Activity 7: Integrated science?

This activity was designed to allow students to appreciate how ideas from different science disciplines can be synthesised, specifically in the context of a model of plant nutrition.

Overview of learning activity

In this activity, teams of (ideally) four students work as project teams, and are assigned roles as project manager, biologist, chemist and physicist. The team has to produce a poster to explain *how a plant manages to obtain the energy and materials needed to live*.

During the ASCEND project this activity, and the following one, were undertaken by groups of students during the same 90 minute sessions. They may easily be separated and used independently. (You should omit the instruction about project brief 2 from the project manager's brief sheet if the group are *not* to proceed to the next activity.)

Rationale for the activity

The activity was designed with a number of considerations in mind. As with most of the ASCEND activities, there is a focus on group-work. However, unusually the roles are assigned in this task. The activity is set up so that the science specialists are each briefed with some of the information that is needed to provide a good overview of plant nutrition (at a suitable level of sophistication for students studying at GCSE level), and that a good overall 'picture' can be developed by considering how the specialist knowledge of the biologist, chemist and physicist may be related. This approach reflects a view that students readily compartmentalise their knowledge. Yet finding the links between topics (and so developing the overall picture) is both essential to appreciate the nature of science (which develops a largely coherent, and mutually supporting knowledge network), and also the type of activity that we expect to both challenge and motivate the most able.

The choice of topic is also significant. ASCEND set out not to simply repeat or preview standard school fare, and yet the topic of plant nutrition is a staple of school science. Yet the author's personal conversations with GCSE students, including the more able ones, had revealed that students may often be able to readily 'describe' photosynthesis and offer formulae for this process and respiration, without having an overview of the roles (and relationship) of these key processes. This suggested that the present activity would not simply be a reinforcement or preview of a school topic, but would offer a chance to integrate understanding of photosynthesis into an extended network of key ideas, linking

ideas about (for example) energy conservation, chemical change and cellular processes.

Each subject specialist is given a list of points that may be relevant to the group's task. So the biologist's briefing sheet includes the points that "in multi-cellular organisms, each cell needs energy to support its own internal processes"; "cellular processes occur all the time, so cells need to keep respiring or they die"; "many, but not all, plant cells contain organelles called chloroplasts"; "the arrangement of cells in a leaf often provides gaps between cells, like a 'spongy' structure". The chemist's briefing includes: "energy is released when bonds are formed during chemical reactions"; "glucose is soluble in water"; "glucose can be converted into a polymer called starch"; "many salts, such as nitrates, dissolve in water" etc. The physicist's briefing includes points such as "energy may seem to change its form, the total amount is constant"; "solar radiation includes infra-red, visible and ultra-violet radiation"; "materials are coloured because they absorb some frequencies of visible radiation and reflect others"; "diffusion occurs in gas mixtures and solutions, from a high concentration to a lower concentration", etc.

The project manager's brief provides criteria for a 'good' poster – that it will explain:

- why roots often spread out into the soil
- why leaves are green
- why leaves have spongy tissue
- why leaves have pores
- why the stomata are usually only on the underside of the leaves
- why leaves are often supported on stems, and spread out in different directions
- why some plants have underground stores of starch

These points have been included to help ensure that students attempt to draw upon the ideas from biology, chemistry and physics that are included on the briefing sheets provided for the team specialists.

The students are also asked to ensure the poster provides information at a cellular level: that the "poster should make it clear how *individual cells* throughout the plant get their supply of carbon, nitrogen and energy". Working at both the whole plant and cellular level can be challenging, but is just the kind of task that gifted learners should respond to (see Chapter 2).

The activity certainly supports outcomes at various levels. The information provided encourages students to extend their explanation of plant nutrition to include such matters as nitrogen uptake, transport and incorporation into tissues, and magnesium uptake for synthesising the chlorophyll, as well as consideration of the sources of the reactants in respiration and photosynthesis.

