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# 決賽時間表

2026 年 4 月 11 日 (六)

- 09:00 報到
- 09:30 開幕式
- 09:45 高中職個人組英文短講競賽
- 10:45 中場休息
- 11:00 國中個人組英文短講競賽
- 11:50 午休與海報參觀
- 13:00 進入競賽主會場
- 13:15 國中團體組英文短講競賽
- 14:00 中場休息與海報參觀
- 14:30 高中職團體組英文短講競賽
- 16:00 休息與海報參觀
- 16:40 評審講評
- 16:50 閉幕暨頒獎典禮
- 17:15 賦歸



## 主辦單位的話

### 搭建一個國中與高中職學生專屬的科學探究英文表達平台

聯合國強調永續發展目標 (SDGs) 是推動全球永續的重要策略，而基礎科學更是全球永續發展的根基。多年來，遠哲科學教育基金會致力於將這一理念轉化為具體的教育行動，培養下一代對科學的理解與熱情。此外，為拓展年輕學子的國際視野，並促進國際科學交流與合作，遠哲科學教育基金會積極舉辦各類工作坊與競賽，協助提升教師的雙語教學能力，並學習如何指導學生以英語進行科學口頭報告，進一步強化中學生的英語聽力、口語與表達能力。

「三分鐘英語科學創新挑戰賽 (3MinTalk4Science - Thinking Outside the Box Competition)」不僅是一場競賽，更是一個啟發與交流的平台，旨在培養學生的批判性思維、新創能力，以及對全球議題的敏銳觀察力。

我們期望參賽學生不僅為這場比賽而努力，更能在未來的學習與職涯發展中持續探索科學，並在相關領域中發揮所長，為世界與在地社會共同面對未來挑戰、尋求永續發展的解方。

財團法人遠哲科學教育基金會

董事長

何建明

## 發起人的話

「三分鐘英語科學創新挑戰賽 3MinTalk4Science – Thinking Outside the Box Competition」於 2026 年邁入第三年。本活動旨在透過參與歷程，培養學生的「五力一心」——敘事力、溝通力、想像力、創造力與行動力，並引導學生在科學學習中建立興趣與信心，進而關懷在地與全球永續議題，與世界接軌。

活動亦期待學生能以英語清晰而有力地表達其科學探究與實作成果，學習去蕪存菁、言之有物，並以證據支持論述，條理分明地傳達觀點，展現對全球永續議題的關懷與科學探究的精神，逐步成為具備全球素養的公民。

2026 年共有來自全國北、中、南、東 53 所學校、136 件作品、285 位學生參與，亦包含印尼泗水臺灣學校學生的加入。探究主題除基礎科學研究外，亦涵蓋多元的社會性科學議題，其廣度與深度皆展現在學生的作品與影音成果中。今年亦舉辦北、中、南三場校園說明會與教師工作坊，以及六場校園講座，使師生更深入理解活動的核心理念與實踐意義；同時，亦為進入決賽的同學提供線上輔導，協助其持續精進與突破。

我相信，每一位參與的同學，無論是否晉級決賽或獲獎，無論是獨立完成研究，或與夥伴攜手挑戰看似不可能的任務，都已在這段歷程中獲得珍貴的體悟——原來自身的潛能，往往超越想像。從發現問題、解決問題，到再度提出新問題、探索新方法，這不僅是一段挑戰自我的旅程，更是一場持續發現自我可能的歷程。

本活動期盼學生在實作與探究中，深刻體會科學思維與實踐的價值，並習得科學方法、培養科學態度與技能，同時提升以英語進行有效溝通的能力。更重要的是，學會跳脫既有框架，勇於思辨與創新，讓視野不設限，讓未來無邊界，堅定前行。

**To Hear To Forget**

**To Read To Remember**

**To Do To understand**

**不聞不若聞之，聞之不若見之，**

**見之不若知之，知之不若行之。**

**學至於行之而止矣。—— 荀子 儒效篇**

財團法人遠哲科學教育基金會董事  
國立臺灣師範大學科學教育研究所  
名譽教授

**邱美虹**

# 關於競賽

## 一、競賽宗旨

遠哲盃三分鐘創意短講以「英語表達 × 科學素養 × 永續目標」為核心，並進一步融合跨域創新與國際視野，為國高中生提供一個啟發思維、展現自我、連結世界的舞台。

1. **鼓勵永續創新研究**：引導學生將所學的科學基礎知識與真實社會議題結合，從環境、能源、健康、科技等面向出發，思考如何以創新方式回應永續發展目標（SDGs）。培養學生的批判思維、創新解決力，並鼓勵以研究成果或行動計畫為藍本，提出可行的未來方案。
2. **跨領域整合與多元思維**：強調科學知識與人文、社會、科技之間的聯繫，鼓勵學生跨域學習與團隊合作。
3. **英文溝通與國際表達**：在強化英文表達力的同時，營造國際交流的氛圍。透過公開發表訓練，讓學生在真實舞台上表達觀點，學會用簡明、有說服力的語言傳達科學與永續的創意。
4. **未來趨勢整合（創新+科技+人文）**：開放使用數位科技與人工智慧（AI）應用元素，協助學生進行資料蒐集、語言潤飾、數據彙整——等來提升效率。（詳細 AI 規範請見 AI 使用原則）

## 二、競賽日程

1. 報名暨初賽徵件：2026 年 1 月 1 日 - 2026 年 2 月 2 日 13:00 止
2. 競賽說明會與工作坊：
  - (1) 北區：2025 年 12 月 30 日（臺北市立中山女中）
  - (2) 中區：2025 年 12 月 11 日（臺中市立忠明高中）
  - (3) 南區：2025 年 11 月 22 日（高雄市立高雄中學）
3. 決賽、海報展暨頒獎典禮：2026 年 4 月 11 日（六）  
（臺灣大學天文數學館國際會議廳）

### 三、競賽辦法

#### 1. 競賽分組：

分國中與高中職兩大組，各組再區分為團體組（2 或 3 人）與個人組。

#### 2. 參賽資格：

(1) 具中華民國國籍之國中或高中職在籍學生，每隊 1-3 人，可跨校，但不可跨組。每人限報名 1 隊。

(2) 每組可選填指導教師 2 名。指導教師資格限擁有學校教師資格或實習教師。

#### 初賽

##### 繳交作品：

- (1) 1 頁英文研究摘要（A4），研究內容為科學探究實作結果，若能與永續和 SDGs 相關更佳。
- (2) 3 頁 PPT 簡報（中英文皆可），第 1 頁為自我介紹，第 2、3 頁為英文摘要之研究議題介紹。
- (3) 參賽者以英文介紹研究主題影片 1 支（長度 30 秒 -1 分鐘）。

#### 決賽

參賽者將進行 3 分鐘英語短講與 2 分鐘英文問答，說明探究過程與成果。團體組每位隊員皆須發表。

##### 海報競賽

決賽者須於指定期限前繳交海報一份，海報將於決賽現場公開並進行海報競賽評分。



#### AI 使用原則

參賽者得使用人工智慧（AI）工具作為輔助，以進行資料蒐集、語言修飾、資料整理或提供靈感參考。但 AI 僅得視為「輔助工具」，不得取代參賽者本身之思考與判斷。

## 四、評分標準

評審將根據以下各方面進行評選。

1. 初賽：科學性（50%）創新性（20%）表達與溝通（30%）
2. 決賽：科學性（20%）創新性（20%）研究的社會貢獻（20%）  
演講技巧（20%）表達與溝通（10%）問答環節（10%）

### | 科學性

研究問題的合理性和重要性。  
研究方法的科學性和有效性。  
結果的可靠性和可重複性。

### | 創新性

對現有知識的新見解和洞察力。  
獨特的研究設計或方法。  
研究成果對解決現實問題和挑戰的潛在影響。

### | 表達與溝通

對研究目的、方法和結果的清晰傳達。  
能夠吸引觀眾並引起他們的興趣。  
能夠解釋研究如何與永續發展目標相關聯。

### | 演講技巧

清晰的演講結構和邏輯。  
語言表達的流暢度和準確性。  
姿勢、語調和眼神接觸的自信和專業度。

### | 研究的社會貢獻

在解決永續發展問題方面的創造性和原創性。  
研究對於實現特定永續發展目標的貢獻。  
對永續發展原則的理解和應用。

### | 問答環節

對評委提問的回答準確性和清晰度。  
對評委的反饋和挑戰作出適切的回應。  
表現出對自身研究的深入理解和扎實基礎。

## 五、競賽獎勵

✦ = 特別獎

| 獎項    | 團體       | 個人       | 指導老師    | 名額                          |
|-------|----------|----------|---------|-----------------------------|
| 金獎    | 24,000 元 | 15,000 元 | 5,000 元 | 高中職／國中個人與團體組<br>每組皆頒發各 1 隊。 |
| 銀獎    | 18,000 元 | 12,000 元 | 3,000 元 |                             |
| 銅獎    | 12,000 元 | 8,000 元  | 2,000 元 |                             |
| 最佳海報獎 | 3,000 元  | 3,000 元  | 1,000 元 |                             |
| ✦ 創意獎 | 9,000 元  | 6,000 元  | 2,000 元 |                             |
| ✦ 永續獎 | 6,000 元  | 2,000 元  | 1,000 元 | 每組頒發至少 1 隊，可依比例增額。          |

得獎隊伍皆頒發獎金、獎狀，金、銀、銅獎另頒發獎盃一座。所有參加決賽未得獎隊伍，每人頒發佳作獎狀。所有參加初賽名次前 25%，每人頒發入選獎狀。

✦ 永續獎、創意獎由新代科技股份有限公司、財團法人創藝文化基金會贊助。

# 隊伍介紹 國中個人組



- J1002 蛤
- J1003 還沒想好要叫什麼隊
- J1007 蘑菇蘑菇
- J1008 Green Chromatography:  
Temperature & Solvent Effects
- J1009 綠色魔法
- J1013 Yukina 隊
- J1014 智伴樂齡隊
- J1016 Orca Go

" 蛤 "

邱繼平

## 探討清潔劑對多齒新米蝦之影響研究



邱繼平個人照

### 個人特色、專長和興趣

操作實驗、與同儕討論日常。

### 團隊簡介與隊名由來

以蝦為隊名，ㄈㄣˊ 也可以打出蝦，所以就用蛤啦！

### 參賽原因與心得

七年級時，文獻探討啟蒙了我們的研究主題，於是邀請同學組隊挑戰科展。到了八年級，我們逐步完成了實驗設計、執行與最終的統整。

過程中最艱辛的挑戰，是簡單卻極度繁瑣的數據紀錄，曾讓我們一度想放棄。此外，「蝦隻不明原因大量死亡」更是嚴重瓶頸。為此，我們耗費數天，從水溫、水質、含氧量到飼料等因素逐一排查。這段過程雖然痛苦，卻也讓我們掌握了關鍵的可控變因，反而大幅提升了實驗的穩定性與可信度！

最有趣的是，英文老師得知我們的研究後，每次見面都會打趣地問：「最近是不是又在『蝦』忙啊？」這句幽默的雙關語，成了我們繁重實驗中最好的調劑。

### 隊伍自評

#### ・優勢

1. 優良的在地生態指標
2. 永續消費與綠色生活實踐

#### ・劣勢

1. 「靜態試驗」帶來的水質惡化干擾
2. 混合溶劑（魚缸水＋飲用水）的變異性





Is "Natural" Really Safe? Exploring the Impact of Detergent Toxicity on Freshwater Shrimp.

# The Effects of Various Detergents on the Acute Toxicity of the Freshwater Shrimp *Neocaridina denticulata*

SINCE THIS SHRIMP IS A KEY INDICATOR SPECIES FOR WATER QUALITY IN TAIWAN, UNDERSTANDING ITS SENSITIVITY TO COMMON HOUSEHOLD CLEANERS IS CRUCIAL FOR ENVIRONMENTAL PROTECTION.

## RESEARCH TOPIC

Evaluating the acute toxicity and Median Lethal Concentration (LC<sub>50</sub>) of four commercial detergents on *N. denticulata*.



### MYTH VS. REALITY



**'NATURAL' ISN'T A GUARANTEE OF SAFETY.**  
Natural ingredients can still harm aquatic organisms.

### ACTION: DILUTION IS KEY.



**SIGNIFICANT DILUTION IS NECESSARY BEFORE DISCHARGE.**

### THE LETHAL CONCENTRATION



**HOUSEHOLD CONCENTRATIONS ARE OFTEN 8-10X THE SHRIMP SURVIVAL LIMIT!**



**SHRIMP SURVIVAL LIMIT (SAFE ZONE)**

**STANDARD HOUSEHOLD CONCENTRATION**

## KNOW AND DO

**Myth vs. Reality:** A "natural" label does not guarantee safety for aquatic life.

**The Lethal Concentration:** Shown through a comparison chart, standard household detergent concentrations are often 8 to 10 times higher than the survival limit of shrimp.

**Action~ Dilution is Key:** Significant dilution is strictly required before discharge to ensure the safety of aquatic ecosystems.

" 還沒想好要叫什麼隊 "

王秉元

## Moving forward step by step -Application of research on friction in bionic animals



王秉元個人照

### 個人特色、專長和興趣

My name is 王 秉 元 (Bing-Yuan Wang). I enjoy thinking about unusual ideas like dreams or new technology, and I am interested in physics and challenging games. When I discover something complex or cool I am always the first one to step forward and try it without hesitation.

### 團隊簡介與隊名由來

Because after this competition, whether I win a prize or not, I will always remember the research I have done. Therefore, I came up with the idea of making my research both special and impressive.

### 參賽原因與心得

I started preparing this competition after seeing an artwork by Theo Jansen named Strandbeests, I kept thinking about its mechanism and finally decided to conduct deeper research to understand how it works. However, I encountered some problem when starting this project, such as finding data because things about linkage often related to the artwork itself but not the mechanism behind it. Despite these difficulties, I learned a lot about mechanical structures and research skills. I also hope to improve my ability to present and explain my ideas clearly.

#### 隊伍自評

##### · 優勢

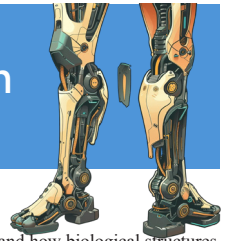
I made a lot of prototypes to ensure structure can work smoothly, so my conclusion is totally reproducible to others. Also bionic robots are a topic that still have Potential for future development.

##### · 劣勢

Because 3D printers are still not a very stable creation platform in Taiwan's weather so I wasted a lot of parts during development. The same problem will happen in different places, also 3D-printed parts are weak for this kind of research, so the durability is also a big problem.



# Moving forward step by step - Application of research on friction in bionic animals



## Abstract

- ◆ In this study, I investigate how friction influences the movement mechanisms of bionic animals and how biological structures regulate friction to improve movement efficiency.
- ◆ The purpose of this research is to understand the relationship between friction, surface structures, and motion performance in bio-inspired systems. I conduct a literature review on friction and animal movement and analyze different biological structures, such as surface textures and body shapes, that are related to friction control.
- ◆ I compare how these structures function in various movement environments, including walking and climbing, and summarize common friction-regulation principles observed in animals. Based on these findings, I examine how such principles can be applied to bionic and engineering designs. The results show that animals can effectively adjust friction through specialized structures to enhance movement stability, efficiency, and adaptability. This study demonstrates that friction plays an important role in bio-inspired engineering and provides useful insights for the development of more efficient and adaptable bionic systems.

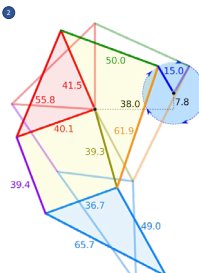
## Introduction



### SDGs



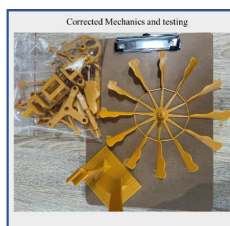
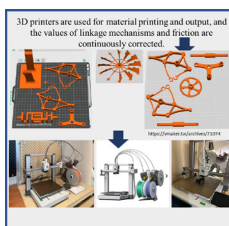
- ◆ Strengthen research and improve industrial technology.
- ◆ Improve scientific research and enhance the technological capabilities of industry and commerce in all five countries, especially developing countries, including encouraging innovation and increasing the number of R&D personnel by x% per million people by 2030, and increasing R&D spending by both the public and private sectors.



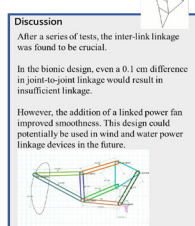
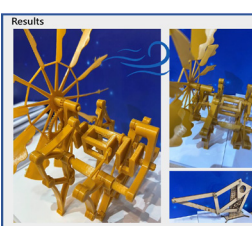
Jansen's Linkage is a planar linkage mechanism invented in 1990 by Dutch kinetic artist Theo Jansen. Its most famous application is as the leg structure for his wind-powered sculptures called "Strandbeests".



## Materials and Methods



## Results and Discussion



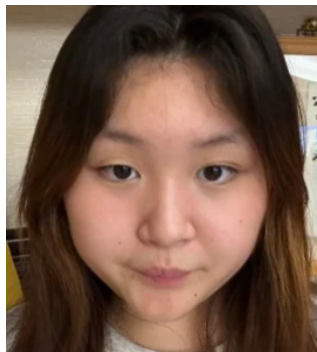
" 蘑菇蘑菇 "

林靖瑀

## Styrofoam Substitute

### 個人特色、專長和興趣

I am an empathetic and adaptable person, which inspired me to create this project. Through my mycelium project, I also gained scientific knowledge, especially about energy dissipation, cellular solids, and hands-on research experience.



林靖瑀個人照

### 團隊簡介與隊名由來

"Mushroom. Mushroom." I chose the name "Mushroom. Mushroom." because it represents the heart of my research and my personal journey through this project. To me, a mushroom is more than just a fungus; it is a symbol of connection, resilience, and transformation. I see my individual experiment as one "mushroom" representing a much larger, global movement of environmental awareness.

### 參賽原因與心得

1. Inspiration & Objectives: My goal was to demonstrate, through a home-based experiment, how mycelium—the root system of mushrooms—can contribute to healthier ecosystems and a future where wildlife can thrive.
2. Methodology & Process: I researched scientific concepts like energy dissipation and cellular solids. This hands-on approach allowed me to track real-time results and observe how this biological material interacts with its surroundings.
3. An Unexpected Discovery: The most striking moment occurred when my findings challenged existing research. I observed the mycelial roots firmly attaching themselves to the synthetic surface of my plastic storage container.
4. Challenges & Future Outlook: The primary challenge was time management—balancing fungal growth cycles with a strict competition deadline. Moving forward, I plan to finalize the beeswax testing to further explore the material's durability, continuing my journey toward innovative, nature-based environmental solutions.

### 隊伍自評

#### ・優勢

研究推導邏輯清晰，並得出有價值的結論。

#### ・劣勢

研究還有更多發展的面向尚未討論，且未完全驗證，如是否為植物激素誘導的部分。



# Mycelium as a Sustainable Bio-Material

Isabelle Lin | School Science Fair Project

## Introduction

Traditional Styrofoam packaging creates massive, long-lasting environmental waste.

This project explores **mushroom mycelium** (the root structure of fungi) as a **fully compostable, renewable, and eco-friendly** alternative with comparable performance.



## Research Question

Can agricultural waste products be successfully repurposed as substrates to cultivate mushroom mycelium into a viable, durable, and **fully compostable** packaging material that provides cushioning comparable to conventional Styrofoam?

## Methods / Experimental Design

- SUBSTRATES:** Investigated **agricultural waste** (coffee grounds and rice husks).
- CULTIVATION:** Mycelium inoculated into substrates with **added white flour** (as a rapid carbohydrate) for **accelerated growth**. Maintained low light.
- HALTING & DRYING:** Growth intentionally halted at **day 23** by **natural air-drying** to **foam-like structure**, durable (prevents mold and pests).



### Optimization Parameters:

- Substrate formulation ratio (coffee to husk).
- Control of humidity (maintain >85%) and temperature (22-25°C).
- Drying time for structural rigidity.

## Discussion

Mycelium demonstrated **excellent cushioning and shock absorption**.

Dried mycelium forms robust, high-strength, cellular solids that **dissipate kinetic energy** through slight deformation.

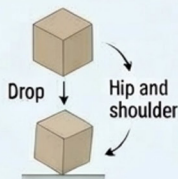
While not **natively waterproof**, it can be effectively coated (e.g., with beeswax).

It is slightly **heavier** than Styrofoam but significantly more **sustainable**.



### Comparative Performance:

| Property          | Mycelium         | Styrofoam  |
|-------------------|------------------|------------|
| Weight            | Slightly Heavier | Very Light |
| Cushioning        | Excellent        | Good       |
| Bio-degradability | Full             | 500+ years |



## Drop Test Comparison



**Styrofoam Post-Drop**  
dented and crushed edges  
(crushed minor wear and ring comparable use)

VS.



**Mycelium Post-Drop**  
intact, minor wear and

## Conclusion & Future Work

The experiment successfully demonstrated that mycelium-based packaging is a viable, high-performing alternative to Styrofoam. It offers comparable strength and durability while being completely decomposable and an important step toward eliminating plastic waste.

**Future work:** Optimize waterproofing methods, investigate different agricultural wastes, and scale production for commercial use.

**We are not just managing waste; we are growing the future of packaging, from waste to wonder, from nature, back to nature.**

## " Green Chromatography: Temperature & Solvent Effects "

張詠絮

## Green Chromatography: Temperature & Solvent Effects



由左至右：田代歲老師、張詠絮、黃子欣老師

### 個人特色、專長和興趣

我是一位動靜皆宜的人，我喜歡科學和運動，期待能在不同領域展現自我。

### 團隊簡介與隊名由來

我之所以會選擇做色層分析是因為之前在課本上有看到毛細現象相關的知識，在上課時老師也有說明到色層分析並讓我們實際操作色層分析，我認為非常有趣，因此我想探究色層分析背後的奧秘。我的隊名是綠色層分析：溶液和溫度的影響，我取這個名字是因為我這在實驗的過程中都使用日常中常見且無毒的材料，希望能環保的製作實驗。

#### 隊伍自評

##### · 優勢

實驗器材容易取得、  
實驗步驟容易。

##### · 劣勢

整體實驗不夠精確。

### 參賽原因與心得

我在實驗過程中我大部分是取用家中常見的用具，例如鹽、糖、保溫袋等。在比賽中我遭遇最大的挑戰是培養皿裡面的水太少，導致在做改變溫度的實驗時溫度無法保持溫度。我的解決方式是把培養皿放在大燒杯（杯子）上面，杯子里裝著熱水，熱水會有熱氣就可以保持培養皿裡水的溫度。最後將整個裝置放進保溫袋，整個保溫裝置就完成了。雖然這次也因時間關係，整體來說做實驗比較急，但我還是認為能參加這項比賽非常有趣。

# Green Chromatography: Temperature & Solvent Effects

## Introduction

In chromatography, different factors will affect the result. For example, different temperatures, different solvents, or mixtures. In this experiment, I will use square coffee filter paper to investigate how different temperatures, solvents, and mixtures affect chromatography, to find a non-toxic way to separate colors.



## Hypothesis

Temperature: Higher heat causes wider and shorter bands, reducing separation clarity.

Alcohol: Shortens bands and stabilizes capillary action for smoother rising.

Salt Water: Lowers pigment solubility and Rf values, but improves resolution.

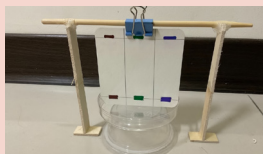
Sugar Water: Increases viscosity, slowing the solvent's climb.

## Materials and methods

This is how the experiment starts every time. I use purple (#503AC1), green (#0B8C4A), and brown (#985241) to test because they are mixed colors. I use a Koi coloring brush pen. I separate one paper into 3 parts, one for each color. I use 0.5cm circles and 1x0.5cm rectangles to test, but after many tests, I found out that the rectangle's results is clearer than the circle's.



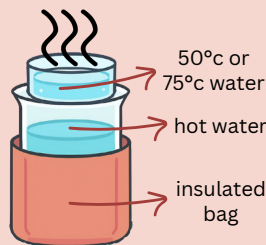
## Experiment tool



This equipment is for testing different solvents and mixtures. I will pour the liquid into the petri dish and put the filter paper inside it, but not touching the color of the pen, otherwise the color will not go on the filter paper.

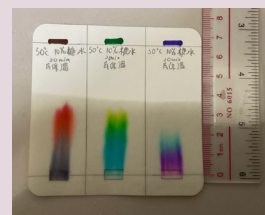


This equipment is for testing different temperatures. The large beaker inside has hot water, which can keep the 50 degrees or 75 degrees water in the petri dish at the same temperature. The insulated bag is for keeping the temperature in the large beaker. I made this because the water's temperature in the petri dish will be lost quickly; this can help keep the temperature.



## Results

Shapes don't affect the Rf value; it remains. Saline lower concentration increases Rf value, Rf value won't be 1. Higher temperatures shorten the color bands and change the color to a blurrier band. Mixtures combine traits. Using 50 degrees, 10% sugar can get the best chromatography result.



## Conclusion

In this experiment, I use non-toxic ways to do chromatography, like using saline, alcohol, and sugar solution, which can be used for teaching and protecting the environment.



Paper Chromatography | Science Project  
<https://www.youtube.com/watch?v=TtAENPSThI4&t=139s>  
 Chemistry Education in Taiwan  
<https://531.9e9.myftpupload.com/archives/610>

## " 綠色魔法 "

楊予和

### Evaluating the Effects of Glutamate on ROS Production & Stress Response in Arabidopsis thaliana Col-0



楊予和個人照

#### 個人特色、專長和興趣

我熱愛植物，夢想透過科學讓農業進步，喜歡做養植物的試驗。英文流利助我吸收新知，但我深知要學的還很多。

#### 團隊簡介與隊名由來

我相信植物是地表最強大的魔法！從餵養生命到點綴生活，這綠色生命體改變世界，幾乎跟魔法一樣。

#### 隊伍自評



· **優勢** 量化標準嚴謹

採用較嚴格之  $p < 0.01$  統計門檻，並透過 ImageJ 數位分析 取代人工測量，確保數據客觀性。

· **劣勢** 濃度範圍有限

目前僅針對 10 ppm 單一濃度進行評估，尚未涵蓋廣泛濃度區間，難以斷定其是否為最具效益之處理劑量。

#### 參賽原因與心得

當初我本來只是參加遠哲基金會的科學館志工培訓，想練習用中文淺白的解釋科學。機緣巧合，我就這樣在基金會的粉專上看到這個比賽。我覺得這是個練習英文科學表達的好機會，還能認識其他喜歡科學的人，因此就報名了。

報名後的挑戰接踵而至，尤其我較晚才得知比賽訊息，要在有限時間內將數個月的實驗成果精簡製成影片和簡報，過程特別燒腦！然而，當我看到完成成品的那一刻，心裡很有成就感。

這場比賽讓我深刻體會到，科學不只是在實驗室裡做實驗，更是一門說故事與交流想法的藝術。這個過程不僅讓我在學術研究上進步，更教會我如何自信地分享發現。真的很感謝有這個機會，讓我在科學探索的道路上變得更加勇敢與全面。



# EVALUATING THE EFFECTS OF GLUTAMATE ON ROS PRODUCTION AND STRESS RESPONSE IN *ARABIDOPSIS THALIANA* (COL-0)

Author: Hannah Yeung

## ABSTRACT

As climate change threatens food security, enhancing plant resilience is vital. Using static hydroponics, we found that **10 ppm Glutamate** significantly reduces accumulation of **hydrogen peroxide** (a stress indicator) and maintains higher chlorophyll levels in *Arabidopsis thaliana*. This demonstrates Glutamate's potential for climate-resilient agriculture, supporting **SDG 2 (Zero Hunger)** and **SDG 13 (Climate Action)**.

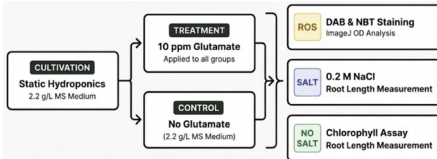
## INTRODUCTION

- **Climate Crisis:** Global warming worsens soil salinity and flood-induced hypoxia, slashing crop yield.
- **Glutamate's Role:** Glutamate (Glu) triggers antioxidant defenses, helping plants adapt to stress.
- **Stress Indicators:** **ROS** (hydrogen peroxide, and superoxide anion) serve as indicators of physiological stress.
- **Health Indicators:** **Chlorophyll** and **root length** indicate photosynthetic activity and plant health.

## RESEARCH QUESTIONS

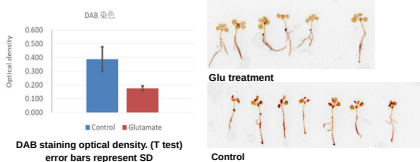
- Does 10 ppm Glutamate regulate hydrogen peroxide and superoxide accumulation in plants within a standard static hydroponic system?
- How does Glutamate influence chlorophyll content under standard conditions and root elongation under both standard and 0.2 M salt stress?

## METHODOLOGY



## Results

- We define statistical significance as  $p < 0.001$ .
- **Hydrogen Peroxide:** DAB staining showed a clear reduction of hydrogen peroxide in Glutamate-treated plants ( $p < 0.001$ ), suggesting the triggering of antioxidant systems to enhance plant adaptation.



## RESULTS

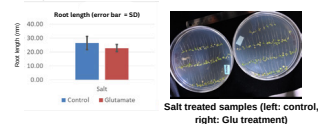
- **Superoxide Anion:** NBT staining revealed no significant change in superoxide anion content ( $p = 0.648$ ).



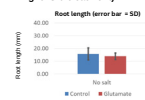
- **Chlorophyll Content:** The Glutamate-treated group showed a higher average chlorophyll content compared to the control. This trend suggests that Glutamate may support photosynthetic activity.



- **Root Length (0.2 M NaCl):** No significant difference in primary root length was observed between the control and 10 ppm Glu groups ( $p = 0.025$ ).



