2019

RESEARCH JOURNAL

UNDERGRADUATE RESEARCH PROGRAM

UCLA Samueli School of Engineering

Table of Contents

Student Research Abstracts & Posters

Poster Symposium and Awards Ceremony | May 21, 2019

5:00 PM - 5:05 PM	Announcement (William Herrera)
5:05 PM - 5:50 PM	Poster presentations
	– DCAB will use a 10-point rubric to score each poster
5:50 PM - 6:00 PM	Break / Transition to Mong Auditorium for Awards Ceremony
6:00 PM - 6:30 PM	Awards Ceremony
	– Dean Murthy will be giving a short welcome and discuss the importance of undergraduate research. Dean Murthy will then be handing out certificates and awards.

DEAN'S MESSAGE

The Undergraduate Research Program's (URP) provides participants with research experience in a wide range of engineering fields. Undergraduate students participate in research with UCLA faculty and research teams to gain real-world lab experience. URP's mission is to help students communicate the results of their research projects. As part of this program, URP students:

- Meet and network with peers who have similar goals and interests
- Learn to communicate research outcomes by participating in Technical Presentation Labs
- Create a professional scientific poster of their research
- Write and publish a research abstract
- Present a detailed Summary of Project
- Become more competitive when applying to engineering graduate schools

This year, 12 Samueli undergraduate students were selected to join the 2018-19 URP cohort. I would like to congratulate this 2nd URP class on completing their amazing research projects. Creating new knowledge is a very important, and very difficult, task. These high-performing students have done an outstanding job balancing their normal academic course load with the rigorous demands of research. They should be very proud of the abstracts and posters they have published today. I encourage you to meet the students, ask questions about their projects, and learn about the amazing new knowledge that is being created here at the UCLA Samueli School of Engineering.

Sincerely,

Jayathi Murthy
Ronald and Valerie Sugar Dean

Brian Chap

Electrical Engineering

Freshman

LAB NAME

Device Research Lab

FACULTY ADVISOR

Kang L. Wang & Philippe Sautet

GRADUATE STUDENT DAILY LAB SUPERVISOR

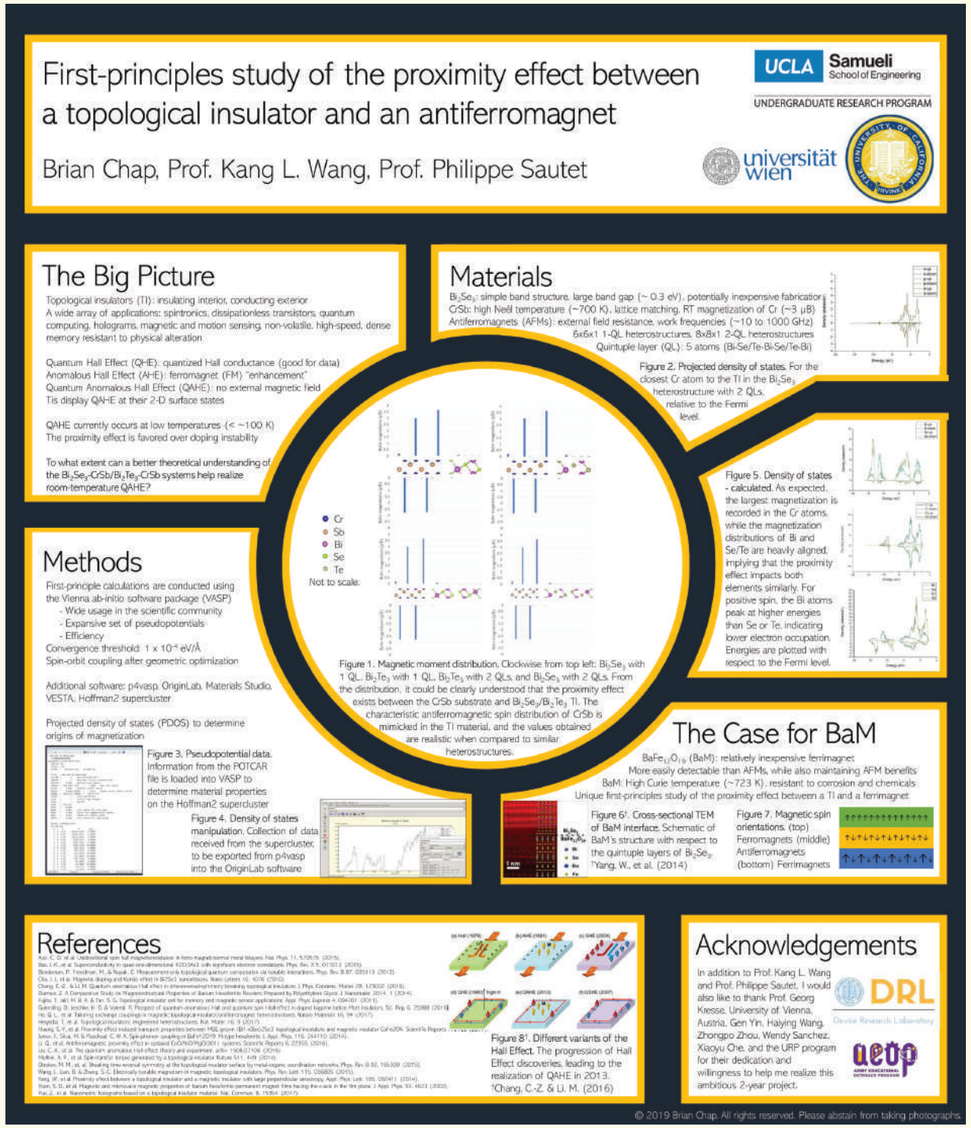
N/A

DEPARTMENT

Electrical and Computer Engineering

First-Principles Study of the Proximity Effect Between a Topological Insulator and an Antiferromagnet

Proximity effects between topological insulators (TIs) and magnetic materials are currently one of the most promising approaches to realizing the room-temperature Quantum Anoma- lous Hall Effect (QAHE), with potential applications in dissipationless transistors, magnetic sensing, and motion sensing. First-principles calculations using the Vienna ab initio simu- lation package (VASP) for density-functional theory (DFT) are performed on the interfaces between Bi2Se3 and Bi2Te3 TI and the antiferromagnet CrSb, selected for its similar lattice parameters that enable accurate measurement and high Ne´el temperature. Results are also pending for the ferrimagnet BaM (BaFe12O19), chosen for its insulating behavior, via the Perdew-Burke-Ernzerhof (PBE) functional. The first-principles study is expected to be the first to analyze the proximity effect between a TI and a ferrimagnet, with the effects of vary- ing quintuple layers and Se/Te substitutions in the heterostructure incorporated. Analysis of the charge contributions of atoms in the heterostructure and spin-DOS calculations are performed and experimental verification of the BaM data is expected to occur in the near future. Combined with the relative affordability of most materials used in this study, the case for using the proximity effect in order to establish QAHE at room temperature is anticipated to be greatly strengthened, with foreseeable uses in quantum computing and non-volatile, high speed, and high density memory resistant to damage.



Jessica Chun

Bioengineering

Junior

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Nasim Annabi

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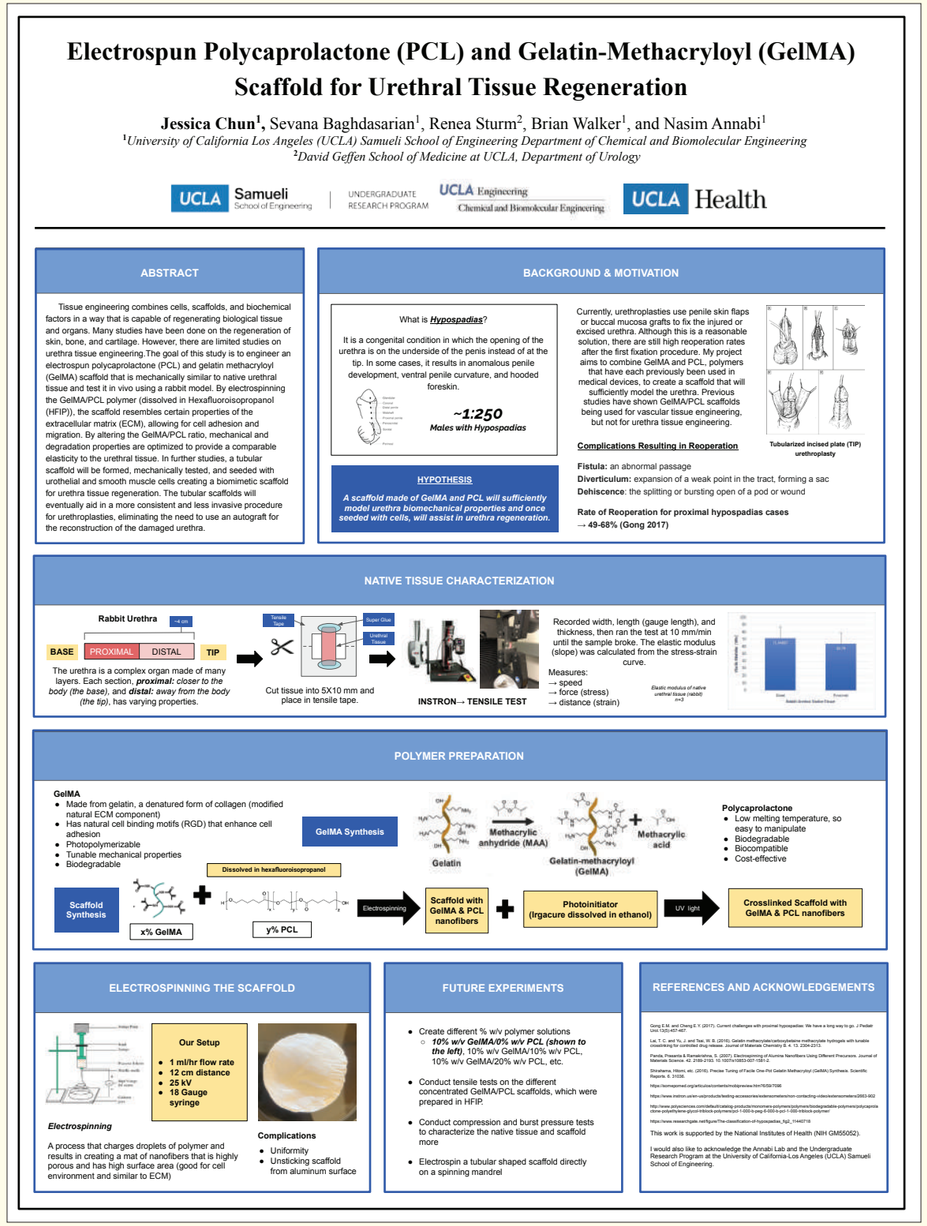
Sevana Baghdasarian

