IPRO 308

Creating an Artificial Pancreas

Project Plan

Instructor	Dr. Emmanuel Opara
Mentor	Raymond DeBoth
Sponsors	The IPRO office
Student Leader	Michael Morley
IPRO Team	Amanda Babicz Linda Goldstein Malgorzata Kochanek Rohan Mathews Walatta Mesquitta Devnaradev Narasimhan Bhavin Patel Amir Rahnavard Kirthi Reddy Maryum Riaz E-Faan Saung David Thomas

Illinois Institute of Technology

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1.0. Objectives

1. Advance extraction technique in order to extract a greater amount of interstitial fluid than achieved before.
2. Modify extraction technique to lessen time needed to extract required amount of interstitial fluid.
3. Research and design a technique of administering insulin into the body without needle injection.
4. Determine optimal wavelength to analyze glucose concentrations with emission spectroscopy.
5. Determine whether the glucose measuring techniques investigated function with an acceptable degree of accuracy over possible physiologic interstitial glucose levels.
6. Determine the highest voltage level while performing impedance spectroscopy that will not harm the skin.
7. Weigh the advantages and disadvantages of the different glucose measuring techniques investigated and select the most advantageous one.
8. Design a prototype small enough to be worn on the body.

2.0. Background

Insulin is a hormone normally released by pancreatic islet cells that interacts with cells to increase their permeability to glucose. Diabetes is a chronic condition that is rapidly becoming more prominent around the world and is linked with abnormal insulin production in the body. Diabetes may be classified into two groups: Type I and Type II. In an individual with Type I diabetes, the pancreatic beta cells that normally produce insulin are nonexistent or are destroyed typically due to autoimmune destruction. In an individual with Type II diabetes, there is tissue-wide resistance to insulin and usually some impairment of beta cells as well. Therefore, although insulin production may be present it does not yield the necessary effect on the body. Type I diabetes is typically treated with frequent extraneous insulin injections, depending on the current blood glucose levels of the individual; however, in order to determine the glucose levels individuals subject themselves to periodic finger pricks through the day which is very uncomfortable and can be emotionally pressing as well.

Mechanical devices for insulin delivery, also known as “artificial pancreases”, are currently available in the marketplace. However, these devices are not only highly-invasive and painful, but also must be sanitized frequently to prevent infections. As a result, they are inconvenient and many diabetic subjects choose not to use them.

The goal of IPRO 308 is to develop an automated, non-invasive artificial pancreas that will be capable of determining and administering an appropriate amount of insulin into the blood stream while causing minimal or no discomfort to the individual. In order to be comfortable and marketable the design will be rather inconspicuous and aesthetically pleasing. To achieve a design that is inexpensive and aesthetically pleasing

to the user, during our investigations this will be used as criteria to compare the advantages and disadvantages of certain techniques when we must select whether they will be introduced into our prototype design.

Insulin is a necessary hormone to sustain metabolic activity; however, excessive amounts of insulin may also be fatal. Therefore, we have a responsibility to ensure that our product maintains the highest safety standards. Ultimately an algorithm based upon the measured interstitial glucose concentration recorded will have to be written to output a responsible dose to the individual so that they are never put at risk. However, this step is currently out of the scope of our project this semester and will be addressed by future groups.

The past IPRO groups made great strides in researching various extraction techniques, measuring techniques, and also in documenting their successes and problems. For example last semester identified the optimal frequency at which to operate sonophoresis, established a relationship to acquire pig skin for testing, and also established connections at Rush University to perform Impedance Spectroscopy. Due to their documentation we were able to approach this semester's topics much more efficiently. In order to optimize our group's resources we have divided into three major subcommittees: the Extraction, Measurement, and Research teams. The Extraction subcommittee is comprised of individuals addressing the issues of sonophoresis, iontophoresis, and the vacuum suction of the interstitial fluid. The Measurement subcommittee is comprised of individuals addressing the topics of Impedance Spectroscopy and Emission Spectroscopy which may be used to determine the concentration of glucose in various samples. Finally, the Research Subcommittee has various responsibilities. They were immensely productive at the start of the semester through researching patents of comparable products in order to give us a better understanding of how to approach each research project. Additionally this semester they will be responsible for learning about and scripting a grant proposal, searching for external funding from various science base foundations, and also aiding in any short term projects that the other subcommittees desire.

