	
NSES	C2c
CONTENT	SC3
PROCESS	1.6 - Discover/evaluate relationships 3.5 - Reason logically (inductive/deductive)
DOK	2 - Skill/Concept
INSTRUCTIONAL STRATEGIES	Cooperative learning Homework and practice
ISTE	

Assessment #2: (See Appendix K)

Gene Mutations - Students are given a table containing short pairs of mRNA sequences, an original and a mutated version. Students must determine the amino acids coded and then determine what types of mutation were involved.

Assessment's Alignment	
NSES	C2c
CONTENT	SC3
PROCESS	1.6 - Discover/evaluate relationships 3.5 - Reason logically (inductive/deductive)
DOK	2 - Skill/Concept
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Student Resources	Teacher Resources
• Human Genetics, McGraw Hill, ©2005 • www.mhhe.com/lewisgenetics6	• Human Genetics, McGraw Hill, ©2005 • http://www.pbs.org/wgbh/nova/sciencenow/3210/02.html • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008 • Ghost in your Genes, NOVA, 2007

Identity Equity and Readiness			
Gender Equity		Technology Skills	

Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	

Content Area: Science	Course: Biology III (Genetics)	Strand: 6 - Mendelian Genetics & Exceptions
Learner Objectives: ● Traits are inherited in predictable patterns. (C)		

Concepts:

A. Modes of inheritance reveal whether a Mendelian trait is dominant or recessive and whether the gene that controls it is carried on an autosome or a sex chromosome. (C2)
B. A Mendelian trait is caused by a single gene. (C2)
C. Monohybrid and dihybrid crosses yield predictable inheritance of genes. (C2)
D. Variations in gene expression and in allele and gene interactions can alter expected Mendelian phenotypic ratios. (C2)
E. The human genome is much more complicated and has revealed "exceptions" to the rules of Mendelian inheritance. (C2)
F. Linked genes are inherited in patterns that differ from Mendelian inheritance and can be used to map genes on chromosomes. (C2)

Students Should Know	Students Should Be Able to
● Gregor Mendel's experiments on pea plants became the foundation of Genetics. ● Autosomal dominant and autosomal recessive are the two modes of inheritance directly derived from Mendel's laws. (have specific criteria) ● Mendel created three laws that serve as the basis for inheritance of single gene traits in all diploid species for; Law of Segregation, Law of Independent Assortment. ● The process of Meiosis enables the chromosomes to segregate and sort independently of one another. ● Punnett Squares are used to predict inheritance of traits. ● Disorders in humans can follow Mendelian patterns of inheritance. ● Pedigrees are used to assess familial traits. ● Mitochondrial genes are maternally inherited. ● At the biochemical level, dominance refers to the ability of a protein encoded by one allele to compensate for a missing or abnormal protein encoded by another allele. ● Pedigrees are charts that depict family relationships and the transmission of inherited traits.	● Deduct, given clues, the inheritance patterns of traits inherited via autosomal dominant or autosomal recessive inheritance. (C2b: A) ● Use a Punnett Square to calculate the probability that a particular couple will have a child who will inherit a particular condition. (C2b; C) ● Recognize the genotype of an organism as homozygous or heterozygous; recessive or dominant. (C2b; B) ● Relate meiosis to Mendel's two laws. (C2b;C) ● Interpret a pedigree and predict inheritance patterns in a family. (C2b; C) ● Recognize how various phenomena can disrupt Mendelian phenotypic ratios. (C2b, C2c; D,E,F) ● Identify causes of particular disorders (i.e. CF, Marfans's, Huntington's, Tay Sachs, albinism) (C2b, C2c; B, C)

• Pedigrees and Punnett Squares are tools that apply Mendel's laws to predict the recurrence risks of inherited disorders or traits. • A lethal allele combination is never seen as a progeny class. • In incomplete dominance, the heterozygote phenotype is intermediate between those of the homozygotes. • In codominance, two different alleles for the same gene are each expressed. • In epistasis, one gene influences expression of another. • Genotypes vary in penetrance and expressivity of the phenotype. A gene with more than one expression is pleiotropic. • Genetic heterogeneity occurs when different genes cause the same phenotype. • Phenocopy is when a trait caused by the environment mimics that of an inherited trait. • Mitochondrial genes mutate rapidly and are inherited only on the maternal side. • In heteroplasmy cells contain mitochondria that have different alleles of a gene. • Linked genes are inherited in patterns that differ from Mendelian inheritance and can be used to map genes on chromosomes.	

