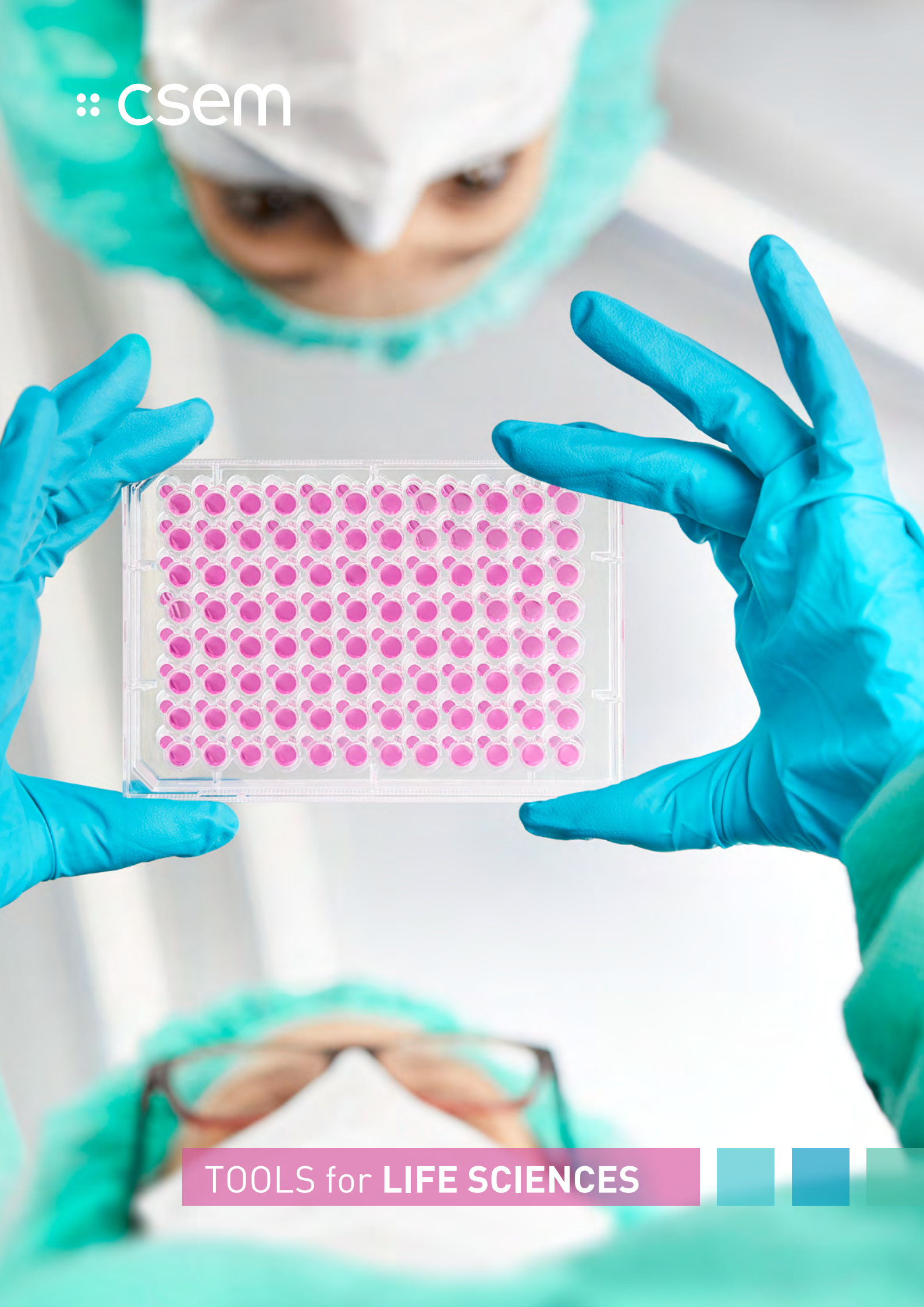
csem



TOOLS for **LIFE SCIENCES**

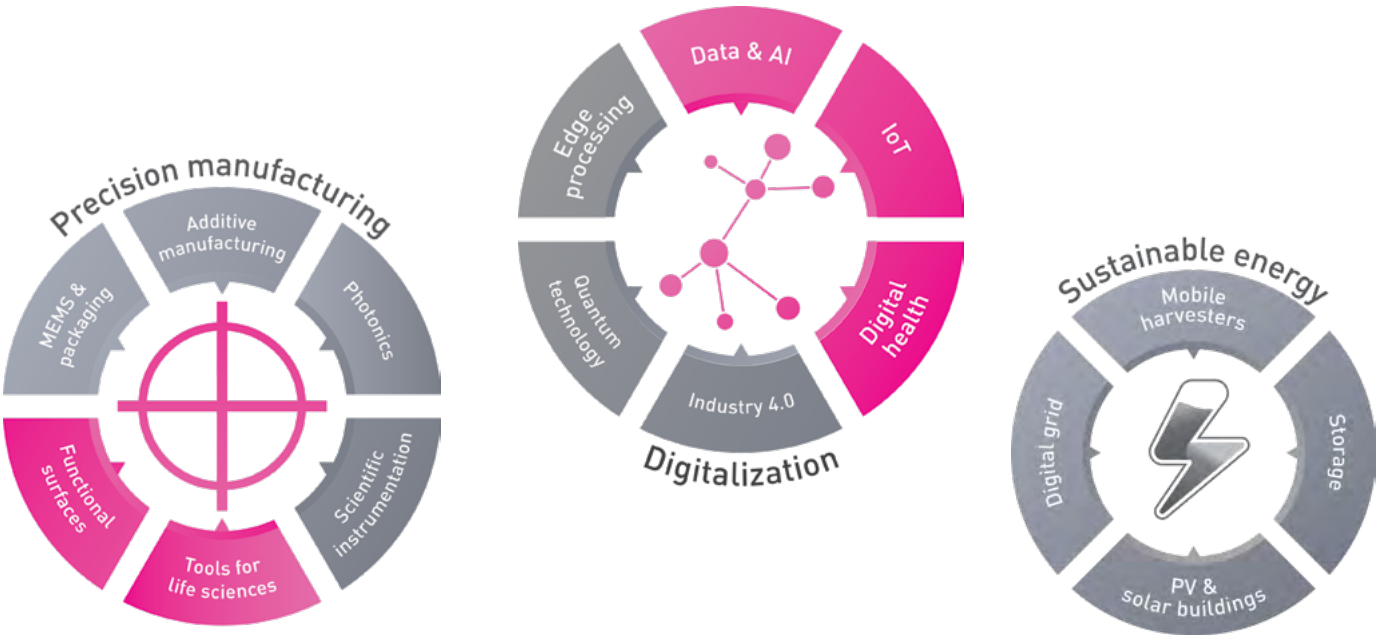
CSEM

Since its creation, CSEM has been a cornerstone of technology development and transfer for precision micro- and digitalization technologies. These innovative technologies are the foundations on which smart systems are built, promising all industries new opportunities for economic growth.

CSEM has long been renowned as one of Switzerland's major research institutes—in the precision manufacturing domain as well as in low-power microelectronics and microtechnology—with our innovations being eagerly adopted by several key partners, including the watchmaking industry.

Pushing ahead into the new digital economy, our expertise extends into advanced technologies, analytics, and algorithms, which enable the Industrial Internet of Things (IIoT) and strengthen manufacturing processes. In domains as diverse as health, energy, aeronautics, space, security, agriculture, and consumer electronics, we provide our partners with the personalized tools, hardware, and software they need to take them forward into the digital age.

From precision manufacturing and sustainable energy to digitalization, we provide the expertise, technologies, processes, and services that can deliver a decisive advantage to all our industrial partners. CSEM is committed to advancing digital technologies in the economy across a competitive and global industrial environment. With 500+ employees, we are passionate about helping our partners achieve success in our rapidly evolving world.



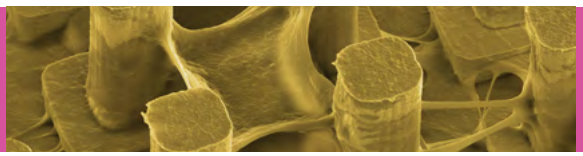
