OpenFlexure microscope
Raspberry Pi version – assembly instructions

Welcome to the OpenFlexure microscope, a build-it-yourself microscope which features a flexure-based XYZ stage with sub-micron precision and a range of 8mm.

Don't be fooled by its appearance. Because it's constructed using flexible plastic, its motion is free from friction and vibration. And because it connects to a Raspberry Pi, you can see pin-sharp detail in a big image on a smartphone, tablet or monitor rather than the limited view through a traditional manual microscope.

Preparing to assemble the microscope

Some of the microscope parts are small and care needs to be taken assembling them. Others, in particular the camera lens, are delicate and need to be protected from dust. So make sure you have a clean work area and wash your hands before you start assembly.

Parts required:

Plastic parts	
Microscope body	1
Focusing wheel cog	3
Focusing wheel base, untilted	1
Focusing wheel base, tilted	2
Illumination arm (vertical part)	1
Illumination arm (horizontal part)	1
Sample clip	2
Optics module	1
Camera PCB cover	1

Plastic tools	
Band insertion tool	1
Nut insertion tool	1
Camera board gripper	1

Hardware:	
M3 hexagon head 25mm screws	3
M3 brass nut	3
M3 stainless steel washer	4
Viton bands	3
(2 spare Viton bands may be included)	
White LED, 5mm, & resistor	1
Pre-crimped wires	2
2-way housings	2
M2 6mm cap head screw	2
M3 8mm cap head screw	3
Raspberry Pi camera module	1

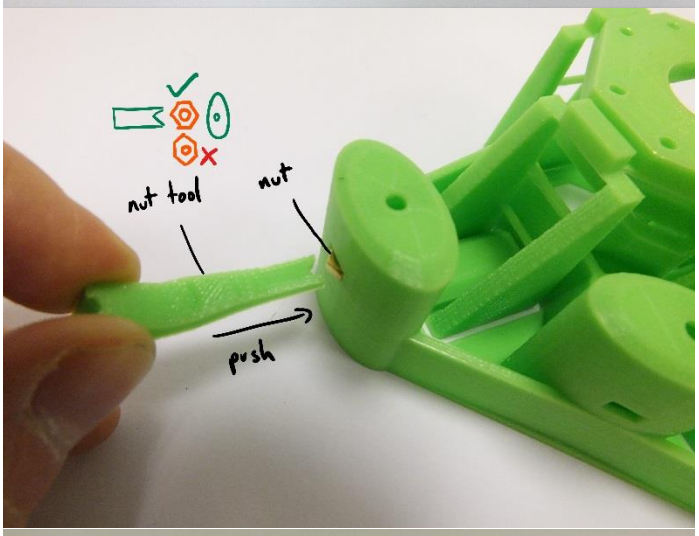
Tools (not supplied in kit)
1.5mm & 2.5mm Allen keys

Go through the instructions carefully and you'll find it's relatively easy– as well as very rewarding – to build your own microscope.

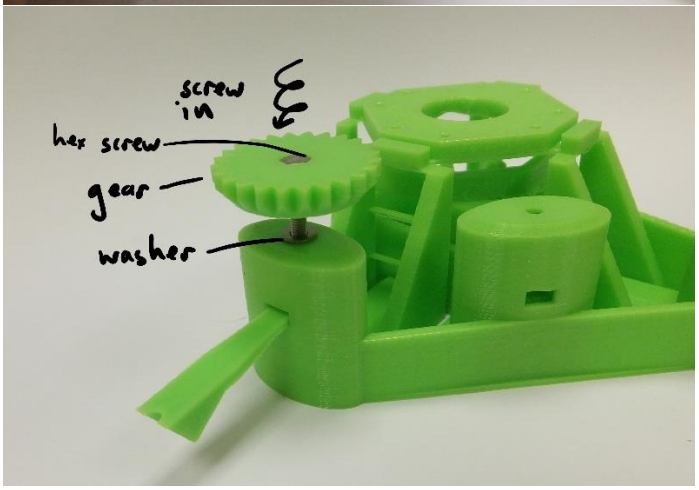
A warning before you start: the Raspberry Pi camera board is static sensitive. Take the usual anti-static precautions (ideally use an anti-static wristband connected to ground), but at the very least make sure you touch an earthed object, such as a metal pipe, before working on it.

