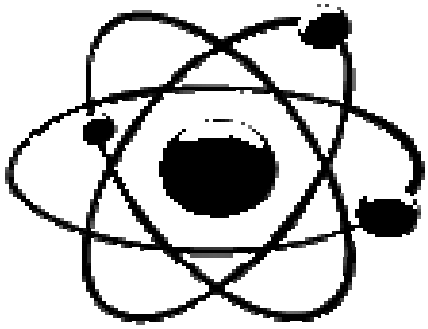
Issues in Science
TY Science Module



Teacher Handout

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Table of contents

Experiment Safety for pupils

- Laboratoryoratory coats to be worn at all time
- Safety glasses to be worn at all time
- Gloves to be worn when handling chemicals
- Long hair to be tied back away from face
- All accidents to be reported to teacher immediately
- All spills to be cleaned straight away
- Wash hands before and leaving on the laboratory
- No eating and drinking in the laboratory

TY Science
Issues in science

Introduction for teachers

New technologies and advancements in science have been debated in the scientific communities throughout the years. New advances in medical and chemical sciences have lead to great discoveries that allow scientists to apply them to everyday life and change the way we live. However, within these great advances there often lurk problems and ethical issues, and whether or not the benefits out weigh the disadvantages.

This module is aimed to teach about issues in science that are controversial and prominent in our society today. The module is designed to allow teachers to build on the pupils' previous knowledge of science and allow pupils to debate the issues presented to them based on their knowledge of scientific fact.

The aims of the module

- To build on the pupils' previous knowledge of science and allow them to solve problems from that knowledge.
- To allow pupils to explore scientific research that is prominent in our society today.
- To allow pupils to debate the issues presented to them based on scientific fact and to gain skills that they can use in everyday life.
- To promote practical skills in the laboratory.
- To develop pupils' use of ICT skills.
- To show pupils the importance of using evidence as the basis for making decisions on controversial issues rather than on feelings or anecdotal evidence.

This module looks at eight issues in science:

Unit 1. Risk assessment and global warming
Unit 2. Genetically modified (GM) foods
Unit 3. Stem cell research
Unit 4. Biofuels
Unit 5. DNA identification
Unit 6. Nuclear power
Unit 7. Electromagnetic Radiation
Unit 8. Fluoridation of water supplies

Each unit contains two singles and a double lesson. However, due to time constraints one of the single lessons is designed as an extra, optional lesson to explain the topic further and conduct activities, if time permits. Suggested activities are also provided at the end of each lesson in this guide. This again is to build on pupils' knowledge of the issue if time permits.

Throughout the units one of the main aims is to see pupils creating a poster or other form of written work based on the issue presented to them. Pupils throughout the eight weeks should create a poster wall in the laboratory or classroom to place their work on, so they and others can see what they have been doing.

Encourage pupils to look out for coverage of these issues in newspapers, magazines or TV and to bring in cuttings etc. for use in class and for their poster display.

Unit 1.

Risk assessment

Unit 1~ Risk assessment
Lesson 1: What is risk assessment? (Single lesson)

Introduction
The aim of this lesson is to find out the pupils previous knowledge on the various topics that they will be studying for the eight weeks. Also pupils will be introduced to the concept of risk assessment before carrying onto the next lesson.

Development
In the first section pupils are asked to define a hazard: A hazard is something that has the potential to cause harm.

Pupils are then asked then to relate the word hazard to risk assessment: the bigger the hazard's present, the greater the risk.

- Pupils are given the following scenario

It is the year 2040, research in science has allowed for the creation of a vaccine. This vaccine allows for the delay in ageing for the human population. It has the potential to prolong their lives by 45 years. However scientists are aware that this vaccine will not work in about 35% of the human population, and could cause immediate death if taken by this portion of the population. There is so far no way of knowing whether this vaccine will be accepted or rejected by individuals.

- Pupils should discuss how much risk is involved, for example 35% is just an estimate and there is no real way of knowing how many people may reject the vaccine or which individuals will be affected.
- It is an important point to discuss how many peoples lives could be prolonged by using the vaccine. How could this benefit people?
- The question of whether or not we have the right to interfere with the natural process of life could also be introduced.

In the second part of the lesson, pupils will be writing their views on the topics that they will be studying in the coming eight weeks.

Note: Pupils may not have previous knowledge on some of the topics. This will be a good starting point for teachers to see what lessons they will pick. For example, many of these units have a third lesson which further explains the topic being taught. If pupils have no previous knowledge of a topic then it may serve as a useful resource to use.

Unit 1
Lesson 2 ~ Risk assessment and Global Warming (Double lesson)

Introduction

The aim of this unit is for the pupils to learn about risk assessment when debating an issue. This means that pupils will be able to debate an issue and make decisions based on scientific fact rather than on emotion.

In this lesson pupils will be learning about global warming and how it occurs, before learning about the debate that is occurring in the scientific community. This will be used as an example of an 'issue in science' that is in debate in the scientific community. Pupils will use this example in order to learn about risk assessment and how to make a decision based on scientific fact. However, you and the pupils should be aware that the global warming sceptics are a tiny fraction of the scientific community and the vast majority of scientific evidence and opinion supports global warming and climate change due to human inputs into the atmosphere.

Development

Global warming

Global warming is a term that can be seen on television; in the media etc. it is a current issue in science that is intensely under research and debate.

Most scientists believe that the rise in temperature of the earth's surface is due to increased production of atmospheric gases such as carbon dioxide, which trap the sun's rays. Much like a greenhouse traps the suns rays and thus they are called greenhouse gases. The effect of global warming has been intensified by human activities.

Activity 1:

Pupils will be carrying out an experiment to test the effects of global warming.

Safety/ hazards

- As with every laboratoryoratory, coats and safety glasses are to be worn at all times.
- Care should be taken when the pupils are using scissors.

Title: **To test the effect of the green house effect**

Resources needed (per group).

2 shoe boxes	2 Thermometers
2 sheets of thick black paper	Sheet of plastic wrap
Tape	

Procedure:

1. Each group receive two shoe boxes
2. Place the black paper on the insides of the shoe boxes
3. Place two thermometers in the two boxes and place by the window in order to get full sunlight for ten minutes.
4. After ten minutes get the pupils to record the results.
5. Pupils will then place plastic over one of the boxes and place tape around to hold.
6. After 15 mins pupils will then record the temperature in the two boxes.

Results:

Pupils should note that the box with the plastic wrap on it reads a higher temperature than that of the open box. This will illustrate to them the greenhouse effect and how it contributes to global warming. Heat is trapped better in the closed box as the warm gases cannot escape by convection.

Notes on experiment:

The plastic wrap is a representation of the atmospheric gases that trap the suns rays and therefore lead to global warming. This is a simple model and illustration of the greenhouse effect and does not model exactly what happens in the atmosphere.

Questions that could be asked:

1. What happened in the box with the plastic wrap?
2. Why was the temperature higher?
3. Why was the temperature lower in the box with no plastic?
4. Why did we use black paper to cover the inside of the box?
5. How does the rise in temperature affect global warming and our world?

This experiment introduces the electromagnetic spectrum which is picked upagain in Unit 7. UV and visible light from the sun passes through the atmosphere and is absorbed by the earth's surface, heating it up. The warm surface then radiates IR radiation i.e. heat, back into space through the atmosphere. Some of the molecules in the atmosphere, like CO_2 and water, absorb IR and this warms them up i..e they move around faster and thus the atmosphere warms up. Absorption of IR is related to structure and only molecules with a dipole moment or one which changes when they vibrate will absorb IR radiation. Thus O_2 and N_2 do not contribute to the greenhouse effect, but many of the trace gases do.

Sine the moon (and Mars) have no atmosphere, there is no greenhouse effect and they are very cold. Without the earth's greenhouse effect the average temperature of earth would be about -15^oC not $+15^oC$.

Notes:

The rise in carbon dioxide levels can be attributed by many reasons

- Increasing use of central heating.
- Increase number of cars on the roads and rise of air transport.
- Increasing development of power stations and industries using fossil fuels.
- Incineration of waste produced.
- Deforestation.

One major contributing factor to global warming, however, is caused by the destruction of forests to clear land for agriculture or to obtain timber.

- Photosynthesis allows carbon dioxide to be removed from the atmosphere and oxygen released. By cutting down the forests people are removing the natural filters of the earth and so therefore contributing immensely to the contribution of carbon dioxide emissions. Disturbing the soil also increases carbon emissions. Planting forests may seem like a viable option, however, with increasing population more space is needed for housing and natural resources etc.

Suggested activity

1. http://www.farmersjournal.ie/2009/0214/farmmanagement/forestry/feature.shtml

The following website contains an article in the Farmers Journal. This article explains how forests can act as a store for carbon dioxide and how planting forests can help with Ireland reaching the targets of the Kyoto Protocol.
Pupils could read this article and be give the question 'should Ireland plant new forests' and 'why'.
It may be interesting to also pose the question 'should planting new forests be the answer to our responsibilities to meeting the Kyoto protocol agreement or is planting new forests a 'lazy way out''.

2. The amount of solar radiation reflected or absorbed by earth, is also a very important factor contributing to global warming.
Scientists use the term **albedo** to define the percentage of solar energy reflected back by a surface. Understanding local, regional, and global albedo effects is critical to predicting global climate change. The following are some of the factors that influence the earth's albedo

- Clouds
- Surface albedo
- Oceans
- Forested Areas

The following website gives an in-depth look at each of these and how they can affect the reflection of the solar energy.
http://www.ucar.edu/learn/1_3_2_13t.htm
Note: Teachers should try when explaining the albedo concept to refer back to the simple experiment of the silver and black can filled with water. The black can absorbs heat and so therefore the temperature of the water in the can rises. The silver can reflects heat and so therefore the temperature does not rise.

3. **Calculating your carbon footprint**
The following link allows pupils to calculate their carbon footprint online by answering a number of simple questions. Pupils will also be able to compare their carbon footprint to the average of various countries.
http://www.zerofootprintkids.com/kids_home.aspx?restart=yes
http://www.zerofootprintkids.com/kids_teacher.aspx?cat_id=wel
This website contains information for teachers on the main causes of global warming and the effects.

Unit 1 ~ Risk assessment
Lesson 3 ~ The debate about global warming (single lesson)

Introduction

In this lesson pupils will read the views of scientists on the global warming debate. The aim of this lesson is for pupils to pick the side which they believe to be the most scientifically sound rather than them picking one using their feelings or prior opnions.

Development

Pupils will work in groups to discuss the issue, before their group will make an informed decision on which side they agree with.

