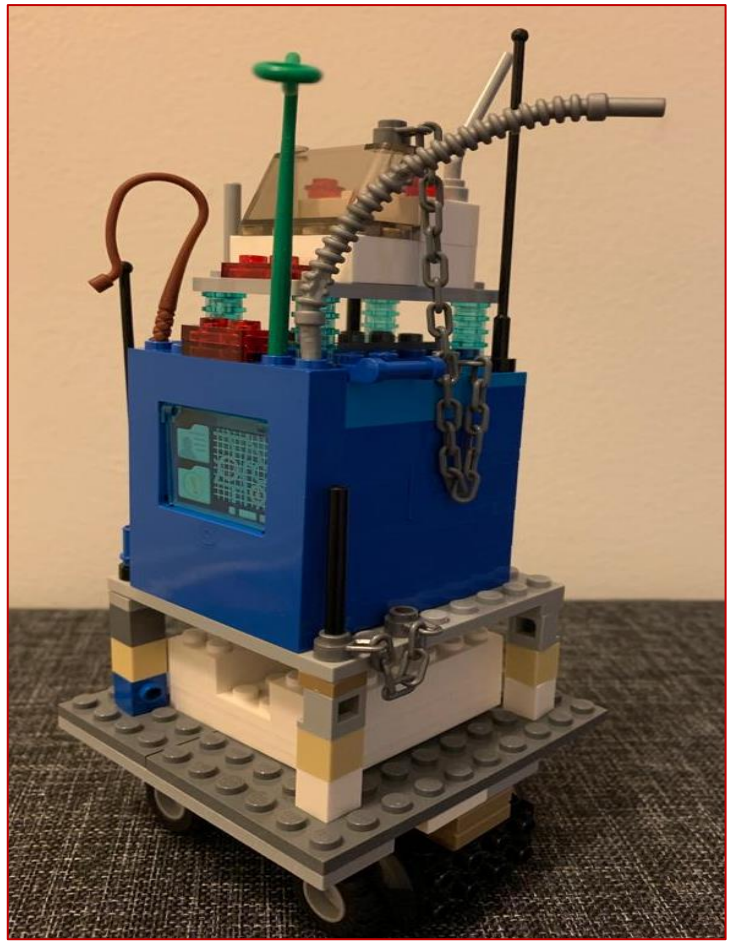
Grades K-3 Abstract

1 in 5 deaths are due to a respiratory disease. The 2020 pandemic with Covid-19 virus infection may cause an increase of lung diseases globally, especially in patients with existing lung problems. This will increase number of patients needing lung transplants. Finding a matching donor may become very difficult and many patients will die while waiting. So, the need for growing 'healthy lungs' is very important. We have developed a method to grow human lungs from the patient himself whose lungs are damaged and need a transplant. The lungs are grown from the patient's own bone marrow stem cells. Since it is his own tissue there is no risk of rejection of the new "mini lungs". We are also adding a biodegradable artificial micro-pump (BAmP) during transplant to support the patient's respiration until the new "mini lungs" have grown to fully functioning adult lungs.

Grades K-3 Present Technology

ECMO machine (made of lego)

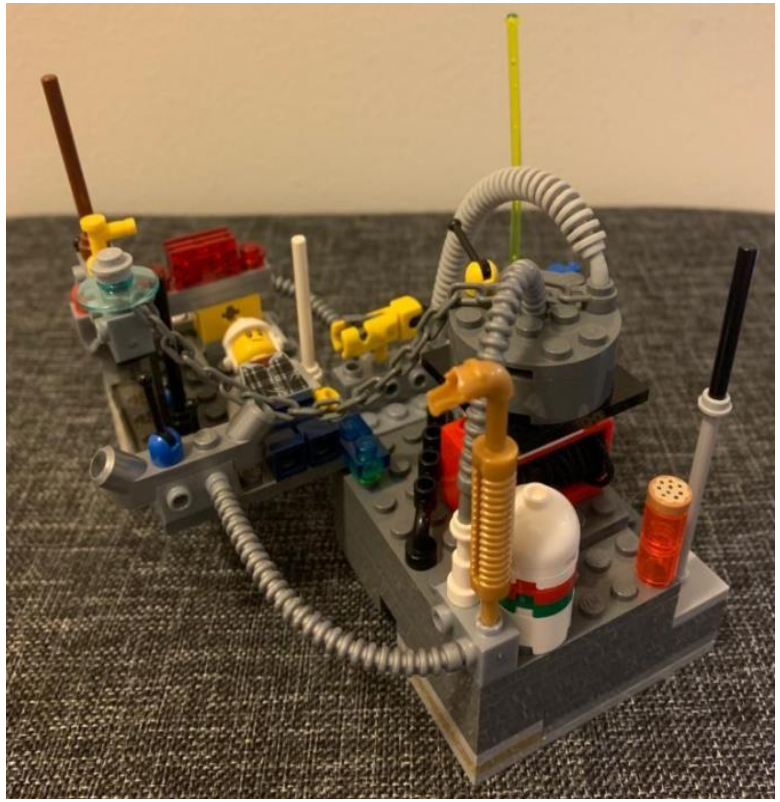


1. Lung transplant from a matching donor: A lung transplant is a surgery to remove a diseased lung and replace it with a healthy lung from a healthy person. Limitations: Very difficult to find a matching donor and people might die while waiting for transplants. Transplanted lung might be rejected if the immune system attacks the donor lung as if it was a foreign invader, like how the body attacks a virus. The donated lung may fail if rejection is bad. The drugs taken to prevent rejection can have side effects. Expensive - average cost of lung transplantation is ~$135,622.00

2. Artificial lung - ExtraCorporel Membrane Oxegenation (ECMO): A pump outside the body that gives oxegen and removes carbon dioxide from blood of a very ill patient. Limitations: Expensive, not as good as real lungs, requires monitering all the time. So it is very important to invent a method of replacing damaged lungs with good healthy lungs.

Grades K-3 History

Heart–Lung machine from 1965
(model made from legos)



We researched the history of Lung Transplant and ECMO invention because both are important for people to breathe and stay alive.

1930s. Concept of artificial organ support - Carrel and Lindbergh

1963: 1st human lung transplant performed at the University Hospital Mississipi - James D Hardy.

