

A Look inside the Lab: Flow Cytometer

OVERVIEW

The VMP Next Step Science resources provide mini lessons, videos, and other materials related to the practice of science. These resources are meant to enhance the exploration of a particular topic or offer insights into the profession of scientific research.

The Next Step Science “A Look inside the Lab” series is comprised of reading passages and videos designed to introduce students to pieces of laboratory equipment and the scientists who use them. The series can be used to enhance an existing lesson or as a starting point for introducing a concept.

Each mini lesson includes:

- Short video featuring scientists from the Children’s Hospital of Philadelphia Research Institute discussing their work and how they utilize the lab equipment on a day-to-day basis
- Related reading passage
- Teacher guide
- Student worksheet

Additional VMP “A Look inside the Lab” videos and materials can be found at vaccinemakers.org/next-step-science.

OBJECTIVES

“A Look inside the Lab” series activities are designed to:

- Introduce students to equipment commonly used in medical research laboratory settings and explore how the technology impacts and serves society
- Introduce students to scientists, science careers, and the types of investigations that scientists conduct on a day-to-day basis
- Provide an opportunity for students to read informational text about scientific topics to enhance their understanding of how science is done and consider how scientists develop possible solutions to problems

Flow Cytometer Lesson Objectives:

- Students will be able to explain how flow cytometers work and why they are useful laboratory tools.
- Students will be able to understand why cell sorting is useful for blood donations and in scientific research.

LESSON RESOURCES

- Lesson video, *A Look inside the Lab: Flow Cytometer*: <https://vimeo.com/530459433>
- Video transcript PDF: [https://vaccinemakers.org/sites/default/files/resources/Look in Lab FlowCytometer video transcript Final.pdf](https://vaccinemakers.org/sites/default/files/resources/Look%20in%20Lab%20FlowCytometer%20video%20transcript%20Final.pdf)
- Reading passage, *The Scientist's Sorting Machine*: [https://vaccinemakers.org/sites/default/files/resources/Look Lab Flow Cytometer reading%20passage Final.pdf](https://vaccinemakers.org/sites/default/files/resources/Look%20Lab%20Flow%20Cytometer%20reading%20passage%20Final.pdf)
- Student worksheet: [https://vaccinemakers.org/sites/default/files/resources/Look Lab Flow Cytometer vocab worksheet FINAL.pdf](https://vaccinemakers.org/sites/default/files/resources/Look%20Lab%20Flow%20Cytometer%20vocab%20worksheet%20FINAL.pdf)
- Resources related to flow cytometry:
 - Flow Cytometry, Cleveland Clinic, <https://my.clevelandclinic.org/health/diagnostics/22086-flow-cytometry>
 - Flow Cytometry: An Overview, Current Protocols in Immunology, <https://currentprotocols.onlinelibrary.wiley.com/doi/10.1002/cpim.40>
 - How a Flow Cytometer Works, ThermoFisher Scientific, <http://thermofisher.com/us/en/home/life-science/cell-analysis/cell-analysis-learning-center/molecular-probes-school-of-fluorescence/flow-cytometry-basics/flow-cytometry-fundamentals/how-flow-cytometer-works.html>
 - CD Markers in Cancer Diagnosis and Treatment, <https://www.verywellhealth.com/understanding-cd-markers-2252468#:~:text=CD%20markers%2C%20also%20known%20as,was%20first%20established%20in%201982>
 - What is the Cell Surface Marker?, CusaBio, <https://www.cusabio.com/Cell-Marker/Cell-Surface-Marker.html>
 - Cell Surface Marker, Integrative Pancreatic Cancer Therapy, <https://www.sciencedirect.com/topics/medicine-and-dentistry/cell-surface-marker>
 - Facts about Blood and Blood Typing, American Red Cross, <https://www.redcrossblood.org/donate-blood/blood-types.html>
 - Average distribution of blood types in the United States as of 2023, Statista, <https://www.statista.com/statistics/1112664/blood-type-distribution-us/>
 - The Blood Typing Game, The Nobel Prize, <https://educationalgames.nobelprize.org/educational/medicine/bloodtypinggame/>

LESSON

The lesson progression outlined below can be completed in two to three 50-minute class sessions.

Engage

Time: 15-20 minutes

Have students:

- Brainstorm examples from daily life where sorting is useful.
 - Laundry (lights from darks)
 - Grocery shopping (finding what you need in the right aisles)
 - Organizing papers or files (making items easier to find and access)
 - Workout plans (not overusing one muscle)
 - Music playlists
- Have a discussion to share student examples. Lead the discussion toward how sorting might be useful in science and health.

Explore

Time: 15-20 minutes

Have students:

- Read part 1 of the passage, “The Scientist’s Sorting Machine.”
- Play the Blood Typing Game:
<https://educationalgames.nobelprize.org/educational/medicine/bloodtypinggame/>

Explain

Time: 15-20 minutes

Have students:

- Use the Think-Pair-Share strategy to have students consider the importance of cell surface markers on blood cells.

Elaborate

Time: 20-30 minutes

Have students:

- Read part 2 of the passage, “The Scientist’s Sorting Machine”
- Watch the short video, *A Look Inside the Lab: Flow Cytometer*
- Complete the lesson vocabulary worksheet related to the reading passage and video and look up or discuss any terms that may be unfamiliar.

Vocabulary list: Cell surface markers, "cluster of differentiation" (CD) markers, fluorescence-activated cell sorting (FACS), fluorescently labeled antibody, forward and side scatter graphs, Rhesus (Rh) factor, universal donors, universal recipients

Evaluate

Time: 30-45 minutes

Have students:

- Discuss theoretical/possible issues that may require sorting.
- Develop a hypothesis and experimental design addressing these issues which includes the use of sorting.
 - Note: This exercise can be formatted by the teacher to fit the class level. The sorting can involve flow cytometry or can be any type of sorting based on teacher preferences.

RUBRIC: STUDENT WORKSHEET – Lesson Vocabulary

Cell surface markers	A molecule found on the surface of a cell. The molecule is typically either a protein or carbohydrate. They are often used to identify cells.
"Cluster of differentiation" (CD) markers	A specific type of cell surface marker that is used to identify different leukocytes (white blood cells).
Fluorescence-activated cell sorting (FACS)	A type of flow cytometry in which fluorescent labels are used to identify and separate different types of cells in a sample.
Fluorescently labeled antibody	An antibody coupled with a fluorescent label that enables scientists to identify and sort cells in the lab. The antibody is chosen based on the cells of interest, so that it will bind to those cells and then the fluorescent label will enable cells bound by the antibody to be visualized or sorted.
Forward and side scatter graphs	Two graphs used to interpret data from a flow cytometer. Forward scatter graphs measure relative cell size and side scatter graphs measure relative cell complexity.
Rhesus (Rh) factor	A cell-surface marker protein found on the surface of red blood cells. Presence of Rh factor is denoted as positive and absence as negative when referring to an individual's blood type.
Universal donors	People with type O negative blood. Known as universal donors because their blood type is compatible with all blood types and as such, it can be used for any patients that need blood.
Universal recipients	People with type AB positive blood. Known as universal recipients because they can receive red blood cells from people with any other blood type.