Mini SRP Feedback (Antacids and Food)
Abstract – personal reason to do the experiment, interest
State actual hazards and explain precautions
Method – logical, must make sense, reread
VALIDITY – controlling variables, answering aim (measuring what is intended- SPEED of reaction not RATE)
Diagrams – MUST be labelled, titled, figures
Tables and graphs – TITLE (very specific and detailed), clear labelled axes
AVERAGES AND RANGES should be calculated
DISCUSSION – PUT IN SPECIFIC DATA, then talk about trends, write out chemical reactions involved
Put in why experiment is relevant to life
IN TEXT REFERENCING!! - cite author and year of publication, italicise the direct quote

10/12/15
BRAINSTORM
- testing solutions to environmental/human issues that need solving
- finding alternate uses for wasteful and non biodegradable products
- testing health myths/misconceptions - https://www.youtube.com/watch?v=bYXZP8eZKcw
(asapscience sick remedies that are scientifically proven)
- experiment with data that is easy to quantify and measure very accurately
- food/sound/music/biochem?

14/12/15
IDEAS BRAINSTORM
- food preservation
- alternate use for paper/plastic
- making energy efficient light bulbs
- anything answering environmental problems
- dairy and vocal chords/production of phlegm
- investigating rate of bacterial death with different treatments (for parasites or infections etc)
  → looked at HSC physics 2005 prac
  → researched stomach parasites and treatments

16/12/15
- energy efficiency → useful power output etc, building prototypes for more useful and efficient appliances using lightbulbs as the energy conversion (simplified)
- making your home energy efficient- making prototypes of insulating windows, efficient bulbs with good wires
- sound or light experiments
PHYSICS EXPS (music/light etc)
http://www.juliantrubin.com/fairprojects/physics/sound.html
16/12/15

21/12/15
- POTENTIAL TOPIC - making energy efficient appliance prototypes
- characteristics of energy efficient motors
http://www.energydepot.com/RPUcom/library/MISC003.asp
For an electric motor, efficiency is the ratio of mechanical power delivered by the motor (output) to the electrical power supplied to the motor (input).

Efficiency = \( \frac{\text{Mechanical Power Output}}{\text{Electrical Power Input}} \times 100\% \)

Thus, a motor that is 85 percent efficient converts 85 percent of the electrical energy input into mechanical energy. The remaining 15 percent of the electrical energy is dissipated as heat, evidenced by a rise in motor temperature. Energy efficient electric motors utilize improved motor design and high quality materials to reduce motor losses, therefore improving motor efficiency. The improved design results in less heat dissipation and reduced noise output. Energy efficient motors are most attractive economically when power costs or operating hours p/year are high.

- making motors more energy efficient
How does an efficiency controller work? Consider a washing machine: more energy is required when the appliance is filled with many clothes and less when there are just a few items to wash. Yet most washing machines consume more electricity than they need when they are lightly loaded, wasting energy. By contrast, an efficiency controller will provide precisely the right amount of power to the washing machine to meet the demands of its motor at any given time. High-speed response circuits continuously monitor the current and voltage and adjust these accordingly, so that the motor maintains its rated speed and torque under variable loads. More specifically, when the voltage and current sine waves diverge greatly (i.e., when the phase lag increases), the motor is lightly loaded and operating inefficiently. The efficiency controller detects this and reduces the current and voltage appropriately. Conversely, when the load on the motor increases, the device registers this fact and increases the power to the motor so it doesn't stall.

→ HINDRANCES: not running at full load, low quality materials,
- comparison between standard and energy efficient motors (financially) http://goo.gl/3Af5mc
Improved design, materials, and manufacturing techniques enable energy-efficient motors to accomplish more work per unit of electricity consumed. Because they are constructed with improved manufacturing techniques and superior materials, they usually have higher service factors, longer insulation and bearing lives, lower waste-heat output, and less vibration — all of which increase reliability. The extra cost of an energy-efficient motor is often quickly repaid in energy savings.

- scholarly articles for “energy efficiency characteristics"

23/12/15
- music/relative pitch investigation
http://www.sciencebuddies.org/science-fair-projects/project_ideas/Music_p015.shtml#background
- desperation http://hubpages.com/literature/100-Science-Topics-for-Research-Papers
- most wasteful products (to find alternate uses for)
  http://www.onegreenplanet.org/lifestyle/things-that-are-super-convenient-but-also-super-wasteful/

  → uses for plastic bags http://www.thisoldhouse.com/toh/photos/0,,20310499,00.html
  → research 'uses for plastic containers, bottles, bags' etc

- POSSIBLE IDEA sugar levels and their effect on cell growth (to tie in with cancer)
  https://www.oncologynutrition.org/erfc/healthy-nutrition-now/sugar-and-cancer/
  http://theconversation.com/starving-cancer-cells-of-sugar-could-be-the-key-to-future-treatment
- close up on the process of sugar being ingested by the cells, without other interferences or variables like diet or other ways of glucose production
  → In a recent study published in Nature Communications we showed that cancer cells stimulate the over-production of the protein known as PARP14, enabling them to use glucose to turbocharge their growth and override the natural check of cell death. Using a combination of genetic and molecular biology approaches, we have also demonstrated that inhibiting or reducing levels of PARP14 in cancer cells starves them to death. The best news is that by comparing cancer tissues (biopsies) from patients that has survived cancer and those that have died, we have found that levels of PARP14 were significantly higher in those patients that have died. This means that levels of PARP14 in cancer tissues could also predict how aggressive the cancer would be and what the chances are of a patient’s survival. - emailed science department about school’s availability to human cells (preferably cancer), cell counters and incubators

24/12/15
- similarities between cancer and bacterial cell communities
  https://www.mskcc.org/blog/turning-bacteria-clues (so in experiment microbes can be used instead of cancer cells) Approaches used for research into the social lives of bacteria can also be used to explore how tumors behave and evolve.

