

## Teacher Guide

### Methods for Protein Purification Natalie Kuldell

This Protein Purification lesson is intended to give students some insight into the process and tools that scientists and engineers use to explore proteins. The lesson is designed to extend the knowledge of students who are already somewhat sophisticated and who have a good understanding of basic biology. For example the lesson presumes students are familiar with the major components that are found in cells. Students and teachers who are not comfortable with the roles that various macromolecules play in cells should review this content before launching into this lesson, since the first segment reviews the names, basic functions and building blocks for the major components of a typical cell, but does not explicitly teach much about them.

The question that then motivates this lesson is, “what makes two cell types different?” This question is posed in several ways. First is to use foods as sources of cells and ask if foods that are protein-rich are in fact made of protein and nothing else. In fact, all cells must have all the major macromolecular components if the cells are to grow and divide. Thus proteins exist everywhere, in all foods—protein-rich or junk—but in different amounts. A second way we ask the question of what distinguishes two types of cells is to ask the students to consider the differences between green peas and lentils. The two kinds of plant cells look very different from one another and are mixes of many kinds of macromolecules but in fact most of the proteins in these two different types of cells are the same. It is counterintuitive to realize that a few specialized proteins can give rise to such different appearances and this raises the experimental question: how could you study just a subset of specialized proteins that distinguish one cell type from another? Two techniques that are useful in this regard are considered in this lesson, namely SDS-PAGE, which separates proteins by size, and protein fractionation, which divides pools on proteins based on some physical attribute (size, charge, solubility...)

Since the lesson is not designed to be a “training video,” the level of detail presented for the two techniques is insufficient for a class to reproduce them. It is hoped, however, that after seeing some of the steps and materials needed to perform these techniques in a laboratory setting, the scientific principles behind the procedures make more sense or are more interesting to the students.

The lesson can motivate further classroom discussion about other separation techniques, e.g. what if you wanted to study the nucleic acids or the lipids in a cell? how different would those be from one cell type to another? what kinds of separation technologies exist for those? The lesson can also motivate further

discussion about what you might want to do once you have a lot of some purified cellular materials, e.g. could they be useful as therapeutics, diagnostics, foods, investigative tools? Finally, examples in which genetic engineering can be used to turn cells in to machines that mass produce some valued compound that is then separated out from the rest of the cellular material could be explored. Insulin production is the traditional classroom example in this arena but more recent ones, like artemisinin and spider silk proteins could also be explored.