College- and Career Readiness Standards for Science Genetics

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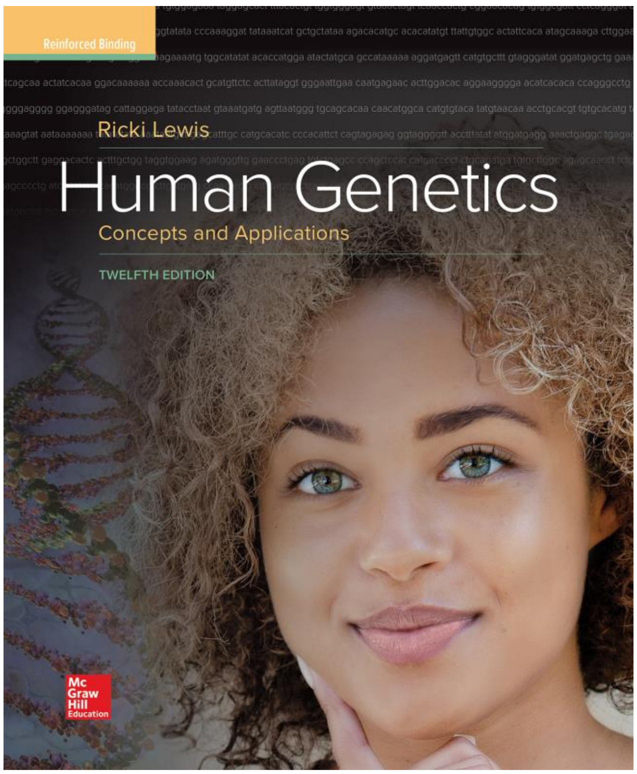

Human Genetics
Concepts and Applications

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STANDARDS	PAGE REFERENCES
GEN.1 Structure and Function of DNA	
GEN.1A Students will demonstrate that all cells contain genetic material in the form of DNA.	
GEN.1A.1 *Model the biochemical structure, either 3-D or computer-based, of DNA based on the experimental evidence available to Watson and Crick (Chargaff, 1950; Franklin, 1951).*	**Student Edition:** Chapter 9 (The student can model the structure of DNA.)
GEN.1A.2 *Explain the importance of the historical experiments that determined that DNA is the heritable material of the cell (Griffith, 1928; Avery, McCarty & MacLeod, 1944; Hershey & Chase, 1952).*	**Student Edition:** 159-162 *Figure 9.3* 161 *Key Concepts Questions* 163 *Table 9.1* 162

STANDARDS	PAGE REFERENCES
GEN.1A.3 *Relate the structure of DNA to its specific functions within the cell.*	**Student Edition:** 176-182 *Figure 10.3 & 10.4* 177 *Figure 10.8 & 10.9* 180 *Figure 10.10* 181 *Key Concepts Questions* 191 #5 *Table 10.1 & 10.2* 178
GEN.1A.4 *Conduct a standard DNA extraction protocol using salt, detergent, and ethanol from various cell types (e.g., plant, animal, fungus). Compare and contrast the consistency and quantity of DNA extracted from various cell types.*	This standard can be met during teacher/class lab instruction.
GEN.1A.5 Enrichment: *Use an engineering design process to refine the methodology to optimize the DNA-extraction process for various cell types.**	This standard can be met during teacher/class lab instruction.
GEN.1A.6 *Investigate the structural differences between the genomes (i.e., circular/linear chromosomes and plasmids) found in prokaryotes and eukaryotes.*	This standard can be met during teacher/class lab instruction.
GEN.1B Students will analyze how the DNA sequence is copied and transmitted to new cells.	
GEN.1B.1 *Compare and contrast various proposed models of DNA replication (i.e., conservative, semi-conservative, and disruptive). Evaluate the evidence used to determine the mechanism of DNA replication.*	**Student Edition:** 167 *Figure 9.15* 167 *Key Concepts Questions* 170 #2-#3
GEN.1B.2 *Develop and use models to illustrate the mechanics of DNA replication.*	Using the following figures, the student can develop and model the mechanics of DNA replication. **Student Edition:** *Figure 9.16 & 9.17* 168 *Figure 9.18* 169
GEN.1B.3 *Microscopically observe and analyze the stages of the cell cycle (G1-S-G2-M) to describe the phenomenon, and identify methods at different cell cycle checkpoints through which the integrity of the DNA code is maintained.*	This figure shows a picture of mitosis microscopically. **Student Edition:** *Figure 2.14* 28-29

