SIMPSONS MALT

The home of good malt

The Science of Mashing

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IBD 25/10/17

Purpose

mash (măsh)

n.

1. A mixture of malt or other ingredients with water, heated to convert starches into fermentable sugars for use in brewing or distilling.

2. A mixture of ground grain and nutrients fed to livestock and fowl.

3. A soft pulpy mixture or mass.

4. *Chiefly British* Mashed potatoes.

5. A crushing or grinding.

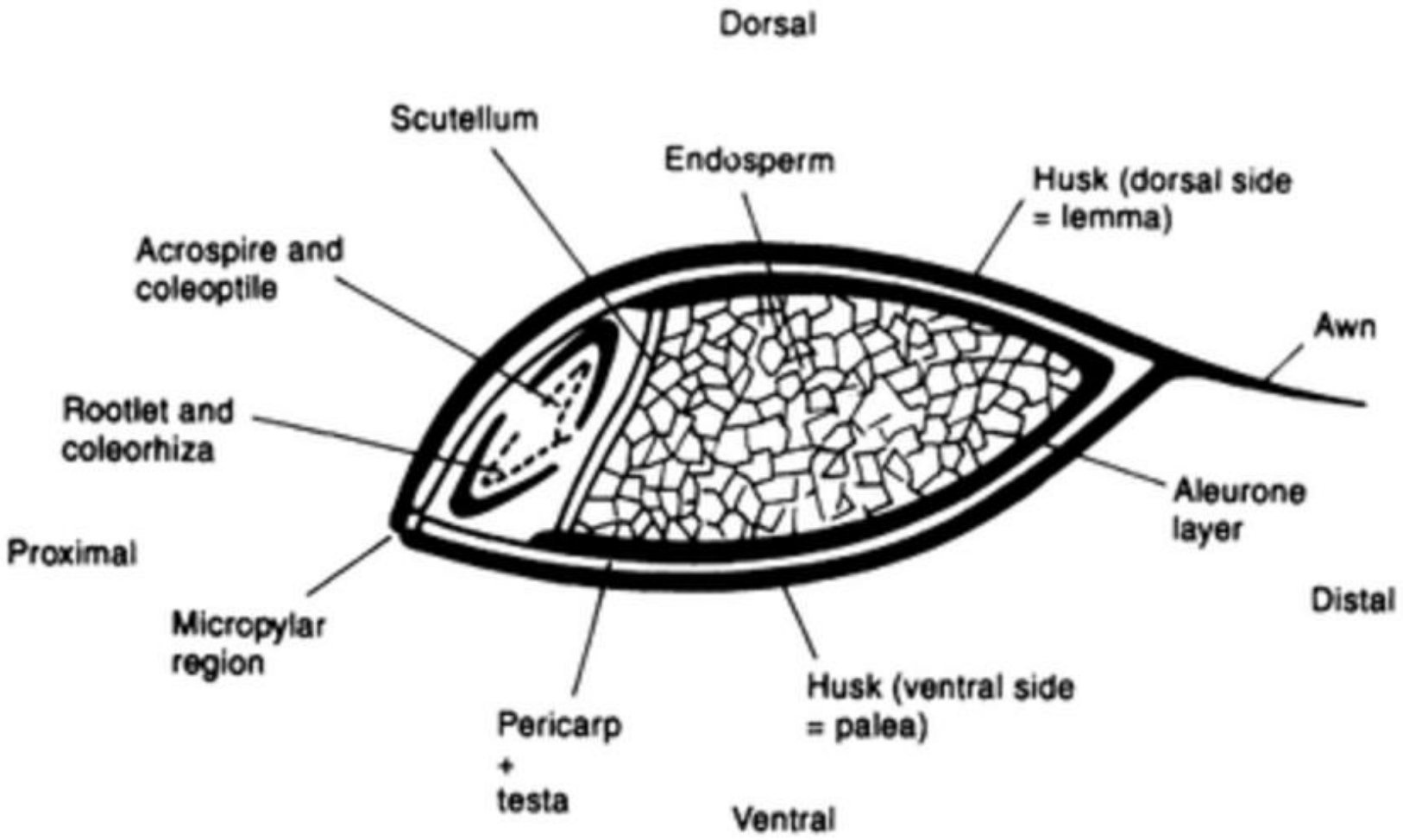
6. *Slang* An infatuation or act of flirtation.

