

MODULE: *Photosynthesis and Respiration*

Activity Sheet 1.1: Your brief

Setting the scene

You are working as researchers in a university bioengineering department. Your director has emailed a press release to you about a recent development in the production of synthetic leaves. In his e-mail, he asks you to put together a proposal to show how this new technology could be used as a basis for a self-sustaining life support system that could be used in space travel and colonization.

You will need to support your proposal with scientific data, so there are a number of activities for you to complete. Finally, you will prepare a poster and a talk to support your proposal.

Route through the Brief

Outcome Checklist

E-mail from Research Centre Director



- Analysis of data
- Interpretations of data

Press release and background



- Analysis of data
- Interpretations of data
- Draw a diagram, list useful scientific terms

Photosynthesis and respiration explained



- Analysis of data
- Interpretations of data
- Conclusions
- Explanations
- Label a diagram; construct equations; describe photosynthesis and respiration

Photosynthesis data analysis



- Analysis of data
- Interpretations of data
- Conclusions
- Explanations
- Recommendations for improvement

Respiration investigation



- Plan
- Experiment carried out
- Conclusions
- Answers to questions

Talk and poster preparation



- Carry out research
- Construct a plan
- Create an interesting talk
- Draft a talk text
- Practise public speaking

Team presentations and peer review



- Checklist
- Setting up
- Improve communication skills
- Completion of peer review sheets

From: Head of Research

To: All research teams

Subject: Synthetic leaves

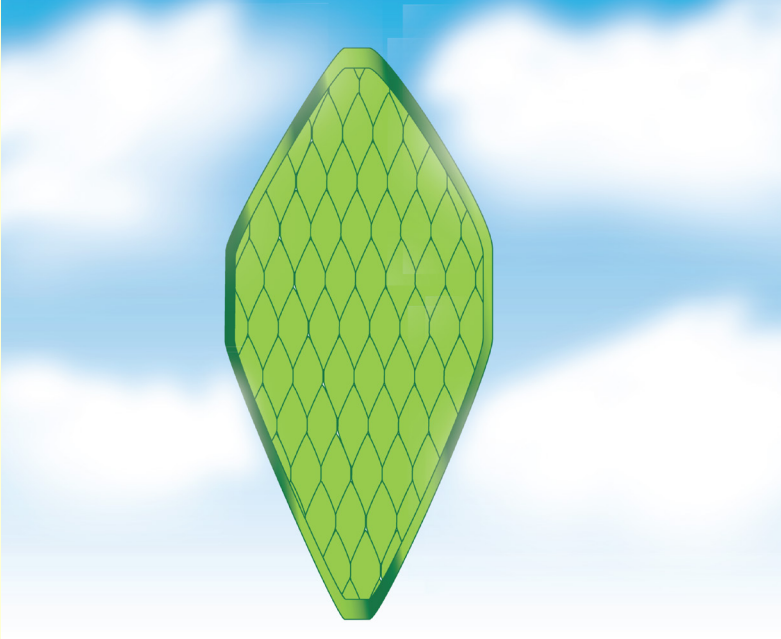
I have just read a press release about a new piece of research that has developed synthetic leaves (see attached document). In the press release, you will see there is a request for suggestions for how these synthetic leaves might be used. It seems to me that we could write a proposal for how they could be used in the development of a self-sustaining life support system. This could then be used in long-distance space travel, and even colonization.

You will need to:

- Read through the press release and background notes I have included, and make sure you understand everything. There is an exercise to help you.
- Analyse the photosynthesis data
- Carry out a respiration investigation
- Produce a poster and talk that summarises all you know about photosynthesis and respiration, and how they relate to self-sustainability.

Good luck!

PRESS RELEASE



An artificial leaf that can power the world and beyond.

