Inspiring better outcomes for our planet through science education
FINDING YOUR NGSS DELIVERY SOLUTION
What we are covering today:

- Who are BIOZONE?
- Comparing BIOZONE’s two NGSS series
- Features of the ebooks and digital support
WHO ARE BIOZONE?
Why is BIOZONE different?

- BIOZONE titles approach the learning experience in the same way as the student, through engagement, inquiry, and exploration of phenomena.

- BIOZONE worktexts are not a basal textbook in the traditional sense:
  - They are designed to be a consumable resource.
  - Students input their answers directly on the page, this forms a record of their work.
  - More flexible in its use than a textbook.
  - Significantly cheaper than a textbook.
Why is BIOZONE different?

- BIOZONE is able to provide small incremental updates (fine tuning), with a more extensive revision cycle every few years.

- This allows us to:
  - Keep abreast of scientific developments
  - Respond to program changes
  - Respond to pedagogical innovations
  - Respond to changes in assessment styles
Flexible content delivery options

BIOZONE offers *print and digital solutions*, enabling you to deliver a comprehensive, engaging program to your students no matter how you are teaching:

- This flexible approach allows you to deliver through:
  - ✔️ Classroom and face to face delivery
  - ✔️ Remote delivery
  - ✔️ Hybrid delivery
  - ✔️ Online or offline options
- Modify your delivery tools to suit current Covid regulations and student ability to access the internet
BIOZONE’s SOLUTION FOR NGSS
BIOZONE has two NGSS series….

**Standard NGSS Series**
- A more traditional, one science one book approach:
  - Physical Sciences for NGSS (chemistry & physics)
  - Earth & Space Sciences for NGSS
  - Biology for NGSS

**Integrated NGSS Series**
- Integrates Earth & Space Sciences with each of the traditional sciences:
  - Physics
  - Chemistry
  - Biology
Standard NGSS Series

Standard NGSS series:

- Has been specifically written to meet the requirements of the Next Generation Science Standards (NGSS) for High School Sciences
- Structured on the DCIs
- Flexible content delivery, present the material in an order which best suits your class

Updated titles coming

https://www.thebiozone.com/ngss-standard/
Integrated NGSS Series

Integrated NGSS series

• Has been designed and written to meet the requirements of the California Science Framework (HS Three-Course Model)

• Perfect for courses where Earth and Space Science are integrated with traditional sciences

• Deliver the content in the order it is provided due to the iterative nature of the framework

https://www.thebiozone.com/ngss-integrated/
In summary....

- Both series have been specifically written for NGSS
- Both series scaffold delivery of material using the 5Es instructional model
- Both series are fully three dimensional (DCIs, CCCs, SEPs)

**Standard NGSS series**
- Phenomena are introduced and student inquiry is supported using a concept-based structure
- **Shorter activities**, mainly focusing on one aspect of a wider concept
- Deep understanding of the wider concept is developed over several sequential activities
- Provides a more traditional approach for delivering NGSS

**Integrated NGSS series**
- **Leads with phenomena**
- **Longer activities** focus on several aspects of a concept
- Deep understanding of a concept is developed within single activities
- Provides an integrated approach for delivering NGSS
Teacher’s Digital Edition (show/hide answers)

Presentation Media (fully editable PowerPoints)

Student Edition

Resource HUB

Classroom Guide

Teacher’s Edition (with answers)
COMPARING THE TWO SERIES
100 Introduction to Photosynthesis

Key Idea: Photosynthesis is the process of converting sunlight, carbon dioxide, and water into glucose and oxygen.

- Plants, algae, and some bacteria are photosynthetic. They use pigments called chlorophylls to absorb light of specific wavelengths and capture light energy. The light energy is used in a process called photosynthesis.
- During photosynthesis carbon dioxide and water are converted into glucose and oxygen. The reaction requires sunlight energy which is transformed into chemical energy within the bonds of the glucose molecule. This chemical energy fuels life’s essential processes.

