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# Conversion Immersion, Version 3.0: Working Together to Create Investigative Labs

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In this workshop, participants worked together to generate ideas for modifying their chosen traditional ("cookbook") labs to a more investigative format. We divided the attendees into small groups and assigned each group one or two related labs to convert. Participants spent about one-quarter of the time learning a framework for conversion and seeing examples of pre- and post-conversion labs; half of the workshop working in their groups, brainstorming and summarizing their ideas for making the labs more investigative; then the remaining one-quarter of the time reporting their ideas to the rest of the workshop participants. The outcomes of this workshop were twofold: Improved labs that participants could use at their institutions, and individuals who are practiced at converting labs, so that they are more comfortable converting any other cookbook labs they are using. This paper summarizes some of the ideas generated in the workshop, which included labs on the following topics: mitosis; plant structure and function; single-celled organisms; compound action potentials; invertebrate dissection; scientific method; island biogeography and conservation; diversity of seedless plants and plant-water relations; animal diversity (sponges, cnidarians, and flatworms); and osmosis and dialysis tubing.

**Keywords**: investigative labs, college science learning cycle, mitosis, plant structure, action potential, island biogeography, invertebrate dissection, scientific method, biodiversity, osmosis

## Introduction

Experience reveals that we engage most deeply in our own learning when the topic interests us, often because of a personal connection, a sense of challenge to understand, active learning, a desire to work collaboratively with others on the topic, or some other reason. Student-centered learning includes strategies to engage students more extensively to improve their learning (e.g., Connell, Donovan, and Chambers, 2015) and is one of the core strategies to implement Vision and Change in Undergraduate Biology Education (2011). Another core strategy endorsed by the Vision and Change report is to collaborate with other biology educators in updating curricula and biology activities.

Now in its third iteration (Hoefnagels and Walvoord, 2005; 2008), our Conversion Immersion workshops provide a forum for instructors to work together to generate ideas for modifying specific, cookbook labs to a more investigative format. That is, we seek to help instructors transform passive-learning labs into revised formats that are student-centered, are interesting, and focus on hypothesis-testing, with the overall goal of better engaging students and helping them learn the biological concepts.

For this workshop, presented at the annual ABLE conference in 2017, we chose to use the College Science Learning Cycle as a framework for converting the labs (Withers, 2016). This cycle includes stating learning outcomes, designing assessments, developing learning activities, and checking alignment with the desired outcomes. The learning activities portion of the cycle includes identifying ways to engage the students, constructing ways for them to practice with tasks that support the learning outcomes, and evaluating their progress along the way.

This paper describes the implementation of the College Science Learning Cycle with workshop participants' labs, and it summarizes the ideas that emerged for lab activity conversions.

## Workshop Methods

Fourteen workshop participants submitted 13 cookbook labs to us several days before the workshop through an online form. This form requested information about the lab topic(s), course name, timing of the lab, level of student, and an explanation of why the lab needed converting (Appendix A). The latter question served as a prompt to encourage participant reflection and goal-making prior to the workshop.

We organized the labs into groups of related activities prior to the workshop. On the day of the workshop, we used the first 30 minutes to explain the day's goals, show two examples of converted labs (Huber and Moore, 2001; Migabo and Guinan, 2007), and describe the College Science Learning Cycle. We then divided the participants into pairs and assigned each group a set of labs. The participants spent about 1.5 hours working in their groups, brainstorming and summarizing their ideas for making the labs more investigative. To help guide the groups through the cycle, they filled out online worksheets (Appendix B).

Each group reported its ideas to the rest of the workshop participants for feedback and further ideas during the last 30 minutes. The summaries listed here represent a compilation of notes we made during the oral presentations and written notes that each group submitted.

## Results of Workshop Sessions

### *1. Mitosis*

Original Objectives and Procedure

The objectives of the lab are to review the cell cycle; recognize the mitotic stages in onion root tips; and compare and contrast the events of mitosis and meiosis. Students tally the frequency of mitotic phases in an onion root tip and sketch representative cells in each phase. They then complete a table that compares and contrasts mitosis, meiosis I, and meiosis II, and they answer follow up questions.

Suggested Revisions

In addition to those summarized above, participants added another objective: Design an experiment to evaluate the effect of environmental factors on cell division events in the bread yeast, *Saccharomyces cerevisiae*. This species is a stand-in for the human pathogen, *Candida albicans*.

