

## Summer Student Research Program Project Description

**FACULTY SPONSOR'S NAME AND DEGREE:** Yingda L. Xie, MD

**PHONE:** 973-972-2246 (o)

**DEPARTMENT AND INTERNAL MAILING ADDRESS:**

Department of Medicine/Public Health Research Institute

225 Warren Street, E250D

Newark, NJ 07103

**E-MAIL:** [ylx1@njims.rutgers.edu](mailto:ylx1@njims.rutgers.edu)

**PROJECT TITLE (200 Characters max):**

*Imaging signatures of early tuberculosis*

### **HYPOTHESIS:**

Tuberculosis (TB) remains one of the leading infectious causes of death worldwide, with about 10 million new cases each year and only slow declines in incidence. Our current prevention tools are imprecise: the vast majority of people who test positive for latent TB will never develop active disease. At the same time, we now recognize that 50% or more of individuals with TB may have no symptoms and can test negative on standard sputum diagnostics.

In this study, we examine early TB using high-resolution CT imaging combined with an AI-based analysis to understand its biological diversity and identify more accurate ways to detect and stage disease before patients become clinically ill. We hypothesize that machine learning applied to chest imaging can identify and stage early TB patterns that predict progression and potential transmission – thereby guiding targeted preventive treatment.

**PROJECT DESCRIPTION (Include design, methodology, data collection, techniques, data analysis to be employed and evaluation and interpretation methodology)**

SSRP Scholars support imaging analysis for an ongoing clinical study enrolling 500 household contacts of pulmonary tuberculosis (TB) cases in Kampala, Uganda. The scholar will learn to interpret lung lesions on Chest CT scans of these household contacts, perform segmentation of these lesions using specialized software, and describe/quantify changes in these lesions among individuals who had disease progression and/or received TB treatment to inform approaches to treat early tuberculosis. Scholars will also have opportunity to audit and learn machine learning/AI-based techniques using texture and geometric features of lesions, airways, and body morphology to predict TB disease progression.

**SPONSOR'S MOST RECENT PUBLICATIONS RELEVANT TO THIS RESEARCH:**

Esmail H, et al. High resolution imaging and five-year tuberculosis contact outcomes. medRxiv [Preprint]. 2023 Jul 3:2023.07.03.23292111. doi: 10.1101/2023.07.03.23292111. PMID: 37461515

**THIS PROJECT IS:**     **Clinical**         **Laboratory**         **Behavioral**         **Other**

**THIS PROJECT IS CANCER-RELATED**

Please explain Cancer relevance

**THIS PROJECT IS HEART, LUNG & BLOOD- RELATED**  Yes

Please explain Heart, Lung, Blood relevance

Evaluates lung pathology of early tuberculosis

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### Project Description

**THIS PROJECT INVOLVE RADIOISOTOPES?**  No

**THIS PROJECT INVOLVES THE USE OF ANIMALS**   
PENDING  APPROVED  IACUC PROTOCOL #

**THIS PROJECT INVOLVES THE USE OF HUMAN SUBJECTS? YES**  
PENDING  APPROVED  IRB PROTOCOL # Pro2023001454

**THIS PROJECT IS SUITABLE FOR:**

UNDERGRADUATE STUDENTS  ENTERING FRESHMAN   
SOPHMORES  ALL STUDENTS

**THIS PROJECT IS WORK-STUDY:** Yes  or No

**THIS PROJECT WILL BE POSTED DURING ACADEMIC YEAR  
FOR INTERESTED VOLUNTEERS:** Yes  or No

To commence summer 2026, with potential option to continue analyses through academic year.

**WHAT WILL THE STUDENT LEARN FROM THIS EXPERIENCE?**

The SSRP scholar will learn how early tuberculosis appears on advanced imaging and how to systematically interpret chest CT scans in a research setting. They will gain hands-on experience identifying and segmenting lung lesions using specialized software, quantifying radiologic changes over time, and linking imaging findings to clinical outcomes such as disease progression or response to treatment. In addition, the student will develop skills in clinical research methods (e.g. defining endpoints in longitudinal cohort studies), data analysis, and image-based phenotyping, and will be introduced to machine learning approaches that use imaging features to predict disease progression. This experience integrates radiology, infectious diseases, global health, and computational analysis in a real-world longitudinal cohort study.