



Ri

Aus

PDplus

# Teacher Notes: Food Security



## INTRODUCTION TO THE GUIDE

RiAus PDplus Teacher Notes is a new initiative of RiAus that has been designed to assist middle school (Years 7 – 9) teachers engage and involve their students.

The notes supplement a PDplus presentation hosted by RiAus on food security, which will allow teachers to have access and put questions to scientists about their research and careers.

### RIAUS PDplus: FOOD SECURITY

**How will we feed a growing global population?**

**Monday 21 March, 3.45pm-4.30pm**

Presented by Peter Langridge, Australian Centre for Plant Functional Genomics

Teachers view live online via Centra Virtual Classroom at <http://bit.ly/peterlangridge> or [www.riaus.org.au/PDplus](http://www.riaus.org.au/PDplus). The briefing will be archived at [www.riaus.org.au/PDplus](http://www.riaus.org.au/PDplus).

## HOW TO USE THE GUIDE

The notes offer both variety and flexibility of use for the differentiated classroom. Teachers and students can choose to use all or any of the five sections – although it is recommended to use them in sequence, and all or a few of the activities within each section.

## THE 'FIVE ES' MODEL

The guide will employ the 'Five Es' instructional model designed by Biological Sciences Curriculum Study, an educational research group in Colorado, USA. It has been found to be extremely effective in engaging students in learning science and technology. It follows a constructivist or inquiry based approach to learning, in which students build new ideas on top of the information they have acquired through previous experience. Its components are:

**Engage** Students are asked to make connections between past and present learning experiences and become fully engaged in the topic to be learned.

**Explore** Students actively explore the concept or topic being taught. It is an informal process where the students should have fun manipulating ideas or equipment and discovering things about the topic.

**Explain** This is a more formal phase where the theory behind the concept is taught. Terms are defined and explanations given to models and theories.

**Elaborate** Students develop a deeper understanding of sections of the topic.

**Evaluate** Teacher and students evaluate what they have learned in

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## Useful Websites

**Population in peril data:** [www.pbs.org/wgbh/nova/worldbalance/eart-flash.html](http://www.pbs.org/wgbh/nova/worldbalance/eart-flash.html)

**Nutrition Tracker:** [www.nutritionexplorations.org/pdf/kids/nutritiontracker.pdf](http://www.nutritionexplorations.org/pdf/kids/nutritiontracker.pdf)

**Poverty and hunger:** [www.globalissues.org/article/26/poverty-facts-and-stats](http://www.globalissues.org/article/26/poverty-facts-and-stats), [http://www.worldhunger.org/articles/Learn/world\\_hunger\\_facts\\_2002.htm](http://www.worldhunger.org/articles/Learn/world_hunger_facts_2002.htm)

**Golden rice:** [www.i-sis.org.uk/rice.php](http://www.i-sis.org.uk/rice.php), [www.goldenrice.org](http://www.goldenrice.org)

## Want to feed the world?

If you're interested in ensuring that we can feed the world in the future, there are a number of career paths that you can choose. Whether you're interested in biology, chemistry, agriculture, genetics or even mathematics, there are ways that you can help protect Earth's food security.



### HOW YOU CAN HELP FOOD SECURITY

If food security is an area you think you might be interested in working in, there are many ways you can be involved. From the geneticists and molecular biologists who are breeding better plants to the town planners who are helping to build more sustainable cities that incorporate gardens and farms, you can participate regardless of where your interests and skills lie.

For those who love studying biology and chemistry, there are a steadily growing number of jobs in Australia and around the world in biotechnology,

agriculture, genetics and molecular biology. Jobs in these fields could see you working to breed more productive crops or even genetically modify plants so that they have a special trait, such as drought resistance or salinity tolerance.

There are also no shortage of jobs for people who are more interested in the environment and ecosystems. If you study ecology, botany, zoology or environmental studies, you can help to ensure that the soil and water systems that plants rely on are the highest quality possible. You could also look

at the pest species that threaten crops and try to work out how to stop these without the use of damaging pesticides.

For those who don't want to work solely in science, there are many policy and planning jobs that can help improve food security. From planning more sustainable cities to creating policies in order to provide food to developing countries, these areas are just as vital to eliminating hunger.

And helping to put food on someone's table is one of the most rewarding careers of all.

### WHERE YOU COULD WORK

While there is a great need for people to help us grow more food in Australia, food security is a field that can take you around the world. And wherever you are, there are opportunities to work in a laboratory, an office, in the field or a combination of all three.

#### A range of careers

Many agricultural students end up becoming researchers around the world, while others work for the government, industry or businesses as environmental consultants. You could also go on to work with not-for-profit organisations to help them decide what food they should be feeding the developing world.

Genetic resource scientists and agriculturalist Kenneth Street studied in Australia and now works in Aleppo in Syria. He spends some of his time in the lab and the rest of the time travelling the world, collecting rare and valuable seeds.

#### An international pursuit

Because food is vital no matter where you live, there are many collaborations between a variety of countries. There are international research groups set up in places such as Mexico, Syria and India, that have researchers from all over the world all working on growing crops for the future.

"There are fantastic opportunities to travel, not as a tourist but as a participant. I really enjoy going to places such as India and Mexico and China and have an opportunity to talk to the people in the field, to really see how they live," says plant geneticist Peter Langridge about the field of food security.

#### Seed protection

One important part of food security is the protection of seeds in order to ensure we have enough for the future. Scientists are needed to collect, identify and store seeds in seedbanks in order to take care of them. The most secure seed bank is known as the 'doomsday vault' and is on a Norwegian island in the Arctic Circle, just 1,300 km from the North Pole. The vault contains seeds from around the world no longer found in the wild.

#### Breeding better crops

There are also many projects right here in Australia. The CSIRO and the University of Western Australia in particular have very successful breeding programs that have led to significant crop advances. There are also genetically modified organisms being created in Australia, such as an insect-resistant cotton created by the CSIRO that has reduced cotton pesticide use by more than 80% in Australia.

**"There are fantastic opportunities to travel."**

# Portrait

## PETER LANGRIDGE, plant geneticist

Peter Langridge never intended to work with plants, however, these days he finds himself not only studying them, but improving their breeding strategies.

"When I was at high school I wanted to be a theoretical mathematician, but I ended up, via a long convoluted route, working on plants."

But it's a career that he's happy to have fallen into. "I've discovered that I really like working with plants," he says.

The chief executive officer of the Australian Centre for Plant Functional Genomics and professor at the University of Adelaide is currently working on improving methodologies of breeding strategies and then taking this technology to the developing world - which he says is a highlight of his job.

According to Langridge, agriculture is not a simple science, like many people think, but an extremely sophisticated field to work in, particularly with the recent improvements in genetics.

"The whole genetics area has been exploding in the last decade or so, we know so much more about the way that the genome operates. Now we're looking at how we can take this information and use it to improve crop plants and help them to succeed in an increasingly difficult environment."

While he now spends a lot of his time teaching and performing administrative tasks, a recent addition to Langridge's role is his work in developing countries.

"I've come to realise increasingly that there is huge variation in the skill level around the world and have been working on setting up breeding programs in developing countries - most recently India and China.

"Australia is in a very good position. Because of necessity -

we have a very difficult environment - we have one of the best agricultural research bases in the world, particularly with low input agriculture. Because of necessity - we have a non-subsidised system in a difficult environment - we've had to be as efficient as we can."

He now has students working around the world, including in Mexico and the UK. They are taking knowledge they have learnt in Australia and are trying to improve crops, using both molecular biology and breeding methods.

While much of the news about food security around the world is grim, Langridge still has hope, which has been reaffirmed by his role as a teacher.

**"There is doom and gloom ... but the opportunities are enormous."**

"There is ability to get trapped in doom and gloom. If you look in a bit more detail at

what can be improved, the opportunities are enormous. And you get these young people coming through who are inspired and enthusiastic and they know so much more about computer and data analysis than I knew when I was their age, and you're reminded that there is so much that we can do still."

One of his main concerns is the declining number of students going into agriculture. "Most don't

understand how exciting and intellectually challenging the agricultural industry is in general. Students need to realise that it's such a broad field. If they're interested in biochemistry, engineering or physics, there's a role for them in agriculture."



## WHERE TO STUDY

Australia is one of the best places in the world to study agriculture. Here are some courses that could help you pursue a career in food security.

### In South Australia:

#### University of Adelaide

The University of Adelaide is the only South Australian university to have a course dedicated to agriculture - the bachelor of agricultural science. If you're keen on improving food crops, this could be the course for you.

[www.adelaide.edu.au](http://www.adelaide.edu.au)

#### Flinders University

There is no specific course related to food security, but you can pursue your passion with a bachelor of science in biotechnology. Those more interested in the environment as a whole rather than individual plants can major in environmental sciences.

[www.flinders.edu.au](http://www.flinders.edu.au)

#### University of South Australia

The University of SA has a bachelor of nutrition and food sciences, which has a subject on food biotechnology that could be useful to your career.

[www.unisa.edu.au](http://www.unisa.edu.au)

### The rest of Australia:

#### University of Western Australia

UWA ranked number one in Australia in life and agricultural sciences. The bachelor of agricultural sciences will help to prepare you for a range of careers in food security.

[www.uwa.edu.au](http://www.uwa.edu.au)

#### La Trobe University, Melbourne

The bachelor of agricultural sciences/bachelor of international development explores every aspect of growing food, from genetics to finance, with a focus on the developing world.

[www.latrobe.edu.au](http://www.latrobe.edu.au)

#### University of Queensland

UQ has a specialised bachelor of agricultural sciences.

[www.uq.edu.au](http://www.uq.edu.au)

#### University of Sydney

The bachelor of science in agriculture is *not* a farming degree, advises the university. But will help you understand all aspects of farming and food production.

[www.usyd.edu.au](http://www.usyd.edu.au)

# Why are we worried about food?

If there is one thing that unites every person on the planet, no matter their culture or background, it is the need to eat and drink to stay alive. But although it is arguably our most valuable resource, the food that we rely on is beginning to run out. Already many people around the world are starving and scientists predict it is only going to get worse.

## WHAT IS FOOD SECURITY?

Food security occurs when all people and nations have ongoing access to an adequate amount of nutritious and safe food. Food security varies around the world, as different countries rely on varying food staples. However the majority rely on three food staples:

rice, maize (corn) and wheat. There are well over 20,000 edible plants in the world, but these three species make up 60% of the world's food energy intake. For this reason, ensuring these crops continue to grow is crucial to food security around the world.

