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[P03-423] Biohybrid Robot-On-A-Chip composed of Brain-Eye Assenbloid/Muscle Bindle-based on Human Nervous System for Toxicity Screening

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Keywords：Biohybrid robot-on-a-chip、Brain–eye assembloid、Muscle bundle、Human nervous system、Toxicity screening

[Purpose]

Biohybrid robot-on-a-chip systems have emerged as promising in vitro platforms for drug and toxicity screening as complementary alternatives to animal experiments. However, current platforms based on the human motor system primarily focus on neuromuscular components and lack a sensory-integrated architecture for evaluating responses to external stimuli. Here, we propose a biohybrid robot-on-a-chip composed of a brain–eye assembloid and muscle bundle based on the human nervous system for toxicity screening.

[Method]

A brain–eye assembloid was constructed by integrating four retinal organoids with a thalamic organoid coated with an Au nanomesh to enable sensory signal generation and processing. This assembloid was functionally interfaced with a cerebral organoid, motor neuron spheroids, and a skeletal muscle bundle assembled on a polymer substrate, forming a human nervous system–based biohybrid robot-on-a-chip platform.

[Results]

To evaluate system performance, retinal stress was induced by blue light irradiation and by treatment with hydroxychloroquine (HCQ), a representative retinotoxic compound. Both stimuli resulted in a significant reduction in muscle bundle contraction. These findings demonstrate that electrophysiological signals generated within the brain–eye assembloid are transmitted through the neural network, including the cerebral organoid and motor neuron spheroids, to regulate muscle activity.

[Consideration]

The observed decrease in muscle contraction in response to external stimuli confirms that the brain–eye assembloid functions as a sensory-processing unit and that its signals are effectively propagated through the reconstructed human nervous system to the muscle bundle, indicating functional integration of sensing and actuation.

[Conclusion]

This biohybrid robot-on-a-chip composed of a brain–eye assembloid and muscle bundle based on the human nervous system provides a physiologically relevant platform for toxicity screening. The proposed system enables sensory-driven functional evaluation and holds strong potential for drug screening applications, particularly in neurodegenerative disease models, as a complementary alternative to animal testing.

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