

Indiana Tutorials are designed specifically for the Indiana Academic Standards to prepare students for the Indiana Statewide Testing for Educational Progress-Plus (ISTEP+) End-of-Course Assessments (ECAs).

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.

## 1. THE NATURE OF LIFE

### • FROM ATOMS TO BIOSPHERE

- **B.6.3** Explain that in multicellular organisms the zygote produced during fertilization undergoes a series of cell divisions that lead to clusters of cells that go on to specialize and become the organism's tissues and organs.

### • CHARACTERISTICS OF LIFE

- **B.2.1** Describe features common to all cells that are essential for growth and survival. Explain their functions.
- **B.3.3** Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, which include the production, modification, transport, and exchange of materials that are required for the maintenance of life.
- **B.1.3** Explain and give examples of how the function and differentiation of cells is influenced by their external environment (e.g., temperature, acidity and the concentration of certain molecules) and changes in these conditions may affect how a cell functions.
- **B.6.1** Describe the process of mitosis and explain that this process ordinarily results in daughter cells with a genetic make-up identical to the parent cells.
- **B.6.2** Understand that most cells of a multicellular organism contain the same genes but develop from a single cell (e.g., a fertilized egg) in different ways due to differential gene expression.

## 2. THE CHEMISTRY OF LIFE

### • BIOMOLECULES

- **B.1.1** Describe the structure of the major categories of organic compounds that make up living organisms in terms of their building blocks and the small number of chemical elements (i.e., carbon, hydrogen, nitrogen, oxygen, phosphorous and sulfur) from which they are composed.
- **B.5.3** Describe the process by which DNA directs the production of protein within a cell.
- **B.5.5** Understand that proteins are responsible for the observable traits of an organism and for most of the functions within an organism.
- **B.1.2** Understand that the shape of a molecule determines its role in the many different types of cellular processes (e.g., metabolism, homeostasis, growth and development, and heredity) and understand that the majority of these processes involve proteins that act as enzymes.

- **B.2.5** Explain that cells use proteins to form structures (e.g., cilia, flagella), which allow them to carry out specific functions (e.g., movement, adhesion and absorption).

- **ENZYMES**

- **B.1.2** Understand that the shape of a molecule determines its role in the many different types of cellular processes (e.g., metabolism, homeostasis, growth and development, and heredity) and understand that the majority of these processes involve proteins that act as enzymes.

### 3. CELL STRUCTURE AND FUNCTION

- **PROKARYOTIC AND EUKARYOTIC CELLS**

- **B.2.2** Describe the structure of a cell membrane and explain how it regulates the transport of materials into and out of the cell and prevents harmful materials from entering the cell.
- **B.2.1** Describe features common to all cells that are essential for growth and survival. Explain their functions.
- **B.2.4** Explain that all cells contain ribosomes (the key sites for protein synthesis), where genetic material is decoded in order to form unique proteins.
- **B.2.5** Explain that cells use proteins to form structures (e.g., cilia, flagella), which allow them to carry out specific functions (e.g., movement, adhesion and absorption).
- **B.3.3** Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, which include the production, modification, transport, and exchange of materials that are required for the maintenance of life.
- **B.2.6** Investigate a variety of different cell types and relate the proportion of different organelles within these cells to their functions.

- **PLANT AND ANIMAL CELLS**

- **B.2.1** Describe features common to all cells that are essential for growth and survival. Explain their functions.
- **B.2.3** Explain that most cells contain mitochondria (the key sites of cellular respiration), where stored chemical energy is converted into useable energy for the cell. Explain that some cells, including many plant cells, contain chloroplasts (the key sites of photosynthesis) where the energy of light is captured for use in chemical work.
- **B.2.6** Investigate a variety of different cell types and relate the proportion of different organelles within these cells to their functions.
- **B.3.3** Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, which include the production, modification, transport, and exchange of materials that are required for the maintenance of life.

