



Prize Winner

Science Investigation

Year 5 - 6

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Pulteney Grammar School



Wrinkly fingers, is it all just a case of nerves?

Question:

Do my fingers wrinkle faster in moving water?

Prediction:

I predict that liquid movement will speed up the rate of wrinkling.

What we know about Finger Wrinkling

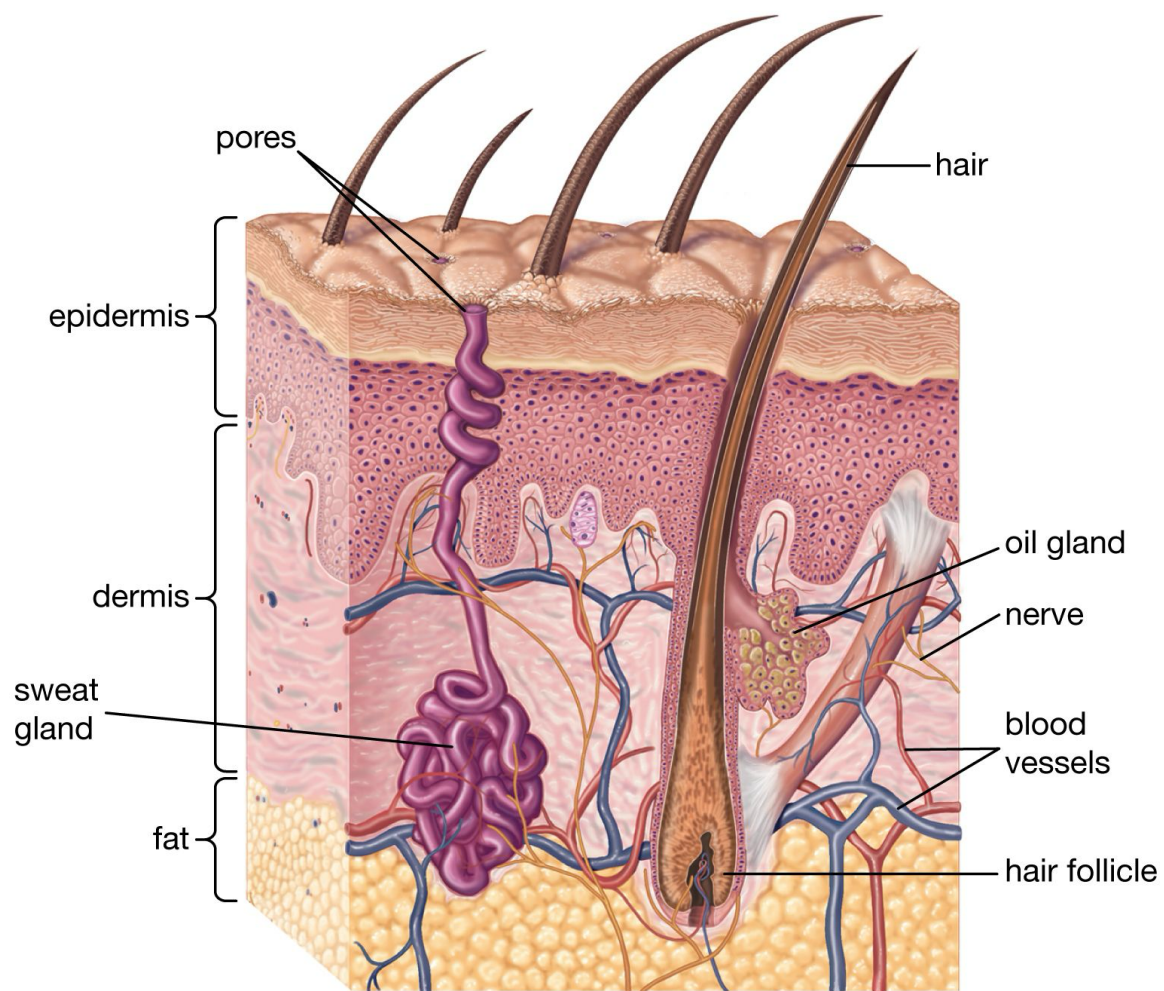
I always have wrinkly fingers after bathing (soaking) or swimming (actively moving) for long periods of time. Like many people I thought that my skin just absorbed the water through a process known as osmosis and then swelled up forming wrinkles. The process of osmosis describes the movement of water from an area with low concentration of salts to an area with a higher concentration of salts. Soaking the skin in water means that water would pass into my skin cells because they contain more salts than the soaking water. This fits in with the observation that skin does not wrinkle as much in sea water as compared to fresh water because of the reverse salt gradient. If the outer layer of skin, despite its thickened waterproof keratin layer absorbed the water necessary to cause wrinkling it would be uniformly plump rather than wrinkled.

