

2/28/2025

BACTERIAL KILLING ASSAY & FACS DATA ANALYSIS DASHBOARD

By: Farah Saleem

This Dash app is built to analyze **Bacterial Killing Assay** and **FACS data** in an interactive way. It loads a datasets with error handling and organizes the analysis into four tabs:

1. **Bacterial Killing Assay**
2. **FACS Gating Strategies**
3. **MFI Bar Plots**
4. **Upload Data**

Each tab pulls in results from different analysis modules, ensuring a smooth and dynamic experience.

1. Bacterial Killing Assay Tab

In this tab, the user can select any analysis.



1) Bacterial Killing Assay: Average Colony Counts by Strain

This section allow users to explore bacterial colony count data across different strains and experimental conditions. This section helps visualize and analyze bacterial killing efficiency using **box plots** and **violin plots**.

a) Key Features

- ✚ **Strain & Condition Selection** – Easily filter data by strain and condition using dropdown menus.
- ✚ **Plot Selection** – Toggle between **box plots** and **violin plots** for different visualization styles.
- ✚ **Summary Statistics** – View key metrics like mean, median, standard deviation, and interquartile range (IQR) in a downloadable table.
- ✚ **Graph & Data Export** – Save plots as **PDFs** and download summary tables as **CSV files** for further analysis.

b) Visualization of AIEC 1:100 Data from Original File

The mean colony count for strain AIEC 1:100 is 228, as presented in both the graph and summary table. Similar calculations have been conducted for other strains and conditions. If no data is available for a particular strain or condition, an empty graph will be displayed.

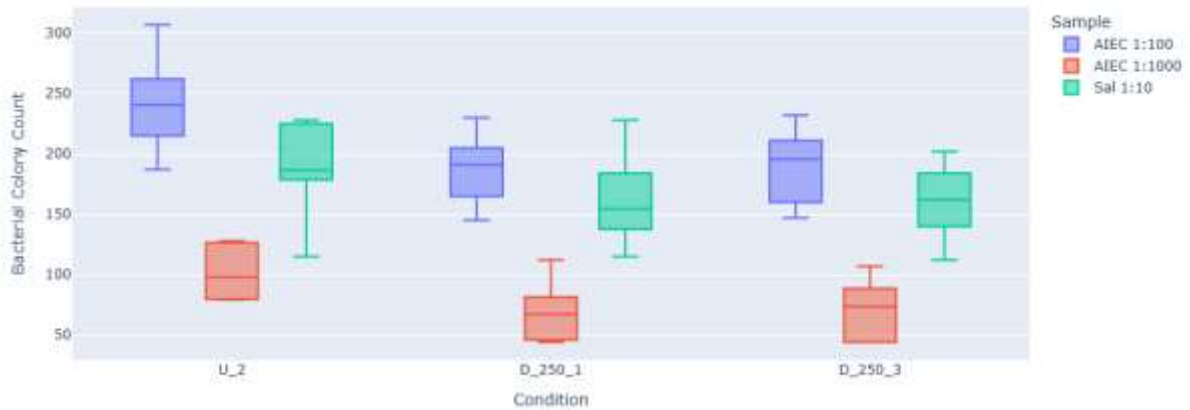
Sample	Condition	Bacterial Colony Count
AIEC 1:100	U_1	221
AIEC 1:100	U_1	230
AIEC 1:100	U_1	201
AIEC 1:100	U_1	186
AIEC 1:100	U_1	235
AIEC 1:100	U_1	235
AIEC 1:100	U_1	235
AIEC 1:100	U_1	281

Bacterial Killing Assay: Average Colony Counts by Strain

× AIEC 1:1000
 × Sal 1:10
 × AIEC 1:100
 ×

× U_2
 × D_250_1
 × L_100+LPS_100ng_3
 × D_250_3
 ×

☒ Box Plot
 ☐ Violin Plot



This plot shows the average bacterial colony counts for selected strains and conditions. Use the dropdowns to filter by strain and condition. The box plot displays the distribution of colony counts, while the violin plot provides a smoothed distribution with a box plot inside.

