



ADVANCED FOOD

Defence bars for peak performance

STEM Education Kit
for teachers, school students and parents



UPPER SECONDARY

Welcome

STEM in Defence

The Australian Department of Defence's mission is to defend Australia and its national interests. The people that work for Defence want to keep Australia and Australians safe and protect our health, freedoms and ways of living.

The Department of Defence includes:

- members of the Australian Defence Force (ADF) within the Navy, Army and Air Force; they're the ones in uniforms
- the government agency staff supporting the ADF, veterans and their families.

The Defence Science and Technology Group is part of the Department of Defence and includes scientists, engineers, project managers, mathematicians, technologists and many others focused on innovation. Plus they employ people with expertise in business; finance; human resources; occupation health, safety and environment; education and communication.

The future workforce for all Defence areas will change as technology advances and the needs of Australian society change. What is certain is that a diverse workforce with STEM skills will be more in demand.

Food research

A crucial aspect of Defence research is related to the food it provides ADF personnel. Realising that ADF members were often not getting the energy and nutrients they needed when out in the field or doing heavy exercise, Defence began exploring solutions. Researchers and technical experts collaborated with industry and university experts in universities to develop a high-energy, gut-friendly snack bar for ADF personnel. This advanced food bar is the focus of these STEM Education Kits.

Pick your education kit

Three kits have been designed for different age ranges. The kits contain engaging information, activities, design tasks and related learning. The age levels can be identified on the front cover and by the colour schemes. While these kits have been designed for teachers, school students and parents, we hope they will be interesting to all.

Connections to the Australian Curriculum are highlighted throughout using relevant codes*. When just the front of the codes is listed, for example 'ACSYS', it indicates that the information is relevant to all the specific sub-codes for the relevant year groups.

Upper primary

Key theme: food bar packaging and its relationship to the chemical properties of materials. The main activities provide opportunities to link to ACSSU074, ACSYS, ACSHE, ACTDE.

Lower secondary

Key theme: getting enough energy through food we eat and its relationship to the physical properties of energy transformation. The main activities provide opportunities to link to ACSSU179, ACSYS, ACSHE, ACTDE.

Upper secondary

Key theme: designing food to meet our different needs, including essential vitamins and minerals. This relates to nutritional requirements of living things. The main activities provide opportunities to link to ACSBL031, ACSBL034, ACSBL036, ACSBL039.

*Source: Australian Curriculum, Assessment and Reporting Authority (ACARA, July 2021)

Teaching and learning approach

These resources use an inquiry and investigative approach underpinned by the 5Es instructional model (Bybee, 2015) which outlines the phases Engage, Explore, Explain, Elaborate and Evaluate. They are also informed by the 21st Century Fluencies (Crockett et al., 2011), with the phases Define, Discover, Dream, Design, Deliver and Debrief.

Acknowledgements

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Engineering food

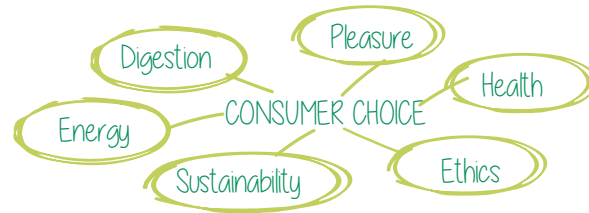
KEY CURRICULUM CODES: ACSBL031, ACSBL034, ACSBL036, ACSBL039

Designer food

From probiotic drinks to meat-free mince, people are increasingly able to meet their varied nutritional requirements with foods that weren't around 20 years ago. Food and drinks are designed now to meet a larger variety of needs than in the past. For example, from being free of common allergens like dairy or nuts to being Australian-made or created through more ethical practices.

As research advances and we increase our knowledge about how what we eat affects our health, our function and our moods, new products are created and marketed. Look around, what products are brand new that weren't available five years ago? What needs are they meeting?

Create a mind map of things that can drive food choices. Include any relevant science facts that you already know.



Food growers and manufacturers are expanding the range of plants and grains on the market. What Australian plants are being looked into? What are their benefits?

