Learn biotechnology, biophysics and business through scientific thinking and innovation

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# Abstract

Scientific, leadership and innovation skills are also an integral framework of the curriculum. All of them together or individually are important for enhancement of knowledge, critical thinking, and creativity. Integration of knowledge and skills from biotechnology, biophysics and business can enhance scientific thinking and enhance the ability to innovate in students. Biotechnology is an amalgamation of natural and engineering sciences which primarily uses advances of molecular biology for application to improve human health, agriculture, medicine, environment and nature. Biophysics is the interdisciplinary science to study complexity in structure of molecules and proteins. Bio-business is the transdisciplinary field in which approaches and strategies of business are applied to a biological phenomenon, natural and synthetic product. This lesson highlights the interdisciplinary nature of biotechnology and biophysics and provides an introduction to key concepts.

# Description

In this lesson students will learn concepts of recombinant DNA, cloning and expression. Further students will apply knowledge and skills to innovate ways to clone & express the gene to form a heterologous protein. Further ideate those concepts and innovative ways to develop a biotechnology company. Students will be taught using PowerPoint slides and videos. Students will engage in learning activities to advance knowledge and attain both transferable and transferable skills. Students will also participate in teamwork taking up leadership roles to complete the group task. Students for engagement evidence will utilize Padlet and Google tools.

# Learning Objectives

Upon completion of this lesson, students will be able to…

* **describe** how to create a recombinant DNA
* **list** different ways to clone and express recombinant DNA
* **explain** the importance of biotechnology in nature.
* **explain** the pros and cons of biotechnology applications.
* **design** a biotechnology company by selecting different leadership roles and skills.

**Lesson Schedule**

**Teaching (20 min)**

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| --- | --- | --- |
| **Resource** | **Instructor notes** | **Time** |
| **Powerpoint Slides** | Instructors may teach about restriction enzyme digestion, plasmid, genome, ligation, recombinant plasmid , transformation, concept of cloning, expression of protein, history of biotechnology and application of biotechnology.  And a brief introduction to the pros and cons of biotechnology. | 7  3 |
| **Video** | Instructors may teach examples of biotechnology - dolly sheep, finally types of biotechnology - human, environmental, industrial, animal and plant. | 7 |
| **Research Articles / Videos / PowerPoint Slides** | Instructors may teach leadership roles and team work. | 3 |

# Learning (40 min)

|  |  |  |
| --- | --- | --- |
| **Learning Process** | **Instructor notes** | **Time** |
| **Exploration** | Students will search for gene(s) of interest on NCBI PubMed, Google Scholar and other sources - Students will open the NCBI PubMed and then search for articles, download the articles in a google folder (to attain organizational skills). Then read about the importance of genes as explained in the second step. Also download the FASTA Sequence to be used in later steps. | 7 |
| **Discussions** | Students will then discuss and select the genes of interest, explaining the scientific reason behind selection of genes in a Google Doc. | 5 |
| **Analysis** | Students will then use Google Sheets to compare the genes of interest in different organisms and create graphs. | 5 |
| **Innovation** | Students will then think of new ways to clone and express the gene(s) to produce a heterologous protein. | 7 |
| **Critical Thinking** | Students will also use a software and Padlet (submit evidence) to understand the structure of protein of the gene of interest – using ([RCSB PDB - 3D View](https://www.rcsb.org/3d-view)), and iCn3D ([iCn3D: Web-based 3D Structure Viewer](https://www.ncbi.nlm.nih.gov/Structure/icn3d/)). Students will summarize the structure of the gene. | 5 |
| **Scientific Thinking** | Students will use Google Slides or PowerPoint slides to explain the importance of method, protein and its management, which is useful for mankind. | 10 |
|  |  |  |

**Assessments (30 min)**

|  |  |  |
| --- | --- | --- |
| **Assessment type** | **Instructor notes** | **Time** |
| **Group** | Students will be asked to summarize the gene of interest and state the scientific reason behind selecting the gene. Finally, why the gene sequence is different in organisms. | **3** |
| **Group** | Students will be asked to explain the innovative way of cloning and expression of genes. | **3** |
| **Group** | Students will asked to evaluate the structure of the proteins as shown by the Mol\* 3D Viewer and iCn3D. | **3** |
| **Group** | Students will be asked to explain the importance of biotechnology in nature through a Fish-Bowl Debate - Students will be asked to explain the pros and cons of biotechnology applications in debate | **12** |
| **Group** | Students will be asked to design and innovate a biotechnology company by selecting different leadership roles and skills. - Students after learning the concept and content pertaining to biotechnology and innovating new ways to produce a heterologous protein- will then design a mini-framework (plan of action) to design a biotechnology company - each member of the group will take a leadership role- write some sentences about their responsibilities and contributions. | **9** |

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| --- | --- | --- |
| **Additional Assessment** | **Instructor notes** | **Time** |
| **Reflection** | Students will write an individual and group reflection for gallery walk. | 3 ( as per adaptation by instructor and availability of time) |
| **Extension assignment** | Each group of students can also create a Google website for a biotechnology company. | May be given as an Project work |

**General rubric and teaching resource suggestions** ( Instructors may create their own rubric and can also use additional resources to teach)

* Students will be assessed on their scientific thinking, scientific writing and scientific presentation.
* Students will be assessed on the creativity of creating a gallery walk.
* Students will be assessed on critical thinking, organizational and presentation skills of the website.

**OpenStax**

* <https://openstax.org/books/concepts-biology/pages/10-1-cloning-and-genetic-engineering>
* <https://openstax.org/books/concepts-biology/pages/10-2-biotechnology-in-medicine-and-agriculture>
* <https://openstax.org/books/concepts-biology/pages/10-3-genomics-and-proteomics>
* <https://openstax.org/books/biology-2e/pages/17-1-biotechnology>

**Research Article**

* Expression of Two Nitrosomonas Europaea Proteins, Hydroxylamine Oxidoreductase and Ne0961, in Escherichia coli. Pankaj V. Mehrotra, Kelli Brunson, Alan Hooper, and David Bergmann

<https://southdakotaacademyofscience.wildapricot.org/2012-Proceedings>