Students will work in groups to choose a factor they think might affect the yeast reproduction rate, then develop a hypothesis and design an appropriate experiment. After incubation, students will count the number of budding cells (indicating active mitosis) and graph their results. Each team will present their work, including a brief introduction, rationale, methods, results (expected and observed), and conclusions.

### *2. Plant Structure and Function*

Original Objectives and Procedure

The objectives of the lab are to review the functional anatomy of vegetative organs (roots, stems, and leaves); compare monocots and dicots; recognize how natural selection modifies plant structures; identify trees by using a leaf key; and create a leaf skeleton. Students answer questions as they observe the parts of living plants, make thin sections of plants from varying habitats, observe prepared slides, use a key to identify common trees, use lye to create leaf skeletons, and identify the anatomical parts of vegetables from the supermarket (Levetin, McMahon, and Reinsvold, 2002).

Suggested Revisions

The objectives were revised to incorporate action verbs:

- Explain how the functions of roots, stems, and leaves relate to their morphology.
- Describe anatomical differences between the vegetative organs of monocots and dicots.
- Match structural adaptations in roots, stems, and leaves to specific environments.
- Prepare useable cross sections of roots, stems and leaves.

To engage students in the lab, instructors will ask them to brainstorm as many functions as possible for roots, stems, and leaves; think about how those plant functions relate to those of the human body; consider how structures in our bodies carry out those functions; and predict the anatomical features of the corresponding structures in plants.

Students will then be given an assortment of roots, stems, and leaves from multiple species. They will sort the organs into groups (monocots and dicots) based on previously discussed criteria, then prepare cross sections of sample from each group and determine whether their predictions were supported by the characteristics of their cross sections.

### *3. Single-Celled Organisms*

Original Objectives and Procedure

The objectives of the lab are to describe the morphology, energy-harvesting, and reproductive capabilities of bacteria; identify cyanobacteria; and describe the types of symbioses. Students examine live cultures and prepared slides, then answer questions about morphological features and their adaptive significance. They also observe and answer questions about the *Azolla-Anabaena* mutualism, *Paramecium*, and *Giardia*.

Suggested Revisions

The revised lab's objectives are to design an experiment that focuses on the impact of environmental variables on single-celled organisms' growth or behavior and to explain how environmental variables can affect growth/energy production in a single celled organism.

To engage students, instructors will invite them to focus on environmental factors that might influence the growth rate of single-celled organisms. Students will then design an experiment to determine how an external factor (temperature, sugar type, sugar amount, etc.) affects the growth rate (as measured by spectrophotometer) and $CO_2$ uptake of cyanobacteria. At the end of the experiment, they will graph and analyze their data, write a report, and make a presentation.

### *4. Compound Action Potential*

#### Original Objectives and Procedure

The objectives of the lab are to use the PowerLab Data Acquisition system and Scope analysis software to obtain extracellular recordings of compound action potentials (CAP) as they propagate along a nerve. Half the groups use the northern leopard frog (*Lithobates pipiens*) and the other groups use the African clawed frog (*Xenopus laevis*). After dissecting the frog, students use the exposed nerve to determine threshold voltage, maximum CAP amplitude, CAP velocity, refractory period, rheobase, and chronaxie. Students then write a report in which they present and explain their results and propose a follow-up experiment.

#### Suggested Revisions

The revised lab incorporates the following learning outcomes:

- Generate a properly formatted graph showing the relationship between CAP amplitude and stimulus intensity data for two frog species.
- Interpret the relationship between CAP amplitude and stimulus intensity data from the above graph.
- Compare the results of the above graph to the properties of a single action potential.
- Measure the conduction velocity for two frog species.
- Generate a properly formatted graph showing the relationship between the amplitude of the second CAP and stimulus interval data for two frog species.
- Interpret the relative and absolute refractory periods from graph above.
- Use correct terminology and scientific format to communicate results from this lab.
- Design an experiment to test hypotheses about environmental effects on the neurophysiology of the compound nerve.

To make it more investigative, one possibility would be for students to explore how nerve function varies with environmental conditions, especially temperature. (Students may suggest changing other parameters including pH or the composition of the Ringer's solution. However, these may likely have little effect and may be challenging to do without advance notice to prepare the media.) Students could also flip the nerve and/or stimulate the middle of the nerve and test whether the nerve can propagate action potentials in both directions.

### *5. Invertebrate Dissections*

Original objectives and procedure: The objectives of the original lab are not explicitly stated. Students dissect earthworms, squids, and crayfish; as they do so, they draw diagrams and answer questions. They also examine and sketch specimens and models of chitons, gastropods, and bivalves.

