Meet my Lab x JFS

Clean, Accessible and Secure Energy Supply

Wednesday, 20 March 2024

9:00-10:45am CET / 15:00 - 16:45 Jakarta

DR HANA CHEN WEI JUN

RESEARCH HEAD - SUSTAINABLE COMMUNITY DEVELOPMENT,
DEPARTMENT OF COMMUNITY MEDICINE INTERNATIONAL MEDICAL SCHOOL
MANAGEMENT AND SCIENCE UNIVERSITY, MALAYSIA

RESEARCH FOCUS:

ELECTROGENIC BACTERIAL BATTERY FOR SUSTAINABLE BIOENERGY GENERATION

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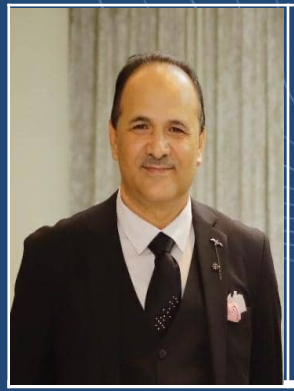
Our Team

Dr. Hana Chen Wei Jun
Public Health Expert

Research Head,
Sustainable Community Development,
International Medical School,
Management and Science University

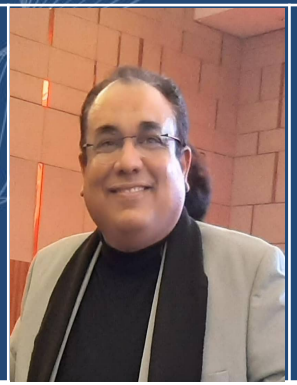
Role: Researcher



Prof. Dr. Abdullah Yahya Al-Mahdi
Microbiologist

Professor of Microbiologist,
International Medical School,
Management and Science University

Role: Supervisor



AP Dr. Mohd Faez Abobakr
Public Health Expert

Associate Professor of Public Health,
International Medical School,
Management and Science University

Role: Co-Supervisor

Dr. Nurul Akmal Jamaludin
Physiologist

Faculty Research Head,
International Medical School,
Management and Science University

Role: Co-Supervisor

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Institutional and Lab Background

Management and Science University (MSU)

- ✓ Leading university in Southeast Asia.
- ✓ Over 2,000 industry partners for industry-embedded research

QS Star: 5 Star
QS Southeast Asia: Top 30
QS Asia University Rankings: Top 200
QS Top 50 Universities Under 50: Top 100
THE Impact Ranking 2023: 401-601

Central Research Lab

- ✓ High performance liquid chromatography
- ✓ Gas chromatography
- ✓ Spectrophotometer
- ✓ Nanophotometer
- ✓ Fourier transform infrared
- ✓ Ultrasonic homogenizer
- ✓ ELISA microplate reader
- ✓ Electrophoresis equipment
- ✓ Lyophilization equipment

Microbiology Lab

- ✓ Real time polymerase chain reaction
- ✓ Laminar flow
- ✓ Microscope
- ✓ Incubator
- ✓ Centrifuge
- ✓ Water bath
- ✓ Oven
- ✓ Autoclave
- ✓ Storage fridge & refrigerator

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Project at Glance

What?

- The development of Electrogenic Bacterial Battery (EBB) for sustainable bioenergy generation

- Electrogenic Bacterial Battery (EBB):
is a bioelectrical device designed to optimize bacterial electricity production by using electroactive bacteria that can transfer electrons to external electrodes.

Why?

- Existing gap of fossil fuel sources:
  unsustainable, climate change, environmental degradation.
- Existing gap of Microbial Fuel Cell (MFC):
  ↓ voltage, ↑ cost, bacterial viability challenges

How?

- Isolation and identification of bacteria
- Assembly of a new EBB device

When?

- Year 1: Isolation and screening of the bacteria; EBB design
- Year 2: Identification of specific bacteria strains; EBB production

Who?

- Team for the Medical Faculty and Engineering Faculty

Where?

