*2023-2024*

*Pine View School*

# BIOMEDICAL ENGINEERING SOCIETY

# CHAPTER DEVELOPMENT REPORT

*Pine View Campus:*
*1 Python Path, Osprey, FL 34229*
*941 - 486 - 2001*

*pvbmes@gmail.com*

# I. Renewal Document

## Faculty Advisor

Rebecca Kehler

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rebecca.kehler@sarasotacountyschools.net

Biology Teacher at Pine View School

**Member Information:**

| | |
|---|---|
| Arya Doshi (Co-President)<br>aryadoshi13@gmail.com | Kathleen Wu (Co-President)<br>kathleenfwu@gmail.com |
| Aadi Bhensdadia (Vice President)<br>aadibhensdadia@gmail.com | Xinyi Liu (Treasurer)<br>zarinaliu@gmail.com |
| Lilyanna Wang (Secretary)<br>lilyannafwang@gmail.com | Kylan Silva<br>Kylan.silva@gmail.com |
| Alex Liu<br>alexliu@duck.com | William Seamen<br>william.t.seaman@gmail.com |
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**Club Website:** https://sites.google.com/view/pvbmes

**Free Student Membership Information:**

Edden Levy (Pine View School, 2024, Female)

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# II. PINE VIEW SCHOOL BIOMEDICAL ENGINEERING SOCIETY CHAPTER DEVELOPMENT REPORT

August 2023 - May 2024

PINE VIEW CAMPUS:
1 PYTHON PATH, OSPREY, FL 34229
941 - 486 - 2001

Corresponding Authors:
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**Executive Summary:**

The Pine View (PV) BMES chapter seeks to foster a dedicated community that shares a passion for biomedical engineering by providing unique opportunities and expanding students' knowledge about the field. Our chapter meets every other Tuesday in the faculty advisor's room at 1:20 P.M. for approximately an hour. Within the 2023-2024 academic year, the Pine View BMES chapter has continued our previous research with plant decellularization and recellularization, while also beginning a photolithography project. Together, members have decellularized kale, celery, kiwi, and plum tissues to use as scaffolds. Some

members have chosen to complete independent research projects, such as the engineering of heart valves, the design of new fluorescent proteins, and the creation of systems for diabetes prediction. During meetings, our members have learned how to read professional research papers, create scientific models, and maintain a sterile laboratory environment. We have utilized the lessons learned from the networking sessions with the University of California, Los Angeles BMES chapter to transform our chapter to include more professional and community development activities. The chapter has shared knowledge and expanded through outreach projects such as club fairs, presentations promoting our research, meetings with experts in the field of tissue engineering, and case studies with medical professionals. These activities have ensured that all types of students have received benefits from participating in the club, whether it be for research or professional purposes. In the future, we hope to form lasting connections with local community leaders and other university chapters to create a strong foundation for future growth. We hope to develop large-scale projects using science and engineering that will leave a lasting impact on our community.

# III. Cover Letter

Dear National BMES:

During our fifth year as a high school chapter of the Biomedical Engineering Society, Pine View BMES' goal was to encourage interest in biomedical engineering through educational and engagement opportunities for students. We began the year with eight returning members from the previous school year. They worked to expand the chapter and introduce interested students to biomedical engineering. Students began learning about different aspects of tissue engineering from experts and from research papers presented by club officers. Students connected with medical professionals and learned about the current developments in the biomedical field for treating specific illnesses. They were able to complete case studies under the guidance of these professionals. The club grew to consist of twenty-two members with an elected executive board. Social, mentor, and outreach committees were formed and assigned appropriate projects. Our chapter met weekly and accomplished social activities, community volunteering, and scientific research.

This year, our club pursued multiple research projects, including decellularization and recellularization using plant scaffolds, and photolithography. Students were effectively able to decellularize the tissues of kale, celery, kiwi, and plum using knowledge that were taught by experts in the field and by presentations earlier in the year. Additionally, students explored the use of photolithography to creating designs that can be applied to nanotechnology, such as dihybrid swimmers. With this knowledge, members have prepared spin-coaters, and some members are undergoing training to use photolithographic equipments at a local microfabrication lab over the summer. Students also explored individual projects under the club's support that included the engineering of heart valves, the design of new fluorescent proteins, and the creation of systems for diabetes prediction. Throughout the completion of the group and individual projects, students explored biomedical engineering and the various career areas associated with the field as they completed networking sessions with collegiate BMES chapters.

The organization has continued this year in its involvement in the local community. Multiple BMES members volunteered at youth science organizations, such as the Suncoast Science Center and its associated FAB Lab. Furthermore, members were also involved with Sarasota Memorial Hospital and the National Alliance on Mental Illness, where they led wellness workshops for the community.

For the upcoming 2024-2025 academic year, Pine View BMES is looking forward to continuing its current photolithography project and beginning a new project as it increases its visibility among students across all grade levels. We plan to expand fundraising efforts beyond campus and increase our presence in the local community. Pine View BMES members are committed to the growth of the chapter, further research, and promotion of interest in the biomedical sciences to their peers.

Sincerely,

Arya Doshi, Kathleen Wu
*Arya Doshi, Kathleen Wu*
PV BMES Co-Presidents
pvsbmes@gmail.com

Rebecca Kehler
*Becky Kehler*
Faculty Advisor
rebecca.kehler@sarasotacountyschools.net

# IV. Table of Contents

## Pine View Biomedical Engineering Society

# V. Administrative Report

The Pine View School Biomedical Engineering Society, formed in 2019, was the second high school in the nation to have a BMES chapter. The current executive board consists of two co-presidents, the vice president, the treasurer, and the secretary, all of which are democratically elected by the chapter's members at the end of each academic school year. We have continued and expanded our social, mentoring, event planning, and outreach committees from last year, which allowed us to expand our influence and reach out to more students within Pine View School. This year, our club has grown to include an unexpected number of members, but we were excited by all of the new students who have found interest in biomedical engineering. Our committees met biweekly and were open to all students, which increased involvement as well as retention of general members. Meeting agendas are shared prior to the meetings, so that the members are aware of what to expect before they enter the room. The meeting agendas are also saved for future reference to ensure that we know which tasks have already been taken. Meeting minutes are written by the secretary for every meeting in order to keep track of our goals and how many we have accomplished.

