A year in the dome

Activity:
In this activity students plan a year's survival in a sealed dome in the desert as a precursor to space colonisation. This involves discussion about the nature of scientific experiment, the carbon, water and nitrogen cycles and the evolution of the atmosphere.

Note: this activity has been used as the basis of a very effective BTEC project in the past.

The activity can be run by leading students through the following questions, or by giving groups of students the prompt sheet below.

Scenario: You are going to be sealed in a dome in the Arizona desert for a year. Satellite communication is possible.

Key question: What will you take with you? You can order whatever you want (prompt sheet below).

Have some illustration of: amount of water consumed per person per day ~ 5 litres
amount of air/oxygen consumed ~ 11,000 litres of air = 550 litres of oxygen = 0.55 m^3

Teacher prompts:
- What are you going to breathe – oxygen source?
- What are you going to drink – water cycle?
- What are you going to eat – balanced diet – carbon cycle?
- What is your likely water/oxygen/food consumption per person per day?
- How will you dispose of waste – recycling through plants – importance of microbes?
- Energy source? It's a closed system but you have 12 hours of energy from sun.
- How do you control temperature – clothes, sleeping, shields, absorbers?
- Illness and medical requirements?

Key question: What are you going to do when you get there?

Teacher prompts:
- Job allocation e.g. organising fresh water, growing the food, cooking the food, sorting out the waste
- Fresh-water can be collected from condensation on the dome at night
- Living entirely off vegetables? – any animals e.g. chickens for eggs and meat?
- What will be needed for communication? - power source?

Student learning outcomes:
Students will be able to:
- explain the scientific limitations of living in a closed environment;
- plan what to take / jobs to be done within the limitations imposed by the water and carbon cycles in a 'biome' experiment;
- compare the 'biome' model with the Earth in the context of human survival at the end of the exercise.

Student practical or teacher demonstration:
Student discussion in groups with some teacher prompts.

Time needed to complete the activity:
30 minutes.

Preparation and set-up time:
Copying the resources listed below.

Resources:
- Water cycle diagram
- Carbon cycle diagram
- Nitrogen cycle diagram
- Photos of domes (e.g. those of the Eden Project http://www.edenproject.com) inside and out (optional)
- 'A Year in the Dome' instruction sheet
- 'Biosphere 2 Center' information

Ideas for leading into the activity:
Highlight for the students the composition of the modern atmosphere (78% nitrogen, 21% oxygen, and 1% for the rest, including CO_2 (0.03%) with variable amounts of water vapour). Then ask them:
"What will happen to this atmosphere if this room is sealed?"
Answer: before we all die, we will notice that oxygen content will decrease, CO_2 will increase at the same rate and the windows will steam up due to the water vapour we breathe out. This lead in activity will set up discussion around the water, carbon and oxygen cycles.

Ideas for following up the activity:
What are the importance of the water and carbon cycles?
What part does the nitrogen cycle play? – important for recycling waste to plant nutrients – role of bacteria and other micro-organisms.
If your year is successful and the dome systems are running well, you will have lived sustainably using only renewable solar energy.
Are there lessons from this activity for future sustainable life of Earth?

Source of activity:
Earth Science Education Unit.

Extension ideas:
What will you miss most? – social factors?
What might cause failure? Is this a scientific reason?
Think about the size of the dome and amount of plants needed to sustain an individual/group.

Additional notes: This experiment has been carried out. It was known as Biosphere 2 and took place in Arizona between 1991 and 1993. It failed because oxygen levels dropped from 21% to 14%. 19 out of the 25 vertebrate species died. Pests increased greatly and the humans needed food supplements.

The Desert USA website has the following information:

Biosphere 2 Center

It wasn't many years ago that Biosphere 2, nestled in the foothills of Arizona's Santa Catalina Mountains about 30 miles north of Tucson, was the laughing stock of scientific research. Biosphere 2 Center has become a major tourist attraction in the Tucson area.

Built in the late 1980s with $150 million in funding from Texas oil magnate Edward Bass, Biosphere 2 was designed as an airtight replica of Earth's environment (Biosphere 1). This 7,200,000-cubic-foot sealed glass and space-frame structure contains 5 biomes, including a 900,000-gallon ocean, a rain forest, a desert, agricultural areas and a human habitat.

Some of the early designers and managers were interested in space travel and the possibility of colonizing the Moon or Mars. By building Biosphere 2 and sealing people inside, they hoped to learn what problems would arise from living in a closed system. So it was that in 1991, a colony of 8 people set about to live inside Biosphere 2 for two years.