- Lab, Management and Science University

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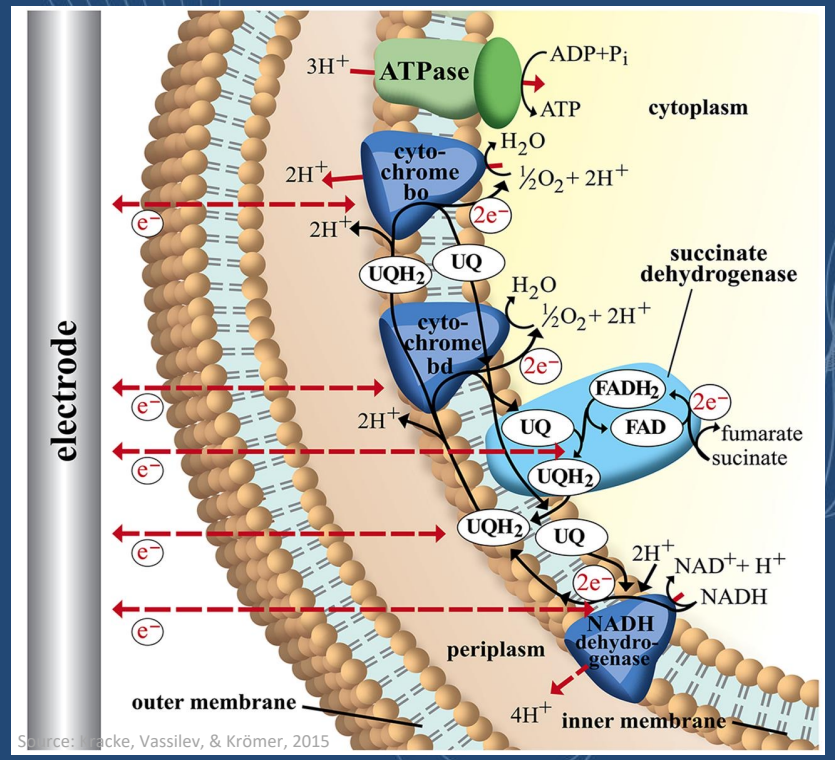
Principle of Electrogenic Bacterial Battery (EBB):

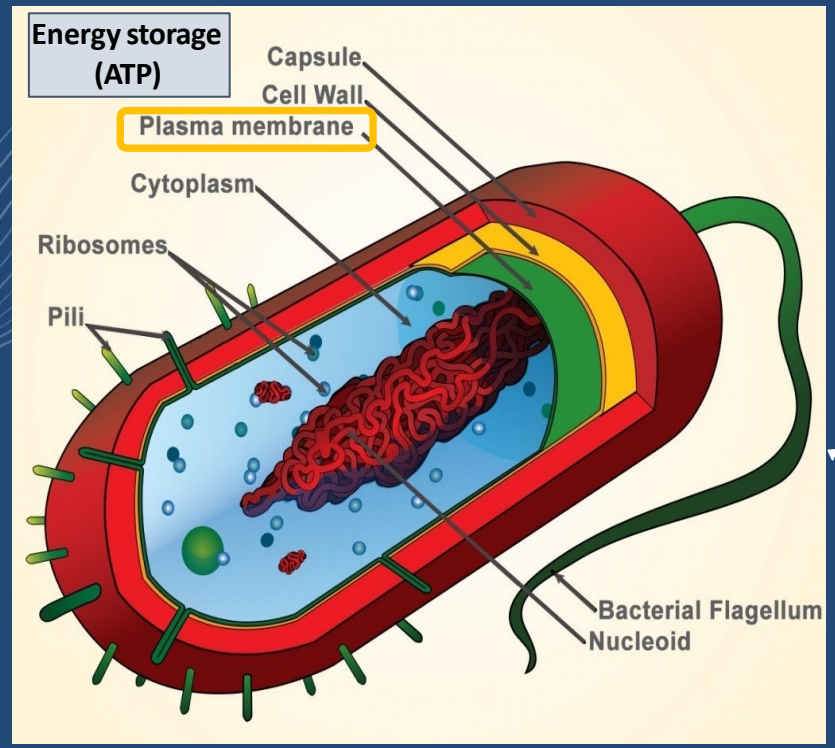
The EBB utilizes electroactive bacteria capable of transferring electrons from the Electron Transport Chain (ETC) to external electrodes, allowing for electricity generation

