Anatomy & Physiology I

This is an advanced placement course in human anatomy and physiology with emphasis on the structure and function of the human body. Major areas of study will include cells, tissues, integument system, skeletal system, muscular system, and endocrine system. *This course may include dissection.
2011-2012 SEInc. HS Curriculum Development Plan

- Survey HS teachers for qualifications to teach dual-enrollment courses
- Identify HS teachers qualified to teach dual-enrollment courses, develop and offer courses
- Add rigorous objectives to HS courses in Math, English, Science, and Social Studies for Honors extensions.
  - Teachers will need to include Honors projects and assignments based on the Honors objectives for each course syllabus.
    - Students will self-identify, teachers will recommend, Principals will approve based on grades and test scores for entrance into the Honors course – a class within a class...
- Create a partnership with ACE and HOOPS so that Juniors and Seniors may begin college course work.
  - Analyze if ACE/HOOPS courses are aligned with Arizona State Standards so that students may receive HS credit for CC courses.
- Work toward AP programming, curriculum, obtaining text and resources, and providing professional development opportunities for HS teachers.

Let’s define some terms....

**Honors:** Rigorous curriculum, courses with intense objectives that focus deeply into the knowledge and experience the course offers.

**Dual Enrollment:** Teachers are qualified to teach a CC level course. Students receive CC credit and HS credit at the same time.

**ACE/HOOPS:** Students go off campus to a local CC to attend CC courses, for CC credit. If the courses align with AZ State Standards, students will be able to receive HS credit as well.

**AP:** HS courses, with specific curriculum and text, where students can test to get college credit after high school.
Curricular Guide for Anatomy/Physiology I

**An Introduction to Curriculum Mapping and Standards Log**

Objectives are mapped according to when they should be introduced and when they should be assessed throughout the quarter (K-8), or course (7-12). A record of when all objectives are introduced and assessed is to be kept through the course map and log, using the month, day, and year introduced. Objectives only have to be reviewed if assessment is not 80% students at 80% mastery.

**In some cases, it is not necessary to teach the standards if 80% students are at 80% mastery when pretested. However, if less than 80% students achieve 80% mastery, it is necessary to give instruction and a posttest.**

Standards Log Example:

<table>
<thead>
<tr>
<th>Introduced</th>
<th>Assessed, 80%@80%</th>
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<tbody>
<tr>
<td>8-1-11</td>
<td>8-4-11</td>
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<tr>
<td>Review, if needed:</td>
<td>8-8-11</td>
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<td>8-7-11</td>
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</table>

The curriculum is standards-based, and it is the Skyline philosophy to use “Backwards Design” when lesson planning. Backwards Design starts with standards, and from there, an assessment is created in alignment with the standards; next, the instruction for that assessment and those standards is created. Also, all standards addressed for instruction and assessment should be visibly posted in the classroom, along with student-friendly wording of the objectives.

Assessments for mastery are to be summative, or cumulative in nature. Formative assessments are generally quick-assessments where the teacher can gauge whether or not student-learning is acquired.

Curriculum binders are set up to have a master of each grade or content level, as well as a teacher’s copy, which is to serve as a working document. Teachers may write in the teacher’s binder to log standards, suggest remapping, adjust timing, and so on.

The curriculum mapping may be modified or adjusted as necessary for individual students and classes, as well as available resources, within reason. Major changes are to be submitted to the school’s Professional Learning Community, Administration, and the Board.
Course Objectives
# Anatomy/Physiology I

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- **Subject**: Science
- **Subject/ Grade/ Domain**: HIGH SCHOOL
- **Strand**: Strand 1: Inquiry Process

  - **Concept**: Concept 1: Observations, Questions, and Hypotheses
    - Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.
    - **Performance Objective PO 1.**: Evaluate scientific information for relevance to a given problem.
    - **Performance Objective PO 2.**: Develop questions from observations that transition into testable hypotheses.
    - **Performance Objective PO 3.**: Formulate a testable hypothesis.
    - **Performance Objective PO 4.**: Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).  

  - **Concept**: Concept 2: Scientific Testing (Investigating and Modeling)
    - Design and conduct controlled investigations.
    - **Performance Objective PO 1.**: Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, organisms) and behavior in all science inquiry.
    - **Performance Objective PO 2.**: Identify the resources needed to conduct an investigation.
    - **Performance Objective PO 3.**: Design an appropriate protocol (written plan of action) for testing a hypothesis:
      - **Example**: Identify dependent and independent variables in a controlled investigation.
      - **Example**: Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes).
Example: Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).

Performance Objective PO 4.: Conduct a scientific investigation that is based on a research design.

Performance Objective PO 5.: Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.

• Concept: Concept 3: Analysis, Conclusions, and Refinements
  Evaluate experimental design, analyze data to explain results and propose further investigations.
  Design models.

• Performance Objective PO 1.: Interpret data that show a variety of possible relationships between variables, including:
  • Example: positive relationship
  • Example: negative relationship
  • Example: no relationship

Performance Objective PO 2.: Evaluate whether investigational data support or do not support the proposed hypothesis.

Performance Objective PO 3.: Critique reports of scientific studies (e.g., published papers, student reports).

Performance Objective PO 4.: Evaluate the design of an investigation to identify possible sources of procedural error, including:
  • Example: sample size
  • Example: trials
| Performance Objective PO 5. | Design models (conceptual or physical) of the following to represent “real world” scenarios:
| Example: carbon cycle |
| Example: water cycle |
| Example: phase change |
| Example: collisions |

| Performance Objective PO 6. | Use descriptive statistics to analyze data, including:
| Example: mean |
| Example: frequency |
| Example: range |

| Performance Objective PO 7. | Propose further investigations based on the findings of a conducted investigation. |

| Concept | Concept 4: Communication
Communicate results of investigations. |

| Performance Objective PO 1. | For a specific investigation, choose an appropriate method for communicating the results. |

<p>| Performance Objective PO 2. | Produce graphs that communicate data. |</p>
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<tr>
<th><strong>Performance Objective PO 3.</strong></th>
<th>Communicate results clearly and logically.</th>
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<td>Support conclusions with logical scientific arguments.</td>
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<th><strong>Activities and Instruction</strong></th>
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<tr>
<td>Rigor/Relevance</td>
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| **Assessment** | | |
|----------------|-----------------|
| **Assessment in the form of:** | **Assessment in the form of:** |
| - Summative Assessments | - Dramatic Assessments |
| - Standardized Tests    | - Student Teacher conference narratives |
| - Student Portfolio     | - Formative observations |
| - Interdisciplinary projects | - Checklists and Rubrics |
| - Student-Teacher conference narratives | |
## Anatomy/Physiology I

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<th>Anatomy/Physiology I, History and Nature of Science</th>
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</table>
| **AZ- Arizona Academics Standards**  
- **Subject**: Science  
- **Subject/ Grade/ Domain**: HIGH SCHOOL  
- **Strand**: Strand 2: History and Nature of Science  
  - **Concept**: Concept 1: History of Science as a Human Endeavor  
    Identify individual, cultural, and technological contributions to scientific knowledge.  
    - **Performance Objective PO 1.**: Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.  
    - **Performance Objective PO 2.**: Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.  
    - **Performance Objective PO 3.**: Analyze how specific changes in science have affected society.  
    - **Performance Objective PO 4.**: Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.  
  - **Concept**: Concept 2: Nature of Scientific Knowledge  
    Understand how science is a process for generating knowledge.  
    - **Performance Objective PO 1.**: Specify the requirements of a valid, scientific explanation (theory), including that it be:  
      - **Example**: logical  
      - **Example**: subject to peer review  
      - **Example**: public  
      - **Example**: respectful of rules of evidence |
**Performance Objective PO 2.** Explain the process by which accepted ideas are challenged or extended by scientific innovation.

**Performance Objective PO 3.** Distinguish between pure and applied science.

**Performance Objective PO 4.** Describe how scientists continue to investigate and critically analyze aspects of theories.

| Activities and Instruction | Teacher Modeling | Learning Centers | Learning Stations | Anchor Activities | Group Work | Small Group Discussion | Independent Study | Mentor Study | Think/Pair/Share | Total Physical Response | Graphic Organizers | Tiered Assignments | Literature Circles | Experiment | Rigor/Relevance | Drama | Arts Integration Projects | Simulations | Data Collection | Lecture | Whole Group Debate | Learning Games | Learning Contracts | Curriculum Compacting | Flexible Pacing | Self-Directed Learning | Problem-Based Learning | Conferencing | Seminars | Real-World Scenarios
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<td><strong>Strand</strong> : Strand 3: Science in Personal and Social Perspectives</td>
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<td><strong>Concept</strong> : Concept 2: Science and Technology in Society</td>
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<td>Develop viable solutions to a need or problem.</td>
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<td>• <strong>Performance Objective PO 1.</strong> : Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems:</td>
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<td><strong>Example</strong> : various forms of alternative energy</td>
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<td><strong>Example</strong> : storage of nuclear waste</td>
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<td><strong>Example</strong> : abandoned mines</td>
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<td><strong>Example</strong> : greenhouse gases</td>
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<td><strong>Example</strong> : hazardous wastes</td>
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<td><strong>Performance Objective PO 2.</strong> : Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.</td>
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<td><strong>Performance Objective PO 3.</strong> : Support a position on a science or technology issue.</td>
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<td><strong>Concept</strong> : Concept 3: Human Population Characteristics</td>
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<td>Analyze factors that affect human populations.</td>
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</table>
| | **Performance Objective PO 1.** : Analyze social factors that limit the growth of a human population, including:
| Example: affluence |
| Example: education |
| Example: access to health care |
| Example: cultural influence |

**Performance Objective PO 2.** Describe biotic (living) and abiotic (nonliving) factors that affect human populations.

**Performance Objective PO 3.** Predict the effect of a change in a specific factor on a human population.

### Activities and Instruction

| Teacher Modeling | Drama |
| Learning Centers | Arts Integration Projects |
| Learning Stations | Simulations |
| Learning Stations | Data Collection |
| Anchor Activities | Lecture |
| Group Work | Whole Group Debate |
| Small Group Discussion | Learning Games |
| Independent Study | Learning Contracts |
| Mentor Study | Curriculum Compacting |
| Think/Pair/Share | Flexible Pacing |
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| Graphic Organizers | Problem-Based Learning |
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| Literature Circles | Seminars |
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### Assessment

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# Anatomy/Physiology I

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<th>Objectives</th>
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<td><strong>Strand</strong></td>
<td>Strand 4: Life Science</td>
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<td></td>
<td><strong>Concept</strong></td>
<td>Concept 1: The Cell</td>
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<td><strong>Understand the role of the cell and cellular processes.</strong></td>
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| Performance Objective PO 1. | Describe the role of energy in cellular growth, development, and repair. |
| Performance Objective PO 2. | Compare the form and function of prokaryotic and eukaryotic cells and their cellular components. |
| Performance Objective PO 3. | Explain the importance of water to cells. |
| Performance Objective PO 4. | Analyze mechanisms of transport of materials (e.g., water, ions, macromolecules) into and out of cells: |
| Example              | passive transport |
| Example              | active transport |
| Performance Objective PO 5. | Describe the purposes and processes of cellular reproduction. |
| Concept              | Concept 2: Molecular Basis of Heredity |
| Understanding the molecular basis of heredity and resulting genetic diversity. |
| Performance Objective PO 1. | Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes. |
| Performance Objective PO 2. | Describe the molecular basis of heredity, in viruses and living things, including DNA replication and protein synthesis. |
| Performance Objective PO 3. | Explain how genotypic variation occurs and results in phenotypic diversity. |
Curricular Guide for Anatomy/Physiology I

- **Performance Objective PO 4.**: Describe how meiosis and fertilization maintain genetic variation.
  - **Concept**: Concept 4: Biological Evolution
  Understand the scientific principles and processes involved in biological evolution.

