Activities Guide

Workshop 6. The Chemistry of Life

Comment

1. All activities have been peer-reviewed but not tested.
2. Some safety considerations are suggested in the activities. For full safety information, consult the MSDS sheets (go to http://msds.pdc.cornell.edu/) before doing the experiment.
3. A concise source book for further assignments, activities, and background information is *ChemSource,* version 2.1 (Orna, Mary Virginia, O.S.U.; Schreck, James O. & Heikkinen, Henry, eds.), 1998. Visit the Web site at http://intro.chem.okstate.edu/ChemSource/chemsource.html.

Iron in Your Cereal Demonstration: Dr. Leslie Pierce

Teacher's Guide

Goals

- To learn about chemicals in foodstuffs
- To let students express their ideas and contribute to learning

The Demonstration

Cereal is soaked with water and stirred for half an hour with a magnet, as a result solid iron sticks to the magnet. Kids make the connection between chemistry and the foods they eat.

Materials

- Total® brand cereal (or other high-iron content cereal)
- A 600 ml glass beaker
- Magnetic stirrer with (optional) hot plate
- Magnet
- Magnetic rod
- Water
- Hourglass
- Optional: 10 ml of 1.0M HCl and 10 ml of 1.0M NaSCN solutions
- An additional 100 ml beaker
- Thermometer

SAFETY

Wear goggles at all times during the demonstration.

Use acid carefully.

Instructions

Fill a 250 ml beaker with cereal.

Pour it into the 600 ml beaker.

Add 250 ml of water to the beaker.

Let the cereal absorb the water.

Insert a Teflon-covered magnet into the cereal and let it stir on the magnetic stirrer for about 30 minutes.

Take the beaker off the stirrer.

Use the magnetic rod to pull out the magnet, but don't touch with your hand.

Put in on a clean hourglass and show the students.

Comment

A demonstration of this procedure is fine, but if you want to do a hands-on experiment, make a slurry and divide it to plastic cups/ beakers, for each student.

Optional: demonstrate the acid action of the stomach.

Take about 100 ml of cereal slurry and add to it 10 ml 1M HCl. Heat to 37°C while stirring. Leave for 30 minutes. Add 10 ml of 1.0M NaSCN solution to identify ions of iron.

Lecture Notes

This is a magnet coated with Teflon. We're going to put the magnet at the bottom. We will stir it evenly so we see it spinning around.

We will find something in it that I bet you didn't know was there.

If you recall from biology, two different kinds of digestion occur in the stomach: physical digestion, breaking foodstuffs into little pieces, and chemical digestion, where the acids preform the chemical change on foodstuffs.

[30 min later] Now we have a soggy cereal. I'm going to find the magnet and take it out. I will drip it off a little. But notice that it is not all rinsing off. There's something still there.

I will pass it around and let you see what stays on it.

Iron in your cereal means iron in your cereal!

[Dr. Pierce relates to unexpected initiative of a student to show class what she had seen on TV.]

I have never done it, but if Bill Nye [the Science Guy] can, even Brittany [the student] can. What I'll do about it, is get a strong magnet from physics and leave it there over the weekend.

Teaching Tips From Dr. Pierce

Lots of times students raise questions that we don't anticipate. But we can go to the back room and pull some materials together really quickly, so that they can do the small experiments—and most of it is small stuff.

Today, when we were looking at extracting the iron from the Total [cereal], Brittany said that she saw the Science Guy do it, but differently. So I said, "Let's get the materials that you need; would you like to show it to us?" and she said, "Yes. Why not?"

References: Links

http://chemmovies.unl.edu/
Site contains links to hundreds of experiments and activities. Click on "Becker Demo Series" and then on Iron in Cereal "Experiment" to see QuickTime movies of this experiment.

References: Readings

Senozan, N.M., and Christiano, M.P. (1997) "Iron as Nutrient and Poison," *Journal of Chemical Education,* Vol. 74, No. 9, pp: 1060-1064.