- **Root Length (standard condition):** No significant difference observed between control and Glutamate groups ( $p = 0.242$ ).



## CONCLUSION

- **ROS Defense:** 10 ppm Glu significantly attenuates hydrogen peroxide, likely by triggering internal antioxidant defenses ( $p < 0.001$ ).
- **Chlorophyll:** As a biosynthetic precursor, exogenous Glu increases pigment retention compared to stressed controls.



The hydroponic system used

- **Hypoxia:** A static hydroponic system was used to minimize root damage during harvest, though such systems may induce hypoxia.

## References

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2. Hossain, M. S., et al. "Tuning of Redox Regulatory Mechanisms, Reactive Oxygen Species and Redox Homeostasis under Salinity Stress." *Frontiers in Plant Science* 7 (2016): 548.
3. Hasanuzzaman, M., et al. "Regulation of Reactive Oxygen Species and Antioxidant Defense in Plants under Salinity." *International Journal of Molecular Sciences* 22 (2021): 9326.
4. Azarabadi, S., et al. "ROS generation, oxidative burst and dynamic expression profiles of ROS-scavenging enzymes of superoxide dismutase (SOD), catalase (CAT) and ascorbate peroxidase (APX) in response to *Erwinia amylovora* in pear (*Pyrus communis* L.)" *European Journal of Plant Pathology* 140 (2017): 279-294.
5. Walch-Liu, P., et al. "Evidence that L-Glutamate can act as an exogenous signal to modulate root growth and branching in *Arabidopsis thaliana*." *Plant and Cell Physiology* 47(2006): 1045-1057.
6. Hebelstrup, K. H., et al. "Mitochondrial signaling in plants under hypoxia: use of reactive oxygen species (ROS) and reactive nitrogen species (RNS)." In: Gupta, K., Iqbal, A. (eds) *Reactive Oxygen and Nitrogen Species Signaling and Communication in Plants. Signaling and Communication in Plants*, vol 23. (2014) Springer, Cham. [https://doi.org/10.1007/978-3-319-50029-1\\_4](https://doi.org/10.1007/978-3-319-50029-1_4)
7. Nagahatennap, Dilrukshi SK, Peter Langridge, and Ryan Whitford. "Tetrapyrrole-based drought stress signalling." *Plant Biotechnology Journal* 13.4 (2015): 447-459.
8. AI is used for grammar and some stylistic suggestions.

## " Yukina 隊 "

鄭雨萌

## Smart Campus System



由左至右：鄭雨萌、蔡佩琦老師

### 個人特色、專長和興趣

我從小喜歡數學科學和一切和邏輯有關的學科，並於六年級接觸到程式相關內容，開始喜歡寫程式。

### 團隊簡介與隊名由來

因為團隊只有我一個人所以就用我自己取的名字。

### 參賽原因與心得

我在國一參加全國科展，並且想在更多地方分享我的作品，看到了遠哲盃的比賽，有幸能用英文和別人討論作品。在準備的期間遇到了許多問題，其中我認為最難的是將海報內容以英文製作，因為我沒有訓練過英語寫作，因此在字詞和文法上需要耗費許多的時間。但也因此學到並獲得了很有價值的經驗。

### 隊伍自評

- 優勢 擅長口說報告，研究內容深入。
- 劣勢 研究仍有改善空間，比賽經驗不足。



## Motivation and Equipments

Research motivation:

During large school events, many parents could not find their way to classrooms, and there were not enough staff to guide them. After conducting an in-depth investigation, I found that our school lacked clear signage, and there were also safety risks such as bullying and smoking. Our school did not have an effective solution to these problems. Therefore, I decided to design a "Smart Campus System".

Equipment: Jupyter Notebook · VSCode · Tinkercad · Arduino

## Methods, Results and Discussion

The Smart Campus System provides three main functions: guiding, air detection, and visual detection.

### Route Guiding

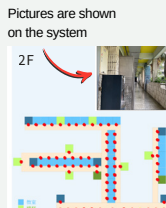
I first observed our school map and marked all classrooms, teachers' offices, and restrooms. Next, I input the data into the program and constructed a graph.



For easier observation, I drew floor plans of each building and combined them with the node graph. Also, I took pictures of corners and staircases, and pictures will be shown when users pass by.

I also designed different modes for visitors. Users can select these modes in the system.

| Mode             | Applicable groups                            | Weight adjusting                   |
|------------------|----------------------------------------------|------------------------------------|
| The shortest     | Most guests or parents                       | Use distance is used as the weight |
| Avoid disturbing | Used when school is in session.              | Classrooms have higher weight      |
| Accessibility    | For disabled users or people carrying goods. | All staircases are prohibited.     |



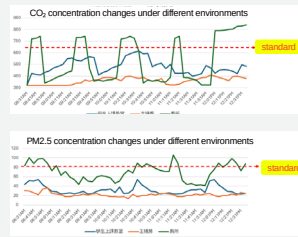
### Air Detection

To understand the normal environmental conditions, I installed sensors on campus. We collected data every five minutes for a total of 4 hours. After analyzing the data, I established threshold standards.

Standards:

Smoking:  $PM2.5 > 80$ ,  $CO_2 > 700$

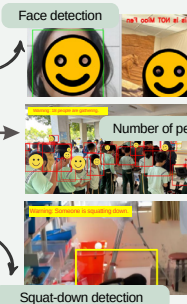
Fire:  $Temp > 35$ ,  $PM2.5 > 80$ ,  $CO_2 > 700$



### Image Detection

Using YOLOv8 and OpenCV, the system detects faces, crowd gatherings, and risky actions.

- Face detection: Visitors upload photos when entering and are removed after leaving. Unknown faces trigger alerts.
- Number of people: If more than ten people gather in a corner, the system alerts teachers and saves photos.
- Squat-down detection: Squatting is a common posture during physical conflicts, but not common in daily life. When the system detects someone squatting down, it'll alert teachers and save photos.



### Questionnaire survey

To understand where the system needs improvement, I introduced my system to my family and my classmates, and asked them to complete the questionnaire



Strength: Image Detection and Air detection received a high score.  
Weakness: The user interface of the route guiding function was not clear enough

## Conclusion and Future Outlook

The "Smart Campus System" successfully provides multi-path planning. A real-time alert system integrating image detection, air sensing, and behavior recognition was successfully developed. However, the user interface can still be improved to provide clearer guidance.

## Literature

1. National Chengchi University. Campus Navigation System. Retrieved from <https://bdmap.nccu.edu.tw/zh-tw/campus-mapbox>
2. YouTube. Illustrated Algorithm: Dijkstra's Algorithm for Finding the Shortest Path. Retrieved from <https://www.youtube.com/watch?v=HHvjmLKJaxM>
3. Wu, C.-H., Chen, Y.-P., Huang, C.-J., Chen, S.-C., & Huang, C.-T. (2019). Campus Navigation System. Airiti Library.
4. A Single Oversight in a Thorough Plan: Construction of a Smart Campus Evacuation System. New Taipei City Science Fair, 2023.

## " 智伴樂齡隊 "

劉書宇

### Using AI Companionship to Reduce Loneliness Among Older Adults in an Aging Society



劉書宇個人照

#### 個人特色、專長和興趣

我的專長是畫畫，曾經拿過全國特優 (1st)，而我的興趣為電腦程式與球類運動。

#### 團隊簡介與隊名由來

我是劉書宇，就讀國中二年級。觀察到長輩在康復與日常生活中需要更多陪伴，因此希望結合自己學習的程式與 AI 技術，為長者帶來溫暖互動，取名「智伴樂齡隊」，期望用科技讓長輩生活更快樂、更有陪伴感。

#### 參賽原因與心得

我之所以想參加遠哲盃，是因為我學習 AI 電腦程式已經超過一年，對科技應用非常有興趣。剛好家中的長輩陸續開刀，需要更多陪伴與照顧，讓我開始思考是否能把 AI 技術與長者陪伴結合，幫助長輩減少孤單。因此我訪談長輩，了解他們的感受與生活需求，作為研究內容。準備過程中，我更了解長輩的孤單，也更確定這個主題的意義。最大的挑戰是如何耐心與長輩溝通，並思考如何把他們的需求轉化成 AI 可以理解與回應的方式。

#### 隊伍自評

- 優勢 研究推導邏輯清晰，並得出有價值的結論。
- 劣勢 研究還有更多發展的面向尚未討論，且未完全做出能讓長輩不孤單的軟體。





# Using AI Companionship to Reduce Loneliness Among Older Adults in an Aging Society

## Abstract

- In 2025, Taiwan became a **super-aged society**, with more than 20% of the population aged 65 and older. Changes in family structure and busy lifestyles have increased loneliness among older adults. Research shows that loneliness is linked to a 40% higher risk of hospitalization, making it a significant public health concern.
- This study proposes an AI-based emotional companionship system using **Large Language Models (LLMs)** to provide natural, family-like conversations for older adults. A pre-test and post-test design using the **UCLA Loneliness Scale** will evaluate whether AI companionship can help reduce loneliness.
- This system aims to support healthier aging in society.

AI

Conversation

Less Loneliness

Health & Social Impact



Taiwan became a super-aged society in 2025.

## Introduction

Taiwan became a super-aged society in 2025, with over 20% of the population aged 65 and above. Due to smaller families and busy lifestyles, many older adults experience loneliness. **Studies show loneliness is linked to a 40% higher risk of hospitalization.** This study explores whether AI companionship can help reduce loneliness among older adults.

## Materials and Methods



This study proposes an AI emotional companionship system using **Large Language Models (LLMs)** as a prototype, implemented through ChatGPT to simulate natural, family-like conversations with older adults.

A pre-test and post-test design using the **UCLA Loneliness Scale** is used to measure participants' loneliness levels before and after interacting with the system.

UCLA

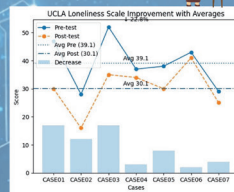


After speaking with the elders, I found that many of them feel lonely, and this loneliness can adversely affect their health. Previous studies indicate that older adults experiencing **higher levels of loneliness face about a 40% increased risk of hospitalization.**



## Results and Discussion

AI companionship may help older adults feel less lonely by providing daily conversations and emotional interaction. **Unlike traditional assistive technologies, the system focuses on emotional support.** However, AI is designed to supplement human relationships rather than replace real family members.



Average score decreased by 22.8%

## Conclusion

This system supports healthier aging and aligns with **SDG 3, SDG 10, and SDG 11** by improving elderly mental health, reducing inequality in companionship, and promoting age-friendly communities.

## References

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- Perlman & Peplau (1981) – Social Psychology of Loneliness
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- The U.S. Surgeon General's Advisory on the Healing Effects of Social Connection and Community- Our Epidemic of Loneliness and Isolation (2023)
- Timothy L. Barnes, Cumulative effect of loneliness and social isolation on health outcomes among older adults

" Orca Go "

賴約辰

## App for Footprint identification: A New Tool for Animal Care monitoring

### 個人特色、專長和興趣

我富有創意，熱愛虎鯨保育、動漫、繪畫與長跑。希望可以結合「科學素養」與「創新思維」來解決物種生存挑戰。

### 團隊簡介與隊名由來

我的英文名字是 Orca，Orca 的中文是虎鯨，這種生物兼具聰明與守護家族的特質，而「Orca Go」則代表我對科學探究的行動力。我從小熱愛動物、畫圖與長跑，這讓我學會細膩觀察足跡特徵，並擁有持續優化 AI 模型的耐力。作為單人隊伍，我將興趣轉化為解決問題的動力，開發出這款足跡辨識 App。我期許自己能像虎鯨一樣靈活，在科學領域精準定位野生動物的蹤跡，為生態保育盡一份心力。

### 參賽原因與心得

我參加這次競賽的主因，是想嘗試用 AI 技術解決 SDG 15 提到的陸域生態保育問題。我一直很關注保育類動物（特別是石虎），發現傳統監測設備如紅外線相機成本高且有死角，因此想開發一款讓手機就能辨識足跡的 App，把大眾的隨手紀錄轉化為保育數據。

準備過程中，最大的挑戰是\*\*「AI 訓練的精準度」\*\*。雖然我平時喜歡畫畫、對圖像細節很敏銳，但要讓模型在泥地或沙地等不同環境下準確分辨貓、狗與熊的足跡，需要極高的邏輯嚴謹性。此外，如何將複雜的辨識流程與數據，濃縮成三分鐘簡潔的英文演說，也讓我花了很多時間排練與刪減冗長內容。

這次參賽讓我學到，科學研究不只是寫程式，更要具備解決現實問題的執行力。即便是一個人參賽，我也能憑藉對動物的熱忱與技術，為生物多樣性監測提供新的可能。



由左至右：蔣德詮老師、賴約辰

### 隊伍自評

#### · 優勢

研究推導邏輯清晰，能將 AI 技術精準應用於 SDG 15 陸域生態保育。透過建立貓、狗、熊三種足跡模型，成功得出具參考價值的初步辨識數據，並展現了將智慧型手機轉化為移動式生物監測工具的可行性。

#### · 劣勢

目前模型僅針對特定三類足跡進行訓練，樣本多樣性仍有提升空間。此外，研究還有更多發展面向尚未深入討論，例如在極端惡劣天氣或複雜植被覆蓋下的辨識準確率，目前尚未完全驗證，是未來需要持續優化與實地測試的部分。



# APP FOR FOOTPRINT IDENTIFICATION A NEW TOOL FOR ANIMAL CARE MONITORING

STUDENT: ORCA LAI  
TEACHER: BENNETT CHIANG

problem we want to solve



## PROBLEMS LEOPARD CATS ARE FACING

- ROADKILL: BUSY HIGHWAYS FRAGMENT THEIR HABITATS, LEADING TO FATAL COLLISIONS.
- FERAL DOGS: ATTACKS AND DISEASES FROM STRAY DOG PACKS ARE INCREASING.
- HABITAT LOSS: EXPANSION OF FARMS AND HOUSING DESTROYS THEIR HUNTING GROUNDS.



## Methods and process

We employ a streamlined AI development workflow to transform mobile devices into active biological sensors for wildlife conservation. Using Google Teachable Machine (FIGURE 1), a specialized image recognition model was trained on a diverse dataset of feline, canine, and ursine footprints across various surfaces like mud and sand (FIGURE 2) to ensure field robustness. The process used cats as a proxy for the endangered Taiwan Leopard Cat, while dogs and bears indicated environmental interference and large-scale wildlife presence. By integrating this AI classification with real-time GPS logging, the approach effectively connects professional researchers with the public. The findings show that while the system achieves high accuracy in distinguishing broad classes, its real value lies in acting as a "precision filter." This allows citizens to crowdsource biodiversity data and address "monitoring blind spots" in Taiwan's terrestrial ecosystems



APP CAN RUN ON ANDROID, IPHONE

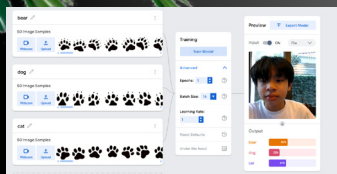


FIGURE 1 SHOWS THE PROCESS OF GOOGLE TEACHABLE MACHINE.



FIGURE 2 SHOWS DIFFERENT ENVIRONMENTS FOOTPRINTS

AI Model Performance: Species Confusion Matrix

| Actual \ Predicted | Actual Cat | Actual Dog | Actual Bear |
|--------------------|------------|------------|-------------|
| Predicted Cat      | 86         | 10         | 1           |
| Predicted Dog      | 14         | 88         | 1           |
| Predicted Bear     | 0          | 2          | 98          |

Overall Accuracy: 90.8% | Model: Teachable Machine v1.1

FIGURE 3 SHOWS THE CHALLENGE OF GOOGLE TEACHABLE MACHINES ACCURACY



SCIENCE LEADER  
SUN CHEN-CHEN

FIGURE 4 SHOWS THE CONCEPT MAP OF LEOPARD CATS CORRIDORS SYSTEM

## results and goals

The project achieved a high success rate (FIGURE 3) in telling apart feline, canine, and ursine tracks. This shows that AI can filter complex data to reduce confusion from domestic species. Although the similarities between domestic and wild felines continue to pose a scientific challenge, the results confirm the app's potential as a precise tool for citizen science. The ultimate aim is to support SDG 15 by removing "monitoring blind spots" and turning every hiker into a "Guardian of the Forest." By combining AI recognition with GPS logging, the project plans to create a large, real-time data grid (FIGURE 4) that maps wildlife corridors and gives conservationists the crucial evidence needed to protect the Taiwan Leopard Cat and other endangered species.



# MEMO



Handwriting practice lines consisting of 20 horizontal dashed lines.

# 隊伍介紹 高中個人組

- SI002 潛「浮」的殺手
- SI005 黑羽快斗
- SI008 斷層追蹤者
- SI012 科學隊
- SI013 吐額司隊
- SI015 選的全都
- SI016 不嘻嘻隊
- SI017 Nicotiana
- SI018 請填寫隊名
- SI021 Shiny



## " 潛「浮」的殺手 "

黃凱煜

### Minor Pollution, Major Impact: Duckweed Growth as an Early Warning System for Environmental Hormones

#### 個人特色、專長和興趣

A dedicated violist and leader of the High School Orchestra, I specialize in solo and chamber music. My journey from piano to viola reflects my persistence. A top prize winner in national competitions, I thrive on stage, from the NSYO tours to performing at the Chimei Museum.



黃凱煜個人照

#### 團隊簡介與隊名由來

I am the Invisible Killers, a passionate research team dedicated to exposing the hidden hormone assassins lurking in our waters. My name highlights the subtle yet destructive impact of discarded pharmaceuticals on duckweed ecosystems. I am here to be the voice for a cleaner, safer aquatic future!

#### 參賽原因與心得

My journey into this research began with a simple question: how do invisible pharmaceutical pollutants affect our delicate aquatic ecosystems? To explore this, I committed to a rigorous schedule, conducting weekly experiments to track the impact of discarded hormones, such as Estromon and Provera, on duckweed.

This path was defined by unexpected challenges, as cultivating duckweed proved far more difficult than anticipated due to its high sensitivity. A sudden cold snap once halted its growth entirely, forcing me to urgently install professional growth lights, and I even battled water lily aphids that preyed on the fronds and threatened my samples.

#### 隊伍自評

##### · 優勢

Clear logical progression, proving duckweed is a valuable bioindicator for hormonal pollution.

##### · 劣勢

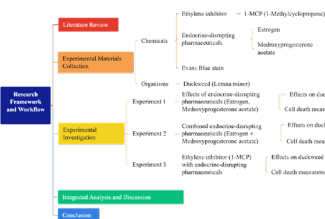
Scope for further research, as the exclusive role of plant hormone induction remains to be fully validated.



# Minor Pollution, Major Impact: Duckweed Growth as an Early Warning System for Environmental Hormones

Huang Kai-Yu

## Abstract



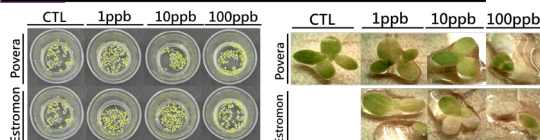
## Goals

- Investigate the effects of single discarded hormonal pharmaceuticals (Estromon, Provera) on duckweed growth.
- Examine the effects of combined discarded hormonal pharmaceuticals (Estromon, Provera) on duckweed growth.
- Assess the influence of discarded hormonal pharmaceuticals on duckweed growth in the presence of an ethylene antagonist (1-MCP).
- Evaluate duckweed cell death under the exposure to single and combined discarded hormonal pharmaceuticals, with and without an ethylene antagonist.

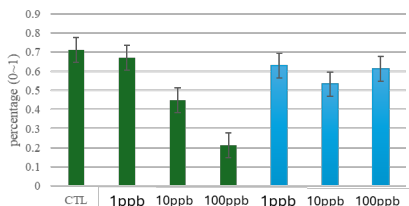
Effects of mixed hormonal pollutants on duckweed growth

## Goals To see weather how the effects of Mixed Hormonal Pharmaceuticals on Duckweed Growth

## Effects of single hormonal pollutants on duckweed growth

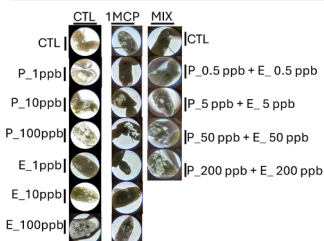


Leaf area green

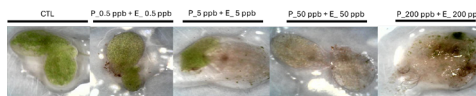
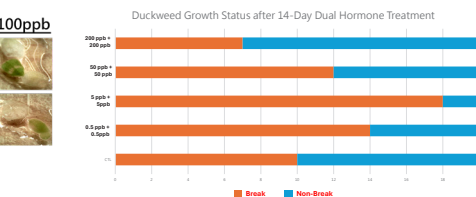


- Control Group: Healthy green coloration; uniform and dense front distribution.
- Dose-Response: Survival is negatively correlated with pesticide concentration.
- Pyriproxyfen Effects: 1 ppb: Viable growth maintained. 10–100 ppb: Marked decline in front count; distinct yellowing.
- Imidacloprid Effects:
  - All Levels: Immediate growth inhibition observed.
  - High Levels: Growth almost completely arrested; sparse, dull fronds.
- Conclusion: Both compounds demonstrate a dose-dependent inhibitory effect on duckweed.

## Assessment of hormone co-culture-induced plant cell damage by Evans blue staining

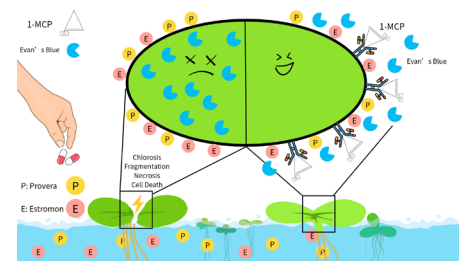


- Dose-Response: Both treatments showed clear concentration-dependent toxicity.
- Severity: Esmitrone caused more rapid and severe degradation (fragmentation and loss of chlorophyll) compared to Provera at similar concentrations.
- Health Indicators: Control maintained optimal growth, providing a clear baseline for chlorosis (yellowing) and necrosis (tissue death) observed in treated groups.



## Effects of ethylene antagonists (1-MCP) on duckweed growth

## Goals Growth changes of duckweed under co-exposure to environmental hormone pollutants with an ethylene antagonist.



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" 黑羽快斗 "

王盈歲

## 分裂式 G- 四聯體在核酸生物感測器的研發之應用



王盈歲個人照

### 個人特色、專長和興趣

我從小對科學抱有興趣，尤其對生物和化學之間的關係：我時常好奇，小小化學分子如何影響生物體的整個運行？

### 團隊簡介與隊名由來

在現代疾病肆虐的時代，本隊旨在運用科學探討更多元的檢測方法。黑羽快斗是名偵探柯南中怪盜基德的本名，他的名字代表著：無論多麼困難的處境，都可以用魔法般的能力迎刃而解，而我們也希望用科學這魔法為世界帶來色彩。

### 參賽原因與心得

在進行實驗時，我常常對於如何用最簡單明瞭的話語傳遞我的實驗內容，因為這才是讓一個實驗的最佳價值清楚傳遞的路徑。在準備過程我也因此訓練我的表達能力：因為在科學的世界裡，許多的原理和概念雖然複雜，但是都是和我們的生活息息相關，我相信只要從平常生活的角度切入，科學就不在是複雜、令人不易理解的，我也因此正在訓練我的這項能力。另外我在整理實驗數據時，我也發現同一組數據可以用不同方式來呈現。什麼樣的圖表才能最好表達我的實驗目的呢？我想這是我在競賽遇到的最大困難，不同的圖表可以表達同樣組數據背後的不同內涵，而我也因此一次次釐清了我的研究最深層的目的和意義。參加此次比賽讓我更了解科學的無遠弗屆，收穫良多。

### 隊伍自評

#### · 優勢

實驗設計過程嚴謹、在不同變因中有系統性地找出最佳解。

#### · 劣勢

雖然已完成大部分的樣品組合，但仍有多項可以進一步探討。

# Application of Split G-quadruplex Structures in the Development of Nucleic Acid Biosensors

Author: YING-WEI WANG Teacher: Shih-Chao Yeh, Ja-an Ho

## Research Purpose

Nucleic acid testing has become an integral part of our lives, from **routine food safety** inspections and **rapid pathogen screening** during illness to environmental water quality monitoring.

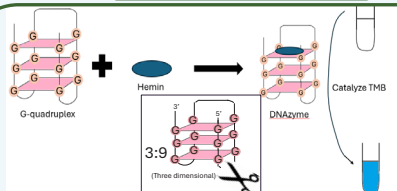
However, traditional detection methods rely on **expensive instrumentation and time-consuming protocols**, making it impossible to obtain rapid results on-site. Consequently, these methods require sophisticated equipment to regulate the reactions.

If alternative, faster, and more accurate methods could be identified to detect reaction transitions for signal output, we could **avoid the excessive consumption of time and energy** while eliminating the need for costly precision instruments.



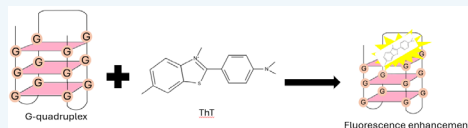
## Experimental methods

### 1. Colorimetric detection



When a specific DNA structure called a **G-quadruplex** binds with **hemin** (a molecule containing iron), it creates a powerful complex known as a **DNAzyme**. This DNAzyme mimics the behavior of natural enzymes to catalyze chemical reactions of **TMB**. A full **G-quadruplex** can split into two isolated sequence to lower the systems background

### 2. Fluorescent detection

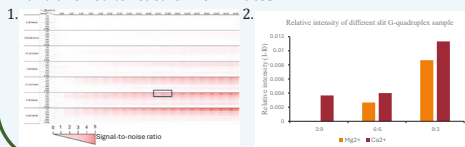


In the field of DNA nanotechnology, ThT is highly valued because it can specifically bind to **G-quadruplex** structures. This binding restricts the internal rotation of the ThT molecule, leading to a significant **enhancement of its fluorescence signal**.

## Results and Future Goals

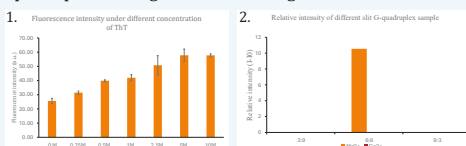
1. 5  $\mu\text{M}$  of hemin and a reaction time of **20 minutes** were selected as the standardized parameters. A binding ratio of **1:5** (G4-hemin) was identified as an eco-friendly and time-efficient catalytic proportion.

2. Under a **9:3 split mode** within a **calcium-containing buffer**, the system exhibited its peak **peroxidase-mimetic activity** when supplemented with **5  $\mu\text{M}$  hemin** as a cofactor and allowed to react for **20 minutes**.



1. ThT saturation occurs at **5  $\mu\text{M}$** . Increasing the concentration further does not improve the specific fluorescence signal; instead, it raises the **background noise** by increasing the amount of **free ThT** present in the buffer.

2. Among the various structures and environments tested, the **split G-quadruplex** configurations demonstrated superior performance in triggering fluorescence—specifically the **6:6 balanced split G-quadruplex** in a **magnesium-containing buffer**.





## " 斷層追蹤者 "

徐千昀

### Understanding the Seismic Potential of the ShanChiao Fault in Northern Taiwan



徐千昀個人照

#### 個人特色、專長和興趣

擅長分析資料、梳理邏輯，每件事皆須審慎提前安排才能安心執行。喜歡大自然，時常觀察生活周遭的自然現象。

#### 團隊簡介與隊名由來

本團隊以地球科學探究為核心，研究臺灣北部山腳斷層的位置與活動特性，透過地形分析、GIS 與實地測量，以評估地震潛勢，並探討其對城市防災與永續發展的重要性。

#### 隊伍自評



##### · 優勢

研究主題明確，並結合地形分析、GIS 與實地測量，使研究內容較具體且具有探究性。

##### · 劣勢

英文口說經驗較少，在以英文介紹研究時需要花較多時間練習與準備。

#### 參賽原因與心得

我一直對地球科學和地震相關議題很有興趣，因此在科學探究與實作中選擇研究臺灣北部的山腳斷層。當看到這個競賽時，我覺得這是一個可以用英文分享自己研究成果的機會，所以決定報名參加。雖然是個人參賽，但我需要自己整理研究重點、製作簡報，並思考如何在短時間內清楚介紹研究內容。

對我來說最大的挑戰是英文口說，因為平時比較少用英文完整介紹研究。一開始練習時常常講得不順，但透過反覆練習，我慢慢把研究內容簡化，也讓自己更能自然地表達。這次參賽讓我不只分享研究，也提升了英文表達能力，是一次很有收穫的經驗。

# Investigation of the Location and Activity Characteristics of the Shanchiao Fault in Northern Taiwan

## ABSTRACT

This study investigates the location and activity characteristics of the Shanchiao Fault in northern Taiwan. As a rare normal fault with unclear surface traces, its exact position remains uncertain. This research integrates historical maps, GIS-based terrain analysis, and field measurements to identify fault scarps and estimate key seismic parameters. The results indicate that the fault is approximately 35 km long, with an average single-event vertical displacement of 0.67 m. The estimated earthquake magnitude is Mw 6.7–6.8, and the recurrence interval is approximately 944 years.

## METHODOLOGY

### 1. Terrain Analysis

- Historical maps were used to identify fault-related lakes.
- QGIS was applied to generate topographic cross-sections.
- Fault scarps and potential fault traces were identified.

### 2. Field Measurements

- Coordinates recorded using TWD97 satellite positioning system.
- Laser rangefinder used to measure scarp height and distance ( $\pm 0.1$  m)

### 3. Data Analysis

- Scarp heights used to estimate single-event displacement.
- Empirical formulas applied to calculate earthquake magnitude and surface rupture length.
- Recurrence interval estimated using slip rate.

