

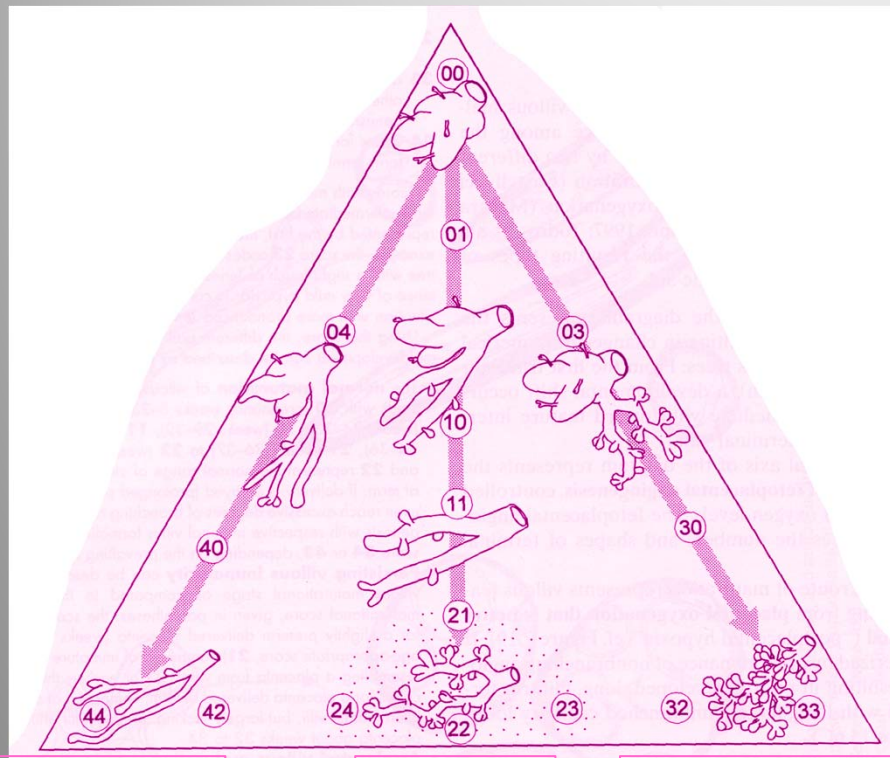
The background of the slide is a microscopic image of placental tissue, showing various cellular structures and blood vessels stained in shades of pink and blue. The tissue is arranged in a somewhat circular pattern around the central text box.

Placental Maturity Analysis

The relationship between placental Geometric properties, gestational age and infant health

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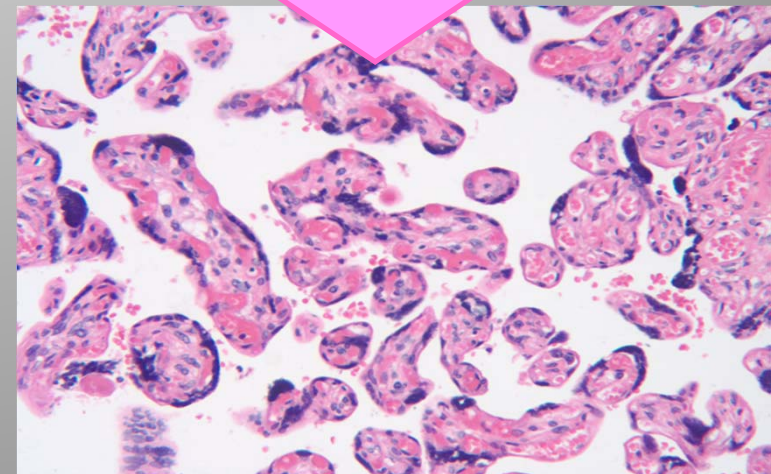
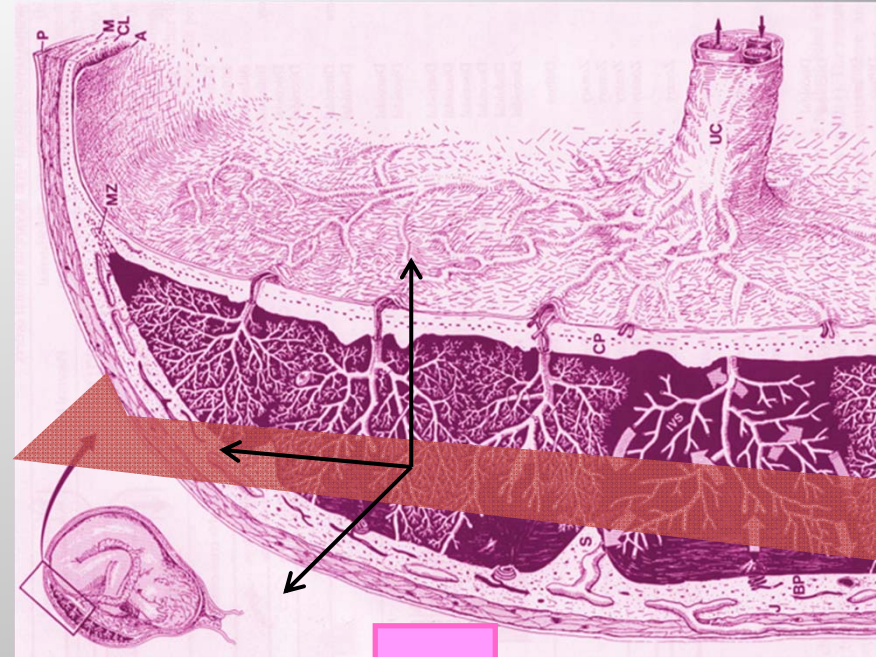
What is Placental Maturity?



Immature
(Unhealthy)

Mature
(Healthy)

Hypermature
(Unhealthy)