Photosynthesis is not a single process but two complex processes (the light-dependent and light-independent reactions) each with multiple steps.

Requirements for photosynthesis
- Places need only a few key molecules to make their own food:
  - Light energy from the sun
  - Chlorophyll absorbs light energy
  - CO₂ gas is reduced to carbohydrate
  - Water is split to provide the electrons for the fixation of carbon as carbohydrate

Production of carbohydrate: light-dependent reactions
- Oxygen is evolved (released) during the light-dependent reactions.

Energy capture (light-dependent):
- Light energy is absorbed by chlorophyll molecules, which excite electrons to high energy levels.

Photosynthesis is not a single process but two complex processes (the light-dependent and light-independent reactions) each with multiple steps.

1. Write the word equation for photosynthesis:

2. Where does the oxygen released during photosynthesis come from?
**101 Investigating Photosynthetic Rate**

**Key Idea:** Measuring the production of oxygen provides a simple means of measuring the rate of photosynthesis.

**Background:**
Photosynthetic rate can be investigated by measuring the uptake of carbon dioxide (CO₂) and production of oxygen (O₂) over time. Measuring the rate of oxygen production provides an approximation of photosynthetic rate.

**Aim:**
To investigate the effect of light intensity on the rate of photosynthesis in an aquatic plant, Cabomba aquatica.

**Hypothesis:**
If photosynthetic rate is dependent on light intensity, oxygen bubbles will be produced by Cabomba at higher light intensities.

**Method:**
1. 0.5-1 g of Cabomba stem were weighed. The stem was cut and inverted to ensure a free flow of oxygen.
2. The stem was placed into a beaker filled with a 20°C solution of 0.2 mol/L sodium bicarbonate (NaHCO₃) to supply CO₂. An inverted funnel and a test tube filled with the NaHCO₃ solution collected the gas produced.
3. The beaker was placed at distances (20, 30, 40, 50, 60 cm) from a 60W light source and the light intensity measured with a lux (lx) meter at each interval. One beaker was not exposed to the light source (0 lx).
4. Before recording data, the stems were left to acclimate to the new light level for 5 minutes. Bubbles were counted for a period of three minutes at each distance.

**The Results**

<table>
<thead>
<tr>
<th>Light intensity (lx)</th>
<th>Bubbles counted in three minutes</th>
<th>Bubbles per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>6</td>
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</tr>
<tr>
<td>30</td>
<td>9</td>
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<td>40</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>50</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>60</td>
<td>35</td>
<td>3</td>
</tr>
</tbody>
</table>

3. **Although the light source was placed at distances from the Cabomba stem, light intensity in lux was recorded at each distance rather than distance per unit. Explain why this would be more accurate.**

4. **The sample of gas collected during the experiment was tested with a glowing splint. The splint ignited when placed in the gas. What does this confirm about the gas produced?**

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**102 Chloroplasts**

**Key Idea:** Photosynthesis occurs in organelles called chloroplasts. Chloroplasts contain the pigment chlorophyll, which captures light energy.

**Chloroplasts** are usually aligned with the cell wall to maximize the surface area of the thylakoid membranes.

Photons on these membranes called chlorophyll capture light energy by absorbing light of specific wavelengths. Chlorophyll reflects green light, giving leaves their green color.

Chloroplasts are higher-level organelles of the endosymbiotic theory. They are organized so as to not shade each other.

Chloroplasts are surrounded by a double membrane, with an inner and outer membrane.

**Thylakoid membranes** provide a large surface area for light absorption. They are organized so as to not shade each other.

**Stroma** is the region outside the thylakoid membranes.

**Starch granules** are formed in the stroma.

**Photosynthesis** takes place in disk-shaped organelles called **chloroplasts** (4.4 µm in diameter). The inner structure of chloroplasts is characterized by a system of membrane-bound compartments called **thylakoids** arranged into stacks called **grana** linked together by **stroma lamellae**. The light-dependent reactions of photosynthesis occur in the thylakoids.

