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Candidate session number 

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Candidate name \_\_\_\_\_

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School Name \_\_\_\_\_

Examination session (May or November) 

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 Year 

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Diploma Programme subject in which this extended essay is registered: BIOLOGY

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: "Are non biological washing powders more effective to the removal of stains than biological washing powders?"

**Candidate's declaration**

*If this declaration is not signed by the candidate the extended essay will not be assessed.*

I confirm that this work is my own work and is the final version. I have acknowledged each use of the words or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

Candidate's signature: \_\_\_\_\_

Date: 22.1.08

**“Are non biological washing powders more effective to the removal of stains than biological washing powders?”**

An Extended Essay in Biology by:

Student Identification Number:

Supervisor:

Words: 3,336

## Abstract

The difference between biological and non-biological laundry detergents is that, biological laundry detergents are genetically modified to insert enzymes which help fight stains at lower temperatures than non-biological detergents, for example the enzyme protease is added to help remove protein stains from clothes, however, non-biological detergents are better for the environment, because they are more biodegradable than biological detergents. The objective of this study is to find out if non-biological laundry detergents are more effective than biological ones; **“Are non biological washing powders more effective to the removal of stains than biological washing powders?”** Pieces of cotton cloth were smeared with different stains, then washed with the different detergents and the change in weight was recorded and compared.

The results were hard to interpret, but essentially the results supported the hypothesis that biological detergents are better at removing stains than non-biological laundry detergents. Two methods were used, and the method of washing the cotton cloths in room temperature yielded results which could not be explained. The results of the second method, in which the cotton cloths were washed in a higher temperature of water (60C), supported the hypothesis. The alternative method that I compared the other methods to; was making a small circle in agar jelly where the different detergents were dropped then iodine was dropped onto the agar jelly and the clear circles around them were measured using a ruler. This experiment also supported my hypothesis. I also found out that higher temperature washes need to be used in order to effectively remove stains, as the enzymes are denatured at higher temperatures.

## Contents Page

Introduction	Page 4
Hypothesis	Page 6
Method Development and Planning	Page 7
Method	Page 9
Results	Page 11
Analysis and Graphs	Page 13
Evaluation	Page 21
Conclusion	Page 24
Bibliography	Page 25

## Introduction

In recent years, pollution of the environment has become a rapidly growing issue. The developing pressure on the younger generations have made virtually all of the youth aware of the “Greenhouse Effect” now commonly referred to as, the more dramatic “Climate Crisis”. During a class, we began to discuss environmental issues, mostly the growing knowledge of the Climate Crisis, which raised a heightened conflict. Since then, I became interested in learning more about the effect that everyday tasks have on the environment. So, as I considered different ideas for an extended essay, it seemed natural to choose a topic I am interested in, so I began research for a suitable idea that would have a simple and efficient way to obtain results and would allow me to find more about environmental issues, however broad enough to make into a good essay question.

I started research, not knowing exactly what I was looking for and found information about detergents and the environment. While researching, I found out that studies have shown that the lacking biodegradability of biological washing detergents may be a contributing factor to breast cancer, which has increased almost 50% in the last 20 years, in addition to the pollution problem. Between the years 1940 and 1970 detergent had become a major problem; in the 1960’s ‘suds’ from the detergent formed in rivers, lakes, streams and even at the foot of Niagara Falls, it was even noted that discolored detergent foam rose eight feet high. Phosphates in waste water increased due to the additives in the detergents, which caused algal blooms (algae) to grow rapidly. The algal blooms consumed the majority of the oxygen in the waters, which caused aquatic plants and animal to die.<sup>1</sup> I also stumbled upon an article/which said companies which manufacture detergent, are not required by law to list all of the properties in the detergents. The thought of not knowing what exactly is in our own household items was extremely thought provoking.

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### Footnotes

1. [http://en.wikipedia.org/wiki/Laundry\\_detergent](http://en.wikipedia.org/wiki/Laundry_detergent)

At first I wanted to use the idea of the effect of detergent toxicity on the environment, but then realized the task of collecting results would be an enduring and tedious process. Nevertheless, I continued searching and subsequently found articles on the effects of biological detergents on the environment, not only are there detergents bad for the environment but they also can cause severe skin irritation, especially in the case of newborns. I decided that it would be interesting to see what difference the detergents have in the effective removal of stains. The difference between biological and non-biological detergents is that biological detergents are genetically enhanced, so that enzymes can be added to help remove protein based and other types of stains. Non-biological enzymes do not have these enzymes, and are better for the environment.

