Name(s)

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Project Number

S0817

Project Title

Waterborne Parasite Infection Risk Mitigation via Microscopy-based Assays and Parasiticide Proteases

Abstract

Objectives

Waterborne disease remains an economic and health burden to approximately 2 billion people, particularly in impoverished regions. Current control methods for waterborne parasites are highly inefficacious and fail to manage parasite populations prior to infection. The objective of this study is to 1) create an automated assay for parasites in water bodies and 2) computationally develop a class of parasiticide proteases to reduce parasite populations.

Methods

Adaptive noise inclusion and feature extraction were performed on an image and video dataset of 5 parasite classes (Cryptosporidium, Schistosoma, etc). Individual organisms were then segmented out via Teh-Chain Approximation contouring and compiled into an ordered dataset. To address phenotypic similarity amongst parasites, a Long Short-Term Memory (LSTM) model was employed in conjunction with a Convolutional Neural Network (CNN) for contextualized image classification of the segmented organisms. Next, proteins from WBPS12 and EuPathDB were evaluated via BLAST and a literature search to find target biomarker protease substrates (TBPS) that were expressed externally in each parasite. A script was written to read PeptideCutter and PROSPER tool results for each TBPS and generate the most probable cleavage sites for protease development. PepComposer results were generated for each TBPS and analyzed to finalize the parasiticide protease scaffolds.

Results

The preliminary segmentation algorithm had an error rate of 1.2% and gathered novel, real-time metrics that were unattainable through previous methodology. Moreover, the hybrid LSTM-CNN model was 97% accurate for multi-class contextualized image classification. Additionally, parasiticide protease scaffolds were evaluated through FoldX energy scores, and 5 were selected with the highest stability and specificity.

Conclusions

This proposed system consists of the assay (1) to determine which parasites are present, after which the appropriate parasiticide (2) is disseminated to reduce parasite presence in a water body. The automated assay demonstrates unparalleled accuracy and range in parasitological study, and the designed parasiticides target parasites precisely. Furthermore, this system is extensible to other organisms due to the retraining potential of the developed pipeline. Thus, water bodies can be efficiently monitored and treated, thereby mitigating exposure and infection.

Summary Statement

I developed an inexpensive, accessible system using computational modeling to detect and treat parasites in water bodies of impoverished regions.

Help Received

Wherever appropriate, I cited freely-available published studies and web-based applications that I used. All model development, bioinformatics analysis, and experimentation was done independently at home by me.