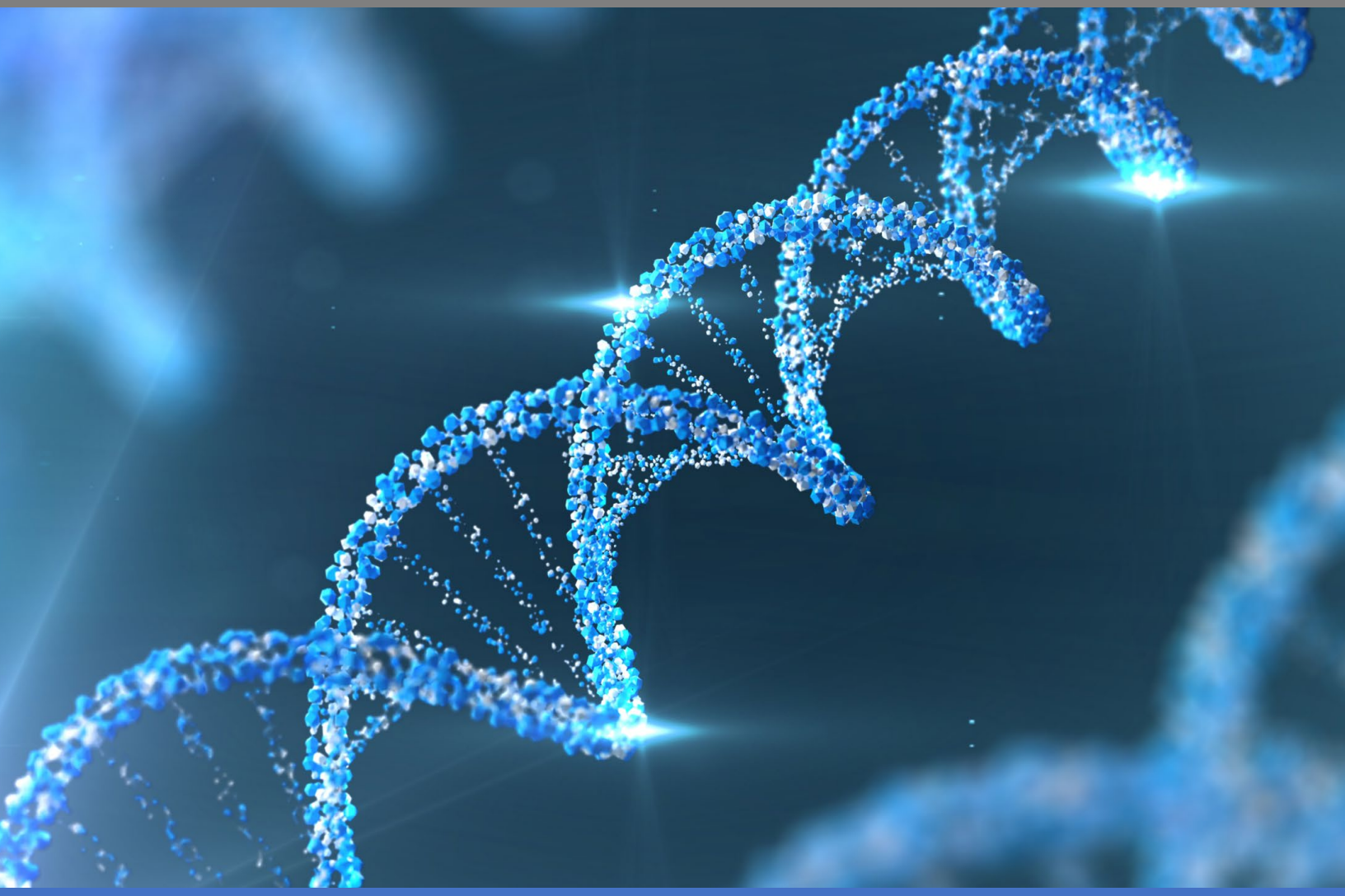
2021 | Mississippi



Teacher Resource Guide

Biology I

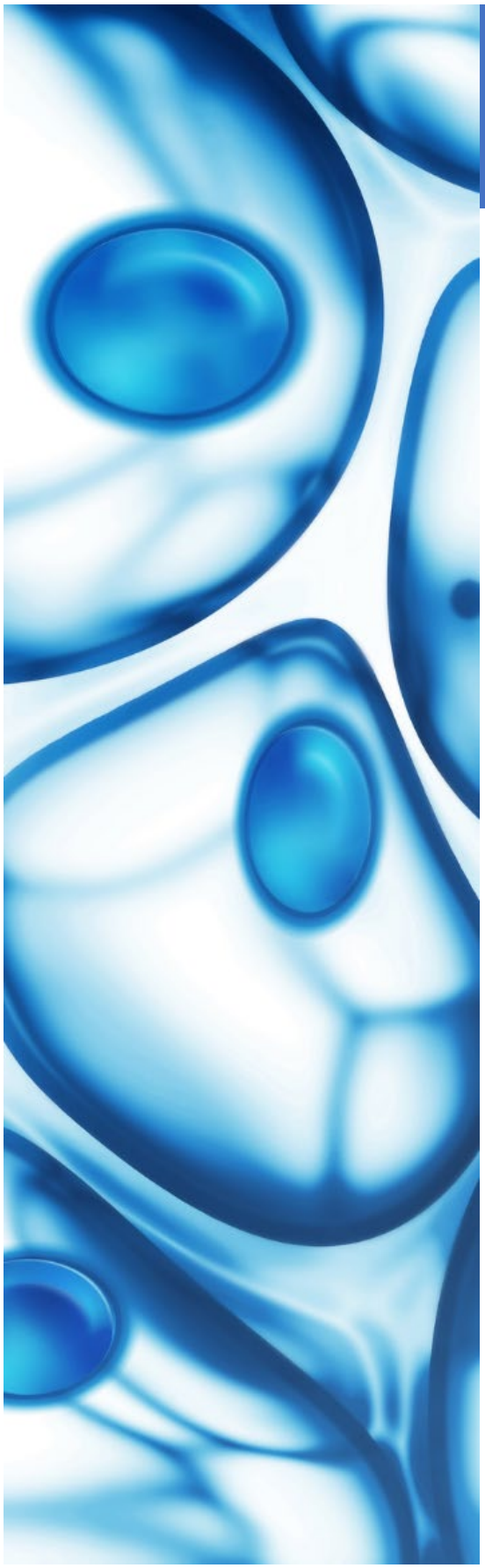
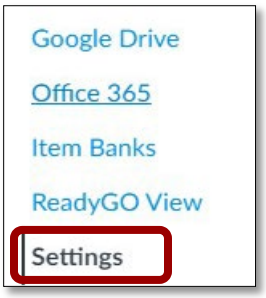


Table of Contents

Importing Course to your Canvas

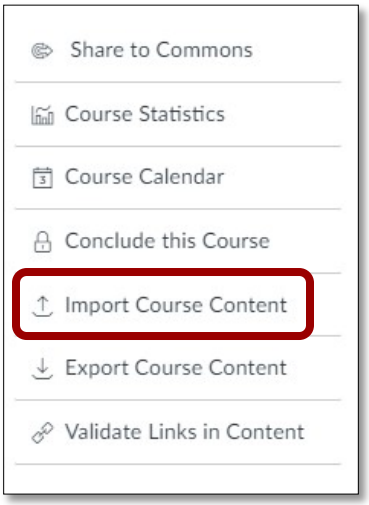
Open Settings

- In course navigation, click the **Settings link.**



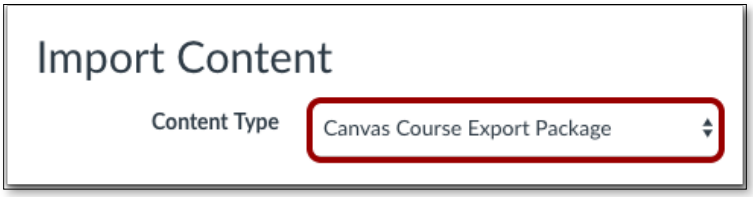
Import Content into Course

- Click the **Import Course Content** link in the top right corner of the Settings page.



