



Opentrons Flex™: Flexible automation for life science workflows

Technical Bulletin



A modular, benchtop liquid handling platform to automate your most time-consuming protocols, including nucleic acid extraction, NGS library prep, and small-scale protein purification

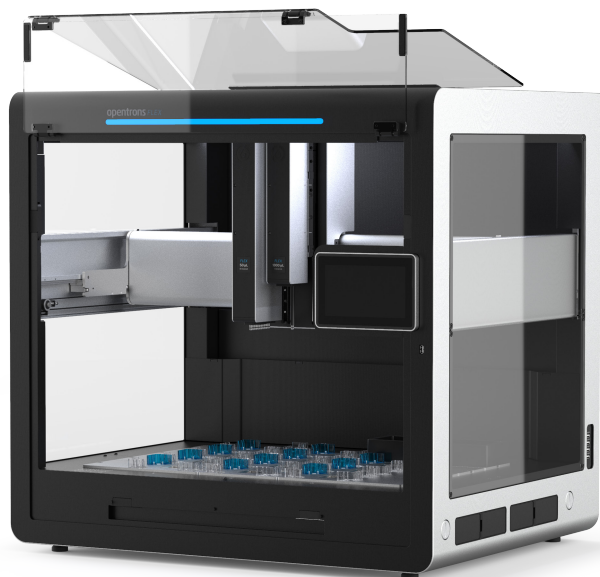


Figure 1. The Opentrons Flex, a new lab automation platform that is highly modular and able to automate a variety of different life science workflows.

INTRODUCTION

Automation is an important tool for life scientists interested in increasing throughput, reducing hands-on time, improving consistency across samples and runs, and minimizing errors. But automation has a number of challenges – platforms tend to be either highly customizable but also expensive and complex, or easy to use and affordable but locked down to a few specific workflows. There is a need for laboratory automation that is customizable, straightforward to implement, and accessible. Here, we demonstrate automation of three popular life science workflows (nucleic acid extraction, NGS library prep and small-scale protein purification) on a new automation platform, the Opentrons Flex, and demonstrate highly accurate results on a system that is flexible and easy to implement for many different types of life science laboratories.

PLATFORM OVERVIEW

Opentrons Flex is a liquid handling robot designed for high throughput and complex workflows. The Flex robot is the base of a modular system that includes pipettes, a labware gripper, on-deck modules, and labware – all of which you can swap out yourself. Flex is designed with a touchscreen so you can work with it directly at the lab bench, or you can control it from across your lab with the Opentrons App using our open-source APIs.

Key features of the Opentrons Flex

- **Gripper to extend walkaway time:** The Flex Gripper can move plates and tip racks across the deck or on or off modules, maximizing throughput and walkaway time.
- **Accurate pipettes with wide volume ranges:** Reliable liquid transfers from 1 to 1000 μL with swappable 1-, 8-, and 96-channel pipettes, featuring automated positional calibration.
- **Touchscreen for easy protocol setup:** Select and run protocols directly from the lab bench using the touchscreen. The touchscreen also guides you through deck setup and automated calibration.
- **Modules to fit your workflow:** Opentrons modules work seamlessly with Opentrons robots and software, and can be easily swapped out yourself. Choose from our on-deck Thermocycler, Heater-Shaker, Temperature Module and Magnetic Block.

There are a number of different Flex workstations that combine the Flex robot with application-specific hardware, labware and custom protocol development:

- **Opentrons Flex NGS Workstation** can automate NGS library prep at the scale you need to increase efficiency, reduce errors, and save hands-on time. Automate all your pre-sequencing workflows including tagmentation- and fragmentation-based chemistries.
- **Opentrons Flex Protein Purification Workstation** can automate small-scale protein purification and proteomics sample prep for up to 96 samples. This workstation is compatible with many popular magnetic bead-based reagents.