Purpose

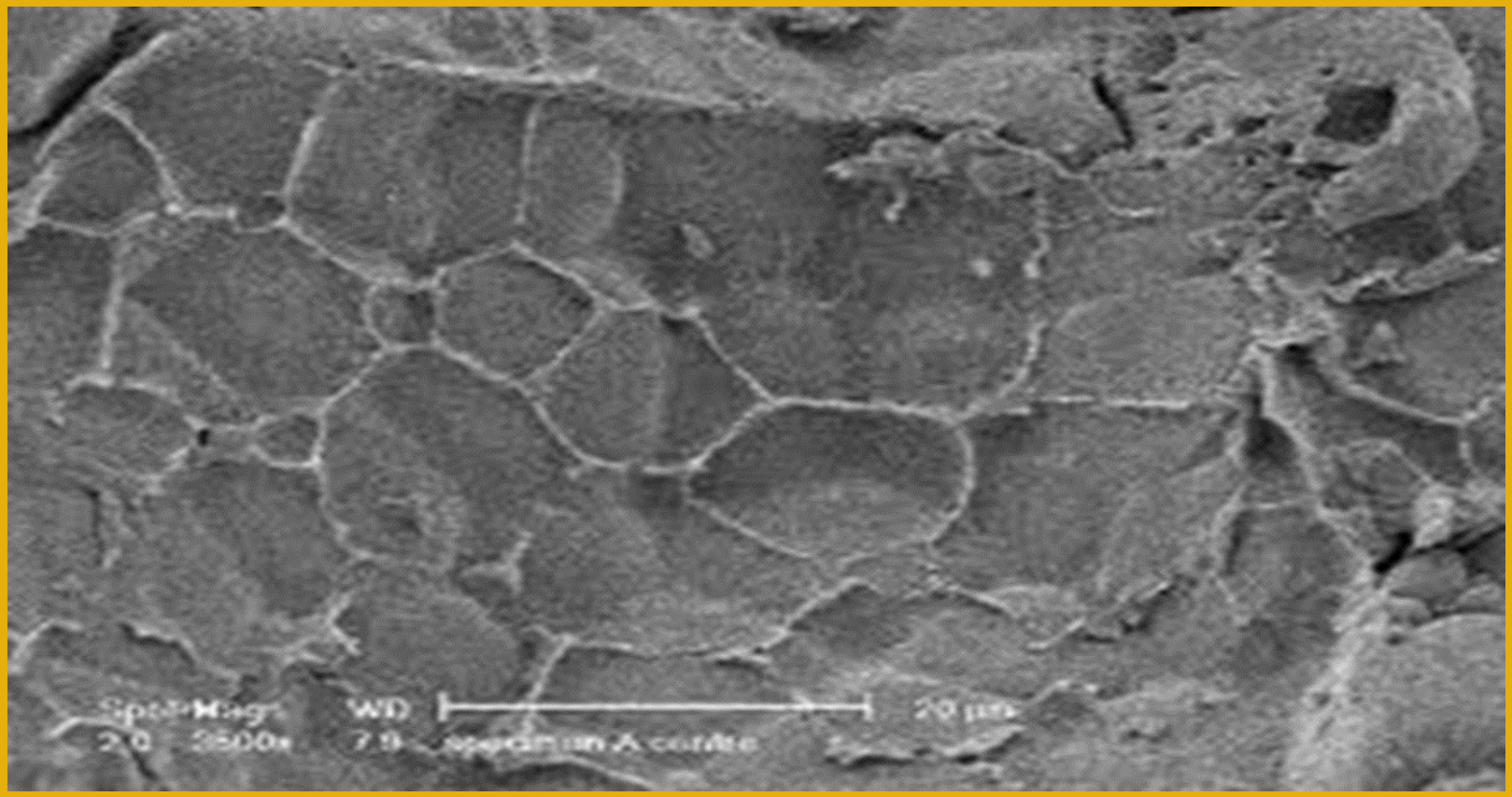
- Extract the starch from a source
- Convert the starch into a sugar that can be utilised by Yeast
- Control the extent of conversion
- Extract what is wanted and leave behind what is not

