# Finding a Better Milk

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# FINDING A BETTER MILK — SCIENTIFIC PROCESSES IN A REAL-WORLD CONTEXT

The TRiPP project that I undertook involved 3 days working at the CSIRO lab at QLD Biosciences Precinct St Lucia with Dr Simone Osborne. The project centred around food futures and the search for a better natural milk to use for infant/baby formula. The project involved simulation on gastric and intestinal digestion and then testing the digesta for the degree of digestion, toxicity on intestinal cell lines and inflammation response. Within this project I was able to work with advanced equipment in a specialist lab environment, conducting relevant and cutting-edge research. Equipment like PC2 fume hoods, culture incubators and robotic autosamplers which normally aren't available in schools was able to be used and explored. I also had the opportunity to work with another teacher who was on the project, which was a great addition to my experience, working collaboratively.

The project was very valuable and refreshed, for me, the idea of linking science to real-world contexts to make it more relevant and exciting. The procedures we undertook, and the labs within which we undertook them are much higher level than what can be achieved in a high school context, however. In order to bring the TRiPP experience back to the classroom I took inspiration in the use of the scientific method to solve real-world problems, as well as adapting the experiment to a more classroom-friendly method.

## Nature of the problem

In keeping with the original research aims of the TRiPP project, the problem given to students will be based around researching milk alternatives. Their aim will be to experiment on Cow, Goat and Soy milk to establish which is the most easily digested. The intention is to take a small part of the research into milk in the future that could be realistically achieved in a year 8 science lab.

Students will extend on their knowledge of the digestive system and chemical changes in this project. As well as this they will be exposed to new content around enzymes, protein structures and chemical indicators. Students will also develop their science inquiry skills as they learn to apply the scientific method to the context of food biochemistry. They will be exposed to equipment and techniques that they haven't used before such as; pipettes, water baths, indicators and volumetric flasks, as well as accurately producing diluted samples and the use of controls. Given the level of the students though, the task was scaffolded so that all students conducted the same experiment, though it was open-ended in terms of the end results.

## Suitable year levels and subject area

This investigation has been designed to be used with year 8 students, though could easily be used with years 9 and 10 as well. It only addresses the science discipline of STEAM directly, however students can incorporate technology aspects in their reflection. It will pull directly from existing science content knowledge as well as address students' use of the scientific process.

It is being considered that this experiment is adapted to suit a year 12 chemistry unit on food and biochemistry. In that case it will be more open-ended and require students to design most parts of the experiment and to more thoroughly explain the results and their potential implications.

| Curriculum Links |
|---|
| **Biological Sciences** |
| Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce (ACSSU150) |
| **Chemical Sciences** |
| Chemical change involves substances reacting to form new substances (ACSSU225) |
| **Science Inquiry Skills** |
| • Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS140)<br>• Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS141)<br>• Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS145)<br>• Communicate ideas, findings and evidence-based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148) |

## Learning objectives

Through this project students will complete the following leaning objectives:

- Students will learn to use Biuret indicator to analyse protein content
- Students will learn how to dilute samples for analysis

- Students will learn how enzymes work in protein digestion
- Students will learn how to take accurate measurements using pipettes

## Students learning outcomes

By the end of this project it is expected that students will:

- Understand that different milks are digested differently
- Understand how to conduct an experiment based on real-world contexts
- Be able to evaluate experiments to identify its validity and accuracy
- Understand how studying food could support the health of future populations

## Format and Assessment

The format of this unit will be as a week-long classroom investigation. Students will have to complete a scaffolded experimental report template as they plan, conduct and analyse the investigation. The experiment will be conducted in groups, with the report being independent. The report is a formative assessment and will be assessed via a criteria sheet at the back of the template. Students will be required to self-assess and then participate in class discussions about the experiment and their efforts.

## ICT

No ICT opportunities are foreseen with this project.