Step One: Assembling the focusing wheels

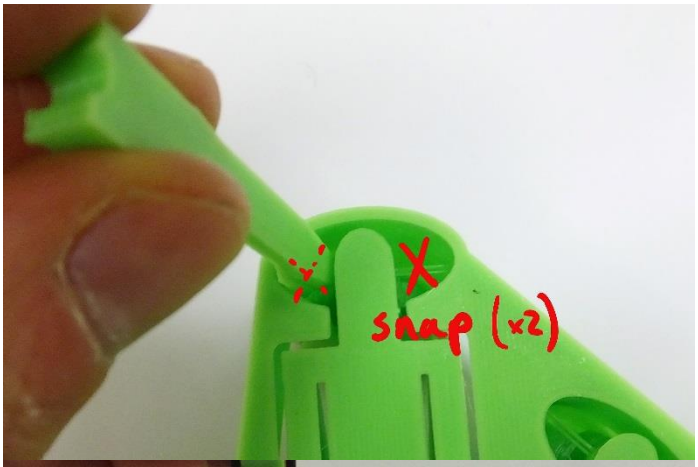
The microscope has three focusing wheels to move your view left and right, forward and backward, up and down. Each focusing wheel is built from a foot, a cog, a screw and nut with a washer, and an elastic band. It's best to start with the centre focusing wheel first.



Insert the nut from the side, through the slot in the actuator column, and push it into place with the tool. Take care to insert the nut corner-first (i.e. with flat sides parallel to the tool), otherwise it will jam.

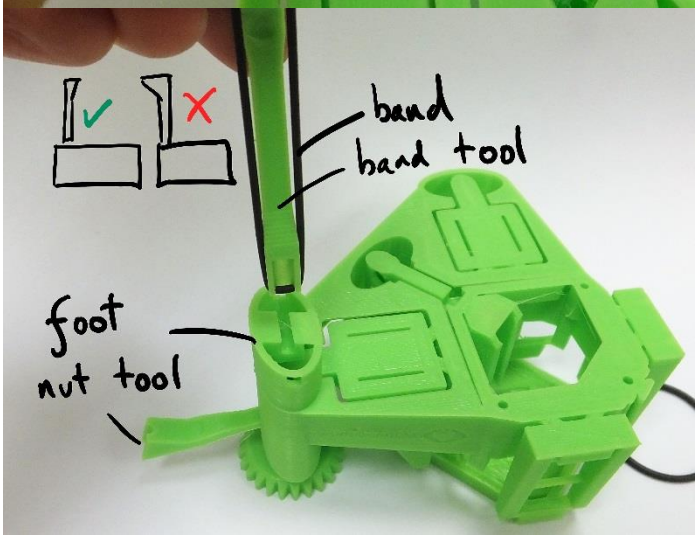


Next, put one of the hex-head screws into the gear, and screw into the nut that is now inside the actuator. Use a washer between the gear and the microscope body.



Turn the microscope over and, using the elastic band tool or a craft knife, snap the two thin plastic supports as shown.

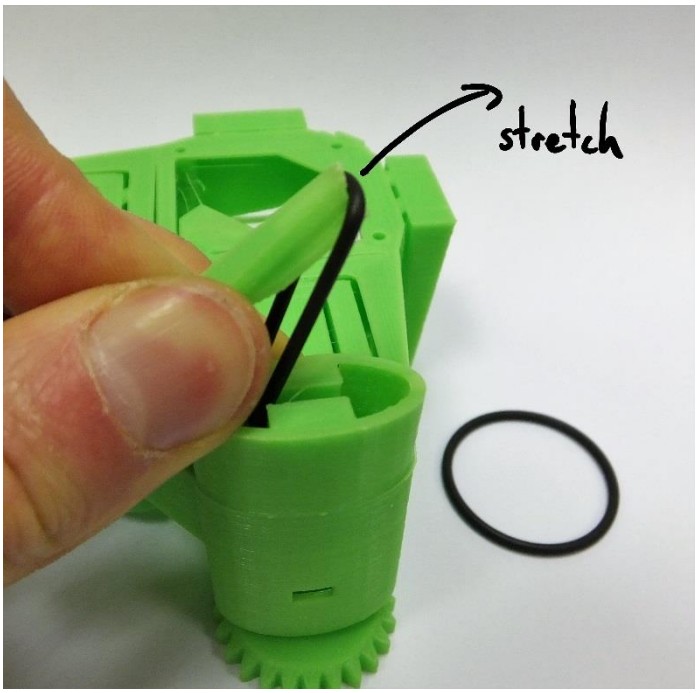
Fit the foot to the bottom of the microscope. NB the two tilted feet must go on the outside of the microscope, and the gap in the foot points towards the optics module.