**Chloroplasts** are best observed with a light microscope after fixing and staining the material.

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**1. Based on the information above, label the transmission electron micrograph (TEM) of a chloroplast below:**

---

2. **What does chlorophyll do?**

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3. **What features of chloroplasts help maximize the amount of light that can be absorbed?**

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4. **The sample of gas collected during the experiment was tested with a glowing splint. The splint ignited when placed in the gas. What does this confirm about the gas produced?**
103 Stages in Photosynthesis

Key Idea: Photosynthesis consists of two phases, the light-dependent and the light-independent (Calvin cycle) phases.

- Light-dependent phase: Light is absorbed by chlorophyll, the energy is converted to ATP and NADPH, and water is split to produce oxygen.
- Light-independent phase: Carbon dioxide is fixed into organic molecules using the energy from ATP and NADPH.

EXPLAIN

1. (a) Where does the light-dependent phase of photosynthesis occur? ____________
   (b) Where does the light-independent phase of photosynthesis occur? ____________

2. How are the light-dependent and light-independent phases linked? ____________

5. In two ways, the Calvin cycle is different from the light-dependent process. Write them down.

   Experiment A: 4CO₂ + 12H₂O + light energy → CH₂O (glucose) + 6O₂ + 6H₂O
   Experiment B: 6CO₂ + 12H₂O + light energy → C₆H₁₂O₆ (fructose) + 6O₂ + 6H₂O

   From these results, what would you conclude about the source of the oxygen in glucose? ____________

   (a) The carbohydrate produced?
   (b) The oxygen released?

ELABORATE

6. Describe the fate of glucose in the fructose, sucrose system shown above. ____________
Review & Assessment

Chapter Review
Summarize what you know about this topic so far under the headings provided. You can draw diagrams or mind maps, or write notes to organize your thoughts. Use the checklists in the introduction and the hints to help you.

1. Test your vocabulary by matching each term to its definition, as identified by the preceding letter.

- **ATP**
- **cellular respiration**
- **chloroplast**
- **glucose**
- **heat energy**
- **mitochondria**
- **photosynthesis**
- **A**
- **B**
- **C**
- **D**
- **A**
- **B**
- **C**
- **D**

2. Test your understanding of photosynthesis and cellular respiration by answering the questions below.

   (a) Name this organism: **algae**
   
   Write the word equation for this process:
   
   Write the chemical equation for this process:

   (b) Name this organism: **plant cell**
   
   Name the main process that occurs here: **photosynthesis**
   
   Write the word equation for this process:
   
   Write the chemical equation for this process:

   **Self assessment**

   **Formative assessment**

KEY TERMS AND IDEAS: Did You Get It?
1. Test your vocabulary by matching each term to its definition, as identified by the preceding letter.

   - **ATP**
   - **cellular respiration**
   - **chloroplast**
   - **glucose**
   - **heat energy**
   - **mitochondria**
   - **photosynthesis**

   - **A**
   - **B**
   - **C**
   - **D**
   - **A**
   - **B**
   - **C**
   - **D**

   2. Test your understanding of photosynthesis and cellular respiration by answering the questions below.

   (a) Name this organism: **algae**
   
   Write the word equation for this process:
   
   Write the chemical equation for this process:

   (b) Name this organism: **plant cell**
   
   Name the main process that occurs here: **photosynthesis**
   
   Write the word equation for this process:
   
   Write the chemical equation for this process:

   **Summative Assessment**

   **The aim**
   To investigate alcoholic fermentation in yeast where glucose is the substrate.

   **Background**
   Yeast is an example of a eukaryotic organism that can undergo both aerobic and anaerobic respiration. In the absence of oxygen, yeast can ferment glucose anaerobically, producing ethanol and carbon dioxide as waste products.

   **The hypothesis**
   In the presence of oxygen, yeast can ferment glucose aerobically, producing carbon dioxide and water as waste products.

