



# How to teach 3rd graders about cellulose



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# What is **Earth's most abundant** natural product?



clothing

First, students were introduced to: **Earth's most abundant** natural product, **cellulose**.

Students were asked to identify **classroom objects** made from cellulose.

Among all, furniture, clothing, books, papers, plants and cellophane were pointed out.



trees, plants



cellophane



books, papers



furniture

# Cellulose vs starch



Students were taught the differences between cellulose and starch:

**Sugar** (glucose) is the **basic component** of both starch and cellulose.

In fact, they both are sugar polymers that differ only by **how their sugar building blocks** are linked together.

In the case of **cellulose**, the links between sugars give rise to a **linear** structure, with a shape comparable to **spaghetti**.

In **starch**, these links cause a **spiral** structure, similar to the shape of **fusilli** pasta.

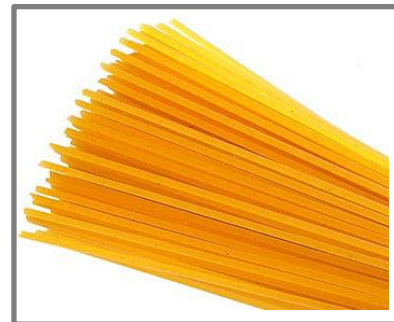
**Starch**

fusilli-like



**Cellulose**

spaghetti-like



# How to differentiate **cellulose** vs. **starch** in food samples?



By performing a starch iodine test!

Students were asked to formulate their experiment hypothesis:

Which of these food contain starch?



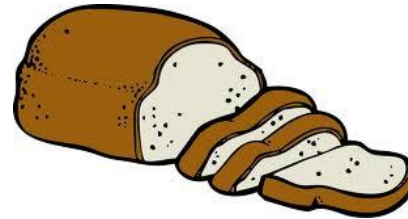
**banana**



**potatoe**



**celery**



**bread**

But first...

# What is lab safety?

Students learned what is lab safety:

A set of rules compiled to **prevent any accidents** potentially harming the scientist and its surroundings.

Students were also asked to enumerate the general lab safety equipment:



Subsequently, three students dressed following the above rules, and performed the experiment.

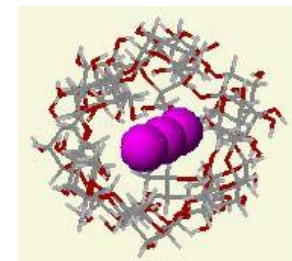
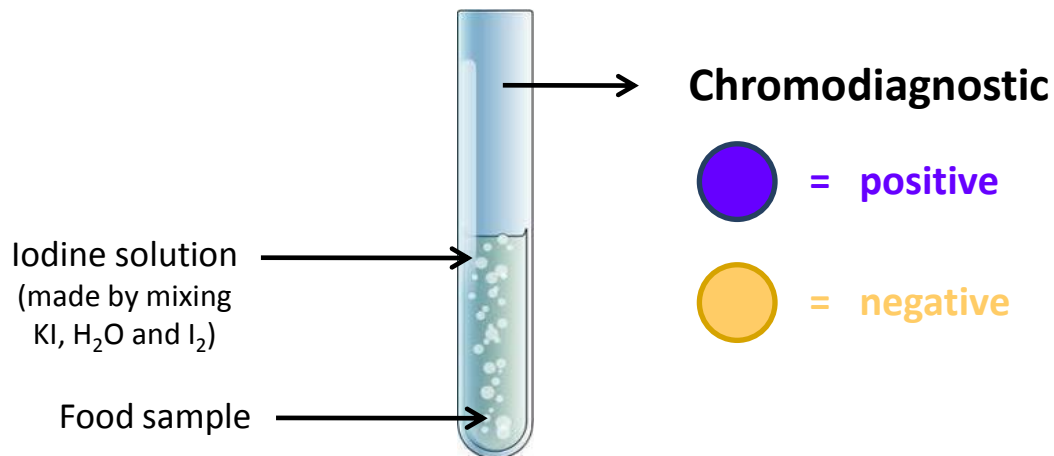
# What is the **starch iodine test**?

Based on knowledge acquired before, students learned the rationale of the starch iodine test:

A simple test which allow to **detect** samples containing **starch**.

The sample adopts a **dark blue-black** hue in the presence of starch, which **enwraps the iodine** (under the form of  $I_3^-$ ).

Contrarily, cellulose cannot surround the iodine and thus **cannot induce** a change in color.



Starch-polymer complexed with  $I_3^-$



# How to do your own starch iodine test?



## STEP #1

### Sample preparation

- Food samples were ground
- A spatula tip of each sample was added into a test tube



## STEP #2

### Addition of reagent

- Ten drops of a previously prepared aqueous  $KI_3$  solution was added to each sample
- Test tubes were shaken for 1 minute



## STEP #3

### Data analysis and discussion

- Experimenters analyzed the color of each sample
- Samples were ranked according to their starch content

# Green chemistry and cellulose

Students were taught “**what is green chemistry ?**”:

Green chemistry is the use of chemical products and processes which **reduce or eliminate** substances hazardous to the environment or human health.



**Recycling paper** is **green** because it reduces the amount of chemical substances needed to transform the wood fibers.

Students then discussed “**why paper can be recycled ?**”:

Paper is made of cellulose fibers.

These fibers can be separated mechanically, dissolved and glued back together by starch fibers.

All together, students learned the art of paper recycling...



# How to **recycle** your own **paper**?



## **STEP #1**

### Fibers separation

- Used papers and old flyers were teared in small pieces



## **STEP #2**

### Smoothing and gluing of fibers

- Fibers were put in a blender, immersed in warm water
- One teaspoon of starch was added
- This mixture was homogenized for 1 min.



## **STEP #3**

### Pulp packing and drying

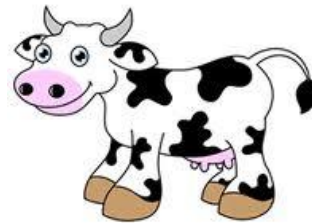
- Homogenized paper pulp was packed in a mold made of screen
- Pulp was dried for 2 days



# Who can **digest cellulose**?

Students learned about cellulose digestion by living organisms:

**Cows** and **termites can eat wood** (and thus cellulose) due to the symbiotic micro-organisms that live in their guts which allow these animals to cleave the cellulose into the sugar needed for energy.




On the other hand, **humans cannot digest cellulose** : it rather serves as 'fibers' to regulate digestive flow.



# Project Summary

In a 1 hour 20 minutes class 3<sup>rd</sup> grade students were taught:

- to recognize cellulose-containing products in their surroundings
- to compare the structure of cellulose and starch, testing for starch in different foods
- why humans cannot and cows and termites can digest wood
- to explore the green chemistry of paper recycling

Thanks to  , 3<sup>rd</sup> graders have been introduced early to chemistry through experiential learning comprised of an art project and a scientific experiment on cellulose.

# To learn more about cellulose



www.  .ca

## Special Thanks

- Active MLP members
- Volunteers and organizers of MLP events

- **Our sponsors**