## THE GLOBAL FOOD CRISIS

Going into supermarkets or hearing your parents talk lately, you may have realised that the price of food is increasing. While this is a problem for us in Australia, this is an even bigger problem for developing regions, such as India and parts of Africa, where many people are living in poverty. In 2010, the United Nations estimated that more than one in seven people around the

world don't have access to enough food. This is 150 million more people who are going hungry than just four years ago. The problem is only going to get worse as Earth's population continues to soar - it is predicted to reach more than nine billion by 2050 and in order to feed this amount of people, we will need to produce more than double the amount of food that we currently do.

## WHY DON'T WE HAVE ENOUGH FOOD?

There are many reasons that we are currently struggling to grow enough food - and these factors combined are causing what many scientists refer to as a 'perfect storm' bearing down on our crops. On top of having to cope with droughts, floods and natural disasters that affect crop growth, these factors also threaten food security:

- The global population is booming, in 40 years there will be another 2.4 billion mouths to feed.
- Arable land needed to grow crops is disappearing fast.
- The planet's climate is changing more rapidly than it naturally would, which means crops are struggling to adapt.
- In addition to pests and diseases becoming more resistant to our pesticides and sprays, the change in

climate is bringing pests and diseases into new areas where crops aren't capable of coping with them.

- The amount of fresh water in many countries is running out, and in some previously fertile regions, droughts are becoming common.
- Fertiliser supplies are dwindling - phosphorous, a key ingredient of fertilisers, is declining significantly and could be running out by 2100.
- People's diets are becoming increasingly unsustainable with people eating more meat than 10 years ago - it takes a lot more space and water to produce meat than plants.
- Many edible crops and acres of arable land are being used to create biofuels to fuel transport to help solve the world's energy crisis.

## Timeline

A brief look at humanity's relationship with food.

**11,000 - 8,000 BC** - the Neolithic Revolution begins in the 'Fertile Crescent', a region that is now mostly desertified and includes Syria, Iraq, Israel, Jordan, Turkey, Lebanon and Iran. The Neolithic revolution is the time during which humans moved from hunting and gathering in order to obtain food, to an agricultural system, where they grew their own food. It is in this region that the ancestors of modern crops originated.



**6,000 BC** - irrigation is developed around the fertile crescent and ancient Egypt.

**1700** - the English agricultural revolution begins. This movement used selective breeding and advances in technology to increase the region's food production.

**1866** - scientist and monk Gregor Mendel first describes the mechanism of inheritance - the basis of modern genetics.

## FEEDING THE FUTURE

Despite all of these obstacles, it is important for scientists and farmers to not only maintain the current amount of food they produce, but increase it. Significant increases in food yield have occurred before, most notably during the 'green revolution' that began in the early 1940s and continued into the 1970s. The green revolution was a time when scientists began to improve fertilisers, crop breeding methods, planting methods and irrigation – and it resulted in food output being almost doubled in some regions, such as India, while using the same amount of land. The leader of the green revolution, Norman Borlaug, won the Nobel Peace Prize in 1970 for his work increasing the world's food supply.

However, today we no longer have unlimited water, land and fertiliser in order to boost the amount of food grown. Therefore one of our best hopes of feeding the world is to improve our crops – making them better suited for a changing climate and able to produce more food.

Scientists around the world are now trying to do this by breeding today's crops with different strains and even

ancient crop-relatives that contain useful genes that may enable pest-resistance or heat tolerance.

Another way to improve crops is by genetically modifying them - which means manipulating an organism's genetic material by a process that doesn't occur naturally. This can allow scientists to use genes from different species, even animals, to significantly and quickly improve crops. But many people worry that in the long term genetic modification may not be safe, although so far evidence suggests that it is.

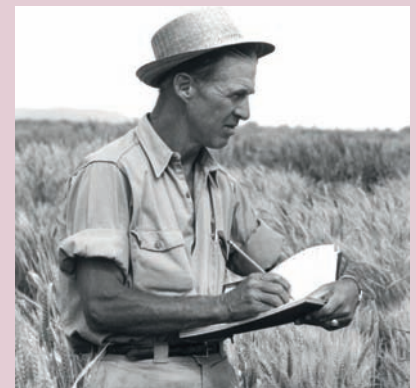
We can also increase the amount of food by making our diets more sustainable, for example, by cutting down the amount of red meat that we eat. Scientists are also looking at creating more sustainable farms and gardens, such as on rooftops in cities. This may increase the amount of land available to grow food.

With so many of the things we need to grow food running out, many people believe that humans and their intelligence, scientific knowledge and creativity are the resource that we have left to exploit.

**1944** - the green revolution begins in Mexico, led predominantly by Norman Borlaug.

**1950** - the Earth's population reaches 2.5 billion.

**1970** - Norman Borlaug receives the Nobel Peace Prize for his work during the green revolution for dedicating his career to feeding the hungry.



**1994** - the first genetically modified plant goes on sale in the U.S.: a tomato known as Flavr Savr, which had a longer shelf life than regular tomatoes.

**2009** - around 134 million hectares of farmland worldwide are used to grow genetically modified crops.

**2011** - the population reaches 6.8 billion, with more than one in seven people having insufficient access to food.



**2050** - the Earth's population is predicted to hit 9.2 billion, which will require a four fold increase in current crop production in order to feed everyone on the planet.

## Fast Facts

### Ten things you need to know about food security.

- 1** The majority of people on Earth rely on the three cereal species: rice, maize and wheat.
- 2** Agriculture uses around 70% of the world's freshwater resources.
- 3** More than one in seven people around the world do not have enough food.
- 4** In 2020, developing countries will eat 107 million tonnes more meat than in the late 1990s.
- 5** It takes around 50,000 L of water to produce 1 kg of beef, compare to around 1,000 L of water to produce 1 kg of wheat.
- 6** Humans use up about 40% of the planet's organic matter produced by green plants,
- 7** Every day, deserts take over more of the Earth's surface, roughly 10 hectares a minute.
- 8** Phosphorous, a key fertiliser ingredient, is set to be running out by 2100.
- 9** By 2100, the average global temperature is predicted to be between 2°C and 7°C higher than pre-industrial temperatures, which will interfere with plant growth.
- 10** Tropical pests and diseases are moving into new areas due to climate change.

15 January 2015

# WHEAT AT RISK OF EXTINCTION

Scientist today estimated that the wheat plant has only six months left before it becomes extinct. The announcement was made as the virus that has been devastating the world's wheat crops continued to spread across the world, yesterday reaching Australia.

## [Task] What would you do?

It is the year 2015. Something strange has been happening to the world's wheat plants. Over the course of six months a virus harmful to wheat has spread all over the world and is quickly destroying wheat plantation after wheat plantation. It is estimated that in six months time there will be no wheat plants left on Earth. What does this mean for you personally, your community, the inhabitants of Australia and the global community as a whole? Follow the steps below to investigate this hypothetical situation.

**1.** As a class, brainstorm all the foods that have wheat as an ingredient that we eat in our everyday lives, who is involved in getting wheat products to your table, other organisms that eat wheat, and any other ideas or information that you think is relevant.

Record all of your ideas on the white board.

The following websites give some more information about wheat and its use in our lives if you need some inspiration:

[www.smallgrains.org/springwh/Jan01/facts/facts.html](http://www.smallgrains.org/springwh/Jan01/facts/facts.html)

[www.canadianmillers.ca/wheat\\_facts.htm](http://www.canadianmillers.ca/wheat_facts.htm)

[www.wheatfoods.org/AboutWheat-wheat-facts/Index.htm](http://www.wheatfoods.org/AboutWheat-wheat-facts/Index.htm)

**2.** Get into teams of three or four to investigate this hypothetical issue. Each team will represent a different interest group in society, such as:

- Wheat farmers
- Supermarket CEOs
- Bakers
- Ecologists
- Economists
- Concerned parents
- Australian Government representatives
- Livestock farmers

**3.** Brainstorm a list of impacts that the extinction of the wheat plant will have on the specific group of people you're representing.

**4.** Brainstorm another list that has possible solutions or actions that could be taken to minimise these impacts to your interest group.

**5.** Present your brainstorm to the class.

## Conclusion

- Write a journal entry that discusses what your life would be like without any wheat.
- Draft a policy that could be put in place to reduce the impact of losing a major crop, such in the scenario above.
- Research a real life scenarios of a major crop failure - such as the potato famine in Ireland in the 1800s, the Great Chinese famine of 1959, the 1991 Somalian famine, the 1998 Ethiopian famine, the 2003 Sudan/Darfur famine or the North Korean famine of 2008 - and identify the similarities between this real life situation and the ideas that you discussed in your hypothetical situation.



## Teacher's information

The aim of the Explore section is for the students to investigate some of the ideas around food security and ponder their possible impacts on humans. It is intended that the students make their own discoveries as they work around the stations in the room.

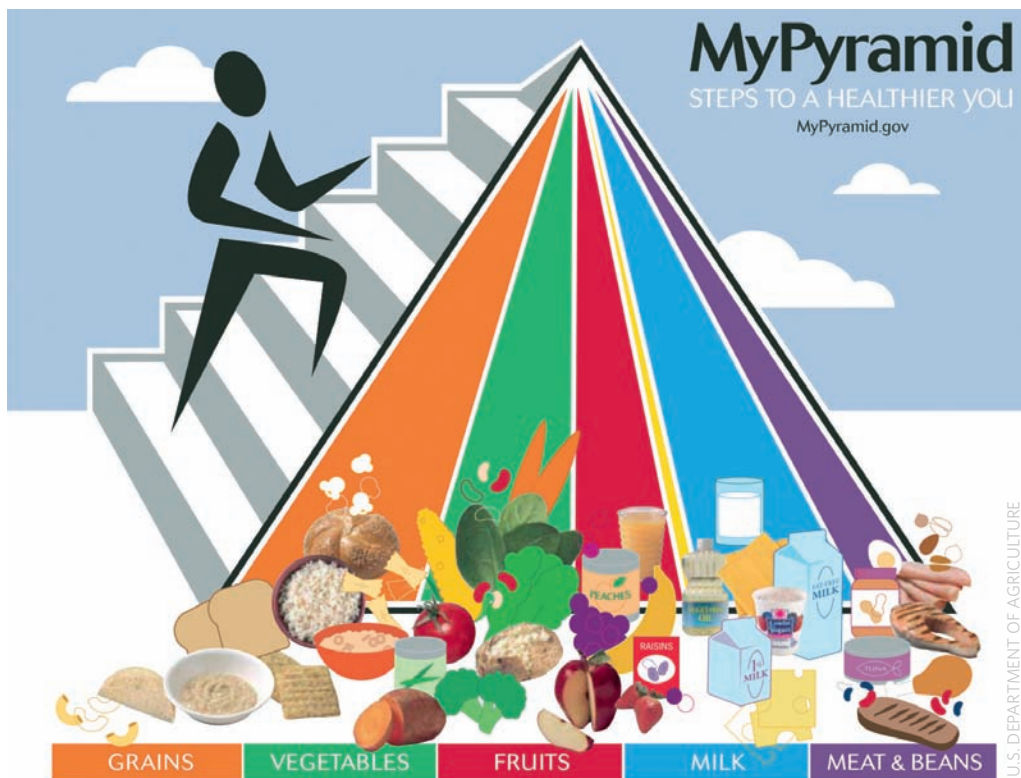
Many of the activities will need preparation a couple of weeks before the start of the unit. The table below lists the equipment and preparation required.

