



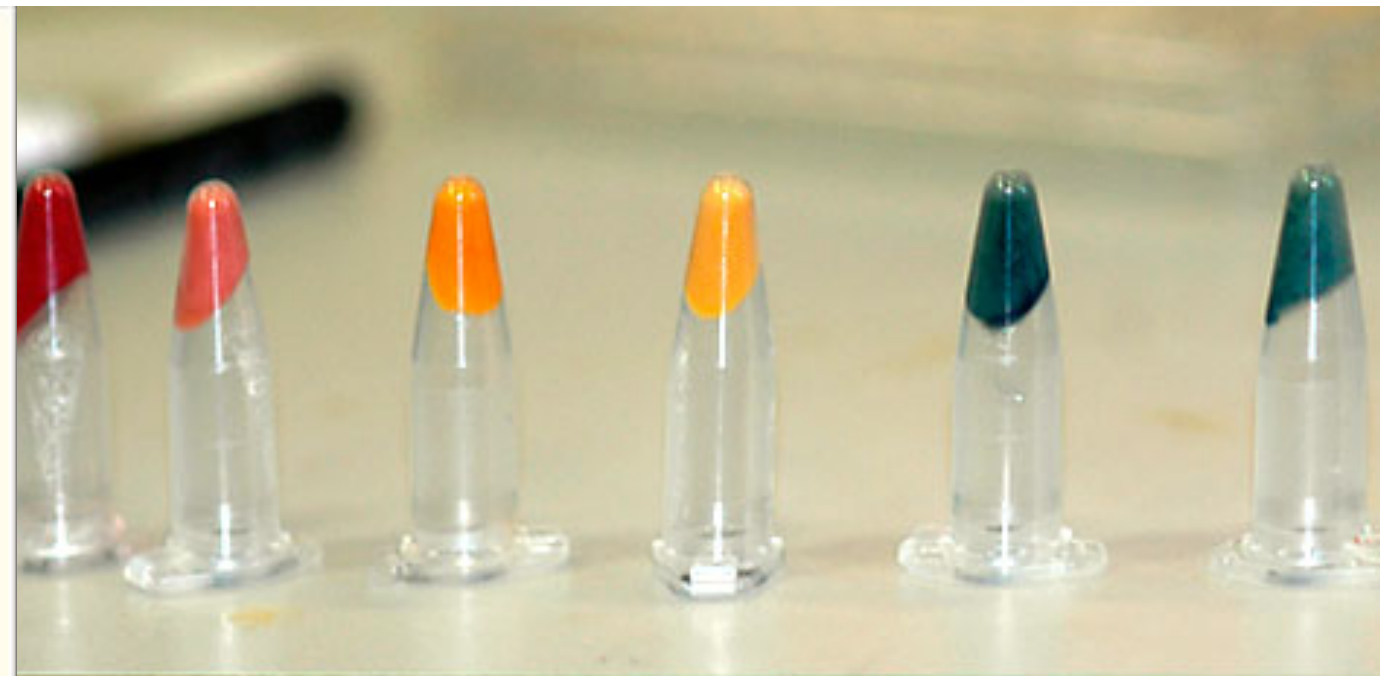
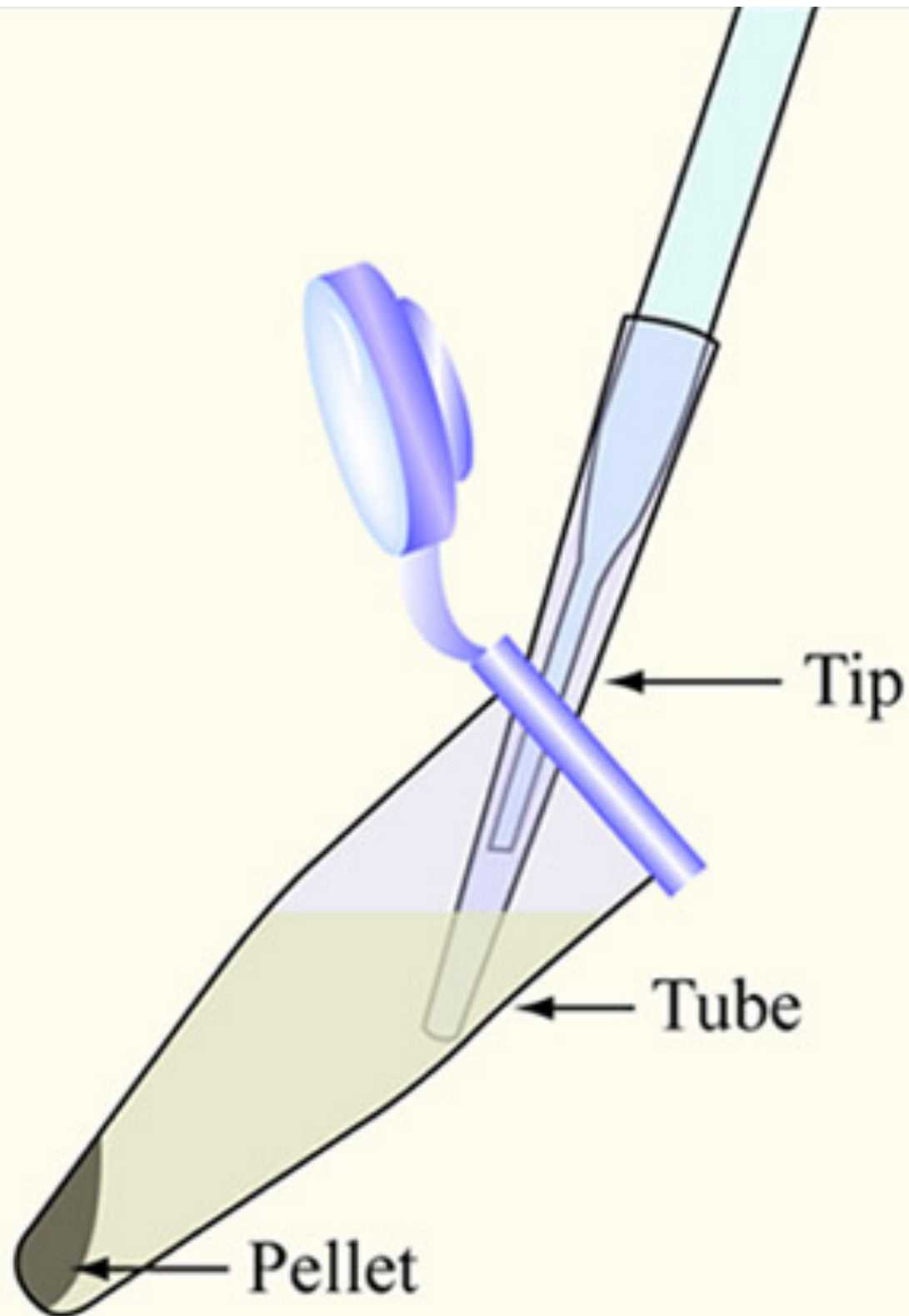
waag society