Instructional Support

Student Essential Vocabulary					
Monohybrid cross	Phenotype	Punnett Square	Law of Independent Assortment	Codominant	Phenocopy
Dihybrid cross	Genotype	Modes of inheritance	Pedigree	Epistasis	Genetic heterogeneity
Law of segregation	Wild type	Autosomal dominant	Lethal allele	Penetrance	Mitochondrial genes
Homozygous	Mutant	Autosomal recessive	Multiple alleles	Expressivity	Heteroplasmy
heterozygous	mutation	Consanguinity	Incomplete dominance	pleiotropy	Gene linkage
recombinant	Linkage maps	haplotype			

Sample Learning Activities

Learning Activity #1 : (See Appendix L)
Who Dun It?
The students will utilize a blood typing kit which identifies blood types by the antigens present. The students will then apply that knowledge to a murder investigation.

Activity's Alignment	
NSES	E1d
CONTENT	SC3
PROCESS	1.7 - Evaluate information 1.10 - Apply information, ideas and skills
DOK	3 – Strategic Thinking
INSTRUCTIONAL STRATEGIES	Generating and testing hypotheses
ISTE	

Sample Assessments

Assessment #1:
Who Dun It: Exit Ticket

1. What ABO agglutinogens (antigens) are present on the red blood cells of a person with blood type AB?

2. What ABO agglutinins (antibodies) are present in the plasma of a person with blood type B?

3. If a person with blood type O needed a transfusion, what ABO type of blood could he/she safely receive? Explain.

KEY

1. *A and B*
2. *Anti- A*
3. *Only blood type O. The person would have anti-A and anti-B antibodies in their plasma. These antibodies would attack any blood with A or B antigens.*

Assessment's Alignment	
NSES	G1a

CONTENT	SC3
PROCESS	1.10 - Apply information, ideas, and skills
DOK	2 – Skill/Concept
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Learning Activity #2: (See Appendix MM)
Mendelian Genetics of Corn - In this activity, students will collect data from ears of corn, prepare dihybrid crosses, and analyze their data with the use of a Chi square test. Additional examples beyond the corn are provided. This activity is expected to take about 3 days.

Assessment #2: (See Appendix M)
Genetics and the Chi-Square Test Assessment

Students complete three paper and pencil Chi square tests on three different organisms.

Activity's Alignment	
NSES	A2d, C3a
CONTENT	SC4, SC3, SC7
PROCESS	1.7 - Evaluate information 1.10 – Apply information, ideas and skills 1.6 – Discover/evaluate relationships 3.5 - Reason logically (inductive/deductive)
DOK	3 – Strategic Thinking
INSTRUCTIONAL STRATEGIES	Generating and testing hypothesis
ISTE	

Assessment's Alignment	
NSES	C3a
CONTENT	SC3
PROCESS	1.7 - Evaluate information 1.10 - Apply information, ideas and skills 3.5 - Reason logically (inductive/deductive)
DOK	3-Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 75%
ISTE	

Student Resources	Teacher Resources
● Human Genetics, McGraw Hill, ©2005 ● Textbook website: www.mhhe.com/lewisgenetics6 ● Biotechnology: Science for the New Millennium, First Edition.	● Human Genetics, McGraw Hill, ©2005 ● Textbook website: www.mhhe.com/lewisgenetics6 ● Biotechnology: Science for the New Millennium, First Edition.

