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Manual

Mirus Evo™ Nanopump

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Mirus Evo™ Nanopump Manual

This manual was produced by Cellix Ltd.

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Introduction

Warranty and Repair Information

The Cellix Mirus Evo nanopump is sold with a warranty of 12 months from purchase date. It covers malfunctioning, abnormal wearing and repair cost but does not cover normal wearing, consumable parts and malfunctioning due to improper use.

Intended Use

The Cellix Mirus Evo nanopump is laboratory equipment certified under the EN-610 10-1 standard. It is not a medic al device and MUST NOT BE connected to patients. To do so will not be the responsibility of Cellix Limited and will invalidate the warranty.

As laboratory equipment, the Mirus Evo nanopump's purpose is to deliver liquids accurately and reproducibly. Main applications for this equipment include studies for drug discovery in combination with Cellix biochips.

Mirus Evo nanopump is intended to be used within the following environmental conditions:

Altitude	<2000 m
Temperature	5–40°C
Atmospheric pressure	562–795 mmHg
Humidity	<80% RH

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Safety Requirements

Mirus Evo nanopump is supplied with a set of cables (power, USB and accessories cables). Do not use any alternative cables. The power cable provides ground connection to your main circuit and is there for the safety of the user. Failure to use the power cable supplied with the equipment may cause serious damage to your equipment and will void the warranty.

Keep fingers out of the syringe slot while the pump is running. Failure to do so may cause injury.

Do not open the casing of the Mirus Evo nanopump for any reason. Doing so may cause serious injuries due to electrical shock. Maintenance of the pump can only be carried out by qualified and trained persons. Opening the casing of the Mirus Evo nanopump will void the warranty.

Use the pump with in its specifications. Be sure to use the pump for the specified voltage ratings.

If it is necessary to replace the fuse, us e the specified fuse for your voltage rating. Be sure you re ad instructions “how to replace the fuse” before replacing it.

Keep the Mirus Evo nanopump on a stable table for proper operation.

Keep the Mirus Evo nanopump clean. Keep all the fluidic tubings and connections as clean as possible for proper operation. Carefully read the manual for proper operation and maintenance of the pump.

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Mirus Evo Nanopump Setup

System Specifications

The Cellix Mirus Evo nanopump is a high precision pumping system designed to dispense/aspirate small sample volumes and to support continuous flow rates (within user-defined shear stress ranges within microcapillary biochips.

Specifications

Shear stress and flow rate ranges available depend on syringe volume used. Check the table below to find the right syringe according to your application.

Syringe volume (µl)	Shear Stress Range (dyne/cm^2)	Volumetric Flow Rates (µl/min)**
50	0.025–75	0.1–300
100	0.05–150	0.2–600
250	0.125–375	0.5–1500
500	0.25–750	1.0–3000
1000	0.5–1500	2.0–6000
2500	1.25–3750	5.0–15000
5000	2.5–7500	10.0–30000

Sample volume increments	Freely adjustable
Linear velocity range**	10 µm/s to 10 cm/s
Flow direction	Reversible
Pumping system dead volume (system liquid only)	600 µL
Sample volume aspiration accuracy	±1%
Shear stress accuracy	±0.5%
Sample volume aspiration precision	<1% CV
Shear stress precision	<0.5% CV

Requirements

Dimensions	84 mm (W) x 180 mm (D) x 192.5 mm (H)
Weight	~ 2 kg
Power requirements	110/220V – 50/60Hz – 60 W

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System Setup

To begin setup, remove the system from the box and clear all packaging away. Please check remaining contents of packaging, ensuring all parts have been supplied (see Pump Packaging document). Place the microfluidic pump in a suitable position, adjacent to both the microscope and operating computer.

The footprint of the Cellix Mirus Evo nanopump is relatively small, as described in the previous table; however, for ease and safety of operation the pump should be placed in a suitable space providing access to the pump environment. This is necessary to allow access to tubing, cables, reservoirs, etc.

Once in position, plug-in the USB cable to the USB port on the back of the pump, as shown in Figure 1. Once connected plug in the power supply cable (see Figure 2). Do not switch on the pump until other accessories are installed (see section on Multiflow8).

