Project ID	**: NSF-SCH-2025-539**
Project Title	**: MicroAlgae Bioreactors for Carbon Sequestration**
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Introduction

Microalgae are tiny plants that use sunlight to grow and absorb carbon dioxide (CO_2) from the air. They can be grown in bottles or "bioreactors" with water, nutrients, and light. By comparing different setups, we can see how well they remove CO_2 and produce biomass.

Aim

To test how aeration (air bubbling) and light conditions affect microalgae growth and CO_2 sequestration.

Hypothesis

Aerated bottles will grow more algae and absorb more CO_2 than non-aerated bottles. Sunlight or lamp-exposed bottles will show better growth than shaded bottles.

Materials Required

Clear bottles/jars (4–6)

Aquarium air pump + tubing + air stones

Desk lamp / LED bulb or sunlight

Pond water with algae (or spirulina powder)

Fertilizer (a pinch of NPK or urea)

Clean water (filtered/RO/rainwater)

Labels, notebook, marker pens

(Optional) pH strips, coffee filter + kitchen scale

Procedure

1. Prepare nutrient water (1 L water + small pinch of fertilizer).
2. Fill bottles with equal amounts of nutrient water.
3. Add equal algae source to all bottles.
4. Label bottles: Aerated (Lamp), Aerated (Sun), Static (Lamp), Static (Sun), Control (Shade).
5. Set up air pump for aerated bottles; leave others still.
6. Provide light: lamp for 12–16 h/day or natural sunlight.
7. Observe daily: record color, pH (if available), and take photos.
8. After 10–14 days, compare final color, pH change, and (optional) dried biomass.

Variables

Independent: Aeration, Light condition

Dependent: Algal growth (color, biomass), pH change

Controlled: Water volume, nutrient level, initial algae amount, duration

Graph Templates

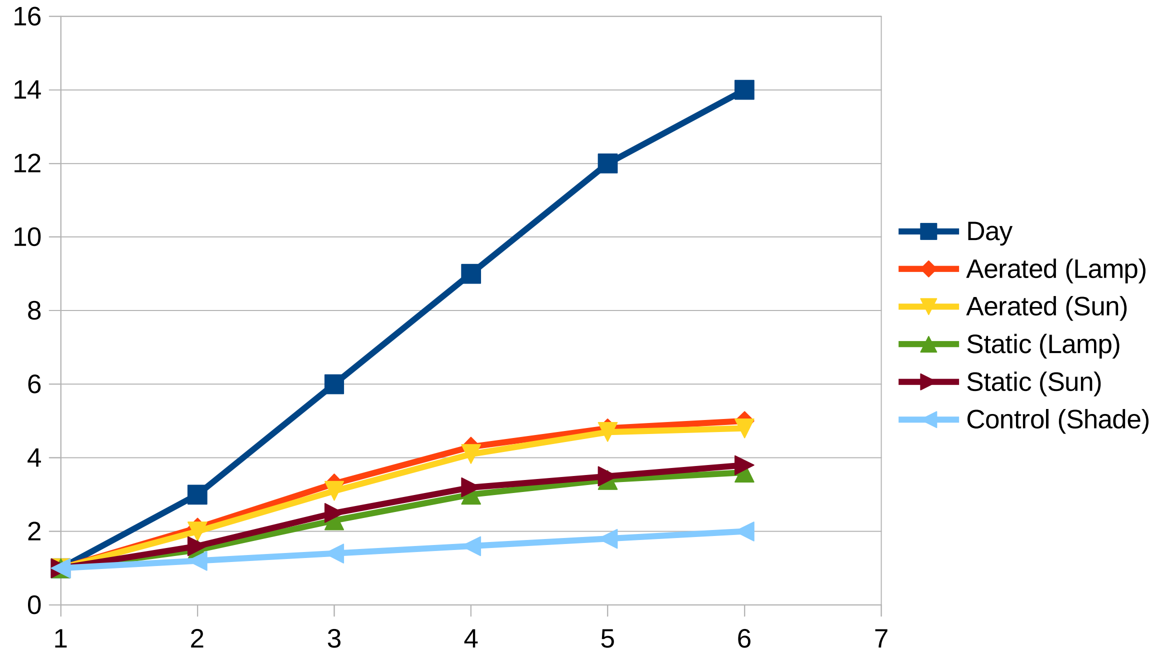
1. Line graph — Growth (color scale 1–5) vs Time (days)

