Pennsylvania Tutorials are designed specifically for the Pennsylvania Core Standards and the Pennsylvania Academic Standards to prepare students for the Keystone Exams and the Pennsylvania System of School Assessment (PSSA).

Biology Tutorials offer targeted instruction, practice, and review designed to help students develop fluency, deepen conceptual understanding, and apply scientific thinking skills. Students engage with the content in an interactive, feedback-rich environment as they progress through standards-aligned modules. By constantly honing their ability to explain and analyze biological scenarios, students build the depth of knowledge and higher-order skills required to demonstrate their mastery when put to the test.

In each module, the Learn It and Try It make complex ideas accessible through focused content, guided analysis, multi-modal representations, and personalized feedback as students reason through increasingly challenging problems. The Review It offers a high-impact summary of key concepts and relates those concepts to students' lives. The Test It assesses students' mastery of the module's concepts, providing granular performance data to students and teachers after each attempt. To help students focus on the content most relevant to them, unit-level pretests and posttests can quickly identify where students are strong and where they're still learning.

Unit 1: Nature of Life

- **FROM ATOMS TO BIOSPHERE**
  - 3.1.9-12.B: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- **CHARACTERISTICS OF LIFE**
  - 3.1.9-12.A: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
  - 3.1.9-12.C: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
  - 3.1.9-12.E: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
  - 3.1.9-12.W: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- **BIOMOLECULES**
  - 3.1.9-12.F: Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other

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large carbon-based molecules.

- **PLANT AND ANIMAL CELLS**
  - 3.1.9-12.C: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Unit 2: DNA Structure and Function

- **COMPONENTS OF DNA**
  - 3.1.9-12.A: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- **THE GENETIC CODE**
  - 3.1.9-12.A: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
  - 3.1.9-12.P: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- **TRANSCRIPTION**
  - 3.1.9-12.A: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
- **TRANSLATION**
  - 3.1.9-12.A: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Unit 3: Homeostasis

- **HOMEOSTASIS IN CELLS: PASSIVE TRANSPORT**
  - 3.1.9-12.C: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- **HOMEOSTASIS IN CELLS: ACTIVE TRANSPORT**
  - 3.1.9-12.C: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- **HOMEOSTASIS IN ORGANISMS**
  - 3.1.9-12.C: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- **FEEDBACK MECHANISMS IN ANIMALS**

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- 3.1.9-12.C: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Unit 4: Cellular Energetics

- **PHOTOSYNTHESIS**
  - 3.1.9-12.E: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
  - 3.1.9-12.G: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
  - 3.1.9-12.K: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- **CELLULAR RESPIRATION**
  - 3.1.9-12.G: Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
  - 3.1.9-12.J: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Unit 5: Cell Growth and Reproduction

- **DNA REPLICATION**
  - 3.1.9-12.Q: Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- **MITOSIS**
  - 3.1.9-12.D: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
- **MEIOSIS**
  - 3.1.9-12.Q: Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

Unit 6: Heredity

- **MENDELIAN LAWS OF HEREDITY**
  - 3.1.9-12.P: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
  - 3.1.9-12.R: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- **MULTIPLE ALLELES AND ALLES WITHOUT DOMINANCE**

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- 3.1.9-12.P: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- 3.1.9-12.R: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Unit 7: Variation and Natural Selection

- **GENETIC CHANGES IN DNA**
  - 3.1.9-12.Q: Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- **GENETIC CHANGES IN CHROMOSOMES**
  - 3.1.9-12.Q: Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- **NATURAL SELECTION**
  - 3.1.9-12.I: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
  - 3.1.9-12.O: Evaluate the evidence for the role of group behavior on individual and species chances to survive and reproduce.
  - 3.1.9-12.T: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
  - 3.1.9-12.U: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
  - 3.1.9-12.W: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Unit 8: Evolution

- **NATURAL IMPACT OF ECOSYSTEMS**
  - 3.1.9-12.L: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
  - 3.1.9-12.M: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
  - 3.1.9-12.X: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1)increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

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- **EVOLUTION OF SPECIES**
  - 3.1.9-12.X: Evaluate the evidence supporting claims that changes in environmental conditions may result in (1)increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- **MULTIPLE LINES OF EVIDENCE**
  - 3.1.9-12.S: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

Unit 9: Ecosystem Dynamics

- **SUCCESSION OF COMMUNITIES**
  - 3.1.9-12.L: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- **FOOD CHAINS AND WEBS**
  - 3.1.9-12.J: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- **PYRAMIDS OF ENERGY, NUMBERS, AND BIOMASS**
  - 3.1.9-12.H: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
  - 3.1.9-12.J: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Unit 10: Cycles in Nature

- **THE NITROGEN AND PHOSPHORUS CYCLES**
  - 3.1.9-12.J: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
  - 3.4.9-12.C: Analyze and interpret how issues, trends, technologies, and policies impact watersheds and water resources.
- **THE CARBON CYCLE**
  - 3.1.9-12.J: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
  - 3.1.9-12.K: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
  - 3.1.9-12.V: Create or revise a simulation to test a solution to mitigate the adverse impacts of human activity on biodiversity.
  - 3.4.9-12.D: Apply research and analytical skills to systematically investigate environmental issues ranging from local issues to those that are regional or global in scope.

Unit 11: Environmental Issues

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- **CLIMATE**
  - 3.1.9-12.N: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **NATURAL RESOURCES**
  - 3.4.9-12.G: Analyze and evaluate how best resource management practices and environmental laws achieve sustainability of natural resources.
- **IMPACTS ON HUMANS**
  - 3.1.9-12.N: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
  - 3.4.9-12.A: Analyze and interpret how issues, trends, technologies, and policies impact agricultural, food, and environmental systems and resources.
  - 3.4.9-12.C: Analyze and interpret how issues, trends, technologies, and policies impact watersheds and water resources.
  - 3.4.9-12.G: Analyze and evaluate how best resource management practices and environmental laws achieve sustainability of natural resources.
  - 3.4.9-12.H: Design and evaluate solutions in which individuals and societies can promote stewardship in environmental quality and community well-being.

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