Compounds From Plants Demonstration and Laboratory: Dr. Leslie Pierce

Teacher's Guide

Goals

- To learn the chemistry of household chemicals
- To introduce pH indicators

The Demonstration

In this demonstration, the principle of action of an acid-base indicator is shown, through the use of household solutions. The students observe the pH change and relate it to acidity and basicity of the substances.

Materials

- 1/2 head of red cabbage, boiled in water for about 30 minutes
- Some acid/base solutions: vinegar, lemon juice, cleaning ammonia, or other detergents
- Four 250 ml beakers or plastic cups

SAFETY

Wear safety goggles at all times in the laboratory.

Handle cleaning detergents and acids with care. They may be harmful.

Instructions and Lecture Notes

This is cabbage juice: water which now contains the pigment extracted from red cabbage leaves, which do not look very red now.

What do we know about the solubility of these pigments? They dissolve in water, which means that both are polar, because like dissolves like.

What would we do to test if the red cabbage juice is an indicator? We could put acid and base in the pigment.

Pour some cabbage juice solution into three beakers.

This is vinegar. If we pour it in here, it's going to give off some H^+ ions and reduce the pH—what will happen to the color?

Pour some vinegar into the first beaker.

It turns red because it is acid. Vinegar is just something that you have around the house, and we call it a household solution.

The household base that we will use is ammonia. Let's see what happens when we put it in this indicator.

Pour some ammonia into the second beaker.

It turns green, so it's a base.

So, in red cabbage juice there is an acid-base indicator, because we can use it to know whether another substance is an acid or a base.

Put some red cabbage juice in here, and some lemon juice. What do you think is going to happen?

Pour some lemon juice into the third beaker.

It turns as red as the vinegar.

What happens if I take another beaker, and mix in some of the red and green solutions?

Pour some of the [vinegar—cabbage juice] solution and some of the [ammonia—cabbage juice] solution into one beaker, until you get purple color.

It turns purple.

To get back the purple color, we used much more red than green. What does it tell us about the ammonia? It must mean that ammonia is a stronger base, or at least that the ammonia is more basic.

It's like doing a titration. When you titrate to find the molarity of acid in vinegar, you see how much base you had to drop into it.

The Laboratory

In this laboratory, the students compare pH indicators from different plant sources, and test them with ammonia and vinegar, to see how they change. They learn about sources of chemicals from plants, and the chemistry of acids and bases.

Materials for Each Group

- 1/2 head of red cabbage, boiled in water for about 30 minutes (divide into several cups)
- Different colored berries and red fruits (blueberries, blackberries, red cabbage juice…)
- Glass rod
- A well plate or a spot-plate
- 50 ml vinegar
- 50 ml cleaning ammonia
- Pasteur pipettes
- pH strips

SAFETY

Wear safety goggles at all times in the laboratory.

Handle cleaning detergents and acids with care. They may be harmful.

Lecture Notes—Concluding Discussion

We do see a theme, don't we? All the reddish pigments turn green in base.

Which one do you like best as an indicator? The blackberry.

We will make a generalization of the colors. What would be the colors in vinegar? Reddish. And in ammonia? Green.

Put the well plate on the overhead projector. Let's see if the colors are coming through.

Whatever the pigments are, they must be similar, because they all turn reddish in acid and greenish in base.

Teaching Tips From Dr. Pierce

That was part of a series of activities having to do with compounds from plants. We have watched a video and done a computer simulation about searching for pharmaceuticals and compounds from plants.

Students are really interested in that, so we are doing a version of it. A compound, which we can extract and assay, is an acid-base indicator.

Sometimes, we use this activity as a take-home kitchen lab; Make it a take-home part of their final exam, do it with their parents, and let their parents sign. We ran a little short on time this year, so we are doing it in class. But we design the lab so that they can use things that they can find in their kitchen, at home.

Very safely they dilute cleaning ammonia and vinegar. And of course the ammonia smells and they find it shocking that they are not doing so much cleaning.