Faculty Advisor, Ms. Becky Kehler, rebecca.kehler@sarasotacuntyschools.net

Co-Presidents, Arya Doshi and Kathleen Wu, pvsbmes@gmail.com
In charge of overseeing all operations, maintaining relations with the PV Bioengineering Faculty Advisor, presiding over all meetings, and managing the general direction of the organization.

Vice President, Aadi Bhensdadia
Responsible for membership logistics, facilitating communication between officers and members, keeping administrative tabs on the officer board, and ensuring overall member engagement.

Treasurer, Xinyi Liu
In charge of managing all PV BMES funds, finalizing research materials, allocating money to the committee chairs, applying for external sources of funding, and contacting potential sponsors.

Secretary, Lilyanna Wang
Ensure meetings are effectively organized, maintain effective records and administration, uphold the requirements of research documents, and communication and correspondence.

| Chapter Membership | Actively Participating Members | National Membership |
|---|---|---|
| 23 students | 15 students | 10 students (43%) |

## Meeting Information

| Date | Description |
|---|---|
| 09/06/23 | Introduction to the club and the goal and mission of the Biomedical Engineering Society. New members are introduced to the projects the club has done or is doing (Glyphosate, Decellularization, Recellularization, and Photolithography). Tasks are assigned to the officer board in regards to the research project and future events |
| 09/13/23 | Described the procedure and materials for decellularization and recellularization. Showed members past work done on these two procedures. Educated members on the process of photolithography and its practical applications in the real world. |
| 09/20/23 | Divided members into small groups, and each officer led a group to perform a decellularization activity for an assigned fruit or vegetable tissue |
| 09/27/23 | Members assessed the decellularized plant scaffolds, used data analysis and log books to record information about the scaffolds grown. Members also practiced microscopy skills to image the scaffolds. |
| 10/11/23 | Members collaborated to draw scientific images including bacteria, microscopes, and chemical compounds on plastic cups that were glued onto a PLINKO booth, which is later used to fundraise for the club at the school's annual fair. |
| 10/25/23 | Discussed the problems previously encountered with recellularization and brainstormed in groups the methods that could address contamination in a school environment to allow successful recellularization in plant scaffolds. |
| 11/01/23 | Met with a research botanist from the Marie Selby Botanical Gardens, who presented to members on tissue engineering, biomimicry, bioengineering, decellularization and recellularization in plants vs animal scaffolds. Discussed with the botanist on issues about contamination and what the club has come up with as potential solutions. |
| 12/06/23 | Club officers read and presented research papers on Plant cell growth in artificial scaffolds, non-animal scaffold applications, and current advancement in decellularized scaffolds to club members. |
| 01/17/24 | Members are divided into groups to prepare the spin-coater, which is later used for photoresist coating to complete the photolithography project. |
| 01/31/24 | Met with Dr. Seaman, a Critical Care Pulmonologist from Sarasota Memorial Hospital, who presented to the members on COPD - Chronic Obstructive Pulmonary Disease and led members to complete a case study about an individual with COPD, where members explored ways to treat this individual, using what they learned. |
| 04/30/24 | Met with the University of California, Los Angeles BMES chapter to learn about pursuing biomedical engineering in college and after college, as well as the different job opportunities available to those with a degree in BME. |
| 05/01/24 | Discussed future goals and potential research topics for the 2024-2024 school year, conducted officer elections, end-of-year celebration |

# VI. Treasury Report

To acquire the funds necessary to continue our projects, the Pine View Biomedical Engineering Society raised money through a variety of fundraising events. These events were purposed for raising money and encouraged students to think of innovative ways to attract both young students and parents to participate in the activities. The activities also proved to be fun for club members. For example, we continued to host PV BMES's annual "PLINKO Board" booth at the Pine View Fair fundraising event on October 21, 2023. Participants threw ping-pong balls in order to potentially win ice cream or candy. The booth taught members about the important skills of the handling of money, problem-solving, and the risks and rewards in life. Furthermore, the members collaborated to draw scientific images, such as bacteria, microscopes, and chemical compounds on the cups that were later glued onto the booth, which introduced participants to interesting STEM topics. Overall, the booth was an enjoyable experience and presented little difficulty to members.
Approximately $450 was made from the booth at the Pine View Fair. Based on PV BMES's fundraising pitch to the Pine View Association last year, our club repurposed its leftover funds for the recellularization project. Members reached out and communicated with the club sponsor to determine how much money was remaining. The funds allowed the chapter to purchase the necessary materials for the photolithography projects.

| Balance Summary | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|---|
| Starting Balance | $750 | $1158 | $1158 | $361 |
| Funds Raised | $452 | 0 | 0 | 0 |
| Expenses | $44 | 0 | $797 | 0 |
| Final Balance | $1158 | $1158 | $361 | $361 |

# VII. Chapter Activities

Overall, our chapter has created and participated in several activities over the past year. Members volunteered in various aspects of our local community both within and outside the bounds of the Pine View campus. For example, many members were able to volunteer at a multitude of events hosted by the Suncoast Science Center's Faulhaber Fab Lab, specifically in the science, technology, and engineering sectors. Members also volunteered at local hospitals within Sarasota County. Our main goal this academic year was to understand and replicate the plant recellularization process using cells of our own making. Students learned how to grow stem cells and decellularize plant tissue during the project. They also created read and summarized various research papers about decellularization to facilitate their understanding of the project. Using experience from the previous year's decellularization project, students were successfully able to decellularize spinach leaves and tissue from three varieties of apples. To cultivate carrot stem cells, students ran multiple trials with different types of disinfectant to determine which environment induced the least contamination. Individual projects about heart valves, liver diseases, and pesticides were also conducted. Students also participated in other activities such as creative career posters, outreach to other chapters and grade levels, and social events. Funding for these activities was provided by a club booth at the Pine View Fair and non-profit organizations such as the Pine View Association.