When I read an article in Oyla kids science magazine in April 2025 I was intrigued. I researched the topic and found out that there are lots of ideas about how and why this skin wrinkling occurs.

In 1935 scientists found out that people who have damage to the medial nerve in the arm or hand do not show skin wrinkling when soaking their hands in water. This means that functioning nerves are important.

Wrinkling only occurs on hands and feet where there is a high number of eccrine sweat glands. The most recent scientific theory to explain the process of wrinkling is that the liquid enters the sweat gland or pore in the outer layers of the skin, triggering the nerves beneath the sweat gland to send a message to nearby blood vessels to constrict and reduce blood flow to the area. This reduces the size of blood vessel structures called glomus bodies in the fingertips.

The negative pressure created by these globus bodies getting smaller pulls down the skin layers above, the dermis and the epidermis, forming a specific deep ridged pattern depending on where these layers are anchored to each other. The wrinkling will repeat in the same pattern each time due to these attachment points. Scientists have found that different liquids and temperatures have different effects on the speed of wrinkling. See Table 1.



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Figure 1. Diagram of the Skin Layers

Liquid	Wrinkling Present	Effect on Speed of wrinkling
De-ionised water	Yes	Faster
Sodium Chloride 0.9%	Yes	Faster
Sodium Chloride 5%	No	
Sodium Chloride 10%	No	
Sodium Chloride 20%	No	slower
Vinegar	Yes	Very fast
Emla anaesthetic cream	Yes	Very fast
Oil	No	
Temperature	Wrinkling Present	Effect on Speed of wrinkling
Cold iced water	No	
18 deg C	Yes	slow
27 deg C	Yes	faster
37 deg C	Yes	faster
40 deg C	Yes	same

Table 1. Effect of different liquids on the speed of wrinkling

Planning:

I plan to test the speed of the wrinkling response of my fingers by soaking them in a range of stationery liquids and then repeating the experiment in the same liquids when the liquid is constantly moving across my skin.

The solutions I will test are included Table 2. and the choice is based on

- solutions that are safe to soak my hand
- solutions that have been reported to have differing effects on skin wrinkling due to salt gradient (or osmotic pressure) including Table 1.

I will place the soaking solution on a magnetic stirrer to create the continuous movement of the liquid over my fingers.

To make sure that I am measuring my finger wrinkles the same way each time I will use finger wrinkling grade system developed by Teoh et al in Figure 2.

I will test my most wrinkle prone finger, the fourth finger on my left hand.

I will end the test early if the solution becomes too irritating or when the wrinkling reaches the maximum score of Grade 4 (endpoint of wrinkling)

After each test I will wash my hands thoroughly and dry and wait 45 minutes before starting the next test and make sure the test finger has returned to Grade 0, with no wrinkles.

Liquid	Test Temperature deg C
De-ionised water	18, 27
Tap Water	18,27
Sodium Chloride solution 0.9%	18, 27
Sodium Chloride solution 10%	18, 27
Vinegar (4% Acetic Acid)	18
Magnesium Sulphate 5%	18,27
Sodium Bicarbonate 5%	18, 27
Dishwashing liquid in water	18, 27
Canola Oil (undiluted)	18, 27

Table 2. The test liquids and temperatures

Fair Test

A fair test to see if liquid moving across my skin makes it wrinkle faster is to compare the time for wrinkles to form in liquids that are still and moving. The independent variable is the absence or presence of continuous liquid movement across my fingers during the soaking time. The dependent variable will be the time it takes my finger to wrinkle after soaking in the liquid. The constants are the type of soaking liquid, the temperature of the solution, the time interval for each measure, measuring the same finger in each test, and using a scale to grade the wrinkling on the finger.

