02. A Guided Tour of the Biomaker Starter Kit

This chapter will introduce you to the 2020 Biomaker Starter kit used in the No-Code Programming for Biology workshop. It will help you to understand the different parts of the Arduino Rich UNO R3 board, as well as the various additional components supplied in the starter kit.

The 2020 Biomaker Starter Kit

The 2020 Biomaker starter kit consists of an extended Arduino board, a collection of electronic components, a small prototyping board and a programmable display. It is based on the Open-Smart Rich UNO R3 board, which contains a variety of embedded components, and is accompanied by a variety of electronic components and sensors which are useful for monitoring and programming of biological systems. The board is Arduino UNO compatible, and can be programmed directly from the visual programming software, XOD.

In addition to the starter kit you will also require a laptop or desktop computer with a type A USB port (or a relevant converter), and a download of the XOD programming software, which can be found on the XOD website: https://xod.io/. This section outlines the basics of your Biomaker starter kit. You can find more information and specifications for the Arduino Rich UNO R3 board and other kit components in the annex of this handbook.

Arduino Rich UNO R3 Board

The Rich UNO R3 board is an expansion of a simple Arduino UNO microcontroller board. Arduino is an open-source electronics company, which makes openly available programming software and low-cost hardware to allow anyone to get started making their own interactive electronics projects. In addition to the basic electronic components included in a simple Arduino board, the Rich UNO R3 board included in this kit also includes a number of integrated components and sensors, such as a four digit display (3), buzzer (4) and temperature sensor (6). Importantly, the connections to the board’s embedded components can be turned off using a DIP switch (10), meaning that each part of the board can be independently switched on and off. Below is a quick explanation of each part of the board. The following chapter, Understanding your Arduino Board, will explore the board in more detail. You can also find specifications for the board in the annex of this handbook.
1. **USB Power and Download Port**: type B USB port. Used to connect the board to a computer, or provide a power supply.

2. **DC Jack Power Supply**: can be used to supply power via a DC connector rather than the USB connector. Also contains a resettable fuse to protect both the DC and USB power ports.

3. **4-Digit Display with Clock Point**: display screen, which can be used to display a digital clock.

4. **Buzzer Module**: inbuilt piezoelectric buzzer.

5. **RTC Clock Module**: high precision clock that allows the board to keep everything running at the correct time.

6. **LM75 Temperature Sensor**: inbuilt temperature sensor. Can also be used to set a protection temperature, allowing it to monitor the temperature of the board and shut down if the board overheats.

7. **Infrared Receiver**: can receive infrared signals from the remote control, allowing the board to be controlled remotely.

8. **Reset Button**: Allows you to restart the programme without unplugging and plugging back in again.
9. **4-Channel Touch Sensor**: inbuilt touch sensor. Each sensor (TCH1-4) acts as a touch sensitive button.

10. **Signal ON/OFF**: onboard DIP switch. Allows you to turn each of the inbuilt components on and off independently.

11. **ATmega328P Chip**: this is the board’s microcontroller. It acts as the brains of the board, instructing each of the other components what to do.

12. **KNOB Sensor**: senses the rotation angle of the knob. Can be used to adjust the volume of the MP3 player, adjust the brightness of the 4-digit display etc.

13. **Shield Interface**: used to plug in expansion shields. These allow you to expand the functionality of your board, and can be stacked on top of eachother to allow endless possibilities.

14. **MP3 Player**: high-quality MP3 music chip. Allows you to plug in a microSD card with MP3 files, and play them. It can also send commands, for example to switch songs, or change the volume. Also includes a headphone port.

### Kit Components

For the purpose of making biological instruments, we often need to use sensors (such as water or gas sensors) and/or actuators (moving components, e.g. motors for making robotics). The Arduino Rich UNO R3 board is available from [Open Smart](#) as part of a kit that includes a wide variety of sensors and actuators. Below is a quick explanation of each component in this kit. You can also find specifications for the kit components in the [annex](#) of this handbook.