   **Materials**
   - Yeast suspension
   - Sugar solution
   - Flask
   - Stopper
   - Tube
   - Micropipette

   **Procedure**
   1. Set up the experiment as shown in the diagram. Place the flask on a shaking table at 22°C.
   2. Collect the CO₂ produced by the yeast fermentation for 5 minutes.

   **The results**
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<tr>
<th>Time (min)</th>
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<th>Glucose</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
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</tbody>
</table>

   **Conclusion**
   The results show that in the absence of oxygen, yeast can ferment glucose anaerobically, producing ethanol and carbon dioxide as waste products.
23 Photosynthesis

ENGAGE: Man in a box

In 1771, Joseph Priestley conducted an experiment to capture oxygen in a bell jar. He placed a plant inside a sealed jar with water and let it sit for 48 hours. At the end of the experiment, the plant had used up all the oxygen in the jar, resulting in a mixture of carbon dioxide and water.

1. As a class or group, research the original bell jar experiment by Joseph Priestley. What was he trying to show? What did he conclude?

2. Compare the scale of Priestley's original 1771 experiment with the experiment above. Do you think the ratio of plant to animal biomass is similar or different? How many plants were needed for the man to compose the oxygen?

3. Why is this experiment an important example of Earth's ecosystems?

4. Identify the gases involved in the experiment. Why did the percentage of oxygen in the air increase over 48 hours?

EXPLORE: Photosynthesis and carbon dioxide

Bromothymol blue is an indicator that turns blue in base (alkaline) solutions, yellowishgreen in neutral water, and yellow/green in acidic solutions. Adding carbon dioxide to water containing bromothymol blue causes the solution to turn yellowish green as the carbon dioxide dissolves into the water. The solution will eventually turn bluish green again as carbon dioxide escapes from solution and returns to the air.

INVESTIGATION 2.1: Carbon dioxide use by Calanths

1. Working in pairs or small groups, measure 300 mL of water into a beaker and add three drops of bromothymol blue (BTB). The color of the water should be blue (photo above left).
2. Bubble carbon dioxide into the water by blowing through a straw until the solution changes color to yellowish green (photo above right). Fill four test tubes with this CO₂-enriched solution.
3. Place a spring of Calanths into two of the test tubes and seal them with stoppers. Cover one of the test tubes (A) in aluminum foil to block out the light. Leave the second test tube uncovered (B).
4. Stopper the remaining two test tubes. Cover one tube with aluminum foil (C) and leave the second tube uncovered (D).
5. Place all four test tubes in direct light for 1 hour. At the end of the experiment record the color of the solution in each tube.

5. Does the set-up for this experiment in the space right:

6. Describe the color of the solutions after one hour:
   (a) Tube A (Calanths, covered);
   (b) Tube B (Calanths, uncovered);
   (c) Tube C (no Calanths, covered);
   (d) Tube D (no Calanths, uncovered);

7. Did you observe anything else happening in any of the tubes. What did you see?

8. Explain the results:

9. What does the experiment tell you about photosynthesis and carbon dioxide?

10. Why are the tubes stopped?
EXPLORE: Photosynthesis and light

You may have noticed bubbles in the uncovered tube containing Cabomba. If you had been able to observe the foil-covered tube, where there was no color change, you would have seen that no bubbles were produced. From this, we can hypothesize that light was causing Cabomba to produce gas during photosynthesis. You can test this in the following investigation of the effect of light intensity on rate of gas production. Work in pairs or small groups.

