TEACHER GUIDE

pH, Indicators & Dyes

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pH, Indicators & Dyes Kit

TEACHING STRATEGY

Kit activities are designed for introductory (grades 6-8) and intermediate-level / high school (grades 8-9) students. There are a total of 6 discrete Model investigations, 3 Inquiry Path investigations, and 2 Going Further investigations.

ACTIVITY 1 can be done independently with introductory-level students. ACTIVITIES 2, 3 and 4 are linked - each precedes the other and are recommended for advanced middle school or high school-level students.

TEACHER GUIDE

ACTIVITY 1 pH, Indicators & Dyes

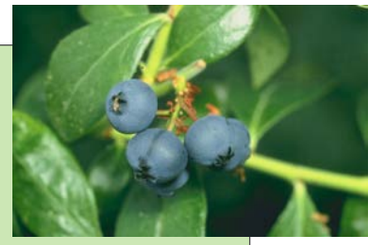
This kit supports 40 students working in groups of 4

KIT CONTENTS

40 medicine cups
10 cotton fabric (4" squares)
10 plastic jars , with lids (2oz)
100 commercial filter paper strips (1 x 4")
1 box, (72) microscope slides
1 pH paper strips, pkg./100 (0 to 14)
10 pipets
10 clothespins
1 sheet, black construction paper
- ball, twine (50')

CD-ROM

- TEACHER GUIDE set PDF
- STUDENT GUIDE set PDF
  - ACTIVITY 1 *Learning About pH*, Indicators, and Dyes PDF
  - ACTIVITY 2 *Learning About the Chemistry of Plant Pigments PDF*
  - ACTIVITY 3 *Learning About Making pH Paper Test Strips PDF*
  - ACTIVITY 4 *Learning About Testing and Accuracy PDF*
- BACKGROUND INFORMATION set PDF
  - pH, INDICATORS, & DYES (INTRODUCTORY) PDF
  - PIGMENT EXTRACTION (INTRODUCTORY) PDF
  - PLANT PIGMENT BIOMOLECULES & THEIR STRUCTURE (INTERMEDIATE) PDF
  - pH & POH (INTERMEDIATE) PDF
  - PLANT PIGMENTS AS pH INDICATORS (INTRODUCTORY) PDF
  - ALTERING PLANT PIGMENT BIO MOLECULES (INTERMEDIATE) PDF
  - LEARNING HOW LITMUS PAPER IS MADE (INTERMEDIATE) PDF
- *Learning About pH* PPT and .MOV (with *Study Notes* (PDF))



NEEDED BUT NOT SUPPLIED

From the grocery store

Bag, Blueberries (bag, fresh or frozen) ACTIVITIES: 1,2
Box, Baking soda (sodium bicarbonate) ACTIVITY 1
Bottle, White vinegar (acetic acid) ACTIVITIES: 1, 2, 3
10+ Bottles water (8 oz; 240mL), or distilled water ACTIVITIES: 1,2,3
Container, lemon / lime juice concentrate ACTIVITIES: 1,2, 3
Container, carbonated water, apple juice ACTIVITIES: 1, 2, 3
Container, table salt or rock salt ACTIVITIES: 1, 2, 3
Container, liquid household detergent, hand soap ACTIVITIES: 1, 2, 3
Container, liquid household ammonia / bleach ACTIVITIES: 1, 2, 3
Package, Ammonium Aluminum Sulfate[1] - optional ACTIVITY: 1
Package, Drano® ACTIVITY: 2

From a local source / school / home

10 Pairs of scissors ACTIVITIES: 1, 3
10 Plastic spoons ACTIVITIES: 1
20 Sheets, white copy paper ACTIVITIES: 1
10 Coffee filters ACTIVITIES: 1
10 Sheets, acid-free paper (fine stationary paper) ACTIVITIES: 1
10 Sets, colored pencils / colored markers ACTIVITIES: 1
10 Sheets, watercolor paper (optional) ACTIVITIES: 1
10 Microscope slides ACTIVITY 2b
10 Marking pens ACTIVITIES: 1, 2

ACCESSING DIGITAL CONTENT

FILE TYPES:
.pdf - portable digital file (Mac / PC)
notes.pdf - powerpoint pdf with lecture notes
.pps - powerpoint (PC)
.mov - Quick Time
iPod .mov Quick Time (iPod / iPad)

NOTE: Animations play within PDF files

See: *Content Delivery Information* to learn more!

