LIFE BEYOND

Imagining our Future in Space

FULL COURSE

UK Centre for Astrobiology

The University of Edinburgh

SPS Scottish Prison Service

Fife College

INTRODUCTION: PARTICIPANT'S GUIDE

WELCOME TO LIFE BEYOND!

One of the great ambitions of humanity is to explore and settle space. **'To boldly go where no one has gone before'**, as they say in Star Trek.

In this course, you will make your own contribution to making a home in space. You don't need to be an engineer, artist or have any special knowledge to do this course. We'll guide you through and give you a step-by-step introduction to each activity. As you go along, the pieces of work you do can be contributed to the **Life Beyond project**, which is a collection of drawings, art and writing made by participants across different prisons. They'll be displayed as part of the University of Edinburgh project (see the information about the Life Beyond project in the box below). There is even the opportunity to contribute to a **Lunar and Martian Cookbook**.

This introductory sheet explains what the project is about, what you can expect to get out of it and what you will learn.

ABOUT LIFE BEYOND

The **Life Beyond course** was started as a partnership between the **University of Edinburgh**, the **Scottish Prison Service** and **Fife College** by **Professor Charles Cockell** at the University of Edinburgh in 2016. It brings together participants in Scottish prisons to imagine the future of society beyond the Earth.

So far, participants have written **two books** (Life Beyond: From Prison to Mars and Life Beyond: From Prison to the Moon) that were published by the UK space advocacy charity, the **British Interplanetary Society**, with proceeds going to space education projects. These books have been sent to space organisations such as the **European Astronaut Centre** (part of the **European Space Agency**), space engineers in **NASA**, and other organisations.

Now you can contribute to the next phase of this project!

Participants taking part in Life Beyond have won awards with **Koestler Arts** for their work and the project was cited as an example of best practice across European prisons in the **EuroPris report**. We have used this experience to develop this course to be done by anyone with an interest.

Now is your chance to take part in this thrilling activity!

YOUR QUESTIONS ANSWERED

WHAT IS THE LIFE BEYOND PROJECT?

The **Life Beyond project** is a course to engage the prison population in the design of settlements beyond the Earth. It leads a participant (you!) through the process of making a home on another planet. **You don't need to be an engineer, artist or have knowledge of space exploration** to take part – you just need to be interested in the idea of exploring space.

The result is that participants can submit these designs and other creative artwork from the project to be part of a book. All entries will be considered for publication by the **Life Beyond team** at the **University of Edinburgh**.

Throughout this project, **activities** or **sub-activities** denoted by an **ENVELOPE ICON** ✉ are ones you can submit to the Life Beyond project if you'd like to. We have provided boxes for you to do your activities, but **feel free to use additional materials or paper if you like**.

Moon Station. A Moon station designed by participants at HMP Glenochil in Scotland. This gives you some idea of what a station on the Moon could look like.

DO I NEED TO BE A SPACE NERD?

No! Some participants had no previous interest in space exploration at all. In this course, there are huge opportunities for **art, creative writing, music, poetry etc**. One group of participants wrote Martian Blues music! You do need to have a little enthusiasm for space exploration, because that's what this course is about, but we're most interested in your **creative expression** and **ideas**.

HOW LONG DOES IT TAKE?

Life Beyond comes in two forms: our **Full Course** and a set of standalone **Short Activities**. You can do either. **This pack is the Full Course**.

The Full Course is comprised of **four modules**, each of which involves between four and eight study hours. Each module can be completed over two to three weeks, depending on your interest, time and commitment. So, the whole course is about **two to three months** of individual study time. However, at the end of each module, there are additional activities that you can do if you want to carry on doing more work. From that point of view, the course can be as long as you want.

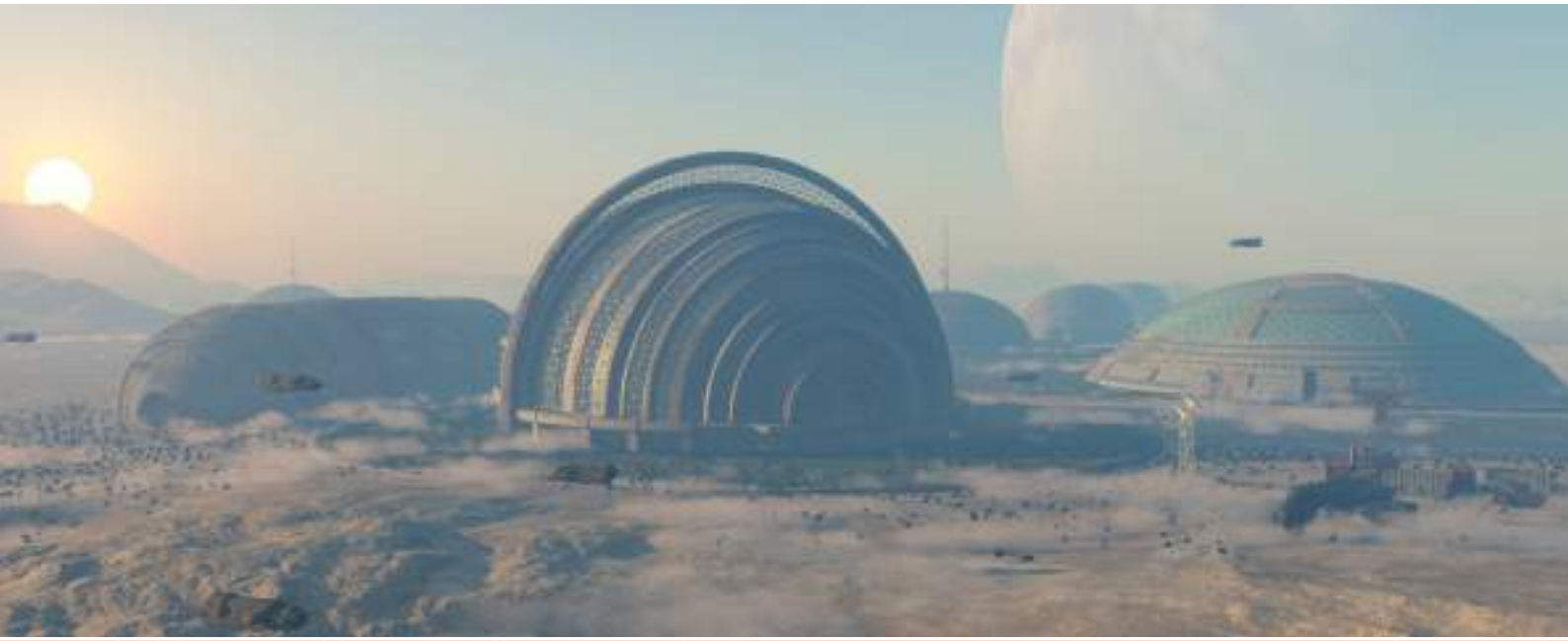
If you don't want to do the full course, there is **another pack** with **five short activities** that can be done in a day and you can still contribute these to the Life Beyond project. They are stand-alone activities and don't require reading the Full Course materials. However, if you like these short activities you could do the full course too.

You are not limited to the activities set out in the course materials. You are free to submit any creative work related to the project that you develop. **We welcome all submissions including art, short stories, poems, music etc.**

There is also a bonus hands-on activity, **Practical Activities: Origami for Space**, which invites you to do an **origami paper-folding task** that Japanese astronauts have to do. You can also try your hands at building a paper replica of some space station building materials that you might use on the Moon or Mars.

CAN I DO THIS ON MY OWN?

Life Beyond is a **stand-alone project** that you can complete as an **individual or with others** in your institution if you have a learning centre that can bring interested participants together.

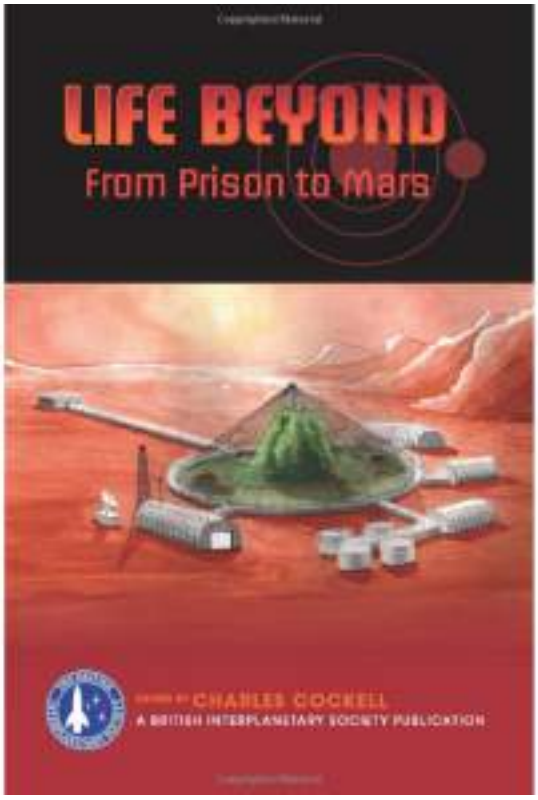


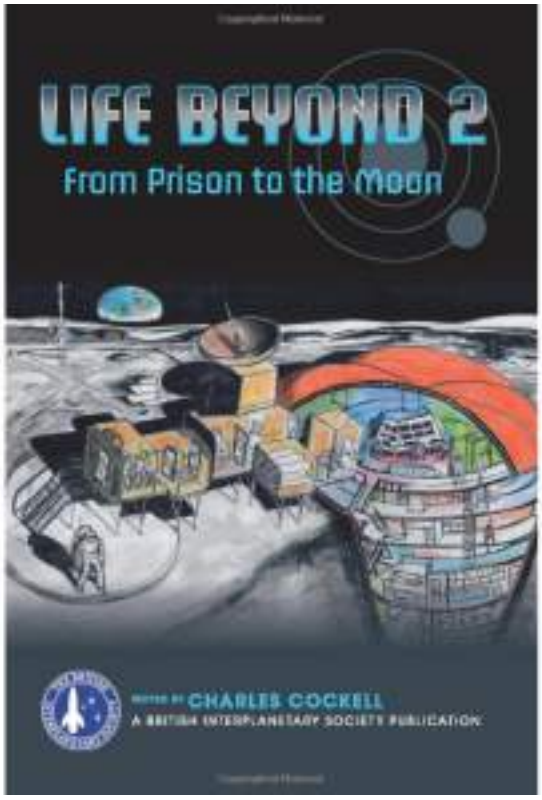
WHAT'S IN IT FOR ME?

This project will take you through the design of a home in space. Your ideas, whether they be drawings, writing or other forms of creativity, will be **published as part of a Life Beyond project,** either in a **book** or **online**. Your work will **contribute directly to a global effort** to design stations for the human settlement of space in partnership with the Life Beyond team at The University of Edinburgh.

In the process of doing this course, you'll learn some interesting things about **science, design, art, creative writing** and, of course, the settlement of space.

As well as **publishing your work**, the Life Beyond project can also give you an opportunity to create things that you could **submit to competitions**. Previous participants have submitted work to **Koestler Arts** and **won awards** for their art. They have published two books with the **British Interplanetary Society**, proceeds of which go to advancing space education projects in the UK.





WHAT HAPPENS IF I REALLY GET INTO THIS?

The activity sheets provide you with boxes in which to present your contributions, but you are not limited to these. You can use additional paper and materials if you'd like to and we welcome any further contributions. **You can send us as much as you like.**

At the end of each module you will also find suggestions for additional activities if you'd like to explore this project more.

WHAT ARE THE LEARNING OUTCOMES?

Completing this course will contribute to a range of learning outcomes, including:

- Improve your **literacy skills.**
- Improve your **science knowledge.**
- Improve your **numeracy skills.**
- Improve your **organisational skills** (studying, collating and analysing information).
- Engage you in **art projects, including creative writing.**
- Engage you in **discussions about the long-term goals of society.**
- Engage you in **what it takes to hold together a society.**
- Give you a taster of what **distance learning** is like and whether that's something you might want to do in future.

CAN I PROVIDE FEEDBACK?

At the end of this pack is a **short evaluation form**. Please do fill this in and send it back with your work. We need to know what you think about this course so that we can improve it for future participants. Beyond that, many people ask us about the value of our work, and it's important for us to be able to provide evidence that the course has been of benefit and interest to you. It won't take long to complete. Please feel free to criticise the course! **Tell us what you don't like , so we can modify the course to make it better for the future.**

MODULE 1: LIVING IN SPACE

WELCOME TO THE LIFE BEYOND PROJECT!

We really hope you enjoy this project to plan a home for the **Moon** or **Mars**. Many of our participants across **Scottish prisons** have found this hugely rewarding, and at the end of it, you get to make a direct contribution to one of humanity's biggest ambitions – to move out and **settle the Solar System**.

Before we go any further, let us just reassure you of one thing – **you don't need to be a space engineer** to do this project! There's something in it for everyone, from art to writing, and at all levels. So, buckle into your spacecraft as we head out into the Solar System!

A lunar base drawn by participants at **HMP Glenochil**. In this project, we'll take you through the process of designing your own station on the Moon or Mars (your drawings don't have to be as elaborate as this).

In this project, you are going to travel to the Moon or Mars (it's your choice) and **design a station for people to live in**. You're going to plan some adventure activities for them and think about how they are going to run their station.

You don't have to do everything in this pack, but you'll probably get the most out of it by working through the material step-by-step in your own time. It has been designed to take you through the different stages in order.

In this module **number 1**, you are going to arrive on the Moon or Mars and you are going to get familiarised with your new home. You'll **plan a meal**, think about some **sports activities** and about the **challenges** of living in this strange new place.

In **Module 2**, you'll be joining a small group of your fellow arrivals to **design a whole new space station**. You'll be taken through the steps of designing this station and you'll be able to send your station design to us at the Life Beyond project to be displayed in our next book or online.

In **Module 3**, you are going to head out of your new station with your crewmates and some tourists to do some **lunar or Martian adventure**. At the end of the module, you'll be coming up with a memento or souvenir of this adventure – for example, a short diary entry or picture, which can also be submitted to the Life Beyond project.

Finally, in the **last module**, you're going to think about how your station will be run. What sort of lunar or Martian government will you build? This is a fun activity in **designing a whole new society** and thinking about governance.

Throughout this project, we hope you'll develop your literary and numerical skills, learn some interesting science, but above all just enjoy the creative process. **There is no permanent settlement on the Moon or Mars yet, so any ideas that you come up with are as good as anyone else's**. In fact, some of our previous participants had such original and creative ideas, that they have written two books! You're not expected to write a book, but you can contribute your ideas to the Life Beyond project. We will display entries either on the web or in a book on space exploration.

Throughout this project, **activities** or s**ub-activities** denoted by an **ENVELOPE ICON**  are ones you can submit to the Life Beyond project if you'd like to. We have provided boxes for you to do your activities, but **feel free to use additional materials or paper if you like**.

If you are keen, don't feel limited by the activities denoted by the envelope icons. These activities are there to provide structure, but feel free to submit any creative work that you feel motivated to do. We'd welcome any contributions!

YOUR ARRIVAL!

