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ARTORG CENTER
BIOMEDICAL ENGINEERING RESEARCH

ARTORG
Organs-on-Chip Facility (OOCF)

OOCF Equipment

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OOCF Laboratory Equipment

BioMEMS Laboratory

The production of microfluidic devices sometimes requires very specific tools. The BioMEMS laboratory provides the necessary equipment for the production and testing of these devices. It consists of equipment for soft lithography and microfabrication in general. Below are some of the instruments listed, needed for chip production and to work with different types of silicone elastomers. If you are interested in using the lab and need training on the equipment, please contact the lab manager in charge.

HTP-200 Henniker Plasma Cleaner

Specifications	
Interface	5.7” Color TFT Display
Chamber dimensions	6” diameter, 9” length
Power	0-200W, continuously variable output
Gas Medium	Oxygen
Vacuum pump	Pfeiffer HISCROLL 6

Expanded Plasma Cleaner PDC-002

Specifications	
Adjustable RF power settings	Low, Medium, High
Maximum RF power (W)	30
Chamber dimensions	6″ diameter x 6.5″ length Pyrex chamber
Gas Medium	Oxygen
Vacuum pump	Scrollvac 7 plus

Background: The Plasma cleaner allows you to make a glass-PDMS microfluidic chip, while bonding the PDMS replica containing the molded microchannel on a glass slide. Besides, the plasma cleaner will also allow you to bond together two PDMS replica to manufacture a multi-layer microfluidic devices.

SPIN150i-NPP Single Substrate Spin Processor	
	
Specifications	
Wafers	Up to 6" (150mm)
Substrates	Up to 4" x 4" (100mm)
Material	Natural Polypropylene (NPP)
RPM (Depending on Substrate)	12.000
Rotation	CW& CCW

Background: The Spin Processor is used to produce a thin PDMS layer (if you are interested in how this process works, here you can find additional information).

Drying Oven VWR DRY-Line DL 115 & Memmert UP 400 Heating Cabinet		
		
Specifications		
Volume (l)	115	53
Programmable Temperature Profiles	No	Yes
Maximum load capacity of trays	15kg/tray, 45kg in sum of all trays	30kg/tray, 90kg in sum of all trays
Settable temperature range	5°C above ambient temperature up to 220°C	5°C above ambient temperature up to 220°C

Background: Many polymers, such as PDMS, show curing temperature dependent material properties. With an oven set at a standard 60° Celsius, most chips can easily be cured over 12 hours, whereas specific temperature settings can be done with a second oven for curing at various temperatures.

Benchtop Laboratory Laminator with Digital Controls LL-100	
	
Specifications	
Laminated samples dimensions	Unlimited length up to 580 mm in width
Top and bottom rolls dimensions (mm)	∅50 x 610
Top and bottom rolls Material	Steel core and are covered with 80 durometer silicone rubber
Drive	Bottom roll driven, top roll idle
Compressed air	Max pressure 6 bar (adjustable for differing levels of laminating pressure)
Laminating pressure (LP)	Approximated by using the following formula: LP = (3.4 x line pressure) / sample width
Controls	Speed, unit of measure and jog functions
Laminating speeds (cm/min)	30-375

Background: Lamination can be used to achieve a successful bond, with no air bubbles between the plastic substrate and film, no distortion of microfeatures, and minimum deformation of the device (here you can find additional information)

Hot-Press

Specifications	
Model	P/O/Weber Manual 2-Column Laboratory Press Model PW 10 H
Hot-/Cooling Plate System	Model HKP 300
Pressforce max. (kN)	130
Piston stroke max. (mm)	50
Temperature max. (°C)	300
Heating plate dimension (mm)	∅165

Background: The hot press can be used for (but not limited to) pressing to layers of BioMEMS chips together, such as PMMA, COC or PDMS, while controlling the temperature of both, top and bottom plate, independently. Furthermore, very thin and structured membranes in the micrometer range can be produced successfully.

Bench top cleaning unit, USC 300 TH – Ultra Sonicator

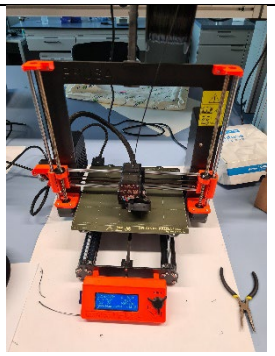
Specifications	
Capacity (l)	2.8
Frequency (kHz)	45
Heating power (W)	200
Tank W×D×H (mm)	237×134×100

Background: Ultrasonic cleaning of e.g. SU8-silicon wafers and micromachined molds works through the creation of cavitation bubbles induced by high frequency sound waves. It therefore produces high forces on contaminants adhering to (hard material) substrates. The sonicator can also be used to fasten dissolution of chemicals. With the independently operational temperature control it can also function as a water bath for an even heating of solutions.

