LIGGINS INSTITUTE
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

NATIONAL RESEARCH CENTRE FOR GROWTH AND DEVELOPMENT

LENScience Senior Biology Seminar Series

Food for a Hungry World—Optimising Plant Growth

Questions and Discussion

Pre-seminar School Discussion

In 1984 Bob Geldof and Midge Ure created Band Aid and brought together stars from the British and Irish pop scene to raise money for famine stricken Ethiopia with their now famous release "Do They Know It's Christmas" in which the chorus line rang out "Feed the World". More than 20 years later and a combination of climatic factors, war, and poverty mean that in the Horn of Africa there are more than 17 million people that will need emergency food aid in 2009. Knowing how to grow food should be simple—but it's not. With a growing population throughout the world, the need for scientific understanding of plant growth is essential.

A Review of Plant Growth and Plant Responses to the Environment

Use your *knowledge of Biology and the information in the seminar paper* to discuss the following questions in your school workshop..... These questions provide background information before the seminar.

1. Photosynthesis is the process by which light energy is transformed into chemical energy. Review the photosynthesis equation and identify the limiting factors in this equation.

2. Plants growth responds to environmental stimuli such as gravity, chemicals and light. Define the term tropism and list a range of positive and negative tropic responses that are common in plant growth, identifying adaptive advantages for these responses.

3. Plant growth is affected by genetic factors, environmental factors and hormones. Review the five key plant hormones and their roles in plant growth. A simple star chart would be a good way to present this.

4. Using the maps on page 1 of the seminar paper, discuss the following questions in your group:
    a) Comparing Fig 2 (current population) with Fig 3 (population in 2050), which parts of the world will face the greatest challenge over the next 50 years.
    b) New Zealand has a relatively large BIOCAPACITY compared to many other countries. What ethical implications (if any) does this have for New Zealand as a nation.
    c) Compare the BIOCAPACITY map with the 2050 Population map. What challenges does this comparison present to the world? What role does science have in meeting some of these challenges?

Vocabulary

Abscisic Acid
Activator
Auxin
Auxin
Biocapacity
Cell Cycle
Cell Differentiation
Cell Division
Cell Elongation
Cell Expansion
Cyclins
Cytokinin
Down-regulation
Ethylene
Gene Expression
Gibberelin
Hormone Receptor Complex
Indole 3 -Acetic Acid (IAA)
Nastic Response
Over-expression
Photosynthesis
Plant Hormones
Polymerase Chain Reaction
Repression (of a gene)
Repressor
Scanning Electron Microscopy
Taxis
Transgenic Plant
Tropism

Level 3 Achievement Standards linking to this seminar:

AS 90715 Describe the role of DNA in relation to gene expression
AS 90716 Describe plant and animal responses in relation to environmental factors
AS 90718 Describe applications of biotechnological techniques

Key Concepts from Level 3 Biology that link to this seminar:

Below are selected objectives from the Year 13 biology programme that link to this seminar. THESE ARE NOT A FULL LIST OF THE CONCEPTS IN YOUR COURSE. You may wish to review these concepts before the seminar.

Biotechnology

- Describe the techniques involved in development of a transgenic organisms and how the use of transgenic can meet human needs and demands.
- Describe the techniques involved in genome analysis and how genome analysis meets human needs and demands.
- Be aware of the differing viewpoints of the use of biotechnological applications.
- Show understanding of applications of biotechnological techniques by using core knowledge to link ideas

Gene Expression

- Describe DNA in terms of structure and function
- Describe the process of DNA replication and the role that enzymes have in this process
- Describe the process of protein synthesis and the role of DNA and enzymes in the production of proteins
- Describe the role of DNA in gene expression and the determination of phenotype
- Describe the control of gene expression at the transcriptional level in prokaryotes and eukaryotes
- Describe the role of metabolic pathways in the control of gene expression

Plant Responses to the Environment

- Describe the mechanism of response to an environmental stimulus
- Describe tropisms & nastic responses.
- Describe the role of hormones in plant growth responses
- Describe the adaptive significance of growth responses in plants

Post Seminar challenge Questions

1. The scientific research tea m developed understanding of the role of Auxin Binding Protein 1 (ABP1) in auxin action using two key biotechnologies:
    - Transgenic plants
    - Polymerase Chain Reaction

By creating a transgenic plant where a gene could be turned on or off, the scientific team worked out what that ABP1 gene did in the cell and therefore the plant.

(a) Explain how a transgenic plant is created and what biotechnologies are required to do this.

(b) Describe what mechanism the team used to turn the gene on and off

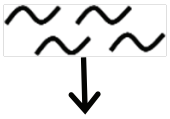
(c) Explain how PCR technologies are used to measure whether the gene is turned on or off

(d) Why did they also need to make observations of the plant using microscopes and simple measurements of leaves and roots?

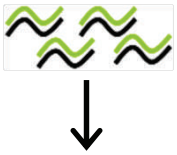
Using PCR Technologies

PCR—the polymerase chain reaction, amplifies DNA and is used in multiple ways. In gene expression studies PCR is used to amplify specific fragments of a gene to find out whether that gene is being expressed in the tissue being studied.