#### Suggested Revisions

The objectives of the revised lab are to compare and contrast various invertebrate species; describe their organ systems; discuss physiological differences; identify the evolutionary process that led to differences between the species; and communicate the findings.

To engage students, instructors would introduce external and internal anatomy and ask students questions about their previous knowledge. Students would then choose an organ system, develop questions about it, and compare/contrast multiple species by dissecting animals, describing what they see, and measuring organs. They would also do out-of-class research on the evolutionary forces shaping each organ system.

Assessments include a post-lab quiz and oral presentations of methods, results, and conclusions.

### *6. Scientific Method*

#### Original Objectives and Procedure

The objectives of the original lab are not explicitly stated. Students view the "Buttered Toast" episode of *Mythbusters* and investigate the claim that toast always falls butter-side down. They then answer a series of questions about the experiments in the episode and write a lab report about the final experiment.

#### Suggested Revisions

The objectives of the revised lab are to use the scientific method to develop a testable hypothesis; identify qualitative versus quantitative observations; identify variables and explain the difference between the independent variable, dependent variable, and control; use basic statistical methods to evaluate results; and justify conclusions based on evidence.

To support these objectives, students will conduct tests to determine which brand of paper towel absorbs the most liquid. Students will brainstorm ideas for testing how much water various brands of paper towels absorb. They will develop a testable hypothesis, identify variables, and identify methods to quantify the amount of water absorbed. Class data will be pooled and a very basic statistical analysis will be done, along with a discussion of the best way to present the data. Students will then create a written report, using evidence obtained to support their conclusions.

*7. Island Biogeography and Conservation*

Original Objectives and Procedure

The objectives of the lab are to learn the basic principles of the theory of island biogeography; apply these basic principles to real data on the flora and fauna of the Lake Erie archipelago and on the distribution of forest frogs in the central Amazon basin of Brazil; graph data on log-log graph paper to compare island size to number of species present; learn and define the following terms: biogeography, taxon, archipelago, dispersal mode, autecology, competitive exclusion.

For the Lake Erie islands, students are provided with a table listing the islands, size (in acres), number of vascular plant species, and number of spider species. They graph the data and draw a best fit line for plants and spiders. They determine which islands diverge from the line and try to account for the deviations, then answer questions about the graphs. For the Amazon frogs, students graph the relationship between forest reserve area and species number, then answer additional questions.

Suggested Revisions

The objectives of the revised labs are listed here:

- Design a protocol to test island biogeography theory and collect the data.
- Be able to determine species richness based on island area and distance.
- Apply these relationships to student-defined islands.
- Graph data on log-log graph paper to compare island size to number of species present.
- In the context of the student study, explain the following concepts and how they relate to the theory of island biogeography: species richness, equilibrium, dispersal mode, species area curves, taxon.

To support these objectives, instructors would start by assigning background readings and a video about island biogeography. They would then assign a small introductory activity using a preexisting dataset and ask students how they might test the theory of island biogeography on campus or in lab. Next, students would collect data using their own protocol, calculate species richness for each island, and construct graphs from the data to test the relationship between area and species richness.

Students could also be provided with an existing dataset that includes information on island size, species richness of different taxa, distance from migration sources. Groups could discuss their own experimental questions, develop hypotheses, define their variables, use the dataset to test the hypothesis, and present their findings to their colleagues.

*8. Diversity of Seedless Plants; Plant Water Relations*

Original Objectives and Procedure

The objectives of the lab are (1) to become familiar with the dominance of the gametophyte in the mosses and the dominance of the sporophyte in the club mosses and ferns, and to gain some appreciation of the diversity in these groups; and (2) to investigate water relations in vascular plants through measurement of water loss via transpiration, and by examination of stomata (McGonigle).

Students sketch and measure moss plants and fern gametophytes, and they identify sporophytes of club mosses, spike mosses, quillworts, horsetails, whisk ferns, and ferns. They then use a potometer to measure water loss from bean seedlings while varying wind, sun intensity, and humidity. They also examine geranium leaf cross sections to view stomata.

Suggested Revisions

The revised objectives are to identify different plant taxa and to compare life cycles and other defining traits. To support these objectives, students would work together to observe plant samples from different taxa and describe each plant's characteristics (color, shape, texture, size). They would try to assign a function to each structure based on morphology, then share their findings with the class to come up with the defining characteristics of each taxon. In addition, students could be given a set of environmental constraints and asked to design a theoretical plant that would be successful in this environment.