Station name	Materials list
The nutrient content of food	A variety of packaging from different foods that has the nutrient label on it. For example: cereal, cheese, yoghurt, muesli bars, packaged meats.
Wheat, barley and rice	Samples of: <ul style="list-style-type: none"> <li>- raw rice grains, wheat kernels or wheat germ, corn kernels, rolled oats, barley or fresh samples of a corn cob or rice and wheat plants</li> <li>- some products made out of raw rice, wheat, corn and barley, such as flour, corn flour, slices of bread, rice crackers, corn thins, cooked rice, muesli bars, etc.</li> </ul>
Material world	A computer to access <a href="http://www.pbs.org/wgbh/nova/worldbalance/material.html">www.pbs.org/wgbh/nova/worldbalance/material.html</a>
The effect of fertiliser	This station needs to be set up about two weeks in advance. Set up two experiments - one that has a group of seeds germinated and grown without fertiliser, and one that has a group of seeds grown with fertiliser. Leave the fertiliser packet out with the plants so the students can look at its contents. You could grow tomato seedlings or other types of fast growing vegetables such as bean plants.
Population data	A computer to access <a href="http://www.pbs.org/wgbh/nova/worldbalance/numbers.html">www.pbs.org/wgbh/nova/worldbalance/numbers.html</a> <a href="http://www.worldometers.info">www.worldometers.info</a>
Famine and poverty around the world	You will need to know the answer to question three - the United Nations Food and Agriculture Organisation, which measures 'undernutrition' says that 925 million people are undernourished ( <a href="http://www.fao.org/publications/sofi/en/">www.fao.org/publications/sofi/en/</a> )
Fasting	No resources needed
Food staples around the world	A computer to access <a href="http://www.cyberschool.oxfam.org.hk/eng/articles.php?id=82&amp;page=2">www.cyberschool.oxfam.org.hk/eng/articles.php?id=82&amp;page=2</a>
Grinding wheat berries	Whole wheat kernels (berries), a mortar and pestle and a sample of processed flour

## Station: The nutrient content of food

**[Task]** Have a look at the nutrient content labels on the food packages supplied by your teacher and answer the following questions in your work book.

1. What type of information does the nutrient label tell you about the food?
2. What units are the amounts of nutrients measured in?
3. Which of the foods has the most fat?
4. Which has the most carbohydrates?
5. Which has the most fibre?
6. Use the labels to put the foods into the five groups from the food pyramid below.
7. Why is it important to read the nutrient labels on foods?
8. Why do you think the yellow (oils) and purple (meat and beans) strips on the pyramid are smaller than the others?
9. What types of foods do you think you eat the most of?
10. Do you eat food from each group each day?



## Station: Wheat, barley and rice

**[Task]** Have a look at samples of wheat, barley, rice and their products that your teacher has provided and answer the following questions in your work book.

1. Make some observations about the fresh sample of the wheat, rice, corn or other grain samples. How are they similar? How are they different?
2. Match up the fresh samples with the foods that have been provided.
3. Choose one of the foods and discuss with your group about the steps that would be needed to transform the raw ingredients to the processed food. Write down your ideas in the form of a flow chart.

## Station: Material world

**[Task]** Go to the following website and take a look at the photos of the families' possessions from around the world: [www.pbs.org/wgbh/nova/worldbalance/material.html](http://www.pbs.org/wgbh/nova/worldbalance/material.html) Then answer the following questions.

1. What differences can you see between the families' possessions? Who has more? Who has less?
2. Why do you think there is a difference?
3. How does the difference between the material possessions of different groups from around the world make you feel? Is it fair that some have more and some have less?
4. How might the families in countries with more possessions affect the rest of the world?
5. Based in what you have seen on the website, predict the relative amounts of food each family would eat each day.
6. Brainstorm how science might be able to help the families that don't have enough food.

## Station: The effect of fertiliser

**[Task]** Look at the plants and fertiliser that your teacher has supplied and complete the following activities.

1. Look at the contents of the fertiliser. What is it made from?
2. Observe the plants that have been grown with and without fertilisers.
3. In your workbook, write down some of your observations of the different types of plants, such as their height, leaf colour, number of fruit or flowers. You may want to create a table to contrast and compare the plants grown with or without fertiliser.
4. Was there any difference between the plants?
5. What do you think are the negative consequences of using fertilisers, especially on a large scale such as on wheat or rice?
6. What are the negative consequences of not using fertiliser?

## Station: Population data

**[Task]** Go to the following website: [www.pbs.org/wgbh/nova/worldbalance/numbers.html](http://www.pbs.org/wgbh/nova/worldbalance/numbers.html) and [www.worldometers.info](http://www.worldometers.info) and then complete the following activities.

1. Look at the PBS website and draw a line graph to show the growth of human population from 0 AD to 2050 AD.
2. Look at the diagram of the Earth's estimated population for the year 2050. What are the continents with the most people predicted to be?
3. List some of the problems associated with the Earth's rapid population growth.
4. On the worldometers website, look at the population statistics from around the world.
5. Choose five statistics that interest, surprise or shock you and list them below.
6. Write down each statistic and the reason you chose it.

## Station: Famine and poverty around the world

**[Task]** Complete the following activities related to famine and poverty around the world.

1. In your exercise book, predict what you think the following words mean: hunger, malnutrition, protein energy malnutrition, under-nutrition and starvation.
2. Now use a dictionary to look up the definitions of the above words and write these down.
3. The world's population is well over 6 billion people. How many of these people do you think are under-nourished? Ask your teacher for the correct answer and compare it to what you originally thought.

## Station: Fasting

**[Task]** Complete the following activities related to fasting.

1. Many of you may have participated in the 40-hour famine to raise money for World Vision or have experienced the sensation of hunger if you have skipped a meal or have needed to fast for a medical procedure. Discuss with your group what it physically feels like to be hungry. How does your stomach feel? What other sensations does your body go through? Does hunger affect your thinking or your mood? Record the main points of your discussion in your work book.
2. According to the United Nations Food and Agriculture Organisation, one in seven people around the world, mostly in developing countries, experiences hunger daily. Do you think this figure is acceptable? How do facts like this make you feel?
3. Read the following passage about under-nutrition:

"Children are the most visible victims of under-nutrition. Children who are poorly nourished suffer up to 160 days of illness each year. Poor nutrition plays a role in at least half of the 10.9 million child deaths each year - five million deaths. Under-nutrition magnifies the effect of every disease, including measles and malaria. The estimated proportions of deaths in which under-nutrition is an underlying cause are roughly similar for diarrhoea (61%), malaria (57%), pneumonia (52%), and measles (45%) (Black 2003, Bryce 2005). Malnutrition can also be caused by diseases, such as the diseases that cause diarrhoea, by reducing the body's ability to convert food into usable nutrients ... Geographically, more than 70% of malnourished children live in Asia, 26% in Africa and 4% in Latin America and the Caribbean."  
 (www.worldhunger.org/articles/Learn/world%20hunger%20facts%202002.htm#Number\_of\_hungry\_people\_in\_the\_world)

What do you think the causes of under-nutrition around the world might be?

## Station: Food staples around the world

**[Task]** Go to the following website and complete the activities below:  
[www.cyberschool.oxfam.org.hk/eng/articles.php?id=82&page=2](http://www.cyberschool.oxfam.org.hk/eng/articles.php?id=82&page=2)

1. Fill in the table below (or create a similar one in your exercise book) to identify the main types of food eaten around the world.

Food staple	Description	Who eats it?	Other important information
Rice			
Wheat			
Maize/corn			
Barley			
Millet			

2. Why do you think food staples are grown in such volume?
3. Why do you think there are different food staples grown around the world?

## Station: Grinding wheat berries

**[Task]** The flour that is used in bread and cakes is made by grinding wheat berries (kernels) in very large machines in a factory. But how was wheat processed before machines were around and how do people in developing countries grind wheat without access to electricity? Complete this exercise to grind your own wheat.

1. Take the wheat kernels provided and put them in the mortar.
2. Take the pestle and grind them for a couple of minutes until they are broken down.
3. Compare your ground wheat to the processed flour. How is it different?
4. Why do you think these differences exist?
5. What other processes do you think occur to the store bought flour that make it different to hand ground wheat?
6. What would be the advantage of people making their own flour at home, either by hand or with a small electric grinder?
7. Would you consider making your own flour for baking? Why/why not?



## Teacher's information

In this section, we explain the science of food security by getting students to read *Cosmos* articles about issues and applications when securing food for the future. This section suggests discussion topics and activities linked to those articles. Each article will have its own literacy activities, which includes:

- Brainstorming
- Glossary
- Comprehension and summary
- Questioning toolkit

The articles include:

### **Article one - The population bomb** (first published in *Cosmos* 25 on 21 January 2009)

This article looks at one of the central threats to food security - the rate of population growth in the world.

Fast facts:

- The planet's population is destined to reach 9.2 billion by 2050, what kind of planet will we be living on then?
- Today, the Earth's human populations appropriate 40% of the planet's organic matter produced by green plants
- "I cannot see any way to avoid the fact that there are bound to be continent-wide famines on a very large scale in Africa and Asia."
- In Africa, within the last one hundred years of bush-meat hunting the numbers of our nearest evolutionary sibling are down to 15,000.

### **Article two - Seeds of Salvation** (first published in *Cosmos* 37 on 20 January 2011)

This article examines how science can help food shortage now and in the future by developing and distributing seeds from wild plant strains that have evolved to survive harsh conditions.

Fast facts:

- In 2010 almost one in seven people on the planet are malnourished.
- Over the last 100 years we have lost about 80% of our agricultural biodiversity.
- "There are something like 20,000 edible species of crop plants in the world and we rely on about four."
- Generally it takes 10 to 12 years to develop one variety of crop.
- "My primary drive is thinking I can contribute to alleviating poverty by ensuring everyone has food on the table."

### **Article three - Reducing your red meat footprint** (first published on *cosmosmagazine.com* on 13 September 2007)

This article discusses the personal and global benefit of reducing your red meat footprint.

Fast facts:

- With the population increase, the average daily meat intake of 100 g per person would have to fall to 90 g just to stabilise the present rate of greenhouse gas emissions
- About 80% of total agriculture-related greenhouse gases come from the methane produced by ruminants
- Consuming less red meat could reduce the risk of cancer and heart disease.