- **Opentrons Flex Nucleic Acid Extraction Workstation** can automate DNA/RNA isolation and purification. This workstation comes with the Flex Magnetic Block for separation of magnetic beads, and the Opentrons Heater-Shaker for sample lysis and resuspension of magnetic beads.
- **Opentrons Flex PCR Workstation** can fully automate your PCR setup and thermocycling workflow for up to 96 samples. Aliquot chilled reagents and samples into a 96-well PCR plate, use the Flex Gripper to load the plate into the on-deck thermocycler on the Flex deck, and then run your chosen PCR program.
- **Opentrons Flex Aliquoting Workstation** can automate aliquoting of samples or reagents from tubes into 96-well plates. This workstation automates one of the most repetitive and time-consuming tasks in many laboratories.

Flex workstations have customized hardware modules and pipette selections to suit the needs of different workflows (see example deck layouts in **Figure 2**).

APPLICATION DATA

We carried out testing with biological samples and popular reagent kits to demonstrate the capabilities of Flex for delivering consistent and accurate results across a range of different applications.

Nucleic Acid Extraction

Nucleic acid extraction is efficiently automated on the Flex. The suggested deck layout includes reservoirs, tip racks and deep well plates required for high-volume binding and wash steps (**Figure 2a**). This configuration includes the Opentrons Flex Magnetic Block, Opentrons Heater-Shaker Module, and Opentrons Temperature Module for bead pelleting, resuspension, and cooling sensitive reagents or samples respectively.

Here we illustrate the efficiency of a 48-sample format extraction protocol. DNA extracted from HeLa cells on the Opentrons Flex demonstrates high integrity and purity ready for downstream applications and analysis (**Figure 3**).

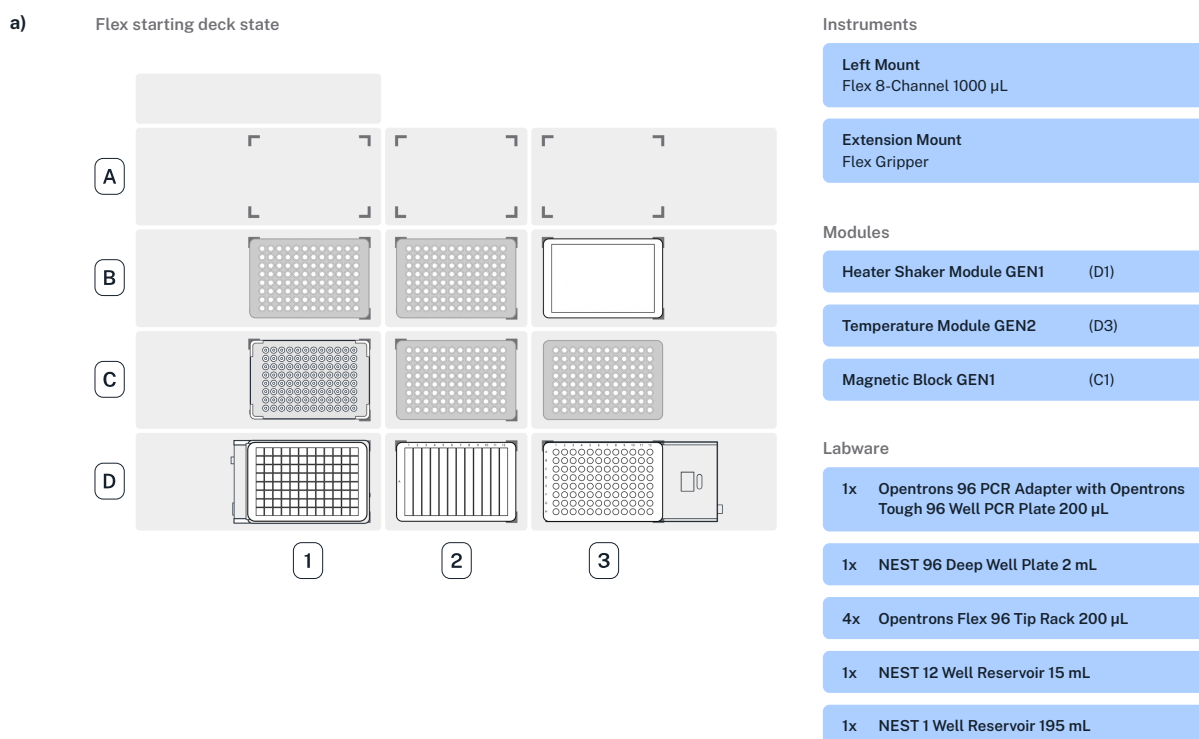
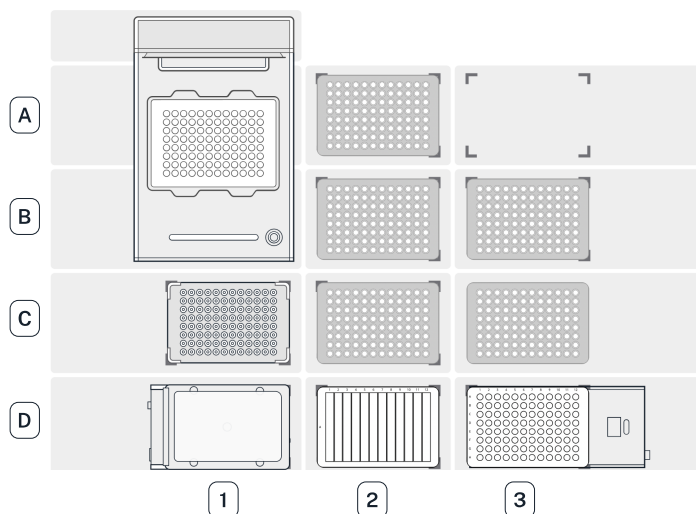