Paradigm Publishing, 2008	Paradigm Publishing, 2008

Identity Equity and Readiness			
Gender Equity		Technology Skills	
Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	

Content Area: Science	Course: Biology III (Genetics)	Strand: 7 - Gender & Multifactorial Traits

Learner Objectives:

- Determination of the phenotype requires interactions with many genes and the environment. (C)

Concepts:

A. Sexual identity is guided by genes, hormones, feelings, and experiences. (C1, C2)
B. Genes on the sex chromosomes (sex-linked) have unique inheritance patterns. (C2)
C. Some genes-autosomal as well as X- or Y- linked- are expressed in one sex but not the other, or may be inherited as a dominant trait in one but a recessive in the other. (C2)
D. Genes and environment affect many human traits. (C2)
E. Polygenic traits are determined by more than gene and vary continuously in expression. (C2)
F. Geneticists evaluate the input of genes, using information from population and family studies. (C2)

Students Should Know	Students Should Be Able to
● Presence or absence of the SRY gene determines sex. ● Sex chromosomes differ in males and females. (The heterogametic and homogametic conditions lead to differences between male and female development) ● X- linked dominant traits are more devastating to males than to females. ● X inactivation in the female evens out the dosages of genes on the sex chromosomes between the sexes. ● Genes likely contribute to homosexuality. ● Traits inherited on the sex chromosomes can be solved using Mendel's Law of Segregation; X-linked recessive, X-linked dominant ● Genes carried on the Y chromosome are Y-linked, and those on the X chromosome are X-linked. ● Males are hemizygous and express all the genes on his X chromosome, whereas females express recessive alleles on the X chromosome only if she is homozygous recessive. ● One X chromosome in each cell of the female is turned off and the effects of X inactivation can be noticeable when the heterozygous alleles are expressed in certain tissues.	● Differentiate between prenatal male and female patterns of sexual development. (C1f; A) ● Differentiate between the cell types and hormones that contribute to the development of male and female reproductive structures. (C1f; A) ● Map the chromosomal regions on the Y chromosome and differentiate between the pseudosutosomal region genes and the male-specific region genes. (C2b; C) ● Analyze a pedigree and determine the inheritance patterns for sex-linked genes. (C2b; B) ● Compare a Mendelian multifactorial trait and a polygenic multifactorial trait. (C2b; E) ● Describe several ways to assess the influence of heredity and the environment. (C2b, D) ● Compare and contrast the types of information gained from studies of adopted individuals and twin studies. (C2b, F)

● A sex-limited trait affects body parts or functions present in only one gender and a sex-influenced allele is dominant in one sex but recessive in the other. ● A bell curve describes the distribution of phenotypic classes of a polygenic trait. ● In genomic imprinting, the phenotype differs depending on whether a gene is inherited from the mother or the father. ● Genomic imprinting is an epigenetic alteration, in which a layer of meaning is stamped upon a gene without changing its DNA sequence. ● Multifactorial traits are evaluated using methods such as association studies, empiric risk, heritability, correlation coefficients, and concordance. ● Single Nucleotide Polymorphism mapping requires enormous amounts of data.	

Instructional Support

Student Essential Vocabulary					
Gonad	Wolffian ducts	Transcriptional factor	Hemizygous	Sex-Limited trait	Polygenic
Mullerian ducts	Heterogametic sex	Y-linked	X inactivation	Sex-influenced trait	Multifactorial
Pseudoautosomal regions	Homogametic sex	X-linked	Barr body	Genomic imprinting	Empiric risk
heritability	Correlation coefficient	concordance	Association study	Single nucleotide polymorphism	

Sample Learning Activities

Learning Activity #1: (See Appendix NN)

BSKI Counseling Service - BSKI Counseling is a genetic counseling service. Students act as the counselors as they follow the bizarre Turkie family through all of life's trials and tribulations. Student draw pedigrees and Punnett squares on Mendelian and non-Mendelian disorders, and demonstrate their knowledge of probability.

