

Laryngeal Bioreactor

Mid-semester Presentation

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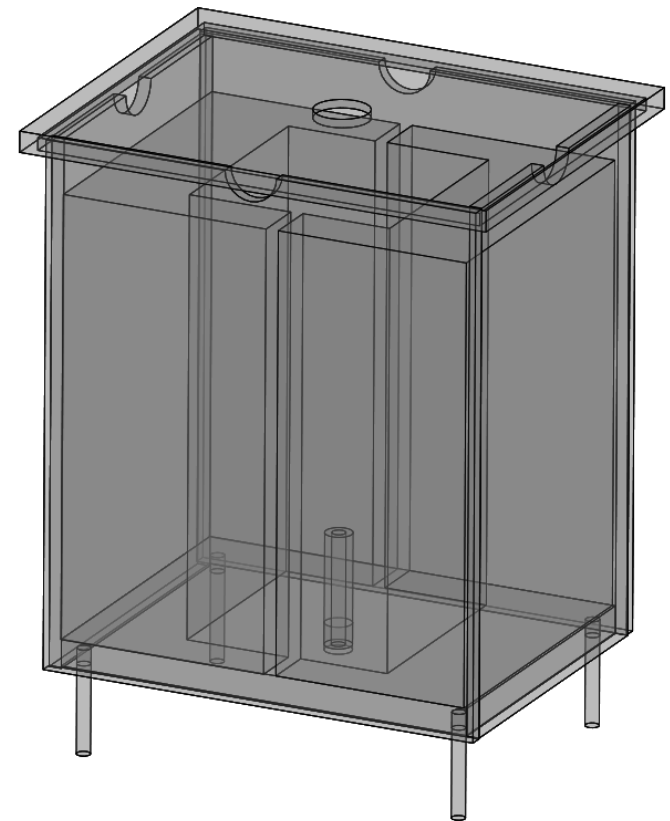
Dr. Nathan Welham- Client

Zhen Davis- Client

Dr. Yutaka Toya- Collaborator

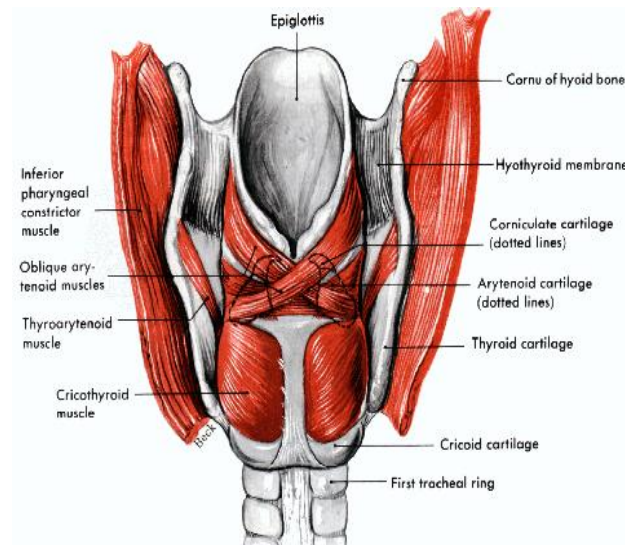
Outline

- Problem statement
- Client description
- Design constraints
- Significance
- Last semester summary
- Modifications
- Goals
- Testing
- Budget
- Design improvements



Problem Statement

- Design a bioreactor that uses vasculature perfusion to perform decellularization and recellularization a human larynx.



Larynx anatomy [1]

