IMSA Fusion

IMSA Fusion is a teacher professional development and student STEM enrichment program for Illinois students who are talented, interested and motivated in mathematics and science. IMSA Fusion places a special emphasis on students who are historically underrepresented in those areas. Fusion works with teachers and students in grades 4-8.

In brief, the program goals are:

- Maintain or increase students interest, involvement and literacy in science and mathematics

- Enhance the knowledge and skills of teachers in science, mathematics, and technology; stimulate excellence in schools

- Stimulate excellence in schools' science and mathematics programs

- Help increase access to programming for students who are historically under-resourced in science, mathematics and technology and for all areas of the state

By design, the IMSA Fusion curriculum is inquiry based, problem centered and integrative. The learning experiences focus on helping students "learn how to learn" and emphasize logic, mathematical thinking and experimental scientific thinking. Topics relate to the students' lives, thereby arousing their curiosity and increasing their motivation to learn.. Teachers from each participating school are supported with on-going professional development for the delivery of the curriculum and use of appropriate pedagogy.

Synthetic Scorecard

Designed for Grades 4-5

Synthetic biology is a young field with promises of finding solutions to issues such as water and environmental pollution, making more nutritional food, treating cancer and other medical conditions, cleaner energy, and improving computer power. Biologists, electrical engineers, and computer scientists merged forces to develop this venture. Taking the approach of design, test, build enables participants to work together to develop methods of standardization, abstraction, and synthesis that are used while engineering biological systems. The genetic code of G, A, T, C can be written and programmed at the cellular level inexpensively with a predictable outcome. In order for this coding to occur, DNA must be able to be sequenced and synthesized.

These processes and others require specialized equipment and protocols that have been shared with biotechnology. All of this has helped to develop a registry of standardized parts available for use in assemblies. This database has been developed through an international effort. http://biobricks.org/about-foundation/.   As the field of synthetic biology expands, so will the parts registry and applications of this technology.

Students completing this curriculum will understand:

- Develop an awareness of the discipline of synthetic biology.
- Identify applications of synthetic biology.
- Refine skills necessary to carry out procedures related to biotechnology and synthetic biology.
- Engage in and evaluate modeling and simulations.
- Use real world data.

Synthetic Scorecard
Unit Summaries

B + E = SB

B + E = SB encourages students to examine their ideas and perceptions about biology and engineering as they predict how these disciplines could possibly work together in the field called synthetic biology. Potential applications of this field are explored in this introduction to the curriculum.

Students will:

- Generate ideas about the work and roles of biologists and engineers.
- Make inferences about the potential applications for the field of synthetic biology.
- Describe and communicate ideas about synthetic biology.

Come Scale Away

DNA may be small compared to a human, yet compared to an individual cell the amount of DNA contained within the cell is multiple times the length of cell. Experiencing a logarithmic scale ranging from nanometers to kilometers, accompanied with visual cues, will allow students to gain perspective of scale involved in **Come Scale Away.**

Students will:

- Analyze a series of objects on the basis of their length from smallest to largest given a set of photos not to scale.
- Explain the meaning of the metric prefixes kilo-, milli-, micro-, and nano-, in terms of powers of 10.
- Model the length of DNA in an E. coli bacterium.
- Discuss the use of models including their benefits and limitations.

Synthetic Scorecard
Unit Summaries

Scratch Cat Fever

Just as programming exists for computers, it also exists for biologic systems. Scratch Cat Fever enables students to investigate the concept of abstraction. Through a series of programming experiences they will explore inputs and outputs, programming and sequencing of scripts, and creating a program to obtain a specific outcome.

Students will:

- Determine a series of mathematical and other functions by observing a set of input/output values.
- Investigate the sequencing of various computer programming scripts to achieve a desired outcome.
- Carry out a series of directions or procedures.
- Create a computer program using an online visual programming platform to achieve a desired outcome.

Standardized Parts

At the heart of synthetic biology is the development of new biologic systems through the insertion of standardized parts into cells to make novel products. Learning to manipulate a database of simulated biological units encourages students to imagine potential products that could be designed. After manipulating the needed building blocks, students will assemble multiple innovative products using this simulation in Standardized Parts.

