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Science Teaching Trust.

SCIENCE ACTIVITY ONE: COLOUR QUESTIONS

WHAT HAPPENS WHEN COLOURED SUBSTANCES ARE MIXED WITH OIL AND WATER?

Students observe what happens when water or fat soluble pigments are added to water, oil or both. They mix a water soluble ink or food dye with water and add oil. They then mix grated carrot with water before adding oil.

The students record their observations, attempt explanations and suggest possible useful applications of the phenomena observed.

DELIVERY

01 Introduction 5-15 minutes

02 Practical activity ~40 minutes

03 Plenary 10-15 minutes

It would be useful to give the school some information about yourself in advance of the session. You may be able to bring photographs, equipment or other means to illustrate your work. The session should help students to recognise that the science they do in school relates to science in the real world, scientists are real people, and that they could be scientists too.

Throughout the session, try to refer to your own personal experience as a scientist as much as possible.

Allow time for students to carry out the investigation and discuss how to describe accurately what they have observed. More able or faster working students might be asked to try other pigments and could spend more time on discussing the possible uses of the observed phenomena.

You could also ask students to test other extracts, such as macerated red tomato skin or orange zest. If time permits, older students might prepare their own samples. Pigments may be lipid soluble or water soluble.

It is worth testing available materials in advance because pigments appear to alter as fruit ripens. For example, during testing, one sample of very ripe dark red crushed raspberries gave a red coloured pigment in water which did not transfer to oil, whereas a less ripe sample gave a lighter red pigment which was at least partially soluble in oil.

During the practical work you will be able to walk round and talk to students to gain an idea of what level you will need to adopt for the discussion and plenary.

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01 INTRODUCTION

Introduce yourself as a professional scientist.

Explain, using examples from your own experience, that:

- Scientists collect data and make sense of it.
- They learn how things work through observation and experiment. They try to explain observations and test their explanations through experiments. When they have a good explanation they can use it to solve problems.

The task

In this activity you are going to work as scientists to try to discover what happens when coloured substances are mixed with oil or water.

You will collect data - working accurately and recording your observations as precisely as you can.

Explain to the students that they will be working in pairs and briefly run through the procedure, emphasising safety precautions and pointing out other important information.

You will need to make sense of your data - using your scientific knowledge to try to explain what has happened.

Can what you have discovered be used to solve problems? You will need to think about how understanding what happens when coloured substances are mixed with oil or water can be useful. It can be very useful indeed!

02 PRACTICAL ACTIVITY

What you will need

Discuss this with the teacher and/or technician at the school. You may wish to take some of your own materials. Make sure that everything will be available on the day.

<u>For each pair of students</u>

- Student Instruction Sheet (may be printed separately, or you may wish to modify this to suit your own circumstances)
- Fresh finely grated carrot (optional: other grated, chopped or mashed coloured fruit materials such as red tomato skin, orange zest, raspberries etc.)
- Food colouring or ink
- Oil
- Test tubes and racks
- Plastic or wooden stirrers
- Spatula or similar

Health and safety

All activities have been trialled and tested by 4science (www.4science.org.uk) and every reasonable effort made to ensure that the activities are safe when conducted as instructed.

However, a full risk assessment should be carried before any practical work is undertaken. The supervising teacher should be able to advise on this and any local requirements, such as procedures recommended by Local Authorities or safety advisers used by the institution.

4science assume no responsibility for any damage or injury caused or sustained while carrying out these activities to the full extent permitted by law.

For this practical you may wish to discuss with the teacher issues such as the safe handling of glassware and potential hazards such as allergens associated with dyes and foodstuffs. Students must be supervised at all times during practical work by a teacher (and/or responsible adult).

03 PLENARY

What you will need

- Internet connected computer/data projector or interactive whiteboard

Observations

Ask students to report their findings. (What are your observations? How have you described what happened?). You may like to praise good examples of accurate descriptions.

Students should see and describe/record:

- Ink or food colouring stay in water and do not colour oil.
- Carrot gives a cloudy orange colour in water. This colour transfers to oil.
- Carrot can give oil a deep orange colour which does not transfer to water.

The Student Instruction Sheet states, “Suggest some possible explanations for what is happening” and “Can you suggest some possible uses for what you have observed, using similar substances?”