Laminar Flow Cabinet - Monmouth Circulaire VLFT1500	
	
Specifications	
Quantity	2
Dimensions (working area) (mm)	1480 / 530 / 720 mm (WxHxD)

Background: Although soft lithography has the advantage of not requiring a cleanroom environment, the fabrication of a microfluidic device still is a delicate process. to avoid contamination of the devices with dust particles, a laminar flow cabinet is beneficial.

Filament 3D printer – Prusa i3 MK3



Specifications	
Quantity	1
Dimensions (working area) (mm)	250 / 210 / 210 mm (WxHxD)

Resin Direct Laser Printing 3D printer – Phrozen Sonic Mini 8k

Specifications	
Quantity	1
Dimensions (working area) (mm)	165 / 72 / 180 mm (WxHxD)
XY Resoultion	22 µm
Layer Thickness	0.01-0.3 mm

Background: For prototyping and the fast production of mountings, holder, etc. different 3D-printing technologies are of interest, depending on the application of the printed part. A new design of a microfluidic chip for example can quickly be printed after the design to test a concept.

Modular Compact Rheometer – MCR 102 e

Specifications	
Quantity	1
Dimensions (working area) (mm)	444 / 678 / 586 mm (W x H x D)
Measure cone	25 mm / 1°

Background: The stiffness of hydrogel is an important factor for cells and can influence their phenotype, proliferation, reproducibility of experiments, etc. With the Rheometer, the mechanical properties, such as fluid flow in response to applied forces of visco-elastic materials, can be determined.

Pump Equipment

Type	Product Name	Quantity	Technology	Range
Peristaltic Pump	CorSolutions PeriWave Nano	2	Peristaltic Flow Control	± 20 to 7000 nL/min
Peristaltic Pump	CorSolutions PeriWave Micro	2	Peristaltic Flow Control	± 0.1 to 50 µL/min
Peristaltic Pump	ISMATEC REGLO Digital MS-4/8 (ISM834)	1	Peristaltic Flow Control	4 x 0.002 to 35 mL/min
Syringe Pump	Harvard Apparatus Dual Syringe Pump (70-2209)	1	Back pressure flow	0.5 µL to 50 mL syringes
Syringe Pump	Harvard Apparatus Dual Syringe Pump (70-2212)	4	Back pressure flow	0.5 µL to 50 mL syringes
Pos. Pressure Controller	Elveflow OB1 Pressure Controller MK3	1	Piezoelectric	4 x 0 to 200 kPa (± 0.006%)
Pos. Pressure Controller	Fluigent Flow EZ 69mbar	1	Modular pressure control system	0 to 69 mBar
Neg. Pressure Controller	Fluigent Flow EZ -800mbar	2	Modular pressure control system	-800 to 0 mBar
Vacuum Pump	Laboport	2	Vacuum Pump	≤8mbar (abs. pressure)
Vacuum Pump	Varian IDP3	1	Dry Scroll Vacuum Pump	3.3 x 10^{-1} mbar (abs. pressure)
Vacuum Pump / Pressure Controller	In-house development	6	(Breather System)	- 200 to 0 mbar (dynamic sinus or triangular pressure signal) or -60 mbar static pressure
Vacuum Pump	Pfeiffer HISCROLL 6	1	Scroll Vacuum Pump	0.02 mbar endpressure
Vacuum Pump	LabTec VP18 Plus	1	Vacuum Pump	≤ 18 l/min ≤ 20 mbar

We also have various flow sensors, valves and the necessary accessories and software to operate the pumps and create microfluidic setups. For more detailed information and enquiries regarding the use of the equipment, please contact the lab manager.

Organs-on-Chip Culture Laboratory

The Organs-on-Chip Culture Laboratory is a BSL-2 laboratory equipped with state-of the art cell biology equipment and additionally specific equipment for organs-on-chip. Listed below is some of the most important equipment, standard and auxiliary equipment (e.g. incubators etc.) were left out. If you are interested in using the lab and need training on the equipment, please contact the lab manager in charge.

Whitley H35 Hypoxystation

Specifications	
Capacity (l)	300
Port Airlock Capacity	Accommodates up to 44 x 96 well plates or 84 x T25s
Airlock Size (l)	12
Gas Supplies	CO2/Air/N2

Background: Creates hypoxic and anoxic conditions within a controlled and sustained workstation environment. It is ideal to work with cells and accurately control oxygen, carbon dioxide, temperature and humidity.

Safety Cabinets – Scanlaf Safe 1200

Specifications	
Quantity	3
Dimensions (working area) (mm)	120x70x60 (WxHxD)

Background: To ensure a sterile working environment, our lab has three safety cabinets for cell culture practices. The Scanlaf Safe Mars 1200 are class 2 safety cabinets providing a laminar flow inside the hood and filtering the air through a HEPA filter.