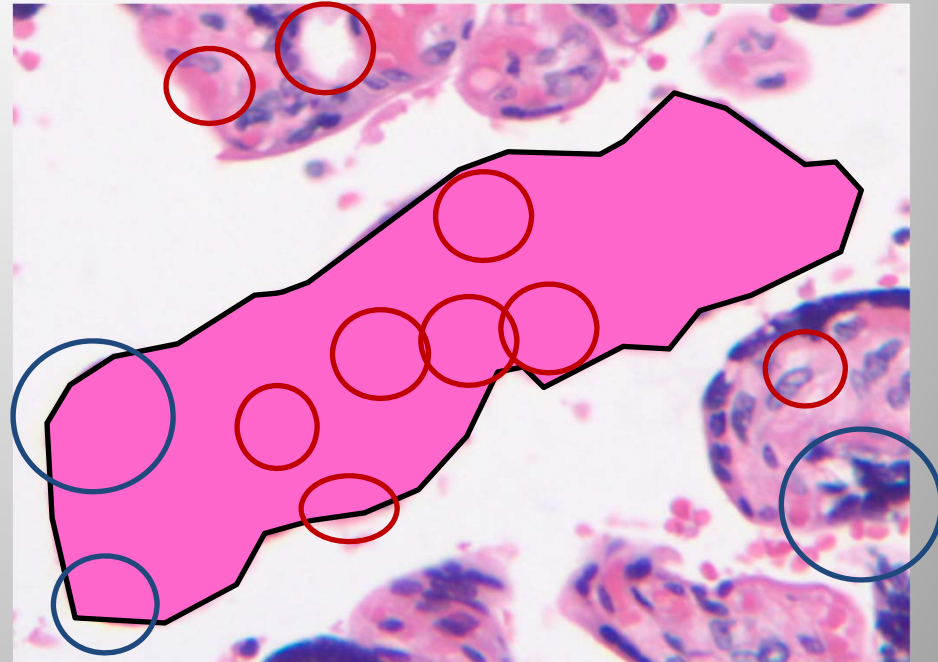


What do histologists look at to assess it?

How do we Measure the PM?

- Relative size, shape, & feature composition of microscopic villi

- Total Area
- Total Perimeter
- Blue “knots”
- # of blood vessels

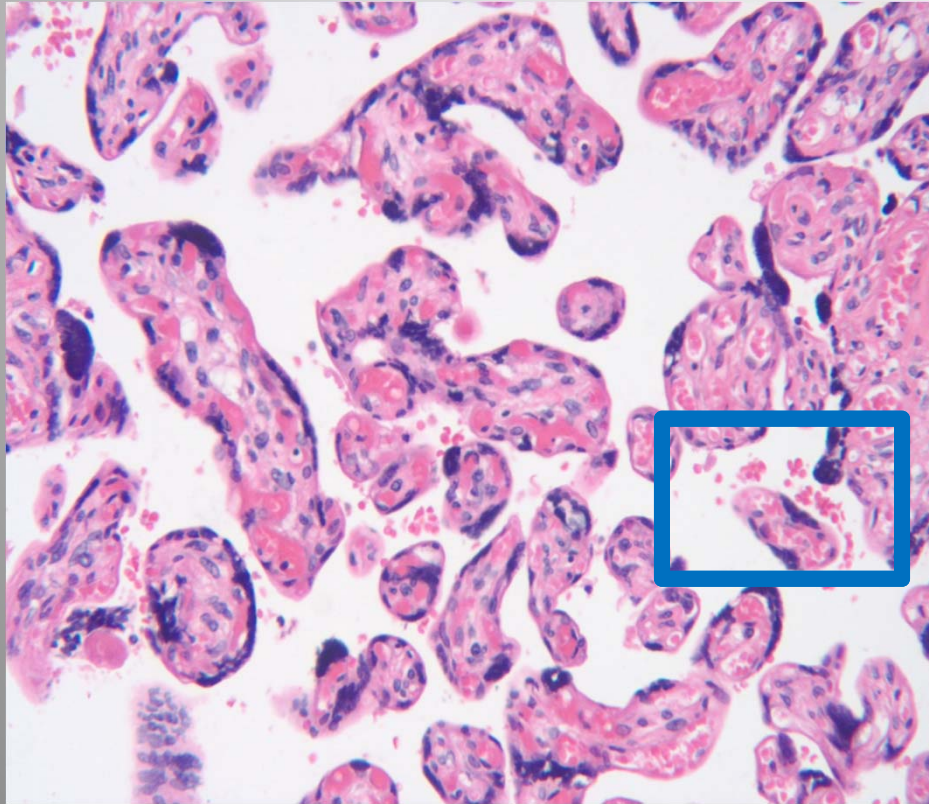


- Wouldn't an automatic process be nice?
1. Pre-process image
 2. Measure PM properties
 3. Data!

But we also want something “reliable” to analyze:

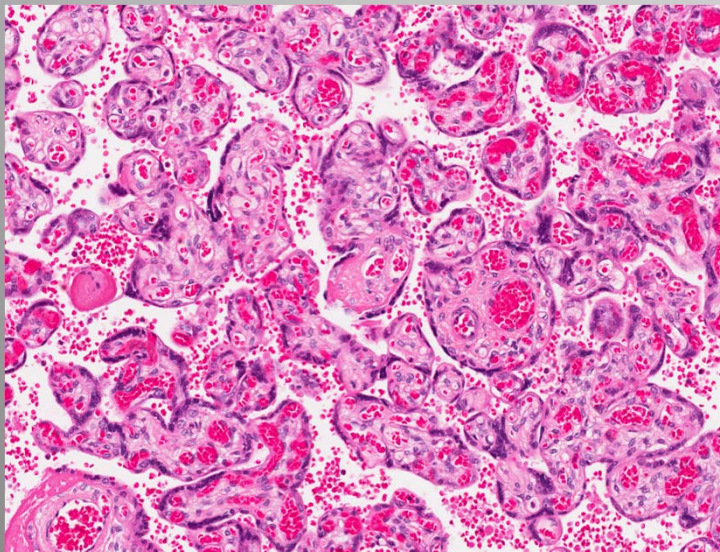
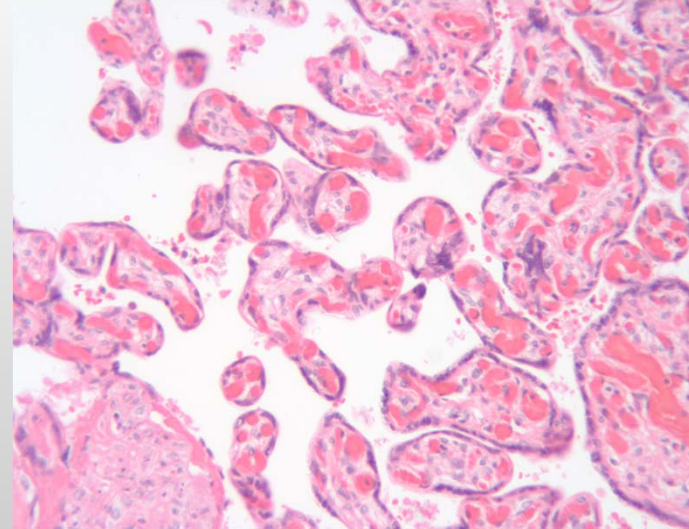
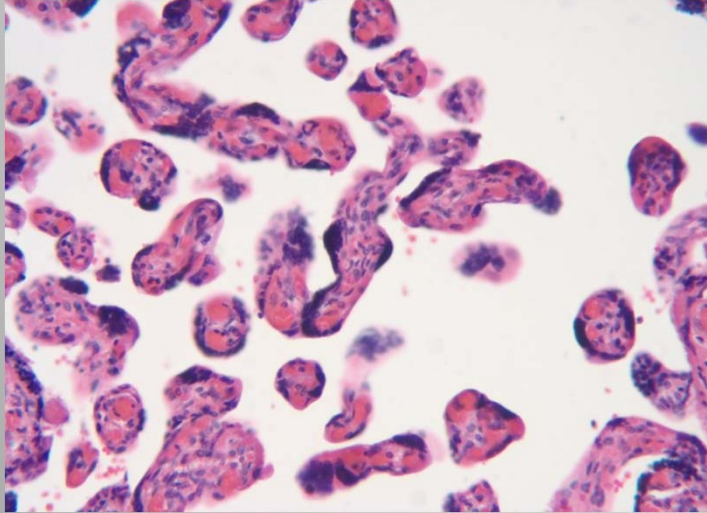
- Hand-trace blobs according to Dr. Salafia's examples
- Hand-Count blood vessels