I choose to prepare and carry out an experiment in which I would use cotton as a base to spread different stains on. This method is an adequate way of testing and can be completed reasonably quickly; also the supplies are readily available. Therefore; this piece will be based on the research question; **“Are non biological washing powders more effective to the removal of stains than biological washing powders?”** This experiment will be completed and analyzed to try to formulate a solid conclusion based on the outcome, and consequently evaluated.

## **Hypothesis**

Biological laundry detergents are synthetically processed, so that enzymes can be added to remove stains, Non-biological Detergents do not have these additives. Protease enzymes break down protein into smaller, more soluble particles<sup>1</sup> (peptides and amino acids), protease is an enzyme that is added to biological laundry detergents. The reason that laundry detergents supposedly work better is because this enzyme is added. The majority of clothing stains are made up of protein, adding protease breaks down the protein during the wash without having to use a stringent high temperature wash.

Thus, I expect my results to show that the biological laundry detergent is more effective than the non-biological laundry detergent. Conversely, I think that during the high temperature wash the detergents will generate similar results when removing the stains.

## **Method Development and Planning**

Formulating a method for testing my hypothesis was tricky because there were various problems that arose as I considered the ways that I could control the variables. It was hard to formulate a way of measuring which washing detergents (biological or non-biological) remove stains more effectively. There is no certain way of measuring how much of a stain is left without visually looking at the stain; even then there is a large room for error because it would only be one person's perception, which is also not a fair test.

At first I thought of using an idea that my group during group 4 project used, in which we tested how much dye had been removed from different cloth samples. After careful consideration I decided to use this method which is described in full detail below, for my project because the method worked during our group four project, I assumed that the same would happen for my experiment. I also wanted quantitative data so that I could use different ways of comparing my results to get a greater picture of the accuracy of my results. I also wanted to be able to formulate graphs using my results, to use as another comparison.

Some of the other ideas I had to consider were the material I would use. I chose to use cotton because of its superior absorbancy<sup>1</sup>. I also had to choose between powder and liquid detergent. The reason I chose liquid is because it is pre-dissolved<sup>3</sup> whereas powder has to be dissolved and there is also the risk of the powder not getting fully dissolved which would make it an unfair test. Another problem I was faced with was the pressure of water. In a laundry machine the water pressure can be adjusted i.e. Higher pressure for heavier stains. There was no way of changing the pressure of water when I did my experiment but I do not expect that to have affected my results significantly. I also had to make the decision of what type of stain I would use. I chose to test ketchup and grape jelly, because they are both common stains and are readily available. Ketchup is also known to stain clothes and jelly is sticky so I figured that the jelly would stick onto the cotton and make it difficult to remove.

Once I had finished my preliminary work I was able to see the problems with my experiment and then I was able to correct them. Some problems that arose were that the



amount of cloth used was far too much so I decided to use a smaller amount (15cm x 15cm down to 12cm x 12cm). Also in my first experiment I did not measure out a specific amount of ketchup to be used. After doing the first experiment I decided I should measure out an estimate of  $4 \pm 0.001$ g. The reason I decided to do this is because the larger mass of ketchup on cotton squares could cause excess ketchup on the cotton squares that dried however, the cotton did not completely absorb all of the ketchup.

After I finished my first experiment I decided to look up the way that laundry detergent works, I then found out that the detergent needs to be used at high temperatures in order to effectively remove the stains. Since I had been using de-ionized water at room temperature with the detergent I had to ~~change~~ my method slightly; instead of de-ionized water at room temperature I decided to ~~boil~~ the water to  $60^{\circ}\text{C}$  before adding the detergent. The problem with using hot water is that heat is lost quickly, so I decided that I needed to use some form of insulation to ensure that it was a fair test. Styrofoam coffee cups seemed to be the best idea because they are readily available and Styrofoam is an excellent insulator.

After completing the experiments I decided to use an alternative method (taken from the book Practical Advanced Biology<sup>2</sup>) to fully ensure that my experiment was working.