Hook one of the elastic bands over the elastic band tool, and insert it through the foot. Push in until it clicks into place on the hook inside the microscope.

NB the band tool will only work one way round; the flat side should be towards the outside of the foot, the handle points inwards.

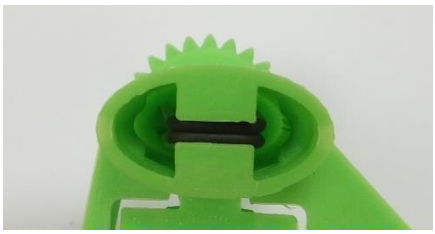
Tip: leave the nut tool in place, to stop the hooks being pushed up when you insert the elastic band.



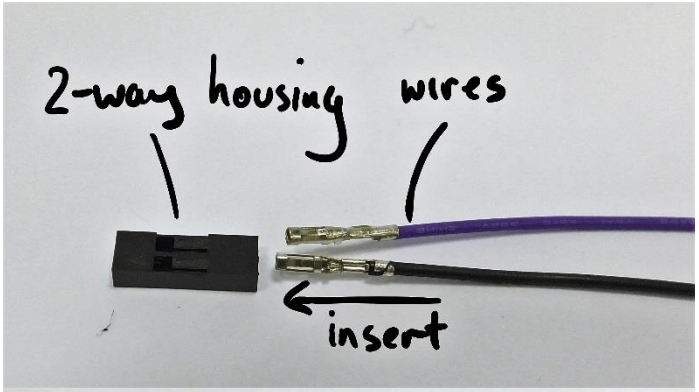
Hook the tool through the free end of the band, and stretch it up and over the channel in the foot. It's important to stretch it before hooking in the other side because otherwise the band can jam in the channel and snap.

Repeat the previous step, to push the free end of the band into the other side of the foot, so it clicks into place on the hook.

You should now have the band pulling both sides of the actuator down as shown.

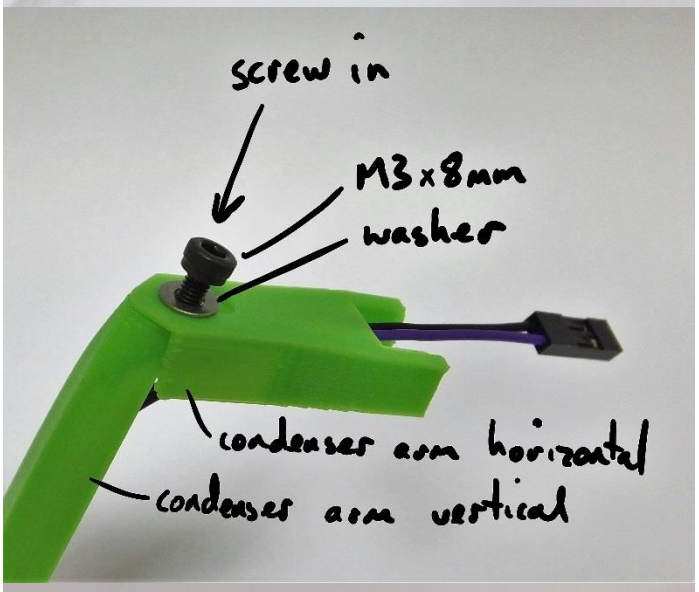


Step two: Adding the light source

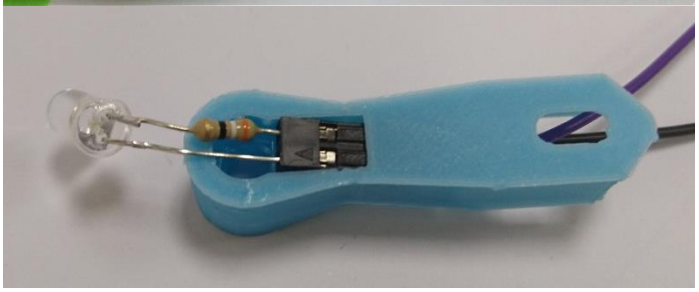


Assemble the cable for the LED. If using pre-crimped cables, as supplied with our kit, fit the 2-way header to either end. Don't worry about polarity, it's easy and harmless to simply rotate the connector 180 degrees if you need to.