27/12/15
- received reply about incubator availability
- talked to some doctors/cancer researchers about feasibility of experiment

- researched cell counting equipment
- researched hallmarks of cancer cells
  https://www.apjohncancerinstitute.org/frequently-asked-questions/healthy-cells-vc-cancer-cells

28/12/15
- wrote a potential aim and hypothesis (below)
  AIM: to investigate the growth of (cancer) cells (or otherwise bacteria or cells with the capacity to multiply many times and are glut4 positive (dependent on sugar like cancer cells are) in different amounts/concentrations of sugar
HYPOTHESIS: the cells given the least amount of sugar will undergo the least amount of multiplication and growth
- researched cell counters further X not going to work

25/1/16
- teacher reply about unavailability of cancer cells
- other similar ideas researched
https://au.answers.yahoo.com/question/index?qid=20090520130600AAtdHTA which cells are dependent on sugar → red blood cells very much as they have no nucleus
https://en.wikipedia.org/wiki/GLUT4 glut 4 info

- different carbohydrate compounds in sugar
http://authoritynutrition.com/10-disturbing-reasons-why-sugar-is-bad/
http://www.sugar-and-sweetener-guide.com/glycemic-index-for-sweeteners.html GI info
http://authoritynutrition.com/agave-nectar-is-even-worse-than-sugar/ agave info
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2900484/ stevia etc

TO DO - find a bacteria stream or human cell type that relies on sucrose to grow or grows significantly better in presence of sucrose - cells that metabolise sugar
- TYPES OF SUGAR TO TEST - no sugar, white sugar (table), raw/brown sugar, coconut sugar, stevia (maybe but it’s artificial)

QUESTIONS TO ASK - am I actually testing how it affects the body or am I simulating it wrong / if what I'm quantifying is merely how much glucose or fructose is in each sugar (which is already known) am I uselessly investigating

- OBJECTIVE OF EXPERIMENT - to research the properties of each component of sugar (fructose, glucose, maybe sucrose though it just gets broken down into the two before) and the chemicals in artificial sweeteners, and how each is metabolised and affects the body, then test them separately as controls then various household sugars/sweeteners to compare- and then extrapolate to discuss which sweetener contains what compounds and how each one affects the body (inadvertently seeing which one is worst/best for you)

26/1/16
- yeast is effective in investigating sugars
https://byo.com/cider/item/1498-the-science-of-yeast-homebrew-science science of yeast, they’re classified as eukaryotic cells (same category as human ones, so have similarities)
http://www.saps.org.uk/saps-associates/browse-q-and-a/169-q-a-a-how-does-sugar-affect-yeast-growth how sugar affects yeast growth - use different types of sugar on each yeast plate and see which sugar grows them the most (then research what the yeast metabolises in the sugar and if that compound is good/bad for the body)
→ Yeast metabolises GLUCOSE - yeast can only use glucose as energy, so the experiment will be showing which type of sugar/sweetener is the most complex carbohydrate - the simplest ones (mostly glucose) will be metabolised the fastest so the yeast will grow more
quickly, whereas the more complex ones will take longer to be broken down and used and the yeast will have less growth in the time allocated

- possible aim and hypothesis written:
AIM: to determine which type of sugar/sweetener is the simplest carbohydrate and thus promotes the most yeast growth
HYPOTHESIS: pure glucose powder will promote the most yeast growth

- how glucose affects the body (to discuss and relate it to real life applications):
http://articles.mercola.com/sugar-side-effects.aspx
- comparison of different sugars http://goo.gl/6qzzNW

27/1/16

- Practicalities and execution thought about and Proposal was begun (in preparation)
  - how to measure the area of yeast growth → first manually with accurate ruler (length x breadth or diameter then area of circle formula) then on a computer electronically? - assuming that every photo is taken at the same distance and angle from the agar plate
  - EQUIPMENT needed - live yeast, various sugar/sweetener samples (equal, splenda, sucrose (table sugar), glucose powder, raw sugar, coconut sugar, stevia powder) water, for controls: a monosaccharide, a disaccharide, a starch and an artificial sugar
  - RISKS - some yeasts are pathogenic under certain conditions
  - VARIABLES- independent: type of sweetener given to yeast microbes / dependent: size of each yeast culture after growth AND/OR the amount of CO2 produced by each yeast culture by fermentation
  - formal sugar/human body information
  - New rethought aim and hypothesis written (metabolised best = fastest and most growth)
AIM: to determine which type of sweetener is metabolised best by yeast and promotes the fastest and most microbial growth
HYPOTHESIS: pure glucose powder will cause the greatest and fastest yeast growth
BKGD - yeast metabolises the simplest sugars (monosaccharides) the fastest because they are easy to break down and can be converted straight into energy by aerobic or anaerobic respiration, so the sweetener that promotes the most yeast growth in a given period of time (has been metabolised the fastest) is the simplest sugar - this shows which sweeteners are the simplest and discussed as human cells are similar to yeasts (eukaryotic cells)

28/1/16

- Background research continued → main sources analysed, bibliography started, information writing begun, controlled variables written
31/1/16

- work on Proposal continued, finished background research :)
- Questions to ask science teachers- how long does yeast take to grow/ferment so how long should the trial be (so far maybe 3 days, measuring every 5 minutes for first hour then once a day at 4pm for 3 days after), how to measure size of yeast colony (ruler, caliper, electronically after taking photo), whether to measure CO2 levels instead of colony size for the short term changes
- Equipment/substances needed were refined (experiment will test glucose, table sugar/sucrose, brown sugar, cornstarch, splenda, equal, stevia/truvia)
- looked at http://www.news.com.au/lifestyle/health/diet/the-shocking-truth-about-how-much-sugar-youre-eating/news-story/db7bb699d3ea766188fc6d5b1f0db3bf and http://capricorn.bc.edu/bi204/wp-content/uploads/2013/08/4-yeast-culture_2013.pdf - a guide to yeast practical work, to mention in discussion about sterilisation etc - use agar plate, using spot plates (mix yeast with water, use high concentration as then individual colonies can’t be seen and all yeast clumps together, use same amount of mL for each plate and drop it in the middle) instead of streak plates so that area size can be determined
- decided after research to grow yeast on agar plate and measure size of yeast blob

3/2/16

- worked on equipment, method etc
- decided to measure CO2 as well as size, and height
- tried to find best sugar/yeast ratio, decided to go fairly equal
- estimated quantities for equipment, will refine later
- remember to have a negative control (pure water in the flask, water on agar)
- found out not to incubate yeast over 30oC
- method and equipment list written
- NOTES on validity and choices of method: can’t take more than 1 CO2 reading as gas escapes, no negative control for agar?, no incubation for test tube trial because inconvenient, 1 hour should be long enough as yeast grows fast and by then most of the sugars that do ferment will have done so to a sufficient amount (baker site says 1 hour is good)

15/2/16

- received back marked proposal
- to change in equipment list - 10 agar plates
- modified method to include negative agar control

17/2/16

- completed practical equipment order form to start log with trials

IDEAS FOR TRIALS
- grow some yeast on an agar plate in same incubation as a blank/empty agar plate as a control to see if a) the yeast grows properly and to see how long it takes it to grow and b) if there is any contamination or excess bacteria growing on the empty agar plate
- grow different amounts of yeast on each plate (one with none, small amount x2, large amount x2, small with sugar x2, large with sugar x2, small with artificial sugar (to make sure it doesn’t promote growth))
- have different intervals between measuring yeast colony size (10 minutes, 30 minutes, 1 hour, 12 hours, 24 hours)
- AT HOME: trial the test tube experiment, seeing if level of mixture actually rises after fermentation and how long the yeast takes to activate and ferment
- check to see if quantities are all correct and make modifications
- seeing if plastic pipette can deliver accurate liquid quantities