# The population bomb

A population the size of Germany's is being added to the Earth each year – the equivalent of one new city born every day. Can our planet take the strain?

**A WEBSITES GO**, the World Clock – created by media group Poodwaddle – is a compelling piece of work. Click on it and a colour chart displays our planet's vital signs: human birth rates, death rates, disease levels and a host of other measurements.

The top line is the most dramatic, however. It shows that Earth is now inhabited by more than 6,821,091,280 human beings, and the numbers flicker upward at a staggering rate. Watch the site and its whirling digits. After a minute, the population figure rises by 145, an increase of more than two people per second.

Click elsewhere and other startling statistics flash before your eyes. In those same 60 seconds, 52,000 tonnes of carbon dioxide are pumped into the atmosphere, around 25 hectares of rainforest are lost, while encroaching deserts conquer a further 10 hectares of the Earth's surface.

Our ecological woes are piling up before our eyes – and there is no doubt among many politicians, campaigners, environmentalists, and scientists as to their cause:

humanity's swelling numbers. Use of oil, land and water is rising dramatically because numbers of people are rising dramatically: it is a simple correlation. And according to statisticians, this trend will continue for another 40 years until – around 2050 – the world's population will finally reach a plateau of nine billion, an increase of more than a third.

Our world will be jam-packed. A population the size of Germany's is being added to the planet each year – the equivalent of one new city born every day. And this vast river of humanity will not be pouring in only from developing countries. Many developed nations also face substantial population hikes and one of the biggest of these is likely to be in Australia. Its population now stands at 22.5 million and by 2050 is expected to reach around 33 million, an increase of more than 50% and one that, in percentage terms, far outstrips the world average.

**The population increases by more than two people per second.**

## DRAINING RESOURCES

The question is: can the planet support nine billion humans? After all, we are not some species of beetle for whom a scrap of foliage is a square meal. We are *Homo sapiens*, an omnivore that requires around 3,000 calories of energy a day and which has already transformed much of the planet to ensure we are supplied with sustenance.

Today the Earth's human populations appropriate 40% of the planet's organic matter produced by green plants, and that figure is destined to rise substantially – with grim consequences for the rest of the plant and animal kingdoms.

Tasmanian tigers, Bali tigers, passenger pigeons and dodos have already paid the price; red wolves, Florida panthers and Asiatic lions are set to follow suit; while even the gorilla and chimp will be hard pressed to survive in the wild. In 1900, there were more than a million chimpanzees in Africa. Now, thanks to bush-meat hunting and habitat loss, numbers have dropped to around 15,000, a reduction that represents the slaughter of around 10,000 chimps a year for more than a century. And they are our nearest evolutionary siblings.

"An Armageddon is approaching," says Edward O. Wilson, conservationist and revered biologist at Harvard University in Boston. "But it is not the cosmic war and fiery collapse that mankind foretold in sacred scripture. It is the wreckage of the planet by an exuberantly plentiful and ingenious humanity."

Wilson estimates that at current rates of human disruption, half of all species now living on Earth will be extinct in 100 years as human populations continue to grow. It's a view backed by biologists, who have warned they now believe the world is in the middle of a mass extinction event



triggered by swelling human numbers. Not everyone despairs, however. For a start, it could have been a lot worse, says Peter McDonald, director of the Australian Demographic and Social Research Institute in Canberra.

He points out that in the 1960s, statisticians were

forecasting there would be around 16 billion people on our planet by 2050.

The UN's World Population Prospects for 2006 predicts a global population of just under 9.2 billion by 2050. "In other words, over the past 40 years, we have reduced the expected world population by seven billion – mainly by implementing family planning programs in the Third World. I consider that a success."

## WIDESPREAD STARVATION

The crucial question is: what kind of planet will we then be living on?

The answer may be particularly grim for countries in Africa and parts of India where population increases and impacts of climate change will be greatest.

"I cannot see any way to avoid the fact that there are bound to be continent-wide famines on a very large scale in Africa and Asia over the next few decades," states Clive Hamilton. Such views echo those of other influential doomsayers, including Paul Ehrlich, a biologist at Stanford University in California. "We have grown in number to the point where our presence is perceptibly disabling the planet like a disease," he says, adding that plague, pestilence and widespread starvation will be the inevitable consequences.

For their part, Ehrlich and others, say we have simply been lucky until now. Technological advances have staved off disaster and Armageddon has been postponed, but not derailed.

– Robert McKie

## Brainstorming

**[Task]** What do you know about the world's population? Take this quiz to find out.

1. What is the current world population?
2. What things does the population have an impact on?
3. Which country is expected to be the world's most populous at 1.6 billion by 2050?
4. What is the current population of Australia?
5. How many people live on less than US\$1.25 a day?
6. Is there enough food grown to feed and nourish all the people in the world?
7. How many people suffer from malnutrition in the world?
8. How many people are overweight in the world?
9. How many people die of hunger or hunger related disease every day in the world?
10. How much food is wasted in Australia each year?
11. What is the single biggest cause of hunger in the world?
12. Which of these foods needs the biggest amount of water to produce it? Beef, rice or soy Beans?

**Answers**  
1. 6.8 billion 2. Food availability, water availability and cleanliness, sanitation problems, agriculture, migration and the climate 3. India 4. Nearly 22 million 5. 1.4 billion 6. Yes 7. 1 billion 8. 1.8 billion 9. 25,000 10. 25% 11. Poverty 12. Beef

## Glossary

**[Task]** Use the following table to define any science words that are related to this article.

Word	Definition
Billion	
Omnivore	
Armageddon	
Ecosphere	
Family planning	
Greenhouse gases	
Environmental degradation	
Median age	
Anthropologist	
Prognostication	
Carbon emission	
Exponentially	

## Summarising

**[Task]** In your exercise book, complete the following activities related to “The population bomb”.

1. Go to the website [www.poodwaddle.com/clocks/worldclock/](http://www.poodwaddle.com/clocks/worldclock/) mentioned in the article and have a look at some of the statistics. Which ones do you find the most interesting and why?
2. Make a list of all the potential negative impacts that overpopulation could and is having on the earth.
3. What is Australia’s population predicted to be in 2050?
4. List some of the animals that are now extinct and endangered due to the impacts that humans have had on the Earth.
5. The population estimates for 2050 have been decreased. Why is this so?
6. Why do some scientists think that the world is the middle of a mass extinction event?
7. Why is overpopulation particularly concerning for developing countries?
8. Describe what kind of a world you think we will be living in 2050 if the population reaches 9.2 billion as it estimated to?

## Questioning toolkit

**[Task]** Below are a series of discussion questions in the form of a questioning toolkit. Choose some or all of the questions, or ask some of your own.

Write your ideas and opinions relating to each of the different types of questions.

Inspired by Jamie McKenzie's Questioning Toolkit - McKenzie, Jamie (2000) *Beyond Technology*, FNO Press, Bellingham, Washington, USA ([www.fno.org/nov97/toolkit.html](http://www.fno.org/nov97/toolkit.html)).

Type of question	Your ideas and opinions
<p><b>Essential questions</b> These are the most important and central questions. They probe the deepest issues that confront us and can be difficult to answer.</p> <p><b>Question:</b> What is the population of the world now? What is the population expected to peak at in about 2050? Why are such large numbers of people such an issue to planet Earth? How will humans continue to produce enough food to eat?</p>	
<p><b>Subsidiary questions</b> These questions help us to manage our information by finding the most relevant details.</p> <p><b>Questions:</b> Why are some of the current farming and fishing practices not sustainable? How does climate change threaten food supplies? What are some ways we can increase the volume of food available for consumption? What are some ways we can improve the quality of the food available for consumption? In which part of the world does food security pose the strongest threat?</p>	
<p><b>Hypothetical questions</b> Questions designed to explore the possibilities, the 'what ifs'? They are useful when we want to test our hunches.</p> <p><b>Questions:</b> What would life be like today if we were on a trajectory for 16 million people by 2050 as first anticipated, would it be any different to life now? What if we were all able to convert our homes to be sustainable - would there still be food shortage issues?</p>	
<p><b>Provocative questions</b> Questions to challenge convention.</p> <p><b>Questions:</b> Have humans become a plague species? Does the world have to have the mass starvations that Clive Hamilton is predicting - how could we try to avoid them? What sacrifices are you prepared to take to help prevent famine in your country or in another country? Who are the people going hungry now in Australia and what is being done for them? Why, as a species, aren't we responding to the warning signs about the risk to food shortages that overpopulation is causing?</p>	

# Seeds of salvation

The world is facing starvation as climate change disrupts food production and the population booms. Cosmos travels to Syria where science's last hope may be locked inside forgotten wild plants.

**I**N THE MIDST OF a red, rocky stretch of land in the northeast of Syria, hundreds of rows of wheat brace themselves against a hot, dry wind. The plants are separated into small square plots by grassy pathways, ensuring no genetic material is transferred between sets.

At first glance, the dry, yellow crops look identical – they're the only signs of life for kilometres around. But, in fact, they couldn't be more different.

Some have grown tall and straight, while others are too wild. Some haven't yet produced seeds, while others are ready to be harvested. Many couldn't take the heat while a few thrived. And these differences will determine what many populations will be eating in the next 10 to 20 years, and could decide how many people go hungry as Earth's population grows.

"We're looking for the crops that show both heat resistance and high yield," says Francis Ogonnaya, a wheat breeder with the International Centre for Agricultural Research in Dry Areas (ICARDA), 30 km south of Aleppo, Syria.

While each plot is genetically different, all the crops are the result of an arranged marriage between a wild Syrian wheat relative (which exhibits heat resistance) and a domestic wheat crop from Sudan – which loses millions of dollars in crop yield annually due to extreme heat.

When it comes to finding plants that can handle the heat, Ogonnaya is in the right place. Temperatures in Aleppo exceeded 40°C almost every day during the 2010 Northern Hemisphere summer. Sometimes, it edged above 46°C.

In the middle of the Arabian desert, it's not just heat resistance that scientists are searching for: researchers have come from all over the world to create crops for the future: wheat that is resistant to drought and salinity, chickpeas that repel fungus and crops with significantly higher yields.

## PERFECT STORM APPROACHES

Genetically superior plants couldn't come sooner – a perfect storm of obstacles is bearing down upon farmers, says Kenneth Street, an Australian agriculturalist and genetic resource scientist at ICARDA. The world's population continues to grow rapidly, and as it is, we can't feed the mouths we have: in 2010, almost



one in seven people on the planet were malnourished.