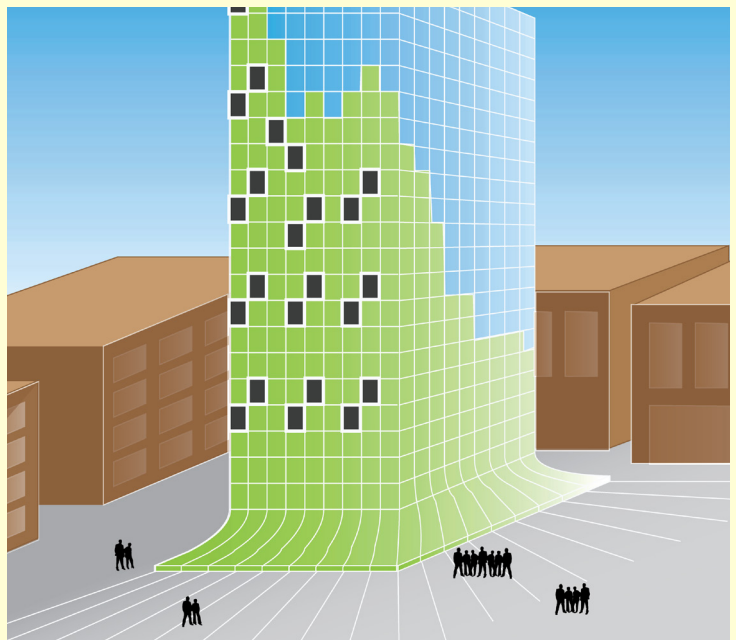
Researchers say that the synthetic biological leaf they have developed, which absorbs water and carbon dioxide to produce oxygen just like a real leaf, could help make long-distance space travel possible.

Real plants do not grow in zero gravity, so NASA is researching different ways to produce oxygen in space. These synthetic leaves could allow us to explore space much further than we do now.

The leaves are made of silk, with chloroplasts inside the silk fibres that produce oxygen and small amounts of water in sunlight.

The leaf is the first man-made biological leaf. They are very light, and they consume very little energy.

There has been a suggestion that they could be used for other things as well as space travel. For example, they could be put on the outside of buildings where they would absorb air from the outside and send oxygenated air inside.



BACKGROUND INFORMATION

Closed ecological systems

A closed ecological system (CES) is an ecosystem that does not rely on an exchange with anything outside the system. The term is most often used to describe small, man-made ecosystems. Such systems are scientifically interesting, and can potentially serve as life-support systems during space flight, in space stations or in space habitats.

Of particular importance in any CES is the role played by plants.

Green plants carry out two processes at a cellular level – photosynthesis and respiration.

Photosynthesis and respiration are complementary processes in the living world.

How do they work together? First, the leaves of plants absorb carbon dioxide from the air.

Then **photosynthesis** uses sunlight to convert the carbon dioxide into oxygen and sugar. The sugar is used as food for the plant. The plant releases most of the oxygen, but keeps some of it stored up. Photosynthesis can only happen in daylight.

Then comes **respiration**. Many people think this is just breathing. But here it means cellular respiration, a process in which oxygen and sugars combine to produce energy, releasing carbon dioxide and water vapour. In plants, respiration uses their stored oxygen to turn the sugars created by the photosynthesis into energy for the plant to live on and grow. Respiration happens at any time of day or night.

In the evolution of Earth, photosynthesis preceded respiration. It probably took billions of years until enough oxygen had been released by photosynthesis to create an atmosphere that could support animal life (now, about 20% of the Earth's atmosphere is oxygen). Luckily for us, plants give out much more oxygen than they absorb, and they absorb much more carbon dioxide than they give out. So as long as we have plenty of plants on Earth, we and other animals will be able to go on breathing.

Exercise 1

1. Using the information above, draw a diagram in the space below to show the relationship between photosynthesis and respiration.

- 2. Read the press release and the background information; highlight or underline all the words or phrases in it that you think you will need to use in your proposal. Then list them in the table below:

Word/phrase	Meaning