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Interactive webinar for high school students connecting physics and ophthalmology

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Abstract

Purpose : To engage high-school students in an interactive webinar aimed at experiencing how principles of physics can be used to study the delicate balance of fluids and pressure in the eye.

Methods : Sponges of different types were used to represent ocular tissues as (1) deformable, (2) containing both structures (elastin, collagen,

extracellular matrix) and fluids (blood, interstitial fluid). An experiment was conducted to study the effect of gravity on sponges when dry and wet. Sponges were laser-cut in 3-4 discs (30mm diameter, 15mm thickness) and stacked inside a graduated cylinder. Using calipers, dry sponges were measured, then soaked in water and re-measured when wet (Fig.1). In another experiment, three types of sponges differing by deformability and porosity were considered (Fig.2a). The sponge discs were stacked within a syringe held by a 3D-printed stand and secured by a mounted plate connected to the plunger (Fig.2a). Dry and wet confined compression measurements were conducted for the different sponge types to study how tissue deformability and porosity affect its response to external pressure load.

Results : The webinar had 25 remote attendees. The experiments were run in the biomedical teaching lab at the University of Maine. In the first experiment, a dry height of 60mm was measured. Next, students were divided into breakout rooms to hypothesize if the wet height would be higher or lower than the dry height. Most of them guessed higher due to the sponge

expansion when filled with water, others thought it would be lower due to stronger gravitational pull. We then checked it together and found a dry and wet height of 61.15mm and 53.64mm respectively (Fig1a,b). A discussion followed on how vision may be affected by gravity. Before conducting experiment 2 students predicted wet sponge deformation, answering questions like, "How will wet sponges' height change with the same mass as dry sponges?". Next, the results were reviewed and discussed (Fig2b).

Conclusions : The interactive webinar provided students with a live experience in the lab that showed how the presence of fluids in a tissue along with its properties impact the response to gravity and external pressure. Inspiring young minds to explore the connection between physics and ophthalmology may help broaden the participation in eye research.

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Experiment one setup and visual results.

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Experiment two set up, with results for displacement over pressure.

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