When I did the red cabbage extract demonstration I had a large beaker, so that I had cups full of red cabbage juice. In the past we did some extractions from plants, using mortars and pestles. But it turns out that using very small pieces of berries and leaves in a spot-plate or a micro-well plate, will work just as well, and the students get to try lots of samples and get the opportunity to do many different trials with very small amounts of sample.

References: Links

http://www.woodrow.org/teachers/chemistry/institutes/1986/exp23.html
A procedure for extracting colors from foods for use as acid-base indicators.

http://www.iit.edu/~smile/ch8622.html
A procedure for using natural acid-base indicators, similar to the experiment in the video.

References: Readings

Kanda, Naoki, Asano, Takayuki, Itoh, Toshiyuki, and Onoda, Makota. "Preparing 'Chameleon Balls' from Natural Plants: Simple Handmade pH Indicator and Teaching Material for Chemical Education," *Journal of Chemical Education,* Vol. 73, No. 12, p: 425.

Compounds From Plants Demonstration and Laboratory: Dr. Leslie Pierce

Students' Guide

Goals

- To learn the chemistry of household chemicals
- To introduce pH indicators

The Laboratory

In this laboratory, you will compare pH indicators from different plant sources, and test them with ammonia and vinegar, to see how they change.

Materials for Each Group

- 1/2 head of red cabbage, boiled in water for about 30 minutes (divide into several cups)
- Different colored berries and red fruits (blueberries, blackberries, red cabbage juice…)
- Glass rod
- A well plate or a spot-plate
- 50 ml vinegar
- 50 ml cleaning ammonia
- Pasteur pipettes
- pH strips

SAFETY

Wear safety goggles at all times in the laboratory.

Handle cleaning detergents and acids with care. They may be harmful.

Instructions

1. Put small pieces of the same berry or fruit into each well in the well plate. Repeat for different kinds of plants and berries.
2. Crush the fruit pieces with a glass rod.
3. Add several drops of acid into one of the two wells with the same fruit and add base to the other well.

4. Summarize your results in the following table:

Fruit	Color in Acid	Strong or Weak	pH	Color in Base	Strong or Weak	pH
Red Cabbage	Red	Strong		Green	Strong	

5. Can you identify any trends in the table? ______________________________

6. What conclusions can you extract from your data? ______________________________

7. What does it mean about the nature of these indicators? ______________________________

8. What properties would you expect a good indicator to have? ______________________________

9. Which would you consider to be the best indicator? Explain: ______________________________

Calcium in Tums Activity: Al DeGennaro

Teacher's Guide

Goals

- To make the distinction between elements and compounds
- To use technology in order to visualize chemistry

The Activity

In this activity, students watch QuickTime movies of chemical reactions between different elements. This is to help students understand the difference between elements and their compounds. Then they try to answer whether there is calcium in Tums. The introduction of technology helps the students to visualize the difference between compounds and elements.

Materials

- CD-Rom about the periodic table: http://jchemed.chem.wisc.edu/JCESoft/Issues/Series_SP/SP17/prog1-SP17.html
- Computer connected to TV set—check connections before class!
- Story about calcium in Tums (See Lecture Notes)

Lecture Notes

Let's talk about the computer software, which I'm going to show you today. What I have is a CD-ROM, which has little animation clips. Most of them are QuickTime movies, samples of different elements.

Name an element. For example, gold. We can have a movie that just shows pictures of gold. If you are a wealthy person, then you are very familiar with it: it is a bright, orange, shiny metal.

Now, let's try some reactions with it. There are the reactions of gold with air, the reaction of gold with water, the reaction of gold with acid and the reaction of gold with base.

Which reaction do you want to be? The reaction of gold with acid.

Show movie. There's no reaction.

But think about it: why do people like to have gold? Because it doesn't react with anything.

Magnesium: what does it look like? (Close-up view) Shiny, silver colored, metallic.

Let's try air, next. It should be heated first, and then the reaction occurs.

Story About Calcium in Tums

Everybody has seen that commercial, that Tums contains calcium.

Now, your lab partner Joe tells you that there's no way that calcium can be in Tums, because it's a bright, shiny, metal.