[Download Graph as PDF](#)

[Download Summary Table](#)

Strain	Condition	Mean	Median	Std	Min	Max	IQR
AIEC 1:100	U_1	228	232.5	28.04	186	281	19
E.Kok 1:10	U_1	79.8	84	10.35	62	88	5
LCAIEC 1:100	U_1	202.75	201.5	18.43	186	222	29.25
Sal 1:100	U_1	59.38	57	10.1	49	75	18.25

Figure 1: Multiple Strains and conditions selected

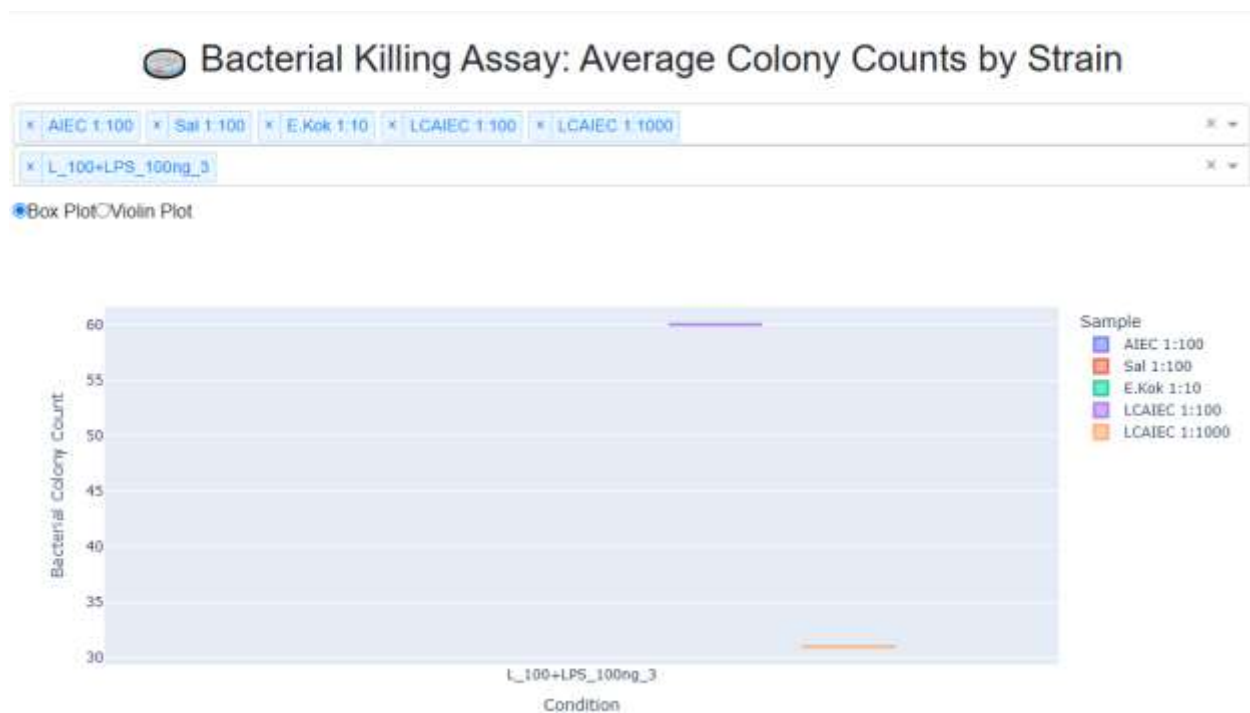


Figure 2: The screenshot highlights strains and conditions with no available data, displaying an empty graph. In cases where only a single data point is available, the graph reflects the individual value without a distribution

2) Triplicate Data Distribution Across Experimental Conditions

This section provides an interactive layout with dropdowns for selecting experiment parameters and dynamically updates visualizations based on user input. The spread of triplicate values across experimental setups, enabling detailed analysis of variability and consistency. Instead of displaying all experimental conditions in a single graph, a separate graph is generated for each selected condition to enhance clarity and user experience. This approach ensures a cleaner visualization, making it easier to compare distributions without clutter.

a) Visualization of AIEC 1:100 Data from Original File

Figure 3 demonstrates how the data from the original file will be displayed when users hover over different points, providing detailed insights for each condition.