# VIII. Social Activities

This year, the Pine View BMES chapter organized several social activities to create a welcoming and uplifting environment for its members. We hope to connect and engage the students within our club. We organized an introductory meeting at the beginning of the year to ensure that each member is informed of the plan for the 2023-2024 school year and to create connections between new members and returning ones. In preparation for the school fair, members collaborated to draw scientific images, such as bacteria, microscopes, and chemical compounds on the cups that were later glued onto the booth to create a PLINKO board. Members also made creative works for the booth that featured interesting science and engineering related concepts, which allowed members to bond while contributing to the club's mission. Additionally, some PV BMES members were inspired to pursue their own research projects in the field of biomedical engineering, and the club meetings became a space where they exchanged ideas about their personal projects. Our end-of-year party allowed members to bond in the stressful finals season and celebrate the accomplishments of the BMES chapter in the past year. Conducting officer elections made it possible for students to look forward to the future of the club, while wishing good luck to graduating members for the future. Overall, these activities were able to bring our club members closer together and create long-lasting connections.

Introductory Meeting

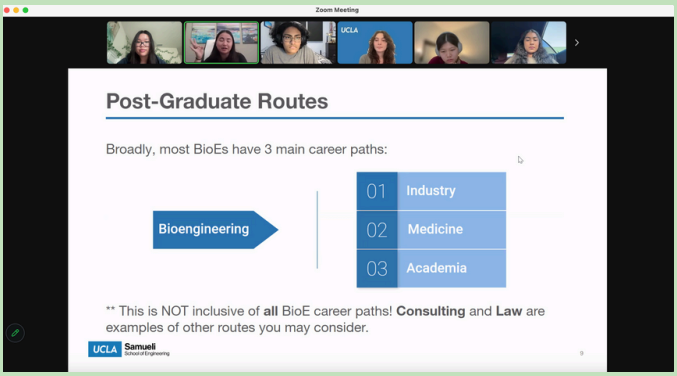
School Fair


Creative Cups

# IX. Inter-Chapter Activities

Even as the COVID-19 pandemic begins to decline, we can still feel the effects of isolation. The Pine View BMES chapter has acknowledged that stricter health guidelines and safety precautions following the pandemic have made meeting with other chapters in the nation in person an unrealistic goal. However, we still hope to create relationships with other chapters through mentorship and collaboration. The growing convenience of Zoom, an online communication platform that many are now familiar with, has allowed the PV BMES chapter to continue to interact with BMES chapters at different universities and to facilitate the sharing of knowledge.

**Meeting with Kelly Tamura & Alexandra Jensen**
**(University of California, Los Angeles)**
**04/30/2024, 9 members, cost: $0**


**The Pine View BMES chapter has had the opportunity to meet with the officers from the University of California, Los Angeles (UCLA) BMES chapter over Zoom. The UCLA chapter president and secretary, Kelly Tamura and Alexandra Jensen respectively, gave an overview of careers in biomedical engineering and, just as importantly, how to get there. They delved into the logistics and leadership structure of their club, a key reason behind their effictiveness and success. This meeting inspired our own members to consider a future in biomedical engineering past high school. Participants were able to engage by asking questions about the field of biomedical engineering, as well as any inquiries about attending college in general. Our interaction with the UCLA chapter has allowed us to gain greater knowledge about the organization of a BMES chapter and showed us how to streamline day-to-day club operations for maximum efficiency, allowing us to do more research despite our junior age.**

**PV BMES is also frequently in contact with PV BMES alumni Ray Min, a current student at UCLA. Ray Min often sends us literature that we may find helpful for our decellularization project and has been an indispensable mentor and supporter of the club ever since its inception.**

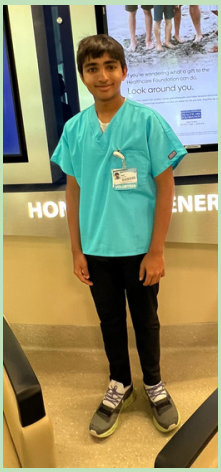
# X. Outreach Activities

The PV BMES chapter is dedicated to enhancing others' understanding of the biomedical sciences while building on its own members' knowledge. Since COVID-19 restrictions had lessened this year, members were able to explore a number of ways to spread knowledge of STEM. This year, the club retained many of its previous members, ranging from grades 9 to grades 12, with additional prospective members from grade 8. Members worked together to create educational posters about biomedical engineering that appeal to younger audiences. Finally, the club has also contributed to its goal by furthering its engagement in volunteer activities at Sarasota Memorial Hospital, organizing blood drives, and collaborating with the Sarasota Fab Lab.

### 1. Volunteering at the Faulhaber Fab Lab

PV BMES members volunteer at the Faulhaber Fab Lab, an organization that supports child innovators through experiential learning in STEAM-based activities. Our members teach children in grades 4 through 8 by contributing to RC Car projects, summer camps, and STEAM Saturdays. Members incorporate aspects of biomedical engineering into their lessons, mainly during STEAM Saturdays and summer camps.

| | | |
|---|---|---|
| SunCoast Science Center/Faulhaber Fab Lab | Year-Round Sarasota, Florida | 2 BMES Members |



### 2. Volunteering at Local Hospitals

Many PV BMES members spend some of their free time volunteering at the Sarasota Memorial Hospital and Doctor's Hospital. At these locations, members have the opportunity to understand how a healthcare setting operates. Volunteers deliver blood products, meal trays, and lab specimens. They also help transport patients to and from infusion centers and the valet, taking care to interact with each person compassionately. Volunteers complete annual education programs and learn how to organize requests from the various departments in a hospital. Since many students from Pine View School volunteer at the hospitals, PV BMES members take the chance to teach them about the club and biomedical engineering applications to healthcare. Our members have volunteered at the hospitals for an approximate total of 300 hours over the academic year.