- **Performance Objective PO 2.**: Explain how genotypic and phenotypic variation can result in adaptations that influence an organism’s success in an environment.

- **Performance Objective PO 6.**: Analyze, using a biological classification system (i.e., cladistics, phylogeny, morphology, DNA analysis), the degree of relatedness among various species.
  - **Concept**: Concept 5: Matter, Energy, and Organization in Living Systems (Including Human Systems)
  Understand the organization of living systems, and the role of energy within those systems.

- **Performance Objective PO 1.**: Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products.

- **Performance Objective PO 2.**: Describe the role of organic and inorganic chemicals (e.g., carbohydrates, proteins, lipids, nucleic acids, water, ATP) important to living things.

- **Performance Objective PO 5.**: Describe the levels of organization of living things from cells, through tissues, organs, organ systems, organisms, populations, and communities to ecosystems.

### Activities and Instruction

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## Rigor/Relevance

### Real-World Scenarios

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Anatomy/Physiology I

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<td><strong>AZ- Arizona Academics Standards</strong></td>
<td><strong>Subject</strong>: Comprehensive Health</td>
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<tr>
<td><strong>Standard 1</strong>: Students comprehend concepts related to health promotion and disease prevention.</td>
<td><strong>Performance Objective PO 1</strong>: Identify the different stages of the human life cycle (conception, prenatal, infant, toddler, preschool, school)</td>
</tr>
<tr>
<td><strong>Grade Range</strong>: PROFICIENCY (Grades 9-12) Students know and are able to do all of the above and the following:</td>
<td><strong>Performance Objective PO 2</strong>: Identify the characteristics and developmental needs related to each stage of the life cycle</td>
</tr>
<tr>
<td><strong>Key Idea/Concept 1CH-P2</strong>: Explain the interrelationships among the mental, emotional, psychological and physical realities that occur throughout the life cycle</td>
<td><strong>Performance Objective PO 3</strong>: Relate the principles of healthy living to each stage of the life cycle</td>
</tr>
<tr>
<td><strong>Key Idea/Concept 1CH-P3</strong>: Explain the impact of personal health behaviors on the functioning of body systems and describe how to delay onset and reduce risks of potential health problems</td>
<td><strong>Performance Objective PO 4</strong>: Determine strategies to reduce health risk for more healthy behavior</td>
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</table>
| **Key Idea/Concept 1CH-P5**: Explain how environmental health influences the community and the functions of local, state and federal resources in addressing health issues | **Performance Objective PO 1**: Summarize major environmental health concerns
### Performance Objective PO 2:
List the roles and functions of agencies that address areas of environmental concern

* **Key Idea/Concept 1CH-P8:** Identify the location and function of the reproductive organs, the fertility cycle, and the process of conception, and emphasize factors that contribute to the birth of a healthy child

### Performance Objective PO 1:
Describe male and female reproductive organs and understand the location and basic function of each (to include menstrual cycle)

### Performance Objective PO 2:
Describe the association of conception to the fertility cycle

* **Key Idea/Concept 1CH-P10:** Explain the association of personal risk factors of chronic and communicable diseases, risk reduction and disease prevention components

### Performance Objective PO 2:
Describe how race, culture and hereditary factors impact disease susceptibility

  a) List environmental influences that affect disease susceptibility
  b) Describe the impact of fitness, diet, rest and other lifestyle issues related to disease

### Activities and Instruction

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<td></td>
<td>• Checklists and Rubrics</td>
</tr>
</tbody>
</table>
Vision
INTRODUCTION

Students are naturally curious about the world and their place in it. Sustaining this curiosity and giving it a scientific foundation must be a high priority in Arizona schools. Application of scientific thinking enables Arizona students to strengthen skills that people use every day: solving problems creatively, thinking critically, working cooperatively in teams, using technology effectively, and valuing lifelong learning.

Science education is much more than merely learning content. It is the active process of investigation and the critical review of evidence related to the world around us, both visible and invisible. Science is a dynamic process of gathering and evaluating information, looking for patterns, and then devising and testing possible explanations. Active engagement in scientific investigation leads students to think critically and to develop reasoning skills that allow them to become independent, lifelong learners. Science methods and thought processes have application well beyond the bounds of science and support learning goals in all subject areas.

The Arizona Science Standard Articulated by Grade Level has been written for ALL students. The science standard is set with the expectation that science instruction occurs at all grade levels – beginning in early grades with simple exploration, progressing to increasingly organized and sophisticated science investigations in higher grades.

Underlying all of the science standard strands are the five unifying concepts as identified in the National Science Education Standards (1995):

- Systems, Order, and Organization
- Evidence, Models, and Explanation
- Constancy, Change, and Measurement
- Evolution and Equilibrium
- Form and Function

This conceptual framework provides students with productive and insightful ways of considering and integrating a range of basic ideas that explain the natural world. Because the understanding and abilities associated with major conceptual and procedural schemes need to be developed over an entire education, the unifying concepts and processes transcend disciplinary boundaries.

These unifying concepts can be introduced in early grades and developed appropriately through the elementary grades and high school. Students should be explicitly shown how each of these unifying concepts apply to and connect life, physical, and Earth and space sciences. These science content areas can be taught in conjunction with each other, as well as with other subject areas in an interdisciplinary approach. The unifying concepts in science education help focus instruction and provide a link to other disciplines.
BACKGROUND
The state Board of Education adopted the Arizona Academic Standards in 1998 to define what Arizona’s students need to know and be able to do by the end of twelfth grade. Developed by committees comprised of educators, parents, students, and business and community leaders, these standards were written in grade-level clusters with benchmarks at 3, 5, 8, and high school.

RATIONALE
Requirements in the No Child Left Behind Act of 2001 (NCLB) and the need for periodic review of the state academic standards prompted the decision by the Arizona Department of Education (ADE) to refine and articulate the academic standard for science by grade level. This refinement and articulation project was started in April 2003, and was completed in May 2004.

METHODOLOGY
The Science Standard Revision Committee was composed of a statewide representation of scientists and science educators to reflect school districts large and small, rural and urban, as well as the ethnic diversity of Arizona. National science consultants, university professors, and community members advised the committee and provided valuable reviews of the work in progress. The goal was to articulate, or align, the current academic standards by grade level (K-8) and in high school with the state requirement of two years of high school science.

The committee utilized several nationally recognized publications to establish content guidelines during the development of the draft:

- National Research Council (NRC)
  - National Science Education Standards
  - Inquiry and the National Science Education Standards
  - Designing Mathematics or Science Curriculum Programs

- The American Association for the Advancement of Science
  - Atlas of Science Literacy
  - Benchmarks for Science Literacy
  - Design for Science Literacy
  - Science for All Americans

- Science Framework for the 1996 and 2000 National Assessment of Educational Progress (NAEP)

The committee created draft documents by first reviewing the existing standards. The performance objectives were articulated, or aligned, to the appropriate grade levels. Over a period of months, subcommittees, composed of representatives of the full committee, met to refine the documents. A
Curricular Guide for Anatomy/Physiology I

guiding principle in the articulation process was whether a performance objective was reasonable, useful, and appropriate. The measurability of each performance objective was also considered.

External reviews by nationally recognized consultants and reviews by university and local experts provided additional guidance and perspective to the committees.

Public review of the Science Standard Articulated by Grade Level occurred during the month of February 2004. A draft of the standard was placed on the ADE website with the option for individuals to make comments online. Six public hearings occurred throughout the state to collect additional comments. After all public comments were collected and organized, the committee met to review them and to recommend appropriate modifications to the standard. This final draft was presented to the state Board of Education in May 2004 for adoption as the Arizona Science Standard Articulated by Grade Level.

**ORGANIZATION OF THE SCIENCE STANDARD**
The Science Standard Articulated by Grade Level is divided into the following six strands:

1. Inquiry Process
2. History and Nature of Science
3. Science in Personal and Social Perspectives
4. Life Science
5. Physical Science
6. Earth and Space Science

The goal in the development of the standard was to assure that the six strands and five unifying concepts are interwoven into a fabric of science that represents the true nature of science. Students have the opportunity to develop both the skills and content knowledge necessary to be scientifically literate members of the community.

Strands 1, 2, and 3 are designed to be explicitly taught and embedded within each of the content strands 4, 5, and 6, and are not intended to be taught in isolation. The processes, skills, and content of the first three strands are designed to “umbrella” and complement the content of Life Science, Physical Science, and Earth and Space Science.

At the high school level, Strands 4, 5, and 6 (Life Science, Physical Science, and Earth and Space Science) contain content area knowledge and skills that are, by nature, course specific. These strands were written to provide frameworks for complete courses in Life, Physics, Chemistry, and Earth and Space sciences.

The high school science Arizona Instrument to Measure Standards (AIMS) will be administered as an end of course test. For each course tested, all performance objectives in Strands 1, 2 and 3 may be included on the assessment. Depending on the course tested, performance objectives from Strand 4, 5, or 6, will be measured. For example, an end of course AIMS for high school biology could include performance
objectives from Strands 1, 2, 3, and 4. A blueprint of the Science AIMS will be available following test development.

The itemized portions of the performance objectives, shown with bullets, provide the specific content that is to be learned by students as part of the outcome of the performance objective. The format of this itemized list does not imply that all components must be taught in one lesson or in any particular order. Teachers should decide how best to organize the content to meet the needs of their students.

Strand One: Inquiry Process

“Science as inquiry is basic to science education and a controlling principle in the continuing organization and selection of students’ activities. Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry…” (NSES 1995). Inquiry Process establishes the basis for students’ learning in science. Students use scientific processes: questioning, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, and communicating results.

Strand Two: History and Nature of Science

“Knowledge of the nature of science is central to the understanding of the scientific enterprise.” (NAEP 2000) Scientific investigation grows from the contributions of many people. History and Nature of Science emphasizes the importance of the inclusion of historical perspectives and the advances that each new development brings to technology and human knowledge. This strand focuses on the human aspects of science and the role that scientists play in the development of various cultures.

Strand Three: Science in Personal and Social Perspectives

Science in Personal and Social Perspectives emphasizes developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the ways people are involved in both. Students understand the impact of science and technology on human activity and the environment. This strand affords students the opportunity to understand their place in the world – as living creatures, consumers, decision makers, problem solvers, managers, and planners.

Strand Four: Life Science

“The fundamental goal of life sciences is to attempt to understand and explain the nature of life.” (NAEP 2000) Life Science expands students’ biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Strand Five: Physical Science

“The physical science component … should probe the following major topics: matter and its transformations, energy and its transformations, and the motion of things.” (NAEP 2000) Physical Science affords students the opportunity to increase their understanding of the
characteristics of objects and materials they encounter daily. Students gain an understanding of the nature of matter and energy, including their forms, the changes they undergo, and their interactions. By studying objects and the forces that act upon them, students develop an understanding of the fundamental laws of motion, knowledge of the various ways energy is stored in a system, and the processes by which energy is transferred between systems and surroundings.

**Strand Six: Earth and Space Science**

“Earth science is the study of the planets, Earth’s composition, processes, environments and history, focusing on the solid Earth, and its interaction with air and water.” (NAEP 2000) Earth and Space Science provides the foundation for students to develop an understanding of the Earth, its history, composition, and formative processes, and an understanding of the solar system and the universe. Students study the regularities of the interrelated systems of the natural world. In doing so, they develop understandings of the basic laws, theories, and models that explain the world (NSES, 1995). By studying the Earth from both a historical and current time frame, students can make informed decisions about issues affecting the planet on which they live.