Image Segmentation



- Our goal with image segmentation is to take this image and “clean” it in order to get a better approximation of the area of the villi as well as perimeter.
- As you can see in this picture, there are several red vessels that lie outside the blobs in the white space, and that is what we wish to “clean” up.

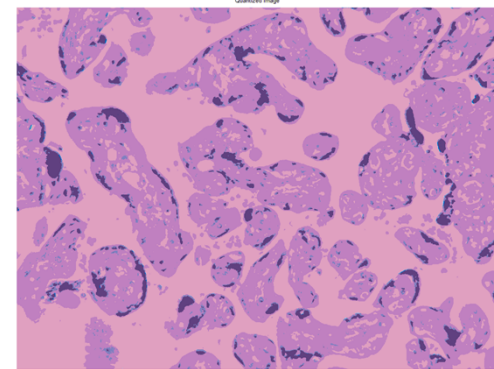
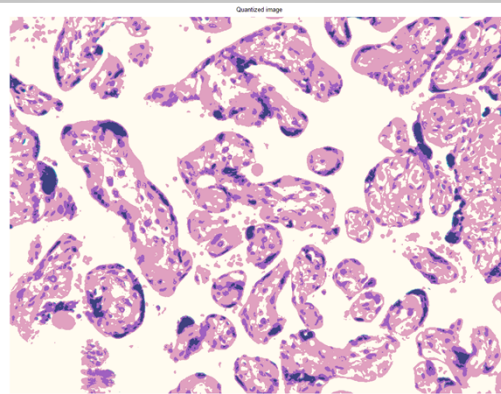
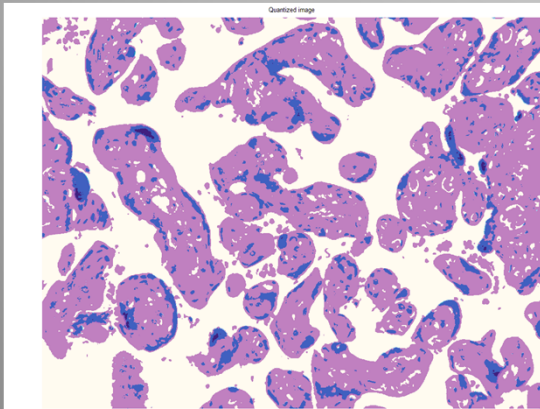
Main Problem



Our biggest problem in segmenting the image was not the complexity of the shapes in each image, but the color difference between them.

Various Methods

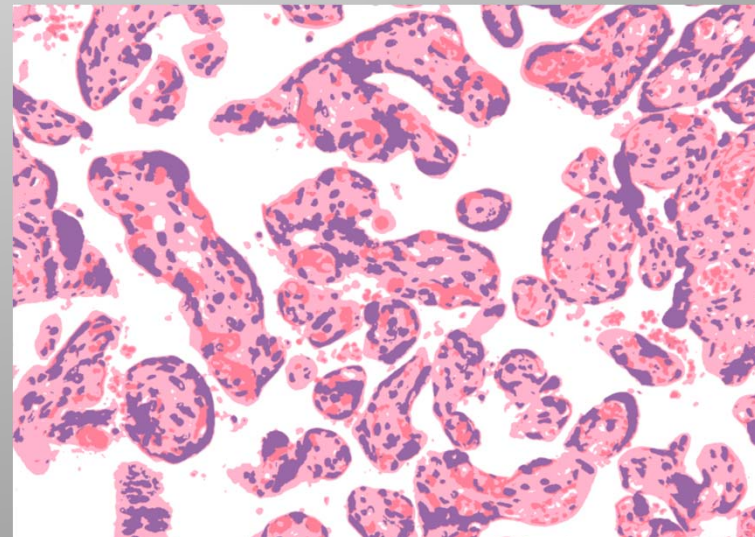
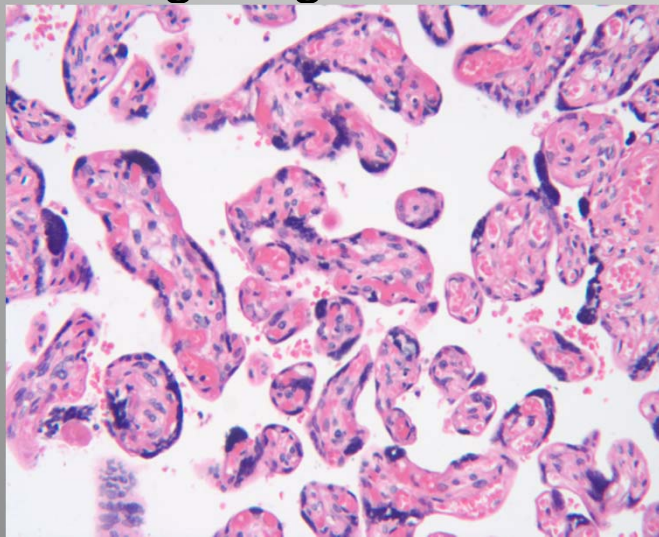
- In order to segment the images, we tried two different types of algorithms, one which automatically calculates the color variations and segments it accordingly and one where color markers are prescribed.
- The algorithms which are automatic uses intensity values and most can be told how many values should be used to segment the images. For our images, that is 4 primary colors. Unfortunately there is a problem with these methods....



They are not consistent!

