opentrons

Prep Sheet

Drafting Protocols with OpentronsAI

Authored by Kennedy Bae, Ph.D.

Getting Started

Before teaching the lesson plan, complete the following steps prior to class.

- ☐ Setup an OpentronsAI account by going to opentrons.ai from Chrome browser
- ☐ Run through the process of prompting OpentronsAI to write a protocol and ensure you are comfortable with the process

Need Additional Support?

For technical support, please check our Opentrons Help Center for relevant articles. If you need further support, please contact support@opentrons.com.

If you have questions related to the lesson plan, please reach out to the authors, Kennedy Bae, at kennedy@opentrons.com.

opentrons

Educator Guide

Drafting Protocols with OpentronsAI

Authored by Kennedy Bae, Ph.D.

Purpose

This lab aims to develop students' understanding of using AI tools like OpentronsAI in life science laboratories. The exercise includes:

- Building and troubleshooting laboratory protocols
- Comparing manual and AI-generated protocols
- Identifying limitations and strengths of AI in laboratory settings

Students will perform manual coding and utilize OpentronsAI, allowing them to see the strengths and opportunities of both techniques.

Student Audience

This lab is designed for use in mid to advanced undergraduate biology courses. It can be adapted to accommodate different class sizes.

Background Knowledge

Students should have a conceptual understanding of basic laboratory protocols, Python coding, and the use of automated liquid handling systems.

Core Competencies

Laboratory Skills

- Coding and protocol development
- Use of laboratory automation equipment

Critical Thinking

- Comparing manual and AI-generated protocols
- Troubleshooting and correcting errors
- Interpretation of AI capabilities and limitations
- Decision-making based on protocol analysis

Supplies

Opentrons Supplies

- ☐ Access to OpentronsAI (https://opentrons.ai)
    - OpentronsAI only support Chrome browser.
    - You will need to create an account to access OpentronsAI. Accounts are free, and can be made by visiting https://opentrons.ai.

Non-Opentrons Equipment

- [ ] Computer with internet access
- [ ] Chrome browser (Opentrons.ai is not supported on other browsers)

Experimental Duration

Required Class Sessions

1

Lab Run Time

Estimated total time: 3-4 hours

- Introduction: 20 minutes
- Building a Protocol: 1.5 hours
- Troubleshooting a Protocol: 1 hour
- Identifying the Limits of the AI: 1 hour
- Discussion and Clean-up: 10 minutes

Note: You can assign students to write their manual protocol (“Building a Protocol) in advance of the class session. This will reduce the in-class time to 1.5-2 hours.

Basic Troubleshooting

1. Do a trial run before class to identify and resolve any unexpected occurrences before students arrive.

Procedure Guide

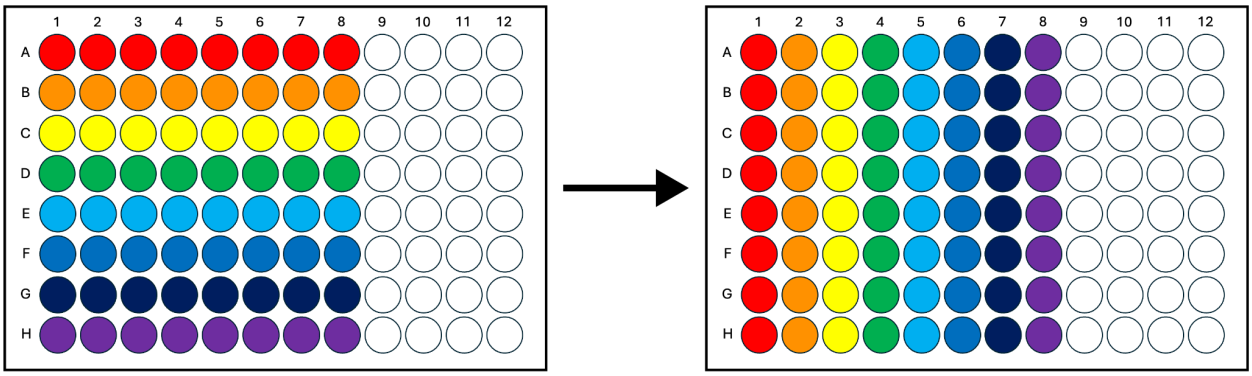
Lab Introduction ~ 20 minutes

- Discuss the objectives and outline of the lab.
- Provide a brief overview of OpentronsAI and its applications in laboratory settings.