**Glossary** – Words and terms defined in the glossary are found throughout the document. The committee provided definitions for teachers to ensure that the meaning of each term was consistent in grades K – high school. These definitions are not vocabulary words to be taught to students in isolation; they represent the terminology students will learn through the lessons prepared by the classroom teacher. If a word or term encompasses more in-depth meaning at subsequent levels, or different meanings within different disciplines of science, the definition notes this.

**Cross-references** – Select performance objectives within the Science Standard contain cross-references to other subject areas or other areas of science. These cross-references were inserted to assist the classroom teacher with identifying connections between the Science Standard and other subject areas to promote the teaching of a comprehensive curriculum at each grade level. These cross-references provide a starting point for integration and are not intended to be inclusive of all opportunities for integrating content. For example, Strand 3 of the Reading Standard (Informational Text) can be taught or reinforced with all areas of the Science Standard. Teachers are encouraged to explore the extensive opportunities to integrate writing, math, social studies, technology and the other academic standards with the Science Standard.
Vocabulary
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>abiotic</td>
<td>nonliving</td>
</tr>
<tr>
<td>absorb</td>
<td>to take up (e.g., plant roots absorb water)</td>
</tr>
<tr>
<td>adaptation</td>
<td>hereditary features of organisms that allow them to live in a particular environment</td>
</tr>
<tr>
<td>affect</td>
<td>to have an influence on</td>
</tr>
<tr>
<td>affluence</td>
<td>plentiful supply of material goods; wealth</td>
</tr>
<tr>
<td>applied science</td>
<td>research aimed at answering questions that have practical applications, e.g., determining the causes of diseases so that cures might be found</td>
</tr>
<tr>
<td>asteroid</td>
<td>small rocky body orbiting the Sun</td>
</tr>
<tr>
<td>atmosphere</td>
<td>gaseous envelope surrounding the Earth</td>
</tr>
<tr>
<td>atom</td>
<td>smallest particle of an element that retains the chemical nature of the element</td>
</tr>
<tr>
<td>barometric pressure</td>
<td>atmospheric pressure as indicated by a barometer, used especially in weather forecasting</td>
</tr>
<tr>
<td>basic science</td>
<td>research designed to describe or explain nature to satisfy one's curiosity</td>
</tr>
<tr>
<td>bias</td>
<td>statistical sampling or testing error caused by systematically favoring some outcomes over others</td>
</tr>
</tbody>
</table>
| biodiversity       | 1. number and variety of organisms found within a specified geographic region  
<pre><code>                  | 2. variability among organisms, including the variability within and between species and within and between ecosystems |
</code></pre>
<p>| biome              | broad area of the Earth’s surface characterized by distinctive vegetation and associated animal life; e.g., broad-leaf forest biome, grassland biome, desert biome |
| biotic             | relating to life or living organisms                                       |
| calorimetric       | relating to the measurement of heat energy by means of temperature measurements |
| camouflage        | concealment by disguise or protective coloring                             |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>carrying capacity</td>
<td>maximum number of individuals that a given environment can support for a sustained period of time</td>
</tr>
<tr>
<td>catalyst</td>
<td>substance, usually used in small amounts relative to the reactants, that modifies and increases the rate of a reaction without being consumed in the process</td>
</tr>
<tr>
<td>cellular respiration</td>
<td>metabolic processes which break down nutrients into usable energy</td>
</tr>
</tbody>
</table>
| circuit            | 1. closed path followed or capable of being followed by an electric current  
|                    | 2. configuration of electrically or electromagnetically connected components or devices                  |
| cirrus             | high-altitude cloud composed of narrow bands or patches of thin, generally white, fleecy parts            |
| characteristic     | distinguishing trait, feature, quality, or property                                                       |
| cladistics         | system of classification that constructs evolutionary trees, showing how shared derived characters can be used to reveal degrees of evolutionary relationships between existing and extinct species |
| classification system| method of organization of objects or organisms using distinct characteristics or features              |
| classify           | to arrange or organize according to class or category                                                    |
### climate
average course or condition of the weather at a place usually over a period of years as exhibited by temperature, wind velocity and precipitation

### comet
body of dust, ice, and gas, which orbits the Sun; the orbit is usually highly elliptical or even parabolic

### community
group of plants and animals living and interacting with one another in a specific region under relatively similar environmental conditions

### compound
substance formed from two or more elements chemically united in fixed proportions

### conduction
process by which heat or electrical energy is transmitted through a material or body without gross motion of the medium itself

### conifer
any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnosperm trees or shrubs such as pines, spruces, and firs

### conservation
**Life science:** the protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water, to prevent exploitation, destruction or neglect

**Physical science:** a unifying principle of constancy of a quantity under specified conditions

### constellation
formation of stars perceived as a figure or design, especially one of 88 recognized groups named after characters from classical mythology and various common animals and objects

### consumer
organisms requiring complex organic compounds for food, which is obtained by preying on other organisms or by eating particles of organic matter

### contrail
artificial cloud created by an aircraft, caused either by condensation due to the reduction in air pressure above the wing surface, or by water vapor in the engine exhaust

### controlled investigation
investigation in which all but one variable remain constant

### convection
transfer of heat energy in a gas or liquid by the circulation of currents of matter from one region to another
| **cumulus** | dense, white, fluffy, flat-based cloud with a multiple rounded top and a well-defined outline, usually formed by the ascent of thermally unstable air masses |
| **data** | factual information, from observations, organized for analysis |
| **decomposer** | organisms such as bacteria and fungi that feed and break down dead organisms, returning constituents of organic substances to the environment |
| **deformation** | alteration of shape, as by pressure or stress |
| **deposition** | 1. act of depositing, especially the laying down of matter by a natural process  
2. something deposited; a deposit |
<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>distinguish</td>
<td>to perceive or indicate differences; discriminate</td>
</tr>
<tr>
<td>dominant</td>
<td>of, relating to, or being an allele that produces the same phenotypic effect whether inherited with a homozygous or heterozygous allele</td>
</tr>
<tr>
<td>DNA</td>
<td>(Deoxyribonucleic acid) double strand of nucleotides that is a self-replicating molecule present in living organisms as the main constituent of chromosomes; contains the genetic code and transmits the heredity pattern</td>
</tr>
<tr>
<td>ecology</td>
<td>study of the interactions and relationships between and among organisms and their environment</td>
</tr>
<tr>
<td>ecosystem</td>
<td>all the organisms in a given area and the abiotic factors with which they interact</td>
</tr>
<tr>
<td>eclipse</td>
<td>partial or complete obscuring, relative to a designated observer, of one celestial body by another</td>
</tr>
<tr>
<td>e.g.</td>
<td>abbreviation for <em>for example</em>; precedes a non-exhaustive list of examples provided as options; other examples may be appropriate but not included (compare to i.e.)</td>
</tr>
<tr>
<td>electron</td>
<td>negatively charged fundamental particle in an atom</td>
</tr>
<tr>
<td>element</td>
<td>any of more than 100 fundamental substances that consist of atoms of only one atomic number and that singly or in combination constitute all matter</td>
</tr>
<tr>
<td>environment</td>
<td>sum of all external conditions affecting the life, development and survival of an organism, including the biotic (living) and abiotic (non-living) elements</td>
</tr>
<tr>
<td>erosion</td>
<td>group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the Earth's surface</td>
</tr>
<tr>
<td>eukaryotic</td>
<td>referring to a cell with a nucleus and other internal structure</td>
</tr>
<tr>
<td>experimentation</td>
<td>act of conducting a controlled test or investigation</td>
</tr>
<tr>
<td>extinct</td>
<td>no longer in existence</td>
</tr>
</tbody>
</table>
| fertilization| 1. act or process of initiating biological reproduction by insemination or pollination  
                            2. union of male and female gametes to form a zygote                               |
<p>| food chain   | arrangement of the organisms of an ecological community according to the order of predation in which each uses the next as a food source     |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>food web</td>
<td>totality of interacting food chains in an ecological community</td>
</tr>
<tr>
<td>force</td>
<td><strong>K-6:</strong> push or pull that changes the motion or shape of an object&lt;br&gt;<strong>7- HS:</strong> vector quantity that tends to produce an acceleration of a body in the direction of its application</td>
</tr>
<tr>
<td>formulate</td>
<td>to devise or invent</td>
</tr>
<tr>
<td>frequency</td>
<td>ratio of the number of times an event occurs in a series of trials of a chance experiment to the number of trials of the experiment performed; the number of cycles an oscillating system executes in one second</td>
</tr>
<tr>
<td>friction</td>
<td>force that resists relative motion between two bodies in contact</td>
</tr>
<tr>
<td>front (weather)</td>
<td>interface between air masses of different temperatures or densities</td>
</tr>
<tr>
<td>gas</td>
<td>state of matter that does not have a definite shape or volume and is much less dense than a liquid because its molecules are far apart compared to their diameters</td>
</tr>
<tr>
<td>genotype</td>
<td>particular combination of genes in an organism</td>
</tr>
<tr>
<td>gravitation</td>
<td>universal force by which every body in the universe attracts every other body</td>
</tr>
<tr>
<td>gravity</td>
<td>attraction of the mass of the Earth, the Moon or a planet for bodies at or near its surface</td>
</tr>
<tr>
<td>greenhouse gas</td>
<td>atmospheric gas such as carbon dioxide, water vapor, and methane that allows incoming sunlight to pass through but absorbs infrared radiation radiated back from the Earth's surface, leading to the phenomenon whereby the Earth's atmosphere traps solar radiation</td>
</tr>
<tr>
<td>guided investigation</td>
<td>teacher-directed investigation</td>
</tr>
<tr>
<td>habitat</td>
<td>place or environment where a plant or animal naturally or normally lives and grows</td>
</tr>
<tr>
<td>hazardous waste</td>
<td>substance, such as nuclear waste or an industrial byproduct, that is potentially damaging to the environment and harmful to humans and other organisms</td>
</tr>
<tr>
<td>heredity</td>
<td>genetic transmission of characteristics from parent to offspring</td>
</tr>
<tr>
<td>heterogeneous</td>
<td>consisting of dissimilar elements or parts</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>homogeneous</td>
<td>uniform in structure or composition throughout</td>
</tr>
<tr>
<td>hydrosphere</td>
<td>aqueous envelope of the Earth, including the oceans, all lakes, streams, and underground waters, ice, and the aqueous vapor in the atmosphere</td>
</tr>
<tr>
<td>hypothesis</td>
<td><strong>K-5:</strong> statement of an anticipated result of an investigation</td>
</tr>
<tr>
<td></td>
<td><strong>6-HS:</strong> proposed relationship among observable phenomena or an inferred explanation for those phenomena</td>
</tr>
<tr>
<td>i.e.</td>
<td>abbreviation for <em>that is</em>; precedes a specific list of items in which all of the items should be used (compare to e.g.)</td>
</tr>
<tr>
<td>igneous</td>
<td>relating to, resulting from, or suggestive of the intrusion or extrusion of magma or volcanic activity; rock formed from molten magma</td>
</tr>
<tr>
<td>inorganic</td>
<td>involving neither organic life nor the products of organic life</td>
</tr>
<tr>
<td></td>
<td><strong>Chemistry:</strong> of or relating to compounds not containing carbon</td>
</tr>
<tr>
<td>interdependence</td>
<td>state of organisms depending on each other and the environment for survival</td>
</tr>
<tr>
<td>interpretation</td>
<td>explanation</td>
</tr>
<tr>
<td>interrelationships</td>
<td>interactions between two or more objects or organisms</td>
</tr>
<tr>
<td>invertebrate</td>
<td>animal, such as an insect or mollusk, that lacks a backbone or spinal column</td>
</tr>
<tr>
<td>investigation</td>
<td>inquiry, research, or systematic examination</td>
</tr>
<tr>
<td>involuntary</td>
<td>not under the influence or control of the will; not voluntary; as, the involuntary movements of the body (involuntary muscle fibers)</td>
</tr>
<tr>
<td>isotope</td>
<td>any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behavior, but with differing atomic mass and mass number and different physical properties</td>
</tr>
<tr>
<td>law</td>
<td>statement that summarizes, identifies, or describes a relationship among observable phenomena</td>
</tr>
<tr>
<td>lever</td>
<td>simple machine consisting of a rigid bar pivoted on a fixed point and used to transmit force, as in raising or moving a weight at one end by pushing down on the other</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>limiting factor</td>
<td>conditions or resources that control the size of a population</td>
</tr>
<tr>
<td>liquid</td>
<td>state of matter that does not hold a definite shape but occupies a definite volume because its molecules are in close contact</td>
</tr>
<tr>
<td>lithosphere</td>
<td>outer part of the Earth, consisting of the crust and upper mantle, approximately 100 km (62 mi.) thick</td>
</tr>
<tr>
<td>living</td>
<td>state of being alive</td>
</tr>
<tr>
<td>lunar</td>
<td>of, involving, caused by, or affecting the Moon</td>
</tr>
<tr>
<td>macroscopic</td>
<td>large enough to be perceived or examined by the unaided eye; large compared to a microscopic object</td>
</tr>
<tr>
<td>mass</td>
<td>property of a body that is a measure of its inertia and causes it to have weight in a gravitational field, that is commonly taken as a measure of the amount of material it contains</td>
</tr>
<tr>
<td>matter</td>
<td>anything that possesses mass and occupies volume</td>
</tr>
<tr>
<td>mean</td>
<td>average value of a set of numbers</td>
</tr>
<tr>
<td>meiosis</td>
<td>type of cell division that occurs during the reproduction of diploid organisms to produce the gametes. The double set of genes and chromosomes of the normal diploid cells is reduced during meiosis to a single haploid set in the gametes. Crossing-over and, therefore, recombination occur during a phase of meiosis</td>
</tr>
<tr>
<td>metamorphic</td>
<td>change in the constitution of rock; specifically, a pronounced change affected by pressure, heat and water that results in a more compact and more highly crystalline condition; a rock produced by these processes</td>
</tr>
<tr>
<td>meteor</td>
<td>bright trail or streak that appears in the sky when a meteoroid is heated to incandescence by friction with the Earth's atmosphere; also called falling star, meteor burst, shooting star</td>
</tr>
<tr>
<td>microscopic</td>
<td>too small to be seen by the unaided eye but large enough to be studied under a microscope; small compared to a macroscopic object</td>
</tr>
<tr>
<td>mimicry</td>
<td>resemblance of one organism to another or to an object in its surroundings for concealment and protection from predators</td>
</tr>
<tr>
<td>mitosis</td>
<td>cell division; cell division in multicellular organisms occurs by mitosis except for the special division called meiosis that generates the gametes</td>
</tr>
<tr>
<td>mixture</td>
<td>portion of matter consisting of two or more components in varying proportions that retain their own properties</td>
</tr>
</tbody>
</table>
| model          | schematic description or representation of a system, theory, or phenomenon that accounts for at least some of its known or
inferred properties and may be used for further study of its characteristics