CURRICULUM CODE: ACSBL043

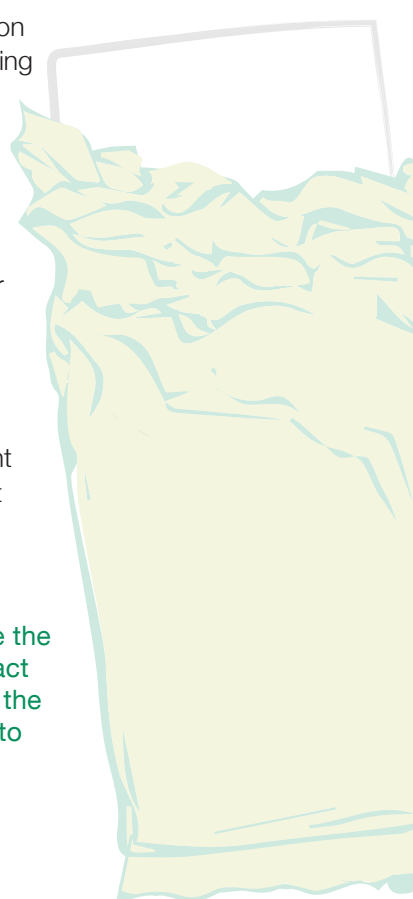
Preserving vitamins



Marmalades are made with the citrus peel. Do marmalades have more Vitamin C than jams?
Source: Calum Lewis on Unsplash.

Did you eat enough fruits and vegetables today? They're packed with nutrients to keep us healthy. Hundreds of years ago, it was trickier to maintain a balanced diet, particularly over winter. Drying food was a common practice used to prevent microorganisms spoiling food. Other preservation techniques included smoking, salting and packing in sugar.

The invention of jams was particularly helpful in places that did not have the right climate for drying fruit out completely. Bringing the fruit to boiling point helped kill any harmful microorganisms and the concentration of sugar interfered with microbial activity. Unfortunately, Vitamin C is heat-sensitive and water soluble, so it is easily degraded during boiling. Look at some jams and marmalades (in your kitchen or at the shops). How does their Vitamin C content measure up to the content of the fruit that went into making them?



Modern packaging means that sugar is added for taste rather than to preserve the food. Sugar substitutes like Stevia (made from a highly refined stevia leaf extract called rebaudioside A or 'Reb-A') provide the taste but aren't broken down by the body to provide energy. This is why non-sugar alternatives are recommended to people with health conditions like diabetes.

Engineering food



Before Vitamin C was mass produced as a supplement, ships used to take citrus juice to prevent scurvy. But it wasn't always successful. Work out why processing with copper tubes may have been an issue.

CURRICULUM CODE: ACSCH099

All cooked out

Test how much vitamin C remains when you boil orange juice for different amounts of time. You'll need to use the Vitamin C titration protocol. Look it up or visit: How to Test Vitamin C in Fruits at Home <https://www.livestrong.com/article/338206-how-to-test-vitamin-c-in-fruits-at-home>.

Test at least four different preparations of orange juice.

- Not boiled. This is your reference.
- Brought to boil and then removed.
- Boiled for 5 minutes.
- Boiled for ten minutes.

Graph your results. What does it tell you about the persistence of Vitamin C in boiling water?

Keep it fair! Remember to only change one thing: the amount of time the juice boils.



If you pour the water into a container surrounded by ice water the juice will cool quicker and reactions will stop. It's part of a cooking technique called blanching.



Research how other nutrients are affected by different cooking processes.



You will need:

- iodine
- corn starch
- eye dropper
- measuring cup
- measuring spoons
- clear glass jar
- two clear glass drinking glasses
 - spoon
- small mixing bowl
- juicer
- oranges
- iced water



Be safe! Observe standard precautions around boiling water.