Electron Transport Chain

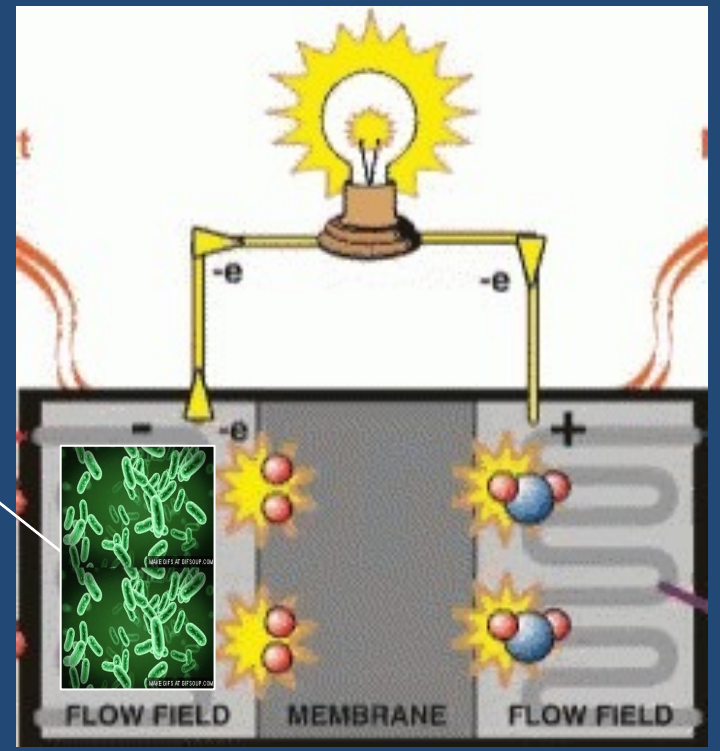


Source: Lracke, Vassilev, & Krömer, 2015

Bacterial Structure



Bacterial Battery



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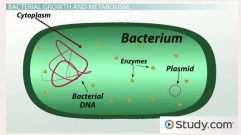
Why EBB?

Microbial Fuel Cell (MFC)

- ↓ voltage
- ↑ cost
- ↑ viability issues

Complex waste



Hydrolysis

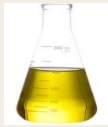
Energy

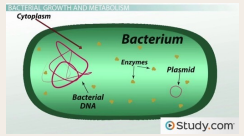
Mix Products + Gas CO2 + HCO3 (e-)

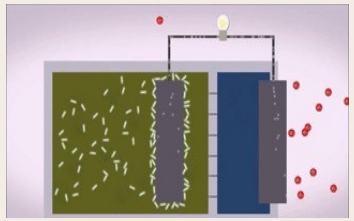
Electrogenic Bacterial Battery (EBB)

- ↑ voltage
- ↓ cost
- ↓ viability issues

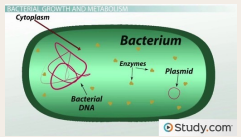
Growth medium







Growth



Oxidation

Energy

Simple Sugar + H- (e-)

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Novelty and Research Gap

Bioelectricity Generation By Electrogenic Bacterial Battery

The development of a novel bioenergy device by using bacterial genera that are part of the human microbiota to generate electricity for the first time.

- ✓ eco-friendly, renewable and sustainable
- ✓ diversity
- ✓ accessible
- ✓ easy handling
- ✓ smaller size but higher voltage
- ✓ lower cost
- ✓ viability can be controlled
- ✓ durability can be controlled

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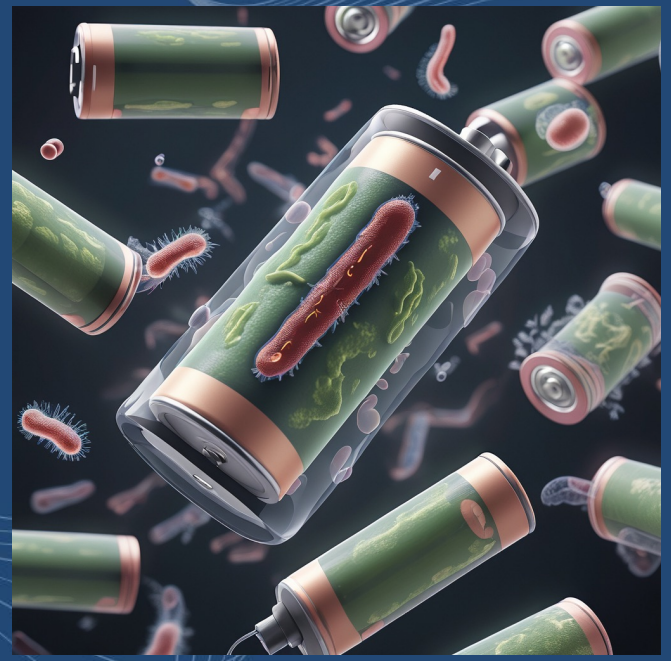
Objectives

