

Developing a New Flu Prevention Drug

Core Concepts:

- Development and scientific testing of new drugs is a time consuming and expensive process.
- Clinical trials are scientific experiments used to determine if a drug is both safe and effective.

Class Time required:

3-5 forty-minute class periods

Teacher Provides:

For each student

- Copy of student handout entitled **Developing A New Flu Prevention Drug**

For each team of 2-3 students

- **Part B: Phase 2 Clinical Trials** - laboratory supplies as described below:
 - Three tubes or cups labeled “Human Volunteer 1”, “Human Volunteer 2”, and “Human Volunteer 3”. *Note: 15 ml test tubes with lids or 1 ounce portion cups with lids work well for this.* Fill the tubes or cups as shown on the chart below.

Label on tube or cup	Fill tube or cup with
Human Volunteer 1	10 ml tap water 1 drop white vinegar 2 drops 2% phenolphthalein **
Human Volunteer 2	10 ml tap water 3 drops white vinegar 2 drops 2% phenolphthalein **
Human Volunteer 3	10 ml tap water 2 drops white vinegar 2 drops 2% phenolphthalein **

**2% phenolphthalein can be purchased from most science supply companies.

- 8 plastic toothpicks or food picks or solid stirring rods
- Small tube labeled “FLUSTOP (10 mg per drop)” containing at least 2 mL of 1% washing soda solution. *Do NOT use baking soda.* Washing soda can be purchased in the laundry section of a supermarket. To make a 1% washing soda solution, mix 100 ml of water with 1 gram (scant 1/4 teaspoon) of washing soda.
- Plastic dropper labeled “FLUSTOP (10 mg per drop)”

- **Part C: Phase 3 Clinical Trials** - laboratory supplies as described below:
 - 25 mL graduated cylinder or graduated pharmacy dosing cup.
 - 2 sandwich size plastic bags labeled “For Influenza Tests” each containing 1/8 teaspoon of **washing soda** (sodium carbonate) available in laundry section of supermarket. Do NOT use baking soda (sodium bicarbonate). Be careful to place the labels on the bags so that they will not interfere with viewing the test sheets in the bags.
 - **Experimental Group Test Sheet** printed on white cardstock paper and cut to size (each group will get ¼ sheet). See page x. Spot 1 of the five circles with phenolphthalein. Use a cotton swab dipped in 1% or 2% phenolphthalein solution to make a spot in the middle circle.
 - **Control Group Test Sheet** printed on white cardstock paper and cut to size (each group will get ¼ sheet). See page xi. Spot 4 of the five circles with phenolphthalein. Use a cotton swab dipped in 1% or 2% phenolphthalein solution to make spots in the four circles on the right.
 - Access to water. Providing a cup or bottle with at least 50 mL of tap water for each group avoids need for students crowding around a sink.

Teacher Resources:

VIDEOS - The following sites provide videos that can be used as an introduction to the drug development and testing processes. Consider showing one of these videos before starting Part B and another of these videos before starting Part G.

- **How a Drug Becomes a Drug** is a 4 minute video from the National Institute of Allergy and Infectious Disease that begins with describing basic research and also describes clinical trials. <https://www.youtube.com/watch?v=U96He401wj4>
- **Introduction to How Drugs are developed** is an animated 2 minute video that describes the phases of clinical research. It is particularly engaging for below average learners as an introduction. <https://www.youtube.com/watch?v=vwDvAEmq-cM&app=desktop>
- **Medical Research** provides short videos about clinical trials. The link below opens to a video on the phases of clinical trials. Scroll down to see other brief videos about clinical trials. <http://research.emedtv.com/clinical-trials-video/different-phases-of-research-studies-video.html>
- **Clinical Drug Trial Phases Explained** is a 4 minute video describing clinical trial phases and what happens after clinical trials. <https://www.youtube.com/watch?v=1FDB8vsOE0g&app=desktop>
- **The Drug Discovery Process** a 3 minute video describing the drug discovery and clinical testing process. <https://www.youtube.com/watch?v=DhxD6sVQEYc&app=desktop>

Additional Resources:

- **The Drug Development Process** website from the FDA provides detailed information for patients about the drug development process. <http://www.fda.gov/forpatients/approvals/drugs/default.htm>
- **The FDA’s Drug Review Process: Ensuring Drugs are Safe and Effective** provides a variety of resources designed to educate the public about the drug development and approval process. <http://www.fda.gov/drugs/resourcesforyou/consumers/ucm143534.htm>
- **FDA Drug Approval Process** infographic is a great visual way to learn about the drug development process. Needs to be printed on legal size paper. <http://www.fda.gov/downloads/Drugs/ResourcesForYou/Consumers/UCM284393.pdf>

Note: Consider doing a Google search using the search term “drug development infographic” and printing several different types of infographics. You can ask students to evaluate which infographic was most effective in helping them complete Part B and in helping them understand and remember the drug development process.
- **Clinical Trials.gov** is a registry and results database of publically and privately supported clinical trials conducted around the world. It has a searchable database that is well worth exploring. It also provides information for patients and families. <http://www.clinicaltrials.gov>
- **NIH Clinical Research Trials and You** provides a wealth of information about clinical research, written for the general public. <http://www.nih.gov/health/clinicaltrials/index.htm>
- **Ethics in Clinical Research** web page from the NIH describes the ethical guidelines for clinical research. <http://clinicalcenter.nih.gov/recruit/ethics.html>
- **NIH Curriculum Supplement Series: Exploring Bioethics** includes information on teaching bioethics to high school students. Module 5 Research Ethics: The Power and Peril of Human Experimentation may be used as an extension to the “Developing A New Flu Prevention Drug” activity. <https://science.education.nih.gov/HighSchool/ExploringBioethics>
- **VCT Virtual Clinical Trials: Advances in Neuroscience** provides three cases in which students are involved in designing clinical trials. Requires Flash Player. Also explore the For Educators, Fun Stuff, etc. at the top of the page. <http://vct.rice.edu/>
- **The Clinical Trials Process: From Trial to Treatment** provides a concise infographic chart that compares the different phases of clinical trials. <http://visual.ly/understanding-phases-clinical-trials>

Suggested Class Procedure:

NOTE: Both animal testing and human testing involve ethical issues that may concern students. Be prepared to value their concerns. Emphasize that the FDA requires both animal and human testing before a drug can be sold as a prescription or over-the-counter medicine. The focus of this activity should remain on understanding how animal and human testing is important for ensuring that medicines are safe and effective.

Homework Prior to Day 1

1. Distribute **Developing A New Flu Prevention Drug** instructions to each student.
2. Students work individually to complete **Part A: FLUSTOP in the News**. This may be done in class or for homework.
3. Students may be concerned about animal testing using monkeys. Consider addressing the importance of testing a new drug on animals before testing it on humans.

Day 1

4. Explain that new drugs (medicines) need to be tested in humans to be sure that they are safe and effective. Scientific tests involving humans are called clinical trials.
5. Show one of the brief videos listed in the Teacher Resources as an introduction to clinical trials and the drug development process.
6. Assign students to work in teams of 2-3 students. Explain that they will be conducting experiments or interpreting data from human testing (clinical trials) for the FLUSTOP medicine.
7. Distribute materials for **Part B: Phase 1 Clinical Trials** to each team of students:
 - 10 mL measuring cup (pharmacy dosing cup) or graduated cylinder
 - 3 small tubes or cups labeled “Human Volunteer 1”, “Human Volunteer 2”, and “Human Volunteer 3”
 - 8 plastic toothpicks, food picks, or stirring rods
 - Small tube labeled “FLUSTOP (10 mg per drop)”
 - Plastic dropper labeled “FLUSTOP”
8. Students use distributed materials and work with their partner to complete **Part B: Phase 1 Clinical Trials**. *Note: Consider asking students for possible explanations for why there is variation in the amount of FLUSTOP that is safe for the three volunteers.*
9. Optional: Ask students to share their answers to questions 9-13 with another team or with the entire class.
10. Ask students to explain the purpose of Phase 1 clinical trials.
11. Be certain that students dispose of the three tubes/cups (“Human Volunteer 1-3”).

