BioMEMS Applications Activity: ELISA
Participant Guide

Description and Estimated Time to Complete

This activity provides the instructions for accessing an on-line tutorial on ELISA (Enzyme Linked Immunosorbent Assay), a medical analytical device that uses antibodies as biosensors. As an analytical device, ELISA provides an accurate measurement of antibody or antigen concentration in a sample. As a bioMEMS, an ELISA is a Lab-on-a-Chip system, a small, portable, rugged, low-cost, easy to use, yet extremely versatile and capable diagnostic instrument.

This activity allows you to explore the ELISA process. It also provides post-activity questions for you to demonstrate your understanding of the information presented in the tutorial.

Estimated Time to Complete
Allow at least 30 minutes to complete.

Introduction

A MEMS platform used in diagnostic bioMEMS is the integrated fluidic microchip. Integrated fluidic microchips allow separations, chemical reactions, and calibration-free analytical measurements to be directly performed with very small quantities of complex samples. These samples include whole blood, water (fresh and salt water), food, and tissue culture. This technology lends itself to applications such as clinical diagnostics (including tumor marker screening) and environmental sensing in remote locations.

The ELISA is a diagnostic microfluidic bioMEMS device that can analyze one sample for several different analytes simultaneously. Therefore, the ELISA is basically a lab on a chip. Lab-on-a-Chip (LOC) systems enable the design of small, portable, rugged, low-cost, easy to use, yet extremely versatile and capable diagnostic instruments. One company, BioLOC ™, developed an ELISA on a polymeric compact disk (CD) (shown in the figure) called the CD-ELISA. This device is still under development, but tests have been positive.

Conventional ELISAs are performed typically in a 96-well microtiter plate about the size of the palm of your hand and that resembles a miniature ice cube tray. The ELISA process involves the identification of a specific antibody or antigen in a sample. Like most biosensors, the ELISA uses a specific antibody (capture molecule) to identify an unknown antigen or antibody (target molecule). When a match is found, a signal is generated. There are several steps to the process and between each step a wash of reagent solution is required. When executed manually, the process is time consuming, labor intensive, and subject to human error.

The CD-ELISA is essentially a compact disk with microfluidic channels that direct the reagent solutions to a reaction area. BioLOC's CD-ELISA™ used micro reservoirs at varying distances from the CD's center to store the various reagent solutions. Different sized microchannels and different rotating speeds controlled the release of the reagent solutions at different times. An analyses of CD-ELISAs in 2011 found that the most challenging part of the CD-ELISA is "controlling the flow process for different biological testing solutions, i.e. the controlling sequence for the microfluidic channel valves." Research conducted in 2011 tested out a new semi-circular microfluidic valve to help alleviated this problem.[1]

BioLOC's CD-ELISA™
[Image printed with permission of BioLOC LLC]

For more information on ELISA review the video and tutorial provided by Rockland antibodies & assays. http://bit.ly/2vYJ05d This tutorial goes into more detail on the types of ELISAs, Competitive and Inhibition ELISA, Overview of Steps in Different ELISA Systems, and Recommended Reagents.

This activity will help you to better understand how conventional ELISAs work and how they could be incorporated into a bioMEMS device.

Activity Objectives and Outcomes

Activity Objectives

- Explain the antibody/antigen ELISA process.
- Correctly demonstrate connecting the enzymatic reaction with amplification of biological signals.

Activity Outcomes

You should be able to explain or illustrate the antibodies-antigens process and how bioMEMS can be used for ELISAs.

Resources

Computer with high-speed Internet access.

Documentation

Your documentation should include all of the questions asked during each stage of this activity and your answer to each of these questions.

Documentation should also include the Post-Activity Questions and your answers.

Activity: ELISA

1. Go to The Molecular Workbench at http://workbench.concord.org/database

2. In the upper right corner "Jump to Activity" #248. Select "Student". This should take you to the activity "*Amplification of Biochemical Signals: the ELISA Test." (NOTE: If you have a problem with the link, do a search within Molecular Workbench for ELISA.)*

3. Launch Activity (It may take a few minutes to download.)

4. Complete the activity by selecting all links on all pages.
   Some links are games. Some links are demonstrations.

5. During this activity, record all questions and your answers to these questions.

6. Answer the Post-Activity questions.

Post-Activity Questions

a. What does ELISA stand for?

b. What is the "antibody-antigen relationship"?

c. What is electrostatic force?

d. What are the two most important factors in affecting the outcome of an ELISA procedure?

e. What determines a positive ELISA test?

f. What is the purpose of the blocking protein in the sample well?

g. What is the difference between the direct ELISA and indirect ELISA?

h. Name at least two (2) possible applications for ELISAs as bioMEMS.

Post-Activity Questions / Answers

a. What does ELISA stand for?
Answer: Enzyme Linked Immunosorbent Assay

b. What is the "antibody-antigen relationship"?
Answer: In our bloodstream there are molecules floating around called antibodies that have just the right shape to attach themselves to antigens, molecules or parts of molecules that are associated with bacteria, viruses, or other foreign bodies.

c. What is electrostatic force?
Answer: Force between charges. The force that causes opposites to attract and likes to repel.

d. What are the two most important factors in affecting the outcome of an ELISA procedure?
Answer: Type of antibody and temperature

e. What determines a positive ELISA test?
Answer: The antigens present match with the antibodies used so the antibodies stay stuck to the well wall despite washing. The antigens react with a substrate solution creating a brightly colored solution.

f. What is the purpose of the blocking protein in the sample well?
Answer: The blocking protein is used to prevent the antibodies from directly sticking to the well. The well is chemically treated so all proteins will stick to it.

g. What is the difference between the direct ELISA and indirect ELISA? Outline the steps of both processes.

Answer: The direct ELISA measures the amount of antigens in the sample using a antibody with attached enzyme. The indirect ELISA measures the amount of antigens using first an antibody without an enzyme followed by an antibody with attached enzyme.

h. Name at least two (2) possible applications for ELISAs as bioMEMS.
Answers will vary, but some examples are Home Pregnancy test, various blood tests to test for viruses, bacteria, pollen or fungi, and an artificial nose to detect for specific particles in the sample.

Summary

This activity provided the opportunity for you to explore the ELISA procedure and the antibody-antigen relationship. It also provided the basic information necessary to understand how ELISA is an ideal procedure for a bioMEMS application.

References

[1] "Parametric analysis of a novel semi-circular, microfluidic CD-ELISA valve:. Samuel I En Lin. Journal of Biological Engineering 2011, 5:15. http://www.jbioleng.org/content/5/1/15

[2] The Molecular Workbench at http://workbench.concord.org/database

[3] SCME's *BioMEMS Applications Overview Learning Module*

[4] Innova Bioscience FlexLISA® Kits https://www.innovabiosciences.com/flexlisa/flexlisa-kits.html

[5] Enzyme-Linked Immunosorbent Assay (ELISA) – video and tutorial. Rockland antibodies & assays. http://bit.ly/2vYJ05d

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