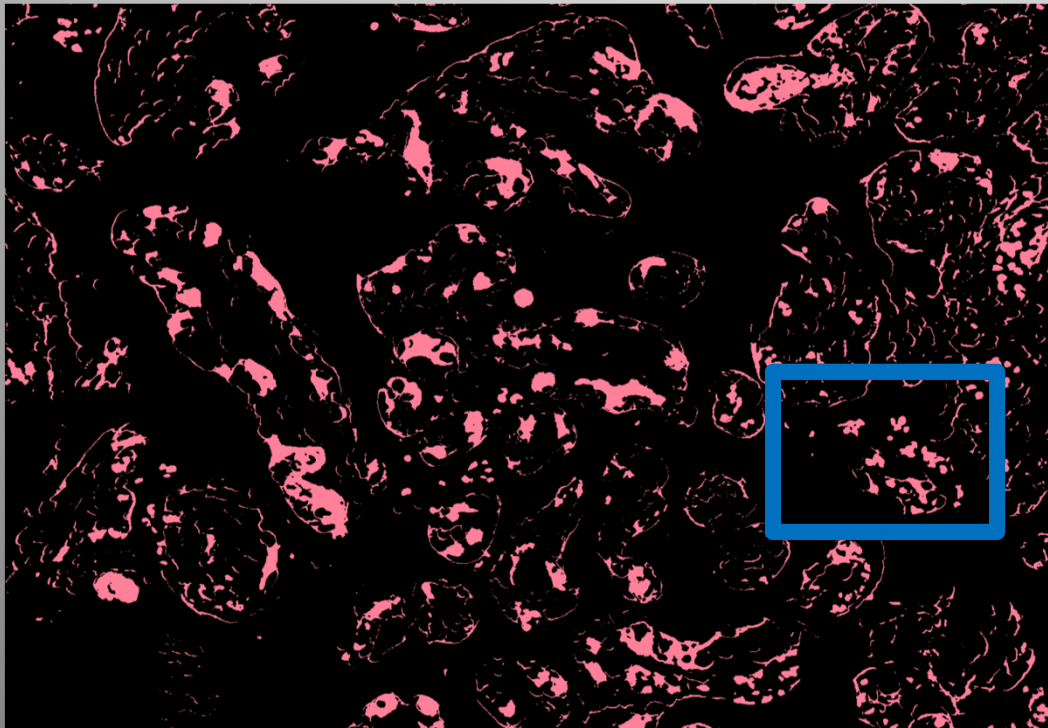
Second Method

- The second method is to prescribe color values based on one image and use that value to segment other images. This method is better for our case because most of the images are of the same color.
- Using these values, we can simplify an image into four colors by calculating the minimum distance between a pixel color value and with the prescribed values. This method is drastically slower than any automated algorithm, but the resulting image is consistent.

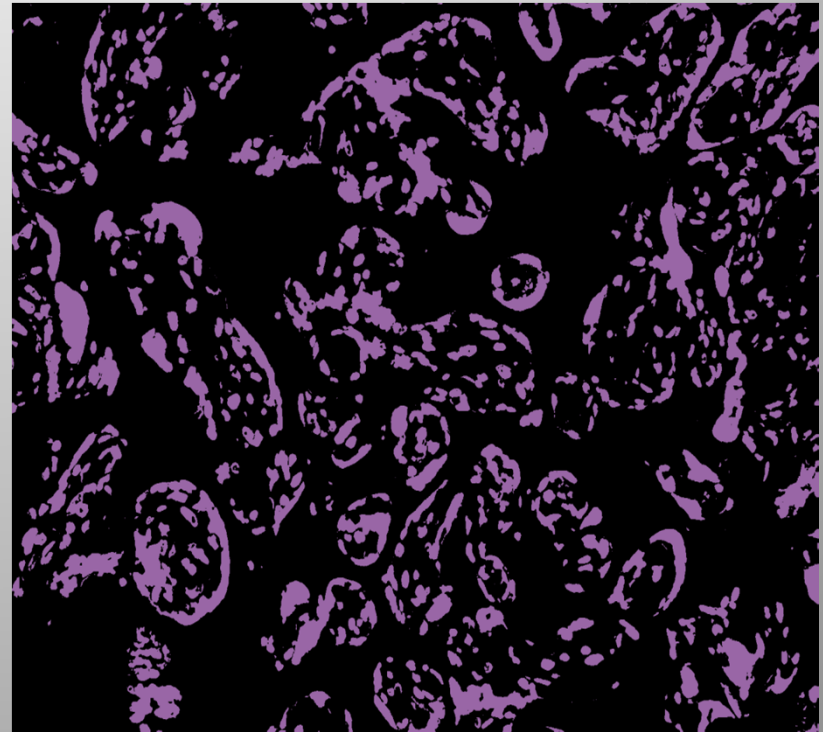
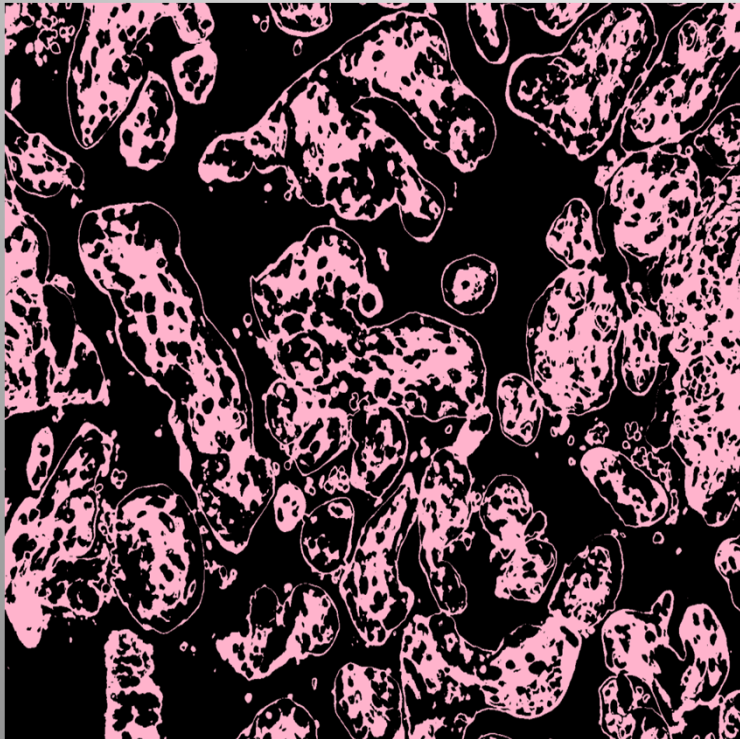


Cleaning

With each image separated into the four colors, we can then begin to remove the small blood vessels in the white area. The main problem associated with this problem is that there are red vessels both inside and outside the villi. Also, not all the individual red vessels are separate. Some are connected to the villi by mere pixels, and although the naked eye can differentiate between what is outside and inside, the algorithm cannot.



