Title: Unit III: DNA & Chromosomes **Subject/Course:** Human Genetics

Topic: DNA Structure/ Replication, Protein Synthesis, Expression & Mutations **Grade:** 11/12 **Designer(s):** Erin Gallagher

Stage 1- Desired Results

Established Goals:

Student knowledge & understanding of…

- Description of DNA structure and replication process
- Explanation of protein synthesis (transcription and translation)
- Role of DNA and protein synthesis gene expression
- Impact of genetic mutations on gene expression

PA Standards for Science & Technology:

3.1.10.B1. Describe how **genetic** information is inherited and expressed.
3.1.B.B1. Explain that the information passed from parents to offspring is transmitted by means of genes which are coded in **DNA** molecules.
Explain the basic process of **DNA** replication.
Describe the basic processes of transcription and translation.
Explain how crossing over, jumping genes, and deletion and duplication of genes results in genetic variation.
Explain how **mutations** can alter genetic information and the possible consequences on resultant cells.
3.1.12.B1. Explain gene inheritance and expression at the molecular level.
3.1.B.B3. Describe the basic structure of **DNA**, including the role of hydrogen bonding.
Explain how the process of **DNA** replication results in the transmission and conservation of the genetic code.
Describe how transcription and translation result in gene expression.
Differentiate among the end products of replication, transcription, and translation.
Cite evidence to support that the genetic code is universal.
3.1.12.B3. Analyze **gene expression** at the **mole**cular level.
3.1.B.B5.
CONSTANCY AND CHANGE
Explain how the processes of replication, transcription, and translation are similar in all organisms.
3.1.B.C2. Describe how mutations in sex cells may be passed on to successive generations and that the resulting **phenotype** may help, harm, or have little or no effect on the offspring's success in its environment.
3.1.10.C2. Explain the role of **mutations** and **gene recombination** in changing a population of **organisms**.

PA Keystone Anchors/Eligible Content:

BIO.B.1.2 Explain how genetic information is inherited.
BIO.B.2.3 Explain how genetic information is expressed.
BIO.B.2.2 Explain the process of protein synthesis (i.e., transcription, translation, and protein modification).
BIO.B.2.4 Apply scientific thinking, processes, tools, and technologies in the study of genetics.

Transfer:

Students will be able to independently use their learning to…

- Explain how DNA functions as the basis of life, from genetic information storage and replication, to coding

for the proteins that determine traits.
- Discuss the importance of the study of genetics and its significant landmark discoveries in understanding how genetics affects human lives
- Describe how mutations occur, and the possible effects of mutations in gene expression
- Distinguish between genetic mutations and abnormal chromosomes, and explain the significance of chromosomal integrity & number

Meaning:

Understandings:

Students will understand that…

- DNA is the basis of life because of three qualities: it holds information, it copies itself, and it changes.
- DNA sequences are the blueprints of life. Cells must maintain this information, yet also access it to manufacture proteins. RNA acts as the go-between, linking DNA to protein.
- Discovering the nature of genetic material, determining the structure of DNA, cracking the genetic code, and sequencing the human genome were steps on the way toward today's challenge: deciphering how the information in the human genome is accessed and used, through tissue and time.
- Mutations provide the variation necessary for life to exist. Usually DNA repair protects against harmful mutations, but some mutations are helpful.
- A human genome has 20,000 plus protein encoding genes dispersed among 24 chromosome types. Abnormalities in chromosomes number or structure can have sweeping effects, but mutation is a continuum. Chromosomal-level illnesses reflect disruption of individual genes.

Essential Questions:

1. How does the structure of DNA enable efficient replication?
2. How is the information encoded within DNA accessed to create proteins?
3. Why is the sequence and structure of proteins so crucial to gene expression?
4. What are the causes and types of mutations?
5. How do mutations contribute to genetic variations?
6. What mechanisms decrease the frequency of mutations?
7. Why is the structure and number of chromosomes so vital in preventing or contributing to chromosomal disorders?