DEPARTMENT

Chemical Engineering

Electrospun polycaprolactone (PCL) and gelatin-methacryloyl (GelMA) scaffold for urethral extension in a rabbit model

Tissue engineering combines cells, scaffolds, and biochemical factors in a way that is capable of regenerating biological tissue and organs. Many studies have been done on the regeneration of skin, bone, and cartilage. However, there are limited studies on urethra tissue engineering.The goal of this study is to engineer an electrospun polycaprolactone (PCL) and gelatin methacryloyl (GelMA) scaffold that is mechanically similar to native urethral tissue and test it in vivo using a rabbit model. By electrospinning the GelMA/PCL polymer (dissolved in Hexafluoroisopropanol (HFIP)), the scaffold resembles certain properties of the extracellular matrix (ECM), allowing for cell adhesion and migration. By altering the GelMA/PCL ratio, mechanical and degradation properties are optimized to provide a comparable elasticity to the urethral tissue. In further studies, a tubular scaffold will be formed, mechanically tested, and seeded with urothelial and smooth muscle cells creating a biomimetic scaffold for urethra tissue regeneration. The tubular scaffolds will eventually aid in a more consistent and less invasive procedure for urethroplasties, eliminating the need to use an autograft for the reconstruction of the damaged urethra.



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Chemical Engineering

Synthesis and Characterization of Elastin-like Polypeptides (ELPs) and Gelatin-Methacrvyloyl (GelMA) Hydrogels for Lung Sealant Application

Sutures and staples are currently the conventional method for lung repair, but these techniques are associated with secondary tissue trauma, and infections. Instead of these two methods, we developed an adhesive and elastic hydrogel that may be used as a lung sealant. As a surgical sealant, we synthesized hydrogels with varying concentrations of proteins gelatin methacryloyl (GelMA) and elastin-like polypeptide (ELP). GelMA is a chemically modified form of gelatin that exhibits robust mechanical and biodegradation properties, and has the ability to support cell adhesion via RGD peptide sequences. ELP is a modified form of the extracellular matrix protein elastin. I specifically aimed to characterize the degradation profiles, swelling properties, and burst pressure using an ex vivo porcine lung model of these hydrogels. These experiments showed the ability to optimize the degradation of the hydrogels based on concentration and to adhere to lung tissue while holding air pressure from mechanical ventilation. This ELP-GelMA hydrogel has the potential of surgical applications with its ability to impart different properties that may closely mimic those of native tissues decreasing secondary tissue trauma and allowing for tissue recovery.

Synthesis and Characterization of Elastin-like Polypeptides (ELPs) and Gelatin-Methacryloyl (GelMA) Hydrogels for Lung Sealant Application

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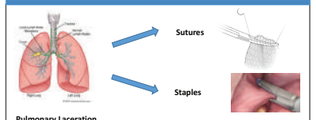
UCLA Samueli School of Engineering

UNDERGRADUATE RESEARCH PROGRAM

Abstract

Sutures and staples are currently the conventional method for lung repair, but these techniques are associated with secondary tissue trauma, and infections. Instead of these two methods, we developed an adhesive and elastic hydrogel that may be used as a lung sealant. As a surgical sealant, we synthesized hydrogels with varying concentrations of proteins gelatin methacryloyl (GelMA) and elastin-like polypeptide (ELP). GelMA is a chemically modified form of gelatin that exhibits robust mechanical and biodegradation properties, and has the ability to support cell adhesion via RGD peptide sequences. ELP is a modified form of the extracellular matrix protein elastin. I specifically aimed to characterize the degradation profiles, swelling properties, and burst pressure using an *ex vivo* porcine lung model of these hydrogels. These experiments showed the ability to optimize the degradation of the hydrogels for surgical applications based on concentration and to adhere to lung tissue while holding air pressure from mechanical ventilation.

Background



Goal: Photocrosslinkable Hydrogel as Sealant Material

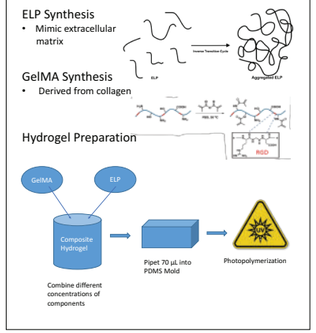
- Hydrogel acts as a scaffold platform for tissue engineering
- Mimic the native tissue of the lung
- Degrade within a certain time frame to allow cell proliferation
- Use crosslinking for strong mechanical properties
- Hold a high enough burst pressure so no air leakage from initial incision

Materials & Methods

ELP Synthesis
- Mimic extracellular matrix

GelMA Synthesis
- Derived from collagen

Hydrogel Preparation



Porcine Ex-vivo Lung Incision Model

1. Cut incision into lung to model surgical lobectomy

2. Apply composite hydrogel and photo crosslink

3. Using ventilator and pressure sensor, get measurements for at which the sealant holds

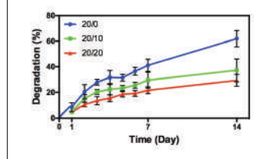
4. Porcine lung is placed in a water bath to determine burst pressure

Depending on the concentration of ELP, the burst pressure will differ. At burst pressure, the sealant no longer holds and will release air.

Hydrogel Degradation

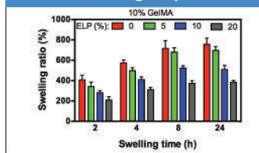
Hydrogel Swelling Analysis

Degradation Profiles



Degradation profiles for composite hydrogels of 20% (w/v) GelMA and 0%, 10% and 20% (w/v) of ELP. Degradation (%) vs. Time (Day). Samples were incubated for 1, 2, 3, 4, 5, 6, 7 and 14 days with collagenase II to determine the initial and final mass.

Swelling Properties



Swelling properties for composite hydrogels of 10% (w/v) GelMA and 0%, 5%, 10%, and 20% (w/v) of ELP. Samples were incubated for 2, 4, 8, 24 hours with DPBS to determine the initial and final mass.

Conclusions

- This work demonstrates a method of ELP-GelMA composite, photocrosslinkable hydrogel as a surgical sealant
- GelMA is derived from collagen, so as a natural polymer it is able to degrade more easily than ELP
- ELP has high hydration properties that allow for swelling
- Different concentrations of ELP vs. GelMA in a hydrogel allow the properties to be tunable depending on the surgical application
- Able to change the optimal timeframe of hydrogel in the body based on concentration of ELP
- As a lung sealant, with high burst pressure it can seal air flow and keep function of organ to allow mobility

Future Directions

- Testing different properties of the hydrogel including biocompatibility, mechanical and adhesive properties to get a holistic results of the hydrogel in-vitro
- Applying and tailoring this hydrogel to different types of tissue in the body by changing degradation, swelling, burst pressure properties, etc.
- In-vitro studies of the surgical sealant on a porcine lung

References & Acknowledgments

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B Hutson, C. *et al. Synthesis and Characterization of Tunable Poly(Ethylene Glycol): Gelatin Methacrylate Composite Hydrogels. Tissue engineering. Part A* **17,** (2011).
Tamayol, A., Annabi, N. & Khademhosseini, A. Biomaterials Synthesis, properties , and biomedical applications of gelatin methacryloyl (GelMA) hydrogels. *Biomaterials* **73,** 254–271 (2015).

Thank you to the Annabi Lab at UCLA Samueli School of Engineering and UCLA Samueli Engineering Undergraduate Research Program.