RNA is extracted from the cells

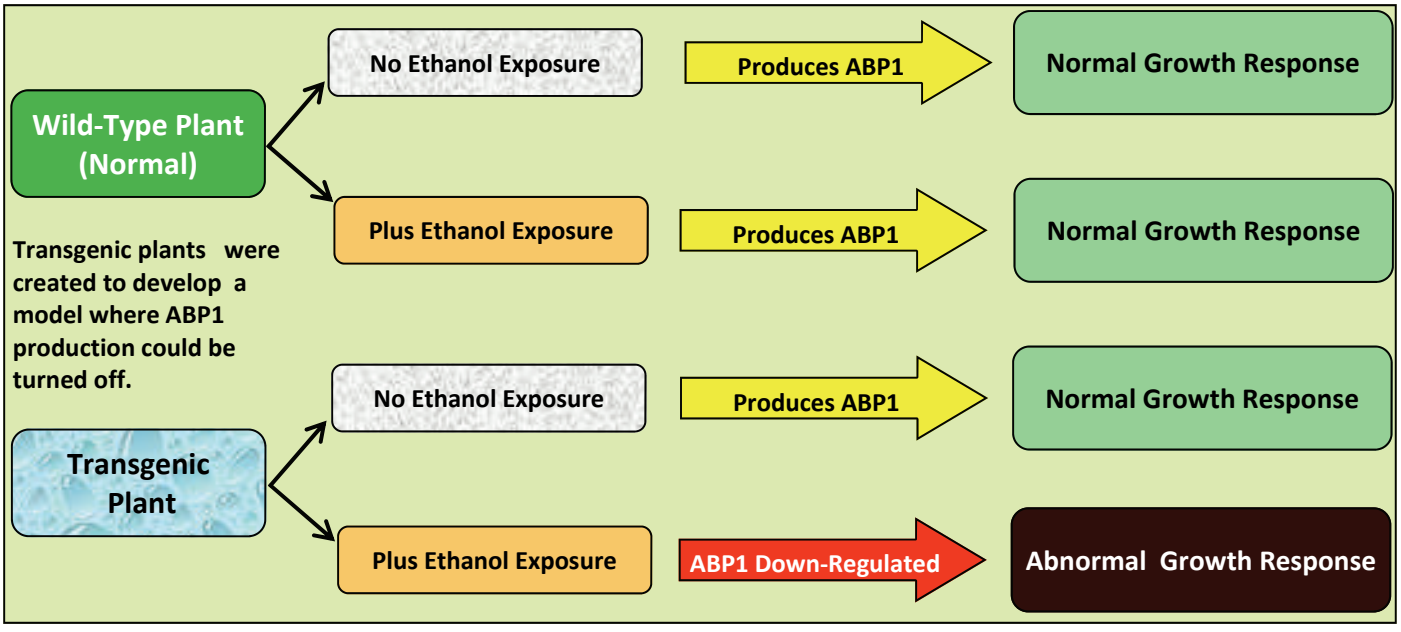


Reverse Transcriptase reaction produces cDNA from the RNA

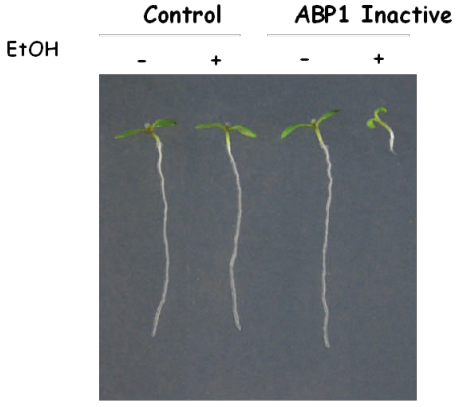


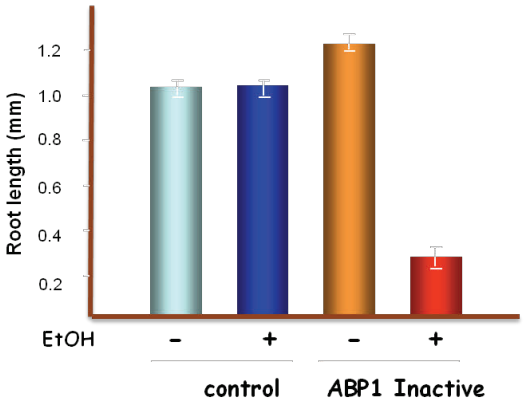
The Polymerase Chain Reaction (PCR) using specific primers produces multiple copies of the target DNA

The target DNA is analysed using Gel Electrophoresis. A variation on PCR called REAL TIME PCR uses fluorescent labels and provides a quantitative analysis of the PCR product.

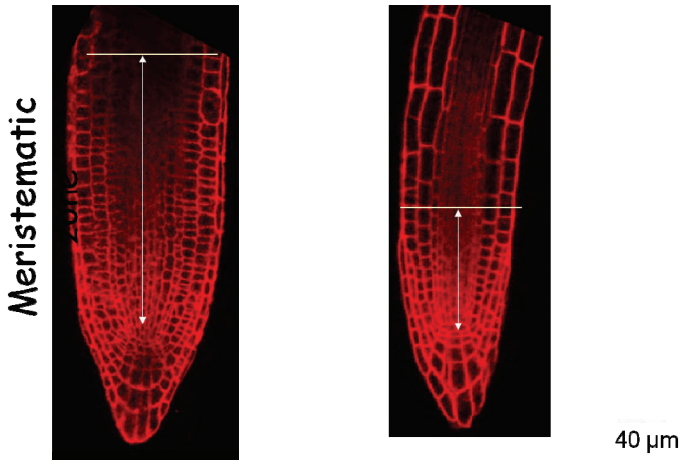


2. The scientific team found that as well as affecting shoots and leaves, inhibiting Auxin Binding Protein affected the growth of roots. As with the shoots they ran tests with and without ethylene to check that the gene was being turned off.





The photomicrographs below show what the cells looked like in the roots
The white arrows show how extensive the meristematic tissue was in the roots.
Meristematic tissue is the tissue in plants that can still divide—it is undifferentiated.



Control ABP1 is turned on

Test— ABP1 is inactive

We know that when ABP1 was inactive the roots did not grow.

What does the information in the micrographs above tell us about the role of ABP1 in root growth?

Why did having ABP1 turned off stop the roots from growing?