

Week 2 Lesson 1

Things that glow in the dark

Aim: To look at luminescence using the example of glow sticks, and at how fluorescence is being used in research.

Keywords: bioluminescence, chemiluminescence, fluorescence, molecules, proteins

Starter activities

1. Bioluminescence

Explain that we are looking at examples of bio-mimicry which have resulted in products that we can buy.

Watch the following TED - Ed talk about bio-luminescence:

ed.ted.com/lessons/the-brilliance-of-bioluminescence-leslie-kenna

Groups of students can be given different information to take from the clip, for example:

- List animals that use bio-luminescence.
- How do they make themselves glow (2 methods)?
- What are the properties of bio-luminescence?
- Which product takes its inspiration from fireflies?
- What are the similarities/differences between fire flies and glow sticks?

Ask students to consider the following.

Imagine you are someone who disagrees with the idea that bio-luminescent trees are a good thing. What would you say?

2. Glow sticks

Show the class some glow sticks and ask them if they can suggest how they work. Can they suggest how they may be related to the theme of biomimicry? See the following site for background information on how glow sticks work.

www.chemistry-blog.com/2013/07/30/chemsummer-carnival-glow-sticks-how-do-they-work/

Main activities

1. Chemiluminescence

Demonstrate chemiluminescence. All the details are available on this site.

www.rsc.org/learn-chemistry/resource/res00000823/chemiluminescence-of-luminol-cold-light-experiment

www.rsc.org/Education/EiC/issues/2010Mar/ExhibitionChemistry.asp

If it is not possible to do a demonstration then show the class a video instead.

www.youtube.com/watch?v=O99_ODyHNQI

2. Using fluorescence

Explain how scientists use fluorescence to track and analyse molecules in cells, see the background information sheet for details.

Show students the clip(s) below to see the DNA code being translated into a code the cell can read to build proteins.

www.dnalc.org/resources/3d/12-transcription-basic.html

www.dnalc.org/view/16933-3D-Animation-of-DNA-to-RNA-to-Protein.html

Ask students what the difference is between luminescence and fluorescence in chemicals.

3. Fluorescent chemicals

Use the worksheets ('Fluorescent Chemical A' and/or 'Fluorescent chemicals, A and B') from which students plot a graph to show the light emitted when a chemical fluoresces.

Differentiation

There are two versions of the worksheet. Give most students the 'Fluorescent chemical A' sheet. For a greater challenge give students the 'Fluorescent chemicals, A and B' sheet instead.

Provide students who need the most support with axes and scales partially filled in.

Assessment opportunity

This is a useful activity to assess students' graph drawing skills and ability to interpret graphs.

Plenary activities

1. Any questions?

Give students the opportunity to ask questions about the ideas covered in the lesson.

Week 2 homework activity

The homework is in preparation for Week 3, lesson 2 'Desalination'. Ask students to research the world water crisis. There is a handout sheet with a video link and questions.

Differentiation

Students should choose to do one of the tasks depending on ability.

Main 2

Using fluorescence – Teaching notes

Background information

Fluorescence is used to track and analyse molecules in cells. If a light is shone on some molecules, such as a molecule of fluorescein, light of a different colour will be emitted by the molecule for a very short period of time afterwards. This is fluorescence. Molecules with this property absorb high energy light (e.g. blue). This increases the energy of the molecule. Some of the absorbed energy will be lost within the molecule before the molecule emits a lower energy photon (e.g. green light) which can be seen through the microscope.

Fluorescent markers can be attached to molecules inside cells. Only those parts will be seen in the microscope. Different markers respond to different energy levels (different colours) of light. By changing the excitation light it is possible to see how different parts of the cell interact together.

Three scientists, Eric Betzig, Stefan Hell and William Moerner were awarded the 2014 Nobel Prize in Chemistry. They used fluorescence to image molecules and to precisely determine their location. **Super-resolved fluorescence microscopy** enables scientists to see the behaviour of **molecules in real time** inside **living** cells.

This technology is still under development. The **cost** of the technique and the **expertise** required to use it mean it will be some time before this type of microscopy is widely available.

This technology will enable scientists to produce even more detailed interpretations of the activity of molecules inside cells.

Main 3

Fluorescent chemicals – Answers

Q1. It emits a high intensity of light for a very short period of time

Q2. No, it emits light for a very short period of time and it needs a flash of light to make it fluoresce in the first place.

Q3. Chemical A reaches its peak of fluorescence more quickly than B. Chemical B emits more light at its peak, and its peak lasts for longer than A.

Fluorescent chemical A

Fluorescent chemicals need to be exposed to a flash of light before they will fluoresce. Draw a graph to show how much chemical A fluoresces.

Time (ns)	0	1	2	3	4	5	6	7	8
Fluorescence intensity (a.u.) of Chemical A	0	550	575	370	260	200	150	110	80

Table 1: Showing the intensity of light emitted by a fluorescent chemical marker used in fluorescence microscopy.

Q1. What does your graph tell you about fluorescent chemical A?

Q2. Would this be a useful chemical to use in a glow stick?

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Fluorescent chemicals, A and B

Fluorescent chemicals need to be exposed to a flash of light before they will fluoresce. Draw a graph which has a line for each chemical.

	Time (ns)	0	1	2	3	4	5	6	7	8
Fluorescence intensity (a.u.)	Chemical A	0	550	575	370	260	200	150	110	80
	Chemical B	0	300	510	600	600	500	350	180	90

Table 1: Showing the intensity of light emitted by a fluorescent chemical marker used in fluorescence microscopy.

Q1. What does your graph tell you about fluorescent chemical A?

Q2. Would chemical A be useful to use in a glow stick? Explain your answer.

Q3. Describe how the two chemicals compare with each other.

Week 2 homework

Research task about the world water crisis for a future lesson on desalination.

Follow the link below and watch the video clip *The World water crisis*.

www.youtube.com/watch?v=_90GvcVA3Gw

Choose one of the following tasks:

- Choose 3 - 5 of the 9 main crisis points in the video. Write one or two sentences about each. Put what you want to say in your own words.
- Write 1 - 2 paragraphs in your own words about the effects on health of unsafe drinking water.
- Write a report on the problems faced by China which are shown in the video and explain what could be done about them.



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