| | | |
|---|---|---|
| Sarasota Memorial Hospital | August 10th, 2024- May 24th, 2024Sarasota, Florida | 5 BMES Members |

### 3. The Club Fair

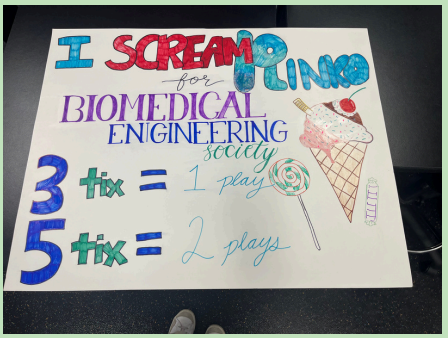
For the past two years, Pine View School has held an event where all clubs and organizations on campus can tell students about what they do and their goals. PV BMES members created a booth with an educational presentation that described BMES and our past and current work on glyphosate poisoning and decellularization. Members learned how to present to younger audiences and gained a deeper understanding of what our club entails. They also learned how to manage a booth and answer a variety of questions about biomedical engineering.Through the club fair, PV BMES gained 7 new members.

| | | |
|---|---|---|
| Pine View Club Fair | August 18th, 2023, Sarasota, Florida | 4 BMES Members |


## Pine View Fair

The annual Pine View Fair provides students and the school to raise funds and teach parents and students about their clubs. PV BMES members created a "PLINKO" booth where participants threw ping-pong balls in order to potentially win ice cream or candy. The booth taught members about the important skills of the handling of money, problem-solving, and the risks and rewards in life. Furthermore, the members collaborated to draw scientific images, such as bacteria, microscopes, and chemical compounds on the cups that were later glued onto the booth, which introduced participants to interesting STEM topics. As young students play the game, members take the chance to tell inquisitive parents about BMES. Participants were also taught about the benefits of public monetary investment into the sciences.


The Pine View Fair teaches PV BMES members about time management as members take turns handling the booth according to a shift schedule. They also learned about monetary transactions as they determine the number of tickets they will require from a student to play the game in order to make a profit. Due to the Pine View Fair being held later into the academic year, PV BMES gained only 2 new members, but spoke with numerous prospective members for the next year. However, we successfully raised over $450 from the fair, which was put to good use by the photolithography and decellularization projects and was vital to the functioning of the club, showing the mutual benefit this activity posed to both the PV BMES chapter and to the general public.




| | | |
|---|---|---|
| Pine View Club Fair | August 18th, 2022<br>Sarasota Florida | 3 BMES members |

## 5. National Alliance on Mental Illness


Members of PV BMES volunteered at the local National Alliance on Mental Illness center by leading wellness workshops for local middle and high school youth, as well as organizing campaigns with NAMI to advocate for more support around youth mental health. Through hosting petitions at farmers markets, and conducting youth-driven workgroups, the volunteers were able to spread awareness for the after effects of COVID on youth wellbeing. Volunteers also studied the science behind mental illness, and some volunteers joined a mental health initiative that analyzed biomarkers and data trends that predicts suicide in teens. A PV BMES volunteer, Xinyi Liu, received the volunteer of the year award from NAMI in recognition of her work in addressing youth mental health.

| | | |
|---|---|---|
| Pine View Fair | November 12th, 2022<br>Sarasota Florida | 6 BMES members |

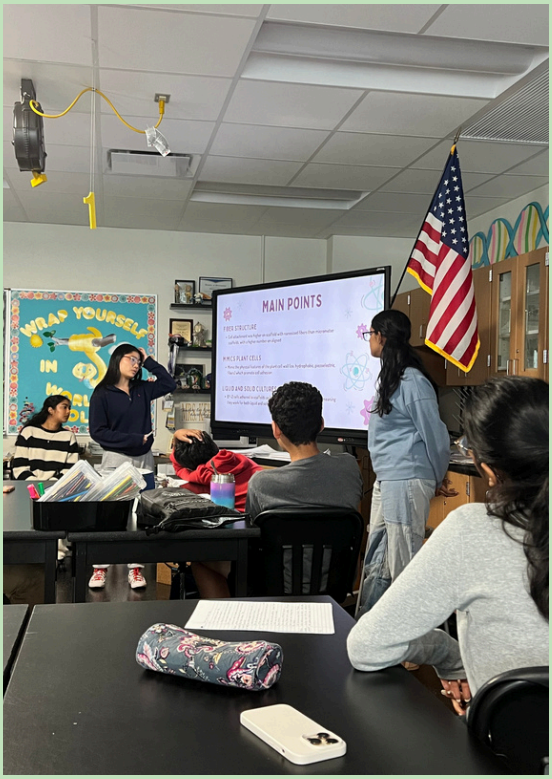
# XI. Mentoring Activities

Over the course of the school year, the PV BMES Club mentored students across grade levels in a variety of ways. Toward the beginning of the year, PV BMES connected with Dr. Arias, a research botanist who works at the Marie Selby Botanical Gardens, and BMES invited Dr. Arias to give the BMES members an educational lecture about tissue engineering, decellularization, and recellularization. Members were able to better understand the perspectives of a researcher through the presentation. Later, PV BMES officers read a variety of research papers on growing organisms through artificial fibrous scaffolds, creating and utilizing non-animal scaffolds, and the current developments around scaffold creation. These papers were then presented to all BMES members, who all found the findings of the study inspiring, some even pursuing their own research around scaffold engineering. Throughout the year, members learned lab techniques such as how to heat solutions and how to prepare tissues for decellularization. Members also completed a medical case study after learning about current advances in the treatment for COPD, from a local critical care pulmonologist. Our chapter strives to enrich others about biomedical research and BMES as an organization.

| | | |
|---|---|---|
| Research Botanist Educational Presentation | 1st November, 2023 | All Members |
| Research Papers Presentation | 6th December, 2023 | All Members |
| Critical Care pulmonologist Case Study | 31st January, 2024 | All Members |
| Plant Decellularization Group Project | School Year | All Members |
| Educational Decellularization, Recellularization, Photolithography Powerpoints | School Year | All Members |
| General Lab and International Science and Engineering Fair Support | School Year | All Members |

**Research Botanist Educational Presention - 11/1/2023, All Members, cost: $0**


In an effort to gain a better understanding of the reasons for encountering contamination issues in the process of recellularization, as well as for the new BMES members to learn more about the research BMES is doing, PV BMES connected with Dr. Arias, a research botanist who works at the Marie Selby Botanical Gardens. Dr. Arias came into the BMES club meeting, and gave an educational lecture for all PV BMES members, where she talked about tissue engineering, the decellularization and recellularization process, biomimicry, the difference between plant and animal cells, and she provided a general overview of the purpose for bioengineering. Dr. Arias also answered some questions the members had about how tissue engineering can be done in a school setting. After the club officers explained the current challenges that PV BMES is facing with contamination during recellularization, Dr. Arias provided guidance and resources for the club in the next recellularization trial.