Part A: Building a Protocol ~ 1.5 hours

Activity 1.1: Students manually code sample transfer and transform (45 minutes)

1. Students will manually code transferring 50 µL of samples from one plate to another. They are expected to transform the samples as part of the transfer (see images below).
    - Documentation for the Opentrons Python API can be found at docs.opentrons.com/v2/



2. Ensure students understand the process and the expected outcome.

Activity 1.2: Students query OpentronsAI to create a protocol for the same process (30 minutes)

1. Guide students to use OpentronsAI to generate a protocol for the same process they manually coded.
    - Note: OpentronsAI only provides complete responses, students may need to wait some moments to see the results of their queries.
    - Hint: use the example prompts to ensure all of the necessary information is provided in the prompt.
        - OT-2 Robot
        - Opentrons Python Protocol API v2
        - Pipette mount:
            - - P1000 Single-Channel GEN2 is mounted on the left
            - - P1000 Single-Channel GEN2 is mounted on the right
        - Labware:
            - - Source Labware: `NEST 96 Well Plate 200 uL Flat` in slot 9
            - - Destination Labware: `NEST 96 Well Plate 200 uL Flat` in slot 10

- - `Opentrons 96 Filter Tip Rack 1000 uL` in slot 8
- - `Opentrons 96 Tip Rack 1000 uL` in slot 3

Activity 1.3: Students analyze the differences in their approach and the approach taken by OpentronsAI (15 minutes)

1. Have students compare their manual protocol with the AI-generated one.
2. Discuss the strengths, weaknesses, and potential improvements for both approaches.

Part B: Troubleshooting a Protocol ~ 1 hour

Activity 2.1: Students manually correct an intentional protocol error (35 minutes)

1. Provide students with the pre-designed protocol containing an intentional error.
2. Ask students to identify and summarize the process being automated by the protocol.
    - Note: This protocol automates magnetic bead extraction of RNA.
    - The errors in the protocol are:
        - Incorrect robot name
        - Insufficient tips to run the protocol

3. Allow students to find and fix the error without AI assistance.

Activity 2.2: Students query OpentronsAI to identify the error (20 minutes)

1. Direct students to use OpentronsAI to detect the error in the protocol.
2. Students should then prompt OpentronsAI to correct the error.

Activity 2.3: Students compare the error identified by themselves and OpentronsAI (10 minutes)

1. Discuss the differences in error identification and correction between manual and AI approaches.

Part C: Identifying the Limits of the AI ~ 45 minutes

Activity 3.1: Students submit queries to OpentronsAI pushing the limits of the AI ability to efficiently code for the desired outcome (30 minutes)

1. Encourage students to submit complex queries to OpentronsAI to test its limits.
    - If students would like to report queries that OpentronsAI was unable to implement, they can do so at https://opentrons-ai-beta.paperform.co/

Activity 3.2: Students identify the limitations of OpentronsAI (15 minutes)

1. Have students reflect on and discuss the scenarios where OpentronsAI was efficient and where it struggled.
2. Discuss situations where manual coding might be preferred over AI-generated protocols, and vice versa.

Discussion and Clean-up ~ 10 minutes

- Summarize key learnings from the lab.
- Encourage students to share their thoughts on using AI in laboratory settings.
- Provide guidelines for the lab report.

Lab Report

Instructions

Assign students to prepare a comprehensive lab report that includes:

- Comparison of manual and AI-generated protocols
- Error analysis and troubleshooting steps
- Reflection on the limitations and strengths of OpentronsAI

- Situations where AI could be beneficial or detrimental

Provide guidelines for report structure and data presentation, encouraging students to include detailed analysis and thoughtful reflections on their experience.

opentrons

Student Guide

Drafting Protocols with OpentronsAI

Authored by Kennedy Bae, Ph.D.

Purpose

This lab will develop your understanding of using AI tools like OpentronsAI in life science laboratories. This includes:

- Building and troubleshooting laboratory protocols
- Comparing manual and AI-generated protocols
- Identifying limitations and strengths of AI in laboratory settings

Required Supplies

Opentrons Supplies

- ☐ Access to OpentronsAI (https://opentrons.ai)
    - OpentronsAI only support Chrome browser.
    - You will need to create an account to access OpentronsAI. Accounts are free, and can be made by visiting https://opentrons.ai.