Client Description

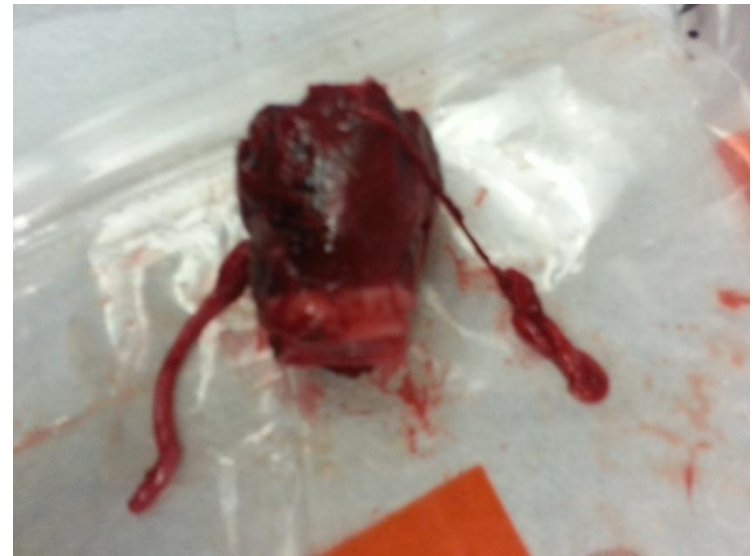
Dr. Nathan Welham PhD, CCC-SLP

- Assistant Professor at UW School of Medicine & Health
- UW Health Clinics
- Specialties: Pediatric voice and swallowing disorders
- Research Interests: Proteome analyses, vocal fold scarring and treatment, animal models



Design constraints

- Sterilizable or replaceable components
- Perfusion-based
- Separate environment for larynx lumen and exterior



Significance

- Each year almost 136,000 patients are diagnosed with laryngocarcinoma
- Immune rejection associated with traditional allographic transplants
- Whole organ bioreactors exist for heart, lung and trachea
- No laryngeal bioreactor commercially available



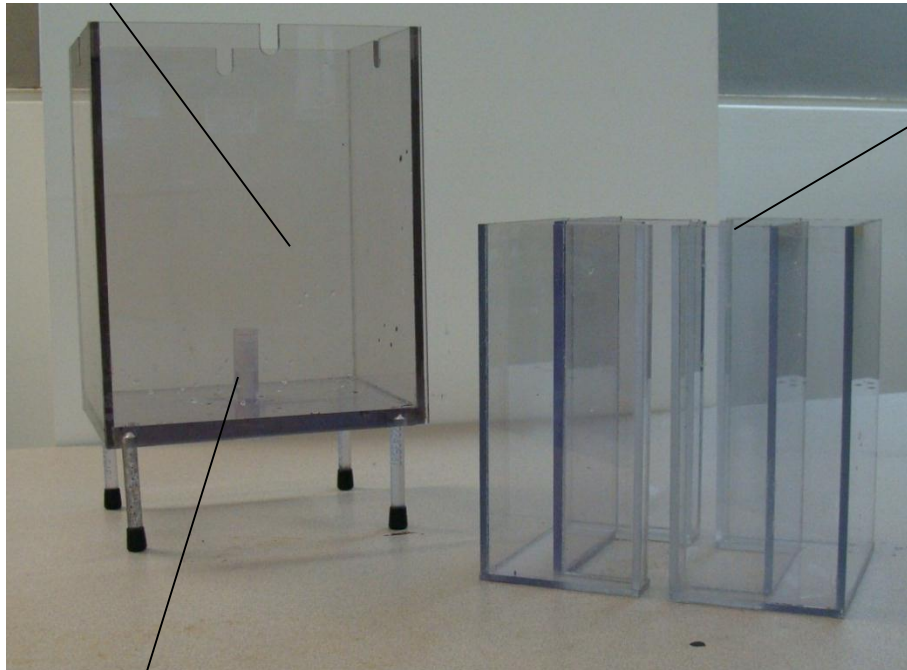
Bioreactor for trachea [2]

