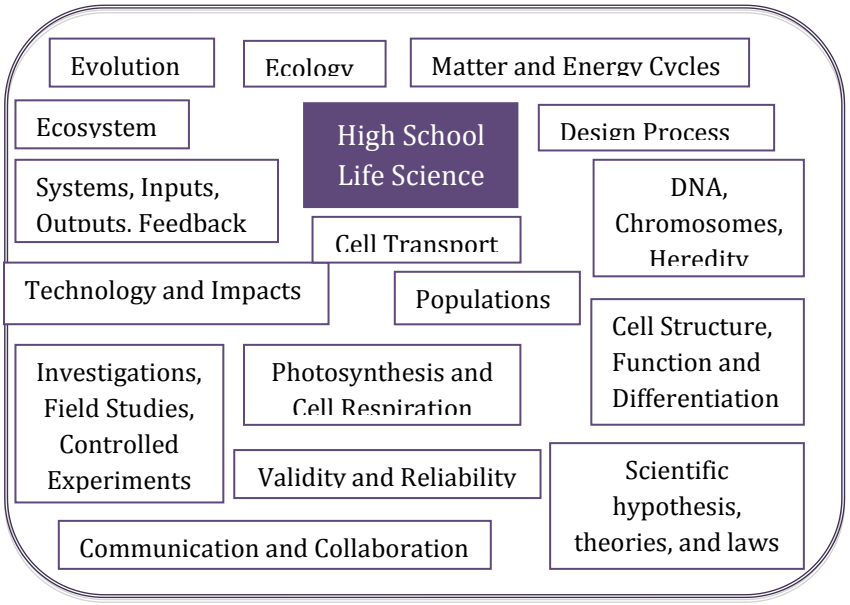
Life Science Standard **LS1F**

Content Standard:
All of the *functions* of the cell are based on *chemical reactions*. Food *molecules* are broken down to provide the *energy* and the chemical constituents needed to synthesize other *molecules*. Breakdown and synthesis are made possible by proteins called *enzymes*.
Some of these *enzymes* enable the cell to store *energy* in special chemicals, such as ATP, that are needed to drive the many other *chemical reactions* in a cell.

Performance Indicators:
Explain how cells break down food *molecules* and use the constituents to synthesize proteins, sugars, fats, DNA and many other *molecules* that cells require.
Describe the role that *enzymes* play in the breakdown of food *molecules* and synthesis of the many different *molecules* needed for cell structure and *function*.
Explain how cells extract and store *energy* from food *molecules*.

Item Specifications:

Describe that large molecules in food are broken down into smaller molecules by cells to provide energy or building blocks (i.e., proteins into amino acids, carbohydrates into simple sugars, fats into fatty acids, DNA into nucleotides).
Describe that cells build large molecules required for cell functions from smaller molecules (i.e., proteins from amino acids, carbohydrates from simple sugars, fats from fatty acids, DNA from nucleotides).
Describe enzymes as proteins that regulate reactions that break down and/or build molecules needed by cell structures and/or functions.
Describe that cells transfer chemical energy from food to special molecules. Describe that chemical energy stored in special molecules is used by cells to drive cell processes.



Reflective Questions for Students:

- How do enzymes break food down into molecules that can be used by cells to make the chemicals required by the cell?
- What are the components that make up proteins, enzymes, fats, complex carbohydrates, or DNA?
- What are the molecules that transfer energy for cell processes?

Assessment Information

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

Quick Links for Students:
The following links will help you visualize the process

- All About Enzymes
  http://www.learnerstv.com/animation/biology/Enzymeactivity.swf
- The Role of Enzymes in Biological Systems
  http://faculty.ivytech.edu/~twmurphy/txt_202/enzymes.htm
- The role of enzymes in DNA transcription video
  http://www.hhmi.org/biointeractive/dna/DNAi_replication_vo2.html
- Molecules Build Cells
  http://faculty.stcc.edu/AandP/AP/AP1pages/Units1to4/epitissmol/molecule.htm
- Respiration and Photosynthesis
  http://vcell.ndsu.edu/animations/

Teacher Center
Elements of Effective Science Instruction

Disciplinary Core Ideas

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.

- Use the big ideas of photosynthesis and respiration as guided by the performance expectations and item specifications for LS1SA and LS1B.
- The focus of LS1F is on the actions of enzymes to break down molecules to provide energy and building blocks required by the cell. Students should also understand how ADP and ATP is used to transfer energy needed for cell processes

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.
- Private Universe Project in Science at http://www.learner.org/resources/series29.html is a collection of videos probing misconceptions of several important science concepts and offers insight into how these misconceptions interfere with learning.
- http://www.doe.mass.edu/omste/ste/default.html: Go to the life science file on this page for extensive descriptions of common student misconceptions about concepts in biology.

Prerequisite knowledge required:

- Know, Wonder, Learn Activity
- Paige Keeley NSTA publication

Student learning progressions for chemical reactions in the cell can be found at:

http://www.doe.mass.edu/omste/ste/default.html.
Click on Life Science-Biology document, pages 15-18. Read the excerpt about **Chemical Reactions in Cells.**

- Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, nucleic acids).
- Explain the important role that ATP serves in metabolism.
- Describe how ATP is generated when food substances are broken down (e.g. during cellular respiration) and is used by proteins to perform work inside of cells (e.g. when protein enzymes build cellular molecules like DNA during cellular reproduction.

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

- Make a model to explain that small molecules are building blocks for each of these large molecules: fats, DNA, proteins, and carbohydrates?
- Explain how large molecules are broken down into small parts and those parts that become available for the cell to make new molecules. Describe how the new molecules are different than the original large molecules?
- Use a model to explain why it requires a different enzyme to break a molecule apart than it did to put the molecule together.

- Analyze the transfer of energy as it comes from fats and carbohydrates to specialized molecules such as ATP then is used for cell processes.

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

- **SYSTEMS (EALR 1):**
  - A
- **INQUIRY (EALR 2):**
  - A
- **APPLICATION (EALR 3):**
  - A
- **LIFE SCIENCE (EALR 4):**
  - From Monomers to Polymers (Three-activity module) *http://workbench.concord.org/database/activities/97.html*
  - Molecular Menagerie (Model Building) http://www.hhmi.org/biointeractive/activities/mol_menangerie/molecular_menagerie_generic_final.pdf
  - Salivating Inquiry Experience: Enzyme Catalysis via the 7E Learning Cycle http://www.nsta.org/highschool/connections/200809ASalivatingInquiryExperience.pdf

Cross Cutting Ideas: *Sense Making*	**Cross Cutting Ideas:** *Classroom Culture and Environment*
Planning time in the lessons to support time for students to make sense of what they are learning include: • This website offers a variety of professional development lessons and videos for strategies to teach specific concepts within science. http://www.teachersdomain.org/search/?q=strategies+for+effective+teaching&fq_grade=PK&fq_grade=PS.	**Activities that show how this content standard relates to students' everyday lives include:** • This site has several lessons on cloning. http://www.lessonplanet.com/lesson-plans/cloning. • This site has several lessons on cancer, including cancer and the cell cycle. http://science.education.nih.gov/supplements/nih1/cancer/guide/pdfs.htm. • The site on cancer lessons also has examples and information on the questions scientist ask to guide their research.
Strategies to focus on student conversations, interactive notebook prompts, model-building include:	**Activities that show how scientists think and do science in relationship to this content standards include:**