Activity One

The debate

Scientist view on Global warming	Critics view on global warming
Side A Carbon Dioxide is one of the main problem atmospheric gases which is causing the heating of earth. Carbon dioxide contains heat trapping properties which leads to the trapping of the suns rays. Scientists view human activity as the major producer of increased levels of carbon dioxide. Carbon dioxide once in the atmosphere is difficult to break down. However by cutting down on our CO_2 emissions we will not add to the problem that already exists. Long term Increase in temperature from increased CO_2 emissions could change the natural world around us. For example the melting of the polar ice caps will not only lead to the rise in sea levels which will be detrimental to low lying lands also it could endanger animals such as polar bears and penguins. The change in temperature could mean the introduction of new species in	Side B Human activity cannot be the single blame for the rise in carbon dioxide levels. Research has shown that carbon dioxide levels in the atmosphere are a result of increased temperature. Studies show that oceans emit carbon dioxide as they warm up and absorb it when they cool down, this is an example of how CO_2 can be emitted. Critics believe that even if humans cut down on their CO_2 emissions, we will not see the results in our lifetime and the temperature of the earth's surface will still rise. An increase in temperature could in fact prove beneficial at the beginning for example northern countries could experience warmer weather and longer growing seasons for their crops. Warmer temperature could prove economically beneficial as a warmer

Ireland. For example mosquitoes thrive in humid weather. With this they will bring threatening diseases such as malaria.	climate would allow farmers in Ireland to grow crops that they could not do so already.
Greater change in temperatures could alter the currents of the oceans such as the north Atlantic Drift. This would be very dangerous to Ireland and England and would have negatives effects on our climate, bringing colder weather to our region.	It is a known fact that through out the centuries the earths climate has changed naturally for example Ireland went through an ice age. This could in fact be a natural phenomenon occurring.

Argument one
In argument one both sides are scientifically correct however, pupils should realise that the increase in the earth's temperature is correlated to the amount of CO_2 produced and so humans are adding to the problem by the burning of fossil fuels and deforestation etc.. The most scientifically sound argument is made by side A

Argument two
Even though side B is technically right as CO_2 takes a long time to break down we will not really see any results in our life time. However this raises the ethical question on whether we should undo our mistakes and preserve our world for future generations. If this view was to be taken then side A would be correct.

Argument three
Again both sides are correct we would see a change in our temperature, side B argues that it would improve growing seasons and bring hotter weather. However Side A takes into account the destructive nature of global warming such as melting of polar ice caps. This is evidence that we can see today and the question arises whether the short term benefits of hotter weather out weigh the destructive nature that global warming can incur.

Argument Four
Side A argues that the increase in temperatures could see the introduction of species such as malaria which thrive in humid conditions, which also are carriers of malaria which can prove to be a deadly disease. Side B argues that it could introduce new species that we were unable to grow or live in Ireland before due to our climate, bringing variety to what we grow and new markets to develop.

Argument five
In this argument, Side A argues that a change in our climate could change the direction of the north Atlantic drift which would have negative effects for Ireland and England. Side B argues that climate change is a natural process that occurs anyway, independent of human activity, which is true. However, science shows that humans are affecting the climate through their activities on a shorter timescale than normal processes.

Conclusions
From this pupils should be able to see that side A has more scientific fact to base their argument on, current research and models support this side. Side B emphasises some results but ignores the weight of scientific evidence for global warming happening. However, a lot of their arguments are 'wait around and see what happens' approach. The often attack the models and their predictions, but the weight of evidence for rapid change is mounting week by week and is currently ahead of the predictions.

Note:
Pupils should be aware that in picking the side which contains the most scientific fact they are making a risk assessment based on evidence rather than emotion or feelings.

Suggested activity:
Creating a poster of opinions.

Material required
Markers
Poster

Allow pupils to create a poster illustrating their views on global warming. Allow the groups to present their views to the class to allow for a greater group discussion.

Suggested activity
Global warming is an issue that is constantly in debate in the media. In order for pupils to take note of the argument of global warming ask the pupils to collect any newspaper clippings they can find in either the newspapers or on the internet. These clippings should be no more than one year old since their date of publication.

Suggested activity

Now that students have explored a variety of perspectives on global climate change, they should take a position on the issue and support it with evidence. The teacher could ask the question :

"In your opinion, is global warming an imminent world threat? Why or why not? "

Create a discussion as to why it is important to make a decision based on scientific evidence rather than on emotion or anecdote. Is it ever okay to go with emotion rather than science?

Books
New Choices, New Responsibilities: Ethical Issues in the Life Sciences. B. Jennings, K. Nolan, C. Campbell, S. Donnelley, E. Parens, L. Turner, E. DeVaro, 1997. Decision-making framework for bioethical issues.

Useful websites
http://www.youtube.com/watch?v=XDI2NVTYRXU

This website contains a site in which Al Gore debates with sceptical scientists on the main reason of Global warming. Al Gore states that increase in carbon dioxide levels, increase the planet's temperature. However, some scientists state that rising temperature precedes that of carbon dioxide levels.

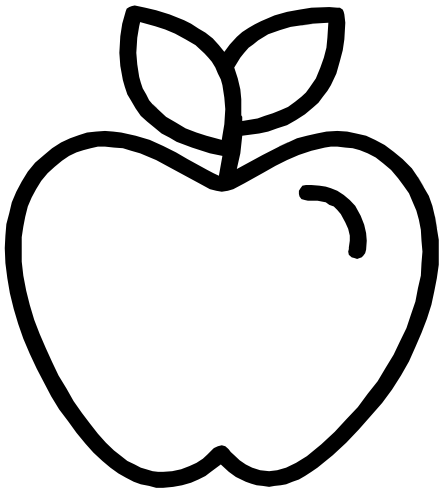
http://www.youtube.com/watch?v=oJAbATJCugs&feature=fvw
This website contains a video made by the National Geographic channel. This video gives a short low down on what Global Warming is. This may act as a valuable video to play before the debate.

http://www.pbs.org/now/classroom/globalwarming.html
This website contains a number of various activities that can be carried out in relation to learning about Global Warming.

http://www.ukrivers.net/climate.html
A collection of resources on global warming suitable for schools.

Unit 2.

Genetically modified (GM) Foods



Unit 2. Genetically modified (GM) foods
Lesson 1 ~ Understanding genetically modified foods. (Single lesson)

Introduction
This lesson will focus on introducing GM foods to the pupils and the arguments for and against GM foods. Pupils at the end of this lesson should be able to distinguish between the pros and cons of using GM foods.

Development

Activity one
The first part of this lesson deals with an example of one of the pros and cons of GM foods in regards to world population. Zambia is used as an example of a poor country which refused American food aid as it contained GMO's.
Pupils should be comfortable distinguishing both arguments before they move onto the next stage.

Suggested activity
Pupils can look up the following website in order to read the full case study on the Zambian food crisis. A discussion should be held on whether the pupils felt that the President was right or wrong in his decision to refuse the food.

http://www.pbs.org/newshour/extra/features/july-dec02/zambia.html

Activity two
In this activity pupils will be split up into groups, where they will work together to decide whether the facts presented to them are pros or cons to having GM foods. Pupils will transfer this onto a poster which will be used in the following lesson. Pupils should be encouraged to discuss the issues as not all pupils may agree on what is a pro and what a con.
Pupils will need to become familiar with these arguments as this lesson will be important for the following lesson.

Remember that it is important for the pupils to consider the facts and think like scientists, rather than making decisions on emotion or other grounds.

Suggested activity
Pupils could research on the internet what is the stance in Ireland and Europe on genetically modified foods.

Useful websites
This website contains the article on the Zambian food crisis
http://www.pbs.org/newshour/extra/features/july-dec02/zambia.html

The first website is a website against GM foods, while the second website is one for. It may be good for pupils to see the varying view points. The second website also show a video from a scientist in Africa arguing for GMO's, which may be beneficial for the pupils to see.

http://www.wholefoodsmarket.com/issues/list_biotech.html
http://www.monsanto.com/biotech-gmo/asp/default.asp

A useful website with information on GMO's and information on the controversies they arouse.
http://www.ornl.gov/sci/techresources/Human_Genome/elsi/gmfood.shtml
Another site with a collection of links:
http://www.occc.edu/biotech/document/Web%20Resources%20for%20GM%20Foods.htm

Book
O' Callaghan, M. (2002) *Biology*, Dublin

Note:
In the following lesson pupils will be taking part in a role play. In order for the class to run smoothly pupils should be given their roles before the class to prepare. The list of the roles to be played are found in the next lesson.

Unit 2. Genetically modified (GM) foods
Lesson 2 ~ Debate about genetically modified foods. (Double lesson)

Introduction
In this lesson pupils will be taking part in a role play in order to discuss what they have learned in the previous lesson.

Role play
Pupils will pretend to take part in a talk show which will consist of:

1. A presenter
2. An environmental campaigner that is against GM crops.
3. A farmer from a developing country that is in favour of GM crops.
4. A scientist that takes a balanced view between the two arguments.
5. An audience, who are free to participate during the debate when the presenter calls upon them.

To make the role play run as smoothly as possible there are some elements that may be undertaken:

1. Each pupil in the class be given their role before the lesson, and asked to do their own research as well as looking back over what they have done in previous lessons.
2. The pupils taking specific roles might like to write notes down to have with them during the role play.
3. The presenter should have questions already written up to ask, before the role play takes place.
4. Pupils could design the 'studio' with the posters that they made in the previous class as the back drop.
5. If you want you might like to record the show so that it can be played back later.

Some pupils will see that all three sides have different views on GM crops. They should focus on listening to the three sides and see how perhaps with stricter regulations and laws GM crops could prove beneficial. However, they should try to evaluate all the arguments and come up with their own informed opinion.

Suggested activity
The pupils could take part in a secret ballot in order to determine if they believe GM crops should be used in the future or should be left in the past.

Useful websites
http://www.actionbioscience.org/biotech/sakko.html
This website contains a number of arguments for and against that the pupils might like to read before the debate.

http://www.bionetonline.org/english/content/ff_cont4.htm#
This website contains an excellent game for the pupils to play 'shopping in the future'. Which brings to light the implications of what they might be buying in the supermarket in the future?

Unit 2. Genetically modified (GM) foods
Lesson 3 – A further look at genetically modified foods. (Single lesson)

With more and more foods becoming availaboratoryle containing genetically modified genes it is important for pupils to recognise the pros and cons of GM foods, and decide whether or not they safe? What exactly are we eating?

Introduction
The aim of this lesson is to build on the knowledge that the pupils currently have in Biology in relation to genetics. Pupils will also develop a greater knowledge of the process of genetic engineering.