- Starch source
- Water
- Process

A Source of Starch - Barley

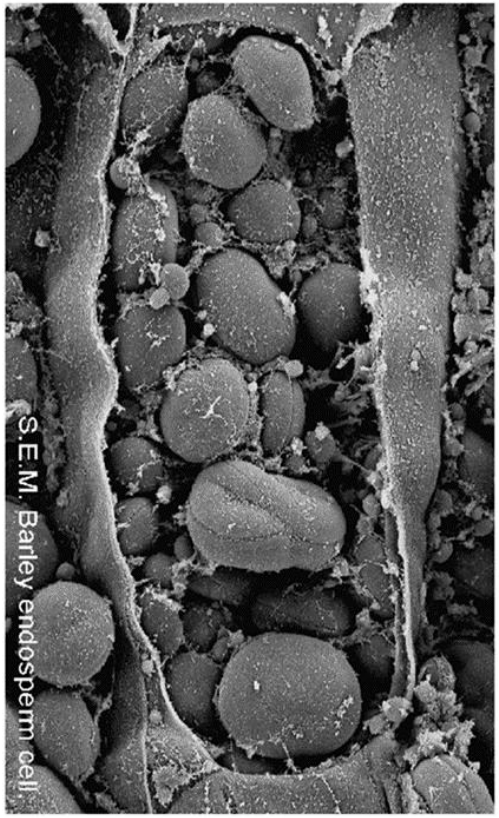


Barley



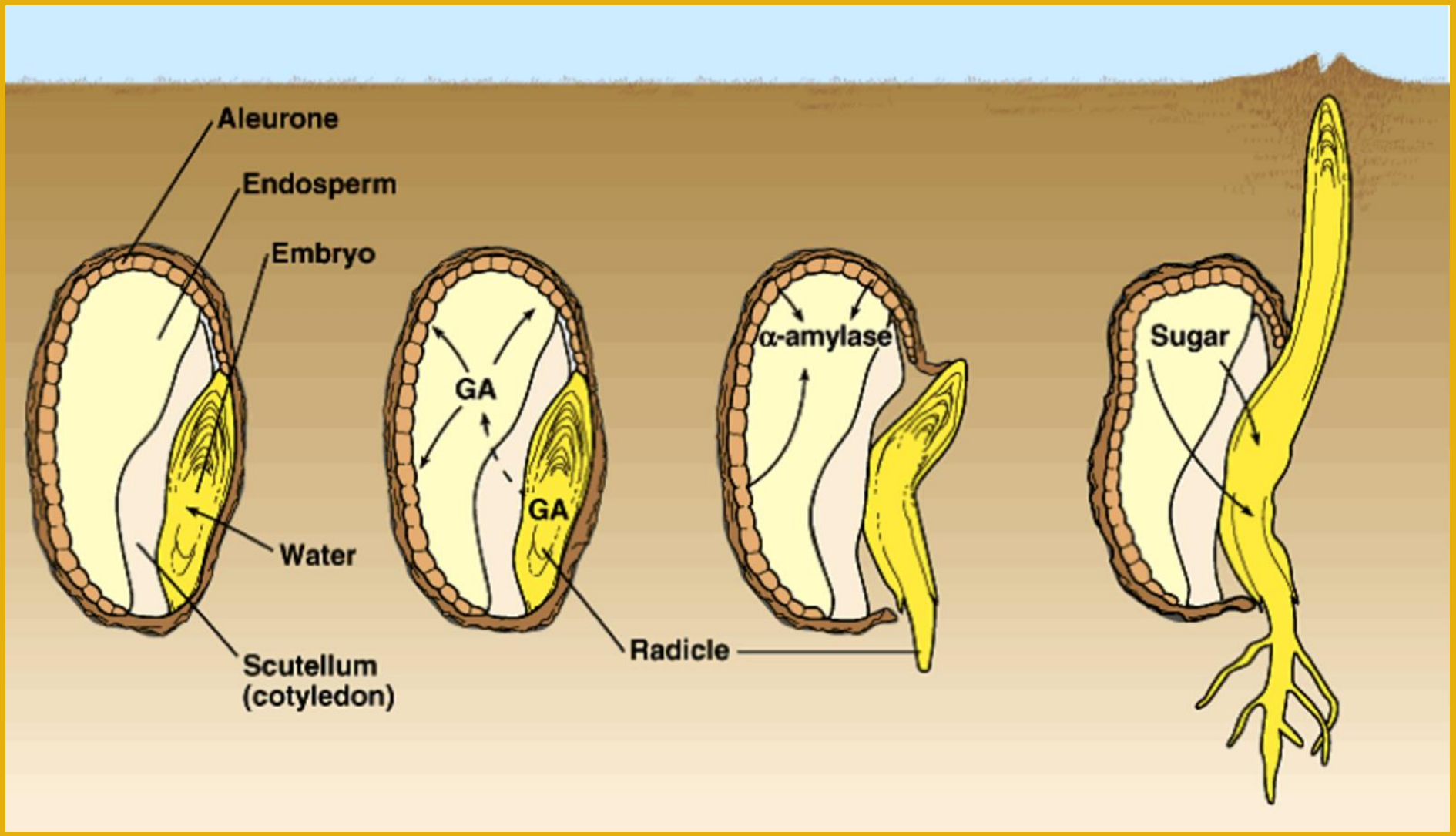
Barley

- Contains:
  - Starch
  - Protein
  - Beta Glucans and Gums
  - Polyphenol in husk
- Need to prepare the barley for quick extraction and degradation at the brewery
- Malting



Barley endosperm cell (S.E.M.)

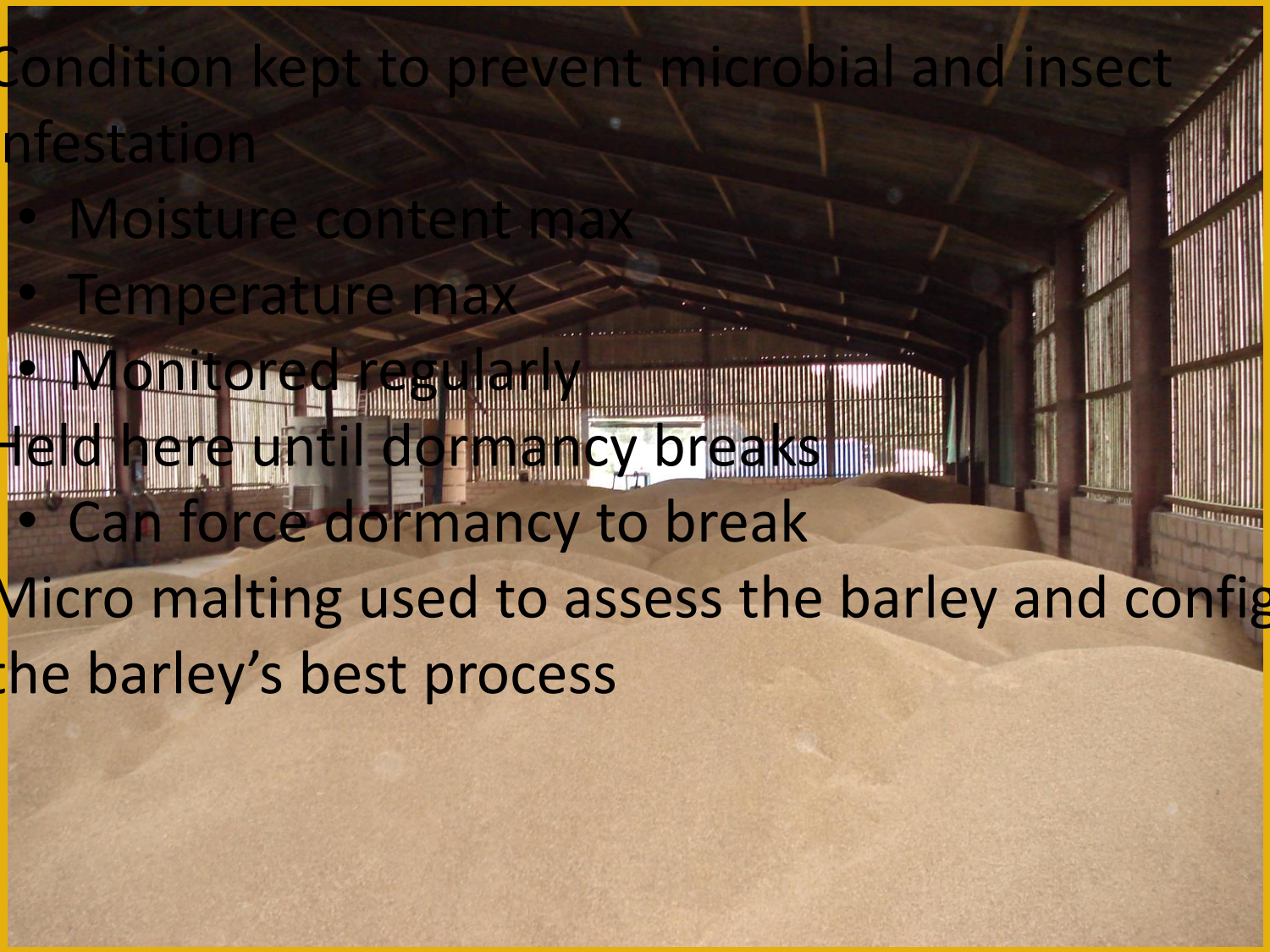
Germination



Harvest

- Grown on light soil
- Winter and spring varieties
- Harvest Winters then Wheat then Springs