Last Semester



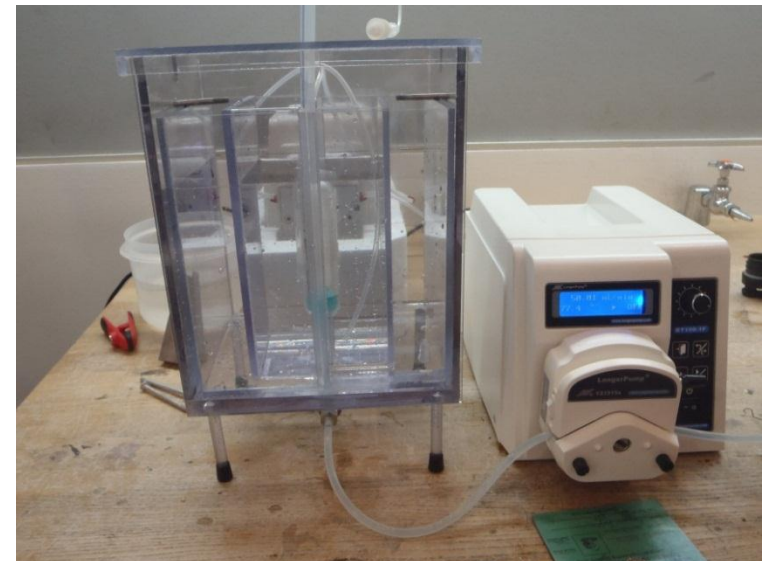
Bioreactor vessel

Final Design



Insertable space-filler

Trachea support



Last Semester Testing

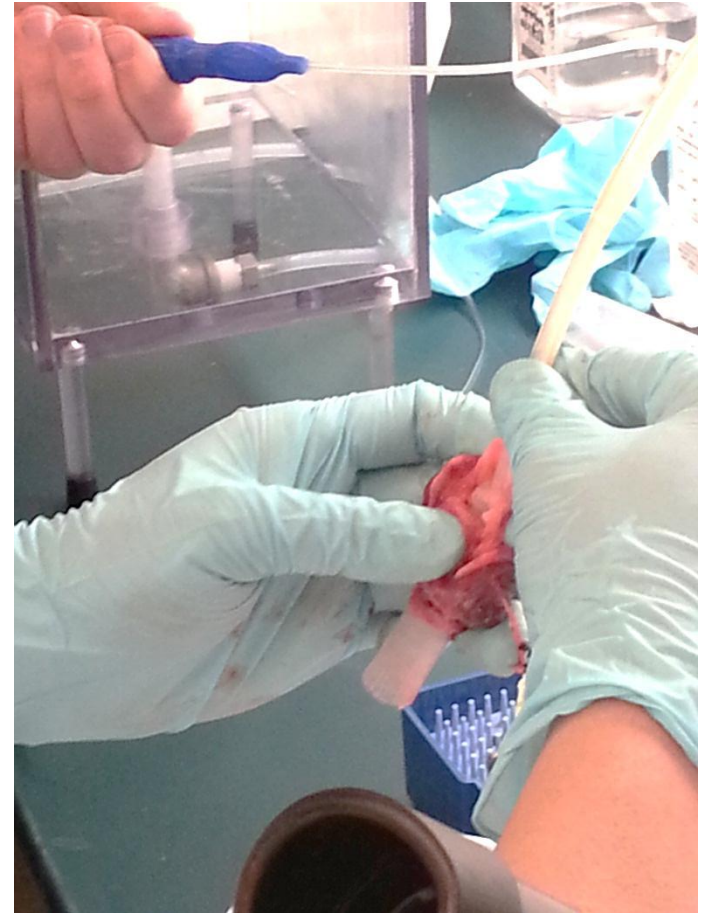
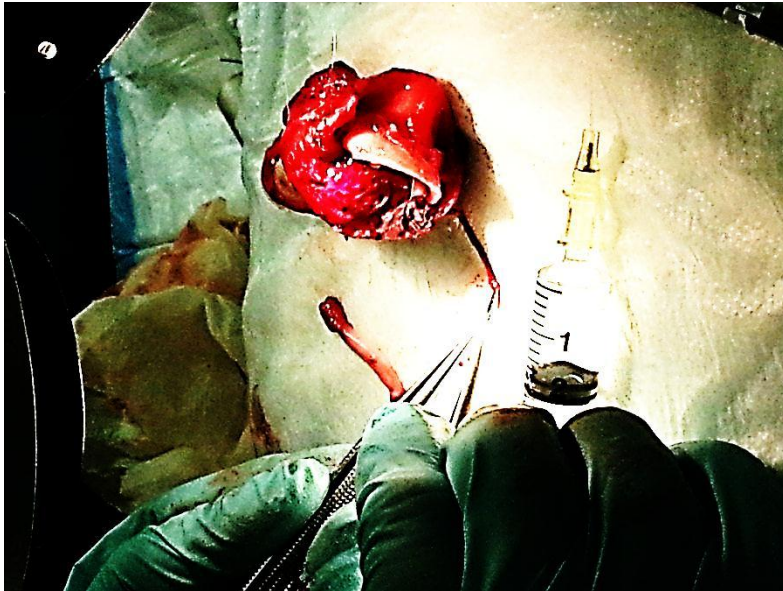
Vasculature Pump

Speed (RPM)	Time (sec)	mL/min
100	77.47	19.4
90	84.5	17.75
80	96.3	15.58
70	108.77	13.79
60	128.54	11.67
50	153.94	9.74
40	193.15	7.77
30	257.64	5.82
20	387.01	3.88
10	773.14	1.94