| **molecule** | smallest particle of a chemical substance that retains all the properties of the substance and is composed of one or more atoms |
| **mutation** | change of the DNA sequence within a gene or chromosome of an organism |
| **mutualism** | close, prolonged association between organisms of two different species in which each member benefits; type of symbiotic relationship |
| **natural selection** | process by which, in a given environment, individuals having characteristics that aid survival will produce more offspring, so the proportion of individuals having such characteristics will increase with each succeeding generation. |

Two mechanisms of natural selection include:

- gradualism - slow genetic modification (evolution) of a population over long periods of time
- punctuated equilibrium - relatively rapid evolution at a speciation event

| **neutron** | uncharged elementary particle that has a mass a little greater than that of the proton and is present in most atomic nuclei |
| **nonliving** | objects that don’t reproduce, grow, react, or use food |
| **nonstandard units of measure** | units of measurement based on everyday items (e.g., hands, feet, pace, candy, potato, paper clip) used as a precursor to learning and using standard units of measurement |
| **mutualism** | close, prolonged association between organisms of two different species in which each member benefits |
| **nucleus** | **Physical science:** central region of an atom, which contains more than 99% of the atom's mass  
**Life science:** cellular organelle in eukaryotes that contains most of the genetic material |
| **observation** | event that is experienced personally or enhanced through measurement or instruments |
| **openness** | mind set that allows a person to consider explanations of a phenomena |
| **organic** | of, relating to, or derived from living organisms  
**Chemistry:** having to do with carbon compounds |
<p>| <strong>organism</strong> | living individual, such as a plant, animal, bacterium, protist, or fungus; a body made up of organs, organelles, or other parts that work together to carry on the various processes of life |</p>
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>periodic table</td>
<td>arrangement of the chemical elements by atomic number, starting with hydrogen in the upper left-hand corner and continuing in ascending order from left to right, arranged in columns according to similar chemical properties</td>
</tr>
<tr>
<td>pH</td>
<td>numerical measure of the acidity or alkalinity of a chemical solution; the negative of the logarithm of the hydrogen ion concentration</td>
</tr>
<tr>
<td>phenotype</td>
<td>physical or visible characteristics of an organism that are determined by its genotype</td>
</tr>
<tr>
<td>photosynthesis</td>
<td>chemical process by which chlorophyll-containing plants use light to convert carbon dioxide and water into carbohydrates, releasing oxygen as a byproduct</td>
</tr>
<tr>
<td>pitch</td>
<td>aurally perceived property of a sound, especially a musical tone, that is determined by the frequency of the waves producing it; highness or lowness of sound</td>
</tr>
<tr>
<td>plane</td>
<td>flat or level surface</td>
</tr>
<tr>
<td>plate tectonics</td>
<td>theory that explains the global distribution of geological phenomena such as seismicity, volcanism, continental drift, and mountain building in terms of the formation, destruction, movement, and interaction of the Earth's lithospheric plates; the theory that the earth's crust is broken into fragments (plates) which move in relation to one another, shifting continents, forming new crust, and causing volcanic eruptions</td>
</tr>
<tr>
<td>population</td>
<td>group of organisms of the same species living and reproducing in a particular habitat or geographic region</td>
</tr>
<tr>
<td>population density</td>
<td>number of organisms per unit area</td>
</tr>
<tr>
<td>precipitation</td>
<td>any form of water, such as rain, snow, sleet, or hail, which falls to the Earth's surface</td>
</tr>
<tr>
<td>predict</td>
<td>to forecast a future occurrence based on past observations or the extension of an idea</td>
</tr>
<tr>
<td>prediction</td>
<td>statement of an expected (future) outcome of a planned test assuming that the hypothesis being tested is correct; to be compared with observed result to test the hypothesis</td>
</tr>
<tr>
<td>preservation</td>
<td>to keep in perfect or unaltered condition; maintain unchanged</td>
</tr>
<tr>
<td>probability</td>
<td>measure of the likelihood of an event occurring</td>
</tr>
<tr>
<td>procedures</td>
<td>series of steps taken to accomplish an end</td>
</tr>
<tr>
<td><strong>producer</strong></td>
<td>organisms (e.g., green plants) that produce their own organic compounds from simple precursors (such as carbon dioxide and inorganic nitrogen), many of which are food sources for other organisms</td>
</tr>
<tr>
<td><strong>prokaryotic</strong></td>
<td>referring to a cell with no nucleus (e.g., a bacterium)</td>
</tr>
<tr>
<td><strong>property</strong></td>
<td>characteristic attribute possessed by all members of a class</td>
</tr>
<tr>
<td><strong>propose</strong></td>
<td>to put forward for consideration, discussion, or adoption</td>
</tr>
<tr>
<td><strong>proton</strong></td>
<td>stable subatomic particle occurring in all atomic nuclei, with a positive electric charge equal in magnitude to that of an electron</td>
</tr>
<tr>
<td><strong>pulley</strong></td>
<td>simple machine consisting of a wheel with a grooved rim in which a pulled rope or chain can run to change the direction of the pull and thereby lift a load</td>
</tr>
<tr>
<td><strong>pure science</strong></td>
<td>science for the pursuit of scientific knowledge</td>
</tr>
<tr>
<td><strong>qualitative</strong></td>
<td>involving quality or kind</td>
</tr>
<tr>
<td><strong>quantitative</strong></td>
<td>involving the measurement of quantity or amount</td>
</tr>
<tr>
<td><strong>radiation</strong></td>
<td><strong>Physical science</strong>: transfer of energy by electromagnetic radiation; process of emitting energy in the form of waves or particles (e.g., visible light, X-rays, alpha and beta radiation). <strong>Life science</strong>: the geographic spreading of a species</td>
</tr>
<tr>
<td><strong>recessive</strong></td>
<td>of, relating to, or designating an allele that does not produce a characteristic effect when present with a dominant allele</td>
</tr>
<tr>
<td><strong>reflect</strong></td>
<td>to throw or bend back (light, for example) from a surface</td>
</tr>
<tr>
<td><strong>refract</strong></td>
<td>to deflect from a straight path undergone by light or other wave in passing obliquely from one medium (e.g., air) into another (e.g., glass) in which its speed is different</td>
</tr>
<tr>
<td><strong>reliability</strong></td>
<td>to yield the same or compatible results in different clinical experiments or statistical trials</td>
</tr>
<tr>
<td><strong>respiration</strong></td>
<td>physical and chemical processes by which an organism supplies its cells and tissues with the oxygen needed for metabolism and relieves them of the carbon dioxide formed in energy-producing reactions</td>
</tr>
<tr>
<td><strong>revolution</strong></td>
<td>orbital motion about a point, especially as distinguished from axial rotation</td>
</tr>
<tr>
<td><strong>RNA</strong></td>
<td>(Ribonucleic acid) nucleic acids that contains ribose and uracil as structural components and is associated with the control of cellular chemical activities</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>rotation</td>
<td>act or process of turning around a center or an axis; the turning of a body part about its long axis as if on a pivot</td>
</tr>
<tr>
<td>sedimentary</td>
<td>of or relating to rocks formed by the deposition of sediment</td>
</tr>
<tr>
<td>sexual</td>
<td>relating to, produced by, or involving reproduction characterized by the union of male and female gametes</td>
</tr>
<tr>
<td>simple investigation</td>
<td>investigation involving a single variable</td>
</tr>
<tr>
<td>solid</td>
<td>body of definite shape and volume; not liquid or gaseous</td>
</tr>
<tr>
<td>species</td>
<td>class of individuals or objects grouped by virtue of their common attributes and their ability to mate and produce fertile offspring, and assigned a common name; a division subordinate to a genus</td>
</tr>
<tr>
<td>spectrophotometer</td>
<td>instrument used to determine the intensity of various wavelengths in a spectrum of light</td>
</tr>
<tr>
<td>stimulus</td>
<td>object or event that causes a response</td>
</tr>
<tr>
<td>stratus</td>
<td>low-altitude cloud formation consisting of a horizontal layer of clouds</td>
</tr>
<tr>
<td>structures</td>
<td>way in which parts are arranged or put together to form a whole; makeup</td>
</tr>
<tr>
<td><strong>Life science:</strong></td>
<td>arrangement or formation of the tissues, organs, or other parts of an organism; an organ or other part of an organism</td>
</tr>
<tr>
<td>subsystem</td>
<td>component of a system (e.g., a solar system is a subsystem of a galaxy)</td>
</tr>
<tr>
<td>symbiotic relationship</td>
<td>close, prolonged association between organisms of two different species that may, but does not necessarily, benefit each member; includes mutualism, commensalisms, and parasitism</td>
</tr>
<tr>
<td>system</td>
<td>1. group of body organs that together perform one or more vital functions 2. organized group of devices, parts or factors that together perform a function or drive a process (e.g., weather system, mechanical system)</td>
</tr>
<tr>
<td>technology</td>
<td>application of science, especially to industrial or commercial objectives; tools and techniques</td>
</tr>
<tr>
<td>temperature</td>
<td>degree of hotness or coldness of a body or environment</td>
</tr>
<tr>
<td>theory</td>
<td>collection of statements (conditions, components, claims, postulates, propositions) that when taken together attempt to</td>
</tr>
</tbody>
</table>
### Curricular Guide for Anatomy/Physiology I

explain a broad class of related phenomena; inferred explanations for observable phenomena