Beneficial bacteria



You can get food poisoning from the microorganisms that cause food to rot. But not all microorganisms are a problem! Our intestines contain millions of microorganisms. The "good" bacteria produce by-products that are helpful for our system. The "bad" bacteria cause us intestinal issues that can affect how we feel. What kinds of bacteria flourish in our intestines depends on what we eat. The mind-gut connection is still being researched but there's science behind the saying "You are what you eat".

The term "probiotics" comes from the Latin "pro" (for) and the Greek "biotic" (life). It refers to live yeast and bacterial cultures that are beneficial to our intestinal flora. Original probiotics like live yoghurt cultures also help pre-digest the lactose in milk, making it more digestible for adults who are commonly lactose-intolerant.



What foods are modified by bacteria or yeasts before they are consumed?



In order to support our intestinal flora, the probiotics have to travel unharmed through our stomach. A real acid test!



Look into the latest research about the surprising spread of lactose tolerance in some human populations. What do you think of the proposed evolutionary processes?

CURRICULUM CODE: ACSBL090



The bacteria that ferment milk into cheese digest much of the lactose and create a product that keeps for much longer.



Source: Mohamed Hassouna on Unsplash.



Source: Photo by Monika Grabkowska on Unsplash.

Fortifying foods

Calcium is essential for healthy bones. But you can eat a diet rich in calcium, including leafy greens, legumes and dairy products, and still have brittle bones! The problem? Not getting enough Vitamin D. Without it we don't absorb calcium properly. Our skin can make Vitamin D using ultraviolet rays from the Sun. However we don't always get enough. Some groups such as the elderly are more at risk, as the skin's ability to synthesise Vitamin D decreases with age.

The solution? Add it to our food (fortify)! Some foods are naturally rich, like oily fish. But with modern food techniques we can add it to foods; commonly dairy foods. Some foods in Australia have mandatory fortification in Vitamin D, including margarines. Others can be fortified by choice. Take a stocktake of milk and milk-substitute products in your local environment. Can you rank their fortification in Vitamin D?



Leafy green smoothies (for example, containing spinach) are another way to drink calcium!



Vitamin D daily intake recommendations are based on dietary intake. Exposing ourselves to ultraviolet light to get Vitamin D needs to be balanced with the risk of skin cancer.



Look at ways in which other vitamins are absorbed. Are there factors that improve absorption? Are there factors that inhibit absorption?

CURRICULUM CODE: ACSBL044

Dietitians delivering delicious energy snacks

The Defence team is innovating with food technologies to take fortified snack bars to the next level. Read more about the science behind it all on page 8. What can you add to your mind map about things that can drive food choices?

Read about what Jaydan Hoult, a Telecommunications Technician with Defence, looks for in his ration packs on page 7. What concerns him when he is out in the field working on satellite or radio technology? What would you ask him if you got the chance?





Design Task

Try this out!

The scenario

Imagine that a company called Snacks4Youth wants to develop a new snack food bar for teenagers. It is intended to supplement their (hopefully already good) diet when they are focussed on exam study. What ingredients should the new bar contain? What do you think students want in a bar? What might the bar look like? How can you check if they would want to eat the bar?

Brief:

Pitch a new food bar concept to Snacks4Youth.

Include:

- a drawing / design of the proposed bar in its packaging
- a list of ingredients and proposed dietary information with information to justify your choices.
- the recipe of the prototype you created and how it rated with some potential stomers.



How does it taste?

It is no use designing the perfect snack bar if no one wants to eat it. Create a prototype that's as close to your designed bar as you can make it with locally available ingredients.

Then ask some potential customers to sample it, and record their feedback using scales similar to those used by the Defence team.



Be thoughtful and allergy safe! Make sure any taste testers are properly informed of everything in the bar, even if it is in small amounts or used to cook ingredients. For people who are severely allergic, trace elements from previous cooking in pans can trigger reactions.



Review the brief as you design and make sure you deliver what's needed.