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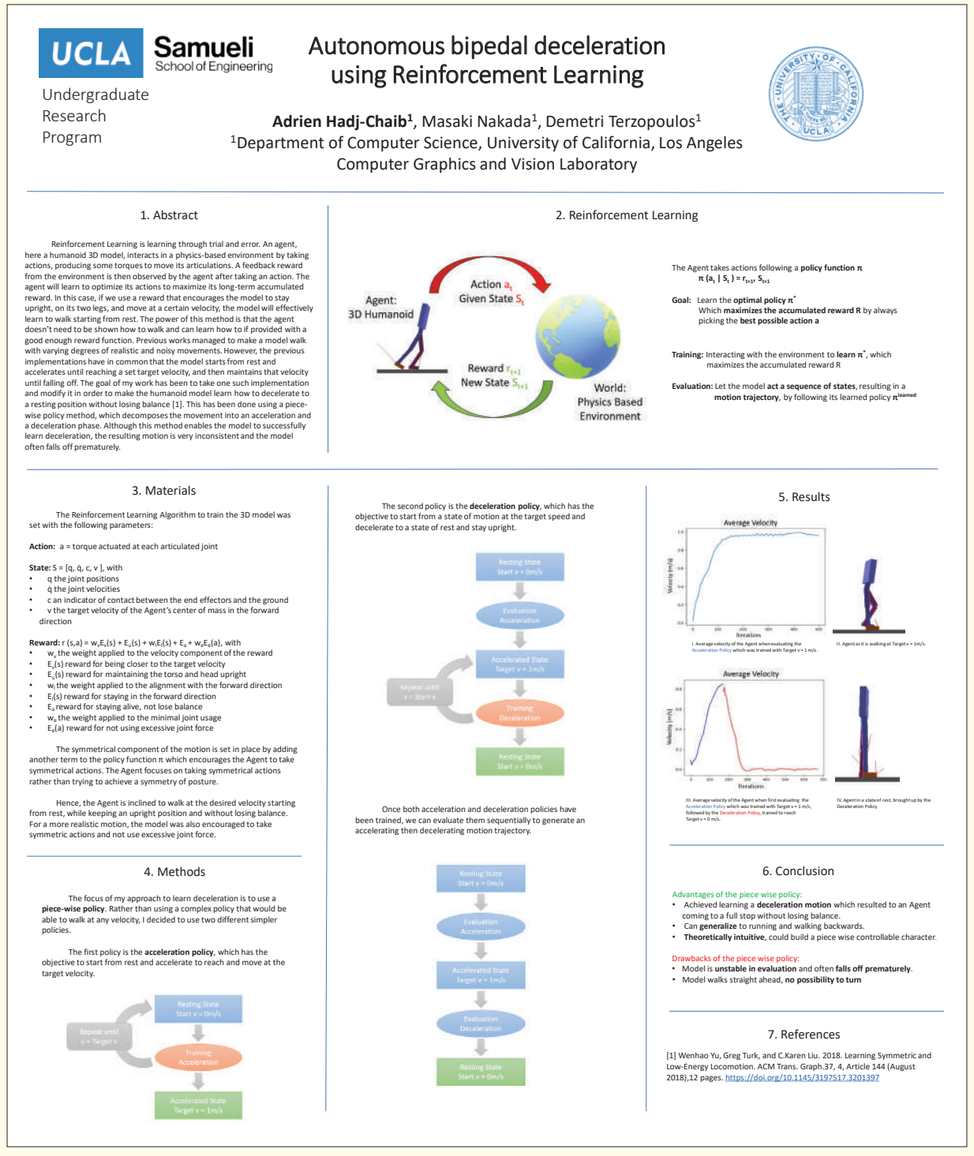
Autonomous Bipedal Deceleration using Reinforcement Learning

Reinforcement Learning is learning through trial and error. An agent, here a humanoid 3D model, interacts in a physics based environment by taking actions, producing some torques to move its articulations. A feedback reward from the environment is then observed by the agent after taking an action. The agent will learn to optimize its actions to maximize its long term accumulated reward. In this case, if we use a reward that encourages the model to stay upright, on its two legs, and move at a certain velocity, the model will effectively learn to walk starting from rest. The power of this method is that the agent doesn't need to be shown how to walk, and can learn how to if provided with a good enough reward function. Previous works managed to make a model walk with varying degrees of realistic and noisy movements. However, the previous implementations have in common that the model starts from rest and accelerates until reaching a set target velocity, and then maintains that velocity until falling off. The goal of my work has been to take one such implementation and modify it in order to make the humanoid model learn how to decelerate to a resting position without losing balance. This has been done using a piece-wise policy method, which decomposes the movement into an acceleration and a deceleration phase. Although this method enables the model to successfully learn deceleration, the resulting motion is very inconsistent and the model often falls off prematurely.



UCLA Samueli School of Engineering

Undergraduate Research Program

Autonomous bipedal deceleration using Reinforcement Learning

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Computer Graphics and Vision Laboratory

1. Abstract

Reinforcement Learning is learning through trial and error. An agent, here a humanoid 3D model, interacts in a physics-based environment by taking actions, producing some torques to move its articulations. A feedback reward from the environment is then observed by the agent after taking an action. The agent will learn to optimize its actions to maximize its long-term accumulated reward. In this case, if we use a reward that encourages the model to stay upright, on its two legs, and move at a certain velocity, the model will effectively learn to walk starting from rest. The power of this method is that the agent doesn't need to be shown how to walk and can learn how to if provided with a good enough reward function. Previous works managed to make a model walk with varying degrees of realistic and noisy movements. However, the previous implementations have in common that the model starts from rest and accelerates until reaching a set target velocity, and then maintains that velocity until falling off. The goal of my work has been to take one such implementation and modify it in order to make the humanoid model learn how to decelerate to a resting position without losing balance [1]. This has been done using a piece-wise policy method, which decomposes the movement into an acceleration and a deceleration phase. Although this method enables the model to successfully learn deceleration, the resulting motion is very inconsistent and the model often falls off prematurely.

2. Reinforcement Learning

The Agent takes actions following a **policy function π**
$\pi(a_t \mid S_t) = r_{t+1}, S_{t+1}$

Goal: Learn the **optimal policy π*** Which **maximizes the accumulated reward R** by always picking the **best possible action a**

Training: Interacting with the environment to **learn π***, which maximizes the accumulated reward R

Evaluation: Let the model **act a sequence of states**, resulting in a **motion trajectory**, by following its learned policy $\pi^{learned}$

3. Materials

The Reinforcement Learning Algorithm to train the 3D model was set with the following parameters:

Action: a = torque actuated at each articulated joint

State: S = [q, q̇, c, v], with
- q the joint positions
- q̇ the joint velocities
- c an indicator of contact between the end effectors and the ground
- v the target velocity of the Agent's center of mass in the forward direction

Reward: $r(s,a) = w_v E_v(s) + E_c(s) + w_l E_l(s) + E_a + w_e E_e(a)$, with
- w_v the weight applied to the velocity component of the reward
- $E_v(s)$ reward for being closer to the target velocity
- $E_c(s)$ reward for maintaining the torso and head upright
- w_l the weight applied to the alignment with the forward direction
- $E_l(s)$ reward for staying in the forward direction
- E_a reward for staying alive, not lose balance
- w_e the weight applied to the minimal joint usage
- $E_e(a)$ reward for not using excessive joint force

The symmetrical component of the motion is set in place by adding another term to the policy function π which encourages the Agent to take symmetrical actions. The Agent focuses on taking symmetrical actions rather than trying to achieve a symmetry of posture.

Hence, the Agent is inclined to walk at the desired velocity starting from rest, while keeping an upright position and without losing balance. For a more realistic motion, the model was also encouraged to take symmetric actions and not use excessive joint force.

4. Methods

The focus of my approach to learn deceleration is to use a **piece-wise policy**. Rather than using a complex policy that would be able to walk at any velocity, I decided to use two different simpler policies.

The first policy is the **acceleration policy**, which has the objective to start from rest and accelerate to reach and move at the target velocity.

The second policy is the **deceleration policy**, which has the objective to start from a state of motion at the target speed and decelerate to a state of rest and stay upright.

Once both acceleration and deceleration policies have been trained, we can evaluate them sequentially to generate an accelerating then decelerating motion trajectory.

5. Results

I. Average velocity of the Agent when evaluating the Acceleration Policy which was trained with Target v = 1 m/s.

II. Agent as it is walking at Target v = 1m/s.

III. Average velocity of the Agent when first evaluating the Acceleration Policy which was trained with Target v = 1 m/s, followed by the Deceleration Policy, trained to reach Target v = 0 m/s.

IV. Agent in a state of rest, brought up by the Deceleration Policy

6. Conclusion

Advantages of the piece wise policy:
- Achieved learning a **deceleration motion** which resulted to an Agent coming to a full stop without losing balance.
- Can **generalize** to running and walking backwards.
- **Theoretically intuitive**, could build a piece wise controllable character.