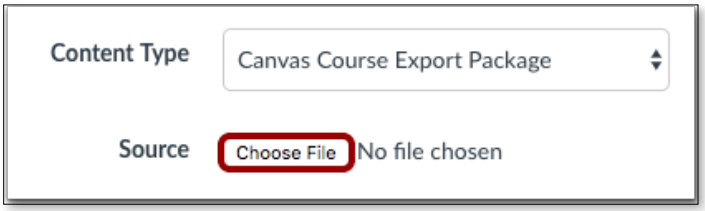
Select Content Type

- In the Content Type drop-down menu, choose the **Canvas Course Export Package** option.



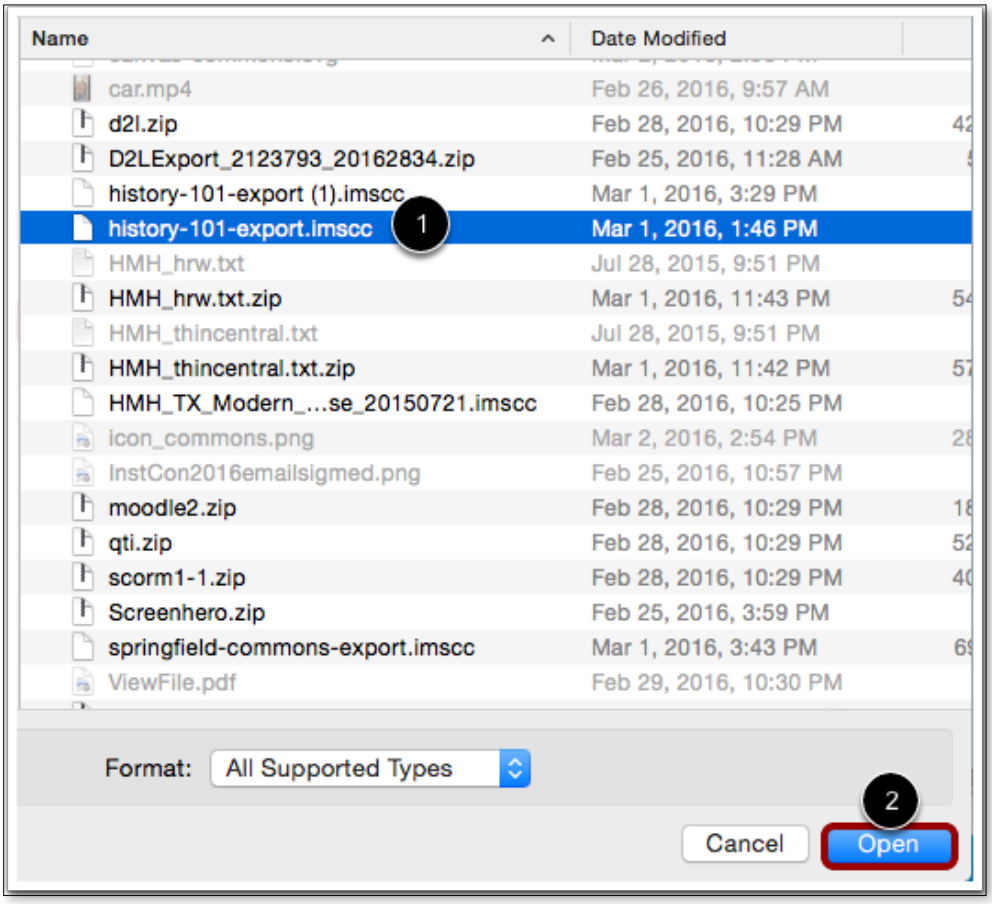
Choose File

- Click the **Choose File** button.



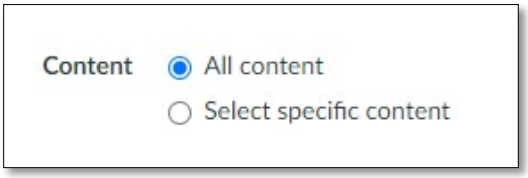
Open File

- Choose the .imscc file you want to import [1]. Click the **Open** button [2].



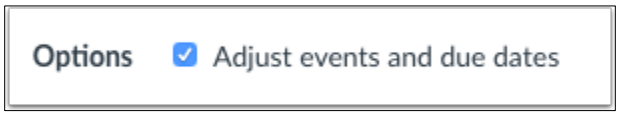
Select Migration Content

- To import ALL content from the course, select the **All Content** radio button.



Adjust Events and Due Dates

- If you want to adjust the due dates associated with the course events and assignments, click the **Adjust events and due dates** checkbox.

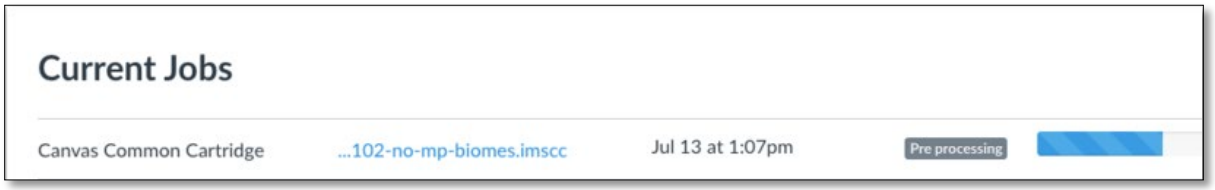


Import Course

- Click the Import button [1]. A progress indicator displays the upload status by percentage [2].