Thread the cable through the two parts of the illumination arm (the shorter part might look slightly different from the one shown)

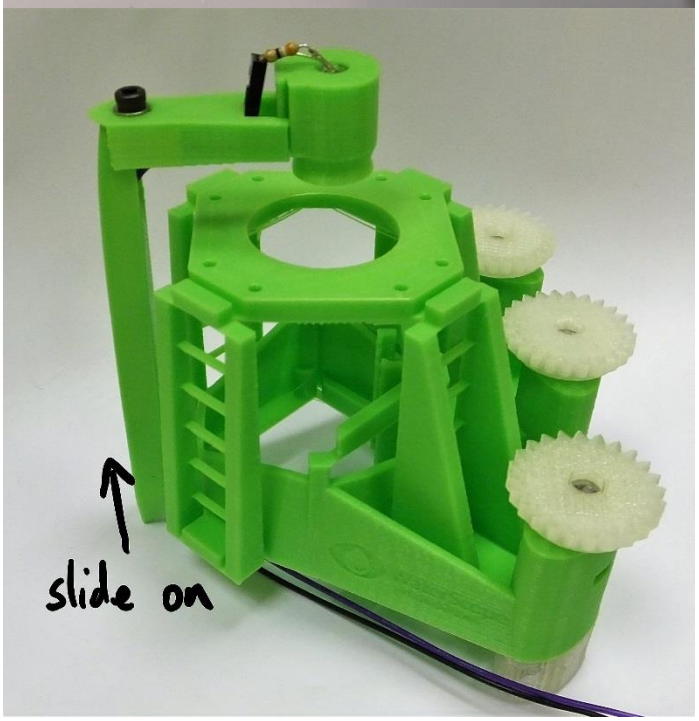


Screw the horizontal part onto the vertical part, using one of the M3 screws and a washer. It's made in two parts so you can loosen the screw and adjust the position of the LED later.



Insert the LED into the 2-way header connector on the cable

Bend the LED by 90 degrees, then push it into the hole in the mount.



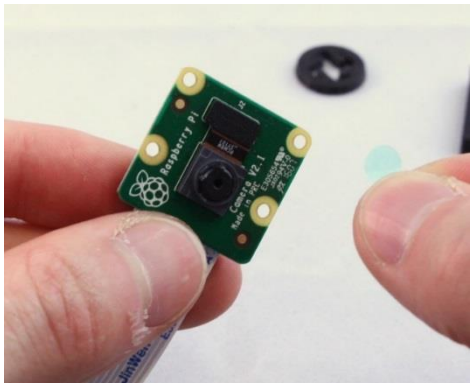
Slide the illumination arm onto the microscope from the bottom.

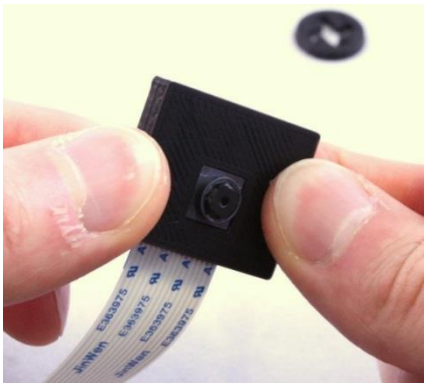
Don’t worry if the thin linker at the bottom of the clip snaps, it’s only there as a support during printing.

Step three: Adding the optics module

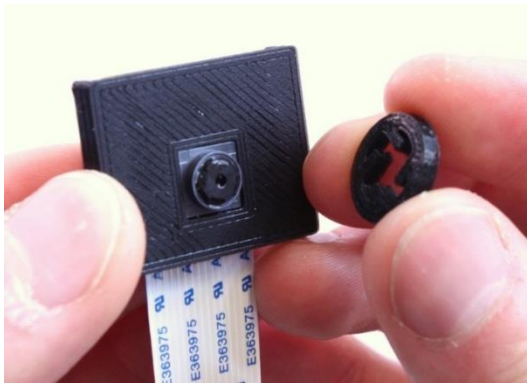
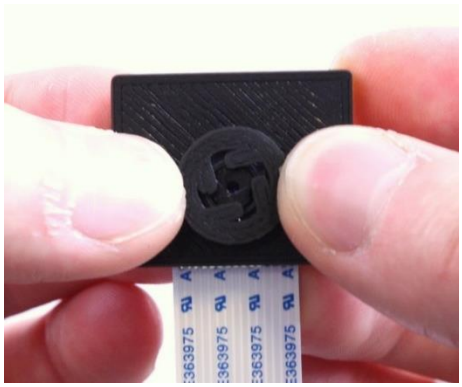
The optics module for the microscope holds a Raspberry Pi camera and lens, but the lens is placed 40mm from the sensor so it can function as a high-magnification microscope.