Development.

Activity One
Pupils will work in groups to match the terms in the box to the correct sentence. This aims to revise what the pupils will have learned in Junior Certificate Science.

Activity two
In this activity pupils again will work in groups to place the steps of genetic engineering in the correct sequence.
A classroom discussion should be held at the end of this activity to make sure that the pupils fully understand how genetic engineering occurs in the laboratoryoratory and to make sure that they recognise all the terms.
Pupils should also discuss the difference between classical breeding and genetic engineering.

Pupils should become aware of the different terms such as insertion, plasmid, transformation etc.

Suggested activity
1. Break the class into one group of six (DNA Strand) and the rest into groups of three (plasmids)
2. Stick a red sheet on one of the pupils back, this represents the target gene.

Demonstrate how not just the target gene will enter into some of the plasmids. Show how the rest of the plasmids will die when placed in the antibiotic as they do not contain the target gene. Discuss all the steps with the pupils and allow them to act them out.

Suggested activity
The following video would be valuable to play along with this activity if the facilities allow. It is a quick video explaining the difference between classical breeding and genetic engineering.
http://www.teachersdomain.org/resources/tdc02/sci/life/gen/breeding/index.html

Suggested activity
Pupils could also research the history of genetic engineering and in what countries is this practice most used. It is widely used in the USA and the population there have

been eating GM foods for many years without any apparent problems. GM foods are banned in Ireland.

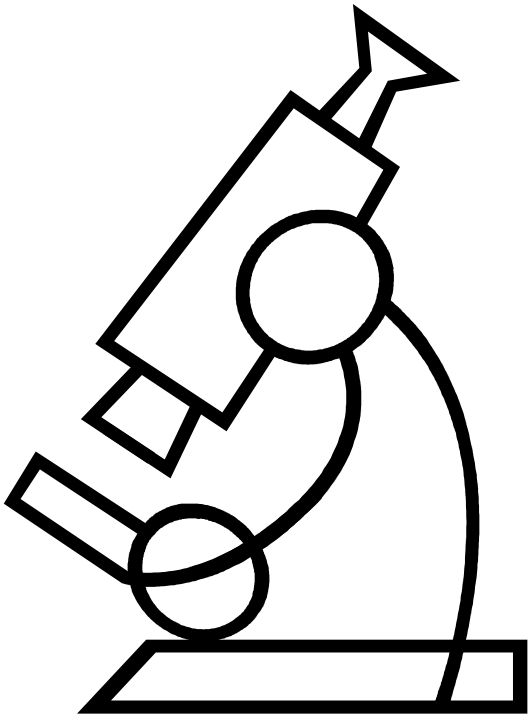
Useful websites

http://www.teachersdomain.org/resources/tdc02/sci/life/gen/salmon/index.html
This website shows another video showing the effects of using genetic engineering on salmon.

http://www.truefoodnow.org/shoppersguide/guide_printable.html
This website shows a list of foods that contain GMO's. Although most of the foods are American there are some foods that are present for sale in Irish supermarkets, however they must not contain any GMOs if sold in Ireland, either for animal or human consumption.

Unit 3.

Stem cells



Unit 3. Stem cells
Lesson 1 What is stem cell therapy? (Single lesson)

Stem cell research is a scientific topic which has been under much debate for many years, due to the ethical issues that surround it. Pupils will look at the science for and against the use of stem cells in this unit, to form an opinion on how they believe this technology should be used in the future.

Introduction

The aim of this lesson is for the pupils to build on their previous knowledge and to become comfortable with the key terminology, which will be used when researching stem cell therapy.

Pupils should become familiar with the following terms, as in the next lesson many of these terms will reappear in newspaper articles. The main object would be to allow the pupils to become familiar with the different types of stem cells and how they function. One aim of this and other units is to enable pupils to read newspaper or magazine articles on scientific topics and understand them.

The following terms:

Fertilisation ~ fertilisation is the fusion of the male sperm with the female ovum.

Embryo ~ an embryo is a multi-cellular organism, which forms from the fusion of a sperm and ovum.

In vitro ~ this is a process whereby the egg and sperm are fused together outside the womb. A number of fertilised eggs are then placed in the womb with hopes that one will attach to the lining of the womb, and then develop normally. (The opposite of *in vitro* is *in vivo*.)

Cell ~ the cell is the functional unit of living organisms, and within the cell is found the nucleus is found, which contains genetic information. Uni-cellular organisms are made up of only one cell. Multi-cellular organisms are made up of many cells.

Tissue ~ a tissue is composed of similar cells, for example muscle tissue.

Organ ~ an organ is composed of a number of similar tissues, which perform a specific function e.g. the liver.

Therapeutic cloning ~ the production of embryonic stem cells in the laboratory, which will be used in order to repair damaged tissue.

Pupils will also learn of the three types of stem cells.

- Embryonic
- Adult stem cells
- Umbilical cord stem cells

Of these three types of stem cell, ethical issues arise only when embryonic stem cells are used. In order to grow this type of stem cells, life must be created i.e. the fusing of

the sperm and ovum. The eggs are then grown to form the blastocyst. When the stem cells are extracted from the blastocyst the chance to form an embryo is gone and it is thus destroyed. Therefore the ethical question arises, what is the moral status of the fertilised egg and do we have the right to destroy it? Do the ends justify the means used to obtain it? Many people have religious or moral objections to the use and destruction of human embryos.

The other two forms of stem cell therapy do not cause damage to the organism:

- Adult stem cells can be extracted from the bone marrow of the individual.
- Umbilical cord stem cells can be extracted from the umbilical cord upon birth and frozen so that they can be used by the family in the event of a disease.

Activity 1 (Case study)

In the following case study the pupils will read about a girl who has diabetes and also an article taken from *The Times* newspaper.
The main aim of this is to make the pupils aware of the benefits that stem cell research is proving to have in the medical domain and how it can or may help people suffering from particular diseases.
Note: Pupils should be aware that this disease breakthrough was cured by adult stem cells and not embryonic i.e. where the ethical issues arise.

Suggested activity

The following website contains Video which could be played at the end of the class or when describing the three different sources of stem cells. The video goes through in detail how stem cell therapy works and is called the 'Stem cell story'.
http://www.eurostemcell.org/films/a-stem-cell-story/English

Suggested activity

Pupils could research the history of stem cell research and how Europe and America stand in regard to stem cell research.

Useful websites

http://www.eurostemcell.org/
This website contains information on various diseases treatable with stem cell research and pictures of what stem cells actually look like.
Note: Go to FAQ and the links will appear.

http://www.stemcellresources.org/teach_lessons.html
This website contains a number of activities that will further explain to the pupils the differences between the different types of stem cells. One activity allows pupils to see the process of stem cell therapy on mice.

Book

O' Callaghan, M. (2002) *Biology*, Dublin

Unit 3. Stem cells
Lesson 2 - Debating stem cell therapy (Double Lesson)

Introduction
In this lesson pupils will be reading two articles, one in favour of stem cell research and the other against stem cell research and discussing the arguments for both.

Activity one
In this activity pupils will be reading a newspaper article which is strongly against embryonic research. Pupils will decide in groups what are the main cons involved in using embryonic cells. Pupils should examine the article carefully and try to find solutions instead of using embryonic stem cells.
Any words which pupils do not understand should be highlighted by the pupils and discussed as a whole class.

Link to article
http://www.irishtimes.com/newspaper/sciencetoday/2008/0424/1208904387013.html.

Activity two
In this activity pupils will be looking at an article which is pro stem cell research. Pupils should work in groups, and pick the reasons they believe show why stem cell therapy should happen and how maybe it could be improved to make it better e.g using adult instead of embryonic stem cells.

Link to article
http://archives.tcm.ie/irishexaminer/2004/11/29/story359000786.asp

Activity three
Pupils will create a poster listing what they believe to be the pros and cons to stem cell research. The poster may be designed in any way they wish.

If time allows:
The pupils should give a one to two minute presentation on how the group feel about stem cell therapy. No group needs to pick a side of the argument.
Pupils could discuss the future of stem cell therapy and how scientists could avoid the ethical issues involved.

Suggested activities
Instead of creating the poster pupils could create a newspaper article themselves showing how they believe about the topic. This article should explain the science involved and evidence behind their arguments. Each group would then submit their article, which would be made into a booklet at the end.

Suggested activity
Tell the pupils that they are creating an advertisement for stem cell research.
Allow pupils in groups to create an advert expressing the view that adult stem cells can be just as effective for stem cell research as embryonic stem cells.
The advert should contain information on why they believe embryonic stem cells should not be used and the potential and advantage of using adult stem cells.

Note:
One major advantage of adult stem cell research is that the person will be an identical match genetically as their own stem cells are used and so there is no chance of rejection by the patient's body.

Useful websites

- http://www.pbs.org/newshour/extra/teachers/lessonplans/science/adult_stemcell.html

This website contains a number of activities that could be done in the classroom in order to debate the issue on embryonic stem cell research.

- http://plato.stanford.edu/entries/stem-cells/

This website explains many of the ethical issues involved in stem cell therapy of embryonic research.

Unit 3. Stem cells
Lesson 3 – The debate about stem cell research (single lesson)

Introduction
In this lesson pupils will be looking further into the use of stem cells in curing diseases.

Activity one
This activity allows the pupils to research a disease that may be treated with stem cell therapy. This activity calls for pupils to research the topic carefully, with specific questions to answer on the issues.

Each group should be given the disease to research before the lesson so they can have the information to work from or pupils should be able to use the computers with internet access during the class.

For e.g. Unspecialised embryonic Stem cells can be cultured to create a number of specialised cells for example skin cells. The benefit of this is that a burn victim could have a skin graft in order to replace the damaged cells.

Diseases to be researched are:
- Alzheimer's
- Parkinson's
- Diabetes
- Heart disease
- Cancer/ leukaemia

What pupils should research:
1. How many people suffer from this disease worldwide?
2. What are the symptoms of this disease?
3. How can this affect peoples daily lives?
4. How can stem cell research help these diseases?
5. What type of stem cells are used in order to treat these diseases?

Pupils should discuss what the benefits of this technology are in relation to curing these diseases. Does the curing of these diseases outweigh the argument that they may be destroying a human life if embryonic stem cells are used? Does it make a difference if it is you who are sick or someone in your family or a close friend?