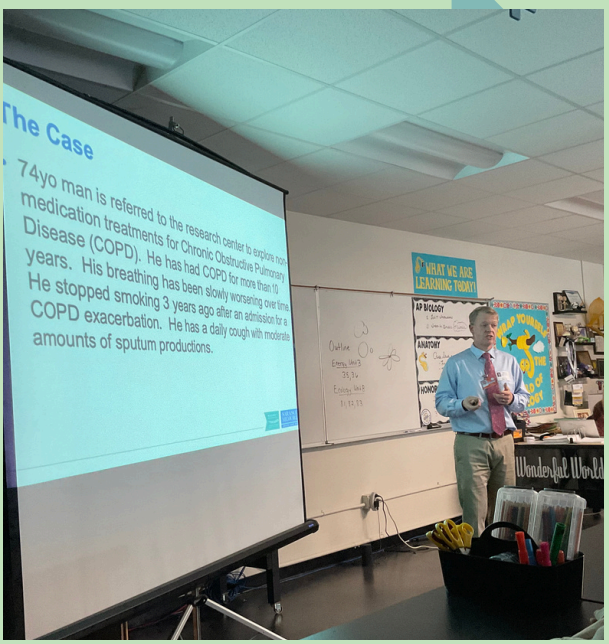


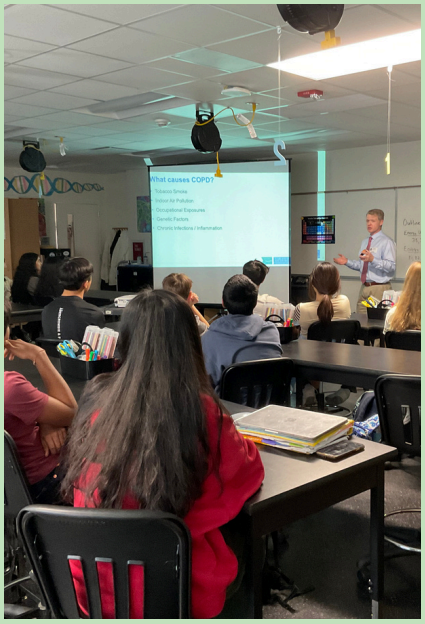

**Research Papers Presentation - 12/6/2023, All Members, cost: $0**

In December, the officers of BMES read research papers including Plant cell adhesion and growth on artificial fibrous scaffolds as an in vitro model for plant development, Scaffolds for 3D Cell Culture and Cellular Agriculture Applications Derived From Non-animal Sources, and Current Advances in the Development of Decellularized Plant ECM. The officers then created presentations, and presented the findings of these papers to all of the BMES club members. In this process, both the club officers and all of the club members were able to learn valuable knowledge about the current research developments around decellularization and recellularization, as well as consider ways in which PV BMES can adopt some of the techniques described in the papers. Members asked a variety of questions, from how certain factors can contribute to the viability of the recellularized sample, to how certain equipments can be built to ensure a sterilized environment.

**Critical Care pulmonologist Case Study - 1/31/2024, All Members, cost: $0**

PV BMES recognizes that many of its members are interested in pursuing a career in medicine research. Therefore, in early January, PV BMES connected with Dr. Seaman, a Critical Care Pulmonologist from Sarasota Memorial Hospital. Dr. Seaman visited the PV BMES club and gave a presentation on COPD - Chronic Obstructive Pulmonary Disease, its underlying causes, and the types of treatments available. In the session, Dr. Seaman led all members to complete a case study about an individual with COPD, and members explored possible ways to diagnose and treat this individual, utilizing what they have learned earlier in the session.



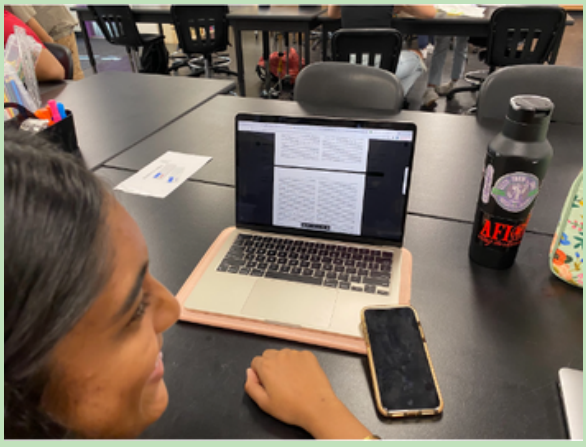




**General Lab and International Science and Engineering Fair Support - All Year, 3 Members, cost: $0**

Through participating in the various activities throughout the school year, all PV BMES members were able to learn various laboratory techniques about the many branches involved in biomedical engineering. Our chapter encouraged many of the underclassman to participate in the research projects including decellularization and photolithography, and to learn about correct aseptic techniques from the older students. The underclassman and new BMES members were about to assist in the research process by isolating cubes of vegetable and fruit tissue, making SDS solutions, sterilizing the laboratory surfaces, and cleaning the tools used with ethanol. We were also able to inspire 9th grade BMES member Aadi Bhensdadia and 11th grade BMES member Xinyi Liu to conduct their own research projects on engineering heart valves and on engineering fluorescent proteins. These two BMES members will later compete in the International Science and Engineering Fair for their research projects. As the PV BMES members conducted their own successful decellularization projects on plants of their choice, they were able to collaborate, exchange ideas, and learn more about tissue engineering and biomedical engineering from each other.

