

Biomanufacturing Module 1

Lesson 1 - Introduction to Biomanufacturing

Lesson objectives:

Students will understand:

- Biological pharmaceutical products are made in large scale manufacturing facilities using living organisms (bacteria and other cells) to produce products
- This process must be tightly regulated to ensure consistent and safe supply

Essential Question

- How can biologically produced medical products be mass produced safely and effectively?

Materials:

- How vaccines are made video &/or “How Pfizer Makes its Covid Vaccine” NYTimes interactive
- Butcher Paper and Sticky Notes
- Biomanufacturing Graphic Organizer
- Introduction to Biomanufacturing Slidedeck

What Students Will Do

- Watch a short video and/or interactive showing how mRNA vaccines are produced or how recombinant insulin is produced
- Create prior knowledge and question boards based on video/interactive
- Brainstorm important factors to consider when producing biologics like insulin or mRNA vaccines
- Complete a graphic organizer to summarize the biomanufacturing process, including upstream and downstream processing, quality assurance, and quality control

Teacher Preparation

- Prior to class prepare two pieces of poster paper/ butcher paper. At the top of one, write “What I think I know”. On the top of the other, write “What I want to know”.
- Ensure the video is ready to play
- Make copies of the graphic organizer student handout

Organizer

Time	Activity	Materials
5 minutes	Watch video/ interactive	Video/interactive
10 minutes	Question Board	Butcher paper and sticky notes
10 minutes	Class brainstorm	Whiteboard or smartboard
25 minutes	Biomanufacturing GO & Slideshow	Slide deck and graphic organizer (1 per student)

Procedure

Introduction (Teachers can choose either insulin or vaccine storyline)

A. Insulin Storyline

1. Ask students what they know about the insulin protein. Likely most students will know that it is used to treat diabetes, or maybe even that it is used to treat Type 1 Diabetes specifically. If you have not yet covered content related to insulin, you could spend a few minutes here reviewing the protein and its function. The first 5 1/2 minutes of this 12 min video from Novo Nordisk is a good place to start:
<https://www.youtube.com/watch?v=HJGjNTJgf48>
2. Ask students how they think insulin protein is produced on a large scale for the world's population. Take responses from 2 or 3 students. Do not correct misconceptions or add to their explanations.
3. Tell students you will watch a short video about the production of insulin. Play the video for them:

- a. https://www.youtube.com/watch?v=ZVa0BZnSd_A

B. mRNA Vaccine Storyline

4. Ask students what kind of vaccines the Moderna and Pfizer Covid vaccines are. Likely most students will know they are RNA vaccines. If you have not yet covered content related to RNA, you could spend a few minutes here reviewing the molecule and its function.
5. Ask students how they think RNA vaccines are produced on a large scale, for the world's population. Take responses from 2 or 3 students. Do not correct misconceptions or add to their explanations.
6. Tell students you will watch a short video about the production of vaccines. Play the video for them:

- a. https://www.youtube.com/watch?v=H09Lk_MW5Dk (1:47 - 2:29)

As an alternate, if your school has access to the New York Times, have students visit the interactive, "How Pfizer Makes Its Covid Vaccine" -

- b. <https://www.nytimes.com/interactive/2021/health/pfizer-coronavirus-vaccine.html>

Question Board

7. Handout two colors of sticky notes to each table group. Designate one color "things I already know" and the other for questions. Tell students to write one thing per sticky note. If students already know things about vaccine or insulin production, they should record this on the first color sticky note and bring to the appropriate poster at the front of the room.
8. Tell students to write at least 2 questions they have about insulin production or vaccine production on the second color sticky note, and put on the class "Things I Want to Know" poster.
9. As students finish, read student ideas and questions from both boards, categorizing questions. Refrain from answering questions at this point.

Brainstorming

10. Ask students to imagine they are picking up a prescription for medicine from the pharmacy, or receiving a vaccine from their doctor. Ask what sorts of assumptions they should be able to make about the medicine or pharmaceutical product. (That the ingredients are as indicated, that the dose is correct, that it has been tested to be safe, that it has been tested to work, that it is not contaminated, etc.) Have students share a few ideas.
11. Next ask student teams to imagine they are responsible for producing a medicine or vaccine. Tell them to brainstorm in small groups as many factors as possible they would be responsible for ensuring. Have a record keeper record the ideas for each group.
12. Ask groups to share ideas, and record on the board. These could be similar to the ideas above, along with ideas such as cost and advertising/marketing.

Introduction to biomanufacturing

13. Tell students that because of the ideas shared during the brainstorming session, the production of pharmaceuticals, especially biologics, requires a tightly regulated process.
14. Distribute the Biomanufacturing Process Graphic Organizer to students.
15. Display the Introduction to Biomanufacturing Slide Show, and have students record notes on their graphic organizer as you proceed.