View Current Jobs

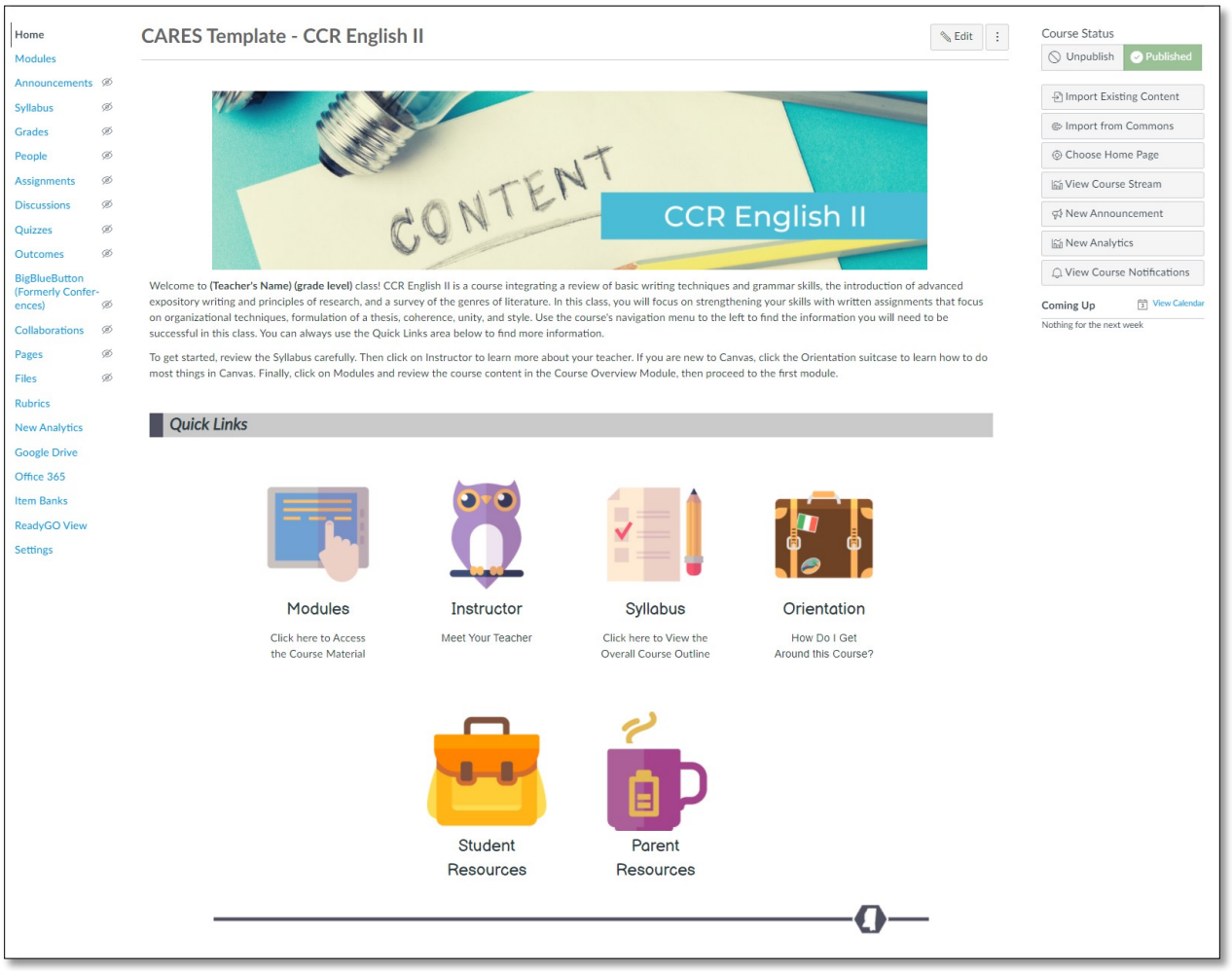
- The Current Jobs section displays the status of your import(s).
- View the content from any completed imports by accessing any link in the Course Navigation.



Course Home Screen

Home Screen Layout

- Teachers, students, and parents will see this screen when they enter the course.
- Each of the graphics under **Quick Links** automatically takes you to the important parts of the course.
- **TIP**: **Always let students know that they need to access the course through the Modules tab. This will help them see the layout and flow of the course in the way it was intended to be seen.**

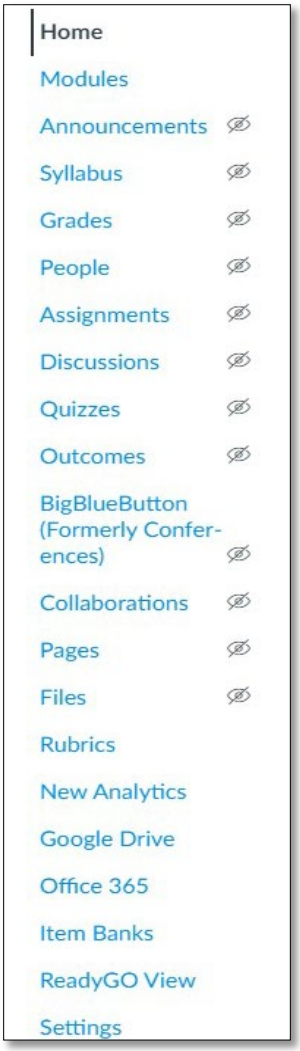


Course Navigation

There can be way too many links in this section for most students which can lead to confusion. You can easily simplify this menu for your students based on what your needs will be. If you choose to hide items from the navigation, you will not be deleting them from your course.

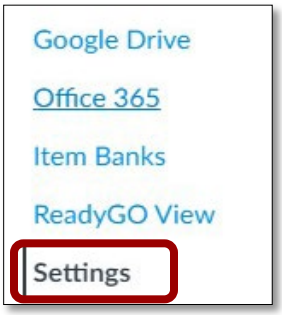
Course Navigation

- Here is an image of the course navigation.
  It will be found on the left side of your Home Page.