Tools for life sciences

We are all unique. Personalized medicine is a modern approach to healthcare that considers the individual genetic makeup of each patient. Today, CSEM converges precision manufacturing and digitalization with life sciences to enable new proactive solutions. Thus, moving healthcare towards a predictive, participatory, and preventive system that is better tailored to the needs of the patient.

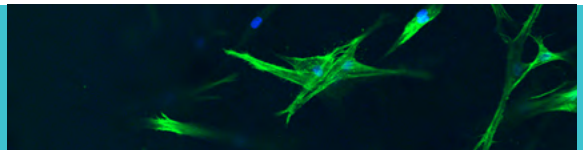
Concentrating on human health, CSEM's technology platforms address the evolving needs of the life science domain by utilizing the latest advancements in cell technologies, biomonitoring, and lab automation. We work to bring together emerging microtechnologies and the biotech/pharma industries. Our goal is to narrow the gap between applied sciences and industrialization. To meet our partners' needs, we draw on two decades of experience in functionalization, biomaterials, microfluidics, fluid control, MEMS, and AI to develop state-of-the-art tools for life sciences.

Acknowledging innovation in the fields of tissue engineering, organoids, and Organ-on-Chip systems for drug discovery and regenerative medicine, CSEM's researchers specialize in the integration of microtechnologies for the next-generation of complex in vitro models and tissues. In sensor development, we are recognized for our innovations in diagnostics and consumer health that provide precise digital data for patient and disease monitoring. Our solutions address the main translational challenges: standardization, transitioning from manual to automated workflows, parallelization, usability, and costs.