Activity's Alignment	
NSES	C2b, C2c
CONTENT	SC3
PROCESS	1.7 - Evaluate information 1.10 - Apply information, ideas, and skills
DOK	3 – Strategic Thinking
INSTRUCTIONAL STRATEGIES	Non-linguistic representation Generating and testing hypothesis
ISTE	

Sample Assessments

Assessment #1: (See Appendix N)

Pedigrees and Punnett Squares - The students will work through a complicated pedigree. Also, they will practice some Punnett squares that exhibit exceptions to Mendel's laws.

Assessment's Alignment	
NSES	C2b
CONTENT	SC3
PROCESS	1.7 - Evaluate information 1.10 - Apply information, ideas, skills
DOK	3 - Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 85%
ISTE	

Learning Activity #2: (See Appendix O)
Polygenic Inheritance - Students will analyze their own fingerprints and find the total ridge count for each finger. They will then use the information to see how fingerprints are an example of multifactorial traits.

Activity's Alignment	
NSES	C2b
CONTENT	SC3
PROCESS	1.3 - Design/ conduct investigations 1.7 - Evaluate information 1.10 - Apply information, ideas, and skills
DOK	2 – Skills/Concepts
INSTRUCTIONAL STRATEGIES	Homework and practice Generating and testing hypothesis
ISTE	

Assessment #2:
Polygenic Inheritance Exit Ticket

1. Write a paragraph in which you discuss the genetic and environmental components of multifactorial inheritance.

Answer Key:
Students should include the ideas that genetic traits are inherited strictly from DNA, whereas environmental conditions can alter the expression of those genes. They may also include the explanation that fingerprints design is a genetic trait, but touching the amniotic sac during fetal development may alter the fingerprints.

Assessment's Alignment	
NSES	C2b
CONTENT	SC3
PROCESS	1.10 - Apply information, ideas, and skills
DOK	2 – Skills/Concepts
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Student Resources	Teacher Resources
• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008	• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008

Identity Equity and Readiness			
Gender Equity		Technology Skills	
Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	X

Content Area: Science	Course: Biology III (Genetics)	Strand: 8 - Cytogenetics

Learner Objectives:

- Chromosomal patterns have an effect on the phenotype of an organism. (C)

Concepts:

A. A chromosome includes DNA and the proteins that allow DNA to be replicated. (C2)
B. The 24 chromosomes in a human cell are distinguished by size, shape, staining pattern and DNA sequence. (C2)
C. Extra sets of chromosomes, or missing or extra individual chromosomes, can devastate health. (C2)
D. Disruption in the precise sequence of events that occurs during meiosis can result in chromosomes with missing or extra genetic material or that exchange parts. (C2)

Students Should Know	Students Should Be Able to
● A chromosome consists of DNA and proteins. Essential parts are the telomeres, centromeres and the origin of replication sites. ● Fluorescence *in situ* hybridization is a process that adds fluorescent markers to individual genes so that they can be identified. ● A karyotype is a size-ordered chromosome chart. ● Non-disjunction (the faulty separation of chromosomes during gamete formation) causes changes in chromosome numbers ● Cells missing a single chromosome or having an extra one are aneuploids. ● Cells having an extra set of chromosomes are polyploids ● Cells with the correct number of chromosomes are euploids. ● Structural chromosomal defects include missing, extra, or inverted genetic material within a chromosome or combined or exchanged parts of nonhomologs. ● The simultaneous occurrence of two rare events causes the inheritance of two alleles of the same gene for one parent.	● Differentiate between the three techniques used to obtain fetal cells and observe their chromosomes. (C2b; B) ● Describe the different parts of a chromosome. (C2b; A) ● Describe how chromosomes are made visible. (C2b; B) ● Diagnosis a genetic disorder using a karyotype. (C2b; B) ● Explain how chromosomes are organized and analyzed. (C2b; B) ● Analyze chromosomal shorthand. (C2b; C) ● Distinguish between various aneuploid disorders. (C2c; D) ● Describe the different types of chromosomal mutations. (C2c; D)