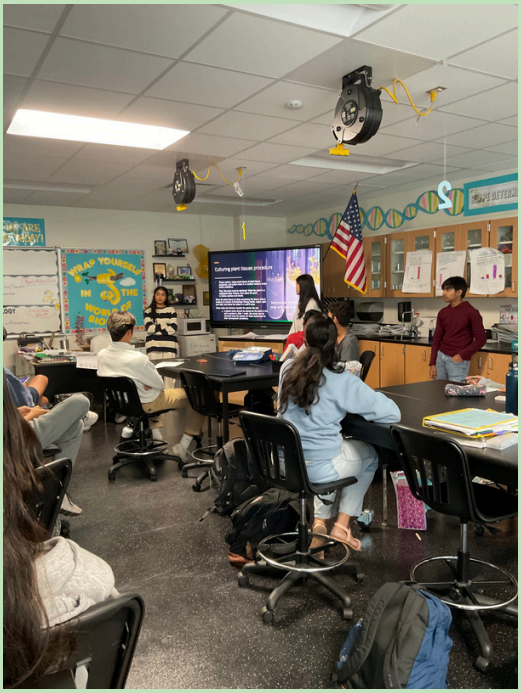

# XII. Industry or Professional Development Activities

Our biomedical engineering club conducted hands-on activities to enhance members' understanding of the industry and prepare them for future careers. We focused on skills crucial in the field, such as reading and analyzing research papers, scaffold design, and prosthetics.
One activity centered on research paper analysis, where upperclassmen presented and dissected a paper on decellularization. Members then worked in groups to extract key information, fostering academic readiness and deepening their grasp of the research topic.
Another activity delved into scaffold design, with officers sharing insights on tissue compatibility and mechanical characteristics. Members synthesized this knowledge into mini-posters, enhancing their contribution to discussions and gaining valuable design experience.
A highlight was the exploration of prosthetics, where officers showcased various types and led a hands-on session to build a prosthetic hand model. This engaging activity not only sparked interest in prosthetics but also provided a tangible glimpse into the industry's innovation and impact on daily life.
Overall, these activities demonstrated the practical applications of biomedical engineering, equipped members with essential skills, and instilled a passion for advancing healthcare through technology.



**Research Papers - 9/13/22, 11 members, cost: $0**

This year, our chapter emphasized the understanding of research papers, when reading and writing one. The upperclassmen within the club opened the meeting with a presentation detailing the structure of a research paper and the kind of information that is explained in each section. The students were then walked through an example of a research paper on decellularization using the knowledge they have gained from the presentation. The club was then split into three different groups and assigned a research paper on decellularization to collectively read and decipher. After approximately thirty minutes, each group shared the information they had gathered from the paper with the rest of the chapter. This information included what the scientists had deduced were the most effective variants of plant tissue and methods used for decellularization. This exercise not only prepared students for a career in academia, but also supplemented their preexisting knowledge of our research topic with information from professional scientists. Reading these research papers immersed our chapter into the world of biology and assisted us in making decisions regarding our decellularization research.

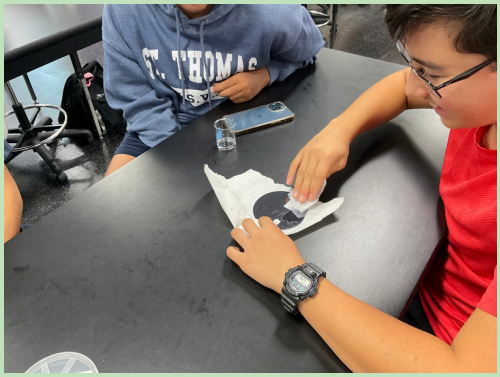


**Mini-posters - 04/30/24, all members, cost: $0**

Earlier in the year, officers read papers on scaffold design and presented their findings to members, who took notes and eventually created their own "mini-posters" regarding the topic. The talks given by officers covered a broad spectrum of important topics in scaffold design, from tissue source compatibility to mechanical characteristics and isotropy. With their newly-acquired scaffold design background knowledge, members were able to actively contribute to the brainstorming process. They also gained valuable experience in poster design and presentation

**Wafer Pre-processing - 04/30/24, all members, cost: $100**

A key step of photolithography is pre-processing the silicon wafer, which consists of cleaning it and removing impurities from the surface. Following widely-available procedures, our chapter worked as a team to pre-process three silicon wafers for photolithography. This gave them hands-on skills and experience that is valuable in any engineering field, from biomedical engineering to computer engineering to industrial engineering.



# XIII. Societal Impact Activities

Every day, approximately 17 lives are lost due to a shortage of organ donors, highlighting the urgent need for innovative solutions in tissue engineering. The PV BMES chapter has embarked on a mission to address this challenge by exploring the potential of plant-based scaffolds for organ regeneration. Through meticulous decellularization processes, the chapter successfully removed living components from plum, kiwi, celery, and kale tissues, laying the groundwork for scaffold development. Recellularization efforts, initially hindered by contamination issues, received a significant boost through collaboration with botanist Dr. Arias, paving the way for groundbreaking experimentation with plant cell integration and, subsequently, animal cell recellularization.

Concurrently, the chapter delved into photolithography, given its pivotal role in advancing healthcare technology. By leveraging this technique, the team aims to fabricate intricate designs tailored to nanotechnology applications, particularly in drug delivery systems such as dihybrid swimmers. Access to state-of-the-art equipment at the University of South Florida's microfabrication and nanotechnology department has accelerated progress, with members undergoing training to operate photolithographic machinery. Anticipated completion of these projects by 2025 heralds a new era of medical innovation, promising enhanced treatments and improved patient outcomes.