1965: ECMO developed. The 1st heart-lung machine for heart surgery - Dr. Gibbon

1972: 1st succesful use of heart-lung machine on humans - Dr. Hill

2010: - Research with embryonic stem cells of lungs in mice

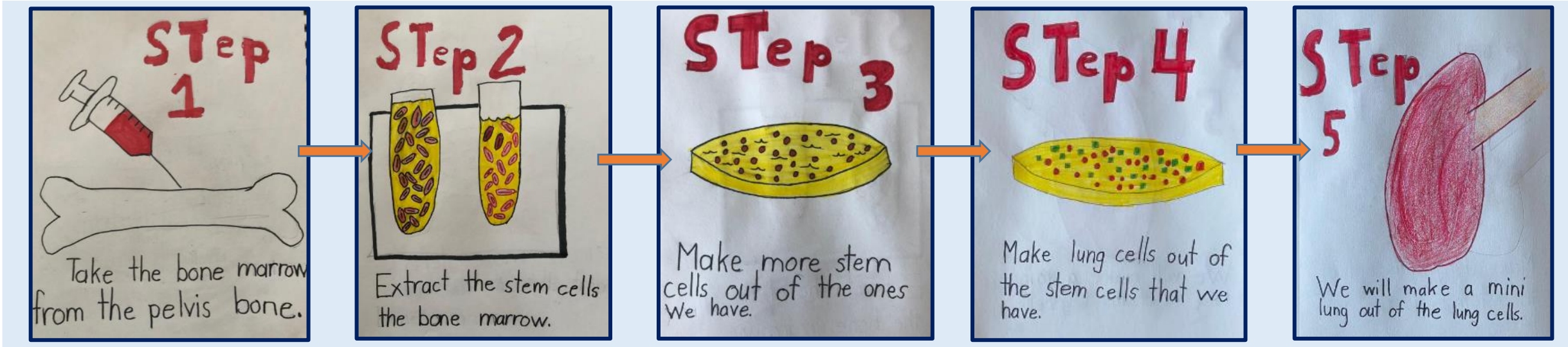
2014: - Human lung grown for the 1st time from dead kids' lungs

2018: - Scientists at University of Texas grew pig lungs in the laboratory

2019: - Scientists at Columbia University grew mice lungs in laboratory

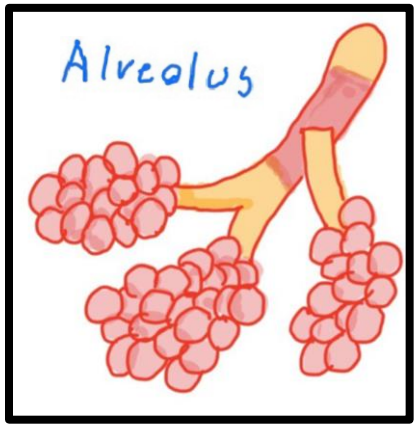
Grades K-3 Future Technology -1

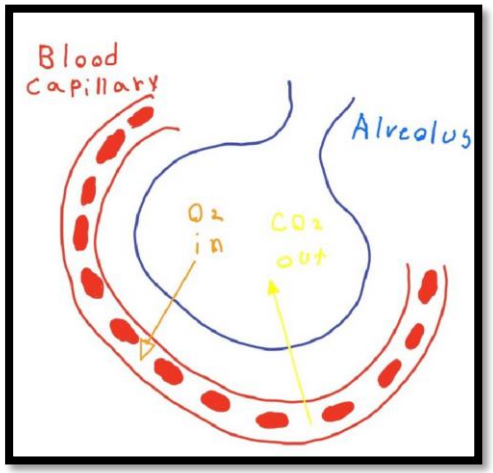
We want to grow lungs in humans. We will use bone marrow stem cells (BMSC) present in bone marrow. These stem cells can differentiate into epithelial cells of human lungs. Process to grow cells for making lungs - We will suck out 1. the bone marrow from the soft part of the hip bone with a hollow needle. 2. We will separate the B.M.S.Cs from the bone marrow. 3. We will grow the cells in growth solution inside incubators to multiply and form more cells. 4. These cells will grow on a bio-scaffold in the incubator into "mini lungs". 5. We will put the bio-scaffold inside the body which helps stem cells grow after transplantation.

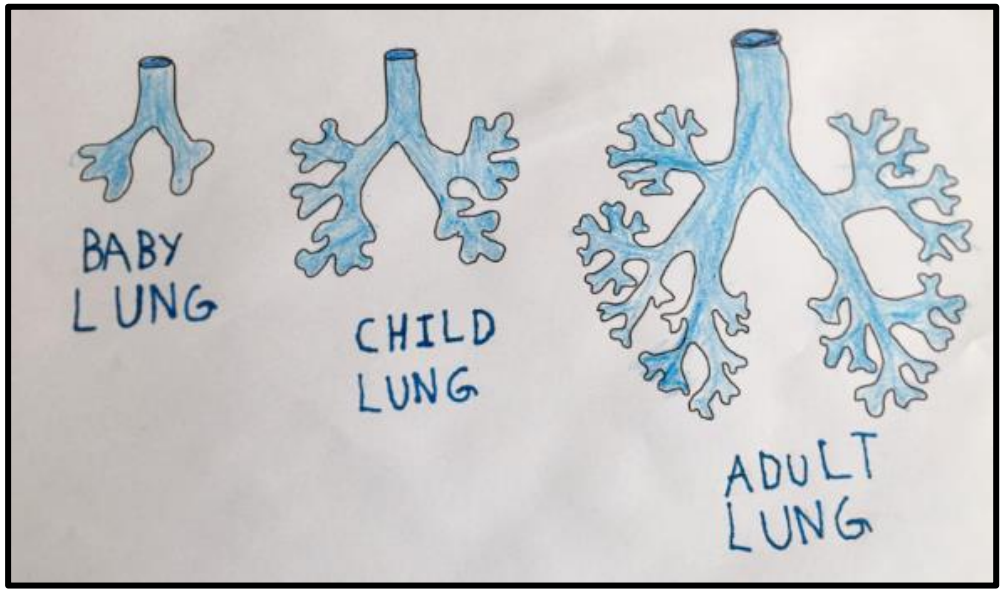


- A bio-scaffold is a frame made of protein (collagen) on which cells can grow to form an organ.