Pink and Purple



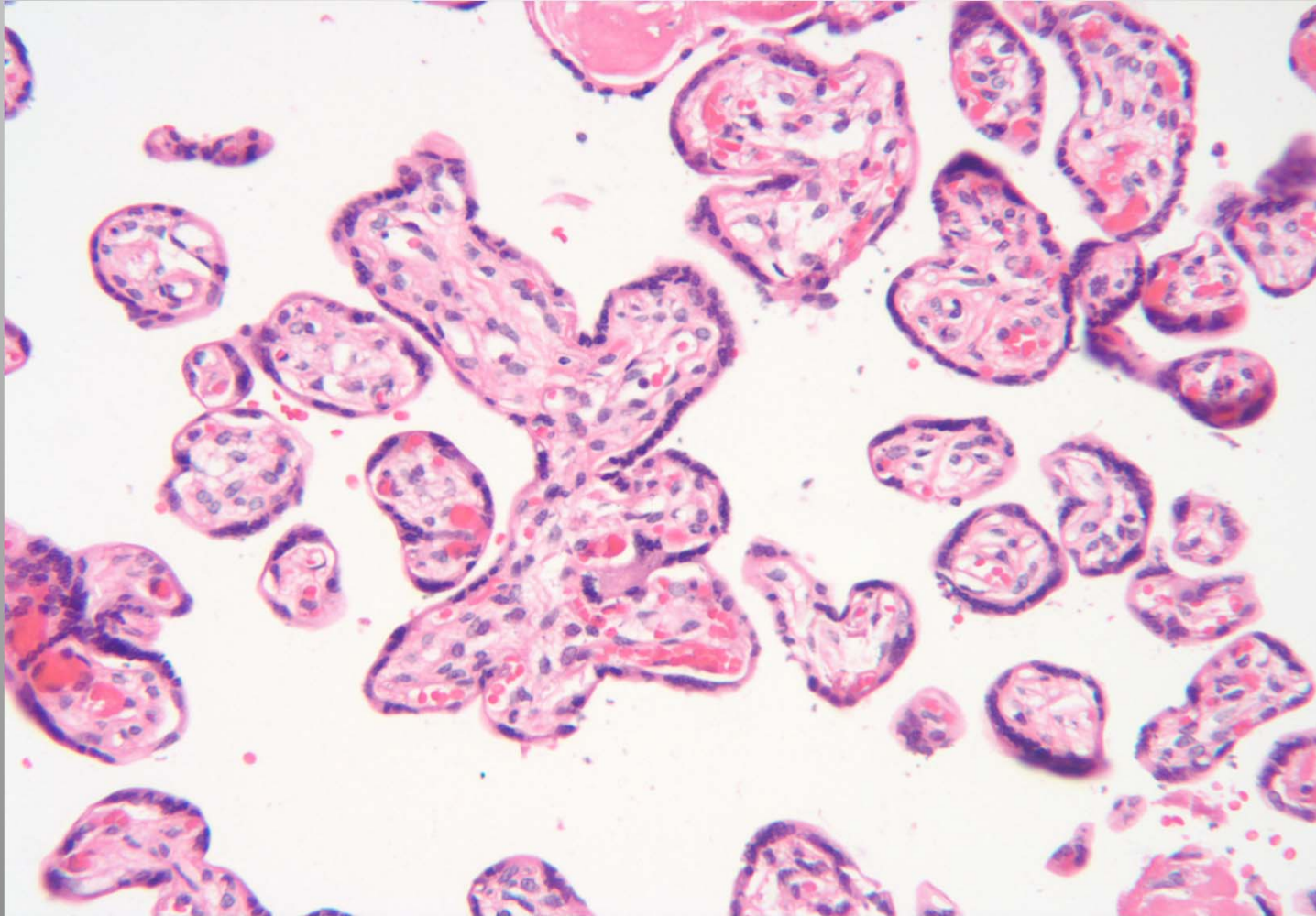
Cleaning cont.

Since achieving perfection is slightly out of reach, the next best we can do is simply remove any red vessels that are separated from the villi by simply filtering the image for shapes smaller than some percent of the total area. Although the number is slightly different for each image, a percent value of 0.4% of the total area seemed to work the best.