The set-up of the activity itself also has two additional components. Working as a 'project team' offers a very simple reflection of the way scientists often do work, in teams where different individuals bring specialist knowledge and skills. The task was also contextualised in terms of the need of scientists to communicate their ideas clearly to the public (the Institute Director's memo tells the team that s/he has "decided to form the *Conceptual Synthesis Project* to help explain plants, and aspects of plant science, to the public" – something taken further in the following activity (Activity 8).

The outcome of this activity, a poster modelling a complex process, was similar to that undertaken in Activity 3, potentially offering some reinforcement of modelling skills used then; and took the form of an extended and complex explanation: building on the work in ASCEND Activity 4 (Explaining Science).

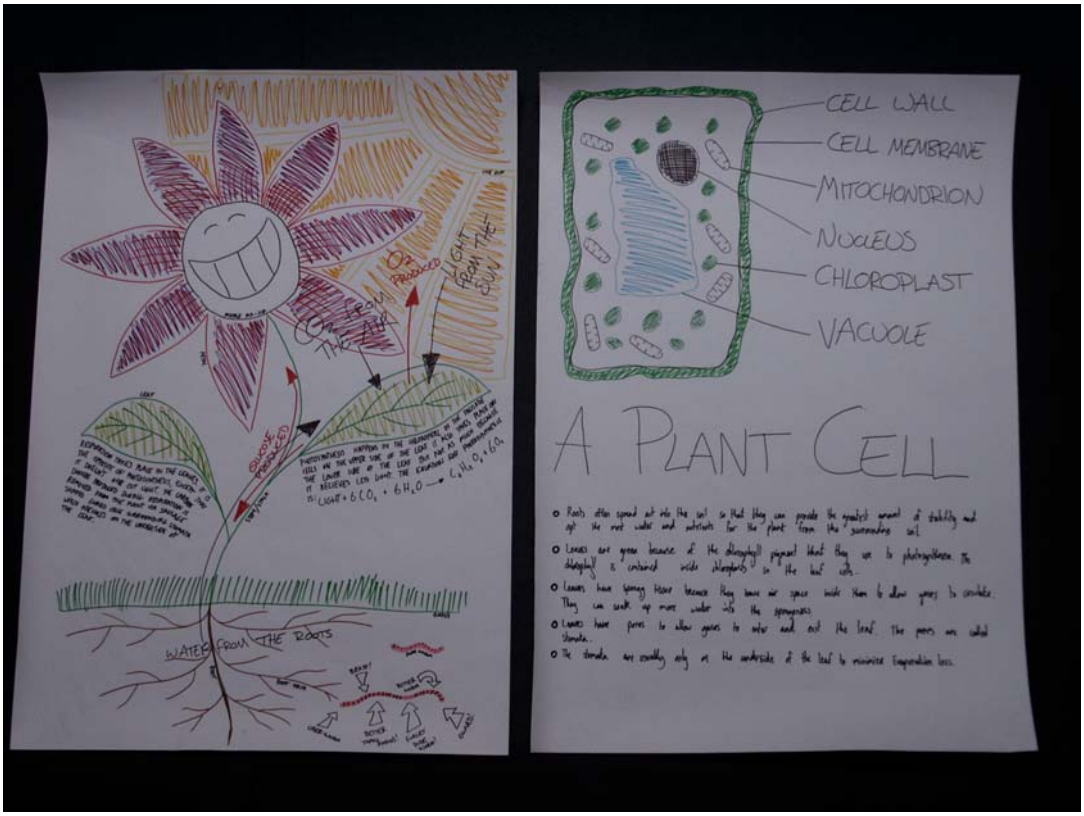

Figure 7.1: Modelling plant nutrition, from an integrated (biological + chemical + physical) perspective.

Resources

The following resources are included on the CD:

Resource	Description	Filename
Introduction	Memo from the director of the SynBot Institute for Plant Sciences to all members of project teams.	Act 7 memo
Project briefs	Briefing sheets for project manager *, project team biologist, project team chemists, and project team physicist	Act 7 briefs

Each group will also need poster paper and drawing materials, and ideally coloured card/paper, scissors, glue, etc.

*Note: project leader's briefing sheet invites her/him to proceed to Activity 8 once the poster is completed. This instruction should be omitted if the groups are not to move on to that activity.