PACING CHART

INFORMATION TABLE 1		
ACTIVITY / Level	**Model Investigations**	**Inquiry Path Investigations**
1 INTRODUCTORY	**1a** *Blueberries as Biological Indicators* *(40 minutes)*	*Dye Color Design* *(40 minutes)*
	1b *Blueberries as a Fabric Colorant* *(40 minutes)*	*The Blueberry Cyanidin Molecule as a pH Indicator* *(40 minutes)*
		GOING FURTHER: *Exploring Natural Dyes in Fabrics* *(40 minutes)*
2 INTERMEDIATE	**2a** *The Blueberry Cyanidin Molecule as a pH Indicator*	*Determine pH range for a biopigment* *(40 minutes)*
	2b *Converting a Chlorophyll Molecule to a Phaeophytin Molecule* *(30 minutes)*	
3 INTERMEDIATE	*Making pH Paper Test Strips* *(40 minutes)*	GOING FURTHER: *Exploring Colored Paper as pH Indicators* *(40 minutes)*
4 INTERMEDIATE	*Evaluating pH Paper Test Strips* *(40 minutes)*	

PREP & EXPERIMENT TIMES

INFORMATION TABLE 2 Expected prep and Experimental Run Times		
ACTIVITY	PREP	LAB
1a *Blueberries as Biological Indicators*	*10 minutes*	*40 minutes*
1b *Blueberries as a Fabric Colorant*	*20 minutes*	*40 minutes*
INQUIRY PATH: *Dye Color Design*	*20 minutes*	*40 minutes*
INQUIRY PATH: *The Blueberry Cyanidin Molecule as a pH Indicator*	*20 minutes*	*40 minutes*
GOING FURTHER: *Exploring Natural Dyes in Fabrics*	*20 minutes*	*40 minutes*
2a *The Blueberry Cyanidin Molecule as a pH Indicator*	*30 minutes*	*30 minutes*
2b *Converting a Chlorophyll Molecule to a Phaeophytin Molecule*	*20 minutes*	*30 minutes*
INQUIRY PATH: *Determine pH range for a Bio Pigment*	*20 minutes*	*40 minutes*
3 *Making pH Paper Test Strips*	*20 minutes*	*40 minutes*
GOING FURTHER: *Exploring Colored Paper as pH Indicators*	*20 minutes*	*40 minutes*
Evaluating pH Paper Test Strips	*10 minutes*	*40 minutes*

ACTIVITY 1 INTRODUCTORY INVESTIGATION

Learning About pH, Indicators, and Dyes

OVERVIEW

In this structured investigation, students learn about biological pigments; how they can be used as pH indicators and be manipulated as fabric colorants.

OBJECTIVES

- *To understand* the difference between a biological pigment, a dye, and other kinds of pigments as chemical compounds.
- *To understand* what solvents are, and how biological pigments can be extracted.
- *To understand* the concept of pH and the role of biological indicators.
- *To design extraction methods for harvesting biological pigments in water-based solutions.*
- *To use extracted biological pigments as indicators.*
- *To dye fabric swatches.*

MATERIALS (Per Class)

In the Kit:

40	medicine cups
10	cotton fabric squares
10	plastic jars, with lids (2oz)
10	clothespins
-	ball, twine (50')
-	CD-ROM

Needed but not supplied:

From the grocery store

1	bag, Blueberries (bag, fresh or frozen)
1	box, Baking soda (sodium bicarbonate)
1	bottle, White vinegar (glacial acetic acid)
10+	bottles water (8 oz; 240mL) - or distilled water

Needed but not supplied (cont.)

1 container, lemon / lime juice concentrate (STRONG ACID examples)
1 container, carbonated water, apple juice (WEAK ACID examples)
1 container, table salt or rock salt (VERY WEAK ACID examples)
1 container, liquid household detergent, hand soap (WEAK BASE examples)
1 container, liquid household ammonia / bleach (STRONG BASE examples)
1 Bottle, Ammonium Aluminum Sulfate[2] - optional

From a local source / school / home:

10 pairs of scissors
10 plastic spoons
20 sheets, white copy paper
10 coffee filters
10 sets, colored pencils / colored markers

BEGINNINGS ...