## RESULTS

### 1. QGIS Analysis of Fault Line and Scarp Locations



Figure: Fault Line of the Shanchiao Fault (north is at the top; all maps in this study are oriented with north at the top)

### 2. Statistical Analysis of Lakes Along the Fault Trace in Historical Maps

Table Comparison of the Number of Lakes Along the Fault Trace

| Year | Old Map Name (same-year maps listed in chronological/appearance order) | Wugu District (五股區) | Taihsan District (泰山區) |
|------|------------------------------------------------------------------------|---------------------|------------------------|
| 1895 | Topographic Map of the Vicinity of Taipei                              | 12                  | 16                     |
| 1904 | Taiwan Fort Map at 1:20,000 (Japanese colonial period)                 | 11                  | 12                     |
| 1921 | Topographic Map at 1:20,000 (Japanese colonial period)                 | 10                  | 20                     |
| 1921 | Taiwan Fort Map at 1:20,000 (Japanese colonial period)                 | 12                  | 13                     |
|      | Tatun National Park Area Map                                           | 12                  | 13                     |
| 1937 | Tatun National Park Area Map                                           | 6                   | None                   |
| 1942 | Map of Administrative Area within Taipei Prefecture                    | 0                   | 0                      |
| 1966 | Topographic Map of Taipei City Suburban Area                           | 0                   | 0                      |
| 1985 | 1:25,000 Economic Construction Edition Topographic Map                 | 0                   | 0                      |

### 3. Measurement Locations of Fault Scarps, Cross-Sectional Profiles, and Scarp Heights.

A total of 24 scarps were measured: 20 in the southern segment (Nos. 1–20) and 4 in the northern segment (Nos. 21–24).

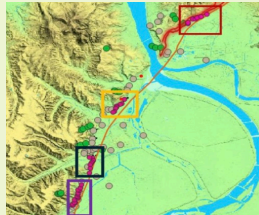


Figure: Map of Fault Scarp Measurement Locations

### 4. Cross-Sectional Profiles and Scarp Heights of Fault Scarps

Table Fault Cross-Sectional Profiles and Scarp Heights

| No.        | Southern Section Topographic profile | Scarp height (m)                                                 | No. | Northern Section Topographic profile | Scarp height (m)       |
|------------|--------------------------------------|------------------------------------------------------------------|-----|--------------------------------------|------------------------|
| 1-1<br>1-2 |                                      | Upper: 0.44 (Blue arrow head)<br>Lower: 0.78 (Orange arrow head) | 21  |                                      | 0.32 (Blue arrow head) |
| 2          |                                      | 0.99 (Blue arrow head)                                           | 22  |                                      | 0.47 (Blue arrow head) |

## DISCUSSION

### Fault Geometry

- Total fault length: ~35 km
- Southern segment aligns with official data

### Fault Activity

- Average scarp height: ~0.67 m
- Total measured scarps: 24 (20 south, 4 north)

### Seismic Parameters

- Magnitude: Mw 6.7–6.8
- Surface rupture length: 21–24 km
- Northern limit reaches Datun Mountain

### Recurrence Interval

- Estimated: ~944 years

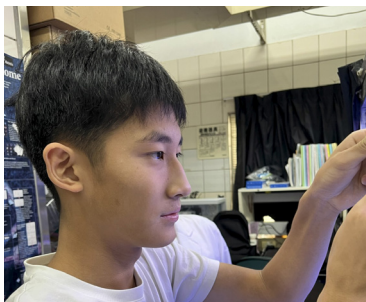
## CONCLUSION

- The Shanchiao Fault is ~35 km long.
- Average single-event displacement is ~0.67 m.
- Estimated magnitude is Mw 6.7–6.8.
- Recurrence interval is ~944 years.

## " 科學隊 "

耿易

### 以機器學習整合基因變異與 臨床表型之憂鬱症風險預測： 族群世代研究



耿易個人照

#### 個人特色、專長和興趣

特色：不放手，直到夢想到手；專長：大數據分析、基因學以及 AI 模型建立；  
興趣：大提琴、籃球。

#### 團隊簡介與隊名由來

隊名「科學隊」象徵對科學探索的熱情與求知的精神，代表以科學方法與數據分析探索未知。希望透過跨領域研究，結合基因體學、人工智慧與流行病學，發掘疾病風險預測的新可能，展現勇於探索與創新的精神。

#### 參賽原因與心得

當我陪媽媽到醫院演奏大提琴給精神科的病人聆聽時，我突然想到，是否可以利用自己的專長（AI 模型、基因學與大數據分析），嘗試發展一套能夠預測憂鬱症風險的模型。當這個構想出現時，中研院剛好釋出台灣人體生物資料庫供學者進行研究，因此也提供了適合的族群資料來發展 AI 模型。在準備的過程中，最困難的是程式碼的撰寫。幸好現在有許多大型語言模型（LLM）可以協助快速生成程式碼，再配合反覆除錯與調整的過程，使我能一步一步克服困難，最終得到相當不錯的研究結果。

#### 隊伍自評

- 優勢 本研究的主要優勢在於整合基因資料、臨床表型與機器學習方法來預測憂鬱症風險。與傳統僅使用單一基因風險分數（PRS）的研究相比，本研究將 PRS 與臨床變數（年齡、性別、共病與生活型態）結合，並透過多種機器學習模型進行分析，使模型的預測能力明顯提升。
- 劣勢 僅使用台灣族群、缺乏外部驗證、憂鬱症的盛行率相對低、憂鬱症與否是採用問卷而非專業醫師診斷、許多心理及環境變項未納入研究。





## Machine Learning-Based Prediction of Depression Using Genetic Variants and Clinical Phenotypes in a Population Cohort

### Background

- Depression is a major global health problem, affecting millions of people and creating a substantial medical and social burden.
- Genetic studies have identified many variants associated with depression, but polygenic risk scores (PRS) alone have limited predictive power.
- Machine learning can integrate genetic and clinical data, allowing the development of more accurate models to predict depression risk in large population cohorts.

### Purpose or Aim

- The aim of this study is to develop and evaluate a PRS-Based prediction model for depression in a large population-based cohort.

### Materials and Methods

- A total of 83,000 participants (55,000 women and 28,000 men) from the Taiwan Biobank were included as shown in **Figure 1**.
- Depression status was defined based on self-reported history, with 4,300 individuals classified as having depression (~5% prevalence).
- The study was conducted in two stages.
- In the first stage, participants were randomly divided into discovery and validation cohorts (1:1) to identify the optimal polygenic risk score (PRS). Genome-wide association analysis was performed using PLINK 2.0, and PRS were constructed using PRSice-2, with the best-performing PRS selected according to validation performance.
- In the second stage, the selected PRS was combined with clinical variables (age, sex, education, marriage, activity, body mass index, smoking, drinking, chronic diseases) to develop prediction models. Data were split into training (60%), validation (20%), and test (20%) sets using stratified sampling, and class imbalance in the training set was handled using SMOTE.
- Multiple machine learning models (k-nearest neighbors [KNN], random forest [RF], elastic net logistic regression [ENET], support vector machine [SVM], and naive Bayes [NB]) were trained, and predictive performance was evaluated on the independent test set using AUROC.

### Results

- Genome-wide association analysis identified several loci showing suggestive associations with depression, as illustrated by the Manhattan and QQ plots (**Figure 2**).
- PRS constructed across multiple P-value thresholds showed that the optimal threshold occurred at  $P_1 = 0.25$ , yielding the best model fit ( $R^2 = 5.7 \times 10^{-4}$ ,  $P = 0.011$ ) (**Figure 3**).
- The PRS-only model demonstrated limited predictive ability, with an AUROC of 0.521 (**Figure 4**).
- When stratified by PRS deciles, depression prevalence increased modestly from approximately 3.4% in the lowest decile to ~4.4% in the highest decile, indicating population-level genetic stratification (**Figure 4**).
- To improve predictive performance, machine learning models integrating PRS with clinical characteristics were applied, yielding validation AUROC values ranging from 0.706 to 0.815 and test AUROC values ranging from 0.701 to 0.817. Among the evaluated models, the ENET model demonstrated the best performance (test AUROC = 0.817), followed by SVM (0.809) and NB (0.807) (**Figure 5**).

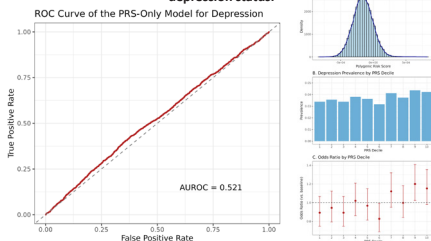
### Limitations

- Limited to Taiwanese participants; no external validation; depression defined by self-reported questionnaires; relatively low depression prevalence; and some psychological and environmental factors not included.

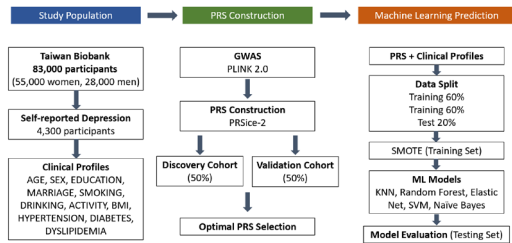
### Conclusion

- Integrating PRS with comprehensive clinical phenotypes using machine learning methods substantially improves depression risk prediction.
- This study demonstrates a scalable precision-medicine framework for population-level mental health risk stratification in a Taiwanese population.

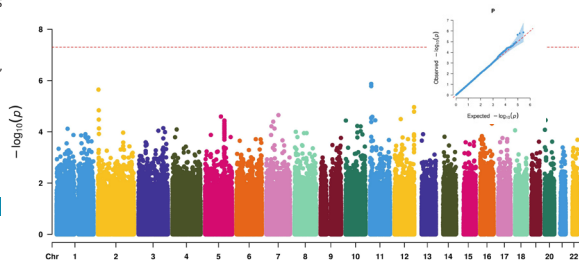
**Figure 4. AUROC of the polygenic risk score model for predictive depression status.**



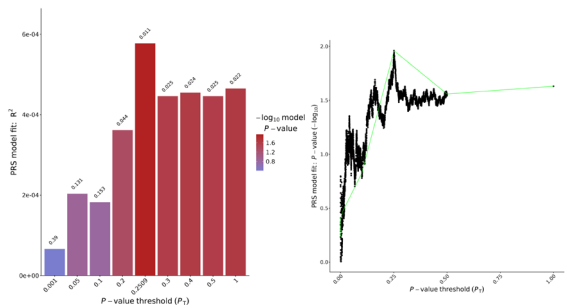
**Figure 1. Flow chart**



**Figure 2. Manhattan Plot and Q-Q plot of GWAS p-value**

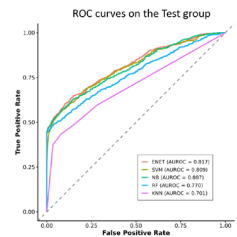


**Figure 3. Polygenic risk score**



**Figure 5. Predictive performance of machine learning models integrating PRS and clinical variables.**

| Model | Validation AUROC | Test AUROC |
|-------|------------------|------------|
| KNN   | 0.706            | 0.701      |
| RF    | 0.775            | 0.770      |
| NB    | 0.800            | 0.807      |
| SVM   | 0.815            | 0.809      |
| ENET  | 0.808            | 0.817      |



" 吐額司隊 "

張馨予

## 醇類影響 BZ 反應的 雙機制模型——模擬統合



張馨予個人照

### 個人特色、專長和興趣

有一點很有趣，我無法一心二用，不能邊做事邊講話。我的興趣是到圖書館逛逛，或是看看劇、影集，唱歌等。

### 團隊簡介與隊名由來

我的隊叫吐額司隊的原因是我很喜歡的一個韓國團體叫TWS，發音念起來就是吐額司的感覺，用意是希望我能帶著他們給我的勇氣，不要害怕、面對比賽、接受挑戰。

### 參賽原因與心得

在打算一個人完成這項研究時，發現要承擔的量不是一般的多，雖然會累，但都是值得的。程式的設計是實驗中最有挑戰性的，因為有許多變因，但幸好最後還是完成了這項研究的核心，還有BZ反應實驗的配方，也是在測試過好幾輪之後，終於找到一個成功的比例。

#### 隊伍自評

##### · 優勢

通過意外的實驗發現以及邏輯、程式推導，得知探討物質在反應裡代表的角色。

##### · 劣勢

研究的反應機制複雜，較難解釋，但還是仍以主要的影響作為探討的變因。





Teacher : Shih-Chao Yeh, Yuan-Chung Cheng

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## " 選的全都 "

王俐人

### How Gut Bacteria Affect Mating Motivat in C.elegans

#### 個人特色、專長和興趣

我從小就喜愛生物，上高中後開始進實驗室做實驗，很新奇有趣。我是牡羊座，平常喜歡看書、聽音樂、打排球，很喜歡芙莉蓮。



王俐人個人照

#### 團隊簡介與隊名由來

我將隊名取作「選的全都隊」，因為我研究的主題是秀麗隱桿線蟲尋找伴侶的動機，這個名字代表線蟲能找到對的伴侶，就像我很幸運能遇到我的指導老師一顏映帆老師，我們就像一個團隊，會一起討論實驗、修改報告，共同做出最正確的選擇！

#### 參賽原因與心得

老師推薦我用我自己的研究參加這個比賽，起初我其實不認為自己能做到，因為我本來就不擅長英文口說，更別提我的研究裡充滿了難唸的專有名詞，但我很喜歡我的研究，希望能分享給大家，如果有人感興趣、能跟我討論，更讓我感到開心，畢竟自己一組有時很孤單，因此我決定參加比賽。我借助 ChatGPT 的幫助順利寫出我的講稿，雖然很精簡，多數句子也沒有用到很困難的語法，但我還是讀了很多次才讀熟，希望大家會喜歡我的研究。

#### 隊伍自評

##### · 優勢

研究推導邏輯清晰，並得出有價值的結論。本研究具有開創性，值得未來深入探討，將有機會供研究腸道微生物影響神經與行為的模式生物系統。

##### · 劣勢

研究還有更多發展的面向尚未討論，且未完全驗證，如是否為植物激素誘導的部分。目前仍在研究初步階段，許多機制的因果關係仍不明朗，如為何 CeMbio 會降低線蟲的尋偶動機。



# How Gut Bacteria Affect Mating Motivation in C.elegans

Li-ren, Wang

## Abstract

Human's gut bacterial metabolites influence appetite, which is regulated by the hypothalamus. Sexual motivation is also regulated by the hypothalamus. Using *C. elegans* fed with CeMbio, I assessed male mating motivation via male-leaving assays. Nine of ten strains reduced "mating motivation ratio," and two also decreased mating "activity level". These study reveals that gut microbiota can modulate sexual motivation. Future studies will provide a model system for studying how gut microbiota affect neural function and behavior.

## Research Methods

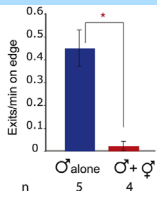


Figure 1. Experimental design  
(adapted from Barrios et al., 2008).

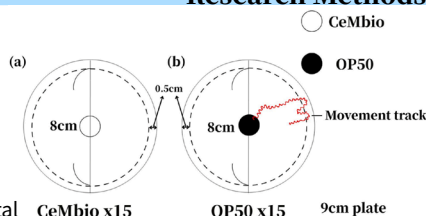


Figure 2. Experimental setup

- mating motivation ratio  
= number of worms crossing the 8cm boundary / total worms (15)
- activity level  
= number of times the movement track reaches the 8cm boundary

select 30 L4 male *C.elegans*



prepare  
15 OP50 plates  
15 CeMbio plates



place Day-1 adult *C.elegans* on each plate



after 24 hours collect data

## Results

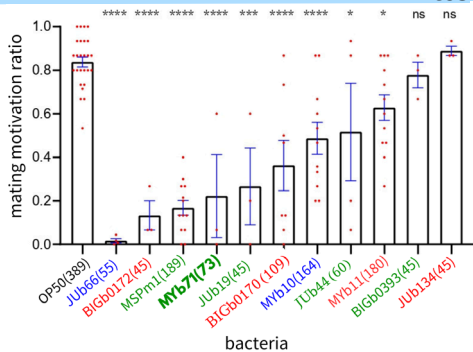


Figure 3. Mating motivation ratio in each bacteria  
Each point represents the proportion of 15 worms leaving the 8 cm boundary; the number of points indicates the number of trials. Error bars represent the standard error. (\* $p < 0.05$ ; \*\*\* $p < 0.001$ ; \*\*\*\* $p < 0.0001$ )

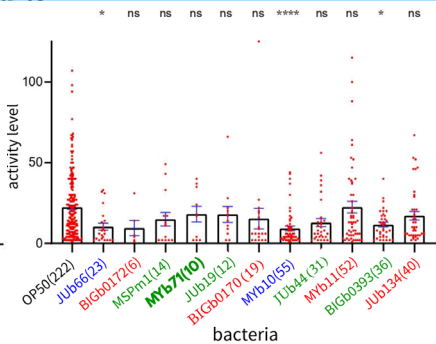


Figure 4. Activity level in each bacteria  
Each point represents the activity level of an individual worm leaving the 8 cm boundary. Error bars represent the standard error. (\* $p < 0.05$ ; \*\*\*\* $p < 0.0001$ )

## Discussion & Conclusion

CeMbio reduces mate-searching behavior in male *C.elegans*. This effect is independent of CeMbio colonization levels and its impact on worm growth rate. Based on previous studies, CeMbio may influence mating behavior through the gut-brain axis by modulating dopaminergic and serotonergic neurons. Further investigation using neuronal mutants in the Male Leaving Assay is warranted.

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## " 不嘻嘻隊 "

陳姿妍

### One-Step Electrochemical Intercalation of Heteroatom-Doped Carbon Dots into MXene for Supercapacitor



陳姿妍個人照

#### 個人特色、專長和興趣

我的個性偏活潑外向，有時候會有點吵，平常的興趣是騎腳踏車亂逛。

#### 團隊簡介與隊名由來

隊名取作不嘻嘻隊，使用網路用語，不僅帶有一點幽默感，也反映了我面對研究時的態度。面對實驗與數據時，往往需要保持專注與嚴謹，沒有太多嘻嘻哈哈的空間，因此便以「不嘻嘻」作為隊名。

#### 參賽原因與心得

在研究過程中，我遇到了不少挑戰。其中最大的困難是，在完成初步實驗之後，對整體研究方向感到有些迷惘，也不確定下一個實驗應該如何設計。當時我向指導老師以及實驗室的學長姐請教，經過多次討論與反覆嘗試之後，逐漸釐清了接下來的研究方向，並建立起下一階段實驗的完整架構。隨著研究逐步推進，最終也順利得到今天所呈現的研究結果。

#### 隊伍自評

##### · 優勢

實驗能再常溫常壓下完成，且不需繁複步驟。

##### · 劣勢

仍須更多化學分析、顯微結構分析，以驗證碳點的化學組成以及確認其確實有插入MXene層間。

# One-Step Electrochemical Intercalation of Heteroatom-Doped Carbon Dots into MXene for Ultra-Stable Supercapacitors

## Introduction

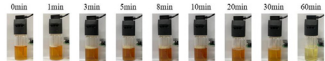
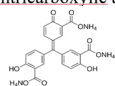
After reading a news report about advanced energy storage technologies, I became interested in supercapacitors. As the demand for sustainable energy grows, developing efficient and practical energy storage systems is increasingly important.

MXene is a promising material due to its high conductivity and large surface area, but its poor stability and restacking limit its performance. To address this, I propose a simple one-step electrochemical method to synthesize carbon dots and intercalate them into MXene.

Unlike conventional methods that require high temperature and multiple steps, this approach works under mild conditions, reducing energy consumption and improving sustainability.

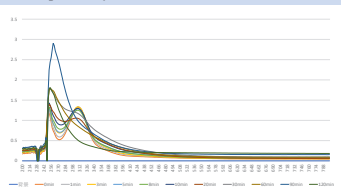
## Result and Discussion

### 1. Electrochemical Synthesis of Heteroatom-Doped Carbon Dots aurintricarboxylic acid ammonium salt(ATA)



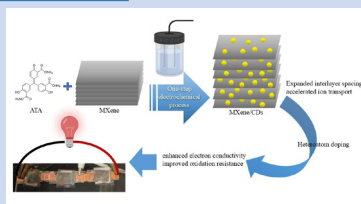
ATA acts as an effective carbon source for the electrochemical synthesis of CDs, yielding stable, well-dispersed carbon dots suitable for intercalation into MXene.

### 3. Spectroscopic Analysis



UV-Vis spectroscopy revealed a peak near 310 nm that gradually decreased as the heteroatom-doped CDs were adsorbed or intercalated into MXene, indicating immobilization of the CDs rather than their loss, which correlates with enhanced electrochemical performance.

## Conclusion



1. A one-step electrochemical method enables simultaneous CD synthesis and intercalation into MXene under mild conditions.

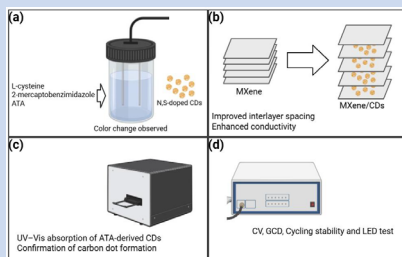
2. CD intercalation expands interlayer spacing, suppresses restacking, and improves oxidation stability.

3. The MXene/CDs composite shows approximately 2.7 times higher capacitance and significantly longer discharge time.

4. Enhanced performance arises from increased active surface area and improved charge transport.

5. The method is simple, scalable, and environmentally friendly, showing strong potential for next-generation supercapacitors.

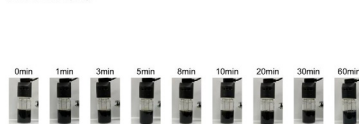
## Methods



Schematic illustration of one-step electrochemical synthesis of N,S-doped carbon dots from ATA and their intercalation into MXene. The formation of CDs was confirmed by UV-Vis, and performance was evaluated by CV, GCD, cycling, and LED tests.

### 2. Simultaneous Intercalation of CDs into MXene

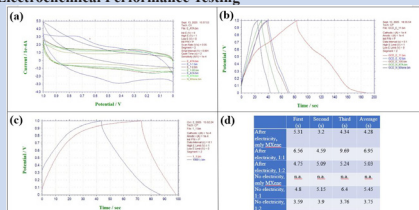
#### ATA+MXene



The ATA precursor was electrochemically treated with MXene for 30 minutes. The solution darkened from black-orange to deep black with gas evolution, while remaining well dispersed.

The final MXene/CDs suspension showed no sedimentation after several days, indicating successful intercalation, improved stability, and enhanced interlayer expansion and oxidation resistance.

### 4. Electrochemical Performance Testing



(a) CV results show that the MXene/CDs electrode has a larger enclosed area than pristine MXene, indicating better charge storage. Both curves remain nearly rectangular, suggesting that electric double-layer capacitance is still the dominant mechanism.

(b) At  $1 \text{ A g}^{-1}$ , the discharge time increases from  $\sim 60 \text{ s}$  to  $\sim 160 \text{ s}$  after intercalation. The specific capacitance rises from  $\sim 6$  to  $\sim 16 \text{ F g}^{-1}$  ( $\approx 2.7$ -fold), with a smaller IR drop indicating improved charge transport.

(c) After 1000 cycles, the intercalated sample retains over 90% of its capacitance, while pristine MXene shows clear degradation. This suggests improved structural stability and reduced oxidation.

(d) In LED tests, illumination time increases from  $\sim 5 \text{ s}$  (pristine) to  $\sim 7 \text{ s}$  (composite). This confirms enhanced charge storage and is consistent with CV and GCD results.

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## " Nicotiana "

黃亭瑄

### 邁向綠色永續農業—— 探討農業廢棄物再利用於 植物保護之效果



黃亭瑄個人照

#### 個人特色、專長和興趣

我平常的興趣是閱讀、聽音樂、做手作以及和外國人線上聊天；專長是生物及化學。我是一個喜歡培養專長的人。

#### 團隊簡介與隊名由來

我的隊名來自圓葉菸草的學名 - *Nicotiana benthamiana*。圓葉菸草是我這三年的研究對象，也是科學界常用的模式植物。它的生命力強韌，葉片較圓滑，我期許自己具備和它相同的人格特質：有毅力、處事圓滑、事事順利。

#### 參賽原因與心得

我是個人組，雖然個人組準備時可能比團體組吃力一些，但一切按照自己的步調進行的感覺也不錯。高一看到遠哲的活動簡章時很想參加，在做完獨立研究後便報名了這項比賽，除了可以精進自己的英語能力並更深度地了解自己的專題內容，亦可增加寶貴的人生經驗。最大的挑戰是需要將生物的專有名詞變為英文，雖然做實驗時若要查找資料時都是看英文論文，雖然看得懂，但要將它轉化為自己的字相對困難，然而在攻克這些問題後，我的英文能力也進步許多。

#### 隊伍自評

##### · 優勢

研究推導邏輯清晰，實驗架構完整，實驗結果符合預期。

##### · 劣勢

數據的數量不夠多，未來需要繼續做實驗以確保實驗準確性。

# Towards Green and Sustainable Agriculture: Exploring the Effects of Agricultural Waste Reuse in Plant Protection

## Abstract

This study investigates using fermented pineapple waste with Trichoderma or Bacillus to boost plant immunity against viruses. An eightfold dilution of Trichoderma fermentation proved most effective, reducing virus levels and triggering early immune responses in tobacco. The results highlight a sustainable, eco-friendly approach to plant protection and pesticide reduction.

## Research Objectives

1. To investigate the antiviral effects of fermentation broth derived from pear peels, supplemented with either Trichoderma or Bacillus, and to determine the optimal concentration for efficacy.
2. To examine the antiviral activity triggered by the fermentation broth via pattern-triggered immunity (PTI) and salicylic acid (SA) signaling pathways, and to monitor corresponding changes in plant disease symptoms.

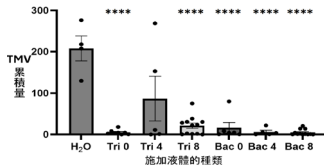
## Research Results and Discussion

- Investigating the impact of immune responses induced by fermented liquid application on plant disease symptoms using the Disease Index.

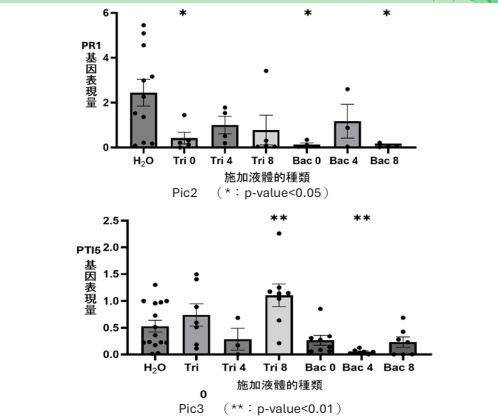
| Severity Level | Description                                     |
|----------------|-------------------------------------------------|
| 0              | No symptoms                                     |
| 1              | Vein clearing                                   |
| 2              | Mild mottling accompanied by leaf chlorosis     |
| 3              | Severe mottling and noticeable leaf deformation |
| 4              | Pronounced leaf drooping                        |
| 5              | Plant death                                     |

| Spraying treatment    | H <sub>2</sub> O(17)                                                                | Tri0(15)                                                                            | Tri4(15)                                                                            | Tri8(15)                                                                            | Tri(15)                                                                             |
|-----------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Disease index average | 3.12                                                                                | 2.10                                                                                | 3.10                                                                                | 2.00                                                                                | 2.80                                                                                |
| Standard deviation    | 0.87                                                                                | 0.55                                                                                | 1.04                                                                                | 0.82                                                                                | 1.09                                                                                |
| picture               |  |  |  |  |  |
| Spraying treatment    |                                                                                     | Bac0(15)                                                                            | Bac4(15)                                                                            | Bac8(15)                                                                            | Bac(15)                                                                             |
| Disease index average |                                                                                     | 2.70                                                                                | 2.70                                                                                | 2.33                                                                                | 2.70                                                                                |
| Standard deviation    |                                                                                     | 1.06                                                                                | 1.07                                                                                | 1.00                                                                                | 1.30                                                                                |
| picture               |                                                                                     |  |  |  |  |

### 二、Effects of Fermentation Broth Application on TMV Coat Protein Accumulation and PR1 and PTI5 Gene Expression



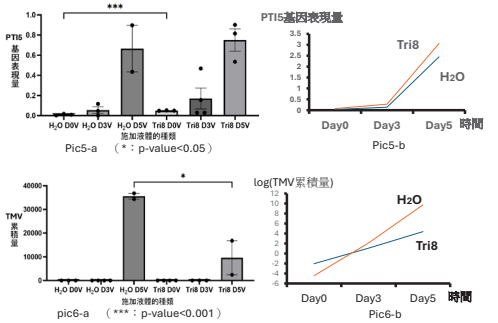
Pic 1 (\*\*\*\* : p-value<0.0001)  
0、4、8 : Dilution levels (undiluted, 1:4, 1:8)



- Effects of Bacterial Suspension or Fermentation Broth Application on TMV Coat Protein Accumulation

As shown in Figure 4, there is no significant difference in TMV coat protein accumulation between Bac8 and Bac, whereas a significant difference is observed between Tri8 and Tri. Overall, the fermentation broth treatment is more effective than the bacterial suspension treatment.

- Assessment of Priming Induced by Fermentation Broth Application



## Conclusion

A 1:8 dilution of Trichoderma fermentation broth was identified as the most effective concentration, resulting in a lower disease index, reduced viral accumulation, and increased expression of the PTI5 gene. Tobacco plants treated with the Trichoderma spore suspension exhibited higher accumulation of the TMV coat protein compared to those treated with the fermentation broth. This indicates that the fermentation broth is more effective than the spore suspension in enhancing disease resistance. This research supports sustainable agriculture and **SDG 12: Responsible Consumption and Production**.



