Key Stage 5 Worksheet

# Podcast: Using Algae To Clean Up Industrial Waste Fumes - Dr Emma Preedy

From the series: Exploring Global Problems, by Swansea University

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**EXPLORING** GLOBAL PROBLEMS

## Introduction

In this Exploring Global Problems podcast, Swansea University's Dr Emma Preedy talks about her work with the Reducing Industrial Carbon Emission (RICE) Project. Emma's research focuses on using algae to capture carbon dioxide gas released by industrial processes.

**Listen to the podcast:**
**www.swansea.ac.uk/research/podcasts/algae/**

**Open file in your web browser to click on the links.**

## Why is research into carbon capture important?

Some gases which exist in the Earth's atmosphere trap infrared radiation by absorbing it and emitting it back to Earth. This means that when they are emitted in large quantities by burning fossil fuels, they enhance the greenhouse effect and warm the Earth. These gases are called greenhouse gases. Carbon dioxide is an example of a greenhouse gas.

The greenhouse effect is not a bad thing, without it the Earth would be too cold to support life, but when too much greenhouse gas is released into the atmosphere the greenhouse effect is enhanced and dangerous climate warming occurs. This is called global warming. The levels of greenhouse gases are so high in our atmosphere now that the average temperature across the surface of the Earth has warmed by $1^{\circ}C$ and our planet is also experiencing more extreme weather events such as droughts and heat-waves.

Carbon dioxide is a really problematic greenhouse gas because a lot of the things people do release carbon dioxide; burning fossil fuels (oil and gas), burning wood, and deforestation all increase emissions of carbon dioxide to the atmosphere.

## What is this podcast about?

Dr Emma Preedy introduces a research project called **RICE** (which stands for "Reducing Industrial Carbon Emissions"). Dr Preedy's project is a **'carbon capture'** project which uses the extra carbon dioxide in our atmosphere to grow algae (plants that live in water). The algae uses carbon dioxide to grow, and emits oxygen into the atmosphere. The algae then produces proteins which can be used in other products. The algae help to reduce carbon dioxide levels but also are useful themselves as a food product. The algae grow in something called a photo (light) bio (biology – the algae) reactor. The reactor will use light and carbon dioxide to grow algae. This produces oxygen and a source of protein, which are both useful products.

## Why use algae?

Algae are a group of aquatic organisms that make their food the same way plants do, through photosynthesis. During photosynthesis carbon dioxide, water and light react to make sugar (glucose) and water.

There are advantages to using algae over plants. For example, the algae used by the RICE project is microscopic so a lot of it can be grown in a relatively small space. The RICE project grows their algae in long plastic tubes in a photobioreactor.

## Find out more about it

- **Read more** about the Reducing Industrial Carbon Emissions (RICE) project and their work with industries in Wales.
- **Watch this Ted Talk** about the potential of algae as a 'green' energy source.
- **Watch this** introduction to nanotechnology.
- **Discover the research** into algae cultivation.
- **Read this Cosmos magazine article** about using algae as a food source.

# Questions

Interactive: Click on box to start typing

What is a photobioreactor?

A photobioreactor  is a device which uses light and carbon dioxide to grow biomass, such as algae.

What are the benefits of using algae to capture carbon dioxide from industrial fumes? You should think about the effects of carbon dioxide in the atmosphere and any useful products produced in this process.

If the carbon dioxide is being used in the photobioreactor and stored as biomass, it won't be released into the atmosphere. Carbon dioxide is a greenhouse gas, which means that when it is in the atmosphere, it traps heat energy from the Sun, which keeps Earth warm. This is called the Greenhouse effect. If extra carbon dioxide is released into the atmosphere, the Greenhouse Effect increases, so more solar energy is trapped by the Earth's atmosphere, which causes the Earth to get warmer. This is called Global Warming and it has dangerous consequences for our planet. Industrial fumes are a large contributor to additional carbon dioxide in our atmosphere, so if a photobioreactor is used to capture this carbon dioxide and stop it being released into the atmosphere, this will help to prevent global warming. Also, the algae produced by the photobioreactor is a useful source of protein and the oxygen produced is necessary for human life.