(See Figure 2).

Wrinkling Grades (Teoh et al. 2008)

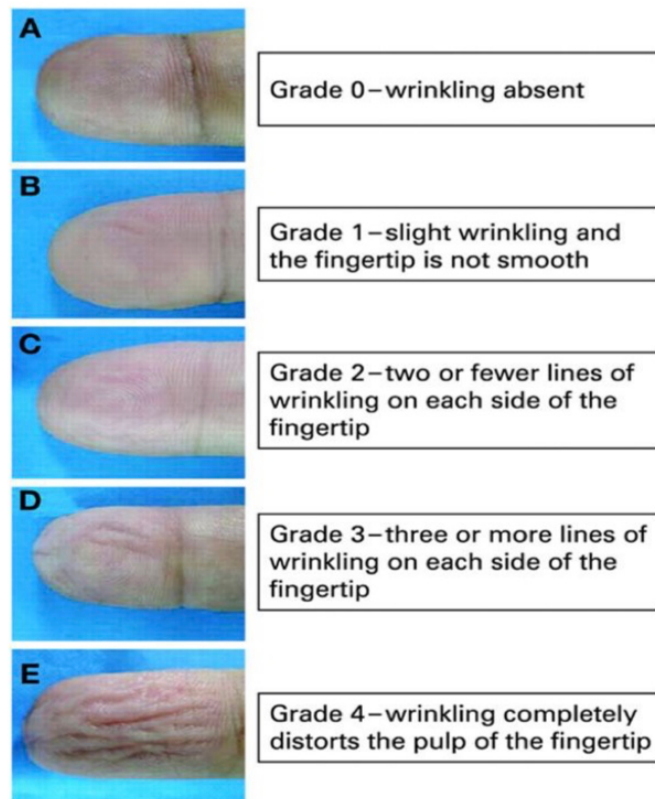


Figure 2. Wrinkling Grades for Water Induced Skin Wrinkling (WISW) (Teoh et al 2008)

Equipment

Ingredients for liquids	Brand
Sodium Chloride	Pickling Salt no fillers
Glucose	Glucose Powder
Magnesium Sulphate	Epsom Salts
Sodium Bicarbonate	Baking Soda
Liquid Detergent	Palmolive
Canola Oil	
De-ionised Water	
Tap Water	
Other Equipment	
Electronic kitchen scales	
Empty, sealable pantry storage containers	
Adhesive labels and pen	
Measuring spoon	
Clear plastic measuring jug	
Digital Food Thermometer with temperature probe	
Circular glass container (capacity 2 litre) (clear glass teapot)	
Magnetic Stirrer base and pellet	
hand towel	
iPhone (camera and timer)	
Laminated measuring guide for finger wrinkles	
Recording table	
Microwave	

Liquid	strength	Measure
De-ionised water	undiluted	
Tap Water	undiluted	
Sodium chloride 0.9%	0.9g/100ml	9g NaCl 991ml water
Sodium chloride 10%	10g/100ml	100g NaCl 900ml water
Vinegar (4% Acetic Acid)	undiluted	No preparation needed
Magnesium Sulphate 5% solution	5g/100ml	50g mag. sulphate 950ml water
Sodium Bicarbonate 5% solution	5g/100ml	50g sod. bicarb. 950ml water
Dishwashing liquid in water	5ml in 1 litre water	
Canola Oil	Undiluted	No preparation needed

Table 3. Test Solutions, concentration and preparation

	Method
1.	Prepare test solutions (weigh ingredients, add to water, dissolve) see Table 3.
2.	Store prepared solutions in sealed, labelled containers
3.	Add 1 litre of prepared solution to the round glass container
4	Measure the temperature of solution and adjust if required, maintain within range of 2deg C of test temperature
5.	First, test the still solution followed by stirred solution
6.	Score wrinkle at start (must be Grade 0 at 0 minutes) Immerse entire left hand in solution and remove at timed intervals of 5, 10, 15, 20 minutes. At each interval, dry fingers, score wrinkles and record * Cease test at any stage when the wrinkling reaches the maximum grade of 4
7.	At the end of test, wait for finger to return to normal (i.e. no wrinkles), estimated recovery time of 45 minutes between each test
8.	Repeat the same test using the magnetic stirrer to get continual liquid movement – place glass container on the stirrer base, add the magnetic pellet and commence stirring and measure at same intervals
9.	Repeat the experiment for each test solution