Eppendorf Centrifuge 5810/ 5810 R

Specifications	
Rotor type	S-4-104
Max. Number of revolutions // cf	3900rpm // 3214g
Dimensions (working area) (mm)	120x70x60 (WxHxD)
Sample capacity	56 falcon tubes of 15 ml 28 falcon tubes of 50 ml
Features	Aerosol-tight caps, temperature control

Background: A temperature controlled high quality centrifuge is a staple of any BSL2 laboratory and allows for the handling of potentially infected patients' materials. With a programmable user-friendly interface, a range of settings can be applied to accommodate any sample-specific needs. For more details, check out the Operating Manual.

TEER measurement / EVOM3

Specifications	
Impedance range	1 – 100'000 Ω
Format	96 well plate
Additional electrode	STX2-Plus

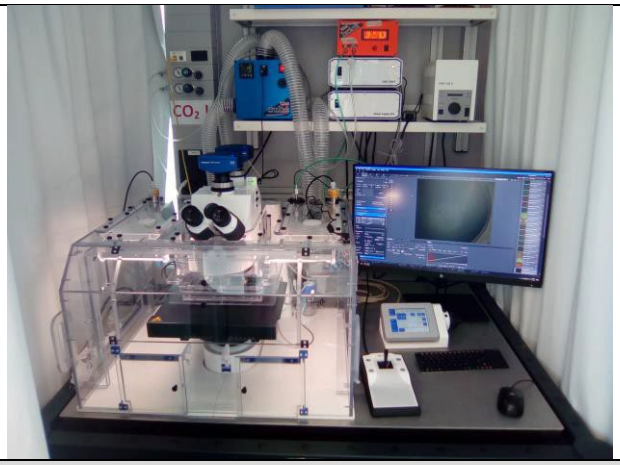
Background: Measuring the trans-endo-epithelial-resistance (TEER) of organs-on-chip models - such as the lung - is an important assessment method for a non-disruptive validation of the confluency of a cell layer. With the additional STX2-Plus electrode not only a wider impedance range can be achieved, it also offers a lower noise-to-signal ratio. For more details, please refer to the EVOM3 webpage.

regenHU 3DDiscovery – 3D Bioprinter

Specifications	
Technology	3D bioprinting
Material	Bio-ink/organic • Cells, bioactives and signal molecules • Hydrogels and biopolymers • Polycaprolactone and thermopolymers • Calcium phosphates • Collagen, Hyaluronic acid and gelatins
Build volume (mm)	130x90x60
Precision	± 10 µm (resolution is highly dependend on material used)
Temperature control	Up to 80°C
Others	Viscosity range up to 10000PaS 5µl dispensing resolution No dead volume 1 hot melt extrusion print head BioCAD software

Background: 3D-BioPrinting has the potential to be the future of not only high throughput Organs-on-Chip production but also being a cornerstone for efficient Tissue Engineering applications. Our bioprinter is equipped with three different print heads (thermo polymer extruder, cell friendly micro needle dispensing, time-pressure contact dispenser) with an additional UC-curing kit and resides in a sterilizable flow hood for live cell printing.

Organs-on-Chip Microscopy

Zeiss AxioImager.M2	
	
Specifications	
Category	Widefield, fluorescence, upright microscope
Camera/Detectors	Axiocam 305 mono, Axiocam 305 color
Light source	VIS-LED, Halogen HXP120
Objectives	Mounted: 5x, 10x, 20x LD neofluar, 40x LD neofluar Additionally available: 1.25x, 20x, 40x, 100x
Software	ZEN 3.1 (blue edition)
Special applications	MEMS-chip validation Additional environmental chamber for live cell imaging

Background: For surface analysis and validation of chips as well as for measurements of active parts of a chip (e.g. bulge test), an upright microscope is optimally suited. Furthermore, with the addition of a custom-made incubation chamber, environmentally controlled (temperature, CO_2, humidity) long-term experiments with live cells on-chip can be conducted.

ThermoFischer EVOS M7000

Specifications	
Category	Widefield, fluorescence, inverted microscope
Camera/Detectors	CMOS 3.2 MP mono and color
Light source	LED
Objectives	4x, 10x, 20x, 40x
Software	EVOS Analysis and Celleste Image Analysis
Special applications	Environmental control/Live-imaging, Multi-well plate scanning

Background: Fulfilling the need for userfriendly, quick scanning of chips and multiwell-plates, the EVOS M7000 is also equipped with an incubation chamber (temperature, CO_2, humidity controlled) for long-term live imaging. An additional hose with inlets for tubings is available.