<table>
<thead>
<tr>
<th><strong>transient</strong></th>
<th>not regular or permanent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S. customary units</strong></td>
<td>measuring system used most often in the United States (e.g., inches, pounds, gallons)</td>
</tr>
<tr>
<td><strong>valid</strong></td>
<td>correctly inferred or deduced from a premise</td>
</tr>
<tr>
<td><strong>variable</strong></td>
<td>characteristic with values (e.g., numbers, colors, sizes) that differ from one object, event, or situation in a group to the others; e.g., in a group of students, their heights differ, thus &quot;height&quot; is a variable</td>
</tr>
<tr>
<td></td>
<td>• independent: manipulated variable in an experiment or study whose presence or quantity determines the change in the dependent variable</td>
</tr>
<tr>
<td></td>
<td>• dependent: observed variable in an experiment or study whose changes are determined by the presence or quantity of one or more independent variables</td>
</tr>
<tr>
<td><strong>vector</strong></td>
<td>representation of a quantity having both magnitude and direction, such as velocity or force</td>
</tr>
<tr>
<td><strong>velocity</strong></td>
<td>rate of change of position and direction with respect to time</td>
</tr>
<tr>
<td><strong>Venn Diagram</strong></td>
<td>representation that uses circles to show relationships between sets</td>
</tr>
<tr>
<td><strong>vertebrate</strong></td>
<td>having a backbone or spinal column</td>
</tr>
<tr>
<td><strong>viable</strong></td>
<td>capable of living, developing, or germinating under favorable conditions</td>
</tr>
<tr>
<td><strong>volume</strong></td>
<td>measure of the capacity of a three-dimensional figure or object, measured in cubic units</td>
</tr>
<tr>
<td><strong>voluntary</strong></td>
<td>normally controlled by or subject to individual volition, such as voluntary muscle contractions</td>
</tr>
<tr>
<td><strong>weathering</strong></td>
<td>effect of exposure to the action of the elements</td>
</tr>
<tr>
<td><strong>wedge</strong></td>
<td>piece of material, such as metal or wood, thick at one edge and tapered to a thin edge at the other for insertion in a narrow crevice, used for splitting, tightening, securing, or levering</td>
</tr>
<tr>
<td><strong>wheel and axle</strong></td>
<td>simple machine made up of two coaxial cylindrical objects of different size in which the axle (a small wheel) is attached to the center of a larger wheel; the wheel and axle must move together to be a simple machine; a wheel and axle lifts or moves loads</td>
</tr>
</tbody>
</table>
### Processes

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>analyze</td>
<td>to examine methodically by separating into parts and studying their interrelations</td>
</tr>
<tr>
<td>classify</td>
<td>to arrange or organize according to category</td>
</tr>
<tr>
<td>compare</td>
<td>to examine in order to note the similarities or differences of</td>
</tr>
<tr>
<td>communicate</td>
<td>to convey information about; make known; express oneself in such a way that one is readily and clearly understood</td>
</tr>
<tr>
<td>conclusion</td>
<td>statement, or statements, that summarize the extent to which hypotheses have been supported or not supported</td>
</tr>
<tr>
<td>evaluate</td>
<td>to examine and judge carefully; appraise</td>
</tr>
<tr>
<td>infer</td>
<td>to conclude from evidence or premises</td>
</tr>
<tr>
<td>interpret</td>
<td>to explain the meaning of</td>
</tr>
<tr>
<td>justify</td>
<td>to demonstrate or prove to be just, right, or valid</td>
</tr>
<tr>
<td>measure</td>
<td>to ascertain the dimensions, quantity, or capacity of</td>
</tr>
<tr>
<td>observe</td>
<td>to be or become aware of, through one’s senses, and may include qualitative or quantitative data</td>
</tr>
<tr>
<td>predict</td>
<td>to forecast a future occurrence based on past observation or the extension of an idea</td>
</tr>
<tr>
<td>question</td>
<td>to ask</td>
</tr>
<tr>
<td>result</td>
<td>quantity or expression obtained by calculation</td>
</tr>
</tbody>
</table>
Content Standards
## Science Standard Articulated by Grade Level

### Strand 1: Inquiry Process

#### Concept 1: Observations, Questions, and Hypotheses

Formulate predictions, questions, or hypotheses based on observations. Evaluate appropriate resources.

<table>
<thead>
<tr>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PO 1.</strong> Evaluate scientific information for relevance to a given problem. (See R09-S3C1, R10-S3C1, R11-S3C1, R12-S3C1)</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td><strong>PO 2.</strong> Develop questions from observations that transition into testable hypotheses.</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td><strong>PO 3.</strong> Formulate a testable hypothesis.</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td><strong>PO 4.</strong> Predict the outcome of an investigation based on prior evidence, probability, and/or modeling (not guessing or inferring).</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
</tbody>
</table>
Concept 2: Scientific Testing (Investigating and Modeling)
Design and conduct controlled investigations.

<table>
<thead>
<tr>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PO 1.</strong> Demonstrate safe and ethical procedures (e.g., use and care of technology, materials, organisms) and behavior in all science inquiry.</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
<tr>
<td><strong>PO 2.</strong> Identify the resources needed to conduct an investigation.</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
<tr>
<td><strong>PO 3.</strong> Design an appropriate protocol (written plan of action) for testing a hypothesis:</td>
</tr>
<tr>
<td>- Identify dependent and independent variables in a controlled investigation.</td>
</tr>
<tr>
<td>- Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes).</td>
</tr>
<tr>
<td>- Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
<tr>
<td><strong>PO 4.</strong> Conduct a scientific investigation that is based on a research design.</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
<tr>
<td><strong>PO 5.</strong> Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>
Concept 3: Analysis, Conclusions, and Refinements
Evaluate experimental design, analyze data to explain results and to propose further investigations. Design models.

**High School**

<table>
<thead>
<tr>
<th>PO 1. Interpret data that show a variety of possible relationships between variables, including:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• positive relationship</td>
</tr>
<tr>
<td>• negative relationship</td>
</tr>
<tr>
<td>• no relationship</td>
</tr>
</tbody>
</table>

**Introduction**
**Practice**
**Assessment**
**Review**

**PO 2. Evaluate whether investigational data support or do not support the proposed hypothesis.**

**Introduction**
**Practice**
**Assessment**
**Review**

**PO 3. Critique reports of scientific studies (e.g., published papers, student reports).**

**Introduction**
**Practice**
**Assessment**
**Review**

**PO 4. Evaluate the design of an investigation to identify possible sources of procedural error, including:**

- sample size
- trials
- controls
- analyses

**Introduction**
**Practice**
**Assessment**
**Review**

**PO 5. Design models (conceptual or physical) of the following to represent "real world" scenarios:**

- carbon cycle
- water cycle
- phase change
- collisions
Concept 3: Analysis, Conclusions, and Refinements
Evaluate experimental design, analyze data to explain results and to propose further investigations. Design models.

| Introduction |  |
| Practice |  |
| Assessment |  |
| Review |  |

PO 6. Use descriptive statistics to analyze data, including:
- mean
- frequency
- range
(See MHS-S2C1-10)

| Introduction |  |
| Practice |  |
| Assessment |  |
| Review |  |

PO 7. Propose further investigations based on the findings of a conducted investigation.

| Introduction |  |
| Practice |  |
| Assessment |  |
| Review |  |
Concept 4: Communication
Communicate results of investigations.

<table>
<thead>
<tr>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO 1. For a specific investigation, choose an appropriate method for communicating the results. (See W09-S3C2-01 and W10-S3C2-01)</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>

| PO 2. Produce graphs that communicate data. (See MHS-S2C1-02) |
| **Introduction** |
| **Practice** |
| **Assessment** |
| **Review** |

| PO 3. Communicate results clearly and logically. |
| **Introduction** |
| **Practice** |
| **Assessment** |
| **Review** |

| PO 4. Support conclusions with logical scientific arguments. |
| **Introduction** |
| **Practice** |
| **Assessment** |
| **Review** |
## Science Standard Articulated by Grade Level

### Strand 2: History and Nature of Science

**Concept 1: History of Science as a Human Endeavor**
Identify individual, cultural, and technological contributions to scientific knowledge.

<table>
<thead>
<tr>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PO 1.</strong> Describe how human curiosity and needs have influenced science, impacting the quality of life worldwide.</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td><strong>PO 2.</strong> Describe how diverse people and/or cultures, past and present, have made important contributions to scientific innovations.</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td><strong>PO 3.</strong> Analyze how specific changes in science have affected society.</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td><strong>PO 4.</strong> Analyze how specific cultural and/or societal issues promote or hinder scientific advancements.</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
</tbody>
</table>
## Science Standard Articulated by Grade Level

### Strand 2: History and Nature of Science

### Concept 2: Nature of Scientific Knowledge

Understand how scientists evaluate and extend scientific knowledge.

<table>
<thead>
<tr>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PO 1.</strong> Specify the requirements of a valid, scientific explanation (theory), including that it be:</td>
</tr>
<tr>
<td>• logical</td>
</tr>
<tr>
<td>• subject to peer review</td>
</tr>
<tr>
<td>• public</td>
</tr>
<tr>
<td>• respectful of rules of evidence</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
</table>

| PO 2. Explain the process by which accepted ideas are challenged or extended by scientific innovation. |
| Introduction | Practice | Assessment | Review |

| PO 3. Distinguish between pure and applied science. |
| Introduction | Practice | Assessment | Review |

| PO 4. Describe how scientists continue to investigate and critically analyze aspects of theories. |
| Introduction | Practice | Assessment | Review |
## Concept 2: Science and Technology in Society
Develop viable solutions to a need or problem.

### High School

PO 1. Analyze the costs, benefits, and risks of various ways of dealing with the following needs or problems:
- various forms of alternative energy
- storage of nuclear waste
- abandoned mines
- greenhouse gases
- hazardous wastes

### Introduction

### Practice

### Assessment

### Review

PO 2. Recognize the importance of basing arguments on a thorough understanding of the core concepts and principles of science and technology.

### Introduction

### Practice

### Assessment

### Review

PO 3. Support a position on a science or technology issue.

