



DANCER IN WATER - MICROALGAE

Jockey Club STEAM Education Resources Sharing Scheme

Student Workbook

Name: _____

Class: _____

School: _____

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INTRODUCTION OF THE MODULE

BACKGROUND

Water covers around 70% of the earth's surface. Aquatic environments, including rivers, lakes, swamps, marshes, mangroves, estuaries, and the oceans, are habitats for numerous microalgae. Microalgae consists of a greatly diverse forms of microorganisms that are able to carry out photosynthesis. They contribute to approximately half of the oxygen production on earth.

With the rapid urbanization and industrialization in cities near water bodies, water pollution has become a severe environmental problem. The outbreaks of harmful algal blooms (HABs), caused by the rapid proliferation of microalgae, are the consequences of the worsening water pollution problem. The occurrence of HABs poses threats to the public health, seafood safety, water quality, and economic development.

On the other hand, the scientific and industrial communities have been exploiting microalgae for their beneficial uses to the human society. For instance, the synthesis of bio-fuel using microalgae, the treatment of wastewater with microalgae, and the production of cosmetic products and food supplements from microalgae. It is high time that students learn more about microalgae, the related experimental skills, and the beneficial uses of them.

There are 3 units in the module. Unit 1 "Getting to know microalgae" introduces the basic knowledge of microalgae. Unit 2 "Cultivation microalgae" provides knowledge and hands-on experience to students to acquire the laboratory techniques related to the isolation, cultivation, and enumeration of microalgae. Unit 3 "The dancing microalgae in the spotlights" requires students to design and conduct experiments to explore some biological concepts concerning microalgae.

Through this module, you can enhance their knowledge in microalgae, get updated on the modern applications of microalgae to the human society, and perfect their laboratory skills in general microbiology.

LEARNING OUTCOMES

Upon the completion of the module, you should be able to:

- Isolate microalgae in environmental water samples
- Select and use appropriate skills in cultivating single strain of microalgae
- Conduct microalgal counting by using microscope
- Quantify the population growth rate of microalgae
- Design and conduct an experiment to demonstrate the phototaxis of microalgae

MODULE STRUCTURE

Units	
1	Getting to know microalgae
2	Cultivation of microalgae
3	The dancing microalgae in the spotlights

This module is designed to progressively increase the engagement and hands-on practise of you as to develop a deep understanding of the academic concepts, to familiarize with the technological tools, and to master the skills in an investigative study.

Unit 1 will help arouse your interest by introducing the background information of microalgae and how microalgae are related to our daily lives. You will get to know about the basic taxonomy, growth phases, beneficial applications and the environmental problems associated with microalgae.

Followed by Unit 2, you will deepen your knowledge in microalgae by learning different technological tools for the isolation, cultivation, and enumeration of microalgae. More importantly, you will have the opportunities to apply these tools to prepare you own microalgae cultures and to estimate the growth condition of microalgae.

Unit 3 will require you to apply all the acquired knowledge and skills to design and conduct an investigative study on the phototaxis of microalgae. You will have to choose the appropriate equipment and materials to set up and conduct their own experiment. You will also need to take measurement and make records of the results, analyse the data, and present the findings. Each group will have to conduct a 10 minutes oral presentation to deliver your findings.

LABORATORY SAFETY

For safety reasons, you must read the following rules and regulations prior to entering the laboratory and follow them strictly:

1. No eating or drinking in the laboratory.
2. Always wear long trousers or dresses and shoes with full coverage of toes and feet. No shorts or sandals are allowed. Tie up your hair if it is too long.
3. Wear basic personal protective equipment (PPE) including a lab coat, and latex or nitrile gloves before handling any chemical or biological samples. Wear additional PPE such as goggles as instructed by laboratory staff.
4. Do not touch any of your personal belongings, such as worksheets, stationaries or electronic devices when wearing gloves.
5. Wash your hands thoroughly after taking off your gloves or before leaving the laboratory.
6. Keep the lab bench clean and tidy. No personal belongings should be placed on the bench.
7. Dispose of all solid waste in the designated container.
8. Treat all liquid biological wastes with diluted bleach before disposal.
9. Discard syringe, sharp glasses, or broken glassware in sharp boxes.
10. Do not leave a Bunsen burner flame unattended.
11. Locate the Emergency Exits, evacuation path, and fire extinguishing devices.
12. Consult laboratory staff when in doubt.
13. Notify laboratory staff **IMMEDIATELY** in case of accidents or emergency.

Handwashing is one of the most important and effective ways to prevent possible contact with infectious diseases. Students are required to follow the handwashing procedures recommended by the Centre for Health Protection, Department of Health, HKSAR, as shown below:

1. Wet hands under running water.
2. Apply liquid soap and rub hands together to make a soapy lather.
3. Away from the running water, rub the palms, back of hands, between fingers, back of fingers, thumbs, fingertips and wrists. Do this for at least **20 seconds**.
4. Rinse hands thoroughly under running water.

5. Dry hands thoroughly with a clean cotton towel, a paper towel, or a hand dryer. Dispose of paper towel properly.
6. The cleaned hands should not touch the water tap directly again.



Source: Centre for Health Protection, Department of Health, HKSAR Government (2020). *Add soap Rub hands for 20 seconds: Step for hand washing.*

UNIT 1 GETTING TO KNOW MICROALGAE

Microalgae are photosynthetic microorganisms that exist in almost all types of aquatic habitats on earth. They contribute substantially to the global primary production and generate oxygen that is essential to most living things. They are also important food sources of organisms in the food chain.

In Unit 1, through lecturing and active engagement, you will be introduced to the basic biology and classification of microalgae, the wide range of uses of microalgae, and the relationship between microalgae and water quality, seafood safety, global warming and renewable energy.

OBJECTIVE

Upon the completion of Unit 1, you should be able to:

- Understand the fundamental knowledge of microalgae
- Recognize the wide range of beneficial applications of microalgae
- Outline the various relationships between microalgae and water quality, seafood safety, global warming and renewable energy.

WHAT ARE MICROALGAE?

Microalgae are incredibly diverse groups of photosynthetic eukaryotic and prokaryotic organisms. They possess the following characteristics.

