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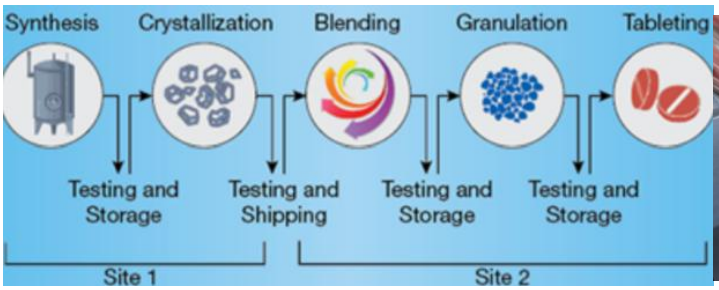

Pharmaceutical Production

https://www.aiche.org/resources/publications/cep/2018/december/pharmaceutical-manufacturing-current-trends-and-whats-next

The DeSIRE Advanced Manufacturing course defines and uses the term "Pharmaceutical Production" as using the latest in technologies, processes, operations, product quality, and cost efficiency to make medications consumed by humans and animals.

By a definition, pharmaceutical production is the process of industrial-scale synthesis of drug development and operations, such as milling, granulation, coating, tablet pressing, blending, and many others.

DeSIRE student learners should discuss key aspects of production operations and processes involved in the finished pharmaceutical product used by the consumer. Some production process steps should include ingredients and materials required for advanced manufacturing,

processing and process methods, product quality samples and testing, product labelling, and packaging.

What is Research?

The DeSIRE Advanced Manufacturing course defines and uses the term "Research" as the process of seeking out answers to a specific problem. The process includes the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings.

By a definition, research is a systematic process of investigating a topic through the collection and analysis of data, aiming to discover new knowledge, expand understanding, or test existing theories on a subject, often involving a structured approach like the scientific method to reach reliable conclusions.

Key points about research:

- To gain new insights, answer questions, or solve problems by gathering and interpreting information.
- Methodical approach:
- Research typically follows a structured process, including defining a research question, formulating a hypothesis, collecting data, analyzing results, and drawing conclusions.
- Data collection:
- Researchers gather information through various methods like experiments, surveys, interviews, observations, or document analysis.
- Critical analysis:
- Collected data is carefully examined and interpreted to identify patterns, trends, and relationships

DeSIRE student learners should discuss key aspects of research across the three industry areas of advanced manufacturing energy systems, food production and food manufacturing, and Pharmaceutical production. Applications of research should also include project-based learning using the scientific method, communication, critical thinking, collaboration, and creativity in presenting and reporting out research results.

Introducing DeSIRE Students to Pharmaceutical Advanced Manufacturing and Engineering

Group Activity 1: About the Pharmaceutical Industry?

Research Questions:

- What is the Pharmaceutical Industry? What products does it include?
- What are some careers and jobs found in the Pharmaceutical Industry?
- Who regulates the Pharmaceutical Industry in the United State of America?

- Who is the Food and Drug Administration (FDA). What are their roles and duties?

Group Activity 2: What is Pharmaceutical Engineering and Advanced Manufacturing?

Research Questions:

- What is Pharmaceutical Engineering?
- What is the relationship of Pharmaceutical Engineering and Advanced Manufacturing?
- How is chemical engineering applied to pharmaceutical industry?
- What are some different forms of medicine? How are they manufactured?
- Why do we take certain medicines to cure illnesses, but not others?

Group Activity 3: Drug Research and Advanced Manufacturing?

Research Questions:

- Look up the medical drug ibuprofen and one other medical drug active pharmaceutical ingredients.
    - What illness(es) is it used for?
    - What is the recommended dosage (if available)?
    - Are your drugs available over the counter? What does over-the-counter mean?
    -
    - What company manufactures the drugs. If your drug has a generic form, list a company that manufactures it.
    - How do you think the product is manufactured (made)?
    - What processes do you think are used and how?
    - What equipment and processes do you think are used and how?
    - What is the common dosage for your drug – each?

Engineers in the pharmaceutical industry are creating modular, continuous, and scalable processes and manufacturing environments to meet cost and quality challenges head on.

Pharmaceutical manufacturers are under constant pressure to fast-track innovation and increase the speed at which they introduce successful drugs to market. Various scientific advances are fueling a fresh wave of pharmaceutical manufacturing innovation. These advances are supported by the U.S. Food and Drug Administration (FDA), which is helping accelerate the industry's throughput of lifesaving medicines and therapeutics.

