

A Dynamic and Integrated Metabolic Map for Teaching Metabolism within the Biological Sciences

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1. Objective

Cellular metabolism is a network of chemical reactions that facilitates all biological processes. Metabolic networks are complex and dynamic and this makes them difficult to visualize using static 2D representations. **We are developing an integrated and interactive 3D metabolic network within the context of a human hepatocyte.** We hope this open-source tool will support learning and communicating metabolic processes across many levels of education.

2. Key Features

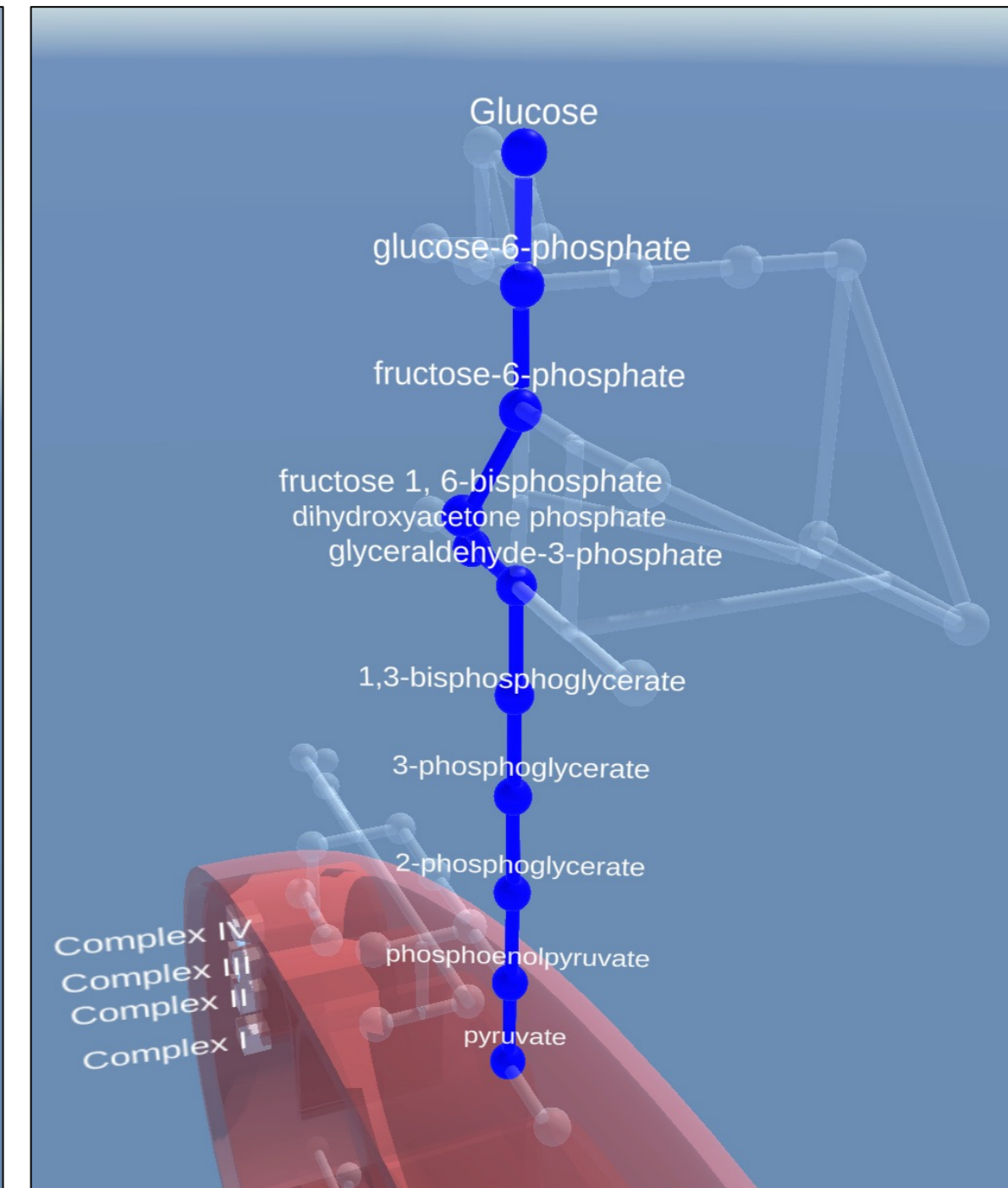
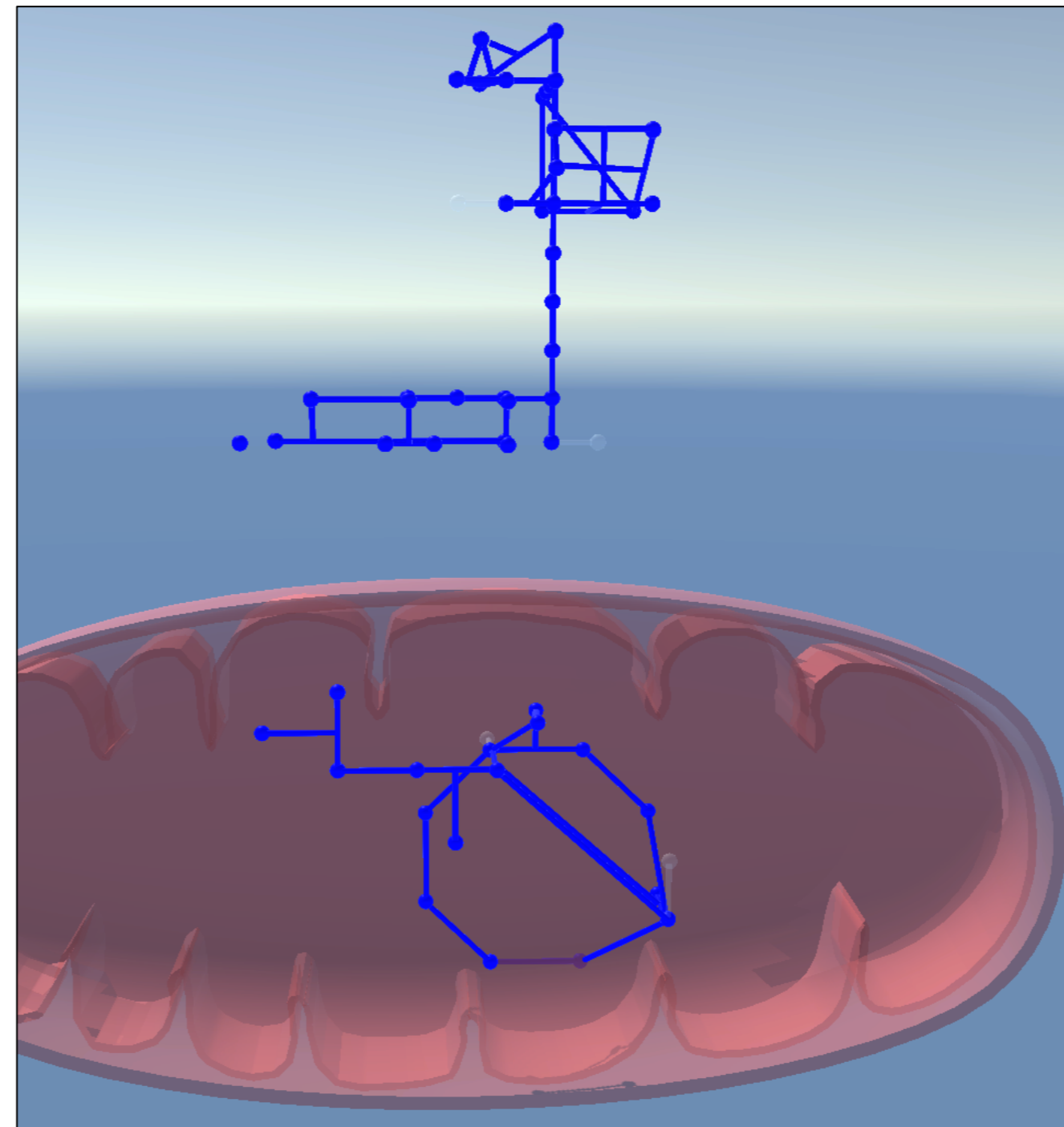
- **3D representation of metabolic pathways visualized within the context of a human cell**
- **Features within the user interface enable the user to manage complexity through highlighting and labeling specific pathways and metabolites**
- **Animations enable the user to visualize metabolic flux**
- **Up-to-date biochemical data is continually made available within the network through a Wikibase**