In the process of developing the artificial pancreas, the members of our team will study the basic biological mechanisms of the pancreas, glucose chemistry and metabolism, product design and implementation, economics, marketing, patent laws and regulations, and psychosocial factors. The major problems we will face include time and space constraints. With only two and a half months to focus on the project it is necessary to limit the team vision to a limited scope with very realizable objectives. Additionally, it has proven very difficult to find laboratory space and supplies and instruments needed to carry out our research. As we are still in the beginning stages of our research only *in vitro* experiments will be carried out. Therefore, we will be using pig skin from a meat factory to test extraction, and we will make solutions of glucose from commercially-available sources to test a few different methods of measuring glucose that we are currently studying. Due to these restraints it is unlikely that there will be a working prototype at the end of this semester, as we have not yet sufficiently tested or decided on the optimal method of glucose measurement that should be implemented, nor have we successfully extracted the amount of interstitial fluid that would be necessary for such a device to work. However, by the end of this semester, we should have extracted enough interstitial fluid from pig skin to be able to test its interstitial glucose concentration, and to have

convincing data to support the use of one of the three types of glucose measuring systems that we are currently investigating.

3.0. Methodology/Brainstorm/Work Breakdown Structure

Research Subcommittee:

A. Define the problem(s).

- Unknowledgeable of grant submittal procedures
- Unaware of the best avenues for securing external financial sponsors.
- Uncertain as to which research topics should hold highest priority
- Similar patents are unknown

B. Describe how your team will go about solving the problem(s).

- Ask subgroups to prioritize their research needs
- Speak with Dr. Opara and other professionals on campus whom have experience applying for grants what the best approach might be.
- Do preliminary research on private foundations that typically donate to medical research especially focus on diabetes related topics
- Research similar patents using Google patents and other websites

C. Explain how the potential solutions will be tested.

- To test the success of our approach to grants, we will script grant proposals and have professionals review them and give us constructive feedback before they are officially submitted.
- Lessons learned will be kept in both electronic and physical form to be passed on to future IPRO teams.

D. Describe how results of research and testing will be documented.

- All significant research will be uploaded to iGROUPS
- Documents will be emailed out to the responsible subgroup team leaders
- Documents may also be placed in the 'Google Documents' of the IPRO308 Gmail account.

E. Define how analysis of the test results will be conducted.

- Through making a rough timeline by which we wish to accomplish our research objectives we will be able to monitor our progress consistently throughout the year
- Peer evaluation by the subgroup leaders will help monitor each individual's productivity.

F. Explain how the IPRO deliverable reports will be generated.

- The deadlines will be monitored and communicated to the team by the research team and the team leader.
- The IPRO deliverable reports will be generated by our group in conjunction with the subgroup leaders, the group leader, Dr. Opara, and Professor Deboth.

- Tasks that are best completed by the individual subgroups will be done so and the overall formatting and review will be performed by the team leader, instructors, and the research subgroup.

G. **Attach any relevant detailed documents**.
- Patent Research Attached

Extraction Subcommittee:

A. Define the problem(s).
- The current mechanical team consists of E-Fann Saung and Amanda Babicz. This team is to produce a device that will provide vacuum (negative) pressure to ensure a complete contact against the surface of the skin. Adhesives may also be used to aid complete contact. If the contact is not complete, the extraction methods to retrieve interstitial fluid will not function properly. The next step is to research the amount of negative pressure to be applied to the skin in order to obtain a sufficient amount of interstitial fluid.