Students will:

- Construct a specific set of directions to move a hypothetical robot from one location to another location.
- Identify and explain the relationship between giving directions and developing systems within synthetic biology.
- Use a database to collect information and standardized parts in order to develop synthetic biological units.
- Develop synthetic biological units to be placed within a hypothetical E.coli cell by incorporating the use of plasmids, terminators, promoters, ribosome binding sites, open reading frames, and coding sequences.
- Discuss how the development of these biological units relies upon the arrangement of standardized parts in an effort to perform an intended function.

Synthetic Scorecard
Unit Summaries

Streaking

Biotechnology provides the skills needed to complete many of the tasks to carry out the work of synthetic biologists, including the growing of needed cells. In Streaking, techniques needed to culture yeast cells will be practiced and employed as students culture samples. Various treatments will be applied to yeast cultures to test for any effects on growth of the yeast cultures.

Students will:

- Use models to practice culturing techniques for growing yeast.
- Design an experiment to evaluate effects of treatments on yeast growth.
- Predict the outcome of treatments on yeast growth.
- Collect, analyze, interpret, and explain data.
- Measure and quantify colony growth.

Pop Culture

Cells go through various stages of growth throughout their life cycles. Characteristics help to identify each of these phases. Pop Culture provides a variety of activities, both quantitative and qualitative, for students to explore this logistical growth process. Students will:

- Construct a specific set of directions to move a hypothetical robot from one location to another location.
- Identify and explain the relationship between giving directions and developing systems within synthetic biology.
- Use a database to collect information and standardized parts in order to develop synthetic biological units.
- Develop synthetic biological units to be placed within a hypothetical E.coli cell by incorporating the use of plasmids, terminators, promoters, ribosome binding sites, open reading frames, and coding sequences.
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Synthetic Scorecard
Unit Summaries

Protein Power

Protein Power introduces students to the abundance, significance, wide range, and critical aspect of proteins at the cellular level through a card game. Making models of proteins furthers the complex and intricate world of proteins.

Students will:

- Interpret, classify and evaluate proteins according to functions.
- Defend their decisions based on evidence.
- Model protein folding.
- Predict the effects of misfolded proteins.

TAG…You're It

Models are built to gain perspective on how DNA is transcribed and translated. The importance of proteins continues in TAG…You're It. Students are introduced to the science behind the proteins: DNA transcription to messenger RNA and translation of the mRNA by ribosomes into the amino acid sequence which form a necessary protein. The importance of the sequencing of the four nitrogenous bases that form the various amino acids is explored through several activities in this unit

Students will:

- Construct a specific set of directions to move a hypothetical robot from one location to another location.
- Construct models of the processes of transcription and translation.
- Evaluate the modeling process.
- Describe amino acids.
- Represent and interpret protein chains.
- Identify and evaluate strategies to solve a problem.

Synthetic Scorecard Unit Summaries

Separation Anxiety

Purification of proteins needs to occur for researchers to use specific proteins. Separation Anxiety provides a series of inquiry activities which engage students in a multi-step simulation of purifying for a particular protein. First, students explore tools and the tools' efficiency; second, students practice extracting a protein of interest, and lastly the class sets economic parameters prior to the last round of purification.

Students will:

- Investigate and test tools for separating proteins.
- Design, test, and refine a plan for separating proteins.
- Collect, measure, analyze, interpret, and communicate results.
- Evaluate models based on evidence.
- Collaborate to determine parameters of evaluating results.

How Are 'Hue'?

There are other methods of separating materials based on their characteristics, including chromatography and gel electrophoresis. How Are 'Hue'? engages students in learning the lab skills needed to successfully carry out these practices, including pipetting, while investigating the composition of various materials.

Students will:

- Carry out procedures & predict outcomes based on previous data.
- Develop lab techniques involved in pipetting.
- Work cooperatively in groups.
- Collect, analyze, interpret, and compare data.

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Synthetic Scorecard
Unit Summaries

The Heist

Chasing Vermeer, about an international art scandal based in Chicago, sets the stage for the culminating activity. Next, students are immersed in solving an art crime. Using biosensors and the lab techniques they have learned, they need to determine, are the paintings real or forgeries? Evidence will be presented to the Museum Board during **The Heist**

Students will:

- Read and discuss a piece of fiction.
- Identify key characters and events.
- Describe applications and techniques of synthetic biology and biotechnology.
- Conduct experimentation on samples to generate data.
- Collect, analyze, evaluate, interpret, and compare data.
- Communicate, present, and defend results based on data.
- Develop and present a multi-media presentation plan.