Contribution ID: **602** Type: **Poster (+) Presentation**

Characterising multi-domain porous structure of the human placenta by synchrotron X-ray micro-tomography

Wednesday, 2 June 2021 16:00 (1 hour)

Multi-scale structural assessment of biological soft tissue is challenging but essential to gain insight into structure-function relationships of tissues and organs [1-4]. The human placenta is one of the most complex vascular organs of the human body. It is an exchange organ with a large surface area of the feto-maternal interface packed in a relatively small volume. The human placenta has the total length of the feto-placental vascular network of over 550 km, and its tightly integrated structural constituents span the spatial range from ~ 10^{-6} to 10^{-1} m [1,2].

Using the human placenta as an example, this study brings together advanced sample preparation protocols, three-dimensional imaging and modelling to provide the first massively multi-scale information that enables detailed morphological and functional analyses of multiple placental domains [5].

We employ machine learning-based segmentation techniques for robust and efficient decomposition of maternal and fetal micro-domains which bridge almost four orders of magnitude (from microns to centimetres). Spatial statistical analysis and flow simulations are performed on the feto-placental vascular network and associated intervillous porous space, and we validate the results against other modalities, such as traditional 2D stereology and in-vivo magnetic resonance imaging. Finally, we quantify the scale-dependent error in morphological metrics of heterogeneous placental tissue, estimating the minimal tissue scale needed in extracting meaningful biological data.

The developed protocol is beneficial for high-throughput investigation of structure-function relationships in both normal and diseased placentas, allowing us to optimise therapeutic approaches for pathological pregnancies. In addition, the methodology presented is applicable in characterisation of tissue architecture and physiological behaviours of other complex organs with similarity to the placenta, where there are complex fluidic / exchanger systems, such as represented by the kidney, lung, lymphatics, spleen and the central nervous system.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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[2] Jensen OE & Chernyavsky IL (2019) Blood flow and transport in the human placenta. Annu Rev Fluid Mech 51: 25 (doi: 10.1146/annurev-fluid-010518-040219).

[3] Plitman Mayo R (2018) Advances in human placental biomechanics. Comput Struct Biotechnol J 16:298 (doi: 10.1016/j.csbj.2018.08.001).

[4] Clark AR & Kruger JA (2017) Mathematical modeling of the female reproductive system: from oocyte to delivery. WIREs Syst Biol Med 9:e1353 (doi: 10.1002/wsbm.1353).

[5] Tun WM, Poologasundarampillai G, Bischof H, Nye G, King ONF, et al. (2020) A massively multi-scale approach to characterising tissue architecture by synchrotron micro-CT applied to the human placenta. bioRxiv 2020.12.07.411462 (doi: 10.1101/2020.12.07.411462).

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