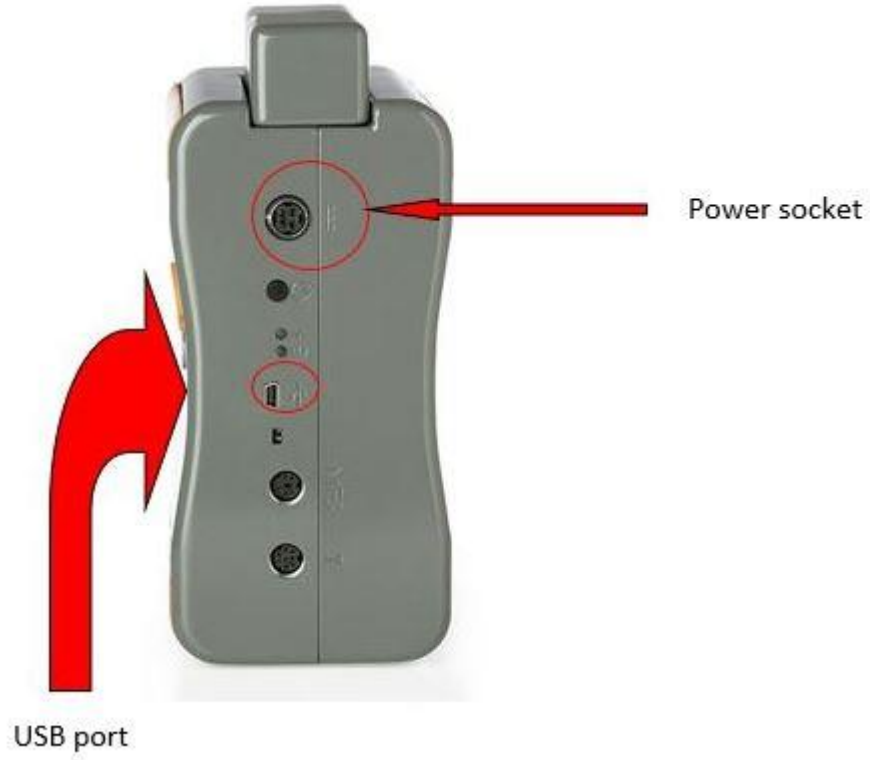

Figure 1 Attach USB cable to USB port and connect power cable to the switch socket on the back of the pump

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Mirus Evo Nanopump Syringe Installation

Attach the syringe to the syringe holder on the front panel of the Mirus Evo nanopump by screwing the syringe into the syringe drive valve in a clockwise direction; taking care not to tighten it completely, as shown in the figure below.

Figure 2 Picture showing syringe attached

Attach the syringe to the drive valve. Manually push the plunger lock-screw down to the syringe plunger. Release the thumb-screw on the plunger locking unit, allowing the syringe plunger to pass inside.

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Screw the plunger lock-screw in a clock wise direction ensuring it is tightly fastened as shown in Figure 3. This plunger lock-screw acts as a rack and pinion drive, which is connected to the stepper motor of the drive; thus, providing syringe movement. Finally, screw the syringe screw into the syringe drive valve until finger-tight. Tighten the syringe screw using a wrench taking care not to over-tighten as shown in Figure 4.

Figure 3 Tighten screw lock onto the syringe

Figure 4 Finish attachment by tightening syringe screw

Mirus Evo Nanopump Tubing Setup

The Mirus Evo nanopump is supplied with a set of tubing with threaded plugs of various colours (orange/blue/green).

- Screw one end of the orange tubing to the input of the pump.
- Screw one e d of the blue tubing to the other end of the syringe drive valve and other end of blue tubing to the manifold input.
- Screw one end of the green tubing to the manifold output (see Figure 5).

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Figure 5

USB Driver Installation

Prior to the installation of the driver, make sure the pump is swithed OFF and the USB cable is connected to the computer. Once this preliminary checking is done, switch on the pump. On all computers using windows 2000 or more recent operating systems, the “Found new hard ware wizard” starts automatically (Figure 6).

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Figure 6 Hardware installation wizard

The wizard first asks if windows can connect to windows update. Select “No, not this time” and click on “Next”.
Then, the next window of the wizard will ask for an automatic or advanced installation (Figure 7).

