Bioengineering Challenges and Middle School Life Science

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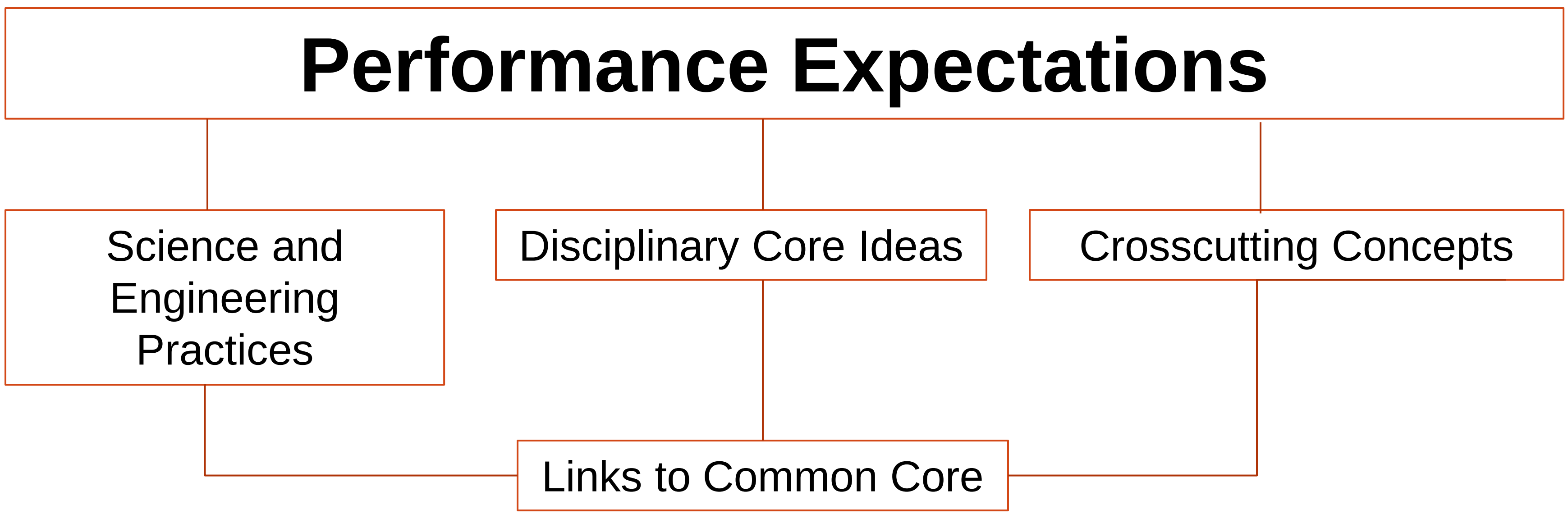
Next Generation Science Standards



Disciplinary Core Ideas

- **Physical Science**
  - Matter and its interactions
  - Motion and stability: Forces and interactions
  - Energy
  - Waves and their applications in technologies for information transfer
- **Life Science**
  - From molecules to organisms: Structures and processes
  - Ecosystems: Interactions, energy, and dynamics
  - Heredity: Inheritance and variation of traits
  - Biological evolution: Unity and diversity
- **Earth and Space Science**
  - Earth’s place in the universe
  - Earth’s systems
  - Earth and human activity
- **Engineering**
  - Engineering design

Crosscutting Concepts

- Cause and Effect
- Energy and Matter
- Patterns
- Scale, Proportion, and Quantity
- Stability and Change
- Structure and Function
- Systems and System Models

Science and Engineering Practices

- Analyzing and Interpreting Data
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information
- Planning and Carrying Out Investigations
- Using Mathematics and Computational Thinking

Performance Expectations

- Middle school examples:
  - **MS-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells
  - **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem
  - **MS-ETS1-3** Analyze data from tests to determine the similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success

Designing Artificial Heart Valves

- **The Challenge**
  - How can you design a heart valve prototype out of common materials?
- **The Task - Designing a Prototype**
  - *As an assignment for your college course in biomedical engineering, you are asked to design a prototype heart valve. Your professors want you and your fellow students to learn more about how the heart works while exploring the design process and the advantages of different valve designs. They require that your valve allow fluid to pass quickly in one direction, while allowing less than 30 mL through every 10 seconds in the other direction.*

The Procedure

- Design (begin with two different prototypes)
- Build
- Test
- Discuss how you could improve the design
- Refine the design – select a factor to change
- Build
- Test
- Discuss
- Refine……

The Materials

- Medium non-toxic latex glove finger(s)
- Medium plastic glove finger(s)
- Latex dishwashing glove finger(s)
- Smaller diameter plastic tubes
- Larger diameter plastic tubes
- Transparent tape
- 2 30-mL graduated cups
- 2 marbles
- 2 small sandwich bags
- 1 sponge or paper towels
- ¼ stick of modeling clay
- 1 timing device
- 1 large container for holding water
- 1 plastic cup
- 1 pair of scissors
- 1 Student Sheet 104.1, "The Design Process"
- 1 Student Sheet 104.2, "Refining Valve Prototypes"

Share and Compare

- Present your best valve prototype
- Test other's prototypes
- Discuss the factors that influenced your design
- What other design requirements could be introduced to improve the device?

Disciplinary Core Ideas

- LS1.A
  - In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.
- ETS1.B
  - A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
  - Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.
  - Models of all kinds are important for testing solutions.
- ETS1.C
  - Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process.
  - The iterative process of testing the most promising solutions and modifying what is proposed on the basis of test results leads to greater refinement and ultimately to an optimal solution.

Crosscutting Concepts

- Structure and Function
- Systems and System Models
- Stability and Change

- Connection to Engineering, Technology, and Applications of Science
  - Influence of Science, Engineering, and Technology on Society and the Natural World

Science and Engineering Practices

- Developing and Using Models
- Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Asking Questions and Defining Problems
- Analyzing and Interpreting Data

Performance Expectations

- **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem
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Engineering Design

Designing and testing an artificial limb in IALS

Testing, redesigning, and retesting a solar collector in IAPS

Engineering Design

- Support for engineering practices in all middle school programs
- Includes the engineering design cycle

Designing a structure to prevent beach erosion in IALS.

Contact Information

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  - This slide show can be found at sepuplhs.org/news