B. Describe how your team will go about solving the problem(s).
- Define the summary tasks and subtasks necessary to go about solving the problem(s).
- Pig Skin will be used for all tests.
- Research and Testing
    1) Research different materials good for skin contact
    2) Once we obtain the gasket material, we will first find a way to attach the gasket material (by use of adhesive) as to not affect the speaker itself. Because we are on a limited supply of speakers, we need to find a way to interchange the gasket without damaging the speaker.
    3) Put together materials for speaker
    -find miscellaneous materials in Dr. Opara's office
    -superglue speaker to make it hydrophobic
    -connect tube to speaker
    -insert one way check valve, and release
    -connect vacuum source to tube
    4) Test these materials using a vacuum source
    5) Analyze results and pick the best possible material
- Implementation
    1) Determine best possible solution to incorporate speaker and vacuum source
    2) Test the best solution

C. Explain how the potential solutions will be tested.
- From empirical research, certain materials like acrylic resin, PVC, and other plastics have been used based on current patents on skin suction. We will choose an additional 2-3 materials that we hypothesize will work just

as well but have not yet been tested. In total about 5-7 different materials we will be tested. We will be measuring the amount of pressure being applied as well as how well the material connection will retain a constant pressure value. This will determine which gasket material can be used for our application.

D. Describe how results of research and testing will be documented.

- First we will document the patents researched. Based on these patents, we will type up a report that will further detail:
    a. the gasket materials empirically used
    b. the materials that we propose to use
    c. the materials we hypothesize will work the best
    d. the procedure of the testing process
    e. document the pressure data for each material used

E. Define how analysis of the test results will be conducted.

- For each gasket, we will be testing recording:
    1) Appeared contact completeness
    2) The measuring pressure being applied
    3) The retention of the pressure over a period of time

F. Explain how the IPRO deliverable reports will be generated.

- Each individual is required to submit a progress report and uploaded into iKnow
- Each subgroup will be required to submit their own part of the project plan

G. **Attach any relevant detailed documents**.

Sketch of vacuum/gasket prototype

Measurement Subcommittee:

Emission Spectroscopy Subgroup:

A. Define the problem(s).

- We are presently in an ongoing project to construct an artificial pancreas that can record blood glucose levels for monitoring and for insulin administration. In order to determine the requisite insulin dosage for a diabetic individual; we must have an efficient method for measuring immediate blood glucose concentrations. Currently there are several methods being examined as a means of measuring glucose within the existing *artificial pancreas* prototype. However, only one can be selected. This semester, our particular subgroup will be examining atomic emissions spectroscopy.

B. Describe how your team will go about solving the problem(s).

- Krebs Ringer Buffer was used to imitate interstitial fluid. From the absorbance at different glucose concentrations in Ringer's solution, we seek to obtain a linear graph that obeys Beer Lambert's law: A = *epsilon* * b * c. Our

subgroup will assess the accuracy and reliability of Atomic Emissions Spectroscopy in measuring blood glucose concentrations, by the linearity of this calibration curve.

C. Explain how the potential solutions will be tested.

- We will prepare several standard glucose solutions from stock, using serial dilutions. A 10% saline solution will be prepared as an experimental control since it contains no glucose. Intensity of emitted light from each standard will be measured at approximately 1000 nm using Atomic Emissions Spectroscopy. The intensities will be correlated with glucose concentration in solution using a standard calibration curve and Beer Lambert's law.

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D. Describe how results of research and testing will be documented.

- The procedure was performed with some degree of success in the last IPRO period. Preparing standard dilutions and measuring the absorbance for glucose analyze is a fairly rapid process. An inability to measure at 3000 nm and exposure of the photosensitive Ringer's solution to light might result in calibration curves that deviate from linearity, compelling us to run additional tests and prolonging experiment time. We intend to make solutions and run tests on a weekly basis. Concentration and absorbance values at the selected wavelength will be recorded for all standards in each run, with a blank subtraction. Calibration curves for each data set will be plotted and stored.

E. **Define how analysis of the test results will be conducted**

- A software program will be utilized to plot absorbance vs. concentration for our standards in each experimental run. We will be seeking a progression in curve linearity with each run. A sufficiently linear calibration curve would render AEM competitive in measuring blood glucose concentrations.

F. Explain how the IPRO deliverable reports will be generated.

- Results from each week will be uploaded to the IPRO site with attendant explanations, as well as our progress towards our semester objective.