Useful websites
- http://www.eurostemcell.org/

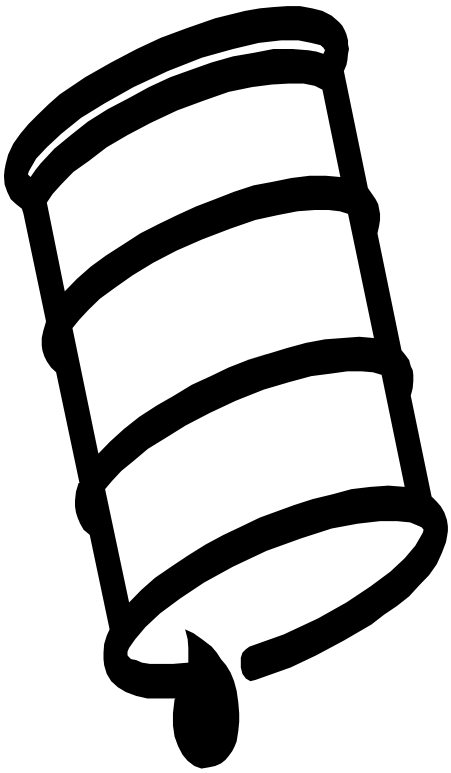
This website contains very useful information on each of the listed diseases above.

- http://archives.cnn.com/2001/ALLPOLITICS/07/29/reeve.cnna/index.html

This website contains a interview with the late actor Christopher Reeve and a CNN reporter. Christopher Reeve is strongly pro stem cell research after a terrible horse riding accident left him paralysed from the neck down. In this interview issues surrounding the ethical issues are addressed.

Unit 4.

Biofuels



Unit 4. Biofuels
Lesson 1 ~ Understanding biofuels (single lesson)

Introduction
The aim of this lesson is to get pupils thinking about biofuels and what part they can play in our society.

Dream Car
In this activity pupils will draw their dream car describing how big it is, what kind of engine it will have etc.

After the pupils have drawn their dream car, the teacher should introduce the following concepts:

- With oil and fossil fuels predicted to be depleted by the year 2030, it is important for pupils to realise that they need to look towards using renewable sources of energy to run such things like cars etc. Renewable forms of energy can include solar power, wind power, biomass and biofuels.
- The bigger the car they choose the bigger the engine and so therefore the more petrol or fuel needed to run it.
- Also pupils should note the environmental damage that bigger engines can have towards global warming.

Different types of fuels:

Biofuels
- Plants photosynthesise to produce biomatter.
- This can be used to produce liquid biofuels.
- Liquid biofuels include biodiesel and bioethanol

Biodiesel
Biodiesel is a combustible fuel, made from vegetable oil or animal fat. The benefit of this is that it can be made from recycled oil such as waste from a restaurant. It can it be used to run cars and heat our homes.

Bioethanol
Ethanol is produced by breaking down carbohydrates in plant matter and fermenting the sugars to produce alcohol. The benefit of bioethanol is that the CO_2 absorbed during photosynthesis is released during combustion, thus in theory adding no net CO_2 in the atmosphere.

Suggested activities
- Create four posters containing pictures of a sports car, a truck, a VW beetle and an S.V.U. Get pupils to stand by the poster of the car that they would like to drive.
- Now explain to the pupils that they must now argue why their car is the best in terms of the environment.
- This activity is to get the pupils to realise that none of these cars really help the environment and they all use forms of non-renewable energy

- A discussion should be held on what type of renewable energy are available for cars, e.g. such as biofuels, electric cars and hydrogen powered cars.

Useful websites

http://www.sciencefriday.com/videos/watch/10079
This website shows how biofuels are made in the laboratory by taking the waste oil from restaurants and reusing them.

http://www.esru.strath.ac.uk/EandE/Web_sites/02-03/biofuels/what_are_biofuels.htm
This website is useful as it explains the differences in biofuels. It may be a good website for pupils to research on before the class.

http://www.habmigern2003.info/biogas/biofuels.html
This website contains a number of key terminologies that can be used by pupils and teachers in understanding biofuels.

Book

O' Callaghan, M. (2002) Biology, Dublin

Note:
In the next lesson pupils will be creating a commercial in order to debate the issues in using biofuels. Pupils should be told in advance of this lesson so that they can think of ideas for the commercial, whether they would like to bring in props or music etc.

Unit 4. Biofuels
Lesson 2 ~ The debate about Biofuels (double lesson)

Introduction

In this lesson pupils will be debating on the pros and cons of using biofuels in order to form their own opinions on the topic.

Activity one

In the first part pupils will be given the pros and cons in the use of biofuels. The pupils will debate in groups and form an informed opinion on whether they believe the use of biofuels to be bad or good. Pupils should try to come up with their own pros and cons also.

List of pros and cons

Pros

1. Biofuels are derived from agricultural crops such as corn and soy beans. This will promote local agricultural development.
2. Biofuels allow for a choice when choosing an energy source. Unlike fossil fuels, biofuels are a renewable source of energy
3. Since biofuels are products of plants, they are safer for the environment when burned. The amount of CO_2 absorbed in forming the plants is released when burned, thus they should be carbon neutral.
4. Biofuels do not pose a problem for people and business to switch too as they are now readily available.

Cons

1. Growing crops for the use of biofuels calls for large amounts of land to be cleared in order for the crops to be grown, which actually releases carbon into the atmosphere.
2. The burning of ethanol and biodiesel may lead to increased levels of nitrogen oxide in our environment.
3. Growing of these crops for biofuels could lead to an increased use of genetically modified crops.
4. Today there is already an increase in food prices so therefore buying of corn etc would come at a higher price as fuel use would compete with use for food.
5. Biofuels are not always carbon neutral when all energy inputs are allowed for e.g. in processing the crops.

Activity two

In this activity the pupils in their groups will create a commercial for television, where they express their opinions on biofuels. In this advert pupils will have to show include a number of points:

- A brief description of the science of biofuels
- Arguments to show whether they are for or against biofuels.

Each commercial will be acted out in front of the class. The winners of the commercial will win a 'contract for a multinational car company'. The winners should be decided by a vote of the class.

Note:
The pupils should be given this activity to think about before the start of this class, in order for them to decide what form it will take, and if they would like to bring in music or props. If the technology is available the adverts could be videoed.

Suggested activities

- Pupils could place the pros and cons of biofuels on a poster to hang as the back drop of the commercial.
- Pupils could also look up the history of biofuels and how much biofuels are used in different countries.
- Brazil would make a useful case study to show the value and importance of biofuels.

Suggested activity

The use of biofuels is becoming more and more common in society today as a means of combating the use of non-renewable sources of energy and also to cut down on emissions which add to global warming e.g. as E5 petrol. Therefore there are vast amounts of information available through the media. One way to get the class thinking about this topic would be for them to actively research information on biofuels on the web.
Numerous articles may be found from: *The Irish Independent* website, *The Irish Times* website and *The Irish Examiner* website.
Each pupil could be given a website to research an article on biofuels. A short portion of the class could be then allocated to what the pupils learned from the article they researched about the potential of biofuels.

Useful websites

http://iteslj.org/Lessons/Fritsch-StudentLessons.html
This website is very useful to look at before getting the pupils to make a commercial as it gives some tips in carrying out the commercial

http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article5040501.ece
This article deals with the current debate that is arising from the use of biofuels and their potential. This article was taken from *The Times* newspaper, where Rob Routs (the Executive Director of Shell) answers questions and queries that members of the general public have on biofuels.

Unit four. Biofuels
Lesson 3 ~ Producing energy from food (single lesson)

Introduction
The aim of this lesson is to show the pupils that energy can be produced by food, which will illustrate how biofuels can act as a source of renewable energy.

Investigation: *To investigate the amount of energy produced by various foods*.

Materials needed:

Thermometers
Laboratory jacket
Laboratory goggles
Bag of marshmallows
Various bags (small) of dry beans — lima beans, etc.
Bag of dry-roasted nuts — peanuts, cashews, etc.
Small plastic cups (for seeds/nuts/foods)
Test tubes
Retort stand
Bunsen burner
Metal tongs or metal lid

Procedure

1. Measure out 30- 50 mL of water in the large test tube so it is about half-full, clamp to the retort stand, and place the thermometer in the test tube. Record the initial temperature.
2. Set the food source on fire using the Bunsen burner and place under the test tube for one minute. Put the food source on a piece of aluminium foil or tin lid or hold it in the tongs. Stir the water carefully using the thermometer and then take the final temperature of the water. (If the temperature rise is too small (< 1^{o}C) allow the sample to burn for longer than 1 minute. But use the same time for all samples.)
3. Calculate the heat given off. It takes 4.2 J to raise the temperature of 1 g of water by 1^{o}C. So it would take 50 x 4.2 = 210 J to raise the temperature of 50 g (= 50 mL) of water by 1^{o}C.
   Heat given off = 50 x 4.2 x temp. rise/^{o}C (adjust if you used a different volume of water.)
4. Repeat for all of the food sources.

Safety!
Care must be taken when dealing with hot surfaces. Laboratory coats and glasses must be worn at all times. Long hair must also be tied back.

This is only an approximate method of measuring the heat content of a fuel. Get them to discuss hw to improve the experiment and make it a fairer test e.g. burning the same mass of food; insulating the test-tube etc.

Note: A discussion should be held at the end of this experiment on which food source would be the best to use as fuel and why? The advantages of liquid fuels over solid

fuels should be discussed. The experiment could be done using various liquid fuels in a spirit lamp and weighing the lamp before and after to measure how much fuel was used.

Suggested Activities

Another experiment that could be carried out is the fermentation of yeast to produce alcohol. This can be found in the majority of leaving certificate books.

Useful websites

http://www.agclassroom.org/teen/ars_pdf/tech/2006/biomass.pdf
This website contains more experiments that could be carried out in the classroom in relation to biofuels.

http://biology.slss.ie/resources/laboratoryhandbook.pdf
This website contains the experiment to show the production of alcohol by the fermentation of yeast.

Unit 5.

DNA Identification

Unit 5. DNA identification
Lesson 1~ Understanding DNA identification. (Single lesson)

Introduction

In this lesson pupils will learn of the concept of DNA profiling and how a DNA profile can be used to determine if a suspect was present at a crime scene or not.

Explanation

DNA profiling is a method used by forensics to make a unique pattern of bands from a persons DNA that can be compared with another person's DNA profile. It may be used in various circumstances such as solving a crime or proving a genetic relationship in a paternity test.

DNA profiling is undertaken in various steps:

- The human cells are broken down in order to release DNA from the cell.
- The DNA is cut into fragments; these are cut using specialized enzymes.
- DNA fragments are separated into bands using gel electrophoresis.
- A photograph of the different DNA bands are taken and compared with other DNA profiles to see if there is a match.

