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מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

Vision Grant
Preeclampsia Foundation

PROGRESS REPORT (February 2021)
Project: 'Early Assessment of Pregnancy Complications: Placental Characterization based on Ultrasound Images and Numerical Biomechanical Models'

## BACKGROUND

The overall goal of this project is to elucidate on the relationship between placental structure and the materno-placental circulation, with the ultimate goal of aiding clinicians at the point of care to diagnose, interpret and treat preeclampsia. To this end, this project combines advanced computational models, placental image analysis and clinical data.

## PROGRESS ACHIEVED SO FAR

Due to COVID-19, there was a significant delay in our ability to enroll patients for this project. Specifically, there was a significant delay in obtaining all the required institutional certifications in Wolfson Medical Center and Tel Aviv University. Up to date, we have enrolled eight healthy, three fetal growth restricted and one PE pregnancy patients. Progress on our specific aims is detailed below:

*Aim 1: To correlate placental transport capacity from in-silico models with in-vivo data*

To meet this aim, we have recruited a M.Sc student (Mr. Tirosh Mekler) at the School of Mechanical Engineering, Tel Aviv University. Since he started in August 2020, Tirosh has been working on generating 3D models of the materno-fetal exchange unit (lobule). He has successfully constructed the truncus chorii and rami chorii of the villous tree (6 branches, see Figure 1). Currently, he is building the ramuli chorii unequally dichotomous and with asymmetric branches using diffusion-limited aggregation (DLA) and he is about to implement porous media conditions obtained from Aim 2. Furthermore, Tirosh already started to generate 2D simulations of blood flow in a placentome, and validate them using models from the literature (see Figure 2). Ultimately, these models aim to calculate a lobule's oxygenation and transport capacity.

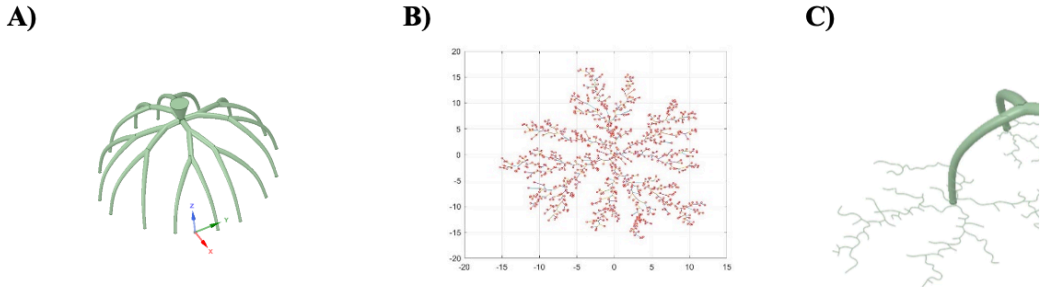


**Figure 1** – **A)** Truncus and rami chorii in SpaceClaim. **B)** Processing in MATLAB the routes from the DLA. **C)** Implement the routes to SpaceClaim.

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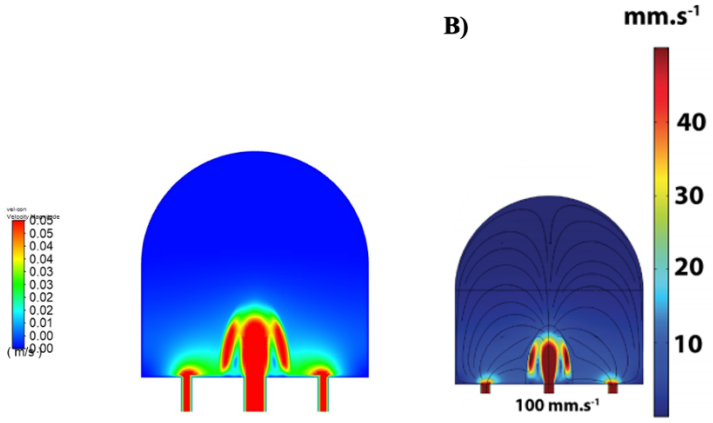


**Figure 2** - Validation: **A)** Our 2D simulation. **B)** Literature simulation (Lecarpentier et al., 2016).

*Aim 2: To correlate placental density with in-vivo ultrasound echotexture*

Immediately after delivery, placental lobules were collected from the center and the periphery of the placenta, fixed by immersion in formaldehyde and stained with standard histological H&E stains (hematoxylin and eosin). Serial sections of 5 $\mu m$ were generated and scanned using a Pannoramic MIDI Scanner, examples of spiral artery openings are shown in Figure 3. In order to analyze these images, we have recruited a M.Sc student (Mrs Anastasiya Burdzina) at the Weizmann Institute of Science, who is currently working on calculating the density and porosity in relation to the spiral artery opening. Ultimately, we would like to address the differences between central and peripheral lobules and between healthy and pathological ones, and to match them to ultrasound echotexture.

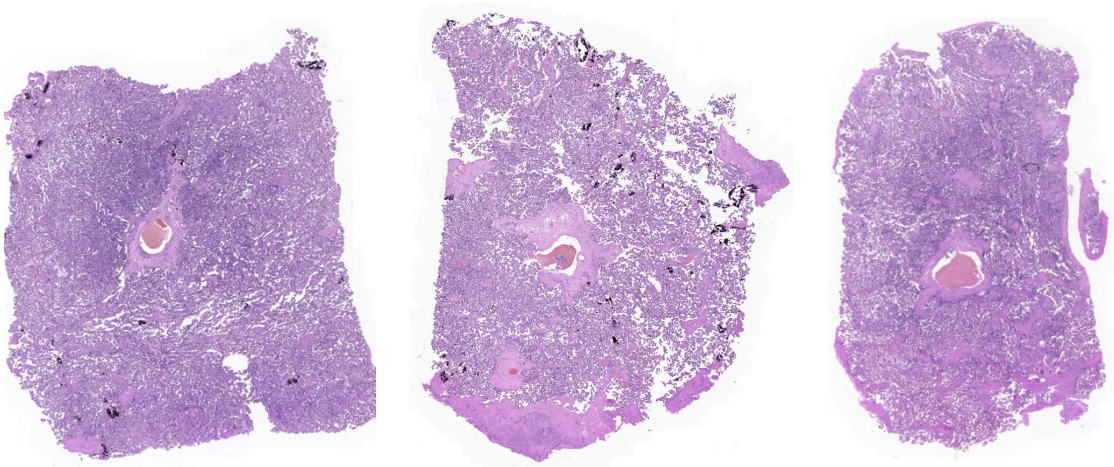

Figure 3 – Examples of spiral artery openings into the intervillous space of healthy placenta (left & center) and FGR placenta (right).

*Aim 3: To estimate the risk of developing PE using routine 2$^{nd}$ trimester scans*
This aim will only be address once we complete Aim 1 & 2.

Sincerely,
Dr. Romina Plitman