18/2/16
- bought all sugars needed
- placed equipment order form for practical trials (including glucose powder, couldn’t find it in coles) - requested it be ready for Monday
- amended equipment and practicalities after consulting with a teacher - decided to test both nutrient and plain agar (to see if the yeast can grow without the nutrients or if the nutrient agar promotes too much growth), mixing the sugar with the agar vs dropping it on top of the yeast spot (seeing which one produces the most effect)
- plan to conduct the trials Monday afternoon

20/2/16
- to find out more about agar looked at:
  http://www.sciencebuddies.org/science-fair-projects/project_ideas/MicroBio_Agar.shtm
- wrote methods and created result tables for mock up trials

22/2/16
- did height of yeast fermenting in test tube trial after school using the powdered yeast, pure glucose powder and water (written up mock-up trials at end of proposal)
- asked about CO2 data logger and agar, agar ready tomorrow and data logger on wed

23/2/16
- prepared 4 petri dishes of yeast for agar trial and observed for 1 hour and 2 hour incubation

24/2/16
- examined petri dishes for 24 hours after incubation
- planned to conduct the final trial with the carbon dioxide data logger but it was unavailable due to another student taking it home
- finished writing up and analysing trials

1/3/16
- Received back marked trials

5/3/16
- Purchased live yeast for experiment/trials from deli
- Ordered agar plates and co2 probe and other equipment

8/3/16
- Started actual report

9/3/16
- Prepared agar plate with live yeast to test

10/3/16
- Solid live yeast growth on agar unsuccessful, solutions merely spilled and solid ones melted

11/3/16
- Growth of yeast on agar researched again to check where flaws were, realised that only pure live yeast cultures grow properly on agar plates and have to be inoculated like bacteria, which can’t be ordered in time to use, so alternative and simpler methods were researched
- Site to buy live brewers yeast in flasks:
- Growth of yeast
  https://au.answers.yahoo.com/question/index?qid=20080306085318AAa55hP,
  http://www.homebrewtalk.com/showthread.php?t=127457,
  http://www.sciencebuddies.org/science-fair-projects/project_ideas/MicroBio_Interpreting_Plates.shtml,
  https://eurekabrewing.wordpress.com/2012/08/24/yeast-banking-2-agar-plates/
- Homemade ‘agar’ plates made with 20mL gelatin water solution (1/2tsp of gelatin per 100mL water) and 1g sugar (different type of sugar for each plate), poured into a small round plastic container and put in the fridge to solidify
- Plates made with just gelatin due to the failed attempts of growing yeast on nutrient agar, also so that the contents of the plate are known completely, the amount of sugar in each can be quantified, and no other nutrients are present to interfere with the growth
  → gelatin’s similarity to agar and its uses/properties researched
- Blob of solid yeast and a drop (10 microlitres) of yeast water solution dropped onto each plate, plates put in fridge to grow

RESULTS: Sucrose- 0hrs 6mm, 1hr 8mm, 2hr 9mm, 3hr 10mm, 12hr 11mm
  Stevia- plate didn’t set (more gelatin to be used next time)
  Equal- appeared to do nothing- 0hrs 7mm, 1hr, 8mm, 2hr 8mm, 3hr 8mm, 12hr 8mm
  Cornstarch- 0hrs 8mm, 1hr 9mm, 2hr 10mm, disappeared (sank into the gelatin)
13/3/16
- More homemade agar made, this time with more gelatin (1tsp for 100mL water) and a teaspoon of white sugar
- Different concentrations of yeast solution were used, the more concentrated ones show up better on the plate and if left solid the yeast just sinks into the plate
- left to grow in a warm humid room (better for yeast growth) but gelatin ended up liquefying from the heat (next time to grow yeast plates at room temperature in a dark box, like how bread is left to rise, temperature is fairly controlled as room is kept at constant temp and conditions are controlled as they are in a box)

15/3/16
- Test tube fermentation trial 1 conducted, heights were measured but not carbon dioxide levels (to do tomorrow) → 0.5g sugar, 0.5g yeast, 5 ml water per test tube
- NOTES: use smaller stoppers that actually fit and don’t pop out when gas is produced, boiling tubes being used are larger/wider than the test tubes used in mock up trials so less of a height increase was seen, but test tubes can’t be used as there are no stoppers that fit them

TEST TUBE FERMENTATION TRIAL RESULTS

<table>
<thead>
<tr>
<th>Type of Sugar added</th>
<th>Height of yeast/water mixture (mm)</th>
<th>Fermentation time (mins)</th>
<th>CO2 concentration (ppm) after 20 mins</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>No sugar</td>
<td></td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Sucrose</td>
<td></td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Raw sugar</td>
<td></td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Brown sugar</td>
<td></td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Cornstarch</td>
<td></td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Splenda</td>
<td></td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Equal</td>
<td></td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Stevia</td>
<td></td>
<td>20</td>
<td>21</td>
</tr>
</tbody>
</table>

NOTES- splenda/equal despite being artificial sugars appeared to bubble/ferment slightly (more than cornstarch did), maybe as their compounds are similar to glucose but theoretically shouldn’t have fermented at all (structurally modified for this), brown sugar clumped together
at bottom but had a faster fermentation than sucrose or raw sugar did (these two were very similar)

- Made more homemade agar plates, in actual petri dishes, this time with every kind of sugar being tested using recipe from https://www.madaboutscience.com.au/store/index.php?main_page=page&id=43 but without the beef stock as that has other nutrients in it and will interfere
- Method: 750mL water, 3tsp gelatin (made the mixture VERY thick), put in saucepan and heated while stirring to dissolve the gelatin
- Each plate: 10mL gelatin/water solution, 2g sugar

It's still possible, however, to use gelatin as a culture medium for bacteria if agar is unavailable.(2) - as the yeast isn’t bacteria and is growing from solid visible form, the gelatin should be ok to use

16/3/16

- Left all the different sugars fermenting in test tubes stoppered yesterday, and took carbon dioxide readings in the mouth of each tube as practice using the meter:

