Log Book

1. Ideas

Planning and approval date: 2nd December 2020

Ideas for Experiments	Status	Notes/Thoughts
Effects of humidity/light intensity/temperature on transpiration rates of plants	No	• Measure with potometer/transpirometer • What plant should I use? • Haven't studied Plant Biology topic in class yet • Doing this experiment over a period of time will create confounding variable of plant age/well-being
Impacts of types of sugar on *S. cerevisiae* respiration rates	Yes (topic and experimental design approved by Biology teacher)	• Most personally relevant to me – can link this to bread-baking and my search for a homemade bread recipe! • What kind of yeast would be most ideal and viable for this experiment? = Use Baker's Yeast – real-life applications in baking • How many and what types of sugars should I use? = Fructose ($C_6H_{12}O_6$), glucose ($C_6H_{12}O_6$), ~~lactose ($C_{12}H_{22}O_{11}$)~~ (not available), maltose ($C_{12}H_{22}O_{11}$) and sucrose ($C_{12}H_{22}O_{11}$) • Control extraneous variables of distilled water volume, experimental duration, *S. cerevisiae* and sugar masses, *S. cerevisiae* type and temperature • At what temperature should the water bath be kept? = 35 °C, ideal temperature for S. cerevisiae respiration (Janssens et al., 2016)

Influence of household cleaning products on plant germination/growth	No	• Low "ecological validity" – the plants in my house are nowhere near household cleaning products? Not really an issue/personally relevant • Dependent variable measured through plant length probably
What factors affect decay of fruits/vegetables? (e.g. humidity, oxygen availability, salinity, temperature)	No	• Difficult to really control variables • How would the rate of decay be measured? Mass/pH/temperature change? Need to do research on plant decay characteristics as data acquired cannot be merely qualitative • Will take a relatively long time

2. **Risk Assessment and Assistance**

- Standard lab safety measures for apparel need to be followed – wear an apron, gloves and goggles.
- No dangerous chemicals and solutions of different types of sugar, distilled water and *S. cerevisiae* are safe to dispose down the sink.
- No ethical issues because *S. cerevisiae* used is the type of dry yeast utilised for baking; no other live organisms involved.
- Electrical components of water bath may be electrocution/ignition hazards – hence, I would need to check for electrical safety, i.e. intact wires, etc., before each trial and keep it away from other electrical and flammable hazards in the science lab.
- Electronic balance may be knocked off laboratory bench and this may cause injuries to feet – I would be able to control this through keeping it back from the edge of the lab's benches that I put it on; if any substances are spilled, I would also have to wipe them off the balance immediately in order to preserve its cleanliness and, by extension, its precision in measuring masses of experimental substances. The balance would also need to be checked for damage before each trial.
- Keep mixtures of different types of sugar, distilled water and *S. cerevisiae* away from eyes, skin and tongue, and ask whether anyone else in the lab is allergic to yeast – if there are allergic people, keep *S. cerevisiae* away from them or conduct the experiment in a different room.
- As a product of *S. cerevisiae* fermentation/anaerobic respiration is ethanol, keep the resulting solution from each experimental trial away from flammable hazards because ethanol is very flammable.
- Glass stirring rod, thermometer and watch glasses may break so they should be checked for any chipped edges and/or other damage before use and if they break, glass pieces should not be touched, especially with bare fingers, and should instead be swept up with a brush and dustpan (provided in school labs).