- Found in soil, marine and freshwater environments
- Contain chlorophyll and other photosynthetic pigments. Can be in different colours.
- Contribute approximately 50% of oxygen production globally.
- Constitute the foundation of food web as the primary producers (Figure 1.1).

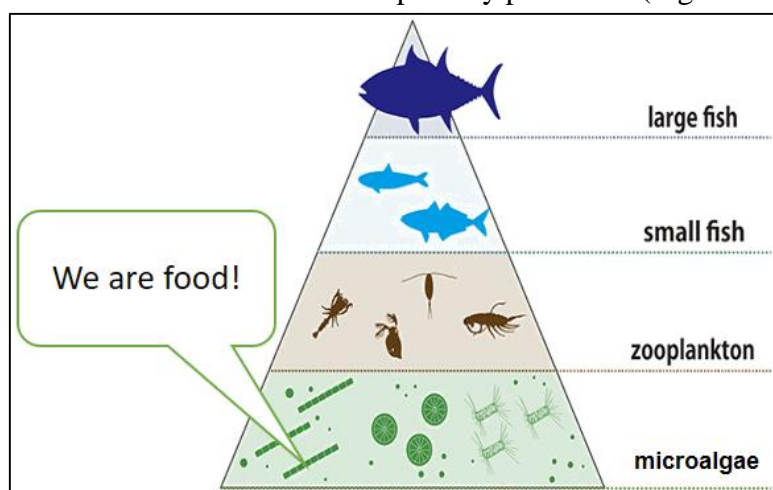


Figure 1.1 Microalgae as the primary producers in the aquatic food web.

- Major groups of microalgae include diatoms and dinoflagellates.
 - Diatoms (Figure 1.2)

- Cell body covered by silicate frustules.
- Can be further divided into centric and pennate diatoms
- Dinoflagellates (Figure 1.3)
 - Can be further divided into thecate and naked (athecate) dinoflagellates
 - Thecate dinoflagellates' cell bodies are covered by cellulose plates
 - Naked dinoflagellates' cell bodies are not covered by cellulose plates

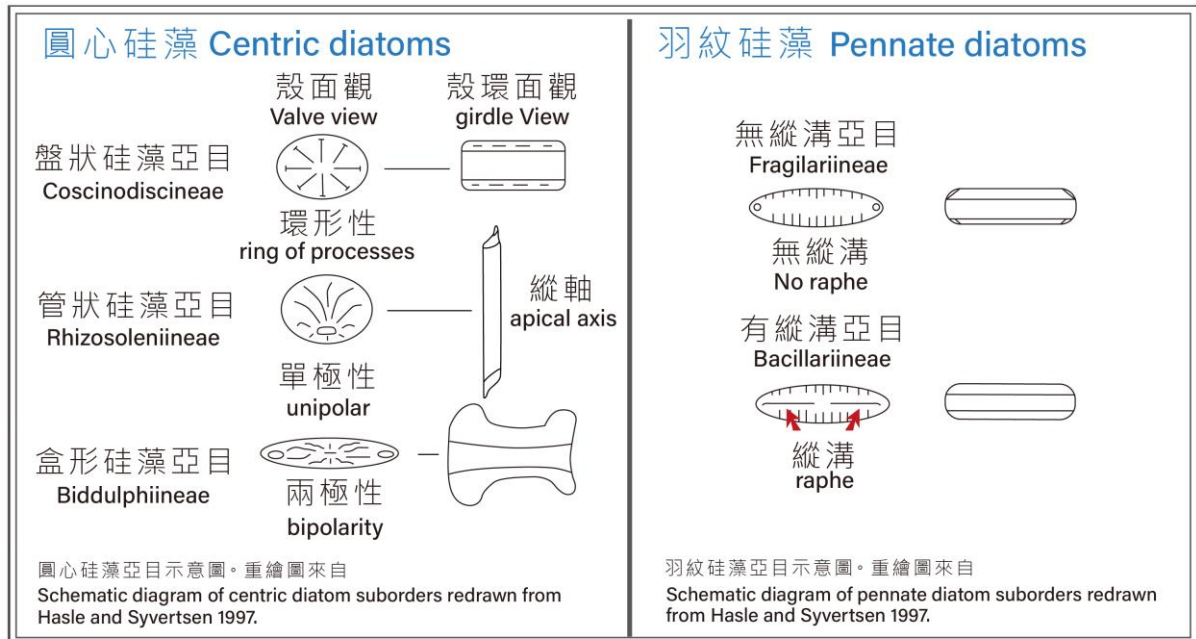
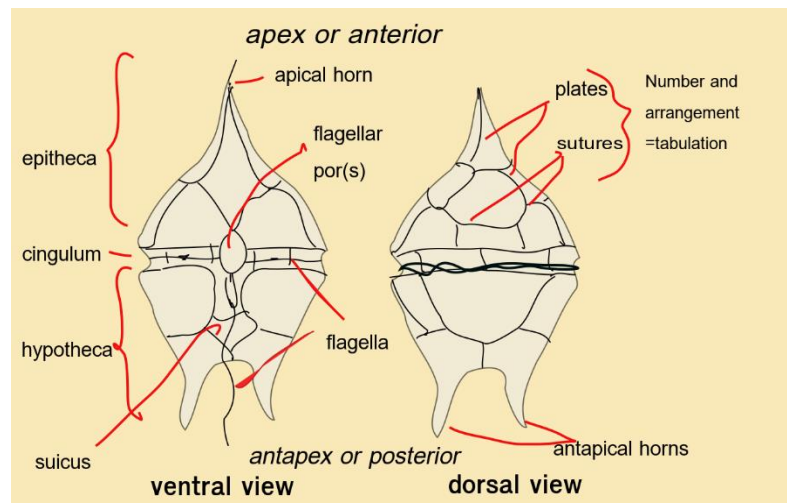


Figure 1.2 The typical cell morphology of diatoms. Source: Law 2018. *Red Tide Species in Hong Kong*.



Source: [Wikipedia](#) licensed under [CC BY 2.5](#)

Figure 1.3 The typical cell morphology of dinoflagellates.