- **PASSIVE TRANSPORT**

- **B.1.3** Explain and give examples of how the function and differentiation of cells is influenced by their external environment (e.g., temperature, acidity and the concentration of certain molecules) and changes in these conditions may affect how a cell functions.
- **B.2.2** Describe the structure of a cell membrane and explain how it regulates the transport of materials into and out of the cell and prevents harmful materials from entering the cell.
- **B.3.3** Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, which include the production, modification, transport, and exchange of materials that are required for the maintenance of life.

- **ACTIVE TRANSPORT**

- **B.1.3** Explain and give examples of how the function and differentiation of cells is influenced by their external environment (e.g., temperature, acidity and the concentration of certain molecules) and changes in these conditions may affect how a cell functions.
- **B.2.2** Describe the structure of a cell membrane and explain how it regulates the transport of materials into and out of the cell and prevents harmful materials from entering the cell.
- **B.2.5** Explain that cells use proteins to form structures (e.g., cilia, flagella), which allow them to carry out specific functions (e.g., movement, adhesion and absorption).

## 4. CELLULAR ENERGETICS

### • PHOTOSYNTHESIS

- **B.2.3** Explain that most cells contain mitochondria (the key sites of cellular respiration), where stored chemical energy is converted into useable energy for the cell. Explain that some cells, including many plant cells, contain chloroplasts (the key sites of photosynthesis) where the energy of light is captured for use in chemical work.
- **B.3.1** Describe how some organisms capture the sun's energy through the process of photosynthesis by converting carbon dioxide and water into high-energy compounds and releasing oxygen.

### • CELLULAR RESPIRATION

- **B.2.3** Explain that most cells contain mitochondria (the key sites of cellular respiration), where stored chemical energy is converted into useable energy for the cell. Explain that some cells, including many plant cells, contain chloroplasts (the key sites of photosynthesis) where the energy of light is captured for use in chemical work.
- **B.3.2** Describe how most organisms can combine and recombine the elements contained in sugar molecules into a variety of biologically essential compounds by utilizing the energy from cellular respiration.
- **B.3.3** Recognize and describe that metabolism consists of all of the biochemical reactions that occur inside cells, which include the production, modification, transport, and exchange of materials that are required for the maintenance of life.

## 5. CELL GROWTH AND REPRODUCTION

### • THE CELL CYCLE

- **B.6.1** Describe the process of mitosis and explain that this process ordinarily results in daughter cells with a genetic make-up identical to the parent cells.
- **B.1.3** Explain and give examples of how the function and differentiation of cells is influenced by their external environment (e.g., temperature, acidity and the concentration of certain molecules) and changes in these conditions may affect how a cell functions.
- **B.6.2** Understand that most cells of a multicellular organism contain the same genes but develop from a single cell (e.g., a fertilized egg) in different ways due to differential gene expression.

### • MITOSIS

- **B.1.3** Explain and give examples of how the function and differentiation of cells is influenced by their external environment (e.g., temperature, acidity and the concentration of certain molecules) and changes in these conditions may affect how a cell functions.
- **B.6.1** Describe the process of mitosis and explain that this process ordinarily results in daughter cells with a genetic make-up identical to the parent cells.
- **B.6.2** Understand that most cells of a multicellular organism contain the same genes but develop from a single cell (e.g., a fertilized egg) in different ways due to differential gene expression.

## 6. DNA STRUCTURE AND FUNCTION

### • COMPONENTS OF DNA

- **B.5.1** Describe the relationship between chromosomes and DNA along with their basic structure and function.
- **B.5.2** Describe how hereditary information passed from parents to offspring is encoded in the regions of DNA molecules called genes.
- **B.5.3** Describe the process by which DNA directs the production of protein within a cell.
- **B.5.4** Explain how the unique shape and activity of each protein is determined by the sequence of its amino acids.
- **B.7.4** Explain the process by which a cell copies its DNA and identify factors that can damage DNA and cause changes in its nucleotide sequence.

### • THE GENETIC CODE

- **B.5.1** Describe the relationship between chromosomes and DNA along with their basic structure and function.