G. Attach any relevant detailed documents.

- A basic guideline to the Beer-Lambert Law and Emission Spectroscopy

Impedance Spectroscopy:

A. Define the problem(s).

- Our greatest setback is that in order to investigate this technique certain instrumentation is needed that cannot be found at IIT. Therefore in the past we have sent groups to Rush Medical to perform experiments; however, they have recently informed us that they are having technical difficulties with their equipment and therefore we will have to look elsewhere for help. Additionally, it is believed that increasing the electric potential will increase

the interstitial fluid extracted; however, a balance needs to be determined so that the maximum amount of fluid is extracted without causing discomfort to the user.

B. Describe how your team will go about solving the problem(s).

- . We have already been in contact with various other labs to see if using their equipment is a possibility. As soon as we establish a definite contact then we will be able to start our experimentation. We have reviewed the last semester's progress and will keep in contact with the student dedicated to this task last semester to see what tips she may have for us.

C. Explain how the potential solutions will be tested.

- The impedance spectroscopy will be tested on a pig skin which we receive from a Chicagoland meat factory. We will increase the voltage and measure the corresponding interstitial fluid extracted and afterwards examine the pig skin under a microscope to look for any visible signs of skin damage.

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D. Describe how results of research and testing will be documented.

- The research results will be documented both electronically through excel documents which will be uploaded onto iGROUPS and also our IPRO308 Gmail account. Additionally each subgroup is required to keep a lab notebook which will be passed on to future IPRO groups.

E. **Define how analysis of the test results will be conducted**

- Ultimately the results will be interpreted to determine the electric potential at which the maximum amount of interstitial fluid was extracted while not causing any visible physical damage to the pig skin. The results will then be compared against the emission spectroscopy data to determine which measurement technique will be used in our final prototype.

F. Explain how the IPRO deliverable reports will be generated.

- With the help of our Research Subcommittee, the group meetings are kept on schedule and everyone is given ample warning to start preparing their portions of the IPRO deliverables.

G. Attach any relevant detailed documents.

- Basic Review on Impedance Spectroscopy

4.0. Expected Results

Research Subcommittee:

Already numerous hours of research has been dedicated into identifying similar patented products and accumulating information from members of this IPRO from past semester. This information was then acted upon and presented to the rest of the team in order to give each subgroup a greater understanding of where to start their experimentation. Additionally, we will soon meet with Dr. Opara or another professor within the next week and learn basic principles of applying for various grants. By the end of the semester we hope to have applied for additional funding from at least three foundations that are focused on sponsoring diabetes-related funding. Obviously if money was eventually secured it would be beneficial for the future IPRO groups who would be able to use such funds to perform more experiments and develop various prototypes. The information researched will not physically be evident in the prototype; however, the specific research that we have done and will continue to do based upon the current needs of each subgroup will aid them in their research and ultimately in creating the prototype.

Extraction Subcommittee:

Vacuum Subgroup:

From testing we expect, for each pressure/vacuum gasket set up that we create, to record whether or not it will even create a vacuum against the skin, what the max pressure it can hold against is, and the amount of time it is able to hold suction for different pressures/vacuums. Also through experimentation we expect to find out the best way to create the suction against the skin and the best speaker, gasket, and tube needed to create the most efficient extraction setup. From our research and testing we will potentially create a system that will suck up the interstitial fluid from the skin and keep the speaker suctioned to the skin when the insulin is being pressured back into the skin. By completing the assigned tasks our subgroup will potentially have all the data and research done necessary for the vacuum and pressure part of the artificial pancreas. It will potentially be able to be added along with the extraction and measuring procedures to create a somewhat working prototype. We expect to have the vacuum/pressure part of the project ready to be integrate into the working prototype at the end of the semester. The results expected from the group address about half the problem proposed by the sponsor. The second half in the insulin injection which will be addressed once the extraction part is completed. The expected results are jus one step in the completion of the overall project, but it is a big step. If all the expected results are actually obtained then this IPRO has made more headway then any of the previous ipros, especially in the vacuum/pressure area of the project.