To prove this, shows you the periodic table CD-ROM that we have just seen. Sure enough, not only is calcium a gray shiny metal, but it also reacts quickly with water, which must be a bad thing, if you actually have swallowed it.

Like a typical student, Joe wants the two of you to write a letter to the Tums company and call them liars. He also tells you they might offer you money to be quiet about this.

You have to decide whether you agree that it is impossible for calcium to be in Tums.

What you're going to do is use what you observe, and what you learned about elements and compounds, to write a letter to Joe that explains why you agree or disagree with the statement that calcium couldn't possibly be contained in Tums.

Let's observe the CD about calcium. What color is it? A dull gray. Let's do water. Any other video clip you want to see about calcium? Acid, because there is acid in your stomach.

To conclude: Is there Calcium in Tums? Why?

Teaching Tips From Mr. DeGennaro

To understand the chemistry of life you need to have a very good understanding of what elements and compounds are. That's actually at certain different levels.

Our objective here is that they be able to make the distinction between elements and compounds. In our society they are thrown about interchangeably. This makes sense to me, as a trained scientist, but it doesn't make any sense at all to students.

The compounds react dramatically differently than the elements from which they are composed. The most obvious example is sodium chloride. Sodium and chlorine are both very toxic, very reactive, and salt is essential for life, almost harmless.

In this assignment, the idea was to create a situation that was more interesting, realistic and challenging and so the mass-media was helping me out: it was right in my lap—that Tums contain calcium.

Is calcium in Tums? Yes or no, I mean, calcium atoms are in Tums, but it's not pure calcium. Now, the scenario with the students is: are they being dishonest by not making the distinction?

And I'm prepared to accept either answer. If the student says, sure it's not actually pure calcium, but it's calcium carbonate, and as far as your health is concerned, that calcium is as good as the calcium that you find in milk or in other stuff. And so it's not really dishonest.

On the other hand, he might be a purist, saying that it's not pure calcium and that they are lying, and what matters is only the justification.

References: Links

http://www.chem.latech.edu/~deddy/chem104/104Antacid.htm
A lab procedure for analyzing antacids chemically.

http://www.calciuminfo.com/index.htm
Click on any of the links on this page for more information on calcium.

http://www.tums.com/
The TUMS homepage.

References: Readings

Turner, Ray. (2001) "Using Technology to Create a Scientific Learning Community," *Journal of Chemical Education,* Vol. 78, No. 6, pp: 717-719.

Kostecka, K.S. (2000) "Atomic Absorption Spectroscopy of Calcium in Foodstuffs in Non-Science-Major Courses," *Journal of Chemical Education,* Vol. 77, No. 10, pp: 1321-1323.

Burning Peanuts Laboratory: Lisa Morine

Teacher's Guide

Goals

- To learn about the energy content of food
- To learn about energy transfer

The Laboratory

In this laboratory, students burn a peanut, and use the heat that it gives off to heat a can of water. Thus, they learn about the energy content of food and about energy transfer processes. This makes it easier to understand the meaning of calories and energy.

Materials for Each Group

- Electronic balance—one for all
- Several peanuts
- A piece of wire
- Cork stopper to hold wire
- 4″x4″ aluminum foil to protect cork from the fire and a sheet of aluminum foil to work on
- Two empty tin cans
- 250 ml graduated cylinder
- A stand with ring clamp
- A thermometer
- Matches
- Tap water

SAFETY

Wear goggles at all times during the laboratory period.

Take extra care when working with fire.

Stay away from flammable liquids (alcohol, ethers, acetone, etc) and do not touch hot parts with bare hands.

Work on a sheet of aluminum foil to avoid burning the bench-top.

Lecture Notes

What does calorimetry mean? We are looking for how many calories: that's the unit of heat energy.

We are going to find out how much heat it (the peanut) releases and calculate how many calories it has. And calorie is just a fancy way of saying potential energy.

When we eat the food, it goes into our stomach, we digest it, and when the bonds break they release energy.