Date	Probe	Sample	Condition	Bacterial Colony Count
02.05.2024	4	AIEC 1:100	U_1	221
02.05.2024	4	AIEC 1:100	U_2	221
02.05.2024	4	AIEC 1:100	U_3	253

Triplicate Data Distribution Across Experimental Conditions

Select Date, Probe, and Strain:

Triplicate Data Distribution for 02.05.2024;4;AIEC 1:100



This section displays the distribution of triplicate data for each experimental condition. Each box plot represents the spread of values across three replicates. Use the dropdowns to select specific combinations of date, probe, and strain.

Figure 3: Interactive visualization of triplicate data distribution across experimental conditions.

3) Killing Efficiency Analysis Using Unstimulated Control As Baseline

This section analyzes bacterial killing efficiency by comparing experimental conditions against an unstimulated control baseline, calculating control triplicate values (U_1, U_2, U_3) mean to serve as the baseline control (U). The preprocessing step calculates the killing efficiency percentage for each treatment condition relative to the control, ensuring standardized comparisons across experiments. Data is transformed into a structured format for visualization. A dynamic bar chart allows users to interactively explore killing efficiency across different conditions, with a dropdown filter to refine the analysis. The chart uses a color-coded scheme to distinguish experimental conditions, and users can hover over data points for detailed insights. Additionally, a sortable and scrollable table displays the processed data, providing a structured overview.

Killing Efficiency Analysis Using Unstimulated Control As Baseline



This bar chart compares the killing efficiency (%) of different conditions while keeping unstimulated control as baseline. Killing efficiency is calculated as the percentage reduction in bacterial colonies across every experiment compared to the control. Use the dropdown to filter by specific conditions.

Sample	Probe	Date	Condition	8X%
AIEC 1:100	4	02.05.2024	D_250_1	10.22
AIEC 1:1000	4	02.05.2024	D_250_1	32.12
Sal 1:10	6	02.05.2024	D_250_1	5.94
Sal 1:100	6	02.05.2024	D_250_1	51.61
E.Kok 1:10	5	02.05.2024	D_250_1	32.93
E.Kok 1:100	5	02.05.2024	D_250_1	33.94
AIEC 1:100	3	05.09.2024	D_250_1	16.53
LCAIEC 1:100	3	05.09.2024	D_250_1	
AIEC 1:1000	3	05.09.2024	D_250_1	38.31
LCAIEC 1:1000	3	05.09.2024	D_250_1	

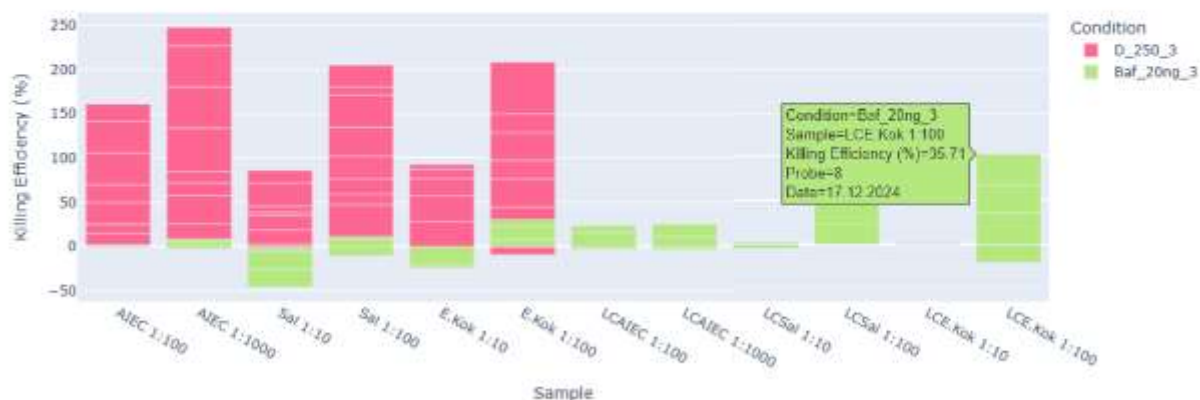
« < 1 / 327 > »

Figure 4: Interactive bar chart displaying bacterial killing efficiency across different experimental conditions. Users can hover over data points to view detailed information, including sample, probe, date, and killing efficiency percentage.