INVESTIGATION 2.2: Measuring bubble production in Cabomba

1. Fill a boiling tube 2/3 full with a 20°C solution of 1% sodium hydrogen carbonate (NaHCO₃).
2. Cut a 7 cm long piece of Cabomba stem (cut underwater). Place the Cabomba into the boiling tube (cut end up). Carefully push the Cabomba down.
3. Place the boiling tube in a rack and position a lamp so that it will shine on the tube when switched on.
4. To test the setup, switch on the lamp for one minute to check that bubbles emerge freely from the stem. If they don't, you may have to reposition the lamp to get it right.
5. When you have checked your setup, switch off the lamp and, after 5 minutes, use a stop watch to record the number of bubbles emerging from the stem over a minute. Repeat.
6. Use a timer to mark out distances 0, 5, 10, 15, 20, and 25 cm from the boiling tube.
7. Starting at 20 cm, move the lamp to each of the distances in turn and use a stop watch to record the number of bubbles emerging from the stem over a minute. Run two tests of each distance and allow 5 minutes after moving to a new distance before recording (this allows for acclimatization).
8. Record your results in the table below. Calculate the mean rate of gas production for each distance (and lamp off).
9. After you have finished recording, unstopper the tube and test the gas with a glowing spirit. What happens?

10. Use your calculated means to draw a graph on the grid of the rate of gas production vs light intensity (distance).
11. What did your graph tell you about photosynthesis, light, and the gas produced?

12. From this experiment what can you say about photosynthesis, light, and the gas produced?

13. Describe how you think you could refine the design of this investigation to improve it?

14. Would you be able to do this investigation at home?
17. Solving the leaves in ethanol removes the green plant pigment (chlorophyll) from the leaf. Why is it important to remove all the color from the leaf?

18. Describe the results you obtained.

19. What does the result of the test suggest about the product of photosynthesis?

20. Why was the plant placed into darkness for 48 hours before covering some of the leaves and leaving the plant in light?

Glucose has the chemical formula C₆H₁₂O₆. Starch is a large molecule (polymer) made up of repeating glucose molecules. Plants use starch to store glucose when glucose is being made faster than it is being used. Starch is stored within chloroplasts and in storage organelles within the cytoplasm.

21. Use the information above to review your answer to 19.

EXPLAIN: Photosynthesis

From your earlier explorations you will have noted that photosynthesis involves light, carbon dioxide (CO₂), oxygen (O₂), water (H₂O), and glucose (C₆H₁₂O₆).

22. Write a word equation for the process of photosynthesis.

23. Using the information from the previous pages give reasons or evidence for the placement of reactants and products in your equation (i.e. what is the evidence that reactants are reactants and products are products)?

EXPLAIN: Chloroplasts

Photosynthesis takes place in disk-shaped organelles called chloroplasts (4-5 μm in diameter). The inner structure of chloroplasts consists of a system of membrane-bound compartments (thylakoids) arranged into stacks (grana). The thylakoids are lined by membranous connections (stroma lamellae).


Chloroplasts are usually aligned with their broad surface parallel to the cell wall to maximize the surface area for light absorption.

EXPLORATION: Water and photosynthesis

25. Are the CO₂ used in photosynthesis and O₂ produced by photosynthesis related? It is easy to think CO₂ is converted to O₂ by removal of carbon. However, in the 1800s, observations of other kinds of photosynthetic organisms led to the hypothesis that O₂ was generated from splitting water. Experiments carried out using isotopes of oxygen tested this hypothesis. The results are shown on the right.

26. Do the results show the oxygen comes from?

27. Where does the carbon in CO₂ go during photosynthesis?

28. Explain why the chloroplasts are aligned with their broad surface parallel to the cell wall.
EXPLAIN: Photosynthesis is actually two sets of reactions

1. Photosynthesis has two phases, the light dependent phase and the light independent phase.
2. In the reactions of the light dependent phase, light energy is converted to chemical energy (ATP and NADPH). This phase occurs in the thylakoid membranes of the chloroplasts.
3. In the reactions of the light independent phase, the chemical energy is used to synthesize carbohydrates. This phase occurs in the stroma of chloroplasts.

Light dependent phase (LDP):
In the first phase of photosynthesis, chlorophyll captures light energy, which is used to split water, producing $O_2$, con (beads), electrons, and $P$ ions. The $H^+$ is transferred to the molecule NADPH and ATP is also produced. The light dependent phase occurs in the thylakoid membranes of the grana.

