Tennessee Tutorials are designed specifically for the Tennessee Academic Standards to prepare students for the Tennessee Comprehensive Assessment Program (TCAP) and the TNReady assessments.

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 concentrate 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.

1. NATURE OF LIFE

- **FROM ATOMS TO BIOSPHERE**
  - **BIO1.LS1.1** *Compare and contrast existing models, identify patterns, and use structural and functional evidence to analyze the characteristics of life. Engage in argument about the designation of viruses as non-living based on these characteristics.*

- **CHARACTERISTICS OF LIFE**
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*
  - **BIO1.LS1.1** *Compare and contrast existing models, identify patterns, and use structural and functional evidence to analyze the characteristics of life. Engage in argument about the designation of viruses as non-living based on these characteristics.*
  - **BIO1.LS1.6** *Create a model for the major events of the eukaryotic cell cycle, including mitosis. Compare and contrast the rates of cell division in various eukaryotic cell types in multicellular organisms.*
  - **BIO1.LS1.7** *Utilize a model of a cell plasma membrane to compare the various types of cellular transport and test predictions about the movement of molecules into or out of a cell based on the homeostasis of energy and matter in cells.*

2. THE CHEMISTRY OF LIFE

- **BIOMOLECULES**
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*
  - **BIO1.LS1.1** *Compare and contrast existing models, identify patterns, and use structural and functional evidence to analyze the characteristics of life. Engage in argument about the designation of viruses as non-living based on these characteristics.*
  - **BIO1.LS1.3** *Integrate evidence to develop a structural model of a DNA molecule. Using the model, develop and communicate an explanation for how DNA serves as a template for self-replication and encodes biological information.*
  - **BIO1.LS1.5** *Research examples that demonstrate the functional variety of proteins and construct an argument based on evidence for the importance of the molecular structure to its function. Plan and carry out a controlled investigation to test predictions about factors, which should cause an effect on the structure and function of a protein.*

- **ENZYMES**
  - **BIO1.LS1.5** *Research examples that demonstrate the functional variety of proteins and construct an argument based on evidence for the importance of the molecular structure to its function. Plan and carry out a controlled investigation to test predictions about factors, which should cause an effect on the structure and function of a protein.*

3. CELL STRUCTURE AND FUNCTION

- **PROKARYOTIC AND EUKARYOTIC CELLS**
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*
  - **BIO1.LS1.7** *Utilize a model of a cell plasma membrane to compare the various types of cellular transport and test predictions about the movement of molecules into or out of a cell based on the homeostasis of energy and matter in cells.*
  - **BIO1.LS1.6** *Create a model for the major events of the eukaryotic cell cycle, including mitosis. Compare and contrast the rates of cell division in various eukaryotic cell types in multicellular organisms.*

- **PLANT AND ANIMAL CELLS**
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*

4. PASSIVE AND ACTIVE TRANSPORT

- **PASSIVE TRANSPORT**
  - **BIO1.LS1.7** *Utilize a model of a cell plasma membrane to compare the various types of cellular transport and test predictions about the movement of molecules into or out of a cell based on the homeostasis of energy and matter in cells.*
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*

- **ACTIVE TRANSPORT**
  - **BIO1.LS1.7** *Utilize a model of a cell plasma membrane to compare the various types of cellular transport and test predictions about the movement of molecules into or out of a cell based on the homeostasis of energy and matter in cells.*

5. CELLULAR ENERGETICS

- **PHOTOSYNTHESIS**
  - **BIO1.LS1.8** *Create a model of photosynthesis demonstrating the net flow of matter and energy into a cell. Use the model to explain energy transfer from light energy into stored chemical energy in the product.*

- **CELLULAR RESPIRATION**
  - **BIO1.LS1.8** *Create a model of photosynthesis demonstrating the net flow of matter and energy into a cell. Use the model to explain energy transfer from light energy into stored chemical energy in the product.*
  - **BIO1.LS1.9** *Create a model of aerobic respiration demonstrating flow of matter and energy out of a cell. Use the model to explain energy transfer mechanisms. Compare aerobic respiration to alternative processes of glucose metabolism.*
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*

6. CELL GROWTH AND REPRODUCTION

- **THE CELL CYCLE**
  - **BIO1.LS1.6** *Create a model for the major events of the eukaryotic cell cycle, including mitosis. Compare and contrast the rates of cell division in various eukaryotic cell types in multicellular organisms.*
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*

- **MITOSIS**
  - **BIO1.LS1.2** *Evaluate comparative models of various cell types with a focus on organic molecules that make up cellular structures.*
  - **BIO1.LS1.6** *Create a model for the major events of the eukaryotic cell cycle, including mitosis. Compare and contrast the*

rates of cell division in various eukaryotic cell types in multicellular organisms.

