



Colorado Science and Engineering Fair

2025 Individual Project Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: BactiScan: A Deep Convolutional Neural Network for Tracking Shigella flexneri Infection

Finalist's Name: Sreyanth S Alla

School and City: Rock Canyon High School, Highlands Ranch

Sponsor's Name: Desmond Hamilton

Category: Micro & Molecular Biology

Division: Senior (grades 9 - 12)

Abstract (250 words or less):

Shigella flexneri (Shigella), a leading cause of severe diarrheal illness and mortality in children under five worldwide uses actin-based motility to push against the plasma membrane, forming protrusions that allow Shigella to move into the neighboring cell making it highly contagious. However, current bacterial identification and analysis relies on tedious manual microscopy which limits the efficiency and accuracy of research on Shigella's infection mechanisms. This study introduces BactiScan, a deep learning-based framework designed to automate bacterial state classification and track the stages of Shigella infection. This convolutional neural network (CNN) was developed using transfer learning and different classification algorithms: Fully-connected (FC), FC + Batch Normalization (BN), Global average pooling (GAP) will be tested on top of 3 pre-trained CNNs (VGG16, DenseNet201, InceptionResNetv2) to differentiate free-moving bacteria, microcolonies, actively dividing bacteria, actin-tail-driven motile bacteria, and bacteria within protrusions. To combat the challenges of deep learning for uncommon disease diagnosis, methods including random data augmentation, adaptive weighted loss function, and gradient descent optimization improve generalizability despite orders of magnitude less data and imbalance. Of all CNNs tested, DenseNet201 with the GAP classifier achieved optimal test accuracy of 88.62% with an AUC-ROC of 0.9421, optimizing sensitivity and specificity performance across 10-fold cross validation and six clinical criteria, and a joint detection ensemble network incorporates all features of tracking. An app called BactiScan will be developed for public use to create a community-supported repository of high-resolution microscopic images for the model to undergo further training. This model is the first to successfully classify all morphologically distinct states of Shigella flexneri.

I hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I also attest that the above properly reflects my own work.

Finalist's Signature:

Date:

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with you Finalist Verification/Permission Form. **A signed copy of this form must be included in your notebook.**