Drawbacks of the piece wise policy:
- Model is **unstable in evaluation** and often **falls off prematurely**.
- Model walks straight ahead, **no possibility to turn**

7. References

[1] Wenhao Yu, Greg Turk, and C.Karen Liu. 2018. Learning Symmetric and Low-Energy Locomotion. ACM Trans. Graph.37, 4, Article 144 (August 2018),12 pages. https://doi.org/10.1145/3197517.3201397

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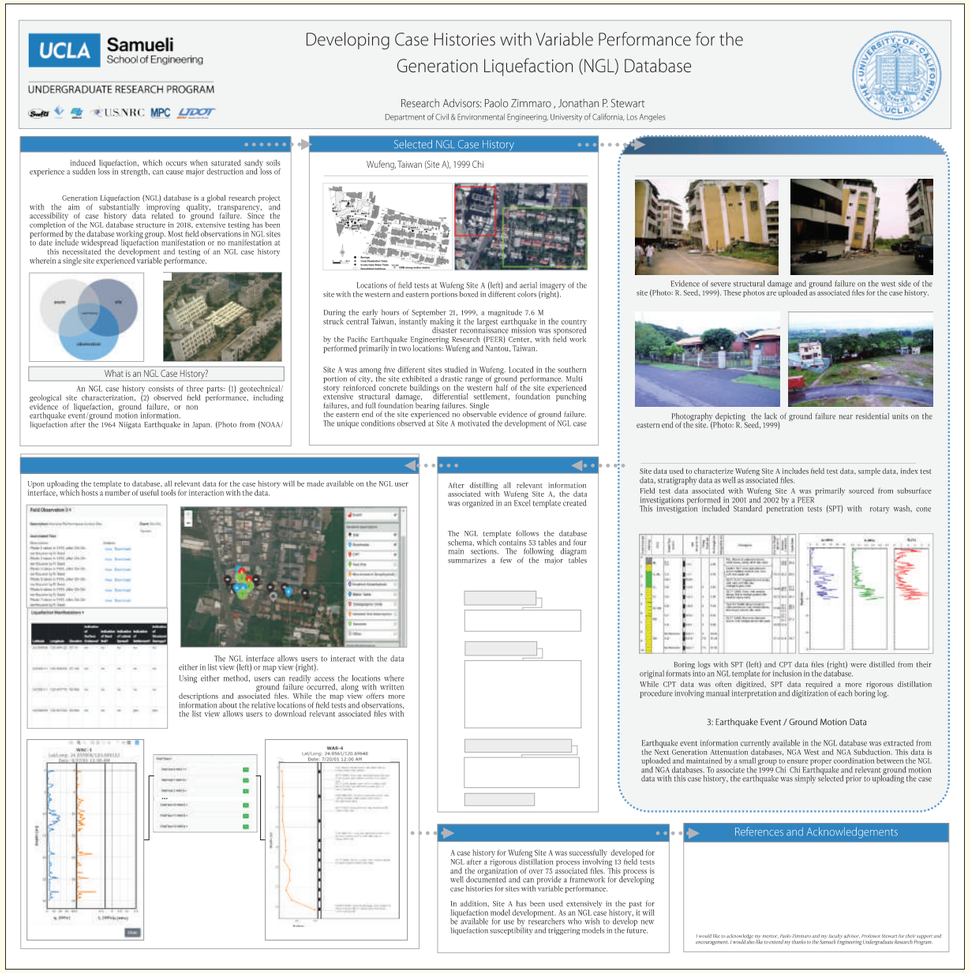
Developing Sites with Variable Performance for the Next-Generation Liquefaction (NGL) Case History Database

Earthquake-induced liquefaction typically occurs in loose saturated sandy soils that, under the cyclic loading imposed by the earthquake, experience a sudden loss in strength. This phenomenon can cause major destruction and loss of life. Current models used to evaluate liquefaction hazard are either purely empirical or semi-empirical, hence heavily reliant on case history data. The Next-Generation Liquefaction (NGL) database is a global research project with the aim of substantially improving quality, transparency, and accessibility of case history data related to liquefaction. Most field observations in NGL sites to date include widespread liquefaction manifestation or no manifestation at all – this necessitated the development and testing of an NGL case history wherein a single site experienced variable performance. This unique scenario was observed in Wufeng, Taiwan (Site A) after the 1999 Chi-Chi Earthquake, wherein the western half of the site suffered extensive ground failure and structural damage while the eastern portion experienced no observable surface evidence of ground failure. Using test data extracted from the Pacific Earthquake Research Center's (PEER) Taiwan Ground Failure Database and written field observations detailed in Chu et. al (2004), an NGL case history was successfully developed and uploaded to the database. In addition to providing a framework for sites with variable performance, data from this case history will be used to develop new liquefaction susceptibility and triggering models in the future.



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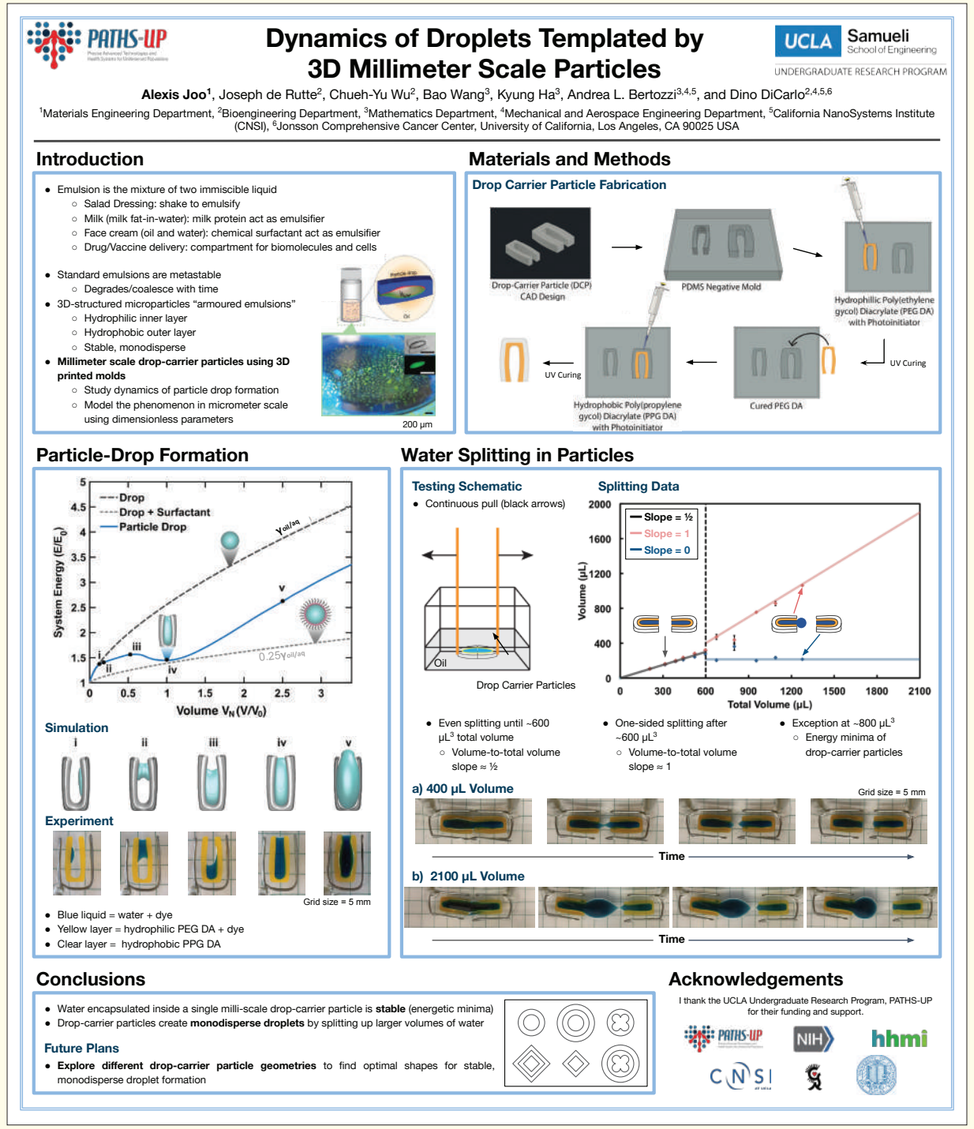
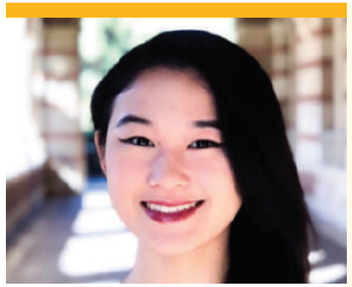
Bioengineering

Dynamics of Droplets Templated by 3D Millimeter Scale Particles

An emulsion is a mixture of two immiscible liquids that is found anywhere from the morning cup of milk (or cream in coffee) to cosmetic creams to micro-scale compartments for biomolecules and cells. Individual droplets within an emulsion system are typically stabilized by hydrophilic and hydrophobic molecules called surfactants, which form a thin layer between the two immiscible liquids. Although this approach is suitable for short term applications, the surfactant-stabilized droplets are metastable, meaning they will eventually coalesce over time to reach their thermodynamic equilibrium. Recently, we developed armoured emulsions which utilized 3D-structured microparticles to stabilize individual droplets. These drop-carrier-particles have an inner hydrophilic layer to capture and stabilize water droplets, and an outer hydrophobic layer to disperse the particles in oil and act as a barrier to coalescence. In contrast to typical emulsions, these armored emulsions have a local energetic minima which enables long term stability and controls the volume in each particle droplet. In order to further understand the mechanics of this system, millimeter scale particle droplets were fabricated using 3D printing and tested in PPG (an oil phase). The millimeter-scale version demonstrated stabilize monodisperse water droplets which agrees with both microscale experiments and simulations. In future work this millimeter-scale platform will be used to elucidate fundamental theories surrounding the physics of this new class of emulsions.