- **BIO1.ETS2.2** *Investigate the means by which karyotypes are utilized in diagnostic medicine.*

7. DNA STRUCTURE AND FUNCTION

COMPONENTS OF DNA

- **BIO1.LS1.3** *Integrate evidence to develop a structural model of a DNA molecule. Using the model, develop and communicate an explanation for how DNA serves as a template for self-replication and encodes biological information.*
- **BIO1.LS1.4** *Demonstrate how DNA sequence information is decoded through transcriptional and translational processes within the cell in order to synthesize proteins. Examine the relationship of structure and function of various types of RNA and the importance of this relationship in these processes.*

THE GENETIC CODE

- **BIO1.LS1.4** *Demonstrate how DNA sequence information is decoded through transcriptional and translational processes within the cell in order to synthesize proteins. Examine the relationship of structure and function of various types of RNA and the importance of this relationship in these processes.*
- **BIO1.LS1.3** *Integrate evidence to develop a structural model of a DNA molecule. Using the model, develop and communicate an explanation for how DNA serves as a template for self-replication and encodes biological information.*
- **BIO1.LS1.5** *Research examples that demonstrate the functional variety of proteins and construct an argument based on evidence for the importance of the molecular structure to its function. Plan and carry out a controlled investigation to test predictions about factors, which should cause an effect on the structure and function of a protein.*

DNA REPLICATION

- **BIO1.LS1.3** *Integrate evidence to develop a structural model of a DNA molecule. Using the model, develop and communicate an explanation for how DNA serves as a template for self-replication and encodes biological information.*

8. GENE EXPRESSION

TRANSCRIPTION

- **BIO1.LS1.4** *Demonstrate how DNA sequence information is decoded through transcriptional and translational processes within the cell in order to synthesize proteins. Examine the relationship of structure and function of various types of RNA and the importance of this relationship in these processes.*

TRANSLATION

- **BIO1.LS1.4** *Demonstrate how DNA sequence information is decoded through transcriptional and translational processes within the cell in order to synthesize proteins. Examine the relationship of structure and function of various types of RNA and the importance of this relationship in these processes.*
- **BIO1.LS1.5** *Research examples that demonstrate the functional variety of proteins and construct an argument based on evidence for the importance of the molecular structure to its function. Plan and carry out a controlled investigation to test predictions about factors, which should cause an effect on the structure and function of a protein.*

9. MUTATIONS

GENETIC CHANGES IN DNA

- **BIO1.LS3.2** *Explain how protein formation results in phenotypic variation and discuss how changes in DNA can lead to somatic or germ line mutations.*

GENETIC CHANGES IN CHROMOSOMES

- **BIO1.ETS2.2** *Investigate the means by which karyotypes are utilized in diagnostic medicine.*
- **BIO1.LS3.1** *Model chromosome progression through meiosis and fertilization in order to argue how the processes of sexual reproduction lead to both genetic similarities and variation in diploid organisms. Compare and contrast the processes of sexual and asexual reproduction, identifying the advantages and disadvantages of each.*
- **BIO1.ETS2.3** *Analyze scientific and ethical arguments to support the pros and cons of application of a specific biotechnology technique such as stem cell usage, in vitro fertilization, or genetically modified organisms.*

10. HEREDITY AND BIOTECHNOLOGY

- **MENDELIAN LAWS OF HEREDITY**
  - **BIO1.LS3.1** *Model chromosome progression through meiosis and fertilization in order to argue how the processes of sexual reproduction lead to both genetic similarities and variation in diploid organisms. Compare and contrast the processes of sexual and asexual reproduction, identifying the advantages and disadvantages of each.*
  - **BIO1.LS4.2** *Using a model that demonstrates the change in allele frequencies resulting in evolution of a population over many generations, identify causative agents of change.*
  - **BIO1.LS3.3** *Through pedigree analysis, identify patterns of trait inheritance to predict family member genotypes. Use mathematical thinking to predict the likelihood of various types of trait transmission.*

- **MULTIPLE ALLELES AND ALLELES WITHOUT DOMINANCE**
  - **BIO1.LS3.3** *Through pedigree analysis, identify patterns of trait inheritance to predict family member genotypes. Use mathematical thinking to predict the likelihood of various types of trait transmission.*

- **BIOTECHNOLOGY**
  - **BIO1.ETS2.3** *Analyze scientific and ethical arguments to support the pros and cons of application of a specific biotechnology technique such as stem cell usage, in vitro fertilization, or genetically modified organisms.*
  - **BIO1.ETS2.1** *Obtain, evaluate, and communicate information on how molecular biotechnology may be used in a variety of fields.*

11. REPRODUCTION

- **MEIOSIS**
  - **BIO1.LS3.1** *Model chromosome progression through meiosis and fertilization in order to argue how the processes of sexual reproduction lead to both genetic similarities and variation in diploid organisms. Compare and contrast the processes of sexual and asexual reproduction, identifying the advantages and disadvantages of each.*

- **SEXUAL AND ASEXUAL REPRODUCTION**
  - **BIO1.LS3.1** *Model chromosome progression through meiosis and fertilization in order to argue how the processes of sexual reproduction lead to both genetic similarities and variation in diploid organisms. Compare and contrast the processes of sexual and asexual reproduction, identifying the advantages and disadvantages of each.*