Nutrition information of the Defence bar

Ingredients: Green banana resistant starch, brown rice Syrup, raisins, rice crisps (rice flour, rice bran), vegetable fat, dark compound choc (sugar, vegetable fat, cocoa powder, milk solids, soy lectin), cocoa powder, Cocoa liquor, vitamin and mineral premix, whey protein, glycerine, natural flavour, rosemary antioxidant

	AVG QTY PER SERVE (70g)	AVG QTY PER 100G
Energy (kJ)	1106	1580
Protein (g)	3.0	4.3
Fat (total, g)	7.5	10.7
Fat, Saturated (g)	7.1	10.2
Carbohydrate (total, g)	45.7	65.3
Sugars (g)	17.6	25.2
Dietary Fibre (g)	3.5	5.0
Sodium (mg)	16	23
<i>Fortified with 20% of MRDI</i>		
Vitamin B ₃ (mg)	11	15.6
Vitamin B ₆ (mg)	1	1.5
Vitamin B ₁₂ (µg)	0.34	0.48
Folate (µg)	56	80
Vitamin D (µg)	0.7	1
Vitamin E (mg)	1.4	2
Calcium (mg)	182	260

Testing, testing

The 9pt Hedonic scale of the sensory descriptors appearance, aroma, texture, flavour and overall acceptability is the most widely used scale for measuring food acceptability.

Appearance, Aroma, Texture, Flavour & Overall Acceptability								
1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither like or Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

The food action (FACT) rating scale measures overall acceptance in terms of intended frequency of eating on a 9-point successive category scale.

FACT Scale								
1	2	3	4	5	6	7	8	9
I would rather go without food than eat this	I would eat this only if there were no other choices	I would hardly ever eat this	I dont like it but would eat it on occasion	I would eat this if available but not go out of my way	I like this and would eat this now and then	I would frequently eat this	I would eat this very often	I would eat this every opportunity I had

After you have finished, take a moment to think about your design process. What went well? What did you find difficult? How might you do things differently next time?

Creating better snack bars



Image left: "Young Diggers" - soldiers from the 2nd Cavalry Regiment assist Litchfield Christain School students. Nine-year-old Liam (left) and eight-year-old Sam find out firsthand how to wear a soldier's webbing and field pack, as part of an ASLAV display at Fred's Pass in the Northern Territory. Image right: Combat ration pack laid out on a table. Source: Australian Department of Defence.

Packs and their perfect packaging

Carrying food while out in the bush or away from towns and cities is something many people in the ADF need to do. The ration packs can be exposed to heat, cold, water and lots of movement. These various stressors could potentially affect the integrity and shelf-life of the food. That's why the ration packs are so carefully created and packaged. The packaging is very important! It needs to withstand extreme environments and protect the food inside.

The packaging is:

- composed of multiple layers of various materials such as polyester, aluminium and polyethylene
- made from materials with varied thickness and important properties such as providing a barrier for flavour and aroma, gas, light, moisture and oxygen
- safe: free from toxicological products
- classified as 'food grade', meaning they are OK to be in contact with food.

What happens with bad packaging? Food can be spoiled!

So that's why Defence tests packaging to make sure it won't: tear, puncture, burst or get squashed.



You want your packaging as light as possible while keeping its contents safe.



- Each combat ration pack is designed to sustain a person for 24 hours, providing three meals, as well as snacks.
- The ration packs weigh just under 2kg making them easy to carry and store.
- Ration packs are designed to be consumed by all personnel during field exercises or while deployed on operations overseas.
- The number of ration packs produced each year depends on ADF requirements. It can be over 350,000 units per year.
- Are ration packs all the same? No. There are a number of different menu options available to provide variety.



The contributors to innovation

An innovative food bar didn't come about on its own. A lot of different people were involved in creating it. Nutritionists; food scientists; experts in food processing, manufacturing, technology; and end users (with experience eating from the ration packs, logistics, storage and environmental conditions). So many people are involved in innovation!

FAST FACT

STEM experts within Defence have been conducting food research and providing nutrition advice to Defence for more than half a century.

Meet Rosa Peterson



Good food is linked to excellent health and top physical and mental performance. When you work for the Australian Defence Force—often outdoors on land, sea or in the air—that health and performance is even more important.