When you measure the volume of the water, be careful. You are going to use the electronic balance to measure the mass of a whole peanut.

See how the peanut catches on fire? That's because it has a lot of energy.

Teaching Tips From Ms. Morine

This exercise is supposed to help students understand that there's energy in food. It is stored energy—potential energy—and this one exercise uses pure liquid water to help calculate a heat change seen when you burn something. A combustion. There is a similar reaction in our body, we burn the food out in combustion, but we don't use a match, we use enzymes. In today's experiment, they used a match, they burned the peanut, and they measured the temperature change in the water. It made it very real to them, that food contains energy.

Comment

You could use different sources of food, not just peanuts, burn them, and compare to food content tables to learn what's in them—see these sites:

> http://www.hoptechno.com/nightcrew/sante7000/sante7000_search.cfm
> Use the Search form to find contents of foods.
>
> http://www.fda.gov/opacom/backgrounders/foodlabel/newlabel.html
> An interactive food label from the FDA.

Also, it may be interesting to learn how the body does the "combustion" process within living cells, and how it uses up the energy by some biochemical cycles of the food groups (carbohydrates, fats, etc)—see any book about biochemistry.

References: Links

http://www.sciencebyjones.com/energy_content_of_food.htm
A lab procedure for the calorimetry of foods.

http://ag.arizona.edu/pubs/health/az1128.pdf
A fact sheet on the calcium and calorie content of foods.

Burning Peanuts Laboratory: Lisa Morine

Students' Guide

Goals

- To learn about the energy content of food
- To learn about energy transfer

The Laboratory

In this laboratory, you will burn a peanut, and use the heat that it gives off to heat a can of water in order to understand the meaning of calories and energy.

Materials for Each Group

- Electronic balance
- Several peanuts
- A piece of wire
- Cork stopper to hold wire
- 4"x4" aluminum foil to protect cork from the fire, and a sheet of aluminum foil
- Two empty tin cans
- 250 ml graduated cylinder
- A stand with ring clamp
- A thermometer
- Matches
- Tap water

SAFETY

Wear goggles at all times during the laboratory period.

Take extra care when working with fire.

Stay away from flammable liquids (alcohol, ethers, acetone, etc) and do not touch hot parts with bare hands. work on a sheet of aluminum foil to avoid burning the bench-top.

Instructions

1. Weigh a peanut on the semi-analytical balance.
2. Stick the peanut on one end of a wire.
3. Stick the other end of the wire through a piece of aluminum foil and into a cork stopper.
4. Place the cork with the peanut on the base of a stand, under the ring clamp.

5. Weigh an empty 250 ml graduated cylinder on the semi-analytical balance: ______________________
6. Measure exactly 200 ml of tap water into the cylinder. The accuracy of the amount of water is very important for this calculation.
7. Weigh the cylinder with water: ______________________
8. Pour the water into the can and measure its temperature with a thermometer: ______________________
9. Take out the thermometer.
10. Put the can on the ring clamp above the peanut, at a distance of more than 2 inches.
11. Set the peanut on fire, and make sure that the fire heats the can. If it doesn't, repeat the procedure, after you readjust the height of the can.
12. Notice the changes, which occur during burning: ______________________

    ____
13. Burn the peanut. Wait until it burns out. When the fire extinguishes, take a temperature reading: _______

    ____
14. What is the temperature difference in the water, before and after the peanut was burned? ____________

    ____
15. A calorie is the quantity of heat required to raise 1gr of water by 10°C. Calculate how many calories were released in the heating process by dividing the temperature change into the exact mass of water (in grams):

    ____
16. Weigh the left-over material from the burning peanut: ______________________
17. Calculate the mass that was burnt, from the difference between the original and left-over mass: _______

    ____
18. How many grams of peanut did you burn, in order to heat 200 g (200 ml) of water by one degree centigrade? ______________________

    How many grams of peanut will you burn to heat one gram of water by 10°C? How many calories is that?

