

Biology Pathway Endorsement Specs

Purpose

This document describes the specifications associated with the Biology Pathway Science Endorsements. There are three endorsements in the Biology Pathway: Science Core, Biology 1, and Biology 2.

The **Science Core Endorsement**, when attached to a current Education License, verifies that the individual has the skills and knowledge necessary to teach students three-dimensionally in a secondary science classroom and is required to teach Middle School Science Courses in Grades 6, 7, or 8. Additionally, this endorsement is required as a prerequisite to earn any high school Level-1 or Level-2 content specific science endorsement.

The **Biology 1 Endorsement**, when attached to a current Education License, verifies that the individual has the skills and knowledge necessary to teach students in a secondary life science classroom and is required to teach High School (9-12) General Biology Courses (Including Honors) and the High School Botany, Genetics, Zoology, and Marine Biology Elective Courses. This endorsement is required as a prerequisite to earn the Biology 2 Endorsement.

The **Biology 2 Endorsement**, when attached to a current Education License, verifies that the individual has the skills and knowledge necessary to teach students in an advanced secondary life science classroom and is required to teach Advanced Biology (AP, CE, and IB) and some high school life science elective courses. Those with this endorsement can also teach all the courses a Biology 1 endorsed educator can teach. NOTE: Advanced biology (AP, CE, and IB) courses may also include additional requirements in order to be approved by the university or college board to teach.

Endorsement Requirement Areas

The Science Core endorsement is a prerequisite for the Biology 1 and Biology 2 Endorsements and has 7 requirement areas:

1. Earth Science Content Knowledge
2. Life Science Content Knowledge
3. Chemistry Content Knowledge
4. Physics Content Knowledge
5. Three-Dimensional Science & Engineering Pedagogical Knowledge
6. Science Education Teaching & Dispositions Knowledge
7. Science Classroom Lab Safety Knowledge

The Biology 1 Endorsement is a prerequisite for the Biology 2 Endorsement and has 5 requirement areas:

8. Biological Molecules Content Knowledge
9. Organisms Content Knowledge
10. Ecosystems Content Knowledge
11. Heredity Content Knowledge
12. Biological Evolution Content Knowledge

The Biology 2 Endorsement has the following 2 requirement areas:

13. Advanced Data Analysis Content Knowledge
14. Advanced Life Science Knowledge

Endorsement Type

A professional endorsement will be awarded when all of the prerequisite and endorsement requirement areas have been met. An associate Science Core Endorsement will be awarded if the applicant has completed at least 3 of the 7 requirement areas. An associate Biology 1 Endorsement will be awarded if the applicant holds a Professional Science Core endorsement, has a college major or minor in Biology, **OR** has completed at least 5 of the 12 prerequisite and endorsement requirement areas. An associate Biology 2 endorsement will be awarded if the applicant holds Professional Science Core and Biology 1 endorsements, has a college major in Biology, **OR** has completed at least 6 of the 14 requirement areas.

Requirement Area Options

The different options available to complete requirement areas 8-14 for the Biology 1 and Biology 2 Endorsements are described below. The options for requirement areas 1-7 associated with the Science Core Endorsement can be found in the [Science Core Endorsement Specs](#). Quick links to the requirement area competencies are linked in parentheses.

Requirement Area 8: Biological Molecules Content Knowledge ([B1.1.A-B](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Molecular Biology
 - Lab course is not required but recommended

College Major or Minor (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- College Major or Minor in Biology, Biology Education, or a Biology Variation (e.g., Microbiology, Ecology, Wildlife Biology, Physiology, Genetics, Evolutionary Biology)
- Other College Majors or Minors may be approved for this endorsement with approval of USBE Science Specialist based on a transcript review

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- **Praxis Exam**
 - [Biology PRAXIS \(5236\)](#) with score of 148 or higher
- **NES Test** (Meets Requirement Areas 8-12 for this endorsement)
 - [Biology NES Test \(316\)](#) with score of 220 or higher
- Other equivalent state or national exams that meet competencies and approved by USBE

Requirement Area 9: Organisms Content Knowledge ([B1.1.C-D](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Zoology (e.g., General Zoology, Vertebrates, Herpetology, Entomology), Botany (e.g., General Botany, Field Botany, Mycology, Algology), or a General Biology II course
 - Lab course is not required but recommended