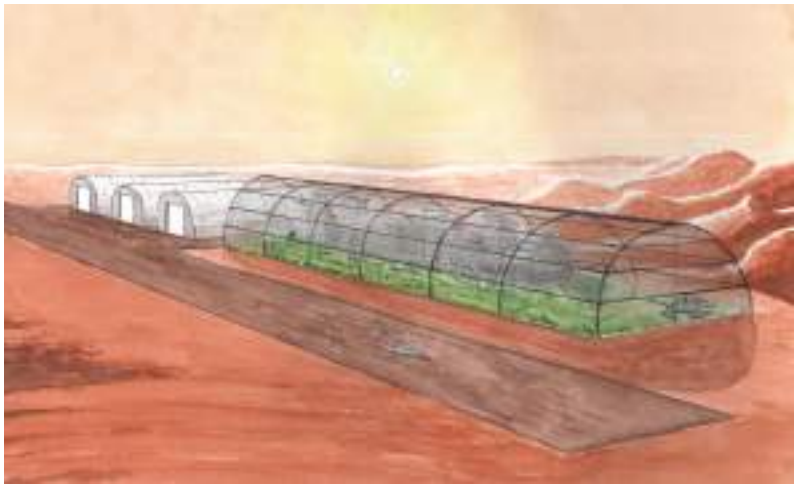
Imagine that you have just arrived at a settlement on the Moon or Mars. If you travelled to the Moon, your journey only took three days or so (the Moon is 386,400 kilometers away). If you have chosen to travel to Mars, your journey took over 200 days, because Mars is tens of millions of kilometres away. During your travels, you could float in your shuttle without any gravity. Once your spacecraft lands near the settlement, you and your crewmates have to put on thick, tightly sealed space suits.

Humans have adapted exceptionally well for life on planet Earth. We have adjusted to living with a specific amount of gravity on a planet whose oxygen-rich atmosphere we can breathe and which protects us from damaging high-energy particles streaming in from space. If we want to live on the Moon or Mars, we must find ways to survive under different conditions.

Your space suit is important for a number of reasons. The moon has no atmosphere, so your suit must provide the oxygen needed to breathe as well as enough pressure to keep your body intact. Also the temperatures in space are much more extreme. The Moon's temperatures can swing from -233°C to 123°C!

While Mars does have an atmosphere, it is less than 1% as dense as Earth's and mostly made of toxic carbon dioxide (CO_2). The temperature swings are still unwelcoming, ranging from -140°C to 30°C. Your spacesuit must be able to keep you warm when it is deathly cold outside and cool when it's boiling hot. NASA's spacesuits can contain up to 16 layers to meet all these protective requirements while being flexible enough to allow you to actually carry out tasks.

As you take your first step towards the station, you suddenly appreciate how light you feel. The Moon and Mars are much smaller than the Earth, so you feel less downward pull – less gravity. On the Moon, you only weigh one sixth of what you did on Earth. On the larger red planet Mars, you still only experience a third of the gravity of Earth.



Mars Station. A large tourist station on Mars with an agricultural area. This was painted by participants in **Life Beyond at HMP Glenochil**. Perhaps you have just arrived at this station.

The station has walls designed to protect crops and people from radiation.

Before entering the thick-walled structure, you are careful to remove any dangerous space dust from your suit. These small particles can be razor-sharp and damage your airways if you inhale them.

After ensuring you've removed dust, you first pass into a chamber that can be closed off to separate you from the extremes outside. This is properly pressurised to create a safe environment for you and your crewmates once you get out of your spacesuits. This is your first glimpse at your new home away from Earth.

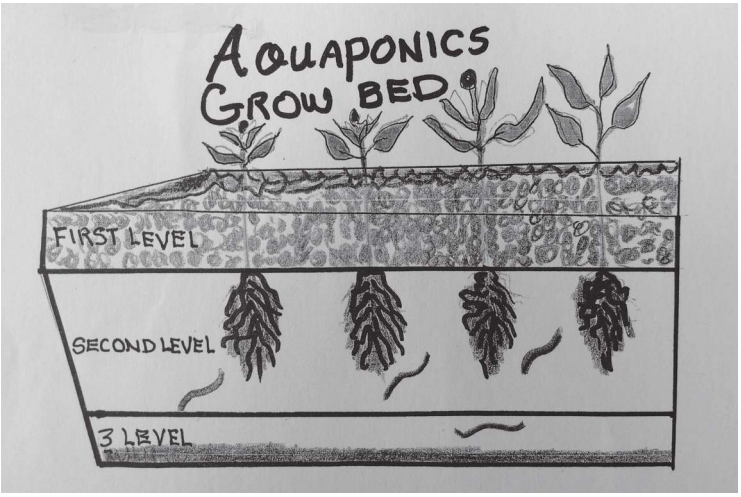
WELCOME HOME

Your new home is designed to protect you from more than the harsh temperature swings. The sun produces high-energy particles that can cause radiation damage if they pass through your body. Earth's magnetic field creates a protective envelope around Earth, deflecting much of the damaging solar radiation. However, neither Mars nor the Moon has its own magnetic field, which leaves both vulnerable to high levels of radiation. Too much exposure can lead to cancer-causing mutations and, in high enough doses, death. Your new home has been designed to protect you from these dangerous particles by having thick walls.

YOUR STATION TOUR

As you are given the tour of the station, the garden catches your eye. The plants look familiar, but they aren't growing in soil. The lower gravity means that water doesn't flow the same way as on Earth. Hydroponics, a farming method that uses nutrient-rich water instead of soil, is a promising approach to farming in space because it removes a reliance on potentially toxic soils or the need to bring heavy soil from Earth. Hydroponics also requires less water than traditional methods, making it well-suited to the requirements of space farming. On the Moon or Mars, there is very little easily gathered water available in the natural environment, so you need to try to conserve it.

In real life, astronauts have already successfully grown edible vegetables in the International Space Station. Freeze-dried pre-made meals brought from planet Earth are fine for short-term, nearby space exploration, but extraterrestrial settlements need their own sustainable food sources. While leafy greens like lettuce have successfully been grown in space, long-term settlements will require higher-protein, higher-calorie crops like beans, wheat, and sweet potatoes. During your tour, you saw some of the modules growing these crops.



Growing food in your station. A diagram, drawn by a participant of the Life Beyond course at **HMP Glenochil**, illustrating an 'aquaponics' set-up on the Moon. The plant roots (which you can see in the second level) dangle into water containing all the nutrients the plants need. No soil is used. This is a very efficient way of growing food.

RECYCLING TURNS OUT TO BE REALLY IMPORTANT

A theme of recycling emerges during your tour. Because of the scarcity of resources, recycling is essential, and every effort is made to reuse what you already have. This includes everything from plastic storage bags (one astronaut on the International Space Station got quite good at using bags as food mixing bowls in zero-G!) to not wasting water. Finding creative ways to reduce and reuse resources and materials will become second nature to you.

YOUR FIRST MEAL

At your first meal, you may find a piece of meat on your plate. But you didn't see any animals around – so where did this come from? Your meat was grown in a lab in the station, using cells taken from animals on Earth and grown around special scaffolds that help replicate the texture. If there are animals on your plate that were alive in the station, they are probably crickets or some other insect that could easily be bred with minimal resources. When cooking in space, flames are avoided to prevent accidental fires in the oxygen-rich environment.

While you will spend much of your day working, you will have some free time. This is your chance to relax and re-energise!

Before we think more about the food and leisure time at the station, let's take a moment to write home and tell loved ones or friends about your first few days at the station. This activity has the envelope icon, which means that if you want to, you can submit it to the Life Beyond project to be published online or as part of our book.

At this stage, you need to decide whether you are going to the Moon or Mars.

There is no right answer – choose whichever place takes your fancy! This is important, though, because you'll be sticking with that choice for the rest of the project.

ACTIVITY 1 - WRITING A LETTER HOME

Imagine you are sending a message home describing your first few days at the station. Have you chosen to travel to the Moon or Mars? Why did you choose this location? What have you done since arriving? What is different from back home? How are things the same? This doesn't have to be a very long message (about 200 words is typical), and you can address it to whomever you want.

Note: If you have done the Life Beyond Short Activities pack, you may already have done this activity.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO 

Dear _____

Like on Earth, one of the best ways get to know others on your mission is over a meal. However, meals in space and at your station are going to be a bit different from what you're used to. For the rest of these activities, stick with whichever location you chose to write about in the first activity.

ACTIVITY 2 - MAKING A MEAL FOR SPACE

People eat all sorts of things in space. For example, on the International Space Station astronauts eat canned curry, noodles, cookies and cake. When there is a fresh cargo delivery from NASA, they even get fresh fruit and veg. On one trip into space, astronauts were even provided with fresh ice cream!

What kind of food have you been eating at your new home? In this activity, you are going to think about making your first space meal. The best way to do this is to think about the food you have been eating here on Earth.

What was the most recent dinner you ate?

What were the ingredients and how easily or not do you think they could be produced on Mars or the Moon?

(You don't need any space expertise here, but just think about how easy or difficult it might be to make each of the ingredients – for example, would it involve growing a small plant or having a whole animal enclosure?).

Could the dish be prepared the same way, or would some changes need to be made?
Remember, open flames and space stations don't mix! You can, however, have a microwave and an electric cooker.

Now that you've thought a bit about what you last ate and the ways this meal could be made space-friendly, let's plan some food – a menu – for the day.

ACTIVITY 3 - WHAT'S ON THE MENU?

You can contribute to the **Life Beyond Lunar and Martian Cookbook**!

Given what you know about how food might be grown on a Lunar or Martian colony, it's time to design your own meal. You can keep it limited to one dish, design a multi-course dinner, or come up with a full day's worth of meals – it's all up to you! You don't have to be a gourmet chef for this activity – you could just list your favourite foods here.

Note: If you have done the Life Beyond Short Activities pack, you may already have done this activity.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

What will you eat for breakfast, lunch and dinner?

What will the dish(es) be called?

(This could be a new name for something you already eat to give it a bit more of a space 'theme').

What ingredients will you use?

THE LIFE BEYOND LUNAR AND MARTIAN COOKBOOK

In this part of the activity, you are going to contribute to the Life Beyond Lunar and Mars Cookbook! We are collecting **recipes**, **drawings of meals** and other **cooking ideas** from establishments taking part in the Life Beyond project for publication.

Note: If you have done the Life Beyond Short Activities pack, you may already have done this activity.

In this activity, you can do one of several things:

- You can write the recipe for a dish that you plan to make available in the station if you have an interest in cooking.
- You could draw what a new dish would look like.
- You could come up with a menu for some special guests.
- You can contribute any other ideas, drawings or writing that you think would be fun in a Lunar and Martian Cookbook. That could be: a poem about food, a design for a Martian kitchen, a love song or sonnet about food you might miss – anything about food that comes to mind.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

Besides needing balanced meals to stay healthy in space, you need to exercise. Living in a low-gravity environment means there is less stress on your muscles and bones than on Earth. Astronauts on the International Space Station work out for about two hours a day, six days a week, to combat losing muscle and bone density.

The space station uses a specially designed stationary bicycle and treadmill for cardiovascular exercise and a system where astronauts push or pull on a bar connected to two small vacuums to simulate lifting weights. The vacuum-based system is needed because traditional dumb-bells would both be too heavy for lift-off and would be weightless once in space. Special modifications are needed when considering exercise in a low-gravity environment.

In the next activity, let's think about your free time at the new station.

ACTIVITY 4 - HOBBIES

How do you like to relax? Reading? Watching TV? Working out? What kinds of activities might you do with your free time in the station? You don't need to come up with brand new low-gravity activities, but you are welcome to if you like!

Note: If you have done the Life Beyond Short Activities pack, you may already have done this activity.

What do you like to do in your free time?

Would this activity be done differently in a low-gravity environment?

Do you like to play any sports?

How might the rules of your favourite sport need to be adjusted to account for balls being able to travel farther and players being able to jump higher or take larger steps in low gravity? What about if everyone is playing indoors?

Besides necessary activities like eating and exercise, creative arts are important for maintaining a positive mental outlook when far from home. This next activity asks you to consider how a new environment might lead art to develop differently than on Earth. **We encourage you to let whatever interests you about life in space guide you in this section.**

ACTIVITY 5 - ART IN SPACE

This is a chance to be a bit more creative. You can choose whatever type of creative expression you like here, and you can produce as much or as little as you want.

What kind of creative activities do you like?

Drawing? Poetry? Writing stories or music? Listening to Music? Something else?

What inspires you creatively?

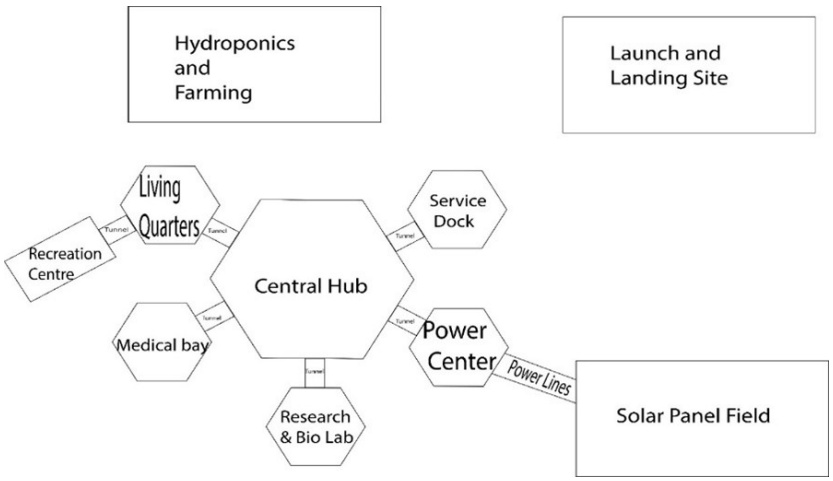
How might your inspirations be different on Mars or the Moon? Will the colours around you inspire your paintings or the low hum of the Martian ventilation system inspire you to create or listen to new music? Write some thoughts down here about what sort of creative arts you might do on the Moon or Mars.

Imagine you are living in your station and decide to create some art. This can be absolutely anything you want, from a short piece of poetry, a simple sketch, a short story, or a detailed landscape drawing of what you see out of your window. It could be a timeline or a journal entry. There are no 'right' ways to go about this.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO 

My lunar or Martian piece of art:

As we've discovered, there are a lot of adjustments needed to make living in space possible. Everything from maintaining a safe temperature to finding ways to stay healthy when there are no grocery stores to shop at or gyms to work out at must be considered.



A **Mars Station** design. A simple diagram of the design of a Mars station drawn by participants of the Life Beyond project at **HMP Edinburgh**.

In **Module 2** of this course, you'll get to design your own station.

At this stage in the module, let's try and answer some questions about what we've learnt. They will help guide some of your ideas. You can find the answers at the back of this module pack, but try to answer the questions before consulting the provided answers. Be careful to read all the answers before choosing the right one. These questions are a really good way to gain some new scientific knowledge, consolidate the knowledge you have, and develop your critical thinking skills.

SOME QUESTIONS TO HELP GUIDE YOUR IDEAS

1. Gravity is related to the mass of the planet or satellite that you're on is. Rank the Earth, Moon, and Mars in order of where you would feel the lightest to the heaviest.

a. Earth, Mars, Moon.
b. Moon, Mars, Earth.
c. Mars, Moon, Earth.
d. Moon, Earth, Mars.

2. What is a danger related to living in space?

a. Extreme temperatures.
b. Radiation.
c. Little to no oxygen.
d. All of the above.

3. Since the Moon doesn't have an atmosphere, there is no wind. This means that small moon dust particles never get smoothed down by rubbing against each other. Why is this a human health risk?

a. The dust is made of cheese; without the wind, it stays in clumps too big to be sprinkled on food.
b. It tastes very good in a sandwich.
c. The dust stays sharp, acting like tiny blades inside the lungs if accidentally inhaled.

4. What might be advantages of using hydroponics to grow plants compared to traditional methods?

a. It takes up less space.
b. It requires less water.
c. It doesn't need heavy soil.
d. All of the above.

5. Radiation is much higher on the Moon and Mars. How could this be reduced in the station?

a. The station could be covered in soil to block out the radiation.
b. The station could be built underground to give it protection from the rock or soil above it.
c. Some scientists think that a powerful artificial magnetic field could be made around a station that would deflect particles and protect it from radiation.
d. All of the above.

THAT IS THE END OF MODULE 1 - CONGRATULATIONS!