This should stimulate some discussion, although younger KS3 students in particular may find it difficult to come up with ideas. These questions can be used to occupy the faster working students while the slower ones catch up, so it is not necessary to give every group the chance to arrive at any concrete suggestions.

Explanations

Ask students to suggest explanations of what is happening. (Can you explain what is happening? Why is this happening? What is causing this effect?)

- Inks and food colours dissolve easily in water but not oil, they are water soluble but not fat (lipid) soluble.
- Carrot contains an orange pigment (a coloured molecule that absorbs certain wavelengths of light but transmits or reflects orange wavelengths) called carotene.
- Carotene seems to dissolve in both water and oil, but close observation reveals that it is just small pieces of carrot in suspension that give the colour to water. These tend to settle to the bottom after a while.
- Carotene dissolves very well in oil staining it orange. Mixing carroty water with oil causes the carotene to dissolve in the oil.

Some students may be able to describe factors which make certain molecules water or fat soluble.

Solving problems

Ask students if they can suggest any possible uses for the effect. (How can we [scientists] use what is happening here? Is it useful?)

Some groups of students may find this difficult (especially early KS3). You may wish to allow only a short time for thinking before offering your own suggestions.

The idea that you can extract or separate molecules may occur to some students, but they may need prompting. (What happened to the carrot? Do carrots only contain carotene? What happened to the rest of the carrot?)

The use of colours to distinguish "fatty" or "oily" structures or molecules may be suggested. (Could we use carotene to test for fats?) From here it is possible to go to the idea that microscopic structures could be made more visible. (What do you see if you look at cells down a microscope? Most of the structures in cells look the same, how could we make them look different to each other?)

If you can, add a slant and examples which relate directly to your own experience.

Some suggestions

In chemistry and biochemistry this process can be used to extract pure products from mixtures. If you can find a solvent which can dissolve the substance that you want, you can make it in a reaction then extract it from a mixture that contains lots of waste products that will not dissolve.

You may need to use simpler, straightforward language with more explanations for younger students, for example: "Chemists and biologists often want to get pure substances from a mixture of things. For example, if you are trying to make medicines, you need to be able to extract a pure drug with nothing else mixed up with it...." You can still ask challenging questions, but give more help and prompts if you don't get the answers that you want.

In biology, the parts of cells and tissues contain all kinds of different molecules, but they tend to look very similar under the microscope. Molecules that can stick to other molecules and make them coloured are called stains. Stains with the same kind of properties as carotene will attach to cell membranes because they contain oily molecules. Other stains attach to other molecules such as proteins.

As well as using colours to distinguish structures in cells, they can reveal the biochemical nature of parts of the cell.

Using stains to make structures in cells or tissues show up under the microscope as different colours is called differential staining.

Differential staining uses stains that attach to different kinds of molecules. This gives structures contrasting colours so that they can be distinguished from each other. Some students will have encountered images of differentially stained material, so you might ask them for examples of where this is useful and to suggest which kinds of molecules are involved (e.g. lipids and proteins in cell membranes, DNA in the nucleus, RNA in ribosomes, starch, fats or proteins in various storage structures like starch grains or adipose tissue, lignin in woody tissues, cellulose in cell walls – ask the teacher what they might know about.)

Being able to see details in the structures of cells and tissues helps us to understand how they work (e.g. DNA in the nucleus and chromosomes when they appear during cell division). When the normal appearance of cells and tissues is known, changes can be observed, for example allowing us to detect changes in diseases such as infections and cancers.

Examples

You may have your own digital images that you can display to show examples of differential staining. Otherwise there are many images available online, for example stained preparations of plant tissues give clear striking images. A few are listed here:

DESCRIPTION	URL & HYPERLINK
Examples of unstained cells, such as onion epidermis	www.flickr.com/photos/homebiology/3511035093/in/photostream/
Stained plant stem and root sections, such as sunflower (*Helianthus*) or maize (*Zea*)	www.flickr.com/photos/88865364@N00/2102037326/in/photostream/
Information on variety of stains (healthy and diseased human tissues can be compared)	http://medinfo.ufl.edu/~dental/denhisto/stains.html
Staining blood smears	http://labtestsonline.org/understanding/analytes/blood-smear/tab/test
Haemotoxylin and eosin stain	http://en.wikipedia.org/wiki/H%26E_stain
Normal cells	www.pathologyoutlines.com/caseofweek/case200527image1.jpg
Diseased cells	www.pathologyoutlines.com/topic/myeloproliferativecml.html
Nature 'Milestones' article on light microscopy, with a potted history of the development of staining techniques	www.nature.com/milestones/milelight/full/milelight02.html

Note: All websites cited in this resource were valid at October 2012

FOLLOW UP

Students could compare pigments from a variety of sources or use microscopes to investigate ready prepared stained slides. They could carry out a test for fats in foods using Sudan III or ethanol.