## " 請填寫隊名 "

高永泰

### BSA-MXene/Au-PDTC

### 奈米複合材料的抗氧化性能檢測 及其作用機制探討



高永泰個人照

## 個人特色、專長和興趣

我平時對自然科學與實驗活動抱有濃厚的興趣，喜歡透過實際操作與觀察去理解課本中的概念。除了課堂學習之外，也會閱讀一些科學相關的文章或資料，希望能更深入了解不同領域的知識。

在這段經驗中，不僅培養了耐心與解決問題的能力，也體會到科學研究需要長時間的嘗試與修正。雖然過程並不總是順利，但每當實驗結果逐漸清楚時，都會帶來很大的成就感，也讓人更想繼續探索未知的事物。

## 團隊簡介與隊名由來

「請填寫隊名。」這是我們在報名這次挑戰賽時看到的第一個欄位。乍看之下只是報名表上一行尚未填寫的空欄，但它其實更像是一種提醒：科學不會有填寫好的答案，而是一段持續延展的篇章，新的問題被提出，既有的理解被修正，未知的空白等待被填補。

## 參賽原因與心得

參與本次科學競賽的原因，是希望將在實驗室進行的研究成果整理並與更多人交流。在準備過程中，需要重新整理研究背景、實驗方法與結果，並將複雜的科學內容轉換成容易理解的展示形式，這對於研究理解與表達能力都是很大的挑戰。

準備競賽的過程中，最困難的部分是如何將大量實驗數據整理成清楚的研究結果。例如在抗氧化測試與細胞實驗中，需要反覆確認數據趨勢是否一致，並思考其可能的機制解釋。透過這次參賽，我不僅更深入理解自己的研究內容，也體會到科學研究不只是實驗本身，更包含了討論、修正與持續探索的過程。

### 隊伍自評

#### · 優勢

本研究在實驗設計上具有明確的研究架構，從材料合成、形貌觀察、化學抗氧化測試到細胞實驗逐步建立證據，使研究結果能夠互相驗證。

#### · 劣勢

本研究仍有部分機制尚未完全驗證。未來仍需要透過更多分析技術與實驗模型，進一步確認材料的作用機制與應用潛力。



# Antioxidant Activity and Mechanistic Insights into BSA-MXene/Au-PDTC Nanocomposites



## Abstract

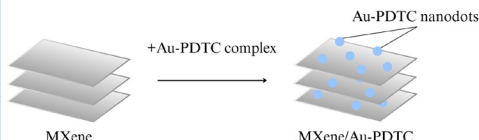


Fig.1 Schematic of MXene/Au-PDTC synthesis.

This study develops a **BSA-MXene/Au-PDTC nanocomposite** and evaluates its antioxidant activity. BSA was used to stabilize MXene nanosheets and improve dispersion, while Au-PDTC complexes were immobilized on the MXene surface. Antioxidant performance was assessed using **DPPH**, **ABTS**, and **Folin-Ciocalteu assays**, and intracellular ROS levels were measured using a **DCFH-DA cell model**. **SEM characterization** confirmed improved MXene dispersion and successful immobilization of Au-PDTC. The composite maintained strong antioxidant activity while reducing the cytotoxicity associated with Au-PDTC.

## Materials and Methods

1. **MXene**, a two-dimensional nanomaterial with a high specific surface area and abundant surface terminations.
2. **Bovine serum albumin (BSA)**, used as a stabilizing agent to improve the dispersibility and aqueous stability of MXene.
3. **Au-PDTC**, a coordination complex formed between PDTC and  $Au^{3+}$  ions, has anti-inflammatory potential.
4. **PDTC**, a compound with antioxidant and anti-inflammatory potential.

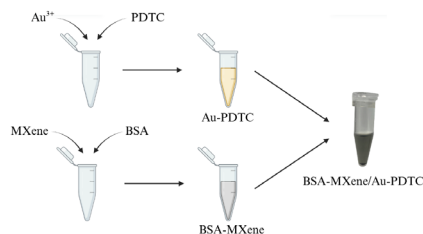


Fig.2 Synthesis procedure of the MXene/Au-PDTC composite material

## Result

### Antioxidant Assay(DPPH) ▶

BSA-MXene/Au-PDTC exhibited **high radical-scavenging activity** comparable to MXene, indicating that immobilization of Au-PDTC did not compromise the antioxidant capability of MXene alone.

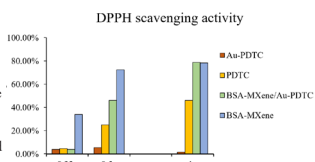


Fig.3 Radical scavenging activity of materials in DPPH assay

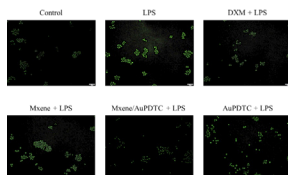


Fig.5 Fluorescence of the samples observed under microscope.

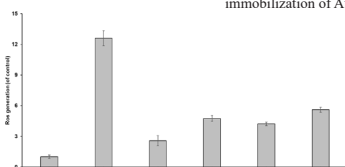
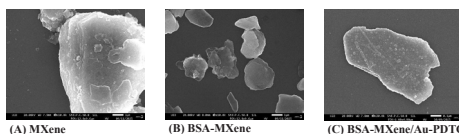


Fig.6 Relative ROS generation quantified from DCF fluorescence intensity.



### ▲ SEM images

SEM images showed that **BSA improved MXene dispersion** and prevented nanosheet restacking, while **surface nanodots on MXene** indicated successful immobilization of Au-PDTC on the MXene surface.

### ◀ Intracellular ROS Generation (DCFH-DA Assay)

BSA-MXene/Au-PDTC showed the lowest intracellular ROS fluorescence, demonstrating **stronger ROS suppression** than MXene or Au-PDTC alone. (Lower fluorescence intensity indicates lower ROS generation.)

## References

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" Shiny "

張芸瑄

## Inclusive Mental Health Support System: Technology for SDGs 3 & 10



張芸瑄個人照

### 個人特色、專長和興趣

具高情商與耐心傾聽特質，專長資訊科技與 VR 開發。熱衷閱讀寫作，偶爾 COS 角色，致力在理性代碼與感性敘事間編織未來。

### 團隊簡介與隊名由來

隊名「SHINY」取自學生英文名字，象徵團隊如名閃閃發亮、充滿能量。在國際化沃土用科技與創意點亮未來，展現最璀璨的雙語創新活力！

### 參賽原因與心得

我們渴望透過科技解決全球心理健康不平等。

準備過程充滿驚喜，最有趣的是在測試「高空玻璃橋」VR 實境時，雖身處室內環境卻因沉浸感，讓我們即時捕捉到超過 120 BPM 的心率數據，成功驗證了生理訊號監測的靈敏度。

然而，最大的挑戰在於從 0 到 1 的突破——除了技術架構的從無到有，最難熬的是系統開發完成後，必須嚴守 IRB 人體試驗倫理規範。那段漫長的等待與審核過程，讓我們深刻體會到：科學創新不只要追求數據精確，對使用者權益的守護與倫理尊重，才是科技溫度的核心。

### 隊伍自評



#### · 優勢

研究推導邏輯清晰，並得出有價值的結論。本研究具備嚴謹且清晰的推導邏輯，從生理訊號擷取、情緒推論邏輯到 VR 即時介入，建立了一個完整的閉環系統。透過數據驗證，充分證明其在心理健康監測與即時輔導上的實踐潛力。

#### · 劣勢

研究還有更多發展的面向尚未討論，且未完全驗證。

由於本研究對象涉及未成年人，目前仍處於嚴謹的 IRB 人體試驗倫理審查階段，因此尚未能進行大規模的臨床實測驗證，僅能先透過模擬場景進行技術驗證。此外，研究尚有許多發展面向有待討論，例如：針對不同受測者生理基準值的多樣性調整，以及系統長期使用的情緒調節成效。

# Human-AI Collaborative VR Mental Health Support System Advancing SDG 3 & 10 through Innovative Real-Time Emotional Regulation

Author : YUN HSUAN CHANG

## Abstract

This study presents a Human-Machine Collaborative VR Mental Health Support System integrating real-time physiological sensing, immersive VR, and a hybrid AI engine. Built on a local edge computing architecture, the system achieves low latency ( $<0.8s$ ), high synchronization ( $>97\%$ ), and minimal data loss ( $<0.02\%$ ), ensuring robust real-time performance. Physiological signals (heart rate, HRV) are processed locally for privacy-preserving emotion inference. A Retrieval-Augmented Generation (RAG) engine, grounded in a 378k-entry professional knowledge base, delivers context-aware psychological support. A dual-alert mechanism with human-in-the-loop VR switching prioritizes user safety and autonomy. Under peak workloads, CPU usage remains at 29% on standard laptops, demonstrating high efficiency. Experimental validation confirms 100% crisis recognition accuracy. This system offers a secure, scalable engineering solution for digital mental health interventions.

## Research Aims

1. Low-latency HR/HRV monitoring
2. Hybrid AI (RAG) for psychological support
3. VR-AI multimodal interaction
4. Privacy-first edge computing
5. System performance & safety validation

## Method

### 1. Physiological Sensing & Processing

- (1) Web Bluetooth API connects to Polar H10 for real-time heart rate and HRV (RMSSD)
- (2) Local browser-based processing ensures low latency and privacy

### 2. Hybrid AI Engine

- (1) Dify.ai platform + 378,450-entry structured psychological knowledge base
- (2) RAG ensures context-aware, safe, and ethical responses

### 3. VR Environment

- (1) Unity + Meta Quest 2
- (2) Four immersive scenes: CitySkyline (anxiety), CanyonBridge (fear), OceanAbyss (isolation), SunnyMeadow (relaxation with alpha music)

### 4. Human-in-the-Loop Safety Design

- (1) RedAlert triggered when heart rate  $>120$  BPM
- (2) VR scene switching manually confirmed by user or caregiver

### 5. Data Management

Local edge storage + user isolation + one-click data export

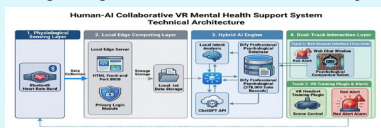


Figure 1. System Architecture  
(Diagram generated by AI based on author's instructions)

## Results

### Low-Latency Physiological Monitoring

HRV (RMSSD) computed locally every second

1. End-to-end latency:  $<0.8$  seconds
2. Data loss rate:  $<0.02\%$  (120-min test)
3. Real-time display success: 100%



Figure 2. Logging 7,199/7,200 points in 2 hours ( $<0.02\%$  loss) proves highly reliable edge computing and Bluetooth transmission.

### Hybrid AI (RAG) for psychological support

- Knowledge base: 378,450 structured psychological entries
- Crisis recognition accuracy: 100% (12 high-risk scenarios)
- Overall dialogue pass rate: 100% (59 test scenarios)
- No hallucinations or unsafe responses detected

### VR-AI multimodal interaction

- 4 immersive VR scenes (anxiety, fear, isolation, relaxation)
- RedAlert triggered in  $<0.5s$  when  $HR >120$  BPM
- Human-in-the-loop VR switching ensures safety and user control

### Privacy-first edge computing

- All raw physiological data processed locally
- Only anonymized parameters transmitted
- User isolation + one-click data export for data sovereignty

### System performance & safety validation

Full load (sensing + VR + AI): 29% CPU, 51% memory,  $<1\%$  disk I/O. Dedicated GPU idle — lightweight & scalable.



Figure 3. System Test Screenshot : The dedicated GPU remains idle, confirming the architecture's lightweight design and scalability.

## Conclusion

This study successfully developed and validated a Human-Machine Collaborative VR Mental Health Support System with the following key contributions :

1. Safety-first architecture: Dual-alert + human-in-the-loop for ethical intervention
2. High performance:  $<0.8s$  latency ·  $>99.98\%$  reliability · 29% CPU usage
3. Privacy by design: Local processing · Anonymized transmission only
4. Professional AI support: 378k RAG knowledge base · 100% crisis recognition
5. Scalable & accessible: Runs on standard laptops · Ready for schools, homes, communities

This system provides a robust engineering foundation for real-world digital mental health applications.





隊伍介紹

## 國中團體組



JG007 PhaseBook

JG008 Tiny Ant Big Impact

JG009 Borderless Trash

JG010 The Pandora Squad

JG011 海洋纖維細細小小影響大

JG013 植物「碳」險隊

JG014 The Corn Whisperer

## " PhaseBook "

周湘東、陳毓欣、王苡晴

## Hands-on

## Moon Phases



由左至右：王哲剛老師、陳毓欣、  
周湘東、王苡晴、周華玲老師

### 個人特色、專長和興趣

#### 1. 周湘東

喜歡看日本動漫，閒適時也會把玩樂器小號等（目前參加學校的管樂社），喜歡用英文吸收數學和自然相關知識。

#### 2. 陳毓欣

熱愛觀察生活細節，喜歡透過寫作與閱讀梳理思緒，也享受拼湊積木的專注時光。音樂是我放鬆的管道（鋼琴、管樂），也常與同學用英文交流。

#### 3. 王苡晴

喜歡和朋友看電影，平常彈鋼琴、聽音樂。樂曲是我放鬆管道之一。不過相較於中文歌，更喜歡古典樂與英文歌。

### 團隊簡介與隊名由來

我們「PhaseBook」結合 Phase（月相）和 Book（紀錄與分享）的概念，也呼應團隊平常在 Facebook 上熱烈討論研究的習慣。我們像是在一起寫一本關於月相的「活的筆記本」，從觀察月亮、設計模型到討論實驗成果，都不斷更新想法與發現～～





## 參賽原因與心得

當知道這個比賽之後，熱愛英文和科學的我們直接成軍「用英文做科展」！為了英文呈現，我們不僅搞懂原理，還要查證專有名詞。最耗時是模型設計：放學後留下討論、測試、修改，不斷改版只為讓它更好用。

最難忘「英文卡卡大作戰」。練習口頭報告時，我們英文唸超不順，越緊張越結巴，三人輪流吃螺絲，唸到後來自己都笑出來。那些反覆練習的午休，從吞吞吐吐到流暢表達，現在格外懷念。

最大挑戰是把複雜科學講得像人話。初版摘要被老師退件：「誰看得懂？」後來我們一句句討論，直到每段都能用簡單英文解釋清楚。

站上評審面前，我們不再只是三個緊張學生。這段用英文卡卡、模型改版、笑容收尾的日子，是我們最珍貴的戰利品。



### 隊伍自評

#### ・優勢

1. 豐富的模型改良經驗：我們從研究二的大型月相模型、研究三的大創紙模型一路測試到研究四的智高積木，最終設計出第五代多功能月相觀察儀，具備完整的實作歷程。
2. 跨領域整合能力：組員熟悉智高積木的齒輪傳動機構，能將工程思維融入地球科學教具設計。
3. 觀察與理論驗證並重：實際記錄一整個月的月相變化，運用 Stellarium App 輔助驗證，發現「文獻月相皆以中天位置呈現」的重要結論。

#### ・劣勢

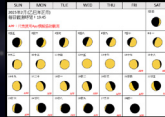
1. 模型機構的精密度限制：受限於智高積木的齒輪尺寸選擇有限，部分傳動機構無法達到理想中的順暢度，仍有改善空間。
2. 文獻探討深度不足：對於白道面與黃道面夾角、月球公轉橢圓軌道等進階概念的文獻回顧較為淺薄，未能深入探討。
3. 口頭表達與臨場應變：面對評審提問時，我們常因緊張而無法清晰表達改良過程中的思考轉折，臨場發揮仍需加強。

# Hands-on Moon Phases

By Phasebook  
Mia, Bryan, Apple, Jihgang, Hualing

## Introduction

In ninth-grade science class, we learned and observed that the Moon's shape changes day by day. However, the models presented in textbooks are static and disconnected from reality. This discrepancy led us to question whether traditional teaching models truly help students understand the mechanisms behind moon phases.



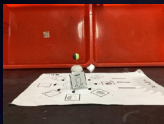
## Project Highlights

- **The Innovation:** Developed a synchronized gear system that automatically aligns the Moon's lit side toward the Sun, fixing the manual errors of paper models.
- **The Goal:** To design better tools for understanding lunar cycles and celestial mechanics.
- **The Research:** Conducted a comparative analysis of learning outcomes between textbook models and manual models.

## Textbook Model vs. Manual Model

| Feature     | Textbook Model                                   | Manual Model                                      |
|-------------|--------------------------------------------------|---------------------------------------------------|
| Method      | Holding by hand                                  | Hands-on                                          |
| Perspective | Earth-based perspective                          | Earth-based perspective<br>Top-down perspective   |
| Pros        | Materials are easily accessible                  | automatically adjusts the Moon's illuminated side |
| Cons        | manual adjustment of the Moon's illuminated side | Requires prior assembly of the block model        |

## Experiments and result



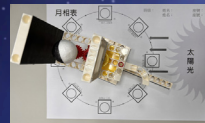
Gen 1: Paper Model (Daiso)

### Gen 1: Daiso Paper Model

- Pros: Top-down "God's eye view", affordable for individual practice.
- Cons: Manual light adjustment required; fragile paper structure.

### Gen 2-N: Gigo Block Model

- Improvement: Used Gigo blocks to create a sturdier and more user-friendly mechanism, enabling the Moon's illuminated side to rotate synchronously for observing moon phase changes.



Gen N: Gigo Blocks

## Classroom Testing & Feedback



- **Method:** Conducted a controlled experiment with 9th-grade science students (Control Group; textbook model vs. Experimental Group; manual model).
- **Results:** The experimental group showed significant improvement in understanding model mechanics and lunar principles.
- **Conclusion:** The model effectively helps students master the spatial relationships between the Sun, Earth, and Moon.



## Moon Observation & Phases: Test Questions

- Observing the Moon daily for a month, what occurs?
  - Appearance remains constant.
  - Illuminated shape changes daily.
  - Brightness increases continuously.
  - Movement is entirely random.
- The Moon's sunlit side always faces:
  - Toward Earth.
  - Toward the Sun.
  - In random directions.
  - Toward the West.
- Can stars be drawn in the Moon's shadowed area?
  - Yes; it is empty space.
  - No; stars are too dim.
  - No; it is the Moon's physical body.
  - No; stars only show on New Moons.
- Relative positions during a Full Moon:
  - Sun-Earth-Moon (Linear).
  - Sun-Moon-Earth (Linear).
  - Sun-Earth-Moon (90° angle).
  - No fixed positions.
- Relative positions during a First Quarter Moon:
  - Sun-Earth-Moon (Linear).
  - Sun-Moon-Earth (Linear).
  - Sun-Earth-Moon (90° angle).
  - No fixed positions.
- Observing the Moon at its highest daily point for a month:
  - Phases change regularly.
  - Phases changes are random.
  - Only Full Moons reach the top.
  - The phase never changes.

## Our Contribution to SDGs



Providing low-cost, high-precision interactive tools to enable scientific inquiry.



Developing a moon phase observation model with gear-synchronized rotation.

## Conclusion

- **Successful Tool Improvement:** The Gigo Moon Phase Observer integrates synchronized illumination and angular viewing, enabling a more realistic representation of moon phase changes.
- **Significant Learning Impact:** Using the tool alongside observation logs significantly enhances learners' understanding of astronomical patterns.

## " Tiny Ant Big Impact "

林心瑜、甘昀加、洪旭恒

烈嶼蟻境，地形映生——

利用 GIS 探究

烈嶼地區螞蟻相



由左至右：林心瑜、甘昀加、  
洪旭恒、傅信堯老師、陳聖別老師

### 個人特色、專長和興趣

#### 1. 林心瑜

我擅長手作與繪圖，能將抽象概念轉化為具體裝置。平時習慣透過觀察動物細節進行邏輯推演，能精準執行實驗並記錄數據，確保競賽表現穩定可靠。

#### 2. 甘昀加

我擅長觀察生活細節，喜歡用畫畫表達想法與情感，透過細膩的觀察把看到的世界記錄在作品中。

#### 3. 洪旭恒

熱愛實驗與實作，具備敏銳觀察力與邏輯分析專長。我喜歡挑戰未知，擅長從日常發現問題，並透過嚴謹探究找尋答案，對科學充滿探索熱忱。

### 團隊簡介與隊名由來

我們是一群對自然與科學充滿好奇的學生，透過觀察身邊的小生物發現大大的科學問題。我們以螞蟻為研究主題，正如隊名 Tiny Ant Big Impact，小小螞蟻也能帶來巨大影響，展現我們用創意、合作與科學精神探索生態的熱情。



## 參賽原因與心得

雖然我們身處不同班級，卻因對科學研究的熱忱而緊密連結。在備戰過程中，我們深刻體會到「實驗不僅是在實驗室裡，更是在大自然中博弈」。面對強風導致裝置受損、誘餌頻頻被吹散等天氣挑戰，我們學會了如何在變動的環境中尋求穩定。過程中更是驚喜不斷：像是發現只有紅火蟻愛吃波卡、跟著老師環島小金門，以及洗用具時來自糖水的黏膩感。這些細碎且真實的瞬間，都成了我們實驗日誌中最精彩的篇章。這些挫折與發現，不僅淬煉了我們的操作技術，更讓我們明白，科學研究的迷人之處，正是在於那份「預料之外」的挑戰。這段經歷，早已超越了競賽本身，成為我們共同成長的珍貴養分。

## 隊伍自評

### ・優勢

本研究以烈嶼在地生態為研究場域，結合 GIS 空間分析與生物監測方法，系統性調查螞蟻物種分布，並探討其與土地利用及人為活動之關聯。研究過程整合實地調查、數據整理與空間分析，不僅展現科學探究能力，也回應 SDGs「保育陸域生態」目標，體現在地議題與全球永續發展之間的連結。

### ・劣勢

由於本競賽需以英語進行簡報，我們在英語口說流暢度與發音上仍有進步空間。然而，我們非常感謝遠哲基金會提供這個寶貴的舞台，讓我們有機會站上舞台挑戰自我、突破自我。透過持續練習與模擬簡報，我們不斷提升英語表達能力，希望能更清楚地向評審分享我們的研究與想法。





# Tiny Ant Big Impact-



## Exploring Ant Diversity in Lieyu: A GIS-Based Spatial Analysis

### 1 Motivation

Lieuu (Little Kinmen) has a unique island ecosystem. **Ants** are "ecological detectives" that are highly sensitive to environmental changes. We noticed a lack of systematic ant records in Lieyu, and increasing development may bring invasive species that threaten local wildlife. Therefore, we conducted a whole-island survey using **GIS** technology to create a monitoring model. Our goal is to protect our homeland's biodiversity and support UN **SDG 15: Life on Land**.

### 2 Objectives

- **Map Ant Distribution:** Identify ant species and populations in school and across Lieyu using digital maps.
- **Compare Bait Efficiency:** Evaluate whether liquid or solid baits are more effective at attracting ants.
- **Analyze Environmental Impact:** Use GIS to see how different land uses or village locations affect ant distribution.



Please scan for details.

### 3 Methods

#### 1. Research Flow:

- ➔ Pilot Study at School
- ➔ Bait Testing & Identification
- ➔ Standardizing Methods
- ➔ 73-Zone Island Survey
- ➔ Species Identification
- ➔ GIS Analysis (Land Use & Villages)
- ➔ Correlation Analysis



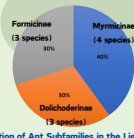
#### 2. What We Did:

- **The Bait Battle:** We placed "Liquid Sugar" and "Solid Protein" baits at each site to compare their performance.
- **Island-Wide Survey:** We divided Lieyu into 73 precise zones, covering residential areas, farms, forests, and the National Park.
- **Rigorous Identification:** We identified species using field guides and expert verification.
- **Digital Mapping:** We entered GPS coordinates into GIS software to transform data into clear, colorful heat maps.



### 4 Results

- **10 Species Identified:** We recorded 10 ant species. Notably, we provided the first official record of the Red Imported Fire Ant (RIFA) in Lieyu, along with *Polyrhachis* and *Eciton* species.
- **Liquid Bait Wins:** Experiments showed that Liquid Sugar Bait is significantly better than solid bait for attracting both a higher number and a wider variety of ants.
- **Ants Love "City Life":** GIS analysis reveals that ant density is higher in populated villages and roadsides. Invasive species (like RIFA) mostly hide near main roads, while native species remain stable in protected areas.



Distribution of Ant Subfamilies in the Lieyu Survey

Figure 1. Ant subfamily distribution in Lieyu using solid bait and sugar solution, with Myrmecinae as the dominant group.

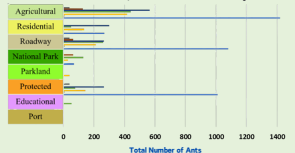


Figure 2. GIS analysis shows human disturbance increases invasive ant abundance.



Figure 3. GIS map showing ant distribution and higher invasive species in disturbed areas.



Figure 4. GIS map of red fire ant density, showing higher concentrations in disturbed areas.

### 5 Discussion & Conclusion

- **How Did They Get Here?** We suspect RIFA arrived via imported potted plants or construction materials, as they appear near high-traffic areas. Another invader, the *Polyrhachis* ant, was first recorded near the Kinmen Bridge—a major warning sign!
- **The Power of Digital Maps:** With GIS, we can pinpoint "Fire Ant Hotspots." This helps the government target pest control precisely instead of searching blindly.
- **Action for SDG 15.5:** We are more than just ant counters; we are "Eco-Detectives." By detecting invasive species early, we prevent them from destroying biodiversity and help maintain Lieyu's natural balance.

### 6 Innovation & Future Research

- **Innovation:** We combined "Ecological Fieldwork" with "GIS Technology" to fill the gap in Lieyu's ant records. Our digital maps reveal the movement of invasive species, creating an intuitive scientific monitoring model.
- **Future Research:** We plan to start "Four-Season Tracking" and use automated monitoring equipment. By combining environmental data, we hope to build an "Early Warning System" to protect our island's environment forever.





## " Borderless Trash " 林昀杰、方鈺勛、楊筱晨 Trash With No Passport



由左至右：吳卓伶老師、林昀杰、楊筱晨、方鈺勛、傅信堯老師

### 個人特色、專長和興趣

#### 1. 林昀杰

我個性隨和，學習態度積極，希望能在這次比賽學習與成長。

#### 2. 方鈺勛

我喜歡玩手機遊戲，也熱衷參加科展與生科競賽，從中學習許多知識。個性較為安靜、不太多話，但做事認真負責。

#### 3. 楊筱晨

我個性開朗、喜歡聊天，也對英文充滿熱情。平常喜歡嘗試各種美食，用樂觀與好奇心探索世界。

### 團隊簡介與隊名由來

我們的團隊名稱是「Borderless Trash（無國界垃圾團隊）」。  
在烈嶼海岸調查海漂垃圾時，我們發現許多垃圾來自不同國家與地區，海洋污染其實沒有國界之分。因此，我們希望透過這個名稱提醒大家：海洋環境需要全球共同守護。身為七年級學生，我們以科學實驗與動態模擬研究海漂垃圾問題，希望用行動與研究讓更多人關注海洋保育。





## 參賽原因與心得

我們參加遠哲三分鐘英文科學挑戰賽的原因，是因為我們對科學一直很有興趣。我們喜歡探索生活中的科學現象，也希望能透過這個活動，把我們學到的知識用英文分享給更多人。同時，我也想挑戰自己，在短短三分鐘內清楚地表達一個科學概念。在準備的過程中，我們學到了很多。不只是科學知識，還包括如何整理重點、如何用簡單的方式解釋複雜的內容，以及如何在台上自信地表達自己的想法。把科學內容轉換成英文說明，其實是一個很大的挑戰，但也讓我們進步很多。透過這次活動，我們不但提升了英文表達能力，也更了解科學溝通的重要性。科學不只是研究，更重要的是能夠讓更多人理解。未來我們也希望能繼續參加類似的活動，學習更多，並把科學分享給更多人。



## 隊伍自評

### · 優勢

我們從烈嶼海岸常見的海漂垃圾現象出發，透過海灘實地調查與海域模型模擬實驗，探討東北季風如何影響垃圾漂移與堆積位置。實驗結果發現，在東北季風影響下，海漂垃圾會往西南方向漂移並集中於烈嶼北側與西側海岸。這項研究不僅關注在地環境問題，也呼應 SDGs 海洋保育目標。身為七年級學生，我們能用科學方法探討海洋議題，是我們最大的特色與優勢。

### · 劣勢

這項研究最初是我們國小六年級的科展作品，目前升上來七年級，我們持續參與與分享，因此在研究深度與英語簡報經驗上仍有進步空間。不過，我們非常感謝遠哲基金會提供這個寶貴的舞台，讓我們有機會站上舞台挑戰自己、突破自己。透過準備與練習，我們也希望能把烈嶼的海洋環境議題介紹給更多人。

# TRASH WITH NO PASSPORT

YUNJIE LIN, XIAOCHEN YANG, AND YUXUN FANG

ADVISORS: XINYAO FU, CHOLING WU



## RESEARCH BACKGROUNDS& PURPOSE

Marine debris is a big problem for the ocean (SDG 14). Wind and climate change move this trash around the world (SDG 13).

In Lieyu, we see a lot of marine debris on the beach during the winter. We want to know: Does the northeast monsoon bring this trash to our island? Also, we want to find out: What kinds of marine debris are on our coast? To answer these questions, we read reports and visit beaches to observe the trash.

## METHODOLOGY

Our study had two parts:

1. Field Survey (Beach Check): We visited two beaches in Lieyu in winter. We recorded the types of marine debris. We focused on plastic and Styrofoam.
2. Simulation Experiment (Water Tank): We used a water tank to simulate the ocean. We used Styrofoam balls as trash. We used fans to simulate the monsoon wind. We watched how the wind moved the trash.



Figure 1. The Research Process



Figure 2. The Water Tank to Conduct Simulation



Figure 3. The Results of the Simulation

## RESULTS& DISCUSSION

### 1. Beach Survey: Reality vs. Prediction

- Discovery: Donggang Beach had more trash than Huangcuo.
- Reason: Donggang has high sand dunes. They trapped the marine debris.
- Observation: At Huangcuo, strong winds blew trash into the grass, making it hard to see.