College Major or Minor (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 10: Ecosystems Content Knowledge (B1.2)

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Ecology (e.g., General Ecology, Field Ecology, Marine Ecology, Stream Ecology, Wildlife Biology)
 - o Lab course is not required but recommended
 - o A course in Environmental Science does not meet this requirement

College Major or Minor (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 11: Heredity Content Knowledge (B1.3)

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Genetics (e.g., Genetics, Animal Genetics/Breeding, Plant Genetics/Breeding)
 - o Lab course is not required but recommended

College Major or Minor (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 12: Biological Evolution Content Knowledge (B1.4)

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Evolutionary Biology (e.g., Evolutionary Biology, Evolution and Diversity, Evolution and Ecology, Natural Selection)
 - o Lab course is not required but recommended
 - o Evolution and Ecology Course can only meet requirements for one requirement area

College Major or Minor (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Content Knowledge Exam (Meets Requirement Areas 8-12 for the Biology 1 endorsement)

- As described in Requirement Area 8 description

Requirement Area 13: Advanced Data Analysis Content Knowledge (B2.1)

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Any 3+ credit university course (passed with a grade of C or higher) in Statistics (e.g., General Statistics, Applied Statistics, Probability and Statistics, Statistics for Scientists)

College Major (Meets Requirement Areas 13-14 for the Biology 2 endorsement)

- College Major in Biology, Biology Education, or a Biology Variation (e.g., Microbiology, Ecology, Wildlife Biology, Physiology, Genetics, Evolutionary Biology)

- Other College Majors may be approved for this endorsement with approval of USBE Science Specialist based on a transcript review

Teaching Experience and Professional Learning (Meets Requirement Areas 13-14 for the Biology 2 endorsement)

- Teach either AP Biology or IB Biology for 3 years.
- Attend the relevant Professional Learning for the course being taught.
 - AP Summer Institute for AP Biology.
 - Diploma Program Biology Workshop for IB Biology.
- Apply principles acquired in professional learning into teaching for 2 years.

Requirement Area 14: Advanced Life Science Content Knowledge ([B2.2](#))

Complete one of the following options to show evidence of competency in this Requirement Area

University Courses

- Complete **TWO** 3+ credit university courses (passed with a grade of C or higher) in any two of the following Advanced/Applied Life Science in addition to the courses taken to meet Biology 1 Endorsement requirements (if applicable).
 - Cell Biology or Microbiology
 - Anatomy and/or Physiology
 - Biotechnology
 - Wildlife Biology, or an additional course focused in advanced Zoology/Botany
 - Other upper division (3000+) biology course

College Major (Meets Requirement Areas 13-14 for this endorsement)

- As described in Requirement Area 13 description

Teaching Experience and Professional Learning (Meets Requirement Areas 13-14 for this endorsement)

- As described in Requirement Area 13 description

Requirement Area Competencies

The Secondary Biology 1 competencies are organized into 1 section:

- Biology 1 Core Ideas** – The Utah Secondary Biology 1 qualifies teachers to teach the core High School (9-12) General Biology course focused specifically in the High School Life Science disciplinary core ideas:

B1.1 From Molecules to Organisms

B1.2 Ecosystems: Interactions, Energy, and Dynamics

B1.3 Heredity: Inheritance and Variation of Traits

B1.4 Biological Evolution: Unity and Diversity

The Secondary Biology 2 competencies are organized into 1 section:

- Biology 2 Core Ideas** – This endorsement is required to teach Advanced Biology (AP, CE, and IB) and high school life science elective courses. These competencies and requirements go above that of the core ideas found in the SEEd Biology Standards.

B2.1 Advanced Data Analysis

B2.2 Advanced Life Science Content Knowledge

Each of the requirement area competencies are described below. Quick links to each requirement area options are provided in the parentheses.