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Chemical Engineering

Optimizing Carbon Dioxide to Ethanol Conversion via the Symbiotic Metabolism of a Yeast and Cyanobacteria Co-culture

In the quest for energy independence, it is key to develop sustainable technologies for renewable energy. Simultaneously, carbon fixation is essential to reducing the atmospheric carbon dioxide contributing to rising global temperatures. One such technology that addresses both of these environmental concerns is the metabolic engineering of photosynthesis and fermentation. Photosynthetic cyanobacteria convert carbon dioxide to glucose while fermenting yeast converts glucose to ethanol and carbon dioxide. The co-dependent nature of these bioprocesses creates the opportunity to co-culture these organisms, producing a symbiotic system in which ethanol is the net product. Thus, this project investigates the growth rate of yeast to find metabolic controls and determine whether ethanol optimization is a viable application.

First, inoculums of the yeast S. cerevisiae BY 4742 and the cyanobacteria S. elongatus WT 7942 were isolation streaked to produce individual colonies. An individual colony of yeast was cultured with or without cyanobacteria in solutions of varying carbon sources and growth media, which were stored in a shaking incubator at 30°C. By monitoring optical density with the spectrophotometer over a week, the growth rate for each solution was found. The data appears to show that YNB/BG-11 is the preferential growth media and that a co-culture with cyanobacteria significantly improves the growth rate of yeast. Future work will use HPLC and YSI analyzers to quantify nutrient consumption and production secretion.

Optimizing Carbon Dioxide to Ethanol Conversion via the Symbiotic Metabolism of a Yeast and Cyanobacteria Co-culture

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UNDERGRADUATE RESEARCH PROGRAM

Introduction

- In the quest for energy independence, it is key to develop sustainable technologies for renewable energy. Simultaneously, it is of paramount importance to reduce the atmospheric carbon dioxide contributing to rising global temperatures.
- One technology that addresses both of these environmental concerns is metabolic engineering. Metabolic engineering is the field of optimizing specific chemical reactions in biological organisms.
- For example, photosynthetic cyanobacteria convert carbon dioxide to glucose while fermenting yeast converts glucose to ethanol and carbon dioxide. The co-dependent nature of these bioprocesses creates the opportunity to co-culture cyanobacteria and yeast, producing a symbiotic system in which ethanol is the net product.

Current Knowledge

- The current field of knowledge for yeast and cyanobacteria as separate organisms is extensive e.g. their optimal growth conditions, their metabolic reactions, and their potential applications in industry.
- In contrast, there is only one notable article researching a co-culture of yeast and cyanobacteria, which used a biotechnology approach to explore lipid production.[1]
- Therefore, this project aims to further investigate this topic by using a metabolic engineering approach with the goal of ethanol production.

Experimental Design

Approach

- I will investigate the growth rate of yeast when cultured with and without cyanobacteria in variations of carbon source and growth media.

No.	Organism(s)	Carbon Source	Growth Media
1	Yeast	Glucose	YNB
2	Yeast	Glucose	BG-11
3	Yeast	Acetic Acid	BG-11
4	Yeast	Glucose	YNB/BG-11
5	Yeast and Cyanobacteria	Glucose	YNB/BG-11
6	Yeast and Cyanobacteria	Acetic Acid	YNB/BG-11

Table 1. Experimental Design. For the organisms, yeast strain *Saccharomyces cerevisiae BY 4742* and cyanobacteria strain *Synechococcus elongatus WT (wild type) 7942* were used. For the yeast carbon source, glucose and acetate were in concentrations of 0.4 grams per liter. For the media, 1X Yeast Nitrogen Base (YNB) without amino acid additives and "Blue-Green algae" media 11 (BG-11) with 50 millimolar sodium bicarbonate were used.

Rationale:

- Experiments (exp.) 1, 2, and 4 controls carbon source to test yeast growth in variations of media e.g. yeast's YNB media, cyanobacteria's BG-11 media, and a combination of the two.
- Exp. 2 and 3 hold media constant to test yeast growth in two carbon sources e.g. glucose and acetic acid.
- Exp. 4 serves as a control for exp. 5 and 6, which test yeast growth in a co-culture with cyanobacteria on two differing carbon sources e.g. glucose and acetic acid.

Methods

Preparation of organisms

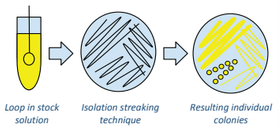

Figure 1. An inoculum of the yeast and cyanobacteria strains were each streaked for isolation using an inoculation loop, resulting in individual colonies.

Preparation of medias

Following "Table 1. Experimental Design," the correct carbon source and growth media were combined create 50 mL each of the six experimental variations.

Culturing organism into media

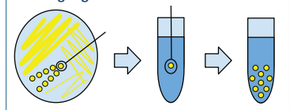

Figure 2. Inoculation loop inoculates, or transfers, an individual colony into the prepared media, in which it will grow for a week in a shaking incubator at 30° Celsius.

Growth Rate via Optical Density (OD)

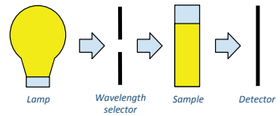

Figure 3. In a spectrophotometer, light from a lamp first passes through a wavelength selector. Then, the selected wavelength of light passes through the sample until it reaches a detector. The natural log of the detected number is called optical density (OD), an indicator of exponential cell growth. Measurements of OD were taken every other day for a week, forming a linear trend line with the growth rate as the slope.

Acknowledgements

I would like to thank Dr. Jun Park for kindly providing his conceptual ideas, support, and lab space. I would also like to thank Ph.D. candidate Derrick Chuang for providing the cyanobacteria. Lastly, thank you to the UCLA Samueli Engineering Undergraduate Research Program for improving my technical writing and presentation skills.

Reference

1. *Biotechnology for Biofuels, 2017, Volume 10, Number 1, Page 1.* Tingting Li et. Al.

Results

Experiments 1 – 4: Yeast Growth

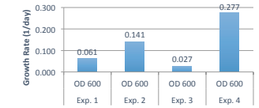

Table 2. Experiments 1 – 4: Yeast Growth. Exp. 1 and 2 show that BG-11 unexpectedly outperformed YNB media. Exp. 2 and 3 show that glucose outperforms acetic acid. Exp. 4 shows that YNB/BG-11 media outperforms either component alone.

Experiment 5: Co-culture with glucose

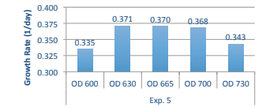

Table 3. Experiment 5: Co-culture with glucose. The optimal wavelengths to measure optical density are 600 nanometers (nm) and 730 nm for yeast and cyanobacteria respectively. Thus, the bell-like curve formed by this range of wavelengths demonstrates a balanced co-culture. The co-culture appears to have improved yeast growth by 150%, from 0.277 (Table 2. Exp. 4) to 0.335 day^{-1}.

Experiment 6: Co-culture with acetic acid

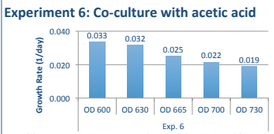

Table 4. Experiment 6: Co-culture with acetic acid. With growth rate decreasing from yeast's 600 nm wavelength to cyanobacteria's 730 nm, the results show an unbalanced co-culture dominated by yeast. However, the co-culture still appears to have improved yeast growth by 120%, from 0.027 (Table 2. Exp. 3) to 0.033 day^{-1}.

Conclusion

Hypothesis revisited and contributions:

- For carbon source, glucose is preferred over acetic acid. For growth media, YNB/BG-11 is preferred over BG-11, which outperforms YNB. Thus, this work contributes two types of metabolic control for yeast growth and renders YNB unnecessary for future experiments.
- The growth rate of yeast appears to have significantly improved via a co-culture with cyanobacteria. This supports the optimization of ethanol production and implies greater applications of co-cultures to a variety of co-dependent organisms.

Future Experiments and Progress

- High-performance liquid chromatography (HPLC) and the Yellow Springs Instrument (YSI) analyzer will quantify nutrient consumption and product secretion to confirm these preliminary results.
- Further variations of carbon source and growth media will be tested e.g. glucose with BG-11 media alone.