- Cell morphologies of diatoms and dinoflagellate vary greatly. This feature could be used to effectively identify different microalgae species.
- Apart from being solitary (one single cell), microalgae will sometimes form colonies that consist of more than one cells of the same species.

- The growth of microalgae is affected by factors including light, temperature, nutrients, salinity, pH, water mixing and so on.
- Similar to other microorganisms, the growth phases of microalgae consist of the induction phase, the exponential phase, the phase of declining relative growth, the stationary phase, and the death phase (Figure 1.4).

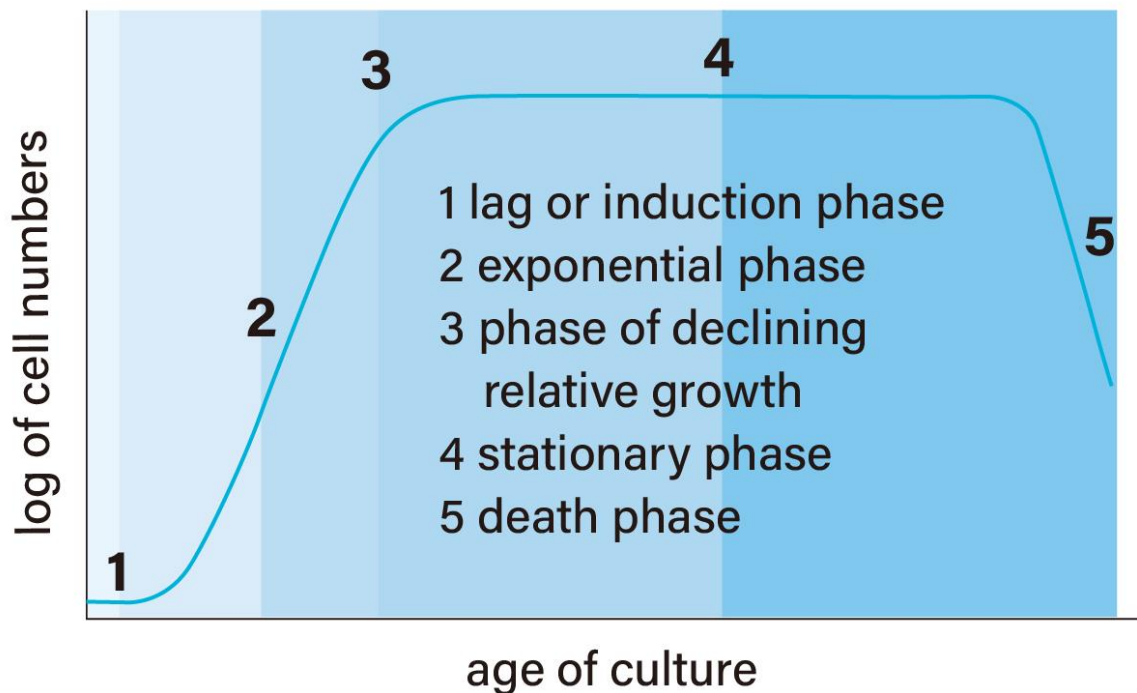


Figure 1.4 The different growth phases of microalgae: 1. The lag phase or the induction phase; 2. The exponential phase; 3. The phase of declining relative growth; 4. The stationary phase; 5. The death phase.

Activity 1.1

Microalgae can be of different shapes. Put down the correct words describing the shapes of the microalgal species to the corresponding blanks below.

Irregular Square Star-shaped Triangular Disc-shaped Round

Fork-shaped Pear-shaped Spindle-shaped Rectangular Rod-shaped



Disc-shaped



Star-shaped



Fork-shaped



Square



Triangular



Spindle-shaped



Rod-shaped



Rectangular



Round



Pear-shaped



Irregular

BENEFICIAL

APPLICATIONS OF MICROALGAE

Despite the small size of microalgae, scientists have been discovering and exploiting many beneficial applications of microalgae to the human society.

CARBON SINK

Approximately 50% of the photosynthesis process taking place on Earth is performed by algae. Microalgae fix and store CO₂ through photosynthesis (Figure 1.5). In addition to fixing C, microalgae also synthesize different biomolecules, such as proteins, carbohydrates and lipids.

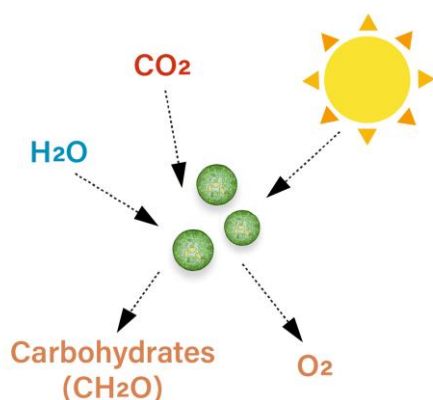
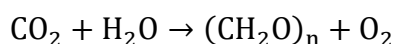


Figure 1.5 Microalgae make use of light energy, carbon dioxide, and water to produce carbohydrates and oxygen through photosynthesis.

WASTEWATER TREATMENT

An emerging biotechnology is the application of microalgae for wastewater treatment (Figure 1.6). This method is environmentally friendly as it uses microalgae to absorb organic nutrients and convert them into useful biomass. Combined with other microorganisms (e.g., bacteria),

the organic matters, nitrogen and phosphorus nutrients, and certain hazardous contaminants and pathogens in the wastewater can be removed by microalgae.