Requirement Area 8 - Biological Molecules Content Knowledge ([Options](#))

B1.1: From Molecules to Organisms

B1.1.A: Structure and Function

- B1.1.A.a Systems of specialized cells within organisms help them perform the essential functions of life, which involve chemical reactions that take place between different types of molecules, such as water, proteins, carbohydrates, lipids, and nucleic acids.
- B1.1.A.b All cells contain DNA
- B1.1.A.c Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level

B1.1.B: Organization for matter and energy flow in organisms

- B1.1.B.a In plants, matter is obtained and converted into energy through the process of photosynthesis. This process results in sugars used for plant growth and the release of oxygen.
- B1.1.B.b These sugar molecules are used to make amino acids and other carbon based molecules.
- B1.1.B.c As matter and energy flow through living systems, chemical elements are recombined to form different products. From these chemical reactions (i.e., aerobic and anaerobic) cellular respiration), energy is transferred.
- B1.1.B.d Matter and energy are conserved in each transfer and this is true of all biological systems, from individual cells to ecosystems.

Requirement Area 9 - Organisms Content Knowledge ([Options](#))

B1.1: From Molecules to Organisms

B1.1.C: Growth and Development of Organisms

- B1.1.C.a In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow.
- B1.1.C.b Organisms begin as a single cell that divides successively to produce many cells, with each parent cell passing identical genetic material to both daughter cells
- B1.1.C.c With each subdivision the process of differentiation occurs which produces and maintains the complexity of organisms.
- B1.1.C.d In sexual reproduction meiosis occurs resulting in the production of gametes, which contain one member from each chromosome pair in the parent cell.

B1.1.D: Information Processing

- B1.1.D.a In complex organisms, the brain has distinct regions responsible for different dedicated functions.
- B1.1.D.b Additionally, some circuits give rise to emotions and memories that motivate organisms to seek or avoid particular interactions with members of their own species and, in some cases, to individuals of other species.
- B1.1.D.c The integrated functioning of all parts of the brain is important for successful interpretation of inputs and generation of behaviors in response to them.

Requirement Area 10 - Ecosystems Content Knowledge ([Options](#))

B1.2: Ecosystems: Interactions, Energy, and Dynamics

B1.2.A: Interdependent Relationships in Ecosystems

- B1.2.A.a Ecosystems have carrying capacities, which are limits to the number of organisms and populations they can support based on the resources of the ecosystem.

B1.2.B: Cycles of Matter and Energy Transfer in Ecosystems

- B1.2.B.a Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- B1.2.B.b At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy. Given this inefficiency, there is a limit to the number of organisms that an ecosystem can sustain.
- B1.2.B.c At each link in an ecosystem matter and energy are conserved.
- B1.2.B.d Photosynthesis and cellular respiration are important components of the carbon cycle.

B1.2.C: Ecosystem Dynamics, Functioning, and Resilience

- B1.2.C.a A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.
- B1.2.C.b Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.

B1.2.D: Social Interactions and Group Behavior

- B1.2.D.a Animals, including humans, having a strong social affiliation with members of their own species will suffer, behaviorally as well as physiologically, if reared in isolation.
- B1.2.D.b Group behavior evolves to increase the chances of survival for individuals and their genetic relatives

Requirement Area 11 - Heredity Content Knowledge ([Options](#))

B1.3: Heredity: Inheritance and Variation of Traits

B1.3.A: Inheritance of Traits

- B1.3.A.a In all organisms the genetic instructions for forming species' characteristics are carried in DNA.
- B1.3.A.b All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.
- B1.3.A.c Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.

B1.3.B: Variation of Traits

- B1.3.B.a The information passed from parents to offspring is coded in the DNA molecules that form the chromosomes.
- B1.3.B.b In sexual reproduction, through meiosis cell division) chromosomes can create new genetic combinations and thus more genetic variation.
- B1.3.B.c Although DNA replication is regulated, errors do occur and result in mutations. Environmental factors can also cause mutations in genes and affect expression of traits, thus the variation and distribution of traits observed depend on both genetic and environmental factors.

Requirement Area 12 - Biological Evolution Content Knowledge ([Options](#))

B1.4: Biological Evolution: Unity and Diversity

B1.4.A: Evidence of Common Ancestry and Diversity

- B1.4.A.a Genetic information, like the fossil record, also provides evidence of evolution.
- B1.4.A.b For example, multiple lines of descent can be inferred by comparing the DNA sequences of different organisms.
- B1.4.A.c Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.