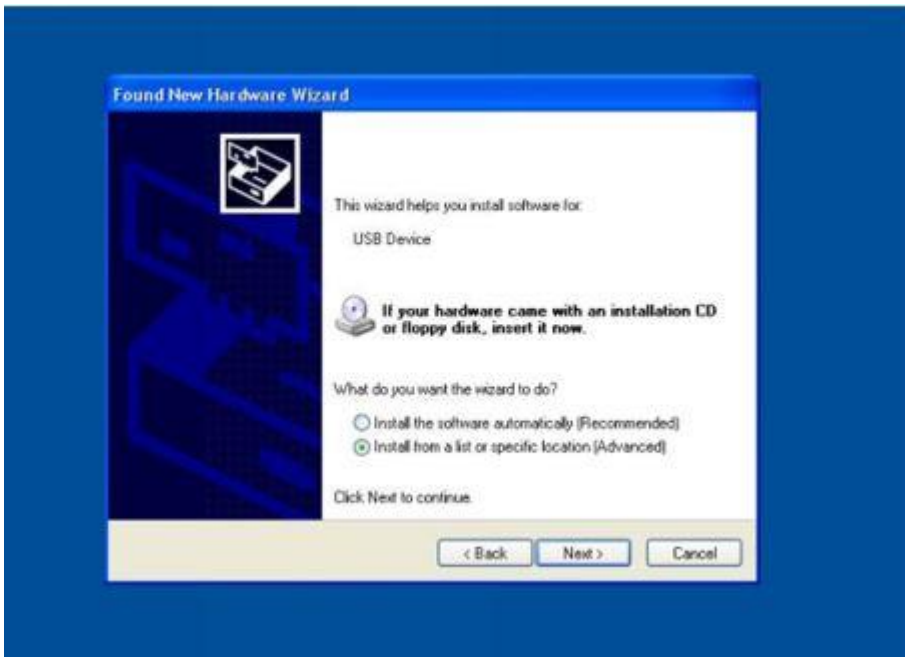

Figure 7

Select “Install from a list or specific location (Advanced)” and click on “Next”.

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Figure 8 Select the folder of the USB driver from the USB stick provided with the Mirus Evo nanopump

In the following window (Figur8 above), tick the box “Include this location in the search” and click on “Browse” to open the browser. Select the folder called “CDM 2.04.16 WHQL certified” located on the USB disk supplied with the Mirus Evo nanopump.
Then click “Next”. The wizard starts the installation of the driver. At the end of the installation, a window will be displayed with a successful message, click on “Finish”.
This operation of installation must be performed as the Mirus Evo nanopump is supplied with a USB serial port.
Once the installation is completed, check COM port assignment for the Mirus Evo nanopump. To check it, follow these instructions:
Click “Start” on your windows toolbar and select “Settings”, “Control Panel” to open the control panel (Figure 9).

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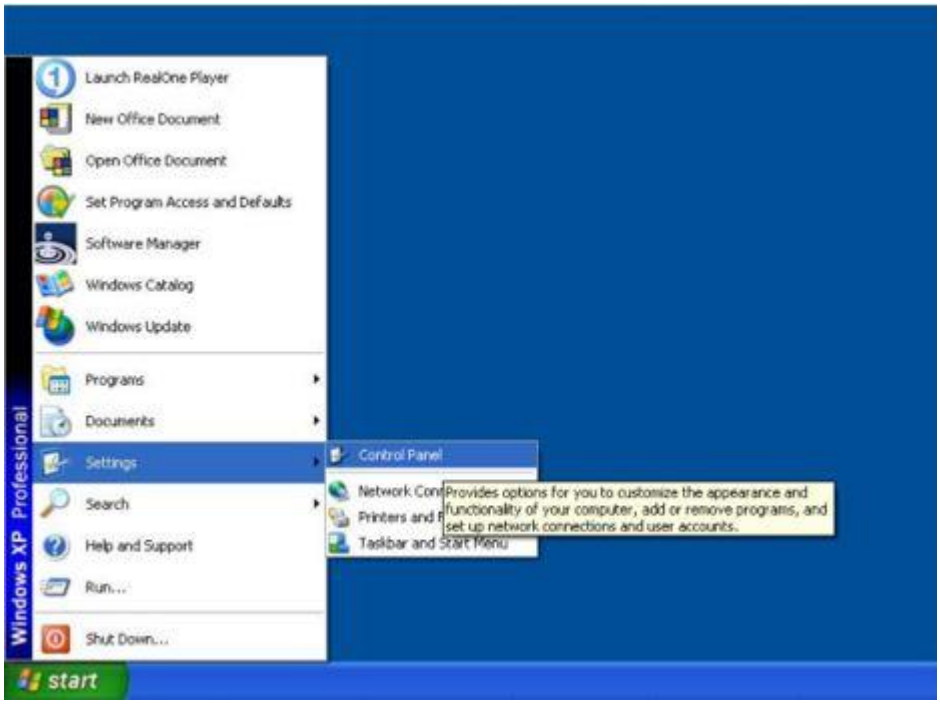