Killing Efficiency Analysis Using Unstimulated Control As Baseline

* D_250_3 * Baf_20ng_3

Unstimulated vs Stimulated: Killing Efficiency



This bar chart compares the killing efficiency (%) of different conditions while keeping unstimulated control as baseline. Killing efficiency is calculated as the percentage reduction in bacterial colonies across every experiment compared to the control. Use the dropdown to filter by specific conditions.

Figure 5: Bacterial killing efficiency across different experimental condition for Stimulated Control D_250_3 and Baf_20ng_3

a) Calculation of Killing Efficiency As Shown In Graph:

Date	Probe	Sample	Condition	Bacterial Colony Count
17.12.2024	8	LCE.Kok 1:100	U_1	48
17.12.2024	8	LCE.Kok 1:100	U_2	54
17.12.2024	8	LCE.Kok 1:100	U_3	52
17.12.2024	8	LCE.Kok 1:100	Baf_20ng_3	33

Mean of Unstimulated Control: 51.3

Stimulated Condition : 33

Killing Efficiency: $[(51.33-33)/ 51.33]*100 = 35.71\%$

4) Killing Efficiency Using Treatment/Control Triplicates Mean Per Experiment

This **section** is designed to process experimental data by combining triplicate values of control and treatment groups to compute bacterial killing efficiency, calculating control triplicate values (U_1, U_2, U_3) mean to serve as the baseline control (U). Then processes multiple treatment groups, computing their respective means across triplicates. Using these values, the killing efficiency is determined as a percentage by comparing the treatment mean to the control mean.

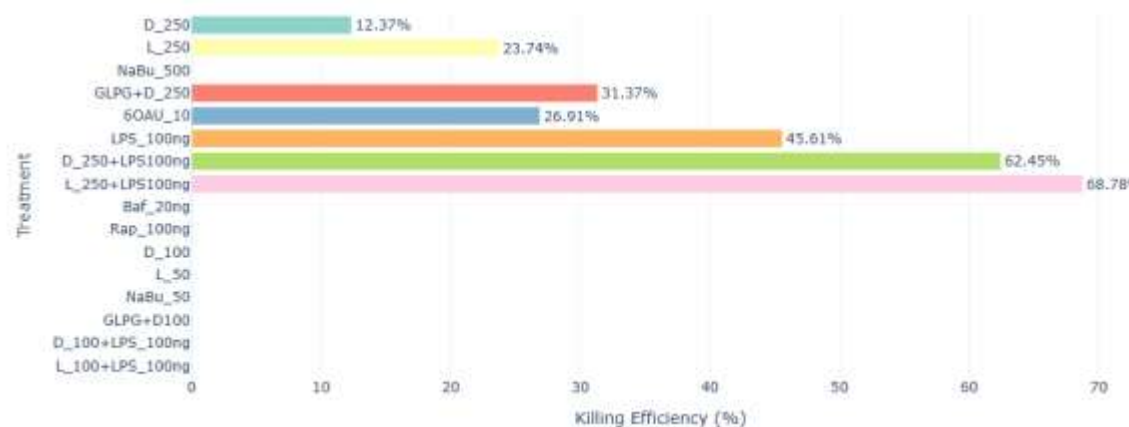
For visualization, A **dropdown menu** allows users to select an experimental ID, which is a combination of the **Date, Probe, and Sample**, enabling filtering for specific experiments. A **horizontal bar chart**, dynamically updates based on the selected experiment, showing the killing efficiency of each treatment. The bars are color-coded for easy distinction. Additionally, a **data table** presents the full dataset in a structured format, allowing users to explore killing efficiency values across all treatments.



Killing Efficiency Using Treatment/Control Triplicates Mean Per Experiment

Select ID (Date | Probe | Sample):

02.05.2024 | 4 | AIEC 1:100



This horizontal bar chart shows the killing efficiency (%) for each treatment, calculated by combining all triplicates. The efficiency is derived from the Treatment/Control triplicates mean per experiment. Select a specific ID (Date | Probe | Sample) to view the results for that experiment.