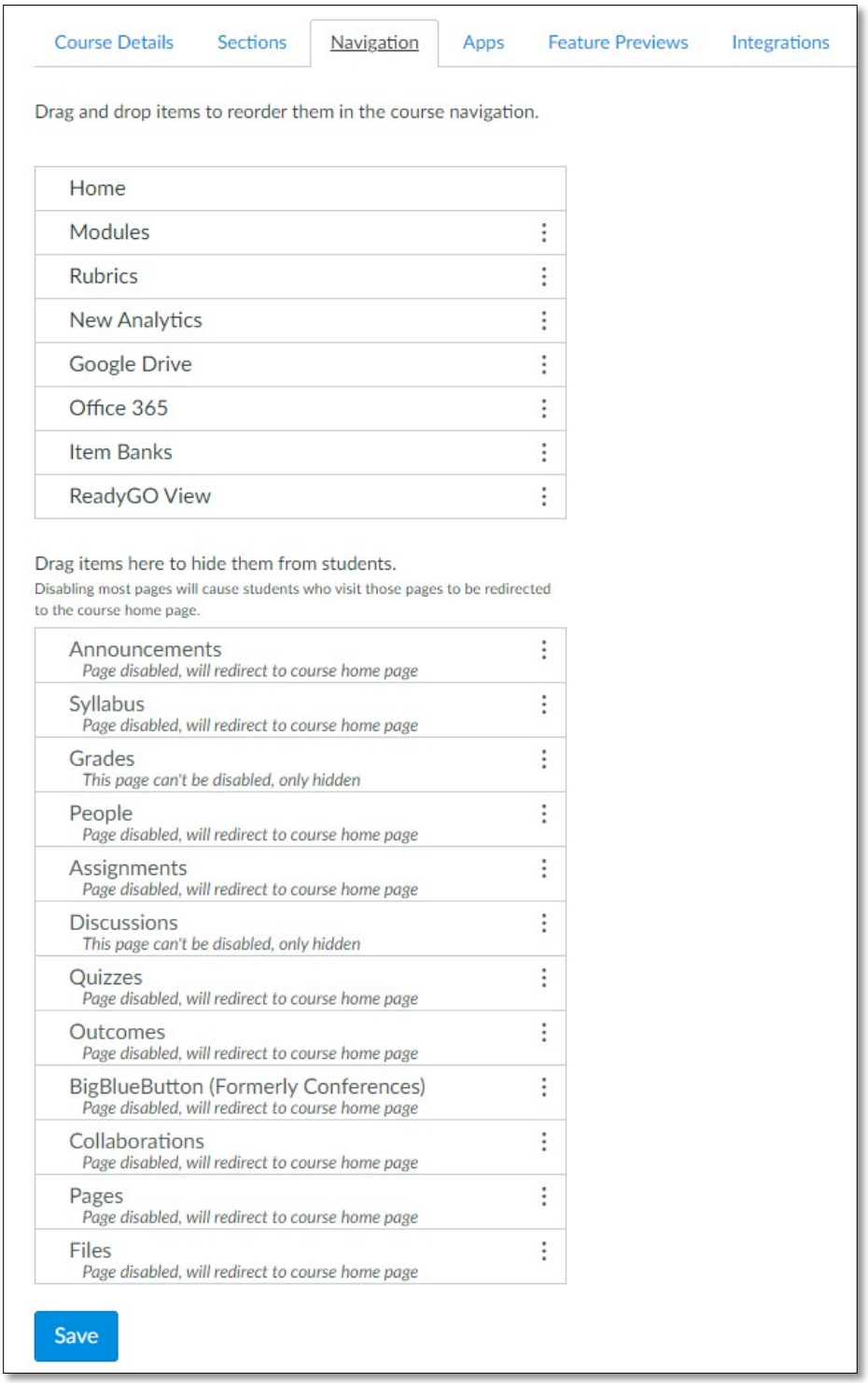
Open Settings

- In the course navigation, click **Settings.**



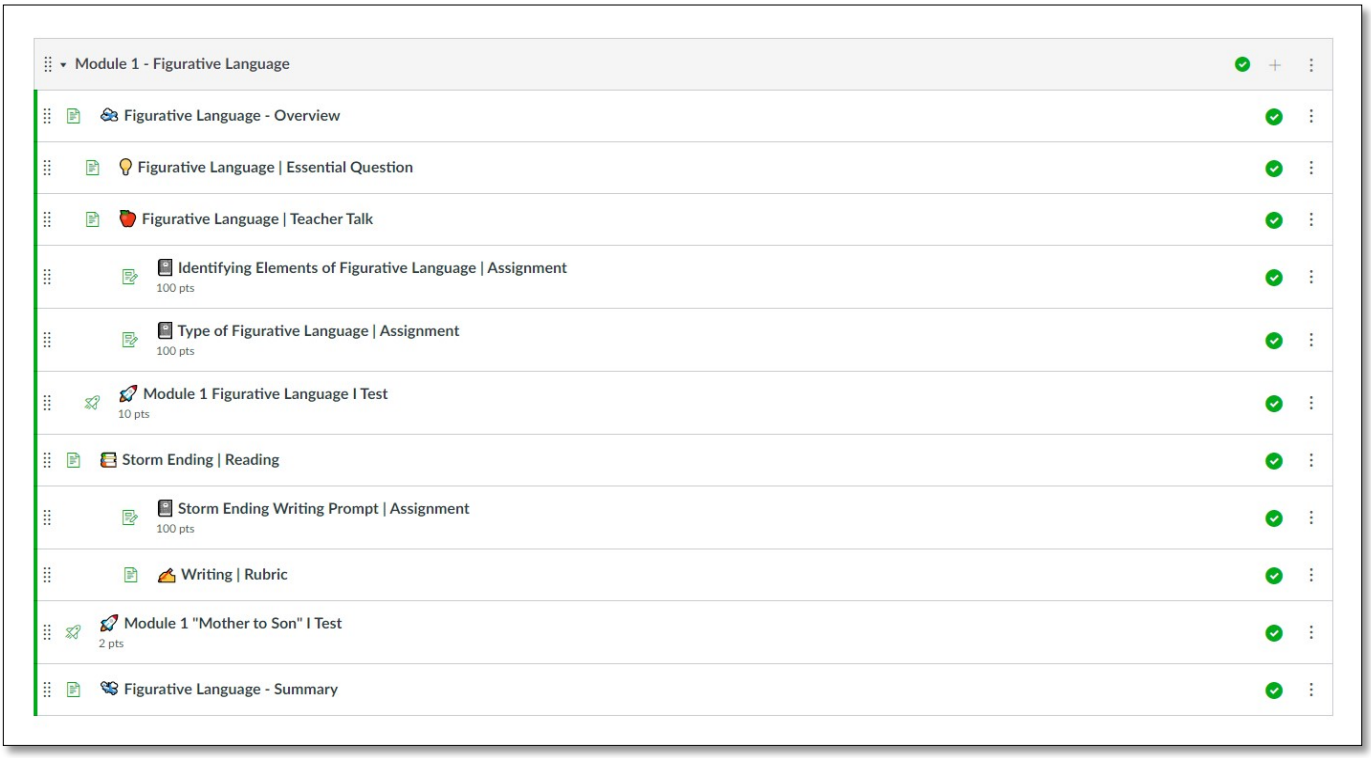
Select the Navigation Tab

- At the top of the page, click the **Navigation** tab to access the menu items. Be sure to click **Save** when you have completed the menu.



Modules

The Modules within this course are designed to cover every standard within the course's curriculum. Most of the modules found within the courses will have smaller lessons inside of them. It is important for students to see and understand how the modules look. The flow of each lesson was designed within the Modules section of Canvas.



Module Icons

- As you can see above, this course has icons within each module. Below, you will find a key to explain each icon's meaning.

Teacher Talk (powerpoints and videos)
Overview (introduction and objectives)
Bellringer (activity for beginning of lessons)
Essential Question (main questions for each module)
Assignments (formative assessments)
Reading (books, poems, articles, etc. for reading)
Labs (will be found in science courses)
Writing (used for writing assignments)
Quiz or Test (summative assessments)
or Wrap up and/or Summart (closing of the lesson)

Publishing Modules and Content

Publishing Modules

- Each module will need to be published for the students to see the content within it. If the module is not published, the students will **NOT** be able to see anything inside of it **EVEN IF** the content is published! There will be a green check mark at the top of the module if it is published.