Grades K-3 Future Technology – 2





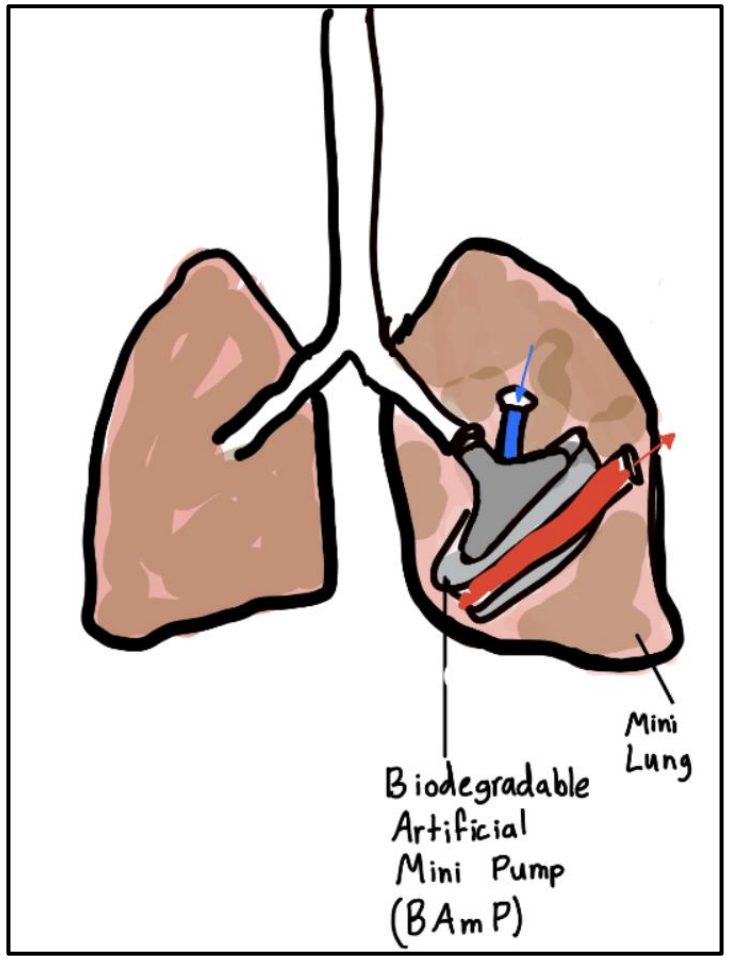


Process of transplantation –

- The damaged lung is removed.
- The bio-scaffold "mini lung is then transplanted into the patient: This bio-scaffold will help the "mini lung" grow after transplantation. It will also allow the transplanted tissue grow blood vessels and receive a blood supply from the patient. The "mini lung" is like a baby lung and will need lubrication to keep it moist and able to expand to take in air. We will add an artifial surfactant to help our baby "mini lung" to breathe. Slowly, the **alveoli** will increase in number from 50-70 million (baby lung) to ~300 million (adult lung) which will help air capcity

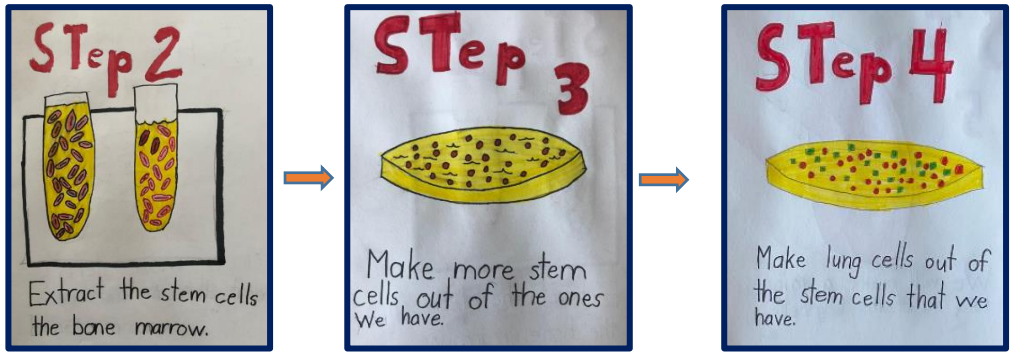
alveoli: Finy air sacs inside our lungs.

Grades K-3 Future Technology – 3

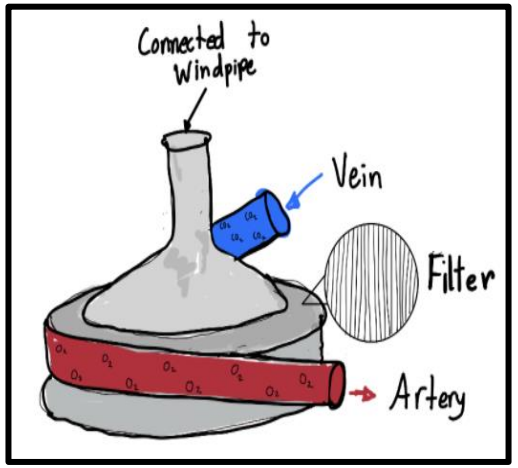


If we transplant only one bad lung, the other good lung will support breathing in the patient when the "mini lung" is growing inside, into the adut lung of the patient. If we need to transplant both lungs, then we will also insert a biodegradable artifial micro-pump (BAmP) during transplantation. The BAmp is made of a biodegradabl substance and will help to exchange oxygen and carbon dioxide just like real lungs for 4-6 weeks until the "mini lung" grow into adult lungs and are able to breathe themselves. As "mini lun grow the BAmP will slowly degrade and shrink and be lost. No surgery is required to remove these lungs.

Grades K-3 Breakthroughs – 1



Fast And Accurate Process



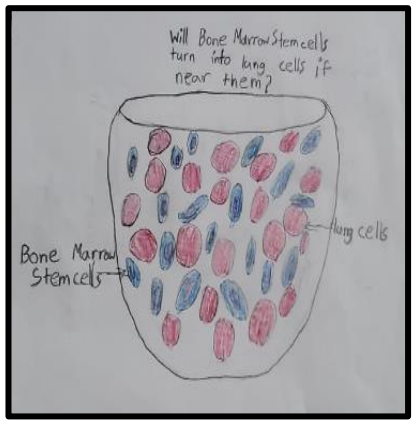
Biodegradable artificial micropump (BAmP)

Scientists have not yet made real human lung from stem cells or make BAmP to be used in human body to breathe for short period of time.

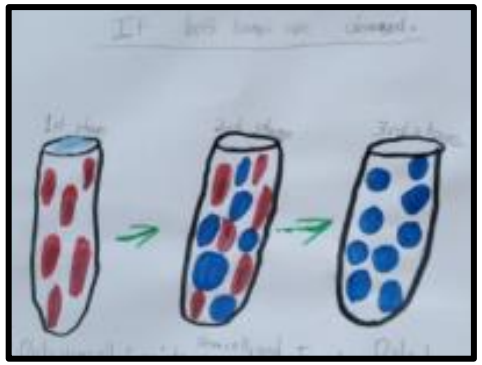
1. We should be able to grow stem cells into healthy lung cells faster and accurately so that we can make healthy human lungs to save lives.

