Supermarket Botany

By Geoff E Burrows and John DI Harper

Supermarket Botany is a frequently-used teaching resource or strategy. It draws on a student's existing familiarity with plant-based foods to explore plant structure and life cycles. One of its strongest points is that it is adaptable to many age levels – from lower primary school to university and general interest groups. We have designed a unique web-based resource that features accurate botanical information in an engaging format, combining a tutorial with an interactive test. High-quality photographic images of key morphological features allow students to interpret the structures they are observing. Teachers can use the website as a stand-alone application or as a resource for previewing/reviewing this material before/after a hands-on laboratory class. Evaluations have shown that this web-based application can result in similar learning outcomes to a traditional laboratory-based session.

Introduction

Supermarket Botany (also called 'Grocery Store Botany', 'Botany on Your Plate', 'Edible Botany', etc.) is an excellent way of introducing various concepts of plant structure and development to students of all ages. Supermarket Botany involves using fruits and vegetables with which students are familiar to help them conceptualise the differences between stems, roots and leaves, to understand the differences between vegetables and fruits and to examine the developmental sequence from flower (with an ovary and ovules) to fruit (with seeds).

As noted, Supermarket Botany is an engaging topic for a wide range of ages. As a part of 'Science in Schools' activities we have given Supermarket Botany presentations to primary school students (Years 1 to 5/6) and secondary school students (Years 9/10). At university we have given presentations to full-time internal students (usually 18-20 years of age) and distance education students (usually 20-60+). We have needed only small changes in content and terminology to effectively bring Supermarket Botany to this wide diversity of students.

A search of the web will show that teachers around the world are using Supermarket Botany as part of their biology curriculum. While a popular subject, investigating Supermarket Botany independently, e.g. preparing a class on the subject, or providing a ready-to-run class resource, is fraught with difficulties. For example, the botany textbook *Plant Biology* (Graham et al., 2006) has only a single page on the subject, while Smith and Avery (1999) wrote a short paper that generated numerous letters (in 'American Biology Teacher' June 1999) pointing out inaccuracies in the original article.

Two web-based Supermarket Botany applications, based on similar information, are available on the Teacher's Domain and Missouri Botanic Gardens web sites (please see the 'On-line Resources' section at the end of this article for details). Only small images of the different plant-based food stuffs are shown, and little background information is presented about either the basic parts of plants (root/stem/leaf/ etc) or the particular species. In summary, Supermarket Botany is a popular and effective science education topic but available resources are generally limited in their information content and/or presentation.

We thought a more interactive and comprehensive web resource would be useful for:

- independent student learning about plant structure and life cycles,
- independent student learning about species of horticultural importance,
- teachers wishing to find out more about the above topics,
- teachers wishing to access pre-prepared resources, and
- students preparing for plant structure practicals and subsequent review.

The web resource

Our aim was to produce a resource (Fig. 1) that provided background information on plant parts and plant reproduction, and a test in which students could

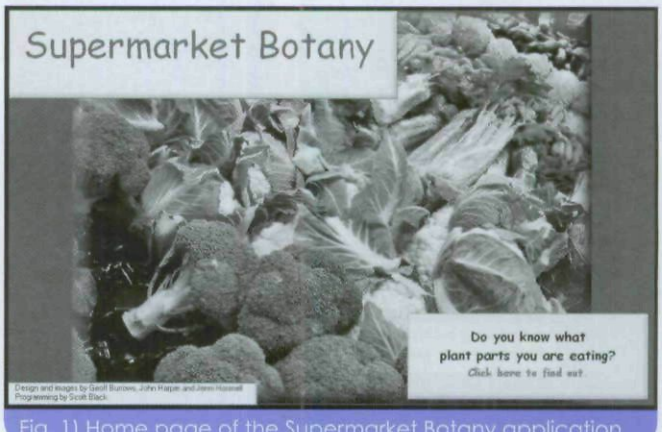


Fig. 1) Home page of the Supermarket Botany application

apply their knowledge. We aimed to produce an engaging and interactive resource that had a 'good' depth of botanical detail and accuracy. The whole application was constructed in ToolBook (Sum Total Systems), an e-learning development application that allows for interactive content. The web address of the application is: *http://www.csu.edu.au/research/grahamcentre/education/*