The people who were selected to be Biospherians and live inside Biosphere 2 during the two closure periods with humans came from 7 different countries. All spent several years in training to become more proficient in their own fields as well as gaining expertise in the skills of the others.

The first crew of Biospherians (4 women and 4 men) entered Biosphere 2 on September 26, 1991. The crew members remained inside for two years despite various problems, including limited agricultural productivity, and emerged on September 26, 1993. After a 6-month transition period, a second crew of 7 biospherians (5 men and 2 women) entered Biosphere 2. Unfortunately, after a number of physical and social problems developed, the project soon suffered scientific disdain and public ridicule before these experiments were suspended in 1994. Since then, there have been no resident crews living inside Biosphere 2, and no future human habitation is planned.

Biosphere 2 Center opened to visitors on November 26, 1996, as a hands-on, interactive science center. Visitors are now able to tour the apartments, kitchen and dining room where the Biospherians worked and lived. From this area, visitors can also look out into the rain forest, ocean, desert, savannah and agricultural ecosystems that the Biospherians struggled to manage.

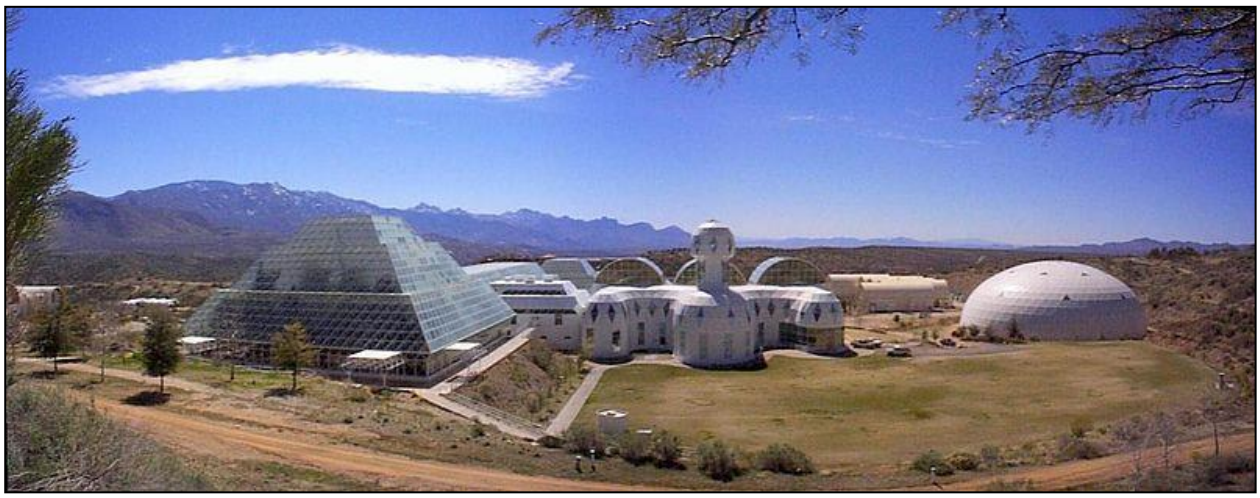
Also on view is the command-and-control room, where scientists monitored data collected by hundreds of sensors within the enclosed 3-acre ecological laboratory. The Habitat also contains a hands-on interactive Climate Change exhibit. The various biomes (rain forest, savanna, desert, marsh, ocean and agricultural area) can be observed.

From the Desert USA website (http://www.desertusa.com/mag99/apr/stories/bios2.html)

More details of the Biosphere 2 Center, including pictures, can be found on the website: http://www.bio2.com/

Much more detail about the experiment can be found at: http://www.biospheres.com/ or by searching for “Biosphere 2” on the internet.

Note: The project was called ‘Biosphere 2’ because ‘Biosphere 1’ was regarded as the Earth. Please check all the web references still work



Biosphere 2 near Tuscon, Arizona (this image is in the public domain)

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Key question:
What will you take with you? You can order whatever you want.

- What are you going to breathe?
- What are you going to drink?
- What are you going to eat?
- What is your likely water/oxygen/food consumption per day?
- How will you dispose of waste?
- What energy source will you use? How will you use it?
- How will you control temperature?
- What will your medical requirements be?
- What else might you need?

Key question:
What are you going to do when you get there?

- Who will do which jobs?
- How will you collect fresh water?
- Will you be vegetarian? If not, how will you get meat?
- How will you produce power?
- What else will you need to do?