Dr Preedy talks about historical uses of algae to solve global problems. In which global event was algae first introduced as a potential source of biomass and food when resources were limited?

The First World War.

# Exercise

**Algae converts carbon dioxide into glucose through photosynthesis.**

The equation for this reaction is:

Carbon Dioxide + Water → Light → Glucose + Oxygen

$$6\ CO_2 + 6H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6O_2$$

If 2.00 mols of carbon dioxide reacts in this way:

a) Calculate how many molecules of glucose are produced.

Number of molecules of CO2 (carbon dioxide) = number of moles of CO2 x Avogadro's number = 2.00 x 6.02x10^23 = 1.204x10^24
From the chemical equation above, we can see that we get one molecule of glucose for every 6

b) Calculate how much oxygen is produced, in grams (g).

From the chemical equation above, we can see that for every molecule of CO2 that reacts, one molecule of O2 (oxygen) is produced. Therefore, if 2.00 moles of CO2 are input to the reaction, we get 2.00 moles of O2 produced.

c) Calculate the volume of oxygen produced, in cubic centimetres ($cm^3$). Assume this is done at room temperature (25°C) and normal atmospheric pressure (1 atm) – i.e. room temperature and pressure.

One mole (mol) of gas at room temperature and pressure occupies a volume of 24,000 cubic centimetres (cm^3). 2.00 moles of O2 are produced. This occupies a volume of
2.00 x 24,000 cm^3 = 48,000 cm^3

c) d) What volume (in $cm^3$) would the same amount of oxygen occupy if the temperature was increased to 50°C and the pressure was increased to 1.5 atmospheres (atm)?

PV = nRT (equation taken from below)
V=nRT/P
T (in Kelvin) = 50 (temperature in Celcius) + 273 = 323 K

# Helpful information

Avogadro's number, $N_A = 6.02 \times 10^{23} mol^{-1}$

Atomic weight of oxygen = 15.999

One mole (mol) of gas at room temperature and pressure occupies a volume of 24,000 cubic centimetres ($cm^3$).

To convert a temperature value from Celsius (°C) to Kelvin (K), add 273. I.e. temperature in Kelvin (K) = temperature in Celcius (°C) + 273.

1 atmosphere (atm) = $1.01 \times 10^5$ Pascals (Pa).

$1 m^3 = 1 \times 10^6 cm^3$

**Remember to check your units!**

# Helpful equation:

The ideal gas law may be written as

$PV = nRT$

Where P is the pressure, in Pascals (Pa).

V is the volume in cubic meters ($m^3$).

n is the amount of gas, in moles (mol).

R is the gas constant, $R = 8.31\ m^3 \cdot Pa \cdot K^{-1} \cdot mol^{-1}$

T is the temperature, in Kelvin (K)

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# For teachers and home schoolers

Links to Science in the National curriculum for Wales (KS5)

AS/A2 Level Chemistry

As Unit 1 The language of Chemistry,  structure of matter and simple reactions: 1.3 Chemical calculations: (a) relative mass terms (atomic, isotopic, formula, molecular).

As Unit 1 The language of Chemistry,  structure of matter and simple reactions: 1.3 Chemical calculations: (e) relationship between the Avogadro constant, the mole and molar mass.

As Unit 1 The language of Chemistry,  structure of matter and simple reactions: 1.3 Chemical calculations: (f) relationship between grams and moles.

As Unit 1 The language of Chemistry,  structure of matter and simple reactions: 1.3 Chemical calculations: (h) molar volume and correction due to changes in temperature and pressure

As Unit 1 The language of Chemistry,  structure of matter and simple reactions: 1.3 Chemical calculations: (i) ideal gas equation ($pV = nRT$).

AS Unit 2 Energy, rate and chemistry of carbon compounds: 2.3 The wider impact of chemistry: (a) social, economic and environmental impact of chemical synthesis and the production of energy.

AS Unit 2 Energy, rate and chemistry of carbon compounds: 2.3 The wider impact of chemistry: (b) role of green chemistry in improving sustainability in all aspects of developments.