2. Our biodegradable artificial micropump should be very tiny but still be able to easily exchange oxygen and carbon dioxide from blood like real lungs. The patient will then be able to breathe properly during the time the "mini lungs" are growing in to adult lungs.

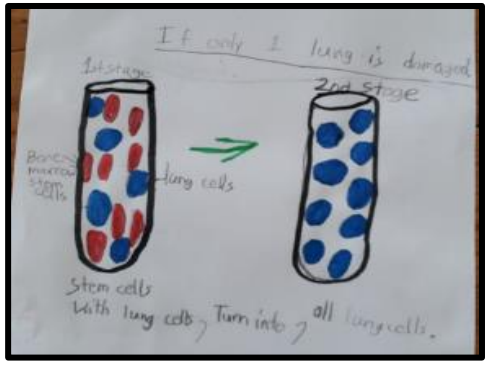
Grades K-3 Breakthroughs – 2



Question:
Will bone marrow stem cells turn into lung cells if kept together ?



Experiment 1 :
Both lungs BAD condition



Experiment 2 :
1 lung good, 1 lung bad
OR
Both lungs medium bad

Experiment 1: Lungs are in very bad condition we use only bone marrow stem cells, Growing Only stem cells.

Experiment 2: Lungs are in medium bad condition (or 1 lung good 1 lung bad) so we are able to get a few healthy lung cells; Growing the lung cells and stem cells together.

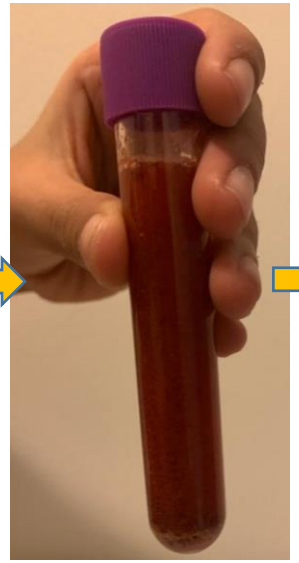
Data to be collected:

- How fast will the stem cells turn into lung cells.
- How healthy the newly formed lung cells are.

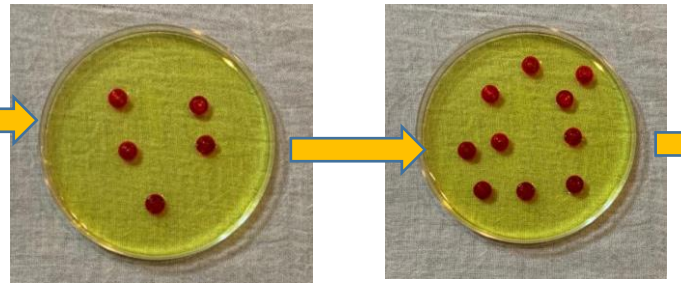
Grades K-3 Breakthrough – 3

Demonstration using Lego model

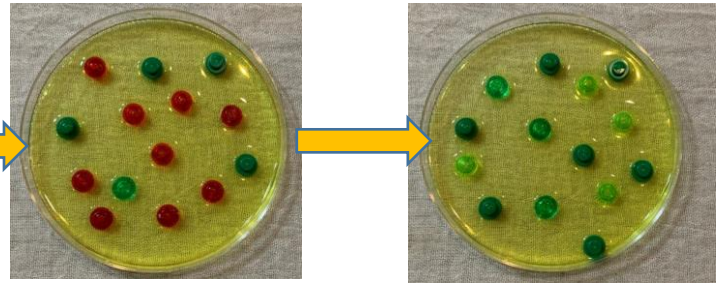
Bone
(made of lego)



Bone Marrow
(colored water in test tube)



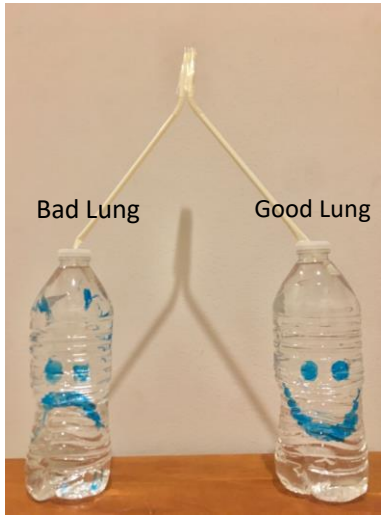
Bone Marrow Stem Cells
(red legos)

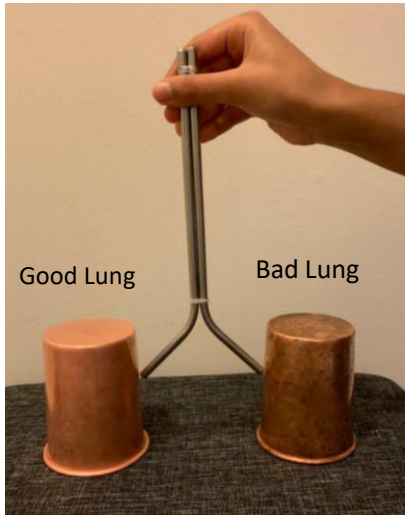


BMSC differentiate to Lung cells
(green legos)

Grades K-3 Design Process – 1

Different Ideas for Lung Models



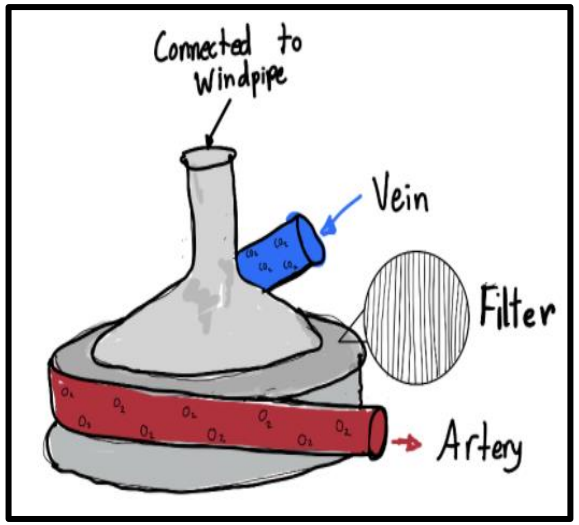


Growing "mini lungs" from bone marrow stem cells

- Plan: At first, we wanted to use a few stem cells from the patient lung to grow the mini lung for transplant
- Problem: If by mistake we picked up damaged lung cells from the patient to make the new lung, there is a chance that many transplanted cells will die soon after transplantation. The new transplanted lung may fail.
- Solution: we found that stem cells from bone marrow has great potential to grow into other cells. We thought this was an excellent way to grow lung epithelial cells using stem cells from the bone marrow.