Table 4 Method

Results

X indicates test was ceased due to Grade 4 (maximum wrinkling reached)

Temp Deg C	De-ionised Water	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		still	0	1	1	2	3	3	
18		moving	0	2	4	x	x	x	
27		still	0	2	3	4	x	x	
27		moving	0	3	3	4	x	x	

Temp Deg C	Sodium chloride 0.9%	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		still	0	0	2	4	x	X	
18		moving	0	0	2	3	4	x	
27		still	0	1	2	3	4	x	
27		moving	0	2	2	3	4	x	

Temp Deg C	Sodium chloride 10%	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		still	0	1	1	1	1	2	
18		moving	0	1	1	1	1	2	
27		still	0	1	1	1	1	2	
27		moving	0	1	1	1	2	2	

Temp Deg C	Magnesium sulphate 5%	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		still	0	3	3	4	x	x	
18		moving	0	2	4	x	x	x	
27		still	0	3	4	x	x	x	
27		moving	0	3	4	x	x	x	

Temp Deg C	Sodium Bicarbonate 5%	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		still	0	1	1	2	3	3	
18		moving	0	2	3	4	x	x	
27		still	0	2	3	4	x	x	
27		moving	0	1	2	3	3	3	

Temp Deg C	Vinegar	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		Still	0	4	x	x	x	x	
18		moving	0	4	x	x	x	x	
27		Still	0	4	x	x	x	x	
27		moving	0	4	x	x	x	x	

Temp Deg C	Detergent	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		still	0	1	3	4	x	x	
18		moving	0	3	4	x	x	x	
27		still	0	2	3	4	x	x	
27		moving	0	3	3	4	x	x	

Temp Deg C	Canola Oil	Still or moving	Time (min)						
			0	5	10	15	20	30	
18		still	0	0	0	0	0	0	
18		moving	0	0	0	0	0	0	
27		still	0	0	0	0	0	0	
27		moving	0	0	0	0	0	0	

What my results showed

My results were similar to Table 1. De-ionised water and sodium chloride 0.9% caused significant wrinkling over 30 minutes whereas Sodium chloride 10% showed very little change. For vinegar wrinkling reached grade 4 almost immediately.

For most solutions there was faster wrinkling time when the temperature was increased from 18deg C to 27deg C. This also followed expectations from Table 1. The exceptions to this were oil where no wrinkling occurred in any liquid at any temperature, vinegar when maximum wrinkle grade of 4 occurred within 5 minutes in all samples and sodium chloride 10% where there was only a small change in the finger i.e. Grade 1 in all samples. Sodium bicarbonate 5% showed a mixed pattern of change.

To test our prediction, we need to look at our results with the liquid moving.

We observed only a small increase in wrinkling speed in most of the sample solutions mixing in the stirrer. These changes were smaller than I expected and only increased the speed by increasing one grade over a 5-minute interval, less than the changes that were caused by increasing temperature.

Evaluation

I think that my prediction is not supported based on these results and my fingers wrinkle faster when swimming is that I simply spend more time in the water.

Magnesium sulphate and sodium bicarbonate are often added to bathing solutions, and the detergent most likely cause softening of the skin layers (giving a soapy feel) and this may also increase absorption and swelling of skin layers along with nervous activation of vasoconstriction.

What I found surprising

After the wrinkling I found my skin returned to its normal state much quicker than I expected.

What are the problems in my experiment

Observations under natural light were much better than artificial light. The experiments need to be done during daylight hours.

The magnetic stirrer only moved the liquid in one direction like a mini whirlpool producing a smooth flowing movement across my skin surface and not replicating irregular movements like splashing in a swimming situation.

What I could do next time, further studies

I should try to simulate a more natural situation of how the liquid is moving and measure the time to reach each grade of wrinkling without using predetermined time intervals.