Storage



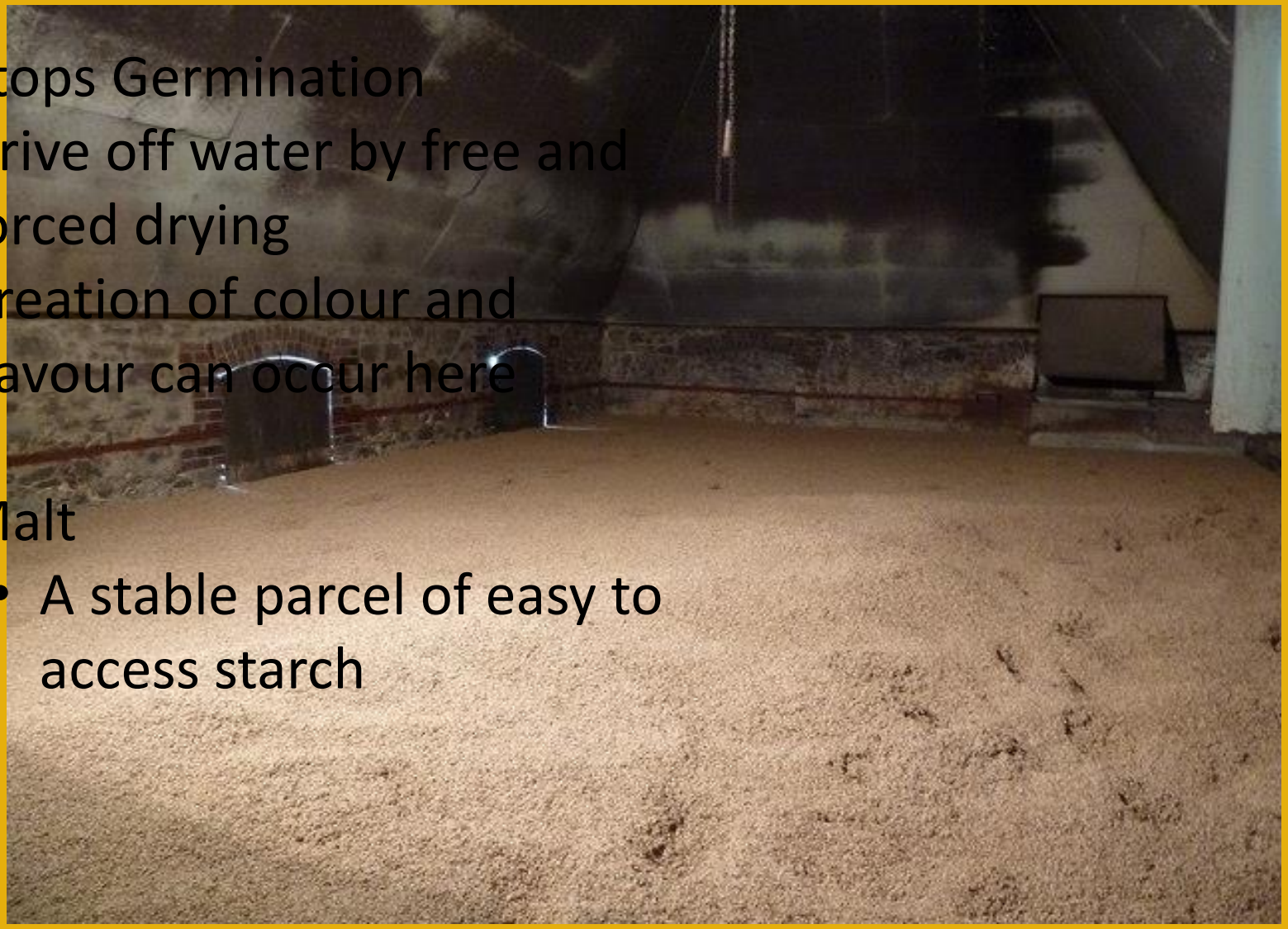
- Condition kept to prevent microbial and insect infestation
  - Moisture content max
  - Temperature max
  - Monitored regularly
- Held here until dormancy breaks
  - Can force dormancy to break
- Micro malting used to assess the barley and configure the barley's best process

Steep

- Soaking and air rests
- Mimics rainfall
- Triggers germination in non dormant grain

Gemination

Kiln



- Stops Germination
- Drive off water by free and forced drying
- Creation of colour and flavour can occur here

- Malt
  - A stable parcel of easy to access starch

Germination and Kilning

Approved UK Barley

- There are approved varieties of barley
- Must pass through a number of standards in order to be approved
  - Seed
  - Agronomic
  - Malting
  - Brewing

PROGRESS TO IBD FULL APPROVAL

(Stairway to Heaven)

POSITION OF VARIETIES UNDER TEST AT 19 May 2017

F8 & F9 NL1 and NL2 Year 0	F10 RL1 Year 1	F11 RL2 Provisional Approval (1) Year 2	>F11 Provisional Approval (2)	>F11 Full Approval Harvest 2018
Micromalt *England* NIAB EMMG *Scotland* SMMG	Micromalt *England* NIAB EMMG *Scotland* SMMG	Macroscale Maltsters Brewers Distillers	Macroscale Maltsters Brewers Distillers	In Commercial Use
				Flagon w B Venture w B Talisman w B Concerto s BD Odyssey s BD Octavia s BD Laureate s BD Propino s B KWS Irina s B RGT Planet s B Sienna s D KWS Sassy s D Belgravia s G
			Craft w B Fairing s G	
		Chanson s B		
2 w B 5 s B 5 s BD 1 s BDG 1 s BG 1 s D 2 s DG	Coref w B Electrum w B Diablo s BD Asteroid s BDG Figaro s D Tomahawk s D Dioptric s G			