### 2. Where is the trash from?

- We checked 24 branded items on the beaches.
- China / Hong Kong: 22 items (92%).
- Taiwan: 2 items (8%).
- Fact: Most trash came from China.

### 3. How the Wind Moves Trash (Simulation)

- We used fans to simulate the northeast monsoon.
- Movement: The wind pushed the Styrofoam balls to the Southwest.
- Accumulation: The balls collected on the North and West coasts of Lieyu.
- Match: Our experiment matches the real trash we found on the beaches!



Figure 4. Types and Distribution of Marine Debris in Huangcuo Beach



Figure 5. Types and Distribution of Marine Debris in Donggang beach

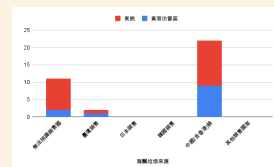


Figure 6. Sources of Marine Debris

## CONCLUSION

### 1. The Monsoon is the Key Factor (SDG 13: Climate Action)

Our simulation proved that the northeast monsoon is the main reason for trash accumulation. The wind pushed trash to the southwest, so it collected on the North and West coasts. Understanding this climate factor (SDG 13) helps us know where to clean the beach more effectively.

### 2. Marine Debris is a Global Problem (SDG 14: Life Below Water)

Most trash we found came from China and Hong Kong brands. This shows that marine debris moves between different countries. To protect Life Below Water (SDG 14), we cannot work alone. We need to work together with our neighbors to stop trash at the source.

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Scan for more details



## " The Pandora Squad "

翁承漢、陳禹齊

### Oasis Under Fire: Design of a Hydroponic Food Supply System for Underground Shelters 烽火中的綠洲：地下避難所 水耕食物供應系統設計



由左至右：陳禹齊、翁承漢

#### 個人特色、專長和興趣

##### 1. 翁承漢

我愛作夢，對於世界充滿好奇，把不可能變成可能，讓我覺得興奮。聽英文歌跟拉小提琴，是我最愛的休閒活動。

##### 2. 陳禹齊

科學實驗就是把不可能的事情轉為現實，是他最吸引我的原因。拉小提琴和研究電腦是最常在空閒時間做的事。

#### 團隊簡介與隊名由來

我們主題為「暮光之盒」，雖然戰爭帶來恐懼，但這些終究會結束，「潘朵拉的盒子」隊名於是產生，當潘朵拉趕緊關上盒子時，唯一留下的就是希望。即便世界充滿痛苦與災厄，最終有一股希望的力量支撐我們面對磨難。



## 參賽原因與心得

長期英語學習，讓我們知道語言是走向全世界最佳的工具。看過三分鐘英語科學創新挑戰賽影片，同學們提出的比賽議題讓我們產生興趣，生活中總有無窮無盡的發想，也因隊友支持，便鼓起勇氣報名。開始決定主題，花樣百出，我們有各自的堅持，最後還得感謝我們身邊的家人朋友，幫我們進行公正的投票，最終定下這個題目，開始做研究。

## 隊伍自評



### · 優勢

因為國小時，曾一起參加學校的創意科展，培養了默契，兩人對於科學驗證，通常是一個提出，一個反駁，最終共同尋求答案，看似吵架，但過程獲得很多。辯證是高效的學習，我想我們是最好的夥伴。

### · 劣勢

上國中之後，課業壓力重，也非同校，見面討論的時間有限，拜科技之賜，勉強補足了這些不便。國中生理解有限，科學理論還不足。

# Box Of Dawn

## Oasis Under Fire : Design of a Hydroponic Food Supply System for Underground Shelters

Hank Weng, Linus Chen

### Background

In wars, pandemics, or disasters, people sheltering underground face prolonged shortages of fresh vegetables — risking serious nutritional deficiencies.

### Motivation

Why is this problem important?

- Limited Fresh Food Supply — Underground shelters lack a stable source of fresh vegetables.
- Dependence on Stored Food — Shelters rely mainly on canned foods and dry rations.
- Health Risks — Long-term vitamin deficiency may affect human health.
- A deployable vertical hydroponic rack — designed like an emergency kit — delivers fresh vegetables reliably in underground shelters.

### Objectives

What does this study aim to achieve?

- Develop a modular hydroponic cultivation system that can be easily installed and dismantled in underground shelters.
- Construct a mathematical model to estimate the vegetable demand for shelter populations.
- Determine the optimal number of cultivation racks required to ensure a stable fresh vegetable supply.

### System Design

The arrival of light from the 'Box of Dawn' brings a glimmer of hope to the residents of the shelter.

- Bamboo hydroponic racks (8 holes of plant rack)\*3, each one 38cm high)
- A storage box with lid (38cm\*55.4cm\*22.5cm)
- LED grow lights with removable stand 23.5cm\*13.7cm, 100W)
- Submersible pump (Power: 8W, Max Li: 1.5m)
- Removable PVC water pipes (40cm\*2, 30cm \*1, Connector\*2)
- Hydroponic fertilizer \* Mul - parameter Water Quality Tester
- Concrete Base or Water-filled Base



### Recommended Hydroponic Crops in Shelters

Table 1. Recommended Crops for the Vertical Hydroponic Rolling-Harvest Model

| Crop         | Lettuce                                                                            | Bok Choy                                                                           | Amaranth                                                                           |
|--------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Growth Cycle | 25-35 days                                                                         | 20-30 days                                                                         | 25-35 days                                                                         |
|              |  |  |  |

### Case Study

Using Taichung Residential Complex < 10 years as a Representative Model Building

- Structure: 23 floors above ground / 4 floors below
- Site Area: 1,091 ping (approx. 3,606 m<sup>2</sup>)
- Experimental Space: B1 & B2 parking levels (Total: 1,653 m<sup>2</sup>)
- Population & Capacity
- Estimated Residents: 350 people.
- Calculation Formula: Total Population = (Units\*3BR + P3BR) + (Units\*4BR + P4BR)
- Regulatory Capacity: Registered for 614 people (per MOI standards)
- Shelter Quality: 4.7 m<sup>2</sup> per person to ensure habitability and comfort—significantly exceeds all applicable minimum humanitarian and civil-defense benchmarks (Taiwan Building Technical Regulations, Art. 141)

### Discussion & Conclusion

This study's proposed hydroponic system offers the following key advantages:

1. Modular Design — Easy to Build and Deploy
- Space-efficient
- Modular by design
- Rapid deployment
2. Continuous Supply of Fresh Vegetables in an Underground Environment
3. Improved Nutritional Quality During the Shelter Period

Since we couldn't test a real underground shelter, we combined research with real-life experiments. We used a 'Dry Lab' (math and simulations) and a 'Wet Lab' (small-scale planting). Our Wet Lab showed that our design can grow plants successfully, and our Dry Lab helped us predict the needs of a full-size shelter. The 'Box of Dawn' is more than just a concept; it is a realistic plan for emergency survival. Our next step is to scale up these modules for real-life use.



### Mathematical Model

How Many Units Must Be Harvested Each Day?

The shelter accommodates a total of 350 occupants. Residents are divided into two equal groups of 175 people per floor (B1 & B2). All calculations below are therefore based on one floor serving 175 people. 16 planting slots per vertical rack, and 150 g of vegetables per yield slot, 300 g of vegetables per person in daily requirement (recommended by the Health Promo on Administration)  
Daily vegetable demand = 175 persons \* 300 g = 52,500 g/day  
Yield per cultivation unit = 16 plants \* 150 g = 2,400 g/unit  
Units to harvest per day = 52,500 / 2,400 = 21.875 units.  
Since harvesting a fraction of a unit (0.875 of a rack) is physically impossible, the result must always be rounded up: [21.875] = 22 units / day (P)

### Production Buffer

Real Risk Factors in Underground Hydroponic System

Table 2 — Risk factor breakdown

| Risk Source                                            | Estimated Loss | Rationale                                                        |
|--------------------------------------------------------|----------------|------------------------------------------------------------------|
| Plant mortality (germination failure, pests & disease) | <5-10%         | Pathogens spread rapidly in closed environments                  |
| Nutrient solution / pH instability → yield reduction   | 5%             | No sunlight means no natural buffering mechanism                 |
| LED failure or power interruption                      | >3-5%          | Power supply is the most vulnerable link in an emergency shelter |
| Operator error (non-specialist)                        | 3%             | Shelter occupants are not trained horticulturists                |
| Combined recommended safety factor                     | ≈ 1.15-1.25    | Consistent with 1.2*, but no evidence-based                      |

Table 3 — Safety buffer days and equivalent conversion factor

| Safety Buffer Days           | Total Days | Conversion factor |
|------------------------------|------------|-------------------|
| <0 day (Normal Growth Cycle) | 30         | 30/30 = 1.00      |
| +1 days                      | 31         | 33/30 = 1.10      |
| +4 days                      | 34         | 34/30 = 1.133     |
| +5 days                      | 35         | 35/30 = 1.167     |
| +6 days                      | 36         | 36/30 = 1.20      |

Therefore, A safety factor of 1.2 is mathematically equivalent to extending each batch's residence time in the system by 6 days beyond the standard 30-day growth cycle.

$$N = P \times D$$

daily harvest      day in system

N = Total number of cultivation units required  
P = Number of plants to be harvested per day  
D = Growth cycle (days)

Table 4 — Safety buffer days and equivalent conversion factor

| Scenario               | Value of D | Total Units Required |
|------------------------|------------|----------------------|
| Without safety factor  | 30 days    | 22 * 30 = 660 units  |
| With safety factor 1.2 | 36 days    | 22 * 36 = 792 units  |

### Mathematical Model -- Rolling Harvest

Imagine a conveyor belt.

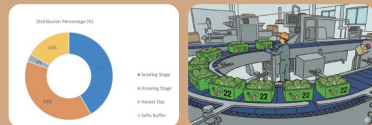
Each day, you place 22 trays at one end. It takes 36 steps (or slots) for each tray to move from one end to the other before exiting.

The hydroponic system works on exactly the same principle — 792 cultivation units are always "on the belt," with 22 entering and 22 leaving every day in a continuous, uninterrupted cycle as Figure 1.

Figure 1. Rolling Harvest



Figure 2. Time Distribution of a 30–36 Day Hydroponic Cultivation Cycle



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## " 海洋纖維細細小小影響大 "

葉韋頡、龔昶睿

## 海洋纖維細細小小影響大



由左至右：葉韋頡、龔昶睿

### 個人特色、專長和興趣

#### 1. 葉韋頡

My name is 葉韋頡 . I enjoy thinking and asking questions, and my specialty is solving math problems. In my free time, I like playing Chinese chess, where I also think about strategies and layouts, helping me develop logical thinking and judgment skills.

#### 2. 龔昶睿

Hi every one. My name is 龔昶睿 , I like learning mathematics. In this experiment, I learned more about biology, AI and I can practice with my partners in this propjet.

### 參賽原因與心得

Our team decided to participate in this competition because we wanted to explore environmental issues and apply scientific methods to solve real-world problems. After discussing different ideas, we formed a team and chose to study marine fiber pollution caused by household laundry. Each member took responsibility for different tasks, such as researching background information, designing experiments, collecting data, and preparing the presentation.





To prepare for the competition, we conducted several experiments using a washing machine while changing factors such as rotational speed, detergent concentration, and water temperature. We carefully recorded the amount of fiber released under different conditions and analyzed the results. During the preparation process, we also spent a lot of time discussing our findings and improving our experimental design.

There were also some interesting moments during the experiment. For example, during one test, we accidentally meddled with the temperature, which produced less fiber than usual. Although it was a mistake, it helped us realize how sensitive fiber release can be to washing conditions.

The biggest challenge we faced was ensuring the accuracy and consistency of our experimental data. Sometimes the results varied, so we had to repeat the experiments multiple times. Through this experience, we learned the importance of teamwork, patience, and careful scientific investigation. This competition not only improved our research skills but also increased our awareness of environmental protection.

## 隊伍自評

### · 優勢

The research methodology is logically rigorous, enabling a systematic analysis of problems and yielding valuable conclusions. Furthermore, the team demonstrates excellent synergy with clearly defined roles; members leverage their complementary expertise to ensure the research proceeds smoothly.

### · 劣勢

The research leaves room for further development as some potential aspects were not discussed in depth, and a portion of the hypotheses remains partially unverified."



# How do marine fibers originate?

The effect of laundry flow rate on the dissolution of different fibers.

## SDGs



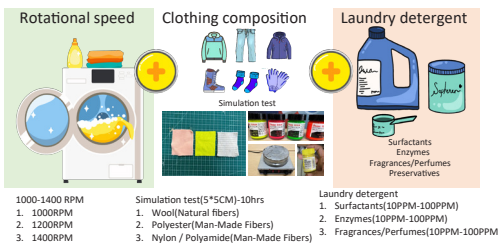
Global microplastic fiber pollution from domestic laundry - ScienceDirect  
 According to the journal **\*Global Microplastic Fiber Pollution from Domestic Laundry\*** the median global emissions of microplastic fibers (MPFs) from household laundry are **estimated at 5.69 million tons annually**.

Machine washing accounts for **93.7% of total emissions**, while hand washing accounts for only **6.3%**.

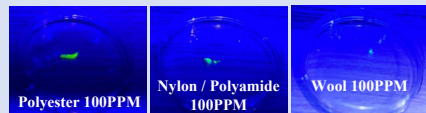
**Asia is the largest source of emissions** (approximately 3.71 million tons), primarily due to low retention rates in wastewater treatment facilities.

Therefore, this article mainly explores the main relationships and influences between different **washing speeds, clothing composition, and detergents**.

## Materials and Methods

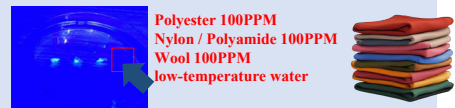


## Discussion



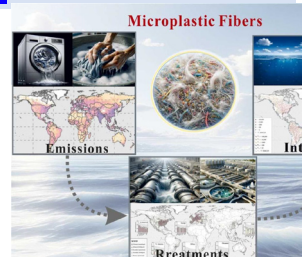
Experimental results showed that **washing machine spin speed is one of the main sources of marine fiber**, and that different detergents at concentrations up to 100 PPM produced cotton-like fibers in clothing.

The results showed that the control group (**low-temperature water**) resulted in less fiber leaching in the washing machine.



## Abstract

Domestic laundry is a major source of microplastic fiber (MPF) pollution. Experiments show that washing machine spin speed, detergent concentration, and water temperature significantly affect fiber release. Higher spin speeds and stronger detergents increase emissions, while lower temperatures reduce them. Simple lifestyle adjustments, such as using cooler water and gentler cycles, can effectively decrease MPF pollution, helping protect aquatic ecosystems, water quality, and the environment.



## " 植物「碳」險隊 "

林恩綺、莊喬茵

### Design of a Carbon-Absorbing IoT Podium with CO<sub>2</sub> Monitoring Using an Algae-Based Battery



由左至右：黃子欣老師、  
林恩綺、莊喬茵、田代藏老師

#### 個人特色、專長和興趣

##### 1. 林恩綺

我是一名熱愛探索、多才多藝的學生，專長於英文寫作、科學實驗與小提琴。課餘時間，我熱衷於打籃球、畫畫與拉琴，喜歡動手做實驗與藝術創作。

##### 2. 莊喬茵

我是一名果斷、具領導力的學生，專長藝術、音樂、作文與自然科學等，課餘時間，熱衷於音樂、藝術、書法與網球，喜歡挑戰與規劃。

#### 團隊簡介與隊名由來

我們是一群熱愛科學的學生，平時喜歡動手做實驗，也關心生活中的環境問題。這次專題把植物固碳、藻類發電和科技監測結合起來，設計出可以改善教室空氣的環保講桌，希望用科技幫助校園變得更永續。隊名「植物『碳』險隊」是參考「大樹碳險隊」(<https://recreation.forest.gov.tw/Education/Course?id=LD-T1211>) 發想而來，代表我們像探險隊一樣，一步步研究二氧化碳的問題，利用植物展開減碳任務，充滿活力與行動力。



## 參賽原因與心得

我們參加這次競賽，是因為學校最近課程介紹了 SDGs 永續發展目標，讓我們開始關心環境保護與減碳議題，也希望把課堂學到的知識實際運用出來。雖然我們隊伍只有兩個人，但因為興趣相同，很快就決定一起合作參賽。我們依照各自的專長分工，一人負責實驗與裝置製作，另一人負責資料蒐集、整理與寫程式。最有趣的是我們到店家製作裝小球藻的壓克力箱，老闆不但細心依照我們的設計客製化製作，還讓我們親自體驗裁切壓克力的過程，讓我們覺得又新奇又有成就感。最大的挑戰是整合生物系統與電子監測系統，讓講台既能吸收二氧化碳，又能穩定監測濃度。經過多次調整，我們終於成功組合了智慧講台。

### 隊伍自評



#### · 優勢

溝通效率高、默契很好，討論事情時能很快達成共識，也能依照各自專長明確分工，讓實驗與製作順利進行。我們動手實作能力強，並願意花時間反覆測試與改良作品，遇到問題時也會主動查資料或請教老師，不輕易放棄。

#### · 劣勢

因為只有兩位成員，人力較不足，準備資料、製作裝置與報告時負擔較重，時間安排也比較緊湊。有時候遇到較困難的技術問題，能一起討論的人較少，想法也可能不夠多元。

# Design of a Carbon-Absorbing IoT Podium with CO2 Monitoring Using an Algae-Based Battery

STUDENT: CHARLOTTE LIN, JOYA CHUANG  
TEACHERS: STAR HUANG, CHRISTINA TIEN

## Research Backgrounds & Purpose

The air in your classroom may be affecting how well you learn!

In poorly ventilated classrooms, CO<sub>2</sub> levels can rise from 400 ppm to over 1000 ppm, reducing students' cognitive performance and focus. This project presents a smart and sustainable solution by combining carbon sequestration and bioenergy generation in a multifunctional classroom podium. We aim to develop a system that can absorb CO<sub>2</sub>, decorate with plants and flowers, and generate enough power to support sensors that monitor CO<sub>2</sub> levels. We use plants and microalgae to carry out photosynthesis, which helps reduce CO<sub>2</sub> levels and increase oxygen in the air. Microalgae, so called "Blue Carbon" are especially effective because they have high photosynthetic efficiency and can absorb CO<sub>2</sub> faster than most plants "Green Carbon". The podium includes a bioelectrochemical system, in which algae can generate a small amount of electricity during their biological processes. This creates a simple bioenergy system that reduces the need for external power. We conduct experiments to identify the most effective plant species and the optimal conditions for algae to absorb CO<sub>2</sub>. We first build a small algae battery, then scale up to a larger single-unit system, and finally develop multiple-unit systems. To monitor multiple classrooms, the system uses Internet of Things (IoT) technology to measure CO<sub>2</sub> levels, temperature, and humidity in real time. This project shows how combining biology, engineering, and smart technology can improve air quality and create a healthier, more sustainable learning environment.

Small-scale algae powered experiment (Success)

## Process

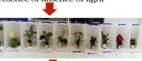
Literature review

Green Carbon

Find out which factor will affect how well a plant absorb carbon: the width and thickness of leaves.



We observed the efficiency of plants to absorb CO<sub>2</sub>. Manipulated variables:  
1. Flower vs. non-flowering plants  
2. Different leaf colors within the same plant species  
3. Presence or absence of light



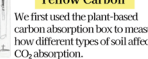
Blue Carbon

We observed the ability of Chlorella to absorb CO<sub>2</sub>. Manipulated variables:  
1. Different concentrations of Chlorella  
2. Presence or absence of light



Yellow Carbon

We first used the plant-based carbon absorption box to measure how different types of soil affect CO<sub>2</sub> absorption.



Trees Shrubs Grassland



Found that the soil could not "breathe," so it could not be used in the plant carbon absorption box experiment.

## Experimental Methods

Exploring how algae generate electricity  
Small battery- Big single battery-big serial batteries



We prepare the Nafion NC700 membrane by heating and soaking it. Next we placed carbon paper and the negative wire in the small box, then seal it with the membrane, and lock the lid. Then, we placed carbon paper and the positive wire in the big box filled with 2000cc of algae. Last, we flipped the small box onto the big box, inject 250cc of algae into the hole, and measure with a multimeter.

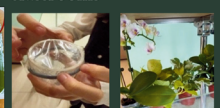


We use alligator clips to connect the black negative wires to carbon paper, then seal them with hot glue to prevent it from getting rusty. Next, we filled the acrylic tank with 1000cc of algae. Finally, we connect the negative wire to the positive wire to create a series circuit.



Three different concentrations of Chlorella, 18.5 x 10<sup>5</sup> ; 9.25 x 10<sup>5</sup> ; 1.85 x 10<sup>5</sup>

Algae battery generate power for IOT to monitor CO2 level in multi-classrooms



Podium equipped with LED lights, air pump, and a CO2 sensor connected to a Raspberry Pi. We placed plants on top to absorb CO2 and decorate the podium.



Three different concentrations of Chlorella, 18.5 x 10<sup>5</sup> ; 9.25 x 10<sup>5</sup> ; 1.85 x 10<sup>5</sup>

## Results

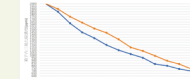
### 1. CO2 Absorption Comparison: Different Plants over Time

- In the first hour, the Snake Plant had the fastest drop rate, due to its large leaf and it's a CAM plants, makes it the best at absorbing CO<sub>2</sub>. However, its absorption rate per unit hour was not the highest.
- We found that plants change CO<sub>2</sub> level the most in the first two hours. After two hours, the levels don't change much. We guess that the plants respiration starts to cancel out the CO<sub>2</sub> create by photosynthesis.

### 2. CO2 Absorption Comparison: Different Leaf Color

- The dark green leaves had the fastest absorption rate in the first 1.5 hours. We think this is because they have more chlorophyll.
- The final order of speed was: Dark Green > Light Green > Mixed dark and light green.

### 3. CO2 Absorption Comparison: Flower and No Flower



- The Phalaenopsis orchard with flowers absorbed more CO<sub>2</sub> than no flowers.
- After 3.5 hours, the CO<sub>2</sub> level stayed about the same. This is because the plant is doing photosynthesis and respiration at the same speed.
- At 3.5 hours, the numbers dropped a lot. This might be a mistake in our experiment. Maybe the plant box had a tiny leak, or the CO<sub>2</sub> sensor didn't read it correctly.



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## " The Corn Whisperer "

詹子頤、李潔晞、林詠祺

### Acoustic Priming in Zea mays: Growth Responses to Recurrent Frequency Stimulation



由左至右：黃子欣老師、李潔晞、  
詹子頤、林詠祺、田代歲老師

### 個人特色、專長和興趣

#### 1. 詹子頤

我平時較為活潑，喜歡說話和溝通，在沒事的時候喜歡看關於科學相關的短影音（化學以及生物）。我的專長與興趣是畫畫、唱歌、寫作，以及資料統整。

#### 2. 李潔晞

我平常喜歡看科學（生物化學）、天文相關的東西，了解背後的原理，我的專長 & 興趣是拉低音提琴、鋼琴（一點點）、好奇心比較重、整理資料。

#### 3. 林詠祺

我平常喜歡在網路上，看一些跟科學有關的影片，例如做實驗和一些比賽的影片。我的專長是寫作、整理資料、以及與人溝通。

### 團隊簡介與隊名由來

我們的團隊，是由三個對科學研究很有熱忱的學生一起組成的，之所以會想要取名叫 The Corn Whisperer 的原因是，我們的研究與玉米、聲學有關聯，所以希望可以讓隊名跟研究內容有連結，因此取名叫做 The Corn Whisperer。





## 參賽原因與心得

在我們參賽前，其實是不知道要往哪個方向前進的，甚至還想做關於甚至還想做關於章魚的主題，但最後與指導老師討論才決定先從較為簡單入門的玉米開始。我們先從簡單的控制變數開始，後面做完簡單的調查，才開始正式實驗。而我們在最後遇到的一些困難是，其中兩個實驗裡的數據較為看不出規律，以及從一開始的搜集資料，再到後面的寫報告以及拍影片都花了較多的實驗準備。但總之，還是很慶幸也很榮幸能晉級決賽，也希望我們能得到滿意的名次。

### 隊伍自評

#### · 優勢

研究數據與範例很多，能夠寫出有邏輯性並有價值的實驗報告。

#### · 劣勢

有些數據看不出規律，無法輕易的整理出這個實驗的結論，並且在實驗上能夠更加精進。





JG014

# THE CORN WHISPERER

Student: Sheena Lin, Jessica Li, Lala Chan  
Teacher: Star Huang, Christina Tien

## Background&Purpose

Every day, we hear that many cultivators find that playing music can enhance the growth of plants. In recent years, some scientific research shows plants react to the sound; they can even learn and respond to some extent("Matz et al. 1"). According to the research, it shows that as the abiotic stress was added to plants, the primed group showed significantly higher output in stress treatments(Liu et al. 187). This inspired us to test whether a group of Zea mays exposed to a specific sound frequency, then allowed to rest for a few days before re-exposure, would show priming in the re-exposure phase through the growth rate (cm/day). We aimed to apply acoustic technology to farm operators. We predict that, as Group A Zea mays are re-exposed to a 432Hz sound frequency, their growth rate will increase, due to the sound vibrations influencing plant growth through mechanoreceptors. When the plant cells are stimulated by sound, the nutrients are encouraged to move throughout the whole plant, fostering new cells and growth(Oxford, 2020).

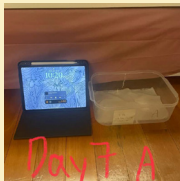
## Methodology

To test this concept, we designed a 12-day experiment to collect data demonstrating acoustic priming in plants.

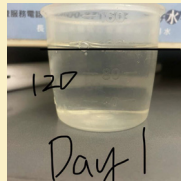
Group A is the experimental group. We played a 432Hz sound frequency song to the Zea mays for 7 days, silence for 3 days, and then finally re-exposed for 2 days.

Group B is the control group. We maintained silence throughout the twelve days.

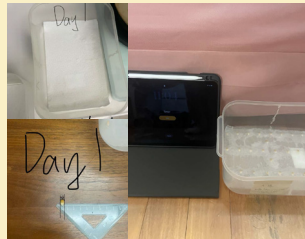
Group C is the experimental group 2. We maintained silence from day 1-12, and played the 432Hz sound frequency music for the Zea mays.



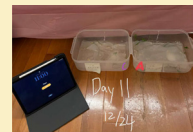
▲ Figure 1 shows that group A was under the exposure(432Hz music)



▲ Figure 2 shows the control variable for this experiment(watering mL)



◀ Figure 3 shows how the experiment worked in day 1 to day 7



▲ Figure 4 shows how the experiment worked in day 11 and day 12

## Results and Future Outlook

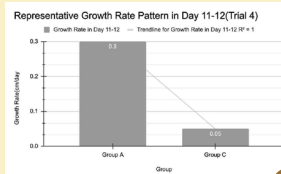
By comparing the growth slope/rate of Group A and Group C on days 11-12 in trial 4(the representative group), we can determine that during the recall phase, Group A had a growth rate of 0.3, while Group C showed a growth rate of 0.05. This indicates that Group A had a significantly higher growth rate slope compared to Group C, demonstrating a retained physiological adaptation from Day 1 to 7. In our experiment, we observed individual variance; however, the representative growth pattern of Group A showed 2.7x acceleration, suggesting a potential genetic factor in the plants' acoustic sensitivity. The results of our experiment support our hypothesis that plants possess acoustic priming. Although plants do not have an auditory system like animals, they retain the physiological footprint of past mechanical stimuli. This technology can be applied in Acoustic Agriculture, enhancing the crop yield without chemicals.



▲ Figure 5 shows the most representative data for group A(Trial 4)



▲ Figure 6 shows the most representative data for group C(Trial 4)



◀ Figure 7 shows the growth rate for group A and group C(Trial 4). The data shows the difference in the growth rate between the two groups

## References

1. "Good Growing Tunes: How Plants Respond to Music | GCM." Garden Culture Magazine, 17 Feb. 2025, [gardenculturemagazine.com/good-growing-tunes-how-plants-respond-to-music/](https://gardenculturemagazine.com/good-growing-tunes-how-plants-respond-to-music/).
2. Oxford, Brittany. "Should You Sing to Your Plants? Here's What the Science Says," Pistils Nursery, 19 Feb. 2020, [pistilsnursery.com/blogs/journal-music-and-plant-growth-heres-what-the-science-says](https://pistilsnursery.com/blogs/journal-music-and-plant-growth-heres-what-the-science-says).
3. Chang, Yee-yung, et al. "Maintenance of Abiotic Stress Memory in Plants: Lessons Learned from Heat Acclimation." [Journal Name], vol. [Vol], no. [Issue], [Year], p. [Page/Article No]. PubMed Central, [www.ncbi.nlm.nih.gov/pmc/articles/PMC9806581/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9806581/). Accessed 14 Mar. 2026.



## 隊伍介紹

# 高中職團體組

- SG003 美麗尾翼成茉莉
- SG012 掌光而行
- SG029 BioClean Water Group
- SG031 對不隊
- SG033 Signal Detectors
- SG039 比堡奇
- SG040 The Siphony
- SG051 The Data Science Talkers
- SG052 藻知道 Algae-Know-It-All
- SG053 讓你看看 [ 城市 ] 的 [COOL]
- SG057 Pore-fect Carbon  
Choreographers
- SG063 Chord Assistant
- SG071 水水菜菜好朋友
- SG075 Three Little Mermaids
- SG076 Micro Matters



## " 美麗尾翼成茉莉 "

陳泓頤、林宥穎、葉晉齊

### An Exploration and Analysis of the Genetic Factors of the Tail of the Jasminoides in the Wild



由左至右：林宥穎、葉晉齊、陳泓頤

#### 個人特色、專長和興趣

##### 1. 陳泓頤

Hello everyone, my name is Chen Hung-Yi. I like to watch and think of the way all the things around me work. In my free time, I love to discuss things I'm now learning and chatting about school life with my classmates and friends.

##### 2. 林宥穎

Hello everyone! I'm Lin Yu-Ying. My specialty is playing the piano, and my hobby is playing basketball. Playing sports makes me feel more relaxed. I'm eager to learn math and English. I can't wait to see you all!