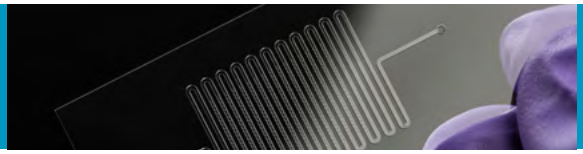
Organ-on-Chip



Tissue engineering

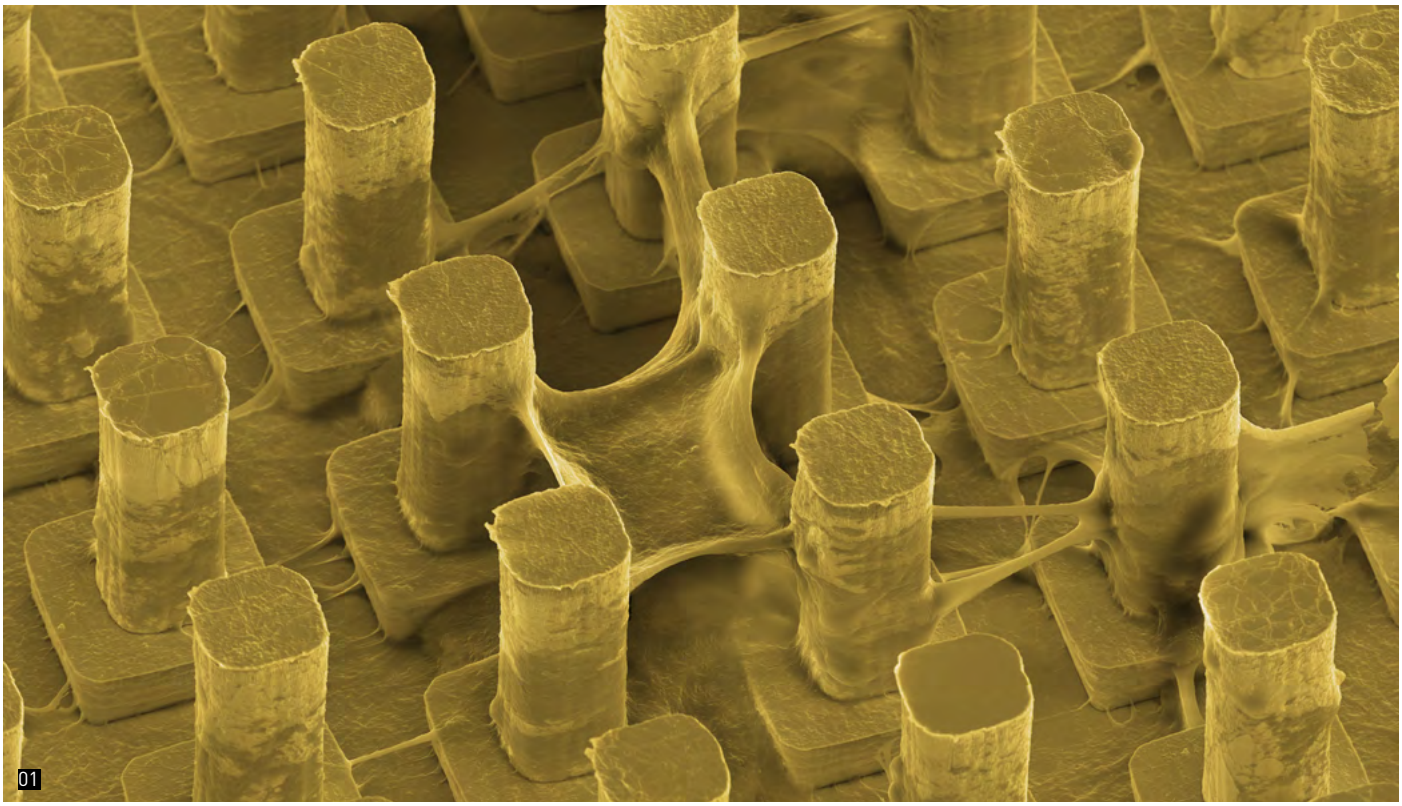


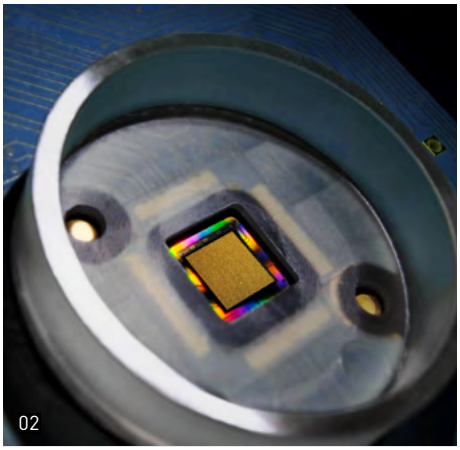
Point-of-care diagnostics

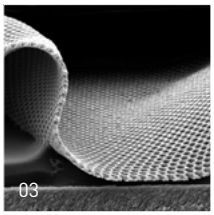


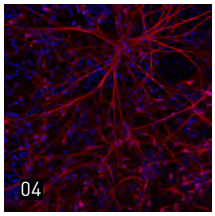
Lab of the future

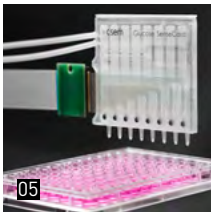
Vital sign monitoring

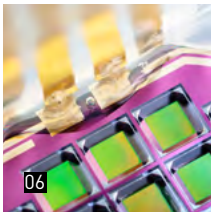












01: High-resolution microelectrode array, 4096 3D electrodes
02: Khiron chip (3Brain), electrical recording of complex 3D neuronal assemblies
03: Flexible high-precision membranes, precisely shaped and aligned pores
04: Biovalidation of neurons derived from stem cells
05: SenseCard, real-time metabolite quantification
06: TEER measurement for biological barriers