Remove the protective film from the camera lens, and then fit the camera board gripper over the camera and printed circuit board. This will stop the camera twisting and damaging the ribbon cable when you remove the lens.

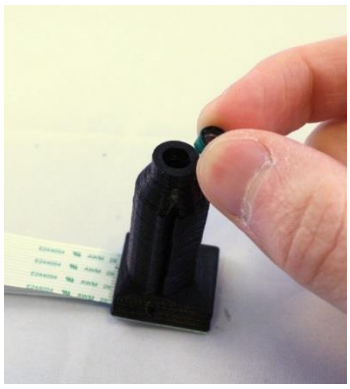
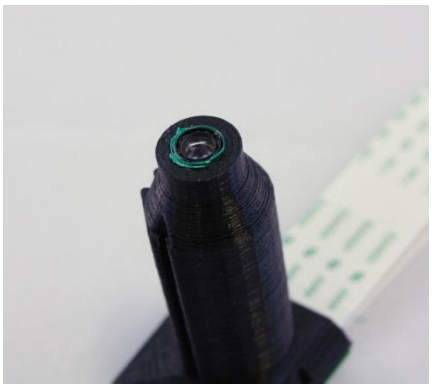




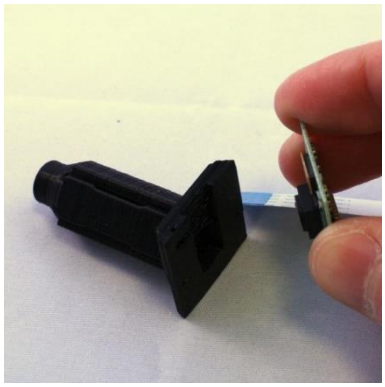
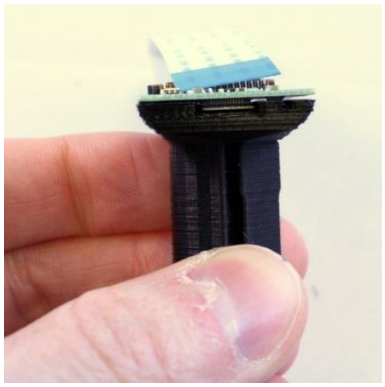
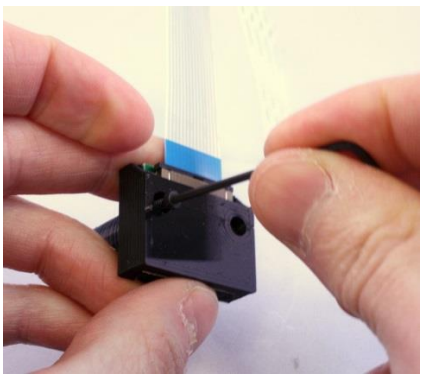
Now unscrew the lens from the camera module. Push the removal tool onto the lens. (Thisshould be supplied with your camera, a white plastic cone that fits onto the lens.) Turn anticlockwise to remove the lens. After removing the lens, check the ribbon cable connecting the camera module to the printed circuit board is still connected - pop it back in by pushing it with a finger if needed.

Next, put the lens into the optics module, with the large aperture (the side that was next to the sensor) facing upwards, and the smaller aperture pointing into the module.

