BioBlocks:
Programming protocols in biology made easier

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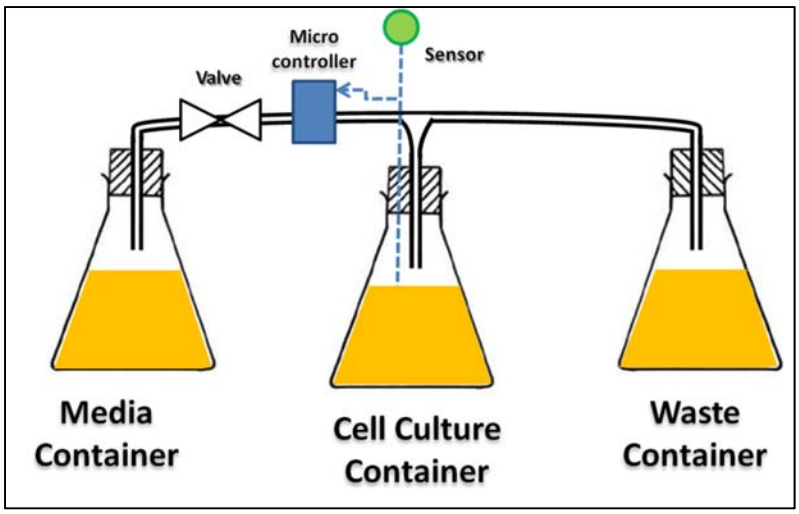
Supplementary Information

To demonstrate the potential of BioBlocks to allow description of complex protocols an example of specifying a Turbidostat is shown. A Turbidostat maintains cells at a constant turbidity based on its OD value inside a specific container. It is being increasingly used in Synthetic Biology experiments to evolve orthogonal genetic parts and whole devices (*Supplementary Figure 1*).