    ____

Summary

Does a peanut have a high or a low energy content? ______________________

____

Which do you think is the most abundant of the five food groups in peanut? Why?______________________

____

____

____

____

Check your answer with the teacher.

The Energy Content of Food Laboratory: Felix Muhiga

Teacher's Guide

Goals

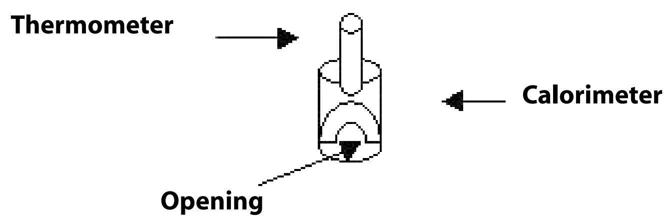
- To compare the food-group content of different foods
- To become aware of the differences between different things that we eat

The Laboratory

In this laboratory, students become involved in doing calorimetric measurements of burning food. They learn how the food-group composition of different foods influences the energy they give off in combustion, and thus about the energy that the human body may use.

Materials for Each Group

- A calorimeter with a side opening and a thermometer on top
- Thermometer
- Calorimeter
- A piece of wire
- Cork stopper to hold wire
- 4"x4" aluminum foil to protect the cork from the fire
- Different foodstuffs: marshmallow, nuts, popcorn
- Matches
- A sheet of aluminum foil



SAFETY

Wear goggles at all times during the laboratory period.

Take extra care when working with fire.

Stay away from flammable liquids (alcohol, ethers, acetone, etc) and do not touch hot parts with bare hands.

Work on a sheet of aluminum foil to avoid burning the bench-top.

Lecture Notes

We will investigate and find out the calorie content, or energy content, of different kinds of foods.

Based on the different foods that we worked with in this lab, can you tell me how we can classify the foods?

What did we say about the fat content of different kinds of food, based on the samples that we did in the lab?

Nuts: do they have more calories, or more fat, as compared to carbohydrates?

Animals like cows and horses must keep on eating all the time, for almost 24 hours, because grass and plants are at the bottom of the food energy spectrum. Above that are the carbohydrates, then the proteins, and the highest energy content is of fats.

So, it's not how much we eat, but the energy content of our food, that counts. That depends on the food content.

Comment

Check this Web site:

> http://www.hoptechno.com/nightcrew/sante7000/sante7000_search.cfm;
> use the Search form to find contents of foods.

Read about food content here:

> http://www.fda.gov/opacom/backgrounders/foodlabel/newlabel.html,
> an interactive food label from the FDA.

References: Links

http://www.mr-damon.com/experiments/3svt/food_energy/
An illustrated interactive guide to food calories experiment.

http://www.woodrow.org/teachers/chemistry/institutes/1988/foodheat.html
An alternative procedure for the calories in food experiment.

The Energy Content of Food Laboratory: Felix Muhiga

Students' Guide

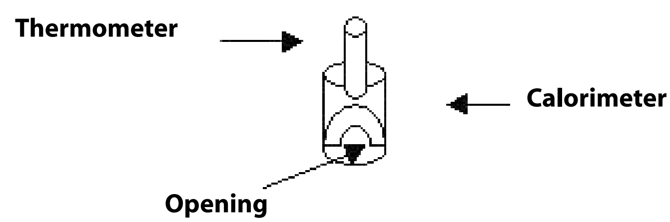
Goals

- To compare the food-group content of different foods
- To become aware of the differences between different things that we eat

The Laboratory

In this laboratory, you will do calorimetric measurements of burning food. You will relate the food-group composition of different foods to the energy they give off in combustion, and thus about the energy that the human body may use.

Materials for Each Group



- A calorimeter with a side opening and a thermometer on top
- A piece of wire
- Cork stopper to hold wire
- 4"x4" aluminum foil to protect cork from the fire
- Different foods: marshmallows, nuts, popcorn, and others
- Matches

SAFETY

Wear goggles at all times during the laboratory period.

Take extra care when working with fire.