You have arrived at your new home and settled in. Hopefully you're getting used to life here. Now the next task is to do what you came here for: to design a new station for future occupants. In **Module 2,** you will be guided through designing your own station for the Moon or Mars.

In each module, there are some additional activities if you want to continue to do further work. You can do these just for your own interest, or if you like, you can submit your work to the Life Beyond project team for display in our next book or on the web.

MODULE 1: ADDITIONAL ACTIVITIES

If you would like to continue Module 1 further and contribute additional work to the Life Beyond Project, here are some activities you could undertake. We would love to see any of the work that you produce.

1. **Design a poster** that advertises the first tourist expedition to your station.

2. **Write a short article** for the local Lunar or Martian Times newspaper about your recent arrival at the station.

3. **Write a journal entry** (or multiple entries) about your journey to the Moon or Mars.

4. **Draw what the dining area might look like** if you are preparing for a special event like an important visitor from Earth or someone's birthday.

5. **Design a new sports game** suited for low gravity and little to no atmosphere. How many players will you need? If it is an outdoors game, what requirements would your space suits need? You can write rules, draw a picture of the equipment or the game in action.

6. **Make a packing list** of the essential items you would bring with you on your journey from Earth. Besides necessary things like clothes, are there any items you would bring that have sentimental value? Remember that you might have weight and space restrictions, so you need to think about how you could pack light.

7. **Imagine the future of your station in 100 years**. What might be the same? What might be different? Have humans managed to make the environment more hospitable?

8. **List the sports that you'll make available at the station** or the items you might request from Earth to put in a gym.

9. **Come up with a week's menu** of lunchtime food for your station canteen.

10. **Write a list of sports** available at the station for a new arrival.

MODULE 1 STUDY QUESTION ANSWERS

1. **Answer b**: Moon, Mars, Earth. Since gravity relates to the mass of the planet or satellite you are on, you will feel the lightest on the Moon and heaviest on Earth.

2. **Answer d**: All of the above. Without any insulating atmosphere, temperatures vary much more drastically on Mars and the Moon than they do on Earth. Special care will be needed to ensure that space stations can properly insulate their inhabitants against extreme cold and heat. Because there is no protective magnetic field like on Earth, you are at higher risk of radiation exposure in space. While oxygen is abundant on Earth, there is very little in space. Humans will need to have their own supply of the gas or we won't survive long at all.

3. **Answer c**. The dust stays sharp. While the moon dust is very sharp, it is too small to do much damage to the sturdy space suit. Your delicate lung tissue is another matter, however. Since moon dust can easily get electrostatically charged, it can be very hard to remove once it's stuck to your suit. Imagine trying to get polystyrene balls off a balloon—it's more challenging than you'd think!

4. **Answer d**. All of the above. Part of what makes hydroponics so attractive for extraterrestrial farming is that it simultaneously uses less water and takes up less space than traditional farming while removing the need to travel from Earth with bulky, heavy soil.

5. **Answer d**. All of the above. The key thing we want to do is cut down on all those high-energy particles that can damage biology such as the cells in your body. So having soil or rock over the station, building it underground or even making an artificial magnetic field around the station would all be ways to reduce the radiation.

MODULE 2: DESIGNING A HOME IN SPACE

INTRODUCTION

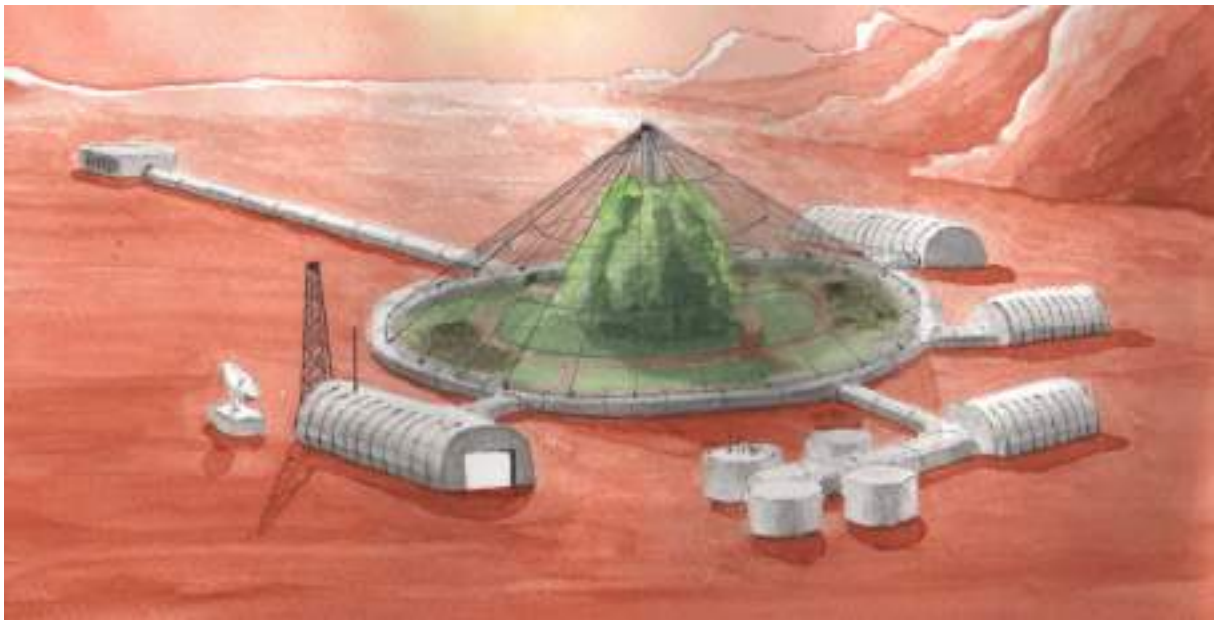
Now we've thought about some of the challenges of living in space, it's time to design your station. You have been tasked with designing a new station next to the one you are now staying in. It will be a new offshoot, and it will house a whole variety of people from crew to tourists and maybe even miners.

In this module, you'll start to put together some **ideas and concepts for your station** and what it will look like. Don't worry, you don't need to be a professional artist for this module or even a space designer! Anyone can contribute to space station designs.

Below, you can see a **Mars station** design by participants at **HMP Glenochil** as part of the **Life Beyond project**. In this module, your goal is to come up with your own station design and contribute this to a growing portfolio of space station designs from participants in the project.

Throughout this project, **activities** or s**ub-activities** denoted by an **ENVELOPE ICON**  are ones you can submit to the Life Beyond project if you'd like to. We have provided boxes for you to do your activities, but **feel free to use additional materials or paper if you like**.

If you are keen, don't feel limited by the activities denoted by the envelope icons. These activities are there to provide structure, but feel free to submit any creative work that you feel motivated to do. We'd welcome any contributions!



SOME BACKGROUND INFORMATION

WHAT WILL OUR STATION BE LIKE?

When we move to other planets, we need to build a home that people can live in – essentially a station. The extreme conditions in the outside environment on the Moon or Mars means that our station must be self-contained and have everything we need to thrive. There'll be no shops or malls we can pop into to do some shopping, so we need to make sure we have everything with us, or that we can make it locally.

Our station will have many of the features you would find in a home: a kitchen, a recreation room and other amenities. It will also be a place to prepare to go out and explore the planet we are living on. Most station designs incorporate garages for rovers and other vehicles that we might use to head out on expeditions to collect rocks or, on a planet like Mars, to look for life.

In many extraterrestrial environments, the conditions are quite extreme, and that means our station will need maintenance. We can imagine station occupants heading out in space suits to mend walls, shovel soil over habitats to protect against radiation or check pipes and valves.

HOW LONG WILL I GO FOR AND HOW MANY PEOPLE WILL THERE BE?

Some stations that have been envisaged by space agencies such as NASA would last for many decades with crews being rotated in and out. A lunar base might have teams going there for a year or two from Earth, a little bit like teams in Antarctica, where they would carry out scientific work and then return to Earth after their rotation is finished.

The size of stations varies. To begin with, we can imagine a small station of three or four modules housing a team of about 5 to 10 people. However, as activities ramp up and the scale of operations expands, we can imagine that the station would expand, perhaps housing a few tens of people. Eventually, we might imagine a much larger facility. Perhaps it will also house tourists, miners and other people who for a variety of reasons need to be on the Moon, Mars, asteroids or other places. Eventually, it will turn into a large-scale permanent settlement.

WHAT SORT OF ACTIVITIES WILL I DO THERE?

Much of your time in the station will be split between a variety of activities. You may spend some portion of your time outside on expeditions, exploring and learning about the environment around you. This might involve excursions for the day, or for a few days and weeks at a time. In the station, you will spend some time working, perhaps studying samples, or writing reports back to Earth. You might send these reports back home using a computer through something similar to the internet or a satellite telephone. Your messages will be beamed back to Earth as radio signals.

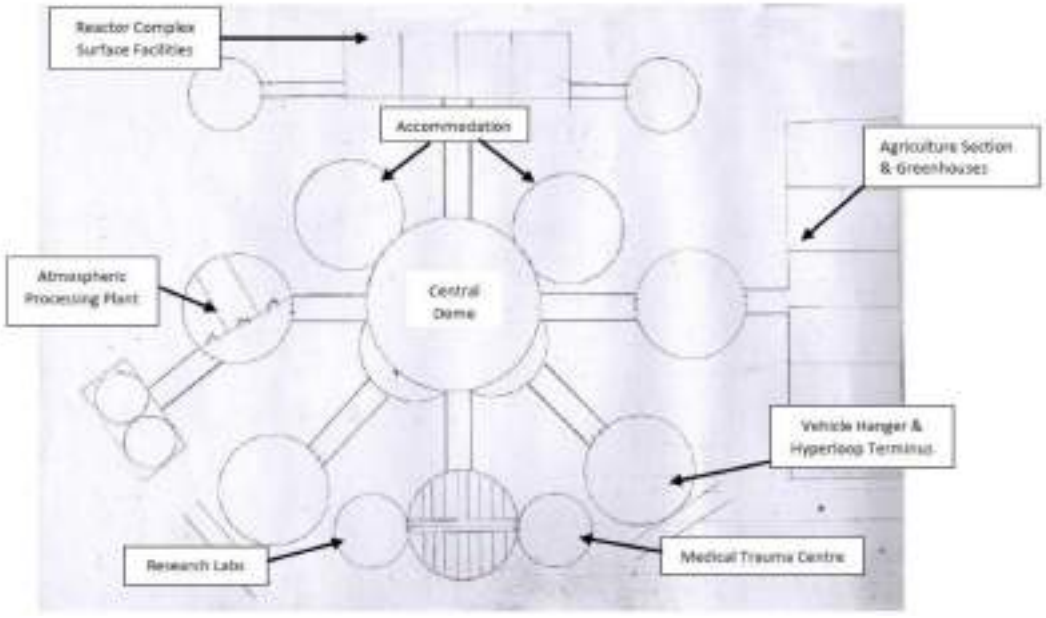
Some of your time will be spent as leisure time, doing sports, reading, watching a movie. You will also spend time meeting other station occupants, and talking about plans for the coming days; station maintenance tasks; science results; and just chatting about Earth, loved ones and the meaning of life. You will also spend time eating together and preparing food.

HOW WILL THE STATION BE OPERATED?

Being so isolated and far away from Earth, the station will need to be self-sufficient. It will need power for all its appliances, heating and cooling. NASA, ESA and other space agencies have considered a variety of possibilities. Wind power would work on Mars where there is an atmosphere. Although the Martian atmosphere is a hundred times thinner than Earth's, it's enough to drive wind turbines. On the Moon, there is no appreciable atmosphere so wind power cannot work. On the Moon and asteroids, solar power could be used if the station is in sunlight for some period of time. Nuclear power could also be used.

Essential to the operation of the station will be to minimise wastage and 'to live off the land'. It is difficult to bring materials from Earth, and it is expensive in energy, volume and mass to move things around the Solar System. A station should recycle its water and waste and use food and other biological waste to grow crops and other edible items. However, recycling can never be 100% efficient, so a station must have a life support segment that not only recycles but can also be fed with water from the local environment, make oxygen and provide for a range of other commodities, such as building materials.

Water might be mined from permafrost or extracted from the atmosphere on Mars. It could come from permanently shadowed craters on the Moon that contain ice. Once you have water it can be broken up using electricity (electrolysis) to provide oxygen. Scientists have also envisaged making plastics from bacteria and other biotechnology processes.



Mars Base Alpha. A sketch of the layout of a Mars station by a participant of the Life Beyond project at **HMP Glenochil**.

WHERE WOULD THE STATION BE LOCATED?

Space agencies have considered putting stations in many different places. On the Moon, there are lots of interesting places. The polar regions have craters that are permanently lit by sunlight, and some people have thought about building stations there. Some of the craters probably contain ice and could be a source of water for a station. These ancient ices might tell us about comets that once collided with the Moon and delivered this material. The far side of the Moon, where radio 'noise' from Earth is blocked, could be used to build a radio telescope tended to by a station and its crew. The telescope would be used for astronomy, and even the search for extraterrestrial intelligence.

Polar Station. A depiction of a station at the edge of the Martian polar ice caps. You can see the distant ice caps with layers of Martian dust in them. In the foreground, explorers study the ice. This was painted by a professional artist.

Mars has many locations that could support a station. For example, the equator, where temperatures can get up to around 20 °C, could be one location for a station. Mars has polar ice caps like the Earth, and we could build a station near the poles and use them as a source of water ice, and as a place to carry out fascinating scientific experiments. The Martian polar ice caps contain ices that have within them millions of years of Martian atmospheric history in trapped gases. Other scientists have wondered about building a station that can move – why not put a station on wheels and travel around on the planet to different locations?

What is so exciting about building stations on distant worlds is that we have not yet started this activity, so almost any ideas are valid contributions to the range of possible solutions. In the Life Beyond, project you'll contribute your own ideas.

STARTING THE STATION DESIGN

In Module 1, you decided whether you were on the Moon or Mars. Your new station is going to be built right next door to the existing station you have arrived at. You are not obliged to decide exactly where on Mars or the Moon you will be located, but it can be fun at this stage to come up with a definite location so you have some sense of where this new home will be. You might like to look at the maps provided at the end of this module and decide where on the Moon or Mars you will be located. You could mark on the map where your new station will be. Would the poles be more interesting than the equator? Would you like to be in a large crater? There is no right answer here. Pick a location that takes your interest.

You also need to think about how many people your station will accommodate. Again, there is no right answer here. You could choose a small starting station, maybe with three to five people, or you could design an advanced station built much later along the road to space settlement with 100 people. The choice is yours!

ACTIVITY 1 - CHOOSE YOUR LOCATION AND TEAM

Have a think about where you will build your station. Take a look at the maps at the end of this module and decide if you have a preference for a particular place.

Decide on how many people your station will accommodate. This will also influence the size of the modules you need to design later. Are you interested in a small station, perhaps built early in the history of settlement, or something quite large?

I have decided to build my station on: Mars/Moon and I am going to locate my station at:
(No need for coordinates here, you can describe generally where it will go.)

The number of people living in my station will be:

Now you have decided where to build your station, you need to think about what sorts of modules (the parts of your station) you will need in order to live there. In this next activity, you can use your own experiences of everyday life to think about the basic segments of your station. Think about some of the types of rooms you visit (e.g. bathroom, exercise area, meal areas) to come up with your list of modules.

ACTIVITY 2 - MODULES FOR MY STATION

List the major modules that you will need for your station. Hint: where will you eat, where will you sleep, where will you relax?
Major modules that will be part of my station are:

Now you have got some idea of the parts of your station, you need to think about how these individual modules might be designed. Don't worry, this is not a full-scale architectural challenge! What you need to do is think about the features of your segments.

At this stage, it is useful to answer some questions to help guide your thoughts. These will help guide you in the next set of activities.