F8/9/10/11 = stage in seed production
NL1/NL2/RL1/RL2 = stage in official testing
s = spring variety
w = winter variety

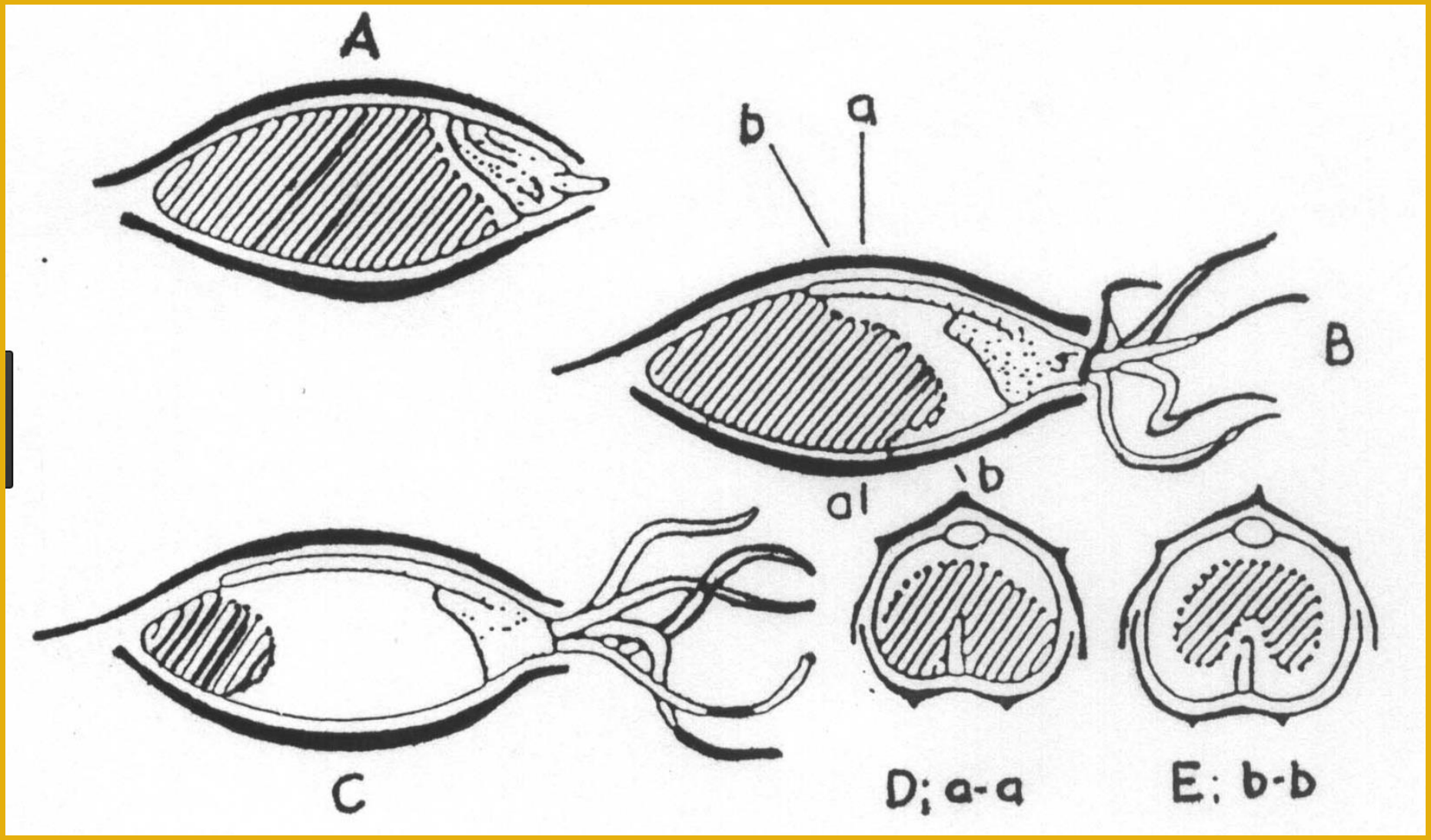
B = approved for Brewing use
D = approved for Malt Distilling use
G = approved for Grain Distilling use