institute for art, science and technology

BioHack Academy Centrifuge Design

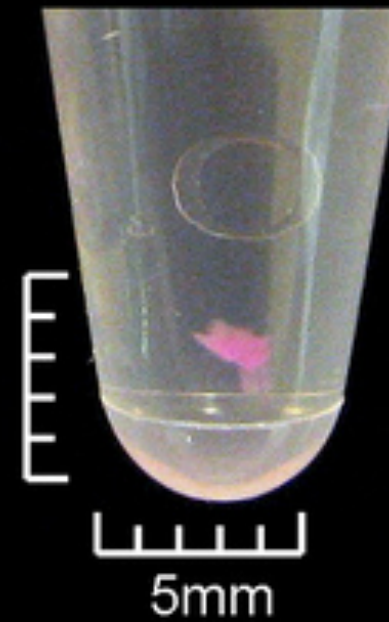


Centrifugation

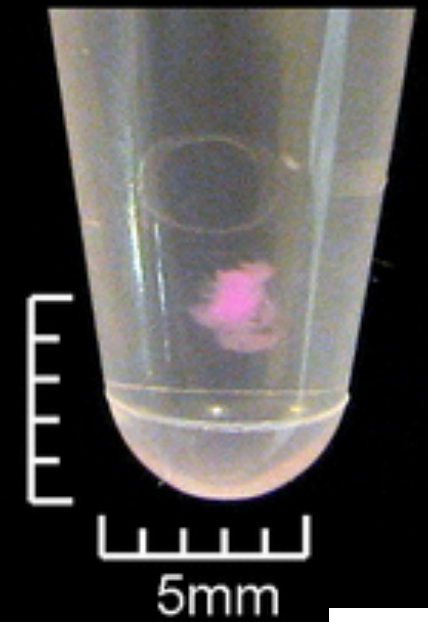


Cambridge iGEM 2009

20ug



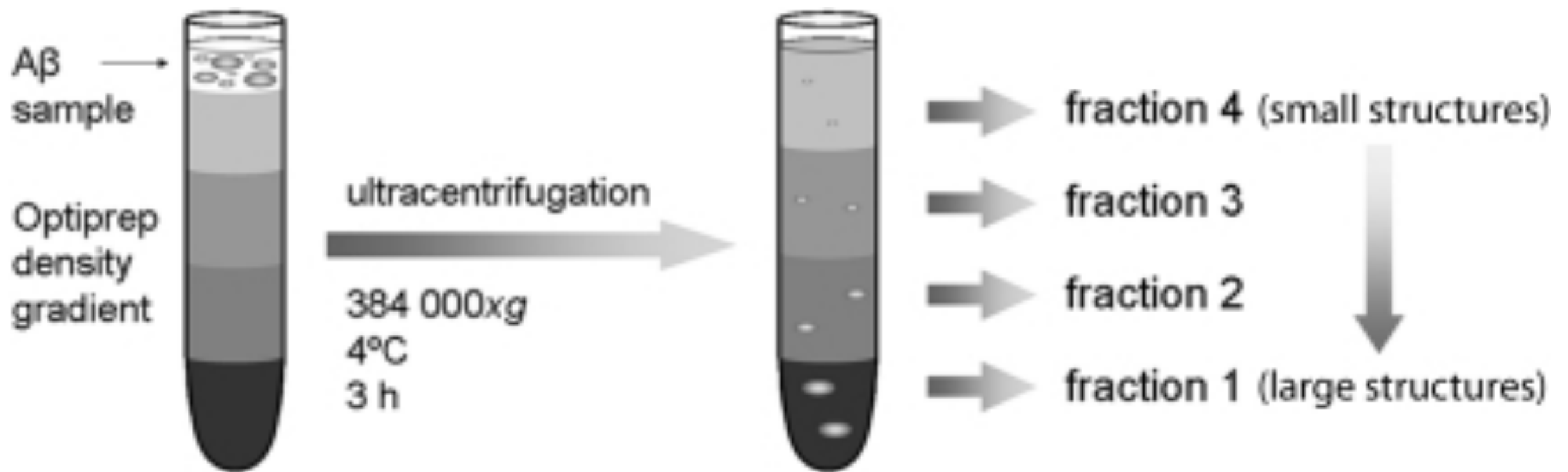
40ug



Damon Tighe



Density gradient





Industry standards



Magnus Manske – CC-BY 1.0



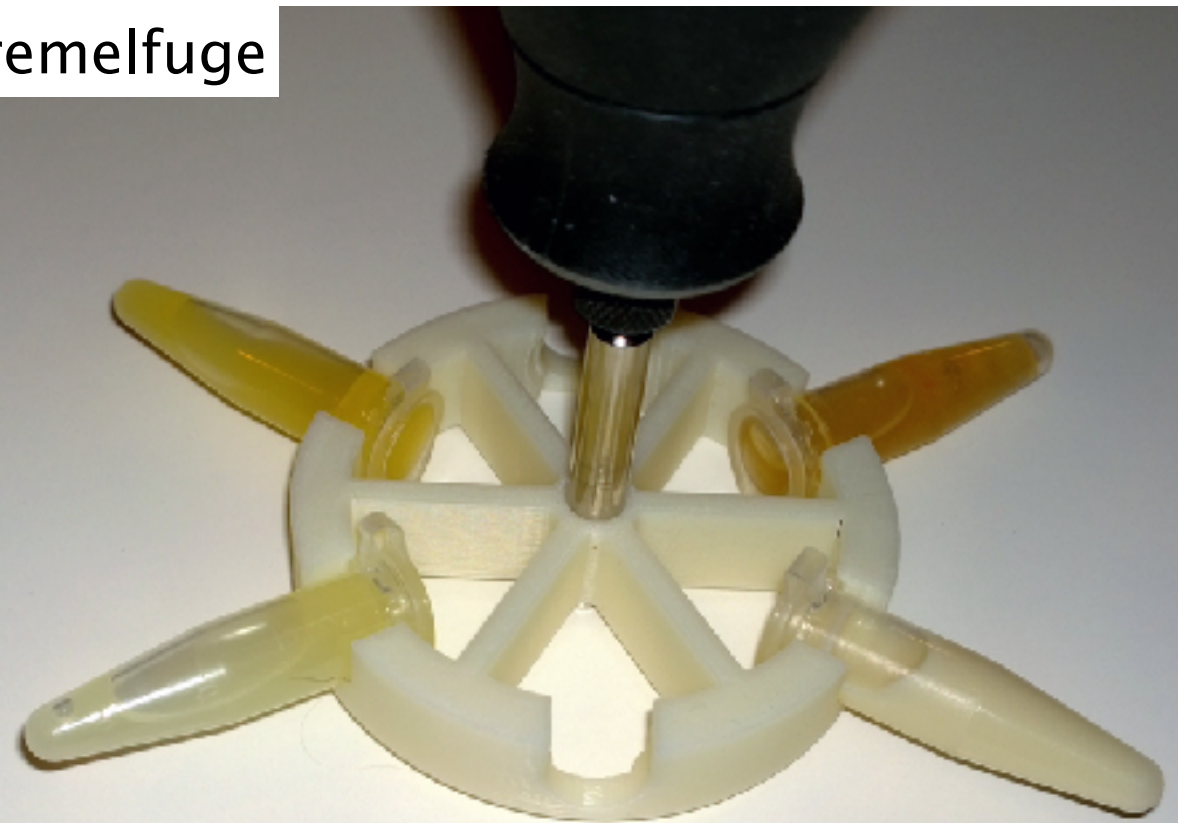


Centrifuge hacks

GoGoFuge



Dremelfuge



OpenFuge



Hackteria harddrive hack





Design constraints



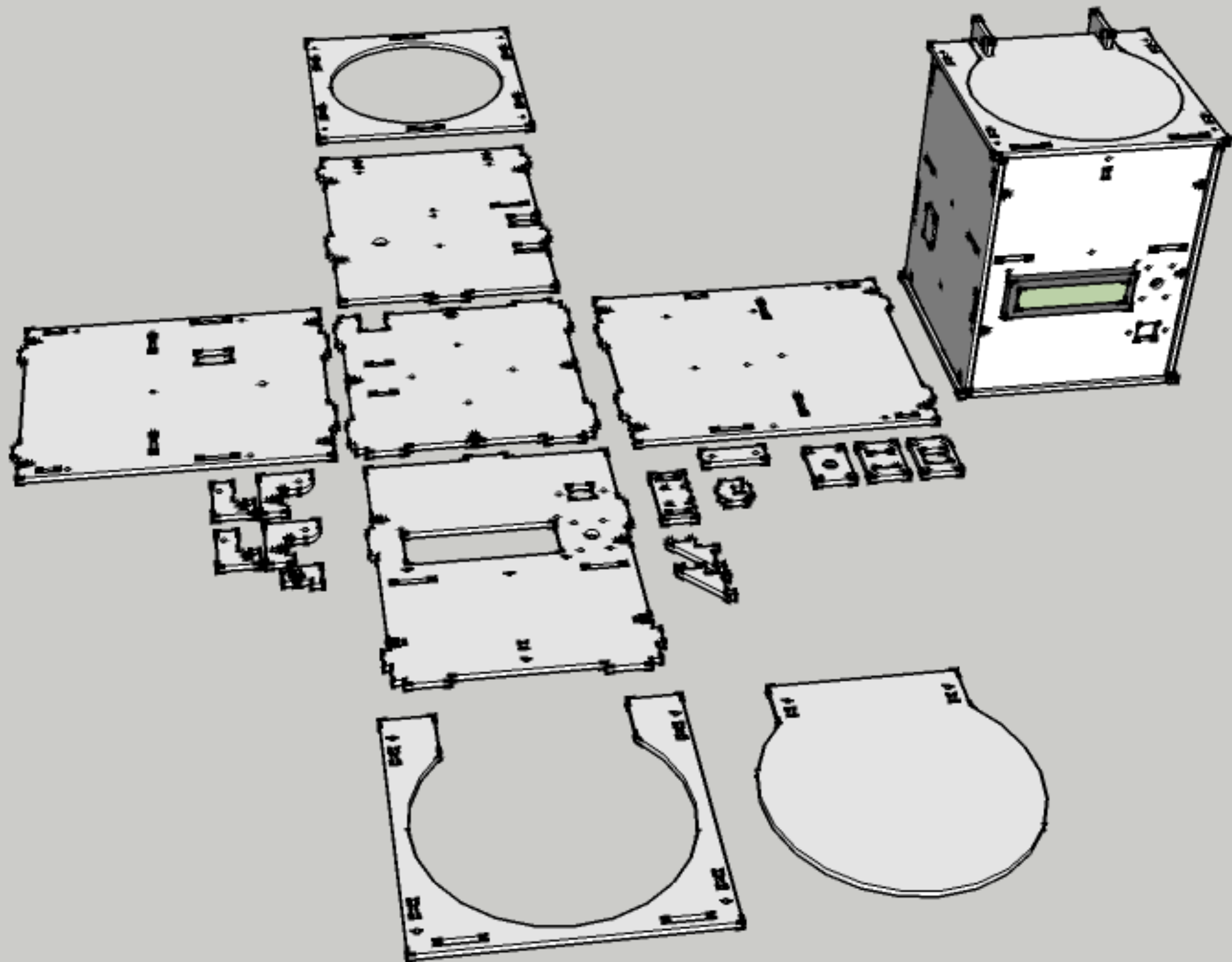


Notice

