Online Inquiry Learning: Making Inquiry Easy with Online Units Featuring Visualizations, Debates, and More
Online Inquiry Learning
Promoting Integrated Understanding

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Web-based Inquiry Science Environment

**WISE v4**

- Inquiry Map
- Embedded Assessments
- Hints
- WISE Evidence

**Inquiry:**

What makes a good medicine? Investigating mitosis and processes

**Evidence:**

A cell was treated with *Typhonium flagelliforme*. Press PLAY to see how it affects mitosis.

Record your observations in your idea basket. Try to note:

**Hints:**

1 of 1

To keep your basket organized, type "Plant 1" as a tag for each new observation you make from this animation.

**Reflection Note:** Would you recommend Plant A?

Question:

What are your recommendations for this plant as a possible medicine? Give reasons for your recommendations.

Response:

This is your first revision.

SAVE CHANGES  SAVE & CLOSE
WISE Units Follow
Knowledge Integration Framework
WISE Versus Typical Cohort

100s of teachers and 1000s of students benefit from WISE Inquiry Units

Standardized Assessments Fail to Measure Integrated Understanding

1. What is the main function of chloroplasts in a plant cell?
   A. absorb light energy and manufacture food
   B. remove waste from the cell
   C. manufacture chemical energy from food
   D. control the shape of the cell

1d Students know that mitochondria liberate energy for the work that cells do and that chloroplasts capture sunlight energy for photosynthesis.
WISE Units Use Inquiry to Promote Knowledge Integration: Photosynthesis

Activity 1: Where Does Energy Come From?

Activity 2: How Is Energy Transformed?

Activity 3: Where Does Energy Go?
Energy Stories and Concept Maps
Measure Knowledge Integration

Write a story about how the rabbit gets and uses energy from the sun.

– Where does energy come from?
– How does energy move?
– Where does energy go?
– How does energy transform/change?
Energy Stories

• Sophisticated Response

The energy comes from carbon dioxide, water, and light energy. The light energy breaks apart the carbon dioxide and the water molecules to form glucose and oxygen. That means it changes to chemical energy from light energy. The glucose is what makes the plant grow and live. When the rabbit eats the plant it is eating the nutrients that the sun helped the plant make.
## Typical Student Progress When Studying WISE Photosynthesis

<table>
<thead>
<tr>
<th>Pretest</th>
<th>The rabbit eats plants. Those plants got energy from the sun. The solar rays hit the chloroplasts, which converted it into glucose so that the plant could grow.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photosynthesis</td>
<td>The energy comes originally from the sun. It comes to earth in the form of light energy. This energy is absorbed by the chloroplasts in the plant's leaves. <strong>Inside of these chloroplasts, the light energy combines with water and carbon dioxide from the roots and breaks them apart, in the meantime transforming into chemical energy.</strong> The atoms that previously made up carbon dioxide and water rearrange into glucose and oxygen. <strong>The chemical energy enters the glucose, and when the rabbit eats the plant, the glucose containing chemical energy is what the rabbit gets and uses.</strong></td>
</tr>
<tr>
<td>Posttest</td>
<td></td>
</tr>
<tr>
<td>Cell Respiration</td>
<td>The energy originally comes from the sun, in the form of light energy. <strong>While it is in the chloroplasts, it breaks up CO2 and H2O molecules, and in the meantime converts into chemical energy.</strong> When glucose forms from the CO2 and H2O's atoms, the chemical energy then enters the glucose. In the mitochondria, the glucose molecules are broken up and this chemical energy is released to be used by the plant or stored. When the rabbit eats the plant, it is harvesting the chemical energy that has already been released, as well as the energy that is still in the glucose, all of which it can use to function and live.</td>
</tr>
</tbody>
</table>
Good progress! Now review the visualization in **Step 3.9** to find out what mitochondria do during cellular respiration and improve your diagram.
Research Can Improve Inquiry Units
Are Dynamic Better than Static Visualizations of Photosynthesis?

Dynamic visualizations can show dynamic movements.
Dynamic visualizations make abstract scientific phenomena visible.

Static Pictures

- Static Pictures Highlight Essential Information
- Static Pictures Draw on Skill in Using Text

Students need to add information between the pictures.

Static pictures do not show continuous movements.
Both Visualizations Add New Ideas

- Both static and dynamic visualizations can add new ideas to students’ repertoire of ideas.
Pre-Posttest Performance

- Significant advantage of dynamic visualization: $F(1,148) = 10.30, p < .01$
More Research on Inquiry Guidance

Draw versus Explore Visualization

Students predict how chemicals will react.

Elicit Ideas

Add ideas

Distinguish Ideas

Sort Ideas

Students predict how chemicals will react.

Based on what happened to the speed and temperature of the atoms in the simulation, what happens to atoms and molecules in an explosion?

In an explosion, atoms...
Molecular Visualization
Should Students Draw or Explore?

2H₂ + O₂ → 2H₂O

Instructions:
1. Run the model.
2. Then press the spark button to initiate the reaction.

Key
Hydrogen molecule (H₂)
Oxygen molecule (O₂)
Water molecule (H₂O)

Molecular Workbench developed by the Concord Consortium
Virtual Experiment

Without the spark there is no combustion

2H₂ + O₂ → 2H₂O

Instructions:
1. Run the model.
2. Then press the spark button to initiate the reaction.

Key
- Hydrogen molecule (H₂)
- Oxygen molecule (O₂)
- Water molecule (H₂O)

Kinetic Energy
Virtual Experiment

With the spark there is combustion. What differences do you observe?

Instructions:
1. Run the model.
2. Then press the spark button to initiate the reaction.

Key
- Hydrogen molecule (H₂)
- Oxygen molecule (O₂)
- Water molecule (H₂O)
Students Explore the Visualization or Draw their Ideas using WISE Draw

Draw four pictures to show combustion of SIX hydrogen gas molecules
Research Shows Drawing More Effective than Exploring

Conclusions

- Inquiry Instruction Promotes Integrated Understanding
- Current Standardized Assessments Send the Wrong Message! Encourage Memorizing not Reasoning!
- Design of Inquiry Instruction Benefits from Research
  - Knowledge Integration Pattern Effective
  - Dynamic Adds Value to Static Pictures
  - Drawing Adds Value to Exploring a Visualization
- WISE Offers Free, Classroom Tested Inquiry Units
  - Enable Teachers to Diagnose Student Difficulties and Tutor Individuals or Small Groups
Start Now at: WISE.berkeley.edu

Free & Open Source

Inquiry Projects for 4th-12th grades

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