Efficiency Data

ID	D_250	L_250	NaBu_500	GLPG+D_250	6OAU_10	LPS_100ng	D_250+LPS100ng	L_250+LPS100ng	Baf_20ng
02.05.2024 4 AIEC 1:100	12.37	23.74		31.37	26.91	45.61	62.45	68.78	
02.05.2024 4 AIEC 1:1000	28.77	35.75		40.78	36.59	77.65	91.62	82.68	
02.05.2024 6 Sal 1:10	6.56	14.96		24.59	11.27	40.37	45.9	68.44	
02.05.2024 6 Sal 1:100	49.77	37.33		49.31	17.97	86.64	100	84.33	
02.05.2024 5 E.Kok 1:10	31.3	37.4		54.47	34.55	72.36	65.85	78.46	
02.05.2024 5 E.Kok 1:100	36.7	40.37		34.86	53.21	62.39	75.23	97.25	
05.09.2024 3 AIEC 1:100	12.95	27.41	32.37	33.75	50.55				8.4
05.09.2024 3 LCAIEC 1:100					27.22				-3.8

Figure 6 : Killing Efficiency Using Treatment/Control Triplicates Mean Per Experiment

5) **Killing Efficiency: Baseline Groups vs. Their Stimulated Counterparts**

In this analysis, the killing efficiency is calculated by comparing **specific baseline groups** against their corresponding **treatment groups** for each experiment. The baseline and treatment groups are predefined as follows:

- **D_250:** Baseline (*D_250_1, D_250_2, D_250_3*) vs. Treatment (*GLPG+D_250_1, GLPG+D_250_2, GLPG+D_250_3*)
- **L_250:** Baseline (*L_250_1, L_250_2, L_250_3*) vs. Treatment (*L_250+LPS100ng_1, L_250+LPS100ng_2, L_250+LPS100ng_3*)
- **LPS_100ng:** Baseline (*LPS_100ng_1, LPS_100ng_2, LPS_100ng_3*) vs. Treatment (*D_100+LPS_100ng_1, D_100+LPS_100ng_2, D_100+LPS_100ng_3, L_100+LPS_100ng_1, L_100+LPS_100ng_2, L_100+LPS_100ng_3*)
- **D_100:** Baseline (*D_100_1, D_100_2, D_100_3*) vs. Treatment (*GLPG+D100_1, GLPG+D100_2, GLPG+D100_3, D_100+LPS_100ng_1, D_100+LPS_100ng_2, D_100+LPS_100ng_3*)

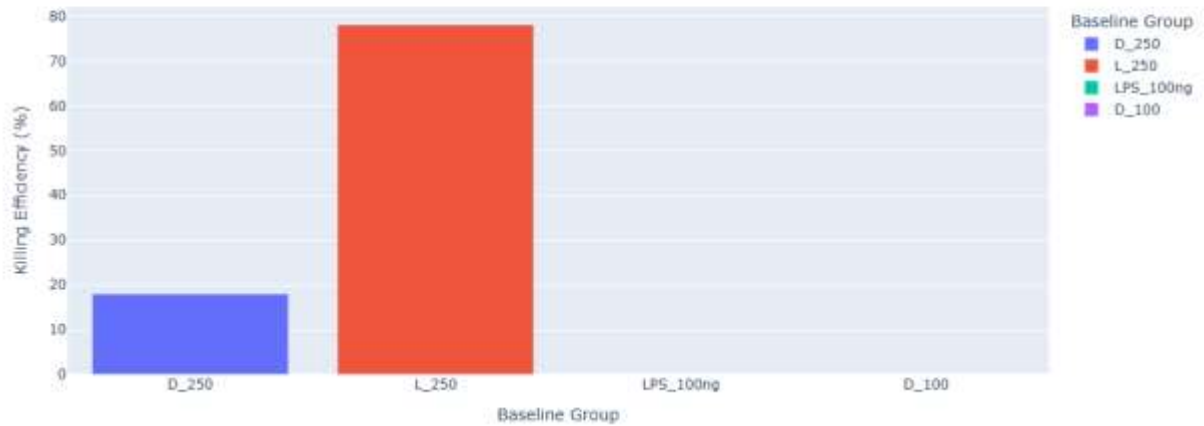
This comparison is conducted **individually for each experiment**, ensuring that killing efficiency is measured per experimental condition. The percentage reduction in bacterial colonies is computed based on the difference between the average baseline and treatment values, providing insights into how effective each treatment is compared to its respective control.