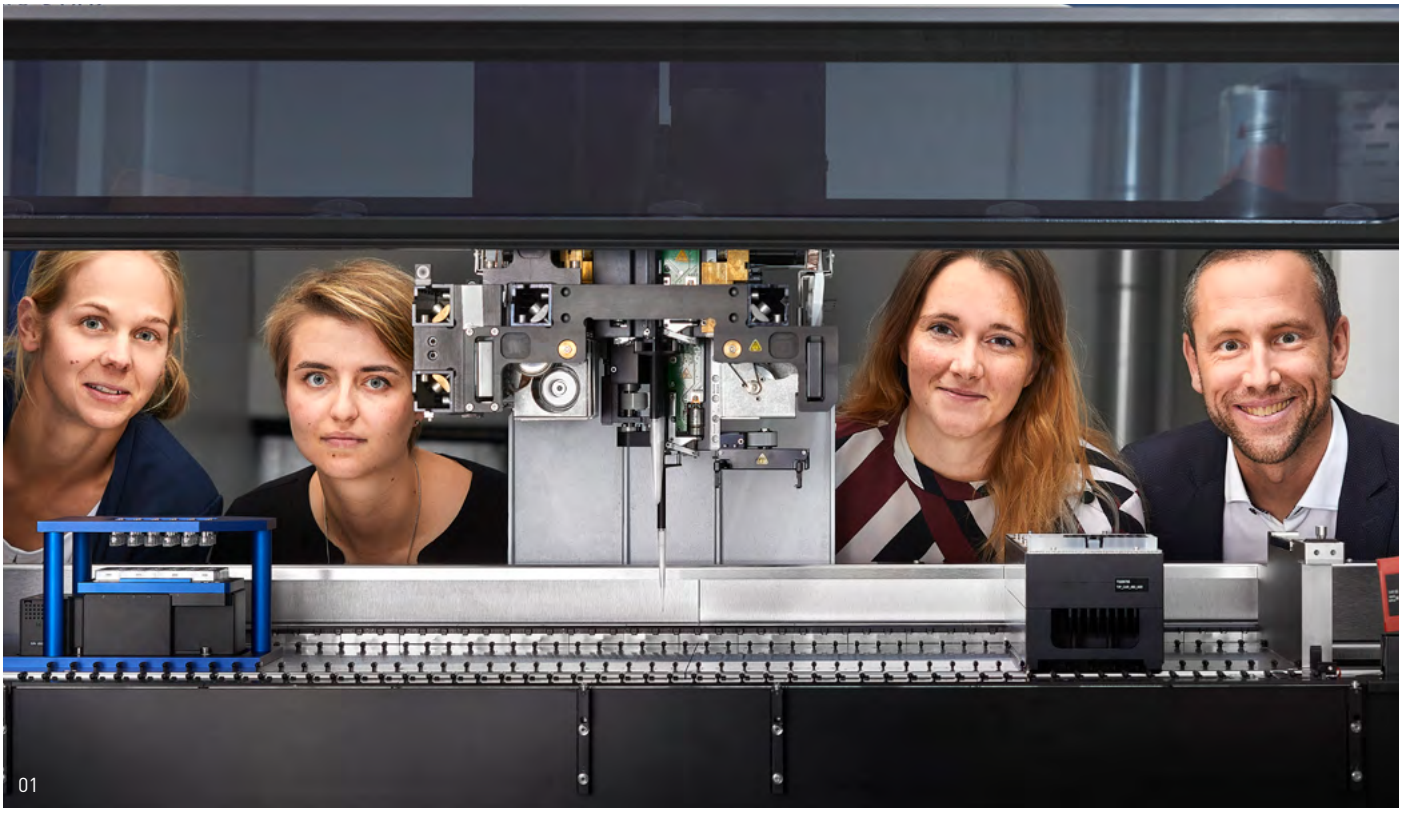
ORGAN-ON-CHIP

An Organ-on-Chip (OoC) is a fabricated microfluidic-based device containing living, engineered tissues in a controlled physiological microenvironment that replicates one or multiple functions of an organ in vivo. They are used for drug development and disease modeling. 3D cell culture models show higher levels of cell differentiation and tissue organization. Thus, OoCs reduce, refine, and replace animal experiments. Following the trends in precision medicine by considering individual gene variability, CSEM has started the development of the proprietary concept YOU-ON-CHIP™.

At the intersection of cell culture and microfabrication technologies, OoCs need the experience of both biologists and engineers, which are found at CSEM. We carry out design, materials selection, microfabrication processes, and biovalidation across a range of fields, including:

- Innovative optical, mechanical, electrical, biochemical actuation, and sensing techniques to reproduce and monitor tissue functions.
- Patented technologies ranging from microporous membranes to microelectrodes for technology transfer alongside tailor-made solutions.
- Long-standing expertise in industrialization processes; CSEM combines innovative solutions with automated fluid control to deliver complete products.

