Developing Research Questions & Hypothesis

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This module has two guided-inquiry projects. Read each project carefully and answer the questions below to complete this lab.

Guided-Inquiry Project 1: Microscopic Examination of Forensic Samples

Scientists have solved most cases in forensic science today by careful examination of the physical evidence under a microscope. There are two types of microscopes that have been applied to forensic investigations; upright and inverted microscopes. In an upright microscope, you look down to see the image, and with an inverted, you look up. In an inverted microscope, the light source and the condenser lens are above the specimen, with the condenser lens typically concentrating the light. The objective and the turret of the microscope are located on the bottom. The objective focuses the light on producing a real image. When the inverted microscope is fitted with fluorescence capability, the resulting device generates an image capable of using optical sectioning to get a better resolution of the fluorescent image. These capabilities are useful in studying the properties of both organic and inorganic substances. In this project, you will use a microscope fitted with both Fluorescence Resonance Energy Transfer (FRET) and Total Internal Reflection Fluorescence (TIRF) capabilities to generate unique images for different fiber samples.

Instrumentation: Inverted Fluorescence Microscope

Guided-Inquiry Project 2: High-Performance Liquid Chromatography Standard Operating Procedures (SOPs) for Obtaining Method Validation Parameters of Drug Mixtures in Analytical Method Transfer

Students obtaining a degree in chemistry take quantitative analytical chemistry and an upper-level analytical chemistry course, such as instrumental analytical chemistry. In both your quantitative and instrumental analysis courses, the learning outcomes for the following have been completed; method development, method validation parameters (i.e., figures of merit: accuracy, precision, specificity, selectivity, sensitivity, repeatability, reproducibility, linearity, range, detection limit, quantitation limit, robustness, and ruggedness), quality control, quality assurance, and the associated statistics. Chapter 5 in the quantitative analysis class explains the meaning of all these parameters. One purpose for method validation, especially in the industry, is to transfer the method from the development laboratory to the manufacturing quality control laboratory. It is the analytical chemist who develops the technique and conducts the method validation process. Once transferred to the new lab, another analytical chemist repeats the method validation process in their laboratory and will follow the written procedure to try to replicate the same figures of merit. The question that remains is, “Did this method transfer without any statistical loss in the figures of merit due to differences in equipment and personnel?” The focus of this project is for students to develop a validated standard operating procedure (SOPs) for obtaining figures of merits for four drugs prepared as a mixture. The result of your experiment will be reproduced by students at other institutions to confirm that your SOP was transferrable without significant statistical loss in the figures of merit.

In this project, your task will be to develop an HPLC instrumentation method to investigate analytical method transfer parameters for four drugs in one mixture. The compounds have to be studied as a mixture, not individually.

Instrumentation: High-Performance Liquid Chromatography

Post-Laboratory Questions

1. Based on the problem described under **guided-inquiry project 1**, write three clear research questions using fibers as the sample that can be investigated with a microscope that has both FRET and TIRF capabilities (hint: review background of FRET and TIRF microscope to develop a good research question).
2. Write three clear hypotheses (one for each research question) you developed in **question 1** for guided-inquiry project 1.
3. Go into SciFinder and conduct a literature review for guided-inquiry project 1. Identify two research papers that directly relate to analyzing fibers with microscopes. You can identify research papers from other sources if you prefer. You will upload your identified articles (PDF files only, no webpage links are accepted) under comments for this submission (be sure to label your articles appropriately so it can be identified as related to **guided-inquiry project 1**). As part of your response, include the title of your articles under this question.
4. Based on the problem described under **guided-inquiry project 2**, write three clear research questions using drugs as the sample of interest to investigate and develop analytical figures of merit with an HPLC instrumentation (hint: review background of HPLC to develop a good research question).
5. Write three clear hypotheses (one for each research question) you developed in **question 4** for guided-inquiry project 2.
6. Go into SciFinder and conduct a literature review for guided-inquiry project 2. Identify two research papers that directly or closely relate to developing analytical figures of merit for drugs using an HPLC. You can identify research papers from other sources if you prefer. You will upload your identified articles (PDF files only, no webpage links are accepted) under comments for this submission (be sure to label your articles appropriately so it can be identified as related to **guided-inquiry project 2**). As part of your response, include the title of your articles under this question.

Instructor tips for writing a meaningful hypothesis.
If you write a hypothesis that answers the three questions below, it will be a sound hypothesis.

a. What is being tested?
b. What is the test performed?
c. What do you expect to learn from the test?

Due Date: **September 18, 2019**.

Submit your report via **Turnitin in Canvas** using the upload submission button. Hardcopy or email attachment reports are not acceptable.

Acceptable Report Format

The report must be submitted as a **Microsoft Word** document using the upload submission link. All identified articles must be submitted under the comment section of the submission link

All reports must contain a cover page with the following information: **Title of the experiment**, **student name**, **class (CHE 2121 - Quantitative Analysis Lab)**, **semester**, and **date**.

Font Style: **Times New Roman**

Font Size: **12-point**

Title Font Size: **14-point bold**

Student Name: **14-point bold**

Note: students who do not follow writing format instructions will be marked down.