Killing Efficiency : Baseline Groups vs. Their Stimulated Counterparts

Select Experiment:

31.05.2024 | 10 | Sal 1:10

Killing Efficiency for 31.05.2024 | 10 | Sal 1:10



This bar chart compares the killing efficiency (%) of different conditions while keeping unstimulated control as baseline. Killing efficiency is calculated as the percentage reduction in bacterial colonies across every experiment compared to the control. Use the dropdown to filter by specific conditions.

Figure 7: Killing Efficiency Analysis: Baseline vs. Treatment Groups

Comparison of bacterial reduction across different experimental conditions, measuring the killing efficiency of treatments relative to their unstimulated controls.

6) Killing Efficiency Across Stimuli: Mean of Triplicates & Samples

This analysis calculates the killing efficiency of various treatment groups relative to a control group. Instead of analyzing each experiment separately, the mean of each specific sample is considered. First, the mean of the control group measurements (U1, U2, U3) is taken as the baseline. Then, the mean of all replicates within each treatment group is computed. Killing efficiency is determined by comparing the treatment group's mean to the control baseline, providing a comprehensive assessment of treatment effectiveness across each sample rather than individual experiments.

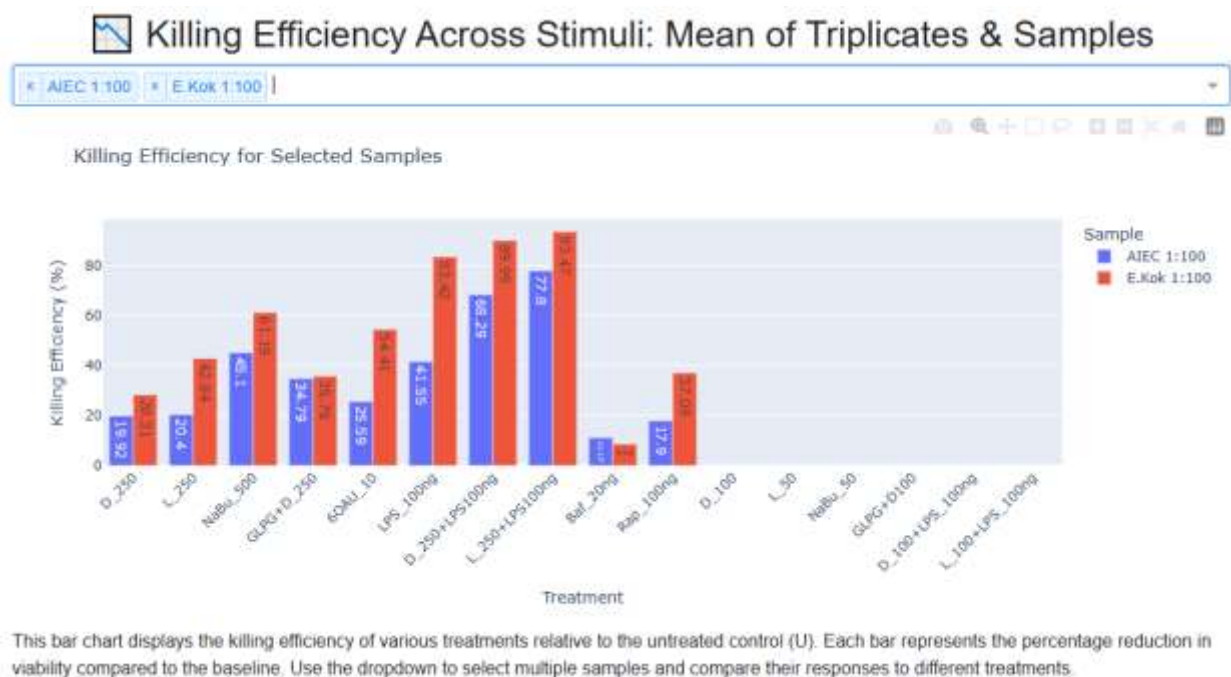


Figure 8: Killing efficiency (%) of different treatments relative to the control baseline, calculated using the mean across each sample instead of per experiment.