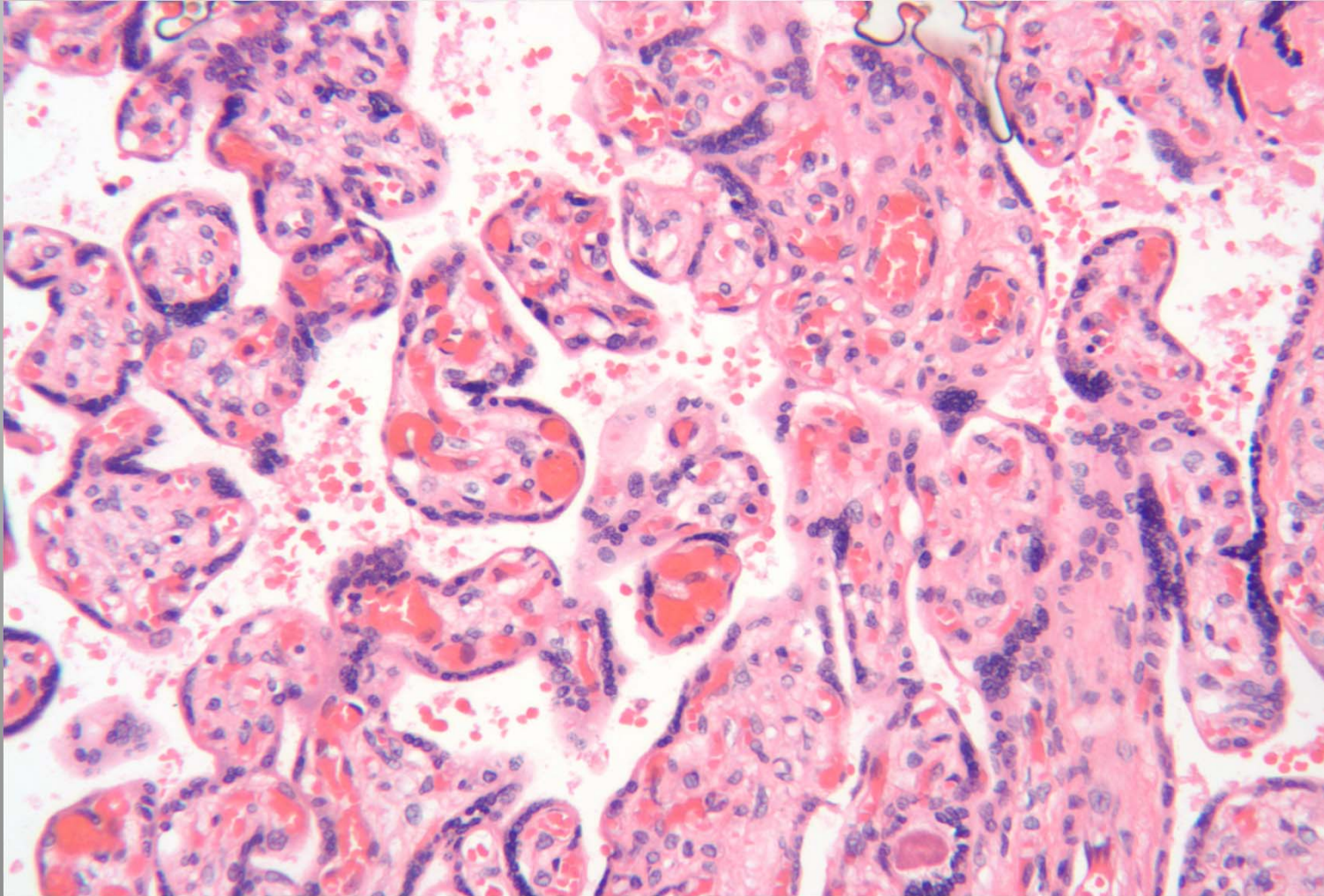


As you can see in this image, most of the external red vessels are removed except for those highlighted by the blue boxes. They are connected to their respective villi.