Figure 9 Open the "Control Panel"

On the "Control Panel", select "Printers and Other Hardware" (Figure 10)

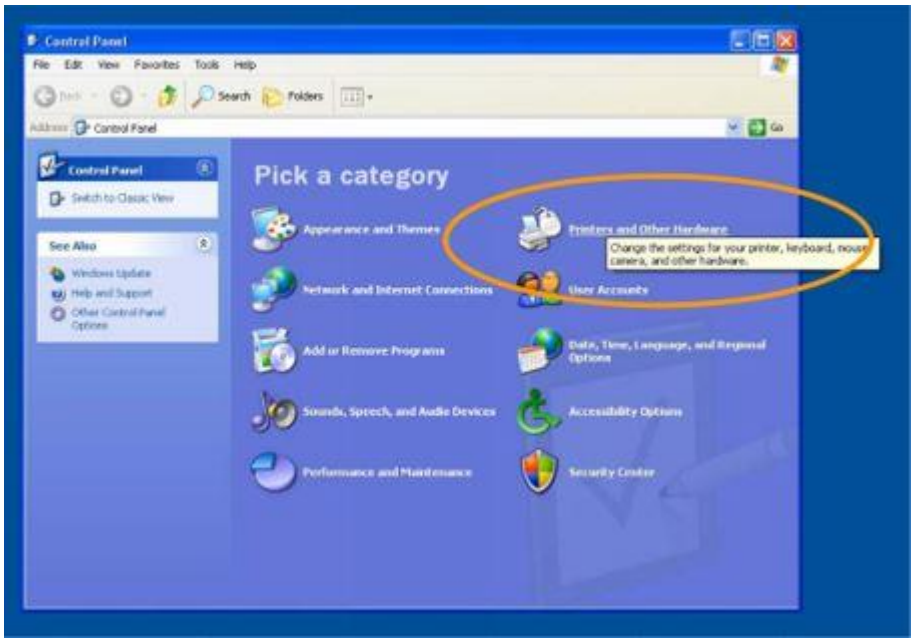

Figure 10 On the control panel, select "Printers and Other Hardware"

On the "Printers and Other Hardware" window, click on "System" on the left hand side to open the system properties.

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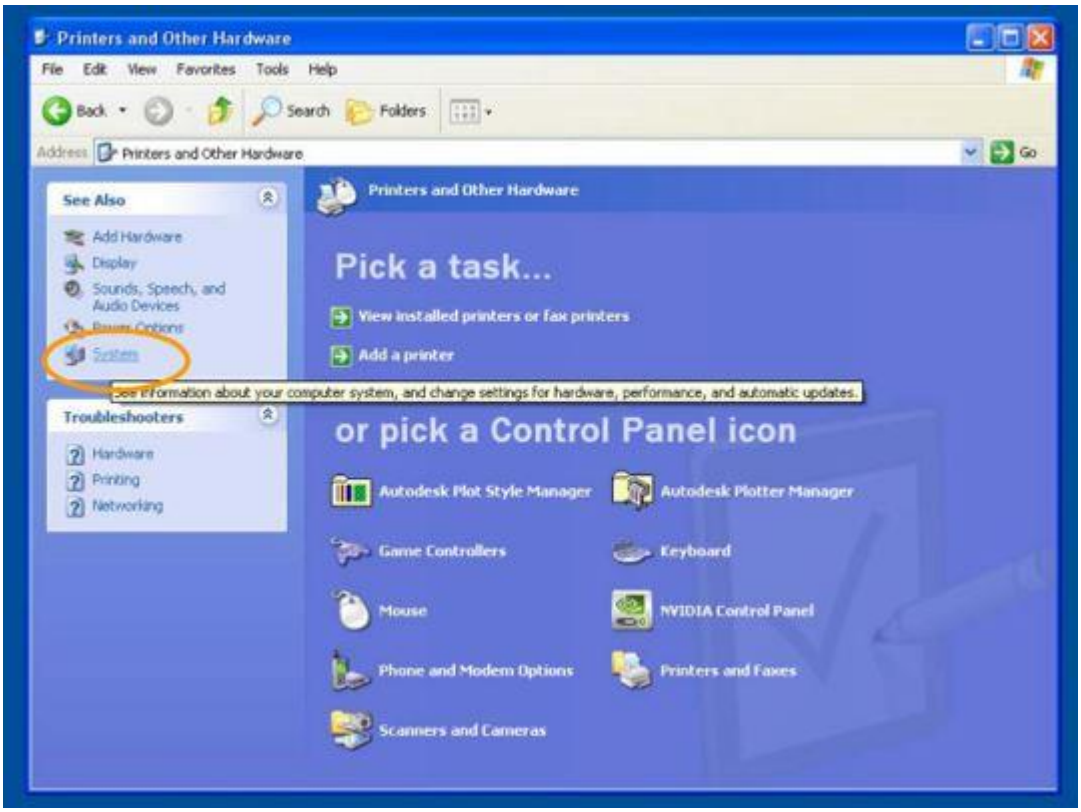