Day 2

12. Distribute materials for **Part C: Phase 2 Clinical Trials** to each team of students:
 - 25 mL graduated cylinder or graduated pharmacy dosing cup
 - 2 plastic bags labeled “For Influenza Tests” containing washing soda
 - **Experimental Group Test Sheet** spotted with phenolphthalein
 - **Control Group Test Sheet** spotted with phenolphthalein
 - Cup or bottle of water
13. Students use distributed materials and work with their partner to complete **Part C: Phase 2 Clinical Trials**.
14. Optional: Ask students to share their answers to questions 16 through 20 with another team or with the entire class.
15. Ask students explain the purpose of Phase 2 clinical trials.

Day 3

16. Students complete **Part D: Phase 3 Clinical Trials**. No additional materials are required. This is a “minds-on” rather than “hands-on” activity.
17. Optional: Use the multiple choice questions on pages vi through ix as homework or a quiz.

Multiple Choice Questions - *A New Flu Prevention Drug*

1. It is important to include a control group in a well-designed experiment so that
 - A. The experiment only includes adult males.
 - B. The control group can control what is done to other people involved in the experiment.
 - C. The results from the control group can be compared to the experimental group results.
2. A fake medication that looks like the real medication but does not contain any substance likely to have an effect is called a
 - A. Placebo.
 - B. Illegal drug
 - C. Experimental medication.
3. An experiment conducted on a small number of healthy human subjects to determine the dose of a medicine that would be safe to use for further testing on humans is called a
 - A. Phase 1 Clinical Trial.
 - B. Phase 2 Clinical Trial.
 - C. Phase 3 Clinical Trial.
4. An informed consent form for a clinical trial must include
 - A. the names of all people participating in the clinical trial
 - B. An explanation of the risks and benefits of participation in the clinical trial.
 - C. Information on whether they will be in the experimental group or the control group.
5. The main purpose for involving thousands of subjects in a Phase 3 Clinical Trial is to
 - A. Advertise the benefits of a medicine to a large number of people.
 - B. Identify people who could be featured in product advertisements for a medicine.
 - C. Determine whether a medicine is safe and effective for many different types of people.
6. Phase 4 Clinical Trials continue to study a drug's safety and effectiveness
 - A. After a drug is sold as a prescription medicine.
 - B. After a drug is sold as an over-the-counter medicine.
 - C. Until the drug is approved by the FDA for sale as a prescription medicine.
7. Researchers randomly assign research subjects to the experimental group or control group so that they can be more confident that
 - A. There are no errors in their experimental procedure and data collection.
 - B. The observed effects are due to a treatment and not to other characteristics of the groups.
 - C. Human subjects are not exposed to any risks from the experimental procedure.

Base your answers to questions 8 through 10 on the reading below.

New Drug in the Fight Against Hair Loss

Scientists announced the discovery of HAIRKEEP, a drug that prevents male pattern baldness. Male pattern baldness (MPB) occurs when hair follicles are damaged by the hormone dihydrotestosterone (DHT). HAIRKEEP is a small molecule that binds to hair follicle cells and blocks the action of DHT.

Tests using rats treated with HAIRKEEP have shown that it was effective in maintaining the health of hair follicle cells. Recently, University of Fiction scientists administered HAIRKEEP injections to an experimental group of 20 monkeys for 10 days. For a comparison, a control group of 20 other monkeys was given a placebo (injection of water) for 10 days. Microscopic examination of hair follicles in both groups of monkeys revealed that 80 % of the monkeys who received a placebo had damaged hair follicles. Only 10% of the monkeys who were treated with HAIRKEEP had damaged hair follicles.

In the future, HAIRKEEP may be used by humans to prevent hair loss in people who have inherited the male pattern baldness gene. Scientists caution, however, that human testing is needed to provide evidence that HAIRKEEP is both safe and effective for use by humans.

8. The monkeys who received a placebo were
 - A. The control group.
 - B. Given lower doses of HAIRKEEP.
 - C. Selected because they had healthy hair follicles.