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# Investigation — Finding a better milk

| Curriculum Links |
| --- |
| **Biological Sciences** |
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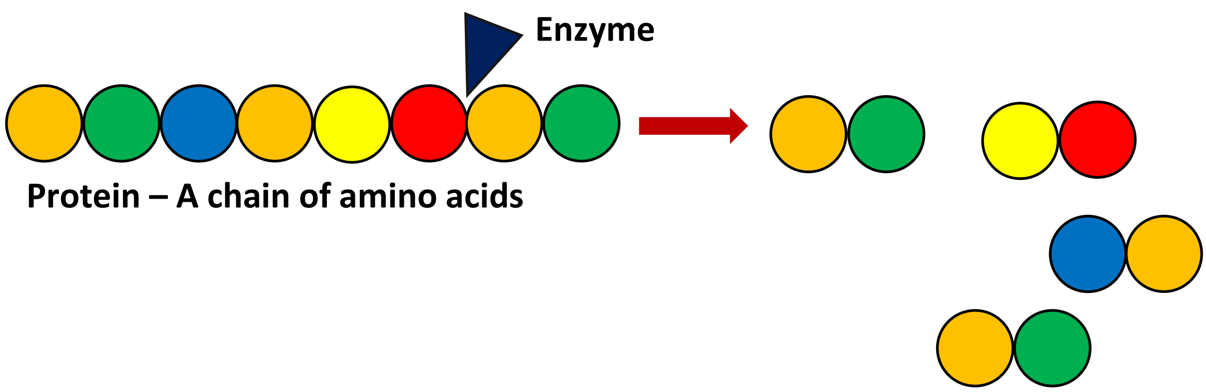
## *Context and Background:*

Milk and dairy products have been used for human nutrition long before agriculture was developed. Milk is defined as "an opaque white fluid rich in fat and protein, secreted by female mammals for the nourishment of their young". It is used by all mammals, though humans were the first to use the milk of another animal to feed their young. Baby formula is used by mothers who cannot, or choose not to, feed their young with their own milk. Dairy based baby formula is currently made almost exclusively from cow's milk.

Alongside these social issues of the use cow's milk, some biological concerns have been raised regarding the consumption of cow's milk. In particular, some evidence suggests that cow's milk is not easily digested and in fact causes inflammation, an irritation to the intestines, as it is digested. This can be a particularly important issue when looking at the developing guts of babies.

Milks are composed of three main biological components: Sugars, fats (lipids) and proteins. These are digested as they move through the digestive system by enzymes (biological catalysts).

Proteins are made up of long chains of amino acids connected together by peptide bonds. When they are digested, they are broken down into chunks that are only two amino acids long and eventually single amino acids. Different proteins will be broken down differently however. How easily they are broken down plays a big role in how much nutrition can be obtained from them and also whether they irritate the intestines.



**Aim:** To determine which milk is most easily digested. Cow's milk, Goat's milk and Soy milk will be provided for testing. Given that this will be undertaken in a junior science laboratory this investigation will be used to make some preliminary conclusions and determine if further study is needed.

**What is the independent variable for this experiment? ___________________________________**

## Risk Management

| Hazard | Risk | Management |
|---|---|---|
| Biuret indicator and Protease enzyme | Irritation and poisoning from spills or ingestion | |
| Broken glass | Cuts and abrasions from broken glass | |
| Chemical wastes | Environmental contamination risks | |

### Method background:

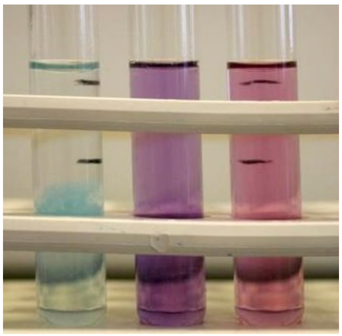


*Figure 1. Example of Biuret test colour range (Source: [http://brilliantbiologystudent.weebly.com/biuret-test-for-protein.html](http://brilliantbiologystudent.weebly.com/biuret-test-for-protein.html))*

The Biuret test is a simple test that is used to detect proteins. It uses a blue solution of copper sulfate and sodium hydroxide which turns purple when a chain of three or more amino acids is present. The copper sulfate reacts with the peptide bonds between the amino acids and turns purple. The more proteins that are present, the darker the darker the shade of purple. Pink indicates a medium amount of proteins. If no proteins are present, the solution with be blue. Therefore, the colour can be used to estimate the concentration of proteins

This experiment will use protease enzyme, an enzyme that breaks down proteins, and a water bath set to 37°C to simulate the body's digestive conditions. The samples will 'digest' for 30 min in the water bath before being tested.