The basics: Gel Electrophoresis

- Gel electrophoresis involves placing DNA fragments at the top of a sheet of sugar-based gel, placed in a glass chamber, sitting in a buffer solution.
- An electric current is applied which draws the DNA towards the end of the chamber. The electric current is successful in drawing DNA towards the end, as the DNA fragments are negatively charged.
- Smaller fragments move faster down the chamber than the larger fragments, forming bands on the gel.
- When the bands are separated, UV light is applied which allows them to fluoresce and makes them visible.
- A photographic image is then obtained of the DNA profile.

Activity: To compare three DNA profiles

In this activity pupils will compare DNA profiles taken from

1. two suspects
2. the victim
3. tissue found at the crime scene

What students should notice

Suspect A's DNA profile is similar to that of the tissue found at the crime scene. The bands in both profiles have matches. Therefore Suspect A is clearly the criminal in this case. This would stand in a court.
Suspects B Profile does not match that of the tissue found at the crime scene, so therefore this would not stand in court.
The victim's profile did not match that of the tissue profile found, so therefore this showed that there was a suspect involved in the crime.

For simplicity only a few bands are shown. A match would have to be obtained at many points for the evidence to be accepted.

Suggested activities

Pupils could compare a paternity test to determine who the father of a child is.
http://www.thetech.org/genetics/images/ask/paternityTestFig3.gif
This website gives an image of a paternity teat that pupils could use.

Useful websites

http://www.teachersdomain.org/resources/tdc02/sci/life/gen/howdnaevidence/index.html
This website gives a good back round on how DNA identification works and a deeper look into the use of gel electrophoresis

http://www.teachersdomain.org/resources/tdc02/sci/life/gen/sheppard/index.html
This video shows how Dna Profiling can be used in solving crimes in specific relationship to a murder that occurred in the U.S. (Teachers will have to log into the website teachers domain in order to access video. Note: registration is free)

Useful resources

The first website contains the website of a scientific company which sell the equipment necessary to carry out a PCR in the classroom for your students. Students will make billions of copies of a small amount of DNA in just 90 minutes. They will just need to mix template DNA & primers with PCR beads that contain all of the other components required to carry out a PCR reaction. Students will see the increasing amounts of DNA for themselves, taking samples every few cycles and analyzing them on a DNA gel.

The kit includes: instructions, PCR beads, DNA template and primers, DNA size ladder, ultrapure water, wax beads, gel loading dye, agarose, electrophoresis buffer and gel stain.
All you need: EdvoCycler (Found on website), electrophoresis tank, power supply, variable micropipette and tips, UV transilluminator, balance and microwave or hot plate.
http://www.edvotek.com/330.html

The second website contains the Laboratory manual of how to use the PCR technique using this equipment.
http://www.edvotek.com/pdf/330.pdf
Prices are roughly the following

- Electrophoresis tank – €310
- EdvoCycler – €1,700 (http://www.laboratoryx.com/v2/newad.cfm?CatID=220&Page=10) (This website contains some Cyclers that may be less expensive)

These experiments have been carried out by the author in her fourth year in University. Although the equipment is expensive to purchase, the learning experience that the pupils will gain will be invaluable. This experimental procedure allows the pupils to put theory into practice and see the real world application of DNA and how we can obtain it.

Unit 5. DNA identification
Lesson 2 ~ The debate about DNA identification (double lesson)

Introduction
In this lesson pupils will be learning of the pros and cons regarding DNA identification and in groups writing a newspaper article outlining their views.

Activity one
In this first activity pupils will read two extracts.

Case study A
Case study A describes how forensics carried out DNA identifications on the 9/11 victims.

- Pupils should discuss in groups the benefit of having this technology in relation to an event like this.
- Pupils should note that at the time forensic teams where only capable of handling cases with 500 victims, so this was a big leap in the use of DNA identification for the U.S government.
- Pupils should note also that there are a number of limitations to this technology, as many of the remains that were found were too badly burned, and could not be identified as they where too damaged.

Other examples of benefits of DNA identification

- Is sufficient evidence to stand in court
- Used to solve crimes such as murders or identifying 'cold cases'.
- Used in paternity tests to declare the father of the child
- Can be used to exonerate a person who has been wrongly accused. Very good example is people on death row in some American states where the use of DNA identification would be vital.

Case study B
In this case study pupils will be reading about the disadvantages of that DNA identification.

- Pupils should discuss how they would feel if their genetic history was available to insurance companies, fro example, for life insurance or future employers and how this could affect their lives.

Other example of negatives to DNA identification.

- Pupils should discuss the fact that for e.g. in crime scene DNA, identification cannot be used alone. Other evidence must point to the suspect. Tissue evidence alone is not enough as the suspect may have just been near the crime scene before the crime was committed. For example if foot prints along with the tissue sample were a match with the suspect then detectives are closer to linking that suspect with the crime. There must be other corroborating evidence.
- There has been discussion by some of the world's governments to have all newborn babies' DNA profile entered onto a database, so that if any future crimes are committed it would be a simple case of comparing profiles of

the samples found to the database. But the question is, does this affect our human rights, the right to freedom?

- Another disadvantage of DNA testing is that it is expensive and takes time - it can't be done instantly, as it appears to be on CSI!

Activity Two

In this activity pupils will work in groups to write a newspaper article on the ethical issues involved in DNA identification. The background given is as follows.

'Statistics show that many people who commit crimes repeat their crimes after they are realised from prison. Many governments now require that their DNA profile may be kept on a database so that they can be used for solving future crimes. However, many governments are now looking at have a nationwide database which will contain the DNA fingerprinting of newborns.'

- Pupils should look at both sides of the background information

1. If DNA profiles of criminals were on file it may reduce the number of crimes taking place and make cities safer. It would also cut down on police time looking for suspects.
2. If we all place our DNA profiles on file, does that not infringe on our human right of freedom? Could we be wrongly accused of a crime that could not be solved, and finally could our information be leaked or sold to certain companies or people?

When the articles are completed

One pupil from each group should read their group's article to the class. The class should then vote on which article was the most interesting and the one that highlighted both arguments the most. This article will take the first page on the 'DNA fingerprinting booklet'

Articles:

- Should be no more than half an A4 page.
- Pupils are free to write in whatever style suits them.
- When the articles are written they should be placed in order of preference and made into a booklet.

Suggested activities

Pupils could later type their articles and create a school newspaper including their articles and perhaps the history and some interesting stories to do with DNA identification.

Helpful websites

http://nature.ca/genome/05/051/0511/0511_12_e.cfm

This website contains another scenario that pupils could read and hold a classroom discussion on. 'Information on an insurance form'

http://www.dartmouth.edu/~cbbc/courses/bio4/bio4-1997/KatieLachter.html
This website contains information on the O.J. Simpson trial and how DNA identification should have in fact found him guilty. This may be interesting to use with the pupils at the end of the lesson, to show the pupils, that even though DNA evidence may be strong, good practices need to be carried out during the investigation in order to convict a person of a crime.

Many cold cases have been solved in recent years using DNA profiles of convicted or arrested people. See http://news.bbc.co.uk/2/hi/uk_news/7959431.stm for example.

Encourage the pupils to collect examples from newspapers on the use of DNA testing.

Unit 5. DNA identification
Lesson 3 ~ Understanding DNA identification (single lesson)

Introduction
In this lesson pupils will build on their previous knowledge of DNA, its structure and how it works.

Explanation

Chromosomes

- Chromosomes are found in the nucleus of every human cell. In each body cell of a human there are 46 chromosomes.
- Chromosomes are made of DNA (40%) and Protein (60%).
- Each chromosome has genes located throughout the strand. These genes are short sections of DNA. This DNA carries instructions for the formation of proteins.
- The length of a DNA strand in each cell is about 3 metres long; this is about the length of a car. This DNA strand is compacted into components called chromosomes.

DNA strands

- DNA is composed of two strands joined together by base pairs.
- There are four base pairs known as the alphabet of DNA they are Adenine which always joins with Thymine, and Guanine which always joins with Cytosine: A, T, G, C.
- DNA can be described as double helix as it contains two strands joined together through the base pairs and it is also twisted.

Activity: Making your own double helix

In this activity pupils will make their own DNA strands out of Marshmallows and Twizzlers this will give the pupils a visual aid to understand what a DNA double helix looks like. You may also have other models of DNA to show them.

Materials required
Twizzlers
Tooth picks
Marshmallows / four different colours

Procedure:

1. Assign each colour of marshmallows a letter A,T,G,C.
2. Place two Twizzlers on the desk and cross them like an x.
3. Place two different colour marshmallows on the toothpick, for example A and its complementary base pair T.
4. Set this tooth pick between the two Twizzlers
5. Continue this through out the length altering the base pairing.

Note:
One of the many advantages of DNA is that it makes us unique as individuals, as every person has their own unique pattern of base pairing on a DNA strand. Just like every person has their own unique fingerprint, each person has their own unique DNA fingerprint. This proves extremely helpful when solving crimes, paternity tests etc, as one person's DNA fingerprint can be compared to another person's DNA fingerprint.

Suggested activities

Pupils could carry out the experiment to extract DNA from an onion. The procedure for this can be found in any Leaving Certificate Biology book.

Useful websites

http://nature.ca/genome/03/a/03a_e.cfm
This website is ideal for explaining the basics of DNA. Pupils could look this up and research the topic of DNA further.

http://www.youtube.com/watch?v=qy8dk5iS1f0
This website contains a video that could be used when teaching the pupils about the structure of DNA.

The man who invented DNA testing was Alec Jeffreys. You can read about him at:
http://en.wikipedia.org/wiki/Alec_Jeffreys
2009 marked the 25th. anniversary of this discovery and Sir Alec Jeffreys called for the DNA profiles of innocent people to be removed from the database.
http://www.timesonline.co.uk/tol/news/uk/crime/article6828771.ece

Books

O' Callaghan, M. (2002) *Biology*, Dublin

Casserly, B., Horgan, B. (2004) *Breakthrough Science*, second edition, Dublin: Gill and Macmillan.

Unit 6.

Nuclear power

Unit 6: Nuclear Power
Lesson 1 ~ Understanding Nuclear energy(Single lesson)

Introduction
The aim of this lesson is to show the pupils how nuclear power stations work and what may be the benefits and disadvantages of having one set up in Ireland

Activity one
Pupils should work in pairs to try and determine the steps involved in producing electricity from a nuclear power station.

Explanation: Nuclear power

Nuclear fission produces heat, this in turn heats water to make steam, the steam then turns turbine, which turn generators which then produce electricity and this electricity is sent to various parts of the country.