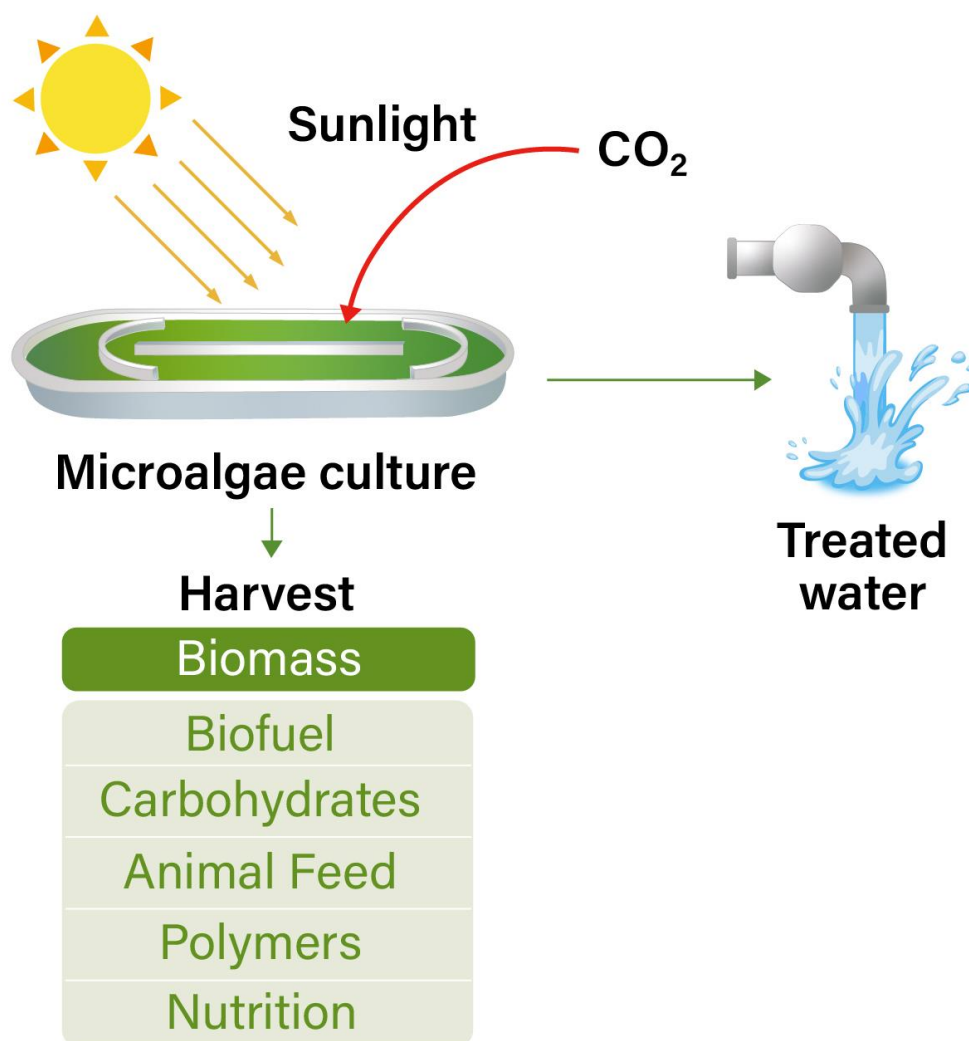


Figure 1.6 Microalgae being use in wastewater treatment.

BIOFUEL

The capabilities of accumulating higher amounts of lipid, growing faster in biomass, and achieving greater photosynthetic yield of microalgae have made them more favourable than their land plant counterparts for the production of biofuel. Microalgae-derived biomass can supply a wide range of biofuels such as biodiesel (biodiesel production the transesterification of lipids), bioethanol (bioethanol production through fermentation of the algal biomass), and biomethane (biomethane production through anaerobic digestion).

FOOD SUPPLEMENTS

Microalgae contain high protein and nutritional contents that allow them to have great potentials for fulfilling the dietary requirement of growing populations. Apart from protein and nutrient contents, microalgae are found to contain biologically active compounds with proven pharmacological activities including anticancer, antioxidant and anti-inflammatory functions.

These properties make microalgae the valuable substances with industrial applications and health benefits.

NANOMATERIALS

Advancement in biotechnology has enabled the production of nanomaterials using microalgae (Figure 1.7). An important microalgal product has been the various metal nanoparticles. Microalgae-mediated green synthesis of metal and metal oxide nanoparticles is thought to be environmentally friendly, non-toxic and low-cost. The nanoparticles are of various catalytic and biological activities such as antibacterial, antiviral, anticancer and so on.

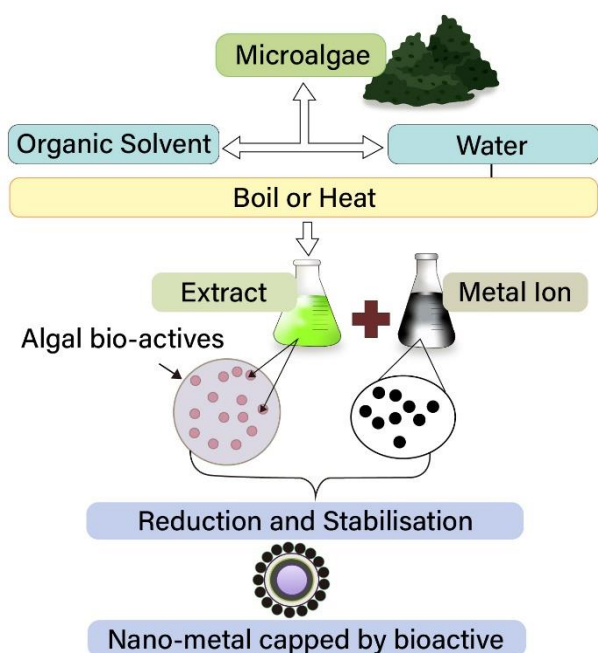


Figure 1.7 The general scheme for the biosynthesis of nanoparticles using microalgal biomass. Source: Jacob et al (2021).

BIO-INDICATOR OF WATER QUALITY

Similar to other organisms, different groups of microalgae have various susceptibilities to environmental pollutions. These adverse water conditions include low dissolved oxygen, fluctuating pH and salinity, high water temperature, high inorganic nutrient concentrations, high contaminant amounts, and so on. The presence of solely pollution-tolerant microalgae species in water bodies indicates poor water qualities.

MICROALGAE & EUTROPHICATION

Eutrophication can be referred as the inorganic nutrient enrichment of natural waters, leading to an increased production of microalgae and macrophytes. The rapid and excessive growth of microalgae in eutrophic waters is usually followed by the generation of a large biomass of dead microalgae. The decomposition of the dead microalgae by bacteria will deplete the dissolved oxygen in the water and lead to the suffocation of other aquatic lives. Additionally, some microalgal species produce algal toxins that are toxic to aquatic organisms. The large biomass of microalgae will therefore produce huge amount of algal toxins that will devastate the aquatic ecosystems.