##### 3. 葉晉齊

Hello everyone, my name is Yeh Chin-Chi. My specialty is playing basketball. In my free time, I like to pursue the knowledge and essence of things around us. I hope I can be a better person in the future. Glad to meet you guys.

#### 團隊簡介與隊名由來

Our team name stems from our research subject: the Molly fish. Despite their small size, Mollies possess incredible resilience, thriving in the harshest environments with vibrant vitality. Inspired by their strength, we strive to emulate their perseverance throughout our study. Just as the Molly fish adapts to adversity, we aim to overcome every challenge, ultimately transforming our efforts into a strong and brilliant future.



## 參賽原因與心得

As students of 10th grade, we want to do something beneficial and meaningful to us during our three-year senior lives. After thinking carefully, we attend the challenging scientific research contest. At first, we have many difficulties doing our research. For instance, we have to arrange our time to do many field research and read numerous references. The most difficult thing is that we have to come up with the thought, inference and conclusion from every experiment process. Due to the difference of everyone's thought, we even have many quarrels over our individual inference. As the experiment progressed, our team's cohesion grew. Through constant discussion and our teacher's dedicated support, we overcame numerous technical hurdles. While winning an award is thrilling, the bonds we forged and the experiences we gained are the true, intangible treasures of this journey.

### 隊伍自評

#### · 優勢

Our research is rigorous and profound, featuring an original and unprecedented theme.

#### · 劣勢

We acknowledge that some unanswered questions and technical difficulties persist. These areas call for more profound exploration and future solutions.



# Beautiful but Costly? — Caudal Fin Morphology and Genetic Determinants in Wild Sailfin Molly (*Poecilia latipinna*)

美麗尾巴是優勢還是負擔？野生茉莉魚 (*Poecilia latipinna*) 尾鰭形態與遺傳因子之研究

Lin Yu-Yin,  
Ye Chih-Chi, Chen Hung-Yi

## Abstract

This study focuses on wild populations of Sailfin Molly (*Poecilia latipinna*) to examine the genetic and phenotypic variation in caudal fin morphology between wild populations and hybrid generations. Wild individuals and successive generations from F1 to F4 were systematically investigated. In each generation, 300 individuals from each category (males, females, and undifferentiated individuals) were sampled, and tail morphology was classified into traditional types and natural hybrid forms.

The results show that wild populations exhibit high morphological diversity. Seven distinct tail types were identified among males, with the Round tail being the most common, while Lyretail, Spear, Needle, and Sword-tail variants were also observed. This pattern suggests that sexual selection and natural selection may jointly maintain phenotypic diversity in natural populations.

Following controlled breeding, the proportion of Round tails increased sharply to 97% in the F1 generation, while specialized tail types declined markedly. By the F2 generation, only a very small proportion of Lyretail and Round-tail individuals remained, indicating that these mutant alleles are unstable without directional selection. By the F4 generation, all individuals (100%) reverted to the Round-tail phenotype, demonstrating a clear trend toward phenotypic homogenization.

## Motivation

### The Puzzle of Phenotypic Reversion

1. **Invasion Trigger:** Floods cause ornate, lab-fed fish to spill into the wild and interbreed with local populations.  
2. **The Paradox:** Despite having few predators in Taiwan, the "fancy" traits of Sailfin Mollies (*P. latipinna*) vanish in wild drainage systems.

3. **Field Observation:** Wild populations consistently revert to modest, ancestral appearances rather than maintaining aquarium-bred traits.

4. **Research Focus:** Does this "reversion" stem from **Female Choice** (sexual selection) or **Survival Pressure** (natural selection)?

## Experiments / Methods

### 1. Classification and Definition of Caudal Traits

According to experimental records, these traits can be categorized into three major groups:

(1) Standard Types:

A. **Round:** Characterized by smooth, semi-circular edges. This is the most stable wild-type trait (final expression in the F4 generation).

B. **Truncated:** The edges are relatively straight and flat; commonly observed in commercial Black Mollies.

C. **Double Sword-like:** Symmetrical protrusions of both the upper and lower fin rays.

(2) Natural Hybrid Variants:

A. **Lyretail:** Features filamentous extensions on the upper and lower margins with elegant curves (residual traits from F1-F3 generations).

B. **Roundtail:** Slightly more pointed than the "Round" type; a transitional state approaching the "Spade-tail."

C. **Swordtail:** Unilateral extension of either the lower or upper margin only.

(3) Rare Variants:

A. **Pintail:** The central fin rays protrude like a needle.

B. **Spade-tail:** The overall shape resembles a spade or a spearhead.

### 2. Swimming performance and locomotion survey of the sailfin molly (*Poecilia latipinna*)

The following are the experimental investigations and results regarding the relationship between fish caudal fin morphology and flow resistance.

### Table 1. SWIMMING PERFORMANCE AND TAIL-BEAT FREQUENCY OF SAILFIN MOLLY (*POECILIA LATIPINNA*) BY TAIL MORPHOLOGY

| COMPARATIVE LOCOMOTION DATA |                                           |                                         |                                           |                                         |                         |
|-----------------------------|-------------------------------------------|-----------------------------------------|-------------------------------------------|-----------------------------------------|-------------------------|
| Flow Velocity (cm/s)        | A-1 Rounded Tail (WT) Locationation State | A-1 Tail-Beat Frequency (Beats/sec, Hz) | A-2 Lyretail (Hybrid) Locationation State | A-2 Tail-Beat Frequency (Beats/sec, Hz) |                         |
| Adaptation                  | Stable                                    | 30                                      | Stable                                    | 85                                      |                         |
| 10                          | Stable                                    | 30                                      | Stable                                    | 80                                      |                         |
| 20                          | Stable                                    | 35                                      | Stable                                    | 95                                      |                         |
| 30                          | Stable                                    | 40                                      | Lyretail (Dynamic)                        | 90                                      |                         |
| 40                          | Stable                                    | 50                                      | Lyretail (Dynamic)                        | 95                                      |                         |
| 50                          | Stable                                    | 60                                      | Lyretail (Fatigue)                        | 90                                      |                         |
| 60                          | Stable                                    | 70                                      | Lyretail (Fatigue)                        | >95                                     |                         |
| 70                          | Stable                                    | 70                                      | Lyretail (Fatigue)                        | >95                                     |                         |
|                             | Round Tail (WT)                           |                                         | Lyretail (Hybrid)                         |                                         | FATIGUE ZONE (A-2 ONLY) |

Tail-beat frequency increased with flow velocity. In both types, tail-beat frequency was positively correlated with the increase in flow velocity. However, A-1 already had a relatively high baseline tail-beat frequency (66 beats/s) during the adaptation phase and was able to respond steadily as the flow increased. By comparison, A-2 showed a sharp increase in tail-beat frequency after entering the fatigue state (above 50 cm/s), rising dramatically from 56 to over 90 beats/s, indicating that it had to expend much more energy to maintain balance under strong currents.



| Generation                              | Total Sample Size (n) | Normal (Round Tail) | Lyretail | Lyretail Ratio (%) |
|-----------------------------------------|-----------------------|---------------------|----------|--------------------|
| P                                       | 100                   | 80                  | 20       | 20                 |
| F1 hybrid generation (wild x lyre-tail) | 127                   | 120                 | 7        | 5.83               |
| F2 hybrid generation (wild x lyre-tail) | 331                   | 304                 | 27       | 8.157              |
| backcross (F1 x P)                      | 100                   | 76                  | 24       | 24                 |

The fish collected from the drainage ditch were bred and raised until the fourth filial generation (F4). This figure shows the results.

## Goals

- Literature Review and Preliminary Field Survey
- Collection of Wild Sailfin Molly Populations
- Collection of Commercial Sailfin Molly Strains
- Tail Morphology Identification and Character Quantification
- Analysis of Tail Trait Variation Across Breeding Generations
- Swimming Performance Tests and Velocity Analysis
- Discussion and Conclusions



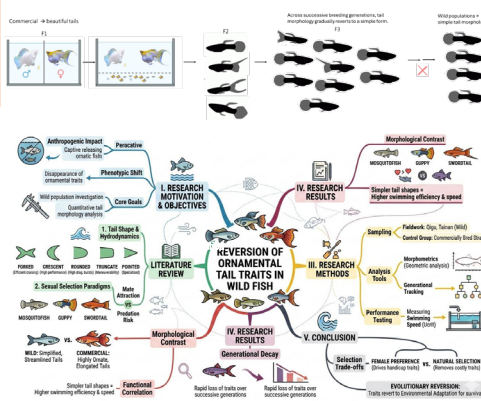
## Literature Review

Table 2: Basic Relationship Between Caudal Fin Shape and Swimming Speed

| Caudal Fin Shape | Morphological Characteristics           | Locomotor Performance & Ecology                  | Literature Citations             |
|------------------|-----------------------------------------|--------------------------------------------------|----------------------------------|
| Forked           | Centrally Concave, Distally Pointed     | High-Speed Cruising (Tuna-like)                  | Webb 1984; Vleisler 1993         |
| Lunate           | Crescent-shaped, Slender/Elongated Tips | Ultra-High Speed, Long-Distance (Tuna, Mackerel) | Lindsay 1978; Fish & Lauder 2006 |
| Rounded          | Arcuate / Semi-circular                 | High Maneuverability, Low Speed (Reef Fish)      | Webb 1984                        |
| Truncate         | Flat-edged / Straight                   | Mid-Speed, Balanced Maneuverability & Propulsion | Blake 2004                       |
| Pointed          | Distally Acuminate / Sharp-tipped       | Explosive Burst, Short-Distance Sprint           | Domenici & Blake 1997            |

In the family Poeciliidae, female mate preferences exhibit significant variation depending on the species' mating strategies. While the *mosquitofish* (*Gambusia affinis*) primarily employs forced copulation (facilitated by a longer gonopodium, a specialized male anal fin), females of *guppies* and *swordtails* possess higher mating autonomy. Consequently, they have developed highly diverse visual and behavioral preferences. 1. **Guppies** 2. **Orange Spots** 3. **Behavioral Boldness** 4. **Rare Male Effect** 5. **Male Choice Copying**

## Mind map



## Conclusion

- Collection and Strain Identification of Wild Sailfin Molly (*Poecilia latipinna*) and Tail Morphology Analysis
- Our team conducted a survey on the tail morphology of wild Sailfin Molly (*Poecilia latipinna*) populations across the wild-caught (W), and subsequent F1, F2, F3, and F4 generations (N=300 per group, consisting of 100 males, 100 females, and 100 unsexed individuals per trial). We categorized these into traditional types—Rounded, Truncate, Half-moon, and Double-sword—as well as natural hybrid types, including Delta/Triangle, Fan, Veil, Flag, Lyretail, Round, Spear, Needle, and Swordtail.
- In the wild populations, morphological observations were as follows: among males, there were 212 Rounded, 1 Double-sword, 51 Round-tail, 33 Lyretail, 1 Spear, 1 Needle, and 1 Swordtail; among females, 225 Rounded, 4 Double-sword, 18 Round-tail, and 18 Lyretail were recorded; for unsexed individuals, we found 259 Rounded, 1 Double-sword, 14 Round-tail, 25 Lyretail, and 1 Needle. After three generations of hybridization experiments, the population fully entered the F4 generation, by which point all individuals had reverted to the traditional morphology, primarily dominated by the Rounded tail.

## References

- Literatures:
1. Webb, J. W. (1984). Form and function in fish swimming. *Scientific American*, 251(1), 72-82.
  2. Fish, F. E., & Lauder, G. V. (2006). Passive and active flow control by swimming fishes and mammals. *Annual Review of Fluid Mechanics*, 38(1), 193-224.
  3. Lindsey, C. C. (1978). Form, function, and locomotor habits in fish. In W. S. Hoar & D. J. Randall (Eds.), *Fish physiology* (Vol. 7, pp. 1-100). Academic Press.
  4. Domenici, P., & Blake, R. W. (1997). The kinematics and performance of fish start swimming. *Journal of Experimental Biology*, 200(8), 1165-1178.



## " 掌光而行 "

張禕庭、吳彥霓

### 抗癌藥物的掌性光—— 物質交互作用



由左至右：張禕庭、吳彥霓

#### 個人特色、專長和興趣

##### 1. 張禕庭

喜歡烹飪、烘焙、手工藝製作等手作的活動；也熱愛科學探究，喜歡透過研究與分析理解科學原理並解決問題。

##### 2. 吳彥霓

熱愛滑板、雙龍板等板類運動，喜歡速度的刺激和挑戰的過程；也愛手作與數學，在實驗中較擅長實作及計算。

#### 團隊簡介與隊名由來

我們因為喜歡科學探索與實驗，且兩人在實驗中擅長之處也不同，所以彼此合作組成團隊。「掌光而行」中的「掌」不但指實驗中藥材的掌性，也代表我們能自己掌握研究方向；「光」則象徵科學探索帶來的啟發。



## 參賽原因與心得

我們是同班同學，平常會一起討論科學問題，也都對實驗研究與科學探究感興趣。因此決定一起組隊參賽。在準備的過程中，我們將研究內容整理成比較簡潔的內容，並反覆練習、調整，希望能在有限時間內介紹所有重點。在準備過程中最大的挑戰是在錄製影片時，雖然已經先排練了多次，正式錄影時仍會因為緊張而突然忘詞或停頓，因此，我們反覆地錄影，逐漸能流暢地介紹研究的內容。



### 隊伍自評

#### · 優勢

研究設計具系統性，且有透過不同量測方法交叉驗證，推導過程清晰，並得到有意義的研究結果。

#### · 劣勢

隊員英文能力略差，且研究仍有許多可能的變因與機制尚未完全驗證，未來仍有深入探討的空間。

# Chiral Light–Matter Interaction in an Anticancer Drug

Presenter: Yen-Ni Wu · Yi-Ting Chang

## Introduction

### Chirality in pharmaceuticals

Chirality is essential in biological systems.  
Many drugs possess chiral centers that influence their activity.

### Optical interaction

Chiral molecules interact differently with circularly polarized light.  
However, these signals are usually very weak in single molecules.

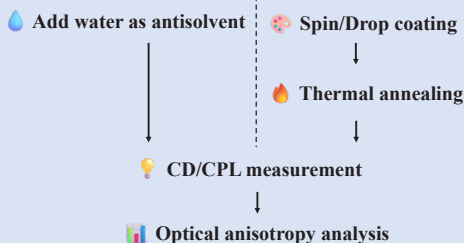
## SDGs relevance

This research supports:

- SDG 9 (Industry, Innovation and Infrastructure)**  
Developing new functional optical materials.
- SDG 12 (Responsible Consumption and Production)**  
Using **physical control strategies instead of complex chemical synthesis**, reducing environmental impact.

## Method

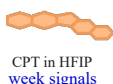
### Different experimental groups



- Supplementary Notes  
CD (Circular Dichroism) : Measures optical absorption chirality  
CPL (Circularly Polarized Luminescence) : Measures optical emission chirality

## Result

### Initial system

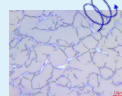
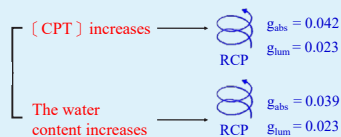


Water-induced self-assembly  
Film formation

### Key terminology used in this study

- LCP = Left-Circularly Polarized light
- RCP = Right-Circularly Polarized light
- $g_{\text{abs}}$  : Quantifies the difference in absorption between LCP and RCP
- $g_{\text{lum}}$  : Quantifies the difference in emission intensity between LCP and RCP

### Method 1 : Water-induced self-assembly



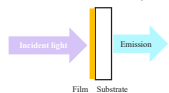
Monomeric state

Aggregated structures

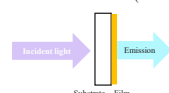
Water content

### Definition of front-side measurement (Condition 1) & backside measurement (Condition 2)

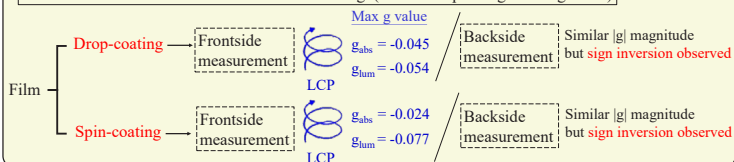
Front-side measurement (Condition 1)



Backside measurement (Condition 2)



### Method 2 : Film formation — Thermal annealing (Molecular packing rearrangement)



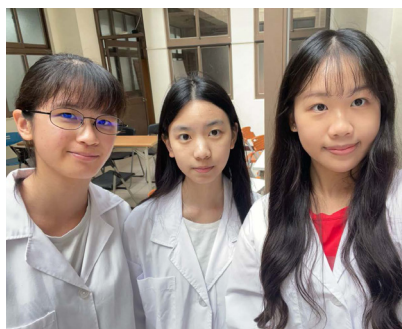
## Conclusion

- Camptothecin self-assembles in water, producing highly anisotropic CPL
- Solid-state thin films fabricated via spin-coating or drop-casting combined with thermal annealing show optimized optical properties and enhanced anisotropic CPL.
- Flipping the camptothecin thin films may induce nonreciprocal inversion of CD and CPL handedness, highlighting the critical role of macroscopic anisotropy in optical behavior.

## " BioClean Water Group "

謝佳君、陳妍心、吳書妍

### **Eco-friendly Algae Control: Synergistic Effect of Enzymes and Activated Carbon**



由左至右：謝佳君、吳書妍、陳妍心

### 個人特色、專長和興趣

#### 1. 謝佳君

擅長查詢與整理資料，將零散的資料整理。想法新奇，提出創意的點子，為團隊帶來新的觀點。

#### 2. 陳妍心

擅長英文口說，在翻譯和背稿有辦法高效率完成。在隊團中的配合度高，以及整合大家的想法，平衡分歧的爭點。

#### 3. 吳書妍

在團隊中擅長製作簡報與海報的排版設計，個性活潑開朗，研究蝴蝶的愛好者，熱愛參加各種英語賽事。

### 團隊簡介與隊名由來

BioClean Water Group：「Bio」代表生物和自然，「Clean Water」代表乾淨的水源。這個名字聽起來很有環保和科技的感覺，加上我們很喜歡簡約和直率的風格，所以大家一聽就覺得：「就是它了！」



## 參賽原因與心得

我們因對科學的熱愛而聚首，成員各具生物、昆蟲與自然研究專長。起初，我們想結合彼此專業，卻因氣候、溫度等不可控的外在因素連番碰壁。被迫重新設計實驗後，我們轉向貼近生活的主题，過程中仍經歷無數次與預期不符的失誤，加上課業壓力與時間逼迫，挫折感遠大於成就感。

時間大概是最大的挑戰。在報名截止前兩天，我們第一次在學校待到晚上九點，老師陪著我們加班，大家圍著電腦、啃著餅乾墊肚子，只為完成最後的資料填報。那晚，我們都印象最深，那是備賽過程中最有趣的時刻。收到晉級通知時，我們欣喜若狂，這份成果得來不易，決賽我們定會全力以赴！

### 隊伍自評



#### · 優勢

具有積極嘗試創新的精神及團結之間永遠保持良好溝通，當下有分歧當下提出並討論到互相皆達成共識。不僅讓我們團隊在備賽的過程中沒有拖彼此後腿，反而越來越有默契！

#### · 劣勢

對於英文的表達能力還有待加強，都不是我們最擅長的，需要依靠花時間練習來精熟。

# LOW DAMAGE AND IMPROVED OXIDATION

By Bio Clean Water Group

## STUDENTS :

Sharon Chen, Livia Wu, Diana Hsieh

## TEACHERS:

Chang An Liu, Chun Chen Yang

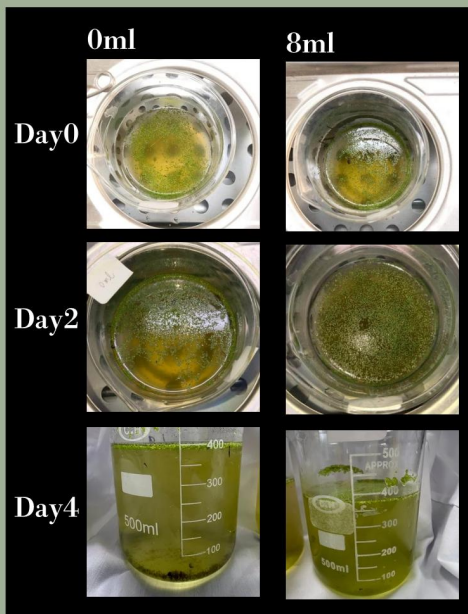
## PURPOSE :

Try low-pollution ways to control algae growth.

## METHOD :

We added 0 ml, 4 ml, and 8 ml of combination of cellulase and pectinase to the algae respectively, and observed the changes in the algae from Day 0 to Day 4. On the fourth day, activated carbon was added to absorb the organic matter produced after enzymatic decomposition.

## PROCESS :



## RESULTS :

The cellulase-pectinase combination effectively degraded algae even at low doses, but showed little improvement beyond a threshold, indicating saturation. Although turbidity increased initially, adding activated carbon later improved clarity by adsorbing decomposition products.

## CONCLUSION :

The integration of enzymatic hydrolysis with activated carbon filtration offers a low-impact strategy for algae management. This method proves effective against eukaryotic algae and holds significant potential for the sustainable maintenance of campus ponds and other small-scale aquatic ecosystems.



## " 對不隊 "

李慶宣、潘語亮

### Application of Fluorescent Carbon Dots for the Detection of Sodium Copper Chlorophyllin Content



由左至右：李慶宣、潘語亮

#### 個人特色、專長和興趣

##### 1. 李慶宣

我的特色是熱愛嘗試和冒險，思考跳躍；專長是統整研究內容；興趣是跳舞及解開挑戰性的題目。

##### 2. 潘語亮

個性外向，喜歡極限運動。會隨身攜帶一隻北極熊娃娃，她叫做白饅頭，是我女兒。

#### 團隊簡介與隊名由來

我們從高一開始一起做專題，整體來說，我們相處很輕鬆，都是該玩的時候玩，該認真的時候認真的類型，當然過程中有過磨合，「對不隊」這個隊名的由來是因為我們在經過磨合後，做實驗時都會和對方用輕快的語氣確認各項細節，減少爭執的同時也緩和了做專題的疲勞。利用諧音也透漏了我們搞笑和愛玩的性格，因此我們最後決定用這個隊名參賽，希望我們能努力且有趣的完美取得佳績。



## 參賽原因與心得

我們高一時就知道互相感興趣的專題方向，覺得還蠻相似的，因此成為了一隊，參加這次比賽的原因是我們想要挑戰一下自己，英文對於我們來說都不是一個輕易的科目，我們想要通過這次的機會好好磨練我們的英文，加強我們的口說及對話能力，而且還能跟大家分享我們的專題研究成果，所以我們決定報名這個比賽。

我們覺得遇到最大的挑戰就是專有名詞有點難發音，因為不是平常單字書或課本裡會出現的詞彙，所以我們需要一個一個上網查找發音並記起來，錄製初賽影片的時候錄了幾十次，常常因為繞口的單字卡頓或是搞錯發音；也因為不小心講出很奇怪的音調我們常常覺得又累又氣又好笑。

### 隊伍自評



#### · 優勢

研究邏輯架構完整、條理清晰，已經用中文報告過研究內容及成果與參加科展。

#### · 劣勢

實際樣品檢測種類較少，尚有擴大空間。英文能力略微不足。

# Application of Fluorescent Carbon Dots for the Detection of Sodium Copper Chlorophyllin Content A Temperature-Triggered Strategy for Fast and Green Food Safety Screening

## Motivation



Copper ions released after dissociation at high temperatures (over 50°C)  
Milk Tea with Copper Chlorophyllin

SCC (sodium copper chlorophyllin) is a widely used green food colorant in beverages and processed foods. Under heating conditions, especially above 50°C, it may partially dissociate and release  $\text{Cu}^{2+}$ , raising potential food safety concerns. Therefore, this study explores a fluorescent carbon dot platform as a simple and effective strategy for the indirect detection of SCC in beverage samples.

## Innovation + Mechanism

photoinduced electron transfer(PET)



Green-synthesized CDs from L-cysteine and D-galactose were used to detect heat-released  $\text{Cu}^{2+}$  from SCC. Under 370 nm excitation, the CDs emit fluorescence; however,  $\text{Cu}^{2+}$  triggers photoinduced electron transfer (PET), causing excited electrons to transfer and the fluorescence to be quenched. Therefore, SCC can be indirectly quantified through  $\text{Cu}^{2+}$ -dependent fluorescence changes.

## Methodology

Precursor : L-cysteine + D-galactose  
One-step reflux method 85°C, 24 hr



Reflux Reaction (24 h)

Purification via dialysis (2 days) and freeze-drying (3 days).



Purification (Dialysis & Freeze-drying)



Final Carbon Dots (CDs)

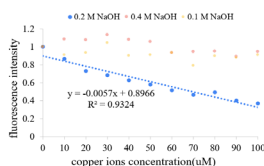


- Synthesize CDs using 0.1, 0.2, and 0.4 M NaOH and compare their  $\text{Cu}^{2+}$  sensing performance.
- Optimize SCC detection by testing different temperatures (RT, 40, 50, 60, and 70°C).
- Evaluate the effect of heating time at 60°C (15, 30, and 60 min).
- Apply the optimized method to green milk tea.

## Result

### Key Result 1

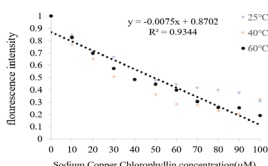
0.2 M NaOH-derived CDs showed the highest sensitivity for  $\text{Cu}^{2+}$  detection. ( $R^2 = 0.9206$ ,  $[\text{Cu}^{2+}] = 0-100 \mu\text{M}$ .)



Higher  $\text{Cu}^{2+}$  concentrations (0-100  $\mu\text{M}$ ) caused stronger fluorescence quenching. CDs synthesized with 0.2 M NaOH showed the best response, whereas those synthesized with 0.1 M NaOH showed poorer linearity. Therefore, 0.2 M NaOH was the optimal synthesis condition.

### Key Result 2

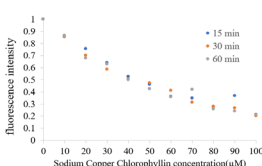
60°C gave the strongest quenching effect and best linearity for SCC detection.



At all tested temperatures, higher sodium copper chlorophyllin concentrations (0-100  $\mu\text{M}$ ) caused stronger fluorescence quenching of the carbon dots. Among these conditions, 60°C showed greater quenching and better linearity, and was therefore selected as the optimal experimental temperature.

### Key Result 3

Heating time from 15-60 min showed no significant effect.

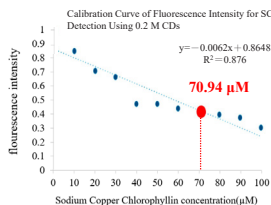


The calibration curves showed similar absolute slope values, indicating that heating time from 15 to 60 min had no significant effect on the fluorescence quenching of the carbon dots.

## Real sample application

### Real Sample Application

Green milk tea contained approximately 142  $\mu\text{M}$  SCC.



## Conclusions

- Copper ions cause fluorescence quenching of carbon dots, and higher  $\text{Cu}^{2+}$  concentrations result in stronger quenching effects.
- Carbon dots synthesized with 0.2 M sodium hydroxide showed the best performance for  $\text{Cu}^{2+}$  detection.
- For SCC detection, carbon dot solutions heated at 60°C showed the optimal sensing performance.
- Heating time had little effect on the fluorescence quenching of carbon dots.
- The sodium copper chlorophyllin content in green milk tea was approximately 141.89  $\mu\text{M}$ .
- Supporting SDG 3, SDG 9, and SDG 12 through safer food monitoring and sustainable sensing innovation.



## " Signal Detectors "

許若妏、柯宜青

### **Cellular Warning sign : Exploring Lipid Toxicity Through Saccharomyces Cerevisiae Cells**



由左至右：黃子欣老師、  
許若妏、柯宜青、田代藏老師

### **個人特色、專長和興趣**

#### 1. 許若妏

I'm Yvonne, and I've always been curious about fascinating scientific investigations. Along with conducting experiments and studying science, I enjoy participating in speech and presentation competitions. Being on stage gives me confidence and energy, and it allows me to express my passion for learning and discovery.

#### 2. 柯宜青

I'm super passionate about Biology and applying my lab skills to solve real-world challenges! Aside from science, I spend my time watching Netflix and diving into the world of fantasy!!

### **團隊簡介與隊名由來**

Our team is called Signal Detectors because science is all about discovering the hidden signals behind complex biological processes, and we are both pleased throughout the process. In our experiment, we investigate how cells respond to different glucose concentrations under lipid toxicity by measuring changes in light intensity. These changes act like signals that reveal how yeast cells grow, struggle, or adapt in stressful conditions that mimic aspects of diabetes.



## 參賽原因與心得

During the process of preparing for this competition, our team encountered several obstacles. One challenge was ensuring that our experimental setup remained consistent, especially when preparing different glucose concentrations and maintaining constant exposure to palmitic acid. We repeated the experiment multiple times to increase reliability and carefully reviewed scientific literature to strengthen our understanding of lipid toxicity and glucose metabolism. As the competition approached, we also practiced our presentation many times, helping each other improve clarity, confidence, and timing. Through these preparations, we not only strengthened our experiment but also developed teamwork, communication, and problem-solving skills, making us more confident and ready for the competition.

### 隊伍自評

#### · 優勢

研究推導邏輯清晰，並得出有價值的結論。

One of the main strengths of our team is our confidence in both our experiment and our presentation skills. Throughout the preparation process, we worked hard to understand the scientific concepts behind our research, which allows us to explain our experiment clearly and confidently. In addition, our team members are comfortable speaking in front of an audience, which helps us present our ideas with enthusiasm and clarity.

#### · 劣勢

研究還有更多發展的面向尚未討論，且未完全驗證，如是否為植物激素誘導的部分。

However, our research also has some limitations. Due to time and resource constraints, we were only able to test a limited number of glucose concentrations and repeats.