It should be noted that 15% of the world's electricity comes from nuclear power stations.

- **Non renewable energy supply**

If the pupils have studied forms of renewable energy sources they might be confused why nuclear power is deemed non-renewable. The reason for this is the fact that the creation of nuclear power seeks to use uranium as a source of energy. Uranium is metal that is mined from the earth and so therefore will eventually run out. Hence the reason why nuclear power is a form of non-renewable energy.

- **Air pollution**

Nuclear energy does not produce carbon dioxide and so does not contribute to the greenhouse effect.

- **Radioactive waste**

Pupil should note that the waste products produced during nuclear power reactions can take up to ten thousand years to decay, therefore one of the major issues is where can we store this waste safely and also not allow it get into hands of people who would misuse it.

Activity two
In this activity pupils will be reading about the case of Chernobyl and how a nuclear accident caused severe damage to the human population. Pupils will answer questions based on this case study. However, it should be noted that there is some dispute as to the number of deaths caused by Chernobyl. Wildlife has actually flourished in the restricted area around Chernobyl, where people are not allowed to live.

Suggested Activities

Pupils could research the history of Sellafield, the nuclear reprocessing plant in England, just across the Irish Sea. Pupils should research the benefits that this plant has had on the area around, and also the negatives. The closest power station to Ireland is near Holyhead. All the measurements show that the amount of radioactivity in the Irish Sea due to Sellafield is far less than the natural background exposure due to other causes.

Useful websites

http://home.clara.net/darvill/altenerg/nuclear.htm
This website gives more detail about nuclear power plants if the pupils were interested on how exactly the energy is produced.

http://sellafieldsites.co.uk/
This website is the official website for Sellafield.

http://www.nrc.gov/reading-rm/basic-ref/teachers/unit3.html
This website give a lesson on Nuclear Power plants and gives a number of questions which pupils could use if researching a nuclear power station. This website also explains some key components which make up a power station.

Unit 6. Nuclear power
Lesson 2 ~ The debate about nuclear power (double)

Introduction
In this lesson pupils will be taking part in a role play in order to discuss their views on nuclear power.

Activity

Scenario
The pupils are part of a small local community consisting of a population of 1, 000. The nearest city is an hour's drive away. A nuclear energy company has proposed plans to build the first nuclear energy plant in their area. Currently there are other major renewable energy projects occurring in their area such as wind power and solar power. It is up to the local community to vote on whether to accept or decline the nuclear power station.

People involved:
Public opposed to the building
This group should focus on

- Deaths that could be caused in the incident of an explosion.
- The selling of the by products produced for nuclear weapons.
- Vulnerability of the plant to terrorist attacks.
- It uses a non-renewable energy source and we are only replacing the problem with oil with another.
- If it only supplies 15% of electricity worldwide why would we bother?
- The problem with disposal of radioactive waste. It takes 10,000 years to decay.

Two people will create a poster to show the cons of having a nuclear power station

Public in favour of nuclear power
This group should focus on:

- The success of nuclear energy throughout the world. In France over 70% of their electricity comes from nuclear power.
- The reduction in greenhouse emissions from using nuclear energy.
- The technology has improved over time so now safer methods are used, and an accident like Chernobyl is unlikely to happen again.
- Building such a station would create wealth and more jobs to the area.
- It would provide a more reliable source of electricity than wind or solar energy.

Two people from this group will create a poster on the pros of having a nuclear power station.

Town council
The town council consist of ten members: the chairperson and nine other associates. Upon hearing both arguments it will be the job of the town council to vote on the matter and decide whether or not to accept.

Chairperson
The chairperson is responsible for the floor when the debate is taking place. If it happens that there is a tie during the voting process, the chairperson will have the final say.

NOTE:
Pupils should be split into groups before this lesson. Each pupil could take a point from the ones listed above and research that point. The groups will then make posters placing all their points on them. Each member of the group will get a chance to explain their point at the town meetings. Each pupil will get time to speak for a maximum of one minute.

While the groups are discussing and creating their posters, the members of the town council can be setting up the area and also research themselves as they have a very important decision to make and so therefore will have to ask some probing questions.

Useful websites
http://www.pbs.org/newshour/extra/search_results.php?q=nuclear+power&where=all
This website gives other ideas on lesson plans that debate the pros and cons of nuclear power.

Unit 6. Nuclear power
Lesson 3 ~ Further understanding of nuclear power (Single lesson)

Introduction
The aim of this lesson is to revise what they have learned about atoms so far and to introduce them to the topic of nuclear energy and nuclear fission.

At the beginning of the lesson pupils should first distinguish the difference between a renewable energy and non-renewable energy.

Activity one
In this activity pupils will be drawing out the structures of the atoms helium, oxygen, and carbon. It is important to have a grasp on this if they are to understand how nuclear fission works. Pupils should become familiar where radioactive elements are found in the Periodic Table and terms like atomic number, mass number etc.

Suggested activity

Material required
Gym cones
Chalk
Sheet with Periodic Table

Pupils could work in groups outside in the yard to create their own atoms. The gym cones would represent the electrons. Pupils could compete in their groups to draw out the atoms, including number of protons and neutrons, with no help bar the sheet containing the Periodic Table.

Activity two

Materials required
Large pink and white marshmallows
Tooth picks
Sheet of paper
Sellotape

Procedure
1. Get two tooth picks and make a cross. Use tape to bind the cross
2. Place the marsh mallows on the tooth pick to make a carbon atom. Use six pink marshmallows for the protons and six white marsh mallows for the neutrons.
3. Repeat the steps creating a helium atom.
4. Now join the atoms together.
5. Remove the helium atom, what atom is now created?
6. Add on two more white marshmallows to represent neutrons
7. Replace one of the a neutron for a proton, what element have you created now
8. Now split the atom in two.

Explanation
Nuclear fission is the splitting of radioactive elements. Nuclear fission produces energy for nuclear power. A small loss of mass is converted into a large amount of energy according to the formula $E = mc^2$.

Steps towards nuclear fission:

- A helium ion (He^{2+}) - when talking about nuclear energy is also known as an alpha particle.
- When the helium and carbon atom where put together an oxygen atom was created.
- When the oxygen atom released the alpha particle, this is called alpha decay.
- When two new neutrons are added, it was noticed that it was still a carbon atom but it did not have the same number of neutrons. This is called an isotope; they have the same number of protons but different number of neutrons.
- The carbon 14 atom now undergoes beta decay. This forms a nitrogen atom as a neutron is converted into a proton.
- To show nuclear fission split the nitrogen atom in two.

Suggested activity
Pupils could research the history behind nuclear energy, and what stance Ireland has on nuclear power stations. Since 1978 there has been a ban on nuclear power in Ireland. However, since the rise in oil prices there have been many articles and letters in the Irish press asking for the government to look again at the ban on nuclear power. Looking at the arguments for and against nuclear power in Ireland would be make a good project. It is also true that we already use electricity generated by nuclear power when we buy electricity from the UK or from Europe via the interconnector.

Useful websites

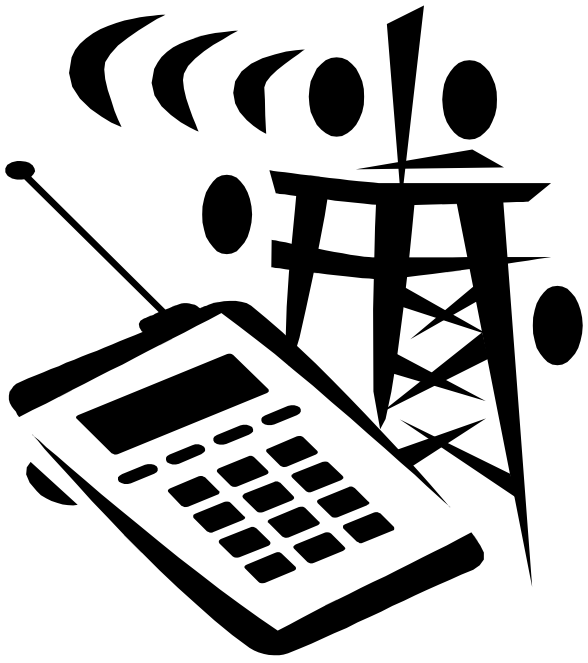
http://www.lbl.gov/abc/marsh-nuclei/pdf-dwnlds/marsh-whole.pdf
This website contains information on the marshmallow activity and also a diagram that pupils may like to follow during the activity.

http://www.eia.doe.gov/kids/history/timelines/nuclear.html
The following website contains an easy to read timeline of the history of nuclear power.

http://www.teachersdomain.org/resources/phy03/sci/phys/energy/fission/index.html
This website contains a website showing how nuclear fission works and the history of nuclear power.

Unit 7.

Electromagnetic Radiation



Unit 7. Electromagnetic Radiation
Lesson 1 ~ Understanding electromagnetic Radiation

Introduction
The aim of this lesson is to introduce the pupils to the various types of electromagnetic radiation in the electromagnetic spectrum.

Activity one
In the first part of the lesson pupils will be investigating what happens when a tuning fork is struck against the desk.

Definition of a wave: A wave is a means of transferring energy from one place to the next.

Pupils should be aware that when the tuning fork is struck this creates vibrations in the air i.e. waves, and when placed against the ear they will be able to hear a noise. Explain to the pupils that sound waves are being transferred from the tuning fork to the pupil's ears.

Suggested activity
The following activity will need some preparation, however it is a very valuable learning experience for the pupils and pupils will thoroughly enjoy the experiment.

Experiment: To show the movement of waves by vibrations

Materials required:
A large plastic bin
Plastic sheet
Large rubber elastic band
Paper cups
Smoke machine (optional)

1. Cut a large hole in the end of the plastic bin.
2. Place the plastic sheet at the top of the bin and place the elastic band at the end to form a flexible membrane.
3. Get each of the pupils sitting at their benches to place the paper cups on their heads.
4. The teacher then lifts the bin and points it in the direction that they wish to knock the paper cup from.
5. Hit the plastic sheet with a thump. This produces a pulse of air, which travels as a wave through the air. With a smoke machine to fill the bin with smoke, this is visible as a smoke ring.

Result
The paper cup should be knocked off of the pupils head.

Conclusion
The waves created by hitting the plastic surrounding the bin created vibrations (i.e. waves), which travelled from the bin to the plastic cup. These vibrations caused the cup to be knocked off the pupil's head.

Note: Adding a smoke machine will increase the effect of the experiment.
Add smoke to the bin before thumping the plastic. Pupils will see the smoke ring travelling from the bin to the cups.
A strap may also be placed on the bin to make it easier to hold.

