Massachusetts Tutorials are designed specifically for the Learning Standards found in the Massachusetts Curriculum Frameworks to prepare students for the MCAS tests.

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: The Characteristics and Chemistry of Life

- **CHARACTERISTICS OF LIFE**
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.
  - HS-LS4-2: Biological Evolution: Unity and Diversity Construct an explanation based on evidence that Darwins theory of evolution by natural selection occurs in a population when the following conditions are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others.
- **BIOMOLECULES**
  - HS-LS1-6: From Molecules to Organisms: Structures and Processes Construct an explanation based on evidence that organic molecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form monomers that can further combine to form large carbon-based macromolecules.
  - HS-LS1-1: From Molecules to Organisms: Structures and Processes Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out essential functions of life.
- **ENZYMES**

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- HS-LS1-1: From Molecules to Organisms: Structures and Processes Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out essential functions of life.
- HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.

Unit 2: Cell Structure and Function

- **PROKARYOTIC AND EUKARYOTIC CELLS**
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.
- **PLANT AND ANIMAL CELLS**
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.
  - HS-LS1-2: From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.

Unit 3: Passive and Active Transport

- **PASSIVE TRANSPORT**
  - HS-LS1-2: From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.
- **ACTIVE TRANSPORT**
  - HS-LS1-2: From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.

Unit 4: Cellular Energetics

- **PHOTOSYNTHESIS**

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- HS-LS1-5: From Molecules to Organisms: Structures and Processes Use a model to illustrate how photosynthesis uses light energy to transform water and carbon dioxide into oxygen and chemical energy stored in the bonds of sugars and other carbohydrates.

- **CELLULAR RESPIRATION**
  - HS-LS1-7: From Molecules to Organisms: Structures and Processes Use a model to illustrate that aerobic cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new bonds form resulting in new compounds and a net transfer of energy.
  - HS-LS1-2: From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.

Unit 5: Cell Growth and Reproduction

- **THE CELL CYCLE**
  - HS-LS1-4: From Molecules to Organisms: Structures and Processes Construct an explanation using evidence for why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms. Model the major events of the cell cycle, including (a) cell growth and DNA replication, (b) separation of chromosomes (mitosis), and (c) separation of cell contents.
- **MITOSIS**
  - HS-LS1-4: From Molecules to Organisms: Structures and Processes Construct an explanation using evidence for why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms. Model the major events of the cell cycle, including (a) cell growth and DNA replication, (b) separation of chromosomes (mitosis), and (c) separation of cell contents.

Unit 6: DNA Structure and Function

- **COMPONENTS OF DNA**
  - HS-LS1-6: From Molecules to Organisms: Structures and Processes Construct an explanation based on evidence that organic molecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form monomers that can further combine to form large carbon-based macromolecules.
  - HS-LS1-1: From Molecules to Organisms: Structures and Processes Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out essential functions of life.
  - HS-LS1-4: From Molecules to Organisms: Structures and Processes Construct an explanation using evidence for why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms. Model the major events of the cell cycle, including (a) cell growth and DNA replication, (b) separation of chromosomes (mitosis), and (c) separation of cell contents.
- **THE GENETIC CODE**
  - HS-LS1-1: From Molecules to Organisms: Structures and Processes Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out

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essential functions of life.

- HS-LS1-4: From Molecules to Organisms: Structures and Processes Construct an explanation using evidence for why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms. Model the major events of the cell cycle, including (a) cell growth and DNA replication, (b) separation of chromosomes (mitosis), and (c) separation of cell contents.

- **DNA REPLICATION**
  - HS-LS1-4: From Molecules to Organisms: Structures and Processes Construct an explanation using evidence for why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms. Model the major events of the cell cycle, including (a) cell growth and DNA replication, (b) separation of chromosomes (mitosis), and (c) separation of cell contents.

Unit 7: Gene Expression

- **TRANSCRIPTION**
  - HS-LS1-1: From Molecules to Organisms: Structures and Processes Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out essential functions of life.
- **TRANSLATION**
  - HS-LS1-1: From Molecules to Organisms: Structures and Processes Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out essential functions of life.

