



## Thinking in Scientific Ways

## Developing and Communicating Scientific Understanding

ACCESS THE SCIENCE EXEMPLARS ONLINE AT [www.tki.org.nz/r/assessment/exemplars/sci/](http://www.tki.org.nz/r/assessment/exemplars/sci/)

## LEVEL 1 2 3 4 5

## Green Machine

## THE LEARNING CONTEXT

The teacher's intended outcomes were for the students to:

- demonstrate their understanding of the structure and functions of parts of a plant and of the processes that enable plants to survive
- present detailed, annotated diagrams and models to explain the relationship between structure and function within a system.

The intended outcomes were aligned to the following "big ideas":

- Plants have structural, physiological, and behavioural features that help them to survive.
- Scientists use detailed diagrams and models to communicate the interactions between elements within a system.

The class worked on a science unit called "green machines". The teacher introduced the unit by asking the students to draw annotated diagrams showing plants as green machines. He used a cartoon diagram from a text showing a plant mixing up ingredients in a photosynthesis bowl to illustrate the model of a plant as a "food-making machine" with particular emphasis on inputs, outputs, and processes.

The teacher used practical activities to help the students to explore, discuss, and record the requirements and structures of plants and the processes of photosynthesis, osmosis, and transpiration. He continued to emphasise the concept of a plant as a machine that makes a product from the materials that are supplied to it. He linked the activities to help the class to develop an overview of how the various structures and processes work together to allow plants to produce food for their survival. Finally, he assessed the students' understanding of the processes by asking them to complete a second diagram (to compare with the first diagram) and to complete a report.

## Teacher-student conversation

Comparing Deborah's "before" and "after" views:

Teacher: Tell me about some of the ways in which your ideas have changed from this ["before" view] to this ["after" view].

Deborah: This picture ["after" view] shows that the plant makes its food by photosynthesis. It makes glucose – here's the formula. In that picture ["before" view], I've got "food" getting sucked up out of the soil through the roots, and I didn't know what was going on inside the plant. But here ["after" view], I show some of the cells inside the plant and inside the leaves and how it all works together.

## REFERENCES

Ministry of Education (1993). *Science in the New Zealand Curriculum*. Wellington: Learning Media.

New Zealand Qualifications Authority (2003). Science 1.3 Describe aspects of biology. Accessed from <http://www.nzqa.govt.nz/ncea/ach/science/index.shtml>

## WHERE TO NEXT?

To move Deborah towards the next learning step, the teacher could help her to focus on:

- exploring the way the environment (for example, the temperature and carbon dioxide concentration) affects photosynthetic processes or exploring transport and respiration processes, focusing on what happens to the food the plant has made (developing and communicating scientific understanding).
- presenting her explanation of photosynthesis to other members of the class for critical scrutiny (thinking in scientific ways).

The teacher could provide opportunities for Deborah to develop and share her ideas in a small group and provide the group with appropriate resources.

## CURRICULUM LINKS

*Science in the New Zealand Curriculum*

## Achievement Objectives

## Level 5: Making Sense of the Nature of Science and Its Relationship to Technology

Students can relate interpretations of the result of their investigations to their original ideas, questions, and predictions.

*Science in the New Zealand Curriculum*, page 34

[http://www.tki.org.nz/r/science/curriculum/p34\\_35\\_e.php](http://www.tki.org.nz/r/science/curriculum/p34_35_e.php)

## Levels 5 and 6: Developing Scientific Skills and Attitudes Reporting:

Students will present well-reasoned, complete reports supported by relevant data in ways, and forms, appropriate to nominated audiences.

*Science in the New Zealand Curriculum*, page 47

[http://www.tki.org.nz/r/science/curriculum/p44\\_51\\_e.php](http://www.tki.org.nz/r/science/curriculum/p44_51_e.php)

## Level 5: Making Sense of the Living World

Students can investigate and describe structural, physiological, and behavioural adaptations which ensure the survival of animals and flowering plants in their environment.

*Science in the New Zealand Curriculum*, page 62

[http://www.tki.org.nz/r/science/curriculum/p62\\_63\\_e.php](http://www.tki.org.nz/r/science/curriculum/p62_63_e.php)