Graph 1: Growth vs Time (Line Graph)

X-axis: Days (1–14)

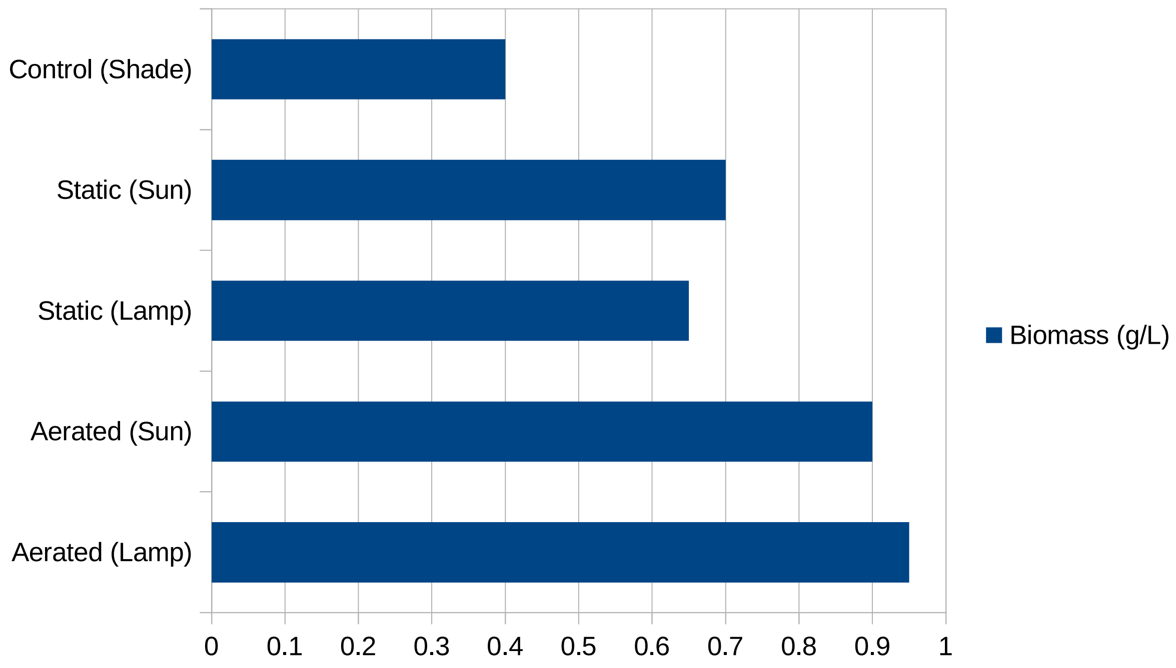
Y-axis: Color Intensity (1–5)

Day	Aerated (Lamp)	Aerated (Sun)	Static (Lamp)	Static (Sun)	Control (Shade)
1	1.0	1.0	1.0	1.0	1.0
4	2.2	2.0	1.6	1.8	1.3
7	3.6	3.4	2.5	2.7	1.5
10	4.4	4.2	3.2	3.3	1.7
14	5.0	4.8	3.6	3.8	2.0