Activity 1.2

Eutrophication of water bodies could produce adverse effects to the aquatic ecosystems. Arrange the letter of the following sentences to describe the potential sequence of the eutrophication and its consequences.

- A. The large biomass of microalgae eventually dies due to the depletion of nutrients in the water.*
- B. Microalgae grow rapidly due to the present of nutrients and form algal blooms.*
- C. Fish, bivalves, other invertebrates and aquatic lives suffocate due to the lack of oxygen.*
- D. Surface runoff or leaching containing high amounts of inorganic nutrients (nitrogen and phosphorus) gets into the water.*
- E. The decomposition of the large biomass of dead microalgae by bacteria consumes dissolved oxygen in the water.*

The potential sequence of eutrophication and its consequences:

___ **D** ___ → ___ **B** ___ → ___ **A** ___ → ___ **E** ___ → ___ **C** ___

UNIT 2 CULTIVATION OF MICROALGAE

Practical laboratory skills in microalgae are as important as in-depth broad-width knowledge in microalgae. To obtain cultures of a single species or strain of microalgae, there are different cell isolation methods available. The cultivation skills of microalgae are essential in maintaining microalgae cultures that could be used in experiment to explore their biology and beneficial applications. The cell counting and application of statistical data provide an effective way to estimate the growth condition of microalgae cultures.

In Unit 2, you will work as a group and be provided with hands-on experience and guidance in using laboratory techniques to isolate microalgae from environmental water samples, preparing microalgae cultures with aseptic techniques, counting microalgae cultures with microscopes, and estimating the growth condition of microalgae.

OBJECTIVE

Upon the completion of Unit 2, you should be able to:

- Isolate microalgae in environmental water samples
- Select and use appropriate skills in cultivating single strain of microalgae
- Conduct microalgal counting with a microscope

MICROALGAE IN THE NATURAL ENVIRONMENTS

Microalgae exist in natural and artificial environments including ponds, lakes, streams, reservoirs, marshes, coral reefs, open oceans, rock pools, and even your aquariums at home. To study microalgae, we can conduct field survey to measure and monitor them in the field or to maintain lab cultures and carry out experiments using microalgae cultures. To maintain microalgae cultures, we need various tools and a set of techniques in the cultivation of microalgae.

ISOLATION OF MICROALGAL CELLS

There are various methods in isolating microorganism cells from environmental samples. In this Unit, we will introduce a few of them by listing the suggested procedures for each method.

STREAK PLATE METHOD

Procedures

1. Disinfect work surface with 70% ethanol.
2. After the disinfectant has dried completely, turn on the Bunsen burner and handle samples within the clean area of the flame.

3. Sterilize the inoculating loop by putting the loop into the flame of the Bunsen burner. Wait for the loop to turn red and let it cool down for a few moments.
4. Transfer a volume (e.g., 100 μL) of diluted environmental samples to an agar plate with autopipette.
5. Gently streak the inoculating loop with a back-and-forth motion in the first quarter of the agar plate.
6. Put the loop in the flame and let it cool. Extend the streaks into the second quarter of the petri plate.
7. Repeat step 6 for the third and fourth quarters of the agar plate (Figure 2.1).
8. Sterilize the loop again after streaking all quarters.
9. Seal the petri dish with parafilm. Position the petri dish upside-down.
10. Incubate the agar plates at the appropriate temperature and light condition.
11. Disinfect work surface again with 70% ethanol.

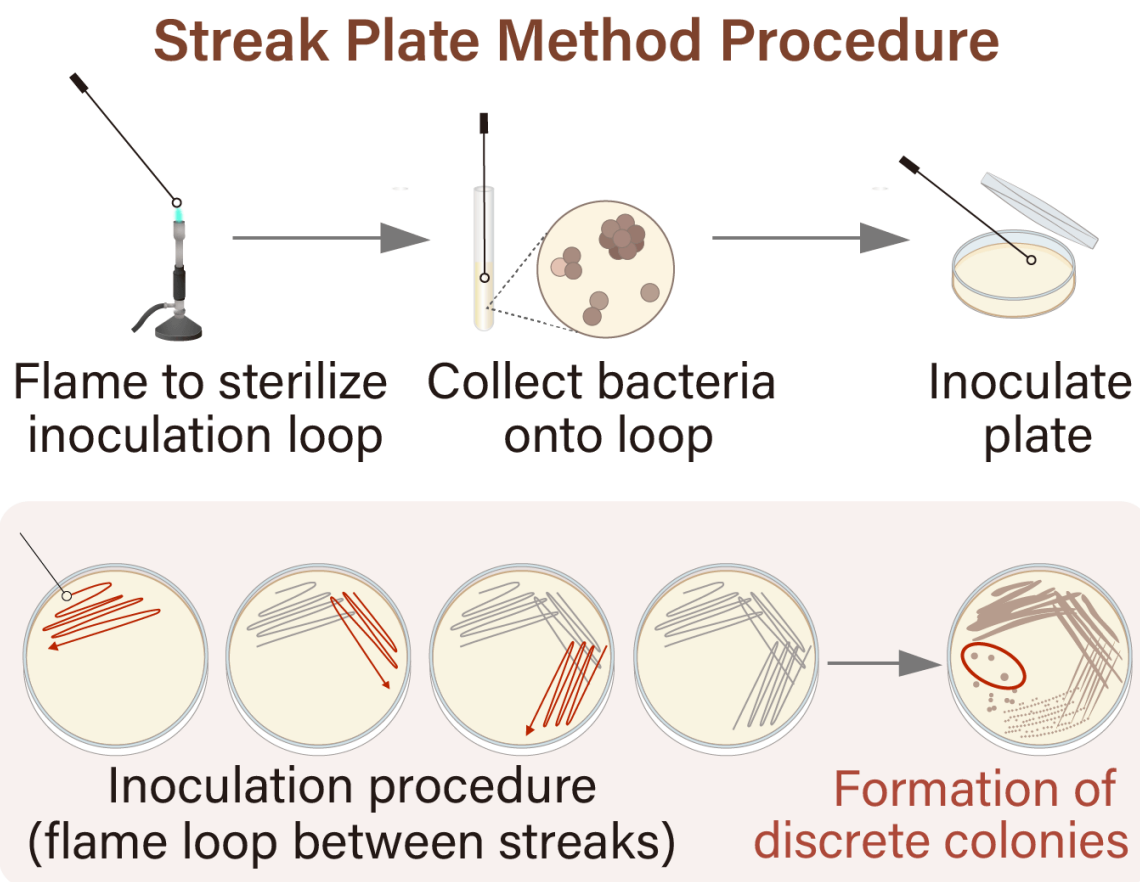


Figure 2.1 Steps of streaking the quarters of an agar plate.