12. EVOLUTION

- **MULTIPLE LINES OF EVIDENCE**
  - **BIO1.LS4.1** *Evaluate scientific data collected from analysis of molecular sequences, fossil records, biogeography, and embryology. Identify chronological patterns of change and communicate that biological evolution is supported by multiple lines of empirical evidence that identify similarities inherited from a common ancestor (homologies).*

- **THE FOSSIL RECORD**
  - **BIO1.LS4.1** *Evaluate scientific data collected from analysis of molecular sequences, fossil records, biogeography, and embryology. Identify chronological patterns of change and communicate that biological evolution is supported by multiple lines of empirical evidence that identify similarities inherited from a common ancestor (homologies).*

13. MECHANISMS OF EVOLUTION

- **NATURAL SELECTION**
  - **BIO1.LS2.1** *Analyze mathematical and/or computational representations of population data that support explanations of factors that affect population size and carrying capacities of populations within an ecosystem. Examine a representative ecosystem and, based on interdependent relationships present, predict population size effects due to a given disturbance.*
  - **BIO1.LS4.2** *Using a model that demonstrates the change in allele frequencies resulting in evolution of a population over many generations, identify causative agents of change.*

- **EVOLUTION OF SPECIES**
  - **BIO1.LS4.1** *Evaluate scientific data collected from analysis of molecular sequences, fossil records, biogeography, and embryology. Identify chronological patterns of change and communicate that biological evolution is supported by multiple lines of empirical evidence that identify similarities inherited from a common ancestor (homologies).*

14. CYCLES IN NATURE

- **THE CARBON CYCLE**
  - **BIO1.LS2.2** *Create a model tracking carbon atoms between inorganic and organic molecules in an ecosystem. Explain human impacts on climate based on this model.*
  - **BIO1.LS2.3** *Analyze through research the cycling of matter in our biosphere and explain how biogeochemical cycles are critical for ecosystem function.*
  - **BIO1.LS1.8** *Create a model of photosynthesis demonstrating the net flow of matter and energy into a cell. Use the model to explain energy transfer from light energy into stored chemical energy in the product.*
  - **BIO1.LS4.3** *Identify ecosystem services and assess the role of biodiversity in support of these services. Analyze the role human activities have on disruption of these services.*

- **THE NITROGEN AND PHOSPHORUS CYCLES**
  - **BIO1.LS2.3** *Analyze through research the cycling of matter in our biosphere and explain how biogeochemical cycles are critical for ecosystem function.*

15. MATTER AND ENERGY

- **FOOD CHAINS AND WEBS**
  - **BIO1.LS2.1** *Analyze mathematical and/or computational representations of population data that support explanations of factors that affect population size and carrying capacities of populations within an ecosystem. Examine a representative ecosystem and, based on interdependent relationships present, predict population size effects due to a given disturbance.*
  - **BIO1.LS2.4** *Analyze data demonstrating the decrease in biomass observed in each successive trophic level. Construct an explanation considering the laws of conservation of energy and matter and represent this phenomenon in a mathematical model to describe the transfer of energy and matter between trophic levels.*

- **PYRAMIDS OF ENERGY, NUMBERS, AND BIOMASS**
  - **BIO1.LS1.8** *Create a model of photosynthesis demonstrating the net flow of matter and energy into a cell. Use the model to explain energy transfer from light energy into stored chemical energy in the product.*
  - **BIO1.LS2.4** *Analyze data demonstrating the decrease in biomass observed in each successive trophic level. Construct an explanation considering the laws of conservation of energy and matter and represent this phenomenon in a mathematical model to describe the transfer of energy and matter between trophic levels.*
  - **BIO1.LS2.1** *Analyze mathematical and/or computational representations of population data that support explanations of factors that affect population size and carrying capacities of populations within an ecosystem. Examine a representative ecosystem and, based on interdependent relationships present, predict population size effects due to a given disturbance.*
  - **BIO1.LS1.9** *Create a model of aerobic respiration demonstrating flow of matter and energy out of a cell. Use the model to explain energy transfer mechanisms. Compare aerobic respiration to alternative processes of glucose metabolism.*

16. ECOLOGY OF SUCCESSION

- **SUCCESSION IN COMMUNITIES**
  - **BIO1.LS2.5** *Analyze examples of ecological succession, identifying and explaining the order of events responsible for the formation of a new ecosystem in response to extreme fluctuations in environmental conditions or catastrophic events.*
  - **BIO1.LS2.1** *Analyze mathematical and/or computational representations of population data that support explanations of factors that affect population size and carrying capacities of populations within an ecosystem. Examine a representative ecosystem and, based on interdependent relationships present, predict population size effects due to a given disturbance.*

- **NATURAL IMPACTS ON ECOSYSTEMS**

- **BIO1.LS2.2** *Create a model tracking carbon atoms between inorganic and organic molecules in an ecosystem. Explain human impacts on climate based on this model.*
- **BIO1.LS2.5** *Analyze examples of ecological succession, identifying and explaining the order of events responsible for the formation of a new ecosystem in response to extreme fluctuations in environmental conditions or catastrophic events.*