Non-Opentrons Equipment

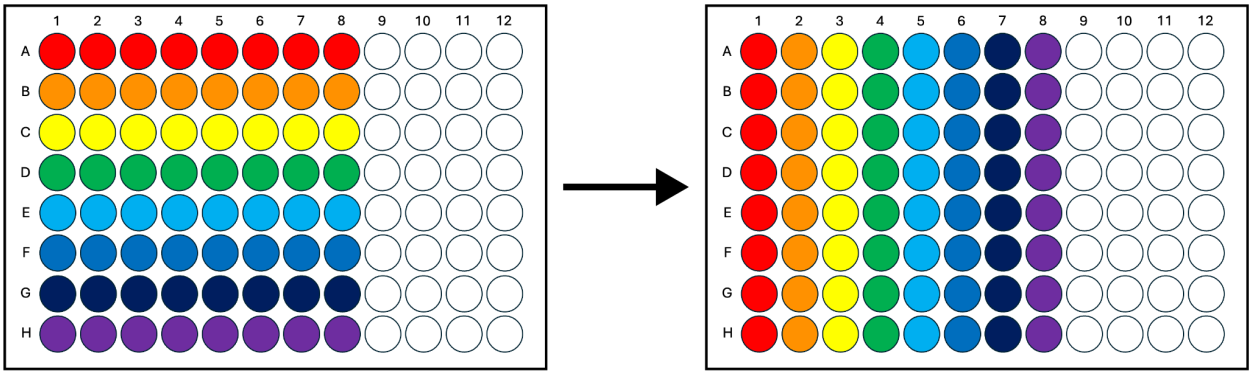
- ☐ Computer with internet access
- ☐ Chrome browser (Opentrons.ai is not supported on other browsers)

Experimental Procedure

Part A: Building a Protocol

Activity 1.1: Manually Code Sample Transfer and Transform

1. Manually code a laboratory protocol transferring 50 µL of samples from one plate to another. You should transform the layout of the samples as part of the transfer (see images below). Use the Opentrons Python documentation for more information about our Python API.
    - Documentation for the Opentrons Python API can be found at docs.opentrons.com/v2/



2. Discuss with a neighbor to ensure you both understand the change in layout that is taking place in the process.

Activity 1.2: Query OpentronsAI

1. Use OpentronsAI to generate a protocol for the same process. Follow the prompts in OpentronsAI to ensure all necessary information is included and properly formatted.
    - Note: OpentronsAI only provides complete responses, you may need to wait some moments to see the results of your queries.
    - Hint: use the example prompts to ensure all of the necessary information is provided in the prompt.
        - OT-2 Robot
        - Opentrons Python Protocol API v2
        - Pipette mount:
            - - P1000 Single-Channel GEN2 is mounted on the left
            - - P1000 Single-Channel GEN2 is mounted on the right
        - Labware:
            - - Source Labware: `NEST 96 Well Plate 200 uL Flat` in slot 9
            - - Destination Labware: `NEST 96 Well Plate 200 uL Flat` in slot 10

- - `Opentrons 96 Filter Tip Rack 1000 uL` in slot 8
- - `Opentrons 96 Tip Rack 1000 uL` in slot 3

Activity 1.3: Analyze Differences

1. Compare your manual protocol with the AI-generated protocol.
2. Discuss the strengths, weaknesses, and potential improvements for both approaches.

Part B: Troubleshooting a Protocol

Activity 2.1: Manually Identify an Error

1. You will receive a protocol that automates a common laboratory process. Review the protocol and summarize the process being automated.
2. The protocol you have been provided contains 2 critical errors. Review the provided code to find, identify, and fix the errors without AI assistance.

Activity 2.2: Use OpentronsAI to Identify an Error

1. Access OpentronsAI at opentrons.ai using Chrome browse. Prompt OpentronsAI to review the protocol and identify the errors.
2. Prompt OpentronsAI to correct the error.

Activity 2.3: Compare and Contrast Error Identification Methods

1. Discuss differences in error identification and correction between manual and AI approaches.

Part C: Identifying the Limits of the AI

Activity 3.1: Push the Limits of OpentronsAI

1. Test the limits of OpentronsAI efficiency by submitting complex queries.
    - If you would like to report queries that OpentronsAI was unable to implement, you can do so at https://opentrons-ai-beta.paperform.co/

Activity 3.2: Discuss Limitations

1. As a class, reflect on scenarios where OpentronsAI was efficient and where it struggled.

2. Discuss situations where manual coding or AI-generated protocols might be preferred.