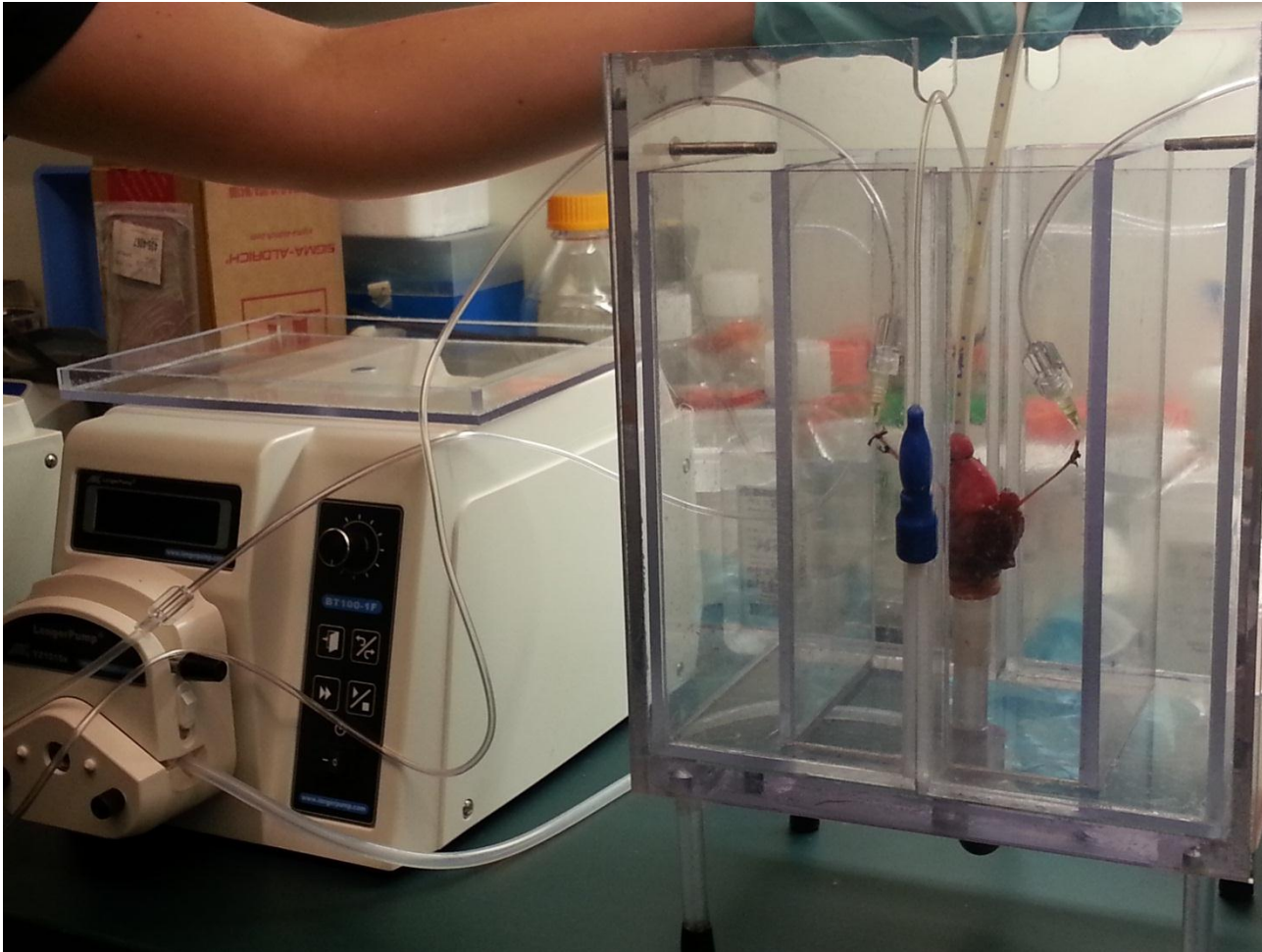
Inner Lumen Pump

Speed (mL/min)	Fill Time (sec)
63.63	30.49
53.63	36.54
43.63	44.98
33.63	58.32
23.63	82.99
13.63	143.48