The website is divided into two main areas (a tutorial and a test - 'The Challenge'). The tutorial is divided into 'vegetable' and 'fruit' sections , with an overall emphasis on distinguishing between fruits and vegetables, a topic that is further investigated in a third minor area ('A tomato – fruit or vegetable?') (Fig. 2)

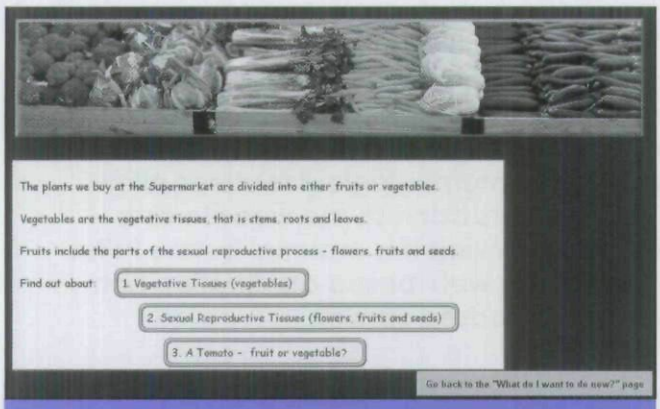


Fig. 2) First page of the tutorial, showing the main features of vegetative and reproductive tissues, with a minor look at tomatoes (to emphasise the difference between vegetables and fruits from a different angle)

The vegetable section is divided into root, stem and leaf subsections. These subsections explain in words and images the features of and differences between these major parts of a plant's vegetative structure. It also explains that many of the roots, stems and leaves that we buy at the supermarket (e.g. carrots, potatoes, celery) are highly-modified versions of the typical vegetative organs of many plants. By understanding typical or 'normal' structure (e.g. stems have leaves or leaf scars and axillary buds or branches) students can interpret more modified forms (e.g. a potato is a stem as the 'eyes' are leaf scars and axillary buds).

Our Supermarket Botany surveys (Table 1) indicated that younger students had a relatively poor understanding of sexual reproduction in plants

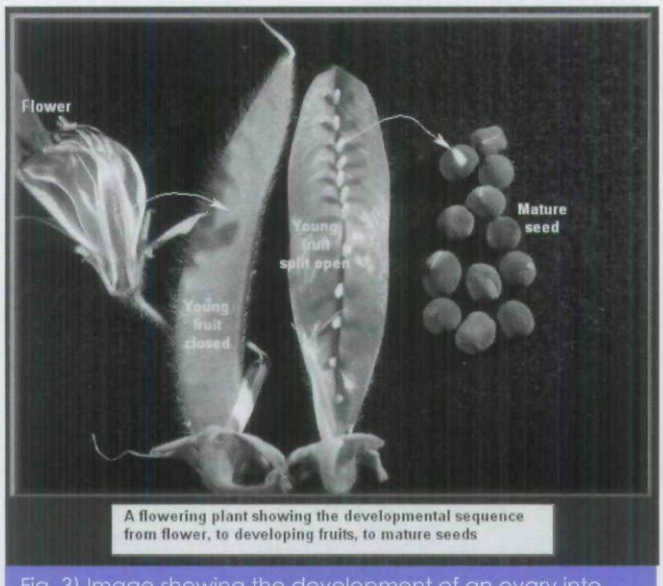


Fig. 3) Image showing the development of an ovary into a fruit with seeds

and the sequence of flower/ovary/ovule developing into fruits and seeds. Consequently, the development of an ovary into a fruit and the associated development of ovules into seeds are illustrated for several species (Figs 3, 4). The concept that fruits develop from flowers and have seeds, while vegetables do not, is emphasised in the tutorial.