Website
This video shows the creator of this experiment Steve Spangler and how effective it is at teaching pupils about waves. It also shows smaller scale experiments to show the same effect.
http://www.youtube.com/watch?v=Ewf60_iyMDM

Activity Two
In this activity pupils will be matching the terms described to the pictures and trying to name the type of radiation.

Important terms

Electromagnetic spectrum
It consists of:

- Microwaves
- Radio waves
- Infra red
- Visible
- Ultra violet
- X rays
- Gamma rays

All of these make up the electromagnetic spectrum. What makes them different from one another is the fact that they each have different wave lengths and different energies.

- **The longer the wave length** the less energy they possess, for example microwaves.

- **The shorter the wave the wave length** the more energy they possess for e.g gamma rays.

Explain to the pupils that the only type of radiation that we can see is in the *visible part* of the spectrum. This is made up of the colours of the rainbow.

Suggested activity: The breaking up of white light
Materials
Prism
White light source
Screen

Method
Shine the white light into the prism and note what happens on the screen.

Result
The white light is broken up to the colours of the rainbow by the prism.

Note:

- At the end of this lesson pupils should be broken up into seven different groups and assigned one of the different types of radiation.
- Pupils in each group should be asked to research the topic for the following lesson under the following headings:
    1. Wavelength
    2. Everyday uses
    3. Benefits
    4. Disadvantages

Information on the electromagnetic spectrum can be found in science books and on the web.

Websites

http://science.hq.nasa.gov/kids/imagers/ems/ems.html

http://www.teachersdomain.org/resources/phy03/sci/phys/energy/nasaspectrum/assets/phy03_vid_nasaspectrum/phy03_vid_nasaspectrum_56_mov.html#
This website contains a video describing the electromagnetic spectrum

Unit 7. Electromagnetic radiation
Lesson 2 ~ The debate in electromagnetic radiation (Double lesson)

Introduction

In this lesson pupils will be working in groups to research one part of the electromagnetic spectrum in order to produce a poster advertising their part of the spectrum.

Note: Ideally pupils should have access to the internet and science books while carrying out this activity.

Activity

Materials required

7 large posters
Internet access
Variety of Science books or encyclopedias

The aim of this activity is for pupils to research their part of the spectrum under the following headings:

- Wavelength i.e is it short or long, is it energetic or not.
- Everyday uses for e.g. radio waves are used for the use of cell phones
- The benefits for e.g. if there were no radio waves how would mobile phones work?
- The negatives for e.g. the risk of brain tumours through long term use of mobile phones.

1. Pupils should display this information on a poster and try to make it appealing as possible.
2. When complete, pupils will be presenting their findings to the class.
3. All pupils will record what they feel is the important information on each type of radiation.
4. At the end pupils will vote on which on they feel is the most important type of electromagnetic radiation.

Allow for pupils to be as expressive as they want, for example the group doing microwaves might want to bring in props such as mobile phones and ask pupils questions such as how would they feel not having the use of mobile phones etc.

A discussion should be held at the end showing how each type of electromagnetic radiation possesses both benefits and negatives, and each one is as important as the next.

Suggested activity

Pupils could hold a debate on the electromagnetic waves that could potentially cause harm to humans.
E,g, After researching the different types of electromagnetic waves pupils could discuss how the deterioration of the ozone layer. And how this could led to more UV radiation from the sun coming in contact with us, and the potential risk it holds for an

increase in skin cancer etc. This would also be a good introduction to the chemistry of the ozone layer, which is described in all Leaving Certificate Chemistry books.

An experiment to show the potential of the depletion of the ozone layer by CFC's is as follows

Materials:
Stick of chewing gum,
Short soda bottle,
Very hot tap water,
Magnifying glass

What to do:
Chew the stick of gum thoroughly. When it's soft, take it out of your mouth. Flatten it into a small disk between your fingers because you need a thin flat cap to seal the top of the bottle. Now fill the bottle right to the top with very hot water. Take the flat piece of gum and place it over the top of the bottle to seal it. Try to avoid making any holes and make sure that the water slightly touches the gum cap. Observe what happens closely with the magnifying glass.

What happens: The gum cap, as it touches the hot water, loses its elasticity and holes begin to form. Eventually the gum cap on the bottle breaks apart.

Why?
In the experiment, the bottle represents the earth while the gum cap represents the Ozone layer. The hot water touching the gum cap stands for the CFCs that are destroying the Ozone layer.
Now repeat the experiment except fill the bottle only half way with hot water. Now you can see how releasing fewer or no CFCs into the air can make a big difference to the earth's ozone layer.

Useful websites

http://www.nrc.gov/reading-rm/basic-ref/teachers/unit2.html
This website contains a lesson which can be carried out on the uses of radiation. It may be useful to introduce the pupils to the uses of radiation that have benefitted science and society which include:

- Diagnosing and treating illnesses.
- Killing bacteria and preserving food without chemicals and refrigeration.
- Processing sludge for fertilizer and soil conditioner.
- Locating underground natural resources and telling a dry hole from a gusher.
- Making smoke detectors, nonstick frypans, and ice cream.
- Growing stronger crops.
- Powering satellites and providing future electrical needs for space laboratories with people on board.
- Designing instruments, techniques, and equipment; measuring air pollution.
- Proving the age of works of art and assist in determining their authenticity.

This website also goes through in detail the uses of radiation in science and medicine.

Unit 7. Electromagnetic radiation
Lesson 3 Understanding waves (Single lesson)

Introduction
The aim of this lesson is for pupils to become familiar with the science of waves and the terms used in describing them

Development
In the first section pupils will be investigating what happens when a tuning fork is struck against the desk

Definition of a wave: A wave is a means of transferring energy from one place to the next.

Pupils should be aware that when the tuning fork is struck that this creates vibrations i.e. waves and when placed against the ear, they will be able to hear a noise.
Sound waves are being transferred from the tuning fork to the pupil's ears.

Activity One
In this activity pupils will be matching the terms to the unlabelled diagram of a wave. Pupils should work in pairs to try and match up the labels.
A discussion should be held at the end of this activity to make sure that every pupil is aware of the different terms in relation to a wave.
Terms

- The top of the wave is called a crest.
- The bottom of the wave is called a trough.
- The distance from one crest to another is called the wavelength and it is measured in meters.
- The distance from one crest to one trough is called 1 cycle.
- The number of cycles per second is called the frequency which is measured in hertz.
- The amplitude measures how high a crest (or how deep a trough) is.

Activity Two (Mexican wave)
Materials
Red sheet labelled tuning fork
Red sheet labelled ear

- This activity will show pupils that waves transfer energy. Pupils will line up in a straight line.
- The first pupil in the line to the far left will place the red paper labelled tuning fork on their top.
- The last person on the far right will place the red sheet labelled ear on their top. Explain that every other pupil in the line is an air molecule.
- Allow the pupils to create a Mexican wave.
- When they have completed this, create a discussion to see if the pupils have understood how waves transfer energy i.e. as the wave moved it transferred energy.

Suggested activity: To show that sound is a form of energy

Materials required
Oscilloscope
Microphone
Tuning fork

Method
1. Strike the tuning fork of the desk and hold it up to the microphone.
2. Note the reading on the oscilloscope.

Result:
A wave pattern will be visible on the screen.
The tuning fork has transferred its energy into electrical energy in the microphone, to create a wave on the oscilloscope.
Note: different frequencies of tuning forks can be used to yield different results.

In the next section pupils will be differentiating between a transverse wave and a longitudinal wave
Transverse waves
Show pupils by creating waves on a skipping rope what transverse waves look like. A slinky will also give the general idea.
Explain to pupils that transverse waves do not need a medium to travel in. An example of this is an electromagnetic wave.
For e.g. UV and visible rays from the sun travel through space, which is a vacuum, before hitting the earth's surface.
Longitudinal waves
Compress part of a slinky to show the pattern that longitudinal waves take. Explain to the pupils that longitudinal waves to need a medium to travel in. An example of this are sound waves travelling through air.

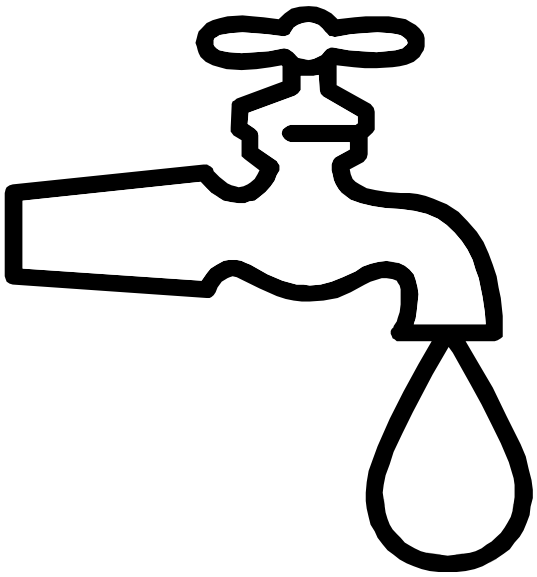
Suggested activity
Remind them of the experiment in JC Science where an electric bell is ringing in a bell jar, and when the air is removed the bell cannot be heard. If you can, demonstrate this to the class as below.
Materials
Bell jar
Suction
Alarm clock
Method
1. Place the bell jar over the ringing alarm clock, and note the results.
2. All the air to be sucked from the bell jar, and note the result.

Result
When a vacuum is present the alarm clock will not be heard ringing as sound does not travel through a vacuum.
Conclusion
Sound waves i.e. longitudinal waves need a medium to travel in.

Books
Dan O' Reagan *Real world physics*

Unit 8.

Fluoridation of water supplies



Unit 8. Fluoridation of water supplies
Lesson 1 ~ Understanding Fluoridation (Single lesson)

Introduction

The aim of this lesson is to introduce the pupils to the concept of fluoridation of water supplies and the benefits that the Irish government see in doing this to our water supplies. However, this is also controversial and they will be introduced to the arguments against fluoridation.

Background

Fluoride

Fluoride is a natural mineral found in water; it is a mineral that has been used for many years in order to prevent tooth decay.

There are many ways to receive fluoride other than from water supplies:

1. Fluoride tooth paste
2. Fluoride mouth wash
3. Fluoride supplements

Fluoridation

Fluoridation is the addition of fluoride to water supplies. The range is usually 1ppm, recently reduced to 0.8 ppm. The Environmental Protection Agency has a strict limit that no addition can be over 4ppm, as this can lead to skeletal fluorosis.