Stay away from flammable liquids (alcohol, ethers, acetone, etc) and do not touch hot parts with bare hands.

Work on a sheet of aluminum foil to avoid burning the bench-top.

Instructions

1. Stick the food on one end of a wire.
2. Stick the other end of the wire through a piece of aluminum foil and into a cork stopper.
3. Light the food with a match.
4. Place the cork with the food into the opening in the side of the calorimeter.
5. Record the temperature that registers on the thermometer for each of the foods, in the following table. Try to decide what the main food group is by comparing it to the list of energy content of food, listed on the following page. Compare the data to the table the teacher gave you.

Food	Temperature	Primary Food Group

Energy Value of Food Groups

1 g of fat has nine calories.

1 g of alcohol has seven calories.

1 g of carbohydrates or proteins has four calories.

Hydrogen Peroxide Decomposition Laboratory: Dr. Leslie Pierce

Teacher's Guide

Goals

- To measure the decomposition rate of hydrogen peroxide
- To learn about enzymes

The Demonstration

Pour some yeast solution into pharmaceutical hydrogen peroxide, and watch what happens. See if there is an indication for catalase action (catalase is the enzyme which decomposes hydrogen peroxide).

Materials

- 50 ml [3% hydrogen peroxide] in 100 ml beaker
- 250 ml Erlenmeyer flask, which contains:
    - Yeast
    - Warm water
    - Sugar
    - Stir and wait for about fi an hour

SAFETY

Wear goggles and gloves at all times during the laboratory.

Be careful not to spill hydrogen peroxide.

For small spills, flood with water. For serious spills, consult safety information at http://www.oxytherapy.com/faq/212.html.

Lecture Notes

What, from biology, has anything to do with chemistry?

What can we use to relate the study of life with the study of materials?

What are cells made up of? Carbon, hydrogen, oxygen, nitrogen. These elements make up our cells.

Those are not only collections of atoms, but they are atoms arranged in certain molecules.

When you studied biology, what did you study about amino acids? Now you know a little bit more about acids.

Are amino acids organic acids? Sure, because they are made up of carbon. How do you recognize amino acids when you see them? Because they have groups in them (and a typical structure).

What else do you know about biology?

We are talking about combustion reactions. If there are so many combustion reactions in your body, why don't you just sit on the desktop and burn like a piece of sugar? Why are you not on fire?

In your body, thankfully, combustion reactions and all other reactions are under control. What molecules in your body control the reactions? Enzymes.

What do enzymes do? They control the chemical reactions, which go on in your body.

Enzymes speed up reactions, also catalysts do. The only difference between them is that enzymes are the catalysts that work in living cells.

The chemical reaction that you are going to be looking at in this laboratory, is a chemical decomposition reaction.

The decomposition reaction of hydrogen peroxide goes as follows:

H_2O_2 —> fi $O_2 + H_2O$

When you buy peroxide in the drugstore, they sell it in brown bottles. Why? What will the dark keep out? The light.

If I took peroxide, put it in a beaker, and waited for a week, what would be left in my beaker? Water. The oxygen has evaporated to the air.

Keeping light out slows down this reaction, which happens anyway.

On the bottle, it gives the concentration of this peroxide, and it says 3%. What's the rest of it then? Water.

Living cells have enzymes in them which break down peroxide.

Instructions

Pour some yeast solution into pharmaceutical hydrogen peroxide, and watch what happens. See if there is an indication for catalase action (catalase is the enzyme which decomposes hydrogen peroxide).

What happens to the solution? Do you hear any fizzing? What is this fizzing? Oxygen.

Where is the oxygen coming from? The hydrogen peroxide.

It looks like it is slowing down. What will happen when all the hydrogen peroxide decomposes? Only water will be left, and then you will not see anymore fizzing.

These are yeast cells in warm water and sugar which sat for half an hour.

For next time, design an experiment using several concentrations of H_2O_2.