**Basic Arduino Rich UNO R3 Kit Components**

- **IR Controller**: infrared remote control. Used to send signals to the infrared sensor and control the board.
- **Speaker with XH-2.54 Port**: speaker that can be plugged into the MP3 module on the board, allowing you to play music and MP3 files.
- **USB Cable**: used to connect the board to a computer. This allows you to programme the board, and also supplies power.
- **Battery**: can be found plugged into the clock module. Powers the inbuilt clock.
- **MicroSD Card**: can be used to store files for the board to read or write to, e.g. MP3 files allowing the board to play music.

### Commonly Used Sensor Modules

- **Water Sensor**: moisture sensor. Can be used to detect raindrops, or measure water levels.
- **NTC Sensor Line and Adapter Module**: water resistant temperature sensor. Can be used to measure the temperature indoors, outdoors, in greenhouses, in water etc.
- **Ultrasonic Sensor**: can be used to measure distances using an ultrasonic wave.
- **Touch Sensor**: touch sensor with three different modes: (i) sends signal when touched, (ii) sends signal when not touched and (iii) stops sending signal when not touched for 12 seconds.
- **Voltage Sensor**: can measure voltage over a wide range of values.
- **Slide Potentiometer**: moving the slider from side to side will change the voltage. Can be used for volume control, or as a lighting regulator etc.
- **Rocker Switch**: simple on/off switch.
- Vibration Motor: can act as a non-audible indicator in place of a buzzer. Will vibrate like a mobile phone.
- PIR Motion Sensor: infrared motion sensor. Often used for sensing the movement of humans or other animals.
- Light Sensor: senses the light intensity in the environment.
- Infrared Emitter: emits an infrared signal. Can be used to wirelessly transfer information or act as a remote switch.

Dupont Line 1*40P

- MicroSD Card Adapter: used to read and write files to a microSD card.
- 4-Digit Display: similar to the inbuilt 4-digit display. Can be used to display a clock, numbers or letters.
- Passive Buzzer: similar to the inbuilt piezoelectric buzzer.
- IO Expansion Shield: extends the board, allowing you to add additional components.
- LED Bar Module: LED board with 8 LED lights.
- Eagle Eye LED Module: very bright LED light.
- I2C 1602 LCD Module: LCD screen that can display two lines and 16 characters of text. Can be used to display read-outs etc.

Additional Components

We have also included several additional components in the 2019-2020 Biomaker kit. Below is a quick explanation of each additional component. You can also find specifications for the kit components in the annex of this handbook.

- Prototyping Shield: expands the capacity of the board. Can be used to assemble custom circuits for prototyping. It allows direct mounting of soldered components on the board, or connection through a mini breadboard. It also has two inbuilt LEDs and two switches.
- Shield with I2C 16x2 LCD Display: LCD screen that can display two lines and 16 characters of text. This module also included two touch-sensitive keys, and several additional pins to input extra components.
- I2C OLED 64x128 Display: high-quality OLED display screen.
- RGB LED Ring: series of 16 LEDs that can display different colours at different times.
- Gas Sensors: includes a smoke sensor that can detect liquefied petroleum gas, natural gas, coal gas and smoke; an alcohol sensor that can detect the concentration of ethanol vapor; and a carbon monoxide sensor that can detect carbon monoxide levels.
- LED Traffic Light: red, yellow and green LED lights. Allows you to simulate traffic lights.
## Making your own kit

We have tried to supply as many participants as possible with Biomaker starter kits. However, if you would like to put together your own kit, all of the components are available from Open Smart. Below is a list of components and their prices (correct as of 23/03/2020). We have also noted where components are essential to complete the materials in this course.

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<th>Cost</th>
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<td>$25.93</td>
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If you do not want to purchase your own kit then some of the tutorials in this course can be completed using XOD simulation only. XOD provides “watch nodes” that will allow you to see if your program is working, without using software. Some useful information about using watch nodes to simulate in XOD can be found on the XOD website: [https://xod.io/docs/guide/debugging/](https://xod.io/docs/guide/debugging/).

This will not provide you with experience working with hardware, but will allow you to follow along with the course and start understanding the basics and underlying logic of biomaking.

## Further Information

More information and specifications for the Arduino Rich UNO R3 board and kit components can be found in the annex of this handbook. You can also download the documents below from Open Smart.
Board manual:

Board circuit diagram:

MP3 Player Manual:

Next Chapter
In the next chapter we will explore how to use your Arduino board, including how to control the board and where to plug in additional components. Go to next chapter >>