**Recellularization - school year, all members, cost: $552**

For the first part of tissue engineering, our chapter decellularized the tissue from plum, kiwi, celery, and kale to act as a scaffold for the new cells. The tissue from each type of plant is unique to a type of human tissue; for example, celery is well-suited to be used when engineering human vasculature, illustrating the specificity of our approach.

By removing the living components, the extracellular matrix is isolated from its previous inhabiting cells, while keeping its structure, and is able to be repopulated with any kind of cell. This technology is suitable for tissue development because it provides a natural scaffold that fits the microenvironment and can be repopulated with any desired tissue cell.

Over the previous year of work, we were able to perfect a plant-specific decellularizing procedure that is suited to our needs. It is explained below:

1. We first made a 5% SDS solution using sodium lauryl sulfate and water.
2. Kiwis, plums, celery, and kale were pre-processed (washed with soap and water, cut into slices ~1 cm in thickness, etc. This was different from plant to plant.)
3. The produce was submerged in distilled water and placed onto a shaker plate for about ten minutes, and then transported to a petri dish.
4. The SDS solution was poured into each petri dish until each piece of apple or spinach was covered, and the petri dish was then placed onto a shaker plate for six hours.

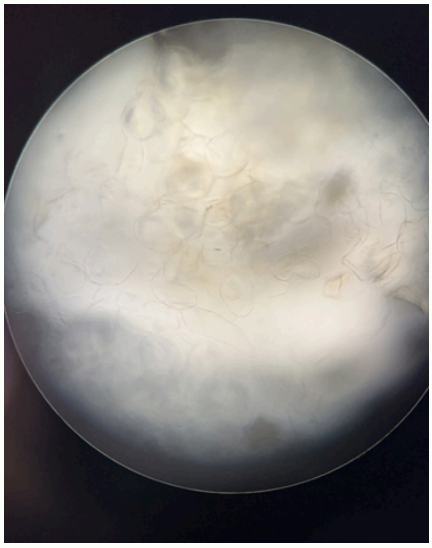
We were able successfully decellularize the plum, kiwi, celery, and kale tissue samples. Celery and kale tissue had the most success, with no remaining cells and an intact extracellular matrix. However, it is worth noting that plum and kiwi samples still mostly decellularized but still contained very few cells.


The plant tissue before 24 hours in the SDS solution

Decellularized kale sample

Decellularized plum tissue

The apple and spinach tissue after 24 hours in the SDS solution



**Recellularization - school year, all members, cost: $552**

Once a scaffold has been isolated, the next step in the tissue engineering process is recellularization, the process of repopulating the extracellular matrix with cells (usually stem cells). In previous years, the PV BMES chapter has attempted to create a callus of carrot cells to recellularize scaffolds with. However, contamination issues had taken their toll.

Naturally, science is a collaborative process. As a result, we reached out to a local botanist, Dr. Arias, for her assistance and advice for our next steps. Together, we designed a tiered process for scaffold validation. The tiered process is listed here:

Tier 1: Recellularize the scaffolds with plant cells: Although this is the first tier of testing, it is still extremely difficult to execute, as our contamination difficulties have proved. In fact, to date, we cannot find any manuscripts which have successfully attempted to recellularize a plant-based scaffold with plant cells. This is likely due to the rigid, immobile nature of most plant cells; the plant's cellulose-based cell walls make it difficult for it to migrate and integrate into the scaffold. As a result, being able to carry out tier 1 will be a historic first.

Tier 2: Recellularize the scaffolds with animal cells. Once tier 1 is completed with no contamination issues, tier 2 will be the next step. Currently, cells such as bovine satellite cells, mouse osteoblasts, and/or stem cells are being considered.

Going forward, we hope to continue this project next year with a different cell type. If possible, our club would like to obtain animal cells and begin the project shortly after the school year so that we may have more time to produce viable results.

Every year, millions of lives are affected by medical conditions that require sophisticated technologies to treat. The demand for advanced medical devices is critical for the diagnosis and treatment of various diseases. Photolithography, a technology used in manufacturing devices, is essential to increasing the quality of health care. For example, microfluidics technology, made possible by photolithography, is critical for establishing precise controls over small fluid amounts, which enhances drug delivery efficiency and allows for the creation of "organ-on-a-chip", which are currently being investigated as an alternative to animal models for drug testing.
This year, the PV BMES chapter has concentrated on exploring the use of photolithography and its application to creating intricate designs that holds the potential to advance health care technology. Our focus is applying these methods to nanotechnology, such as dihybrid swimmers, which can be used for drug delivery.
Photolithography consists of five steps, as explained by Vasilev 2023. They are:

1. Substrate preparation: Wafer is baked, cleaned, and coated with a barrier layer.
2. Photoresist coating: Wafers are coated with a thin layer of photoresist using a spin-coater.
3. Soft baking: Most of the solvent is removed from the photoresist, rendering the resist-layer photoresist.
4. Photomask alignment and pattern exposure: The photomask is usually made of quartz, with features patterned with metal. An optical system is used to etch the patterns onto the silicon wafer.
5. Post-exposure baking and pattern transfer: The process is now complete, and there the pattern is hardened (if needed) for future use.

This year, we have successfully obtained the myriad of materials required for our foray into photolithography. In addition, we reached out to the University of South Florida (USF)'s microfabrication and nanotechnology department to use their equipment for our work, and they agreed. We are extremely grateful for their support, and some of our members are currently undergoing training to use the photolithographic equipment over the summer. With the current rate of progress, we expect to finish this project by the end of 2025.