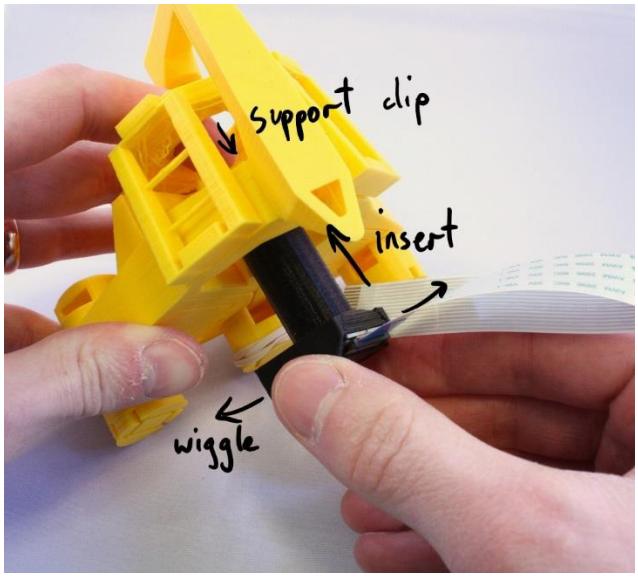



Now screw the Raspberry Pi camera module and the plastic cover for the board onto the bottom of the optics module. The two M2 screws should go first into the cover, then through the camera PCB, then into the mount. You'll need a 1.5mm Allen key to screw them in.

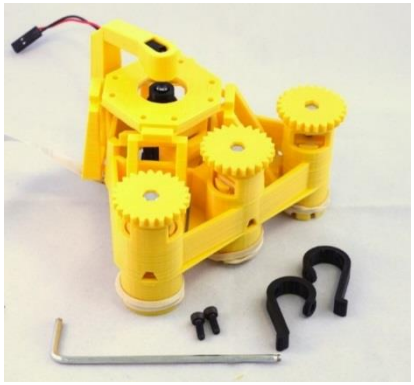
Now you're ready to fit the optics module into the microscope. Simply slot it onto the dovetail mount in the centre, from the bottom. You may find it easier to fit if you wiggle it from side to side as it goes in. It may also help to support the dovetail from the top (through the hole in

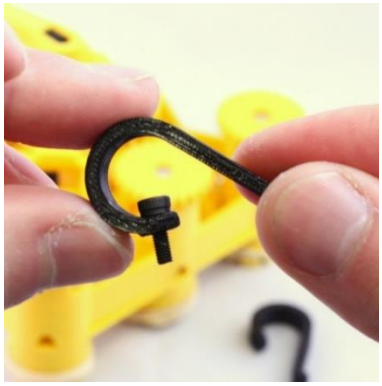
the stage), because it will flex when you push the mount onto it – pushing too hard can crack the Z axis of the microscope.

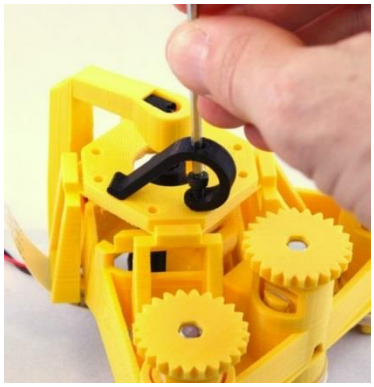


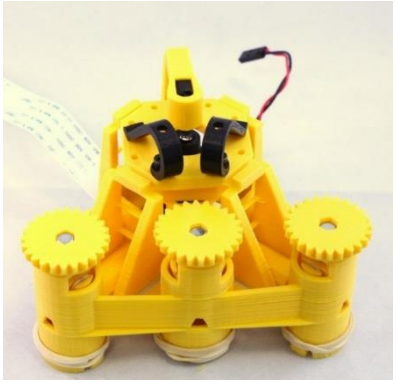
Step four: Adding the sample clips

Fitting the sample clips is the final stage and exactly where you place them depends on the samples you intend to use. Wherever you plan to put them, you simply push the M3 screws into the clips, then screw them into the pre-drilled holes on the stage. For using standard microscope slides, the two holes furthest from the illumination arm work best.









Step five: Connecting to the Raspberry Pi

Plug the cable from the LED light source into the GPIO connector on the Raspberry Pi, to the 0v and 5v lines. These are the second and third pins from the top of the connector, on the outside edge – pins number 4 and 6. Next, plug in the camera to the camera connector as described in the Raspberry Pi documentation (the connector is next to the Ethernet port, and the contacts on the cable face the port, i.e. they face away from the tab on the plug).

Your microscope is now complete – happy observing!

If you need help setting up the camera, please visit:
https://www.raspberrypi.org/documentation/usage/camera/
https://www.raspberrypi.org/documentation/usage/camera/raspicam/README.md