3. Commencement of Experimental Trials

Date	Activities	Ideas/Notes/Thoughts
18/02/2020	Risk Assessment on RiskAssess approved	Use CO_2 Vernier gas probe instead of subverting a plastic measuring cylinder in a container filled with water and recording the water level? The former method would yield more accurate and precise results than the latter
11/03/2020 - 1st day of experiment	Fructose trial 1 completed	Everything went well but setup took too long - need to acquire all equipment and glassware necessitated and collect them in personal plastic box prior to next experimental session
	Glucose trial 1 completed	**Qualitative Observations** • In every single trial, the solution containing disaccharides/monosaccharides, distilled water and *S. cerevisiae* turned into a pale brown colour as its constituent ingredients were mixed together. • A thin layer of light brown froth was produced during each trial of the experiment and increased as the duration of the trials increased.
17/03/2020	Glucose trial 2 completed	
	Maltose trial 1 completed	
	Sucrose trial 1 completed	
18/03/2020	Fructose trial 2 completed	
	Fructose trial 3 completed	
	Maltose trial 2 completed	
	Sucrose trial 2 completed	
19/03/2020	Fructose trial 4 completed	
	Glucose trial 3 completed	
	Maltose trial 3 completed	
	Sucrose trial 3 completed	
20/03/2020	Fructose trial 5 completed	
	Glucose trial 5 completed	

	Maltose trial 4 completed	
	Sucrose trial 5 completed	
25/03/2020 - last day of experiment	Glucose trial 4 completed	
	Maltose trial 5 completed	
	Sucrose trial 5 completed	

4. <u>Research</u>

- 19/02/2020 - From *Biology Course Companion* (Allott and Mindorff, 2014):
  - Types of sugars are disaccharides, monosaccharides and polysaccharides – I should group the types of sugars tested into disaccharides and monosaccharides and analyse results acquired based on their respective characteristics.
  - Disaccharides linked through condensation reactions (endoergic, requires ATP, forms water)
  - *S. cerevisiae* can respire both aerobically and anaerobically (alcoholic fermentation) – simplified equation for aerobic respiration in the presence of glucose is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + ATP; comprises glycolysis, Krebs cycle and oxidative phosphorylation
  - Simplified anaerobic respiration equation is C6H12O6 → 2CO2 + 2C5H5OH + ATP
  - Anaerobic fermentation's real-life applications include manufacturing biofuel, drinks, food, **baking bread** as carbon dioxide produced causes dough to rise – personal engagement
- 28/04/2020 - *Intakes and food sources of fructose in the United States* (Park and Yetley, 1993), stated that fructose is naturally found in fruits, honey and vegetables, while glucose can be found in most dietary carbohydrates and honey; the *CRC handbook of food additives* (Furia, 1973) declared that there is abundant maltose in partially-hydrolysed starch products like acid-thinned starch, corn syrup and maltodextrin and an Indonesian article called *Industri Rafinasi Kunci Pembuka Restrukturisasi Industri Gula Indonesia* (Pakpahan and Supriono, 2005) said that sucrose exists in many plants such as sugar beet and sugarcane, which is where sucrose is mainly extracted from in order to create table sugar
- 28/04/2020 - From *Sugar transport in Saccharomyces cerevisiae* (Lagunas, 1993):
  - *S. cerevisiae* can respire in the presence of any type of sugar, but when it is placed in the presence of both disaccharides and monosaccharides simultaneously, it utilises the latter more rapidly – **use this as a point of analysis in lab report**
- 29/04/2020 – From *On the differing rates of fructose and glucose utilisation in saccharomyces cerevisiae* (Cason, Reid and Gatner, 1987):
  - Glycosidic bonds that link 2 monomers together in disaccharides must be broken down before the monomers can be used in respiration
- 30/04/02020 – From *Sugar utilization by yeast during fermentation* (D'amore, Russell and Stewart, 1989):
  - Generally, *S. cerevisiae* has more affinity for glucose than fructose – **analyse results acquired in regards to this statement**
- 08/06/2020 - From *The differentiation of monosaccharides from disaccharides and polysaccharides and identification of fructose* (Barakat and Abd El-Wahab, 1951):
  - This is because monosaccharides (monomers) need less energy to break down than disaccharides which consist of 2 monomers linked together with a glycosidic bond
- 08/06/2020 – From *Manufacturing, composition, and applications of fructose* (Hanover and White, 1993):