Unit 8: Mutations

- **GENETIC CHANGES IN DNA**
  - HS-LS3-2: Heredity: Inheritance and Variation of Traits Make and defend a claim based on evidence that genetic variations (alleles) may result from (a) new genetic combinations via the processes of crossing over and random segregation of chromosomes during meiosis, (b) mutations that occur during replication, and/or (c) mutations caused by environmental factors. Recognize that mutations that occur in gametes can be passed to offspring.
  - HS-LS4-5: Biological Evolution: Unity and Diversity Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.
- **GENETIC CHANGES IN CHROMOSOMES**
  - HS-LS3-2: Heredity: Inheritance and Variation of Traits Make and defend a claim based on evidence that genetic variations (alleles) may result from (a) new genetic combinations via the processes of crossing over and random segregation of chromosomes during meiosis, (b) mutations that occur during replication, and/or (c) mutations caused by environmental factors. Recognize that mutations that occur in gametes can be passed to offspring.

Unit 9: Heredity

- **MENDELIAN LAWS OF HEREDITY**

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- HS-LS3-3: Heredity: Inheritance and Variation of Traits Apply concepts of probability to represent possible genotype and phenotype combinations in offspring caused by different types of Mendelian inheritance patterns.

- **MULTIPLE ALLELES AND ALLELES WITHOUT DOMINANCE**
  - HS-LS3-3: Heredity: Inheritance and Variation of Traits Apply concepts of probability to represent possible genotype and phenotype combinations in offspring caused by different types of Mendelian inheritance patterns.
  - HS-LS3-4(MA): Heredity: Inheritance and Variation of Traits Use scientific information to illustrate that many traits of individuals, and the presence of specific alleles in a population, are due to interactions of genetic factors and environmental factors.

Unit 10: Reproduction

- **MEIOSIS**
  - HS-LS3-1: Heredity: Inheritance and Variation of Traits Develop and use a model to show how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
  - HS-LS3-2: Heredity: Inheritance and Variation of Traits Make and defend a claim based on evidence that genetic variations (alleles) may result from (a) new genetic combinations via the processes of crossing over and random segregation of chromosomes during meiosis, (b) mutations that occur during replication, and/or (c) mutations caused by environmental factors. Recognize that mutations that occur in gametes can be passed to offspring.
- **SEXUAL AND ASEXUAL REPRODUCTION**
  - HS-LS3-1: Heredity: Inheritance and Variation of Traits Develop and use a model to show how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
  - HS-LS3-2: Heredity: Inheritance and Variation of Traits Make and defend a claim based on evidence that genetic variations (alleles) may result from (a) new genetic combinations via the processes of crossing over and random segregation of chromosomes during meiosis, (b) mutations that occur during replication, and/or (c) mutations caused by environmental factors. Recognize that mutations that occur in gametes can be passed to offspring.

Unit 11: Evolution

- **MULTIPLE LINES OF EVIDENCE**
  - HS-LS4-1: Biological Evolution: Unity and Diversity Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence, including molecular, anatomical, and developmental similarities inherited from a common ancestor (homologies), seen through fossils and laboratory and field observations.
- **THE FOSSIL RECORD**
  - HS-LS4-1: Biological Evolution: Unity and Diversity Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence, including

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molecular, anatomical, and developmental similarities inherited from a common ancestor (homologies), seen through fossils and laboratory and field observations.

- **EVOLUTION OF SPECIES**
  - HS-LS2-6: Ecosystems: Interactions, Energy, and Dynamics Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience.
  - HS-LS4-5: Biological Evolution: Unity and Diversity Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.
  - HS-LS4-1: Biological Evolution: Unity and Diversity Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence, including molecular, anatomical, and developmental similarities inherited from a common ancestor (homologies), seen through fossils and laboratory and field observations.
  - HS-LS4-2: Biological Evolution: Unity and Diversity Construct an explanation based on evidence that Darwins theory of evolution by natural selection occurs in a population when the following conditions are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others.