Figure 11 Click on "System" on the left-hand side

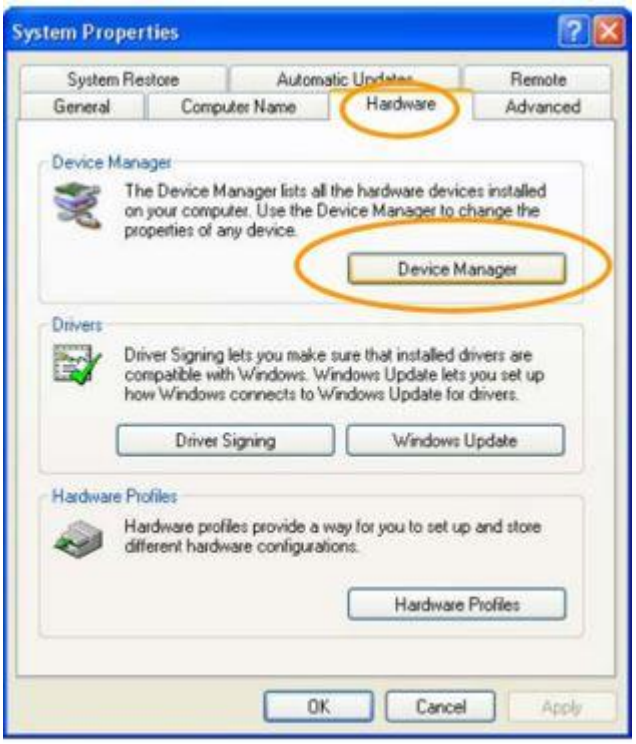

Figure 12 Select the hardware tab and then open the device manager

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Then, click on “Device Manager”. On the Device Manager window, open the “Ports (COM & LPT)” tree. Check the COM port number of the two devices called “USB Serial Port”. These two devices are the Mirus Evo nanopump COM port (or USB serial converter A) an d the optional dispenser COM port (or USB serial converter B). The lowest rank between the two COM ports is the Mirus Evo nanopump COM port.

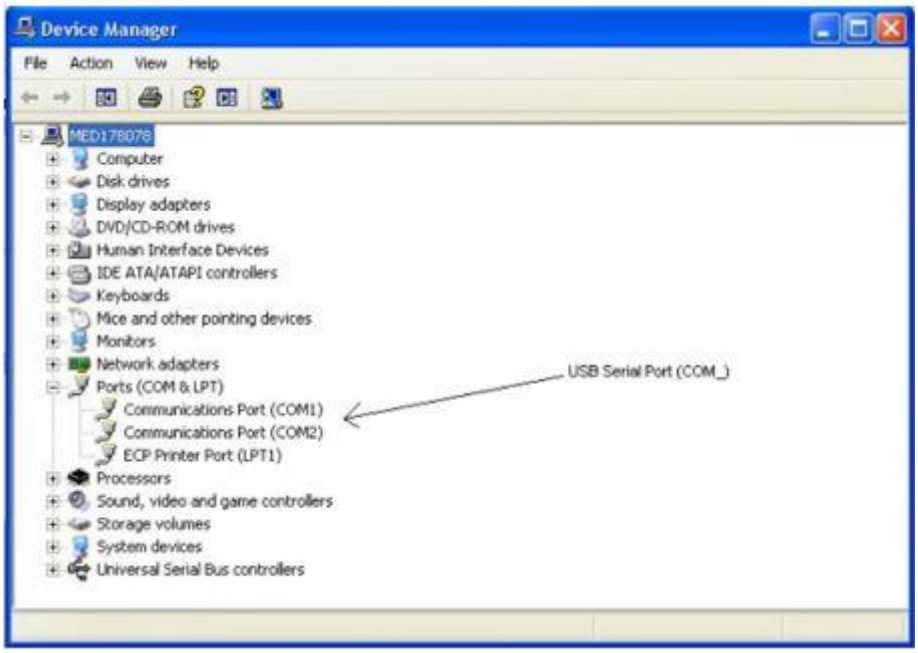

Figure 13 On the “Device Manager”, open the ports tree and check the COM port number of the devices called USB serial port