SOME QUESTIONS TO HELP GUIDE YOUR IDEAS

Here are some **multiple-choice questions** to guide your thinking about the forthcoming activities. You can find the answers at the back of this module pack, but try to answer the questions before consulting the provided answers. Be careful to read all the answers before choosing the right one.

1. In space, people will explore and conduct experiments, activities we don't normally do every day at home. What sort of modules and facilities will these activities need in addition to the 'usual' modules like a kitchen and recreation areas?

a. A place to store a rover on the Moon and Mars.
b. A science laboratory.
c. A place to store dusty space suits.
d. A place to store samples that have been collected during expeditions.
e. All of the above.

2. Where might we get power to keep our station going on the Moon?

a. Wind power.
b. Solar power.
c. Horse power.

3. Why do some people think that building a station underground on the Moon would be a good idea?

a. It would protect against radiation.
b. It would make the temperature changes less extreme.
c. Both of the above.

4. How would we grow plants to eat in space?

a. Grow them in a special module with plant growth units such as hydroponics.
b. Do without any plants altogether.
c. Call Tesco and ask them to bring groceries.

5. In space, people will need some entertainment and recreation. Which of the following might be good activities for people on the Moon or Mars?

a. Pool table.
b. Exercise area.
c. Reading room and library.
d. Gardening plot.
e. All of the above.

6. In space, commodities like water are hard to come by. When designing a station how might we make sure we have enough water?

a. Use it all up and just hope someone brings some more from Earth.
b. Recycle as much water as possible in a life support module.
c. Dig underground and hope we find a lake.

7. Our kitchen and station crew will also produce waste. What is the best way to handle waste in a space station?

a. Throw it out into space and hope no one crashes into it.
b. Recycle as much as possible in a small recycling centre because there could be valuable materials we could use.
c. Pile it up in the living quarters and just tell everyone to hold their noses when it starts to rot.

8. What purpose do living quarters serve in a space station?

a. A place to sleep.
b. A place to get some private time.
c. A place to study and work.
d. All of the above.

9. How do people arrive and leave a space station?

a. Arrive in a rocket that would need a landing pad area near the station.
b. Get beamed up by Captain Kirk.
c. Open the airlock and walk out.

10. How are modules usually linked together in a space station?

a. Small pressurised walkways that link them together.
b. Underground tunnels that link the modules.
c. They are all enclosed under a giant dome that is pressurised so people can walk freely between modules.
d. Any of the above solutions.

Moon Station. Just one design for a lunar station by **NASA**. Note how they are covering it in lunar soil to protect it from radiation (Credit: NASA).

To start designing your station, you next need to think about what challenges you will encounter living in space (think about Module 1 of this course) and how they will influence the design of your station. For example, building a brick house on the Moon probably won't work because the Moon is essentially a vacuum and all your oxygen would leak out (unless you had very well-sealed bricks!). There is also a lot of radiation in most places in space, so you probably want some good thick walls. What will you build it out of? Plastic? Concrete?

There are no right or wrong answers here. Don't worry too much about engineering either– you're not expected to know about this. Let your imagination flow and see if you can list or sketch some ideas on what a basic module will look like (this will be the core of your station). To do this, complete Activity 3. In this activity, we are not designing a module for a specific purpose. This module could become the kitchen, lab, sleeping or any other area. What we are doing here is trying to come up with a basic design that all your modules will follow. Will it be circular, rectangular, a dome-shaped module? The choice is yours.

ACTIVITY 3 - STATION DESIGN - THE FIRST STEP

You need to come up with a basic design for your station. Work through this activity to come up with a preliminary concept.

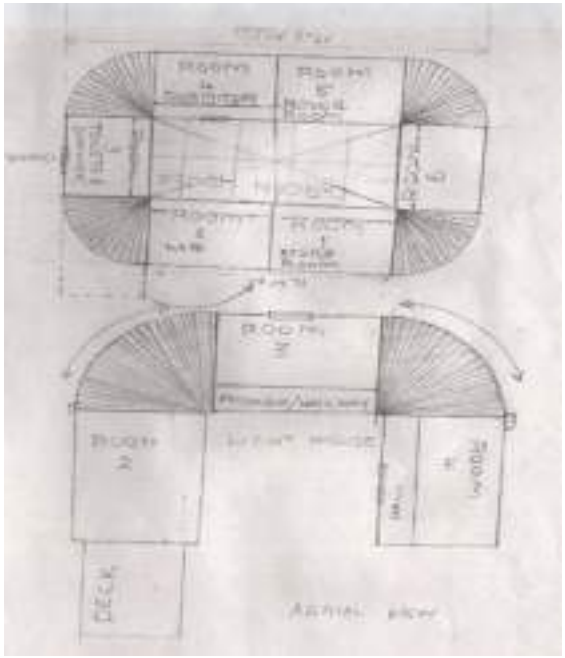
Your modules must be designed to withstand the harsh conditions of space. In the space below, jot done some general notes about your modules and their characteristics. We've provided some questions to guide you.

Will my module have thick walls to protect from radiation or will I cover it in soil?
What will I build my module from: concrete, plastic, something else?
What shape will my module be: square, rectangular, circular, something else?
How will my module be built: will it be in one big single unit, fabricated from smaller pieces, made as a giant inflatable structure, or something else?

How big will your module be?
Have a think about its dimensions. A human is about 1.5 meters high, so you could use that to think how wide, long and tall your module will be. It's not necessary to be really accurate here unless you want to be. Write an approximate dimension below.

Draw a diagram of your core module for your station.
No artistic skills are needed here! You can make a line drawing of its shape if you want. If you are artistic, feel free to go to town here.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO



A small telescopic module. An example of a module designed by a participant of the Life Beyond project at **HMP Glenochil**.

Congratulations! You've basically designed the core of a new station.

The next step is to think about how this core module might be modified to accommodate all the different modules you identified in Activity 2. For example, to make a recreation module, maybe you would have it slightly larger and have a garden or small football area in the middle. In this next activity, you will list the different modules you identified in Activity 2 and describe or draw the modifications needed for them.

ACTIVITY 4 - MY MODULE DESIGNS

List the individual types of module you came up with in Activity 2. Beneath each, describe some of the special features that you would add to the core module you designed in Activity 3. If you want to, you could even draw these other modules, for example a sketch of a top-down view of them.

Module A (e.g. kitchen module)

Module B (e.g. garage module)

Module C

Module D

Other modules

Now we are really making good progress. Well done for having come this far! To recap, you have: 1) Thought about some of the challenges of living in space, 2) Considered how those challenges influence the sort of home you will make in space and how it will be built, 3) Designed your core module for your new station, 4) Come up with a list of modules you'll need to make the station complete, 5) Thought about the design of each of the modules.

In the next stage, we are going to think about the detailed design of one of the modules. The purpose here is to give you the chance to think about how some of the details of living in space that you considered in Module 1 would influence the station design in a bit more detail.

In this next activity, you'll drill down a bit and think about the design of one of your modules a bit more. Again, no design experience is needed here. This is an exercise in thinking about what you need to live in space and letting your imagination roam. The purpose is to think in a bit more detail about one particular part of your station.

ACTIVITY 5 - DESIGNING ONE OF YOUR MODULES IN MORE DETAIL

In this activity, you'll chose one of your favourite modules and do a bit more detailed design work on it and get into its capabilities a little more.

I've chosen the following module to do some more detailed study:

List some of the functional capabilities of this module (e.g. for a kitchen: cooking food, storing food, storing utensils etc.)

Think about what the module will be used for. In this part, you are not thinking about the equipment (that comes next), just think about the major functions of this module. The major purpose and function of this module will be to:

a)

b)

c)

List the major facilities, tools and equipment you need in this module (e.g. for a kitchen, facilities would include electricity for equipment, running water. Tools and equipment would include a fridge, bowls etc.) In this part, you are really coming up with a shopping list of what you would want to order if someone asked you to list everything you needed. You could literally write a shopping list of the things you'd want in order to equip this module.

Draw a diagram of this module with some detail about where your major bits of equipment will go, where people will go, how people will walk through. Again, this doesn't have to be a work of art, it can just be a basic line diagram, but feel free to make it a work of art if you want! Design it to any level of detail you like.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

In this final phase, we are now ready to bring this all together into a finished station design. To do this, you need to think a bit about how the modules you identified in Activity 2 will fit together. This is a little like designing a house. You need to think about how you will put the modules together and which modules will go next to which. For example, you probably don't want your module with a toilet on the opposite side of the station to the area with sleeping quarters – that could be inconvenient. Maybe you don't want your food storage area right next to the module for your waste. Think about the arrangement of the modules.

Lunar Station design and rover. A station design conceived and drawn by participants in the Life Beyond project at **HMP Glenochil, Scotland** in 2019.

ACTIVITY 6 - THE STATION DESIGN

In this activity, you'll bring together your ideas into an overall station design. Yet again, this doesn't need to be a work of art, but if you like art you can certainly spend as much time on this as you like. We will display these images in our on-line gallery of space station designs. Feel free to sketch some designs before you decide on your final configuration. **Use the next page to design your station (or you may use separate sheets of paper or art paper if you have them)**. Your station design can be a simple pen or pencil line diagram or an elaborate painting – whatever you would like (and depending on what materials you have the opportunity to use).

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

We now have a station and it's time to tell all of humanity about your amazing achievement!
To complete this module, now do Activity 7.

ACTIVITY 7 - A NEWS ITEM ABOUT YOUR STATION

This activity involves some creative writing. In the space below, write a short news item for an audience back on Earth. It could be a short announcement or newsflash announcing the completion of your station. Perhaps it is a news story to be read out on the 10 o'clock news. It should be no more than **about 200 words**, but in any style you want.

Feel free to embellish it, describing some of the famous people who came to visit the opening, maybe with some quotes from your new station commander and some details about what the festivities of the opening involved. You could think about the following:

Did any celebrities come along? What food was eaten? How many people attended? What did the first day of activities in the station involve?

We've given you a suggested title, but feel free to change it.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO 

NEW SPACE STATION OPENS TO INTERNATIONAL ACCLAIM!

MODULE 2: ADDITIONAL ACTIVITIES

If you would like to continue Module 2 further and contribute additional work to the Life Beyond Project, here are some activities you could undertake:

1. **Make some side-on drawings of your new station** or draw some sketches of what it looks like from the outside.

2. **Make more detailed line drawings** or designs of one particular module of interest (you could draw the interior of the garage or kitchen modules, for instance).

3. **Make some more notes about what each of your modules contains**, what furniture, fixtures and fittings it will need in addition to your ideas in Activity 5.

4. **Describe how you want the recreation module to be designed** and what activities you might have inside it.

5. **Write a brief letter home** (of around 400 words) about how you feel living in your new home on the Moon or Mars. What's new and exciting, and what are some of the challenges?

6. **Write an enticing description of your station for someone back on Earth** who is thinking about moving permanently to your station, like an estate agent's pitch for why they might like to move there.

7. **Write a poem** about your station.

8. **Describe a typical day** in the life of a person living in your station.

9. **Paint a picture or poster** that you might put on the walls of your station.

10. **Write a short science fiction story** about life in your station or something that happened there.

11. **Write an imaginary message sent by aliens back to their home world** after they stumble across your station and meet the occupants.

MODULE STUDY QUESTIONS – ANSWERS

1. **Answer e:** All of the above. When we built a station on the Moon or Mars, we will use a rover to drive out across the surface and explore. This could be to take drill samples, collect rocks or, on Mars, to look for life. We'll need a science lab to study all those samples when we bring them back to the station, and a place to store the samples before and after we've examined them. This could all be brought together in one 'science module'.

2. **Answer b**: Solar power. There is no wind on the Moon as it has no appreciable atmosphere, so wind power will not work. We could use solar power. However, it's worth knowing that the Moon spends two weeks in light and two weeks in darkness, so we would have to store that solar energy for the dark periods (nuclear power might be an alternative). We can't rule out taking horses to the Moon, but they are probably not the best form of power!

3. **Answer c**: Both of the above. Some people have thought about building a station underground on the Moon or Mars because it would reduce the radiation from the Sun and from space. On Earth, this radiation is blocked by our thick atmosphere and magnetic field, but that's not the case on the Moon, which has no atmosphere, or on Mars, which has a much thinner atmosphere. Neither the Moon nor Mars has a protective magnetic field. About a metre of topsoil on the Moon or Mars will cut out most of the radiation. Underground, the extreme temperature swings (between about –120 and +120 °C on the Moon) will be evened out a bit more. Being underground will also protect us against pieces of small rock flying in from space (called micrometeorites).

4. **Answer a**: A special module. We need a growth module or some sort of greenhouse to grow plants. We could do without them altogether (answer b) but this would lead to a very boring diet. We could also call Tesco, but at the moment they don't do grocery deliveries to the Moon or Mars (Who knows, maybe one day answer c will also be true!)

5. **Answer e**: All of the above. Some people like to play pool, others to read or watch a movie. So, we should have as many diverse types of recreation to meet as many interests as possible. We might also build a learning centre to give people the opportunity to engage in educational activities.

6. **Answer b**: Recycle. We can never be sure that people will bring water from Earth when we need it, so it's best to recycle as much as possible. There are unlikely to be lakes underground to provide us with water (some people think they may exist on Mars, but they would be kilometres underground).

7. **Answer b**: Recycle. It's a good idea to recycle paper , plastic, metals and any other things we can use in our station. It costs a lot to transport material from Earth, so we should try to recycle as efficiently as possible. Even food and human waste can be used to feed bacteria that break them down and provide nutrients that we could use in a greenhouse. Throwing the waste into space is an unnecessary loss of potentially recyclable material. Piling it all up in the living quarters is a bad idea for hygienic and lifestyle reasons!

8. **Answer d**: All of the above. As with any relaxed living space, there are all sorts of uses we have for it: reading, sleeping, working etc., and we would need these spaces in a space station.

9. **Answer a**: A rocket landing zone. At the moment, we don't have teleportation technology (unfortunately) so being beamed up won't work. If you open the airlock, you'll find yourself on the surface of the Moon or Mars, which is lethal as there is no air.

10. **Answer d**: Any of the above. The crucial thing is that people are not directly exposed to the lethal conditions outside, so any of these ways of linking up modules or building them all under a giant pressurised dome would work.

THAT IS THE END OF MODULE 2 - CONGRATULATIONS!

MODULE 3: PLANNING AN ADVENTURE IN SPACE

INTRODUCTION

Now we have a station on the Moon or Mars, we want to go on some excursions, to explore our neighbourhood, to go further afield and discover new things about the universe. Or maybe we just want to go out and explore for the fun of it! In this module, your ultimate objective is to come up with a memento of this exploration. It could be a poster to entice tourists to visit your station, a diary of an explorer, a timeline of your station, a drawing of an exploration rover or anything else. Like your station design, you can keep this piece of work yourself or display it in your learning centre. Or you can send a copy to the Life Beyond team to display online and in the next book on space station designs to be published by the team.

In this module, you'll develop a piece of work focused on exploration and adventure from your newly designed station.

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Lunar Expedition. A rover with its own small station heads out across the lunar surface to study craters, carry out experiments and engage the crew in the thrill and adventure of lunar exploration. This was designed and drawn by participants in the Life Beyond course at **HMP Glenochil** in 2019.

SOME BACKGROUND INFORMATION

ACTIVITIES ON THE MOON AND MARS

Once you are on the Moon or Mars, you need to do something. What you do will depend on why you went there in the first place. Let's have a look at some of the reasons why people might be on the Moon or Mars.

STUDYING ANCIENT CRATERS AND LOOKING FOR LIFE

If you went to the Moon as a scientist, you may have gone to study its ancient craters and the composition of the rock. As we think that the Earth and Moon were made from the same material, by studying the composition of the Moon, we might learn something about our Solar System, how it came to exist and why the Earth is made in the way it is.