<table>
<thead>
<tr>
<th>Type of Sugar added</th>
<th>Height of yeast/water mixture (mm)</th>
<th>Fermentation time (mins)</th>
<th>CO2 (ppm) after 20mins</th>
</tr>
</thead>
<tbody>
<tr>
<td>No sugar</td>
<td></td>
<td>0  3  6  9  12  15</td>
<td>34675</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 19 20 20 20 20</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
<td>20 23 27 30 35 40</td>
<td>139160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 23 25 27 29 35</td>
<td></td>
</tr>
<tr>
<td>Sucrose</td>
<td></td>
<td>20 23 25 27 29 35</td>
<td>94686</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 21 23 28 30 36</td>
<td></td>
</tr>
<tr>
<td>Raw sugar</td>
<td></td>
<td>20 21 23 27 31 37</td>
<td>116004</td>
</tr>
<tr>
<td>Brown sugar</td>
<td></td>
<td>20 21 23 27 31 37</td>
<td></td>
</tr>
</tbody>
</table>

- Did a second trial of fermentations
- All poured in and shaken
- Yeast left to activate in water for 5 mins before adding sugar
- Co2 readings - reading taken after 10 secs as fluctuations don’t stop and choosing a
time to measure keeps it controlled
- Stoppers completely solid (not hollow) so no gas escapes and they don’t pop off
- Agitating changes liquid height level

17/3/16
- Conducted the fermentation trial again

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>No sugar</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Glucose</td>
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<td>22</td>
</tr>
<tr>
<td>Sucrose</td>
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<td>21</td>
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<tr>
<td>Raw sugar</td>
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<td>20</td>
</tr>
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<td>Brown sugar</td>
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<tr>
<td>Splenda</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Equal</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Stevia</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

- Same boiling tubes used each time (same dimensions)
- Water mixture level at the beginning same each time
- This one took a lot longer to ferment than the other trials (perhaps due to the
  yeast/sugar being exposed to the air, not enough water, conditions different, not
  enough yeast?)
- Readings taken after a few hours too to make sure the fermentation still happened and was just slow (which it was)

- PREPARED THE YEAST SPOTS ON THE HOMEMADE PLATES for growth trials → 5g dry yeast, 10mL water to form paste (50% concentration), 10 microlitres (a drop with the micropipette) for each yeast dot, 3 dots on each plate (3 trials)
- Reasoning- the plate just gave the yeast mixture a place to grow on uniformly, it’ll multiply in the presence of any sugar but here it will hopefully grow uniformly outwards
- Gelatin began to melt after 3 or so hours - most of the sugar plates’ yeast blobs had little bubbles around their edge (blobs still kept their shape when gelatin was jiggled so no interference, still left intact as normal)
- Next time use more gelatin
- The more liquefied the plates became, the larger the yeast blobs grew (sank ie the equal plate melted quickly so its blobs grew fast)
- Sugar more accessible for metabolism when gelatine mixture is liquid?
- 1hr Equal and glucose blobs looked lot bigger, brown sugar blobs looked more raised
- 12hr glucose looked significantly larger and was bubbling slightly (small bubbles)
- After 24 hours the yeast spots either sunk into the liquified agar mixture or created enough co2 from their fermentation/growth that they stuck to the top of the dish (they grew while it was solid so no more measurements could be taken after this time-makes sense as yeast ferments very quickly (24 hours) so no more growth was likely to occur anyway)
- Glucose made uniform circles, brown/raw/equal/splenda made irregular shapes

<table>
<thead>
<tr>
<th>Type of Sugar in plate</th>
<th>Diameter of yeast spot (mm)</th>
<th>Hours after preparation</th>
<th>Total growth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>1</td>
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<tr>
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</tr>
<tr>
<td>Glucose</td>
<td></td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Sucrose</td>
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<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Raw sugar</td>
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</tr>
<tr>
<td>Brown sugar</td>
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<td>Cornstarch</td>
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<td>Splenda</td>
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<td>Equal</td>
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<td>8</td>
<td>10</td>
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<tr>
<td>Stevia</td>
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<td>6</td>
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</tr>
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<tr>
<td></td>
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<tr>
<td>Glucose</td>
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<td>Sucrose</td>
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<tr>
<td>Raw sugar</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Brown sugar</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Cornstarch</td>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Splenda</td>
<td></td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Equal</td>
<td></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Stevia</td>
<td></td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Sugar in plate</th>
<th>Diameter of yeast spot (mm)</th>
<th>Hours after preparation</th>
<th>Total Growth (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>No sugar</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Glucose</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Sucrose</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Raw sugar</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Brown sugar</td>
<td>7</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Cornstarch</td>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Splenda</td>
<td></td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Equal</td>
<td></td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Stevia</td>
<td></td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

18/3/16
- Finished the growth trials
19/3/16
- Wrote up more of report - amended method, calculated averages to put into tables in results section
- Reread and edited background research, inserted pictures

20/3/16
- Continued writing report - graphed results on excel, inserted method and result pictures, wrote discussion, proofread report and wrote abstract

21/3/16
- **SELF EVALUATION OF EFFECTIVENESS IN COMPLETING THE TASK**
  I think I completed this task to the best of my ability, though the management of time could have been better. I'm happy with the amount of effort I put into the research and writing up of the report and the amount of time I spent refining my ideas. I'm also satisfied with the amount of time I spent deciding on an idea; though I may have come up with a better one if more research was done I'm happy with my execution of this idea.

  In terms of the hand ins for the proposal and the log containing trials, I started working early and completed everything with time to spare and enough time to proofread and refine. However, towards the end of the project, I rushed through the actual experimentation due to time constraints and struggling to get my equipment ready, as well as had unsuccessful experimentation attempts. Through this, though, I think I refined my practical skills in accurately measuring and taking precise reading, and in problem solving to try and amend the method.

  On carrying out the method, I should have done so in a safer and less frazzled way, and could have minimised clean up time by being more careful pouring quantities and not spilling things and remembering to wear safety glasses the whole time. However, I think I effectively carried out the trials a number of times for repetition even in a small amount of time, and in terms of final write up I quickly and thoroughly completed my report after experimentation. I could have spent more time refining the discussion and proofreading better but I was generally happy with what went into the report and with its detail. Overall, I’m glad this task is completed and I think I did so fairly effectively and in the best way I could.

