

RIPS 2009

Placental Analytics

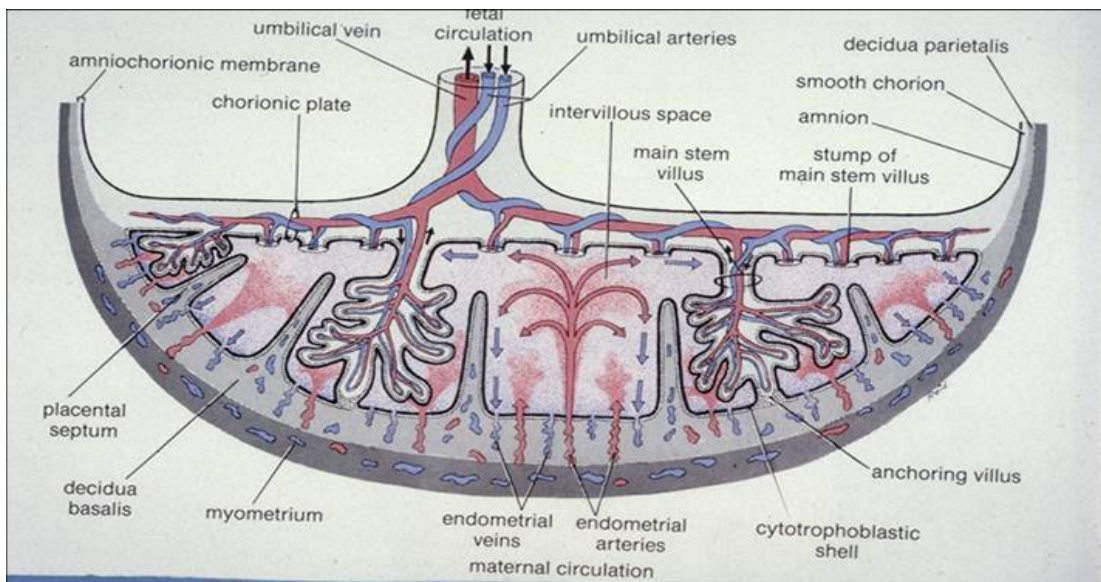
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PROJECT DESCRIPTION

Many of our important organs (like blood vessels, lung, kidney, pancreas and neurons of our brain) have to branch as they grow to develop normal function. The placenta (**Figure 1**), attached to your belly button during your life in your mother's womb, uses many of the same genes that those other organs use in order to grow, branch and supply you with all the oxygen and nutrients you need to grow to be a healthy newborn.

Many studies indicate that stresses before birth affect the fetus in ways that create lifelong health risks; many of those health problems involve abnormal or reduced function of organs such as blood vessels, lung, kidney, pancreas, and brain in adulthood. We know that important aspects of growth and development of those organs during pregnancy occur at the same time the placenta is growing, developing, and using many of the same genes and molecular signals to grow itself.



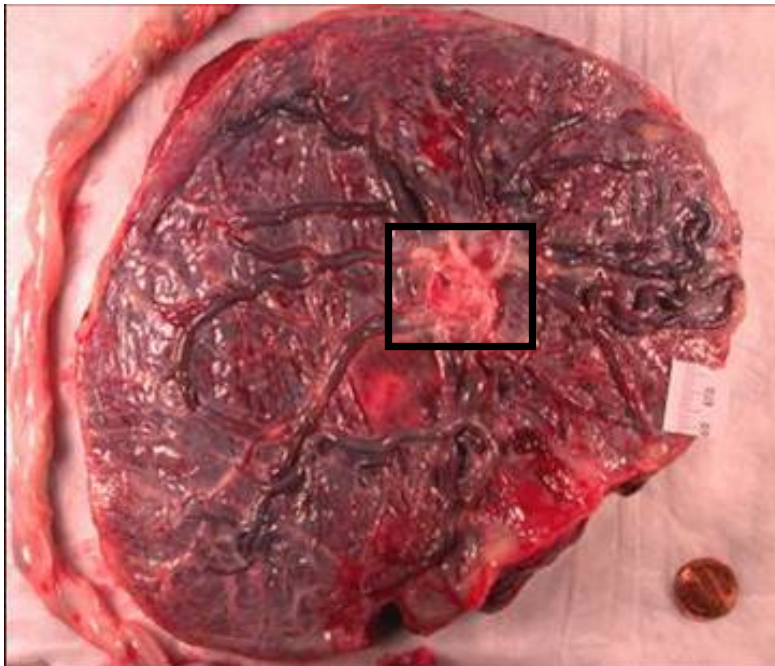
These organs cannot be dissected (taken apart and their finer microscopic structure analyzed), in living children. But the placenta, a (genetically) fetal organ most commonly discarded after birth as medical waste, can be so studied, and may be a “biomarker”, a “yardstick” that can be used to assess, at birth, lifelong health risks. Such studies may help us understand risks for (and causes of) diseases such as high blood pressure, heart attack, stroke, lung cancer, diabetes and obesity, and such diverse neurologic diseases as autism, schizophrenia and Parkinson’s disease.