The problem is not only that we have more mouths to feed, but the fact that everything we need to grow food – water, land, fertiliser – is running out at an alarming rate, stresses Street. According to the United Nations, the world needs to double its output of food by 2050 in order to avoid global mass starvation; other estimates suggest a four-fold yield boost is needed. But Street warns that, the way things are looking now, we'll be lucky to maintain our current rate of production.

"There's climate change, our phosphorous is running out, most of the world's water basins are being sucked dry – those are the three big ones. We're also losing something like six billion hectares a year to land degradation, so you add all those things up and it's scary."

Climate change in particular is a concern, as it changes ecosystems at an unnatural rate and crops can't keep up. It also alters the entire pest and insect game for plants, as species and diseases that were once confined to the tropics spread out, adds Street. "I'm glad I'm going to be an old bastard by the time this storm hits."

The increase in output that we need to feed the growing world has been achieved before during the 'green revolution' that began in the early 1940s and continued into the late 1970s – and resulted in food output being almost doubled in some regions using the same amount of land.

However, in addition to improved breeding techniques, this increase was achieved by using a large amount of water and fertiliser, both of which today are less plentiful. "We only increased wheat yield with a lot of inputs. We've now reached a plateau," says Muhammad Imtiaz, senior chickpea breeder at ICARDA.

Without being able to increase inputs, the only hope is to improve the crops, says Imtiaz – making them work more efficiently and adapting them to better suit the region they will feed.

And this brings us back to Aleppo. Despite the barren terrain today, some 11,000 years ago Aleppo and most of northern Syria was part of the verdant Fertile Crescent – the region from which modern agriculture emerged. It was here that the eight Neolithic founder crops – emmer wheat, einkorn, barley, flax, chickpea, pea, lentil and bitter vetch – were first cultivated.

And it was here that early humans realised that hunting and gathering might not be the best use of their time and learnt

## The world needs to double its output of food by 2050.

to grow and harvest food – a movement known as the Neolithic revolution. In the thousands of years that followed, humanity changed greatly – and so

did the plants we fed on.

In the beginning, agriculture wasn't overly successful. To ensure they had enough to eat, early farmers chose plants that grew quickly and provided the most food. Through this selective breeding, modern crops were born. And they have served us well.

Yet, buried within the hundreds of thousands of plants that our ancestors didn't pick are genes that have helped these wild plants survive in one of the harshest regions on the planet, enduring droughts, salinity and temperatures ranging from –12°C to 50°C. These genes now hold the hopes of scientists around

the world and may offer a way to boost the output of regular crops.

But thanks to the increasing focus on fewer and fewer higher-yield plants in modern agriculture, these genes – which could well be our saviours in the decades ahead – are fading into the background.

“Over the last 100 years, we’ve lost about 80% of our agricultural biodiversity,” says Street. “What a lot of people argue is that all the useful biodiversity has been captured within modern crop plants. But when you’ve got all the new disease and changes in the ecosystem, you don’t know what is going to come up and what useful biodiversity is there.”

A major part of Street and his team’s work at ICARDA is to go out and collect as many seeds of ancient species as possible and screen them for useful genes.

“We rely on too few species – there are something like 20,000 edible species in the world, and we

rely on four. And if we’re going to maintain that system, we’re going to need that biodiversity to help the crops evolve.”

Of course changes to ecosystems and new diseases occur regularly, and plants have survived these pressures for hundreds of years, adds Street. “But now things are changing so quickly, our crops can’t respond in one generation to the changes. Basically, we have to drive the evolution of our crop plants artificially.”

This process is similar to an online dating service; it collects as many candidate members as possible and then creates the most fruitful matches it can.

## MAKING BETTER CROPS

Even with human intervention, the process is long and slow. First, a scientist needs to select and grow seeds that might display a desirable trait, which can range from flood resistance to the ability tolerate a disease. This in itself is harder than it sounds. There are approximately six million types of seed contained in more than 1,300 genebanks around the world. Just looking for wheat seeds involves scouring well over 500,000 different seedtypes around the world.

Once a seed has been found that displays the desired trait comes the lengthy process of incorporating the trait from the wild plants into a modern variety. And it takes a long time.

“Generally, it takes 10–12 years to develop one variety of crop,” says Imtiaz.

When food is a matter of life or death, this isn’t always an amount of time that can be afforded. Researchers at ICARDA

are currently trying to speed up the process. One way to do this is to start at the beginning and develop strategies to help scientists find the seed with their desirable trait quicker – saving both time and money. Street is currently working on a program that could improve the likelihood of finding a trait from 10% to 80%.

Of course, this isn’t the only place where the process can be sped up. Molecular biology has the potential to revolutionise the creation of new crop strains. Genetic markers for traits are common in many crops, and these allow researchers to confirm that what they’re looking for is in fact present in a plant – removing a lot of the guess work and cutting procedures that would usually take three months down to a week, says Imtiaz.

## “Basically, we have to drive the evolution of our crop plants.”

The other way to get improved crops to farmers faster is the one that no one readily wants to talk about: genetically modified organisms

(GMOs). None of the crops produced by ICARDA are genetically modified, and yet there are contained labs set up on the site and introductory work being carried out, in case the process ever becomes more accepted. The scientists are preparing for good reason – GMO technology could take the 12-year process of creating a new crop strain down to as little as a year or two, according to Imtiaz.

Creating GMOs involves manipulating an organism’s genetic material by a method that doesn’t occur in nature – for example, by using bacteria to transfer an appropriate gene from one organism to another. This can provide a number of beneficial traits without the need for the lengthy breeding process.

And it won’t only shorten the procedure, it will open up avenues for a range of traits that can’t be incorporated into modern crops the traditional way. This includes creating crop strains using genes not only from different plants, but also different organisms.

Examples include the CSIRO taking an insect-resistant gene from wheat and using it to create a strain of genetically modified cotton that has reduced cotton pesticide use by over 80% in Australia.

About 134 million hectares of farmland worldwide are currently used to grow genetically modified crops. But in the public mind at least, there are still significant concerns about the technique’s safety. After reviewing extensive research, the World Health Organisation currently does not find genetically modified food a threat to human health, but scientists accept the reality that people still worry about the long-term effects.

Imtiaz understands the concerns, but feels GMOs will only ever play a specific – yet crucial – role. “GMO technology will never replace normal breeding.”

Street agrees, but thinks that eventually people will have to come to accept GM as a normal facet of modern agriculture. “I’m all for organic agriculture,” he stresses. “But if we’re going to maintain the agricultural system we have, then we are going to have to bring yields to unprecedented levels using whatever tools are at our disposal or just say, ‘OK all these masses of people are going to die, we don’t have enough food and we don’t feel comfortable using certain technologies’. We’ve got in our toolbox stuff that can integrate genes from, say, a bacterium, into crop plants, so that they’re not eaten by insects. Should we do that? It’s OK for us to sit back and say it’s messing with nature, but what do we tell a farmer in Africa when half his crops get destroyed by an insect that’s moved down [due to] climate change?”

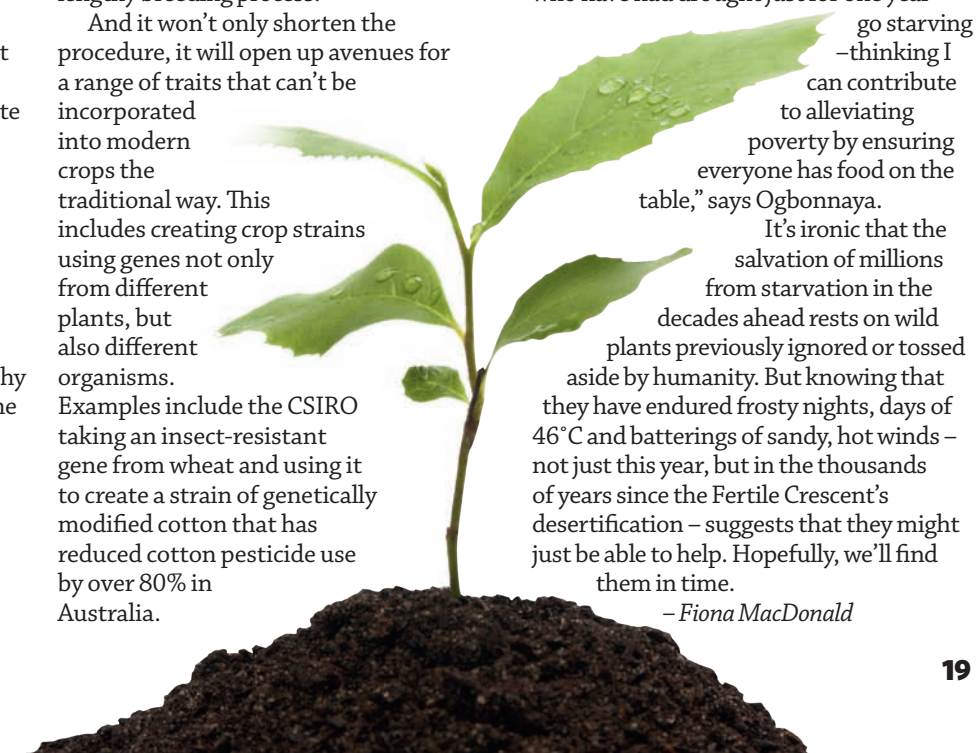
Ogbonnaya agrees: “If we can ensure that people can have nutritious food, then we should do it if it’s safe.”

Overall it seems the researchers agree that GM should only be used as a last resort – and that we are quickly approaching that juncture.

“My primary drive is seeing people who have had drought just for one year go starving – thinking I can contribute to alleviating poverty by ensuring everyone has food on the table,” says Ogbonnaya.

It’s ironic that the salvation of millions from starvation in the decades ahead rests on wild plants previously ignored or tossed aside by humanity. But knowing that they have endured frosty nights, days of 46°C and batterings of sandy, hot winds – not just this year, but in the thousands of years since the Fertile Crescent’s desertification – suggests that they might just be able to help. Hopefully, we’ll find them in time.

– Fiona MacDonald



## Brainstorming

**[Task]** Where does your food come from? Think about what you had for breakfast this morning. In the table below, list the food you ingested this morning and next to this write down where you think the ingredients in each piece of food come from, as we have done for toast.