# XIV. National BMES Meeting

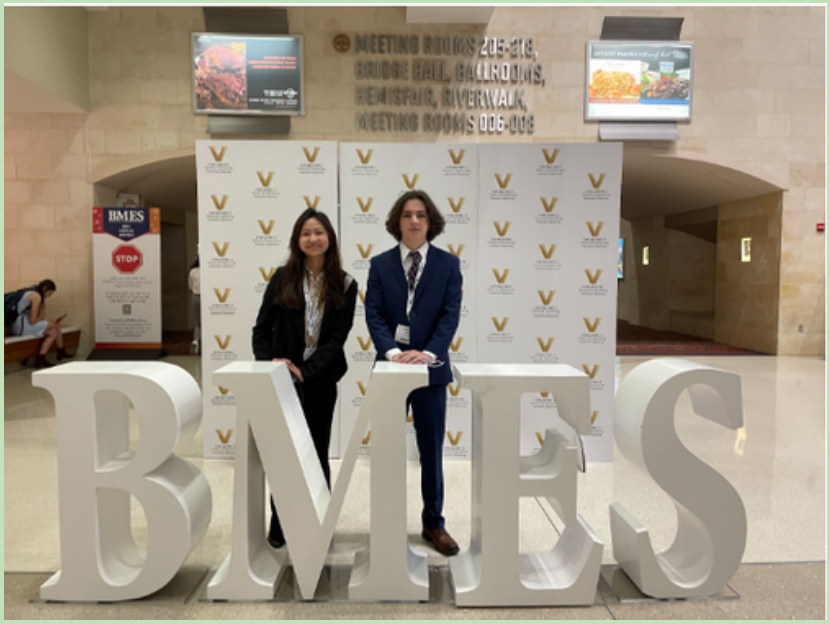
BMES Club Member Aadi Bhensdadia worked on a research project where he used bioprinting to develop an improved aortic valve prosthesis. After over 80 failed prototypes, he settled on 2 prototypes, which were tested through a combination of physical and computational testing methods.

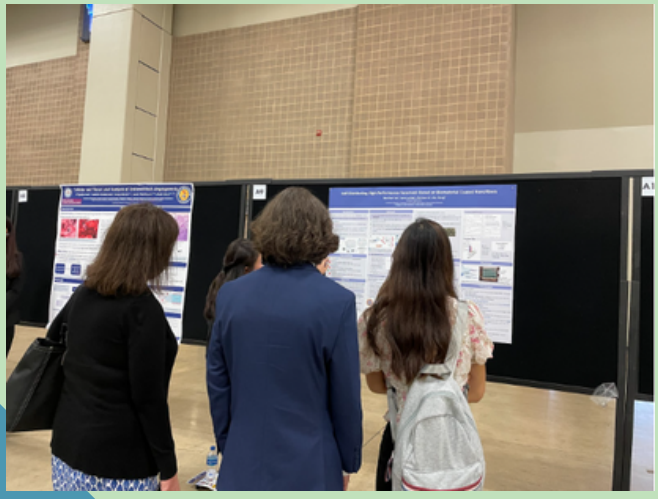
BMES Club member Xinyi Liu worked on a research project where she redesigned the single chain fragment variable to create a pocket in the antibody away from its normal binding site. Through various docking and molecular dynamics simulation runs, she was able to optimize this binding pocket so that it becomes a fluorogen-activating site, where fluorogens can bind to scFv and create a fluorescent complex. She created a library of redesigned scFv's and planned to screen this library's ability to capture fluorogens. She later submitted her research to the BMES late abstract submission, and was accepted to present her research poster at the National BMES meeting.

Due to age limits, both Xinyi Liu and Aadi Bhensdadia were not able to attend the national BMES meeting. However both students plan on submitting their research to the BMES high school research poster competition in the following years for a chance to compete at the National BMES Meeting, to connect with the aspiring scientists, as well as to network with research professionals and experts in the field of biomedical engineering.

In 2022, PV BMES had the opportunity to attend the annual BMES meeting. Krystal Tran and Jack Suchora represented our chapter at the conference.

## Pictures from the 2022 BMES Conference:



# XV. Future Direction

In the 2022-23 academic year, PV BMES remained on the trajectory set by the previous years. The club gained many new members through our extensive outreach and we had the opportunity to learn about the numerous projects completed by other BMES chapters, which has inspired some of our ideas for a new project next year. Also due to our outreach, the club was able to inspire more prospective members to join the club when they become eligible. Furthermore, our club was able to strongly connect with our members to create a deeper understanding of the biomedical sciences through hands-on learning, individual research, and presentation. PV BMES also achieved its professional goal of teaching its members proper laboratory techniques and the skills required to pursue a career in biomedical engineering.

Through our communications with the UCLA BMES chapter, members saw the true potential of PV BMES. Some members verbally expressed the profound impact that the work of UCLA BMES had on them and explained that they were now motivated to continue our current work.

The long-term goals for the PV BMES are to increase membership and encourage interest in subjects related to biomedical engineering. In the past, our club has succeeded in teaching students about STEM-related topics, so we aim to focus more on current impactful research being done in the fields of technology and medicine.

PV BMES leadership has set an ambitious goal of passing a plant-based decellularized scaffold through tier 1 of scaffold validation by early 2025 (validation process outlined in Societal Impact). Completion of Tier 2 is expected by mid to late 2025, depending on how logistical factors play out.

We are making good progress on the photolithography project. By mid to late 2025, we expect to have an etched silicon wafer that can be used for nanotechnology fabrication.

In the upcoming year, club officers largely aim to increase participation in the research projects. We hope for more members to have hands-on opportunities to learn so that they may familiarize themselves with more lab techniques and safety protocols. Officers should take the time to kindly interact with current and new members as they thoroughly explain the background, goals, and procedures for research. The Pine View Biomedical Engineering Society chapter hopes to continue to create a lasting effect on our members and community through our research in biomedical engineering.

# Outline of Current Goal Achievements

Much has been done towards our goal of furthering biomedical engineering and fostering a sense of excitement for the field. Our membership has grown significantly over the previous years, and we are working towards adding even more members in the years ahead. Compared to where we started several years ago, we have made significant strides forward in our decellularized scaffold and now have fully decellularized, intact scaffolds. With the establishment new validation goals, we have created a framework to build on for the next year to successfully complete the project.
Despite logistical challenges, our photolithography project is proceeding well. All materials required for work have been obtained, as has permission to use equipment from the University of South Florida. It is our hope that PV BMES continues on this exciting trajectory towards the future of biomedical engineering.