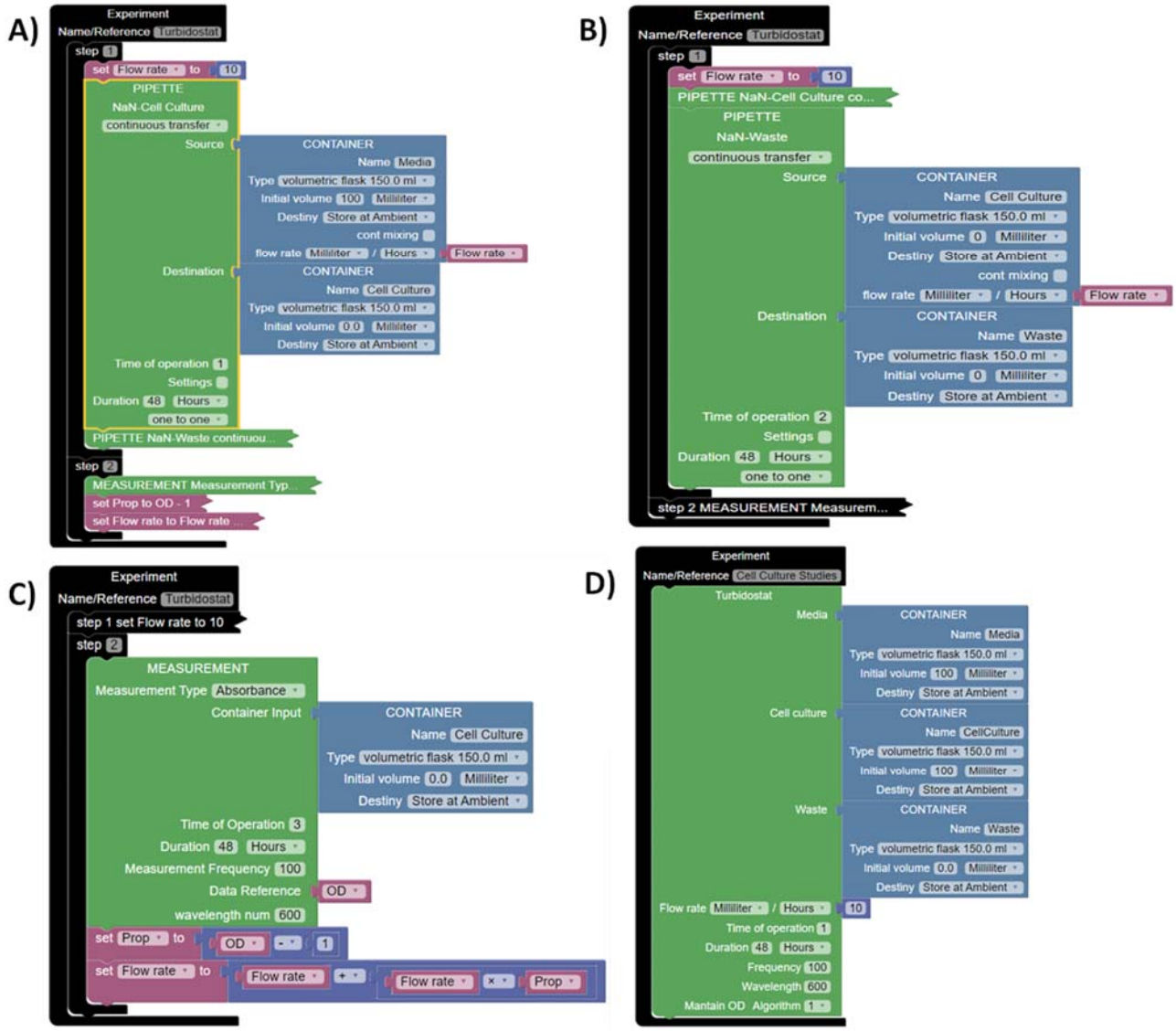


***Supplementary Figure 1*:** *A sketch of a Turbidostat- The liquid (media) flows from the media to the cell container and further into a waste container. The OD is measured using the sensor (green). The flow rate is controlled using the micro-controller which in turn controls the actuators like valves and pumps.*

A typical protocol of a Turbidostat consists of transferring media at a certain flow rate to the Cell Culture container. Depending upon the required turbidity, the flow rate of media into the cell culture container and flow rate of the excess cell culture into waste container is changed. Protocol of a Turbidostat in English-

1. Transfer liquid from Media Container to Cell Culture container at 10 ml/hr for 48 hours.
2. Transfer liquid from Cell Culture Container to Waste container at 10 ml/hr for 48 hours.
3. Measure OD of Cell Culture container for 48 hours at 600 nm wavelength every 100 seconds (measurement frequency).
4. Change Flow rate of containers proportionate to the change in OD value.

The highlighted part in red is usually not communicated and is very ambiguous. Also, textually coding the above protocol in a textual programming language based on Python or JSON is very cumbersome. Below, the same Turbidostat protocol is described using BioBlocks. Also, a new simplified block, specifically for Turbidostats, has been shown to highlight the capability of the BioBlocks to encapsulate complex protocols in a single block (*Supplementary Figure 2*).



***Supplementary Figure 2**: Programming a Turbidostat using BioBlocks - A, B and C show how a Turbidostat can be programmed using general BioBlocks. They are shown in three parts so that user can observe all the steps in the protocol. The Blocks have been selectively minimized in all the three figures for the sake of viewing (A, B, C). D shows a simplified new BioBlock to program a Turbidostat. It has the same functionality of the protocol as shown in A,B and C. Simple BioBlocks with complex underlying functionality can be created to ease specification of complex protocols.*

Table 1: List of BioBlocks and their respective Autoprotocol instructions -

BioBlocks	**Autoprotocol Instruction**
Container Block	Container Access Covers and Seals
Pipette Block	One-Channel Liquid Handling Multichannel Liquid Handling Acoustic Liquid Handling Reagent Dispensing
Colony Picking Block	Colony Picking
Cell spreading Block	Cell Spreading
Sanger Sequencing Block	Sanger Sequencing
Thermocycling Block	Thermocycling
Centrifugation Block	Centrifugation
Incubate Block	Incubation
Electrophoresis Block	Gel Electrophoresis
Measurement Block	Measure Property Spectrophotometry
Oligosynthesize Block	Oligosynthesize
Flash Freeze Block	Flash Freeze
Flow Cytometry Block	Flow Cytometry
Not available	Magnetic Separation
Mix Block	*Not available*
Continuous Transfer option in Pipette Block	*Not available*