### Introduction

### Practice

### Assessment

### Review
Concept 3: Human Population Characteristics
Analyze factors that affect human populations.

<table>
<thead>
<tr>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO 1. Analyze social factors that limit the growth of a human population, including:</td>
</tr>
<tr>
<td>• affluence</td>
</tr>
<tr>
<td>• education</td>
</tr>
<tr>
<td>• access to health care</td>
</tr>
<tr>
<td>• cultural influences</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| PO 2. Describe biotic (living) and abiotic (nonliving) factors that affect human populations. |</p>
<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| PO 3. Predict the effect of a change in a specific factor on a human population. |</p>
<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Concept 1: The Cell
Understand the role of the cell and cellular processes.

### High School

<table>
<thead>
<tr>
<th>PO 1. Describe the role of energy in cellular growth, development, and repair.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PO 2. Compare the form and function of prokaryotic and eukaryotic cells and their cellular components.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PO 3. Explain the importance of water to cells.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PO 4. Analyze mechanisms of transport of materials (e.g., water, ions, macromolecules) into and out of cells:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- passive transport</td>
</tr>
<tr>
<td>- active transport</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
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<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PO 5. Describe the purposes and processes of cellular reproduction.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>
### Science Standard Articulated by Grade Level

#### Strand 4: Life Science

<table>
<thead>
<tr>
<th>Concept 2: Molecular Basis of Heredity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the molecular basis of heredity and resulting genetic diversity.</td>
</tr>
</tbody>
</table>

#### High School

<table>
<thead>
<tr>
<th>PO 1. Analyze the relationships among nucleic acids (DNA, RNA), genes, and chromosomes.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PO 2. Describe the molecular basis of heredity, in viruses and living things, including DNA replication and protein synthesis.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PO 3. Explain how genotypic variation occurs and results in phenotypic diversity.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PO 4. Describe how meiosis and fertilization maintain genetic variation.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>
**Science Standard Articulated by Grade Level**  
**Strand 4: Life Science**

| Understand the organization of living systems, and the role of energy within those systems. |

<table>
<thead>
<tr>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PO 1.</strong> Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products.</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
<tr>
<td><strong>PO 2.</strong> Describe the role of organic and inorganic chemicals (e.g., carbohydrates, proteins, lipids, nucleic acids, water, ATP) important to living things.</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
<tr>
<td><strong>PO 5.</strong> Describe the levels of organization of living things from cells, through tissues, organs, organ systems, organisms, populations, and communities to ecosystems.</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td><strong>Practice</strong></td>
</tr>
<tr>
<td><strong>Assessment</strong></td>
</tr>
<tr>
<td><strong>Review</strong></td>
</tr>
</tbody>
</table>
Comprehensive Health Education Standards
(Adopted 4.28.97)
(Performance Objectives Added 8.28.00)

- 1CH-P2. Explain the interrelationships among the mental, emotional, psychological and physical realities that occur throughout the life cycle

PO 1. Identify the different stages of the human life cycle (conception, prenatal, infant, toddler, preschool, school)

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
</table>

PO 2. Identify the characteristics and developmental needs related to each stage of the life cycle

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
</table>

PO 3. Relate the principles of healthy living to each stage of the life cycle

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
</table>

- 1CH-P3. Explain the impact of personal health behaviors on the functioning of body systems and describe how to delay onset and reduce risks of potential health problems

PO 1. Identify personal health behaviors that promote and/or detract from the functioning of body systems

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
</table>

PO 2. Predict the impact of personal health behaviors that promote and or detract from the functioning of body systems (to include sleep, nutrition, exercise, sexual and substance abuse)

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Practice</th>
<th>Assessment</th>
<th>Review</th>
</tr>
</thead>
</table>
PO 3. Construct a personalized continuum of health behaviors that range from more healthy to less healthy and defend rationale

**Introduction**

**Practice**

**Assessment**

**Review**

PO 4. Determine strategies to reduce health risk for more healthy behavior

**Introduction**

**Practice**

**Assessment**

**Review**

- 1CH-P5. Explain how environmental health influences the community and the functions of local, state and federal resources in addressing health issues

PO 1. Summarize major environmental health concerns

**Introduction**

**Practice**

**Assessment**

**Review**

PO 2. List the roles and functions of agencies that address areas of environmental concern

**Introduction**

**Practice**

**Assessment**

**Review**

- 1CH-P10. Explain the association of personal risk factors of chronic and communicable diseases, risk reduction and disease prevention components

PO 1. Define and provide examples of acute, chronic, communicable, noncommunicable, degenerative, metabolic, hereditary and congenital diseases

**Introduction**

**Practice**

**Assessment**

**Review**

PO 2. Describe how race, culture and hereditary factors impact disease susceptibility

a) List environmental influences that affect disease susceptibility

b) Describe the impact of fitness, diet, rest and other lifestyle issues related to disease

**Introduction**

**Practice**

**Assessment**

**Review**
Supplementary Resources
## Curricular Resources

**Grade Level:**

<table>
<thead>
<tr>
<th>Content Area</th>
<th>Provided Resources</th>
<th>Suggested/Supplemental Resources</th>
<th>Field Trips, Grade Special Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language Arts</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rigor/Relevance Framework

The Rigor/Relevance Framework is a tool developed by staff of the International Center for Leadership in Education to examine curriculum, instruction, and assessment. The Rigor/Relevance Framework is based on two dimensions of higher standards and student achievement.

First, there is the Knowledge Taxonomy, a continuum based on the six levels of Bloom's Taxonomy, which describes the increasingly complex ways in which we think. The low end involves acquiring knowledge and being able to recall or locate that knowledge. The high end labels the more complex ways in which individuals use knowledge, such as taking several pieces of knowledge and combining them in both logical and creative ways.

The second continuum, known as the Application Model, is one of action. Its five levels describe putting knowledge to use. While the low end is knowledge acquired for its own sake, the high end signifies use of that knowledge to solve complex real-world problems and to create unique projects, designs, and other works for use in real-world situations.

The Rigor/Relevance Framework has four quadrants. Each is labeled with a term that characterizes the learning or student performance at that level.
### Quadrant A - Acquisition
Students gather and store bits of knowledge and information. Students are primarily expected to remember or understand this knowledge.

### Quadrant B - Application
Students use acquired knowledge to solve problems, design solutions, and complete work. The highest level of application is to apply knowledge to new and unpredictable situations.

### Quadrant C - Assimilation
Students extend and refine their acquired knowledge to be able to use that knowledge automatically and routinely to analyze and solve problems and create solutions.

### Quadrant D - Adaptation
Students have the competence to think in complex ways and to apply their knowledge and skills. Even when confronted with perplexing unknowns, students are able to use extensive knowledge and skill to create solutions and take action that further develops their skills and knowledge.

The Rigor/Relevance Framework is easy to understand. With its simple, straightforward structure, it can serve as a bridge between school and the community. It offers a common language with which to express the notion of a more rigorous and relevant curriculum.

The Rigor/Relevance Framework is versatile; it can be used in the development of instruction and assessment. Likewise, teachers can use it to measure their progress in adding rigor and relevance to instruction and to select appropriate instructional strategies to meet learner needs and higher achievement goals.
In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of levels of intellectual behavior important in learning. Bloom found that over 95% of the test questions students encounter require them to think only at the lowest possible level...the recall of information.

Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order which is classified as evaluation. Verb examples that represent intellectual activity on each level are listed here.

1. **Knowledge**: arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state.
2. **Comprehension**: classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate.
3. **Application**: apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write.
4. **Analysis**: analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test.
5. **Synthesis**: arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write.
6. **Evaluation**: appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate.
**Cognitive Domain**

The cognitive domain involves knowledge and the development of intellectual skills. This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. There are six major categories, which are listed in order below, starting from the simplest behavior to the most complex. The categories can be thought of as degrees of difficulties. That is, the first one must be mastered before the next one can take place.

<table>
<thead>
<tr>
<th>Category</th>
<th>Example and Key Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Examples: Recite a policy. Quote prices from memory to a customer. Knows the safety rules.</td>
</tr>
<tr>
<td></td>
<td>Key Words: defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces, selects, states.</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Examples: Rewrites the principles of test writing. Explain in one's own words the steps for performing a complex task. Translates an equation into a computer spreadsheet.</td>
</tr>
<tr>
<td></td>
<td>Key Words: comprehends, converts, defends, distinguishes, estimates, explains, extends, generalizes, gives Examples, infers, interprets, paraphrases, predicts, rewrites, summarizes, translates.</td>
</tr>
<tr>
<td>Application</td>
<td>Examples: Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test.</td>
</tr>
<tr>
<td></td>
<td>Key Words: applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td><strong>Examples</strong></td>
</tr>
<tr>
<td>--------------</td>
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</tr>
<tr>
<td>Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.</td>
<td>Troubleshoot a piece of equipment by using logical deduction. Recognize logical fallacies in reasoning. Gathers information from a department and selects the required tasks for training.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Synthesis</strong></th>
<th><strong>Examples</strong></th>
<th><strong>Key Words</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.</td>
<td>Write a company operations or process manual. Design a machine to perform a specific task. Integrates training from several sources to solve a problem. Revises and process to improve the outcome.</td>
<td>categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Evaluation</strong></th>
<th><strong>Examples</strong></th>
<th><strong>Key Words</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Make judgments about the value of ideas or materials.</td>
<td>Select the most effective solution. Hire the most qualified candidate. Explain and justify a new budget.</td>
<td>appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarizes, supports.</td>
</tr>
</tbody>
</table>
**Affective Domain**

This domain includes the manner in which we deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations, and attitudes. The five major categories are listed from the simplest behavior to the most complex:

<table>
<thead>
<tr>
<th><strong>Category</strong></th>
<th><strong>Example and Key Words</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Receiving Phenomena:</strong></td>
<td><strong>Examples:</strong> Listen to others with respect. Listen for and remember the name of newly introduced people.</td>
</tr>
<tr>
<td></td>
<td><strong>Key Words:</strong> asks, chooses, describes, follows, gives, holds, identifies, locates, names, points to, selects, sits, erects, replies, uses.</td>
</tr>
<tr>
<td><strong>Responding to Phenomena:</strong></td>
<td><strong>Examples:</strong> Participates in class discussions. Gives a presentation. Questions new ideals, concepts, models, etc. in order to fully understand them. Know the safety rules and practices them.</td>
</tr>
<tr>
<td></td>
<td><strong>Key Words:</strong> answers, assists, aids, complies, conforms, discusses, greets, helps, labels, performs, practices, presents, reads, recites, reports, selects, tells, writes.</td>
</tr>
<tr>
<td><strong>Valuing:</strong></td>
<td><strong>Examples:</strong> Demonstrates belief in the democratic process. Is sensitive towards individual and cultural differences (value diversity). Shows the ability to solve problems. Proposes a plan to social improvement and follows through with commitment. Informs management on matters that one feels strongly about.</td>
</tr>
<tr>
<td></td>
<td><strong>Key Words:</strong> completes, demonstrates, differentiates, explains, follows, forms, initiates, invites, joins, justifies, proposes, reads, reports,</td>
</tr>
</tbody>
</table>
are expressed in the learner's overt behavior and are often identifiable.