Project Page 10

Grades K-3 Design Process – 2



Digital Design of BAmP

Model made of tape roll and straw

Vein – carrying blood with carbon dioxide

Artery – carrying blood with oxygen

Adding the artificial micro pump

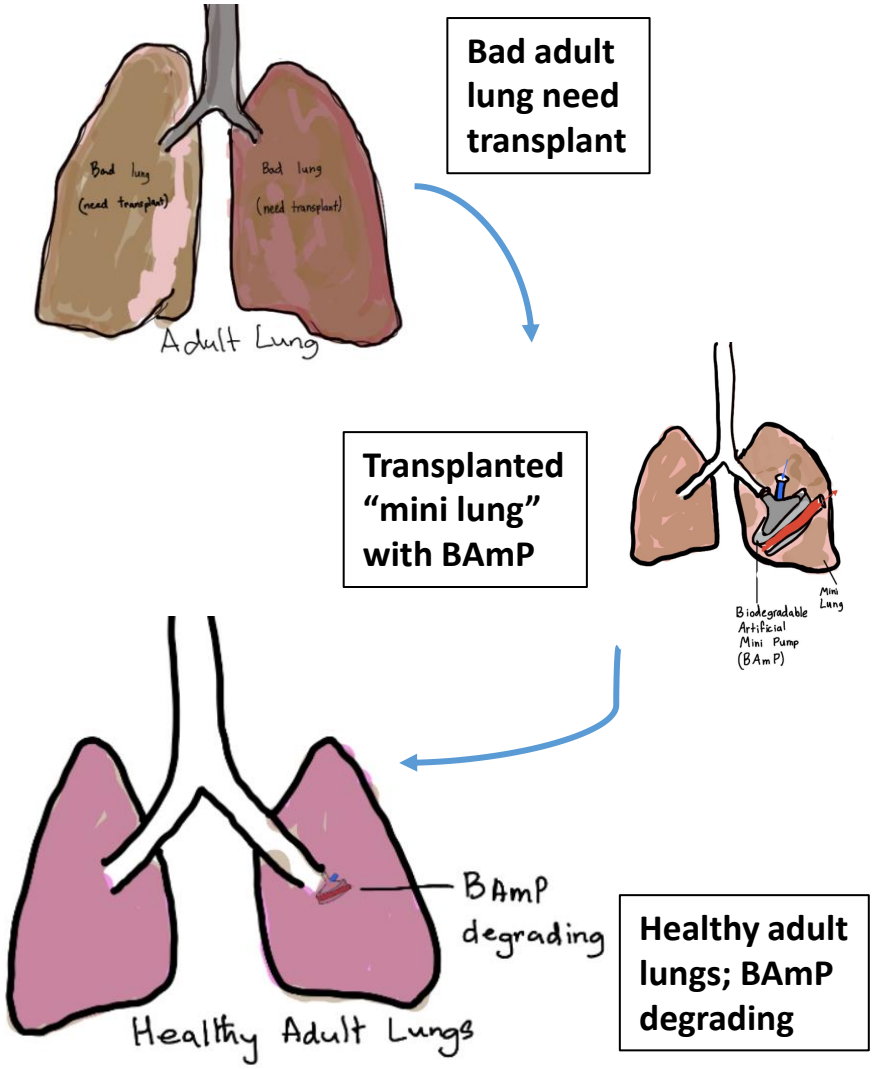
Plan: We planed to make "mini lungs" from stem cells to transplant into the patient. The "mini lungs" will grow into adult lungs INSIDE the patient. If only 1 lung is damaged it will be transplanted and the good lung will help to breathe until the mini lung is fully Developed.

Problem: What happens if both lungs need to be transplanted? How does the patient breathe with 2 "mini lungs" when they are growing into adult lungs?

Solution: We decided to add an artificial micro pump that will work like a normal lung to exchage oxygen and cabon dioxide while the "mini lungs" Grows into fully independent adult lungs and the patient can breathe normally.

Project Page 11

Grades K-3 Design Process – 3



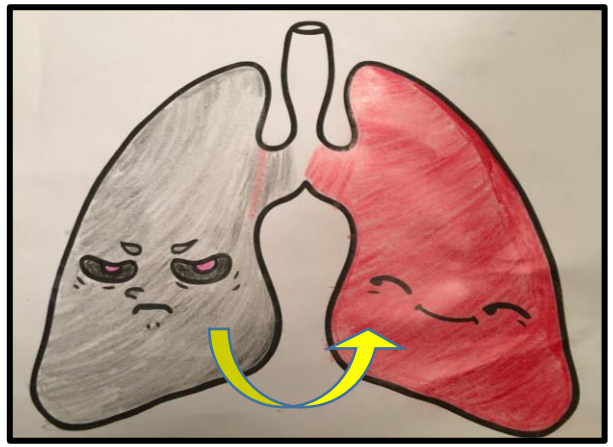
Do we require 2nd surgery to remove the artifical micro-pump?

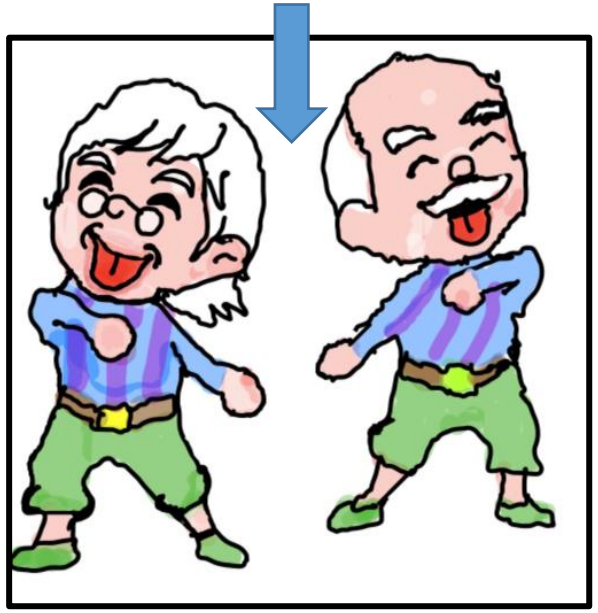
Plan: We will do a micro-surgery to remove the artifical micro-pump once the "mini lungs" are grown into adult lung and are functioning properly.