- NEVER test your centrifuge with a rotor attached

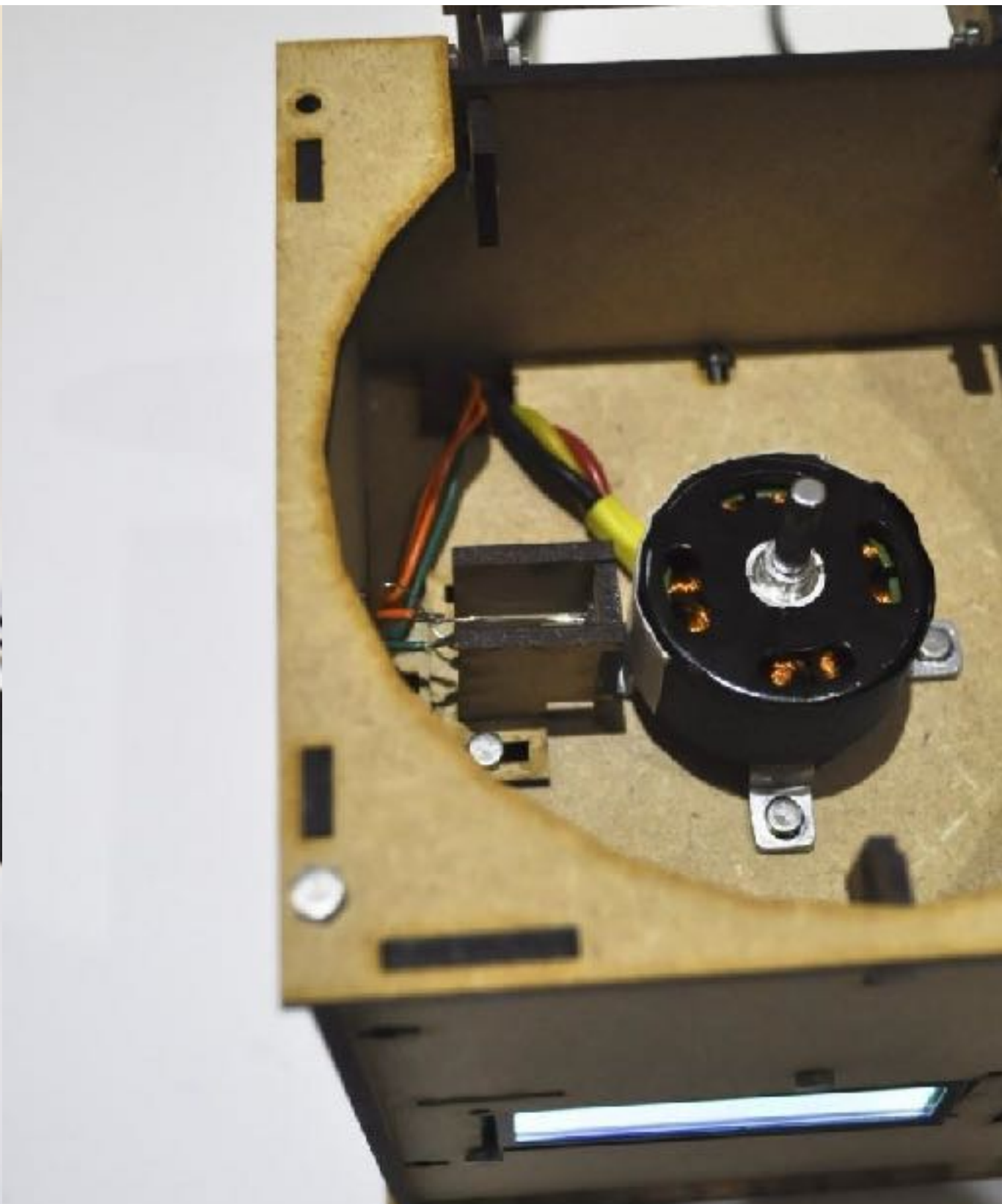
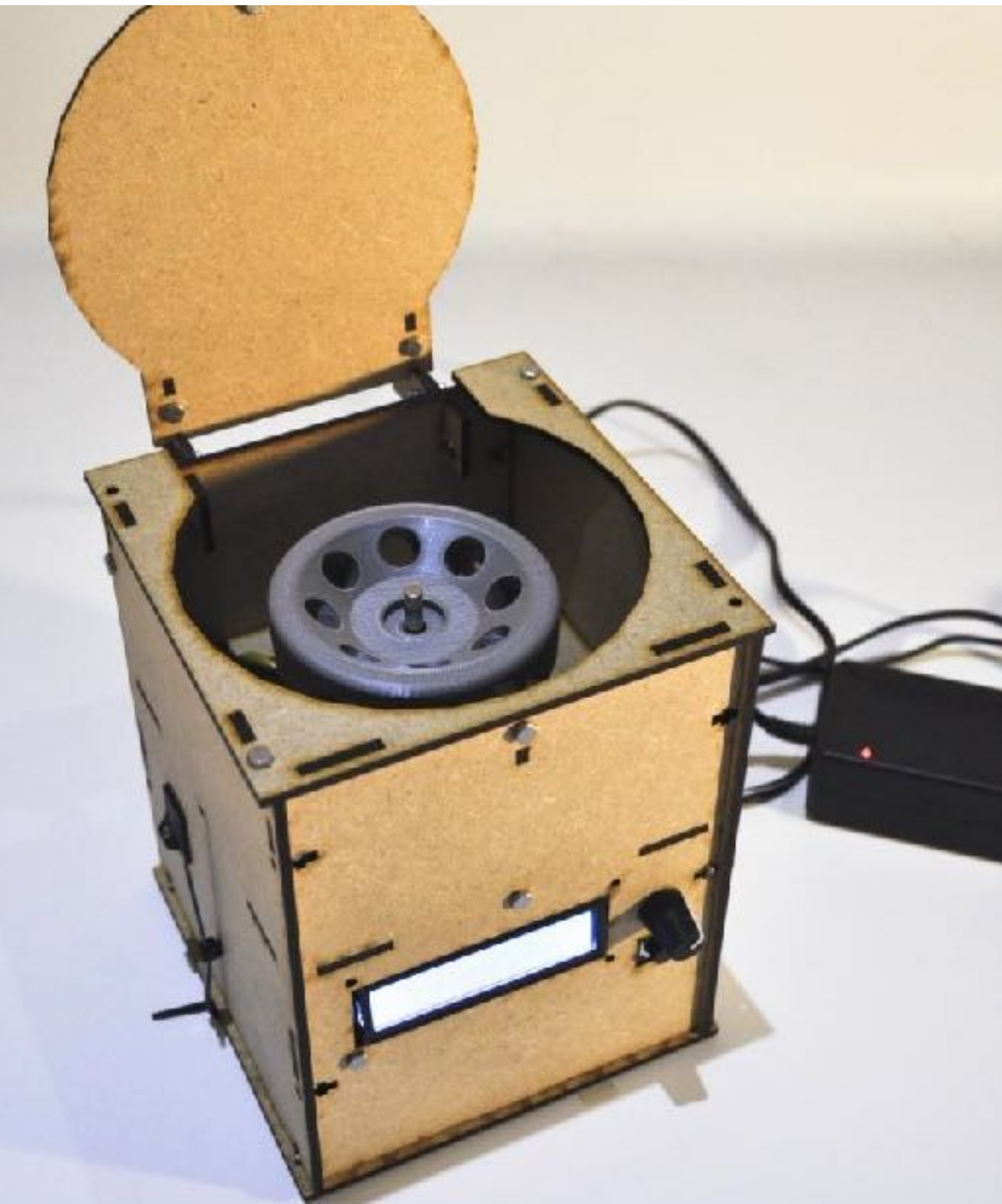


BioHack Academy design





Some pictures





Bill of Materials

No	Amount	Description	Supplier NL	Cost
1	1	DC Brushless motor 800 RPM/V & Electronic Speed Controller	HobbyKing	15.22
2	1	3.5mm connector	HobbyKing	3.14
3	1	Rotary encoder	Farnell , iPrototype , EEO	0.42
4	1	Knob	Farnell	0.23
5	1	Power switch	Farnell , iPrototype	0.71
6	1	DC power jack	Farnell , EEO	0.85
7	1	12V 5A Power supply	Farnell , EEO	38.13
8	1	Push button	Farnell , iPrototype , Sparkfun	0.47