- **B.5.2** Describe how hereditary information passed from parents to offspring is encoded in the regions of DNA molecules called genes.
- **B.5.3** Describe the process by which DNA directs the production of protein within a cell.
- **B.5.4** Explain how the unique shape and activity of each protein is determined by the sequence of its amino acids.
- **B.2.5** Explain that cells use proteins to form structures (e.g., cilia, flagella), which allow them to carry out specific functions (e.g., movement, adhesion and absorption).
- **B.5.5** Understand that proteins are responsible for the observable traits of an organism and for most of the functions within an organism.
- **B.5.6** Recognize that traits can be structural, physiological or behavioral and can include readily observable characteristics at the organismal level or less recognizable features at the molecular and cellular level.

- **DNA REPLICATION**

- **B.7.4** Explain the process by which a cell copies its DNA and identify factors that can damage DNA and cause changes in its nucleotide sequence.

## 7. GENE EXPRESSION

- **TRANSCRIPTION**

- **B.7.4** Explain the process by which a cell copies its DNA and identify factors that can damage DNA and cause changes in its nucleotide sequence.
- **B.2.4** Explain that all cells contain ribosomes (the key sites for protein synthesis), where genetic material is decoded in order to form unique proteins.
- **B.5.3** Describe the process by which DNA directs the production of protein within a cell.
- **B.5.4** Explain how the unique shape and activity of each protein is determined by the sequence of its amino acids.
- **B.5.5** Understand that proteins are responsible for the observable traits of an organism and for most of the functions within an organism.

- **TRANSLATION**

- **B.2.4** Explain that all cells contain ribosomes (the key sites for protein synthesis), where genetic material is decoded in order to form unique proteins.
- **B.5.3** Describe the process by which DNA directs the production of protein within a cell.
- **B.1.2** Understand that the shape of a molecule determines its role in the many different types of cellular processes (e.g., metabolism, homeostasis, growth and development, and heredity) and understand that the majority of these processes involve proteins that act as enzymes.
- **B.2.5** Explain that cells use proteins to form structures (e.g., cilia, flagella), which allow them to carry out specific functions (e.g., movement, adhesion and absorption).
- **B.5.4** Explain how the unique shape and activity of each protein is determined by the sequence of its amino acids.
- **B.5.5** Understand that proteins are responsible for the observable traits of an organism and for most of the functions within an organism.

## 8. MUTATIONS

- **GENETIC CHANGES IN DNA**

- **B.7.4** Explain the process by which a cell copies its DNA and identify factors that can damage DNA and cause changes in its nucleotide sequence.
- **B.8.6** Explain how genetic variation within a population (i.e., a species) can be attributed to mutations as well as random assortments of existing genes.
- **B.7.5** Explain and demonstrate how inserting, substituting or deleting segments of a DNA molecule can alter a gene, how that gene is then passed to every cell that develops from it and how the results may be beneficial, harmful or have little or no effect on the organism.

- **GENETIC CHANGES IN CHROMOSOMES**

- **B.5.1** Describe the relationship between chromosomes and DNA along with their basic structure and function.
- **B.6.4** Describe and model the process of meiosis and explain the relationship between the genetic make-up of the parent cell and the daughter cells (i.e., gametes).
- **B.6.5** Explain how in sexual reproduction that crossing over, independent assortment and random fertilization result in offspring that are genetically different from the parents.
- **B.8.6** Explain how genetic variation within a population (i.e., a species) can be attributed to mutations as well as random assortments of existing genes.
- **B.7.4** Explain the process by which a cell copies its DNA and identify factors that can damage DNA and cause changes in its nucleotide sequence.

## 9. HEREDITY

- **MENDELIAN LAWS OF HEREDITY**

- **B.7.1** Distinguish between dominant and recessive alleles and determine the phenotype that would result from the different possible combinations of alleles in an offspring.
- **B.7.2** Describe dominant, recessive, codominant, sex-linked, incompletely dominant, multiply allelic and polygenic traits and illustrate their inheritance patterns over multiple generations.
- **B.5.2** Describe how hereditary information passed from parents to offspring is encoded in the regions of DNA molecules called genes.
- **B.5.6** Recognize that traits can be structural, physiological or behavioral and can include readily observable characteristics at the organismal level or less recognizable features at the molecular and cellular level.
- **B.7.3** Determine the likelihood of the appearance of a specific trait in an offspring given the genetic make-up of the parents.

