Automated Microbial Screening and Phenotypic Classification Using the QPix FLEX System

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Introduction

Microbial platforms drive biotechnology, synthetic biology, and microbiome research, yet manual workflows for plating, colony picking, and phenotype classification remain slow, error-prone, and limited to hundreds of colonies per day per technician, with 5–10% error rates and frequent contamination. The QPix® FLEX™ Microbial Colony Picker automates plating, streaking, colony picking, classification, and hit picking within a sterile and traceable framework. This enables thousands of colonies to be processed per day – a 4-5x throughput improvement compared to manual methods, while integrated imaging and data tracking eliminate transcription errors and subjectivity in colony selection.

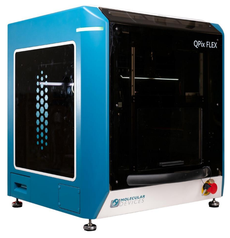
Using bacterial and yeast strains (*Escherichia coli, Klebsiella aerogenes, Candida albicans, Saccharomyces cerevisiae*), colonies were plated or streaked under sterile conditions with the QPix FLEX system and incubated. Automated colorimetric and morphology-based screening enabled targeted selection of colonies of 0.4–3 mm in diameter. The integrated hit-picking module consolidated colonies for downstream functional assays, while onboard data tracking ensured reproducibility and eliminated manual errors.

To extend phenotypic classification, the QPix FLEX color camera was applied to automated grouping and selection of hemolytic and coagulase phenotypes in isolates. Streptococcus strains exhibited distinct hemolysis patterns—γ (*S. oralis*), α (*S. salivarius*), and β (*S. pyogenes*)—while Staphylococcus species were differentiated by coagulase activity and colony color: S. aureus (yellow, halo-positive) versus *S. epidermidis* and *S. hominis* (pink, halo-negative). RGB-based digital grouping enabled objective classification of halo zones and colony morphology. The QPix FLEX workflow was also applied to a microbiome study involving gut sample processing. Traditionally, these workflows are slow and require extensive anaerobic chamber handling. QPix FLEX's automation of plating, colony picking, liquid handling and hit-picking reduced protocol complexity and cut turnaround time by up to 3 days directly addressing scientists' pain-points of lost productivity and fragmented steps.

Across applications, the QPix FLEX integrated workcell enhances colony recovery, reduces operator fatigue, and supports scalable, reproducible microbial research — from hit selection to phenotype classification, accelerating innovation in therapeutic development, synthetic biology, and microbiome science.

QPix FLEX features and advantages

Microbiology laboratories rely on precision, reproducibility, and efficiency to ensure reliable microbial culture analysis. Plating/Streaking ensures colony isolation, and media preparation requires sterility and accuracy. Colonies are picked based on traits (e.g., color), and hit picking identifies positive clones for sequencing. Glycerol stocks are prepared for long-term storage. Challenges in these workflows include contamination, manual error, and low throughput. The QPix FLEX system automates plating, streaking, media prep, colony and color picking, hit selection, sequencing prep, and glycerol stock creation. Designed for precision and efficiency, it streamlines microbial workflows and supports scientists in conducting reproducible, trackable, and reliable experiments.



Flexibility
- Seamlessly switch between sterilizable and disposable tips
- Deck layout adaptability
- Variety of labware

Accuracy
- Multipoint ultrasonic sensor
- High precision mechanical stepper

Compact Design
- Easily fits on a lab bench, in anaerobic chambers, and in constrained lab spaces

Sterility
- UV light, ultrasonic, 3-bath washing system, optional HEPA

Traceability
- 2D barcode reading

Integrability
- Automation

Multi-Functionality
- Liquid handling
- Plating and streaking
- Hit picking, colony picking (morphology and color)

Workflow Processes

Plating and Streaking

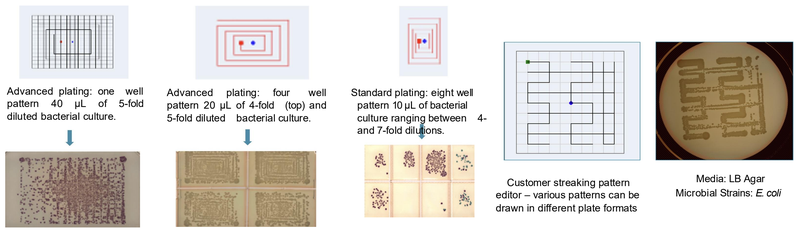
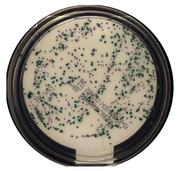


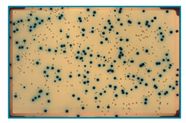
Figure 1. ***Plating:*** *Various concentrations of the bacteria E. coli (blue, white) and Klebsiella (pink) were plated on the agar surfaces. Lowering the volumes with advanced plating or decreasing concentrations yields single colonies. Streaking: The plating/streaking tip dipped in an overnight culture has been used to streak on a 9 cm petri dish (right).*