<table>
<thead>
<tr>
<th><strong>Organization</strong>: Organizes values into priorities by contrasting different values, resolving conflicts between them, and creating an unique value system. The emphasis is on comparing, relating, and synthesizing values.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Examples</strong>: Recognizes the need for balance between freedom and responsible behavior. Accepts responsibility for one's behavior. Explains the role of systematic planning in solving problems. Accepts professional ethical standards. Creates a life plan in harmony with abilities, interests, and beliefs. Prioritizes time effectively to meet the needs of the organization, family, and self.</td>
</tr>
<tr>
<td><strong>Key Words</strong>: adheres, alters, arranges, combines, compares, completes, defends, explains, formulates, generalizes, identifies, integrates, modifies, orders, organizes, prepares, relates, synthesizes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Internalizing values (characterization)</strong>: Has a value system that controls their behavior. The behavior is pervasive, consistent, predictable, and most importantly, characteristic of the learner. Instructional objectives are concerned with the student's general patterns of adjustment (personal, social, emotional).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key Words</strong>: acts, discriminates, displays, influences, listens, modifies, performs, practices, proposes, qualifies, questions, revises, serves, solves, verifies.</td>
</tr>
</tbody>
</table>
The psychomotor domain includes physical movement, coordination, and use of the motor-skill areas. Development of these skills requires practice and is measured in terms of speed, precision, distance, procedures, or techniques in execution. The seven major categories are listed from the simplest behavior to the most complex:

<table>
<thead>
<tr>
<th>Category</th>
<th>Example and Key Words</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perception</strong></td>
<td>The ability to use sensory cues to guide motor activity. This ranges from sensory stimulation, through cue selection, to translation.</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Detects non-verbal communication cues. Estimate where a ball will land after it is thrown and then moving to the correct location to catch the ball. Adjusts heat of stove to correct temperature by smell and taste of food. Adjusts the height of the forks on a forklift by comparing where the forks are in relation to the pallet.</td>
</tr>
<tr>
<td><strong>Key Words</strong></td>
<td>chooses, describes, detects, differentiates, distinguishes, identifies, isolates, relates, selects.</td>
</tr>
<tr>
<td><strong>Set</strong></td>
<td>Readiness to act. It includes mental, physical, and emotional sets. These three sets are dispositions that predetermine a personís response to different situations (sometimes called mindsets).</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Knows and acts upon a sequence of steps in a manufacturing process. Recognize oneís abilities and limitations. Shows desire to learn a new process (motivation). NOTE: This subdivision of Psychomotor is closely related with the &quot;Responding to phenomena&quot; subdivision of the Affective domain.</td>
</tr>
<tr>
<td><strong>Key Words</strong></td>
<td>begins, displays, explains, moves, proceeds, reacts, shows, states, volunteers.</td>
</tr>
<tr>
<td><strong>Guided Response</strong></td>
<td>The early stages in learning a complex skill that includes imitation and trial and error. Adequacy of performance is achieved by practicing.</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Performs a mathematical equation as demonstrated. Follows instructions to build a model. Responds hand-signals of instructor while learning to operate a forklift.</td>
</tr>
<tr>
<td><strong>Key Words</strong></td>
<td>copies, traces, follows, react,</td>
</tr>
</tbody>
</table>
**Mechanism:** This is the intermediate stage in learning a complex skill. Learned responses have become habitual and the movements can be performed with some confidence and proficiency.

**Examples:** Use a personal computer. Repair a leaking faucet. Drive a car.

**Key Words:** assembles, calibrates, constructs, dismantles, displays, fastens, fixes, grinds, heats, manipulates, measures, mends, mixes, organizes, sketches.

---

**Complex Overt Response:**

The skillful performance of motor acts that involve complex movement patterns. Proficiency is indicated by a quick, accurate, and highly coordinated performance, requiring a minimum of energy. This category includes performing without hesitation, and automatic performance. For example, players are often utter sounds of satisfaction or expletives as soon as they hit a tennis ball or throw a football, because they can tell by the feel of the act what the result will produce.

**Examples:** Maneuvers a car into a tight parallel parking spot. Operates a computer quickly and accurately. Displays competence while playing the piano.

**Key Words:** assembles, builds, calibrates, constructs, dismantles, displays, fastens, fixes, grinds, heats, manipulates, measures, mends, mixes, organizes, sketches.

**NOTE:** The Key Words are the same as Mechanism, but will have adverbs or adjectives that indicate that the performance is quicker, better, more accurate, etc.

---

**Adaptation:** Skills are well developed and the individual can modify movement patterns to fit special requirements.

**Examples:** Responds effectively to unexpected experiences. Modifies instruction to meet the needs of the learners. Perform a task with a machine that it was not originally intended to do (machine is not damaged and there is no danger in performing the new task).

**Key Words:** adapts, alters, changes, rearranges, reorganizes, revises, varies.
Origination: Creating new movement patterns to fit a particular situation or specific problem. Learning outcomes emphasize creativity based upon highly developed skills.

Examples: Constructs a new theory. Develops a new and comprehensive training programming. Creates a new gymnastic routine.

Key Words: arranges, builds, combines, composes, constructs, creates, designs, initiate, makes, originates.

Other Psychomotor Domains

As mentioned earlier, the committee did not produce a compilation for the psychomotor domain model, but others have. The one discussed above is by Simpson (1972). There are two other popular versions:

Dave's:(4)

- Imitation: Observing and patterning behavior after someone else. Performance may be of low quality. Example: Copying a work of art.
- Manipulation: Being able to perform certain actions by following instructions and practicing. Example: Creating work on one's own, after taking lessons, or reading about it.
- Precision: Refining, becoming more exact. Few errors are apparent. Example: Working and reworking something, so it will be "just right."
- Articulation: Coordinating a series of actions, achieving harmony and internal consistency. Example: Producing a video that involves music, drama, color, sound, etc.
- Naturalization: Having high level performance become natural, without needing to think much about it. Examples: Michael Jordan playing basketball, Nancy Lopez hitting a golf ball, etc.

Harrow's:(5)

- Reflex movements - Reactions that are not learned.
- Fundamental movements - Basic movements such as walking, or grasping.
- Perception - Response to stimuli such as visual, auditory, kinesthetic, or tactile discrimination.
Supplementary Resources, Taxonomies

- **Physical abilities** - Stamina that must be developed for further development such as strength and agility.
- **Skilled movements** - Advanced learned movements as one would find in sports or acting.
- **No discursive communication** - Effective body language, such as gestures and facial expressions.
Reference


What is the theory of multiple intelligences (M.I.)?

"An intelligence is the ability to solve problems, or to create products, that are valued within one or more cultural settings."

— Howard Gardner
FRAMES OF MIND (1983)

Howard Gardner claims that all human beings have multiple intelligences. These multiple intelligences can be nurtured and strengthened, or ignored and weakened. He believes each individual has nine intelligences:

1. **Verbal-Linguistic Intelligence** — well-developed verbal skills and sensitivity to the sounds, meanings and rhythms of words

2. **Mathematical-Logical Intelligence** — ability to think conceptually and abstractly, and capacity to discern logical or numerical patterns

3. **Musical Intelligence** — ability to produce and appreciate rhythm, pitch and timber

4. **Visual-Spatial Intelligence** — capacity to think in images and pictures, to visualize accurately and abstractly

5. **Bodily-Kinesthetic Intelligence** — ability to control one's body movements and to handle objects skillfully

6. **Interpersonal Intelligence** — capacity to detect and respond appropriately to the moods, motivations and desires of others.

7. **Intrapersonal Intelligence** — capacity to be self-aware and in tune with inner feelings, values, beliefs and thinking processes

8. **Naturalist Intelligence** — ability to recognize and categorize plants, animals and other objects in nature

9. **Existential Intelligence** — sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life, why do we die, and how did we get here.

(From http://www.thirteen.org/edonline/concept2class/mi/index.html)
The theory of multiple intelligences was developed in 1983 by Dr. Howard Gardner, professor of education at Harvard University. It suggests that the traditional notion of intelligence, based on I.Q. testing, is far too limited. Instead, Dr. Gardner proposes eight different intelligences to account for a broader range of human potential in children and adults. These intelligences are:

- **Linguistic intelligence** ("word smart")
- **Logical-mathematical intelligence** ("number/reasoning smart")
- **Spatial intelligence** ("picture smart")
- **Bodily-Kinesthetic intelligence** ("body smart")
- **Musical intelligence** ("music smart")
- **Interpersonal intelligence** ("people smart")
- **Intrapersonal intelligence** ("self smart")
- **Naturalist intelligence** ("nature smart")

Dr. Gardner says that our schools and culture focus most of their attention on linguistic and logical-mathematical intelligence. We esteem the highly articulate or logical people of our culture. However, Dr. Gardner says that we should also place equal attention on individuals who show gifts in the other intelligences: the artists, architects, musicians, naturalists, designers, dancers, therapists, entrepreneurs, and others who enrich the world in which we live. Unfortunately, many children who have these gifts don’t receive much reinforcement for them in school. Many of these kids, in fact, end up being labeled "learning disabled," "ADD (attention deficit disorder)," or simply underachievers, when their unique ways of thinking and learning aren’t addressed by a heavily linguistic or logical-mathematical classroom. The theory of multiple intelligences proposes a major transformation in the way our schools are run. It suggests that teachers be trained to present their lessons in a wide variety of ways using music, cooperative learning, art activities, role play, multimedia, field trips, inner reflection, and much more (see *Multiple Intelligences in the Classroom*). The good news is that the theory of multiple intelligences has grabbed the attention of many educators around the country, and hundreds of schools are currently using its philosophy to redesign the way it educates children. The bad news is that there are thousands of schools still out there that teach in the same old dull way, through dry lectures, and boring worksheets and textbooks. The challenge is to get this information out to many more teachers, school administrators, and others who work with children, so that each child has the opportunity to learn in ways harmonious with their unique minds (see *In Their Own Way*).

The theory of multiple intelligences also has strong implications for adult learning and development. Many adults find themselves in jobs that do not make optimal use of their most highly developed intelligences (for example, the highly bodily-kinesthetic individual who is stuck in a linguistic or logical desk-job when he or she would be much happier in a job where they could move around, such as a recreational leader, a forest ranger, or physical therapist). The theory of multiple intelligences gives adults a whole new way to look at their lives, examining potentials that they left behind in their childhood (such as a love for art or drama) but now have the opportunity to develop through courses, hobbies, or other programs of self-development (see *7 Kinds of Smart*).

**How to Teach or Learn Anything 8 Different Ways**

One of the most remarkable features of the theory of multiple intelligences is how it provides *eight different potential pathways* to learning. If a teacher is having difficulty reaching a student in the more traditional linguistic or logical ways of instruction, the theory of multiple intelligences suggests several other ways in which the material might be presented to facilitate effective learning. Whether you are a kindergarten teacher, a graduate school instructor, or an adult learner seeking better ways of pursuing self-study on any subject of interest, the same basic guidelines apply. Whatever you are teaching or learning, see how you might connect it with
 Supplementary Resources, Multiple Intelligences

一封信 (linguistic intelligence)
◆ numbers or logic (logical-mathematical intelligence)
◆ pictures (spatial intelligence)
◆ music (musical intelligence)
◆ self-reflection (intrapersonal intelligence)
◆ a physical experience (bodily-kinesthetic intelligence)
◆ a social experience (interpersonal intelligence), and/or
◆ an experience in the natural world. (naturalist intelligence)

For example, if you’re teaching or learning about the law of supply and demand in economics, you might read about it (linguistic), study mathematical formulas that express it (logical-mathematical), examine a graphic chart that illustrates the principle (spatial), observe the law in the natural world (naturalist) or in the human world of commerce (interpersonal); examine the law in terms of your own body [e.g. when you supply your body with lots of food, the hunger demand goes down; when there's very little supply, your stomach's demand for food goes way up and you get hungry] (bodily-kinesthetic and intrapersonal); and/or write a song (or find an existing song) that demonstrates the law (perhaps Dylan's "Too Much of Nothing?").