*9. Animal Diversity: Sponges, Cnidarians, and Flatworms*

Original Objectives and Procedure

The objectives of the lab are to study the anatomy and life cycles of animals representing three basal phyla; compare organizational differences between animals with and without tissues; illustrate asymmetry, radial symmetry, and bilateral symmetry; and collect evidence that tests the hypothesis that animals in this lab cannot be arranged in a sequence of increasing complexity (Dolphin and Vleck, 2015).

Students observe whole specimens and slides of sponges, *Hydra, Gonionemus, Obelia,* planaria, flukes, tapeworms. They answer questions as they go along and summarize their observations in a table.

Suggested Revisions

The revised objectives are listed below:

- Define *biodiversity* and *species* in your own words.
- Compare and contrast structures for feeding/digestion, locomotion, and gas exchange, and determine how these structures relate to both classification and habitat (particularly aquatic/terrestrial).
- Identify the factors/adaptations that influence evolutionary success (or failure) and that can lead to speciation/diversity.
- Develop phylogenetic relationships based on observable physical characteristics and DNA sequences.
- Evaluate the biodiversity of a clade and compare to other clades.

To support these objectives, students will track changes in the definition of *biodiversity* over time; compare and contrast phylogenetic trees for the same groups; and design experiments to test habitat preferences based on feeding, locomotion, and gas exchange.

*10. Osmosis and Dialysis Tubing*

Original Objectives and Procedure

The participant who worked on this lab did not provide the original list of objectives or the protocol.

Suggested Revisions

The objectives of the revised lab are to demonstrate an understanding of the concept of diffusion; explain how concentration affects diffusion rate across a membrane; and explain how temperature affects diffusion rate across a membrane.

To spark interest, the instructor would begin with a case study relating to kidneys, an IV solution, medication, etc. The TA would then demonstrate osmosis by showing what happens to bovine blood cells in salt water, an isotonic solution, and distilled water. Students would then design and carry out their own experiments by varying concentrations and/or temperatures, graph their diffusion rate data, and interpret their results.

## Conclusions

For this iteration of our workshop, we had fewer participants than in past sessions, which limited us to two individuals per group. Previously, we usually formed groups of three people working together, giving more opportunity for idea generation and discourse about the efficacy of lab setups. Participants commented verbally and in our workshop assessments about group size, so we encourage groups of three or more instructors to work on conversions when using the provided resources (Appendix B).

Conversions for this workshop centered on editing learning objectives to include action verbs and, sometimes, to targeting broader concepts instead of detailed biology knowledge. Converted activities focused on hypothesis-testing, experimental design practice, use of a case study, communicating scientific findings, on solving a puzzle or using creativity to suggest a solution to a problem. All labs exercises appear to have been improved by this conversion process, but participants indicated that they needed additional time to plan more details of the new labs before implementation.

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## About the Authors

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Mariëlle H. Hoefnagels is a professor in the departments of Biology and Microbiology/Plant Biology at the University of Oklahoma, where she teaches nonmajors biology, science writing, and mycology. She is also the author of two university-level biology textbooks: *Biology: Concepts and Investigations* and *Biology: The Essentials*, both published by McGraw-Hill. Mariëlle serves as the assistant treasurer for the Association for Biology Laboratory Education. She received her Ph.D. in Botany and Plant Pathology at Oregon State University, her M.S. in Soil Science at North Carolina State University, and her B.S. in Environmental Science at the University of California, Riverside.

# Appendix A
# ABLE Conversion Immersion 3.0 Pre-Survey

This form allows ABLE 2017 attendees of the *Conversion Immersion 3.0* major workshop to submit information about the biology laboratory exercise they would like to convert from a "cookbook" format to a more active inquiry format. Information submitted here will be used to form working groups during the session.

Contact Information:

Name (Last, First):

City, State, Country:

Name of Institution:

What is the title, and a one-sentence description, of the lab exercise you are submitting?

How much time do you allocate to this lab (number of lab periods and number of hours per lab session)?

What is the name of the course in which you use (or will use) this exercise?

Describe the students in this class

___ Non-Biology majors

___ Biology majors

___ Mixed majors

For what level of student is this lab being (or will this lab be) used? Check all that apply.

| | |
|---|---|
| ___ Freshmen | ___ Seniors |
| ___ Sophomores | ___ Graduate Students |
| ___Juniors | ___ Others |

Why do you think this lab needs converting?

Please upload your lab as a single PDF file.