Mirus Evo Nanopump Operation

The Mirus Evo nanopump is a software-controlled system (possibility to be controlled by Cellix analysis software VenaFlux assay). It comes with a set of commands presented briefly below

Command	Description
Init command	Initialize para meters of the pump to default value and initialize the syringe plunger position to the position.
Geometry setup command	Set the geometry of biochips connected to the pump (width, depth, length); set the volume of the syringe used; set the viscosity of the liquid used.
Displace/pick-up command	Displace/pick-up a specified volume at a default speed. This command is commonly used for large dispense (for example, for washout operations).
Start assay/set shear commands	Starts operation of the pump in the assay mode. The pump will start at the specified shear rate without target volume.
Set syringe command	Position the plunger to a specified position (volume)
Stop command	Abort operation of the syringe pump
Set channel command	Control Multiflow8 channels (see next section)

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MultiFlow8 System

Specifications

MultiFlow8 is an electronically controlled splitter which splits flow coming from the Mirus Evo nanopump from 1 up to 8 channels simultaneously.

Software control	Plug-and-play connection to the Mirus Evo nanopump and controlled by VenaFlux assay software
Material of the main body (in contact with the fluid)	PEEK
Type of actuation	Solenoid valves
Dimensions	140 mm (H) x 35 mm (D) x 140 mm (W)
Weight	<0.5 kg
Power requirements	24 V, Max 12 W

Setup

The MultiFlow8 is controlled by the Mirus Evo nanopump by its dedicated cable. To connect both systems together; first, make sure the Mirus Evo nanopump is switched off. Plug the SUB-D9 plug of the MultiFlow8 cable to the dedicated socket on the Mirus Evo nanopump tagged “MultiFlow8” and securely lock it (Figure 14). Plug the other end of the cable into the Multiflow8 (back) and tighten the lock screw (Figure 15).

Figure 14

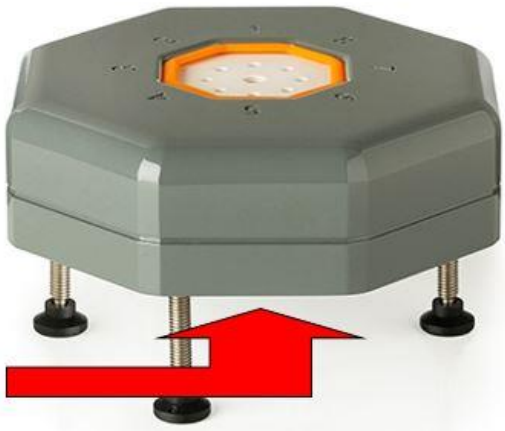

Figure 15

Connect the cable to the MultiFlow8 tighten the lock screw (beneath)

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Tubing setup

To interconnect the Mirus Evo nanopump to the MutliFlow8, use the output port cable (green connectors) from the pump (Figure 16).

Figure 16 Pump & MultiFlow8 setup prior to assay

The MultiFlow8 is supplied with a stopcock T junction. Plug the Mirus Evo nanopump on the side of the j unction and lock it. The top junction can be used to add a syringe (Luer male end) for quicker washout (Figure 17).

Figure 17 MultiFlow8 setup

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The MultiFlow8 is also supplied with a set of 8 micro-nozzles and a dedicated 8-way cable. Mount the 8 nozzles to the 8 dedicated threads on top of the MultiFlow8, hand screw them and add a 1/4 turn with an appropriate tool. Plug the 8-way tubing on each nozzle with respect to the channel number.

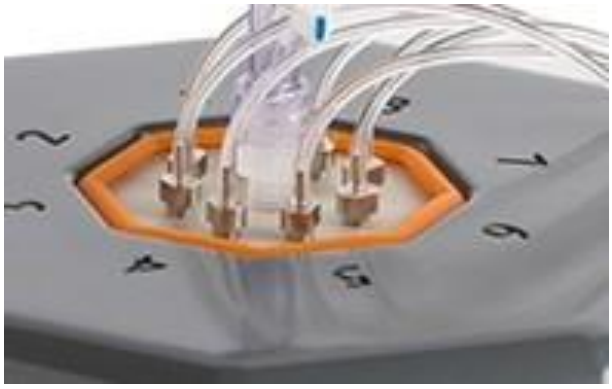

Figure 18 Connect tubing 1 through 8

Using the Mirus Evo Nanopump and its Accessories

Cleaning instructions
To ensure proper operation of Mirus Evo nanopump, the device needs to be periodically cleaned.
Cleaning agents allowed are:

- Deionised water
- Ethanol 70%

Do you want to use other cleaning agents? Ask the Cellix team.