Food	Ingredients	Where they came from
Toast	<ul style="list-style-type: none"> <li>▪ Flour - made from wheat kernels</li> <li>▪ Water</li> <li>▪ Yeast</li> </ul>	<ul style="list-style-type: none"> <li>▪ Wheat - was grown on a farm in Queensland. The farmer harvested the wheat and then collected the kernels and transported them to a factory where they were ground down and made into flour.</li> <li>▪ Water - came from the local dam where it was treated.</li> <li>▪ Yeast- made at a yeast-making factory where it was grown in a culture and extracted.</li> </ul>

## Glossary

**[Task]** Use the following table to define any science words that are related to this article.

Word	Definition
High yield	
Resistance	
Genetic	
Rigorous	
Parameter	
Salinity	
Degradation	
Irrigation	
Malnourished	
Phosphorous	
Water basins	
Biofuels	
Fossil fuels	
Selective breeding	
Biodiversity	
Genes	
GMOs	
Bacteria	
Organic agriculture	
Desertification	

## Summarising

**[Task]** In your exercise book, complete the following activities related to “Seeds of salvation”.

1. Before reading the article, what did you think it would be about by just looking at the title “Seeds of salvation”?
2. What are the favourable traits the scientists are trying to breed in the wheat in Aleppo?
3. Why are the scientists working with wheat seeds from Syria?
4. What do you think the journalist means when she writes about “an arranged marriage” between the wheat?
5. The article mentions three big problems facing food production in the future. What are these?
6. In your exercise book, create a table that contains columns that compare the cause, effect and possible solutions of the following issues affecting food production:
  - Climate change
  - Over population
  - Decrease in biodiversity
  - Decreasing water availability
  - Amount of phosphorous running out
7. Create a brief timeline, from the information in the article, that summarises the various agricultural techniques and methods from 11,000 years ago to today.
8. Draw up a flow chart that outlines the steps involved in artificially breeding seeds with desirable traits from the selection of the seeds to the shipping of these seeds out to the farmers.
9. The use of genetically modified organisms is discussed as a possible solution to the world’s food shortages. Why might GMOs cause concern for some people?

## Questioning toolkit

**[Task]** Below are a series of discussion questions in the form of a questioning toolkit. Choose some or all of the questions, or ask some of your own.

Write your ideas and opinions relating to each of the different types of questions.

Inspired by Jamie McKenzie's Questioning Toolkit - McKenzie, Jamie (2000) *Beyond Technology*, FNO Press, Bellingham, Washington, USA ([www.fno.org/nov97/toolkit.html](http://www.fno.org/nov97/toolkit.html)).

Type of question	Your ideas and opinions
<p><b>Essential questions</b> These are the most important and central questions. They probe the deepest issues that confront us and can be difficult to answer.</p> <p><b>Question:</b> How might a seed bank be our salvation to global food shortages? What are genetically modified organisms (GMOs)? What is selective breeding?</p>	
<p><b>Subsidiary questions</b> These questions help us to manage our information by finding the most relevant details.</p> <p><b>Questions:</b> What is biofuel? Why did our ancestors choose such a limited range of seeds to grow - what were/are the advantage and disadvantages of this? Is food security a new issue or has it plagued human civilisations before? Which communities are more threatened by the problem of getting enough food to eat? How does climate change threaten food security?</p>	
<p><b>Hypothetical questions</b> Questions designed to explore the possibilities, the 'what ifs'? They are useful when we want to test our hunches.</p> <p><b>Questions:</b> If we did use drought resistant GM crops in some of the dry areas of the world, roughly how many lives could we save from malnutrition or starvation? If we can't even maintain current food production do you think the world population will actually reach 10 billion by 2050?</p>	
<p><b>Provocative questions</b> Questions to challenge convention.</p> <p><b>Questions:</b> If we do not continue research into GMOs how will we know if they are safe? Should crops be grown for food or biofuel? What will happen when we finally run out of fertiliser, water or space to grow food? If your crops were prone to destruction by a particular locust, would you eat crops genetically modified to resist locusts?</p>	

# Reducing your red meat footprint

Easy on the greenhouse gases: aspiring greenies should cut down on red meat. A new report says that cutting meat consumption by 10% has environmental benefits.

**IF THEY REALLY WANT** to offset climate change, carnivores around the world should cut down their meat consumption by around 10%, according to a new report.

Greenhouse gases from farming, especially those associated with livestock, currently account for about one fifth of the total emissions worldwide, according to the Food and Agricultural Organization of the United Nations (FAO).

Global meat production could more than double by 2050, so we have to act now to mitigate the effects say authors of a new study published in the U.S. journal, *The Lancet* today. They argue that with massive population increases forecast, the average daily global meat intake of 100 g per person would have to fall to 90 g just to stabilise the present rate of greenhouse gas emissions.

## GREENHOUSE AMPLIFIER

“Meat consumption is rising in the world, as lower-income countries become wealthier and develop a consumer preference for meat-eating,” said epidemiologist and lead author, Anthony

McMichael of the Australian National University (ANU), in Canberra. “[This] is amplifying the human-induced greenhouse effect. There is a need and opportunity to reduce the amount of greenhouse gas production per unit of meat production,” he said.

About 80% of total agriculture-related greenhouse gases come from the methane produced by belching and farting cows, sheep and ruminants. Transporting grain and animals, clearing land for pasture, and the release of nitrogen from fertilisers, account for some of

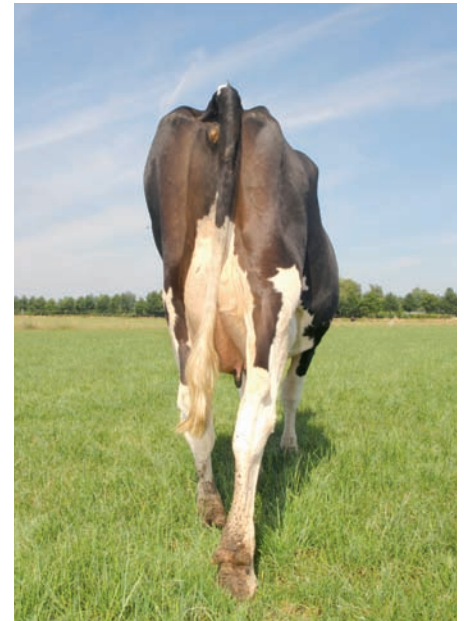
**Greenhouse gases from farming account for about one fifth of total emissions.**

the remaining emissions.

The authors argue that the environmental burden should be placed on consumers of meat because the enormity of emissions from the industry cannot be offset by good environmental practices alone. However, McMichael says, the livestock industry can do its part. “The livestock production industry needs to develop, as soon as possible, less emissions-producing methods of production,” he said.

Meat consumption varies greatly across nations. Heavy meat-consuming countries such as the U.S. and Australia weigh in at an average of more than 200 g per person per day whereas people in developing nations consume less than 25 g per day.

Consuming less red meat, down to 50 g or less per day, could also confer health benefits, such as reduced risk of cancer and heart disease. But that doesn’t mean everyone should reject a juicy steak. People suffering from iron



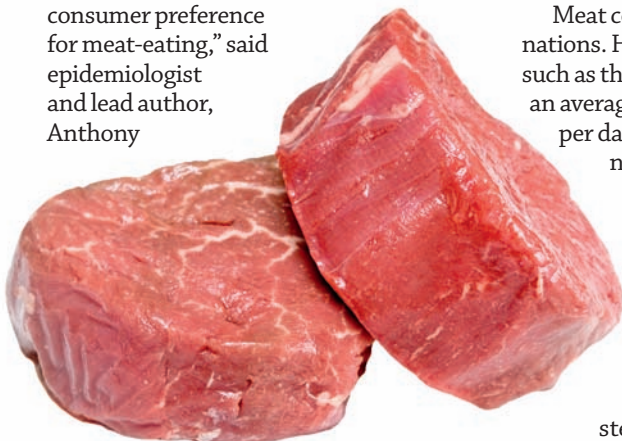
deficiency, as well as those at risk in the developed world, should actually eat more red meat said epidemiologist and co-author Colin Butler, also at the ANU.

## SUSTAINABLE AGRICULTURE

Spokesperson Damon Whittock from industry body Meat & Livestock Australia, based in Sydney, said he welcomes the report, but believes that the industry can combat climate change by developing better environmental practices.

“Climate change scenarios are far from conclusive and it is not possible to conclude that agriculture can’t adapt in a sustainable way,” he said. “We don’t deny that a great deal needs to be done to further reduce greenhouse gas emissions from the livestock industry but it would take several decades before any noticeable change could take place using the recommendations suggested in the report.”

A recent Japanese study in the *Animal Science Journal* found that the greenhouse gases generated in the production of 1 kg of beef were roughly equivalent to the environmental impact of driving for three hours and leaving all the lights on at home. – Carolyn Barry



## Brainstorming

**[Task]** How much red meat do you or your family eat? Complete the following activities in your exercise book to find out.

1. Make a prediction about how much red meat you and your family eat every week. Write down all the types of meat you would eat in a week, such as chicken, ham, beef, sausages, steak, meat pies, sausage rolls, salami etc.
2. Why do you eat red meat? If you are a vegetarian why don't you?
3. List some of the problems with eating red meat that you can think of.
4. Now create a table that allows you to list the type of meat eaten and the amount each day, similar to the example below. If you don't eat meat, track one of your family members or friends consumption for the week, with their permission.

Day of the week	Types of meat eaten	Amount
Monday		

5. At the end of the week, compare your prediction to the amount of meat you ate. Was your prediction close to the reality?
6. Did anything surprise you about your (or your study person's) meat consumption?
7. What do you think about your (or your study person's) red meat consumption? Too much, not enough or just right?

## Glossary

**[Task]** Use the following table to define any science words that are related to this article.

Word	Definition
Carnivore	
Livestock	
Greenhouse gases	
Emissions	
Mitigate	
Epidemiologist	
Amplifying	
Methane	
Nitrogen	
Conclusive	

## Summarising

**[Task]** In your exercise book, complete the following activities related to “Reducing your red meat footprint”.

1. How much do we need to cut our red meat consumption by to have an effect on climate change?
2. How much does livestock contribute to greenhouse gases worldwide?
3. What other activities contribute to the production of greenhouse gases?
4. Why is meat consumption rising in the world?
5. What is the cause of most of the agricultural greenhouse gases produced?
6. What countries eat the most red meat around the world?
7. Why is there a difference between the consumption of red meat in developed and developing countries?
8. What are the health benefits to reducing meat production in developed countries?
9. What are the benefits of increasing meat production in developing countries?
10. What did the Japanese study in the *Animal Science Journal* find about the greenhouse gases produced by the production of 1 kg of beef? What do you think about this finding?
11. If you are a red meat eater how would you feel about reducing your meat consumption? List some ways you could do this?
12. If you are not a red meat eater, suggest some ways you might be able to convince others to reduce their meat intake.

## Questioning toolkit

**[Task]** Below are a series of discussion questions in the form of a questioning toolkit. Choose some or all of the questions, or ask some of your own.

Write your ideas and opinions relating to each of the different types of questions.

Inspired by Jamie McKenzie's Questioning Toolkit - McKenzie, Jamie (2000) *Beyond Technology*, FNO Press, Bellingham, Washington, USA ([www.fno.org/nov97/toolkit.html](http://www.fno.org/nov97/toolkit.html)).