# Appendix B
# ABLE 2017 – University of Wisconsin – Conversion Immersion 3.0 Info Sheet

Mark Walvoord and Mariëlle Hoefnagels, presenters

Please type your responses in this Word template named with the Lab Submitter's last name, and save it **frequently** to our dropbox (AM or PM folder as appropriate). If you are working on more than one lab, please use a separate Word template for each lab.

WHAT ARE WE DOING TODAY?

Working together in your group, describe your ideas for specific activities that support one or more skills that are consistent with the investigative approach. If your group figures out a way to revamp one (or more!) whole labs, you are truly awesome. But a more realistic goal is to generate ideas for how to apply one or more investigative approaches to all of your group's labs. Don't worry if you don't develop a complete lab. Even one well-developed idea could become an enormously useful element in an otherwise cookbook lab. So, brainstorm and collaborate!

The framework we are using comes from Withers (2016). Figure 1 from that paper, which describes the College Science Learning Science, is copied at right.

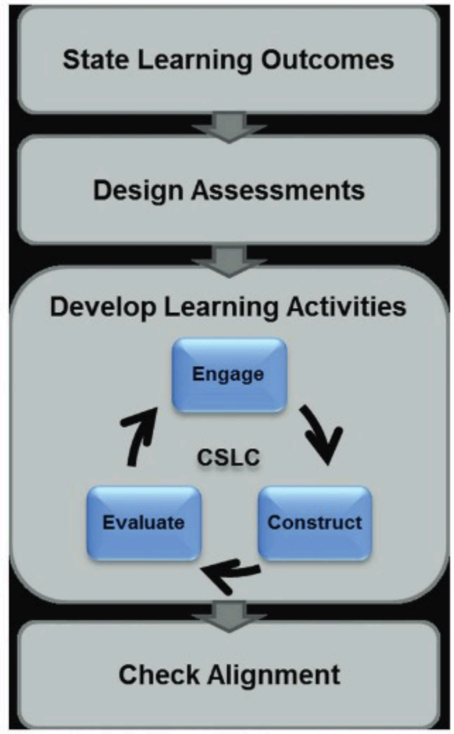


FIGURE 1. The CSLC embedded in backward design. The gray boxes and arrows represent the stages of backward design. The blue boxes and black arrows represent the stages of the CSLC embedded in the "develop learning activities" stage of backward design.

I. ASSIGN GROUP MEMBERS TO THE FOLLOWING ROLES AND PUT THEIR NAMES HERE:

- Discussion leader (someone who's good at making sure everyone gives input while also keeping the discussion on-topic):
  *[Type name of discussion leader here]*
- Scribe (someone who's good at taking notes that other people can understand):
  *[Type name of scribe here]*
- Clock watcher (someone who's good at paying attention to time):
  *[Type name of clock watcher here]*
- Name(s) of additional group member(s):
  *[Type names of additional group members here]*

II. NAME AND/OR TOPIC OF LAB(S) YOUR GROUP IS WORKING ON – If you have more than one lab, you can use this form for all of them, or you make a form for each.

*[Type lab name or lab topic here]*

III. BACKGROUND OF STUDENTS –What population of students is likely to complete the lab (class levels, majors, etc.)? This information might be useful in question VI-A, when you set the context that will make the topic interesting or relevant.

*[Briefly describe students here]*

IV. LIST THE LEARNING OUTCOMES OF THE REVISED LAB – What should students know or be able to do by the end of the lab? If desired, organize in priority order from most to least important. Use **action verbs,** not wishy-washy ones. *[Estimated time: 15 minutes]*

*[Type list of learning outcomes here. If desired, consult the list of core concepts and competencies from the Vision and Change report at the end of this document.]*

V. FOR *EACH LEARNING OUTCOME,* DESIGN ONE OR MORE ASSESSMENTS THAT WILL REVEAL A STUDENT'S LEVEL OF MASTERY. How might a student prove that he or she has achieved the outcome? *[Estimated time: 15 minutes]*

*[Type list of assessments here. Make sure each learning outcome is represented by one or more assessments.]*

VI. DEVELOP LEARNING ACTIVITIES *[Estimated time for A-C + alignment: 75 minutes,* ***including break****]*
According to the College Science Learning Cycle, include these elements:

A. **Engage** interest and draw on prior knowledge with an open-ended question (e.g., "List all the known functions of…" or "What would you need to know to answer [question]?"), a task, a dilemma, a problem, clicker questions that reveal misconceptions, etc.
*[As your group brainstorms ways to engage students, type the ideas here.]*

