Final high school project (profielwerkstuk)

At the end of my studies at Trevianum, my pre-university education, I did my final project on the visualisation of the paracetamol-induced changes in the respiratory chain in mitochondria of cultured human liver cells. I did so in collaboration with Jian Jiang from the department of Toxicogenomics at Maastricht University who, at the time, was doing her PhD on Mechanisms of Drug-Induced Liver Injury. The goal of this study was to research the hepatotoxicity of paracetamol (APAP) by analysing whole-genome gene expression data. Her study revealed that a dose of 10mM APAP results in an increase in Reactive Oxygen Species (ROS) formation and disrupts the assembly, stability and structural integrity of Electron Transport Chain (ETC) complexes. Ultimately, resulting in electron leakage into the cell, depleting the cell of ATP, thus, possibly inducing cell death. This is a very brief summary of the research and only a small proportion of the entire thesis, if you are interested and would like to read more, click here: <a href=\”<https://toxicogenomics-um.nl/research/apap-induced-liver-injury-dili>”>Read More…</a>, or send me a message for a free pdf.

As I heard about this research I saw an opportunity to visualise this in a 3D environment to visually explain the data. This was done, by first modelling all individual component like the phospholipids, inter-membrane proteins, ATP, proton (carriers) and so forth. Here, arguably the most challenging part was to shape the components because there is no actual proof of their appearance due their incredibly small size and the complexity of protein folding. Therefore, most models were based on their appearance in scientific schematics, and a little bit of artistic freedom. However, for the phospholipids there was some actual information on their appearance and movement which I tried to follow as closely as possible, although I did not consider phospholipid saturation. With all individual components model and textured, I commenced the animating part, ATP synthase was animated to illustrate proton binding and release, inducing the rotary motion which acts as power supply for ATP synthesis. Protons were animated using a particle system, illustrating their chaotic movement and inability to travel through the membrane. Additionally, the co-enzymes were animated to illustrate the electron transport chain in accordance to each other. Finally, I did a voice over to explain the electron transport chain (ETC) and the effect of APA on the ETC. Moreover, I edited in some blurring and numbering to clarify what part of the animation I was talking about. Due to the used terminology and assumption of background knowledge, the animation can be challenging to understand for a layman.

Link: <https://toxicogenomics-um.nl/research/apap-induced-liver-injury-dili>

<https://www.ncbi.nlm.nih.gov/pubmed/26155718\>