22/3/16
Handed in report and logbook :)
## PROPOSAL FOR SRP - student 119485

### TIMELINE to organise work to be completed

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Work to be completed</th>
</tr>
</thead>
</table>
| 1A   | 29.1 - 31.1| - Decide upon an idea on which to experiment  
- Complete the background research (incl. outlining the investigation, explaining real life relevance, in text referencing and citing) for experiment  
- Discuss the reliability of 3 sources and produce bibliography  
- Write aim and hypothesis for experiment |
| 2B   | 1.2 - 7.2  | - Talk to science staff about practicalities of experiment, and thus produce a full equipment list, risk assessment and method  
- Evaluate the validity of method for investigating hypothesis  
- Identify and write the independent and dependent variables, thus finishing the Proposal |
| 3A   | 8.2 - 14.2 | - Hand in the Proposal (8th Feb)  
- Do some trials with various yeasts (baker’s, pure yeast, powdered, creamed) to see which grows best, and which one grows significantly more in sugar |
| 4B   | 15.2 - 21.2| - Commence formal experimentation after receiving marked Proposal, conduct 3 times in same incubation (3 trials) and take photos and accurate measurements  
- Ask teacher for advice on experimentation if needed |
| 5A   | 22.2 - 28.2| - Hand in Log with Trials (25th Feb) including informal trials and formal experimentation results, analysing the method and results for improvements and adjustments  
- Commence another experimentation |
| 6B   | 29.2 - 4.3 | - Create a report using the Proposal information  
- Continue experimentation, insert photos into report  
- Organise results into tables and graphs, make calculations from data like range/sd/outliers  
- Amend information from Proposal from marking feedback |
| 7A   | 5.3 - 11.3 | - Write a detailed discussion (accuracy/reliability/validity) referencing actual data from the experiment  
- Write a concise conclusion and make sure it answers the aim |
TITLE: The Sweet Job of Yeast - an investigation of the metabolism of different sugars using yeast microbes

BACKGROUND INFORMATION

Overview of Sugar
Sugars are small carbohydrate compounds, consisting of only carbon, hydrogen and oxygen atoms, and along with their fellow carbohydrates make up the most abundant group of organic compounds in nature. These sugar compounds are essential for cellular respiration and various chemical reactions in cells (metabolism) and provide the main source of energy for the cells of living organisms. Carbohydrates, scientifically termed saccharides, can be classed by complexity depending on their size, chemical structure, and how quickly they are digested and absorbed (nlm.nih.gov 1997). Monosaccharides are the smallest and most simple compounds, with disaccharides- two monosaccharides joined- and polysaccharides being more complex. There are also compounds classed as artificial sugars that are derived from sugars but are structurally modified to elicit a sweet taste whilst not presenting a significant calorie load (fmarion.edu 2012). There is much debate among the nutritionist and scientific communities about the effects of different sugars and carbohydrates on human health and their behaviour in the body, and a constant preoccupation of finding the healthiest alternative to satisfy the sweet tooth. This research project will attempt to investigate this by practically demonstrating the effects of complexity and artificiality on the metabolism of different sugars by yeast microbes, in order to discuss firstly how each behaves and interacts with living cells, and also assess their benefits and detriments to human health.

Sugar in the Body
All organisms require an energy source, and sugar is the main source for the cells of the human body and is essential for survival. Sugar is metabolised (used in chemical reactions within cells or organs in the body) by organisms. To keep an organism alive, produce its energy, allow it to grow and in general to maintain cellular function. In digestion, the monosaccharide compound glucose, the simplest and most common sugar, is isolated after ingested carbohydrates are broken down and enters the bloodstream, and is then delivered to every cell in the body to fuel cellular respiration. Hence, it is the standard by which other carbohydrates are ranked to show how fast they will be metabolised by cells.
Glucose powder is a white crystalline powder with a GI at the maximum of 100, meaning that glucose is rapidly absorbed into the bloodstream (nutritionist Catherine Saxelby 2016). With our modern Western diet, there is often excess glucose in the body after eating which is not needed as energy at that time, so it is converted into glycogen by the liver and stored as fat somewhere in the body, to which there is no limit. Larger carbohydrates and sugars that are more complex than glucose have a slower metabolic rate, and take longer to be broken down and converted into energy. This is the basis of the belief that more complex and unrefined carbohydrates (like whole wheat rather than refined white bread) are healthier, as this way the body has more time to use the energy it has been given by food because the glucose in it is being released at a slower rate. This also ensures that levels of the hormone insulin, related to blood sugar levels, do not spike immediately after eating and energy lasts longer.

The human body can also metabolise many other molecules, including starches, lipids, proteins and other sugars like fructose, though these are done differently. However, we are not able to metabolise certain artificial sugar compounds, like those in sugar-free sweet foods- they are deliberately manufactured that way so they cannot provide the body with any energy. Another alternate strategy is having the sugar modified to have an extremely sweet taste so that only a very small amount is needed (fmarion.edu 2012) so its caloric impact is minimal with little or no excess to convert into fat.

**Domestic Consumption of Sugar**
The consumption of sugars is one of great proportions, comprising 10% of total daily calories for the average adult. The World Health Organisation now recommends it only make up 5% of the diet or 6 teaspoons per day in response to the growing epidemics of diabetes and heart disease, which is alarming to Australians, who on average eat 27 teaspoons of total sugars a day (including natural sugars), according to the 2012 report Sugar Consumption in Australia: A Statistical Update (news.com.au 2015).
Consumed sugars come in natural, artificial, caloric and non-caloric forms, each presenting its own pros and cons.

Natural consumed sugars include the monosaccharides glucose and fructose (which can both come in powdered and syrup form), the disaccharides sucrose (table sugar, either white, raw or brown) and lactose (milk sugar) and various natural unrefined sweeteners (such as truvia, agave and honey). Many of these unrefined sweeteners like raw sugar and honey, though they contain some beneficial vitamins and minerals which add a small nutritional value, are either mono or disaccharides that are metabolised identically to their refined counterparts. The complex natural carbohydrate starch is a polysaccharide, a long chain of sugar molecules, which is to be tested in this experiment to include a compound of greater complexity. Artificial
sugars available for purchase include saccharose (Splenda) and aspartame (Equal), which merely pass through the body without being absorbed and are excreted out. They are chemically similar to sucrose, Equal more so, but are structurally different with some added atoms and some absent. Their non-caloric nature means they are beneficial for diets and weight control, but it can be argued that the modified chemicals are harmful for the body in other ways, and can cause side effects and long term damage in large quantities. The fact that sugar’s existence in our diet is so large and is in need of such a great modification means that it’s vital to consider each of the many alternatives’ behaviour in and effects on the body. This is the backbone of this experiment and its connection to human and real life issues.

**Yeast and its Relation to Sugar**

Yeast is a microbial fungus which derives its energy source from sugar. They are among the smallest eukaryotes, which means they are much larger than common bacteria, have a cell nucleus containing DNA, have organelles for cellular function and have a structure and behaviour alike to human eukaryotic cells. In the presence of yeast, sugar is metabolised/fermented anaerobically (without oxygen), converting the sugar to alcohol and producing carbon dioxide, which is utilised in baking bread and brewing beer. As the simplest eukaryotic organisms to perform this metabolic process of cellular respiration, they are useful models in cell biology. The activity of yeast in the presence of sugar and its similarities to human cells make it ideal for this experiment, as it can not only show which of the tested sugars are the simplest by investigating their effects on growth but can also simulate a simplified action of these sugars in the human body itself.

