Instructional Implications for Biology

To meet the goals of *Each Child, Our Future*, Ohio's strategic plan for education, schools and districts will find it essential to have appropriate local curricula supported by high-quality instructional materials. Science is part of providing well-rounded content for students, as well-rounded content is one of the four learning domains listed in the strategic plan.

Science is an essential subject for students in grades K-12. It is important to build a strong foundation in science in early elementary years so students are prepared for understanding more complex material in intermediate and middle grades. It is equally important to continue students' science instruction by offering more advanced courses at the high school level. This allows students to better compete for admission to college or other postsecondary programs, as well as jobs. Advanced science courses in high schools also help produce a more scientifically literate public.

This document outlines the most notable changes from the 2010 standards to the 2018 standards and offers insight into how teachers can best prepare their students using the revised content. **The document is merely an overview; it does not provide a comprehensive treatment of changes or take the place of the model curriculum or instructional resources.**

The document consists of tables containing three columns that show the 2010 standard, the 2018 standard and the implications of any significant shifts from 2010 to 2018. The document addresses only areas in which the focus of instruction has changed. Standards that say "No change to content focus" should continue to be taught with the same goals as the corresponding 2010 standards. For standards in which the instructional focus has shifted, only the changed content is included in the third column of the table. Portions of the standard unaffected by the changes may not appear here but should continue to be taught.

Educators should teach all content in the standards incorporating the science and engineering practices, and they should engage students in scientific thought processes. Where possible, instructors should use real-world data and both problem-based and project-based experiences. *Ohio's Cognitive Demands*, which Ohio initiated in the 2010 standards, are clarified in the 2018 standards, featuring additional *Visions into Practice* examples categorized by cognitive demand. These levels of knowledge relate to current understanding and research about the ways people learn, and they are important aspects of an overall understanding of science concepts. Educators should give their students opportunities to practice all four types of thinking. Please note, the *Visions into Practice* section of the Model Curriculum suggests ways to incorporate these levels into instruction, but the examples are not mandatory; they are simply ideas educators could implement or adapt to suit local curriculum.

Also, educators need to design lessons to incorporate the concepts described in the *Nature of Science* sections. The *Nature of Science* provides a way for increasing students' understanding of science as more than a body of knowledge about how the natural world works. It also is a process for gathering information and gaining deeper knowledge about the world. These concepts of science should not form a standalone unit or be additional course materials. They should be embedded in each area of the science classroom experience, including lessons, laboratory or field studies, and assessments.

2010 Content Statement	2018 Content Statement	Instructional implications of revisions
Heredity	**Heredity (B.H)**	
Cellular genetics	**B.H.1: Cellular genetics**	No change in the content Cellular heredity instruction should acknowledge epigenetics as the final arbiter of individual gene expression and the basis for cellular differentiation. Instruction also should explore the complete process, including the role of RNA in gene expression and function within the cell.
Structure and function of DNA in cells	**B.H.2: Structure and function of DNA in cells**	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Genetic mechanisms and inheritance	**B.H.3: Genetic mechanisms and inheritance**	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Mutations	**B.H.4: Mutations**	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Modern genetics	**B.H.5: Modern genetics**	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.

2010 Content Statement	2018 Content Statement	Instructional implications of revisions
Evolution	**Evolution (B.E)**	
Mechanisms Natural selection Mutation Genetic drift Gene flow (immigration, Emigration Sexual selection History of Life on Earth	**B.E.1: Mechanisms** Natural selection Mutation Genetic drift Gene flow (immigration, emigration) Sexual selection	*History of Life on Earth* is no longer listed as a separate subtopic in the syllabus. However, the standards address this content throughout the study of the evolution. Mutations do not form a mechanism for macroevolutionary progress. Instead, they form the basis of thousands of human diseases and cancer. Instructors should distinguish between microevolutionary adaptation of changes within kinds that are readily observable and macroevolutionary change from single cell creatures to higher complexity — changes that are never directly observed but must be inferred.
Diversity of Life Speciation and biological classification based on molecular evidence Variation of organisms within a species due to population genetics and gene frequency	**B.E.2: Speciation** Biological classification expanded to molecular evidence Variation of organisms within a species due to population genetics and gene frequency	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Diversity and Interdependence of Life	**Diversity and Interdependence of Life (B.DI)**	
Classification Systems Classification systems are frameworks created by scientists for describing the vast diversity of organisms indicating the degree of relatedness between organisms.	**B.DI.1: Biodiversity** Genetic diversity Species diversity	This standard focuses on the study of diversity and similarity at the molecular level of organisms. Examples of diversity at both the macro and micro levels should be observed and discussed. Standards encourage using cladograms to visualize the relatedness of species.
Ecosystems Homeostasis Carrying capacity Equilibrium and disequilibrium	**B.DI.2: Ecosystems** Equilibrium and disequilibrium Carrying capacity	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
	B.DI.3: Loss of diversity Climate change Anthropocene effects Extinction Invasive species	This is an additional focus for the biology course. Students should examine factors that contribute to the accelerated extinction rates observed today and the implications of declining biodiversity. Instructors should address misconceptions about population growth capacity, interspecies and intraspecies competition for resources and what occurs when members of a species immigrate to or emigrate from ecosystems. Using technology to access real-time data on population changes and growth in specific locations can help relate concepts to current events.

2010 Content Statement	2018 Content Statement	Instructional implications of revisions
Cells	**Cells (B.C)**	
Cell structure and function Structure, function and interrelatedness of cell organelles Eukaryotic cells and prokaryotic cells	**B.C.1: Cell structure and function** Structure, function and interrelatedness of cell organelles Eukaryotic cells and prokaryotic cells	No change to content focus, but be sure instruction reflects the strong emphasis on the *Nature of Science* and the *Cognitive Demands* included in the 2018 standards.
Cellular processes Characteristics of life regulated by cellular processes Photosynthesis, chemosynthesis, cellular respiration, cell division and differentiation	**B.C.2: Cellular processes** Characteristics of life regulated by cellular processes Photosynthesis, chemosynthesis, cellular respiration, biosynthesis of macromolecules	Cell division and differentiation have been removed as a topic. This content was introduced in grade 8 and should be built upon in this course. Focus on the biosynthesis of macromolecules, cellular reactions and the external conditions necessary for those reactions to take place.