Problem: Patients with lung problems should not have surgeries so often.

Solution: We want to use biodegradable atifical micro-pump (BAmP). This biodegradable pump will degrade slowly in a period of 4-6 weeks as the "mini lungs" grows bigger and will be lost. No surgery will be required.

Grades K-3 Consequences





Happy healthy people after lung transplant

PROS

.Save people's lives: Lungs grown from bone marrow stem cells will not be rejected as patient's own cells are being used. Transplant is expensive and this technology can help save people's lives. When patients need we can make inexpensive organs and do transplants, without waiting for a donor.

•Research purposes: These artificially grown lungs can be used to study lung diseases including lung cancer and new medicines to cure these diseases.

.Other organ transplant: We can use this technology to make other organs and save people's lives.

CONS

-Expensive process to grow lungs by scientists

.Takes a lot of time to grow cells and make lungs

.Making lungs in the lab can result in infection/contamination

Grades K-3 Bibliography

1. What can stem cells do? https://youtu.be/K7D6iA7bZG0
2. What are stem cells? How can they be used for medical benefit? https://youtu.be/8JTw2RpDo9o
3. Ventilator vs ECMO: https://youtu.be/MwotQDLAUw4
4. Scientist grow a human lung in a lab (2014) : https://youtu.be/eL1sCk7Vv4c
5. Scientists at University of Texas grow pig lungs in the laboratory (2018) https://youtu.be/Mb5Ri9TZOR4
6. Bioscaffold : https://youtu.be/syF2750A8r4
7. Lung Transplant Process https://youtu.be/0-X3J1biPZA
8. Mouse lungs: https://www.drugtargetreview.com/news/51806/transplanted-stem-cells-used-to-grow-functional-lungs-in-mice/
9. How young lungs develop : https://www.lung.org/blog/how-young-lungs-develop

Grades K-3 Bibliography Template – 2 (optional)

NA

Grades K-3 Bibliography Template – 3 (optional)

NA

Sample Web Page – 1

Home | Present | Future | Breakthrough | Design Process

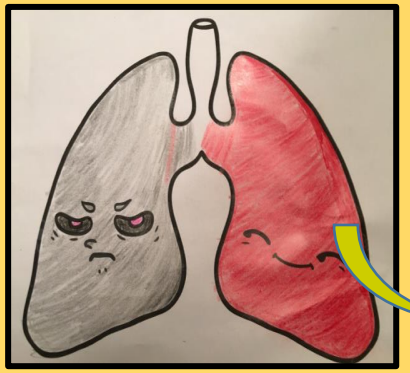
Need a Lung Transplant?

Why Stem Cell Lung Transplant ?

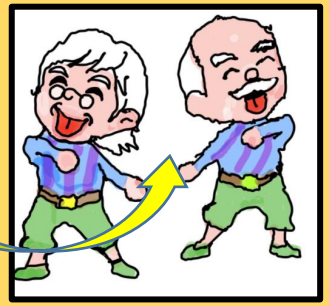
- No need to wait for a matching donor
- No chances of rejection of lungs
- Get healthy lungs faster
- Single surgery for double lung transplant
- BAmP helps you breathe freely
- 99.9% success rate

YOUNG LUNG RESEARCH INSTITUTE

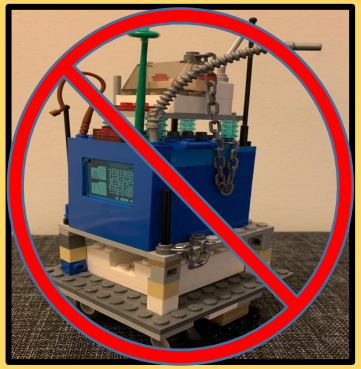
Healthy Lung



Young Lung

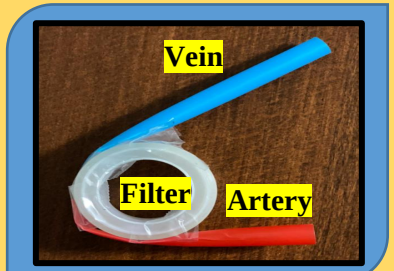


No more ECMO



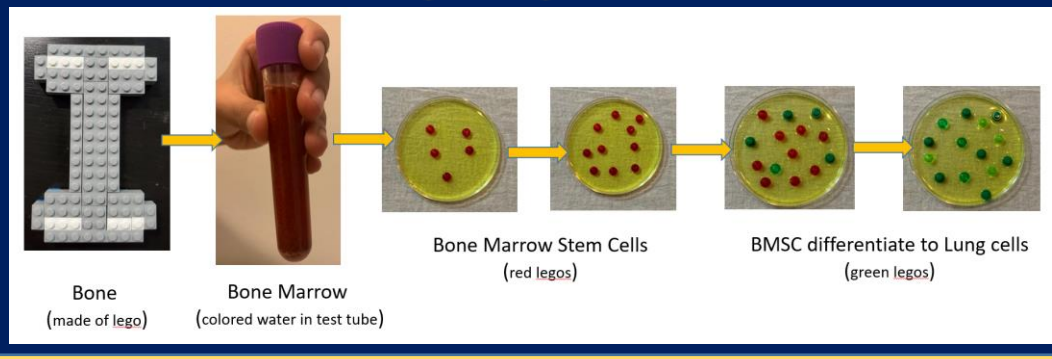
Why Stem Cell Research ?