Instructional Support

Student Essential Vocabulary					
Euploid	Aneuploid	Polyploid	Trisomy 13	Trisomy 18	Trisomy 21
XO	XXY	XYY	XXX	Cri du Chat	Metacentric
Submetacentric	Acrocentric	Telocentric	Nondisjunction	Robertsonian translocation	Paracentric inversion
Pericentric inversion	Amniocentesis	Chorionic Villus Sampling	Fetal Cell Sorting		

Sample Learning Activities

Learning Activity #1 : (See Appendix PP)

Genetic Disease PowerPoint - Students will research a genetic disease. They will find the genetic cause, mode of transmission, treatments, etc. and convey this information using Microsoft PowerPoint. Students must include bibliographic information (APA format).

Activity's Alignment	
NSES	C2c
CONTENT	SC3, CA3, CA6
PROCESS	1.5 – Comprehend/evaluate resources 2.1 – Plan and make presentations 2.7 – Use information technology
DOK	2 – Skill/Concept
INSTRUCTIONAL STRATEGIES	Nonlinguistic representations
ISTE	3d – use digital tools to process data and report results.

Sample Assessments

Assessment #1: (See Appendix P)

Genetic Disease Diagnosis – Students will read several scenarios and diagnose which genetic disease is being referred to, justifying their answers.

Assessment's Alignment	
NSES	C2c
CONTENT	SC3
PROCESS	1.7 – Evaluate information 1.10 – Apply Information, ideas, and skills
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Learning Activity #2: (See Appendix QQ)
Murder and Genetics - The students will work in groups to evaluate many pieces of evidence acquired from a crime scene. The evidence includes, blood samples, DNA samples, and suspect histories. Students are required to analyze the DNA evidence, form a karyotype, draw a pedigree and give a motive for the killer.

Activity's Alignment	
NSES	C2a, C2b
CONTENT	SC3
PROCESS	1.4 - Organize information using tools 1.8 Organize date and ideas 1.10 Apply information and ideas
DOK	4– Extended Thinking
INSTRUCTIONAL STRATEGIES	Cooperative learning
ISTE	

Assessment #2: (See Appendix Q)
Karyotyping Analysis -
After studying two karyotypes, students will identify if there is an abnormality, which genetic disease is associated with it, and justify their answer.

Assessment's Alignment	
NSES	C2a
CONTENT	SC3
PROCESS	1.10 – Apply information, ideas, and skills 3.5 – Reason logically (inductive/deductive)
DOK	3 – Strategic thinking
LEVEL OF EXPECTATION	Mastery Level - 85%
ISTE	

Student Resources	Teacher Resources
• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008	• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008

Identity Equity and Readiness			
Gender Equity		Technology Skills	X
Racial/Ethnic Equity		Research/Information	X
Disability Equity		Workplace/Job Prep	

Content Area: Science	Course: Biology III (Genetics)	Strand: 9 - Population Genetics
Learner Objectives: ● Gene frequencies can change over time and affect populations. (C)		

Concepts:

A. Population genetics considers allele, genotype, and phenotype frequencies to determine whether microevolution is occurring. (C3)
B. In Hardy-Weinberg equilibrium, no allele frequencies change, thus no evolution is currently occurring. (C3)

Students Should Know	Students Should Be Able to
● Allele frequencies change if migration, nonrandom mating, genetic drift, mutations, or natural selection occurs ● The Hardy-Weinberg equation is a binomial expansion used to represent genotypes in a population. It is written algebraically as: $p^2 + 2pq + q^2$ ● If one part of the Hardy-Weinberg equation is known, the other portions can be algebraically determined ● In the Hardy-Weinberg equation, p2 stands for the frequency of homozygous dominant individuals; 2pq stands for heterozygotes; q2 corresponds to the frequency of homozygous recessive condition ● In the Hardy-Weinberg equation, p corresponds to the frequency of the dominant allele, and q corresponds to the frequency of the recessive allele ● Clines are changes in allele frequencies from one geographic area to another ● Human migration patterns through history explain cline boundaries ● Genetic drift occurs when a small population separates from a larger one, and its members breed only among themselves. This causes gene frequencies that are not characteristic of the ancestral population ● Genetic drift is random and may occur within a larger group or apart from it ● A founder effect is a type of genetic drift that when a few individuals found a settlement and their alleles for an new gene pool that favors some alleles and eliminates others	● List and explain the five factors that would cause gene frequencies to change over time. (C3a; B) ● Discuss instances of microevolution in human history for each of Hardy- Weinberg's five factors. (C3a; B) ● Use the Hardy-Weinberg equation to determine the frequency of each allele in a population and the frequency of each phenotype in a population. (C3a; B)) ● Describe the effects of inbreeding in genotypic terms. (C3a; A)