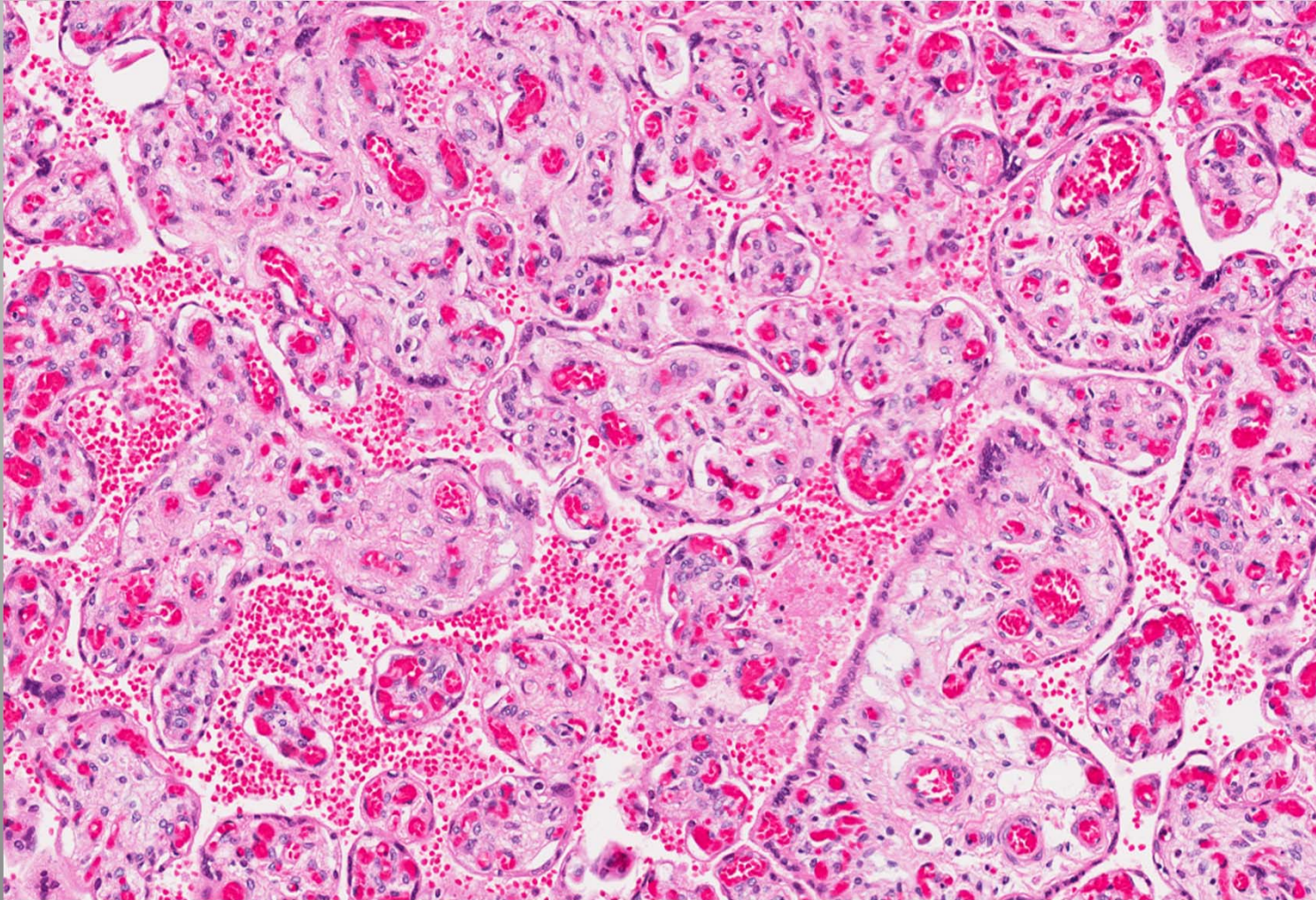
Good Results



Bad Results



Very Bad Results

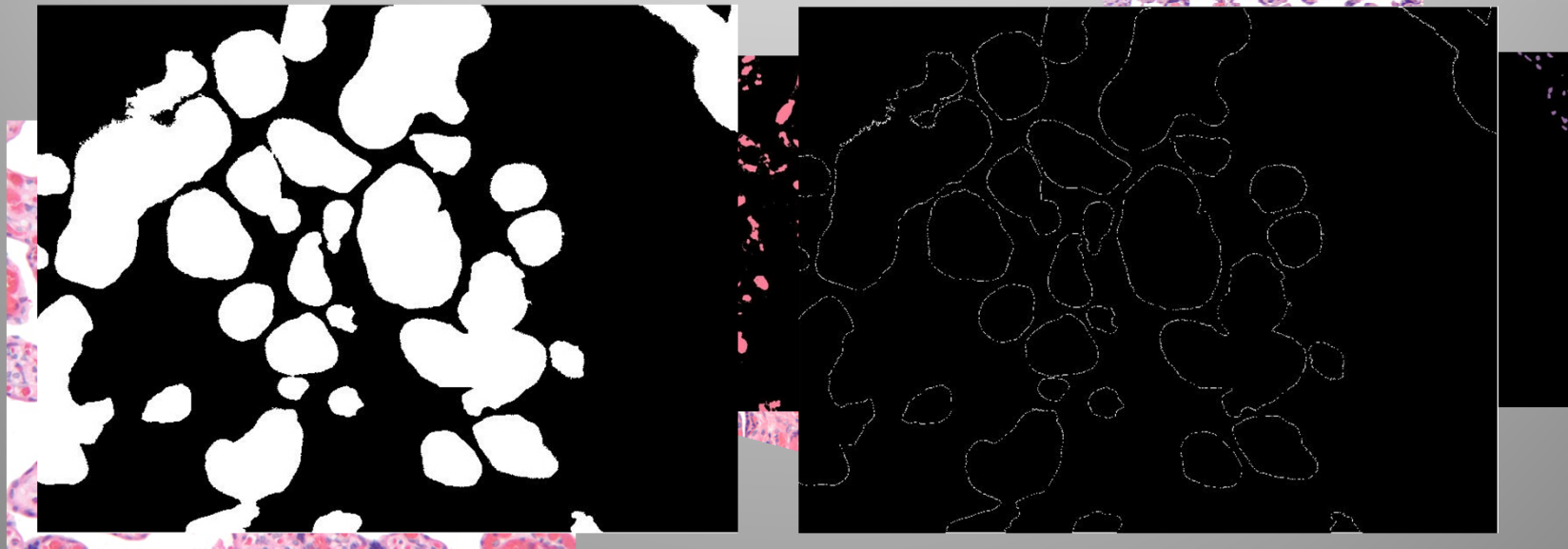


Villi Perimeter and Area

Photoshopped images

Segment images

Converted white pixels to black and color
white

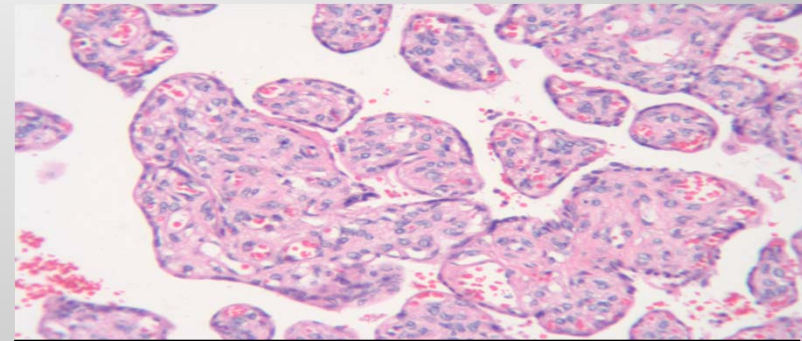
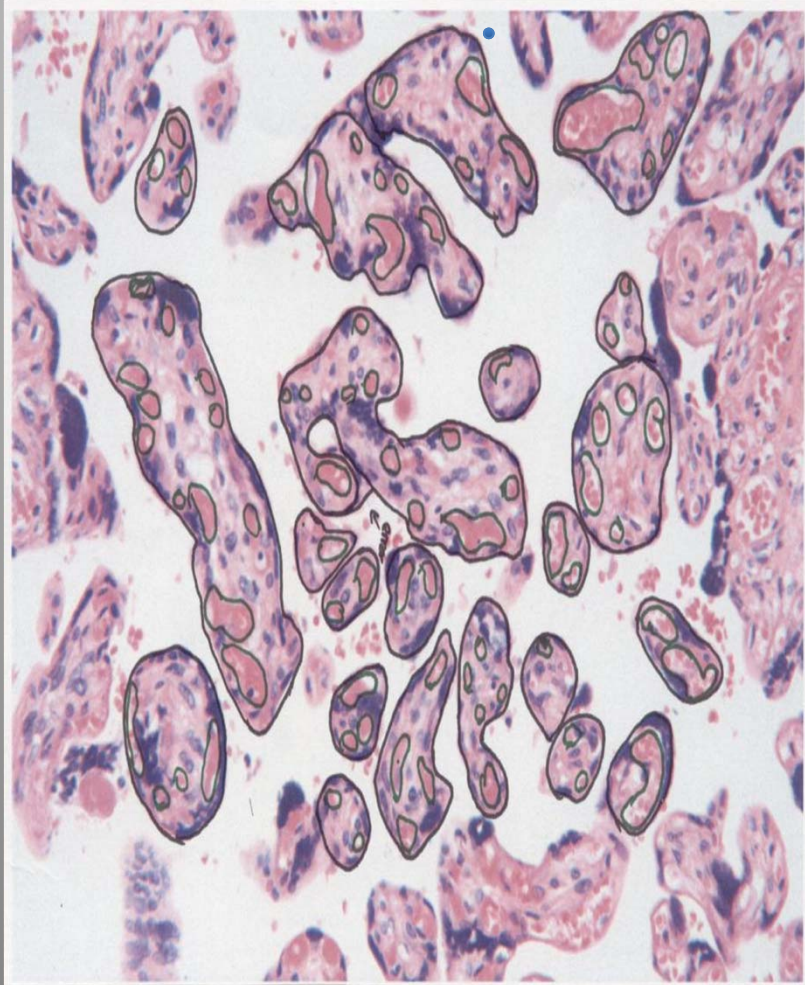


Significance of Blood Vessel Count

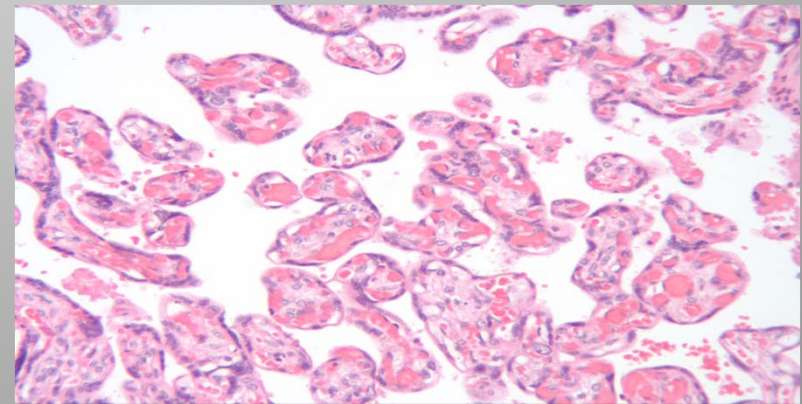
- The number of blood vessels can indicate over or under development of a placenta
- The more mature a placenta is, the more blood vessels it has, but an extremely large or small number of blood vessels can indicate a pathology
- The blood vessel count can determine if a placenta has an adequate oxygen and blood supply