On Mars, you could look for life. We know that the planet once had a lot more liquid water than it does today, and perhaps environments were habitable to life. Even underground today, where there is protection from radiation and the desiccated surface, maybe there are habitable environments. So, there is plenty for you to do on the Moon and Mars and one way you will want to explore your various ideas is by heading out in rovers and collecting samples that you can bring back to the laboratory in the station for investigations.

Polar Expedition. A brave group of adventurers arrives at the north geographical pole of Mars having travelled across the barren frozen wastelands of the pole.

Painting by astronomical artist **Michael Carroll**.

GOING MINING

You might be on the Moon or Mars to mine minerals that could support human presence in space. You and your fellow miners will need to head out in rovers to map minerals and prospect for interesting metals and elements that you might want to mine. You use rovers specially equipped to sample rocks and examine them for useful minerals.

GOING ON GREAT ADVENTURES

Some explorers will travel to the Moon and Mars to achieve great exploration 'firsts'. Imagine being the earliest explorer to circumnavigate the Moon. Travelling about 11,000 kilometres around the Moon, crossing its craters and lava fields, would make yours the first team to cross the near and far side of the Moon!

On Mars, there are spectacular accomplishments awaiting adventurers. Olympus Mons is a mountain that is two-and-a-half times higher than Everest. When explorers stand on its summit they will have eclipsed Hillary and Tenzing who first climbed Mount Everest on Earth. Olympus Mons is a giant extinct volcano, and once we get to the top we might explore the ancient vents at its summit to understand the volcanic history of Mars.

The Ascent of Olympus. An explorer (maybe a tourist mountaineer?) stands at the summit of Olympus Mons on Mars while a friend watches on and another takes a photo of this great moment. The explorer is holding a pole with prayer flags that are traditional for mountaineering in the Himalayas back on Earth (painting by Marilynn Flynn)

Like Earth, Mars has polar ice caps made up of water ice that has been laid down over millions of years. Within them are pockets of gas that could contain information about the history of the Martian atmosphere. Pieces of asteroid and comet might tell us about the history of impacts on the planet. So, we can imagine heroic expeditions across the Martian polar caps to traverse the poles and collect samples of the ice. These samples will not only tell us about Mars but also about the history of our whole Solar System. We might learn something about our own planet and its future by studying Mars.

Let's not forget the great canyon systems of Mars. The Valles Marineris, which is about 5 km deep and 4,000 km long would fit the whole Grand Canyon in sideways on! We might trek to the bottom of the canyon and walk along its length.

GOING FOR THE TOURISM

Aside from exploring, many people imagine that tourists and thrill-seekers might eventually travel to the Moon and Mars. What would they do? We can imagine them going on sight-seeing excursions to craters, canyons, and the edges of the polar caps. Maybe they could abseil down cliffs or go on adventure treks just to experience the Moon and Mars. Perhaps, within pressurised domes, they might enjoy low-gravity sports. Imagine football, cricket and tennis in the one-sixth gravity of the Moon or three-eighths gravity of Mars, on giant courts where the balls would travel much further and higher than on Earth. Or perhaps some people would come to the station just to experience an alien world, go out on a few short walks and otherwise sit in a pressurised habitat looking out of a window at the landscape beyond.

We can see that there are a variety of different reasons for people to set out on expeditions and adventure on the Moon and Mars. Scientists, explorers, tourists, adventure seekers, and miners all have reasons to plan adventures or excursions on the Moon and Mars. In this module, we are going to plan our own adventure.

PREPARING FOR ADVENTURE

The first thing we need to do is decide what adventure we are going to embark upon. This will determine whether we can walk, whether we need a rover and what equipment we need. For example, if we have decided that a light stroll for a couple of hours around the station would be fun, then you won't need much – just a spacesuit and maybe some water. However, if we have decided that we are going to circumnavigate the Moon, we are going to need vehicles, lots of equipment and food and water.

Holiday Mars. A highly imaginative poster enticing tourists to come to Elysium Station on Mars to play golf, listen to music, come to museums, look for fish fossils (maybe a bit optimistic!) and explore. Drawn by a participant of the Life Beyond course at **HMP Glenochil**.

In this first activity, you'll come up with the adventure that will frame the rest of the module and ultimately the piece of work that you produce. Before we do that, it will be useful to answer the questions below. These are designed to give you some insight into the sorts of things that people have previously envisaged for the Moon and Mars, and they might help guide your thoughts. You are not expected to know the answers to some of these questions. If you don't, then have a guess – you can look up the answers at the end of this module. It may look daunting to answer questions right at the start of this module, but you'll find these very useful.

SOME QUESTIONS TO HELP GUIDE YOUR IDEAS

Here are some **multiple-choice questions** to guide your thinking – they'll give you an opportunity to think about exploration on other planets and the adventure you might launch from your station. You can find the answers at the back of this module pack. In this set of study questions, don't worry too much about the right answer. Instead, read them through and use them to gather knowledge about the exploration of the Moon and Mars.

1. If we wanted to travel across the surface of the Moon for many weeks to explore, the best sort of transportation for this would be:

a. A 'pressurised rover', a little like a car, but sealed to allow for an atmosphere inside.
b. A well-bred horse.
c. A large number of well-trained hamsters with ropes attached to a cart.

2. Some people think that exploring the asteroid and comet impact craters that cover the Moon could be interesting because:

a. They might tell us about what effect asteroid and comet impacts can have on planets.
b. They might tell us more about how commonly impacts happen and whether they might threaten the Earth.
c. We could find useful resources in them like ice.
d. All of the above.

3. Some people have imagined climbing Mount Olympus on Mars (Olympus Mons) which is more than two times higher than Mount Everest. Why would anyone be interested in doing this?

a. For the sheer thrill of it.
b. Because we could learn interesting things about the geology of large mountains and volcanoes on Mars.
c. Both of the above.

4. On Mars, people have imagined expeditions to collect rocks to look for life. How might they do that?

a. Walk out of the station in space suits and collect samples in a grid around the station.
b. Drive out in a pressurised rover and collect rocks from many locations across the surface.
c. Set up a small base camp far away from the station to collect rocks.
d. They might do any of the above.

5. On an expedition across Mars people will need food and water. How will they get this?

a. They will regularly call Sainsbury's and have deliveries made to wherever they happen to be.
b. They will farm alpacas at the back of the expedition rover.
c. They will have to take enough food and water with them from the station.

6. It is possible that tourists will one day go to Mars. What sort of activities have people imagined for tourists on Mars?

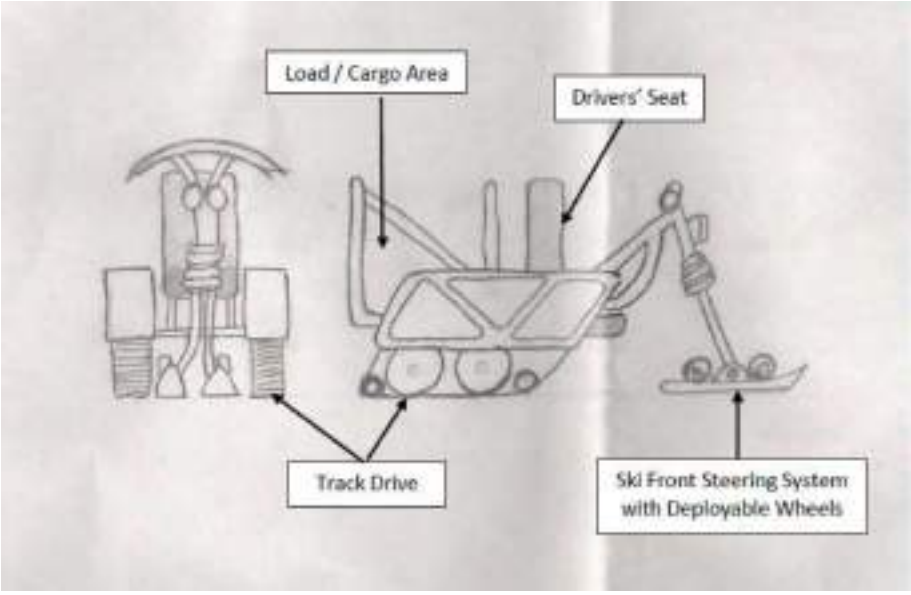
a. Visiting canyons.
b. Climbing mountains.
c. Playing sports in a lower gravity environment.
d. All of the above.

7. On an expedition on the Moon, one of the group gets sick. What will the expedition do?

a. The expedition might be organised so they are never more than a few days away from the station, allowing them to get back quickly for help.
b. The rover should have some medical supplies so people can be helped immediately.
c. The expedition should have someone trained to provide medical help in the field.
d. All of the above.

8. On a long-duration expedition on the Moon or Mars what facilities would a rover need to have?

a. A place to prepare some food.
b. Sleeping bunks.
c. Driver's cab.
d. Place to store samples.
e. All of the above.



A Mars chopper bike. A diagram of a bike for Mars designed by a participant of the Life Beyond project at **HMP Glenochil**.

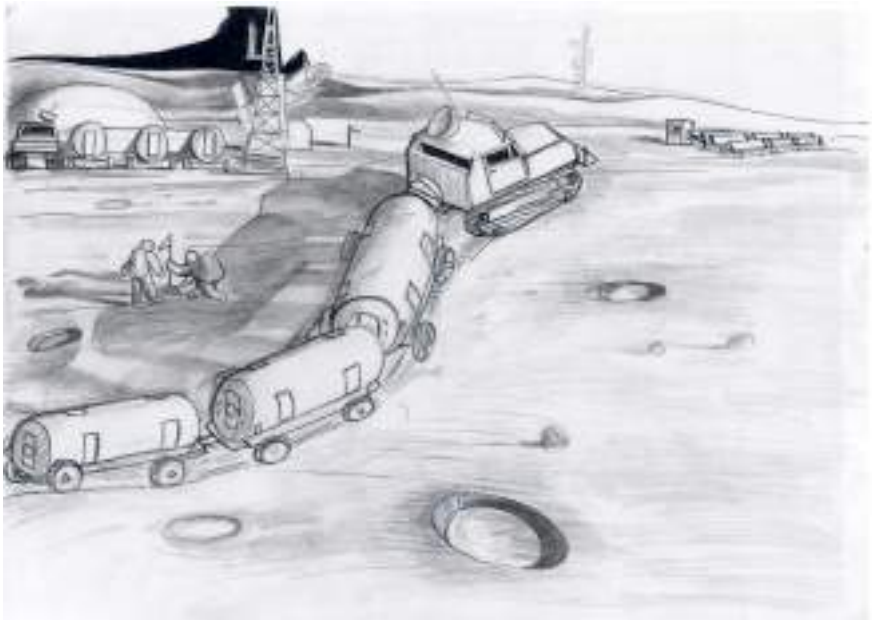
9. Some people think that expeditions could be organised just to do scientific experiments. What sort of activities and tools have people imagined for these expeditions?

a. A drill to collect samples underground to search for life on Mars.
b. A small balloon to allow for images to be taken from high up or, on Mars, a balloon could be used to collect samples of the atmosphere.
c. A sample box on the rover in which rocks and other valuable samples that the expedition stumbles across can be stored for later study.
d. All of the above.

10. Tourists might head out on expeditions who have no experience of space. What precautions should be taken?

a. Prepare them with a spacesuit and a safety discussion so they realise the dangers of 'going outside'.
b. Ensure that when they are climbing or undertaking adventure activities they are watched over by someone with experience in space.
c. Ensure we have medical packs and other equipment in case they get hurt.
d. Have plenty of water and food to keep them healthy.
e. All of the above.

These study questions have hopefully given you some thoughts about what sort of excursions we might go on when on the Moon or Mars. **In the next set of activities, you are going to come up with your own activity or adventure**.



A tube rover. A concept for a tubular rover made of round, tube-shaped habitats for driving across the Moon or Mars. It was designed by participants of Life Beyond at **HMP Glenochil**.

ACTIVITY 1 - CHOOSE YOUR ADVENTURE

Think about a major piece of exploration or adventure you might undertake from your station – something that will be an important accomplishment for your crew. It could be anything, from a walk to a major excursion. You might like to consult the maps of the Moon and Mars provided at the end of this module.

The type of adventure you think up will obviously partly depend on where your station is located. If it is at the Martian poles, maybe your adventure will be a daring expedition to cross them. If it is on the Moon, maybe it is a long, two-week trip to explore some craters. The questions below will to help you think about this. You don't have to answer them all. They are designed to help you come up with a proposed adventure. At the end of this activity, you should briefly describe your adventure.

Will my adventure be for the whole crew or part of the station crew?

Will it involve collecting samples, doing experiments, or just be an adventure for the thrill?

How far will they go from the station?
This need not be accurate, but will it be a walk or a long journey using rovers?

How long will my adventure last?
For example, how many days?

Will my adventure involve tourists or other people visiting the station to join my adventure?
For example, will it involve paid-up customers?

The title of my adventure will be:

Write a brief one-hundred-word (five to ten sentences) description of your adventure:

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO 

This first activity has been very important in gathering ideas for an adventure on the Moon or Mars. Hopefully now you have an emerging idea of what this will be and what is going to happen. Perhaps you can even begin to mentally picture this adventure happening – the explorers setting out from your station on their trek or adventure!

Now we've got an idea for an adventure, we need to think about what equipment, food and other provisions we'll need for the adventure. **The next activity gets you to start thinking about the details of your adventure.**

ACTIVITY 2 - WHAT I'LL NEED FOR MY ADVENTURE

In this activity, we need to imagine that we have gone to the station commander with our plan laid out in Activity 1. He or she has said to us: "Well, that all sounds great. Please let me know exactly what you'll need from the station to do this." Here we are going to think about what we'll need for the adventure and what equipment we'll need. The activity is a mix of questions to help you think about these requirements, with some spaces to list what you'll need.

You don't need to consider food and drink here – we'll have a look at that in the next activity. This activity is just focused on vehicles and equipment. You don't need to have a knowledge of space engineering and vehicles for this activity. If you imagine that a rover can fit four people, for example, you can come up with a rough idea of the sorts of things you'll need.

Lunar rover. A rover for traveling across the Moon drawn by participants of Life Beyond at **HMP Glenochil**.

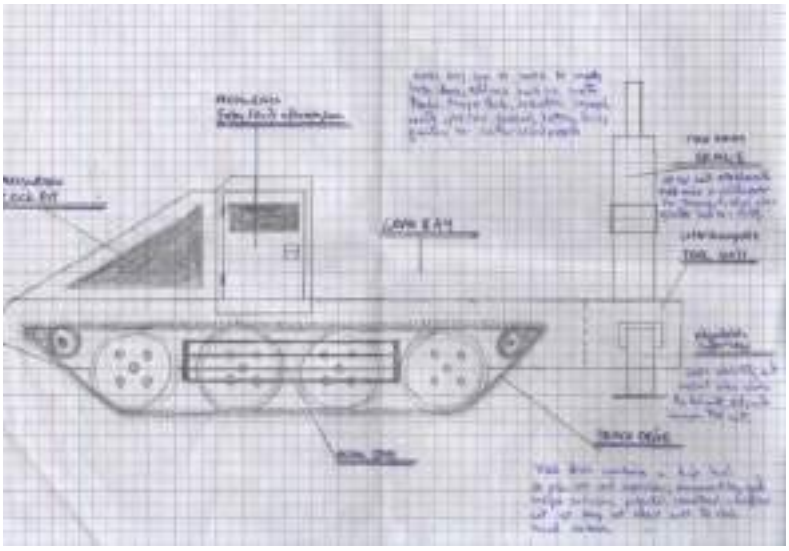
Will I need any vehicles for my adventure?

Describe what you'll need below.

Will my adventure involve leaving the vehicles?
In other words, would I need spacesuits and other equipment to walk away from the vehicles? Describe what you'll need below.