# Metabolic Stress in a Sugar-Rich World

Signal Detectors: Yvonne, Phoebe

Our experiment connects to SDG 3, focusing on goal 3.4. Through this experiment, we aim to acknowledge the effect of lipid toxicity and glucose concentration on cell growth and gain a greater understanding of the biological effects within a diabetic patient.

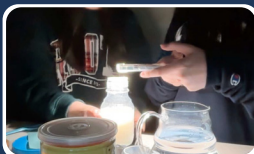


## PROBLEM + PURPOSE

Research has shown that the number of diabetic patients is estimated to reach 853 million by 2050 ( International Diabetes Federation, 2025). To treat diabetes, scientists use insulin, a hormone that reduces hyperglycemia by facilitating the uptake of glucose from the blood into tissues and adipocytes, reducing glucose's accumulation in the bloodstream (Vargas et al., 2022). Yet, since insulin plays a vital role in diabetes treatment, this brings us to a major problem: what is the effect of cell when insulin is absent or inefficient? The absence of insulin will lead to an increase in hormone-sensitive lipase (HSL), an enzyme that breaks triglycerides into glycerol and free fatty acids. The fatty acids would pile up in the bloodstream and flow into the organs, such as the pancreas and liver, disrupt cell functioning, or even trigger cell death (Semrad et al., 2011). Inspired by the devastating impact of saturated fatty acids on cell growth, we aimed to dive deeper into different phenomena that appear in cells of a diabetic patient, the differentiation in glucose concentration.

## RESEARCH QUESTION

How do varying glucose concentrations (0%, 2.5%, 5%, and 7.5%) affect the growth of *Saccharomyces cerevisiae* with constant palmitic acid exposure, quantified by the optical turbidity measured through light intensity (lux) transmission over 24 hours?



## HYPOTHESIS

We hypothesized that the light intensity increases along with glucose concentration, with 5% of glucose concentration having the biggest rate of decrease, and the 0% glucose concentration having the least rate of decrease.

## METHODS & EXPERIMENTAL PROCEDURE

- Liquid Cultural Medium: Allows a suitable environment for yeast cells to grow evenly in constant conditions.
- Palmitic Acid & Soybean Lecithin: Stimulation of lipid toxicity. Palmitic acid presents as a saturated fatty acid; soybean lecithin keeps fatty acids mixed and distributed evenly in water.
- *Saccharomyces cerevisiae*: A single-celled eukaryote, used as a model organism that is similar to the majority of fundamental functions of human cells, including metabolic processes, DNA replication, cell cycle, and more.

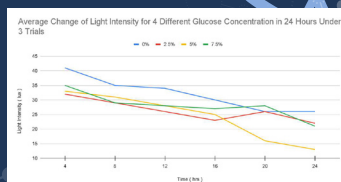
We repeat the experiment 3 times to enhance the precision of the data. (n=3)



## RESULTS

- (1) All glucose concentrations have a decrease in light intensity over 24 hours.
- (2) 5% glucose concentration has the highest rate of decrease in light intensity over 24 hours.

According to research, higher sugar levels accelerate cell growth and proliferation, disrupting normal functioning (Cleveland Clinic, 2023). The final product and resolution underscore the global significance of understanding and managing metabolic disorders within the context of sustainable, healthy societies.

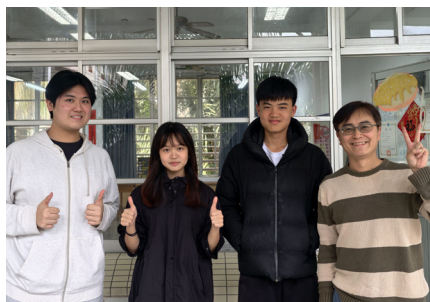




## " 比堡奇 "

高資恆、黃凱莉、王金甲

### How Mixing Speeds Determine the Stability and Density of Whipped Egg Whites



由左至右：高資恆、黃凱莉、王金甲、顏伯昌老師

#### 個人特色、專長和興趣

##### 1. 高資恆

我是個有活力且開朗的人，我平時喜歡烹飪以及觀察人事物，我擅長團隊合作和解決問題，我喜歡時尚，這讓我得以在團隊中發揮創意及展現獨樹一格的美感與能量。

##### 2. 黃凱莉

我是擁有健康膚色的人，熱心且具創意。擅長用英語溝通，喜歡團隊活動與烘焙。我喜歡在合作中發揮美感，用細膩的心思為團隊創造獨特價值。

##### 3. 王金甲

我很內向，不喜歡在很多人面前講話。我也很喜歡運動，棒球是我最會的運動。

#### 團隊簡介與隊名由來

我們是「比堡奇」，這個名字的由來其實是個隨便的錯誤，我們常把比奇堡記反，但這反而成了我們的標籤。就像海綿寶寶裡那越看越可愛的比奇堡居民，我們這群人也很有愛。我們喜歡用科學腦去拆解東西，把烘焙當成精密的科學實驗，對我們來說，名字記反只是變因失控的結果，但面對任務的邏輯與數據，我們絕對不會搞錯！



## 參賽原因與心得

我們參賽其實是因為導師要求我們要參加，雖然一開始不是很願意，但是我們在準備這個比賽的途中漸漸發現其中的樂趣。我們在去年便開始準備我們的實驗，在做完我們設計的第一個實驗之後，我們遇到了一個最大的挑戰：沒有控制好實驗的變因，這導致我們的實驗結果不明確，我們和指導老師討論很久要怎麼解決，所以設計了另外一個實驗來驗證是什麼變因會影響最終實驗結果，還好有得出一個比較明確的變因。另外我們這組是自然探究實作課程的分組，一個學期下來我們的合作越來越有默契，也發現了和隊友合作的樂趣。



### 隊伍自評

#### · 優勢

1. 研究主題貼近生活且具有創意。
2. 之前有過相關成果發表的經驗。

#### · 劣勢

1. 研究還有更多變因及可能還沒有探討，例如會不會有圈數和轉速以外的變因存在。
2. 這次以全英語方式演講，雖此類經驗不多，但我們仍能汲取許多寶貴經驗，運用在生活當中。

# How Mixing Speeds Determine the Stability & Density of Egg White Foam

LEO WANG, JAYDEN KAO, CAYLEE HUANG

## ABSTRACT

This study investigates how an electric mixer's speed affects the density of egg white foam. After initial tests using a fixed mixing time proved unstable, the experiment was redesigned to keep the total number of rotations constant across different speeds. This change ensures a more reliable measurement of how speed alone impacts the foam's final density.

## METHODOLOGY (a)



**Step1.**  
50 g of sugar and egg whites were measured



**Step2.**  
Both sugar and whites were added to a bowl and blended for 5 minutes at speed 1 with an electric mixer, all whilst keeping hand and bowl position still



**Step3.**  
The created foam was transferred to a cup (121.35 mL). Air bubbles were then removed and the top was flattened, thus making the foam volume fixed



**Step4.**  
Foam mass was measured to calculate density ( $D=M/V$ ).

Steps 1-4 were then repeated for speed 2-5. All experiments to each speed repeated 3 times.

## METHODOLOGY (b)

To isolate the effect of speed, the total rotation count was fixed at 5,000 turns by adjusting mixing times for each speed setting. Measurements were conducted using the same procedures as Experiment (a). Using the equation on the right, we calculated each mixing durations.

$$\text{Total Rotations} = \frac{\text{RPM} \times \text{Time (sec)}}{60} = 5,000$$

## DATA ANALYSIS (a)

As Figure (a) shows, the average density of each foam lowers as rotational speed (RPM) increases. Although average foam density and rotational speed share a negative linear correlation, variables of Experiment (a) weren't controlled properly. As RPM increased, rotation count simultaneously increased.

## DATA ANALYSIS (b)

Figure (b) exhibits, similar experimental results as Experiment (a), where average density lowers with the rise of rotational speed. This phenomenon indicates that rotational speed is the primary factor of differences in foam density since Experiment (b) was designed only to have rotational speed as the fixed variable, leaving the total rotation amount having little to no impact.

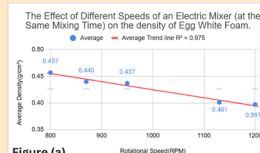


Figure (a)

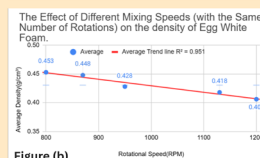


Figure (b)

## DISCUSSION

1. Lower density in foam reflects air incorporation, resulting in a light, aerated structure.
2. The fluffiness creates a robust protein film that prevents bubble merging and liquid drainage, delaying foam collapse. Low-density foams thus exhibit superior structural stability when whipped.



## CONCLUSION

In summary, while the number of rotations plays a role in the whipping process, rotation speed is the primary driver of the lower density of the egg white foam. Although the initial experimental design was flawed, the subsequent refinement allowed for a definitive conclusion: higher speeds yield lower density foams. This experience has reinforced our commitment to precise experimental design, and we will apply these insights to ensure greater rigor in all future scientific inquiries.

## SDGs

**SDG 12**  
(Responsible Consumption and Production)  
This research promotes

Responsible Consumption and Production by optimizing baking parameters to reduce food waste caused by unstable mixtures and failed batches.



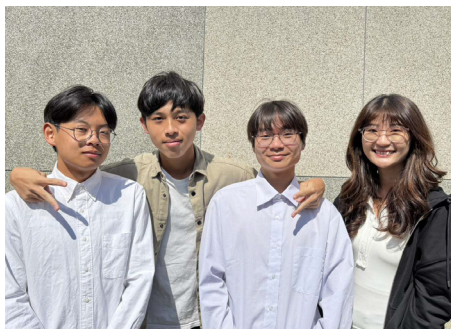
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4. Variations in foam collapse and thin film stability with constant interfacial and bulk properties <https://doi.org/10.1016/j.lcis.2023.102845>
5. A Kinetic Description for the Destabilization Process of Protein Foams. <https://www.tandfonline.com/doi/pdf/10.1080/10941911093687264>

## " The Siphony "

陳泓頤、林宥穎、葉晉齊

### Simple Siphons, Fewer Sirens



由左至右：洪睦鈞、林呈紘、胡彥鈞、  
李欣蓓老師

### 個人特色、專長和興趣

#### 1. 胡彥鈞

樂觀、積極進取，熱衷歌唱表演並擅長口語表達，活躍於朗讀、演講、辯論等英語競賽，同時擔任高中社團社長。

#### 2. 洪睦鈞

正向活潑，喜歡思考和討論物理現象，熱衷於研究飛機噴氣式引擎，並看到流體相關理論，期盼未來可朝此進修。

#### 3. 林呈紘

外向、抽象，喜愛各式球類運動（最愛籃球），最近熱衷於研究奇怪的電磁學，並擔任現任科學研究社教學。

### 團隊簡介與隊名由來

本團隊由三位創意無限的成員組成，而隊名取自虹吸管 Siphon 與交響樂 Symphony，不僅希望團員三人能各司其職、如交響樂共同創造絕美樂音，更是期許我們得以利用自啟動虹吸管能達成社會永續以及世界和諧。



## 參賽原因與心得

從英文老師口中聽說此項比賽，由於過往有合作經驗，我們三人很快就組隊報名，如火如荼開始設計本次的實驗。主題「自啟動虹吸管」由來是線上虹吸裝置影片，我們連結到當時花蓮的堰塞湖潰堤，並希望能以此作為應對機制展開相關研究與實驗。而實驗中遇到最大困難，便是儘管虹吸管形狀已經和影片範例樣本相近，成功率仍無法提高，故為此花費不少心思，也難免有負面的想法；但後來經過十餘次的不斷修正，才得以有今日成果。值得一提的事情是，在試錯的過程中，因沮喪而想改變心境時，我們將實驗的容器用不同的高度與虹吸現象，創造出三階連續水道，看起來十分療癒，讓我們成功找回幹勁與熱忱。實驗雖然折磨心智，仍為我們在科學研究路上留下難忘經驗。



### 隊伍自評

#### · 優勢

不只對於科學理論和實驗操作相當有熱忱，更有絕佳臨場反應力，且三位都個性外放，敢於分享和發表自身想法，總是能在討論中擦出趣味的火花。

#### · 劣勢

辦事效率起伏不定，總不按照計畫執行進度。



# SIMPLE SIPHONS, FEWER SIRENS

Author: Becca Li\*, Cheng-Hong Lin, Mu-Chun Hong, Yen-Chun Hu

## Background

In 2025, an enormous barrier lake burst in Hualien, causing severe damage with an estimated discharge volume of 60 million cubic meters. Grieving over this incident, we came up with a potential solution with the assistance of “self-priming siphons,” which operate without the prerequisite of pre-filling. Thus, our team will examine whether it is feasible to drain the water in the barrier lake and save it from collapsing, hoping to create a viable and sustainable drainage solution that barely require energy.

## Method

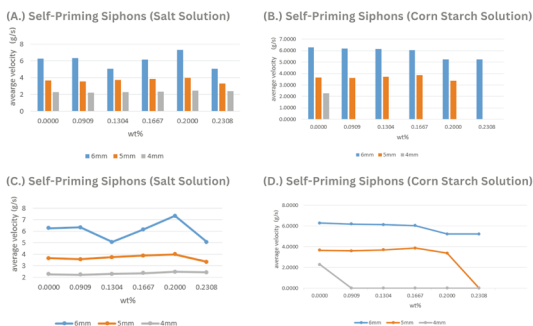
Siphons are prepared in different tube diameters, ranging from four, five, to six millimeters. The methodology of our research was divided into 2 stages.

Stage (1): The correlation between concentration of salt and discharge speed is examined. Test liquids are prepared by mixing water and salt in varying ratios to simulate an ideal condition where dissolved substances will not precipitate.

Stage (2): The correlation between concentration of corn starch and discharge speed is examined. Test liquids are prepared by mixing water and corn starch in varying ratios to simulate the viscous and precipitating fluids typically found in barrier lakes.

These experiments aim to determine the critical concentration threshold at which the self-priming siphon maintains operational functionality.

## Results



- The siphon with a diameter of 6 mm drains the largest amount of water in the salt solution and the corn starch solution, whereas the 4 mm siphon performs the worst.
- The siphon with a diameter of 6 mm could drain the corn starch solution with the highest viscosity.
- The siphon with a diameter of 5 mm performs most steadily in both the salt and corn starch solutions.

## Conclusion

Conclusion: The most effective tube diameter—achieving both the highest drainage speed and the highest bearable concentration—is 6 millimeters, which can operate in a 23.08% salt solution and a 25% corn starch solution. However, the 5-millimeter tube demonstrates greater stability in terms of siphoning and drainage speed. Furthermore, comparing Chart (C.) and Chart (D.), we discovered that self-priming siphon works more steadily in corn starch solution, which indicates that it is more suitable for realistic situations such as barrier lakes where precipitation and viscous fluid exists.

Discussion: We compared the experimental results with the actual conditions of liquid in the barrier lake. To drain a volume of 60 million cubic meters from the Hualien barrier lake, it is feasible to utilize approximately 950,000 siphons made of discarded plastic straws, requiring only 3 months. These findings provide a reference for future applications.



## References

Self-Siphon Simulation:  
<https://arxiv.org/abs/1104.1847>  
 Self-Priming Siphons: <https://reurl.cc/R2b6qg>  
 Mataian River Barrier Lake: <https://reurl.cc/O6qn1R>



## SDGs





## " The Data Science Talkers "

朱家亨、章睿軒、徐睿霆

### Does Spending More Mean Living Longer?



由左至右：沈容伊老師、章睿軒、  
朱家亨、徐睿霆、林孟學老師

### 個人特色、專長和興趣

#### 1. 朱家亨

我是一心思細膩的人，興趣是唱歌、繪畫與音樂，並且參加另類音樂創作社，創作並演出自己的歌曲。

#### 2. 章睿軒

我是一個樂觀且積極向上的人，興趣是彈鋼琴和與同學一起完成各種挑戰，專長是清楚的表達和高效率的合作。

#### 3. 徐睿霆

我擅長團隊合作及溝通表達的能力，而我亦喜愛嘗試新事物，踏出舒適圈並挑戰自己的極限。

### 團隊簡介與隊名由來

我們的隊名為 The Data Science Talkers，因為我們的研究採用了新興研究方法「資料科學」，所以我們的隊名結合了這項研究方法，以展現我們如何將對事物的好奇與現代科技發展結合產出完整的作品。



## 參賽原因與心得

以校內專題研究課程為起點，我們一直思索如何深化人工智慧與現有的公開數據平台的連結，而這場比賽提供了我們一次機會。抱著好奇心，我們希望在比賽中能遇見志同道合的人與之討論、切磋，並跨出舒適圈。

藉由龐大的數據庫搭配 AI 輔助撰寫程式，我們將資料彙整成圖表及可視化數據，為後續的數據整理與分析奠定了堅實基礎。準備競賽過程中，我們常需要回頭檢視先前的資料和結果，這個過程會使我們發覺更進一步的想法和問題，這讓我們更能了解到探究的魅力所在。



### 隊伍自評

#### · 優勢

我們有良好的學術基礎及探究能力，並具備流暢的英文表達能力。另一方面，我們採用了資料科學的新興研究方法，此亦為我們團隊的一大特色之一。

#### · 劣勢

繁忙的行程以及課業壓力導致準備時間稍有不足。



# "Does Spending More Mean Living Longer? "

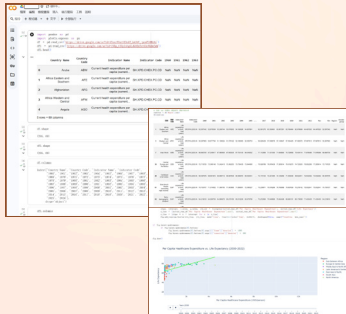
— Exploring the Relationship Between Per Capita Healthcare Expenditure and Life Expectancy Across Countries

Author: Henry Chu, Carlos Chang, Jasper Hsu

## Background & Motivation

The COVID-19 pandemic showed massive health investments in many countries didn't always yield better health outcomes. Meanwhile, past research indicates that health spending has diminishing marginal returns. Ultimately, public health infrastructure and social factors matter more for longevity than medical spending. This brings us to our question: Is there a direct correlation between healthcare expenditure per capita and life expectancy?

## Methods & Processes



### 1. Data Collection:

Sourced core datasets on life expectancy, per capita healthcare spending, and country classifications from the World Bank.

### 2. Data Cleaning:

Filtered out missing values, retaining only the complete 2000–2022 dataset to ensure accuracy.

### 3. Data Merging:

Combined the cleaned data into a single master table using the Country Code as the primary key.

### 4. Data Visualization:

Created charts grouped by region and income level to illustrate the relationship between spending and longevity over time.

## Results

Upon analysis, we observed that the distribution of countries trends from bottom-left to top-right, indicating that life expectancy tends to rise with increased health spending; however, the gains in life expectancy diminish as expenditure increases. Regionally, North American and European nations are mainly clustered in the upper-right area, characterized by high expenditure and high life expectancy, while regions such as Sub-Saharan Africa are situated in the lower-left.



We identified specific countries in the same region to share similar life expectancies with significant disparities in health expenditure, such as Spain and Switzerland. After reviewing relevant literature, we discovered that Switzerland's high price levels and labor costs, combined with a strong currency, significantly inflate the figures converted to USD, while distinct resource allocation models further worsen these statistical discrepancies, suggesting that the expenditure gap

|                                                                                        |    |             |
|----------------------------------------------------------------------------------------|----|-------------|
| Spain                                                                                  | VS | Switzerland |
| 83.2years                                                                              |    | 83.5years   |
| 2000\$ USD                                                                             |    | 8000\$ USD  |
| • the varying economic environments<br>• healthcare funding models of the two nations. |    |             |

primarily reflects differences in price levels, exchange rates, and resource utilization, rather than actual medical outcomes.

## Contribution to Our Society

- Analyzing database to figure out the key factors which affect health expenditure
- Finding increase of life expectancy among low-income nations

## Conclusion & Prospect

This study confirms that health and longevity depend not only on financial investment but on policy and resource management. Regrettably, Taiwan was not included in the dataset for this study, leaving an opportunity for further research. We hope that policymakers will prioritize systemic design and resource efficiency when enacting future policies.

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- Wilkinson, R. G., & Pickett, K. (2006). Income inequality and population health: A review and explanation of the evidence. *Social Science & Medicine*, 62(7), 1768–1784.
- World Health Organization. (n.d.). Domestic general government health expenditure (GCHE-D) as percentage of current health expenditure.

## " 藻知道 Algae-Know-It-All "

陳宇哲、陳宇家、陳政瑋

### **A Low-Cost Detection Module for Microalgae Carbon Fixation —— Assessment Using Digital Image Analysis**



由左至右：陳宇哲、陳宇家、陳政瑋

#### 個人特色、專長和興趣

##### 1. 陳宇哲

喜歡打球與爬山，也喜歡親近大自然與觀察生態，常閱讀小說及各類書籍，並動手製作藝術與創作小作品。

##### 2. 陳宇家

喜歡跑步與爬山，喜歡昆蟲與自然生態，平時閱讀小說及各類書籍。

##### 3. 陳政瑋

個性活潑開朗，喜歡隨興跳舞，平時聽音樂並接觸動漫文化，具節奏感與創意表現。

#### 團隊簡介與隊名由來

我們是 3 兄弟組成的科學團隊，因生活在一起，能隨時討論想法並調整實驗設計。

隊名象徵好奇心和 Cooperation 精神，透過觀察、實驗與思考，在科學研究中找到新的發現。



## 參賽原因與心得

科學家 John Martin 曾說：「給我半艘郵輪的鐵，我就能製造出冰河期。」這句話讓我們對海洋碳循環與藻類產生興趣，在學校自主學習課程中開始研究與微藻固碳相關的主題，進而報名參加遠哲盃。

我們是兄弟，平時生活在一起，能隨時討論研究想法並修正實驗設計。準備的過程中，我們查閱資料和討論設計實驗，希望利用手機影像亮度分析來觀察微藻生長，以生活化工具替代部分實驗儀器，解決設備限制。

報名過程中最具挑戰的是釐清比賽規則與繳交資料。起初製作簡報缺乏方向，但看了官方說明影片後漸漸理出頭緒。雖然參賽影片僅有 30 秒，但須反覆擬稿與練習，希望在有限時間內精準表達研究重點並展現團隊默契。這段過程是難忘的經驗，期待在決賽中能穩定發揮，爭取好成績。

### 隊伍自評



#### · 優勢

研究所使用的設備為生活中容易取得的器材，使實驗具有可操作性與推廣性；同時將研究方法與流程整理成標準化操作手冊。

#### · 劣勢

尚未對微藻濃度與影像亮度之關係進行完整的定量分析。

# CAN SMARTPHONES TRACK MICROALGAE GROWTH?

Turn Your Phone into a Low-Cost Scientific Tool



## Problem

- Traditional measurement requires expensive equipment
- Limited accessibility in school laboratories

## Objective

- Develop a low-cost and reproducible method
- Evaluate whether B-value can represent microalgae growth

## KEY INSIGHT

B-value serves as a reliable proxy for microalgae growth

## Method

1. Microalgae cultivation
2. Light control (15 / 40 / 90 cm)
3. Dark box imaging
4. Image capture  
(Manual mode: ISO: 200, Shutter Speed: 1/60s, WB: 5000K)
5. B-value extraction (via Color Picker App)
6. Growth trend analysis

Figure 1. Experimental Procedure

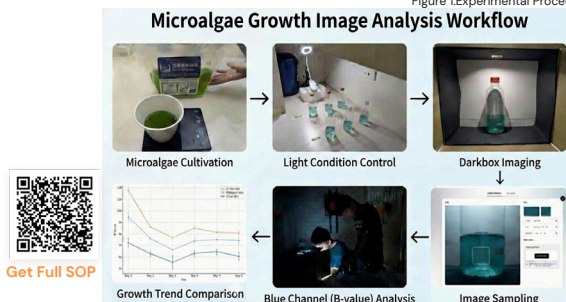
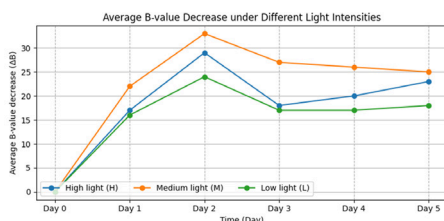


Figure 2. B-value Decreases as Microalgae Density Increases



## Results

### Key Findings:

- Strong inverse relationship between B-value and microalgae density
- Medium light condition shows the most stable growth pattern

## Innovation

- Transforms smartphones into scientific measurement tools
- Enables low-cost and accessible experiments
- Standardized workflow ensures reproducibility

## Impact

- Enables quantitative experiments in schools
- Supports inquiry-based learning (SDG 4)
- Scalable for environmental monitoring

## Conclusion

- B-value is a reliable proxy
- Method is low-cost and reproducible
- Suitable for education and research

| Table 1. Growth Patterns Under Different Light Intensities |                                |                             |
|------------------------------------------------------------|--------------------------------|-----------------------------|
| High Light                                                 | Medium Light                   | Low Light                   |
| ↓ Strong drop (Day 2 lowest)                               | ↓ Moderate drop (Day 2 lowest) | ↓ Small drop (Day 2 lowest) |
| ↑ Large rise (Recovery)                                    | ↑ Stable rise (Consistent)     | ↑ Weak rise (Limited)       |
| ⚠ Light stress                                             | ✅ Optimal                      | ⚠ Energy low                |

Growth Pattern Summary

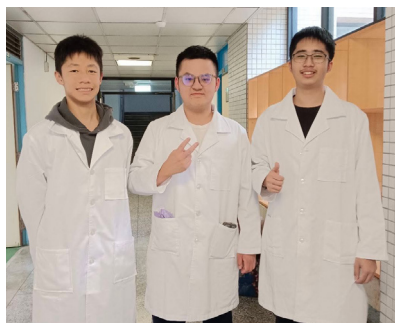
## References

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**" 讓你看看 [城市] 的 [COOL] "**  
**鍾効辰、吳胤寬、陳宣文**

## **An AI-Integrated Approach That Mitigating UHI Effect through Albedo Optimization**



由左至右：陳宣文、鍾効辰、吳胤寬

### **個人特色、專長和興趣**

#### 1. 鍾効辰

我擅長的方面是演說，而我的興趣則是閱讀小說。至於我的特色，大概就是我「很有創意」，黑的都能說成白的，尤其擅長中文辯論。

#### 2. 吳胤寬

我的專長是編碼，而我最喜歡的休閒活動是閱讀。因為家庭的環境，所以我很早就接觸資訊，可以說我的血管裡流的就是一行行代碼。

#### 3. 陳宣文

我對於環境工程很有興趣，可以將化學性質與物質融入生活對於我來說是一件很有趣的事，在實驗中我比較擅長實驗操作與設計實驗。

### **團隊簡介與隊名由來**

嗨！我們是最最最神奇的貓咪！又或許是最最最勞累的牛馬？總之，我們是一群超級認真的資訊人，我們不但努力而且超有創意的啦！題目也失因為怕熱才想出來的呢！至於為什麼會有這麼神奇的名字，當然是因為身為台灣人的我們酷愛諧音梗啦！我們保證能夠用超級 cool 的程式讓城市 cool down。



## 參賽原因與心得

我們整個比賽過程可以說是一波三折，尋找隊員還算順利，幾個人看到網路上的訊息之後一拍即合，於是就組成一個隊伍了，也是因為這樣，我們其實很早就在準備這個比賽了，我們每個禮拜都會抽出一兩天的時間討論，然後在平日的時候分工將任務達成，進度穩步推進，可最大的挑戰卻在比賽前兩個月前出現了，我們發現我們的題目有瑕疵，所以我們只能將前三個月的結果捨棄，並將每個禮拜投入的時間翻了好幾倍，才勉強在截，不得已必須要換一個題目前繳交，好在成品倒是沒辜負我們的努力，在所有實驗數據及好幾天爆肝打程式之後，終於架構出了合適的模型。只能聰明的選擇遠比盲目的努力重要，與其事倍功半的勞累，不如事先做好調查，方能夠事半功倍。



### 隊伍自評

#### · 優勢

1. 報告不只停留在理論，而是透過實際物理實驗取真實數據，再以此建構 AI 模型，具備高度說服力。
2. AI 線性回歸模型的值達到  $R^2=0.94$ ，顯示預測溫差的準確性極佳，能有效推估經實驗測試的建材。
3. 研究目標直接連結聯合國永續發展目標 SDG 11（永續城市）與 SDG 13（氣候行動），提升了研究的實踐價值與高度。
4. 報告不僅指出問題，還針對不同材質給出具體的應用建議，具備城市規劃的參考價值。

#### · 劣勢

1. 研究數據受到地理限制主要來自受控物理實驗，若能加入更多台北實際街道的場域驗證，報告的實務應用性將更強。
2. 未討論高反射材料長期使用受汙損後，其反射率衰減對降溫效果的影響。

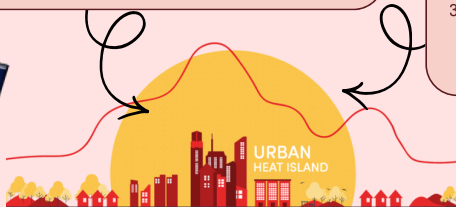
# LET YOU SEE HOW COOL OUR CITY CAN BE

## Introduction

- What is UHI: Urban infrastructure replaces nature, shifting solar energy from evaporation to direct air heating.
- Health: Elevated nocturnal temperatures impair thermoregulation and sleep quality, increasing heat-related morbidity.
- Thermal comfort: Built-up areas lacking green structure may exhibit temperatures up to 7°C above adjacent green spaces.

