OCR
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AS GCE APPLIED SCIENCE

G623/01/INSERT Cells and Molecules

PLAN FOR AN INVESTIGATION

INSERT

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INFORMATION FOR CANDIDATES

- The abstract on pages 2–3 of this insert is to give you some background that you might find helpful in planning for the task that follows. Not all the information included will be directly relevant and you are expected to select the information that is relevant to the task.
- This document consists of **4** pages. Any blank pages are indicated.

Home brewing

Beer is made from four basic ingredients: grain, water, hops and yeast. The basic idea is to extract the sugars from grains (usually barley) so that the yeast can turn them into alcohol and CO_2, creating beer.

Malting

The brewing process starts with grains, usually barley (although sometimes wheat, rye or other grains). The grains are harvested and processed by heating them, drying them out and cracking them open. The main goal of malting is to isolate the enzymes needed for brewing so that it's ready for the next step.

Mashing

The grains then go through a process known as mashing, in which they are steeped in hot, but not boiling, water for about an hour. This activates enzymes in the grains that cause them to break down and release their sugars. Once this is all done the water is drained from the mash. The water is now full of sugar from the grains. This sticky, sweet liquid is called wort – it's basically unmade beer.

Boiling and fermenting

The wort is boiled for about an hour while hops and other spices are added. Once the boil is over the wort is cooled, strained and filtered. It's then put in a fermenting vessel and yeast is added to it. At this point the brewing is complete and the fermentation begins.

MASHING DEFINED

Mashing is the brewer's term for the hot water steeping (soaking) process which hydrates the grain, activates the malt enzymes, and converts the grain starches into fermentable sugars. There are several key enzyme groups that take part in the conversion of the grain starches to sugars. During malting, the debranching, beta-glucanase, and proteolytic enzymes do their work, preparing the starches for easy access and conversion to sugars. During the mash, a limited amount of further modification can be accomplished, but the main event is the conversion of starch molecules into fermentable sugars and unfermentable dextrins by the enzymes. Each of these enzyme groups is favoured by different temperature and pH conditions. A brewer can adjust the mash temperature to favour each successive enzyme's function and thereby customize the wort to their taste and purpose.

The starches in the mash are about 90% soluble at 130 °F and reach maximum solubility at 149 °F. Both malted and unmalted grains have their starch reserves locked in a protein/carbohydrate matrix which prevents the enzymes from being able to physically contact the starches for conversion. Unmalted grain starch is more locked-up than malted. Crushing or rolling the grain helps to hydrate the starches during the mash. Once hydrated, the starches can be made soluble by heat alone or by a combination of heat and enzyme action. Either way, an enzymatic mash is needed to convert the soluble starches to fermentable sugars.

Brewing enzymes

All brewing enzymes are active below their stated range. However, at lower temperatures, they are working more slowly. The top end of an enzyme's range is determined by the enzyme's activity and denaturation point. Heating a mash over the top end of an enzyme's range does not cause that enzyme to stop working instantly. It takes time for enzymes to denature. In some cases, enzymes will actually denature within their stated range. For example, at 149 °F (65 °C), beta-amylase is denatured within 40–60 minutes and alpha-amylase activity will cease after 2 hours at 153 °F (67 °C). The point is, that by changing mash temperatures, you are not cleanly switching enzymes on and off. Due to their simple mechanism of action, your control over them is much less precise.

Table 1 Brewing enzymes

Enzyme	Optimal Temp. Range		Maximize the Enzyme		Denatures	
	°F	°C	°F	°C	°F	°C
Phytase	86–128	30–53	95	35	~140	60
β-glucanase	95–131	35–55	113	45	~140	60
Peptidase	113–128	45–53	122	50	~145	63
Proteinase	122–138	50–59	136	58	~155	68
β-amylase	130–150	54–66	148	64	~160	71
α-amylase	150–160	66–71	158	70	~170	77