▸ Have your students read the checked information topics:

Background Information Topics

✔ **pH, INDICATORS, & DYES**
✔ **PIGMENT EXTRACTION?**
PLANT PIGMENT BIOMOLECULES & THEIR STRUCTURE
pH & POH
PLANT PIGMENTS AS pH INDICATORS
ALTERING PLANT PIGMENT BIO MOLECULES
LEARNING HOW LITMUS PAPER IS MADE

▸ Have students research the answers to these questions ...
(Students can obtain answers using *Background Information* and other web resources, as you direct.)

TEACHERS NOTE: These topics are available as individual PDF files on the CD-ROM. They can be emailed or uploaded to the school server. *Background* material is available to students as individual topic PDFs.

✔ **Define and give an example of a universal solvent.**
Water. Most chemical compounds can be dissolved in it.

✔ **Is a pigment a dye? organize your answer in an information table.**
In some ways, and not in others:

Information Table 1		
Characteristic	**Dye**	**Pigment**
Chemical Compound (consisting of 2 or more atoms)	✔	✔
Easily Dissolves (is soluble in ...)	✔	
Present in living things		✔ (biological pigment)
Appear colored due to light reflection	✔	✔
Man-made colored substance	✔	✔
Natural colored substance	✔	✔

✔ **What is the bio pigment in blueberries?**
The red/blue flavonoid bio pigment cyanidin.

✔ **What is the usual purpose of biological pigment extraction?**
To obtain a colored, transparent solution.

✔ **What is an indicator solution?**
A solution that indicates, through a color change, the presence of an acid or alkali (acid or base).

✔ **What is pH; what are acids and alkalis?**
pH is a numerical measure of how acidic or basic a solution and/or substance is. pH is measured on a pH scale: (0) STRONG ACID to (14) STRONG BASE.

An acid is a chemical compound that has a pH less than 7.

A base is a chemical compound having a pH greater than 7.

✔ Can extracted biological pigments be both dyes and indicators?

Yes.

✔ What is vinegar and baking soda? What are their chemical formulae?

vinegar is a 5-7% solution of acetic acid CH_3COOH.

baking soda is sodium bicarbonate $NaHCO_3$

✔ What is the pH of vinegar and baking soda?

vinegar is pH 3

baking soda is pH 9

✔ If an acid is reacted with a base, what happens?

A chemical compound called a salt is produced, along with water.

GETTING STARTED ...

▸ MODEL INVESTIGATION 1a - *Blueberries as biological indicators* introduces students to:

- *Extraction* of a biological pigment (cyanidin, an anthocyanin in the skin of blueberries - See: *Information Table 2*) to create a *colored, transparent, water solution*
- *Visual recognition* that this extracted pigment is an indicator - changes color with the change in pH
- Students will use this model investigation as a guide in designing an extraction method to produce a biological dye to color a fabric a color (at a specific pH).

▸ MODEL INVESTIGATION 1b - *Blueberries as a Fabric Colorant* introduces students to:

- *Dyeing a fabric swatch using an extracted biological pigment.*
- Students will use this model investigation as a guide in designing a method to dye fabric a specific color.

PREP NOTES

▸ Provide the following materials and work areas:

- ✔ bottle of white vinegar (weak acid)
- ✔ box of baking soda (weak base)
- ✔ set up a 'drying area' by installing a string 'clothesline' in the classroom for student use

▸ Provide the following materials for each student group:

- ✔ 4 medicine cups
- ✔ 3 blueberries (fresh or frozen)
- ✔ 1 plastic jar (2oz), filled with bottled or distilled water▲
- ✔ 1 bottle water (8oz; 240mL)
- ✔ 1 plastic spoon
- ✔ 1 sheet, copy paper
- ✔ 1 fabric swatch
- ✔ 1 scissors

▲ Do not use tap water which has chlorine, it can interfere with the extraction

▸ (INVESTIGATION 1a) Following 15 minutes of blueberry anthocyanin extraction, visit each group and add:

Cup #1 a pinch of baking soda (enough to change the pH to dark blue)
Cup #2 nothing
Cup #3 1 capful (3mL) vinegar (enough to change the pH to a pink color)

TEACHERS NOTE

One key action is that students observe the leaching of the bio pigment, cyanidin, directly from the skin of the blueberry - without any application of heat, or physical maceration. They should conclude that water is the solvent - forming a colored solution. These same blueberries are then set aside - ready for use in the INQUIRY PATH.