● The frequencies of some disadvantageous alleles are maintained because of balanced polymorphisms. (Sickle cell and malaria, CF and diarrheal disease) ● Eugenics is the control of an individual reproduction to serve a societal goal.	

Instructional Support

Student Essential Vocabulary					
Cline	Population	Gene pool	Migration	Nonrandom mating	Population bottleneck
Founder effect	Hardy-Weinberg equilibrium	Microevolution	Population genetics	Genetic drift	Mutation
Natural selection					

Sample Learning Activities

Learning Activity #1 : (See Appendix RR)
Hardy-Weinberg Interactive Activity - The students will complete a tutorial which will take them through the Hardy- Weinberg equilibrium. They will practice problems using the Hardy-Weinberg equilibrium and look at the conditions that would allow for it to happen.

Activity's Alignment	
NSES	C3a
CONTENT	SC3
PROCESS	3.1 - Identify and define problems 3.4 – Evaluate problem solving processes 3.5 – Reason logically
DOK	3 – Strategic Thinking
INSTRUCTIONAL STRATEGIES	Generating and testing hypothesis
ISTE	1c – use technology to use models and simulations 3c – use digital tools to complete specific tasks 3d – use digital tools to process data and report results

Sample Assessments

Assessment #1: (See Appendix R)
Hardy-Weinberg Principle Assessment
Students are presented with various pieces of data regarding a population and are expected to predict, using the H-W formula, whether or not the population is in genetic equilibrium or not.

Assessment's Alignment	
NSES	C3a
CONTENT	SC3
PROCESS	1.7 – Evaluate information 1.10 – Apply information, ideas, and skills 3.5 – Reason logically
DOK	2 – Skill /Concept
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Learning Activity #2: (See Appendix S)
Evolution and Gene Frequencies - Students use two colors of M&M's, other candy, or disks to represent alleles for the presence of fur in **Bengal Tigers**. The absence of fur is lethal in this population because of the environmental conditions they experience. Students select random alleles, record and graph their data, and answer concluding questions. Understanding of Hardy-Weinberg equilibrium is necessary.

Activity's Alignment	
NSES	C3a, C3c
CONTENT	SC3, SC7
PROCESS	1.3 - Design/conduct investigations 1.7 - Evaluate information 1.8 - Organize data and ideas 3.5 - Reason logically
DOK	3 - Strategic Thinking
INSTRUCTIONAL STRATEGIES	Generating and testing hypotheses
ISTE	

Assessment #2:
Five Conditions of Hardy Wienberg Equilibrium -
Imagine an island with a population of Snorks. Snorks are four legged, long haired, plant-eating mammals. The population contains some individuals with lime green hair, and some with hot pink hair. The two variations successfully interbreed. Design a procedure of a least five essential steps that would test the effect of either the founder effect or genetic drift on the Snork population.