Will I be doing any science on my expedition or will it be just for adventure?
List the items you'll need. (For science, you might want drill corers, sample collection boxes. For adventure, you might want ropes, ice picks, cameras etc.)

Can you think of any other items you'll need to ask the station commander for?
List them below:



A rover concept for an expedition. A design drawn by a participant of the Life Beyond course at **HMP Glenochil**, for a rover that can be used to carry modules such as sleeping quarters on an expedition.

The writing in the diagram may be too small to read, but the picture is designed to illustrate to you the sort of drawings made by some previous course participants.

Now we have an adventure in the making, and we are almost ready to go! Before we move on to this next stage, we also need some food and water. In the next activity, let's prepare a basic list of some of the food and drink items we'll need.

ACTIVITY 3 - MAKING SURE WE HAVE ENOUGH FOOD AND WATER

In this activity, we need to think about how much food and water we'll need. This isn't an easy calculation, as it depends on how much exertion people are involved in and how hungry and thirsty they get. In fact, this can be very complicated, but nevertheless, it's still possible to come up with an estimate for the station commander so they know roughly what you'll need. You can make these calculations based on what you eat and drink each day and then scale it up for your expedition. These questions will help you work through these calculations.

FOOD AND DRINK

Write down the food items that you imagine your expedition team members eating each day, trying to work out the approximate numbers for each person and then the total amount for the whole team. Then you'll need to work out how much you'll need for the duration of the expedition. We've given you an **example below** for breakfast. Do the same for lunch and dinner (and feel free to give them a different breakfast!).

Breakfast

For each person:
1 bowl of cornflakes. I have four people in my crew, so I need 4 bowls of cornflakes for each day. My expedition will last for four days, so I will need in total 4 x 4 =16 bowls of cornflakes. I estimate that to be roughly 3 boxes of cornflakes (don't worry about accuracy on this last bit – you can roughly estimate how many boxes or bags of things you need – remember this is to give the station commander some rough ideas).

2 slices of toast. I have four people in my crew, so I need 8 slices of toast for each day. My expedition will last for four days, so I will need in total 8 x 4 = 32 slices of toast. I estimate that to be roughly 2 sliced loaves of bread.
I will need a large tub of butter and jam for the toast.

1 cup of milk. I have four people in my crew, so I need 4 cups of milk for each day. My expedition will last for four days, so I will need in total 4 x 4 =16 cups of milk. I estimate that to be roughly 4 cartons of milk (roughly one-litre cartons).

Breakfast summary: So, for breakfast I need, in total, from the station commander: 3 boxes of cornflakes, 2 loaves of sliced bread, a large tub of butter and jam, and 4 cartons of milk.

Lunch

You could refer to your menus and food items from Module 1, Activities 2 and 3.
Work out your calculations below:

Dinner

Work out your calculations below:

WATER

You've already included some drinks in your meals, but during the day, between meals, your adventurers are going to get thirsty. You need to make sure they have enough water to keep them hydrated. Each individual will need about 2 litres of water a day to keep well hydrated. **In the space below, calculate the total amount of water that you will need to take on the expedition**. The formula for working this out is shown below:

2 litres of water X number of people on expedition X number of days of the expedition = total number of litres of water.

Congratulations. You now have a full shopping list of vehicles, equipment, food and drink for your expedition.

The station commander is happy, but there is one problem: you don't have an expedition team! **In the next activity, you will bring together your team and ready them for the adventure.**

ACTIVITY 4 - GATHER TOGETHER YOUR ADVENTURE TEAM!

You are ready to go, but there is one final problem. You don't have anyone to join you! **In this activity, we'll prepare an advert to attract other crew members or tourists to join you.**

Imagine you have been given a space in the 'Lunar Times' or the 'Martian Gazette' and you must use this to advertise for an expedition team. Use the space below and in no more than about ten sentences write an advert. It should summarise what your adventure is about, how many people you are looking for and what sort of qualities you are looking for in your ideal crew members. We've given you the title to get you started.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO 

ATTENTION: ADVENTURERS NEEDED…

In this next part of the module, you will work on your major piece of work that can also be submitted for inclusion in the Life Beyond project.

Your objective in this last activity is to come up with a **memento of your expedition**. This could be anything from art, to writing, to music. You can develop and present your idea in the space below. What we mean by a momento is something that you collect or create which will help people to remember your expedition in years to come.

Examples include: A diary of a tourist and their thoughts about the expedition, a poster advertising your excursion, a sketch drawn of the landscape by someone on your expedition, a line drawing of your expedition vehicle, a letter home from one of the team, a poem written by one of the team, and a list of the meals eaten on the expedition.

ACTIVITY 5 - YOUR ADVENTURE MEMENTO

Draw, write or sketch your expedition memento below. You can use your own paper, art materials or other media if you have access to these. If you have the facilities, you could also make an object from card, paper or any other material if you like and get a member of staff to take a photograph which you can send in.

Note: If you have done the Life Beyond Short Activities pack, you may already have done this activity.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

MODULE 3: ADDITIONAL ACTIVITIES

If you would like to continue Module 3 further and contribute additional work to the Life Beyond project, here are some activities you could undertake.

1. Write **a short timeline** of expedition and adventure activities that have happened at your station.
2. Make **a poster for tourists** to entice them to come and play low gravity sports in your station.
3. Write **a short story** about an amazing discovery made on an expedition from your station.
4. Draw **a sketch of your expedition** in the field engaged in some sort of activity.
5. Make a **line drawing of a rover** used in an expedition.
6. Write **a short newspaper article** announcing the launch of your adventure to the world.
7. Write **a poem** about your expedition or adventure.
8. Sketch **a portrait** of your expedition team members.
9. Write **a short email or letter home** telling a friend or loved one about your adventure either before or after you set off (or both!).
10. Write **the lyrics to a song** about your adventure.

MODULE STUDY QUESTIONS – ANSWERS

1. **Answer a**: A pressurised rover. Horses would need spacesuits to be able to move around on the Moon and Mars which would be quite unlikely to happen! Even if we did make a horse spacesuit, they would not be very effective, because they would need feeding. Even a very large number of hamsters couldn't really pull a rover. Instead, we would likely have an electric or fuel-powered rover, like a small truck, that we could use to travel around on the surface.

2. **Answer d**: All of the above. There are lots of reasons to go and explore the craters on the Moon and all of the answers are right. We can learn what effect asteroids and craters have on planets and thus how planets, including the Earth, have changed over time. We think that an asteroid collided with the Earth 66 million years ago and was one mechanism for making the dinosaurs extinct. Learning about how often they occur and what their effects are is of huge interest so we can predict if this would happen on the Earth again. By studying craters on the Moon, we might get better ideas about asteroids and comets in general and their possible destructive effects. Some craters on the Moon are thought to contain ice, so craters can contain useful resources.

3. **Answer c**: Both of the above. We might explore Olympus Mons just because it is an exciting thing to do. Mountaineer George Mallory was once asked why he had climbed Mt. Everest and he replied, "Because it's there". As the highest peak in the Solar System who wouldn't want to climb to the summit of Olympus Mons on Mars? While we're there, we could use science to explore this ancient volcano and learn more about volcanic activity on Mars.

4. **Answer d**: Any of the above. Explorers might collect samples in a variety of ways, including all of these suggestions.They might collect samples near the station, head out in a rover, or go far away and set up a small base camp from which they could begin expeditions.

5. **Answer c**: Take it with them. Unfortunately, at least for a long time to come, they won't be able to just call a supermarket to bring food. Farming alpacas won't do! That wouldn't provide enough variety of food and the alpacas won't really fit in a pressurised rover! The best way is to bring all the food and water you need with you.

6. **Answer d**: All of the above. Tourists might do any of these activities and more. We can imagine them going on treks into canyons in space suits, climbing mountains and maybe just trekking outside the station in spacesuits. In pressurised domes, they might play sports in the low gravity of the Moon or Mars.

7. **Answer d**: All of the above. A sensible option is to be no more than a few days away from the station so you can go back for help if you need to. However, it's also useful to have medical supplies and at least one person on a team, particularly on a long trek, who has some basic medical training.

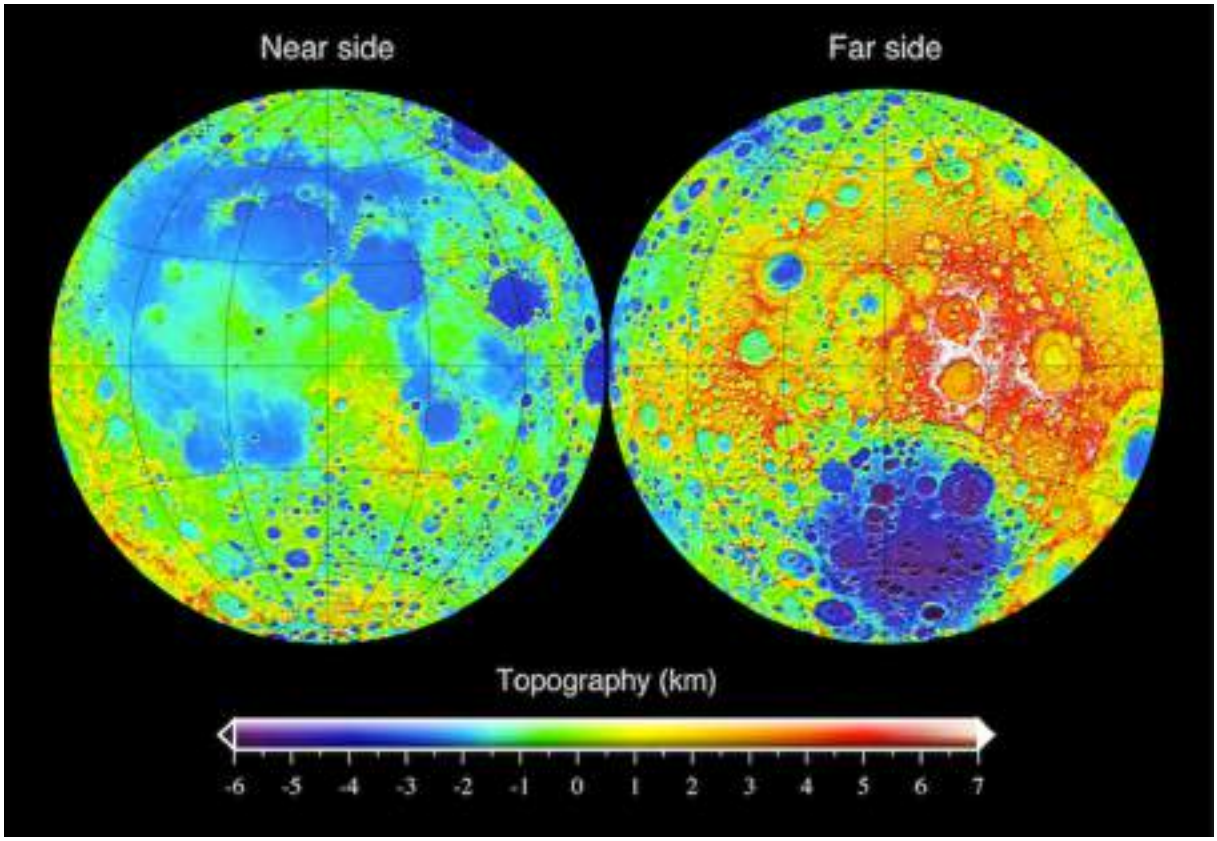
8. **Answer e**: All of the above. Our expedition vehicle is basically going to be a small mobile home, so we'll need everything for our excursion. We'll want to eat, so we'll need some space to prepare food. We'll need somewhere comfortable to sleep at night – basically some bunks. The driver will need a cab so they can concentrate on driving without distractions. If we are out doing experiments, we'll need somewhere to stow the valuable samples that we collect.

9. **Answer d**: All of the above. Scientists use a wide variety of methods to gather samples, information and data. That can include drilling into the ground to get samples, using sample boxes to collect specimens from different locations, and using balloons and aerial vehicles to get images of landscapes, sample collection sites and other information.

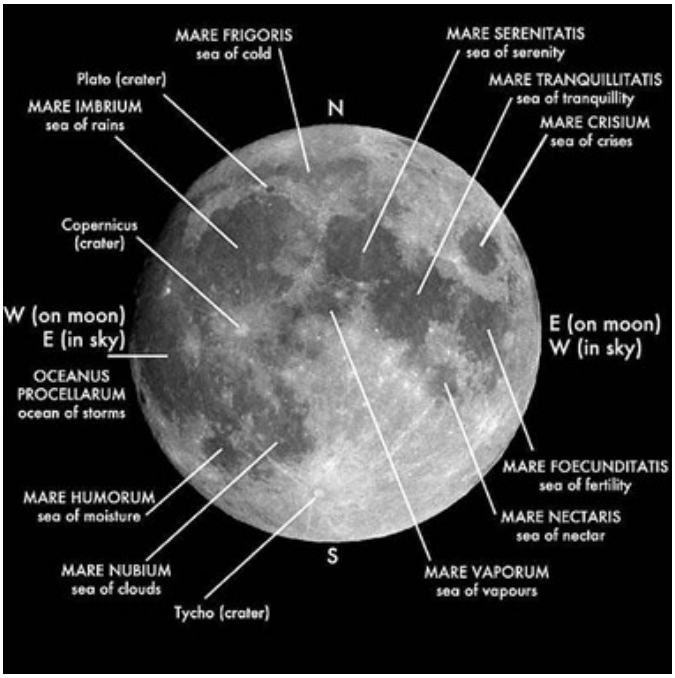
10. **Answer e**: All of the above. When tourists go to the Moon and Mars they are travelling to a very extreme environment and will need to be prepared. For example, they will need spacesuits and training to make sure they can go outside and on adventures safely. They will need to be watched by people with experience. Medical provisions will be needed in case people get hurt, even if that's just blisters from a long hike across the lunar or Martian surface. They will need to be provided with plenty of food and water.

MAP OF THE MOON

Maps of the 'near side' (facing us) and the far side of the Moon showing the 'topography' (the height above or below the average height in kilometres).

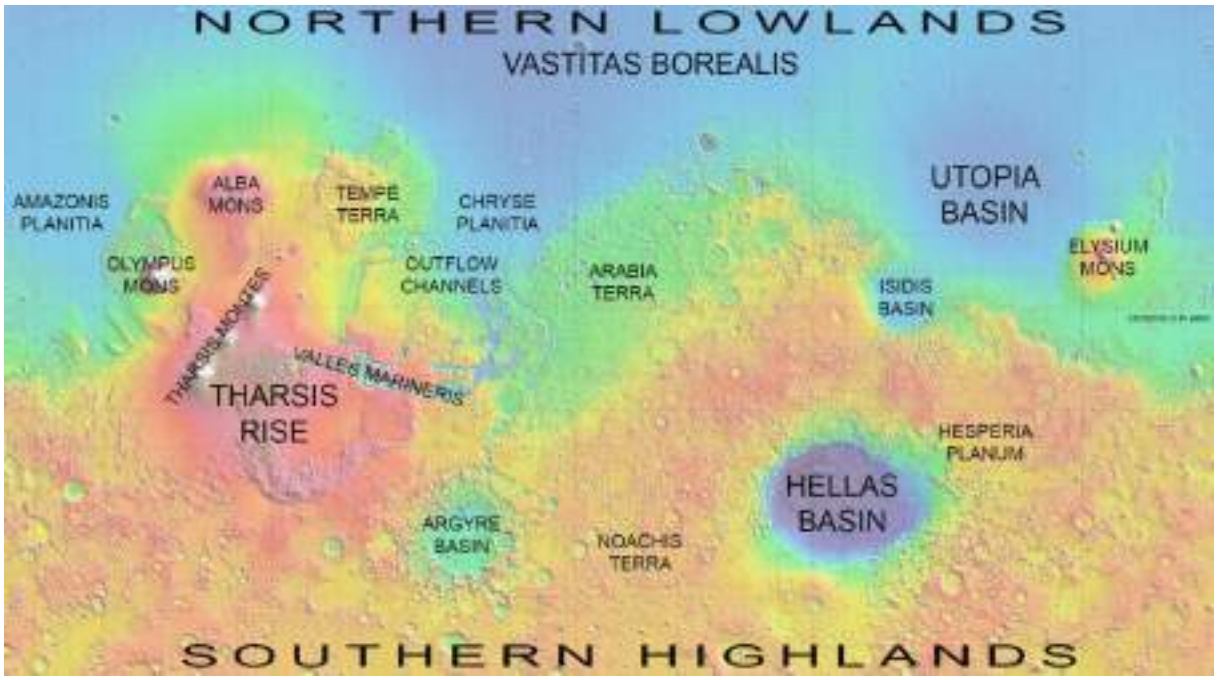


NAMES OF MAIN FEATURES ON THE NEAR SIDE OF THE MOON



MAP OF MARS

A map of Mars showing some of the major features of the planet and their names. In the colour version, the blue areas are deeper regions (below the average height of Mars), such as canyons and the red regions are high regions (above the average height), such as volcanoes. If you are looking at a black and white version of the map, the dark (blacker) regions (such as the Hellas Basin) are the deeper areas and the light (whiter) regions (such as the Tharsis Montes) are the high regions.