Malt Specification

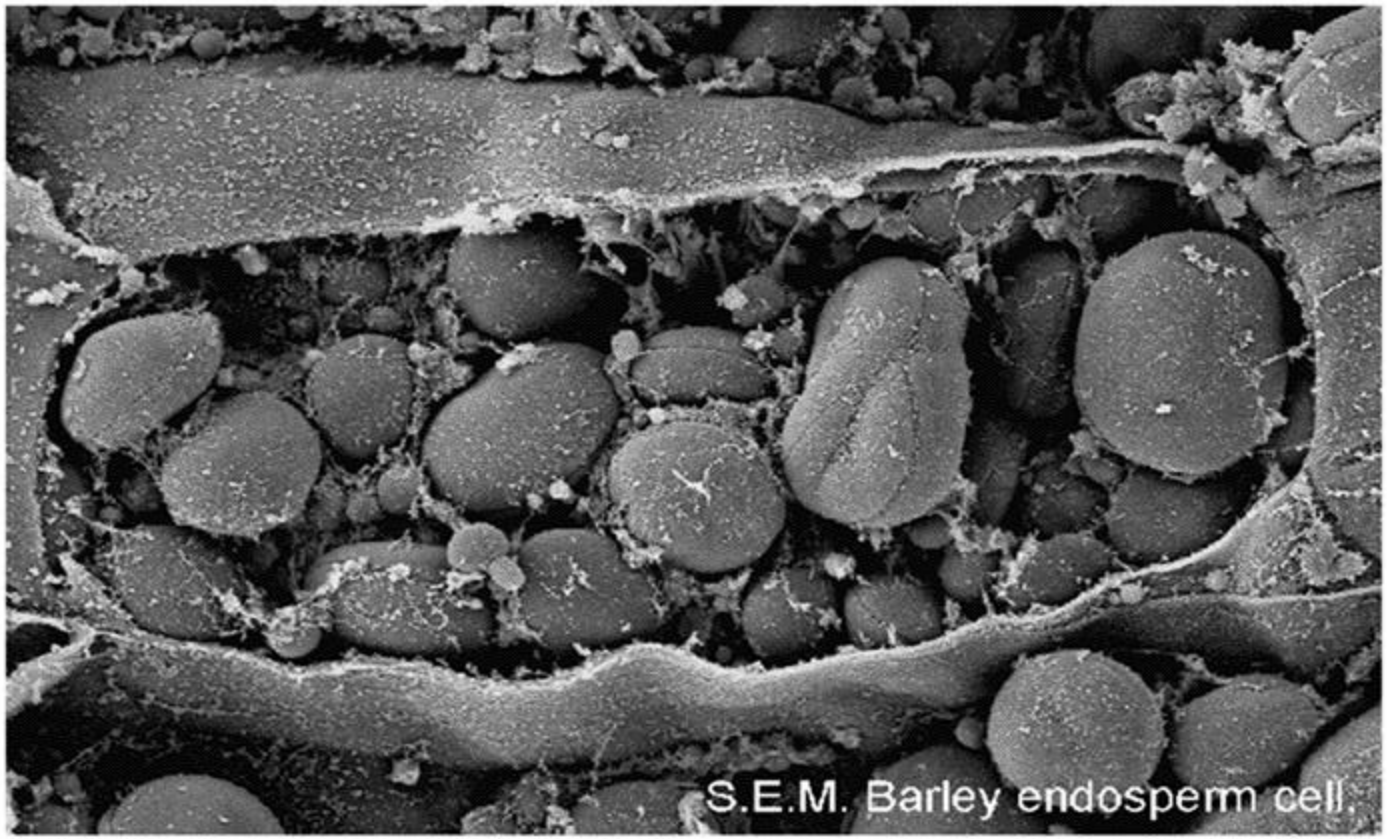
Malt Specification
Finest Pale Ale Malt (Golden Promise)

Analysis		***Min***	***Max***
Moisture %	:		3.7
Extract lt°/kg (7 Dry)	:	306	
Colour °EBC	:	3.5	5.0
Total Nitrogen %	:		1.55
Total Soluble Nitrogen %	:	0.58	0.68
Soluble Nitrogen Ratio	:	38.0	44.0
Friability %	:	85	
Homogeneity %	:	99	
Steely Corns %	:		2.0
Glucan I Wort (ppm)	:		120
Diastatic Power IOB “dry”	:	45	65
Screenings % <2.2mm	:		2.0
NDMA (ppb)	:		1.5

Germination



Mashing Chemistry



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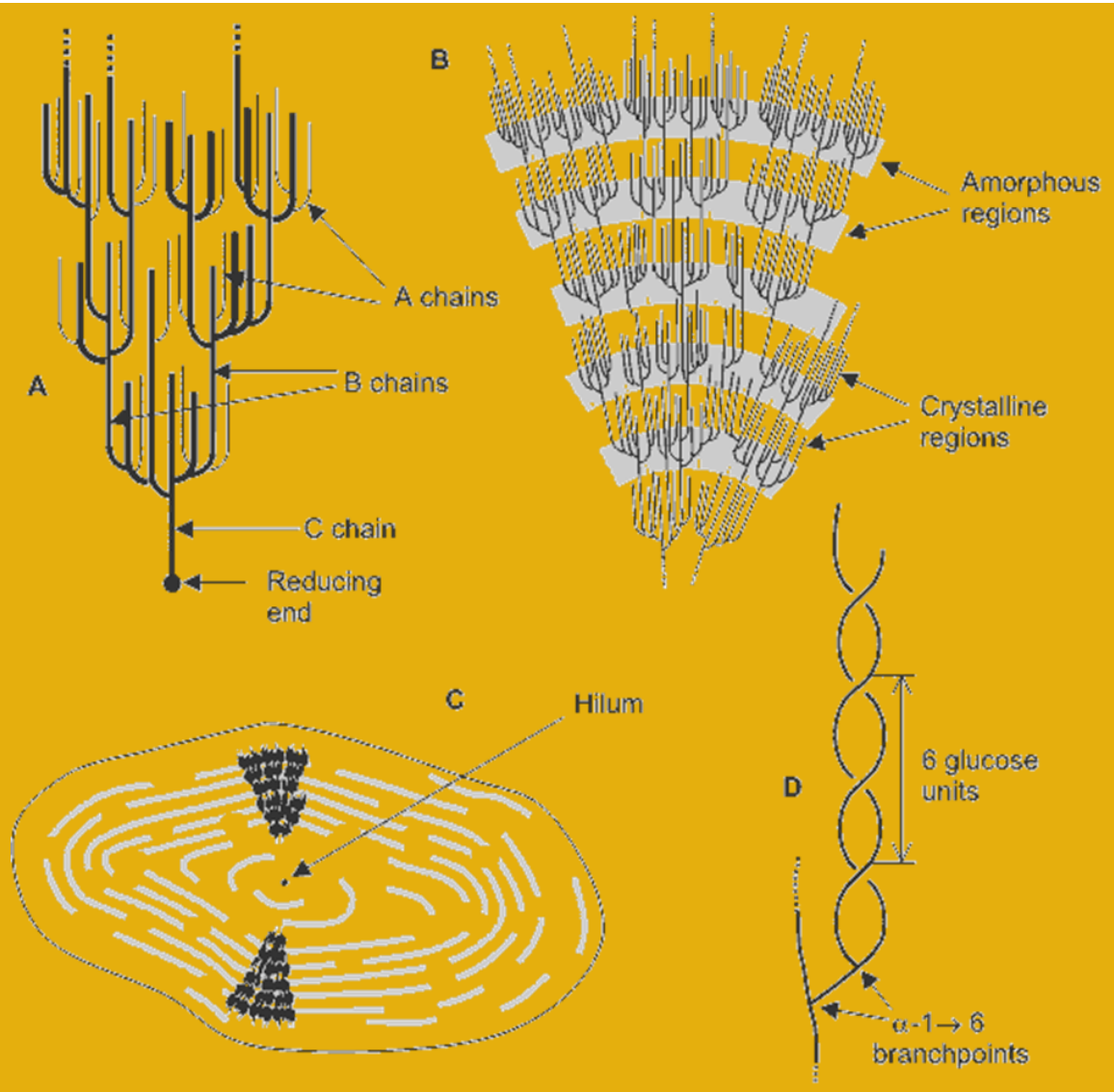