Next-generation OoC systems are increasingly sophisticated, with multiple organs now being developed to study drug pharmacokinetics addressing: absorption, distribution, metabolism, and excretion. The parallelization for high-throughput testing—in a multiwell plate format—is coupled with the development of smart lids containing integrated microsystems for tissue perfusion and sensing. Both miniaturization and automation are required to provide standardized OoC platforms for preclinical studies. Held annually, CSEM's symposium entitled "Next Gen OoC & Organoids" features discussions to help industry professionals explore the future potential and application of these next-generation OoCs in healthcare and disease treatment.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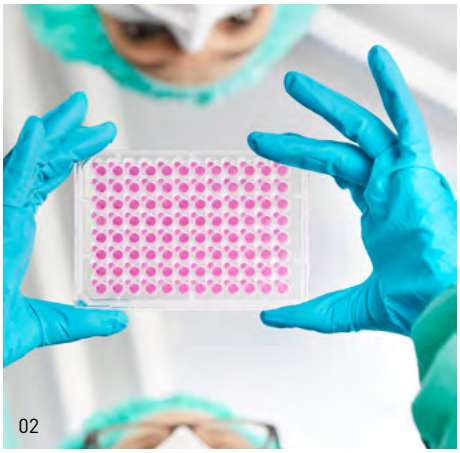
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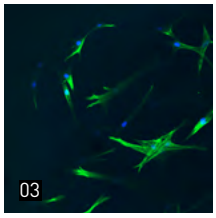
03


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06

01: CSEM's team standardizing SUN bioscience's fabrication process
02: Gri3D® (SUN bioscience), standardized organoids
03: Imaging and analysis of a 3D cell culture
04: Bioreactor for intervertebral discs
05: Fibroblasts within collagen gels
06: DEMOX X—Optical oxygen sensing system

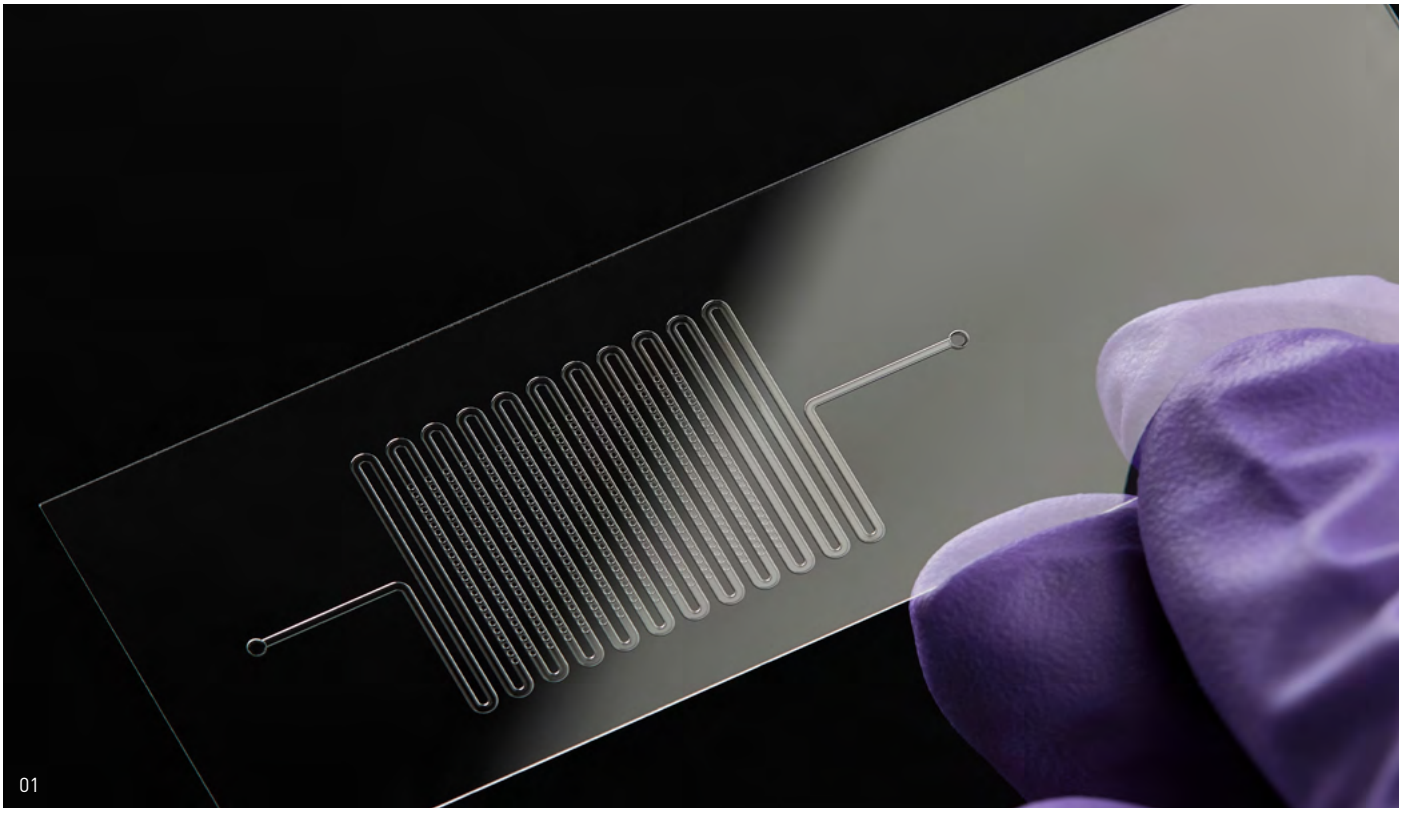
TISSUE ENGINEERING

Regenerative medicine is constantly developing, acquiring new solutions from emerging technologies. Life microtechnologies provide unprecedented tools to manipulate cells and orchestrate their 3D positioning to create tissues. More than cells, patient-derived organoids grown from stem cells offer miniature, immature organs in a dish, which are produced by autonomous self-assembly. Having the same genetic makeup as the patient, they represent the building blocks for personalized tissues.

