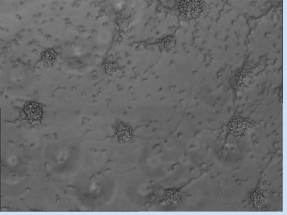
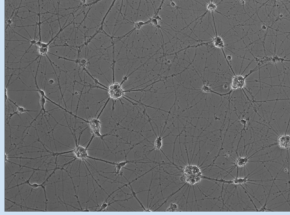


Living Electrodes for Hearing Rehabilitation

Ashrita Nagpal, Halle Kincaid



Abstract

Sensorineural hearing loss affects roughly 9 out of 10 people with hearing loss. As the name implies, sensorineural hearing loss can be caused by damage to the sensory organs (typically hair cells in the cochlea) or the auditory nerve. The cochlear implant, a device surgically implanted in the cochlea, attempts to restore the function of damaged hair cells. Meanwhile, an auditory brainstem implant, an electrode implanted in the midbrain or cortex, attempts to restore the function of a damaged auditory nerve. In our research project, we attempt to re-create the neural auditory pathway that extends from the cochlea to the auditory cortex. To do so in-vitro, we are harvesting 3 neuronal subtypes (spiral ganglion neurons, cortical neurons, and thalamic neurons) from postnatal rats. Then, we culture the neurons in microelectrodes that allow the subtypes to extend axons and dendrites bidirectionally to neighboring subtypes, as they would in-vivo. After conducting tests of growth and electrical activity of the in-vitro microelectrode, we will implant it back into postnatal rats suffering from neural loss.

Methods

We began the process of mimicking the auditory pathway by isolating neuronal subtypes from E18 rats, focusing on cortical and spiral ganglion neurons. Cells were grown in specialized media for up to two weeks with half the media being replaced every two days. To monitor neuronal health and growth, multiple images where taken of each well in culture plates at time of media change. Cell viability was specifically determined by a viability assay which involved formalin fixing of the culture and a staining with live-dead stain.

Conclusions

From the preliminary summer experiments, some conclusions were made about optimal cell isolation and culture maintenance going into the next steps of the project. Since the spiral ganglion and cortical neurons could both be harvested at the same time from one rat at the time of euthanasia, the day of isolation was important to consider in order to optimize the strength and penetrability of the skull and inner ear bones. This date was determined to be embryonic day 18.

The cell growth media was also strategized to maximize cell growth and viability. The standardized media composition was determined to be 100 mL neurobasal medium, 2 mL B-27, and 250 µL L-glutamine.

Future Directions

Future directions for the project include harvesting and culturing thalamic cells to complete the in vitro auditory pathway design.

We will also begin designing and printing a scaffold model of auditory system in which to grow these cultured cells and to see if they synapse.

The cells will then be transduced with optogenetic genes and stimulated with light in order to visibly observe the neuron action potential interactions.