*The more sugar there is, the more active the yeast will be and the faster its growth, up to a certain point - even yeast cannot grow in very strong sugar - such as honey* (saps.org.uk 2016). An excess of sugar inhibits the growth of the yeast colony, so only small amounts will be used in the tests. There are a number of commercially available yeast products, but the most suitable of these will most likely be a very small amount of a pure yeast culture. Baker’s yeast is made using yeast culture and molasses, which is activated in water allowing the yeast to grow. As there is already added sugar in this type of yeast, this would interfere with the experimental method involving growth in different types of sugar, so a pure yeast culture grown on agar plates and in test tubes will be used to ensure validity of the tests. As yeast is often harvested, especially by brewers and bakers, its growth rates must be significant and noticeable, meaning that when measuring the size of the yeast colony, visible growth will be evident.

Yeast grows in separate colonies, although when a high concentration of the culture is used, the colonies become confluent and hence the area of yeast on the agar plate is measurable. Like bacteria and most microorganisms, yeast growth begins
exponentially (log phase), becomes stationary then steadily decreases in the death phase.

The activity of yeast relies on glucose. Each sugar (fed to the yeast) needs to be converted to glucose to enable it to feed into respiration and it is this process which produces the gas which causes the foaming (saps.org.uk 2016). Yeast produces enzymes which break down sugars to release glucose, much like in the human body, and then uses it as energy to ferment and grow. As a result, the simplest carbohydrates- those closest in structure to monosaccharide glucose- are metabolised fastest, and those requiring the most enzymatic breakdown will take the longest, resulting in a slower growth and fermentation.

BIBLIOGRAPHY

RELIABILITY OF SOURCES


This source is a blank practical report of an experiment done by students at Francis Marion University, South Carolina, relating to the metabolism of yeasts and their inability to metabolise artificial sugars due to their manufactured chemical composition. There is no data in the report (just blank tables) of the experiment so the validity of data cannot be discussed, although there is sufficient information in the research section to predict the results and these have been discussed. This research information is not biased as it comes from a group of qualified teachers and their students and not an individual, originates from a reputable educational site (a university) and is has current information (2012). This proves its reliability.


This site comes from the Science and Plants for Schools organisation, directly discussing sugar’s relationship with yeast growth through the results of a practical investigation, showing its validity in relation to this topic. The site itself is reliable as a .org website, which is current and has been revisited/revised in 2016, and the information is objective and not emotionally influenced. Although it is not emotive, no information is provided on the named authors, and the article includes personal pronouns (I, we) written in an informal tone, which could detract slightly from its reliability. Overall, the reputability and currency of the site and its direct relevance to the topic prove general reliability and validity.


This website has the most general information out of the three, explaining the chemistry, composition and classification of sugars and carbohydrates, which was necessary to understand the metabolism of sugars. The reliability of this source comes from it’s website’s repute, the author’s credibility, it’s relative currency and it’s unbiasedness. There is no reference to information from practical investigations, as it
AIM: to determine which type of sweetener is metabolised best by yeast and promotes the most microbial growth and fermentation

HYPOTHESIS: pure glucose powder will cause the most yeast growth and fermentation

EQUIPMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x vial of pure yeast culture</td>
<td>10g Equal sweetener</td>
</tr>
<tr>
<td>1x packet of active dry yeast</td>
<td>10g Truvia</td>
</tr>
<tr>
<td>1x bottle of distilled water</td>
<td>8x petri dishes of agar</td>
</tr>
<tr>
<td>10g pure glucose powder</td>
<td>1x paper outline of petri dish with dot in middle</td>
</tr>
<tr>
<td>10g white table sugar (sucrose)</td>
<td>8x stoppered test tubes</td>
</tr>
<tr>
<td>10g raw sugar</td>
<td>2x test tube rack</td>
</tr>
<tr>
<td>10g brown sugar</td>
<td>10mL measuring cylinder</td>
</tr>
<tr>
<td>10g Splenda sweetener</td>
<td>1x 3mL small pipette</td>
</tr>
</tbody>
</table>

METHOD

Petri dish and agar size of growth trials

1. A benchtop was sterilised by wiping down with ethanol and a Bunsen burner was lit to produce a sterilised environment to conduct the experiment.
2. A petri dish filled with nutrient agar was placed on the paper template of the dish on the sterilised bench, and using the small pipette 3mL of pure yeast culture was transferred onto the dish in the centre of the agar.
3. Step 2 was repeated for another 8 agar plates. A final agar plate was left empty without yeast as a negative control to see if any excess bacteria grew.
4. 3g of pure glucose powder, measured using the electronic balance, was applied using the spatula to the yeast spot in the middle of the first agar plate and labelled as ‘pure glucose.’
5. Step 4 was repeated for each agar plate, each with a different sugar (raw, brown, cornstarch, Splenda, Equal, Truvia). No sugar was added to the final plate as a negative control.
6. The 10 petri dishes were placed in the incubator at 30°C.
7. The petri dishes were taken out of the incubator 1 hour later and the diameter of the yeast spot on each dish was measured with a millimetre ruler, without exposing the dish to the air.

8. The dishes were returned to the incubator and the readings taken in step 7 were taken every 24 hours for 3 days and were recorded and analysed.

9. The experiment was repeated twice to test for reliability.

**Test tube and carbon dioxide probe fermentation trial**

1. 9 test tubes were each filled with 10mL of distilled water, measured by the 5mL measuring cylinder, and were placed in test tube racks.

2. 3g of active dry yeast was emptied into each test tube.

3. 5g of pure glucose powder was added to the first test tube and then it was stoppered, labelled and replaced into the test tube rack. The remaining sugars used in the agar growing experiment were each allocated a test tube. 5g of sugar was added to its corresponding tube and each was placed in the rack. No sugar was added to the final test tube as a negative control.

4. The test tube racks were placed in the incubator at 30°C.

5. After 1 hour the amount of carbon dioxide produced by the fermentation of the pure glucose was measured and recorded by the CO₂ probe by hovering it in the mouth of the opened glucose test tube. The same was done for each of the other sugars, in the order they were prepared.

6. The height of the liquid mixture in the test tube was also measured using the millimetre ruler after the CO₂ readings were taken.

7. The carbon dioxide and mixture height measurements were recorded and analysed.

8. The experiment was repeated twice to test for reliability.

**VALIDITY OF METHOD**

This method is valid as the measurements being taken are as accurate as possible, are testing the hypothesis and are measuring the intended variables. These are the amount of yeast growth, which can be measured mechanically by the size of the yeast cluster, and the amount of fermentation by the amount of carbon dioxide produced and height of the mixture. The accuracy of the carbon dioxide measurements is very high as the apparatus being used is electronic so there is no degree of subjectivity. The height and size readings are less so, as only a millimetre ruler can be utilised as more precise forms of measuring distance, such as calipers, cannot be used correctly in these trials for mechanical reasons.