9	1	10K resistor	Farnell , EEO	0.03
10	4	Rubber feet	Conrad	0.08
11	1	Infrared sensor	Farnell	1.70
12	1	6.8 KOhm resistor	Farnell	0.02
13	1	220 Ohm resistor	Farnell	0.02
16	1	I2C LCD display	iPrototype , Hackerstore	8.95
17	2	10K resistor	Farnell , EEO	0.6
18	2	10nF capacitor	Farnell , iPrototype , EEO	0.14
19	2	100nF capacitor	Farnell , EEO	0.14
20	1	Breadboard	Farnell , iPrototype	2.56



Motor

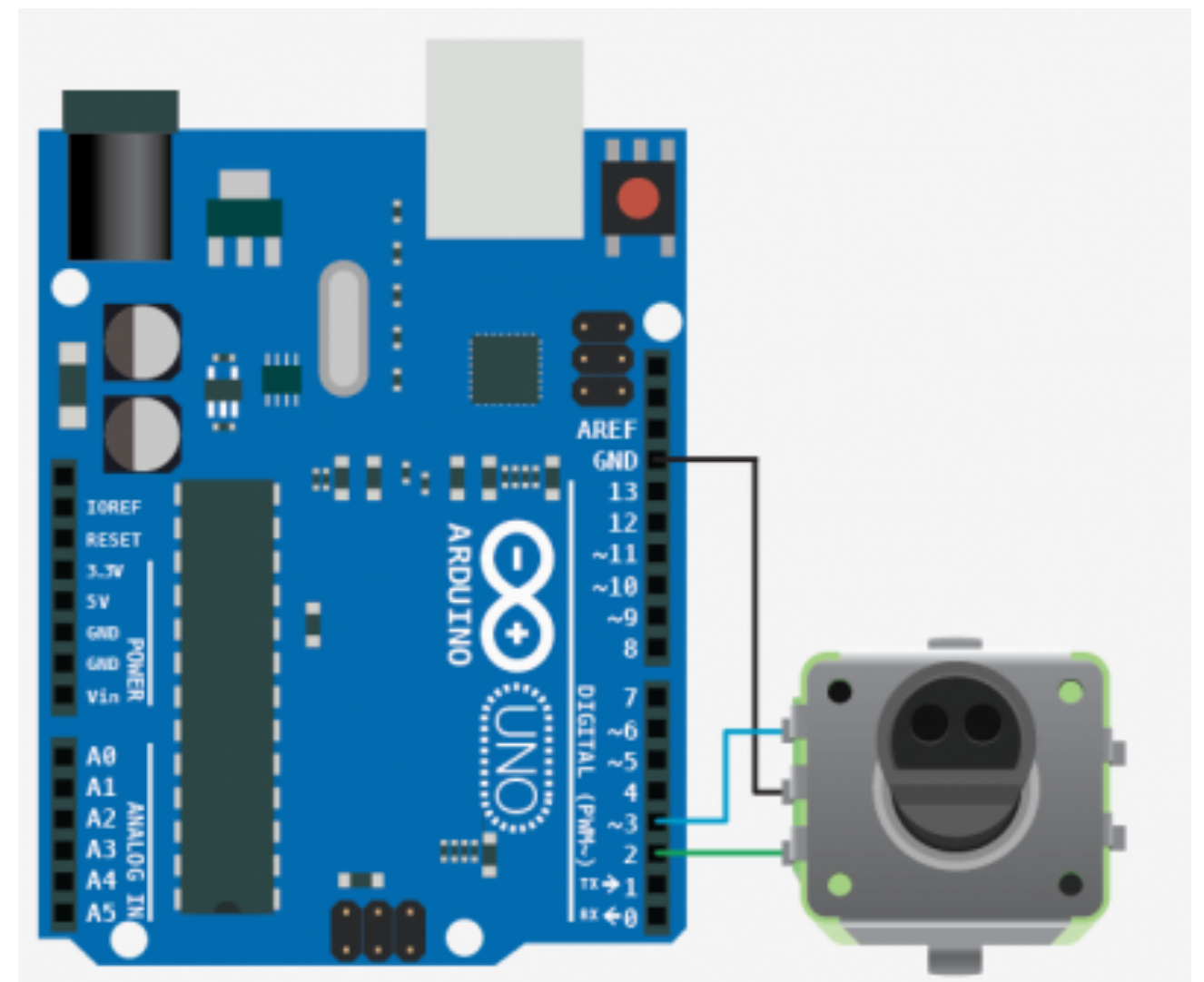
- Brushless
 - $\text{RPM} / \text{V} = 810$
 - 12V, so 9720 RPM
- ESC
 - power limit
 - voltage regulator