Light independent phase (LIP):
The second phase of photosynthesis stores in the stromes and uses the NADPH and the ATP to drive a series of enzyme-controlled reactions (the Calvin cycle) that fix carbon dioxide to produce three phosphate. This phase does not need light to proceed.

29. Explain how the light dependent and light independent reactions are linked:

29. Using all the information from this activity, complete the model of photosynthesis below by filling in the boxes:

30. The chemical equation for photosynthesis is:
$$\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$$
Explain how this equation is actually a summary of the process occurring in the light dependent and light independent reactions. At what point is energy added to the equation:

ELABORATE: The fate of glucose

31. The model below shows the possible fates of glucose resulting from photosynthesis. Note that glucose by itself can form different polymers (large multi-atom molecules) depending on the type of bond(s) linking the glucose monomers (single units) together. The elements present in each type of molecule are identified in red. Use the model to justify why photosynthesis could arguably be called the most important process on the planet.

Storage as sources of glucose, e.g., starch (in plants) or glycogen (in animals) C, H, O

Excess C, H, O

Cellulose, a glucose polymer (plant cell walls) C, H, O

Hexoses C, H, O

Nucleic acids (DNA, RNA) C, H, O, N, P

Amino acids C, H, O, N, S

Transportation for storage as starch in the plastids of storage organs such as seeds and tubers C, H, O

Energy (production of ATP) C, H, O

Phospholipids in plasma membranes C, H, O

Process (excluding carbohydrates) C, H, O, S
EXPLAIN: Photosynthesis is actually two sets of reactions

- Photosynthesis has two phases, the light dependent phase and the light independent phase.
- In the reactions of the light dependent phase, light energy is converted to chemical energy (ATP and NADPH). This phase occurs in the thylakoid membranes of the chloroplasts.
- In the reactions of the light independent phase, the chemical energy is used to synthesize carbohydrates. This phase occurs in the stroma of chloroplasts.

Light dependent phase (LDP):
In the first phase of photosynthesis, chlorophyll captures light energy, which is used to split water, producing O₂, ATP (adenosine triphosphate), electrons, and H⁺ ions. The H⁺ ions are transferred to the molecule NADPH, and ATP is also produced. The light dependent phase occurs in the thylakoid membranes of the chloroplasts.

Light independent phase (LIP):
The second phase of photosynthesis occurs in the stroma and uses the NADPH and the ATP to drive a series of enzyme-controlled reactions (the Calvin cycle) that fix carbon dioxide to produce triose phosphate. This phase does not need light to proceed.

28. Explain how the light dependent and light independent reactions are linked:

29. Using all the information from this activity complete the model of photosynthesis below by filling in the boxes:

ELABORATE: The fate of glucose

30. The chemical equation for photosynthesis is 6CO₂ + 6H₂O + light energy → C₆H₁₂O₆ + 6O₂. Explain how this equation is actually a summary of the process occurring in the light dependent and light independent reactions. At what point is energy added to the equation?
Summative assessments ask students to undertake a variety of different tasks related to the Performance Expectations. They may include:

- Modeling/computational practical
- Short answer questions
- Long answer questions
- Graphing
- Data analysis and interpretation
- Calculations
Test Banks

- BIOSZONE is developing **test banks** to test the DCI content within each chapter.
- These banks complement the three dimensional assessments in the work text and test content knowledge.
- Test bank questions for **general education** and **credit recovery** are formatted for **ingestion** into test generator software (e.g. Illuminate, ExamView).

**Question types include:**
- Multiple choice
- True/False
- Modified True/False
- Multiple response
- Matching
- Short answer
In summary…

If you want a more traditional approach to teaching NGSS, we recommend BIOZONE’s standard NGSS series.

If you want an integrated approach to teaching NGSS, we recommend BIOZONE’s integrated NGSS series.