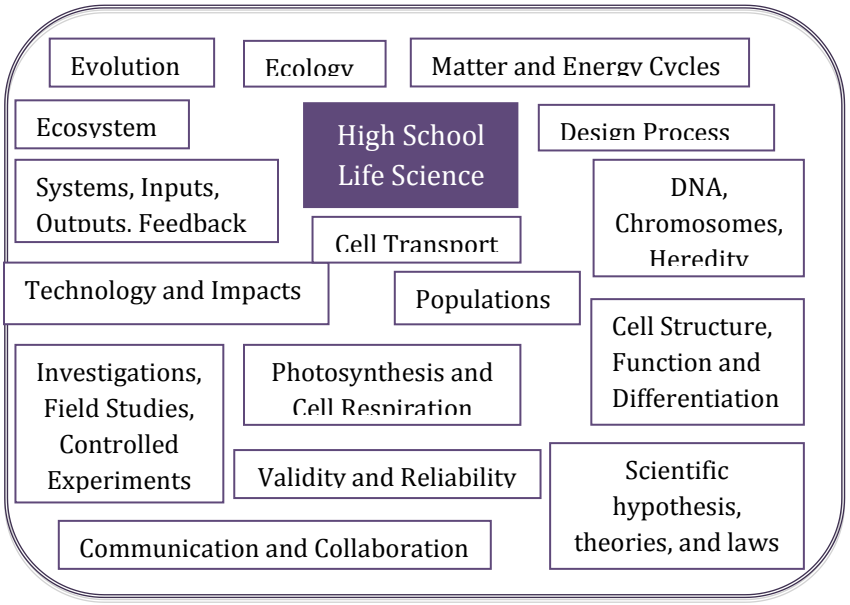
Life Science Standard **LS1E**

Content Standard:
Genetic information responsible for inherited characteristics is encoded in the DNA molecules in chromosomes. DNA is composed of four subunits (A, T, C, G). The sequence of subunits in a gene specifies the amino acids needed to make a protein. Proteins express inherited traits (e.g., eye color, hair texture) and carry out most cell *function*.

Performance Indicators:
Describe how DNA *molecules* are long chains linking four subunits (smaller *molecules*) whose sequence encodes *genetic information*.
Illustrate the process by which *gene* sequences are copied to produce proteins.

Item Specifications:

Describe the structure of DNA molecules in terms of the four nucleotides (i.e., A, C, G, and T subunits are combined in various sequences).
Describe that the sequence of the four nucleotides in the DNA molecule encodes genetic information.
Describe the relationships among DNA, chromosomes, genes, amino acids, proteins, and/or traits.
Describe that the sequence of the nucleotides in a gene specifies the amino acids needed to make a protein.
Describe inherited traits (e.g., eye color, hair texture, attached earlobes, tongue rolling) and cell functions as primarily determined by the proteins expressed by genes.
Predict the complementary strand of mRNA given the nucleotide sequence in a single strand of DNA.
Describe the steps and/or structures in the process by which gene sequences are copied to produce proteins.



Reflective Questions for Students:

- How is the molecule DNA linked to proteins?
- How does the structure of DNA affect its function?
- How does DNA code our genetic information?

As you think about the answers to these questions, think about models that you could develop, diagrams that would demonstrate processes and functions of parts in relationship to their structure.

Assessment Information

http://www.k12.wa.us/Science/Assessments.aspx

Quick Links for Students:
The following links will help explore your understanding of DNA, proteins, and their functioning.

Learn the basics: http://learn.genetics.utah.edu/content/begin/tour/

Build a DNA Model:
http://learn.genetics.utah.edu/content/begin/dna/builddna/

Protein to DNA: http://learn.genetics.utah.edu/content/begin/dna/

Teacher Center
Elements of Effective Science Instruction

Disciplinary Core Ideas

Use the big ideas of DNA, Genes, and Protein Synthesis as guided by the performance expectations and item specifications.

Student learning progressions for DNA, Genetics, and Protein Synthesis can be found at

http://www.doe.mass.edu/omste/ste/default.html.