Older KS3 students could attempt staining a variety of cells and tissues using different stains. This could include macerated tissues, blood smears or self cut sections of stems or roots. They could do research to relate staining by specific stains to the biochemical nature of the stained structures.

>> CURRICULUM LINKS

There is an opportunity for curriculum links to be made. You may like to discuss with the supervising teacher whether they would like specific examples to be used or any issues to be raised. For example, they may like a discussion of the Sudan III or ethanol test for fats.

KS3 Science: Programme of Study for Key Stage 3

Key concepts

1.1 Scientific thinking

a. using scientific ideas and models to explain phenomena and developing them creatively to generate and test theories.

b. critically analysing and evaluating evidence from observations and experiments.

1.2 Applications and implications of science

a. exploring how the creative application of scientific ideas can bring about technological developments and consequent changes in the way people think and behave.

Key processes

2.1 Practical and enquiry skills

Pupils should be able to:

a. use a range of scientific methods and techniques to develop and test ideas and explanations.

b. assess risk and work safely in the laboratory, field and workplace.

c. plan and carry out practical and investigative activities, both individually and in groups.

2.2 Critical understanding of evidence

Pupils should be able to:

a. obtain, record and analyse data from a wide range of primary and secondary sources, including ICT sources, and use their findings to provide evidence for scientific explanations.

b. evaluate scientific evidence and working methods.

2.3 Communication

Pupils should be able to:

a. use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues.

Range and content

3.3 Organisms, behaviour and health

a. life processes are supported by the organisation of cells into tissues, organs and body systems.

Curriculum opportunities

The curriculum should provide opportunities for pupils to:

a. research, experiment, discuss and develop arguments

b. pursue an independent enquiry into an aspect of science of personal interest

c. use real-life examples as a basis for finding out about science.

e. experience science outside the school environment, including in the workplace, where possible.

f. use creativity and innovation in science, and appreciate their importance in enterprise.

i. prepare to specialise in a range of science subjects at key stage 4 and consider career opportunities both within science and in other areas that are provided by science qualifications.

k. make links between science and other subjects and areas of the curriculum.

>> CHECKLIST

You will need to liaise closely with the teacher.

Have you checked:

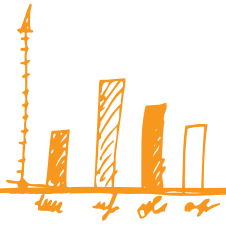
- that all the necessary materials and resources, including worksheets, will be available?
- the meeting arrangements at the school (for example: time, place, people's names, contact numbers, parking)?
- the length of the session?
- that risk assessments have been made and any appropriate safety measures are in place?
- how your experiences as a working scientist can be related to the activity?
- if and how any curriculum links should be made to the activity (this might also be related to your experience if you have provided the school with information about your work and interests)?
- what kind of follow up (if any) would be useful?

COLOUR QUESTIONS

What happens when coloured substances are mixed with oil and water?

WHAT YOU NEED TO DO

1. Place about 2 cm of water in a test tube. Add a few drops of food colouring or ink and shake.
2. Add 1 cm of oil and shake vigorously. Allow to settle. Record your observations. (Describe what happens.)
3. Place a spatula full of grated carrot in about 2 cm of water in a test tube. Mix vigorously with a stirrer. Allow to settle and decant into a second test tube (decant – 'dee-kant' – means pour off some liquid leaving the solid behind).
4. Add 1 cm of oil to the decanted liquid and shake vigorously. Allow to stand for a few minutes.
5. Repeat but add carrot to oil instead of water, decant and add some water to the decanted liquid. Record your observations.



RESULTS AND QUESTIONS

1. Suggest some possible explanations for what is happening.
2. Can you suggest some possible uses for what you have observed, using similar substances?