Illinois Mathematics and Science Academy

A Pioneering Educational Community

Comprehensive Course Syllabus for SI Biology (Spring 2020)

Instructors

Instructors:

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Meeting Information

All Scientific Inquiries - Biology classes meet twice a week for 100 minutes, time and date depending on section.

Course Description

Scientific Inquiries in Biology is a one-semester sophomore course for IMSA students to gain understanding and experience working with fundamental biological concepts. The course is based on essential questions that focus on the history of life on earth, biological processes fundamental to cellular function, and the interactions between organisms and the environment, all with an Evolutionary context. Students will engage in learning designed to generate growth in select Standards of Significant Learning.

Essential Content

The following IMSA Standards of Significant Learning are essential content that guide the choice of biological concepts found in Organisms and Ecosystems. As indicated in the list (FA = formal assessment; IA = informal assessment; and NA = not assessed), assessment is driven by them as well.

SSLs and Associated Assessed Outcomes

IA. Students are expected to demonstrate automaticity in skills, concepts, and processes that enable complex thought by:

- Completing homework activities and assigned reading to support content (**IA**),
- becoming adept at identified lab skills (**NA**),
- demonstrating competence on quizzes and (**FA**), and
- applying content knowledge in alternative scenarios and new problems (**FA**).

IB. Students are expected to construct questions, forge connections and deepen meaning
- informally in discussion groups, during set up and analysis of labs, and when observing data from experiments (**IA**), and
- in formal assessments (**FA**).

IC. Students are expected to precisely observe phenomena and accurately record findings
- through lab experiments and assessments (**FA**/**IA**), and
- through analysis of data generated from experiments (**FA**/**IA**).

ID. Students are expected to evaluate the soundness and relevance of information and reasoning
- by evaluating sources for research papers (**FA**),
- through analysis of experiments completed in lab (**FA**), and
- through explanation of models of phenomena in biology (**FA**).

IIA. Students confront misconceptions
- by completing a pre-assessment for the evolution unit (**NA**),
- processing information on the nature of science (**FA**),
- discussing the results in class (**IA**), and
- completing a follow-up assessment to determine extent of resolution of misconceptions (**IA**).

IIIA. Students use appropriate technologies as extensions of the mind
- through daily use of computers, including web sources and videos (**NA**),
- by using the course website as a resource (**NA**),
- by using computers to create graphical representations and perform other analyses of laboratory data **(FA**/**IA**/**NA**), and
- through use of standard laboratory equipment (**NA**).

IIIB. Students recognize, pursue, and explain substantive connections within and among areas of knowledge
- by studying the chemistry behind the biology (**FA**), and
- by studying the connections between sub-sections within biology (**IA**).

IIIC. Students recreate models and systems in biology, such as cell theory, evolution, DNA synthesis, as well as structures and functions of the cell and DNA, etc.,
- in classroom discussion and activities (**IA**),
- as well as in formal assessments (**FA**).

VB. In order for students to make reasoned decisions which reflect ethical standards, and act in accordance with those decisions, students

- ➢ are made aware of what plagiarism is, its ethical implications, and repercussions of plagiarizing (**IA**),
- ➢ are made aware of the scientific and ethical significance of accurately representing data (vs. not skewing data to fit expectations)(**IA**), and
- ➢ are assessed for the authenticity of written work and the efficacy of analysis of lab experimentation (**FA**).

Conceptual Content

This course addresses questions which will help students to understand concepts fundamental to organisms and ecosystems. The main concepts, topics, and possible labs/activities addressed during the semester are listed in the following table.