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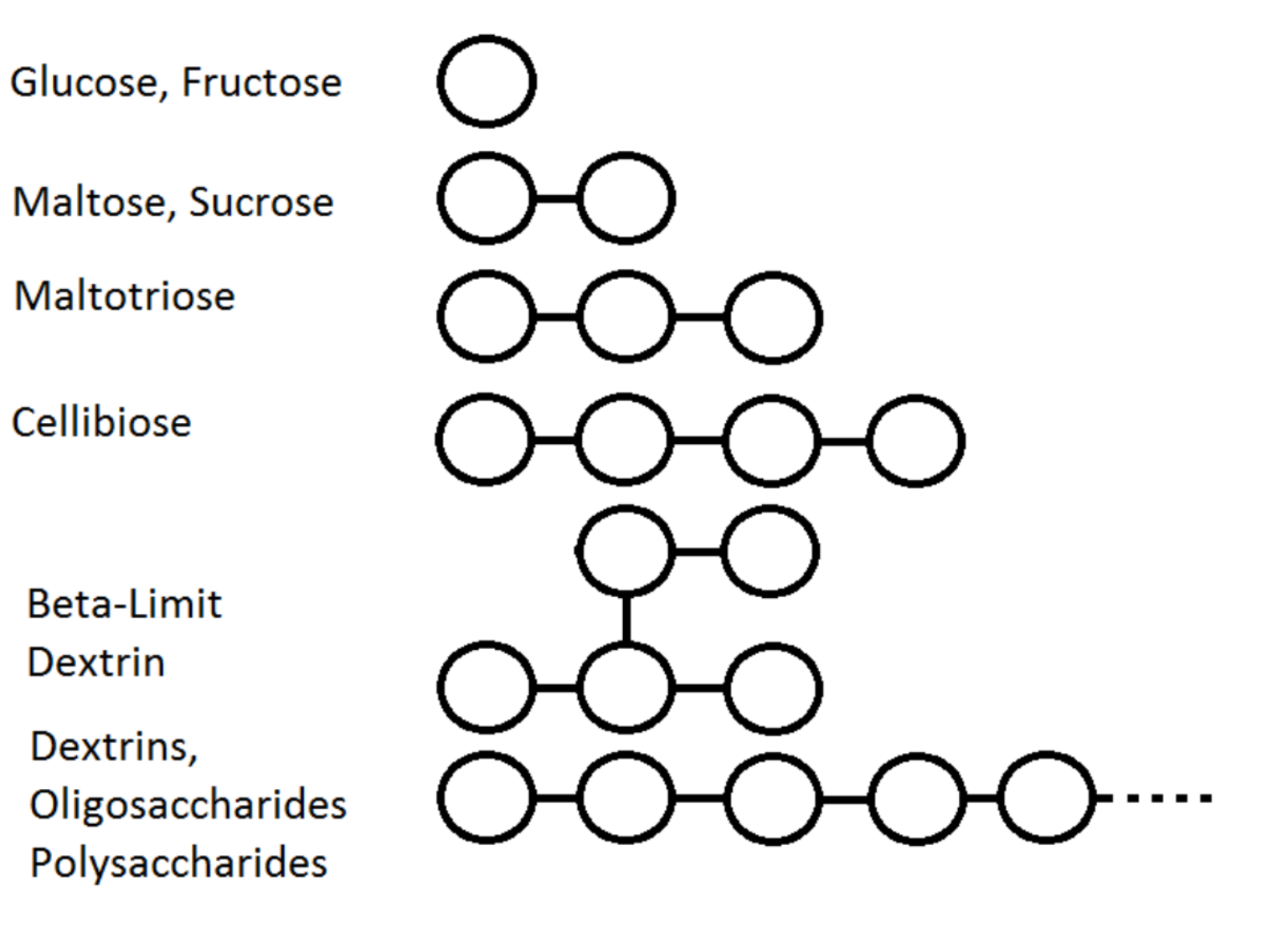