Scoring:
- 1 point: Set up of the independent variable is described; the dependent variable measured is specified; adequate controls are included.
- 1 point: Procedure is logical and appropriate for answering the question, with enough quantitative detail that another student could successfully perform the investigation.
- 1 point: Qualitative outline of at least five steps

Assessment's Alignment	
NSES	C3a, A1b
CONTENT	SC3, SC7
PROCESS	1.3 - Design/conduct investigations
DOK	3 - Strategic thinking
LEVEL OF EXPECTATION	Mastery Level - 80%
ISTE	

Student Resources	Teacher Resources
• Human Genetics, McGraw Hill, ©2005	• Human Genetics, McGraw Hill, ©2005

• Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008	• Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008

Identity Equity and Readiness			
Gender Equity		Technology Skills	
Racial/Ethnic Equity		Research/Information	
Disability Equity		Workplace/Job Prep	

Content Area: Science	Course: Biology III (Genetics)	Strand: 10 - GMO's & Gene Therapy

Learner Objectives:

- Organisms can be genetically modified for various human purposes. (F)

Concepts:

A. Biotechnology has produced organisms with combinations of traits that would probably not have arisen in nature. (F6)
B. Organisms with DNA from other species produce novel proteins or carry out processes more efficiently or in different ways. (F6)
C. Designing a gene therapy requires the creative combining of genetic material. (F6)
D. Genetic counselors combine scientific, medical, communication, and psychological skills to educate people facing the possibility of inherited illnesses. (F6)

Students Should Know	Students Should Be Able to
● Biotechnology is the use or modification of cells or biological molecules for a specific application. ● In recombinant DNA technology, a cell receives a cloning vector that contains foreign DNA encoding a protein of interest. ● Antibiotic sensitivity and resistance genes, as well as gene variants that cause color changes to growth media, are used to select single cells bearing plasmids containing recombinant DNA. ● Genetically modified foods may be easier to grow or have novel combinations of traits. ● Gene targeting takes advantage of a gene's natural tendency to swap places with other versions of themselves, improving on the precision of transgenesis. ● Gene targeting is a more precise modification that inactivated or replaces a gene. ● Directing a single strand of RNA against its complementary mRNA can silence a gene's expression. ● Swapping an inactivated allele for a gene of interest produces a knockout organism and replacing a gene with another that has an altered function creates a knockin organism.	● Describe how biotechnology has been used to create everyday items in their lives. (C2,F6b; A) ● Describe the process required to make a recombinant DNA molecule. (C2, F6b; B) ● Predict the outcome of a transgenic experiment. (C2,F6b; B) ● Summarize the pros and cons of genetically modifying foods. (C2,F6d; B) ● Describe how gene targeting has helped to perfect gene therapy. (C2, F6b; C) ● Differentiate between "knockout" and "knockin" genes. (C2, F6b; C) ● Trace the development of gene therapies from 1990 to present. (C2, F6b; D) ● Differentiate between the different types of gene therapy (ex vivo, in vivo, in vitro). (C2,F6b; C)

Instructional Support

Student Essential Vocabulary					
	Bacteriophage	Biotechnology	Electroporation	Ex vivo	Genetic engineering
Gene targeting	Gene therapy	Germline gene therapy	In situ	In vivo	Knockin/ knockout
Liposome	Plasmid	Recombinant DNA technology	Somatic gene therapy	Transgenic	Vector

Sample Learning Activities

Learning Activity #1 : (See Appendix TT)

Enviropig

Students read an article about several genetically modified organisms and fill out a graphic organizer detailing the trait modified, the source of the gene, the benefits of the new organism, and its potential harm to the environment.

Activity's Alignment	
NSES	F4a, F6d
CONTENT	SC3
PROCESS	1.5 Comprehend/evaluate resources 1.4 Organize information using tools
DOK	2 – Skill/Concept
INSTRUCTIONAL STRATEGIES	Nonlinguistic representation Identifying Similarities and Differences
ISTE	

Sample Assessments

Assessment #1: (See Appendix T)

Debate: Genetically Modified Food

Students take on a role in a community and investigate how the introduction of Genetically Modified Food (GMO's) will affect them. They will research and prepare a position paper to defend their position and then will debate with others on this GMO.