References:

- https://www.aiche.org/resources/publications/cep/2018/december/pharmaceutical-manufacturing-current-trends-and-whats-next

Introduction to Google Sheets

Time Requirement: 60 Minutes

Lesson Summary:
Students will be able to enter data, tabulate data, learn a few shortcuts, and create graphs/tables from data entered. Students will complete a scavenger hunt worksheet that requires them to follow steps for data entry, tabulation, and graph creation in Google Sheets. The final product will be a line graph based on the data they enter.

Introductory Activity:

- Begin with a brief discussion on how data is used in everyday life (e.g., budgets, sports statistics).
- Ask students, "How do you think data can help us visualize information?"
    - Introduce a fun fact about data visualization to spark interest
- Demonstrate the Google Sheets interface, highlighting key features.
    - Show how to enter data into cells and format it (e.g., bold, color).
    - Introduce shortcuts (e.g., copy, paste, undo).
- Explain how to select data for graph creation.
    - Common Misconception: Students may think that graph creation is only for specific types of data; clarify that any data can be visualized.

Learning Activities:

Guided Practice:

- In pairs, students will practice entering sample data provided by the teacher.
- Monitor students as they work, asking guiding questions like:
    - "What happens when you change the data in this cell?"
    - "Can you show me how to format this data?"
- Offer support for students struggling with shortcuts or data entry.

Independent Practice:

- Students will receive a scavenger hunt worksheet with specific tasks to complete in Google Sheets, including:
    - Entering a specified set of data.
    - Creating a line graph based on their data.
    - Formatting the graph with labels and colors.

Extension Activity:

Students who finish early can explore additional graph types (e.g., bar graphs, pie charts) and create a new graph from the same data set.

DeSIRE defines pharmaceutical production as the process of making medications for humans or animals.

Protect That Pill

Time Required: 45 minutes

Much design goes into developing pill tablet coatings and the systems that apply these coatings. Varying the material or thickness of a coating can dramatically affect a medication's effect on the body. Engineers play an integral role in this process, from developing and testing chemicals for coatings to designing the complex systems used to mass produce uniformly-coated pills.

After this activity, students should be able to:

- Describe how simulation is used to test the human body's reaction to medication.
- Explain how engineers can directly and indirectly help people who are suffering from medical issues, specifically those relating to the digestive system.
- Describe the function of the stomach in the human digestion process.

A protective coating can serve a variety of functions: Protecting the chemical components in a pill during packaging and handling; protecting the pill from temperature, moisture or light during storage; covering the bad taste of the pill chemicals; smoothing the edges so it is easier to swallow; helping the pill resist digestion to protect certain parts of our digestive system; providing an extended dose of medication; providing a surface for printing; and enhancing the image of the drug for marketing purposes.

Teacher Background Sheet:
https://www.teachengineering.org/content/cub_/activities/cub_biomed/cub_biomed_lesson05_activity1_background.pdf

Reference: https://www.teachengineering.org/activities/view/cub_biomed_lesson05_activity1

Pill Dissolving Demo

Time Required: 30 minutes.

In a class demonstration, the teacher places different pill types ("chalk" pill, gel pill, and gel tablet) into separate glass beakers of vinegar, representing human stomach acid. After 20-30 minutes, the pills dissolve. Students observe which dissolve the fastest, and discuss the

remnants of the various pills. What they learn contributes to their ongoing objective to answer the challenge question presented in lesson 1 of this unit.

Biomedical engineers use experiments to discover how various chemical substances react in the human body, for example, the absorption of medication and how the body breaks down the outer coatings of pills and capsules. To test new medicines, scientists use solutions with chemical compositions similar to the environments found in the human body to model various body reactions. Engineers also create all sorts of devices and tools used in experiments, and creative medicine delivery materials and equipment, including syringes and patches, and even the factories for making different types of pills and bottling liquids.

After this activity, students should be able to:

- Describe what happens to a pill in the human stomach.
- Explain which pill form is absorbed the fastest.

https://www.teachengineering.org/activities/view/van_feelbetter_lesson01_activity01

Introduction to Water Chemistry

- https://www.teachengineering.org/lessons/view/wst_environmental_lesson02

Acid and Base Rainbows

- https://www.teachengineering.org/activities/view/cub_air_lesson06_activity1

Biosensors for Food Safety

- https://www.teachengineering.org/lessons/view/mis_biosensors_lesson01