Name_____Date_____

Biosphere 2

Watch the following 2 video clips

Biosphere 2: An American Space Odysseyhttps://www.youtube.com/watch?v=oUJGR6qNVzA
Jane Poynter: Life in Biosphere 2 https://www.youtube.com/watch?v=a7B39MLVeIc

By studying “closed ecosystems, ” artificial environments in which matter is not exchanged with the external environment, scientists have been able to learn more about the Earth’s natural cycles and to apply that knowledge to research projects on other planets.

One such controlled environment was Biosphere 2, a 4-acre facility located 20 miles north of Tucson, Arizona. Originally this glass-covered dome, which mimicked a giant greenhouse, showed what it might be like to live in outer space. It has now been turned into a public and educational research facility offering daily tours to the public. But back in 1992, Julia Brink and a seven-member crew lived in Biosphere 2 for two years along with a variety of plants and animals. The plants in the system were intended to produce enough oxygen to enable the animals to survive. However, after Julia and her crew had lived in Biosphere 2 for about one year, the amount of carbon dioxide inside had risen to a critical level. Even though there were plenty of plants under the dome, the high level of carbon dioxide was causing the humans to suffer from respiratory acidosis, in which levels of CO2 in the bloodstream are too toxic to sustain animal life.

Daily fluctuation of carbon dioxide dynamics was typically 600 ppm because of the strong drawdown during sunlight hours by plant photosynthesis, followed by a similar rise during the nighttime when system respiration dominated. As expected, there was also a strong seasonal signature to CO_2 levels, with wintertime levels as high as 4,000-4,500 and summertime levels near 1,000 ppm. The rate of CO_2 through respiration was faster than the photosynthesis (due to relatively low light penetration through the glazed structure) resulting in a slow decrease of oxygen and build up of CO_2.

Life was becoming intolerable for the animals inside the enclosed space, and the researchers were almost forced to abandon their mission. But then Julia and her team discovered that the increase in CO2 was due to an unanticipated super-growth of soil microbes, which in turn had caused unmanageable amounts of CO2 to be released during cellular respiration. The team designed a plan to recirculate the "used" air over and over again through a large water system containing mats of common river algae. Flowing over the mats was a constant stream of water aerated with the recycled air. Fortunately, the carbon dioxide level returned to normal, and the mission on dioxide level returned to normal, and the mission was saved.

The next closed ecosystem experiment—Laboratory Biosphere in Santa Fe, New Mexico—was developed based on the information obtained from Biosphere 2. Initial experiments in 2002 and 2003 tested the cultivation of soybeans and dwarf wheat, respectively. Following each succeeding experiment, Laboratory Biosphere was further developed and improved upon. Currently, Laboratory Biosphere scientists are conducting research on the cultivation of sweet potatoes. Information gained from Laboratory Biosphere has helped scientists compare an artificial closed ecological system with the global biosphere of planet Earth. It has shown that, at the current scale of global alteration and human population expansion, the biosphere can no longer safely buffer and absorb the amounts of pollutants being produced by humans.

Finally, a four-person, sustainable biospheric life support base called Mars Base is currently being designed. This prototype will simulate a long-term inhabited Mars mission to determine the feasibility of maintaining humans in a self-sustaining system—that is, one able to provide food, air, and water regeneration for an entire community. The Mars On Earth® biosphere modules will be constructed so that they can be replicated and can support more occupants over time. It is hoped that mankind will have a sustainable system on Mars within the next 20 years.

Questions

1. What is a "closed ecosystem”? Why can Biosphere 2 be considered a closed system?

2. What is respiratory acidosis? Describe how a human might acquire acidosis in a normal environment. What do you think will eventually happen to an animal with respiratory acidosis?

3. Why could the Biosphere 2 team not simply punch a hole in the dome to allow the excess CO2 to escape?

4. What was the main source of oxygen production within the biosphere?

5. What was the cause of the buildup of CO_2? Why were there daily fluctuations in oxygen levels?

6. Why would you think that algal mats were used to remove CO2 from the recycled air?

7. What lessons have the biosphere experiments taught humans about Earth?

8. What is the purpose of the Mars Base experiment? Why might such a system be necessary for humans?

9. Design a sustainable system that you feel would work on Mars. List all the components you would need to keep you and your crew alive.