24 steps rotary encoder

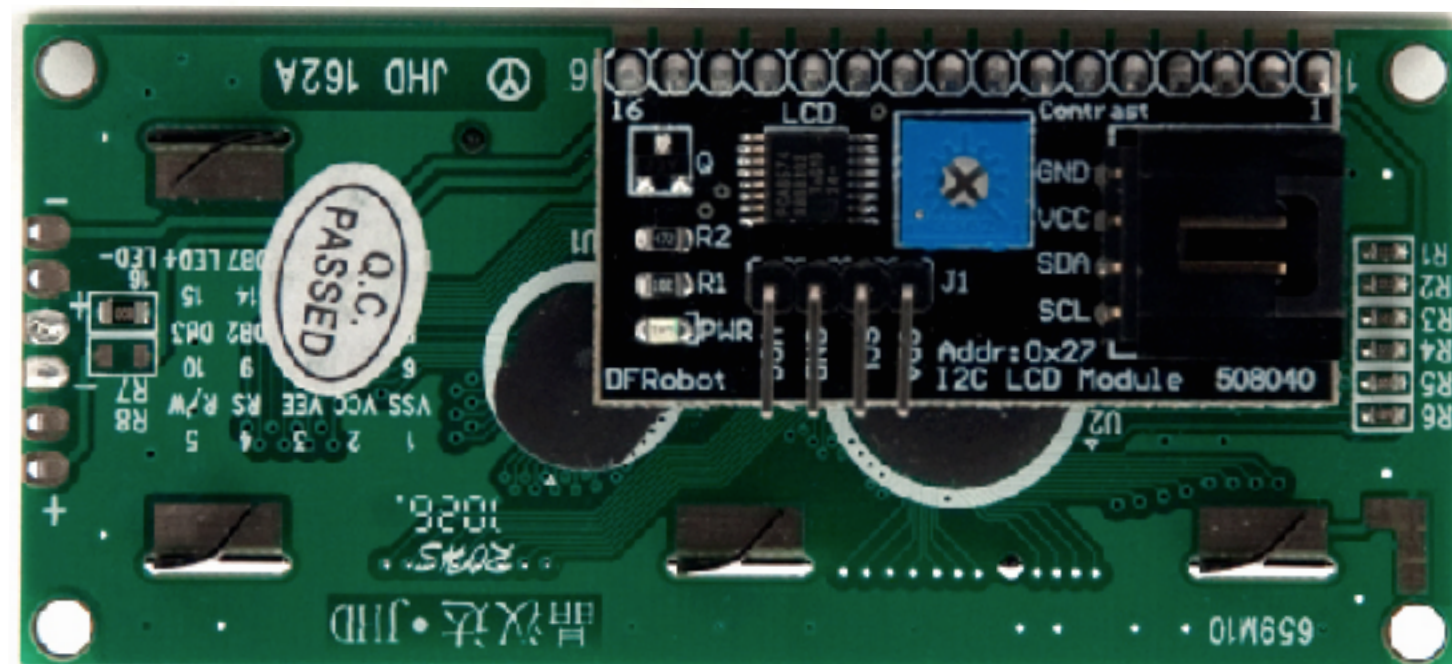
- Rotates infinitely
- 3 pins:
 - GND
 - State1
 - State2
 - 2 bits:
 - 00
 - 01
 - 11
 - 10
- Interrupt pins
 - `attachInterrupt()`
- Demo code in Syllabus





I2C Display

- Arduino I2C ports
 - SLC -> A5
 - SDA -> A4
- Libraries
 - Wire
 - LiquidCrystal_I2C
- Demo code in Syllabus





Heavy weight

- Stabilising the machine





Infrared sensor

- Emitter
- Detector
- `pulseIn()` function
 - <http://arduino.cc/en/Reference/pulseIn>