MODULE 4: PLANNING FOR GOVERNANCE IN SPACE

BUILDING A SOCIETY IN SPACE

We have a station on the Moon or Mars, and now we need to manage this new branch of civilisation. In this final module, you'll consider how your station is going to be run and, beyond your station, what sort of government you will create to run all the different stations on the Moon or Mars.

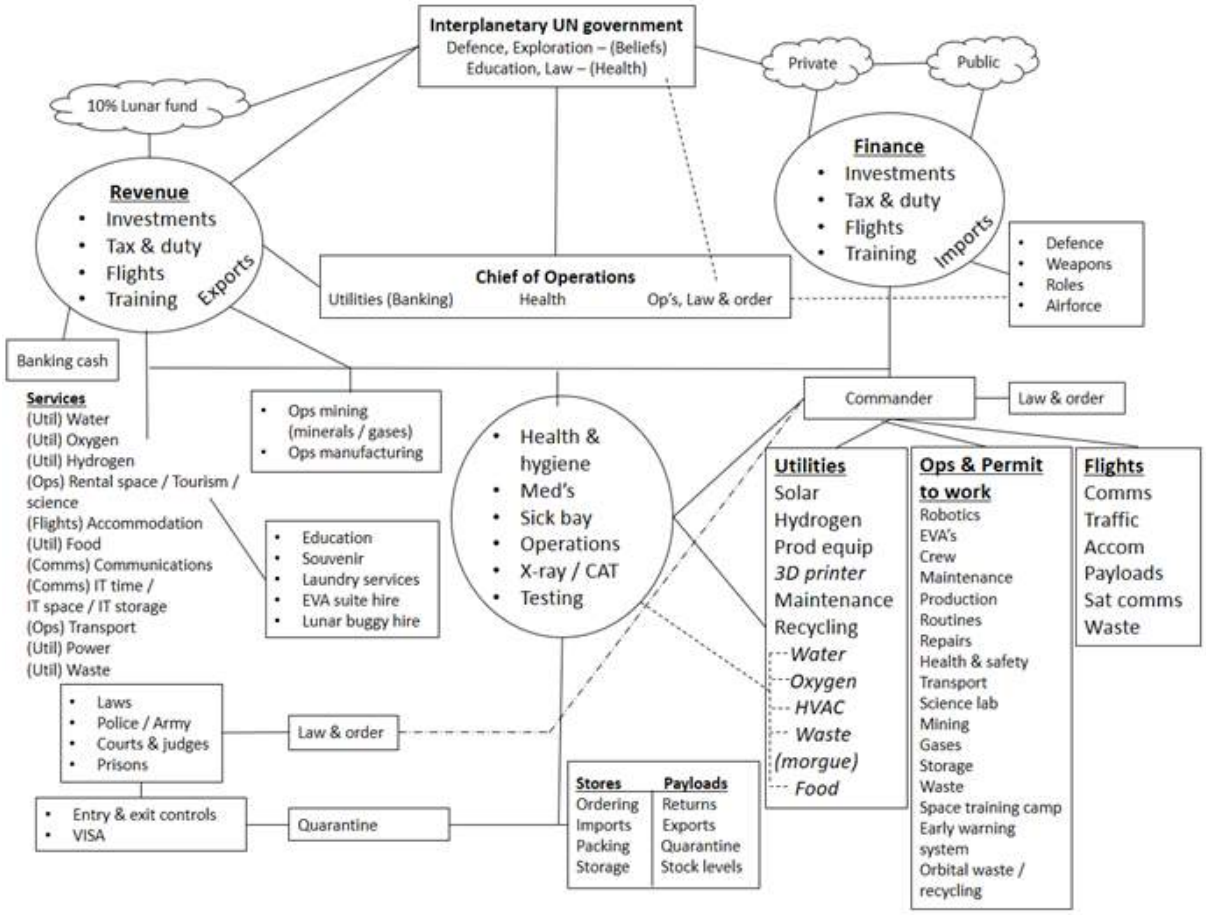
This module is a little different from the previous modules. It's less about technicalities and design and more **about the planning of human societies**. We have found that this has been enormously fun for participants since it gives you the chance to design a whole new society. As with other modules, you are not expected to be a politician or economist to do this module! The idea is to think through some of the things your station will need and how you might plan for them. The module will take you through this with step-by-step activities.

On the next page, you can see a flow diagram for an interplanetary government for the Moon designed by a group of participants in the Life Beyond project at HMP Glenochil. This is quite a complicated example, and you don't need to produce something like this at the end of the module. However, if you look at the diagram you can get some idea of the different items that this group thought could be brought together to make a lunar government. **This module will guide you through producing a smaller version of this.**

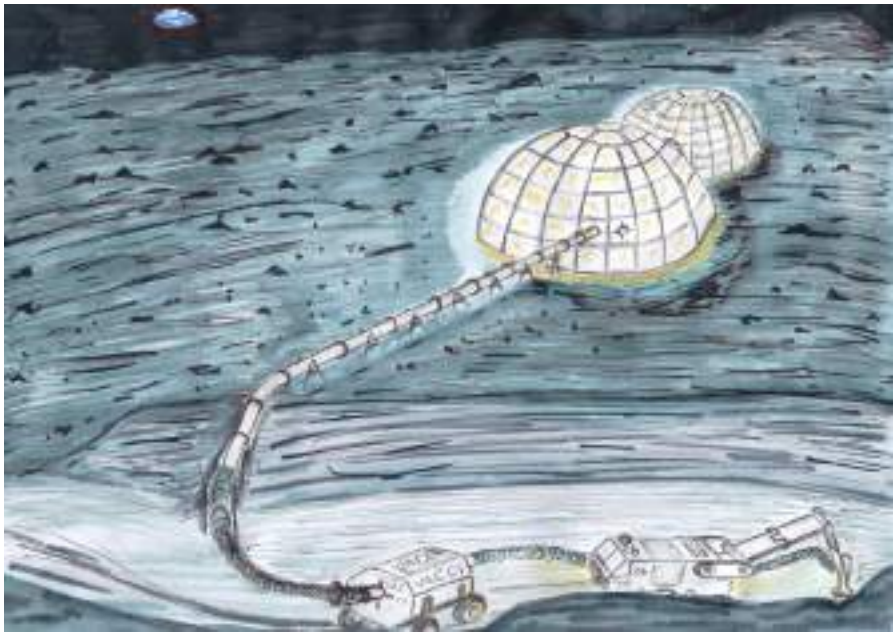
This module will take you through the process of planning for the governance of your station on the Moon or Mars.

Throughout this project, **activities** or s**ub-activities** denoted by an **ENVELOPE ICON**  are ones you can submit to the Life Beyond project if you'd like to. We have provided boxes for you to do your activities, but **feel free to use additional materials or paper if you like**.

If you are keen, don't feel limited by the activities denoted by the envelope icons. These activities are there to provide structure, but feel free to submit any creative work that you feel motivated to do. We'd welcome any contributions!



A government for the Moon. A quite complex flow diagram showing an interplanetary government for the Moon and how the pieces interconnect. This was designed by a group of participants in the Life Beyond project at **HMP Glenochil**. Your design doesn't have to be this complicated.



Lunar Station. A station on the Moon, such as this one designed by participants in the Life Beyond course at **HMP Glenochil**, will need a well-planned governance structure to make sure it has enough supplies to keep running.

SOME BACKGROUND INFORMATION

Once we have stations on the Moon or Mars, we need to have some organisational structure. First, we need to organise the basics for survival. We need to have plans for how our food, oxygen and water is going to be produced, and how it is to be distributed fairly. All the machines that make these various things need to be kept operating, and they need spares. To do all this we need to have some management structure.

Aside from the basic things for survival, we may have visitors. Tourists may come to the Moon and Mars to take part in adventures and go on treks. They will need food, living quarters and vehicles. Someone needs to manage these items to make sure that no one goes hungry and the tourists are satisfied with what they came for.

Beyond all this, we will need some way to manage our station and decide on everyday decisions. How will decisions be made on food production, the number of tourists to visit, and who gets to go out on scientific expeditions? Our station as a whole must be managed. Will this be by some top-down military-style management or a small democratic assembly?

There is no right way to do this and people have speculated for a long time about how stations on other planets could be organised. Some people have imagined them to be like small groups of people in an isolated environment where they take decisions among themselves in a very democratic way and then implement the decisions. Other people have imagined that they would be more like a nuclear submarine with a very hierarchical organisation – a well-defined commander and crew. Some people think it might be between these two extremes.

Whatever we decide, outer space is a blank canvas, and you have a chance to design your own society in space.

PREPARING FOR GOVERNANCE

In this activity, we will start to think about the structures of governance that you are going to plan. The first thing you need to do is to put yourself in a position of responsibility in the station. You have to decide what managers you are going to appoint to run your station. You might find the questions below useful to get you thinking about some of the important issues.

SOME QUESTIONS TO HELP GUIDE YOUR IDEAS

Here are some **multiple-choice questions** to guide your thinking and to give you an opportunity to think about governance in your station and for the whole of the Moon or Mars. You can find the answers at the back of this module pack. In this set of study questions, don't worry too much about the right answer. Instead, read them through and use them to gather knowledge about the governance of the Moon and Mars.

1. In a Moon or Mars station, managers will be needed to oversee the following requirements:

a. Oxygen production.
b. Food production.
c. Water production.
d. All of the above.

2. Which of the following activities might be happening at your station that could need a manager or committee to oversee?

a. Pony trekking.
b. Mining.
c. Sunbathing on the beach.

3. Which of the following may be critical for the safe operation of a station on the Moon or Mars?

a. A health and safety committee to oversee mining and/or tourism.
b. A manager to keep an eye on all the infrastructure, particularly pressurised habitats to make sure they remain safe.
c. A manager to make sure that tourists, if they are visiting, are properly briefed and safe.
d. All of the above.

4. Which of these facilities are not usually found in stations on the Earth, but could be very important to manage on the Moon and Mars?

a. A rocket landing area and pad that must be overseen, operated and kept safe.
b. A garage with pressurised rovers that must be kept in working order to avoid dangerous depressurisation.
c. Pressurised plant growth modules producing food for the whole crew at the station.
d. All of the above.

5. A government on the Moon and Mars must accomplish the following:

a. Keep everyone safe.
b. Make sure there is plenty of food, oxygen and water for everyone.
c. Resolve disputes.
d. Plan the distribution of rovers, spacesuits and other things needed for the station.
e. All of the above.

ACTIVITY 1 - SELECTING YOUR MANAGERS

The first thing we need to do is to divide up all the tasks in our station and assign some managers to run them. In this activity, you'll need to think about all the things that are going on in your station and how you will manage them. For example, you could have a manager for food and one for water, but you could have a 'utilities' manager to oversee both food and water. It's up to you. However, the first thing to do is to list the major activities that you think are going on in your station. We've given you two examples to get you started:

The major activities going in my station that will need managing are:
Feel free to add more bullet points.

- **Food production**
- **Tourist operations**
-
-
-
-
-

Now you have a list of some of the major things happening at your station, you could think about whether they can be consolidated – can any of them be bunched together in departments or units? For example, food and water production could be put into a 'Department of Food and Water Supplies'.

Below you now need to move one layer up in your station planning, listing the major 'departments' or 'units' and which activities they will oversee. If you're stuck, you could find inspiration in the **diagram drawn by participants at HMP Glenochil** on **page 68**.

The major departments of my station and their associated activities will be:

Now we've got some ideas of what managers we'll need and what sort of activities are going on, we should think about appointing some people! In the next activity, you'll think about what sort of job you'd like to do at the station, and you'll draw up a job advert for this position.

ACTIVITY 2 - A JOB POSTING IN YOUR STATION

This is your chance to think about the various roles you defined in the previous activity and consider one or two of them in greater detail.

What role would you like in the station? What qualifications are needed for this role?

What special skills might you need in space that are not required here on Earth?

Write a job advertisement for this position.
Imagine that this would be posted on an electronic job board for all members of the station to see. If people in your society do not apply for jobs but are selected by their superiors, you can create a list of criteria that these leaders will use to find a suitable candidate.

You can go into as much or as little detail as you want, but you will probably want to include at least a job description, responsibilities, and desired skills. We've given you some headings to help you out.

Job title:

Skills needed for the job:

Advert to be posted for the job:

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

Not all your jobs in the station will be directly appointed. Maybe someone will run for election, perhaps to be your station commander. In the next activity, you'll design a campaign poster for someone hoping to get elected to a position in the station.

ACTIVITY 3 - DESIGNING A CAMPAIGN POSTER

While some positions might be appointed or applied for, others in your society might be elected. Just as here on Earth, a successful campaign is key to getting elected. You'll have the chance here to design a campaign poster for someone running for one of these positions. That someone can be you or a fictional character.

What is the position that is being campaigned for? How long is the appointment?

What policy changes or plans will your campaign be based on?
For example, perhaps you will campaign for cheaper oxygen or more space suits?

Now that you have thought a bit about the context of the campaign, it is time to design your candidate's campaign poster.

You can keep it simple with just a slogan, or you could incorporate a visual element. If you like, you could even make a storyboard for what a campaign video for your candidate would look like.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

Now you have some people in post and working at your station, they need to have a uniform to wear. Well, they could just wear some informal clothes, but perhaps a station uniform would give your station some identity, and it might be useful to know who does particular jobs. In the next activity, you'll design a uniform. Again, you don't need to be an artist to do this activity.

ACTIVITY 4 - DESIGN A UNIFORM

Just as a plumber requires a different uniform from a rocket engineer, so do workers in different roles in your lunar or Martian base. This is your chance to think about how the function of the job guides the design of a space suit. Don't forget the safety considerations of a spacesuit either!

What role will you draw a uniform for?

This can be the same one you wrote a job posting for, the position your campaign poster was based on, or a completely different position that you outlined in your hierarchy.

What aspects of this job require special features?

Does the individual need a large range of motion for physical work? Will they be working mostly indoors or outside the station? Are there any tools that they use that will need to be attached to the suit or built into it? Does the fabric need to be breathable? Does it need to be more insulated than a usual suit? List helpful features that are unique to this job.

Draw the spacesuit for this position.

You can do a simple sketch with some labels or go into as much detail as you like. Just be sure to note what job the space uniform is for! If you don't feel like drawing or doing art, you could list the characteristics of your uniform and its main features.

