Choose Your Mars Habitat

https://www.nasa.gov/directorates/spacetech/centennial_challenges/3DPHab/top-10-virtual-model-stage

Getting humans to Mars is hard enough. But being able to survive there a long time is also a tough challenge. Any structure on Mars will have to withstand intense solar radiation, high winds and massive daily temperature changes. It will have to provide a pressurized environment inside for humans to inhabit over a long period of time.

Mars is a very different environment than Earth. The atmospheric pressure, gravity, temperature, soil composition, and availability of water are vastly different than Earth planetary conditions. However, there are some important similarities between the two planets. The day length is similar and water is present on Mars, usually in the form of ice. In many ways current Martian conditions are similar to some of the most extreme environments on Earth (e.g., Antarctica), and similar to what many scientists believe primitive Earth soil and atmospheric chemistry were like. A crewed mission to Mars would most certainly have limited storage capacity. Once astronauts arrived on Mars, it would be necessary to manufacture much of what they need on site. Being able to produce food and generate oxygen on Mars (and during the actual voyage) would greatly increase the feasibility of a crewed Mars mission.

When a space habitat is designed, it is important that it should be:

- Safe – this is the most important consideration
- Robust – strong, reliable, durable, requiring minimal maintenance
- Lightweight – the average fridge weighs 100 kg and is clearly not an option in a space habitat
- Launch capable - different elements have to fit an available rocket in terms of weight, shape and power requirements or elements can be constructed with 3D printing on Mars
- Effective – it must do what it was designed to do
- Affordable – space exploration is expensive, so all steps to reduce costs without compromising performance and safety must be taken.

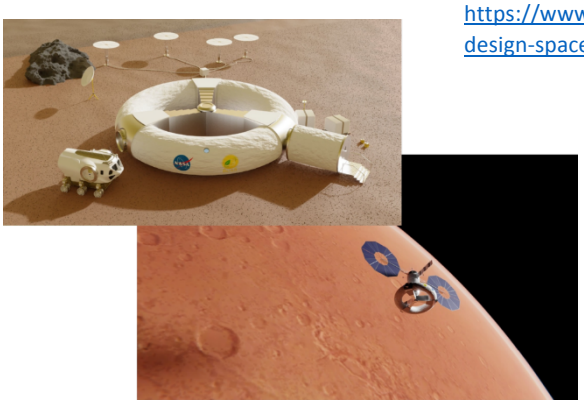
Considerations: How can we meet the requirements of a space habitat under the constraints that are imposed? This is done by:

- Using a modular construction system, beginning with the essential features and adding 'rooms' as needed for particular purposes (e.g. research or space for more crew)
- Developing technology to utilize the resources on the Moon or Mars, e.g. making lunar bricks or lunar cement, or using the underground caves on Mars for habitats
- Recycling (air, water, waste, parts of the landing spacecraft for construction, the oxygen and hydrogen in extra rocket fuel for water production)
- Miniaturizing as many things as possible, standardizing all tools, power connections, etc.
- Making areas multipurpose, e.g. a dining table that folds away so that the space can also be used for other purposes. https://www.scienceinschool.org/2011/issue19/habitat

Each of the 4 designs below has pros and cons for living and working on the Mars. Each design also needs to be transported to the planet for construction or has components that can be 3D printed on site. Look at the following images and evaluate each on the criteria in the table.

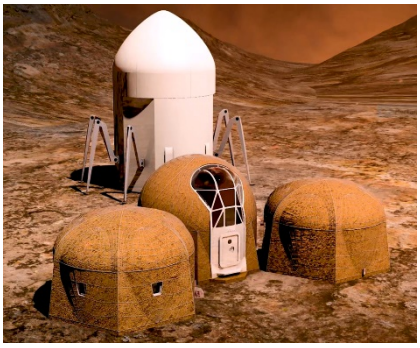
Design #1

Design #2



https://www.nasa.gov/feature/students-design-space-habitat-concepts-for-mars

Design #3



https://www.nasa.gov/directorates/spacetech/centennial_challenges/3DPHab/fiv

Design for 3D printed structures on Mars using local Mars materials.

Design #4

https://www.nasa.gov/directorates/spacetech/centennial_challenges/3DPHab/fiv

Design for 3D printed structures on Mars using local Mars materials.

Design #	Can it be easily transported to Mars or is it made on site?	Would this design be easy to put together on Mars? Explain	Is the exterior is tough and durable? Explain	Can the spaces be modified for different uses? Explain	Is the space large enough to comfortably work and live in? Explain
1					
2					
3					
4					

Challenge: Design Your concept of a Mars Habitat

How much space does an astronaut usually have? The Apollo spacecraft which carried 3 people was small. The crew's main living quarters was 10 feet 7 inches from base to apex and 12 feet 10 inches around at the base. 210 cubic feet of livable space was crammed with three couches and all the instrumentation and display panels the crew would launch in and return to Earth. Another vehicle was attached that managed the trip from Moon orbit to the surface and back.

The ISS carries a crew of six people and has a habitable volume of 13,696 cubic feet, NASA reports. Any craft headed to Mars will be much more cramped, as weight will be tightly controlled because every pound needs to be propelled for the journey of around 140 million miles. NASA has estimated that the minimal acceptable volume for a human mission to the Red Planet will be about 883 cubic feet per person. Once the crew is on the planet, space is not a problem. It can be as large as the constructed habitat can allow.

1. Calculate the space of one of your living spaces in cubic feet. This can be a living room, a bedroom, or other area where you spend a lot of time. Estimate the length, width, and height and multiple all three of these factors.

2. Compare this to the living space that an astronaut has on the ISS.

3. Compare the number that you calculated in #1 above to the space an astronaut will have on the trip to Mars.

4. Calculate the space that will be needed for a crew of 12 to go to Mars.

5. Once on Mars, how much space in cubic feet do you think you would need for staying over 1 year?

6. If time permits, draw your concept of a habitat on Mars.

Answers:

1. Calculate the space of one of your living spaces in cubic feet. This can be a living room, a bedroom, or other area where you spend a lot of time. Estimate the length, width, and height and multiple all three of these factors. Typical bedroom might be 10 feet by 12 feet by 9 feet. 1,080 cubic feet

2. Compare this to the living space that an astronaut has on the ISS. Astronauts have 2,283 cubic feet but all of that is not living space. They have a lot of equipment taking up space that cannot be used for other things.

3. Compare the number that you calculated in #1 above to the space an astronaut will have on the trip to Mars. Mars travelers will have 883 cubic feet per person, lesson than a typical bedroom on Earth.

4. Calculate the space that will be needed for a crew of 12 to go to Mars. 10,596 cubic feet

5. Once on Mars, how much space in cubic feet do you think you would need for staying over 1 year? Answers will vary

6. If time permits, draw your concept of a habitat on Mars.

Answers will vary.