3D printing and virtual reality provides opportunity to improve learning experience for biochemistry students

The School of Medicine, Medical Sciences and Nutrition at University of Aberdeen is a thriving community of researchers working on cutting-edge biomedical subjects to understand how the human body functions. Professor John Barrow recently collaborated with experts at STFC's Advanced Manufacturing facility to create a 3D printed model and virtual reality (VR) project that used visualisation tools to assist teaching biochemistry.

Challenge

Many cellular processes are difficult for students to understand due to their abstract nature, with textbooks and traditional methods of education often being composed of text, static imagery, and basic visualisations. Molecular visualisation methods have been used extensively in research when explaining processes and mechanisms that occur within cells.

John Barrow centres his research on developing innovative ways of delivering biochemistry and molecular biology teaching to students; recently he has explored methods such as virtual and augmented realities to bring these structures to life in a digital format that can be very immersive.

Solution

STFC provides access to a range of additive manufacturing and virtual reality equipment to enable both physical and digital prototyping. The outputs available include several different types of polymer additive manufacturing (also known as 3D printing) and several different types of virtual reality headset appealed to Barrow, giving him the opportunity to use the most suitable equipment to create innovative examples.

Firstly, John Barrow provided STFC with Computer Aided Design (CAD) files of the glucokinase enzyme, a protein involved in glucose metabolism, that were created from real scientific data downloaded from the Protein Data Bank (PDB) research database. The PDB files were then converted to a 3D model before being physically printed on the new J55 3D printer, a recent addition to STFC's additive manufacturing capabilities.

Using this initial print, STFC then resized the CAD of the protein molecule, separated different elements for colouring, applied textures, and digitally cut the model so that the internal elements could be viewed in two halves. The revised model was then 3D printed with the internal parts of the molecule coloured to represent different component parts, and the outer shell in a clear translucent polymer to be able to 'see' the structures inside.

Finally, STFC engineers used the same CAD file to import into a gaming engine to create the virtual reality application. Working with John Barrow, information panels were created to virtually illustrate the main mechanisms this enzyme is responsible for in our cells. The finished experience was then exported so that it can be viewed in a virtual reality headset.

Benefits

Students physically interacting with a 3D printed model reinforces the concepts of form and function and how they are crucial for molecular processes such as the reactions that glucokinase carries out. Coupling this with a dynamic VR experience only serves to enhance this learning experience and make it both memorable and more effective at explaining these concepts.

This is just the start of the relationship between John Barrow, the team at University of Aberdeen and STFC with discussions already taking place to look for future funding opportunities that will allow for further collaboration.

The initial work on this project was made possible by support from the Physiological Society David Jordan Teaching Award, 2019.

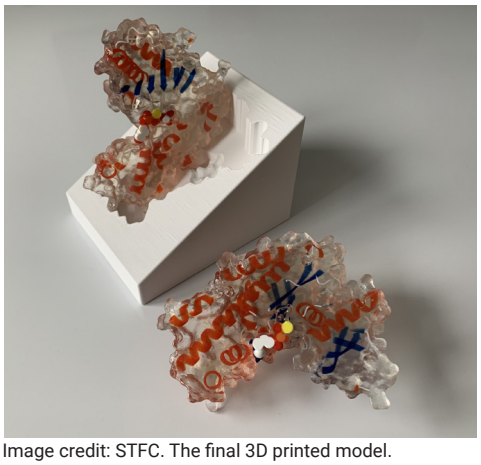

Image credit: STFC. The final 3D printed model.

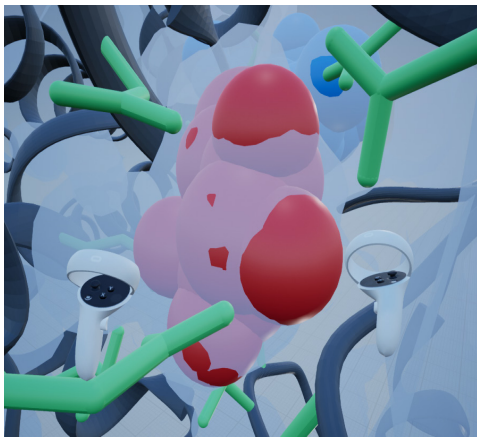

Image credit: STFC. One part of the virtual reality environment on the headset.

"Working with STFC has allowed me to create and test innovative ways of learning with my students. Being able to hold a physical model or interact virtually with a VR model really allows students to see how form and function go hand in hand even at the molecular scale. It also allows me to enhance my teaching by making the invisible visible – for example, the glucokinase 3D printed model is approximately 30 million times larger than the actual enzyme in our cells!"

Professor John Barrow, Chair in Biochemistry & Molecular Biology Education at Aberdeen University

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