- Fructose is more soluble than other sugar types – **may be important in results' analysis**

- 08/06/2020 – From *Switching the mode of metabolism in the yeast Saccharomyces cerevisiae* (Otterstedt, Larsson, Bill, Ståhlberg, Boles, Hohmann and Gustafsson, 2004):
    - It is possible for *S. cerevisiae* to transition between aerobic respiration and anaerobic respiration because of low remaining concentrations of the sugars and/or low oxygen concentration in environment – type of respiration was not controlled in experiment

5. Results – Raw Data

The uncertainty for the periods of time recorded are ±1 second, as the data were taken from a continuous line graph of time (in seconds) plotted against carbon dioxide concentration (in parts per million) produced by a data logger connected to the Vernier carbon dioxide gas sensor.
The uncertainty for the concentration of carbon dioxide gas produced is ±10% of its reading, as stated by the Vernier carbon dioxide gas sensor manual (Vernier, 2016).

Table 1 – Concentration of Carbon Dioxide Gas Produced During *S. cerevisiae* Respiration in the Presence of Monosaccharide Fructose

	Concentration of Carbon Dioxide Gas Produced in ppm (±10% of reading)									
Trial	**30s**	**60s**	**90s**	**120s**	**150s**	**180s**	**210s**	**240s**	**270s**	**300s**
1	84	161	270	412	581	763	1046	1484	2003	2657
2	195	348	480	671	854	1098	1365	1699	3346	3951
3	402	615	778	926	1074	1281	1535	1969	2607	3344
4	120	255	401	560	761	1008	1349	1869	2482	3142
5	110	251	421	618	846	1126	1594	2114	2710	3354

Table 2 – Concentration of Carbon Dioxide Gas Produced During *S. cerevisiae* Respiration in the Presence of Monosaccharide Glucose

Carbon Dioxide Gas Concentration in ppm (±10% of reading)										
Trial	**30s**	**60s**	**90s**	**120s**	**150s**	**180s**	**210s**	**240s**	**270s**	**300s**
1	4	12	37	78	157	276	416	580	789	1166
2	-14	35	150	293	443	621	810	1009	1353	1844
3	71	180	289	398	519	647	792	961	1729	2188
4	192	335	443	540	638	744	864	1000	1159	1489
5	179	358	491	617	751	923	1145	1486	1913	2376

Table 3 – Concentration of Carbon Dioxide Gas Produced During *S. cerevisiae* Respiration in the Presence of Disaccharide Maltose

Concentration of Carbon Dioxide Gas Produced in ppm (±10% of reading)										
Trial	**30s**	**60s**	**90s**	**120s**	**150s**	**180s**	**210s**	**240s**	**270s**	**300s**
1	145	255	343	425	520	658	800	1002	1266	1573
2	62	132	199	268	349	441	534	655	810	1100
3	51	158	260	375	526	688	869	1062	1368	1761
4	103	227	359	485	631	799	984	1225	1597	2007
5	79	168	270	423	608	833	1082	1373	1810	2295

Table 4 – Concentration of Carbon Dioxide Gas Produced During *S. cerevisiae* Respiration in the Presence of Disaccharide Sucrose

Concentration of Carbon Dioxide Gas Produced in ppm (±10% of reading)										
Trial	**30s**	**60s**	**90s**	**120s**	**150s**	**180s**	**210s**	**240s**	**270s**	**300s**
1	155	265	342	413	479	554	640	738	884	1298
2	236	438	581	717	852	1001	1240	1522	1976	2605
3	13	80	176	291	418	567	738	927	1232	1798
4	66	178	299	421	549	689	852	1043	1314	1757
5	58	150	263	401	610	1900	2526	3060	3561	4163

Note: As yeast cannot respire without the presence of sugar as a source of nutrition, there were no trials in the control condition, i.e. trials that involved no sugar at all.

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