Read the following excerpt from the Massachusetts site about DNA, Genes, and Protein Synthesis:

Students recognize that all organisms have DNA and genes. Students can explain the role and function of genes in living organisms. They can relate and distinguish between chromosomes, genes, DNA, and nucleotides in animal and plant cells. They understand the order of nucleotides in a gene determine the structure of a protein, and consequently the function of a protein in cells. Students can explain how a mutation in a gene can affect the structure, function, or behavior of a cell or an organism by influencing the structure or function of proteins.

Essential teaching components leading to the big ideas:

Student acquisition of the content of science involves opportunities to meet state crosscutting and domain standards and recognize how the big ideas fit within a large conceptual framework. Learning is best achieved through sequencing learning targets into learning progressions that inform teacher's instructional decision making.

The essential teaching components leading to the big ideas of DNA, Genes and Protein synthesis include:

1. Understanding of the components of DNA and how the components fit together.

2. DNA codes for genes, which code for specific amino acids needed to make a protein.

3. Proteins are expressed as inheritable traits.

Additional supports and extensions for understanding how students grasp the concept:

DNA Animations:

This website has multiple short animations at various levels to aid understanding of DNA processes.
http://www.hhmi.org/biointeractive/dna/animations.html

Basic tutorials for students can be found at http://learn.genetics.utah.edu/.

Animations at various levels of cell processes http://vcell.ndsu.edu/animations/

Cross Cutting Ideas:
Designing for Learning

Strategies to reveal student understanding include:

- Paige Keeley's Formative assessment probes available through nsta.org
- Teacher's Toolkit: Misconceptions in the science classroom, Science Scope at www.nsta.org
  This article in Science Scope offers suggestions for identifying science misconceptions in general.
  - Know-Wonder-Learn Charts
  - Science assessment probes—NSTA Paige Keely: Science assessment probe books
  - Site for misconceptions with DNA, Genetics, and Protein synthesis
    - http://rpdp.net/sciencetips_v2/L12A1.htm#misconcept
    - http://www.doe.mass.edu/omste/ste/default.html

Prerequisite knowledge required:

- Basic understanding of Chemistry—atoms, bonding, molecules (add Physical science Standard links)
- Understanding the structure of DNA and proteins
- Understanding how genes link proteins to traits.

Learning progressions DNA, genes and protein synthesis include:

- Understanding of components of DNA and proteins
- Understanding of genes linking to protein to traits.

Scientifically oriented questions focused on clarifying and extending student understanding include:

- What is the role of enzymes in protein production?
- How is DNA structure connected to the function of DNA?

Activities supporting opportunities for students to make claims, use evidence and communicate reasonings:

- Northwest Association for Biomedical Research-- http://www.nwabr.org/education/bioethcurr.html
- Case Studies http://sciencecases.lib.buffalo.edu/cs/
  Human Genome Project with case studies http://ehrweb.aaas.org/ehr/books/index.html

Cross Cutting Ideas:
Sense Making

Planning time in the lessons to support time for students to make sense of what they are learning include:

- Reflective writing on what the student now knows about the molecule of DNA, RNA and/or protein compared to what they thought they knew—by the day, week, and unit.
- Students write cartoons of protein synthesis
- Students brainstorm analogies of DNA, RNA, and Protein Synthesis

Cross Cutting Ideas:
Classroom Culture and Environment

Activities that show how DNA, Genes, and Protein Synthesis relates to students' everyday lives include:

- DNA fingerprinting Simulation: http://www.pbs.org/wgbh/nova/teachers/body/create-dna-fingerprint.html
- What makes a Firefly glow: http://learn.genetics.utah.edu/content/begin/dna/firefly/
- Howard Hughes Medical Institute: multitude of resources for everyday genetics: http://www.hhmi.org/coolscience/
- Biointeractive—video, lectures, interactive, virtual labs, and more: http://www.hhmi.org/biointeractive/
- HHMI resources for educators by topic: http://www.hhmi.org/coolscience/resources/SPT--

	Home.php
Strategies to focus on student conversations, interactive notebook prompts, model-building include: Strategies for girls in science—work for all students—website http://dww.ed.gov/Encouraging-Girls/topic/?T_ID=18	**Activities that show how scientists think and do science in relationship to this content standards include:**