Combining micro- and organoid technologies, CSEM develops automated and standardized tissue engineering platforms. Tissue manufacturing starts with the production of large-scale uniform organoids followed by scrupulous sorting based on deep learning algorithms to predict and eliminate any phenomena related to tumorigenesis. Assembly (e.g. bioprinting) is probably the most challenging phase to induce angiogenesis. The microsystems must be biocompatible, sterilizable, and disposable. Although the major issue of vascularization remains unsolved, CSEM provides physiological microenvironments with integrated sensors for monitoring oxygenation and metabolites during tissue maintenance and maturation.

Tools for histological evaluation of engineered microtissues serve not only personalized regenerative medicine but also 3D in vitro tumor models. CSEM is supported by third parties for the regulatory framework of medical products and the integration of its innovative technologies from concept to biovalidation, including:

- Production
- Picking and sorting
- Assembly
- Maturation and biomonitoring
- Endpoint analysis



01: Disposable glass microfluidics
02: Wearable sweat tracker
03: Multiarray for electrochemical urine analysis
04: BIOCDX—disposable microfluidic cartridge for biophotonic companion diagnostics
05: Miniature reader for electrochemical diagnostics
06: Non-invasive wound monitoring based on fluorescent markers
07: A disposable parallel-sensing card for glucose analysis

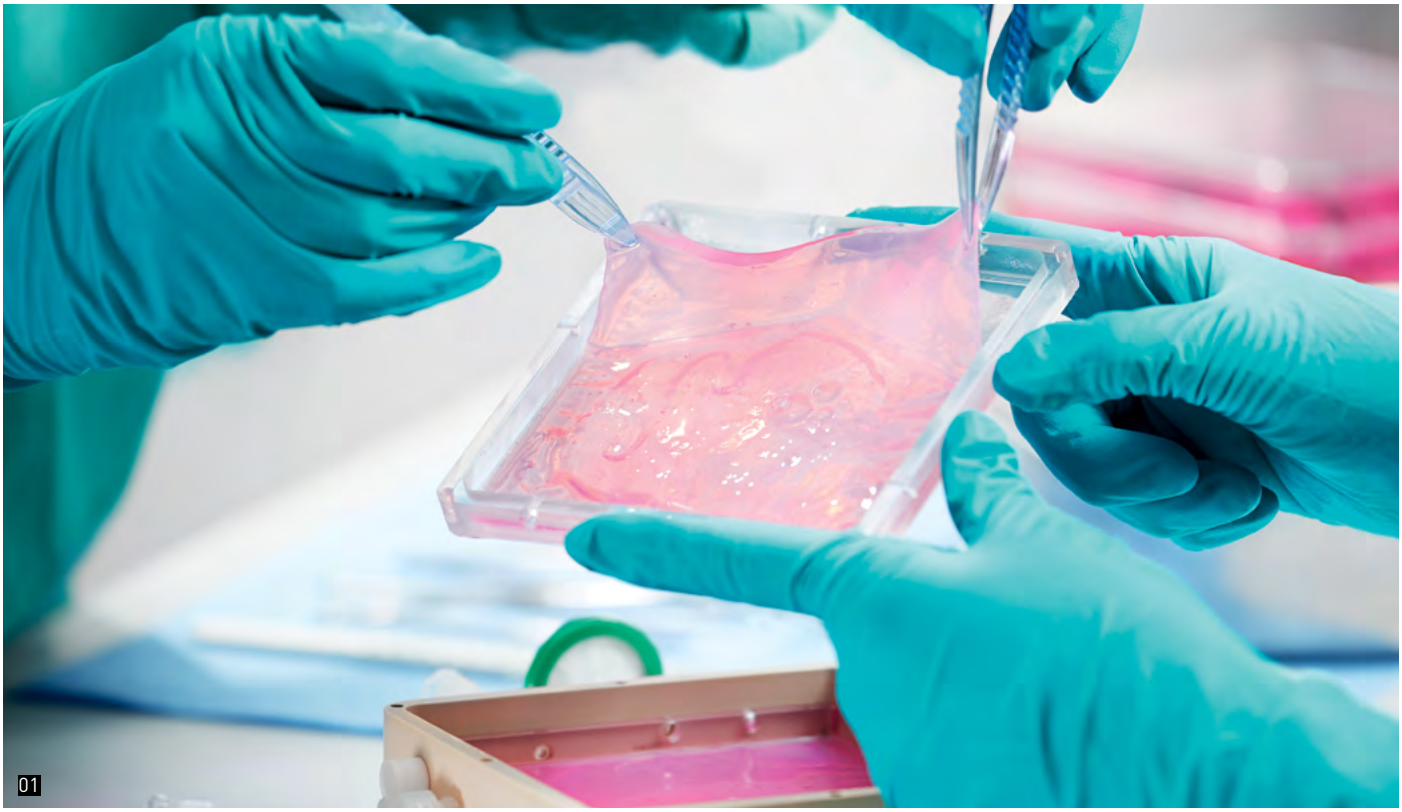
POINT-OF-CARE DIAGNOSTICS

Point-of-care diagnostics (POCD) technologies are crucial as they can be used next to or directly at the patient's location. They better facilitate disease diagnosis, monitoring, and management by enabling quick and cost-effective medical decisions. This in turn leads to improved health outcomes for patients, as it allows for the early administration of treatments.