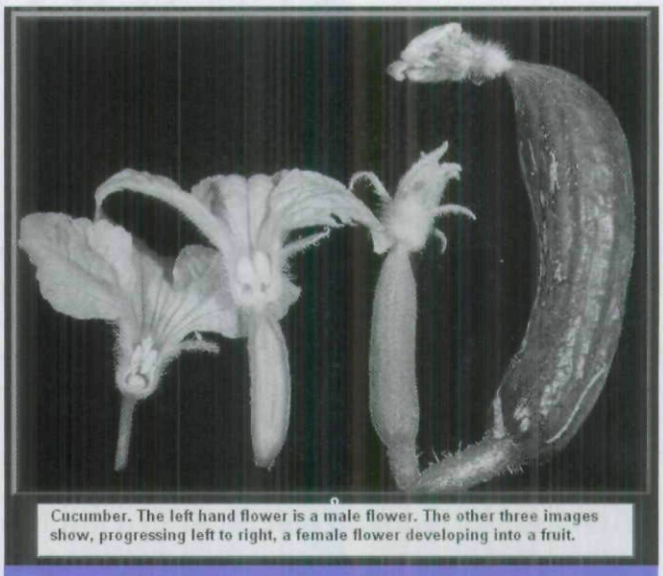


Fig. 4) Image showing the development of the inferior ovary of a cucumber (a monoecious species) into a fruit

Before each Supermarket Botany presentation we assess the students' existing level of knowledge with a short anonymous survey (18 items for which the botanical origin, i.e. root, stem, leaf, flowers, fruit, or seed, needs to be selected; Table 1). This indicates which fruits and vegetables present the greatest levels of botanical misunderstanding and the nature of these misunderstandings. For the test, or 'The Challenge' as it is called on the web site, we chose 15 fruits and vegetables. These were chosen to provide a representative cross-section of items derived from roots, stems and leaves and the various stages of the sexual reproductive cycle (flowers, fruits and seeds). They were also chosen to elicit a wide range of botanical understanding, from the well understood (e.g. carrots are roots) to the commonly misunderstood (e.g. celery is the stalk (petiole) of a leaf).

In 'The Challenge' students select an item 'from the shelf' (Fig. 5). They then go to a larger image of the item and are asked to select root/stem/leaf/flower/fruit/seed (Fig. 6). An incorrect choice generates a unique feedback box. From the surveys we know which mistakes are the most common and the misunderstandings that most probably led to the mistake. Thus we have been able to tailor the feedback based on the survey results. For example, a high proportion of students consider a potato to be a root,

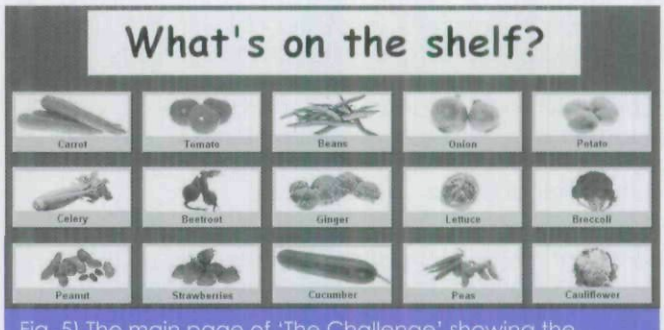


Fig. 5) The main page of 'The Challenge' showing the 15 items 'on the shelf' that can be selected.

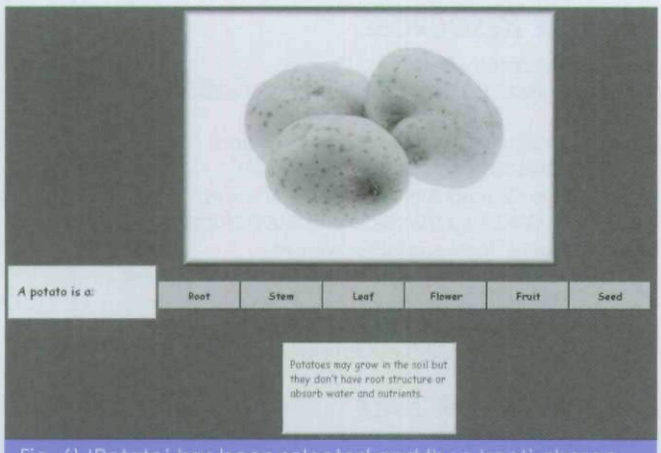
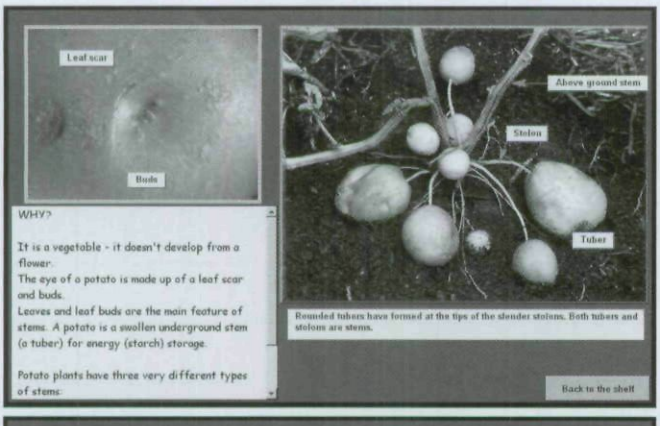


