# Centrifugal Cell Separation and Blood Mimic Development

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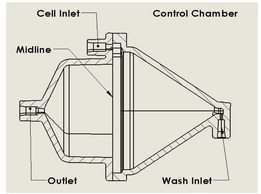
TERUMOBCT
Unlocking the Potential of Blood

## Background

Maximizing throughput of the centrifuge will provide patients with better treatments for a wide range of blood diseases. Increasing rotational speeds and centrifuge radius will increase the throughput but will in-turn increase the stresses and strains being induced on the cell fluid.




Purpose:

- Alter centrifuge chamber geometry to increase cell throughput while maintaining cellular viability
- Create a non-biohazardous blood mimic that matches the viscosity of whole blood

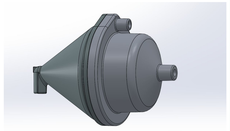
## Project Goals

Primary Goals:

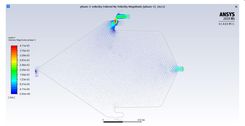
- Create centrifuge chamber CFD simulation
- Develop new chamber geometries compatible with current spectra optia apheresis machine and validate using CFD simulations
  - Capsule Constraint: increase flow rate to greater than 167 mL/min for higher throughput

Secondary Goal:

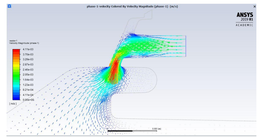
- Create an extensive blood mimic viscosity table to be used in Terumo BCT R&D validation testing



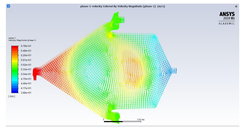
## CFD Validation



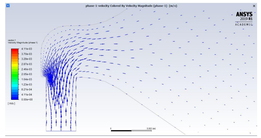
Velocity Pathlines



Velocity at Cell Inlet

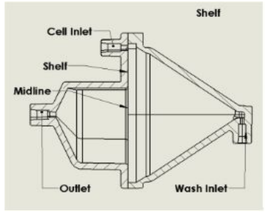


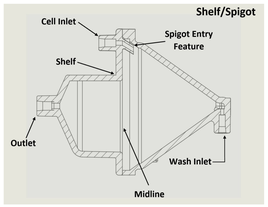
Velocity Distribution with Rotation

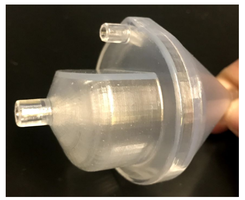


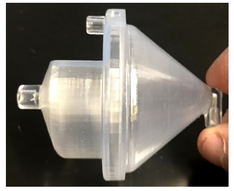
Velocity at Wash Inlet

## Elutriation Centrifuge Chamber Design





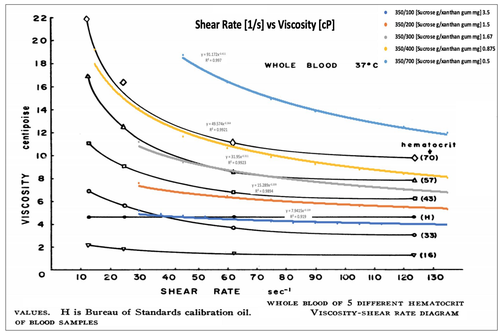
3D printed Chamber Key Features:

- Shelf deflector
- Spigot

Each feature was included to improve throughput of cell solution in chamber and limit cells crossing midline

## Blood Mimic Development

- Measured the viscosity of the sucrose & xanthan gum mixture at different shear rates
- Whole blood is a non-newtonian shear thinning fluid
- Shear rate is inversely proportional to the dynamic viscosity




Graph of the blood mimic created with sucrose and xanthan gum overlaid with a graph of whole blood at different hematocrits

## Results

### Centrifuge Chamber

- Printed chamber was unable to be tested at the Lakewood, CO Terumo BCT facility with blood or non biohazard blood mimic for comparison with CFD simulation results

### Blood Mimic

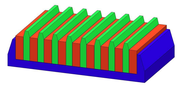
- The blood mimic follows the power law of a shear thinning fluid
- The power law of the blood mimic closely matches that of whole blood at varying hematocrits

## Conclusions

- Increasing the xanthan gum concentration increases the consistency and behavior index of the blood mimic
- Testing the new chamber prototype using blood will provide insight into the effectiveness that the design improvements have made
- The CFD simulations show a general inefficiency of flow direction from the cell inlet and could greatly benefit from a change in geometry

## Future Work

- Create a 3D CFD simulation of the chamber to properly add centrifugal forces along the correct axis
- Test the new chamber design in the centrifuge with whole blood
- Create a graph of concentration vs viscosity after further iterations of the mimic have been made
- Test blood mimic in conjunction with a rheoscopic concentrate fluid to visualize flow patterns in the control chamber compared to whole blood runs
- Create a magnetic simulation of a hybrid array to design a cell flow path along a constant magnetic flux for cellular separation



## Acknowledgements

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