Type of question	Your ideas and opinions
<p><b>Essential questions</b> These are the most important and central questions. They probe the deepest issues that confront us and can be difficult to answer.</p> <p><b>Question:</b> Why is red meat such a greenhouse problem? Why is it so much more productive to grow plant crops on the same amount of land?</p>	
<p><b>Subsidiary questions</b> These questions help us to manage our information by finding the most relevant details.</p> <p><b>Questions:</b> What are some of the benefits of eating red meat? What are some of the drawbacks of eating red meat? What are the dietary alternatives to eating red meat? Does eating white meat (ie chickens) create the same environmental problems as eating red meat?</p>	
<p><b>Hypothetical questions</b> Questions designed to explore the possibilities, the 'what ifs'? They are useful when we want to test our hunches.</p> <p><b>Questions:</b> What if majority of the population stopped eating red meat? What if we had to kill our own red meat - would we still eat as much?</p>	
<p><b>Provocative questions</b> Questions to challenge convention.</p> <p><b>Questions:</b> If we insist on eating red meat why don't we switch to the more environmentally friendly and healthier kangaroo meat? Do we need to eat meat at all? Should there be a meat tax to help invest money in a more environmentally friendly meat industry?</p>	

## Bringing it all together

**[Task]** In your exercise book, complete the following activities to summarise the three articles.

1. In your exercise book, draw a mind map to show how the relationship between the three articles.
2. List five big issues that you have learnt about from the articles.
3. Make up five questions that you now have.



## About the COSMOS matrix

### What is the COSMOS Science Matrix?

A learning matrix such as the COSMOS Science Matrix is a flexible classroom tool designed to meet the needs of a variety of different learning styles across different levels of capabilities. Students learn in many different ways – some are suited to hands-on activities, others are strong visual learners, some enjoy intellectually challenging independent hands-off activities, while others need more guidance. The matrix provides a smorgasbord of science learning activities from which teachers and/or students can choose.

### Can I use the matrix for one or two lessons, or for a whole unit of study?

Either! The matrix is designed to be time flexible as well educationally flexible. A time frame for each activity is suggested on the matrix. Choose to complete one activity, or as many as you like.

### Is there room for student negotiation?

Yes! Students can be given a copy of the matrix and choose their own activities, or design their own activities in consultation with their classroom teacher.

### Can I use the matrix for a class assessment?

Yes! You can set up a point system – perhaps one lesson equals one point. Students can be given a number of points to complete. If they choose less demanding activities, they will have to complete more of them.

### What do the row headings mean?

Row heading	Description of activity
<b>Scientific procedure</b>	Hands-on activities that follow the scientific method. Includes experiments and surveys. Great for kinaesthetic and logical learners, as well as budding scientists.
<b>Science philosophy</b>	Thinking about science and its role in society. Includes discussion of ethical issues, debates and hypothetical situations. An important part of science in the 21st century.
<b>Being creative with science</b>	For all those imaginative students with a creative flair. Great for visual and musical learners and those who like to be innovative with the written word.
<b>Science time travel</b>	Here we consider scientific and technological development as a linear process by looking back in time or travelling creatively into the future.
<b>'Me' the scientist</b>	Personalising the science experience in order to engage students more deeply.

### What do the column headings mean?

1. Read and revise	2. Read and relate	3. Read and review
Designed to enhance student comprehension of information.	Gives the student the opportunity to apply or transfer their learning into a unique format.	Involves the more challenging tasks of analysing, and/or assessing information in order to create and express new ideas and opinions.

	<b>1. Read and revise – one or two lessons</b>	<b>2. Read and relate – three or four lessons</b>	<b>3. Read and review – four or five lessons</b>
<b>Scientific procedure</b>	How much energy is there in different nuts? Conduct an experiment to try to heat water by burning the 'fuel' in an everyday nut variety. See Experiment 1.	How do scientists know what kinds of chemicals are in different types of food? Conduct food tests in Experiment 2.	Design your own experiment to test how wheat reacts to a particular environmental condition such as high salinity, high winds, poor soil, soil erosion, pests, drought or availability of fertiliser. Write up your results in a full scientific report.
<b>Science philosophy</b>	How much responsibility as individuals should we be taking for the overall food security of others less fortunate than ourselves? If you lived in a developing country would you expect the rich countries to help?	Some doctors have called the global nutritional problems in the world today a 'nutritional holocaust'. Do you agree? What are they trying to emphasise when they make a statement like this?	Research the history of the GM crop known as Golden Rice. Perhaps different members of the class could represent different community groups, such as Greenpeace, GMO researchers, local government legislators, a parent of a child with Vitamin A deficiency. Debate whether or not Golden Rice should be given to communities suffering from Vitamin A deficiency.
<b>Being creative with science</b>	Design a poster to advertise red meat footprint reduction including all the benefits mentioned in the article. OR Create a comic strip that students could read to learn about Genetically Modified Foods.	Create a poster, brochure or PPT presentation that you could show to other students at a school assembly that highlight the issues around poverty, hunger and food production. It should also address solutions that are being sought to these problems and ways they can help in their own way.	Design a domestic 'garden' for your house, or a shared community garden on a part of the land at your local park. Make sure the garden produces a small amount of organic food that can be picked and eaten as a supplement to the food bought outside the house.
<b>Science time travel</b>	Create a timeline that shows the history of the human population and how it has changed up to today. Also include some predictions as to what the Earth's population may be in the Year 2050.	Are food shortage issues a new problem for humans? Research and present a case study of a period in history (wars, natural disasters) when food has been a problem for a community of people. Why was there a food issue? What were the consequences? What action took place (individuals, NGOs, governments) to alleviate the problem? How was the issue overcome? Could a similar problem take place again? OR Create a timeline of humans and agriculture and include the top 10-15 most significant events in the field of agriculture from simple hunting and gathering and subsistence farming of centuries ago to the production of the genetically modified foods.	It is 2050 and the world population has reached 10 billion people. Write a journal entry to describe a day in the life of someone living in a developed country and then do the same thing for someone in a developing country.
<b>'Me' the scientist</b>	How healthy is your eating? Imagine you are a nutritionalist. Keep a food diary or use the food tracker found at the site below to analyse your food choices. <a href="http://www.nutritionexplorations.org/pdf/kids/nutritiontracker.pdf">www.nutritionexplorations.org/pdf/kids/nutritiontracker.pdf</a>	Imagine you are a food security scientist and want to estimate how much food is wasted in the developed world. Keep a 'food throw' diary for one week either as an individual or for your household. Place a chart by the bin and record the type of food, volume and reason for throwing the food out. When you are done, analyse the information and try to answer the following questions: what was the most common reason for throwing away the food? How much of the binned food could have been saved? Suggest ways to reduce the amount of good food thrown away.	October 16 is International World Food Day. Imagine you are a science activist. Plan an event for school assembly or write an article for your school magazine that will raise awareness of World Food Day. Outline what the day is for, its history and some of the events that take place. Suggest ideas for events that could take place at your school to help others gain access to the food they need to stay healthy.
<b>Communicating with graphics</b>	Choose a set of data/figures from one of the articles and present them in a visually striking manner that would grab someone's attention using a graph or a chart of some sort	Create a single graph to show global population increases from the 1800s to now and then predicted populations to nine billion in 2050. OR Draw a Venn diagram of the food security problems or nutritional problems typical of the developed world compared to the developing world.	Choose one of the groups of statistics from the Poodwaddle World Clock and create a graphic that presents them in a different format, such as a graph or an applet
<b>ICT</b>	Create a video or a poster that will inform your classmates or community about one of the issues addressed in these notes that you are passionate about. It could include issues such as food wastage, poverty and food production, decreasing our red meat consumption, global population growth.	Use a computer animation program to produce a clip that could be used to inform people about the process involved in the production of 'super seeds' or genetically modified foods. Supplement the information in the article with images and further detail using the internet.	Go to the Poodwaddle World Clock site and write a review for your class or a local magazine. To evaluate the site consider the following: the range of categories where data is presented, the reliability of the data, the source of information for the site, the value of such a site, any problems with misinterpretation of the data, any way in which the data could be applied to help create a better world.

# Experiment 1

## HOW MUCH ENERGY IS THERE IN A NUT?

### BACKGROUND INFORMATION

We all need to eat food because it provides nutrients and energy. Many people eat nuts instead of meat to gain valuable proteins and oils as well as gaining energy from them.

### AIM

To try to heat water using the chemical energy stored in a nut.

### MATERIALS

- Variety of nuts
- Scalpel
- Matches
- Candle
- Test tube
- Test tube rack
- Test tube holder
- Thermometer
- Water



### RISK ANALYSIS

Complete the following table before you start the experiment.

Risk	Precaution	Consequence
Heat from Bunsen Burner		Could burn skin resulting in damage to skin and/or infection
Sharp broken glass	Check glassware for cracks before starting, place test tubes in a test tube rack, do not leave glassware near the end of the bench, notify teacher of any broken glass immediately.	
Scalpel blade		
Nut allergies (if nuts are a problem then tiny teddies can be used instead)	Check that there is no-one in the class that suffers a nut allergy before bringing them into the class	Anaphylactic shock

### METHOD

1. Choose a nut and remove any other seed coat (usually a brown 'skin' on the nut). Almonds work well.
2. Shave one end of the nut with the scalpel to make a point. Be careful to shave away from your fingers and toward the bench.
3. Set up 2 mL of water in a test tube and record the temperature.
4. Light the candle.
5. Light the end of the point of the nut with the candle flame. You will have to experiment with how sharp to make the point so that the nut can light.
6. Hold the test tube with the water over the burning nut for as long as the nut stays alight. You may need to relight the nut.
7. When the nut no longer burns, record the temperature of the water.
8. Repeat 2 more times with a fresh nut and 2 mL of room temperature water.

(Note: if using tiny teddies it will be difficult to shave them to a point so they will need to be held in a Bunsen flame with metal tongs in order to ignite)

## RESULTS

Fill in the table below, or create a similar table in your exercise book, with your results.

Nut type	Temperature of water before heating (°C)	Temperature of water after heating (°C)

## DISCUSSION

Complete these activities in your exercise book.

1. How many degrees did you manage to raise the temperature of the water in the test tube?
2. What is the unit used to measure energy?
3. Did the results for the class vary much, if so, why do you think they varied?
4. Suggest one way to improve this experiment.
5. What did you learn while conducting this experiment?

## CONCLUSION

In your exercise book, write a conclusion that responds to your aim and summarises your results.