Fig. 6) 'Potato' has been selected and then 'root' chosen as the answer. A customised text box has appeared indicating why this is not correct.

when it is actually a stem. Thus for feedback for the 'root' choice we point out that although potatoes grow beneath the ground they have buds and leaf scars (features of stems) (Fig. 6). While most students know a cucumber is a fruit, most of the incorrect responses had them classifying it as a stem. Thus for the 'stem' response we indicate that while a cucumber is long, cylindrical and green it is not a stem because there are no leaves or axillary buds and it has seeds inside.

Once the correct choice is made the user is taken to the 'Why?' page, where additional high-quality images and explanatory text are provided (Figs 7, 8). These additional images are usually close-ups, dissections and cut-aways. These pages are also used to list interesting facts (e.g. beetroot has an unusual arrangement of vascular tissues – anomalous growth), present basic botanical concepts (e.g. differences between monocots and dicots – scattered vascular bundles in



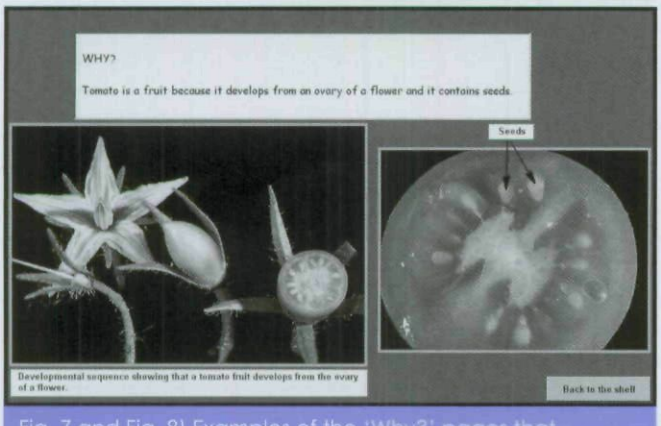


Fig. 7 and Fig. 8) Examples of the 'Why?' pages that appear once the correct answer has been selected. These pages are designed to provide further information regarding the particular species, as well as background information and images supporting the correct answer choice made on the previous page.

the stem of ginger) and botanical relationships (e.g. cauliflower and broccoli are different forms or cultivars of a single species; when the base of a lettuce is cut a milky latex exudes, just like many thistles, because lettuce is in the same genus, *Lactuca*, as several species of thistles).

This web-based application could be used as a stand-alone teaching application but we prefer to use it to augment, rather than replace, face-to-face and hands-on presentations. We expect students to have worked through the application before attending the relevant laboratory class. After the group demonstration they are expected to assess the botanical structure of some less common items of produce e.g. parsnip, rhubarb, fennel and pomegranate, to see how they apply their knowledge.

Evaluation

Student response to the Supermarket Botany website has been uniformly positive:

- *Logically laid out, easy to navigate, a great resource.*
- *I found 'The Challenge' is a great way to reinforce important learning principles.*
- *I actually understood more in 15 minutes than two hours of textbook reading!*
- *The SMB site has helped me heaps! Pennies are dropping everywhere!.*

Informal assessment (Table 1) has indicated that the Supermarket Botany website can have similar learning outcomes to a 'traditional' laboratory-based session with a demonstrator.

Using Supermarket Botany in the Classroom

We have provided two tables that will hopefully help teachers to integrate Supermarket Botany into their biology programme. Table 1 is a partial version of the Supermarket Botany survey sheet. Additional items can be added, depending on availability and the concepts to be investigated. Table 2 is a sheet on which students record their findings. We also use this sheet to discuss the correct expression of scientific names, authority citations, plant family relationships etc. Table 2 includes a dicotyledon/monocotyledon column. Almost all botanical items found in supermarkets are from angiosperms (the flowering plants). The angiosperms are primarily divided into two major groups, the dicotyledons and the monocotyledons. Supermarket botanical items can be used to explore some of the differences between these two large and important groups.

