



Australian Government
Department of Defence

ADVANCED FOOD

Defence bars for peak performance

STEM Education Kit

for teachers, school students and parents



UPPER PRIMARY



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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Packaging for performance

KEY CURRICULUM CODES: ACSSU074, ACSIS, ACSHE, ACTDE

Why worry about nutrition?

For hundreds of years scurvy was a curse for many sailors on long journeys. Their wounds wouldn't heal well, their gums would bleed, they would get extremely tired and, if things didn't improve, they would eventually die. Suggested cures were often vile and rarely worked. In 1753, James Lind proved that citrus fruits were effective to treat and prevent scurvy. After that, fruit juice was routinely distributed to English sailors. Unfortunately, it didn't always work to prevent scurvy as this depended on how much was available, what fruits were used and how it was stored.

In the 1930s, Vitamin C was the first vitamin to be mass-produced and made into a dietary supplement. Protecting sailors from scurvy became inexpensive and foolproof. But cases can still occur today if people are not careful. People need the right amount of energy and nutrients. Food engineers work hard to research and design food solutions to meet specific needs.



Investigate what different people travelling to Australia in the 1800s ate on the ship journey and how it affected their health.

CURRICULUM CODE: ACHASSK085



An artist's impression of the First Fleet of ships that travelled to Australia. Source: State Library of New South Wales, Public domain, via Wikimedia Commons.

What do I know?

Imagine you want to provide a yummy snack bar for people going on long hikes that will take their hunger away and give them energy. They will carry their supplies in a pack on their back.

Create a mind map of things you might want to consider. Include any relevant science facts that you already know. Next, read the information text on pages 5, 6 and 7, with the help of an adult if needed.

What can you add to your mind map now?



Investigate the traditional foods of Aboriginal and Torres Strait Islander peoples and add their knowledge to your mind map.

CURRICULUM CODE: ACHASSK107

Packaging for performance

Test the competition

Some people are going on a hike through dense bush in the heavy rain. You are going to suggest which commonly available snack bar they should pack.

Design and conduct some tests of the bars in and out of their packets. You might soak them in water for five minutes or jump on them. Record what you observe in a table.

Snack bar observations

TYPE OF BAR	AFTER WATER TEST	AFTER SQUASH TEST
Bar 1	It looked: It felt:	It looked: It felt:
Bar 2	It looked: It felt:	It looked: It felt:
...

You will need:

- a selection of different snack bars
- containers the bars will fit in
- water

Questions you might think about

- How do the packets help?
- Which bar would you recommend they take and why?

Keep it fair! Remember to only change one thing: the type of bar. Keep all the other variables the same as much as possible. For example, use water from the same source, same time in the water, same size of bar, same forces applied. You want the product tests to be comparable!



Be mindful of allergies, including peanuts, when choosing bars to investigate.



Keep the packaging to use for design inspiration later.



Compare the mould growth on different bars in different conditions.

CURRICULUM CODE: ACSSU094

The Combat Rations Team

The Defence team is taking snack bars to the next level. They developed an eat-on-the-go, high-energy bar full of nutrients. But this advanced bar needs to be packaged to protect it as it goes into the combat ration pack.

The Combat Rations Team is a specialist team within Defence who design, test and test again the rations that Defence personnel are getting when they are away in the bush in Australia or overseas.

Read more about the Combat Rations Team on page 9.

What would you ask someone from this team if you got the chance?



Elizabeth Mongta and Naomi Summers, Defence civilians from the Joint Health Unit, try ration packs during Exercise Diamond Warrior. Source: Australian Department of Defence.



Design task

Try this out!

The scenario

Imagine that a company called Snacks4Youth is developing a new version of the Defence bars for primary children to carry in their packs on hikes. What might the packet around a bar look like? What materials should it be made from?



The brief

Draw your ideas of what the top and the back of the bar's package would look like on two separate A4 pages. Make sure that the packaging keeps out water and air. On a separate page, list what the packaging is made of and why you recommend those materials.



Put a box where the dietary information and ingredients would go. You don't need to have all the details.

Get inspired

Designers often find it useful to look at what is already available and to talk to the people who will use the product.

Find snack bar packets in your home, school or shops:

- Are they interesting or fun to look at?
- Do you think the food inside looks yummy?
- What information is included?
- What could be improved?
- What is the packaging made of?
- Why do you think they used those materials



Why do you think ration packs looks like this?
Source: Australian Department of Defence.

Record your notes and ideas. Share your ideas with others and ask them questions.



Test and compare the properties of different packaging materials. Can you tear them? Can you puncture them? Are they waterproof? Do they let sunlight through? Can they be made from recycled materials?

Share your design

Bring your ideas together to create your design for the package. Don't forget to include everything the brief asked for!



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



Share your design with others and use their feedback to improve it.

CURRICULUM CODE: ACHASSK107

After you have finished, take a moment to think about your design process. What went well? What did you find difficult? What feedback did you get from your family or friends when you talked to them about it? How might you do things differently next time?

