

**University of Arkansas Microelectronics-Photonics Graduate Program**  
**PhD Candidacy Exam – March 2006**

**Advanced Materials, Processing, And**  
**Devices at the Micro to Nano Scale as Applied To Chemistry and Biology**

**PROBLEM TO BE SOLVED**

According to information provided by Center for Disease Control and Prevention (CDC), avian influenza is an infection caused by avian (bird) influenza viruses. While these viruses occur naturally among wild birds, they are very contagious and can be deadly to some domesticated birds such as chickens and turkeys.

Avian influenza rarely affects humans. However, there are many different types of avian influenza viruses and one particular type, avian influenza type A (H5N1), has been identified as the cause for recent infections in birds and humans in Asia. Human infection of the H5N1 virus is usually the result of close contact with infected birds or surfaces contaminated with secretion from them. Person to person transmission is possible, although rare.

Based on studies performed in biomedical laboratories, some antiviral medications such as oseltamavir and zanamavir prescribed for human influenza (H1N1, H1N2, and H3N2) can be used to treat avian influenza. But just like any other virus, avian influenza can mutate and new medications will have to be developed very quickly to combat new viral strains. Furthermore, there is currently no commercially available vaccine for H5N1 virus. This is the main reason why US government officials are worried about a worldwide outbreak (pandemic) of avian influenza.

You are the CTO of a small biomedical laboratory in charge of developing a nanotechnology based biosensor for fast-detection of avian influenza virus. Currently, there are two types of test kits available on the market. One is based on polymerase chain reaction (PCR) for analyzing the virus' genomes and the other checks for the presence of antibody in the patient. Your biosensor can consist of some components found in these test kits, but the sensor output must be an electrical instead of an optical signal. Also, the response time and sensitivity level of your biosensor must be at least close to what the PCR and antibody tests can provide.

The implementation of this biosensor must be in a field instrument, capable of being used in developing countries, and able to operate continuously in stand-alone portable mode for a minimum of 12 hours without recharge.

## **YOUR DELIVERABLE**

Your task is to write an internal proposal for your corporate officers describing your approach to this issue. In this document you should lay out the development of a nanotechnology based biosensor for avian influenza. Be sure you address all of the following in detail:

**Current technologies** – What is currently available on the market? What are the sensing mechanisms; time response; sensitivity level; and cost for available products? The current state-of-the-art for both the science and the implementation should be described, making use of diverse resources such as science literature, journals, conference proceedings, the internet, patents or other sources of existing public knowledge. Be sure to cite all references used.

**Your design** – What is the basis for the chosen sensing mechanism? What is the estimated response time and sensitivity level? Why is your sensor better than the existing test kits? Be sure to address both the scientific and engineering issues of the question.

**Other Issues** – Address any other issues of major importance

**Manufacturing flow** – provide a detailed step-by-step process flow for manufacturing the biosensor in your company.

**Testing and Qualification** - Describe a set of tests and demonstrations that you will use to demonstrate the effectiveness of your biosensor.

**Cost Analysis** - Provide a cost analysis for manufacturing 10,000 units of your biosensor unit on an annual basis. Make sure to include the cost for raw material acquisition, labor, etc.

**Intellectual Property** - List in rank order of importance all IP sources that were consulted while formulating the answer, including the full list of examined documents along with key important reference data as an appendix to this exam. For instance, if the IP source is a patent, include the patent number; title; inventor name; and assignee name. (The full list will not be counted as part of the 15-page limit.) The three that are the most significant threats to your solution should be discussed within the 15-page document, making comparisons of strengths and weaknesses of these approaches relative to your own.