3. Future Directions

Our team is working towards a minimal viable product which will be introduced into UBC courses during the 2022 winter session. We are currently focused on expanding our network to include additional metabolic pathways relating to lipid and amino acid metabolism. We are also designing a website and learning resources to support the use of this learning technology, and collecting data through user testing and classroom implementation to assay learning impact. Our current build is a web-based application but we plan to also develop an extended reality user interface.

4. Acknowledgements

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Language	Label	Description	Also known as
Canadian English	No label defined	No description defined	
English	Glycolysis	Glycolysis stands for glykys (sweet) and lysis (splitting). In other words, this pathway is involved in the breakdown of glucose into pyruvate which can be further used to create energy for the cell.	
British English	No label defined	No description defined	

Statement	References
has part	<p>glucose 6-phosphate <=> fructose 6-phosphate</p> <p>isBidirectional Glycolysis</p> <p>0 references</p>
	<p>fructose 6-phosphate + ATP => fructose 1,6-bisphosphate + ADP</p> <p>0 references</p>

Visualizing Cellular Metabolism

Top: Unity prototype. Metabolites and metabolic reactions are represented by nodes and edges. The 3D mitochondrion is shown in orange. Functions within the user interface enable labeling and highlighting specific pathways and metabolites.

Bottom: Wikibase. The Wikibase contains linked data relating metabolic pathways, metabolites and metabolic reactions. The Unity build calls data from the Wikibase to enable the user to access biochemical detail.