Comment

Dr. Pierce lets the students do trials for one concentration of hydrogen peroxide. Then, she asks them to design an experiment for next time using several concentrations. It is possible to catch the momentum of the first experiment, when all equipment is already present, and the students are thinking about it, and go right on with the experiment that they designed. It is possible to prepare several more solutions ahead of time and guide the students, through their own ideas, to an experiment, which utilizes the solutions that were already prepared.

In addition, it is recommended that one wear goggles and gloves during this experiment, certainly at higher concentrations of hydrogen peroxide.

The Laboratory

In this laboratory, the students learn about the decomposition rate of hydrogen peroxide. The question you will try to answer in this lab is: what is the relationship between initial concentration of hydrogen peroxide and how fast the decomposition reaction goes.

Materials for Each Group

- Water
- 50 ml [6% hydrogen peroxide] in 100 ml beaker
- 50 ml [4% hydrogen peroxide] in 100 ml beaker
- 50 ml [3% hydrogen peroxide] in 100 ml beaker
- 50 ml [2% hydrogen peroxide] in 100 ml beaker

- 50 ml [1% hydrogen peroxide] in 100 ml beaker
- Yeast solution with sugar
- Well plate
- Pasteur pipette
- 6 small discs of filter paper
- Plastic tweezers
- Stopwatch

SAFETY

Wear goggles and gloves at all times during the laboratory.

Move away from acid!

Be careful not to spill hydrogen peroxide.

For small spills, flood with water. For serious spills and safety information, consult MSDS sheets at http://www.oxytherapy.com/faq/212.html. See instructions for the activity in the students' guide.

References: Links

http://www.woodrow.org/teachers/chemistry/institutes/1988/catalyst.htm
A lab procedure that compares the effects of inorganic catalysts and enzymes on peroxide decomposition.

References: Readings

Ragsdale, R.O., Vanderhooft , J.C., and Zipp, A.P. (1998) "Small-Scale Kinetic Study of the Catalyzed Decomposition of Hydrogen Peroxide," *Journal of Chemical Education,* Vol. 75, No. 2, pp: 215-216.

Marzzacco, C.J. (1999) "The Enthalpy of Decomposition of Hydrogen Peroxide: A General Chemistry Calorimetry Experiment," *Journal of Chemical Education,* Vol. 76, No. 11, pp: 1517-1518.

Hydrogen Peroxide Decomposition Laboratory: Dr. Leslie Pierce

Students' Guide

Goals

- To measure the decomposition rate of hydrogen peroxide
- To learn about enzymes

The Laboratory

In this laboratory, you will learn about the decomposition rate of hydrogen peroxide. The question that you will try to answer in this lab is: what is the relationship between the initial hydrogen peroxide concentration and the speed of the decomposition reaction?

Materials for Each Group

- Water
- 50 ml [6% hydrogen peroxide] in 100 ml beaker
- 50 ml [4% hydrogen peroxide] in 100 ml beaker
- 50 ml [3% hydrogen peroxide] in 100 ml beaker
- 50 ml [2% hydrogen peroxide] in 100 ml beaker
- 50 ml [1% hydrogen peroxide] in 100 ml beaker
- Yeast solution with sugar
- Well plate
- Pasteur pipette
- 6 small discs of filter paper
- Plastic tweezers
- Stopwatch

SAFETY

Wear goggles and gloves at all times during the laboratory.

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Instructions

1. Soak a filter paper disc in the yeast.
2. Fill a well in the well plate with one of the peroxide solutions.
3. Use plastic tweezers to put the disk on the hydrogen bottom of the well, and immediately start the stop watch.
4. Measure how long it takes until the disc floats.
5. Record results in the table below.
6. Repeat for all hydrogen peroxide concentrations.
7. Do one trial with water only (no peroxide), as a control.

Hydrogen Peroxide Concentration	Time
6%	
4%	
3%	
2%	
1%	
0%	

8. Draw a graph of the hydrogen peroxide concentration vs. time before floating.

9. What is the relationship between the concentration of the hydrogen peroxide and the rate of floating of the disc? ____

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10. What other experiments would you have done to study these changes? ______________

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