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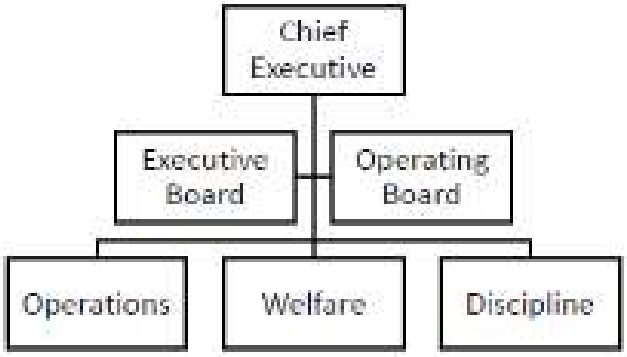
In the first activity in this module, you identified some of the main things going on at your station and grouped them together into units or departments (or any other name you'd like to give them). This is the basis of your station. Now we need to ask how they are going to be linked together. If you have a look at the **diagram on page 68 of this module** you can see an example of the sort of diagram that participants at **HMP Glenochil** came up with for their station. That is a quite complicated diagram, and you are not expected to produce anything like that, but it gives you some idea of how it is drawn out. **In activity 5, try designing your own management diagram for your station**.



A corporate Mars. The basic organisational structure of a proposed company on Mars, designed by participants of Life Beyond at **HMP Glenochil**. Their idea was to run the planet Mars like a company, and they designed this 'corporate Mars' structure for their government. As they said in their plan: "Mars will be a 'corporate planet' where all aspects of life are controlled by the **Martian Operations company**." Is this the best way to run a whole planet? What do you think?

ACTIVITY 5 - THE STATION MANAGEMENT

In this activity, you'll think about how your various departments link to one another.

For example, the department that looks after food will need to talk to the department that organises tourists to make sure that they have enough food. We could write 'Food department' in one box, 'Tourist division' in another and draw a line between them to signify that they communicate with each other. **In the space below, try drawing some boxes signifying each of your departments and some lines between them that indicate which departments must talk to each other.**

Congratulations – when you have done this activity you will have drawn an 'organogram', a diagram setting out the organisation of your station. Now your station occupants can consult this diagram when they need to talk to someone or see who is responsible for different activities. For example, if they want to plan a tourist trip, they can consult your diagram to see who to talk to.

What you have done is to get a good idea of how your station is going to be run. **In this next activity, we are going to move up to a bigger scale and think about how a whole lunar or Martian government is going to be run.** This is the organisation that might oversee many stations on the Moon and Mars, as well as how the lunar or Martian society is going to interact with authorities back on Earth. Again, don't be intimidated by this – you're not expected to know how to run a country to do this activity! It's actually a fun exercise in **designing a whole new society**.

This activity is a little bit like the last one. You need to think about what major departments you are going to need to have to run the Moon and Mars. Have a think about how the country you live in is run and what major departments of government exist. To get you started, you might think about a Department for Food and Water to oversee the whole of Mars or the Moon and make sure that supply routes between stations are kept open. You might need a Treasury to raise some money to be able to send spaceships to Earth for supplies. What else will you need? Activity 6 expands on these ideas.

ACTIVITY 6 - YOUR LUNAR OR MARTIAN GOVERNMENT

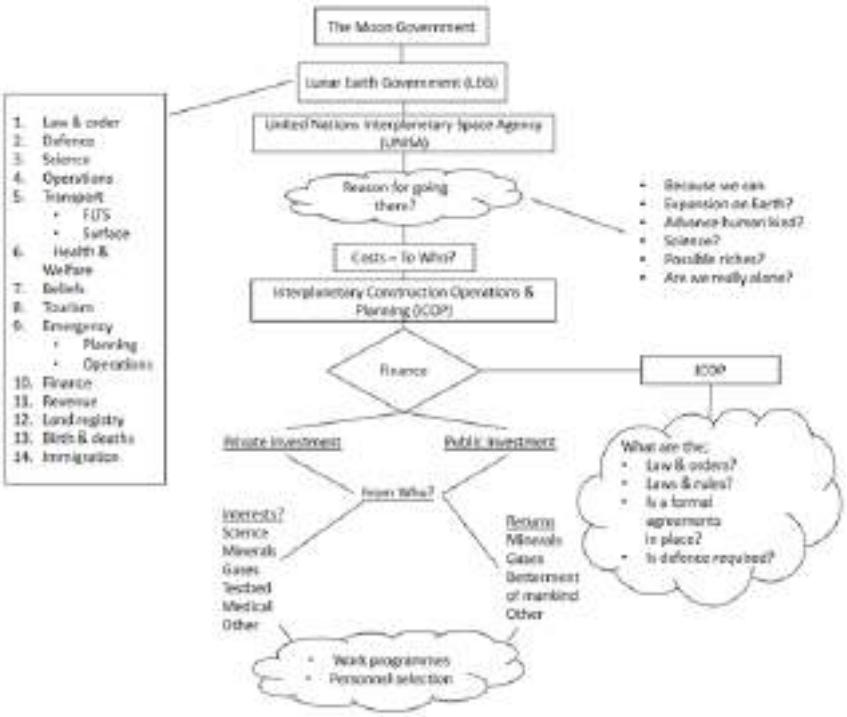
We want to come up with a list of things that a lunar or Martian government will need to do and identify who is going to oversee these tasks. **In the space below, list a few activities that you could imagine your lunar or Martian government doing and then who would run each one.** We've given you two examples to start off with. You can let your imagination go free here – no one has yet set up a lunar or Martian government, so any ideas are good!

Examples:
Making sure there is **enough food** for all the stations – run by the **Department of Food**
Making sure that **relations with Earth** are good – run by the **Department for Interplanetary Affairs**

In this final stage of this module, you need to think about the style of your government. What we mean by that is thinking about what sort of society you will live in. Example questions are:

- Will the government have a President?
- Will the government have a Central Committee of 'wise' space explorers that decides everything, or will it have an elected Parliament? If it is elected, will it have one house or two (a bit like the House of Commons and the House of Lords in the UK)?
- If members of your parliament are elected, will you have one person per station or one person per lunar or Martian district?
- What about ownership? Will oxygen be owned privately or by a cooperative, or by the state? Who gets to decide?

As with all the previous activities there is no right answer – you can invent any government you want. In this next activity are some smaller activities to help you think about your lunar or Martian government. It could look something like the diagram below, which was drawn by some Life Beyond participants.



A general lunar government structure. An example of a government structure on the Moon, designed by participants at **HMP Glenochil**. You can design a 'high level' structure like this that sets out the major things that a whole government on the Moon or Mars would oversee.

ACTIVITY 7 - THE STYLE OF YOUR LUNAR OR MARTIAN GOVERNMENT

To put together your lunar or Martian government, **answer the questions below**. In the final part of your activity, you could draw an organisational chart of your government.

The new government will have a committee or parliament that oversees all the policy and political decisions on the Moon or Mars. **How many people will it have on it, and how will they be decided – by vote or appointed in some way?**

How will representatives to the parliament be chosen?
For example, one or more per station, or by geographical area on the Moon or Mars?

How will your government be represented back on Earth?
Or will it be completely independent of Earth? Jot some notes down below about what sort of link with planet Earth you plan for your new lunar or Martian government.

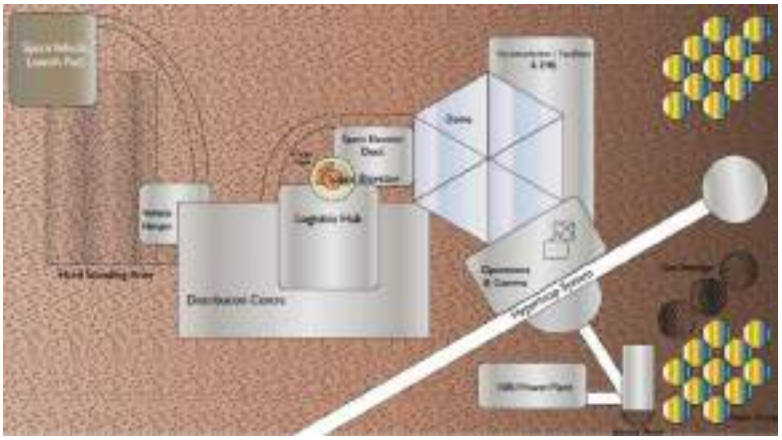
ACTIVITY 8 - YOUR LUNAR AND MARTIAN GOVERNMENT

In this activity, you can draw a diagram of your government a little like the one shown on page 80, drawn by participants of HMP Glenochil . You can make it as simple or detailed as you like. The main things to capture are a box showing your committee or parliament and some boxes showing the main branches of your government. **Remember: there is no 'right' way to do this – we don't yet have a government on the Moon or Mars! So, let your imagination go and enjoy the fun of designing a completely new society on another planet.**

Note: If you have done the Life Beyond Short Activities pack, you may already have done this activity.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

Now we have a full-scale station, we want to think about the rules that will be used to run your station into the future. These final two activities ask you to think a bit more about managing a station in the extreme environments on the Moon or Mars, including the rules you'll have on your station and how discipline might work in the extreme conditions on the Moon or Mars.



Equatorial Base Bravo on Mars. A station plan from participants of Life Beyond at **HMP Glenochil**. But who will govern the station, and what sort of government will it have?

ACTIVITY 9 - RULES IN THE STATION

Now is a chance to consider how rules will be implemented in your station. Recall the dangers and difficulties of living in space discussed in the first module.

Below, list some of the major health and safety risks in your station.
It might be helpful to consider access to water, heating, oxygen, and the need to keep the station properly sealed against the outside environment. Remember that, due to your distance from Earth, if life-sustaining supplies are destroyed, replacements and aid may not be able to reach you in time. Similarly, communication systems provide a lifeline between different stations and between your station and the Earth. Are there other survival aspects that must be considered?

Given these risks, what kinds of behaviours should be discouraged?
Beyond wilful destruction of goods, what actions could endanger aspects of the safety of the station and its inhabitants? Are there any behaviours which wouldn't necessarily be viewed negatively on Earth, but which could have more serious impacts on the Moon or Mars?

Rules exist not only to prevent undesirable behaviour but also to protect individual and group rights. Considering the structure of your society, what individual human rights should be protected on your station? Are there any rights that should be afforded to groups? For example, anti-discrimination laws protect individuals who belong to specified groups. **Write a list of what rights individuals have on the Moon or Mars and note if any of these rights are based on group identity.**

Write some rules for your station.

This could be in the form of a poster for the station so that everyone knows what rules they can expect. These should consider not just the physical well-being of the station's inhabitants and structure, but also any rights that those living in the station have. You could think of this as a poster for tourists or new miners just arriving on the Moon or Mars to help them understand how everyone operates in the station.

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO.

ACTIVITY 10 - DISCIPLINE IN THE STATION

Now that you have had a chance to think about how your society's structured and the need to protect both people and property inform laws, **it's time to consider what happens when people break the station rules.**

What are the goals behind discipline in your Mars or Moon society?
Punishment? Rehabilitation? In crimes committed against individuals, is the focus of sentencing on healing for the victim or penalizing the person who committed the crime?

Now that you have some rules, write about what will happen if people break them.
You can take this question in many different directions. You might want to describe who enforces these rules, or maybe you want to focus on how discipline varies based on the severity of the violation. Is sentencing decided by an individual, a jury, or society as a whole? Should the intent behind the crime impact sentencing? Whatever direction(s) you choose to go is okay. **You can answer this with a paragraph, flowchart, table, or whatever format makes the most sense to you.**

YOU CAN SUBMIT THIS WORK TO THE LIFE BEYOND PROJECT IF YOU'D LIKE TO

MODULE 4: ADDITIONAL ACTIVITIES

If you would like to continue Module 4 further and contribute additional work to the Life Beyond project, here are some activities you could undertake.

1. **Make a health and safety poster** for your station, developed by your health and safety manager on the Moon or Mars, to keep crew or tourists safe.

2. **Write a letter from the water manager** asking for more water resources for your crops, explaining how much water you need, by when and how it should be delivered.

3. Imagine that your station is well established and has a self-sustaining and growing population. Public parks have started to emerge, and you've been asked to **design a park** that is beautiful, functional, and respectful of limited resources like fertiliser and water. Draw your garden, keeping in mind what plant characteristics are valued and how they will be watered.

4. **Think about one of your departments or units in more detail** and draw up a more detailed structure or management diagram for it.

5. Public art can reflect a society's values. **Design a piece of art** that you think would fit in with the structure of your society. It can be a painting, sculpture, or even a piece of music.

6. **Draw up an agenda of a meeting** of one of your critical departments, like food or water production, and list some of the things they need to discuss for the day.

7. **Draw up an inventory list** for one of your departments that you will send to Earth, requesting new supplies for your station.

8. **Write a short story** about a day in the life of an emergency responder on your station. This could be a doctor, firefighter, nurse, or some other professional.

9. **Write a short essay** describing a day in the life of your lunar or Martian President.

10. **Write a poem** about lunar or Martian government.

11. **Design a flag** for your station.

12. You need to ask your health and safety manager to give a briefing to a small group of tourists who are about to go on a trek to a newly discovered crater. However, they haven't given such a talk before. **Write a list of rules and items** that they should bring up with the tourists before they head out to the crater, to make sure they are safe.

13. **Draw the layout of a lunar or Martian Parliament** and how it might be laid out in a giant dome on the Moon or Mars.

14. **Write a short description of a day's proceedings** in your Martian or lunar parliament with some of the matters discussed in the day.

15. **Create a timeline** that describes how society grew in size and complexity from when your station was brand new until 50 years later. Be sure to note if there were any notable political reorganisations or disagreements.

MODULE STUDY QUESTIONS – ANSWERS

1. **Answer d**: All of the above. You'll need to have managers for all of these needs. Particularly in the extreme conditions of space it will be very important to make sure everyone has oxygen, food and water because these things don't exist naturally in the outside environment. If the station runf short, they can't just go out into the wild and find water in a stream, or plants to eat. You'll need managers to make sure that these production systems are kept working and well repaired.

2. **Answer b**: Mining. Pony trekking isn't going to happen (unless you've made spacesuits for ponies...) and sunbathing can't happen because the outside environment is lethal. However, mining could be one activity on the Moon or Mars, and you'll need a mine manager.

3. **Answer d**: All of the above. Health and safety is going to be quite critical in the lethal extraterrestrial environment. If a tourist doesn't put on a spacesuit properly, they could die. If a habitat isn't carefully looked after it could depressurise. We'll need to keep an eye out for failures in infrastructure such as habitats and vehicles and try to prevent them from happening in the first place.

4. **Answer d**: All of the above. Living in space is not exactly like living on Earth, and throughout this course you have probably realised that there are some big differences, not least the need to wear spacesuits and live in pressurised conditions. That means that there are some things that will need managing in space that we don't normally have to worry about on Earth. This question listed a few of them and all of them are relevant to space: rocket pads, garages for servicing and preparing pressurised rovers (not unlike garages on Earth, but the rovers will need special care to make sure they don't depressurise), and pressurised plant growth modules.

5. **Answer e**: All of the above. A government on the Moon and Mars will have to be quite proficient in lots of things and deal with lots of situations. From making sure enough food gets produced to resolving any disputes in the settlement, the government will have to make sure that everyone gets on together as fairly as possible, people are responsible, and disagreements can be overcome through discussion between all the occupants of the settlement (and maybe tourists as well if they are present).

EVALUATION FORM

Below is a short evaluation form. Please do fill this in and send it back with your work. It's not compulsory, but it's important for us to know what you think about this course so that we can improve it for future participants. Beyond that, many people ask us about the value of our work and it's important for us to be able to provide evidence that the course has been of benefit and interest to you. It won't take long to complete. Of course, you may also feel free to criticise the course! **Tell us what you don't like, so we can modify the course to make it better for the future.**

Did you find this course interesting (yes/no)?

What did you most like about this course?

What would you improve in this course?

Did this course make you think any differently about educational projects and courses of this type?