Before running experiments, it is recommended to wash the pump tubing and accessories with Ethanol 70 % and then deionised water. This procedure must be repeated at the end of each experiment.
If the pump is not used for a longer period of time, it is recommended to flush tubing with air before rest.

Preparing tubing
If it is necessary to replace the Mirus Evo nanopump tubing, follow these steps. Alternatively, it is possible to purchase a full new set of tubing from Cellix — check the pump accessories list in Appendix A.
Grip per fittings are a flangeless tube connection system from Omnifit™, which incorporate a PTFE seal housed in a 316 stainless steel case. These provide a minimal dead volume and low flow disturbance connection. The gripper system is ideal for repeated connect/disconnects.

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operation. These fittings do not twist the tubing during connection and are pressure rated to 1000 psi (68 bar).

With a scalpel, cut the tubing to form a point ~30 mm long (see Figure 19). This enables the tube to be passed through the gripper. Fit a PTFE threaded fitting to the tubing. Then fit a grommet to the tube ensuring the PTFE seal is facing towards the pointed tube end (see Figure 20).

Figure 19 Cut tubing to a pointed end using scalpel

Figure 20 Pass grommet over tubing, ensuring PTFE end is facing out

With the aid of pliers or similar, grip the pointed tube end and pull though the grommet until the PTFE seal has reached the uncut section of the tube (see Figure 21). Keeping the grommet as perpendicular a s possible to the tube will ensure the best performance. Rotate the grommet around the tube 3 or 4 times to seat the grommet on the tube correctly (see Figure 22).

Figure 20 Pull grommet over tubing until uncut section of tubing is reached

Figure 21 Cut the remaining tubing as close to the grommet as possible

Using a scalpel, cut the pointed tube end as close to the PTFE face as possible, ensuring the PTFE face is not cut. Tube is now ready for use.

Safety precautions: always take care when using scalpels. Always make tube cuts away from body and keep fingers away from blade.

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Troubleshooting

Issues	Advice
There is no flow coming from the output of the pump, but pump operates	• Check that the pump draws liquid at the input
	• Check that you use the proper output from the pump (output or auxiliary)
Pump does not want to operate	It can be due to the fluidic path being blocked
	• First, check the fluidic path is not blocked
	• If the pump is connected to the MultiFlow8, make sure the channels are physically opened
	• Check that you are not trying to dispense a large volume of liquid through flow restrictions (e.g. pins, capillary, etc.)
Flow is coming from pump, but it is not steady	This is mainly due to bubbles and/or air in tubing
	• Remove bubbles from tubing via wash out.
	• If you can't remove all bubbles, check for leakage (syringe, tubing connections)
Pump does not switch ON	The pump is not powered
	• Check that the pump is correctly plugged in and connected to a proper main socket
	• Check that the fuse is not broken (if broken, replace it following instructions)
	• Contact Cellix team for further investigation
Pump does not answer to commands	There is a communication issue
	• Check USB cable is plugged in properly
	• Check Mirus Evo nanopump is physically detected by your computer (check COM port assignment)
	• Check commands are sent on the right COM port by your software
Pump does not operate at the set flow rate	• Check that the geometry set is correct (biochip dimensions, viscosity and syringe volume)

For any further assistance, please telephone us at +353-1-4500-156 or email us at info@wearecellixltd.com.