## Method

### Materials and Apparatus

12 Medium Styrofoam coffee cups with lids	Scale (3dp)
Measuring cylinder (50ml)	De-ionized Water
Ketchup (Heinz)	Kettle
Grape Jelly (Welch's)	Thermometer (°C)
Oven (°C)	Ruler (30cm)
Stopwatch	Pencil
Washing detergent; Fairy (non-bio), Tide	Glass rod
Scissors	Small droppers

Twelve 12x12cm squares were marked on cotton sheets, using a pencil, and then cut out using scissors. After the squares were cut, they were weighed using a 3dp scale and recorded in an appropriate table. Around 5g of ketchup was measured onto each piece of cotton, and then spread evenly with a glass rod. Each piece was put into the oven, (arranged in diagram \_\_\_ to dry at 100°C, and then removed 60 minutes later. Each piece is then placed into a 150ml glass beaker with 7ml of washing detergent and 143ml of de-ionized water at room temperature for 30 minutes, each beaker of detergent, water and cotton square is stirred for 2 minutes each. This method was then repeated using ketchup however the water temperature was 60°C and insulated coffee cups with lids instead of the glass beakers. Then the method was repeated once more but with jam instead of ketchup.

The alternative method I decided to use was taken from the book Practical Advanced Biology<sup>2</sup>.

### **Materials and Apparatus**

Cork borer	Ruler
Starch–Iodine Agar Jelly	Dropper
Washing detergent; Fairy (non-bio), Tide	Iodine

A cork borer is used to cut 3 evenly dispersed wells in 6 starch–iodine Agar jelly Petri dishes. Next a dropper is used to place 3 drops of detergent in each of the wells. The dishes were left overnight in room temperature.

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#### Footnote

1. <http://en.wikipedia.org/wiki/Cotton>
2. Practical Advanced Biology by Tim King, Micheal Reiss with Micheal Roberts (Nelson Thornes)
3. <http://www.laundromatfinder.com/powder-vs-liquid.shtml>

## Results

### Experiment One: Ketchup on Cotton Squares

**Table One.** First set of results, water at room temperature of  $23 \pm 0.1^\circ\text{C}$ .

Square No.	Weight ( $\pm 0.001$ g) of Cotton Square		
	Before	After	Change (+ / -)
<i>Biological Washing Detergent: Tide</i>			
1	4.961	1.917	-3.044*
2	3.351	1.892	-1.459
3	3.419	1.929	-1.49
4	3.601	1.929	-1.672
5	3.468	1.905	-1.563
6	3.562	1.948	-1.614
<b>Average</b>	<b>3.727</b>	<b>1.920</b>	<b>-1.5596</b>

<i>Non-Biological Washing Detergent: Fairy</i>			
7	3.543	1.995	-1.548
8	3.461	2.094	-1.367
9	3.485	2.320	-1.165
10	3.715	2.209	-1.506
11	3.413	1.960	-1.453
12	3.334	2.015	-1.319
<b>Average</b>	<b>3.492</b>	<b>2.099</b>	<b>-1.393</b>

\*This result was anomalous so I chose to leave it out of my calculations.

**Table Two.** Second set of results, water at temperature of  $60 \pm 0.1^\circ\text{C}$

Square No.	Weight ( $\pm 0.001$ g) of Cotton Square		
	Before	After	Change (+ / -)
<i>Biological Washing Detergent: Tide</i>			
1	2.081	2.204	0.123
2	2.133	2.243	0.11
3	2.079	2.067	-0.012
4	2.052	2.048	-0.004
5	2.065	2.117	0.052
6	2.049	2.266	0.217
<b>Average</b>	<b>2.077</b>	<b>2.158</b>	<b>0.081</b>

<i>Non-Biological Washing Detergent: Fairy</i>			
7	2.183	2.245	0.062
8	2.069	2.2	0.131
9	2.144	2.217	0.073
10	2.196	2.25	0.054
11	2.133	2.196	0.063
12	2.223	2.303	0.08
<b>Average</b>	<b>2.158</b>	<b>2.235</b>	<b>0.077</b>

\*Note: The before results, are measured after the ketchup has dried in an oven of 100°C. The after results, are measured after the ketchup after submerged in detergent and dried in the oven of 100°C, thus displaying the weight of ketchup that has stayed on the 12x12±0.05mm piece of cotton.