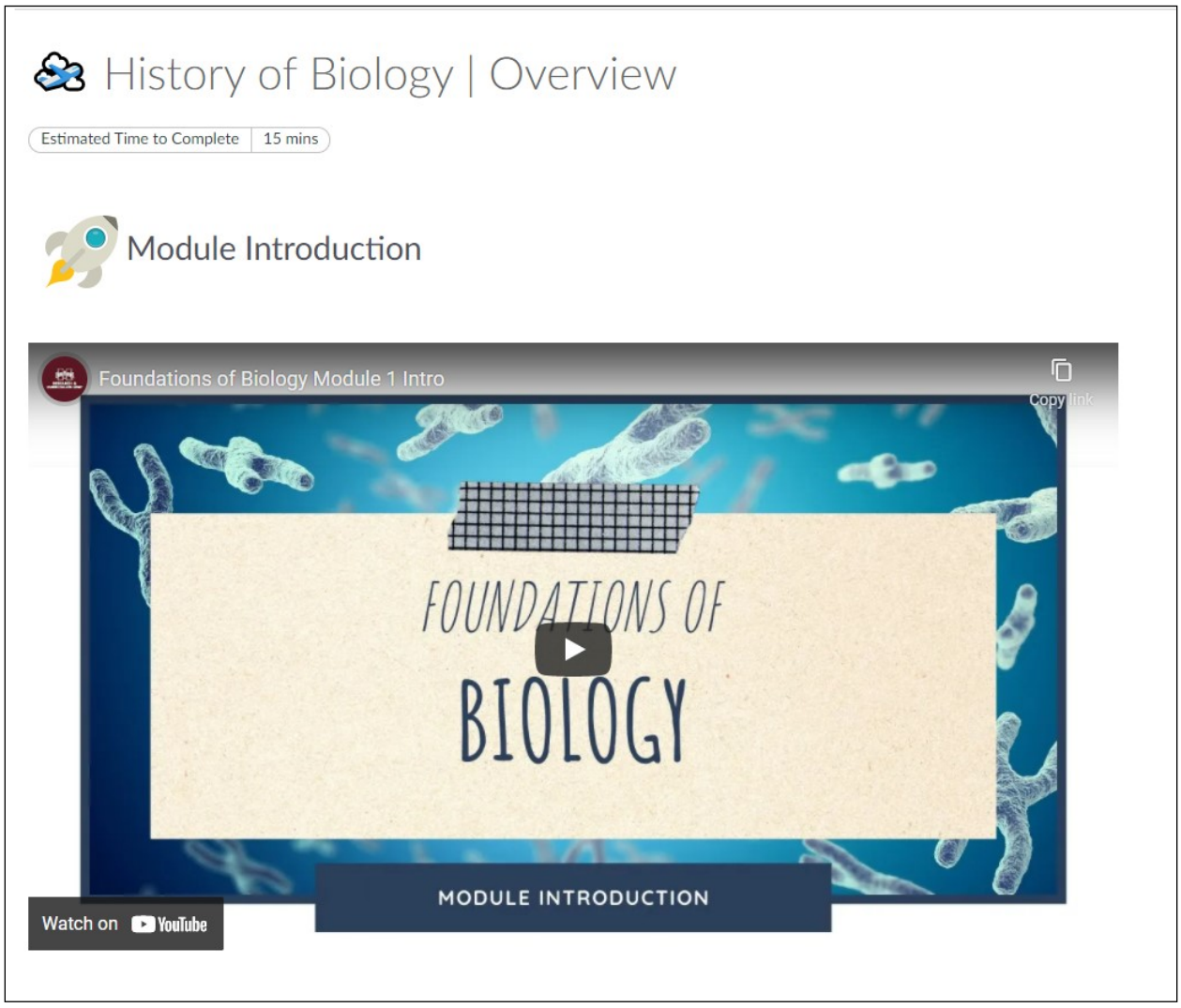
Publishing Content

- Publishing content works the same way as publishing the module. You can click or unclick the published button to the right of each piece of content within the module. This gives you the option to only show parts of the module if needed.

REMINDER: The students will NOT be able to see it if the green check mark is not present!

Introduction and Wrap Up Videos

Every module will have an *Introduction Video* and a *Wrap Up Video*. These videos will be embedded into the **Overview** and **Wrap Up** sections as YouTube videos. This was designed to help the students get a clearer understanding of the educational expectations for each module. Below, you will see an example of what the embedded videos will look like.

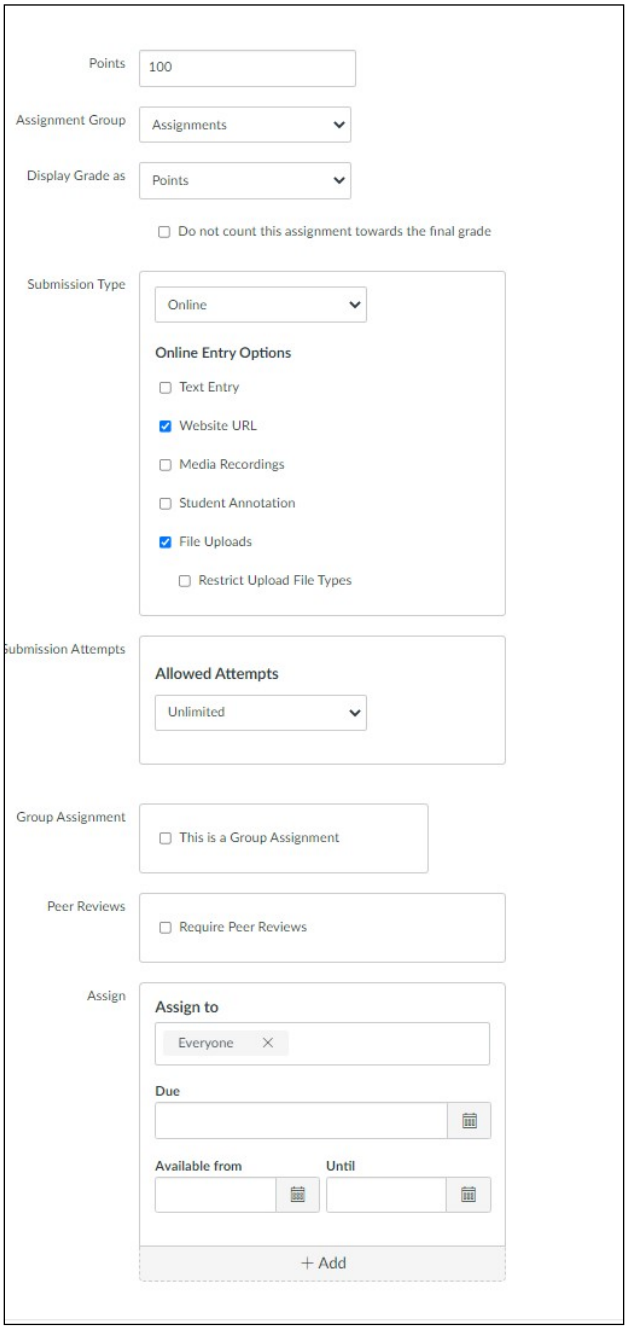


Assignments

Every assignment that has been created within this course can be adjusted to your liking. All assignments use links to *Adobe Acrobat PDF files*, *Google Docs*, or *Word Documents*. If you choose to change the style of the assignment, feel free to download the assignment and save it in whatever way works best for your classroom.

Assignment Settings

- The assignments will come without any specific settings. When you click **Edit** in the top right corner of the assignment, you will move to a screen that allows you to change anything within the assignment.
- You can **adjust these settings** to your liking by changing the point value, assignment group, grade display, submission type, allowed attempts, due dates, and what group of students it is assigned to.
- If you want it to be **a group assignment**, you can click the box and form groups within the class. You can also make an assignment a Peer Reviewed assignment. This will be helpful if you are wanting feedback from your students.
- Be sure to click **Save** when you are done adjusting the settings.



Course Overview

The Biology course is designed to provide introductory material via presentations and videos, followed by practice assignments and quizzes for formative assessment and a module test for summative assessment. The provided materials can be supplemented or modified as necessary to accommodate the needs of individual students or classes. **Click the hyperlinks below to access the resources.**

Suggested Additional Resources

Amoeba Sisters Video Recap Handouts

- This dropbox contains PDFs of free video recap worksheets to correspond with the Amoeba Sisters videos found throughout the course. Keys are available for purchase through Teachers Pay Teachers (just search for "Amoeba Sisters" on the site), but you can easily get by just watching the videos and making keys as you go.

Biology Corner

- This site has been around for a while, but there are several short worksheets and activities available for free. *Be aware, many of the digital labs rely on Adobe Flash Player, which is incompatible with many browsers at the time of this publication.*

HHMI BioInteractive

- Great collection of interactive modules and resources free for classroom use. Use the link above and easily search by topic or module. Even if you don't have time for a full lab or multi-day activity, they have great videos which demonstrate important themes in Biology (especially natural selection and evolution). Many activities have corresponding activities on Teachers Pay Teachers (like video handouts with keys -- great, easy "emergency" lesson plan for unexpected days off).

Teachers Pay Teachers

- The two teacher vendors listed below have a wide variety of resources (many paid, some free) that can be used to supplement any module of study. They have great labs, complete module guides, diagram and note-taking templates, presentations, digital notebook resources (all set up in Google Drive). Feel free to preview their material to get a sense of what the content is like, especially if you find yourself looking for activities or labs. Don't pay out-of-pocket -- contact your school administrator to discuss purchasing materials via purchase order or use your EEF funds.
    - It's Not Rocket Science
    - Science with Mrs. Lau

Sample Pacing Guide: Year-Round (180 days, 45-60 minute class time)

Concept	**Time allotted**
Back to School, Lab Safety & Inquiry	10 days
Module 1: Macromolecules	12 days
Module 2: Cellular Structure & Function	14 days
Module 3: Cellular Transport	12 days
Module 4: The Cell Cycle & Cell Division	15 days
Module 5: Genetics	10 days
Module 6: Complex Genetics	10 days
Review & Midterms	*7 days (90 days total)*
Module 7: Central Dogma	17 days
Module 8: Photosynthesis & Respiration	11 days
Module 9: Evolution	14 days
Module 10: Ecology	16 days
Review for State Test	*15 days*
State Test to Finals	*10 days*
Finals	*7 days (90 days total)*