STANDARDS	PAGE REFERENCES
GEN.2 Transcription, Translation, and Mutations	
GEN.2A Students will analyze and explain the processes of transcription and translation in protein production.	
GEN.2A.1 *Compare and contrast the structure of RNA to DNA and relate this structure to the different function of each molecule.*	**Student Edition:** 20, 167-169, 177-178 *Figure 9.17* 168 *Figure 10.4* 177 *Key Concepts Questions* 182 #1 *Review Questions* 191 #4 *Table 10.1 & 10.2* 178
GEN.2A.2 *Describe and model how the process of transcription produces RNA from a DNA template in both prokaryotes and eukaryotes.*	**Student Edition:** 176-182 *Applied Questions* 191 #2 *Figure 10.3* 177 *Figure 10.6* 179 *Figure 10.8 & 10.9* 180 *Figure 10.10 & 10.11* 181 *Key Concepts Questions* 182 #2-4 *Review Questions* 191 #5
GEN.2A.3 *Develop a model to show the relationship between the components involved in the mechanics of translation at the ribosome.*	Using the figures and diagrams from the following page references, the student can develop a model of the translation. **Student Edition:** 182-187 *Figure 10.12* 182 *Figure 10.15* 185 *Figure 10.16, 10.17, & 10.18* 186
GEN.2A.4 Analyze the multiple roles of RNA in translation. Compare the structure and function of tRNA, rRNA, mRNA, and snRNA.	**Student Edition:** 184-187 *Figure 10.15* 185 *Figure 10.16, 10.17, & 10.18* 186
GEN.2A.5 Enrichment: *Evaluate Beadle and Tatum's "One Gene-One Enzyme Hypothesis" (1941) in the development of the central dogma (DNA →RNA →Protein). Explain how new discoveries, such as alternate splicing of introns, have led to the revision of the central dogma.*	This standard can be met during teacher/class lab instruction.

STANDARDS	PAGE REFERENCES
GEN.2B Students will determine the causes and effects of mutations in DNA.	
GEN.2B.1 *Identify factors that cause mutations (e.g., environmental, errors in replication, and viral infections).*	**Student Edition:** 212-215 *Figure 12.6* 212 *Figure 12.7 & 12.8* 213 *Key Concepts Questions* 215 *Review Questions* 227 #12, #15
GEN.2B.2 *Explain how these mutations may result in changes in protein structure and function.*	**Student Edition:** 215-217, 219 *Clinical Connection* 218 *Key Concepts Questions* 219
GEN.2B.3 *Describe cellular mechanisms that can help to minimize mutations (e.g., cell cycle checkpoints, DNA polymerase proofreading, and DNA repair enzymes).*	**Student Edition:** 222-223 *Figure 12.13* 222 *Figure 12.14 & 12.15* 223 *Review Questions* 227 #22
GEN.2B.4 *Investigate the role of mutations and the loss of cell cycle regulation in the development of cancers.*	**Student Edition:** 29-30, 345-348, 352-355, 358-359 *Figure 2.15* 30 *Figure 18.3* 347 *Figure 18.10* 353 *Figure 18.11* 354 *Figure 18.15* 358 *Review Questions* 363 #10, #17, #19
GEN.2B.5 Enrichment: *Use an engineering design process to research the current status of genetic technology and personalized medicine, then propose and test targeted medical or forensic applications.**	This standard can be met during teacher/class lab instruction.

STANDARDS	PAGE REFERENCES
GEN.3 Biotechnological Applications	
GEN.3 Students will investigate biotechnology applications and bioengineering practices.	
GEN.3.1 *Explain and demonstrate the use of various tools and techniques of DNA manipulation and their applications in forensics (e.g., paternity and victim/suspect identification), agriculture (e.g., pesticide or herbicide resistance, improved yields, and improved nutritional value), and personalized medicine (e.g., targeted therapies, cancer treatment, production of insulin and human growth hormone, and engineering insect vectors of human parasites).*	**Student Edition:** 261-269, 367-373, 374-379 *Applied Questions* 381 #10 *Bioethics* 171, 268, 289, 371, 432 *Case Studies and Research Results* 381-382 *Clinical Connection* 263, 361, 396 *Figure 19.7* 374 *Forensics Focus* 84 #1, 105, 271, 317 #3 *Key Concepts Questions* 313, 379 *Post Conviction DNA Testing* 256-257
GEN.3.2 *Experimentally demonstrate genetic transformation, protein purification, and/or gel electrophoresis.*	This standard can be met during teacher/class lab instruction.
GEN.3.3 Enrichment: *Use an engineering design process to refine methodology and optimize the process of genetic transformation, protein purification, and/or gel electrophoresis.**	This standard can be met during teacher/class lab instruction.
GEN.3.4 Enrichment: *Develop logical arguments based on scientific evidence for and against ethical concerns regarding biotechnology/bioengineering.*	**Student Edition:** *Bioethics* 171, 268, 280, 371, 410, 432
GEN.4 Classic Mendelian Genetics	
GEN.4 Students will analyze and interpret data collected from probability calculations to explain the inheritance of traits within a population.	
GEN.4.1 *Demonstrate Mendel's law of dominance and segregation using mathematics to predict phenotypic and genotypic ratios.*	**Student Edition:** *Applied Questions* 83 #1, #3-#6 *Solving a Problem in Following a Single Gene* 73
GEN.4.2 *Illustrate Mendel's law of independent assortment by analyzing multi-trait cross data sets for patterns and trends.*	**Student Edition:** *Applied Questions* 84 #12 *Figure 4.11* 77 *Figure 4.12* 78 *Solving a Problem in Following Multiple Genes* 76-77