Summary

By learning about how our fingers wrinkle we can predict changes when we experience health problems, disease or even just the aging process and help provide a useful and inexpensive health screening tool.

Word Count 1096

Reference list

Antonin Gechev (2019) 'Fluid Containing Structures in the tips of the fingers and toes delineated by Ultrasound Imaging before and after Induced Skin Wrinkling', *Scientific Reports*, 9(1). Available at: <https://doi.org/10.1038/s41598-018-38476-5>.

Baisas, L. (2025) *Your fingers wrinkle the same way every time they're in water*, *Popular Science*. Available at: <https://www.popsoci.com/science/fingers-wrinkle-same-pattern/>.

Baker, L.B. (2019) 'Physiology of Sweat Gland function: the Roles of Sweating and Sweat Composition in Human Health', *Temperature*, 6(3), pp. 211–259. Available at: <https://doi.org/10.1080/23328940.2019.1632145>.

dunking my fingers in a bunch of liquids to maximize wrinkliness (no date) *www.youtube.com*. Available at: <https://www.youtube.com/shorts/ua9kgF9gJd8> (Accessed: 25 June 2026).

Episode 87 – Aquagenic Wrinkling (2024) *The Curious Clinicians*. Available at: <https://curiousclinicians.com/2024/04/17/episode-87-aquagenic-wrinkling/>.

Khetrupal, A. (2017) *Why does skin go wrinkly in water?*, *News-Medical.net*. Available at: <https://www.news-medical.net/health/Why-Does-Skin-Go-Wrinkly-in-Water.aspx>.

Saliccioli, L. *et al.* (2019) 'Skin wrinkling (SW) is a normal response to water immersion (WI) that is impaired after peripheral nerve injury. Available at: <https://irispublishers.com/ann/fulltext/water-immersion-induced-skin-wrinkling-more-accurately-reflects-neurovascular-coupling.ID.000628.php> (Accessed: 25 June 2026).

Swims, O. (2022) *Why Does The Skin On Your Hands And Feet Go Wrinkly After Swimming?*, *oceanswims.com*. Available at: <https://oceanswims.com/health-and-fitness/why-your-fingers-go-wrinkly-after-a-swim/>.

Tsai, N. and Kirkham, S. (2005) 'Fingertip skin wrinkling - the effect of varying tonicity', *Journal of Hand Surgery (Edinburgh, Scotland)*, 30(3), pp. 273–275. Available at: <https://doi.org/10.1016/j.jhsb.2004.12.010>.

Wrinkly skin theory doesn't hold water (2013) *Abc.net.au*. ABC Science. Available at: <https://www.abc.net.au/science/archive/articles/2013/01/22/3673601.htm> (Accessed: 25 June 2026).



Grade 1 wrinkling from sodium chloride 10%



Grade 2 wrinkling from sodium bicarbonate



Grade 3 Wrinkling from detergent



Grade 4 Wrinkling from vinegar

Log Book Daniel Maddern May 2025 – June 2026

May 2025	Reading the Oyla Magazine article gave me a new idea for my next Oliphant science inquiry in 2026, finger wrinkling caused by soaking in liquid
Feb 2026	I started my research on finger wrinkling by looking at popular science articles online on the topic, most of the sites used the same explanation for finger wrinkling and I knew I would need to go much deeper for my reading to be able to find some interesting question to answer. Prune fingers has a scientific name Water Induced Skin Wrinkling (or WISW)
March 2026	I found an article on sympathetic nerves and opposite hand temperature change after immersing one hand in cold water – maybe this applies to wrinkling. Plan to develop and test this idea
April 25/4/26	The first experiment on contralateral wrinkling failed after left hand showed no wrinkling after immersing right hand in liquid I decided that the temperature change hypothesis does not match with developing a soak wrinkling hypothesis as temperature regulators in cold water cause central sympathetic changes whereas the wrinkling vasoconstriction is probably a local sympathetic response to the finger. When I found a youtube with someone dipping each finger of their hand in a different solution at the same time, and getting a different wrinkling response in it finger it changed the approach I would take. Plan research to see what other things I could try
May 2026	I found an article suggesting that hands immersed in moving water might wrinkle because of sweat outflow rather than water inflow to the gland. I realised that my regular lap swimming causing severe finger and palm wrinkling could be related to water movement rather than just chlorinated water.
May 2026	I did a trial experiment soaking my left hand to work out which of my fingers wrinkle the most so I could use this finger for the wrinkle grade in 40deg C water, but it was very uncomfortable
May 2026	Mum purchased a magnetic stirrer online (it was not expensive and Mum said it could be used to dissolve lots of things at home like salts and for my brothers experiment). It
May 2026	Purchased from Gaganis pickling salt, canola oil and vinegar
June 7, 2026	Commenced first tests with distilled water and sodium choride 0.9% Very difficult to do under artificial light, shadows and variation. Plan to complete all tests in daylight hours First lot of test results