Sample Pacing Guide: Block
(90 days, 90-120 minute class time)

Concept	Time allotted
Back to School, Lab Safety & Inquiry	5 days
Module 1: Macromolecules	6 days
Module 2: Cellular Structure & Function	7 days
Module 3: Cellular Transport	6 days
Module 4: The Cell Cycle & Cell Division	7 days
Module 5: Genetics	5 days
Module 6: Complex Genetics	5 days
Review & Midterms	*4 days (45 days total)*
Module 7: Central Dogma	8 days
Module 8: Photonthesis & Respiration	5 days
Module 9: Evolution	6 days
Module 10: Ecology	8 days
Review for State Test	*7 days*
State Test to Finals	*9 days*
Finals	*2 days (45 days total)*

Notes about pacing guides:

- These pacing guides are approximations to suggest the relative length of time needed for individual modules. Based on your school setting, the need for review and midterm/final exam days may be adjusted or removed.
    - You will want to learn your state test date (or testing window) as soon as possible. Speak with your school or district testing coordinator. Knowing this date early on can help you adjust if you have more or less time prior to state testing than what is shown above.
- When pacing for the term, be sure to account for potential interruptions like:
    - Holidays
    - Major sporting events, homecoming week
    - Inclement weather
    - Benchmark testing (e.g., Case 21, ELS, NWEA)
- ***Tip:*** It is better to leave a few days of "wiggle room" at the end of a term so that if a module is interrupted (or needs to be lengthened for remediation or review), you can extend without "borrowing time" from other modules. If you end up with extra time at the end of a term, you can always fill with additional activities.
- Depending on individual timelines, modules may be rearranged to better accommodate how the term is divided on your school's calendar. For example, Module 8: Cellular Energy can easily follow Module 2: Cell Structure & Function, and one or both Genetics modules can be moved to the second half of the term.

Module 1 - Macromolecules

Essential Vocabulary:

1. carbohydrate
2. lipid
3. protein
4. nucleic acid
5. monosaccharide
6. disaccharide
7. polysaccharide
8. triglyceride
9. fatty acid
10. amino acid
11. peptide bond
12. polypeptide
13. nucleotide
14. polymer
15. monomer
16. isomer
17. phospholipid
18. macromolecule

Guiding Questions:

- Describe the structure (elements found within) of the four major types of macromolecules.
- What do the four types of macromolecules look like in diagrams?
- What are the monomers and polymers for each of the macromolecules?
- Provide examples (as molecules and in foods, where appropriate) of each of the four major types of macromolecules.
- What are the functions of the four major types of macromolecules?
- How do enzymes interact with substrates? How do they influence biological chemical reactions?
- Explain the lock-and-key analogy with enzymes.
- How do various environmental conditions impact enzyme function?

Common Misconceptions and Challenges:

- This is a challenging module because students have little to no background in chemistry prior to this course, and there is a lot of new vocabulary. Allow time for vocabulary review and interactive games (especially with students in pairs or small groups) to help students build confidence with the terminology. Getting students to say the words aloud or talk about the terms in context will help with confidence and retention.
- Because of diet trends and marketing, students may have misunderstandings about what different macromolecules do for our bodies (e.g., assuming proteins are a preferred energy source) or that certain macromolecules are good or bad (because of low-carb or low-fat diet trends).
    - Frequently reinforce the many benefits each group provides for living things and maintain positive language when discussing different macromolecule categories.
- Nearly all students struggle to visualize what these molecules look like (because they have little to no background in chemistry).
    - Be sure to provide several examples of atomic models and help students identify trends and patterns in molecule diagrams so they aren't overwhelmed by these images. For example, show a molecular diagram of a carbohydrate and lipid side-by-side so students can make comparisons (similar elements, very different quantities, and arrangements).
    - The more students are involved in generating these connections, the better their understanding will be.

Additional Module Resources:

Macromolecule Murder Mystery Lab (free resource on Teachers Pay Teachers)

- If you are short on time or resources, you can modify this lab to allow different groups to perform one of the four tests, or you can present as a teacher demo. It allows students to make predictions and see authentic qualitative tests in the lab. Low-cost for most supplies, but you will need certain reagents from a laboratory supply company (e.g., Biuret solution).

Macromolecules Card Sort

- Printable cards for an in-class activity. This is very similar to the digital version in the module guides. You can have students create four sections using desks or a lab table, and work in small groups (2-3 students) to sort the cards into groups. Mix up groups for multiple rounds of review. The teacher can circulate to confirm correct/incorrect category placement and/or can review with the whole class to check. Simple, straightforward formative activity.

Module 2 - Cell Structure & Function

Essential Vocabulary:

1. Cell Theory
2. Cell
3. Prokaryote
4. Eukaryote
5. Nucleus
6. Plasma membrane
7. Mitochondrion
8. Chloroplast
9. Endoplasmic Reticulum
10. Cytoskeleton
11. Ribosome
12. Golgi body
13. Lysosome
14. Cilia
15. Flagella
16. Centriole
17. Cell Wall
18. Virus

Guiding Questions:

- Define the criteria comprising the modern cell theory, as well as the scientists who contributed to this theory.
- What are the differences between prokaryotic and eukaryotic cells?
- Which organelles are unique to animal and plant cells?
- Define the characteristics of all living things.
- Are viruses living or nonliving? Support with evidence.
- Identify cellular organelles in diagrams.
- Identify the functions of cellular organelles.

Common Misconceptions and Challenges:

- Students who struggle in this module tend to confuse the functions of different organelles within cells. Be sure to reinforce the key differences between prokaryotes and eukaryotes, plants, and animals, etc.
- Students will have some misconceptions about the features of living things (Example: Must be able to breathe). You can explore these by having students suggest characteristics of living things and have them work in pairs or small groups to refine their lists and evaluate their peers' suggestions.

Additional Module Resources:

Learn Genetics - Utah: Cells

- The link above provides many resources including interactive animations, videos, image galleries, and guided questioning to help students better visualize cell parts and processes.

Module 3 - Cellular Transport

Essential Vocabulary:

1. homeostasis
2. solute
3. solvent
4. concentration
5. diffusion
6. facilitated diffusion
7. osmosis
8. selectively permeable
9. fluid mosaic model
10. hypotonic
11. hypertonic
12. isotonic
13. Na+/K+ pump
14. endocytosis
15. exocytosis
16. pinocytosis
17. phagocytosis

Guiding Questions:

- Identify the parts and functions of the plasma membrane.
- Explain the concept of the fluid mosaic model.
- How are active and passive transport processes different? Remember to consider molecule movement and energy used.
- How can you correctly identify hypotonic, hypertonic, and isotonic solutions?
- How can you correctly predict how cells will respond when placed in the above environments?
- What is the difference between endocytosis and exocytosis.?
- Cite a situation in which each of these cell transport processes is beneficial to the cell.

Common Misconceptions and Challenges:

- Students tend to get confused when classifying solutions as hypertonic or hypotonic by solute concentration, and then describing the way water will move (they often get this backwards). Students frequently assume that the solute is moving from high to low concentration through the membrane to reach equilibrium. Remind them about selective permeability and reinforce that in sample problems, water can move freely across the membrane, but solutes cannot. Water is moving from high to low concentrations. Taking the time to fully explain this at the beginning will help (videos and visual models help, too).
- Students may struggle with visualizing the sodium-potassium pump; make sure to use videos to show them how it moves ions across the membrane.