9. Scientists tested HAIRKEEP on animals because
 - A. HAIRKEEP is only effective when used in rats and monkeys.
 - B. Animals are less likely than humans to be harmed by HAIRKEEP.
 - C. Animal tests may reveal that HAIRKEEP is not safe and should not be tested on humans.

10. According to the article, which step in the drug development and testing process has not been completed?
 - A. Research to determine the cause of male pattern baldness.
 - B. Research to identify a substance that may prevent male pattern baldness.
 - C. Research to provide evidence that HAIRKEEP may prevent human male pattern baldness.

11. The data table below shows the results of testing HAIRKEEP on 3 healthy human subjects to determine the dose of HAIRKEEP that would be safe for humans.

Human Subjects #	Highest dose of HAIRKEEP that did <u>not</u> result in harmful effects (milligrams per injection)
1	20
2	30
3	10

What is the highest dose of HAIRKEEP that should safely be used for human testing on larger numbers of subjects?

- A. 10 milligrams per injection
- B. 20 milligrams per injection
- C. 30 milligrams per injection

Base your answers to questions 12 through 15 on the information below.

Researchers conducted a Phase 2 clinical trial to determine if HAIRKEEP was safe and effective for preventing male pattern baldness. They enrolled 100 male subjects who had inherited at least one gene for male pattern baldness. At the beginning of the experiment, researchers counted the number of hairs in 1 square centimeter of scalp for each of the subjects. Subjects were given a weekly injection of either HAIRKEEP or a placebo for one year. At the end of the year, researchers counted the number of hairs in 1 square centimeter of scalp and calculated the percentage hair loss for each subject.

12. For an experiment to determine if HAIRKEEP is effective, which treatment should be given for one year to the control group subjects?
- A. Treatment with HAIRKEEP
 - B. Treatment with a placebo
 - C. Treatment with DHT (a hormone that causes male pattern baldness)
13. Random assignment to create an experimental group and a control group for an experiment would best be accomplished by assigning
- A. Bald people to the experimental group and people with hair to the control group.
 - B. Males to the experimental group and females to the control group.
 - C. Subjects to an experimental treatment or control treatment by chance (like the flip of a coin).

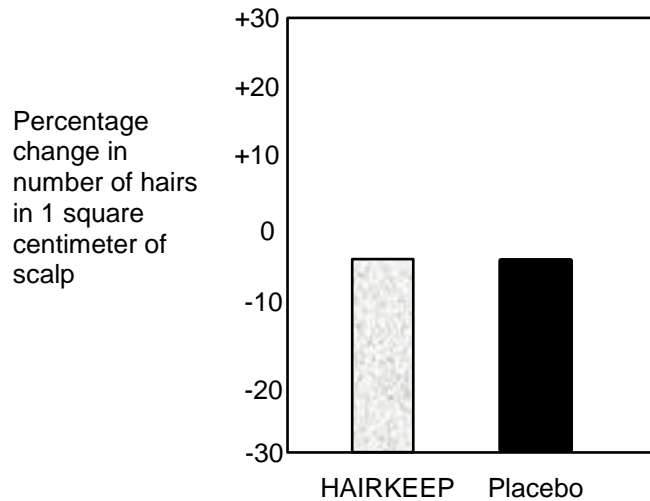
14. The researchers also collected information on side effects that the subjects experienced during the experiment.

Percent of research subjects that reported side effects	With HAIKKEEP	With Placebo
Dizziness	2%	3%
Headache	10%	2%
Insomnia	10%	10%
Fatigue	5%	1%

Based on the information in the table above, what side effects are likely caused by HAIKKEEP?

- A. Headache and fatigue
- B. Headache and dizziness
- C. Headache and insomnia






15. The graph below shows the results of the Phase 2 clinical trial.








According to the information in the graph, HAIKKEEP

- A. Is effective for preventing hair loss.
- B. Is effective for treating hair loss.
- C. Is not effective for reducing hair loss.






Experimental Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5






Experimental Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5






Experimental Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5






Experimental Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5






Control Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5






Control Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5

Control Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5

Control Group Influenza Test Sheet

				
Subject 1	Subject 2	Subject 3	Subject 4	Subject 5