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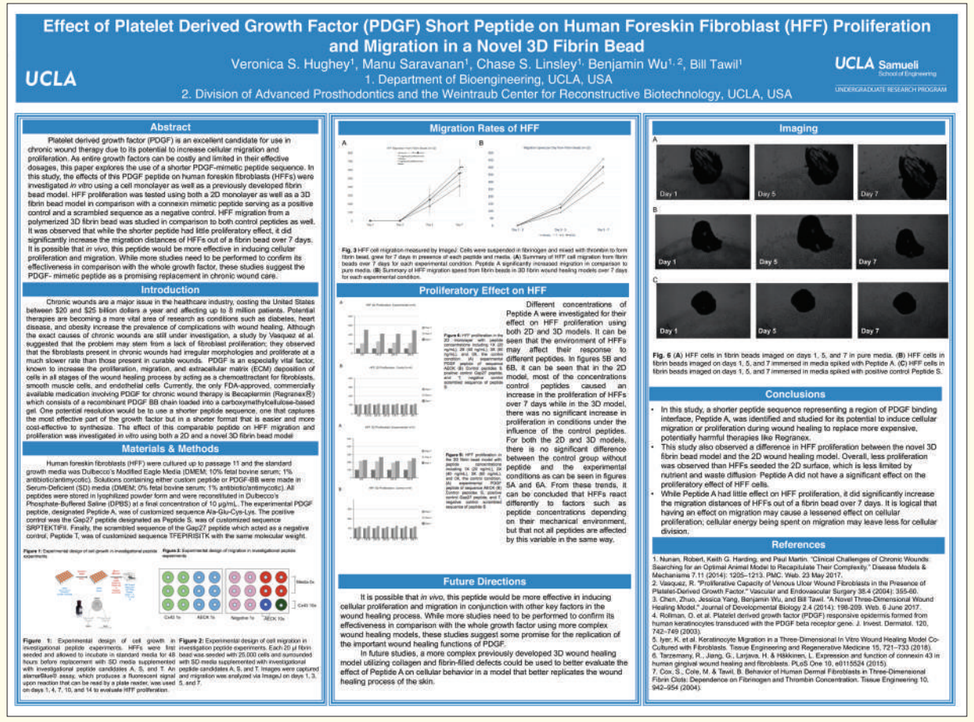
Effect of Platelet Derived Growth Factor (PDGF) Short Peptide on Human Foreskin Fibroblast (HFF) Proliferation and Migration

Chronic wounds are an increasingly prevalent problem in the healthcare industry with the recent rise in diabetes, heart disease, obesity, and other conditions that adversely affect the rate of wound healing. Platelet derived growth factor (PDGF) is an excellent candidate for use in chronic wound therapy due to its potential to increase cellular migration and proliferation. As entire growth factors can be costly and limited in their effective dosages, this paper explores the use of a shorter PDGF-mimetic peptide sequence. In this study, the effects of this PDGF peptide on human foreskin fibroblasts (HFFs) were investigated in vitro using a cell monolayer as well as a previously developed fibrin bead model. HFF proliferation was tested using both a 2D monolayer as well as a 3D fibrin bead model in comparison with a connexin mimetic peptide serving as a positive control and a scrambled sequence as a negative control. HFF migration from a polymerized 3D fibrin bead was studied in comparison to both control peptides as well. It was observed that while the shorter peptide had little proliferatory effect, it did significantly increase the migration distances of HFFs out of a fibrin bead over 7 days. It is possible that in vivo, this peptide would be more effective in inducing cellular proliferation and migration. While more studies need to be performed to confirm its effectiveness in comparison with the whole growth factor, these studies suggest the PDGF-mimetic peptide as a promising replacement in chronic wound care.



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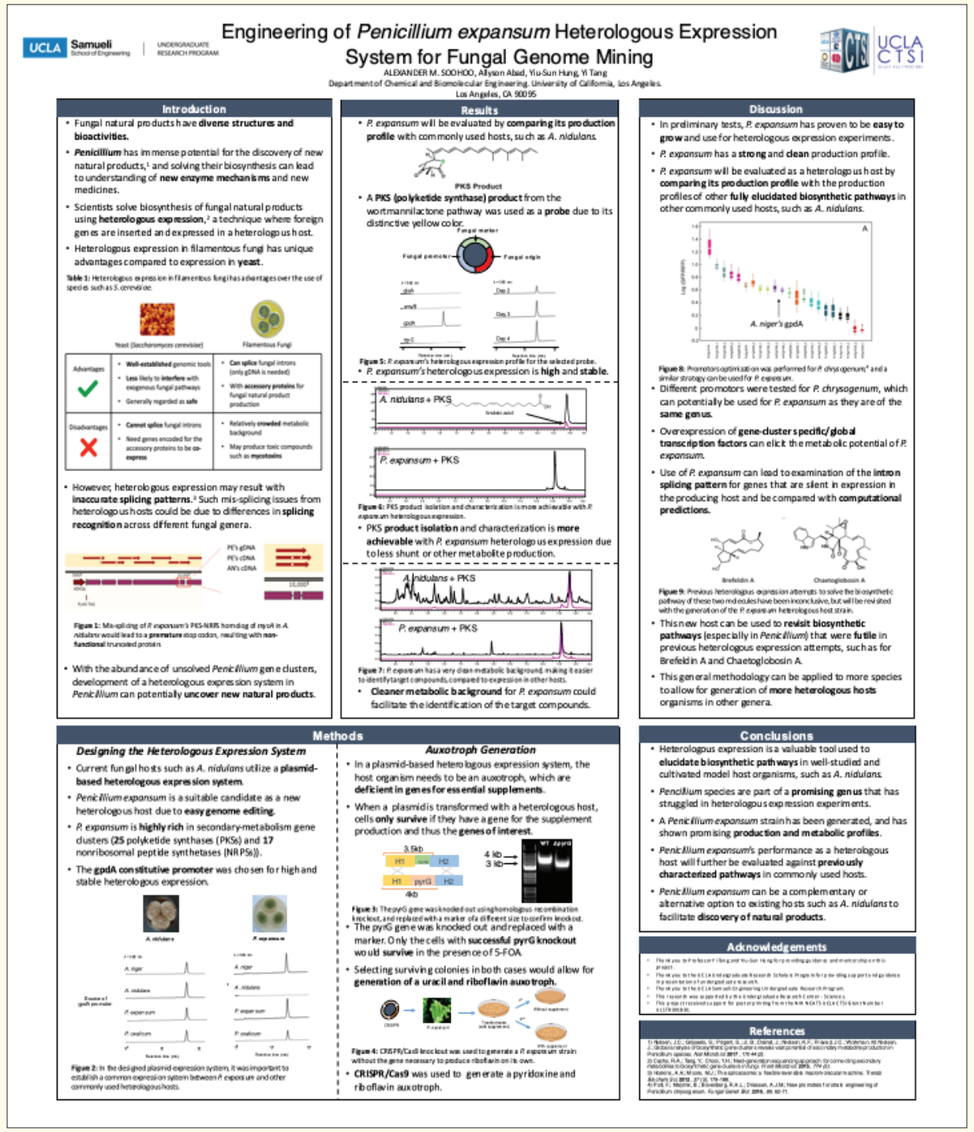
Engineering of Penicillium expansum as a New Heterologous Host for Natural Product Biosynthesis Elucidation

Heterologous expression is a technique commonly used in recombinant DNA technology to elucidate biosynthetic pathways of natural products. Compounds of interest can be investigated by expressing an organism's genomic DNA in a well-studied host. Genetic manipulation is more flexible in heterologous hosts, allowing for efficient discovery of the genes responsible for a compound's production. However, heterologous expression often fails due to differences in intron splicing and protein folding resulting from the large genetic differences between the native organism and the heterologous host. From prior experiments, results from the native organism Penicillium brefeldianum in the commonly used host S. cerevisiae have been inconsistent. Therefore, the focus turned to developing a new heterologous host, Penicillium expansum, to facilitate heterologous expression in Penicillium species, as there is likely conservation in chaperone proteins and intron splicing mechanisms of species within a genus. First, CRISPR/Cas9 gene editing and 5-FOA selection were used to generate an auxotrophic strain. Then, diverse groups of previously characterized fungal pathways were expressed to compare the performance of P. expansum with established hosts such as A. nidulans. The generated P. expansum strain will be available as a host for future heterologous expression experiments using Penicillium species, allowing for investigation of uncharacterized gene clusters.