RIPS METHODS

After a child is born, we can take the placenta and analyze its structure to identify those features that are potential indicators of risk factors during early childhood and whole lifetime development. The RIPS 2009 analysis will be based on digital photographs of the placenta. The branching structure of the placenta under the microscope is very complex (see **Figure 1**), however, its overall shape (as appreciated

by the naked eye and in digital photographs) has been shown to closely parallel the microscopic structure of the tiny branches of the placental villous tree that are key to fetal (and potentially lifelong) health. Its **chorionic plate** surface vasculature (see **Figure 1** and **Figure 2**) is also visible to the naked eye and can be measured and quantified.

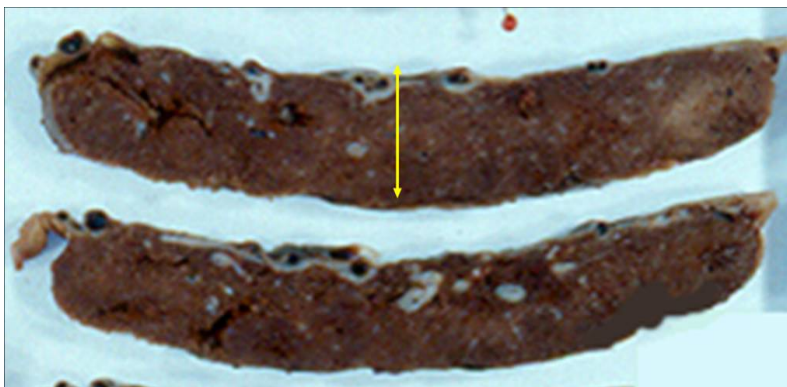
In this project we will use data collected from photographs of the placenta to derive information about the 3-D placental shape and volume. The photographs will include a view of the **chorionic plate** surface of the placenta (the surface onto which the umbilical cord implanted, **Figure 2**), and a view of cross sections of the placenta taken at regular intervals (e.g., **Figure 3**). In both cases, the outline of the placental **chorionic plate** surfaces, the site of the **umbilical cord insertion** (framed in **Figure 2**, the initial “center point” of the placenta out from which the placenta grows) and each of the placental **slices**. In some cases, the **chorionic plate** vessels will also be traced by an expert.



The RIPS team will be provided with data **both** as traced images from which the coordinates of the boundaries and cord insertion site can be read **and** as a set of 2-D coordinates produced after marking the **umbilical cord insertion** site and the **chorionic plate** and **slice** boundaries at regular intervals using a graphics tablet.

The team will then use these data to reconstruct an approximation of the **3D shape of the placenta** with the **umbilical cord insertion** appropriately placed, so that metrics can be computed, such as cord displacement, volume and surface area.

Many potential methods for both reconstructing and representing the shape are possible, and the early portion of the project will focus on learning about these and choosing an appropriate one to solve the problem.



The team may wish to start developing the methods using control data that they create where the properties we are seeking to reconstruct are known. For example, if the team photographs an object (such as a fruit) and performs the

same slicing and tracing on their images as is done on the placenta, they can test their methods to ensure that they are working properly when applied to the real placental data.

DELIVERABLES

The team will produce:

- The standard RIPS project report
- Code (matlab, C, or C++) that takes as input the set of tracing coordinate sets, reconstructs the 3d shape and reports a set of measures such as volume and surface area in relation to umbilical cord insertion.

REFERENCES

1. Dey, T.K., Curve and surface reconstruction: Algorithms with mathematical analysis. 2007. Cambridge University Press, Cambridge.
2. McLeod, Robin J. Y., Baart M. Louisa, Geometry and Interpolation of Curves and Surfaces.1998. Cambridge University Press, Cambridge.
3. Zhao,H. K.,Osher, S.,Fedkiw, R., Fast surface reconstruction using the level set method. Variational and Level Set Methods in Computer Vision, 2001. Proceedings. IEEE Workshop on. 194-201,2001