### Experiment Two: Grape Jelly on Cotton Squares

**Table Three.** third set of results for second experiment, water at temperature of 60±0.1°C

Square No.	Weight (+0.001g) of Cotton Square				
	Before (Without Jam)	Dried Jam	After Wash	Change (+ / -)	
				Before → Dried Jam	Before → After Wash
<i>Biological Washing Detergent: Tide</i>					
1	2.123	5.919	2.014	3.905	-0.109
2	2.117	5.687	1.998	3.689	-0.119
3	2.121	5.469	2.001	3.468	-0.120
4	2.119	4.362	1.998	3.364	-0.121
5	2.130	5.651	2.013	3.638	-0.117
6	2.139	5.864	2.033	3.831	-0.106
<b>Average</b>	2.125	5.492	2.100	3.649	-0.115
<i>Non-Biological Washing Detergent: Fairy</i>					
7	2.091	5.682	2.024	3.658	-0.067
8	2.075	5.467	2.014	3.453	-0.061
9	2.079	5.138	2.014	3.124	-0.065
10	2.081	4.784	2.002	2.782	-0.079
11	2.100	4.604	2.028	2.576	-0.072
12	2.101	4.757	2.042	2.715	-0.059
<b>Average</b>	2.088	5.072	2.021	3.051	-0.067

### Experiment 3

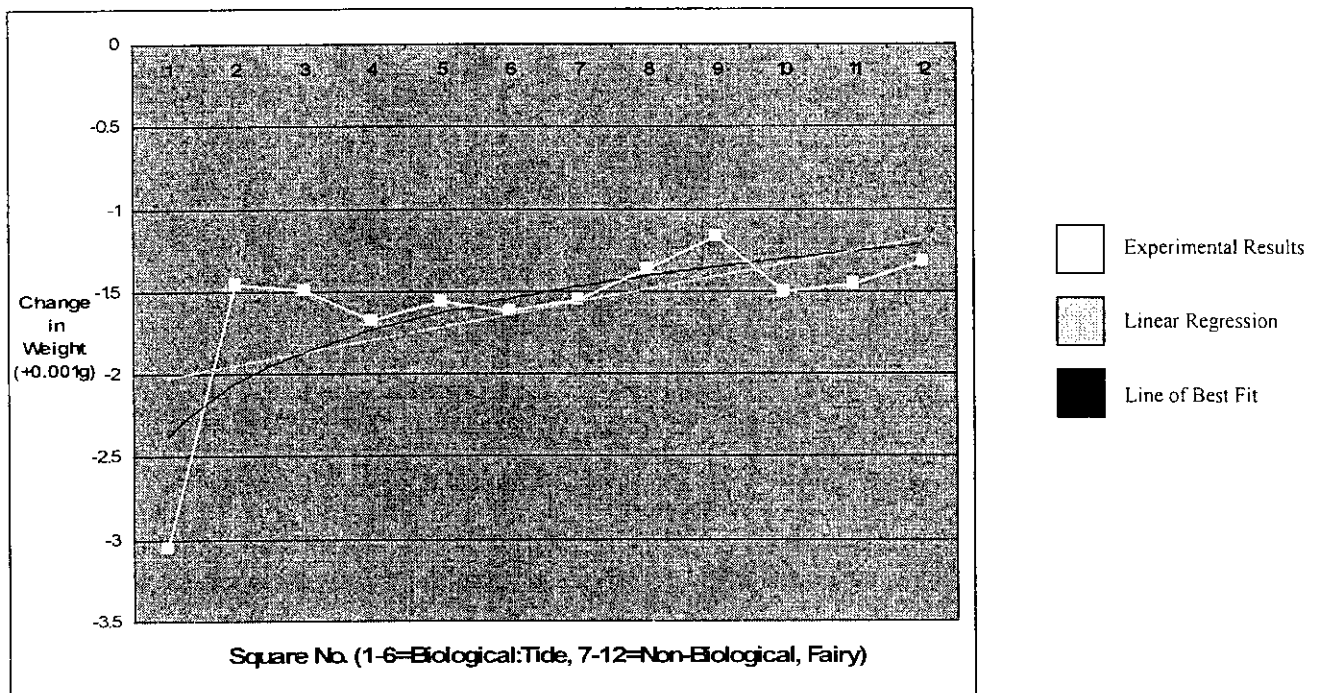
**Table Four.** Agar Jelly, used in the comparing break down of starch abilities between non biological and biological washing powders at room temperature of 17±0.1°C

Circle No.	Circle Diameter
<i>Non-Biological Detergent: Fairy</i>	
1	7
2	8
3	6.5
<b>Average</b>	<b>7.167</b>
<i>Biological Detergent: Tide</i>	
4	13
5	10
6	15
<b>Average</b>	<b>12.667</b>

