Instructor Guide:

Introduction to the immune system and immunology

Overview

This lesson introduces basic concepts related to the human immune system and immunology for high school students. It includes an instructional worksheet with student questions, an interactive activity demonstrating a technique commonly used in immunology research, and a guided experimental design.

Grade level

Introductory to advanced high school biology (grades 9-12), after some cell biology and human health content has been introduced

Learning objectives

- Students explain key features that distinguish the human innate vs. adaptive immune system and name some important cell types in the immune system
- Students explain the concept of homeostasis as it applies to the immune system, and describe some consequences of when homeostasis is lost
- Students construct a model that demonstrates what a flow cytometer does
- Students describe what flow cytometry does, how it is useful in studying the immune system, and its limitations
- Students design an experiment using flow cytometry to study an immune system function or disorder of their choice
- Students conduct independent research into the immunology literature

Equipment

- Laptop or desktop computers
- Internet access
- For flow cytometry activity in Part 2: see worksheet for detailed list of common classroom and household supplies

Outline and contents

Section 1 – Introduction to the immune system

- Explanatory handout introduces fundamental concepts in the immune system, including
  - Innate vs. adaptive immune system
  - The immune response to a threat
  - Balance of the immune system (homeostasis vs autoimmunity vs susceptibility)
- Students answer questions reinforcing their understanding of fundamental concepts in immune function

Section 2 – Flow cytometry, an important method in immunology

- Students learn what a flow cytometer is and how it can be used in immunology research
- Instructions for how to build a model flow cytometer from common classroom/household supplies that sorts marbles, candies, or other small round objects
- Students answer questions about their observations of the model flow cytometer
- Students answer questions about interpreting flow cytometry data, applications of flow cytometry data

Section 3 – apply your knowledge

Students design their own experiment that uses flow cytometry to investigate a disease or immune system function of their choice

Expected student knowledge

Students should already be familiar with:

- The idea that there are many different types of cells in the body
- The scientific method and how to develop a research question

Students do not need to already be familiar with:

- Any detailed knowledge about the immune system
- Types of cells in the immune system and how they work
- Any methods used for studying the immune system

Standards alignment

Next Generation Science Standards

Science and Engineering Practices	
Asking questions and defining problems	X
Developing and using models	X
Planning and carrying out investigations	X
Analyzing and interpreting data	X
Using mathematics and computational thinking	X
Constructing explanations and designing solutions	
Engaging in argument from evidence	
Obtaining, evaluating, and communicating information	X

Crosscutting concepts	
Patterns	
Cause and effect	
Scale, proportion, and quantity	
Systems and system models	X
Energy and matter	
Structure and function	X
Stability and change	X

Disciplinary Core Ideas - Life Science	
HS-LS1: From Molecules to Organisms	X
HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.	X
HS-LS2: Ecosystems	
HS-LS3: Heredity	
HS-LS4: Evolution	

About the Allen Institute for Immunology

The Allen Institute is a nonprofit biomedical research institute located in Seattle, Washington. Our four divisions – Allen Institute for Brain Science, Allen Institute for Cell Science, Allen Institute for Immunology, and The Paul G. Allen Frontiers Group – are dedicated to answering some of the biggest questions in bioscience and accelerating research worldwide. We share all of our data and research findings with the scientific community and general public. Launched in 2003 by founder Paul G. Allen, the Allen Institute is supported by government, foundation, and private funds to enable its projects.

The Allen Institute for Immunology works to understand the dynamic balancing act of the human immune system, how it senses friend from foe and what goes wrong when we're ill. This will help us to improve immune health and how we diagnose, treat and prevent immune-related diseases. Everything we do begins with patients who are living with and suffering from these diseases. We believe that by unlocking the mysteries of the immune system, we can make a significant improvement in patients' health and well being.

To learn more, visit immunology.alleninstitute.org.