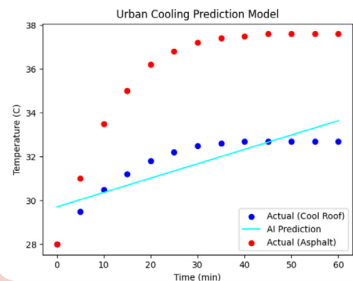
## method

1. Solar Simulation: Using xenon lamps to provide a constant 1000W/m<sup>2</sup> irradiance across various urban materials.
2. Thermal Monitoring: Deploying thermocouples and infrared sensors to capture real-time surface temperature and heat flux.
3. Data Acquisition: Channeling all sensor inputs into a microcontroller-based logger for high-fidelity analysis.



## Combine program

- Empirical Correlation: Linked thermal inertia with equilibrium temperatures via regression trajectories.
- Optimal Viability: Identified high-albedo materials as the premier urban solution.
- Thermal Interruption: Effectively disrupts the positive feedback loop of heat accumulation.
- Strategic Mitigation: A scalable approach to curbing heat islands and optimizing energy efficiency.



## Experimental results and applications

- Multidimensional Synthesis: Correlates regression trajectories with thermal inertia across diverse urban substrates, which could help us to find out the best material.
- SDG 11 Resilience: Provides a scalable framework to bolster climatological resilience in metropolitan habitats.
- Strategic Habitability: Offers a data-driven foundation for UHI mitigation under increasing thermal stress.

Comparative Thermal Index Projections for 10 Urban Materials

| Material Category | Material Type             | Predicted $T_{eq}$ | Mitigation Rank |
|-------------------|---------------------------|--------------------|-----------------|
| Roofing           | 1. White EPDM Membrane    | 31.8°C             | 1 (Best)        |
|                   | 2. Galvanized Steel Sheet | 35.2°C             | 6               |
|                   | 3. Terra Cotta Tile       | 34.9°C             | 5               |
| Pavement          | 4. Permeable Pavers       | 33.8°C             | 4               |
|                   | 5. Dark Granite Slab      | 37.2°C             | 9               |
|                   | 6. Light-Colored Gravel   | 33.5°C             | 3               |
| Façade            | 7. Glass Curtain Wall     | 32.2°C             | 2               |
|                   | 8. Red Sandstone          | 35.8°C             | 7               |
|                   | 9. Exposed Aggregate      | 36.5°C             | 8               |



## conclusion

asphalt, with low albedo and high thermal inertia, acts as a primary UHI catalyst by sustaining elevated temperatures. Conversely, High-Albedo Materials (HAMs), such as Cool Roofs, are the most thermodynamically viable alternatives. By reflecting incident solar energy, these surfaces disrupt the heat-accumulation feedback loop, offering a superior, scalable solution for enhancing urban resilience.

## " Pore-fect Carbon Choreographers "

李慧恩、古姍穎

## MOFs: A Nanoscale Solution to Global Warming



由左至右：李慧恩、古姍穎

### 個人特色、專長和興趣

#### 1. 李慧恩

沈溺影集電影的沙發馬鈴薯，同時在舞蹈教室度過青春。專於精準品味美食，熱愛嘗試新事物。在極致懶散與追求卓越間自由切換，我是慧恩，Why Not？

#### 2. 古姍穎

我是個樂觀單純、堅持負責、充滿好奇、樂於挑戰和學習的人，我喜歡跑步、跳舞、心理學、爬山、運動和旅遊。

### 團隊簡介與隊名由來

「碳」索未來，也要優雅轉圈！我們是 Pore-fect Carbon Choreographers。我們愛跳舞，也正在研究 MOF 的孔洞（Pore），湊在一起就是個有點冷的諧音。我們組沒什麼遠大的口號，就是擁有停不下來的好奇心，想到什麼就去試，Why Not？弄壞了或失敗了也沒關係，拍拍灰塵繼續就好。對我們來說，科學跟芭蕾一樣，都是在不斷嘗試中找尋那個 Pore-fect 的瞬間。



## 參賽原因與心得

我們的故事始於一份純粹的默契。一句邀約，「Pore-fect Carbon Choreographers」就此成軍。為了與時間競速，我們將假日化為高強度的實驗編舞。最難忘的是隊友在出發機場前最後一秒仍不肯停手，回國落地後更立刻回校集合，將時差拋在腦後無縫衝刺。面對簡報、影片與摘要等全新挑戰，我都是全新的一次體驗，是我們遭遇過最大的挑戰。但在無數次的失敗中，我們學會了拍掉灰塵、重新校準。對我們而言，這不只是一場比賽，更是將好奇心轉化為實踐力的過程。Why Not？

### 隊伍自評



#### ・優勢

對科學的熱情、台風穩健。

#### ・劣勢

時間緊迫、英文程度可再加強、臨場反應可再加強。



# MOFs: A NANOSCALE SOLUTION TO GLOBAL WARMING

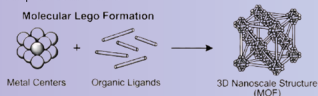
## RESEARCH MOTIVATION

- **The Global Challenge:** Escalating extreme weather and natural disasters driven by global warming.
- **Our Alignment:** Addressing these critical environmental issues through the UN Sustainable Development Goals (SDGs 7, 12, & 13).

## ABSTRACT

### What are MOFs?

- **Core Characteristic:** Porous solids acting as molecular-scale mazes to adsorb, store, and separate gas or liquid molecules.
- **Broad Applications:** Widely utilized in catalysis, drug delivery, air purification, and energy conversion.
- **Classification:** Categorized by pore size into microporous, mesoporous, and macroporous materials.



## RESEARCH AIMS

- Experiment 1: Determine the adsorption behavior of MOFs toward specific gas molecules by simulating the pores of customized MOFs.
- Experiment 2: Analyze the relationship between the adsorption capacity of MOFs for carbon dioxide and the surface area of their pores through simulation.

## METHODOLOGY

### DIY Simulation of MOF Capture

- Box acts as MOFs
- Super Glue acts as Van der Waals Forces in MOF Pores
- Gray sphere acts as carbon dioxide molecule
- Steel Ball acts as Other Molecules



- The velcro: Density vs. Sparseness

### Experiment 1

By simulating the pore structures of customized MOFs, we determine the adsorption behavior of MOFs toward specific gas molecules.

### Experiment 2

By simulating the pore surface area of MOFs, we analyzed the relationship between MOFs and their carbon dioxide adsorption capacity.

x10

Place 8 gray balls (carbon dioxide molecules) and 3 steel balls (other molecules) at the starting point.

Lift the partition so that the ball falls under the force of gravity.

Record the total number of gray balls and steel balls that stick to the Velcro and fall off.

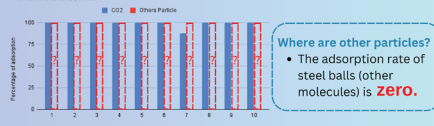
### Result

Calculate the percentage of gray balls that stick to the Velcro and the percentage of steel balls that fall.

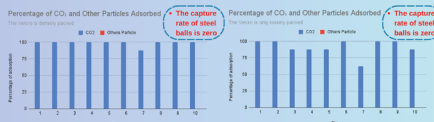
## RESULTS

**Experiment 1:** By simulating the pore structures of customized MOFs, determine the adsorption behavior of MOFs toward specific gas molecules. On average, 99% of the gray balls (CO<sub>2</sub>) are stuck to (adsorbed by) the velcro in the box, while 100% of the steel balls (other molecules) are not stuck (adsorbed).

Percentage of CO<sub>2</sub> and Other Particles Adsorbed  
The Velcro is densely packed



**Experiment 2:** Analyze the relationship between the surface area of MOFs pores and the adsorption capacity of MOFs for carbon dioxide.



When the velcro on the box is densely packed (increasing the pore surface area of the MOFs): 99% of the gray balls (CO<sub>2</sub>) are adsorbed, while 100% of the steel balls (other molecules) are not.

When the velcro on the box is sparsely attached (the pore surface area of the MOFs decreases): 93% of the gray balls (CO<sub>2</sub>) are adsorbed, while 100% of the steel balls (other molecules) are not.

## DISCUSSION

**Experiment 1:** Determine the adsorption behavior of MOFs toward specific gas molecules by simulating the pores of customized MOFs.

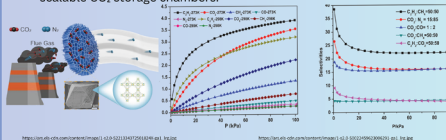
- **Van der Waals Forces:** Weak attractive forces trap molecules. CO<sub>2</sub> experiences significantly stronger attraction than other particles.
- **Precision Sieve Effect:** Pore sizes are customized to perfectly match target molecules, effectively trapping CO<sub>2</sub> inside.

**Experiment 2:** Analyze the relationship between the surface area of MOF pores and their carbon dioxide adsorption capacity through simulation.

- **Direct Correlation:** More pores generate a larger surface area.
- **Result:** Increased surface area provides stronger van der Waals forces and greater spatial capacity for CO<sub>2</sub> adsorption.

### Application: Industrial Carbon Reduction

- **Factory Chimneys:** MOF-based gas separation systems selectively capture CO<sub>2</sub>, allowing nitrogen to pass through.
- **Storage Sites:** Microscopic MOF pores serve as highly efficient and scalable CO<sub>2</sub> storage chambers.



## CONCLUSION

- **Highly Selective Adsorption:** Customized MOF pores effectively trap specific gas molecules (CO<sub>2</sub>) while ignoring others, proving their potential as precision molecular sieves.
- **Surface Area Drives Capacity:** CO<sub>2</sub> adsorption capacity directly correlates with pore surface area. Maximizing the internal surface area significantly increases the CO<sub>2</sub> capture rate.



## " Chord Assistant "

江芹宇、林雨蓁、游千恩

### Smart Chord Suggestions for Your Melodies



由左至右：陳思靜老師、林雨蓁、  
游千恩、江芹宇

### 個人特色、專長和興趣

#### 1. 江芹宇

喜歡音樂，學過鋼琴和中提琴、對唱歌和編曲有興趣，  
除此之外也喜歡上資訊課。

#### 2. 林雨蓁

我平常喜歡學習各種樂器，目前演奏過打擊樂、吉他、  
貝斯、鋼琴等，也喜歡邊彈邊唱歌。

#### 3. 游千恩

國中在教會司琴，因要反覆傳唱同一首歌曲，需幫詩歌  
的旋律重新配對和弦，從而開始研究樂理並產生興趣。

### 團隊簡介與隊名由來



我們的隊名就是作品的名稱——和弦助手，  
希望這個程式能成為大家的好幫手。

## 參賽原因與心得

在製作程式的期間，我們曾遇到一個瓶頸，初版的程式中無法辨別升降，因此可判斷出示配和弦的主旋律非常稀少。後續我們將所有含三顆音的和弦製作成檔案，且改變音符從 XML 檔案中提取出來的方式，成功將這個缺陷修復。而在準備比賽的期間，比較困難的則是要將音樂領域中的專有名詞翻為英文，很多詞其實有不只一種說法，且我們要讓不完全了解樂裡的人聽懂，為此花費了許多時間。

### 隊伍自評



#### · 優勢

三個人組成的團隊能收集更多的想法，準備時比較更可以察覺敘述是否清楚明確；全員平時皆有接觸音樂的經驗，皆了解基本樂理。

#### · 劣勢

研究尚未能分析所有類型的旋律，例如重音不在一三拍的旋律、含有小於十六分的其他音符。



## " 水水菜菜好朋友 " 周立珣、吳宜蓁、吳宥萱 **Eco-Friendly Optimization of an Aquaponics System**



由左至右：張程皓老師、吳宥萱、  
吳宜蓁、周立珣、陳芳誼老師

### 個人特色、專長和興趣

#### 1. 周立珣

我的個性外向開朗，享受站在台上與大家分享的感覺。我喜歡參與交流活動，也熱衷於挑戰自己、嘗試新的事物。

#### 2. 吳宜蓁

個性安靜內斂、沉穩木訥，但談到感興趣的科目會特別投入；高中後積極探索科學與科技領域並把握發表的機會。

#### 3. 吳宥萱

我是熱情且外向的人，並且熱愛挑戰自我，讓生活充滿不確定性和樂趣，不斷向外探索各種領域、創造不同可能。

### 團隊簡介與隊名由來

個性互補並彼此互相扶持走過挑戰與挫折的我們組成「水水菜菜好朋友」！！希望用簡單的隊名讓人們耳目一新，以疊字清晰傳達出實驗的元素「水水菜菜」，再以「好朋友」代表彼此在青春最難忘、共同為未來努力的深刻友情。



## 參賽原因與心得

發現比賽後，我們便迅速組隊，在龐雜課業中努力抽身兼顧競賽，調整各自腳步配合團體。準備過程也非一帆風順，我們不斷尋找合適的題目，討論實驗的可行性、創新性，否決許多來自組內的提議，探討主題對社會的幫助及可延伸性，尋找實驗器材也力求以現有資源為主。在一次次篩選、兩難中，我們才逐漸找到方向。

此外，討論與製作簡報途中，我們突發奇想，為曾兩度剪壞瀏海的組員親手操刀理髮，留下獨特的插曲。更與指導老師臨時在深夜開會，將原本較為生活化的語句調整為科學領域中較嚴謹的用詞，琢磨發音、檢視各種專有名詞及化學式的精確寫法。過程或許稍顯慌忙，這些回憶與磨合卻也使我們更有默契，也在跌跌撞撞中，悄悄的成長。

### 隊伍自評



#### · 優勢

團隊向心力十足，善用現有資源積極探索與嘗試；面對困難時，能凝聚團隊力量共同討論、尋求解方；表達能力清晰流暢，能有效傳遞核心概念。

#### · 劣勢

在既有成果的基礎上，對外延伸的廣度仍有成長空間；部分細節的討論與精修尚不夠深入，未來可在現有基礎上更精益求精，使作品臻於完善。

# Closing the Loop: Eco-Friendly Optimization of an Aquaponics System

Author: Audrey Wu, Claire Wu, Jean Chou Instructor: Eva Chen, Howard Chang

## Abstract

Aquaponics systems are prone to water quality instability, which can impair fish physiology and plant growth. In this study, we applied *Terminalia catappa* leaf water, enhanced filtration and aeration, and regulated of stocking density and feeding to stabilize the nitrogen cycle, reduced pH value from 7.6 to 7.2, maintained ammonia at ~0 mg/L, and improved overall system stability.

## Purpose

1. To lower the pH value to a suitable range.
2. To keep ammonia and nitrite concentrations close to 0 mg/L and 0 ppm, respectively.
3. To maintain nitrate within a range indicating an active yet non-toxic nitrogen cycle.

## Research Background

In many small-scale school and household aquaponics systems, water quality fluctuates greatly, harming fish and limiting plant growth. Our team therefore aims to explore simple, eco-friendly strategies for stabilizing water quality in small educational aquaponics systems, thereby promoting sustainability.

## Laboratory Equipment and Procedure



Fish Tank Settling Tank Brush Physical Filter Tank \*K1 Biofilter Tank

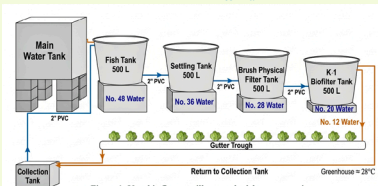


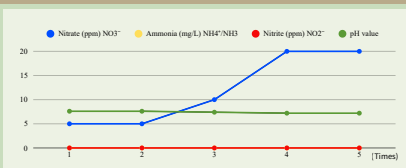
Figure 1: Use this figure to illustrate the laboratory equipment

\*The figure was created by the producer of the equipment and was translated into English by the team.

Our aquaponics experiment, incorporated four main components:

- **The fish tank:** where the fish live and produce waste that **serves as a nutrient source for the system**.
- **The settling tank:** Slows down the water flow, **enabling heavier dirt and particles to sink** to the bottom and be removed more easily.
- **The brush physical filter tank:** Uses brushes to **catch and remove small solid particles** that did not settle out before.
- **The K1 biofilter tank:** Contains floating K1 plastic media that provide a large surface area for nitrifying bacteria to grow, allowing them to **convert toxic ammonia into relatively safe nitrate** and **keep the water cleaner for fish and plants**.

## Data Analysis



- **A decrease in pH values was observed —**  
*Terminalia catappa* leaf water, which contributes to biological activity, was added.
- **Maintenance of ammonia and nitrite concentration —**  
The use of **filter media and strong aeration** enhances biological nitrification.
- **An increase in low nitrate concentrations was observed —**  
**Increase fish density and feeding rate** elevates the production of metabolic waste and uneaten feed.

## Results and Conclusion

| Item                                                      | Ideal Condition | Before & After                 | Method                               | Remark                            |
|-----------------------------------------------------------|-----------------|--------------------------------|--------------------------------------|-----------------------------------|
| pH value                                                  | 6.8–7.2         | Reduced from 7.6 to 7.2        | <i>Terminalia catappa</i> leaf water | More suitable for fish            |
| Ammonia (NH <sub>3</sub> / NH <sub>4</sub> <sup>+</sup> ) | 0 mg/L          | Maintained close to 0 mg/L     | Filter media, enhanced aeration      | Supports nitrifying bacteria      |
| Nitrite (NO <sub>2</sub> <sup>-</sup> )                   | 0 ppm           | Maintained close to 0 ppm      | Filter media, enhanced aeration      | Supports nitrifying bacteria      |
| Nitrate (NO <sub>3</sub> <sup>-</sup> )                   | 20–40 ppm       | Increased from 5 ppm to 20 ppm | Increased fish density, feeding rate | Confirms an active nitrogen cycle |

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- 2.) Salenave, R. (2016). Important water quality parameters in aquaponics systems. Las Cruces, NM, USA: College of Agricultural, Consumer and Environmental Sciences.
- 3.) Rachana, V. V., & Jinu, A. (2025). IoT-Enabled Automated Aquaponics System for Optimized Water Quality Monitoring and Control. International Journal of Environment and Climate Change, 15(10), 200-222.

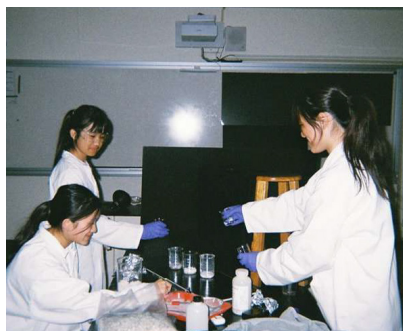




## " Three Little Mermaids "

梁右潔、林芷渝、羅婕恩

### **Scales That Tip the Oil Balance: Exploring the Adsorption Ability of Fish Scales on Diesel**



Three Little Mermaid 團體照

#### 個人特色、專長和興趣

1. 梁右潔

我的情緒轉換很快，能以樂觀的態度面對所有困難！

Smile and be happy.

2. 林芷渝

我非常喜歡聽音樂，因為我在聽音樂時，能遠離外界的紛紛擾擾並沈浸在自己的世界中。

3. 羅婕恩

我走路的時候會突然開始唱歌，因為我喜歡將我快樂的事情分享給周遭的人。

#### 團隊簡介與隊名由來

我們的隊名是 Three Little Mermaids。Three 不只代表了我們三位成員，更是呼應了我們實驗中的三種魚類和三種魚鱗型態；Little 訴說我們是如何從魚鱗微小的構造、我們小小的實驗室，為全球議題盡一份心力！最後，Mermaids 象徵我們希望與海洋共生的理念。



## 參賽原因與心得

我們三個是志同道合的同班同學，都非常喜歡科學實驗，加上我們平時就生活在雙語的環境中，時常接觸英文相關專題與報告。因此在認識這個比賽以後，我們二話不說就報名參賽。

我們選擇的題目不僅是出於我們對科學的熱愛，更是身為全球參與者，希望可以負擔共同解決問題的責任，提出環境污然的有效解決方法。

參賽歷程中，我們很享受製作一分鐘介紹短片的過程，甚至為了拍攝魚鱗不同狀態的畫面，在實驗室用「鋼琴的布」和實驗椅子搭了簡易的攝影棚，是有趣且難忘的經驗！



## 隊伍自評

### · 優勢

我們是一群對周遭事物有各種天馬星空想像的高中生，也常常在生活中發現有趣的問題，並樂在找尋答案的科學旅途中。即使在實驗過程中遇到瓶頸，我們也能以樂觀、相信彼此的態度找到問題所在，一起想辦法解決。另外，我們三個都是屬於喜歡向別人闡述自己想法的人，能透過簡報大方展現自己的研究成果。

### · 劣勢

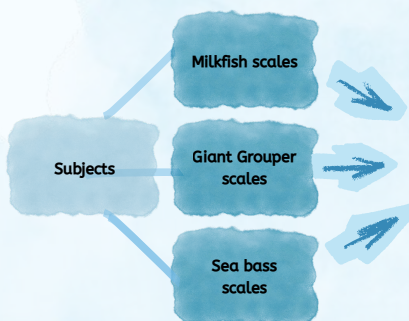
在準備過程中，我們時常過度拘泥於細節，導致拖延到作品完成的時間，在最後繳交期限前夕又慌又亂。

Jessily Liang | Lori Lin | Joanne Lo | Wei-Chen Li\* | Kimberly Chang\*

According to the research, 4000 tonnes of oil spilled in 2025. These spills, often caused by equipment failure or extraction accidents, pose a significant threat to marine ecosystems. To address this environmental challenge, there is an urgent need for eco-friendly and sustainable remediation methods. Our study explores the potential of upcycling fish scales—a common fishery waste in Taiwan—as a natural adsorbent to mitigate diesel oil pollution.

The primary objective of this study is to evaluate the diesel oil adsorption capacity of fish scales from three prevalent species in Taiwan—Milkfish, Giant Grouper, and Sea Bass. By comparing their performance across three physical forms (slice, floucculent, and powder), we aim to identify the most effective configuration for marine oil spill remediation. We hypothesize that the physical structure and surface area provided by these various forms will significantly influence adsorption efficiency, with the potential for specific species' scales to serve as a superior, eco-friendly alternative to synthetic materials.

### Investigating the ability of fish scales to adsorb diesel oil:



Each type of fish scale was processed into three forms:

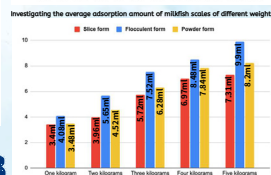
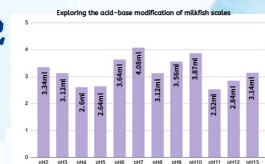
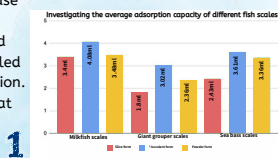
- slice
- flocculent
- powder



Since the **Milkfish flocculent form** performed the best, this sample was further selected for analysis across a broad **pH range of 2–13** to determine its chemical stability and efficiency.

- **Species Comparison [1]:** Milkfish scales showed the best oil adsorption, followed by sea bass and giant grouper scales.
- **Acid–Base Modification [2]:** Unmodified fish performed the best, as no consistent pattern was observed for acid–base modification.
- **Form and Mechanism [3]:** The flocculent form performed the best; besides having a larger surface area, the tangled flocs create gaps that trap oil through physical adsorption.
- **Weight Correlation [3]:** Experimental evidence shows that the adsorption amount increases as the weight of the milkfish scales increase.

The Milkfish scales in flocculent form showed the best performance in initial tests.



By developing a low-cost and natural filtration method, this study provides a sustainable solution to purify water with fish scales without using harmful chemical additives.

This research repurposes fishery waste into a powerful tool for oil spill remediation, which effectively protects marine biodiversity and restores damaged ocean ecosystems.

By using the scales' oil adsorption to treat spills, we transform waste into a tool for **water remediation**. More importantly, this approach reduces pollution while preventing a more serious ecological degradation by using **biodegradable materials** from the fish themselves. In conclusion, our research is a scientific explanation and a commitment toward global environmental sustainability.

Citation:  
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## " Micro Matters "

陳家琳、周佳儀、曾鈺捷

### The Invisible Shield : How Microplastics Retard the Photodegradation of Organic Pollutants



從左至右：曾鈺捷、陳家琳、周佳儀、  
徐翠徽老師

#### 個人特色、專長和興趣

1. 陳家琳

I believe every time I step onto the stage is a chance to grow. I enjoy challenges and I am not afraid of difficulties. I like to test my ideas through experiments and hands-on projects. Being willing to try new things is my unique trait.

2. 周佳儀

I'm a detail-oriented problem solver with an inquisitive attitude towards life. I specialize in environmental chemistry, data analysis, and bridging theoretical concepts with real-world issues. Outside the lab, I enjoy exploring nature, which continuously fuels my passion for protecting water resources through rigorous scientific research.

3. 曾鈺捷

I would describe myself as a hardworking, imaginative, and ambitious person with a strong interest in fashion design. While pursuing academic excellence, I actively participate in various fields such as science, sports and arts, as I value well-rounded personal development.

#### 團隊簡介與隊名由來

Our three team members each possess distinct characteristics. One is optimistic and proactive; another has strong English skills and a solid theoretical foundation; and the third is creative and adept at problem-solving. We believe these complementary qualities will allow us to learn from each other and achieve success.

Our team name, " Micro Matters," comes from the topic of our experiment. Besides representing the potentially significant impact of microplastics, it also reflects our spirit of not overlooking anyone's efforts and striving for excellence.

## 參賽原因與心得

As freshmen in high school, we were eager to try out all sorts of competitions, but didn't know where to start. That's when we learned about the competition and were deeply attracted to it not only because our teacher had mentioned three-minute presentations were popular in universities, but also because it gave us ample space to unleash our imagination and scientific abilities, allowing us to explore diverse topics.

Initially, we brainstormed various themes, ultimately deciding on ocean pollution. Since it's a common topic, we chose to focus on a less familiar aspect: how microplastics affect existing pollutants in the water.

With the help of the lab administrator and chemistry teacher, we gradually discussed, conducted experiments, and produced videos and presentations. Although the whole process took a considerable amount of time, it was enjoyable. Of course, we also encountered many difficulties, including moldy experimental materials and not knowing how to use the App, which were overcome by adding plastic wrap to the containers and by consulting the teacher.

Besides the obstacles in the experiment, there were unexpected problems while filming. While filming in the school's public area during lunch break, we accidentally bumped into a patrolling teacher! When he asked us to return to the classroom, we were all so relieved that we had just finished recording the last segment of the video.

So far, we've all gained something during this time and learned how to cooperate. We also look forward to improving our oral expression skills and pushing our limits in the next stage of the competition.

### 隊伍自評



#### · 優勢

1. We have a sound scientific theoretical foundation.
2. We have extensive experience in experiment design and data analysis.
3. Our individual strengths and personalities are different, which complement each other.

#### · 劣勢

1. Some of us lack confidence when giving a presentation.
2. In impromptu English conversations, some of us lack the ability to respond fluently.



# The Invisible Shield: How Microplastics Retard the Photodegradation of Organic Pollutants

Student : Cubie Chen  
Nelly Tseng  
Chloe Chou  
Teacher : Tracy Hsu

## Abstract&Motivation

Microplastics pollute oceans, enter food chains, and threaten global health. To investigate if they also inhibit pollutant degradation, we added PET microplastics to three liquid pollutants and measured lux daily in a custom dark box. Our results demonstrate that microplastics slow decomposition rates, revealing a compounding environmental hazard. This research directly supports SDG 6 and SDG 14.

## Questions

1. What are the characteristics of microplastics affecting pollutants ?
2. Do microplastics reduce the decomposition rate of pollutants?
3. How do we reduce the impact of microplastics on pollutants in water?

## Experimental Methods

1. Cut and abrade PET plastic bottles with 600-grit sandpaper, then suspend them in water to form a homogeneous microplastic suspension.
2. Prepare two solutions with the same concentration for each of the three pollutants.
- Experimental group: add microplastics
- Control group: no microplastics



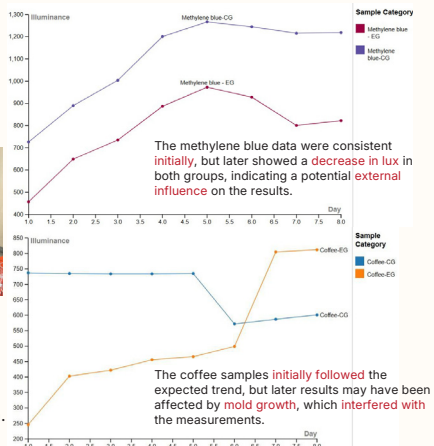
3. Place all solutions by the window to receive natural light, simulating natural conditions.
4. Construct a homemade dark box using a biscuit container. A smartphone with a full white screen is placed inside, with a small opening for the camera to measure the lux transmitted through the solution.



|                     | Colored Organic Pollutants                              | Natural Organic Matter                     | Surfactants                               |
|---------------------|---------------------------------------------------------|--------------------------------------------|-------------------------------------------|
| Simulation material | Left : Methylene blue                                   | Middle : Diluted coffee                    | Right : Dishwasher                        |
| Real-world sources  | Textile wastewater, printing effluents, industrial dyes | Humic substances, natural organic residues | Laundry effluents, dishwashing detergents |

5. Measure the lux and take the average after three measurements at a fixed time each day using the dark box setup, and convert it to absorbance using the Beer-Lambert law ( $A = \epsilon lc$ ).
6. Due to the dishwasher being transparent, we used a separate approach by dyeing the sample with methylene blue and measuring the absorbance of the red color channel in the organic layer after using dichloromethane to complete phase separation.

## Results



## Conclusion

The results suggest that microplastics may inhibit pollutant degradation by adsorbing pollutants, blocking light, and creating micro-environments that interfere with photodegradation processes.

In response to this outcome, we believe despite reducing microplastic production at the source, improving wastewater treatment technologies could be something worth developing.

1. Removal of microplastics
  - a. Coagulation-flocculation
  - b. Dissolved air flotation (DAF)
2. Degradation of pollutants
  - a. Advanced oxidation processes (AOPs)
  - b. Engineered microbial systems to break down polymers.

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# MEMO



Handwriting practice lines consisting of multiple horizontal dashed lines for text entry.



## A digital timer with a black frame and red LED display, mounted on a black tripod stand. The timer shows '03:00' in red digits. The stand has adjustable height and a three-legged base.