# Experiment 2

## TESTING FOOD FOR NUTRIENTS

### BACKGROUND INFORMATION

Different foods contain a wide variety of different nutrients such as vitamins, carbohydrates glucose and starch, protein and lipids (fats and oils). Scientists conduct food tests to identify these nutrients within food so that we can use this information to help design a balanced diet.

### AIM

To identify a variety of nutrients in different food types.

### MATERIALS

- A selection of your favourite foods from a range of food groups
- Chemical reagents: Biuret solution, Benedict's solution, iodine, DCPIP
- Bunsen burner
- Matches
- Brown paper
- Pestle and mortar
- Pipettes
- Water
- Scalpel, scissors
- Test tubes
- Test tube rack
- Test tube holder



### RISK ANALYSIS

Complete the following table before you start the experiment. You can look up the risk analysis for the chemical reagents on the sides of the bottles.

Risk	Precaution	Consequence
Heat from Bunsen Burner	Tie hair back, do not place Bunsen Burner near the edge of the desk, make sure you have no loose clothing that could accidentally come near the flame, do not leave Bunsen flame unattended.	
Sharp broken glass		Could cut oneself leading to infection.
Scalpel blade		
Biuret solution		
Benedict's solution		
Iodine		
DCPIP		

## METHOD

1. Choose a piece of food from your selection and cut a small amount to mash with a pestle and mortar. Add water to turn it into a liquid solution.
2. Place a small amount of your mashed solution in a clean test tube.
3. Make a prediction as to what nutrients it will contain in the data table in the Results section.
4. Test it for the presence of protein, glucose, starch, lipids and Vitamin C using the chemical reagent and the procedure outlined below in the reference table.
5. Repeat steps 1 and 2 for a few different food types.
6. Record all results in the data table.
7. Throw all used food in the bin, return unused food to the place you got it from, wash test tubes thoroughly and pack away all equipment.

### Reference table for testing nutrients in food

Chemical to test for	Chemical reagent to test with	Procedure: How to test for the presence of the nutrient	Positive result/nutrient present if...
Protein	Biuret	Add a few drops to sample	Solution turns purple
Glucose	Benedict's solution	Add a few drops to sample and heat gently over a Bunsen Burner	Solution turns orange/red
Starch	Iodine	Add a few drops to sample	Solution turns blue / black
Lipid	Paper	Rub sample on paper	Translucent marks are left on the paper
Vitamin C	DCPIP	Add a few drops to sample	Solution goes colourless

## RESULTS

Complete the following table firstly by predicting which food will contain which nutrients before you carry out each test. When you have carried out the test, include the actual results.

### Data table: predicted and actual results of the nutrient content of different foods

Food tested	Positive result = present (✓) or negative result = not present (X)									
	Protein		Glucose		Starch		Lipid		Vitamin C	
	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual

## DISCUSSION

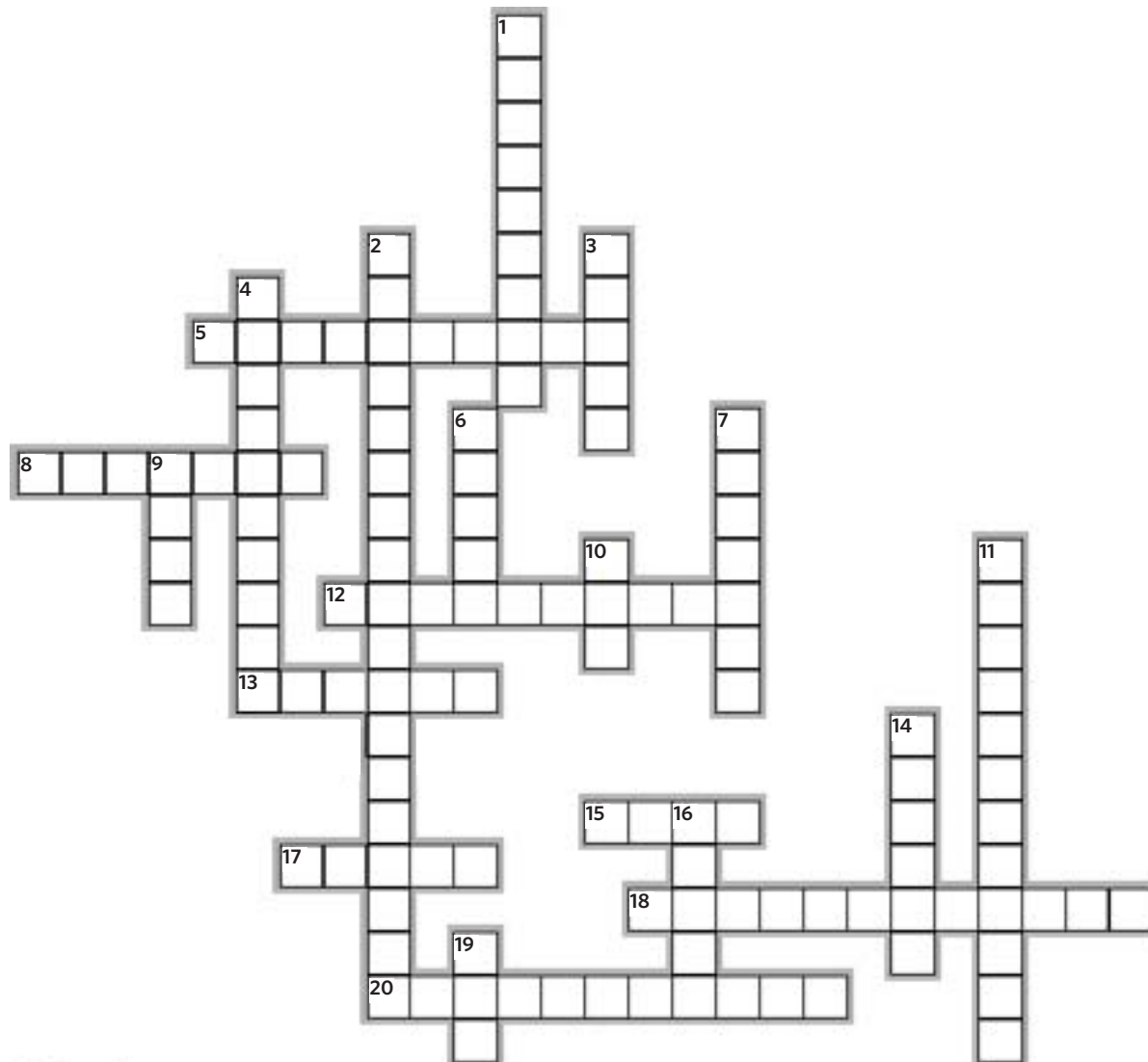
1. Which food type tested contained the most different nutrients?
2. Which food type tested contained the least number of different nutrients?
3. Did all the food types contain the nutrients you expected?
4. Which foods contained nutrients you didn't expect?
5. Which foods didn't contain nutrients you expected them to?
6. Testing tissues with chemical reagents requires care and results can often vary. From your experience, list two ways to improve your results so that each time you carry out a test you will receive the correct results.
7. What did you learn by conducting this investigation?

## CONCLUSION

In your exercise book, write a conclusion that responds to your aim and summarises your results.



## Food security crossword



### Answers

**Across:** 5. population, 8. biofuel, 12. fertiliser, 13. energy, 15. rice, 17. India, 18. biodiversity, 20. genetically.

**Down:** 1. Australia, 2. selective breeding, 3. genes, 4. golden rice, 6. wheat, 7. poverty, 9. fuel, 10. six, 11. malnourished, 14. hunger, 16. China, 19. one.

### Across

5. the total number of organisms inhabiting a certain area
8. a fuel used that is made from substances with a biological origin such as ethanol
12. used to boost plant growth
13. the thing that an organism needs in order to function
15. this number one food staple feeds half the worlds population
17. predicted to be the world's most populated country in 2050
18. the mix of plants and animal life in an environment
20. foods that have had their genes changed in some way are said to be \_\_\_\_\_ modified

### Down

1. this country had a population of 22,581,000 in March, 2011
2. a natural technique used by humans to produce plants with certain advantageous traits
3. these carry the hereditary information in organisms
4. genetically modified food staple designed to be used in communities with a Vitamin A deficiency
6. second most popular staple food
7. the number one cause of hunger and malnutrition in the world
9. made from coal, oil, wood or gas to provide energy for things to do work.
10. there are more than \_\_\_ billion people in the world
11. poorly or improperly nourished
14. a compelling need or desire for food
16. the world's most populated country in 2010
19. number of billion people experiencing hunger in the world

## Food security word search

C H J D S E M F Y E C S Q A M I I Y N S  
 B H A B E G A S T S F N A A O M G R H M  
 T E M D E P O O I G L F Z Q R N S C A H  
 A G T A E M Y T R E V O P R O T E I N F  
 E T D A H D Z D U N O I T A L U P O P D  
 H N A O R E E F C E I O O W R E N T K D  
 W U I F V D A H E S S Z S R T N E S X M  
 C T N B Y G Y R S U S H M F P T G O O L  
 I R B G M G V H B I O D I V E R S I T Y  
 T I A A E S R T O H R E S I L I T R E F  
 E T R B A R L E Y B E U R L B P F S R E  
 N I L M L H E F N O R O O P G X G M B F  
 E O M E B I O F U E L A S N C N P F F D  
 G N I D E E R B E V I T C E L E S A H C  
 S V V T M N P I N M F I B R E A E C I R  
 I Y S Y L G V Z D O R P I A R L M O I T

**Find the following words hidden backwards, forwards, diagonally, downwards and upwards.**

population, biofuel, fertiliser, poverty, fuel, malnourished, nutrition, hunger, meat, carbohydrate, fat, protein, fibre, energy, genetic, selectivebreeding, rice, barley, wheat, genes, biodiversity, security

## Create your own food security quiz

1. Ask each student to call out a word related to food security. Record these on the board.
2. Each student must pick six words from the board and write a definition for each.
3. Students then pick four more words from the board and write a paragraph describing them. They should highlight their chosen words in the paragraph.
4. Students create a concept map showing all they have learnt about food security using at least half the words from the board. They should show links between words and write along lines connecting words to show how the terms are related.

## Food security individual unit review

<b>Personal food security summary</b>	<b>Where to now?</b>
<p>Make a dot point summary or a mind map of all the things that you learnt while completing this unit on food security. Highlight or underline a couple of things that you found the most interesting.</p>	<p>Write at least five questions that have come up when studying this unit of work on food security.</p>
<b>Something ethical</b>	<b>Something political</b>
<p>List as many ethical issues you can think of that arose during your study of food security and then propose ways that some of these issues could be alleviated.</p>	<p>If you were a science leader in the world today and money and borders were not an obstacle, what are the positive changes you would like to make to remove current and possible threats so that the world is a better place for all?</p>

