# Nanotechnology Project IV

## Project Summary

This project aims to identify and efficiently remove selected antibiotics from agricultural water sources employing nano-technology based processes

## Introduction

This project will allow to address a current unmet need in obtaining survey data on key classes of antibiotics and the identification of major contaminants in various agricultural water sources and effluents. The work will result in development and testing of a sustainable and eco-friendly process for the removal of such contaminates. Data obtained from this project may be used to correlate the concentration of the selected antibiotics to their potential health risk through relevant existing models.

## Problem Statement

The River Nile accounts for around 97% of Egypt's total fresh water resources of which approximately 80% is used in agriculture. These figures are striking especially considering the additional limitations on water resources through the ever-increasing Egyptian population and the growing need for water resources from other Nile Basin countries. It is thus clear that water contamination in Egypt is an issue of major concern. The reuse of agricultural water therefore is a question of concern. The current project focuses on the removal of antibiotics as contaminants of emerging concern from agricultural water effluents for their safe re-use.

## Background

Antibiotics are classified as a major class of contaminants of emerging concern (CECs) that emerge from daily routine chemicals which are discarded in any form during washing and flushing and thus end up in the water and soil [1]. Despite their alarming impact, the regulatory methods of their analysis and detection have not been fully developed [2, 3]. However, recent studies have reported some of the potentially adverse effects of antibiotics on human health and the ecological system at large. Thus, there is an urgent need to find more efficient and environmentally-friendly solutions for antibiotics removal from water [4]. Recently, the use of nano-adsorbents in water treatment has been proven successful by virtue of the high surface area of these adsorbents which led to their high reactivity and hence better adsorption. Various nano-adsorbents were used in that regard such as carbon nanotubes, metal nanoparticles, polymeric nanoparticles and nano-zeolites. Magnetic nanoparticles proved useful in removing heavy metals such as arsenic, lead and zinc. Recently, there has been a growing interest in coating metal nanoparticles with biopolymers since these polymers are considered 'green water treatment agents' that can efficiently and selectively remove contaminants such as organic compounds and metals ions due to their active functional groups [5]. Not many studies were conducted on antibiotic removal from water. Primary studies included the use of permanganate and ozone to decompose pharmaceuticals [6]. Manganese ferrite nanomaterials anchored on activated carbon as well as nanocomposites produced from nanocrystalline cellulose successfully removed sulphamethoxazole from water [7, 8]. Polymer coated nanoparticles, magnetite/pectin and magnetite/silica/pectin hybrid nanocomposites were successful in the removal of ciprofloxacin and moxifloxacin from aqueous solutions [9].

## Significance

To the best of our knowledge, the data on the concentration and types of antibiotics in various agricultural Egyptian water sources and effluents is very sparse. This research would contribute to this much-needed data. This research will allow for the development and testing of efficient and eco-friendly removal processes of selected antibiotics, that are relevant to Egypt, using bio-polymer coated metal nano-particles. This will allow for the safe re-use of agricultural water effluents, an issue of great importance especially due to the current limitation on Egyptian water resources. Data obtained from this project may be used to estimate human health risks through relevant existing models. This is a challenging project that involves environmental sampling, instrumental analysis as well as the development and testing of bio-polymer coated metal nano-particles for the removal of antibiotics from Egyptian agricultural water.

## Project Description

1) Sampling and extraction of various antibiotics from agricultural water sources and effluents.
2) Analysis of extracted antibiotics employing techniques that includes HPLC.
3) Synthesis of biopolymer coated metal nanoparticles using commercially available biopolymers and biopolymers extracted from plant sources.
4) Development and testing of sorption processes for the efficient and eco-friendly removal of selected antibiotics using bio-polymer coated metal nano-particles.

## The Advancement of Scientific Knowledge and Broader Impact

This project may allow for the development of an eco-friendly cost effective antibiotic removal from water through a simple and efficient process that may have the potential for scaling up. This work will also allow for the safe re-use of agricultural water effluents, an issue of great importance especially due the current limitation on Egyptian water resources. Data obtained from this project may be used to estimate human health risks through relevant existing models.

## Biographical Sketches

Dr. Shoeib holds an Honors BSc and PhD in Chemistry from York University in Toronto, Canada. His research interests brings to bear knowledge in the areas of analytical chemistry, biophysical chemistry and molecular structural elucidation with the goal of understanding the structure, reactivity, and function of metal-containing bio-molecules, the complexes formed by these interactions and their uses in environmental, medicinal and pharmaceutical chemistry. Dr. Shoeib has supervised over 15 graduate theses, co-authored over 100-refereed publications in academic journals, and conference proceedings and received over 1000 citations.

Dr. Mayyada El-Sayed has a PhD in Chemical Engineering from Cambridge University in the UK. Her expertise lies in areas of separation processes, water treatment, and nanotechnology. She worked and collaborated in several relevant projects funded by STDF, NSF and DARPA in the fields of Environmental and Biochemical Engineering. She authored and co-authored more than 50 refereed publications in academic journals, books and conference proceedings.

## Leveraging Resources

The proposed project leverages the experience of the Co-PIs in environmental research. This experience extends to conducting surveys of contaminates in various media including water, the development of sorption separation processes for the removal of contaminants from water using nanoporous materials and bio-based materials. The Co-PIs have had previous and current fruitful collaborations employing the techniques to be used in the project which are available at AUC and other Egyptian public institutions (Cairo University and National Research Center in Cairo).

## Deliverables

This research project aims to the development of an efficient process for the removal of major contaminants of emerging concern from Egyptian agricultural water effluents for their safe re-use. The results of the research project will be disseminated through international conferences and/or journals. Deliverables also include a master thesis deposited at the Digital Archive and Research (DAR) Repository of the American University in Cairo, which is publically accessible.

## Professional Development and Mentoring Plan

The selected student will work as part of an active multidisciplinary research team with broad experience in different aspects of the proposed work. He/she will also be encouraged and supported to participate in local and international venues in the environmental field in order to develop expertise and network with peers and professionals specialized in water treatment and nanotechnology.

## References


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