You don’t have to teach or learn something in all eight ways, just see what the possibilities are, and then decide which particular pathways interest you the most, or seem to be the most effective teaching or learning tools. The theory of multiple intelligences is so intriguing because it expands our horizon of available teaching/learning tools beyond the conventional linguistic and logical methods used in most schools (e.g. lecture, textbooks, writing assignments, formulas, etc.). To get started, put the topic of whatever you’re interested in teaching or learning about in the center of a blank sheet of paper, and draw eight straight lines or "spokes" radiating out from this topic. Label each line with a different intelligence. Then start brainstorming ideas for teaching or learning that topic and write down ideas next to each intelligence (this is a spatial-linguistic approach of brainstorming; you might want to do this in other ways as well, using a tape-recorder, having a group brainstorming session, etc.). Have fun!

Resources


Association for Supervision and Curriculum Development, Multiple Intelligences CD-ROM, and Multiple Intelligences Video Series; 1250 N. Pitt St., Alexandria, VA 22314-1453 (800-933-2723).


National Professional Resources, 25 South Regent St., Port Chester, NY 10573, 914-937-8879. Producer of several videos on MI including, Howard Gardner, "How Are Kids Smart?" Jo Gusman, "MI and the Second Language Learner", and Thomas Armstrong, *Multiple Intelligences: Discovering the Giftedness in All".*

New City School, *Celebrating Multiple Intelligences* (5209 Waterman Ave., St. Louis, MO 63108).


Zephyr Press, PO Box 66006, Tucson, AZ 85728 (602-322-5090). Publisher of many MI materials.

(From: http://www.thomasarmstrong.com/multiple_intelligences.htm)
PBL Research Summary: Studies Validate Project-Based Learning

Research shows the efficacy of an authentic form of education that expects students to immerse themselves in a topic and meaningfully demonstrate acquisition of skills and knowledge.

by Edutopia Staff

Teamwork, technology, and hands-on work are important elements of project-based learning.

Credit: Edutopia

A growing body of academic research supports the use of project-based learning in schools as a way to engage students, cut absenteeism, boost cooperative learning skills, and improve test scores. Those benefits are enhanced when technology is used in a meaningful way in the projects. Following are synopses of a range of studies on project-based learning:

British Math Study

A three-year 1997 study (To view this study, you must be a registered user on the Edweek site. Registration is free.) of two British secondary schools -- one that used open-ended projects and one that used more traditional, direct instruction -- found striking differences in understanding and standardized achievement data in mathematics.

The study by Jo Boaler, now associate professor of education at Stanford University, found that students at the project-based school did better than those at the more traditional school both on math problems requiring analytical or conceptual thought and on those considered rote, that is, those requiring memory of a rule or formula. Three times as many students at the
project-based school received the top grade achievable on the national examination in math.

**Challenge 2000**

In a five-year study, researchers at SRI International found that technology-using students in Challenge 2000 Multimedia Project classrooms outperformed non-technology-using students in communication skills, teamwork, and problem solving. The Center for Learning in Technology researchers, led by Bill Penuel, found increased student engagement, greater responsibility for learning, increased peer collaboration skills, and greater achievement gains by students who had been labeled low achievers.

The project conducted a performance assessment designed to measure students' skills in constructing a presentation aimed at a particular audience. Students from Multimedia Project classrooms outperformed comparison classrooms in all three areas scored by researchers and teachers: student content, attention to audience, and design. The Multimedia Project involves completing one to four interdisciplinary multimedia projects a year that integrate real-world issues and practices.

**Cognition and Technology Group**

A 1992 study of 700 students from eleven school districts in Tennessee found that students doing projects using videotaped problems over a three-week period performed better in a number of academic areas later in the school year. The study, by the Cognition and Technology Group at Vanderbilt University, examined student competence in basic math, word problems, planning capabilities, attitudes, and teacher feedback. Students who had experience in the project work performed better in all categories. The study appeared in Educational Psychologist, 27 (3): 291-315.

**Co-nect**

A 1999 study by the Center for Research in Educational Policy at the University of Memphis and University of Tennessee at Knoxville found that students using the Co-nect program, which emphasizes project-based learning and technology, improved test scores in all subject areas over a two-year period on the Tennessee Value-Added Assessment System. The Co-nect schools outperformed control schools by 26 percent.

**Does It Compute?**
Analyzing data from the math portion of the 1996 National Assessment of Educational Progress test given to students nationwide, Educational Testing Services researcher Harold Wenglinsky found that the effectiveness of computers in the classroom depended on how they were used. In his report, "Does It Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics," Wenglinsky found that if computers were used for drill or practice, they typically had a negative effect on student achievement. If they were used with real-world applications, such as spreadsheets, or to simulate relationships or changing variables, student achievement increased. Data were drawn from the samples of 6,227 fourth graders and 7,146 eighth graders.

**Expeditionary Learning Outward Bound**

Three elementary schools in Dubuque, Iowa, showed significant test score gains after incorporating the Expeditionary Learning Outward Bound (ELOB) program. At ELOB schools, students conduct three-to-six-month-long studies of a single topic with an emphasis on learning by doing. After two years in the program, two of the three schools advanced from "well below average" to "well above the district average" on the Iowa Test of Basic Skills. One elementary school raised its average score from the 39th to the 80th percentile. After four years in the program, student scores were "above the district average in almost every area." Separate analyses showed similar test score gains in ELOB programs in Denver, Boston, and Portland, Maine.

**Laptops**

Since 1996, ROCKMAN ET AL, an independent research firm in San Francisco, California, has studied the impact of widespread use of laptop technology on teaching and learning. The focus of the firm's multiyear studies has been on dozens of public and private K-12 schools participating in a pilot laptop program sponsored jointly by the Microsoft and Toshiba corporations. Through both observation and feedback from laptop-using teachers and students, researchers have documented a shift from lectures and other teacher-centered forms of delivery to lessons that are more collaborative and project-oriented. Teachers, researchers note, become facilitators in project-oriented classrooms, with students increasingly assuming the role of directors of their own learning.

In a 1998 report, researchers note that three-fourths of the teachers who participated in a ROCKMAN ET AL survey reported that project-based instruction had increased since the introduction of the laptops in their classrooms. Among the many reported benefits of this project-based
Supplementary Resources, Project-Based Learning

approach to learning are greater student engagement, improved analytic abilities, and a greater likelihood to apply high-order thinking skills.

Laptop-using students also performed better on a ROCKMAN ET AL-administered writing examination. The research firm did not, however, identify significant differences in the standardized test scores of laptop-using students. Researchers offered two possible explanations for the lack of significant improvement in this area: 1. Standardized tests are not designed to reflect the types of learning that laptops support. 2. Because the students had been using their laptops for less than two years, it might have been too soon to see noticeable gains in areas that are covered by standardized tests.

Successful School Restructuring

A five-year study by University of Wisconsin-Madison researchers found that structural school reform works only under certain conditions:

1. Students must be engaged in activities that build on prior knowledge and allow them to apply that knowledge to new situations.

2. Students must use disciplined inquiry.

3. School activities must have value beyond school. In their report, "Successful School Restructuring," the researchers at Wisconsin's Center on Organization and Restructuring of Schools found that even innovative school improvements, such as portfolio assessment and shared decision making, are less effective without accompanying meaningful student assignments based on deep inquiry. Researhers analyzed data from more than 1,500 elementary, middle, and high schools and conducted field studies in forty-four schools in sixteen states between 1990 and 1995.

Union City, New Jersey School District

The Center for Children and Technology at the Education Development Center, Inc., monitored a two-year technology trial that was first implemented in the district in September of 1993. The study found that after multimedia technology was used to support project-based learning, eighth graders in Union City, New Jersey, scored 27 percentage points higher than students from other urban and special needs school districts on statewide tests in reading, math, and writing achievement. The study also found a decrease in absenteeism and an increase in students transferring to the school. Four years earlier, the state had been considering a takeover because Union City failed in forty of fifty-two indicators of school effectiveness.
Supplementary Resources, Project-Based Learning

This article originally published on 11/1/2001

(From: http://www.edutopia.org/project-based-learning-research)

Internet Resource List

http://pblchecklist.4teachers.org/
http://en.wikipedia.org/wiki/Project-based_learning
http://www.pbl-online.org/
http://www.bie.org/index.php/site/PBL/overview_pbl/
http://www.edutopia.org/project-based-learning-research
Writing Rubrics and Resources
Teacher Name:  

Student Name: ____________________________  
Reviewer Name: ___________________________  

Date: __________________

Project:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>RESPONSIBILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventions</td>
<td>- My paragraphs have more than one sentence.</td>
</tr>
<tr>
<td></td>
<td>- Each of my paragraphs has one main idea.</td>
</tr>
<tr>
<td></td>
<td>- I have used correct grammar.</td>
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<tr>
<td></td>
<td>- I have used correct punctuation.</td>
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<tr>
<td></td>
<td>- I have checked my spelling.</td>
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<tr>
<td></td>
<td>- Stylistic effects enhance the report. They do not distract the reader.</td>
</tr>
<tr>
<td></td>
<td>- My handwriting is legible.</td>
</tr>
<tr>
<td></td>
<td>- My printout contains no typographical errors.</td>
</tr>
<tr>
<td>Fluency</td>
<td>- My sentences build logically upon the one(s) before.</td>
</tr>
<tr>
<td></td>
<td>- My sentences are different lengths.</td>
</tr>
<tr>
<td></td>
<td>- My sentences start in different ways.</td>
</tr>
<tr>
<td></td>
<td>- The meaning of each of my sentences is clear.</td>
</tr>
<tr>
<td></td>
<td>- My sentences flow easily from one to another.</td>
</tr>
<tr>
<td></td>
<td>- There are no run-on sentences.</td>
</tr>
<tr>
<td></td>
<td>- There are no incomplete sentences.</td>
</tr>
<tr>
<td></td>
<td>- I maintain one verb tense, especially in summaries.</td>
</tr>
</tbody>
</table>
I express similar ideas using parallel construction.

Ideas
- I used brainstorming and a concept map or outline to create and organize my ideas.
- My report is clear and focused. I stay on topic.
- I can summarize my topic in just a few sentences.
- I understand my topic and could explain it to someone else easily.
- Details in my report give the reader important information.
- My ideas relate to one another.
- I have listened to suggestions from the teacher or peer writers.
- I have cited my sources correctly and included a References page.

Organization
- Ideas are organized in a meaningful way.
- The sequence of ideas is logical.
- My introduction is interesting and inviting.
- My ideas flow from one to another.
- I used helpful transitions between main points, (e.g., "First of all," or "Similarly").
- I have a satisfying conclusion.

Punctuation
- Commas surround parenthetical expressions and appositives.
- Commas separate the items in a series.
- A comma precedes "and" or "but" when introducing an independent clause.
- A comma follows an introductory word or phrase.
- A semicolon connects two sentences.
- Closing quotation marks always follow commas or periods.
- A question mark follows closing quotation marks unless part of quoted material.
- Apostrophes are used correctly to show possession or to create contractions.
I only put an apostrophe in the word "it's" when I mean "it is."

A colon is used for emphasis or to introduce a list.

A period, question mark, or exclamation mark ends every sentence.

Long quotations are set off (e.g., indented on both sides, single spaced, and/or italic font) from the text that is not a quote.

Foreign words not in common use are italicized or enclosed in quotes.

Citations use the prescribed format including correct capitalization, punctuation, and italicization.

Word Choice

- My sentences begin in different ways.
- Every word seems just right.
- The language I use expresses voice.
- I use descriptive words (adjectives and adverbs) often.
- My words paint pictures in the reader's mind.
- I use my own words or enclose other's words in quotation marks.
- I use strong, active verbs.
- I use synonyms and different verbs to add variety.
- My pronouns match the nouns to which they refer.
- I omitted needless words from the first draft.