2. FACS Gating Strategies Tab

The **FACS Analysis** Tab is designed to process and visualize flow cytometry (FACS) data. This enables users to interactively explore FACS gating strategies and statistical data for various specimens. The system parses XML data to extract specimen names, populations, gating information, and relevant statistics. Users can select a specimen and its corresponding population through an intuitive dropdown interface, which dynamically updates based on the available data. The extracted gating information, including Rectangle Gates, is visualized through interactive scatter plots, providing clear insights into the gating regions. Additionally, key statistical data for the selected population is displayed in a structured table, allowing for easy interpretation.



Figure 9: FACS Analysis: Interactive Flow Cytometry Data Visualization and Gating Analysis

3. MFI Analysis (Macrophages)

The updated MFI Analysis tab enhances the analysis of **Mean Fluorescence Intensity (MFI)** data by enabling users to select multiple specimens while focusing exclusively on **macrophages**. The section extracts MFI values from an XML file, filters out macrophage population, and visualizes the data using an interactive bar plot.

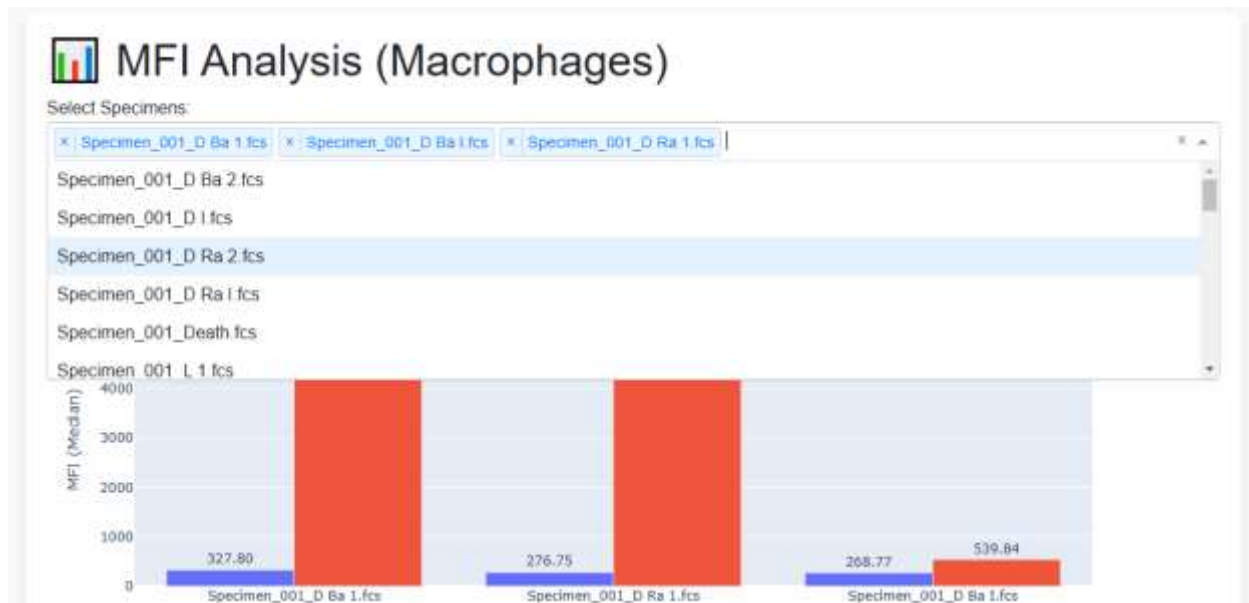


Figure 10: Interactive MFI analysis tool allowing users to select multiple specimens while focusing exclusively on macrophage populations, providing a clear visualization of fluorescence intensity across different markers.

4. Upload File Panel

The implemented Dash application provides an interactive interface for uploading and visualizing bacterial colony count data from CSV files. Users can upload a CSV file, preview the first five rows, and dynamically generate graphs based on selected parameters. The application allows users to choose the X-axis and Y-axis columns, select between box plots and bar charts, and include additional data points for hover interactions.



Figure 11: Upload File Panel



Figure 12: Bacterial Colony counts Graphs for selected columns