Assessment's Alignment	
NSES	F6d
CONTENT	SC8, CA3, CA4
PROCESS	4.1 Support decisions 3.1 Identify and Define Problems 3.5 Reason logically
DOK	4 – Extended Thinking
LEVEL OF EXPECTATION	Mastery Level - 90%
ISTE	

Learning Activity #2: (See Appendix UU)
Genetics Ethical Debate - Groups of four students will research the pros and cons of five ethical issues involved in genetics: human cloning, GMOs, gene therapy, stem cell research, and designer babies. The students will then be spilt into groups of two and assigned to one side of the debate. A formal debate format will be used to argue the topics.

Activity's Alignment	
NSES	F6d
CONTENT	SC8
PROCESS	4.1 Support decisions 3.1 Identify and Define Problems 3.5 Reason logically
DOK	4 – Extended thinking
INSTRUCTIONAL STRATEGIES	Cooperative Learning
ISTE	3b- use digital tools to find and use information

Assessment #2: (See Appendix U)
Of Cats and Clones – The students will analyze a bioethical scenario involving the decision to clone pets. They will decide whether it is right or wrong and give their reasons why. They will go on to make decisions about other types of cloning. Finally, the students will write a law determining what limits should be placed on cloning.

Assessment's Alignment	
NSES	F6d
CONTENT	SC8
PROCESS	1.7 – Evaluate information
DOK	3 – Strategic Thinking
LEVEL OF EXPECTATION	Mastery Level - 90%
ISTE	

Student Resources	Teacher Resources
• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008	• Human Genetics, McGraw Hill, ©2005 • Textbook website: www.mhhe.com/lewisgenetics6 • Biotechnology: Science for the New Millennium, First Edition. Paradigm Publishing, 2008 • http://www.pbs.org/wgbh/nova/sciencenow/3210/02.html

Identity Equity and Readiness			
Gender Equity		Technology Skills	

Racial/Ethnic Equity		Research/Information	X
Disability Equity		Workplace/Job Prep	X

Appendix
Learning Activities and Assessment

Strand	Appendix	Activity	Appendix	Assessment
1 – Cells and Cancer	**AA**	p53 Gene and Cancer	**A**	Inheritance of Cancer Exit Card
	B	U.V. Light	**	UV Light Constructed Response Quest.
2- Reproduction & Development	**CC**	Personal Development Story	**C**	Personal Development Assessment
	DD	Simulation of Meiosis	**D**	Meiosis Assessment
3 – DNA & Genomics	**EE**	Model of DNA	**E**	DNA Assessment
	FF	Restriction Enzyme Packet	**G**	Restriction Enzyme Assessment
	F	Restriction Enzyme Power Point		
4- Proteins	**H**	Protein Synthesis Investigation	**	Protein Synthesis Exit Questions
	II	Evolutionary Relationship of Fish – Protein Profiling	**I**	Protein Electrophoresis Assessment
5- Control of Gene Expression and Mutation	**JJ**	Gene Regulation in Bacteria	**J**	Assessment of Gene Regulation in Bacteria
	KK	Mutation Invasion	**K**	Gene Mutations
6- Mendelian Genetics & Exceptions	**L**	Who Dun It	**	Who Dun It Exit Ticket
	MM	Mendelian Genetics of Corn	**M**	Genetics and the Chi-Square Test Assessment
7- Gender & Multifactorial Traits	**NN**	BSKI Counseling Service	**N**	Pedigrees and Punnett Squares
	O	Polygenic Inheritance	**	Polygenic Inheritance Exit Ticket
8- Cytogenetics	**PP**	Genetic Disease PowerPoint	**P**	Genetic Disease Diagnosis
	QQ	Murder and Genetics	**Q**	Karyotyping Analysis
9- Population Genetics	**RR**	Hardy Weinberg Interactive Activity	**R**	Hardy-Weinberg Principle Assessment
	S	Evolution and Gene Frequencies	**	Five Conditions of Hardy Weinberg Equilibrium

10- GMO's & Gene Therapy	**TT**	Enviropig	**T**	Debate: Genetically Modified Food
	UU	Genetics Ethical Debate	**U**	Of Cats and Clones
	W	National Science Education Standards Condensed	**X**	National Science Education Standards

**** Assessments are found in the Curriculum Document and not in the Appendix.**