Unit 12: Natural Selection and Biotechnology

- **NATURAL SELECTION**
  - HS-LS4-2: Biological Evolution: Unity and Diversity Construct an explanation based on evidence that Darwins theory of evolution by natural selection occurs in a population when the following conditions are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others.
  - HS-LS4-2: Biological Evolution: Unity and Diversity Construct an explanation based on evidence that Darwins theory of evolution by natural selection occurs in a population when the following conditions are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others.
  - HS-LS4-5: Biological Evolution: Unity and Diversity Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.
  - HS-LS4-2: Biological Evolution: Unity and Diversity Construct an explanation based on evidence that Darwins theory of evolution by natural selection occurs in a population when the following conditions

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are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others.

- **BIOTECHNOLOGY**
  - HS-LS4-5: Biological Evolution: Unity and Diversity Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.

Unit 13: Homeostasis and The Nervous System

- **HOMEOSTASIS AND DYNAMIC EQUILIBRIUM**
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.
  - HS-LS1-2: From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.
- **FEEDBACK MECHANISMS IN ANIMALS**
  - HS-LS1-2: From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.
- **THE NERVOUS SYSTEM**
  - HS-LS1-3: From Molecules to Organisms: Structures and Processes Provide evidence that homeostasis maintains internal body conditions through both body- wide feedback mechanisms and small-scale cellular processes.
  - HS-LS1-2: From Molecules to Organisms: Structures and Processes Develop and use a model to illustrate the key functions of animal body systems, including (a) food digestion, nutrient uptake, and transport through the body; (b) exchange of oxygen and carbon dioxide; (c) removal of wastes; and (d) regulation of body processes.

Unit 14: Matter and Energy

- **FOOD CHAINS AND WEBS**
  - HS-LS2-4: Ecosystems: Interactions, Energy, and Dynamics Use a mathematical model to describe the transfer of energy from one trophic level to another. Explain how the inefficiency of energy transfer between trophic levels affects the relative number of organisms that can be supported at each trophic

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level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment.

- HS-LS2-1: Ecosystems: Interactions, Energy, and Dynamics Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity.
- HS-LS2-2: Ecosystems: Interactions, Energy, and Dynamics Use mathematical representations to support explanations that biotic and abiotic factors affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem.
- HS-LS2-6: Ecosystems: Interactions, Energy, and Dynamics Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience.
- HS-LS2-7: Ecosystems: Interactions, Energy, and Dynamics Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.

- **PYRAMIDS OF ENERGY, NUMBERS, AND BIOMASS**
  - HS-LS2-4: Ecosystems: Interactions, Energy, and Dynamics Use a mathematical model to describe the transfer of energy from one trophic level to another. Explain how the inefficiency of energy transfer between trophic levels affects the relative number of organisms that can be supported at each trophic level and necessitates a constant input of energy from sunlight or inorganic compounds from the environment.
  - HS-LS2-1: Ecosystems: Interactions, Energy, and Dynamics Analyze data sets to support explanations that biotic and abiotic factors affect ecosystem carrying capacity.
  - HS-LS2-2: Ecosystems: Interactions, Energy, and Dynamics Use mathematical representations to support explanations that biotic and abiotic factors affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem.

Unit 15: Cycles in Nature and Natural Impacts on Ecosystems

- **THE CARBON CYCLE**
  - HS-LS2-5: Ecosystems: Interactions, Energy, and Dynamics Use a model that illustrates the roles of photosynthesis, cellular respiration, decomposition, and combustion to explain the cycling of carbon in its various forms among the biosphere, atmosphere, hydrosphere, and geosphere.
  - HS-LS2-7: Ecosystems: Interactions, Energy, and Dynamics Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.

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- **THE NITROGEN AND PHOSPHORUS CYCLES**
  - HS-LS1-6: From Molecules to Organisms: Structures and Processes Construct an explanation based on evidence that organic molecules are primarily composed of six elements, where carbon, hydrogen, and oxygen atoms may combine with nitrogen, sulfur, and phosphorus to form monomers that can further combine to form large carbon-based macromolecules.
  - HS-LS2-7: Ecosystems: Interactions, Energy, and Dynamics Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.
- **NATURAL IMPACTS ON ECOSYSTEMS**
  - HS-LS2-6: Ecosystems: Interactions, Energy, and Dynamics Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience.
  - HS-LS2-2: Ecosystems: Interactions, Energy, and Dynamics Use mathematical representations to support explanations that biotic and abiotic factors affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem.

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