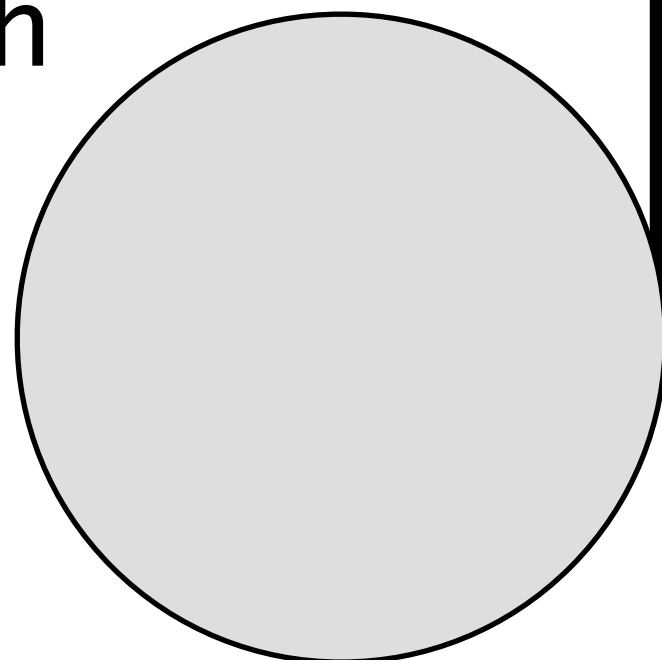
Roller coaster





Centrifugal force

Circular path



Inertial path



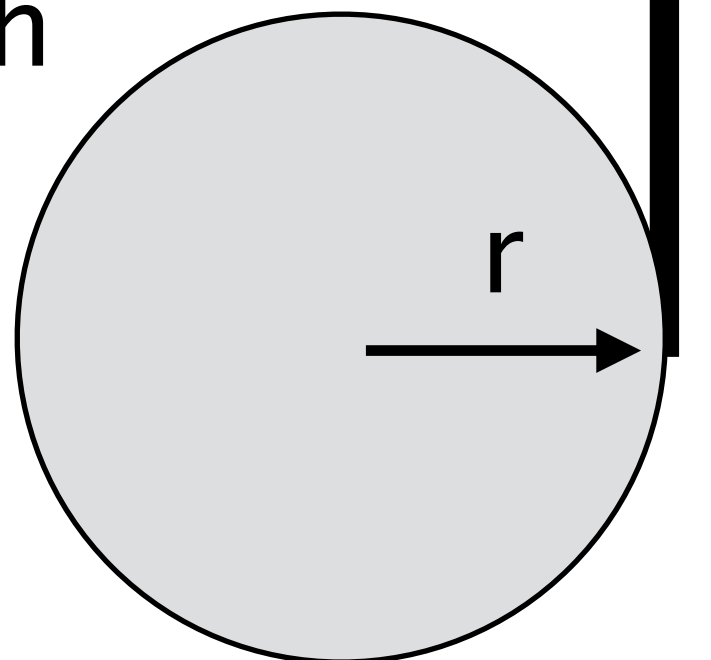


Centrifugal force

$$G \text{ force} = \left(\frac{RPM}{1.000}\right)^2 \times 1.118 \times r$$

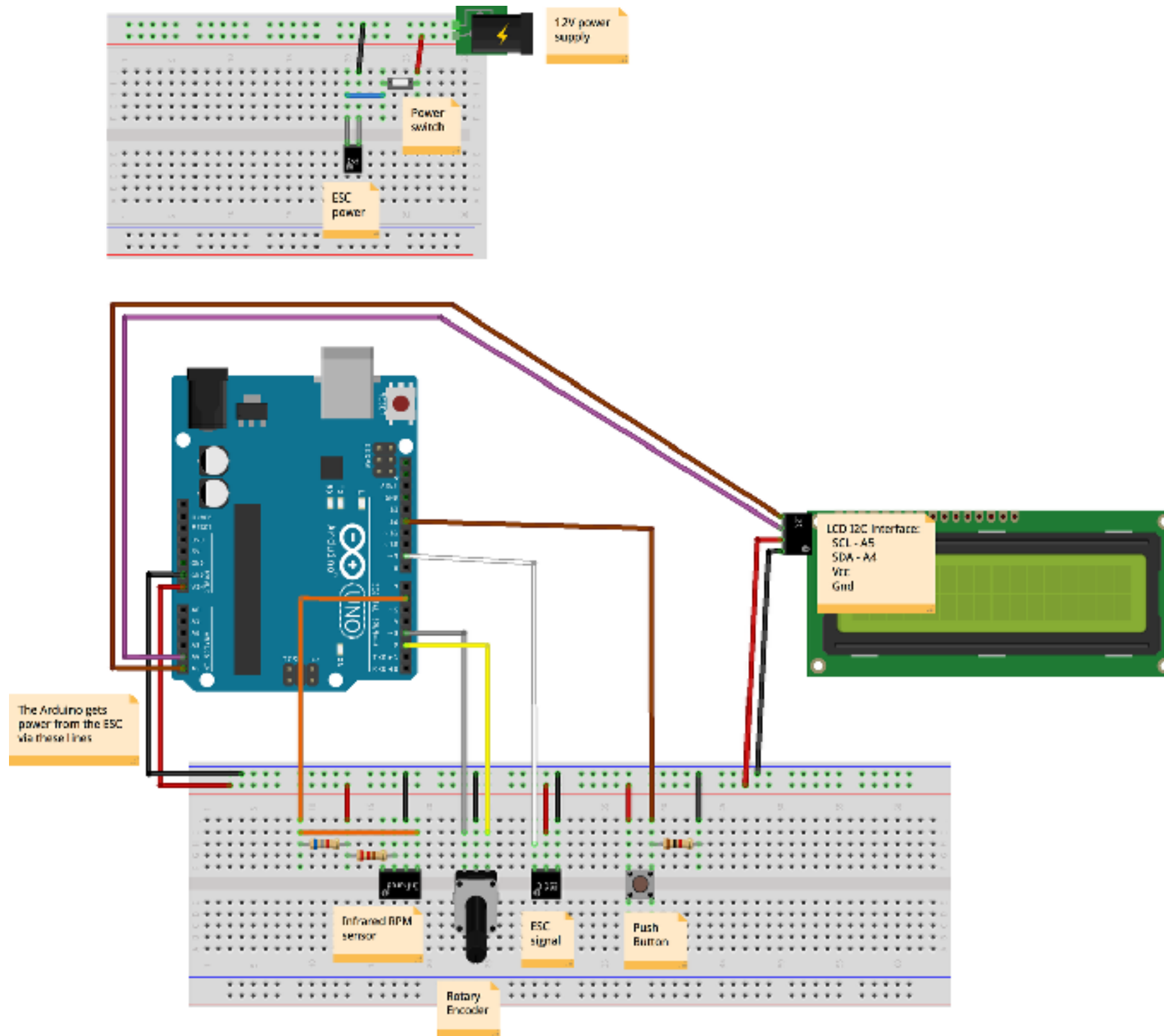
Circular path

Inertial path



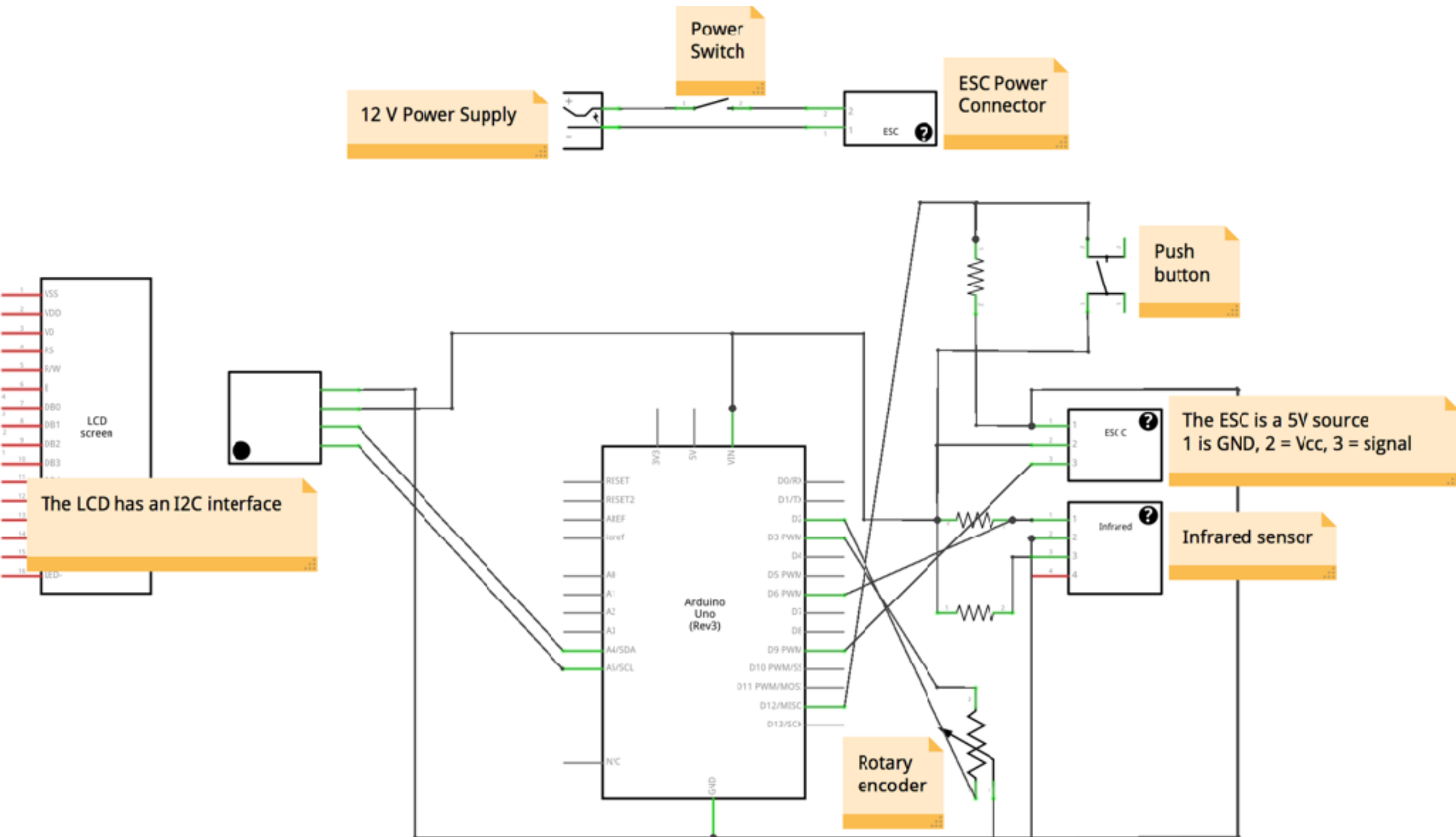


Wiring





Circuit scheme



