uBEATS Teacher's Guide:

Drug Discovery

(Grades 11-12)

This teacher guide is a supplementary text to support the use of the uBEATS Drug Discovery pharmacology module for grades 11-12.

To help students develop the knowledge necessary for an incredible future in health care, we created UNMC Building Excellence in Academics Through STEM (uBEATS), an online health science resource for Nebraska students.

UNMC uBEATS modules are short (15 minutes or less), interactive online health science modules to supplement curriculum taught in grades 6 – 12. These do not replace curriculum, but are a supplement for teachers and students incorporating evidence based information and UNMC expert guided material. Each module is chunked into sections with formative and summative assessments with immediate feedback provided.

Tips on how to utilize uBEATS modules:

- Internet access is required to view uBEATS modules.
- For those who have access to one-to-one technology, modules can be used in or outside of the classroom as a topic introduction, extension, or review.
- For classrooms without individual student devices modules can be used in whole group instruction. Formative assessment questions can use the teacher's preferred call and response method and summative assessment questions can be displayed on the board and answered individually by students or printed and distributed to students after viewing the module.

Objectives

- Describe how compounds found in nature are used as a basis for drug development.
- Identify multiple steps of the drug discovery process: Target Validation, Preclinical testing, Investigational New Drug application, Phases 1-4 of Clinical Studies, and New Drug approval.
- Explain the financial costs associated with the drug discovery process.

ubeats@unmc.edu

© University of Nebraska Medical Center, 2020

Introduction

The process of getting a drug on the market is extremely complex. To help you understand this process of drug discovery, pretend that you are a pharmaceutical scientist. Throughout this module you will discover a new drug and put the drug through the approval process. Note: This is a fictional scenario. The drug is fictional, the company is fictional, all of the specific details about this drug are fictional. The scenario is designed to help you understand the very real process of drug discovery.

Prior Knowledge

Before beginning this module, the student should understand the Next Generation Science Standards (NGSS) featuring Three-Dimensional Learning.

Core Idea PS1.B: Chemical Reactions A Framework for K-12 Science Education

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.

Science and Engineering Practices NGSS

- Constructing explanations and designing solution

Crosscutting Concepts NGSS

- Patterns
- Stability and change

© University of Nebraska Medical Center, 2020

Key Terms/Vocabulary

Compounds, therapeutic agents, aspirin, salicylic acid, acetylsalicylic acid, penicillin, antibiotic, pneumonia, gonorrhea, rheumatic fever, staphylococcus, sodium bicarbonate, antacid, heparin, anticoagulant, morphine, target validation, cellular, molecular, organismal, preclinical, in-vivo, in-vitro, toxicity, efficacy, Investigational New Drug Application (IND), U.S. Food and Drug Administration (FDA), Investigator IND, Emergency Use IND, Treatment IND, animal pharmacology and toxicity, manufacturing information, clinical protocols, institutional review board (IRB), Phases 1-4 of clinical studies, fast track, breakthrough therapy, accelerated approval, priority review, patent, diabetes, insulin.

Science Standards

Nebraska Science Standards

SC.HSP.6 Structure and Function: Anatomy & Physiology

- Gather, analyze, and communicate evidence of the relationship between the structures and physiological processes of the human body systems.

SC.HSP.3 Chemistry: Structure and Properties of Matter

- Evaluate a solution to a complex, real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Extensions of the lesson

- To help students become more familiar with the Key Terms of this module, the teacher can use the vocabulary list for a classroom Word Wall, or integrate the vocabulary into classroom word games during review sessions.
- To help the students see personal relevance, suggest that they have a **private** conversation at home about the safety of new drugs developed during the COVID-19 pandemic.
- As student misconceptions become apparent, the teacher may need to reinforce these important concepts:
  - All forms of life in nature are composed of chemical compounds.
  - Some of those molecules can be isolated and used to prevent or treat human diseases.
  - Some drugs are based on molecular compounds found in nature, while other drugs are synthesized in chemical laboratories.

© University of Nebraska Medical Center, 2020

- A rigorous, multi-step protocol is in place for studying the risks and benefits of each new drug that is developed.
- The first three phases of clinical trials gradually expose more people to the new drug. During times of emergency, there are special processes available for changing the timeline.
- Once a new drug has been approved for distribution to the general public, on-going Phase 4 Clinical Studies are conducted to monitor the effects and analyze the safety and benefits of the new drug.

Enrichment

- For information about career opportunities, see UNMC's Careers in Healthcare.
- Students should be watchful in current events for recent stories about the development and approval process for new drugs developed during the COVID-19 pandemic.
- The National Institute of Allergy and Infectious Diseases offers a 4-minute video explaining How a Drug Becomes a Drug.
- A classroom lab activity about the source and use of salicylic acid is offered by AAAS at this site: Acid Stomach.
- To make connections in your community, contact local universities, medical centers, clinics, drug manufacturers, and pharmacists.

© University of Nebraska Medical Center, 2020