Iontophoresis Subgroup:

A workable implementation of iontophoresis and reverse iontophoresis will be developed by the end of the semester. It will be used in conjunction with sonophoresis and the vacuum to extract sufficient amount of interstitial fluid from the pig skin to measure accurately. We will have a working and implemental circuit design with appropriate specifications and will have determined the optimal method of measuring skin resistance and incorporate this measurement into the prototype if advantageous. In order to take these future accomplishments and apply them to a working prototype according to our marketing strategy of miniaturizing the device we will design a smaller IC circuit and appropriate components for future use in the project. Additionally, in order to provide all safety precautions possible for the prototype we will develop a failsafe mechanism to indicate faulty functioning in the device.
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Measurement Subcommittee:

Emission Spectroscopy subgroup:

We hope to experiment on a weekly basis, producing and analyzing different concentrations of glucose by using the spectrophotometer. Although this process was done in the previous semester, we hope to confirm there results and also look for practical methods of miniaturizing spectrophotometry to fit a prototype. We expect to obtain a linear graph that obeys Beer Lambert' Law i.e. $\mathbf{A=\varepsilon}bc$ .Where A is absorbance (no units, since $A = log_{10} P_0 / P$) Obtaining a quasi linear graph will enable our IPRO to perform mechanism efficiency comparisons, which should allow us to select the most effective procedure for measuring blood glucose concentrations. Once this is assessed it could then be incorporated into the artificial pancreas prototype.

Impedance Spectroscopy Subgroup:

We hope to continue on from where last semester's IPRO group left off; however, our previous contact at Rush Medical will no longer be able to assist in the program as they are having complications with their equipment. Therefore the first item of our plan is to identify another lab which we could use and establish a friendly relationship with them. It is expected that there will be two conflicting factors in our experiments: the electric potential delivered and the amount of interstitial fluid extracted. It is believed that the greater the electric potential applied, the more readily the fluid will be extracted; however, this could cause pain and permanent damage to the skin which is obviously not acceptable. Eventually once an appropriate electric potential is identified we will compare the impedance spectroscopy results against the emission spectroscopy and decide which measuring technique is the most advantageous to enter the prototype design.

5.0. Project Budget

Subcommittee	Item	Quantity	Price	Total
Extraction	175 Miniature speaker	2	$2.95	$5.90
Extraction	Clear Check Valve 1” Diameter	1	$11.44	$11.44
Extraction	Clear Vinyl Tube (1ft)	1	$2.35/ft	$2.35
Extraction	Rubber Gasket Ring	1	$7.52/50 pack	$7.52
Extraction	Flexible pvc tube 1” diameter	1	$2.14/ft	$2.14
Extraction	Stiff pvc tubing 1” Diameter	1	$2.51/ft	$2.51
Extraction	Iontophoresis Device (Existing device for injecting medicines) → Used for reverse engineering the working → Useful to study adaptations with sonophoresis	1	$330	$330.00
Extraction	LP 3983 Current regulating chip with constant Iout=5mA	35	$0.33	$11.55
Extraction	Miscellaneous Equipment (Speakers, tubing, coating, capacitors, resistors, …)	1	1	$100.00
Measurment	Pig Skin for experimentation	10	$3.00	$30.00
Measurement	Breadboard for building circuit	1	$30	$30.00
Measurement	Cuvettes (UV-VIS)	1	$55	$55
Measurement	Ringer’s Solution	2	$3.29	$6.58
Measurement	Sodium Bicarbonate 500g	1	$24.80	$24.80
Measurement	Ringer’s Solution	2	$3.29	$6.58
Measurement	Sodium Bicarbonate 500g	1	$24.80	$24.80

Administrative	Projector rental	5	$42	$210
Overall Total				**$861.17**

*All quotes determined from major biomedical and chemical corporate websites

6.0. Schedule of Tasks and Milestone Events

Extraction Subcommittee:

Iontophoresis Subgroup:.

Standard Lab Schedule: Fridays, 12pm to 3pm.