**VARIABLES**

- **Independent** - the type of sweetener given to the yeast microbes
- **Dependent** - the size of each yeast colony after growth on agar, the amount of carbon dioxide produced by each yeast culture after growing and fermenting AND the height of the yeast/water mixture after fermentation
- **Controlled** - initial amount/concentration of yeast in each trial, conditions of preparation environment, conditions of yeast growing environment, amount of sugar or sweetener applied to each yeast trial, amount of time between measurements of yeast colony size, amount of agar in each plate, amount of water in each test tube, dimensions of each test tube, amount of time each trial is open or exposed to air.

**RISK ASSESSMENT**

**Activity Description:** Growing and fermenting yeast in agar and in test tubes

<table>
<thead>
<tr>
<th><strong>Step 1:</strong> Identify the hazard</th>
<th><strong>CSIS user code</strong></th>
<th><strong>Step 2:</strong> Strategies to minimise the hazard</th>
<th><strong>Step 3:</strong> Assessment of risk (see table below)</th>
<th><strong>Step 4:</strong> What if something goes wrong?</th>
<th><strong>Step 5:</strong> Packing up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glassware can break and cause cuts</td>
<td>n/a</td>
<td>Place glassware away from edges of benches and keep outside dry to minimise slipperiness</td>
<td>1+2=3= MODERATE</td>
<td>In case of breakage consult teacher. Empty glassware, brush up and place in 'broken glass' bin. Wipe up any spills. If cuts occur, seek first aid.</td>
<td>Clean, dry and pack away carefully</td>
</tr>
<tr>
<td>Some yeasts are pathogenic under certain conditions when ingested</td>
<td>n/a</td>
<td>Use gloves, do not eat, clean and disinfect workspace after</td>
<td>2+1=3= MODERATE</td>
<td>If a yeast infection is apparent after experiment is conducted, consult a doctor and/or visit a specialist</td>
<td>Wrap up and throw away yeast in rubbish bin and avoid direct contact</td>
</tr>
<tr>
<td>Bunsen burner can cause burns or start a fire</td>
<td>n/a</td>
<td>Don’t touch flame, push burner to back of the bench</td>
<td>1+2=3= MODERATE</td>
<td>Run burned area under cold water, bandage and consult teacher if burns are more serious</td>
<td>Turn off gas tap, run extinguished matches under water and return burner to cupboard</td>
</tr>
<tr>
<td>Ethanol is flammable and toxic if ingested in large amounts</td>
<td>C₂H₅O</td>
<td>Make sure there is no ethanol near the Bunsen burner, don’t ingest and try</td>
<td>2+1=3= MODERATE</td>
<td>Extinguish flame by covering or using fire extinguisher if too large or dangerous</td>
<td>Pour away down sink</td>
</tr>
</tbody>
</table>
Any excess bacteria growing on agar could be harmful if ingested. n/a

Do not touch agar plate after growth. 1+1= LOW

Wash hands thoroughly after touching, if symptoms occur alert a teacher. Dispose of agar in the bin carefully and with gloves.

**Mandatory precautions:** Covered shoes, safety glasses, hair exceeding shoulder length tied back.

**Date:** 5/2/15

**Student Signature:** Sabena Bhadri

**How do you assess the risk?** For each hazard identified in Step 1, answer A then answer B. Then add A and B together to determine Risk and Action required.

<table>
<thead>
<tr>
<th>A</th>
<th>What is the potential impact or consequence of the hazard?</th>
<th>B</th>
<th>What is the likelihood of the event happening?</th>
<th>Add the numbers in columns A and B together</th>
<th>How to assess the risk</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = MINOR</td>
<td>First Aid required with little or no lost time</td>
<td>1 = LOW</td>
<td>It could happen but only rarely</td>
<td>1 – 2 = LOW RISK</td>
<td></td>
<td>Proceed with caution</td>
</tr>
<tr>
<td>2 = MODERATE</td>
<td>Medical treatment required, some lost time</td>
<td>2 = MODERATE</td>
<td>It could occasionally happen</td>
<td>3 – 4 = MODERATE</td>
<td></td>
<td>Consult with teacher</td>
</tr>
<tr>
<td>3 = SERIOUS</td>
<td>Medical treatment required, extended lost time</td>
<td>3 = HIGH</td>
<td>It could frequently happen</td>
<td>5 – 6 = HIGH</td>
<td></td>
<td>Reassess the need to perform practical/ consult with teacher</td>
</tr>
</tbody>
</table>

**MOCK-UP TRIALS**

- provides data from repeated trials in a log
- analyses the method and results to identify areas for improvement
- suggests adjustments to the method (thoroughly described)

For the trials, I have decided, rather than perform my actual experiment, to break down my method (see previous) and test certain parts of it to find optimum quantities of substances required and making sure the desired yeast growth occurs. As repetition was not required, each trial was only conducted once to make sure it worked or to see areas for improvement.
TRIAL 1 - yeast and sugar on agar

**METHOD**

1. Nutrient agar was prepared and poured into 2 petri dishes.
2. In a sterile environment created by ethanol disinfection and the lighting of a Bunsen burner, 1mL of 20% dry yeast and water mixture was pipetted into the centre of each of the 2 plain agar plates.
3. 1g of pure glucose powder was added to one of the yeast plates, the other left with just yeast and no sugar.
4. The 4 petri dishes, along with an extra nutrient agar plate without yeast as a negative control to make sure no excess bacteria was growing, were placed in the incubator at 30°C.
5. The sizes of the yeast clusters were measured with a millimetre ruler after 1 hour, 2 hours, 15 hours and 24 hours.

**RESULTS**

Size of dry yeast cluster in nutrient agar with different amounts of sugar

<table>
<thead>
<tr>
<th>Incubation time (hours)</th>
<th>Size of yeast cluster (mm)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With 1g sugar</td>
<td>Without sugar</td>
</tr>
<tr>
<td>0</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>1</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>2</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>24</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Size of **yeast solution** cluster in nutrient agar with different amounts of sugar

<table>
<thead>
<tr>
<th>Incubation time (hours)</th>
<th>Size of yeast cluster (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With 1g sugar</td>
</tr>
<tr>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>1</td>
<td>n/a</td>
</tr>
<tr>
<td>2</td>
<td>n/a</td>
</tr>
<tr>
<td>24</td>
<td>n/a</td>
</tr>
</tbody>
</table>

0hrs incubation (start)  
2hrs incubation  
24hrs incubation

**ANALYSIS**

This trial was designed to investigate whether the yeast actually grows outwards, in either solid or liquid form. It also tested whether the quantities were conducive to growth, if adding glucose made a difference to growth and examining the sterility of the agar, as well as providing an opportunity to practice delivering small quantities of liquid (1mL) with very small pipettes and the techniques of working with agar.
It was evident that the quantity of yeast/water mixture pipetted onto the agar plate was too large as its diameter, although defined and easy to quantify, was more than half the size of the dish. It was very hard to measure the diameter of the yeast in solid form, as the grains kept moving around and dispersing, and once the sugar was added to both the liquid and solid forms, the uniform circles became uneven and raised, making the diameter even harder to distinguish. For these reasons, if this trial is to be conducted again, a very small amount of yeast/water mixture, just a drop in the centre of the dish, and a uniform application of 0.5g of sugar (1g was too much, distorted the uniform circle) across the top of the drop should be used, as this will ensure reliable measuring of diameter.