- Saves people lives
- Use for research to study lung diseases
- Use this technology to make other organs



Biodegradable Artificial micro Pump (BAmP)

Process of making Lung cells from Stem cells



Sample Web Page – 2

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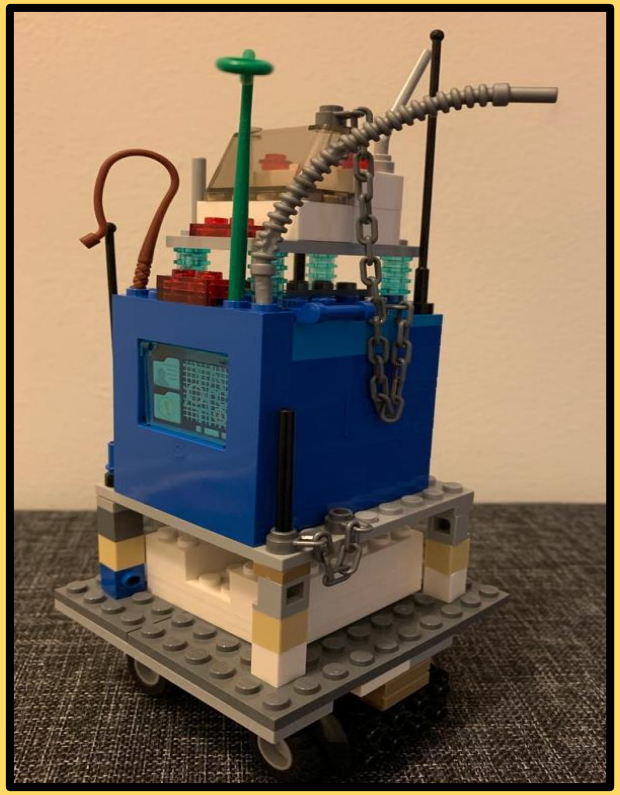
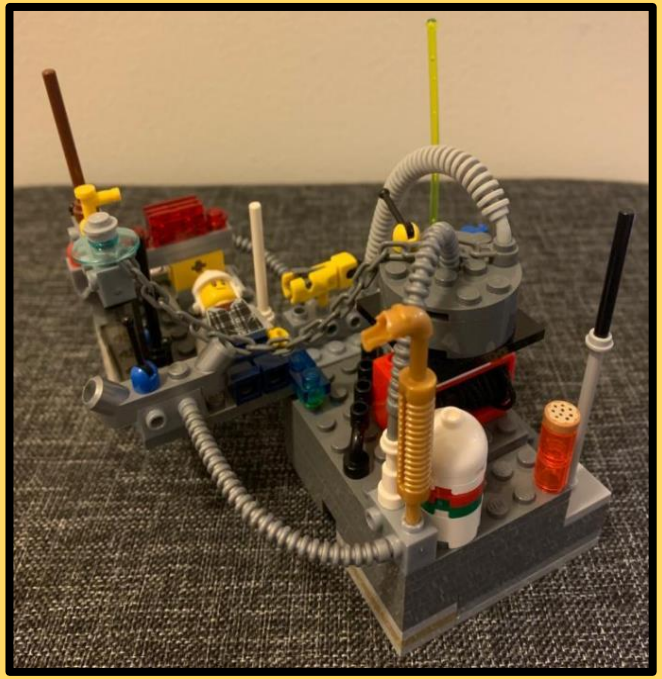
Home | Present | Future | Breakthrough | Design Process

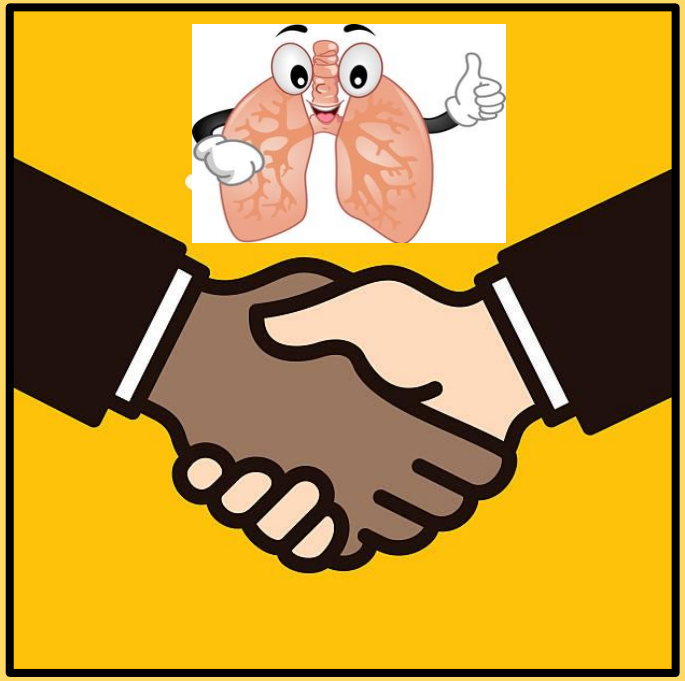


ECMO machine model made from Legos



Artificial Lung - ExtraCorporeal Membrane Oxygenation (ECMO):

A pump outside the body that gives oxygen and removes carbon dioxide from blood of a very ill patient.

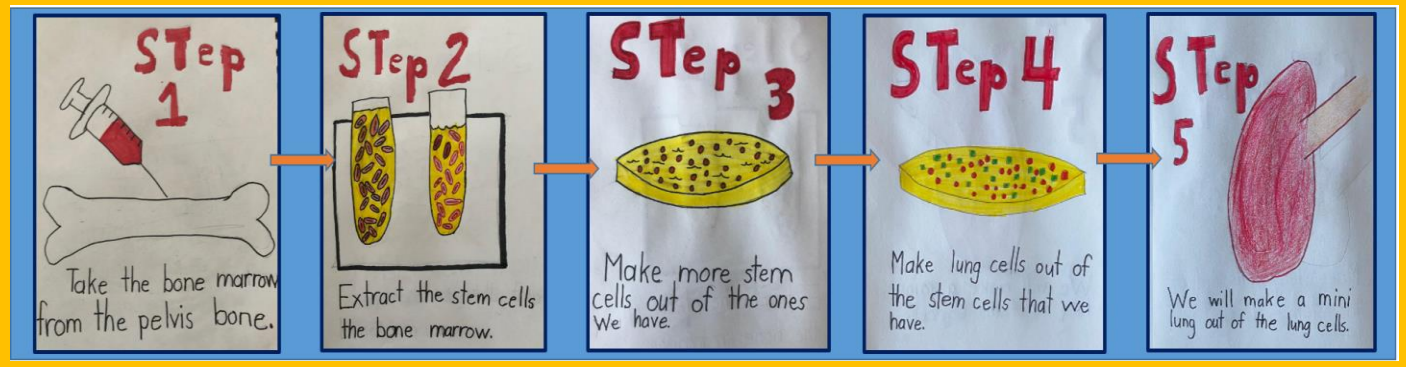


Lung Transplant from a Matching Donor:

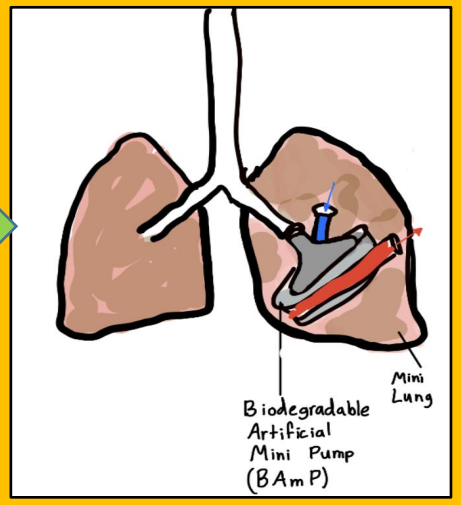
A lung transplant is a surgery to remove a diseased lung and replace it with a healthy lung from a healthy person.