When Defence realised that their staff needed better nutrition, Rosa Peterson, a Dietitian-Nutritionist, and her team were straight on the case.

They set about creating an advanced food bar that delivers 1000 kJ of energy and essential vitamins and minerals, including calcium and vitamin D to improve bone health. Additional micronutrients are included to improve energy and protein metabolism, brain function and immune and nervous system function.

“We know that when our Defence Force members are out in the field it's easy for them to run out of energy,” said Rosa.

“Also, they are often lacking the nutrients that promote good gut health and microflora, the good bacteria. So, that's why we added the green banana flour. It helps promote the good microorganisms in the gut,” she said.

We asked Rosa: How might you modify the bars to suit the needs of teenagers?

“Increase the nutrients in the bar to meet the needs of growing and active teenagers as recommended by the Australian Dietary Guidelines such as protein, carbohydrates, iron, calcium and vitamin D,” she said.



The Field Ration Eating Device otherwise known as 'FRED' from the 1950's through to today, which are held at the Australian Army Museum, Duntroon, Canberra.

Source: Australian Department of Defence.

Meet Jaydan Hoult



Jaydan Hoult, a Telecommunications Technician with the Australian Army, works with advanced military satellite and radio systems. He builds these systems out in the field and also tests and maintains them while on base in Townsville.

A big part of Jaydan's job is physical. From doing regular fitness training to travelling and working out in the rugged, Australian bush or overseas. Jaydan can be out in the field for up to seven months in a year. This means he is using Combat Ration packs (also known as 'rat packs') a lot.

“When we are out in the field, it's 24/7 work. It's hard and tiring work, but there is a really good feeling when you have been working on faults, or improving the network for a few days or a week with little sleep, and then you get it all working,” Jayden said.

“We use the ration packs every time we deploy to the field environment or when deployed overseas where standard catering isn't available.

“The packaging is good because when out in the field you want to know that your food hasn't been infested with ants or other bugs. Also, you can rely on the packaging to keep the food preserved for a very long time,” he said.

It's not just the food in the ration pack that Jaydan appreciates.

“The FRED (Field Ration Eating Device) is my favourite thing in a rat pack. It's a can opener, a spoon and a bottle opener. You can put it on your keychain too,” he said.

The contributors to innovation

Meet the Combat Rations Team

Food is crucially important for Defence personnel when they are out in the field, both in Australia or overseas. The Combat Rations Team is a specialist team making sure that the combat ration packs are nutritious and enjoyable to eat.

Creating ration packs that are nutritious, will not spoil and that people enjoy (not only how it tastes, but also how it looks, smells and feels) is important. The Combat Rations Team is continually researching new and innovative technologies and processes to ensure the packs are meeting needs of the troops.

“In consultation with the soldiers, we are always looking at ways to improve the combat ration pack,” said Emma Roccasalva, Technical Specialist in Food with the Combat Rations Team.

Some of the new innovations that the team is looking at include providing greater variety in the menu, devising simpler cooking methods and reducing the weight of the pack to make it easier for soldiers to carry.

What factors do they consider when they are revising packaging?

Emma said: “We only include packaging that meets food safety and quality standards. Depending on the product, the level of protection needed is determined by understanding the properties of the food, including shelf-life”.

Some examples of the foods with different properties:

- dried products need to be protected from moisture so packaging is thicker
- brittle products like biscuits need physical protection against being crushed so there is extra air in their packets
- main meal pouches are heated to ensure they last a long time in ration packs plus the packaging provides a light-weight alternative to canned foods and can be heated so the food can be eaten directly from the packaging
- spreads (like vegemite and jam) and sweetened condensed milk are packed in tubes so they can be used and then resealed for later use.



Image left: Analytical Chemist Liisa Trimble, examines samples of ration pack food to see how it changes over time. Image right: A vegemite and jam sandwich created from a ration pack. Source: Australian Department of Defence.



Visit the Defence website

<https://www.dst.defence.gov.au/event/national-science-week-2021>

to read the full stories.