Summary

Supermarket Botany is a widely-used and effective way to introduce several important aspects of plant structure and function. Many of the existing teaching materials are either botanically inaccurate, lack important details or could be more interactive. We have designed a web-based resource that offers accurate botanical content in an engaging presentation.

Acknowledgments

We thank Jenni Horsnell for taking the images of the plant items used on the 'On the Shelf' page, Scott Black for the ToolBook programming and Alison Pound for comments on the manuscript. This development was funded by a CSU Flexible Learning Institute Seed Grant.

Table 1) Part of the survey sheet for assessing student knowledge before and after Supermarket Botany exercises.

What Plant Part am I? Tick one column per item. If you think the item is made up of more than one organ indicate the one that makes up the majority of the item.

COMMON NAME	ROOT	STEM	LEAF	FLOWERS	FRUIT (AND SEEDS)	JUST SEEDS
Carrot						
Tomato						
Potato						
Ginger						
Apple						

Table 2) Supermarket Botany recording sheet.

Species to be examined for 'Supermarket Botany', with some relevant details. **CA** - Citation authority, **D or M** - Dicotyledon or monocotyledon, **V or R** - Vegetative (root, stem, leaf) or reproductive (flower, fruit, seed), **PP** - Which plant part (root, stem, leaf, flower, fruit or seed), **Reason** - How did you decide?

References

Graham LE, Graham JM, Wilcox LW (2006) Plant Biology. Second Edition. Pearson Prentice Hall, New Jersey.

Smith, DG, Avery DF (1999) Supermarket Botany. American Biology Teacher 61, 128-131

On-line Resources

Supermarket Botany. Teachers' Domain
http://www.teachersdomain.org/resource/lsps07.sci.life.oate.plantparts/

Supermarket Botany. Missouri Botanic Garden.
http://mbgnet.net/bioplants/supermkt.html

Botany at the Grocery Store. University of Illinois.
http://www.inhs.uiuc.edu/~kenr/grocery/botany.htm

Delicious Pieces: the vegetables we eat.
http://www.wsu.edu:8080/~wsherb/edpages/delicious/introduction.html

Edible Botany, Texas A&M University
http://aggie-horticulture.tamu.edu/syllabi/201h/ediblebotany/

Resources for Sale

Botany on your Plate (www.gardeningwithkids.org)

Supermarket Botany (www.brit.org)
(Botanical Research Institute of Texas) TS

About the authors:

Geoff Burrows is a Senior Lecturer in Plant Science at Charles Sturt University. His research interests focus on the anatomy of Australian plants, including buds and fire in the eucalypts and buds and branches in the Wollemi pine. He also enjoys constructing interactive botanical web sites.

John Harper is a Senior Lecturer in Plant Science at Charles Sturt University. His research interests focus on the cell biology of plants with particular interests in the function of protein fibre components of cells collectively called the cytoskeleton.

SCIENTIFIC NAME	CA	FAMILY	D or M	COMMON NAME	V or R	PP	REASON
Daucus carota	L.	Apiaceae	D	Carrot			
Beta vulgaris	L.	Chenopodiaceae	D	Beetroot			
Solanum tuberosum	L.	Solanaceae	D	Potato			
Zingiber officinale	Rosc.	Zingiberaceae	M	Ginger			
Apium graveolens	L.	Apicaeae	D	Celery			
Allium ampeloprasum	L.	Amaryllidaceae	M	Leek			
Lactuca sativa	L.	Asteraceae	D	Lettuce			
Allium cepa	L.	Amaryllidaceae	M	Onion			
Brassica oleracea	L.	Brassicaceae	D	Cauliflower			
Brassica oleracea	L.	Brassicaceae	D	Broccoli			
Punica granatum	L.	Puniceae	D	Pomegranate			
Malus x domestica	Borkh.	Rosaceae	D	Apple			
Cucumis sativus	L.	Cucurbitaceae	D	Cucumber			
Solanum lycopersicum	Mill.	Solanaceae	D	Tomato			
Arachis hypogaea	L.	Fabaceae	D	Peanut			
Pisum sativum	L.	Fabaceae	D	Peas			
Fragaria x ananassa	Duch.	Rosaceae	D	Strawberry			