Colony Picking

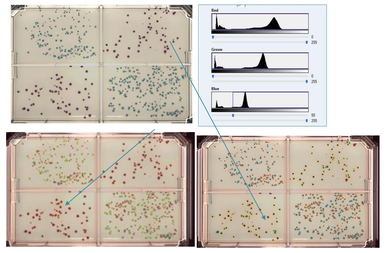
The QPix FLEX system enables high-precision color-based colony selection using RGB gradient analysis and morphological grouping. *Candida albicans* (green), *Saccharomyces cereviciae* (purple), *Klebsiella aerogenes* (pink), and *E. coli* (blue) were differentiated on CHROMagar™ selective media, while blue-white screening identified recombinant *E. coli* on LB agar with ampicillin. Colonies were picked by color, shape, and region (e.g., 4- or 8-well omnitray), then transferred into liquid media across various plate formats. Each colony was assigned a unique ID for traceability, and high-resolution imaging allowed for retrospective analysis. Flexible source-destination mapping and sterile handling achieved >95% picking efficiency with >99% accuracy and zero cross-contamination.



Media: CHROMAgar Candida
Microbial Strain: *Candida* and *Saccharomyces*



Media: LB Agar Amp+ X-GAL+IPTG
Microbial Strain: *E. coli (ΔlacZ,* +lacZ)



Media: ChromAgar ECC Microbial Strains: *E. coli* and *Klebsiella*

Automated Phenotypic Classification of Hemolysis and Coagulase Activity Using the QPix FLEX System

The QPix FLEX workcell enables automated, high-resolution hemolysis phenotyping on blood agar through integrated imaging and color-based segmentation. Initial whole-plate imaging of mixed Streptococcus cultures provides clear visualization of colony boundaries, opacity differences, and halo formation—key features required for hemolysis assessment. Using RGB-based digital analysis, the system reliably distinguishes β-hemolysis (*S. pyogenes*, clear zones), γ-hemolysis (*S. oralis*, no halo), and α-hemolysis (*S. salivarius*, greenish partial clearing), enabling objective, phenotype-specific classification. Automated segmentation tools further enhance accuracy by detecting individual colonies, applying adjustable thresholds, and filtering by morphology and size. This workflow eliminates subjective interpretation, increases consistency across plates, and provides a fully traceable, software-driven approach to hemolysis characterization.

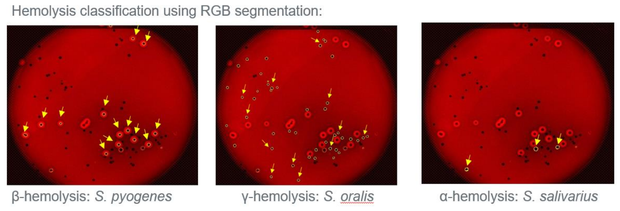


Figure 2. Automated RGB-based segmentation of hemolytic Streptococcus colonies. γ-hemolytic colonies (yellow outlines) show dense, opaque growth without clearing, and segmentation accurately traces their varied morphologies. β-hemolytic colonies exhibit sharply defined zones of complete erythrocyte lysis, producing high-contrast halos that the workflow captures with strong boundary fidelity. α-hemolytic colonies display greenish partial clearing from hemoglobin oxidation, and the algorithm reliably detects these subtle chromatic shifts while maintaining clear separation between colony cores and surrounding discoloration

The QPix FLEX platform supports automated differentiation of coagulase-positive and coagulase-negative *Staphylococcus* species using chromogenic media. Coagulase-positive strains (e.g., *S. aureus*) produce yellow halos due to fibrin precipitation, while coagulase-negative staphylococci (CoNS) such as *S. epidermidis* and *S. hominis* retain smooth pink coloration with no halo. High-resolution imaging paired with automated segmentation outlines colony boundaries, quantifies morphology, and identifies halo formation with high confidence. This workflow provides a stable, plate-based phenotype ideal for automated imaging, digital classification, and high-throughput microbial characterization.

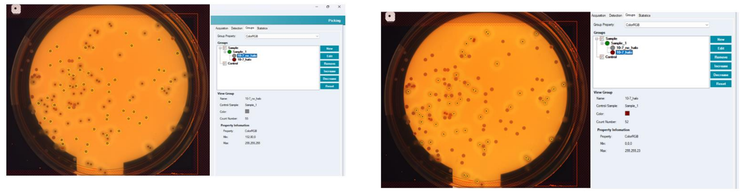


Figure 3. . Differences in colony pigmentation and substrate reactivity are visible, establishing the baseline appearance of coagulase-positive and coagulase--negative- phenotypes. Coagulase-negative colonies identified by the analysis workflow (left Image). Colonies retain their native pink coloration and lack halo formation; segmentation cleanly isolates colonies. Coagulase-positive colonies identified by the analysis workflow (right image). These colonies display halos, and segmentation accurately outlines the colony

Anaerobic Microbiome Workflow

We implemented an automated anaerobic microbiome workflow using the QPix FLEX system to isolate lactic acid bacteria (LAB) from human gut samples. Traditional anaerobic culturomics requires manual plating, colony picking, and subculturing inside hypoxic chambers, limiting throughput to ~60 colonies/day and extending workflows to 6–8 days. With the QPix FLEX system, high-resolution imaging and automated picking enabled colony selection as early as day two. Colonies ≥0.2 mm were transferred directly into 96-well deep-well plates, eliminating manual streaking. MALDI-TOF identification was performed from liquid cultures and confirmed LAB strains were automatically re-arrayed.