Additional Module Resources

pHet Simulation - Membrane Channels

- This simulator allows students to add channel or carrier proteins to the membrane and adjust concentrations of different molecules to see how particles will move across the membrane. Be sure to click the "for teachers" drop-down menu for instructional tips and sample lessons provided by other users.

pHet Simulation - Diffusion

Module 4 - The Cell Cycle & Cell Division

Essential Vocabulary:

1. asexual reproduction
2. sexual reproduction
3. chromosome
4. chromatin
5. cell cycle
6. interphase
7. mitosis
8. cytokinesis
9. prophase
10. chromatid
11. centromere
12. centriole
13. metaphase
14. anaphase
15. telophase
16. apoptosis
17. cancer
18. somatic cell
19. gamete
20. haploid
21. diploid

Guiding Questions:

- Why do cells need to divide?
- Why do organisms need to reproduce?
- How are sexual and asexual reproduction processes different?
- Describe the stages of the cell cycle (as well as how the cycle is regulated).
- What happens when the cell cycle is dysregulated/unregulated (apoptosis, cancer)?
- Describe the stages of mitosis in somatic cells.
- Describe the stages of meiosis in gametes.
- What are the key differences between mitosis and meiosis?
- How can you differentiate stem cells from specialized cells? What are their potential applications for stem cell research and therapy?

Common Misconceptions:

- Many students assume that somatic cells have only autosomes and sex cells have only sex chromosomes; remind students that ALL cells have autosomes and sex chromosomes, but haploid and diploid cells will have them in different quantities. It can help to prompt students -- "What about during reproduction or fertilization? How do offspring get all of the necessary traits from gametes (if gametes only have sex chromosomes?)" Helping students make predictions like this can help them to understand better.
    - It also helps to demonstrate the changes to chromosome number (designating a sex chromosome pair) throughout the steps of meiosis and fertilization by drawing or using models for students to manipulate. You can also search for videos online that demonstrate this process of independent assortment, stopping to help them track chromosome number and type through different stages of division and fertilization.
- Frequently reinforce the differences between mitosis and meiosis, focusing on the goal/outcome of each process.
- Because many students do not understand the complexity of cancer causes (various mutations and how they come about), they may struggle to understand why finding a "cure" for cancer is such a difficult task. Allow time for students to research and discuss the ways a cell's DNA can mutate and impact the cell cycle, leading to cancer.

Additional Module Resources:

Research Essay: Stem Cells

- This document provides instructions for students to explore the topic of stem cells a bit deeper. This can be a one-lesson activity, extra credit, or can be expanded over multiple days in preparation for a large-group discussion. The use of a discussion is preferred over a debate so that students do not become too competitive or focused on the winning argument -- the use of stem cell research and therapy is controversial among different groups, so it is unlikely that they will all reach the same conclusion.

Module 5 - Genetics

Essential Vocabulary:

1. Allele
2. Dominant
3. Recessive
4. Gene
5. Genetics
6. Trait
7. Fertilization
8. Homozygous
9. Heterozygous
10. Genotype
11. Phenotype
12. Law of Segregation
13. Law of Independent Assortment
14. Dihybrid
15. Incomplete Dominance
16. Codominance

Guiding Questions:

- What is the difference between a gene, an allele, and a trait?
- How are dominant and recessive alleles different from one another?
- What is a dihybrid cross? Be able to set up and solve dihybrid crosses.
- How is incomplete dominance different from complete dominance?
- How is codominance different from complete dominance?

Common Misconceptions:

- Students regularly struggle to set up dihybrid squares; they see genotypes with 4 letters (AaBb) and a 4x4 Punnett square, and assume they should place 1 letter per row/column. Have them set up a problem this way and work through it with them at the board -- ask them WHY this setup cannot work (some boxes are missing genes for the traits studied in the problem). Use this example to reinforce the value of the "FOIL" method step.
- Many students assume heterozygous means "one dominant and one recessive allele." Reminding them heterozygous means "two different alleles" will set them up for success with more complex patterns of inheritance later.
- Remind students that dominant does not necessarily mean "stronger" or "better." It just means "will be displayed physically."
- Students may have trouble visualizing the law of segregation and the law of independent assortment. Draw out a quick diagram, use models, and or use videos to demonstrate these two steps so students can better picture this process of separating and reorganizing gene pairs.

Additional Module Resources:

HHMI BioInteractive - Using Genetic Crosses to Analyze a Stickleback Trait

- Straightforward lab activity that aligns data analysis with genetic crosses in Punnett squares.

Module 6 - Complex Genetics

Essential Vocabulary:

1. Multiple alleles
2. Sex-linked traits
3. Pedigree
4. Carrier
5. Karyotypes
6. Nondisjunction
7. Down syndrome
8. Turner's syndrome
9. Jacob syndrome
10. Klinefelter syndrome
11. Trisomy X syndrome

Guiding Questions:

- How are multiple-allele traits different from the traits in the previous module?
- How are sex-linked traits different from autosomal traits? Which sex is more likely to be impacted by a sex-linked condition?
- How can pedigrees demonstrate a particular pattern of inheritance? What patterns or clues suggest a trait may be dominant, recessive, autosomal, or sex-linked?
- What are karyotypes, and what kinds of information can they demonstrate?
- How can we identify genetic conditions using a karyotype?

Common Misconceptions:

- Some students will assume that a trisomy always leads to Down syndrome; clarify that this is only true for Trisomy 21. You can have students research the results of trisomies or monosomies of other genetic conditions.
- Students may still assume sex cells have only sex chromosomes and body cells have only autosomes; show karyotypes of sex cells and somatic cells to clarify.
- Many students struggle with solving pedigrees, as it is a skill in recognizing patterns and making predictions (and sometimes the pedigree may be inconclusive). Walk through several examples slowly and allow students to work on solving pedigrees with partners before tackling the process independently. Encourage them that it gets easier with more practice.

Additional Module Resources:

Learn Genetics - University of Utah

- This site has many different animations surrounding DNA, karyotypes, inheritance, and so on. Explore their modules for animations to show in class or direct your students to specific articles or activities as needed.

HHMI - Analyzing Pedigrees Lesson

- Free resources available for extra practice.

Carolina Biological Supply - Blood Typing Lab (synthetic blood)

- This is one of several variations of lab kits available for purchase through Carolina Biological Supply. Students can use it to model blood typing with synthetic blood. One kit per group is suggested, or you can purchase bulk quantities of synthetic blood/testing sera and divide among groups.

Module 7 - Central Dogma

Essential Vocabulary:

1. Replication
2. Transcription
3. Translation
4. Central Dogma
5. RNA
6. mRNA
7. rRNA
8. tRNA
9. Codon
10. Anticodon
11. Mutation
12. Missense
13. Nonsense
14. Deletion
15. Insertion
16. Duplication
17. Inversion
18. Translocation
19. Gel electrophoresis
20. Genome
21. GMOs

Guiding Questions:

- What are the common features of DNA and RNA? How are these molecules different?
- Why does replication take place? Where does this happen? When does this happen?
- Why does transcription take place? Where does this happen? When does this happen?
- Why does translation take place? Where does this happen? When does this happen?
- Describe the main stages of the Central Dogma.
- What are the different types of RNA, and how do they function differently?
- What are mutations? How do they occur?
- What are possible outcomes to DNA mutations?

Common Misconceptions:

- Students tend to lump replication as part of the Central Dogma with transcription and translation. Remind students that these are separate processes. It can help to clarify when each process takes place, and for what purpose. Transcription and translation are ongoing throughout the cell cycle; replication is only happening during S phase in preparation for division.
- It is easy to focus on the potential negative impacts of mutations; reinforce those mutations can simply lead to different outcomes for the cell (not always negative). Point out the variations of traits humans and other organisms have (ex. Hair color) and remind students that these variations began with mutations to DNA (often during replication or because of exposure to some mutagen).