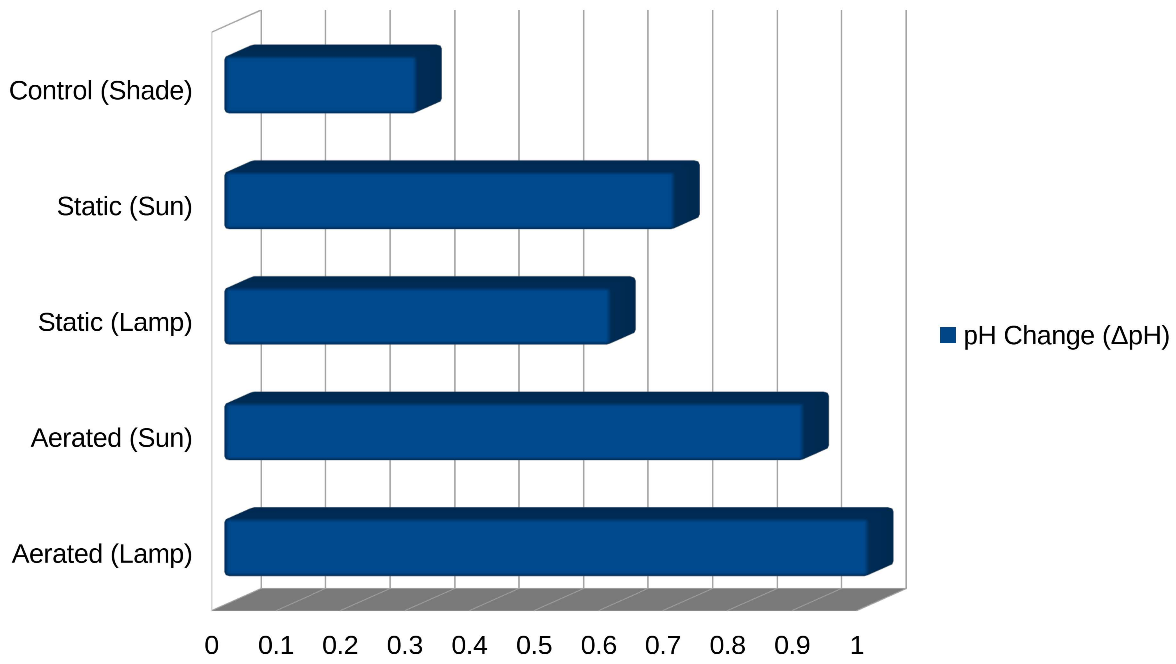
2. Bar graph — Final biomass (or turbidity) vs Bottle type

Bottle Type	Biomass (g/L)
Aerated (Lamp)	0.95
Aerated (Sun)	0.90
Static (Lamp)	0.65
Static (Sun)	0.70
Control (Shade)	0.40



3. Bar graph — pH change vs Bottle type

Bottle Type	ΔpH
Aerated (Lamp)	1.0
Aerated (Sun)	0.9
Static (Lamp)	0.6
Static (Sun)	0.7
Control (Shade)	0.3



RESULT

After 14 days of observation, the aerated and light-exposed bottles produced visibly denser green color, indicating higher algal growth.

pH readings increased slightly in these bottles, confirming CO_2 uptake during photosynthesis.

Bottle Type	**Condition**	**Final Color (1–5)**	**Biomass (g/L)**	**pH Change (ΔpH)**	**Observation**
Aerated (Lamp)	Air + Lamp Light	5.0	0.95	+1.0	Darkest green; highest growth
Aerated (Sun)	Air + Sunlight	4.8	0.90	+0.9	High growth and CO_2 absorption
Static (Lamp)	Still + Lamp	3.6	0.65	+0.6	Moderate growth
Static (Sun)	Still + Sunlight	3.8	0.70	+0.7	Slightly higher than static-lamp
Control (Shade)	No Air + Low Light	2.0	0.40	+0.3	Minimal growth; pale color

Observation Summary

- Aerated bottles developed a deeper green color faster, showing stronger photosynthetic activity.
- Sunlight and lamp exposure both promoted growth, while shaded samples stayed almost colorless.
- Increase in pH demonstrated active CO_2 consumption and conversion into biomass.

☑ CONCLUSION

The experiment supports the hypothesis that **aeration and light significantly enhance microalgal growth and carbon sequestration**.

Bottles supplied with both air bubbling and light achieved the **highest biomass yield and pH rise**, proving that **CO_2 absorption by microalgae increases under well-aerated, illuminated conditions**.

This indicates that simple microalgae bioreactors can be effective, low-cost tools for reducing atmospheric CO_2 while generating valuable algal biomass.

🚀 FUTURE ENHANCEMENT

1. **Use Sensors:** Integrate CO_2 and oxygen sensors to record exact gas exchange rates.
2. **Species Comparison:** Test different microalgae such as *Chlorella*, *Spirulina*, or *Scenedesmus*.
3. **Nutrient Optimization:** Examine how varying fertilizer concentration or using wastewater affects growth.
4. **Photobioreactor Design:** Build transparent acrylic or PVC tube reactors with LED control.
5. **Biomass Utilization:** Analyze harvested algae for protein, lipid, or pigment extraction for biofuel or food use.
6. **Automation:** Employ Arduino or IoT sensors for real-time monitoring of pH, temperature, and light intensity.

📚 BIBLIOGRAPHY

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