In terms of the results, the diameter readings were unable to be taken after incubation, as the yeast did not end up growing outwards on the agar like anticipated. Instead, the yeast plates with glucose applied fermented and splattered all over the top of the petri dish, while the ones without glucose either remained stationary or fermented slightly from the sugars in the agar. The carbon dioxide produced by the fermentation most likely pushed the yeast to the top of the dish and off the agar, seen in the liquid yeast with glucose plate that had many large bubbles in it. Once the sugar was all metabolised, the yeast remained inactive and after 24 hours, the plates looked very similar to how they looked after 2 hours, just slightly dried, showing that dry yeast is manufactured to ferment and produce carbon dioxide and not to physically grow and multiply. The lack of growth could be because there was too large a quantity of yeast, or because the powdered dry form, with the yeast microbes trapped inside a casing, simply doesn’t grow on agar. For the actual experiment, a live yeast should be used as it’s not artificially encased or manufactured to ferment quickly and and will hopefully be able to grow on the agar like conventional live bacteria strains. This will be tested at a later date before the actual experiment is commenced, with a drop of live yeast culture on the agar plate and its diameter readings after periodic incubation taken. If this too is unsuccessful, the growth section of the experiment will be removed and the focus will shift to fermentation, which can still be used to determine the metabolism of different sugars.

**TRIAL 2** - yeast and sugar in test tube

1. 3 test tubes were set up, each with 5mL of distilled water and 2g of dry yeast powder.
2. 0.5g of sugar was added to the first test tube, 1g was added to the second and 2g was added to the final one. The initial height of the mixture in each test tube was measured with a millimetre ruler.

3. Every 3 minutes for 15 minutes, timed with a stopwatch, the height of the water mixture in the tube was measured with a millimetre ruler. The mixture was also stirred every minute.

4. These results were recorded to determine the sugar to yeast ratio required for the most water level change.

RESULTS

Height of yeast water mixture after fermentation with different amounts of sugar

<table>
<thead>
<tr>
<th>Amount of sugar (g)</th>
<th>Fermentation time (mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>41</td>
</tr>
<tr>
<td>Height of yeast water mixture (mm)</td>
<td>43</td>
</tr>
<tr>
<td>1</td>
<td>49</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

0mins (start) 6mins
ANALYSIS

This trial was one of optimisation- trying to find the ideal quantities of components for experimentation. The quantity of yeast used, 2g, was very large, and created a very viscous, gluggy and congealed mixture, which spread around the insides of the test tubes and settled to the bottom very slowly, so it was hard to distinguish where the level of liquid was. For this reason, only 0.5g of yeast for the 5mL of water (10% concentration) will be used in the real experiment, so that the mixture is a thinner liquid and doesn't stick to the insides of the test tubes, and so that it's easier see, stir and mix in the sugar uniformly. The mixtures in the test tubes rose not because of the multiplication of the yeast but the production of carbon dioxide bubbles from the fermentation, seen in the pockets of air and bubbles forming inside the mixtures.

The predicted outcome was that the more sugar, the fastest fermentation and the most increase in height of the mixture up the test tube, which was only partially true. The one with the most glucose, the 2g, fermented the least in the given amount of time, as it clumped at the bottom of the test tube and didn't disperse or come into contact with very much of the yeast. The fermentation of the 0.5g and 1g glucose test tubes were quite similar, although the 1g was slightly faster and did speed up and by 15 minutes this test tube had overflowed. It took about 6-7 minutes for the heights of the mixtures to start rising dramatically, most likely due to there being a large amount of yeast and a greater time needed to activate. Because of this, the 1g quantity of sugar will be used in the formal experimentation as it produced the greatest increase in mixture height, and with the lessened quantity of yeast, this amount glucose will make an even bigger difference. As there will be less yeast, it will not take as long to activate and the mixture height will start rising quicker, but there won't be enough of it to overflow in the given 15 minutes. This also showed that the 15 minute experimentation is a good amount of time as it is enough time for the height of each mixture to increase dramatically but any longer and they will spill over the top of the test tubes.

Overall, this trial gave information into the optimum quantities for each component to use to amend the previous method - 0.5g yeast, 5mL water, 1g sugar and 15 minutes to ferment.
TRIAL 3 - trialling the carbon dioxide data logger

- This trial was meant to be conducted on 24/2, however the data logger was unavailable for the whole week before, due to it being lost and then another student taking it home, so it will be conducted at a later date. The method that will be used and its results table is included here.

1. 3 test tubes, each with 5mL of water and 1g of pure glucose powder, were set up in a rack.
2. 0.5g of yeast was added to the first test tube, 1g to the second and 2g to the third.
3. The test tubes were stoppered and the rack was placed in a container of warm water for 5 minutes.
4. After this time, the test tubes were taken out of the container and each was opened individually and the amount of carbon dioxide produced by the fermentation was measured and recorded by the data logger.

RESULTS
Amount of carbon dioxide produced by different amounts of yeast after a 5 minute fermentation with 3g of sugar

<table>
<thead>
<tr>
<th>Amount of yeast in test tube (g)</th>
<th>Amount of CO2 produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

ANALYSIS
This trial method was written on the basis that I hadn’t used the data logger before and thus it was important that I practised with it before conducting the full experiment. The different amounts of yeast is merely so that the composition of the yeast/water/sugar mixture hypothesised to be the most ideal after the test tube fermentation trial (1g of glucose, 5mL water, 0.5g of yeast) can be tested and further proven by measuring the fermentation products. The fixed amount of sugar was chosen as the amount of sugar was changed in trial 2 and another independent variable relating to ratios and quantities was desired. I’m assuming that the fact that once the test tubes are open, the carbon dioxide escapes into the air and an accurate reading can only be obtained straight after opening means that the measurement can only be taken once.

When the carbon dioxide data logger is returned and I am able to conduct this trial, I will see if it is possible to take the carbon dioxide reading more than once after
practising with it, and determine whether the hypothesised ideal quantities of yeast, water and sugar are correct.