B. **Construct** new knowledge by involvement in deliberate practice directly related to the learning outcomes, e.g. acquire content knowledge, practice critical-thinking and/or scientific process skills, etc.
*[As your group brainstorms activities that promote your learning outcomes, type the ideas here. See some suggestions for generating ideas on the next page.]*

**C.** **Evaluate** ability to apply new knowledge, understanding, or skills and relate them to the bigger picture (e.g., students create a new example, present their findings, make a concept map, write a lab report, etc.)
*[As your group brainstorms ways to evaluate student knowledge, type the ideas here.]*

CHECK ALIGNMENT *[Included in the 75 minutes allocated above]*. If you picture the ideal products of this lab, do they match with the learning outcomes stated in IV?

*[Type your thoughts here.]*

VII. REPORT OUT! SHARE YOUR IDEAS AND DISCUSS THEM WITH OTHERS – If the discussion with the other workshop participants leads to any last-minute revelations, please record them here. *[Estimated time: 45 minutes]*

*[Type new, last-minute ideas here.]*

AT THE END OF THE WORKSHOP, WHAT SHOULD YOU TURN IN?

Please be sure to save this document in the dropbox before you leave (retain the Lab Submitter's last name in the filename). We'll summarize the ideas and publish them in this meeting's *Proceedings*.

**Need help generating ideas?**

**Think of questions:** One way to generate ideas during for new learning activities is to challenge yourself to come up with as many questions about the topic as you can, then think of ways students might be able to answer them using scientific reasoning.

**Don't reinvent the wheel:** If a group member wants to use the internet to search for relevant inquiry activities that others have already developed, try these sources:

- ABLE Proceedings, http://www.ableweb.org/proceedings
- C.R.E.A.T.E., https://teachcreate.org/
- Science Education Resource Center, http://serc.carleton.edu/index.html
- Carl Wieman Science Education Initiative, http://www.cwsei.ubc.ca/index.html
- Pathways to Scientific Teaching, http://first2.plantbiology.msu.edu/resources/frontiers/scientific_teaching_first.html
- National Center for Case Study Teaching in Science, http://sciencecases.lib.buffalo.edu/cs
- CourseSource, http://www.coursesource.org
- Timely topics, http://SENCER.net

**Also, see information about Vision and Change on the next page.**

## Vision and Change

To help you focus on learning outcomes and assessment, consider the following excerpts from the influential Vision and Change report (AAAS, 2009). The report advises instructors to **integrate core concepts and competencies** throughout the curriculum. The following is a partial list of suggestions:

- Introduce the scientific process to students early, and integrate it into all undergraduate biology courses.
- Define learning goals so that they focus on teaching students the core concepts, and align assessments so that they assess the students' understanding of these concepts.
- Relate abstract concepts in biology to real-world examples on a regular basis, and make biology content relevant by presenting problems in a real-life context.

**Core Concepts:**
1. **Evolution:** The diversity of life evolved over time by processes of mutation, selection, and genetic change.
2. **Structure and function:** Basic units of structure define the function of all living things.
3. **Information flow, exchange, and storage:** The growth and behavior of organisms are activated through the expression of genetic information in context.
4. **Pathways and transformations of energy and matter:** Biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of thermodynamics.
5. **Systems:** Living systems are interconnected and interacting.

**Core Competencies:**
1. **Ability to apply the process of science.** Examples: Observational strategies, hypothesis testing, experimental design, evaluation of experimental evidence, developing problem-solving strategies.
2. **Ability to use quantitative reasoning.** Examples: Developing and interpreting graphs, applying statistical methods to diverse data, mathematical modeling, managing/analyzing large data sets.
3. **Ability to use modeling and simulation.** Examples: Computational modeling of dynamic systems, applying informatics tools, managing/analyzing large data sets, incorporating stochasticity into biological models.
4. **Ability to tap into the interdisciplinary nature of science.** Examples: Applying physical laws to biological dynamics, chemistry of molecules and biological systems, applying imaging technologies.
5. **Ability to communicate and collaborate with other disciplines.** Examples: Scientific writing, explaining scientific concepts to different audiences, team participation, collaborating across disciplines, cross-cultural awareness.
6. **Ability to understand the relationship between science and society.** Examples: Evaluating the relevance of social contexts to biological problems, developing biological applications to solve societal problems, evaluating ethical implications of biological research.

**Literature Cited:**

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## Mission, Review Process & Disclaimer



## Citing This Article

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