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Appendix A: List of Accessories

Product	Product Code	Product Decription
Mirus-Evo-Connect-Tubing Set	MIRUS-EVO-CONNECT-SET1	Mirus Evo nanopump replacement tubing for INLET and OUTPUT
MF8-Connect-Biochip1 Inlet Cable	MF8-CONNECT-BIC1	8 connected disposable tubes to connect from Mirus Evo nanopump to the inlet of the biochip
Mirus nanopump replacement valve	MIRUS-PUMP-VALVE	Mirus nanopump replacement valve
Mirus nanopump syringe 100 µl	MIRUS-PUMP-SYRINGE-100UL	Mirus nanopump syringe 100 µl
Mirus nanopump syringe 250 µl	MIRUS-PUMP-SYRINGE-250UL	Mirus nanopump syringe 250 µl
Mirus nanopump syringe 500 µl	MIRUS-PUMP-SYRINGE-500UL	Mirus nanopump syringe 500 µl
Mirus nanopump syringe 1 mL	MIRUS-PUMP-SYRINGE-1ML	Mirus nanopump syringe 1 mL
Mirus nanopump syringe 5 mL	MIRUS-PUMP-SYRINGE-5ML	Mirus nanopump syringe 5 mL
MF8-Connect-Biochip2 Inlet Cable with resistance tubes	MF8-CONNECT-BIC2-RT	8 connected disposable tubes to connect from Mirus Evo nanopump to the inlet of the biochip and includes resistance pins for simultaneous accurate 8-way dispensing
MultiFlow8 cable assembly 8-way with resistance & MultiFlow8 pins	MULTIFLOW8-CABLE_8WAY_RES+PINS	8 connected disposable tubes to connect from Mirus Evo nanopump to the inlet of the biochip and includes resistance pins for simultaneous accurate 8-way dispensing and replacement pins for the MultiFlow8
MF8-Connect-Biochip3 Inlet Cable for thrombosis experiments	MF8-CONNECT-BIC3-THROMBOSIS	Cable from MultiFlow8 of Mirus Evo nanopump to connect to biochip
MultiFlow8 cable assembly thrombosis with MultiFlow8 pins	MULTIFLOW8-CABLE_THROMBOSIS_PINS	Cable from MultiFlow8 of Mirus Evo nanopump to connect to biochip. Contains replacement pins for the MultiFlow8. This will only need to be replaced every 6 months depending on the usage and maintenance

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Appendix B: Flow Rate Conversion Table

			Vena8 Fluoro+ Biochip				Vena8 Endothelial+ Biochip			
Sample	Shear Stress (dyne/cm^2)	Shear Rate (s^{-1})	Flow Rate (cm^3/s)	Flow Rate (µL/min)	Flow Rate (µL/h)	Vol (µL) for 3 min experiment	Flow Rate (cm^3/s)	Flow Rate (µL/min)	Flow Rate (µL/h)	Vol (µL) for 3 min experiment
Cell suspension	0.5	50	0.00003	2	120	6	0.00001	6	346	17
Cell suspension	1	100	0.00007	4	240	12	0.00019	12	691	35
Cell suspension	5	500	0.00033	20	1200	60	0.00096	58	3456	173
Cell suspension	10	1000	0.00067	40	2400	120	0.00192	115	6912	346
Cell suspension	15	1500	0.00100	60	3600	180	0.00288	173	10368	518
Cell suspension	18	1800	0.00120	72	4320	216	0.00346	207	12442	622
Cell suspension	20	2000	0.00133	80	4800	240	0.00384	230	13824	691
Whole blood	2.25	50	0.00003	2	120	6	0.00001	6	346	17
Whole blood	4.5	100	0.00007	4	240	12	0.00019	12	691	35
Whole blood	22.5	500	0.00033	20	1200	60	0.00096	58	3456	173
Whole blood	50	1111	0.00074	44	2667	133	0.00213	128	7680	384
Whole blood	67.5	1500	0.00100	60	3600	180	0.00288	173	10368	518
Whole blood	81	1800	0.00120	72	4320	216	0.00346	207	12442	622
Whole blood	90	2000	0.00133	80	4800	240	0.00384	230	13824	691

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	Vena8 Fluoro+	Vena8 Endothelial+
Channel width, b (cm)	0.04	0.08
Channel height, h (cm)	0.01	0.012
Channel length, l (cm)	2	2
Microcapillary/channel volume (cm^3)	0.0008	0. 00192
Microcapillary/channel volume (µL)	0.8	1.92

Flow rate: $Q = \tau bh^2/6\mu$	Viscosity of cell culture suspension: $\mu = 0.011$ dynes/cm^2 Viscosity of whole blood: $\mu = 0.0445$ dynes/cm^2
Shear Stress: $\tau = 6Q\mu/ bh^2$	Equivalent to: $cm^3/s = 0.001$ L/s = 0.06 L/min = 60 mL/min = 60,000 µL/min

For more information on the Mirus Evo nanopump or any other Cellix product or service, please call:
Republic of Ireland: +353-1-4500-156.