At CSEM we innovate minimally invasive diagnostic technologies, which use low-volume samples and non-invasive techniques to analyze freely accessible bodily fluids, such as saliva or urine. We also develop sample preparation procedures that are compatible with different detection systems and ensure their integration across a range of products. Moreover, our unique expertise in surface functionalization, electrochemical sensing, photonics, packaging, system design, and machine learning means we are perfectly poised to implement biosensing into disruptive products. We have successfully integrated these technologies into the sports, digital, and consumer health fields.

CSEM's POCD activities focus on:

- Sample preparation, including, liquid formatting, chemical modification, and concentration.
- Microfluidics at chip or device level.
- Biosensors and signal readout capable of monitoring, for example, pH, lactate, glucose, ions, or proteins. Up-scaling and large-surface printing alongside replication for manufacturing low-cost biosensors for integration into disposables.
- Device automation using AI and actuation.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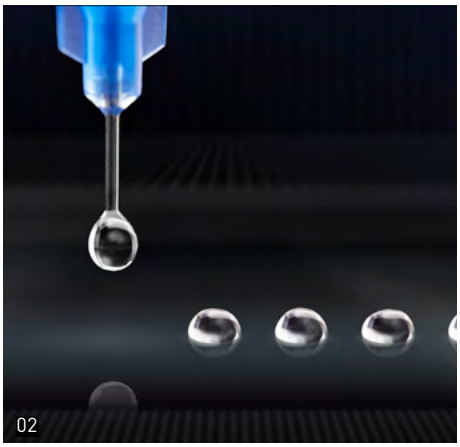
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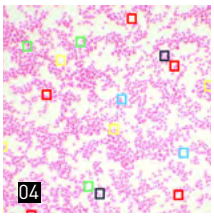
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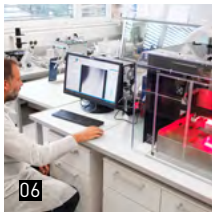
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01: denovoCast—Automated manufacturing of bioengineered skin grafts
02: Precision liquid dispensing with closed-loop control
03: DISPENS+ a self-calibrating, pressure-driven nano-dispenser for low to high viscosities
04: Cell classification enabled by deep learning
05: LABEYE—Monitoring of the manual pipetting process and labware recognition using deep learning
06: MUSTANG—Automated contractility screening platform for 3D bioprinted muscle tissues

LAB OF THE FUTURE

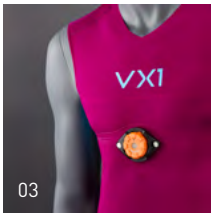
Innovations in life sciences are constantly evolving with lab technologies keeping pace to enable the next-generation of solutions. CSEM's research activities focus on innovating sensor and data analytic approaches to automate and monitor laboratory processes. The rising complexity of biological processes and smaller batch sizes have led us to shift our development from high-throughput towards flexible systems that can dynamically reconfigure to changing conditions. Moreover, the improved connectivity of systems is enabling us to collect and utilize data to improve laboratory usage and processes. Decades of experience in the fields of sensor design, miniaturization, packaging, microfluidics, liquid handling, data analytics, and deep learning combined with a comprehensive understanding of laboratory processes make CSEM a unique partner to address new challenges. We are ready to develop breakthrough technologies for the labs of the future.

CSEM combines its expertise in microtechnologies and digitalization to deliver next-generation laboratory systems, including:

- Self-calibrating liquid handling with patented solutions to pipette, dispense, or feed microfluidic devices without pre-calibration or liquid classes.
- Vision technologies to monitor processes and alert the user in case of handling errors or improper starting conditions.
- Automation of complex decisions based on deep learning for quality control and sorting of biological entities with a focus on spheroids and organoids.
- Process optimization (digital twin) and predictive maintenance of complete systems or sub-systems.
- Ultra-low power connectivity and edge computing enabling smart devices to dynamically reconfigure themselves.

01


02



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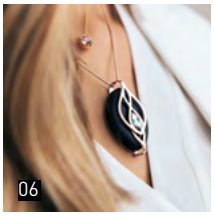
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01: WELMO prototype with 24 dry CS electrodes
02: First Swiss smartwatch to monitor HR(V)
03: Vexatec's smart textile sports performance monitor
04: AVA's fertility tracker
05: Aktiia's continuous blood pressure monitoring at the wrist
06: Bellabeat's smart activity tracking jewelry
07: Biospectal's blood pressure monitoring app


07

VITAL SIGN MONITORING

CSEM's research activities in digital health aim to innovate sensing and processing concepts for non-invasive human vital sign monitoring. Our emphasis is on integration aspects of microtechnologies as well as specific portable medical application demands: resource limitation, miniaturization, precision, reliability according to ISO-13485 standards, comfort, and production cost.

CSEM is a leading innovator thanks to its decades of experience in ultra-low power ASIC design, miniaturization, wireless connectivity, and unrivaled medical sensor systems. We specialize in developing medical wearables that keep pace as the digital heath domain becomes smaller, more interconnected, and complex. The recent COVID-19 pandemic confirms the need for remote patient monitoring systems to prevent diseases, track at risk patients, and support behavior change or preventive interventions. CSEM's remote patient monitoring systems are the driving force behind medical wearables that focus on patient empowerment, enable disease self-management, improve the lives of patients, and facilitate the work of caregivers.