Preparation

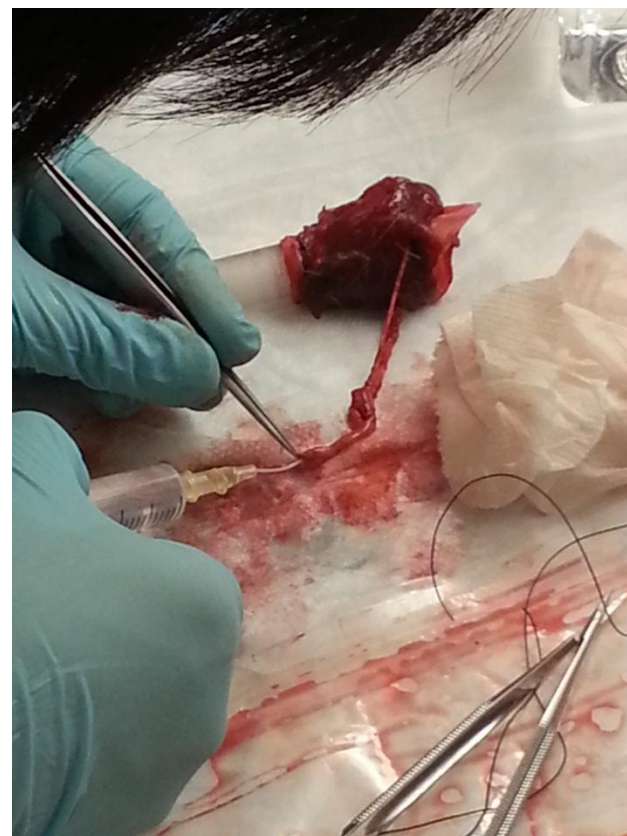


Setup

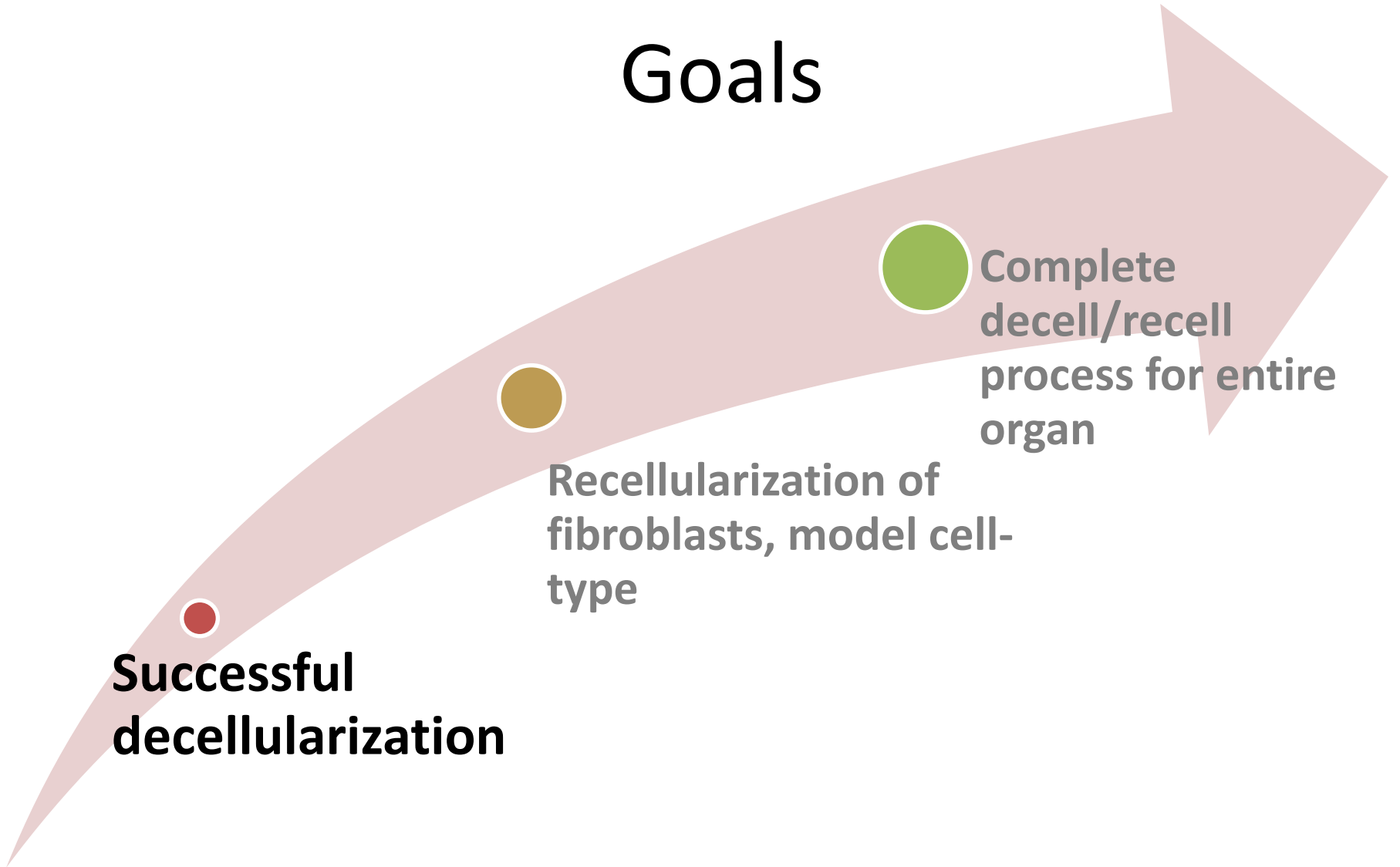


Modifications

- Circulating inner lumen fluid
 - Inferior to superior flow
 - Outlet via endotracheal tube
- Attachments
 - Arterial cannulae
 - Vasculature pump tubing to cannulae
 - Endotracheal tube to extra tubing



Goals



Decellularization Testing

- SDS
 - Perfuse through vasculature
 - Circulate through inner lumen
- Bioreactor filled with
 - Deionized water
 - SDS
- Assays
 - Progressive biopsy
 - Histology
- Compare with decellularization time in static bath



Goals



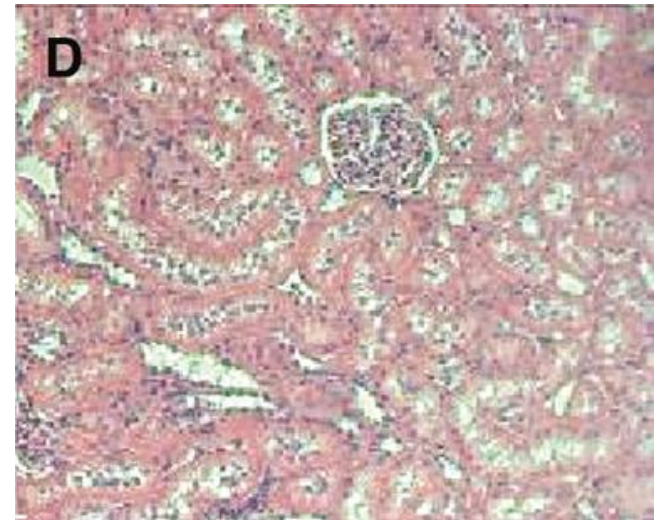
Successful
decellularization

Recellularization of
fibroblasts, model
cell-type

Complete
decell/recell
process for
entire organ

Recellularization Testing

- Fibroblasts and media perfused through scaffold
- H & E staining
 - Observe where fibroblasts have implanted
- Incorporate different cell types
- Direct seeding as well as perfusion
- Histological studies



H&E stain [3]

Design Improvements

- Automate pumps for the recellularization process
 - Ease of use
 - Minimal human interaction
- Incorporate sensory equipment (pH, temperature, pCO₂)

Budget for Bioreactor

Component	Material (Manufacturer)	Cost
Bioreactor	Polycarbonate (Grainger, Midland Plastics)	\$126.55
Pumps (perfusion, vasculature)	Peristaltic pumps (Langer Instruments)	\$1,329.00
Miscellaneous & accessories	Stainless steel (McMaster), Trach Tubes	\$47.61

Total = \$1503.16

Budget for Individual Use

- Cost of media
 - Varies depending on media type
 - \$100-400 per 500 mL*
- Total volume: 1.5-2 L
 - Change media once/week for 4 weeks
- Estimated cost: \$1600 - \$6400

*Estimate from Dr. Welham on October 15, 2012

References

1. Organ Procurment and Transplantation Network.
<http://optn.transplant.hrsa.gov/organDatasource/>.
2. <http://www.businessinsider.com/lab-grown-organs-2012-8?op=1> Asnagni 2009 Biomaterials
3. <http://jasn.asnjournals.org/content/20/11/2338/F1.expansion.html>]