STANDARDS	PAGE REFERENCES
GEN.4.3 *Investigate traits that follow non-Mendelian inheritance patterns (e.g., incomplete dominance, codominance, multiple alleles, autosomal linkage, sex-linkage, polygenic, and epistasis).*	**Student Edition:** 87-90, 97-100, 111-112, 117-121 *Applied Questions* 104 #1-#2 *Clinical Connection* 113-114 *Figure 5.1* 88 *Figure 5.2 & 5.3* 89 *Figure 5.4* 90 *Figure 5.13* 99 *Key Concepts Questions* 94 #2-#3 *Review Questions* 103 *Solving a Problem of X-Linked Inheritance* 115
GEN.4.4 *Construct pedigrees from observed phenotypes. Analyze and interpret data to determine patterns of inheritance and disease risk.*	**Student Edition:** *Applied Questions* 83 #10
GEN.4.5 Enrichment: *Construct maps of genes on a chromosome based on data obtained from 2- and/or 3-point crosses or from recombination frequencies.*	The teacher can introduce this standard using the following page references. **Student Edition:** *Figure 5.17 & 5.18* 101 *Solving Linking Problems Using Logic* 100-102
GEN.5 Population Genetics	
GEN.5 Students will apply population genetic concepts to explain variability of organisms within a population.	
GEN.5.1 *Model the inheritance of chromosomes through meiotic cell division and demonstrate how meiosis and sexual reproduction lead to genetic variation in populations.*	Using the following figures, the student can develop and model the inheritance of chromosomes. **Student Edition:** *Figure 3.3* 43 *Figure 3.4 & 3.5* 44 *Figure 3.6 & 3.7* 45 *Figure 3.8* 46 *Figure 3.12* 48

STANDARDS	PAGE REFERENCES
GEN.5.2 *Explain how natural selection acts upon genetic variability within a population and may lead to changes in allelic frequencies over time and evolutionary changes in populations.*	**Student Edition:** 281-286 *A Glimpse of History* 285 *Applied Questions* 291 #2 *Clinical Connection* 113, 278-279 *Figure 15.8* 281 *Figure 15.11* 283 *Figure 15.12* 284 *Figure 15.13* 285 *Figure 15.14* 286 *Key Concepts Questions* 287 *The Evolution of Lactose Tolerance* 272
GEN.5.3 *Describe processes that cause changes in allelic frequencies (e.g., nonrandom mating, small population size, immigration and emigration, genetic drift, and mutation).*	**Student Edition:** 259, 273-277, 279-281 *An End to China's One-Child Policy* 106-107 *Applied Questions* 291 #4-#7 *Clinical Connection* 278-279 *Figure 15.2* 274 *Figure 15.3* 275 *Figure 15.5* 276 *Figure 15.7* 280 *Key Concepts Questions* 273, 275, 276, 280 *Review Questions* 290 *Table 15.4* 287
GEN.5.4 *Apply the Hardy-Weinberg formula to analyze changes in allelic frequencies due to natural selection in a population. Relate these changes to the environmental fitness of the phenotypes.*	**Student Edition:** 258-259 *Applied Questions* 292 #10 *Applying Hardy-Weinberg Equilibrium* 260-261 *Figure 14.4* 259 *Solving a Problem Using the Hardy-Weinberg Equation* 259-260
GEN.5.5 Enrichment: *Analyze computer simulations of the effects of natural selection on allelic frequencies in a population.*	This standard can be met during teacher/class lab instruction.
GEN.5.6 Enrichment: *Apply the concept of natural selection to analyze differences in human populations (e.g., skin color, lactose persistence, sickle cell anemia, and malaria).*	**Student Edition:** *Applied Questions* 291 #3, #7; 292 #9 *Case Studies and Research Results* 293 *Clinical Connection* 278-279

STANDARDS	PAGE REFERENCES
GEN.5.7 Enrichment: *Use genomic databases for sequence analysis and apply the information to species comparisons, evolutionary relationships, and/or determine the molecular basis of inherited disorders.*	**Student Edition:** *Bioethics* 311