- **MULTIPLE ALLELES AND ALLELES WITHOUT DOMINANCE**

- **B.7.3** Determine the likelihood of the appearance of a specific trait in an offspring given the genetic make-up of the parents.
- **B.7.2** Describe dominant, recessive, codominant, sex-linked, incompletely dominant, multiply allelic and polygenic traits and illustrate their inheritance patterns over multiple generations.
- **B.5.2** Describe how hereditary information passed from parents to offspring is encoded in the regions of DNA molecules called genes.

## 10. REPRODUCTION

- **MEIOSIS**

- **B.6.4** Describe and model the process of meiosis and explain the relationship between the genetic make-up of the parent cell and the daughter cells (i.e., gametes).
- **B.6.5** Explain how in sexual reproduction that crossing over, independent assortment and random fertilization result in offspring that are genetically different from the parents.

- **SEXUAL AND ASEQUAL REPRODUCTION**

- **B.6.1** Describe the process of mitosis and explain that this process ordinarily results in daughter cells with a genetic make-up identical to the parent cells.
- **B.6.2** Understand that most cells of a multicellular organism contain the same genes but develop from a single cell (e.g., a fertilized egg) in different ways due to differential gene expression.
- **B.6.3** Explain that in multicellular organisms the zygote produced during fertilization undergoes a series of cell divisions that lead to clusters of cells that go on to specialize and become the organism's tissues and organs.
- **B.6.4** Describe and model the process of meiosis and explain the relationship between the genetic make-up of the parent cell and the daughter cells (i.e., gametes).
- **B.6.5** Explain how in sexual reproduction that crossing over, independent assortment and random fertilization result in offspring that are genetically different from the parents.

## 11. EVOLUTION

### • MULTIPLE LINES OF EVIDENCE

- **B.8.1** Explain how anatomical and molecular similarities among organisms suggests that life on earth began as simple, one-celled organisms about 4 billion years ago and multicellular organisms evolved later.
- **B.8.3** Use anatomical and molecular evidence to establish evolutionary relationships among organisms.
- **B.8.7** Describe the modern scientific theory of the origins and history of life on earth and evaluate the evidence that supports it.
- **B.8.4** Understand that molecular evidence supports the anatomical evidence for these evolutionary relationships and provides additional information about the order in which different lines of descent branched.

### • THE FOSSIL RECORD

- **B.8.1** Explain how anatomical and molecular similarities among organisms suggests that life on earth began as simple, one-celled organisms about 4 billion years ago and multicellular organisms evolved later.
- **B.8.3** Use anatomical and molecular evidence to establish evolutionary relationships among organisms.
- **B.8.7** Describe the modern scientific theory of the origins and history of life on earth and evaluate the evidence that supports it.

## 12. MECHANISMS OF EVOLUTION

### • NATURAL SELECTION

- **B.5.6** Recognize that traits can be structural, physiological or behavioral and can include readily observable characteristics at the organismal level or less recognizable features at the molecular and cellular level.
- **B.8.5** Describe how organisms with beneficial traits are more likely to survive, reproduce, and pass on their genetic information due to genetic variations, environmental forces and reproductive pressures.
- **B.8.6** Explain how genetic variation within a population (i.e., a species) can be attributed to mutations as well as random assortments of existing genes.

### • EVOLUTION OF SPECIES

- **B.8.5** Describe how organisms with beneficial traits are more likely to survive, reproduce, and pass on their genetic information due to genetic variations, environmental forces and reproductive pressures.

## 13. CLASSIFICATION

### • TAXONOMY

- **B.8.2** Explain how organisms are classified and named based on their evolutionary relationships into taxonomic categories.
- **B.8.3** Use anatomical and molecular evidence to establish evolutionary relationships among organisms.
- **B.8.4** Understand that molecular evidence supports the anatomical evidence for these evolutionary relationships and provides additional information about the order in which different lines of descent branched.

