Multiwell Optogenetics for Enhanced Cell-based Assays

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Multiwell MEA Technology

The feasibility and accessibility of neural and cardiac in vitro models, particularly reduced explanted organ (REPO) cell (ESPC) technology, has allowed complex human biology to be reproduced in vitro at unprecedented scales. Accurate characterization of neurons and cardiomyocytes requires assay tools that provide a functional phenotype. Measurements of electrophysiological activity across a networked population offer a comprehensive characterization beyond standard genomic and biochemical profiling.

Axion BioSystems’ AxioTTM multiwell microelectrode array (MMEA) platform provides this comprehensive functional characterization. The Mexas is a non-invasive benchtop system that simply, rapidly, and accurately records functional activity from cellular networks cultured on a dense array of extracellular electrode in each well.

Multiwell Optical Control

Why use the Luminos®?

- Artifact-free simultaneous and pacing
- High throughput with 192 LEDs over 48 wells
- Compatible with any opsins with 4 wavelengths encompassing the visual spectrum (460-705 nm)
- Maximal intensity with high-power LEDs and optimized LED/ECD ratio
- Precise control with microsecond precision and finely adjustable intensity for each LED
- Flexible control at each LED can be controlled independently and simultaneously

The Luminos® is the first commercial multiwell light delivery device designed for in vitro optogenetics. The Luminos provides precise control over cardiomyocytes beat rate or neural activity.

Optogenetics in Neural MEA Assays

Transduction of neuronal cell populations with opsins allows for precise, artifact-free control of neuronal activity. Here, primary rat cortical neurons (RBMC Cell Science) were transduced with electrophysiological opsins. The Lumos applied intensity sweeps across light wavelengths to explore the magnitude and timing of each opsins’ response.

Optogenetics in Cardiac MEA Assays

With optogenetics, light can be used to control and pace cardiomyocytes without artifact. Pacing cardiomyocytes offers many advantages:

- Specify beat rate of 190 for enhanced physiological relevance
- Establish well-to-well and plate-to-plate consistency with matched beat rates in all wells
- Detect use-dependent drug effects for superior safety screening

Optical pacing of cardiomyocytes with mRNR-based transfection

Here, Axiogenesis Cor.4U cardiomyocytes were transfected with channelrhodopsin-2 (ChR2) using Xpress.4U CH2, a transient mRNA-based delivery system. Daily optical pacing and recordings were used to optimize the assay time window and light delivery protocol.

Optogenetic devices offer fine control of activity in a controlled environment, allowing for precise, artifact-free control of neuronal activity.

Optogenetic in Neural MEA Assays

Why use microelectrode arrays?

- Label-free, non-invasive recording of extracellular voltage from cultured electroactive cells
- Integrated environmental control provides a stable benchtop environment for short- and long-term toxicity studies
- Fast data collection rate (12.5 kHz) accurately quantifies the depolarization waveform
- Sensitive voltage resolution detects subtle extracellular action potential events
- Industry-leading array density provides high quality data across the entire culture
- Scalable format (12-, 24-, 48- and 96-well plates)
- Automated high throughput multiwell processing chip (BioCore®) offers high throughput, flexible hardware, and enhanced flexibility

Axion’s AxioTTM multiwell microelectrode array (MMEA) platform enables functional cellular analysis on the benchtop with an industry leading & invasive benchtop system.

Optogenetics to control complex biology

Optogenetics is the integration of fast, light-activated ion channels (opsins) to enable targeted manipulation of cell activity or intracellular signaling. Optogenetic techniques enable:

- Artifact-free simulation for pacing cardiomyocytes or controlling neural activity
- Bidirectional control of activity via activation or inhibition of cell subtypes
- Genetic targeting for cell type specificity
- Control of gene expression and intracellular signaling for enhanced development of diseases in vitro models
- Establishing well-to-well and assay-to-assay consistency for more reliable results

Optogenetic devices offer fine control of activity in a controlled environment, allowing for precise, artifact-free control of neuronal activity.

Optogenetics is a powerful tool. When combined with MEA assays, optogenetics can enhance your neural or cardiac assays by reducing well-to-well variability, detecting rate and activity-dependent drug effects, and systematically controlling cell activity for better sensitivity and specificity.

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