Sample Web Page – 4

We want to grow lungs in humans.
We will use bone marrow stem cells (BMSC) present in bone marrow. These stem cells can differentiate into epithelial cells of human lungs.
Process to grow cells for making lungs is in the diagram.
These cells will grow on a bio-scaffold in the incubator into "mini lungs". We will put the bio-scaffold "mini lung" inside the body which helps stem cell to grow after transplantation.



Biodegradable artificial micro-pump (BAmP)



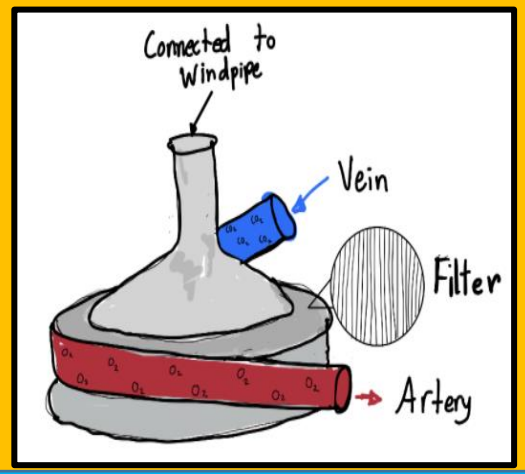
- If we transplant only **one** bad lung, the other good lung will support breathing in the patient when the "mini lung" is growing inside, into the adult lung of the patient.
- If we need to transplant **both** lungs, then we will also insert a biodegradable artificial micro-pump (BAmP) during transplantation.
- The BAmP is made of a biodegradable substance and will help to exchange oxygen and carbon dioxide just like real lungs for 4-6 weeks until the "mini lungs" grow into adult lungs and are able to breathe by themselves.
- As the "mini lungs" grow, the BAmP will slowly degrade and shrink and be lost.
- No surgery is required to remove these lungs.

Sample Web Page – 4

Scientists have not yet been able to make real human lungs from bone marrow stem cells or make the BAmP to be used inside the human body to help people breathe artificially for a short period of time.

Fast And Accurate Process

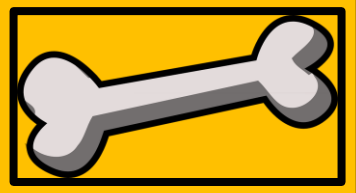
Biodegradable artificial micropump (BAmP)

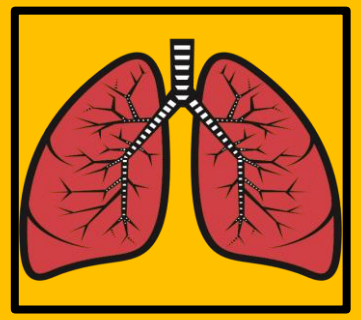


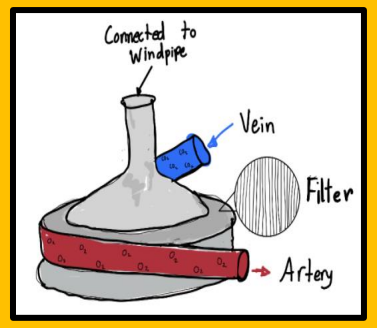
We should be able to grow bone marrow stem cells into healthy lung cells ***faster and accurately*** so that we can make good healthy HUMAN lungs to transplant and save lives.

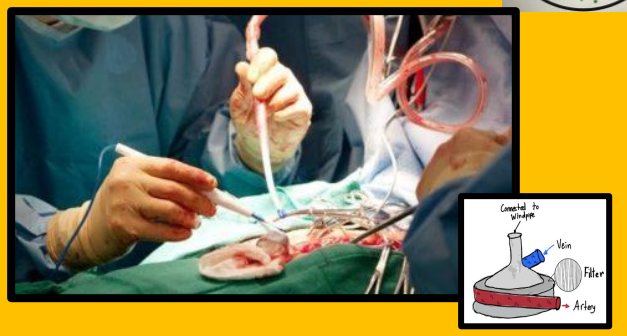
Our ***biodegradable artificial micropump (BAmP)*** should be very tiny but still be able to easily exchange oxygen and carbon dioxide from the blood just like real lungs. The patient will then be able to breathe properly during the time the "mini lungs" are growing into adult lungs.

Sample Web Page – 5









Growing "mini lungs" from bone marrow stem cells:

- **Plan**: At first, we wanted to use a few cells from the patient lung to grow the "mini lung" for transplant.
- **Problem**: If by mistake we picked up damaged lung cells from the patients to make the new lung, there is a chance that many transplanted cells will die soon after transplantation. The new transplanted lung may fail.
- **Solution**: We found that stem cells from bone marrow has great potential to grow into other cells. We thought this was an excellent way to grow lung epithelial cells using stem cells from the bone marrow.

Adding the artificial micro-pump

- Plan: We planned to make "mini lungs" from stem cells to transplant into the patient. The "mini lungs" will grow into adult lungs INSIDE the patient. If only 1 lung is damaged, it will be transplanted, and the good lung will help to breathe until the mini lung is fully developed.
- Problem: What happens if both lungs need to be transplanted? How does the patient breathe with 2 "mini lungs" when they are growing into adult lungs?
- Solution: We decided to add an artificial micro-pump that will work like a normal lung to exchange oxygen and carbon dioxide while the "mini lungs" grows into fully independent adult lungs and the patient can breathe normally by himself.

Do we require a 2nd surgery to remove the artificial micro-pump?

- Plan: We will do a micro-surgery to remove the artificial micro-pump once the "mini lungs" are grown into adult lungs and are functioning properly.
- Problem: Patients with lung problems should not have surgeries so often.
- Solution: We want to use a biodegradable artificial micro-pump (BAmP). This biodegradable pump will degrade slowly in a period of 4-6 weeks as the "mini lungs" grows bigger and will be lost. No surgery will be required.