CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Anjini Karthik

Project Number
36735

Project Title
Combating Viral Outbreaks: Rapid and Selective Detection of Viruses Using Inexpensive Polymer Films

Abstract

Objectives/Goals
Viral diseases are a leading cause of death worldwide. In order to control the spread of viral infections and minimize fatalities, we must be able to detect virus pathogens rapidly and accurately. However, the methods we currently use to diagnose viral infection, such as PCR, take far too long#often taking hours to days, when results are required in minutes. These methods are also laboratory based, expensive, and labor-intensive. An urgent need exists for a tool that can detect viral pathogens rapidly, selectively, at the point of care, and at a low cost. This study addresses this need by producing a virus imprinted polymer (VIP).

Methods/Materials
A nanopatterned polymer film of polydimethylsiloxane (PDMS) was produced by curing a prepolymer in the presence of a template with the target virus on it; after the polymer hardened, the template was removed, leaving on the imprinted surface cavities (mean size of 120±4 nm) that were complementary in shape and could specifically capture the target virus. Two inactivated viruses with similar shape, Influenza A (HK68) and Newcastle Disease Virus (NDV), were employed as model strains.

Results
Evaluation of the VIP revealed that it has distinct advantages over existing viral detection methods. The VIP captures a target virus from an aqueous suspension of ultralow volume (5 microL) after only 1 minute of contact, detects viruses at concentrations found in influenza infections, and is sensitive down to 8 fM without requiring any additional device. The polymer film, which was first imprinted with HK68 and exposed sequentially to suspensions containing fluorescently labeled NDV and HK68, was able to preferentially bind HK68 at a capture ratio of 1:8.0. When the procedure was reversed and the polymer was imprinted with NDV, the capture ratio was 1:7.6. These results were obtained within 20 minutes of static exposure and indicate that the VIP distinguishes between viruses with a similar size and shape on the basis of chemical recognition.

Conclusions/Discussion
Production of virus-imprinted films can be readily scaled to large quantities and yields a disposable, simple-to-use device that allows for rapid detection of viruses. Thus, it is envisioned that the VIP can be used in the field as a disposable tool for the rapid and selective detection for viruses at the point of care, without electricity, and in line with the World Health Organization guidelines.

Summary Statement
I produced a wipe to detect viral infection rapidly (within 1 minute), selectively, at the point of care, and at a low cost, using a virus imprinted polymer (VIP).

Help Received
I acknowledge my family and teacher for constant support; Dr. Ren, Dr. Margulis, and Dr. Zare from Stanford University for guidance and for giving me the opportunity to develop my project in their lab; Dr. Leung for providing virus particles; and the journal Nanoscale for publishing this research.