Acquisition:

Students will know…

- Experiments and research that determined DNA structure
- Structure of DNA
- Process steps of DNA replication
- Structure of RNA
- Role of RNA in protein synthesis (transcription)
- Steps of protein synthesis (translation)
- Impact of protein sequence and shape on function
- Effect of epigenetics on gene expression
- Gene expression control factors
- Coding vs. non-coding (exons & introns) impact of gene information maximization

Students will be skilled at …

1. Describing the work involved in determining DNA structure
2. Explaining the structure of DNA
3. Explaining the process of DNA replication
4. Describing RNA structure
5. Explaining role of RNA in transcription
6. Identifying the steps of transcription
7. Describing the process of translation
8. Explaining protein processing (shape formation) and its role in function
9. Describing epigenetics
10. Explaining epigenetic processes and their effect on gene expression

• Causes and types of mutations • Impact of mutations on gene expression • Role of DNA repair in mutation prevention • Structure and types of chromosomes • Impacts of atypical chromosome numbers and structures	11. Describing gene expression controls (methyl groups, microRNAs) 12. Explaining how DNA division into exons and introns maximizes protein numbers 13. Describing the causes of mutations 14. Identifying the types of mutations 15. Describing how mutations effect gene expression 16. Explaining how DNA repair prevents mutation frequencies 17. Identifying parts of the chromosome 18. Identifying chromosome types 19. Explaining how atypical chromosome numbers occur 20. Identifying syndromes associated with atypical chromosome numbers 21. Explaining how atypical chromosome structures occur 22. Describing syndromes associated with atypical chromosome structures
Stage 2- Assessment Evidence	
Unit-Based Project <u>Gene Expression Story</u> Students will create a middle school children's book explaining the path of the expression of mutation or chromosomal disorder/disease The book must describe/explain, and students will be evaluated on, the inclusion, accuracy and organization of: • DNA structure • DNA replication • Protein synthesis pathway • Meiosis, fertilization and mitotic development • Process of mutation/chromosomal abnormality (DNA replication, protein synthesis, meiosis, fertilization, mitosis, etc) • Factors affecting expression of disorder • Rate of occurrence of disorder/ groups affected • Manifestations of disorders • Treatments/outcomes Additional evaluations: Project quality (neatness, layout, organization) Accuracy and quality of information Diagrams and images Bibliography	**Other Evidence:** Chapter quizzes: • Ch9: DNA Structure & Replication • Ch10: Gene Action: From DNA to Protein • Ch11: Gene Expression & Epigenetics • Ch12: Gene Mutation • Ch13: Chromosomes Unit test: DNA and Chromosomes Laboratory Activities Chapter Case Studies

Stage 3- Learning Plan

Pre-Assessment

Learning Events	**Progress-Monitoring**
Vocabulary: CH9: DNA Structure & Replication *Adenine, thymine, cytosine, guanine, purines, pyrimidines, nucleotide, deoxyribose, complementary base pairs, antiparallel, chromatin, semiconservative, replication forks, DNA polymerase, ligase* Vocabulary Chapter topic scenario questions/discussion • Chap 9: "On the Meaning of Gene" p.164 Lecture/ notes/ discussion Animations/videos Exercises: • DNA diagrams • Base pairing practices Chapter outline Chapter Review Questions • Chap 9: pp.176-177 Online activities/webquests • Chap 9 p.177 Laboratory exercises (online & hands-on) • Creating DNA models, modeling replication • DNA extraction lab Chapter Applied Questions • Chap 9: pp.176-177 Bioethics reading and discussion questions • Chap 9: "Infidelity Testing" p.175-176 Forensics Focus and/or Case Studies • Chap 9: p.178 Guided reading/Review handouts CH10: Gene Action: From DNA to Protein *Exome, transcription, translation, template strand, coding strand, messenger RNA, codon, ribosomal RNA, transfer RNA, anticodon, transcription factors, RNA polymerase, promoter, exons, introns, alternate splicing, genetic code, conformation, primary structure, secondary structure, tertiary structure, quaternary structure, chaperone proteins, proteasomes*	✓ Do Nows ✓ Vocabulary quizzes ✓ Outlines check ✓ Online activities completion and accuracy check with discussion on results ✓ Accuracy of review and applied questions, guided reading handouts, chapter reading synopses ✓ Bioethics scenarios discussion ✓ Forensic focus/case studies analyses ✓ Lab exercises execution & data analyses ✓ Unit project progression monitoring

Vocabulary
Chapter topic scenario questions/discussion
- Chap 10: “Whole Exome Sequencing” p.179

Lecture/ notes/ discussion
Animations/videos
Exercises:
- RNA & amino acid diagrams
- Transcription practices
- Translation practices
- Protein structures & organization diagram

Chapter outline
Chapter Review Questions
- Chap 10: p.197

Online activities/webquests
- Chap 10 p.198

Chapter readings with 5 sentence synopsis
- Reading 10.1: “Considering Kuru” p.195-196