Figure 2. Example deck layouts and pipette configurations for three popular applications, (a) nucleic acid extraction, (b-c) continued on page 4.

b) Flex starting deck state



Instruments

Left Mount
Flex 8-Channel 1000 μ L

Right Mount
Flex 8-Channel 50 μ L

Extension Mount
Flex Gripper

Modules

Thermocycler Module GEN2 (A1 & B1)

Heater Shaker Module GEN1 (D1)

Temperature Module GEN2 (D3)

Magnetic Block GEN1 (C1)

Labware

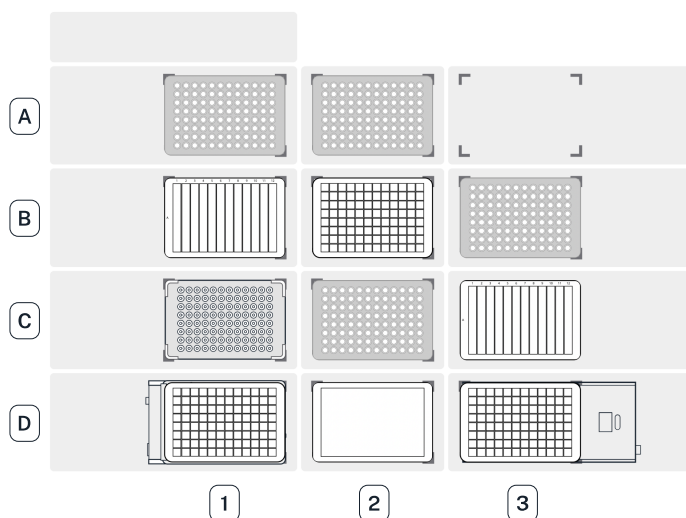
2x Opentrons Tough 96 Well PCR Plate 200 μ L

4x Opentrons Flex 96 Tip Rack 200 μ L

1x Opentrons Flex 96 Tip Rack 50 μ L

1x NEST 12 Well Reservoir 15 mL

c) Flex starting deck state



Instruments

Left Mount
Flex 8-Channel 1000 μ L

Extension Mount
Flex Gripper

Modules

Heater Shaker Module GEN1 (D1)

Temperature Module GEN2 (D3)

Magnetic Block GEN1 (C1)

Labware

3x NEST 96 Deep Well Plate 2 mL

4x Opentrons Flex 96 Tip Rack 1000 μ L

1x NEST 1 Well Reservoir 195 mL

1x NEST 12 Well Reservoir 15 mL

Figure 2. Example deck layouts and pipette configurations for three popular applications, (b) NGS library prep, and (c) small-scale protein purification.

| | DIN | A260/280 |
|---------|------|----------|
| Average | 9.41 | 1.90 |
| CV (%) | 0.79 | 0.96 |

Figure 3. Automated nucleic acid extraction from HeLa cells on the Opentrons Flex results in extracted DNA with high average DNA Integrity Number (DIN) and 260/280 absorbance ratio, ready for downstream applications.