SPREAD PLATE METHOD

Procedures

1. Disinfect work surface with 70% ethanol.
2. After the disinfectant has dried completely, turn on the Bunsen burner and handle samples within the clean area of the flame.
3. Dip the L-shaped glass spreader into 70% ethanol.
4. Flame the L-shaped glass spreader over a Bunsen burner and let it cool down for a few moments.
5. Transfer a volume (e.g., 100 μ L) of diluted environmental samples to an agar plate.
6. Spread the sample evenly over the surface of agar using the sterile glass spreader, carefully rotating the petri dish underneath at the same time.
7. Seal the petri dish with parafilm. Position the petri dish upside-down.
8. Incubate the agar plates at the appropriate temperature and light condition.
9. Disinfect work surface again with 70% ethanol.

SERIAL DILUTION METHOD

Procedures

1. Disinfect work surface with 70% ethanol.
2. After the disinfectant has dried completely, turn on the Bunsen burner and handle samples within the clean area of the flame.
3. Prepare 5 test tube with proper labels by filling each with 9 mL sterilized water using autopipette.
4. Transfer 1 mL of the properly mixed sample into the first test tube to make a total volume of 10 mL. This provides an initial dilution of 10^{-1} .
5. Seal the 10^{-1} test tube properly and mix the sample throughout.
6. Repeat steps 4 and 5 by transferring 1 mL mixture from the previous test tube to the next 9 mL diluents sequentially to prepare dilutions of 10^{-2} , 10^{-3} , 10^{-4} , and 10^{-5} (Figure 2.2)
7. Incubate the test tubes at the appropriate temperature and light condition.
8. Disinfect work surface again with 70% ethanol.

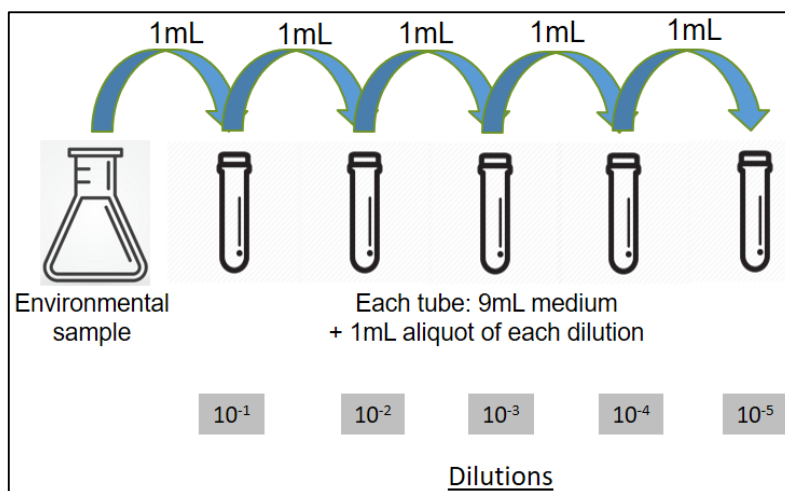


Figure 2.2 Steps of the serial dilution method.

CULTIVATION OF MICROALGAE

Using the proper cell isolation techniques, clonal cultures of microalgae could be established. The next step is to maintain the established cultures to allow continuous propagation of microalgae cultures. To promote the growth of microalgae, nutrient enrichment will be added to the culture medium. There are numerous recipes for nutrients additions which could be broadly divided into 3 types. They are namely the macronutrients (N, P, and Si), the trace metals (e.g., Fe, Mn, Zn, Co, Cu, Mo, etc.), and the vitamins (e.g., vitamin B₁, vitamin H, vitamin B₁₂, etc.).

PREPARING YOUR OWN CULTURE MEDIUM

By adding the appropriate amounts of different nutrients into sterilized water, you can prepare a freshly made culture medium for microalgae. Aseptic techniques are required for the preparation of culture media.

Procedures

1. Disinfect work surface with 70% ethanol.
2. After the disinfectant has dried completely, turn on the Bunsen burner and handle solutions within the clean area of the flame.
3. Flame the neck and cap bottles by passing them through a hot Bunsen burner flame several times.
4. Transfer the correct volumes of stock solutions separately using autopipette to the autoclaved water.
5. Flame the neck and cap of bottles again.
6. Mix the solution by inverting the closed bottle up and down several times.
7. Disinfect work surface again with 70% ethanol.

Activity 2.1

Complete the Table 2.1 below for the preparation of a 500 mL fresh culture medium.

No.	Stock solution		Add ? mL for 500mL medium
1	MgNa ₂ EDTA		0.5
2	Trace metal solution A	H ₃ BO ₃	0.5
		MnCl ₂ · 4H ₂ O	
		ZnSO ₄ · 7H ₂ O	
		NaMoO ₄ · 2H ₂ O	
3	Trace metal solution B	CuSO ₄ · 5H ₂ O	0.5
		Co(NO ₃) ₂ · 6H ₂ O	
4	Fe citrate solution	i. Citric acid	0.5
		ii. Ferric ammonium citrate	
5	NaNO ₃		2.5
6	K ₂ HPO ₄ · 3H ₂ O		0.5
7	MgSO ₄ · 7H ₂ O		0.5
8	CaCl ₂ · 2H ₂ O		0.5
9	Na ₂ CO ₃		0.5

Table 2.1 The components and volumes of the stock solutions to be added to make a 500 mL culture medium.