**What is the dependent variable for this experiment? ___________________________________**

**Describe how the dependent variable is going to be measured.**

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___________________________________________________________________________

___________________________________________________________________________

**Equipment and materials:**

- Samples of Cow's, Goat's and Soy milk
- 3x 100ml volumetric flask
- 3x 10ml pipette
- Distilled water
- Biuret indicator
- Protease enzyme
- Water bath
- 6x medium test tubes
- Test tube rack
- Permanent marker
- 1x Disposable 1ml pipettes

**Sample Preparation:**

For this investigation you will be using a 5% solution of each milk.

1. Label three 100ml volumetric flasks. One each with Cow's, Goat's and Soy
2. Use the pipettes to take a 5ml sample Cow's milk and place it into the labelled volumetric flask. Fill the flask up to the line with distilled water and place the stopper on top.
3. Gently invert the flask three times to mix.
4. Repeat steps 2 and 3 for Goat's and Soy milk.

**Protein determination method:**

1. Label one medium test tube "Undigested Cow's" and another "Digested Cow's".
2. Using the pipette place 10ml of the prepared Cow's milk solution into each test tube.
3. Repeat steps 1 and 2 for the remaining milks.
4. Place 1ml of protease enzyme into the "digested" test tubes using the disposable pipette.
5. Place the three 'digested" test tubes into the water bath and leave for 15 minutes.
6. After 15 minutes, remove the test tubes from the water bath. Add one squirt of Biuret indicator to each of the "undigested" and "digested" test tubes. Gently shake to mix and record observations of colour after 1 minute.

## Results:

| | Observed Colour | |
|---|---|---|
| **Milk type** | **Undigested** | **Digested** |
| Cow | | |
| Goat | | |
| Soy | | |

## Observations:

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**Analysis of results – Using your results and observations explain which milk, if any, is most easily digested.**

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**Discussion:**

1. **Are these results qualitative or quantitative? How would this affect the reliability of the results?**

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2. **Do the result you obtained match with other groups? Why/Why not?**

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3. **Was your experiment a fair test? Explain your response.**

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4. **What could be done to increase the reliability of this experiment? Suggest two changes that could make the experiment more reliable/fair.**

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## Conclusion:

**Which milk would be best to use in baby formula in the future? Is it possible to make a responsible decision from these results? Was the aim successfully fulfilled? How could this investigation be extended using these results? (Answer in full sentences and paragraphs)**

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## Self-assessment: Mark yourself honestly based on how you feel you did.

| ASSESSABLE ELEMENTS | A | B | C | D | E | Overall |
|---|---|---|---|---|---|---|
| | The student work demonstrates evidence of: | | | | | |
| Planning & conducting | • Planning of investigations that:<br>− identify and describe how variables are changed, measured and controlled<br>• Accurate collection of reliable data | • Planning of investigations that:<br>− identify and describe how variables are changed, measured and controlled<br>• Accurate collection of data | • Planning of investigations that:<br>− identify variables to be changed, measured and controlled | • Partial planning of investigations that:<br>− identify variables to be changed, measured and controlled | • Use of provided investigations methods | |
| Processing & analysing data & information & evaluating | • Use of these patterns and trends when explaining relationships to justify conclusions | • Use of these patterns and trends when describing relationships when justifying conclusions | • Use of these patterns and trends when justifying conclusions | • Drawing of conclusions | • Statements about data | |
| Evaluating | • Evaluation of the quality of data to justify the explanation of how effective modifications to methods could improve the quality of their data | • Explanation of how effective modifications to methods could improve the quality of their data | • Explanation of how modifications to methods could improve the quality of their data | • Description of modifications to methods | Statements about modifications | |
| Communicating | Concise and coherent use of appropriate language and accurate representations to communicate science ideas, methods and findings in a range of text types | Coherent use of appropriate language and accurate representations to communicate science ideas, methods and findings in a range of text types | Use of appropriate language and representations to communicate science ideas, methods and findings in a range of text types | Use of everyday language and representations to communicate science ideas, methods and findings | Fragmented use of language and representations to communicate science ideas, methods and findings | |