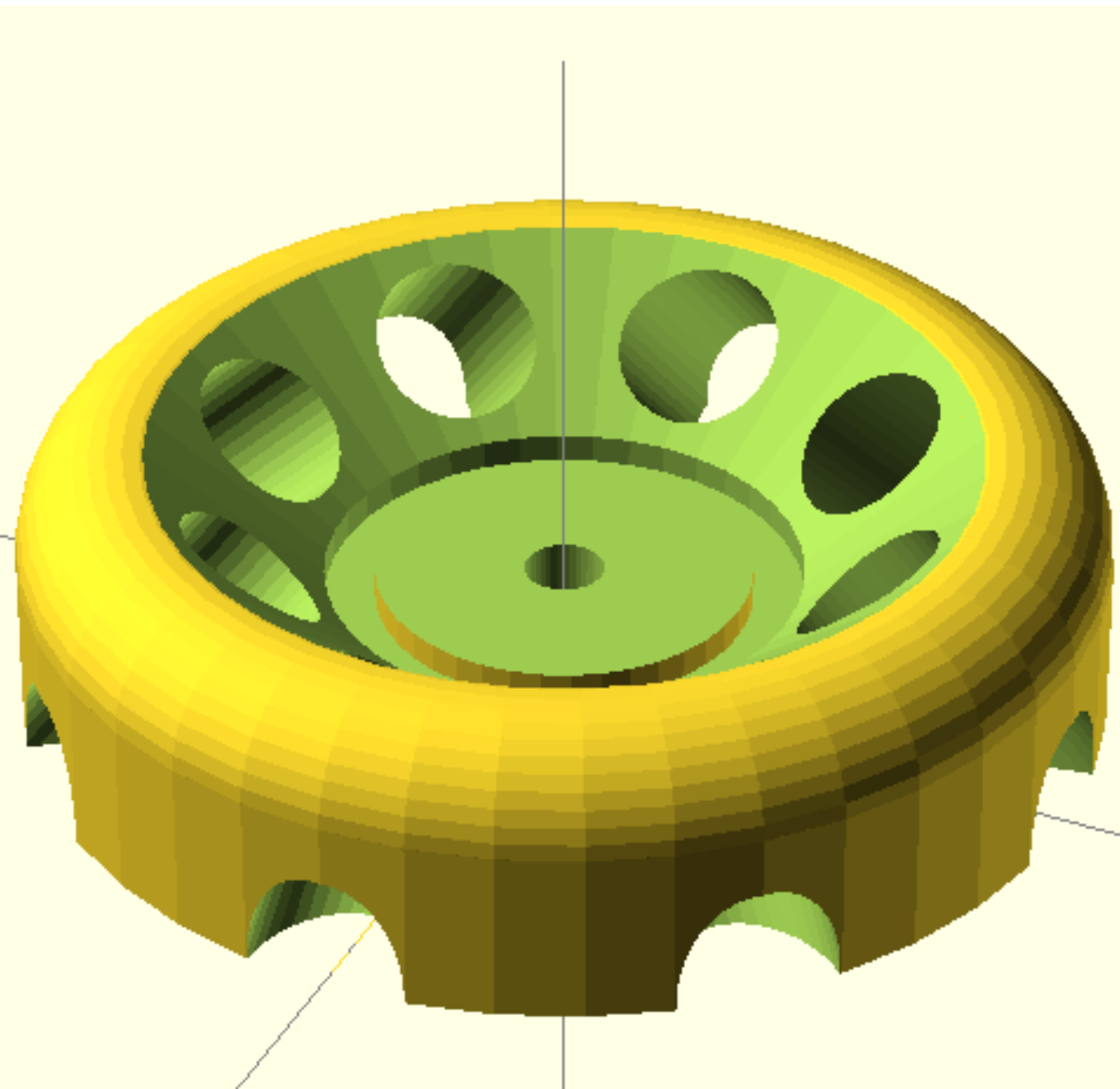


Code tutorials

- Rotary encoder
 - <http://bildr.org/2012/08/rotary-encoder-arduino/>
- I2C LCD
 - <http://playground.arduino.cc/Code/LCDi2c>
- Infrared sensor
 - <http://bildr.org/2011/03/various-proximity-sensors-arduino/>
- Arduino + Electronic Speed Controller
 - <http://www.instructables.com/id/ESC-Programming-on-Arduino-Hobbyking-ESC/>