SUB-CULTURING MICROALGAE

The goal of sub-culturing microalgae is to maintain healthy populations of microalgae in cultures for the continuous propagation of the cultures. This is essential to obtain the healthy microalgal cultures for experiments. To sub-culture the cultures, the old microalgae cultures need to be transferred to freshly prepared culture media regularly.

Procedures

1. Prepare fresh culture medium with the proper steps.
2. Adjust the medium to the culturing temperature.
3. Disinfect work surface with 70% ethanol.
4. After the disinfectant has dried completely, turn on the Bunsen burner and handle solutions within the clean area of the flame.

5. Flame the neck and cap bottles by passing them through a hot Bunsen burner flame several times.
6. Transfer the 10% volume of the original microalgae culture to the fresh medium.
7. Flame the neck and cap of bottles again.
8. Incubate the culture at the appropriate temperature and light condition.
9. Disinfect work surface again with 70% ethanol.

COUNTING MICROALGAE SAMPLES

The growth conditions of microalgae in cultures provide essential information for monitoring their growth as well as for determining the effects of different treatments on microalgae in laboratory experiments. One of the ways to estimate microalgae' growth condition is by estimating the rate of change of their population size over time. To do so, the first step is to count the number of microalgal cells in samples. After cell counting, you will use the data to estimate the growth rate of microalgae in cultures with the application of exponential and logarithmic functions.

Procedures

1. Mix the preserved sample by slowly inverting the closed sample container several times.
2. Use an autopipette to draw 1 mL of the sample and slowly load it on the Sedgewick-Rafter counting chamber.
3. Position the cover slide in place. Make sure no air bubbles are trapped underneath the slide.
4. Wait for approximately 3 minutes to allow the microalgal cells to settle onto the bottom layer of the counting chamber.
5. Count the number of microalgal cells in a certain number small grids of the counting chamber. In case that the microalgal cells are settled on the edges of the small grids, count only the cells overlapping the right-hand and top boundaries (Figure 2.3).
6. Calculate the cell density of microalgae (D , cells/mL) in cultures as

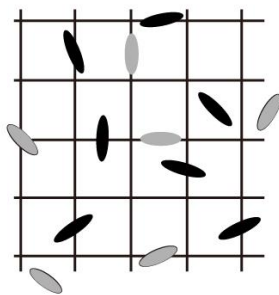
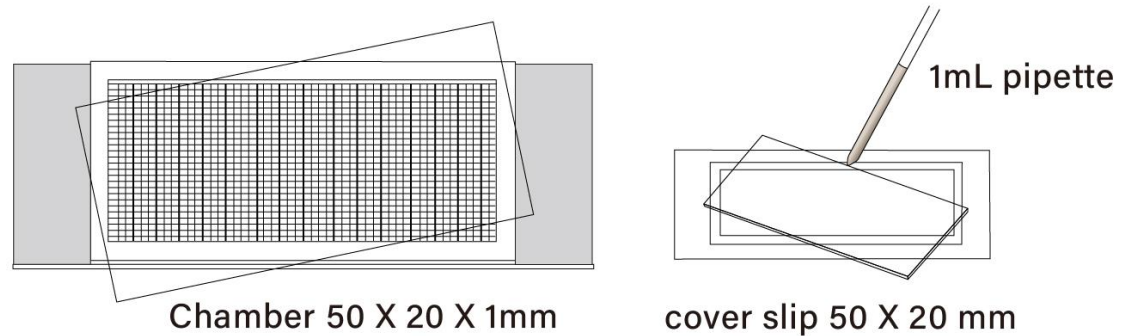
$$D = \frac{n}{1 \text{ mL} \times p} \times \text{dilution factor}$$

where n = the number of cells counted and p = the proportion of the number of counted small grids to 1000 grids.

7. Calculate the cell densities of microalgae cultures collected at different time points.
8. Estimate the growth rate (r , /day) of microalgae cultures as

$$r = \ln\left(\frac{D_t}{D_0}\right) / t$$

where D_t = cell density at time t , D_0 = cell density at previous time point, and t = time intervals in days.



Schematic drawing of the counting convention: all organisms overlapping the right-hand and top boundary are counted (black cells), but those overlapping the bottom and left-hand boundary are not (gray cells).

Figure 2.3 Steps in using the Sedgewick-Rafter counting chamber for cell counting.

Activity 2.2

Count at least two samples collected at different time points and estimate the growth rate of microalgae.

Sample 1: _____

- Number of grids counted: _____
- Number of algal cells counted: _____
- Dilution factor: _____
- Density of sample 1 (cells/mL): _____

Sample 2: _____

- Number of grids counted: _____

- Number of algal cells counted: _____
- Dilution factor: _____
- Density of sample 1 (cells/mL): _____

Growth rate (r, d^{-1}) of the culture: _____

UNIT 3 THE DANCING MICROALGAE IN THE SPOTLIGHTS

While microalgae are plant-like microscopic organisms, they are not completely a plant since microalgal cells can move or swim in the water, particularly for some flagellated species. Upon receiving a stimulation, certain microalgal species can move or swim from one position to another. Movement of microalgae allows them to reach places that provide favourable growth conditions or allow them to avoid predation by consumers. One common feature of microalgae upon a stimulation is phototaxis. Phototaxis of microalgae enables them to move directionally, either towards or away from, in response to a light source.

In Unit 3, you will work as a group to conduct an investigative study on the topic in phototaxis of microalgae. Following the 5 stages of an investigative study, you will first identify the relevant information of a study question provided by the teacher. You will then plan the investigation by choosing the right equipment and resources, and figuring out the experimental procedures. After carrying out the investigation themselves, you will have to analyse and interpret the data and draw conclusions based on evidence. Lastly, you and your groupmates will have to give a 10 minutes oral presentation of your findings.

OBJECTIVE

Upon the completion of Unit 3, you should be able to:

- Identify the relevant information of a study topic
- Design and plan the steps in carrying out an investigative study
- Conduct the investigative study with the appropriate equipment and resources
- Analyse and interpret collected data
- Communicate the findings of the investigative study to audience
- Explain phototaxis in microalgae

AN INVESTIGATIVE STUDY

The goal of an investigative study is to apply your knowledge and skills in solving problems. There are 5 stages involved in general.