B1.4.B: Natural Selection

- B1.4.B.a Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information
- B1.4.B.b Traits that positively affect survival are more likely to be reproduced and thus are more common in the population.

B1.4.C: Adaptation

- B1.4.C.a Natural selection leads to adaptation and is the result of four factors:
 - the potential for a species to increase in number,
 - the genetic variation of individuals in a species due to mutation and sexual reproduction,
 - competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and
 - the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.
- B1.4.C.b Adaptation also means that the distribution of traits in a population can change when conditions change. These changes can result in expansion of some species, the emergence of new distinct species, or the decline of some species.
- B1.4.C.c Species become extinct because they can no longer survive and reproduce in their altered environment.

B1.4.D: Biodiversity and Humans

- B1.4.D.a Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- B1.4.D.b Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity can also adversely affect biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change.
- B1.4.D.c Sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.

Requirement Area 13 - Advanced Data Analysis Content Knowledge ([Options](#))**B2.1: Advanced Data Analysis****B2.1.A: Representing and Describing Data**

- B2.1.A.a Construct a graph, plot, or chart (X,Y; Log Y; Bar; Histogram; Line, Dual Y; Box and Whisker; Pie) showing correct: a) Orientation, b) Labeling, c) Units, d) Scaling, e) Plotting, f) Type, g) Trend line
- B2.1.A.b Describe data from a table or graph, including: a) Identifying specific data points, b) Describing trends and/or patterns in the data, c) Describing relationships between variables

B2.1.B: Statistical Tests and Data Analysis

- B2.1.B.a Perform mathematical calculations, including: a) Mathematical equations, b) Means, c) rates, d) ratios, e) percentages.
- B2.1.B.b Use confidence intervals and/or error bars (both determined using standard errors) to determine whether sample means are statistically different.
- B2.1.B.c Perform chi-square hypothesis testing
- B2.1.B.d Use data to evaluate a hypothesis (or prediction), including a) Rejecting or failing to reject the null hypothesis, b) Supporting or refuting the alternative hypothesis.

Requirement Area 14 - Advanced Life Science Content Knowledge (Options)**B2.2: Advanced Life Science Content Knowledge****B2.2.A: Molecules to Organisms**

- B2.2.A.a Properties of water that result from its polarity and hydrogen bonding affect its biological function.
- B2.2.A.b Structure (composition and properties) and function (processes and mechanisms) of macromolecules required by living organisms
- B2.2.A.c Mechanisms by which genetic information is copied for transmission between generations and mechanisms by which genetic information flows from DNA to RNA to protein.
- B2.2.A.d How the binding of transcription factors to promoter regions affects gene expression and/or the phenotype of the organism.
- B2.2.A.e Connection between the regulation of gene expression and phenotypic differences in cells and organisms.
- B2.2.A.f Structure and function of subcellular components and organelles and how they contribute to cell function including a) how they capture, store, and use energy, b) exchange molecules within the cell and with the cell's environment
- B2.2.A.g Structure of biological membranes and how they influence selective permeability including a) mechanisms that organisms use to maintain solute and water balance, b) mechanisms that organisms use to transport large molecules across the plasma membrane, c) how the structure of a molecule affects its ability to pass through the plasma membrane.
- B2.2.A.h Properties and Role of Enzymes in life function
- B2.2.A.i Role of Energy in living organisms including: a) photosynthetic processes, b) using energy stored in biological macromolecules
- B2.2.A.j Ways that cells can communicate with one another and sense/respond their environment including feedback mechanisms to maintain homeostasis
- B2.2.A.k Regulation and checkpoints in the Cell cycle

B2.2.B: Heredity

- B2.2.B.a How the process of meiosis generates genetic diversity.
- B2.2.B.b Deviations from Mendel's model of the inheritance of traits.
- B2.2.B.c How the same genotype can result in multiple phenotypes under different environmental conditions.
- B2.2.B.d Types of interactions that regulate gene expression and how the location of regulatory sequences relates to their function
- B2.2.B.e How alterations in DNA sequences contribute to variation that can be subject to natural selection.
- B2.2.B.f The use of genetic engineering techniques in analyzing or manipulating DNA.