Projected Time line:

Date	**Task**
9/20/07	Build and Test circuitry for the device
9/21/07	Begin experimentation on Pig Skin
9/28/07	Continuing experimentation
10/05/07	Continuing experimentation
10/11/07	Report on progress to be sent in for Midterm presentation
10/12/07	Continuing experimentation + Midterm presentation
10/18/07	In Class presentation of sub-group's work and progress so far
10/19/07	Fall Break
10/26/07	Continuing experimentation
11/02/07	Continuing experimentation
11/09/07	Continuing experimentation
11/16/07	Continuing experimentation
11/22/07	Final Presentation to class on goals met and prospects for future semesters
11/23/07	Compose final IPRO Day presentation on semester's work

Note: Projected time for each experiment around 2 or 3 Hours.

Vacuum Subgroup:

Date	TASK
10-01 to 10-06	Ordering supplies and designing different gasket/speaker setups, Find useable pressure gages

10-8 to 10-13	Building the setups
10-15 to 10-20	Begin testing with pressure/vacuum, Midterm presentation
10-22 to 10-27	Testing
10-29 to 11-03	Testing
11-05 to 11-10	Revise setup if necessary
11-12 to 11-17	Testing
11-19 to 11-24	Choose best set up, compile results
11-26 to 12-01	Report results to group and incorporating them with the rest of the extraction methods
12-03 to 12-08	Discussing results

Measurement Subcommittee:

Emission Spectroscopy:

Date	Task
9/20/07	Lab Safety Training Completion
9/21/07	Script "Lab Safety Agreement" Document
9/28/07	Enter the Lab for the first time
10/05/07	Continue serial dilutions at lesser concentrations
10/11/07	Report on progress to be sent in for Midterm presentation
10/12/07	Complete Midterm Update Documentation
10/18/07	In Class presentation of sub-group's work and progress so far
10/19/07	Fall Break
10/26/07	Continue experimentation
11/02/07	Continue experimentation
11/09/07	Continue experimentation
11/16/07	Perform Data Analysis to determine statistical significance of findings
11/22/07	Final Presentation to class on goals met and prospects for future semesters
11/23/07	Compose final IPRO Day presentation on semester's work

Impedance Spectroscopy:

Date	Task
9/20/07	Lab Safety Training Completion
9/21/07	Script "Lab Safety Agreement" Document
9/28/07	Establish contact for Lab Space
10/05/07	Meet with past semester's Impedance Spectroscopy researcher
10/11/07	Report on progress to be sent in for Midterm presentation
10/12/07	Complete Midterm Update Documentation
10/18/07	In Class presentation of sub-group's work and progress so far
10/19/07	Fall Break
10/26/07	Continue experimentation
11/02/07	Continue experimentation

11/09/07	Continue experimentation
11/16/07	Perform Data Analysis to determine statistical significance of findings
11/22/07	Final Presentation to class on goals met and prospects for future semesters
11/23/07	Compose final IPRO Day presentation on semester's work

Research Subcommittee:

Date	**Task**
9/28/07	Secure all needed patent information
9/14/07	Attend IPRO Ethics Seminar
9/18/07	Present to class on Ethics Seminar
9/21/07	Attend IPRO Project Management Seminar
9/25/07	Present to class on Project Management Seminar
10/02/07	Meet with professor about Grant Application Process
10/09/07	Identify 3 possible foundations to apply for funding
10/11/07	Identify the application processes of each foundation and follow-up
10/25/07	Rough Draft of Grant Proposal
11/01/07	Final Draft of Grant Proposal Due

7.0IPRO 308 Fall 2007 Team

8.0 IPRO 308 Fall 2007 Team

7.1 Member List:

Dr. Emmanuel Opara-Instructor

Professor Deboth- Co-Instructor

Morley, Michael BME- Team Leader. *Michael has three years experience in Biomedical Engineering. He holds leadership roles in numerous student activities on campus including being the President of Union Board. This previous summer, Michael worked with Dr. Opara and Dr. Brey on diabetes related research.*

Babicz, Amanda MMAE- *Being an Aerospace major, Amanda has mechanical experience that can greatly contribute to this IPRO. Amanda also displays her leadership as she was the President of the Kappa Phi Delta sorority.*