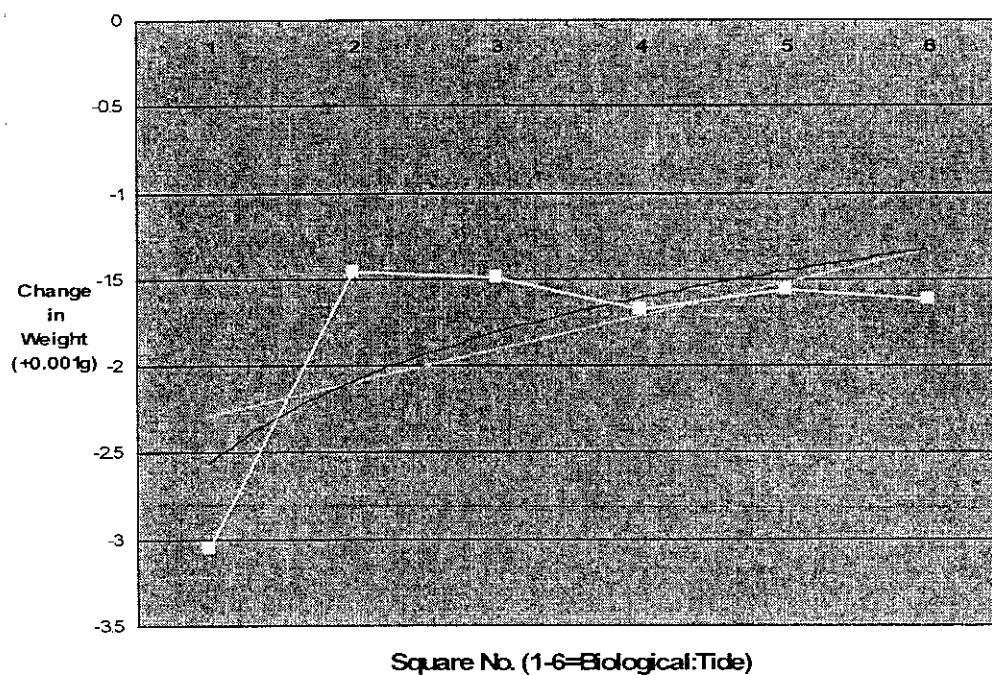
## Graphs

Experiment One: Ketchup on Cotton Squares Washed in Biological and Non-Biological Washing Detergent

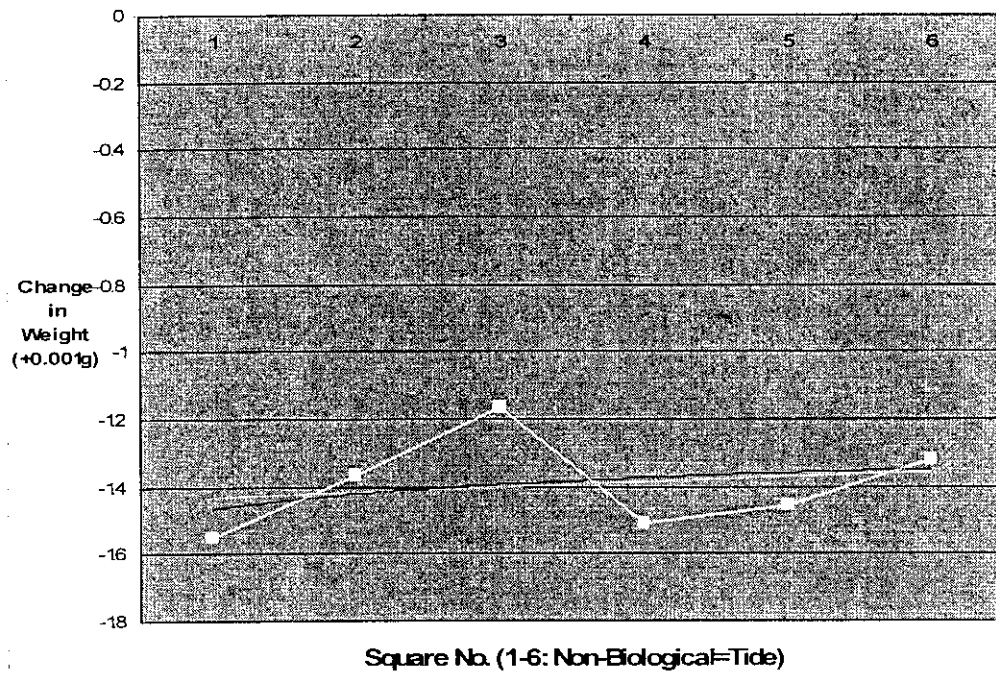
### Graph One



### Graph Two



Graph Three



Graph Four