Unit	Essential Questions	Topics Covered
Unit 1: History of Life on Earth & Evolution	What is the history of biological life on Earth through the current era? o *What are the environmental, organismal, and geographical characteristics of the Earth in each Era?* o *What has changed over time?* What has driven the changes in biological life on Earth? o *How do we study biology?* o *What is a scientific process?* o *How do theories and laws inform science?* o *What makes science different than other fields?* o *What is Evolution?* o *How do you define Evolution as a theory? As a process?* o *What are some evidences of Evolution? How do structures (homologous) and carbon dating support the theory?* o *What are the mechanisms by which Evolution as a process occurs? How do interactions between different individuals of*	History of life on Earth ● Change over time* ● Characteristics of the Earth and the life on it in different eras Evolution* ● Nature of scientific knowledge* ● Definition & Structures* ● Evidences* (include carbon dating) ● Mechanisms (basic level; gene= trait)*

	the same species drive change over time? o *How do new species arise?*	
<u>Unit 2 & 3 Biological Structures & Processes</u>	What fundamental biological processes for sustaining cellular and multicellular life on Earth? o *What structures are the fundamental structures involved in these processes?* o *What are the steps involved in each of these processes?* o *How is each process regulated?* o *How do these processes contribute to the uniqueness within an organism (cell types) and between different organisms?* o *How do changes in these processes contribute to Evolution?*	Cell Structures ● Comparison of prokaryotes & eukaryotes ● Endosymbiotic theory * ● Organelles ● Mitochondrial maternal inheritance * Molecular Structures (DNA/Protein structures) ● Basic bonding ● DNA structure o Conservation of nucleotides across all living organisms* ● RNA Structure ● Protein Structure/Folding o Difficulty in protein prediction; answer with technology only works because of ancestry/relatedness /trends (comparing sequence to other known proteins)*S Enzymes ● Basics on reactions and coupling ● Structure/Function Relationship* (change structure = change function, connect in next unit to mutations) ● Impact of conditions on enzyme structure/function Replication & cell division ● Meselson and Stahl o Extension of other ways to use isotopes in research ● Okazaki Model

		• Mutations as a result of replication error*
		• Comparison of Prok & Euk *
		• Mitosis & Meiosis
		  o Comparison of mutations & outcome vs replication *
		  o Discussion of recombination for variety
		  o Independent Assortment & Segregation
		  o Cell types/connect to life cycle (& where mutations matter most, etc)
		  o Probabilities (later to connect to population genetics) *
		Protein Synthesis & Regulation (cell differentiation)
		• Gene structures (promoter/terminator)
		• Transcription
		• mRNA structures (lead/start/stop/trail/utr's)
		• Translation & folding revisited
		• Comparison of outcome (long term) of mutations here vs in replication/Meiosis
		• Addition of regulatory units to increase/decrease probability/how often created
		• Cell differentiation (basics… give some connection to pathway, domino affect of proteins being upregulated, etc… maybe mention hox?) *
		• Regulation : lactose metabolism?
		Photosynthesis & Respiration
		• Development of photosystems (historically)
		• Basic processes of light dependent and independent reactions

		• Recycling • Connection to structure/function • Evolution of different plant types* • Partner process: Respiration * (evolutionary advantage of interaction of the two processes/development of life
Unit 4: Ecology	How do interactions between organisms and their environment play a role in function and biological life of an organism? o *How do the processes addressed previously contribute to these interactions?* o *How do essential components like food and nutrients cycle/move through an ecosystem?* o *How do the interactions between organisms and their environment affect how organisms interact with one another? How does the species diversity in an ecosystem impact these relationships?* o *How do all of these interactions characterize biological life and promote Evolutionary change?* o *How can we study these interactions and the changes that occur over time in a scientific manner?* o *How can we use our fundamental understanding of biological processes like inheritance and the Evolutionary mechanisms, as well as statistical analysis, to determine forces between change over time? What are some challenges with this?*	Ecology (geochemical cycles, food web, species interactions) • Carbon and water cycles • Food web info/transfer of energy • Species interactions: a few examples * o Connect to natural selection Revisit Evolution * • Population genetics: HardyWeinberg* o How to analyze change over time: connect to mechanisms for HW Equil Criteria
Unit 5: Ecosystem Disruption	What are ecosystem disruptions? o *How have environmental changes impacted the organisms in our*	•

	ecosystems? Why are these changes important to consider? o *Has human influence played a role in this ecosystem disruption directly or indirectly? How?* o *How do these disruptions impact other organisms in the ecosystem? Are there specific species interactions that have been affected?* o *How might these changes impact human society and well-being?*	

Instructional Design and Approach

Key to the learning that will take place in this course is a student's active participation in the process of scientific investigation. Students work individually and cooperatively to build models, make inferences from observations, and draw conclusions based on data. They must communicate conclusions and explanations orally and in writing. These experiences will help students to develop laboratory skills fundamental to research in the biological sciences.