This automated workflow shortened total time to 3–5 days, doubled throughput to >120 colonies/day, reduced agar usage, and minimized operator time in anaerobic chambers. Barcode-based tracking ensured full traceability. Overall, QPix FLEX enabled faster, more reproducible isolation of LAB strains for probiotic discovery and metabolic analysis.

Integration into Hypoxic Environments: The integration of the QPix FLEX system into anaerobic culturing workflows enabled early, automated, and morphology-based colony selection with high reproducibility. Stratifying colonies by diameter and applying iterative picking cycles expanded the diversity of recovered strains while minimizing manual intervention. Combined with MALDI-TOF validation, this approach streamlined the isolation of viable, phenotypically distinct clones, accelerating downstream microbiome analysis and strain development.

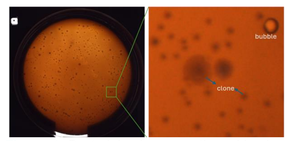


Figure 4. Bacterial colony growth on blood agar after overnight anaerobic incubation (left). By day 2, discrete clones began to emerge that could be detected by the software to be picked (right), but manual identification was hindered by low contrast and surface artifacts like bubbles. By days 3–4, colony morphology improved, enabling manual picking—though visual inspection introduced delays and variability.

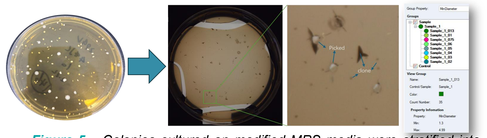


Figure 5. . Colonies cultured on modified MRS media were stratified into eight groups based on diameter metrics derived from QPix® FLEX™ imaging. Each group represented a distinct size range, enabling targeted selection of morphologically diverse clones. From each group, 12 colonies were picked, ensuring consistent representation across the diameter spectrum. Following overnight incubation under identical anaerobic conditions, a second cycle of colony picking was performed. The same imaging and classification settings were applied to identify newly emerged colonies.

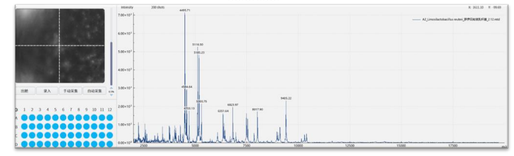


Figure 6. MALDI- TOF data from an anaerobic strain isolated on the QPix FLEX integrated workcell. The strain isolated with the QPix FLEX system in anaerobic conditions displays the expected MALDI-TOF profile

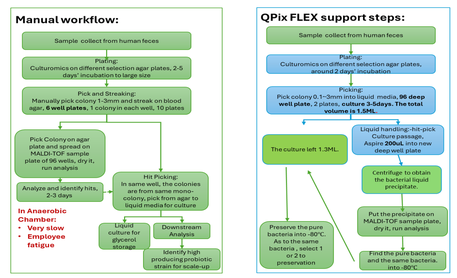


Figure 7. Comparative Anaerobic Workflows for Culturing Fecal-Derived Bacteria: Manual vs. the QPix FLEX-Integrated Approach

Conclusion

The QPix FLEX workcell delivers high-precision, automated microbial screening with 99% accuracy, 95% workflow efficiency, and 0% contamination, enabling reliable processing of bacteria and yeast. Automated imaging and detection algorithms support consistent isolation of single colonies (0.5–2 mm for bacteria, 1–3 mm for yeast) and accurate identification of micro-colonies as small as 0.2 mm, reducing dependence on manual inspection. Integrated data tracking improves reproducibility and minimizes transcription errors across workflows. RGB-based color and morphology analysis enables 100% accurate differentiation of species on selective media such as CHROMagar™ Candida and CHROMagar™ ECC.

The QPix FLEX workcell significantly accelerates microbial screening by automating plating, imaging, colony picking, and phenotype classification within a sterile, traceable workflow. Automated morphology- and color-based selection enabled reliable detection of colonies as small as 0.4 mm and objective classification of hemolytic and coagulase phenotypes. Across microbiome applications, the QPix FLEX system increased throughput 4–5×, reduced manual errors and contamination risk, and shortened complex workflows by up to three days. This integrated approach improves reproducibility, reduces operator burden, and supports scalable microbial research for synthetic biology, therapeutic development, and microbiome science.

MOLECULAR DEVICES

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