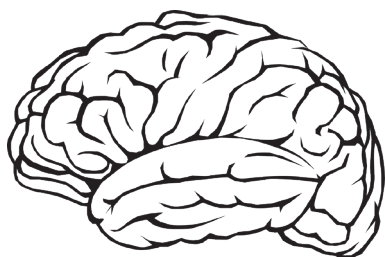


Creating better snack bars

Defence noticed that personnel on intense training courses needed more energy and better nutrition. They decided to create a snack bar to help their teams be at their best. The advanced food bars incorporate a lot of science and technology plus dedication and passion from the people involved. In addition, a lot of people helped trial the bars. That sounds like a pretty fun job!

Long-lasting energy boost

Your body is constantly using energy. It needs energy to grow, repair itself and keep your internal organs (like your heart and lungs) working. We also need lots of energy to move around, talk and think. Good energy supply is crucial for the brain; so our memory, senses and problem solving functions work properly. Physical and mental fatigue from low energy can lead to poor decision making.



Our brain is an energy drain! It is 2% of an adult's mass but can consume 20% of the body's energy.

Exercise

When you start exercising, the cells in your muscles start converting their stores of energy into useful energy. The muscle cells also absorb glucose (a simple sugar) from the bloodstream to convert to useful energy. The liver starts replacing the glucose in your blood using its stored energy (glycogen). If the exercise is intense, you use up all those easily available stores of energy too quickly. Your blood sugar drops and you feel weak, disoriented and exhausted.

Need to eat

We replenish our energy by eating and drinking. The advanced food bar delivers 1 Megajoule (MJ) of energy. That's 1,000 kilojoules (kJ)! Carbohydrates, for example starches in pasta, and fats (in oils and meat fats) are broken down by your chewing, saliva and digestive juices and absorbed through the small intestine. Proteins (in legumes, meat) are broken into essential building blocks, called amino acids, for cell function. Note that these amino acids are absorbed, but these are rarely used for energy, unless you are starving. Fibre is generally not digested but moves through us to keep our system healthy.

Making it appetising

One of the reasons the advanced food bar was developed is because personnel needed better snacks. It can be hard to find the time to have a proper meal during intense physical training and outdoor exercises. The food bar provides a powerful snack.

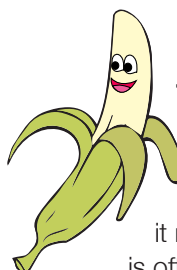
The researchers and Combat Rations Team knew that for a bar to be eaten, delivering all its goodness, people would have to actually want to eat it. Many factors were considered when they developed the bar: texture, flavour, appearance, smell and how dry/moist it was. Taste testers were asked to rank it on a scale from "I would eat this at every opportunity I had" (number 9 on the scale) to "I would rather go without food than eat this" (number 1 on the scale).



*The chocolate in the Defence bar helps it taste good.
Source: Australian Department of Defence.*

FAST FACT

Cold-press technology is used to make the bar. This is a new processing technique. It does not use heating processes that destroy the active properties of the starch and some of the useful vitamins.



The food bars have an amazing addition: Green bananas!

These bananas have a special kind of starch that resists being broken down until it reaches the large intestine. This special starch is often classified as dietary fibre. Once the banana starch reaches the large intestine it feeds good bacteria, slowly releasing useful fuel into the large intestine and suppressing hunger. Eating the bar not only gives a much-needed energy boost to replenish depleted blood sugar, it keeps you going for longer.

Thanks green bananas!

Creating better snack bars

FAST FACT

The combat ration packs are fondly called 'rat packs' by members of the Australian Defence Force. See what Jaydan says about them on page 8.

Balancing nutrition and enjoyment in 'rat packs'



Signalman Patrick Rothe grabs his last ration packs at Camp Bradman. Source: Australian Department of Defence.

The advanced food bar was developed as a supplement, not as a meal replacement. This means that it isn't designed for people to live off all the time. Balanced nutrition is important to ensure your body can work properly, fight illness and stay strong, preventing injury. It's also important that food is enjoyable! Eating together with friends and family is, after all, a joy of life.



Source: Alexander Pokusay via dreamstime.com.

Food to be healthy and strong

One thing the Defence team noticed was that their personnel had a high number of broken or fractured bones. Further investigation identified that they were not getting enough calcium and vitamin D through their normal diets. Those two micronutrients are particularly vital to creating strong, healthy bones. The bar was created to include enough calcium, vitamin D and other micronutrients (such as vitamins B3, B6, B12, Folate and Vitamin E) to give personnel 20% of the Military Recommended Dietary Intake. These micronutrients support your immune and nervous systems. They also help you to sleep better and digest your food.

Having a variety of foods in your diet helps keep your head and your intestines healthy. The connection between your mind and your intestinal health is actually very strong. Happy intestines make for happier minds.



The full ration pack contains a variety of foods; enough meals and snacks for 24 hours. Source: Australian Department of Defence.

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 Houlst



Jaydan Houlst, 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.