NGS Library Prep

NGS library prep is efficiently automated on the Flex. The workflow utilizes the on-deck Opentrons Thermocycler Module, Opentrons Flex Magnetic Block, Opentrons Heater-Shaker Module and Opentrons Temperature Module (**Figure 2b**). High-temperature enzymatic incubations and indexing can take place on the thermocycler with stable storage of the sample plate for subsequent clean-up steps. Employing the gripper enables optimal walkaway time for these complex workflows.

NGS library preparation with enzymatic fragmentation of genomic *E. coli* DNA was highly uniform on the Opentrons Flex as shown on the consistent fragment distribution from TapeStation analysis (**Figure 4**). The sequenced libraries yielded highly mappable reads and accuracy after sequencing on an Illumina® MiSeq®.

Protein Purification

Small-scale protein purification using magnetic beads can be efficiently automated on the Opentrons Flex. The workflow utilizes the Opentrons Flex Magnetic

Block, Opentrons Heater-Shaker Module, and Opentrons Temperature Module for pelleting of protein magnetic beads, resuspension, and cooling sensitive reagents or samples respectively (**Figure 2c**).

Here we demonstrate that automated immunoprecipitation using Protein G beads reproducibly captures the target protein, recombinant GAPDH, with consistent CV across samples (**Figure 5**).

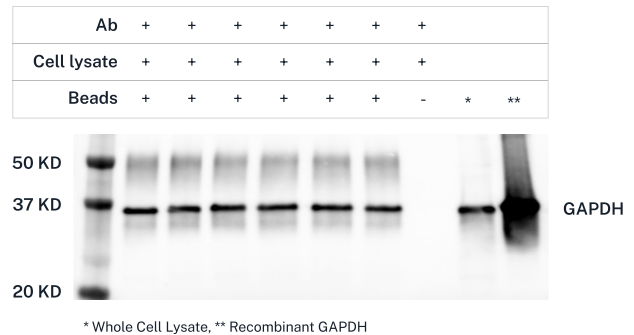
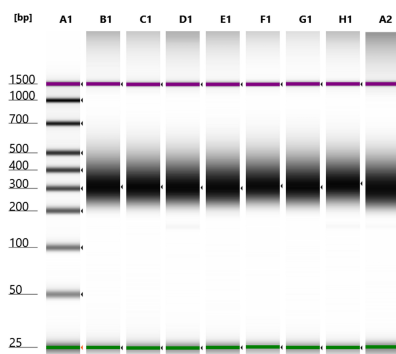


Figure 5. High efficiency and consistent coefficient of variation (CV) across samples for isolation of recombinant GAPDH on the Opentrons Flex.

CONCLUSION

Here, we show highly accurate and consistent results from automating three popular life science workflows, nucleic acid extraction, NGS library prep and small-scale protein purification, on the Opentrons Flex. The Flex robot can be easily reconfigured with pipettes, hardware and labware needed for different applications by laboratory scientists for these or many different applications. [Contact us](#) to receive further information on the Opentrons Flex and how it will fit you and your workflows.



| | Size (bp) | Mapped (%) | Index CV | Duplicate (%) | Error Rate (%) |
|---------|-----------|------------|----------|---------------|----------------|
| Average | 264 | 99.04 | 0.6 | 0.6 | 0.10 |
| CV (%) | 2.77 | 0.05 | - | - | - |

Figure 4. Expected size distribution, high uniformity, and low coefficient of variation (CV) of NGS libraries constructed from genomic *E. coli* DNA on the Opentrons Flex.

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