R^0

T	distilled water	0	5	10	15	20	30	
18	distilled water	0	1	1	2	3	3	still
27		0	2	3	4	4	4	still
22	movement	0	2	4	4	4	4	movement with finger
27		0	3	3	4	X	X	movement
T	0.9% sod. Cl.	0	5	10	15	20	30	
18		0	0	2	4	4	4	still
27		0	1	2	3	4	4	still
27	movement	0	0	2	2/3	4	4	movement
27		0	2	2	3	4	4	movement
	distilled water	0	5	10	15	20	30	

18
27
40

~~03~~

June 13 2026

Dad took some photos of my hand (and my brothers) after 1 hour of swimming. His fingers wrinkle more than mine, but they are skinny and it would take a lot of persuasion to get him to be my test subject with the long hours of testing, and I have already started measurements on my hand.



June 14 2026

Completed reminder of tests

decided that could not complete 40deg C tests as planned originally
see raw data

Sodium acetate 10% still

Temp °C	0	5	10	15	20	30	
18	0	1	1	1	1	2	Still
27	0	1	1	1	1	2	Still
40	0	1	1	1	1	2	Still
18	0	1	1	1	1	2	Stirrer
27	0	1	1	1	2	2	stirrer
40							stirrer

Comments - hand very itchy

Vinegar (4% acetic acid)

Temp	0	5	10	15	20	30	
18	0	4	4	X	X	X	Still
18	0	4	4	X	X	X	stirrer

~~glucose~~ Comments - hand itchy

T Vinegar
13 0 5 10 15 20 30

2% Sodium acetate

	0	5	10	15	20	30	T
11/12	0	1	1	1	1	2	81
11/12	X	4	4	5	5	0	75
stirrer	X	4	4	5	5	0	81
stirrer	5	5	5	5	1	0	75

2% Sodium acetate

	0	5	10	15	20	30	T
11/12	X	4	4	5	5	0	81
11/12	X	X	4	4	5	0	75
stirrer	X	X	4	4	5	0	81
stirrer	X	X	X	4	5	0	75

2% Sodium acetate

	0	5	10	15	20	30	T
11/12	X	X	4	4	5	0	81
11/12	X	X	4	4	5	0	75
stirrer	X	X	4	4	5	0	81
stirrer	X	X	X	4	5	0	75

2% Sodium acetate

	0	5	10	15	20	30	T
11/12	0	0	0	0	0	0	81
11/12	0	0	0	0	0	0	75
stirrer	0	0	0	0	0	0	81
stirrer	0	0	0	0	0	0	75

June 20 2026	Completed write up, scan documents to file
June 27 2026	Deleted sections of report to meet word count, upload project

OSA RISK ASSESSMENT FORM

for all entries in ☒ Models & Inventions and ☒ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: Daniel Maddern ID: _____

SCHOOL: Pulteney Grammar School

Activity: Give a brief outline of what you are planning to do.

I am planning to test how different chemical solutions and temperatures affect the rate of finger wrinkling. I am also planning to use a device to stir the water while my hand is immersed to see if liquid movement speeds up the rate of wrinkling.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
- Burns to skin from hot water	- Measure the temperature of water, keep temperature within 18°C and 40°C
- Chemical irritation to skin	- Choose chemicals tested on human skin by other scientists. - Remove hand if solution irritates skin.

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Daniel Maddern

SIGNATURE(S): DM

☒ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Robyn Cox

SIGNATURE: [Signature] DATE: 23/6/26