Textbook
There is no required textbook for this course, as we wish for students to create their own "book" from their course notes, the work they do with the material outside of class, and the worksheets and handouts provided to them. A textbook is available for those who request it, with the disclaimer that we will not use or refer to the book in class, and we cannot guarantee that the material is covered with the same depth, detail, or focus in the book as in the course.

Notes and Organization
We expect students to follow the guidelines we have set in place for both their note taking and reflection, as well as their organization (w/ binder, etc.) for the course. These will be periodically assessed, and will contribute to the final semester grade. Expectations have been outlined in the "Taking Notes" presentation and the "Success in Biology" document.

Help Sessions
There are help sessions on Wednesdays from 12:30-2:30 in B156. These are primarily focused on group work with teachers. While it is a casual setting, students may be asked to find

another place to work if they are working on assignments for other courses or being a distraction to other students.

Assessment

Assessments may include quizzes, tests, presentations, projects, writing assignments, homework, and notebook grades. We will also be gauging student progress with respect to both learning skills and mindset, as defined in the "Success in Biology" document.

Various categories of work are not weighted to calculate the semester grade in this course. Instead, a running total of all work is maintained to reflect on student grades. An approximate contribution percentage of categories of assessment toward the final grade is:

- Tests: 50%
- Lab reports: 25%
- Quizzes, presentation, small essays, miscellaneous: 10%:

Grading generally follows the scale:

90% and above = A
80-89% = B
70-79% = C
Below 70% = D

Major assessments will be graded and returned to students for review as soon as possible. This will usually be one week for tests and ten days for reports. Formative work that demands quick turnaround time to support continued student progress will be given priority in grading.

Course Policies

Late work

Students may submit work late with a penalty of 10% each day the assignment is late up to 3 calendar days maximum. Once any assignments are returned to students with grades/comments, this late work will not be accepted. Once the deadline has passed, a 0 will be assigned.

It is expected that the students communicate with their instructor if they are making use of this policy for extended time on assignments.

Computer problems of any kind (including document corruption, hard drive failure, problems with uploading to Classroom) will <u>not</u> be treated as acceptable excuses. This being the case, it would be wise to make a backup copy of any computer work that you do for this course, and we suggest ensuring that you've received return receipts in your email from Turnitin. However, if you are having problems getting your work in, it is still recommended that you talk with your teacher.

Attendance

See the IMSA handbook for official attendance policy. If you have a <u>counselor excused absence</u>, or an unexcused absence, you will not be able to make up the missed work. This includes earning a 0 on any tests or quizzes given during the missed period.

If you have an excused absence, be sure to contact your teacher to find out what you will miss. If that is not possible, you should see your teacher as soon as possible to discuss your absence. It is **your responsibility** to follow up on what you missed in class.

Plagiarism
Plagiarism is unacceptable and will be dealt with as per IMSA policy on academic dishonesty. Plagiarism includes, but is not limited to, knowingly using another person's work – whether it is a student or a research paper – as your own, improper citations and bibliographic information, improper use of secondary sources, or any other behavior that is deemed dishonest.

Contacting Your Teacher

If at all possible, see your teacher in person! If that is not possible, send an email message, but be aware that it may take some time for your teacher to get back to you, particularly if you send a message after normal school hours. If you fail to get a response, go see your teacher when you can, or send another message. (Please be mindful of the tips for emailing your teacher we have posted on Classroom!) Lastly, please be aware that any SI Biology teacher in his/her office generally will be happy to work with you, unless currently in the middle of something important.