To generate electricity from bacterial genera that are part of the human microbiota as a new sustainable bioenergy source



- ✓ To isolate and identify bacteria with the highest electricity generation
- ✓ To optimize different parameters for bioelectricity generation
- ✓ To enhance the structure and design of the EBB for higher voltage
- ✓ To develop a novel bioenergy device by using bacterial genera that are part of the human microbiota

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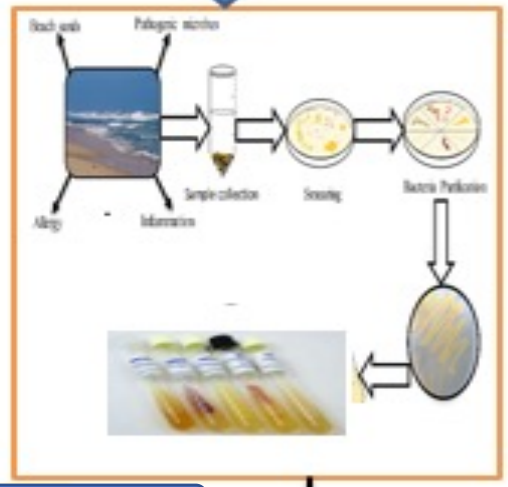
Conceptual Framework

Development of a sample EBB device

Isolation and purification of bacteria

1



Assembly of a new EBB device

2

Measure voltages with different parameters

Identification of bacteria

3

Development of EBB

Glass model of EBB

Final EBB model

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Gantt Chart

Task	2024												2025											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Proposal writing																								
Proposal submission to RMC																								
Approval by RMC																								
Assembly and development of the EBB																								
Review paper publication																								
Samples collection																								
Electricity generation																								
Bacterial Identification																								
Data analysis																								
Report writing and data presentation																								
Final Research project presentation																								
Second paper Publication																								
Final report submission																								

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Research Budget (Malaysian Ringgit / RM)

Budget Type	Details	Year 1	Year 2	Grand Total
Travelling and Transportation	1) Sampling and cultures 2) Travelling allowances	15,000	10,000	**25,000**
Research Materials and Supplies	1) Electrogenic bacterial battery 2) Isolation of the bacteria 3) Identification of the bacteria 4) Voltage measurement 5) Storage of the bacteria	150,000 20,000	 70,000 20,000 20,000	**280,000**
Maintenance and Minor Repair Services	Electrogenic bacterial battery	10,000	10,000	**20,000**
Accessories and Equipment	1) Lab autoclave 2) Laminar flow 3) Incubators 4) Water bath 5) Voltage meter 6) pH meter 7) Glassware	30,000	10,000	**40,000**
Statistical analysis	1) Expert consultation 2) SPSS software	10,000	15,000	**25,000**
Publication & conference	1) Review paper 2) Original Article 3) Conferences	20,000	 20,000 15,000	**55,000**
	Total	255,000	190,000	**445,000 (RM)**

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Possible Joint Research Project
Integrated Approach to Enhance Bioelectricity Generation in EBB

Experts Needed and Potential Roles:

- ✓ Microbiologist, physiologist:
  Characterize electrogenic bacteria, physiological analyses
- ✓ Genetic engineer:
  Enhance bacterial electron transfer pathways and metabolic activities
- ✓ Electrochemical engineer:
  Electrochemical analyses, electrode optimization, electron mediation system
- ✓ Bioprocess engineer, materials science engineer:
  Design and optimization of EBB and its components

Future scope:

- ✓ Industrial-scale EBB design
- ✓ Performance, stability, and durability evaluation
- ✓ Viability evaluation
- ✓ Techno-economic analyses

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Warm Welcome to Our Lab

Thank you

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