## NCEA (National Certificate for Educational Achievement)

## Achievement standard

AS90188: Science 1.3 Describe aspects of biology

<http://www.nzqa.govt.nz/ncea/ach/science/index.shtml>



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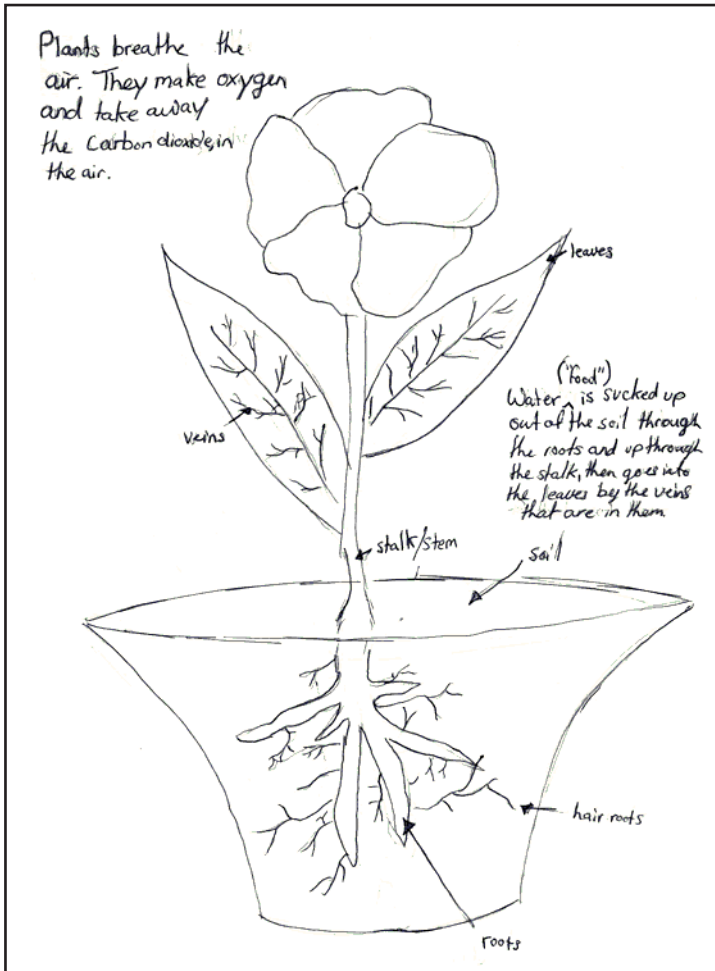
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LEVEL 1 2 3 4 5

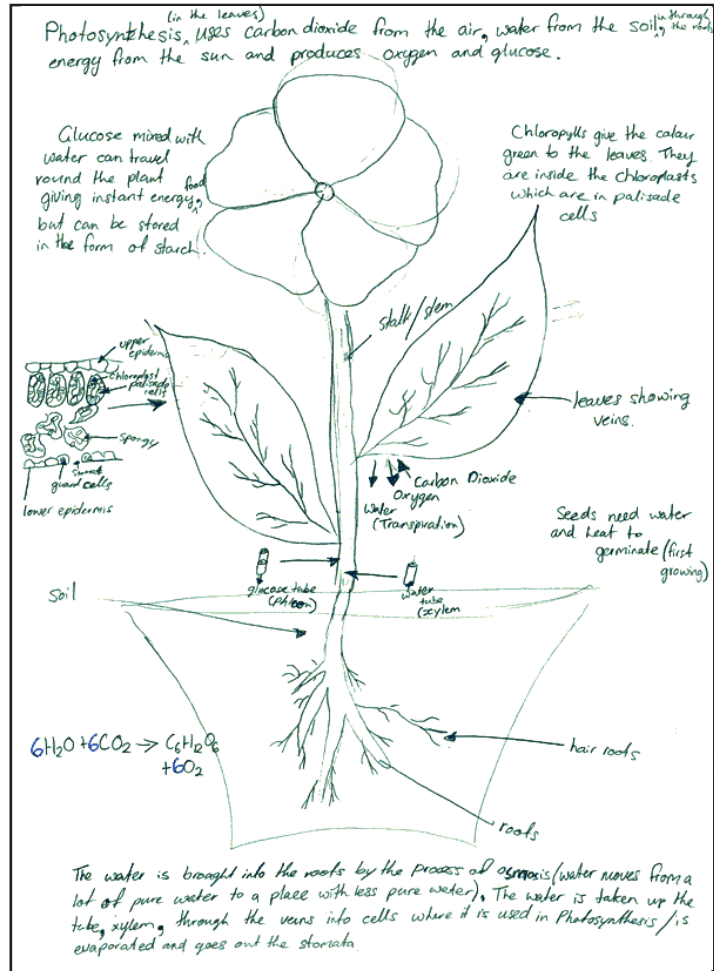
# Green Machine

## WHAT THE WORK SHOWS

Deborah's diagrams demonstrate a significant increase in her scientific understanding, from levels 3 and 4 to levels 4 and 5. In her "after" view, her diagram and written statements describing the plant as a functioning green machine indicate that she is able to present a number of interconnected ideas using a model or analogy. Her ability to zoom in and expand on an aspect of the plant form (the leaf cross-section and xylem and phloem tubes) indicate that she is thinking and demonstrating understanding in advance of level 5.



Deborah's "before" view



Deborah's "after" view



LEVEL

1

2

3

4

5

# Green Machine

## Progress Indicator

### Thinking in Scientific Ways

#### Comparing and evaluating explanations

Deborah's detailed final explanations show a major shift in her ideas from her initial understanding. She is able to explain the concept of the plant making its food rather than obtaining it from the soil as she originally thought. She *changes her ideas after considering the evidence and argument* as she works through the unit. She is moving towards level 5 in her ability to use evidence to support an explanation (L 4).

## Progress Indicator

### Developing and Communicating Scientific Understanding

#### Using scientific ideas in constructing explanations

In her "before" view, Deborah *constructs an explanation for an experience using appropriate scientific ideas*. She uses appropriate aids to help communicate key ideas about the structure and function of plants and explains and elaborates on the connections between ideas (L4).

In her "after" view, Deborah *constructs a well-reasoned and coherent explanation for her experience using appropriate scientific ideas*.

#### Using scientific vocabulary

Her annotated drawing (see "before" view) suggests she is *developing and using scientific vocabulary* (L 3).

She *uses a range of scientific terms and symbols appropriately, with increasing reference to abstract ideas* (see "after" view).