Laboratory exercises (online & hands-on)
- Modeling RNA and protein synthesis

Chapter Applied Questions
- Chap 10: p.197

Forensics Focus and/or Case Studies
- Chap 10: p.198

Guided reading/Review handouts

CH11: Gene Expression & Epigenetics
Epigenetics, proteomics, chromatin remodeling, microRNAs, pseudogenes, transposons

Vocabulary
Chapter topic scenario questions/discussion
- Chap 11: “The Dutch Hunger Winter” p.199

Lecture/ notes/ discussion
Animations/videos
Exercises:
- Gene expression controls chart
- Venn diagram: introns & exons

Chapter outline
Chapter Review Questions
- Chap 11: pp.209-210

Online activities/webquests
- Chap 11 p.210

Laboratory exercises (online & hands-on)
- See web activities

Chapter Applied Questions
- Chap 11: pp.209-210

Forensics Focus and/or Case Studies
- Chap 11: p.210

Guided reading/Review handouts

CH12: Gene Mutation
Mutation, mutant, germline mutation, somatic mutation, allelic disorders, mutagen, point mutation, transition, transversion, missense mutation, nonsense mutation, splice-site mutation, exon skipping, frameshift mutation, deletion mutation, insertion mutation, tandem duplication, expanding triplet repeat, copy number variants (CNVs), conditional mutation, nucleotide incision repair, base excision repair, mismatch repair,

Vocabulary
Chapter topic scenario questions/discussion
- Chap 12: "Cystic Fibrosis Revisited: Counteracting a Mutation" p.211

Lecture/ notes/ discussion
Animations/videos
Exercises:
- Gene mutations practices (DNA replication, protein synthesis)
- Mutation causes chart
- Mutation types chart

Chapter outline
Chapter Review Questions
- Chap 12: pp.232-233

Online activities/webquests
- Chap 12 p.233

Chapter readings with 5 sentence synopsis
- Reading 12.1: "Fragile X Mutations Affect Boys and their Grandfathers" p.224

Laboratory exercises (online & hands-on)
Chapter Applied Questions
- Chap 12: pp.232-233

Forensics Focus and/or Case Studies
- Chap 12: pp.233-234

Guided reading/Review handouts

CH13:Chromosomes
Cytogenetics, heterochromatin, euchromatin, telomeres, centromeres, karyotype, metacentric, submetacentric, acrocentric, translocation, DNA probe, amniocentesis, chorionic villus sampling, chromosome microarray analysis, trisomy, polyploidy, euploid, aneuploidy, monosomy, non-disjunction, deletions, duplications, Robertsonian translocation, translocation carrier, reciprocal translocation, paracentric inversion, pericentric inversion, isochromosome, uniparental disomy

Vocabulary
Chapter topic scenario questions/discussion
- Chap 13: "A Late Diagnosis" p.235

Lecture/ notes/ discussion
Animations/videos
Exercises:
- Reading and interpreting karyotypes
- Chromosome diagrams
- Chromosomes in meiosis & fertilization diagrams (norm vs. abnorm

chromosome number) • Translocations & inversions diagrams Chapter outline Chapter Review Questions • Chap 13: p257-258 Online activities/webquests • Chap 13 p.258 Laboratory exercises (online & hands-on) • Observing ultrasound images, genetic tests for markers of chromosomal abnormalities Chapter Applied Questions • Chap 13: p257-258 Bioethics reading and discussion questions • Chap 13: "Down Syndrome Ups and Downs" p.240 Forensics Focus and/or Case Studies • Chap 13: p.259 Guided reading/Review handouts	
Technology • Laptops and Internet for online activities and project research • Powerpoint/LCD projector for lecture/discussion • Laboratory equipment & materials for lab exercises • McGraw-Hill Connect Genetics (teacher): online assignments, quizzes, tests, online activities, questions, presentations, animations, student performance tracking • McGraw Hill ConnectPlus Genetics (student): eBook, assignments, quizzes, tests, questions, activities, vocab flashcards, animations • Text companion website: www.glencoe.com/lewis10 or www.mhhe.com/lewisgenetics10 • Discovery Streaming videos	**Pacing Guide** Chapters 9-13 = 4 weeks Approx: 6 days: Chap 9 & 10 (quiz) 10 days: Chap 11-12 (quiz) 4 days: Chap 13 (quiz) Review/reteach Unit test / Unit Project due