CSEM provides high-performance medical wearables platforms in many form factors and for many locations for multi-signal recording/ monitoring of human vital signs, such as:

- Photoplethysmography (PPG), pioneered by CSEM with the first patent for heart rate monitoring at the wrist granted back in 2001, and today applied to: continuous optical blood pressure monitoring (oBPM™ fulfilling the new norms ISO81060-2 and ISO81060-3), arrhythmia classification, sleep analysis, heart rate variability, medical-grade cardiac interbeat interval detection (R-R), and detection of epizootics.
- CSEM patented cooperative sensors, enabling electrocardiogram (ECG) and impedance measurement with active dry electrodes connected via a one-wire bus; capable of not only monitoring ECG and respiratory volume and frequency during intense physical activity but also for imaging in electro-impedance tomography (EIT) to address conditions ranging from sleep apnea and pulmonary hypertension to severe acute respiratory syndrome.
- Smart medical systems, focusing on the integration of commercial off-the-shelf (COTS) sensors to develop up to class 3 medical products, as well as private and secure data management in medical ecosystems.
- Movement analysis, currently focusing on fall detection prevention.

Tools for life sciences powered by CSEM technologies

Successful technology transfers

CSEM is significantly growing its life science activities, and we have successfully developed a range of microsystems, biosensors, and automation solutions enabling new applications and products.

We work in close collaboration with EPFL, ETHZ, Universities, the Universities of Applied Sciences and European Research and Technology Organizations to access cutting-edge research and validate our emerging technologies. We are especially dedicated to simplifying laboratory workflows, improving data quality, and enabling new insights to free scientists from repetitive tasks so they can unleash their creativity.

As a recognized Research & Technology Organization, CSEM's mission is to enhance the competitiveness of industry by developing and transferring its IP and life science technology platforms. We are pleased to share and highlight here some recent success stories.

CSEM is your innovation partner for the life science industry.

Adamant Innotech

Optical microarray technology

Thanks to the established collaboration with CSEM, we were able to rapidly develop a serological test that can simultaneously trace for past infections of COVID-19, influenza, or SARS. The CSEM team supported Adamant Innotech in our bioassay development, plastic chip fabrication, and during the validation phase.

Xiaoming Tang
CEO
La Chaux-de-Fonds (Switzerland)
www.adamant-innotech.ch

AVA

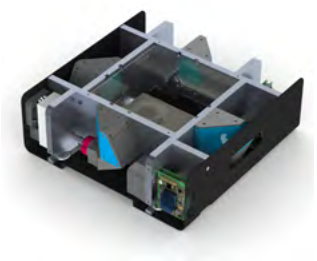
Fertility tracker

CSEM belongs to the globally leading organizations when it comes to medical wearables. Their experience, technology portfolio, IP, know-how, and advice have greatly contributed to building Ava, a company with the mission to improve women's health.

Pascal Koenig
CEO
Zürich (Switzerland)
www.avawomen.com

Hamilton

DropWatch



Thanks to CSEM's high-speed camera systems and well-founded experience in optical designs, we were able to create a novel method for analyzing and measuring small droplets in the sub-microliter range. Our close and fruitful collaboration has helped us to quickly develop a high-end measuring device, the so-called DropWatch system.

Hans-Peter Romer
Head of Research and New Technologies
Bonaduz (Switzerland)
www.hamiltoncompany.com

INVENesis

Organism-on-chip for drug testing

INVENesis provides services for drug discovery to industrial partners in animal health, pharmaceutics, and crop protection. Working with CSEM allowed us to develop a motility trap assay (MTA) for the automated high-throughput screening of drug candidates on parasitic nematodes by assessing their behavioral phenotypes.

Lucien Rufener
Managing Director
Neuchâtel (Switzerland)
www.invenesis.com

Novartis

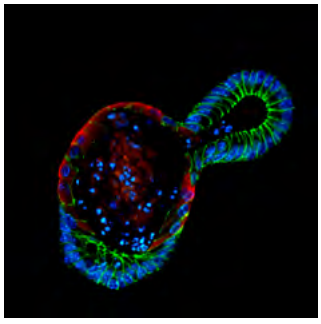
MUSTANG—The Muscle Analyzer

It was a great pleasure and extremely rewarding to work with CSEM on the development of the first automated human microphysiological lab system, which screens for the drug compounds that regulate muscle functions, such as force and fatigue. MUSTANG has the potential to find new musculoskeletal disease therapies and we have been able to transfer the technology to our partner companies.

Hansjörg Keller
Senior Principal Scientist
Novartis (Switzerland)
www.novartis.com

SUN bioscience

Personalized medicine with standardized organoids



In addition to its technical skills, CSEM had the advantage of being familiar with the required multidisciplinary approach and has a solid experience in production process engineering.

Sylke Hoehnel
CEO & Co-founder
Lausanne (Switzerland)
www.sunbioscience.ch

Swiss Tropical & Public Health Institute

New diagnostic solutions for all

Working with CSEM allowed us to develop and jointly validate a new diagnostic microarray/sensor device designed for use in low-resource settings. To better promote point of care solutions for everyday life, synergistic partnerships between health experts and technology providers are both mutually beneficial and highly relevant.

Daniel Paris
Medical Director, Head of the Department of Medicine
Basel (Switzerland)
www.swisstph.ch

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