The Government have added fluoride to Ireland's water supplies for many years, their aim at 2007 was to reduce the level of fluorine added from 1ppm to 0.8 ppm. The levels in water supplies is carefully monitored. Fluoride may also be present in water from natural sources.

Too much fluoride can lead to a condition known as *dental fluorosis,* which is seen in the mottling or brown staining of teeth.

Research has also shown that too much fluoride added to water may lead to a condition known as *skeletal fluorosis*, which causes pain to bones and joints.

Like any chemical in high doses fluoride can be lethal to any one who ingests too much. There is also often confusion between the element fluorine, which is highly toxic and corrosive, and its ionic form in the fluoride ion, which is non-toxic at low levels. The same applies to chlorine and chloride. This distinction should be clearly made. Also emphasise the correct spelling of fluoride (NOT flourine!).

Interesting fact!

Due to the high consumption of sugary food, Ireland should have the highest rate of cavities, however research has shown that Ireland has one of the lowest rates of dental decay of 5 yr olds in the European Union.

Investigation ~ to see the effects of fluoridation

NOTE:

This investigation will require you to set up part of the experiment twenty four hours before the next double lesson.

For time management, it may be preferred that you conduct this part and just show as a demonstration.

Part A (requires set up 24 hrs before)

Material required
Two large jars or beakers
Hard boiled eggs
Fluoride solution (available at dentists and some pharmacies; fluoride mouth wash will also do)
Vinegar

Method
1. Hard boil two of the eggs, making sure that none of the shells are cracked as this can alter the results.
2. Place one of the hard boiled eggs in each of the jars. Label the jars A and B.
3. In jar A place the fluoride solution, covering the egg.
4. In jar B place the vinegar solution, covering the egg.
5. Leave to stand until the next class

This will be used as a demonstration to the pupils.

Jar A
The egg in jar A should still have its shell intact and should be firm.

Jar B
May not have its shell intact and may be soft.

In the double class pupils will see the effects by storing an egg in fluoride solution in the short term. This demonstration allows the pupils to see the long term effects of storing an egg in fluoride solution

Notes:
The vinegar acts as an acid (much like the acid produced by the sugary foods we eat.) The acid dissolves the eggshell which is made of calcium carbonate. The shell of the egg represents as the enamel on our teeth.

Suggested activities
This experiment can act as a further extension to the experiment just carried out.

1. Place the hard boiled egg in a graduated cylinder or tall glass and cover the egg with vinegar.
2. Look closely at the egg. Do you see any bubbles forming on the shell? Leave the egg in the vinegar for a full 24 hours.
3. It's time to change the vinegar on the second day. Carefully pour the old vinegar down the drain and cover the egg with fresh vinegar. Place the glass with the vinegar and egg in a safe place for a week, that's right, 7 days! Don't disturb the egg but pay close attention to the bubbles forming on the surface of the shell (or what's left).
4. One week later pour off the vinegar and carefully rinse the egg with water. The egg looks translucent because the outside shell is gone! The only thing that remains is the delicate membrane of the egg. You've successfully made an

> egg without a shell. Okay, you didn't really make the egg-- the chicken made the egg-- you just stripped away the chemical that gives the egg its strength.
>
> http://www.stevespanglerscience.com/experiment/naked-egg-experiment

Pupils could research the history of fluoridation in Ireland and find out what are the countries which allow the fluoridation of water supplies

Useful websites

http://www.dentalgain.org/fluoridation.html

This website contains information on the fluoridation of Ireland's water supplies, if pupils want to look more into the history of fluoridation.

http://history.nih.gov/01docs/education/TheFlourideStory.htm

This website contains the full story of how fluoridation of water supplies came about.

Books

Kennedy D. , 2000, *Chemistry Live*, Dublin: Folens

Unit 8. Fluoridation of water supplies
Lesson 2 ~ The effects of Fluoridation (Double lesson)

Introduction
In this lesson pupils will be doing investigations to see the chemical effects which different doses of fluoride can have. They will be also be investigating themselves how fluoride can help to protect the teeth by carrying out the egg and vinegar experiment.

Development

Activity one ~ To investigate the difference in dose levels
This investigation will allow pupils to see that different dose levels of chemicals yield different results. Pupils should understand at the end, that every chemical at high concentrations can be lethal if entered into our body system (using the example of fluoride), however chemicals at low doses will generally cause no health effects.

Method 1.
Material required (for each group)
Three large beakers
Food dye
Procedure
1. Label three large beakers A, B and C
2. Place equal amounts of water into each of the beakers
3. Add one drop of food colouring into A, note the results
4. Add three drops of food dye into beaker B, note the results
5. Add seven drops of food dye into beaker C, note the results

Colour change

Beaker A	Beaker B	Beaker C

Method 2.
This investigation will show pupils that the same dose applied to different masses may have different effects. For example even though the same amount of fluoride may be added to the water supply the effect will be different between a young child and a mature adult. The different size beakers act as a visual aid for this.

Materials required (for one group)
One larger beaker
One small beaker
Food dye

Procedure

1. Fill the larger beaker with water and place four drops of the food dye in it.
2. Fill the small beaker with water and place four drops of food dye in it.

Result

Colour change in large beaker	Colour change in small beaker

<u>Activity Two:</u> To see the effects of fluoridation.

Material required (For each group)
Two large beakers
Two eggs hard boiled

Method

1. Place water in a beaker and bring to the boil using a Bunsen burner or water bath
2. Place the two eggs in and allow to cook for five minutes in order for them to hard boil
3. When done allow to cool and carefully remove the hard boiled eggs
4. Place one egg in a large beaker and label. Pour fluoride solution over the egg just like before and allow to stand for ten minutes.
5. Prepare a second beaker, pour vinegar in but do not place in an egg, allowing enough vinegar in to cover two eggs.
6. After ten or fifteen minutes remove the egg standing in the fluoride solution.
7. Label this egg with a black marker.
8. Place the labelled egg and the unlabelled egg into the vinegar and note the results.

Pupils should note the following

- When both eggs are added to the vinegar, a lot more bubbles will be seen coming from the unmarked egg.
- Pupils should conclude that since the marked egg has been covered in fluoride, then it is harder for the vinegar/ weak acid to attack it.
- Pupils should make the link between their teeth and sugary foods with this experiment, i.e. acidic foods attack the enamel on our teeth causing cavities, however using fluoride can help to protect the enamel on our teeth.

Note: show the pupils the previous day's eggs that were placed in the fluoride and the vinegar. Pupils should be able to see the difference, as the egg that was in vinegar will

be soft and broken away. This will show the pupils the long term effects of eating sugary foods which produced acid in the mouth and the benefit that fluoride can have in protecting our teeth.

Suggested activities

Pupils could research on the internet the stance that different countries have on the fluoridation of water supplies. An interesting discussion that could be held, as some countries that have banned the fluoridation of water supplies show no increase in the percentage of cavities in children such as Sweden. However, tooth decay is worse in N. Ireland (no fluoridation) than in the Republic (with fluoridation).

Note:

In the following lesson pupils will be carrying out a debate with two main speakers. It would be ideal to select one speaker beforehand who will be against the fluoridation of water supplies and one who is for it, so that they can read over the arguments of both sides, so that they will be well rehearsed for the next class. A list of the pros and cons can be found in the next lesson.

Unit 8. Fluoridation of water supplies
Lesson 3 ~ The debate in fluoridation of water supplies (single lesson)

Introduction
In this lesson two pupils will be arguing their sides in the fluoridation of water supplies debate. The class will listen to both sides and at the end will vote on what they believe is best for their community.

Scenario for pupils

Activity~ the great community debate
Your community must take part in a debate in order to decide whether or not to allow the government to fluoridate your local town's water supplies. As a member of the public you will all be impartial and will hear both sides of the debate. It will then be up to you to vote for which side they feel has their town's best interest at heart, based on your evaluation of the evidence.

Pro Fluoridation
Mr. Ryan, a respected member of the Government, who has implemented the fluoridation of water supplies in several towns located around your area.

Against Fluoridation
Mrs. Lyons , a respected member of the town council, who has more than twenty years experience in dealing with town matters.

The pros of fluoridation of water supplies (Mr. Ryan)
- Since the fluoridation of water supplies, Ireland has seen a decrease in the levels of cavities in young children and the less loss of the teeth at old age.
- Ireland has the lowest rate of dental cavities in 5 yr olds in the whole of the E.U.
- According to the World Health Organisation, Ireland should have the greatest dental decay when compared with the consumption of sugary foods and the amount of profit the food companys' are making.
- There are strict guidelines in place to make sure that the fluoride level added to Irish waters is only 0.8 ppm, well below the average of other countries.
- Since fluoride is added to water supplies, people do not have to go to any great lengths to get an intake of it such as fluoride supplements.

The cons of fluoridation of water supplies (Mrs. Lyons)
- There is an ethical issue involved, as people should have the right to decide whether or not they want fluoride in their drinking water, and should the government really have the authority to speak on their behalf?
- How do people know that they are not getting too much fluoride, as every person will drink a different amount of water each day?
- In 1989 a survey was carried out in the United States comparing fluoridated states to non-fluoridated states. They found that their was little difference between the two in the rates of tooth decay.

- There are already enough fluoride products on the market such as tablets, mouth wash, and tooth paste; do we really need our water supplies tainted?
- An increase in fluoride levels has been shown to cause dental and skeletal fluorosis. What if a malfunction occurred and too much fluoride was added to our water supplies?

Notes:

- Each of the two pupils should be well rehearsed for this debate.
- These pros and cons are only points: the pupils should try and make these into a formal debate. With introduction, development and closure.
- Further research could be carried out in order to make their speech more interesting. Remind the pupils that they are trying to win over the class with their arguments!
- It might be beneficial for one or two other pupils to help collecting information or help speech writing for the debate.
- Allow for a discussion at the end, before the pupils vote, in order for the pupils to have their say on the topic and to express their views.

Suggested activities

After the debate allow the pupils who voted no and the pupils that voted yes to form groups. Allow each group to create a poster, explaining why they support their side.

Useful websites

This website contains a debate on whether or not fluoridation of water supplies is necessary and what implications it has. Each question on the left to the website contains an argument for and against. This website would be beneficial to give to the pupils before carrying out the debate.
http://www.fluoridedebate.com/

This website gives cases of fluoridation of water supplies in China and Africa and the ethics debate involved. This may serve as an interesting back story for the pupils to read about on fluoridation of water supplies
http://www.africanwater.org/fluoridation.htm

There has also been a good amount of coverage in the Irish papers over the last few years, with articles and letters for and against fluoridation.