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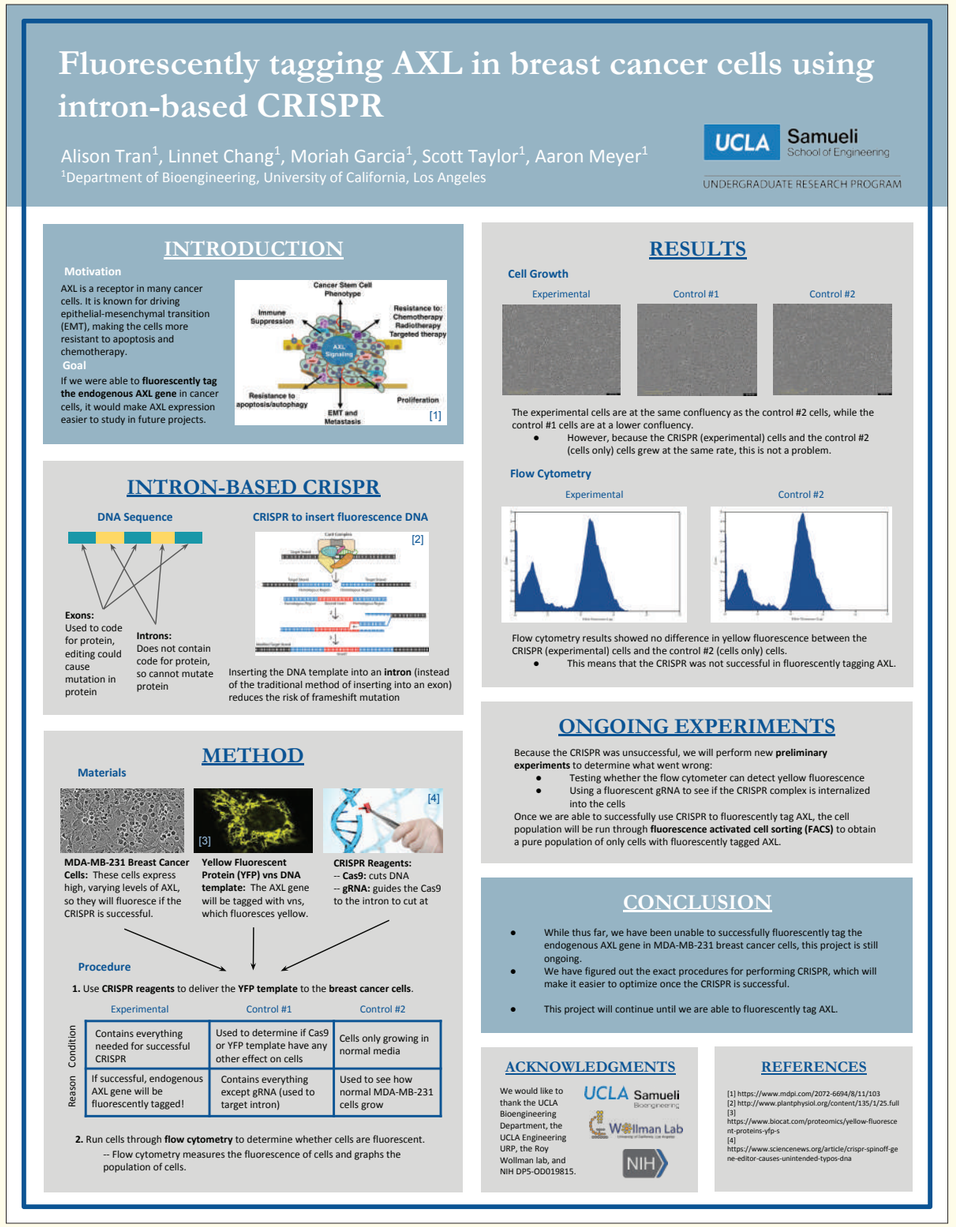
Bioengineering

Fluorescently Tagging the Endogenous AXL Gene in MDA-MB-231 Breast Cancer Cells Using CRISPR Intron Knock-In

Many cancer cells undergo epithelial-mesenchymal transition, which leads to metastasis and chemoresistance. Studies have shown that the expression of AXL, a member of the TAM family of receptor tyrosine kinases, contributes to inducing the mesenchymal state. Tagging the endogenous AXL gene with fluorescence would make it easier to study AXL in future research. Traditionally, endogenous genes are tagged by using CRISPR to attach the fluorescence template to the exon at the end of the gene sequence. Instead, by inserting the YFP template into an intron in the AXL gene sequence, the template can be generic. This simplifies the process by reducing the risk of frameshift mutation and allowing for homology-independent repair. Five different intron locations in the AXL gene sequence were chosen and CRISPR was performed to target those specific locations. The cells were then expanded and analyzed by flow cytometry. So far, flow cytometry results have not shown fluorescently tagged cells, but the project is still ongoing. Future experiments include testing whether the flow cytometer can detect the fluorescent tag, using fluorescent gRNA to see if the CRISPR complex is internalized into the cells, and eventually growing the cells out until they can be run through FACS. Successful fluorescent tagging of endogenous AXL would make it easier to visualize and quantify AXL expression in cells in future projects, and understanding AXL is important to improving cancer treatment and chemotherapy.



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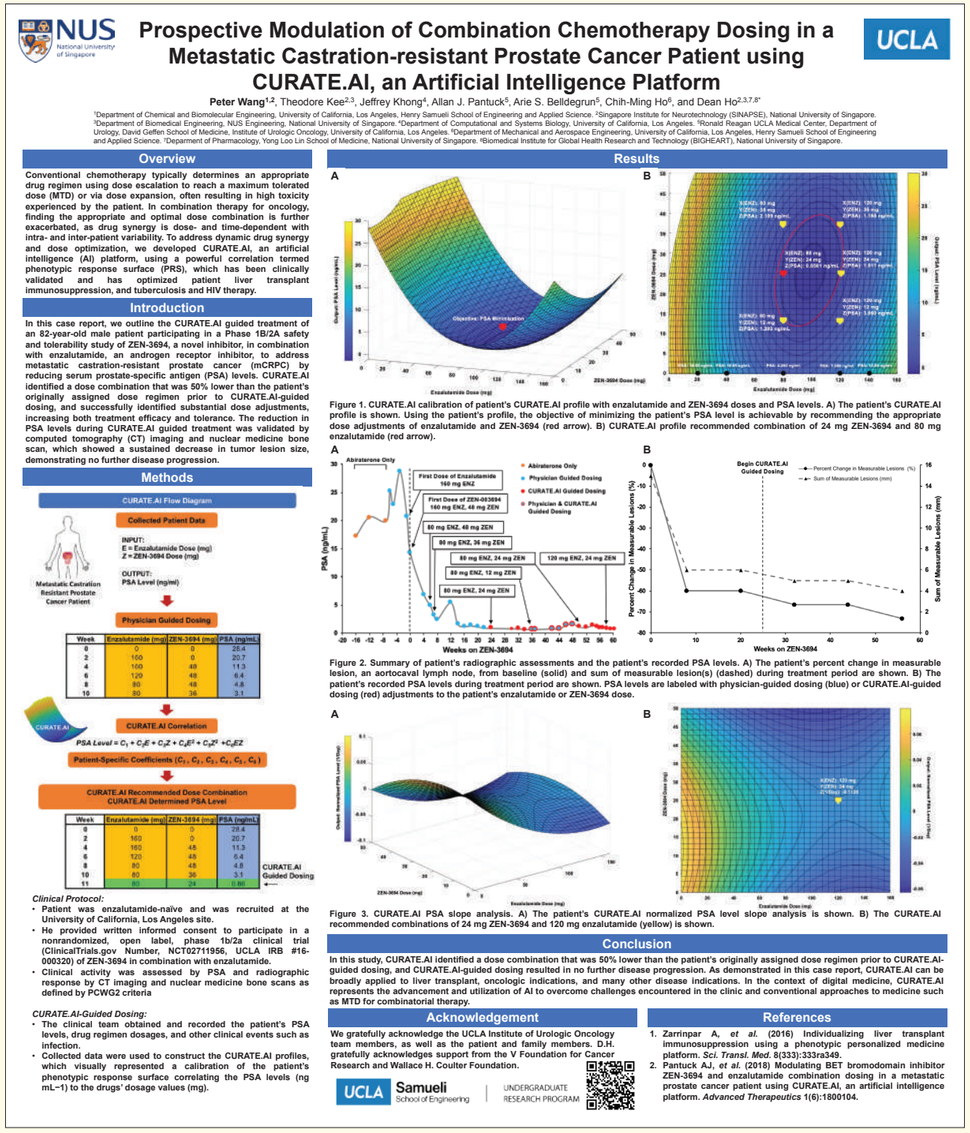
Prospective Modulation of Combination Chemotherapy Dosing in a Metastatic Castration-Resistant Prostate Cancer Patient using CURATE.AI, an Artificial Intelligence Platform

Conventional chemotherapy typically determines an appropriate drug regimen using dose escalation to reach a maximum tolerated dose or via dose expansion, often resulting in high toxicity experienced by the patient. In combination therapy for oncology, finding the appropriate and optimal dose combination is further exacerbated, as drug synergy is dose- and time- dependent with patient variability. To address dynamic drug synergy and dose optimization, we developed CURATE.AI, an artificial intelligence platform, using a powerful correlation termed phenotypic response surface, which has been clinically validated and has optimized patient liver transplant immunosuppression, and tuberculosis and HIV therapy. In this case report, we outline the CURATE.AI guided treatment of an 82-year-old male patient participating in a Phase 1B/2A safety and tolerability study of a novel inhibitor, in combination with enzalutamide, to address metastatic castration-resistant prostate cancer (mCRPC) by reducing serum prostate-specific antigen (PSA) levels. CURATE.AI identified a dose combination that was 50% lower than the patient's originally assigned dose regimen prior to CURATE.AI-guided dosing, and successfully identified substantial dose adjustments, increasing both treatment efficacy and tolerance. The reduction in PSA levels during CURATE.AI guided treatment was validated by computed tomography (CT) imaging and nuclear medicine bone scan, which showed a sustained decrease in tumor lesion size, demonstrating no further disease progression.



Prospective Modulation of Combination Chemotherapy Dosing in a Metastatic Castration-resistant Prostate Cancer Patient using CURATE.AI, an Artificial Intelligence Platform

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Overview

Conventional chemotherapy typically determines an appropriate drug regimen using dose escalation to reach a maximum tolerated dose (MTD) or via dose expansion, often resulting in high toxicity experienced by the patient. In combination therapy for oncology, finding the appropriate and optimal dose combination is further exacerbated, as drug synergy is dose- and time-dependent with intra- and inter-patient variability. To address dynamic drug synergy and dose optimization, we developed CURATE.AI, an artificial intelligence (AI) platform, using a powerful correlation termed phenotypic response surface (PRS), which has been clinically validated and has optimized patient liver transplant immunosuppression, and tuberculosis and HIV therapy.