### • THE SIX KINGDOMS

- **B.8.2** Explain how organisms are classified and named based on their evolutionary relationships into taxonomic categories.
- **B.8.3** Use anatomical and molecular evidence to establish evolutionary relationships among organisms.
- **B.2.6** Investigate a variety of different cell types and relate the proportion of different organelles within these cells to their functions.
- **B.8.1** Explain how anatomical and molecular similarities among organisms suggests that life on earth began as simple, one-celled organisms about 4 billion years ago and multicellular organisms evolved later.
- **B.8.4** Understand that molecular evidence supports the anatomical evidence for these evolutionary relationships and provides additional information about the order in which different lines of descent branched.
- **B.8.7** Describe the modern scientific theory of the origins and history of life on earth and evaluate the evidence that supports it.

## 14. MATTER AND ENERGY

### • FOOD CHAINS AND WEBS

- **B.4.1** Explain that the amount of life environments can support is limited by the available energy, water, oxygen and minerals and by the ability of ecosystems to recycle the remains of dead organisms.
- **B.3.4** Describe how matter cycles through an ecosystem by way of food chains and food webs and how organisms convert that matter into a variety of organic molecules to be used in part in their own cellular structures.
- **B.3.5** Describe how energy from the sun flows through an ecosystem by way of food chains and food webs and how only a small portion of that energy is used by individual organisms while the majority is lost as heat.
- **B.4.2** Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.
- **B.4.3** Describe the consequences of introducing non-native species into an ecosystem and identify the impact it may have on that ecosystem.
- **B.4.4** Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long-term stability of an ecosystem.

### • PYRAMIDS OF ENERGY, NUMBERS, AND BIOMASS

- **B.4.1** Explain that the amount of life environments can support is limited by the available energy, water, oxygen and minerals and by the ability of ecosystems to recycle the remains of dead organisms.
- **B.3.4** Describe how matter cycles through an ecosystem by way of food chains and food webs and how organisms convert that matter into a variety of organic molecules to be used in part in their own cellular structures.
- **B.3.5** Describe how energy from the sun flows through an ecosystem by way of food chains and food webs and how only a small portion of that energy is used by individual organisms while the majority is lost as heat.
- **B.4.2** Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.
- **B.4.4** Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long-term stability of an ecosystem.

## 15. CYCLES IN NATURE

### • THE CARBON CYCLE

- **B.4.1** Explain that the amount of life environments can support is limited by the available energy, water, oxygen and minerals and by the ability of ecosystems to recycle the remains of dead organisms.
- **B.3.4** Describe how matter cycles through an ecosystem by way of food chains and food webs and how organisms convert that matter into a variety of organic molecules to be used in part in their own cellular structures.
- **B.4.4** Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long-term stability of an ecosystem.
- **B.4.2** Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.

### • THE NITROGEN AND PHOSPHORUS CYCLES

- **B.4.1** Explain that the amount of life environments can support is limited by the available energy, water, oxygen and minerals and by the ability of ecosystems to recycle the remains of dead organisms.
- **B.3.4** Describe how matter cycles through an ecosystem by way of food chains and food webs and how organisms convert that matter into a variety of organic molecules to be used in part in their own cellular structures.
- **B.4.4** Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long-term stability of an ecosystem.
- **B.4.2** Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.

## 16. ECOLOGY OF SUCCESSION

- **SUCCESSION IN COMMUNITIES**

- **B.4.2** Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.
- **B.4.4** Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long-term stability of an ecosystem.

- **NATURAL IMPACTS ON ECOSYSTEMS**

- **B.4.2** Describe how human activities and natural phenomena can change the flow and of matter and energy in an ecosystem and how those changes impact other species.
- **B.4.4** Describe how climate, the pattern of matter and energy flow, the birth and death of new organisms, and the interaction between those organisms contribute to the long-term stability of an ecosystem.