Activity 3.1

List the 5 stages of an investigative study.

1. Identifying relevant information and defining questions for study
2. Planning an investigation that involves choosing equipment and resources

3. [Conducting the investigation](#)
4. [Organising and analysing information; drawing conclusions based on evidence](#)
5. [Presenting the findings](#)

PHOTOTAXIS IN MICROALGAE

Phototaxis refers to an organism's movement in response to light. It can be a negative response, marked by movement away from the light, or positive, where the organism moves toward the light. Phototaxis of microalgae allows them to reach places that provide favourable growth conditions (e.g., high light intensity) or allow them to avoid predation by predators (Figure 4.1)

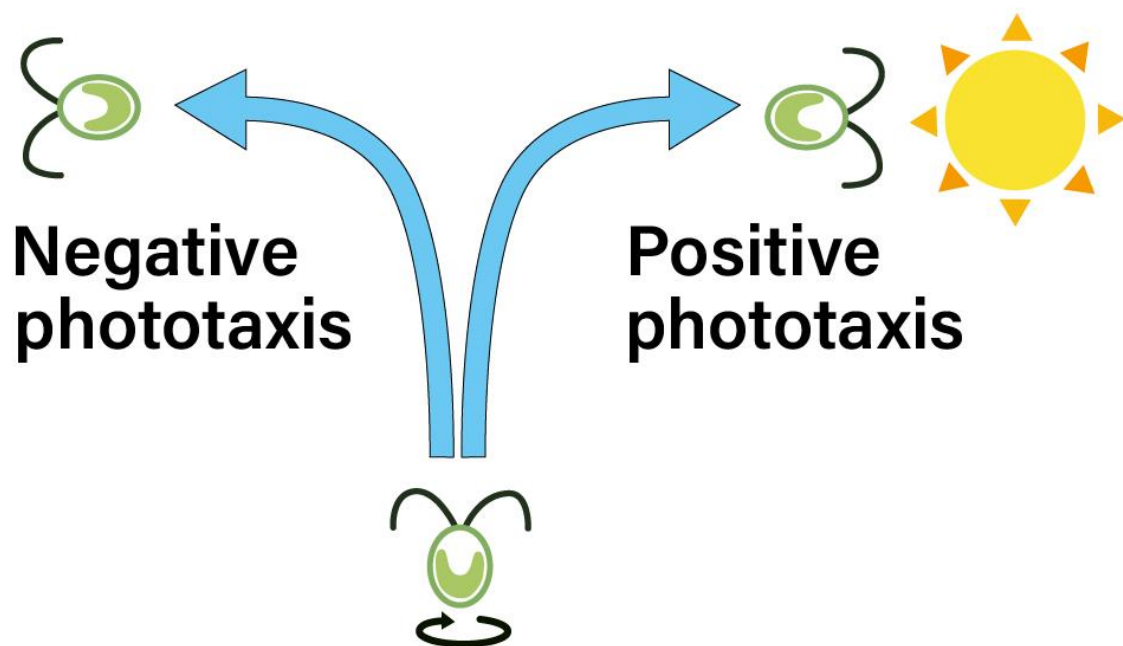


Figure 4.1 Positive phototaxis and negative phototaxis of a microalgal cell in response to light. Source: Ueki et al (2016)

Microalgae react to light stimulus by the movement of the flagella. Phototaxis response of microalgae leads to aggregation of cells near the light source (i.e., positive phototaxis) (Figure 4.2). Microalgae react to high light intensity (white light) via phototaxis. The absorption percentages of light by chlorophylls are high at blue and red lights in general. However, do they react to various colours of light differently?

Stage 2: Plan an investigation that involves choosing equipment and resources

Select the appropriate tools and materials and write down the step-by-step procedures of your investigation.

Tools needed:

Materials needed:

Step-by-step procedures:

The suggested design of an investigative study on the phototaxis response of microalgae to different colours of light:

1. Cut a piece of black paper to make an open-bottom black box large enough to cover a whole petri dish.
 2. Cut a 1 cm² opening at one side of the black box.
 3. Pour 5 mL microalgae cultures into the petri dish and cover the petri dish with the black box.
 4. Cover the 1 cm² opening of the black box with the red coloured filter.
 5. Fix a white LED light immediately in front of the red coloured filters with sticky tape.
 6. Wait for 5 minutes for the microalgal cells to settle inside the petri dish.
 7. Turn on the LED light and start counting down 5 minutes at the same time.
 8. After 5 minutes, remove the black box and immediately take a picture of the microalgal cells in the petri dish.
 9. Measure the position of cell cluster(s) in the petri dish (e.g., distance away from the centre of the petri dish) and the intensity of colour (i.e., a qualitative/quantitative comparison) shown by the cell cluster(s) on the picture taken using a computer software.
 10. Repeat steps 4-9 with a different coloured filter.
 11. Compare the measurements taken in step 9 among treatments using different coloured filters.
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Stage 3: Conduct the investigation

Conduct the investigation and properly record your data.

Record your experiment results below (e.g., in tables):

Stage 4: Organize and analyse information & draw conclusions based on evidence

Organize and analyse your data (use the appropriate computer software to assist your analysis).

Based on the results, what conclusion can be drawn?

Conclusion:

Stage 5: Present your findings

4. RESOURCES

RESOURCES FOR UNIT 1 GETTING TO KNOW MICROALGAE

- Dancer in Water - Microalgae - Unit 1 (PPT)
- Teacher's Guide
- Student Workbook

RESOURCES FOR UNIT 2 CULTIVATION OF MICROALGAE

- Dancer in Water - Microalgae - Unit 2 (PPT)
- Teacher's Guide
- Student Workbook

RESOURCES FOR UNIT 3 THE DANCING MICROALGAE IN THE SPOTLIGHTS

- Dancer in Water - Microalgae - Unit 3 (PPT)
- Teacher's Guide
- Student Workbook

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6. PROJECT TEAM

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