Rotor



NEVER test your centrifuge with a rotor attached

```
OpenSCAD - 8 Place Rotor

$fn=40; // resolution of the arcs

axis_radius = 0.275; // radius of the motor shaft

tube_radius = 0.575; // inner radius of the tube holders
tube_angle = 45; // angle in the rotor
tube_pos = 4.75; // position of tube holders

scale([10,10,10]) { // cm to mm scaling

difference () { // subtract tube holders from outer ring

    difference () { // subtract inner groove

        difference() { // subtract cone from main disk

            union() {
                cylinder (h = 1.25, r=3.75); // main disk part 1
                cylinder (h = 1.9, r=3.25); // main disk part 2

                // smoothen edge torus
                translate([0,0,1.25])
                rotate_extrude(convexity = 10)
                translate([3, 0, 0])
                circle(r = 0.75);
            }

            translate([0,0,1]) // raise cone from bottom
            cylinder (h = 1.1, r1 = 1.65, r2 = 3, center = false); // co

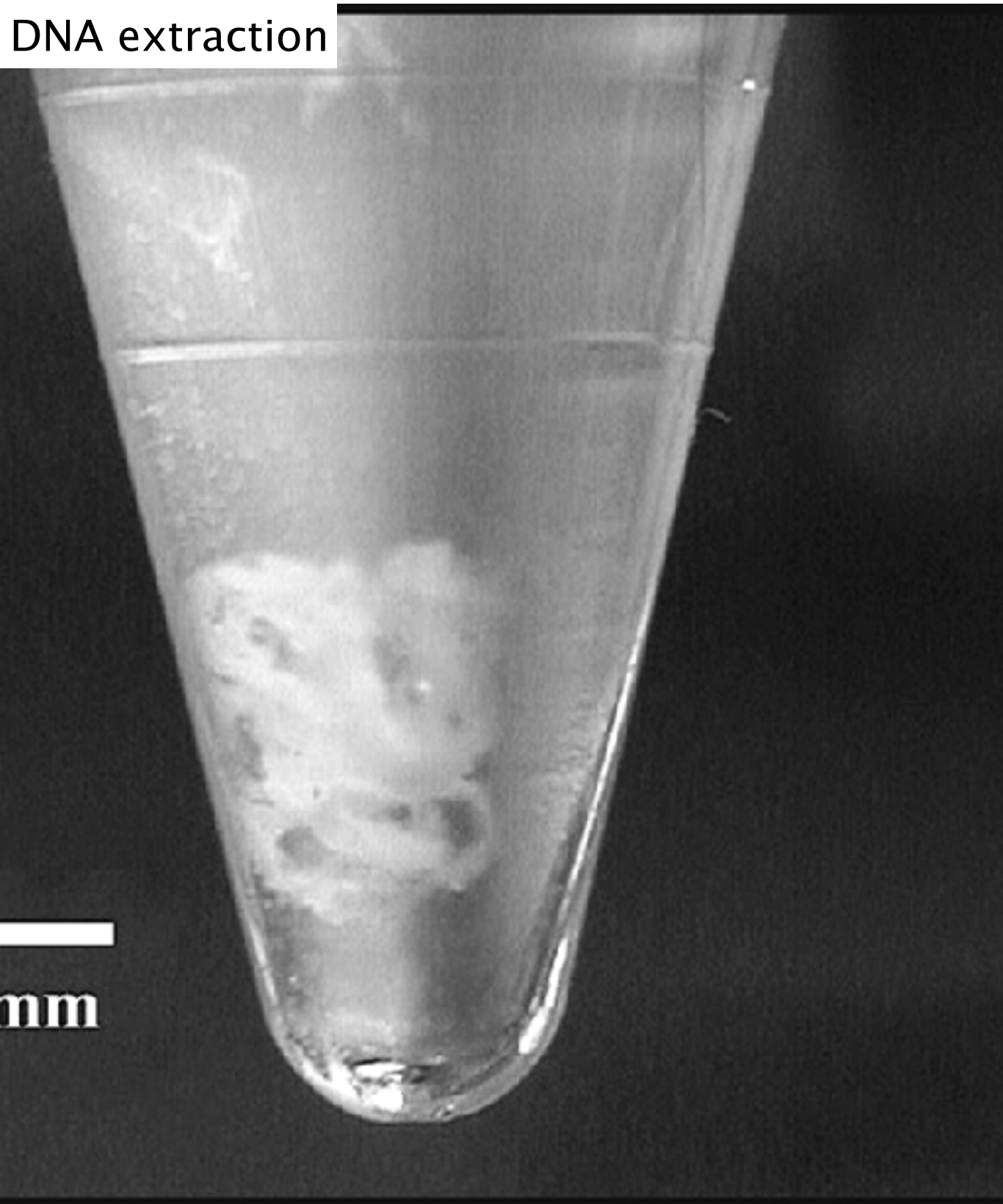
            translate([0,0,-0.1])
            cylinder (h = 1.2, r=axis_radius); // axis

            // groove under tube holders
            translate([0,0,0.8])
            difference() { // ring
```

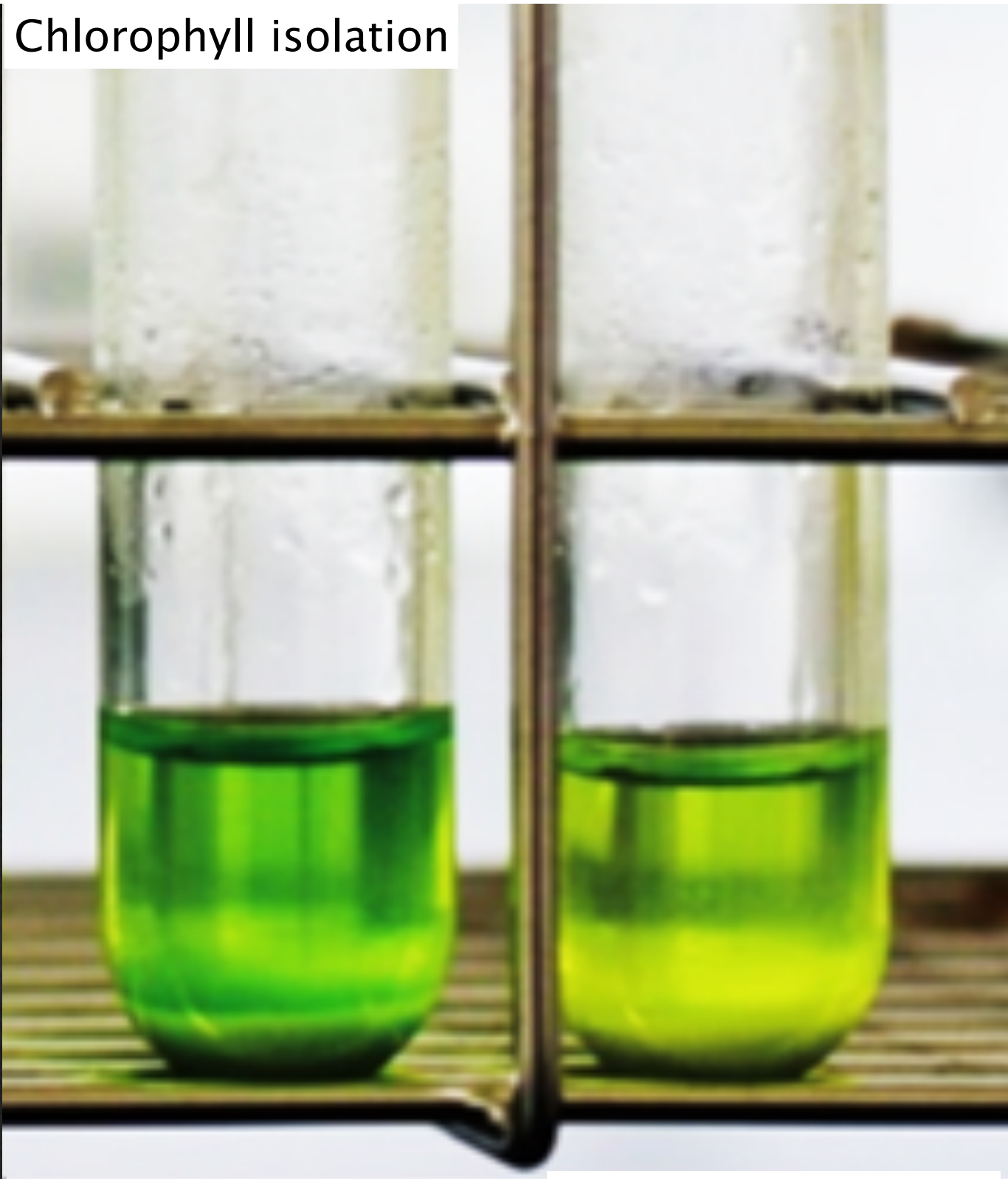


Practicals

DNA extraction



Chlorophyll isolation





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