Goldstein, Linda HUM- Secretary. *Linda is a fourth-year Technical Communications major. She has had previous experience with Grant writing and she is also on the executive board of GLAM, Secretary of Hillel, and a Layout Editor for and contributor to TechNews.*

Kochanek, Malgorzata PSYCH/BIO- *Malgorzata has had research experience relating to Dystrophin in Dr. Menhart's laboratory. She holds leadership experience as a TA Computer Science and in Commuter Student Association she holds Social Chair*

Mathews, Rohan ECE – *Rohan is a third year Electrical Engineering student who decided to join the project after Dr. Opara called for EE majors. He has had prior experience working on prosthetics with Professor His leadership skills are displayed as he is the President of IIT's Dance 101.*

Mesquitta, Walatta BCPS – *Walatta is in her third year as a Molecular Biochemistry and Biophysics major. She has had research experience in physiological regulation of sodium chloride transport via NCC within the mammalian nephron. This is her third year as a Molecular Biochemistry and Biophysics major.*

Narasimhan, Devnaradev BME – *Dev is a fourth year Biomedical Engineering student in the Cell and Tissue track. He has research experience focused on human movements with Dr. Kamper. Dev was a former programmer for Union Board and held the Alumni Relations and Scholarship Chair in his fraternity Phi Kappa Sigma.*

Patel, Bhuvin BME-*Bhuvin is in his fourth-year of Biomedical Engineering. He holds lab experience working with Dr. Anastasio on CT scan algorithms and Imagery Techniques. Bhuvin was also part of one of the previous IPRO 308 sections. On campus, he is an active member of Indian Student Association.*

Rahnavard, Amir BME – *Amir is in his third year of Biomedical Engineering. He has prior research experience with Diabetes and vision loss, including testing of Lucentis for vision enhancement. Amir is also part of Sigma Phi Epsilon Fraternity and holds an executive role in the group. He is involved on campus as a student ambassador*

Reddy, Kirthi ECE – *Kirthi is a fourth year Electrical Engineering major with a Pre-med Minor. She was also a member of IPRO 308 in one of its previous semesters. Outside of school, Kirthi is an Learning Assistant and Teaching Assistant for ECE 100. She is also a board member of ISO and Tau Beta Pi.*

Riaz, Maryum BME- *Maryum is a fourth-year Biomedical Engineering Student.*

Saung, E-Fann ECE- *E-fann is a fourth year Mechanical Engineer student and has done research on Homogenous Charge Thermal Ignition. E-fann is also involved in Triangle Fraternity, SAE.*

Thomas, David BCPS- *David is in his third year of Molecular Biochemistry and Biophysics. He had previous research experience in Protein Investigation lab. David is also The President of IIT Amnesty International Chapter.*

7.2 Sub-Groups:

Extraction Team Develop a viable option to remove interstitial fluid

Name	**Role**	**Concentration**
Patel, Bhavin	Extraction Team Leader	Reverse Iontophoresis
Mathews, Rohan		Reverse Iontophoresis
Narasimhan, Devnaradev		Sonophoresis
Riaz, Maryum		Sonophoresis
Saung, E-Fann		Vacuum
Babicz, Amanda		Vacuum

Measurement Team Develop a system to measure interstitial fluid for glucose concentration

Name	**Role**	**Concentration**
Reddy, Kirthi	Measurement Team Leader	Impedance Spectroscopy
Morley, Michael		Impedance Spectroscopy
Mesquitta, Walatta		Emission Spectroscopy
Rahnavard, Amir		Emission Spectroscopy

Grants/Patent/Research Team Responsible for IPRO deliverables as well as patent and grant research

Name	**Role**	**Concentration**
Kochanek, Malgorzata	Research Team Leader	Grant Proposals
Goldstein, Linda		Patent Research
Thomas, David		

8.0 DESIGNATION OF ROLES

8.1 Meeting Roles

Minute Taker- Linda Goldstein

Agenda Maker- Dr. Opara, Michael Morley

Time Keeper- Michael Morley

8.2 Status Roles

Weekly Timesheet Collector/Summarizer- Linda Goldstein

Master Schedule Maker- Michael Morley

iGROUPS- Linda Goldstein