Photoshop Count Tool

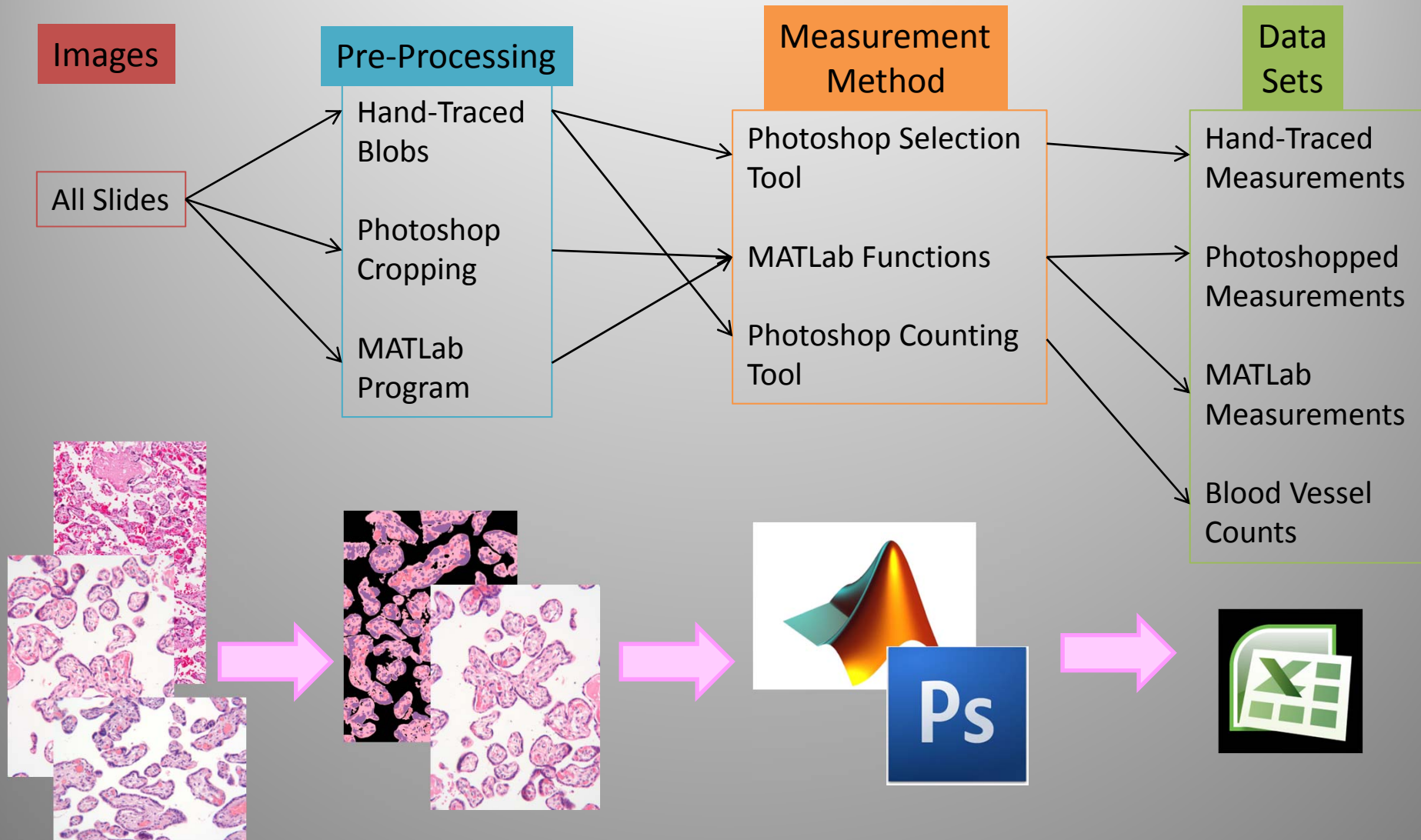


Slide 1707_2. Fifty-six blood vessels.



Slide 1618_2. One-hundred twenty six blood vessels.

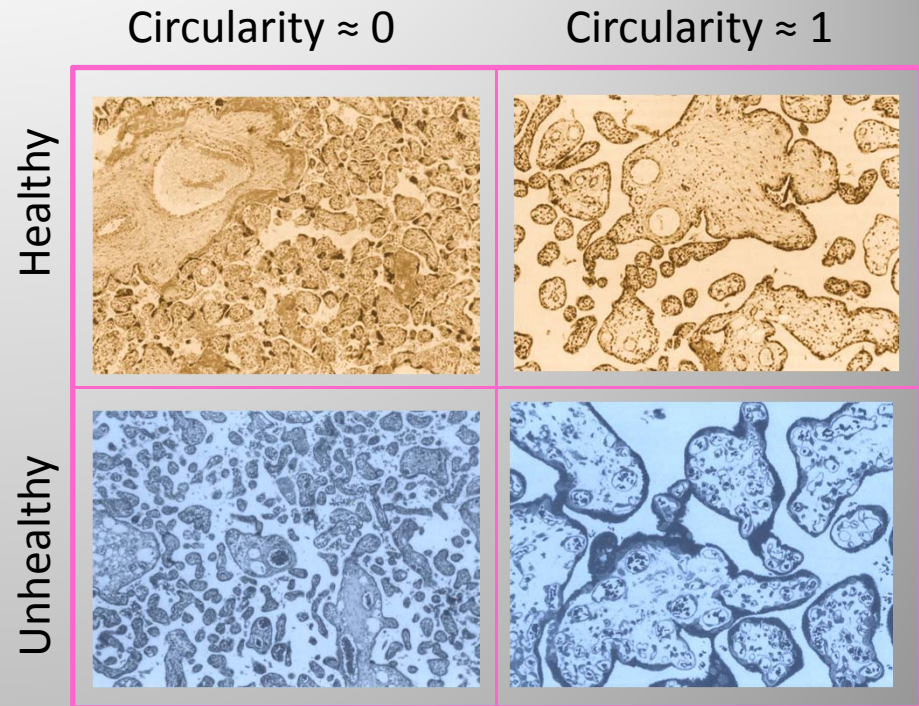
Data Collection



Maturity Analysis

- Do healthy and unhealthy infants have different values of placental circularity and blood vessels on average?

$$Circularity = 4\pi \left(\frac{area}{perimeter^2} \right)$$



- Statistical Tests:
 - Student's T-test (health \rightarrow circularity)
 - Logistic Regression (circularity \rightarrow health)
 - Likelihood ratio method (proportion healthy vs. circularity)
 - Linear Regression
 - Power Analysis...

Power Analysis on Hand-Traced Data

- Power ($0 < P < 1$) is the probability that a test will find a non-random relationship between circularity and placental health.
 - 95% Power means the relationship is almost surely causal

Retrospective

What does the data say about its power level?

Ad Hoc	Effect Size	Sample Size	Actual Power
Observed	0.0154	27	0.0502

Prospective

For a statistically significant power level over 80%, how many samples would we need?

A Priori	Effect Size	Sample Size	Actual Power
Observed	0.0154	1354	0.8
Small	0.20	788	0.8006
Medium	0.50	128	0.8015
Large	0.80	52	0.8075

In Conclusion...

- Compare our clean-up and measuring techniques to each other
- Use the most reliable data to discover any relationships between PM & gestational age or health



Questions?