Additional Module Resources:

Learn Genetics - University of Utah

- Several animations and short videos/articles students can use for review.
- Gel Electrophoresis Interactive Virtual Lab

Module 8 - Cellular Energy

Essential Vocabulary:

1. ATP
2. Photosynthesis
3. Chloroplast
4. Chlorophyll
5. Thylakoid
6. Stroma
7. Light-dependent reactions
8. Light-independent reactions
9. Cellular respiration
10. Aerobic respiration
11. Anaerobic respiration
12. Lactic acid fermentation
13. Alcoholic fermentation

Guiding Questions:

- Why is ATP useful in cells? Where do different organisms get energy?
- What happens during photosynthesis?
- What happens during cellular respiration? Which organisms carry out this process?
- How is aerobic respiration different from anaerobic respiration? Which process produces more energy?
- What are electron carriers, and what do they do? Give examples.
- What are the reactants and products of photosynthesis?
- What are the reactants and products of cellular respiration? How do they connect to photosynthesis?

Common Misconceptions:

- Many students assume that plants carry out photosynthesis and animals, etc. carry out cellular respiration. Remind students that plant cells have mitochondria along with chloroplasts, so they carry out both processes.
- Because this module is focused on chemistry, students will have less background knowledge upon which to draw. They will struggle to visualize molecules and the processes of photosynthesis and respiration in cells. Help students create concept maps, flow charts, or diagrams to strengthen connections. Frequently reinforce the reactants, products, and purpose of each set of reactions.
- If students are intimidated by chemical formulas and equations, help them connect the names of substances (water, carbon dioxide) to formulas. Draw on their prior knowledge (ex. What do plants take in? What do plants put off?) to simplify the equation.

Additional Module Resources:

HHMI BioInteractive - Photosynthesis

- This links to resources on photosynthesis, including an interactive module/animations, worksheet, and resource folder.

Amy Brown Science - Cellular Respiration

- This links to Amy Brown's blog where she gives several tips on teaching cellular respiration (including examples of simplified diagrams). If interested, you can follow the link to her Teachers Pay Teachers paid resources (most modules are inexpensive).

Module 9 - Evolution & Natural Selection

Essential Vocabulary:

1. Evolution
2. Organic evolution
3. Chemical evolution
4. Fossil
5. Endosymbiosis
6. Homologous structure
7. Analogous structure
8. Vestigial structure
9. Ancestral character
10. Derived character
11. Natural selection
12. Comparative anatomy
13. Comparative embryology
14. Comparative biochemistry
15. Artificial selection
16. Divergent evolution
17. Convergent evolution
18. Speciation

Guiding Questions:

- What is meant by the term evolution? What bodies of evidence support evolutionary theory?
- Distinguish between chemical and organic evolution, as well as divergent evolution and convergent evolution.
- Under what conditions does natural selection occur?
- What does evolution suggest about the diversity of life on Earth? What does it suggest about the moduley of life on Earth?
- How are natural selection and evolution related concepts?
- What are the different types of natural selection? What do they have in common, and how do they differ?

Common Misconceptions:

- Students may get confused with the concept of adaptations; because of how we use "adapt" to describe behavioral changes or decisions (particularly with humans and new situations), they may believe that organisms decide to change in response to their environment. Remind students that nearly all the adaptations discussed in Biology are inherited physical features (controlled by DNA), so the organism(s) cannot choose which features they may display.
- Some students may resist evolutionary theory because of conflicts with personal beliefs; it is okay to acknowledge and affirm their rights to individual beliefs. Try to approach the controversial parts of the theory (ex. common descent) by reinforcing that scientists consider data and observations and seek to draw the most logical conclusions from those facts. Also reinforce that the nature of science is continual learning -- seeking knowledge and testing ideas for a deeper understanding.

Additional Module Resources:

HHMI Biointeractive Classroom Resources

- This database of classroom resources has several activities of varying length; there are several great videos, labs, and activities surrounding evolution. Use the link above and search for "evolution" or "natural selection" and use other filters to narrow your search.

HHMI Biointeractive Evolution Course for teachers

- This asynchronous course can be used as a professional development opportunity. If you complete the whole course in sequence, you can earn CEUs, or you can skip to the topics that most interest you. The course is meant to deepen understanding and skills in teaching evolution at the high-school level.

pHet Natural Selection Simulation

- This simulation allows students to manipulate predator and prey populations as well as environmental factors to see how these changes influence the process of natural selection. Be sure to visit the "For Teachers" drop-down menu for insight into using the simulation and a glance at lessons provided by other teachers.

Module 10 - Ecology

Essential Vocabulary:

1. Habitat
2. Ecosystem
3. Niche
4. Predator
5. Prey
6. Autotroph
7. Heterotroph
8. Biotic factor
9. Abiotic factor
10. Food web
11. Mutualism
12. Parasitism
13. Commensalism
14. Succession
15. Tolerance
16. Limiting factor
17. Emigration
18. Immigration
19. Carrying capacity
20. Natality
21. Mortality

Guiding Questions:

- How is energy transferred throughout an ecosystem?
- What is the difference between an abiotic and a biotic factor in an ecosystem? Why are both of these factors important?
- How are nutrients like nitrogen, carbon, phosphorus, and water cycled through ecosystems? Why are these elements essential to maintaining a healthy ecosystem?
- What are greenhouse gases? What impact do they have on climate factors?
- Describe the symbiotic relationships that can exist between two different species.
- Describe the differences between density-dependent and density-independent factors. How do these factors influence population growth?
- What is carrying capacity for a population? What factors influence the carrying capacity?
- What is succession? How are primary and secondary succession different?

Common Misconceptions:

- Students have studied ecological concepts since elementary school to a small degree, but many will still have misunderstandings about relationships among organisms or energy transfer in food webs. Provide students with a food web and describe a change to one population -- ask students to describe what might happen to others in the ecosystem. This can help to build upon foundational understanding and help to reinforce how all organisms are vital to the health of the overall ecosystem.
- Students usually feel confident about the water cycle, but struggle with nitrogen and phosphorus. Spend additional time on these processes and allow students to diagram stages to solidify understanding.
- Students may hold many misunderstandings about greenhouse gases and climate change. Videos like this one can help; if you can work in time for a hands-on activity, there are several versions of simple, low-cost experiments online to examine temperature change in different environments (ex. A soda bottle half-filled with water vs. a soda bottle half filled with water and an Alka-Seltzer tablet (CO_2) will absorb heat differently).

Additional Module Resources:

HHMI BioInteractive - Ecology Resources

- Here are several resources to expand students' understanding of population dynamics and limiting factors.

Learn Genetics - Utah: Extreme Environments: Great Salt Lake

- Here are several videos and interactive modules to examine living and nonliving factors in this unique ecosystem. This can provide good bonus material if needed.

Lab Safety & Experimental Design

The following pages can be used as a guide reviewing lab safety, equipment, and experimental design. You may present to students in whatever format you feel is most useful -- these pages are meant to supplement class discussions and activities for these topics. This information is not mandatory in the state curriculum but will support the science and engineering practices which are interwoven into the Biology standards.

Lab Safety and Procedures

- Laboratory Safety Guidelines (Student Contract)
- Lab Safety Video (Amoeba Sisters)

Lab Equipment and Functions

- Lab Equipment and Functions Chart
- Activity: Lab Equipment Scavenger Hunt

Measurement, Scales, and Conversions

- Measurement and the Metric System (*OpenStax)*
- Measurement and Conversion Notes

Microscopes

- Microscope Notes (videos and review worksheets included)

Notable Scientists

- Notable Scientists Chart (including research report instructions)

Experimental Design

- Experimental Design Notes

Graphing

- Graphing Notes

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