Introduction

In this case report, we outline the CURATE.AI guided treatment of an 82-year-old male patient participating in a Phase 1B/2A safety and tolerability study of ZEN-3694, a novel inhibitor, in combination with enzalutamide, an androgen receptor inhibitor, to address metastatic castration-resistant prostate cancer (mCRPC) by reducing serum prostate-specific antigen (PSA) levels. CURATE.AI identified a dose combination that was 50% lower than the patient's originally assigned dose regimen prior to CURATE.AI-guided dosing, and successfully identified substantial dose adjustments, increasing both treatment efficacy and tolerance. The reduction in PSA levels during CURATE.AI guided treatment was validated by computed tomography (CT) imaging and nuclear medicine bone scan, which showed a sustained decrease in tumor lesion size, demonstrating no further disease progression.

Methods

Week	Enzalutamide (mg)	ZEN-3694 (mg)	PSA (ng/mL)
0	0	0	28.4
2	160	0	20.7
4	160	48	11.3
6	120	48	6.4
8	80	48	4.8
10	80	36	3.1

Week	Enzalutamide (mg)	ZEN-3694 (mg)	PSA (ng/mL)
0	0	0	28.4
2	160	0	20.7
4	160	48	11.3
6	120	48	6.4
8	80	48	4.8
10	80	36	3.1
11	80	24	(-) RI

Clinical Protocol:

- **Patient was enzalutamide-naive and was recruited at the University of California, Los Angeles site.**
- **He provided written informed consent to participate in a nonrandomized, open label, phase 1b/2a clinical trial (ClinicalTrials.gov Number, NCT02711956, UCLA IRB #16-000320) of ZEN-3694 in combination with enzalutamide.**
- **Clinical activity was assessed by PSA and radiographic response by CT imaging and nuclear medicine bone scans as defined by PCWG2 criteria**

CURATE.AI-Guided Dosing:

- **The clinical team obtained and recorded the patient's PSA levels, drug regimen dosages, and other clinical events such as infection.**
- **Collected data were used to construct the CURATE.AI profiles, which visually represented a calibration of the patient's phenotypic response surface correlating the PSA levels (ng mL−1) to the drugs' dosage values (mg).**

Results

Figure 1. CURATE.AI calibration of patient's CURATE.AI profile with enzalutamide and ZEN-3694 doses and PSA levels. A) The patient's CURATE.AI profile is shown. Using the patient's profile, the objective of minimizing the patient's PSA level is achievable by recommending the appropriate dose adjustments of enzalutamide and ZEN-3694 (red arrow). B) CURATE.AI profile recommended combination of 24 mg ZEN-3694 and 80 mg enzalutamide (red arrow).

Figure 2. Summary of patient's radiographic assessments and the patient's recorded PSA levels. A) The patient's percent change in measurable lesion, an aortocaval lymph node, from baseline (solid) and sum of measurable lesion(s) (dashed) during treatment period are shown. B) The patient's recorded PSA levels during treatment period are shown. PSA levels are labeled with physician-guided dosing (blue) or CURATE.AI-guided dosing (red) adjustments to the patient's enzalutamide or ZEN-3694 dose.

Figure 3. CURATE.AI PSA slope analysis. A) The patient's CURATE.AI normalized PSA level slope analysis is shown. B) The CURATE.AI recommended combinations of 24 mg ZEN-3694 and 120 mg enzalutamide (yellow) is shown.

Conclusion

In this study, CURATE.AI identified a dose combination that was 50% lower than the patient's originally assigned dose regimen prior to CURATE.AI-guided dosing, and CURATE.AI-guided dosing resulted in no further disease progression. As demonstrated in this case report, CURATE.AI can be broadly applied to liver transplant, oncologic indications, and many other disease indications. In the context of digital medicine, CURATE.AI represents the advancement and utilization of AI to overcome challenges encountered in the clinic and conventional approaches to medicine such as MTD for combinatorial therapy.

Acknowledgement

We gratefully acknowledge the UCLA Institute of Urologic Oncology team members, as well as the patient and family members. D.H. gratefully acknowledges support from the V Foundation for Cancer Research and Wallace H. Coulter Foundation.

References

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2. **Pantuck AJ, *et al.* (2018) Modulating BET bromodomain inhibitor ZEN-3694 and enzalutamide combination dosing in a metastatic prostate cancer patient using CURATE.AI, an artificial intelligence platform. *Advanced Therapeutics* 1(6):1800104.**

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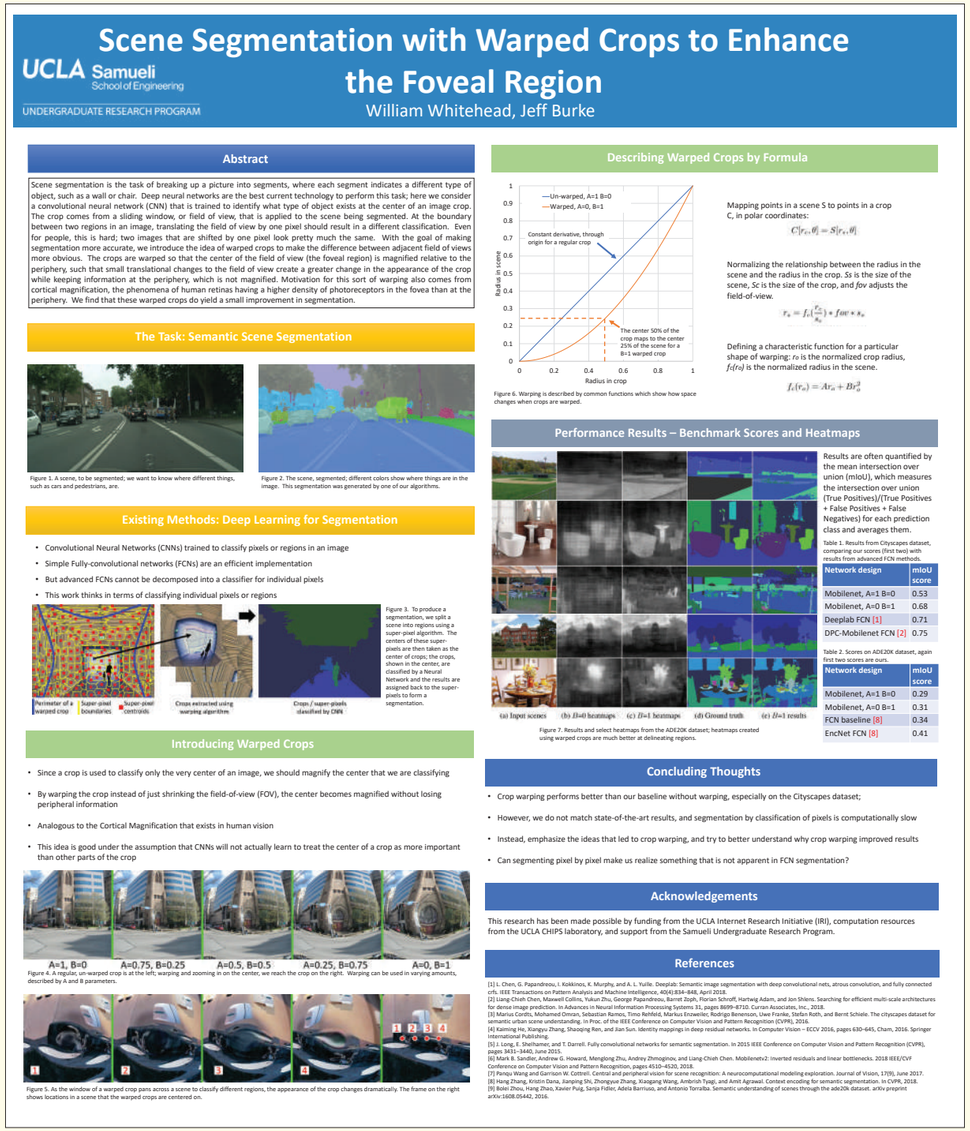
Theater, Film, and Television

Scene Segmentation with Warped Crops to Enhance the Foveal Region

Scene segmentation is the task of breaking up a picture into segments, where each segment indicates a different type of object, such as a wall or chair. Deep neural networks are the best current technology to perform this task; here we consider a convolutional neural network (CNN) that is trained to identify what type of object exists at the center of an image crop. The crop comes from a sliding window, or field of view, that is applied to the scene being segmented. At the boundary between two regions in an image, translating the field of view by one pixel should result in a different classification. Even for people, this is hard; two images that are shifted by one pixel look pretty much the same. With the goal of making segmentation more accurate, we introduce the idea of warped crops to make the difference between adjacent field of views more obvious. The crops are warped so that the center of the field of view (the foveal region) is magnified relative to the periphery, such that small translational changes to the field of view create a greater change in the appearance of the crop while keeping information at the periphery, which is not magnified. Motivation for this sort of warping also comes from cortical magnification, the phenomena of human retinas having a higher density of photoreceptors in the fovea than at the periphery. We find that these warped crops do yield a small improvement in segmentation.



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