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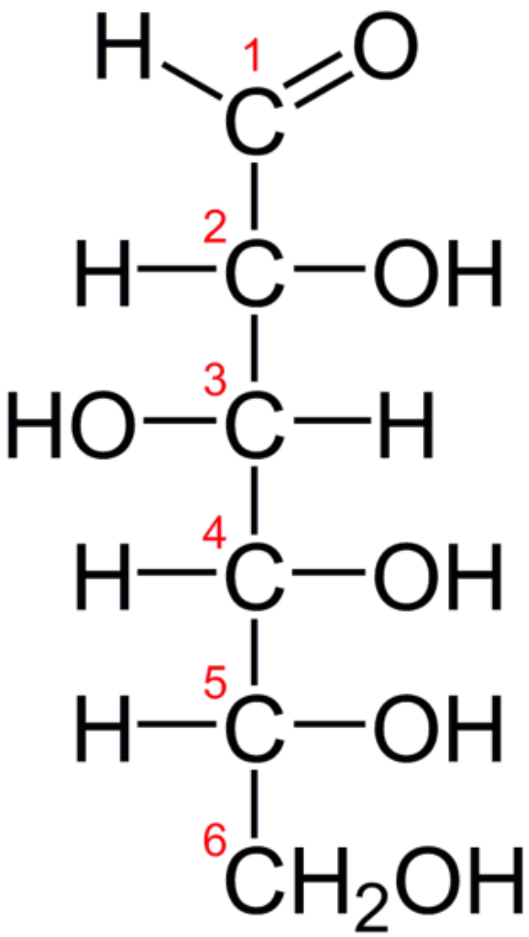
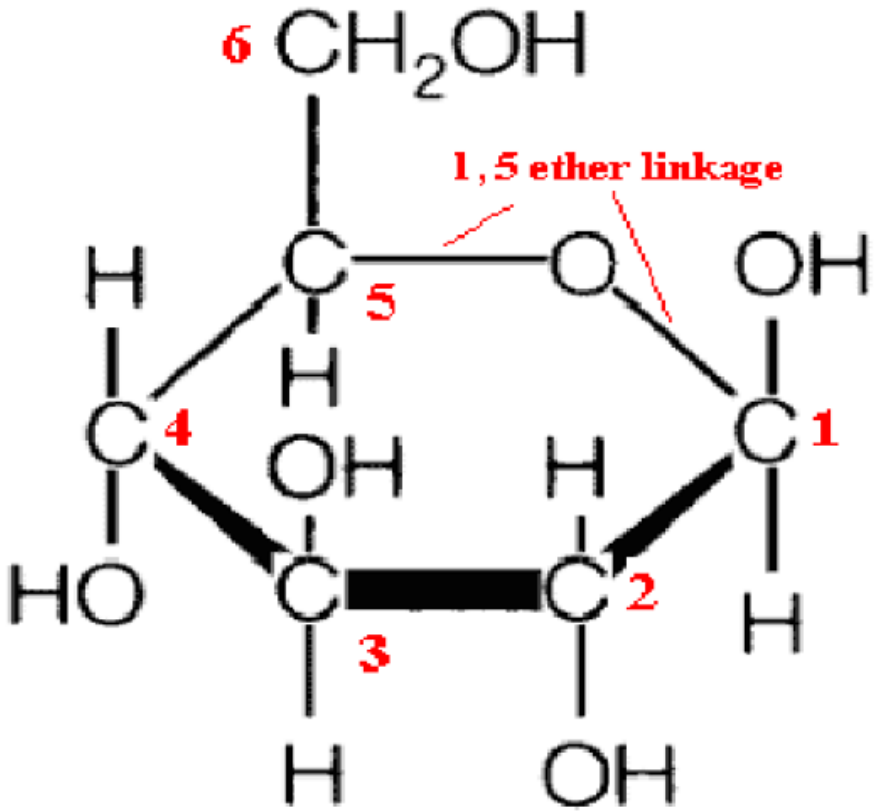
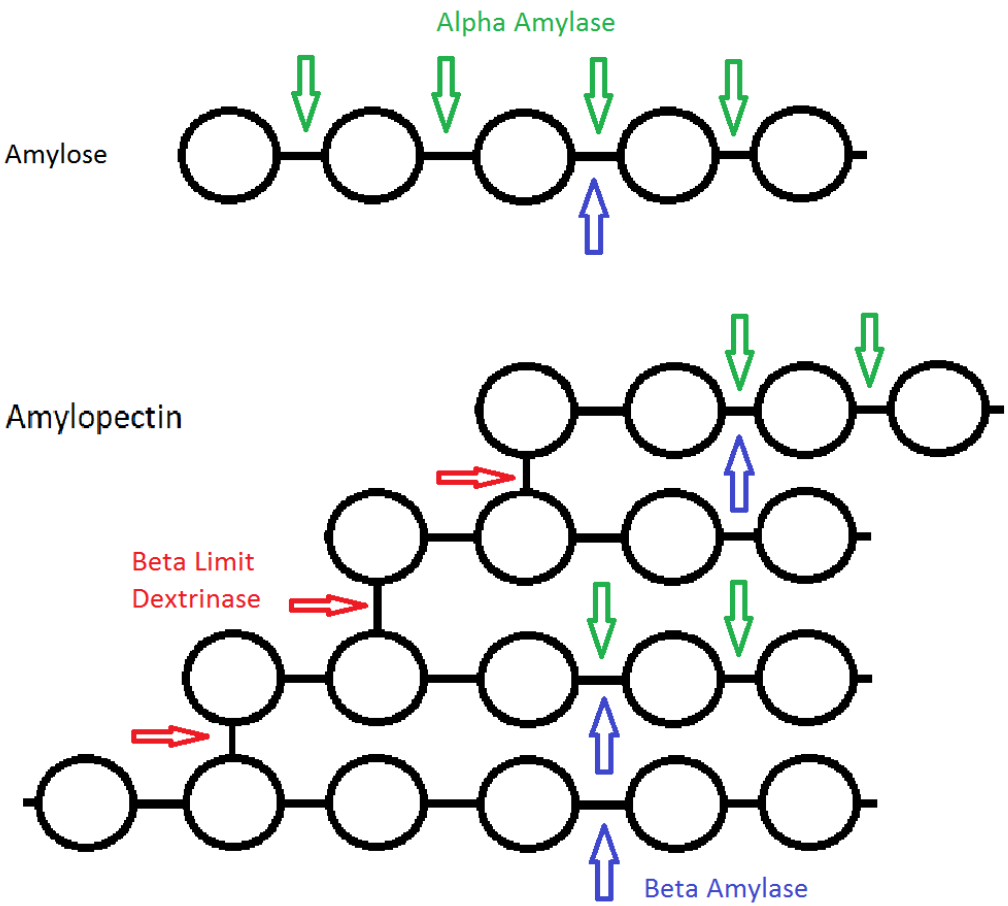




D-glucose

Mashing Chemistry



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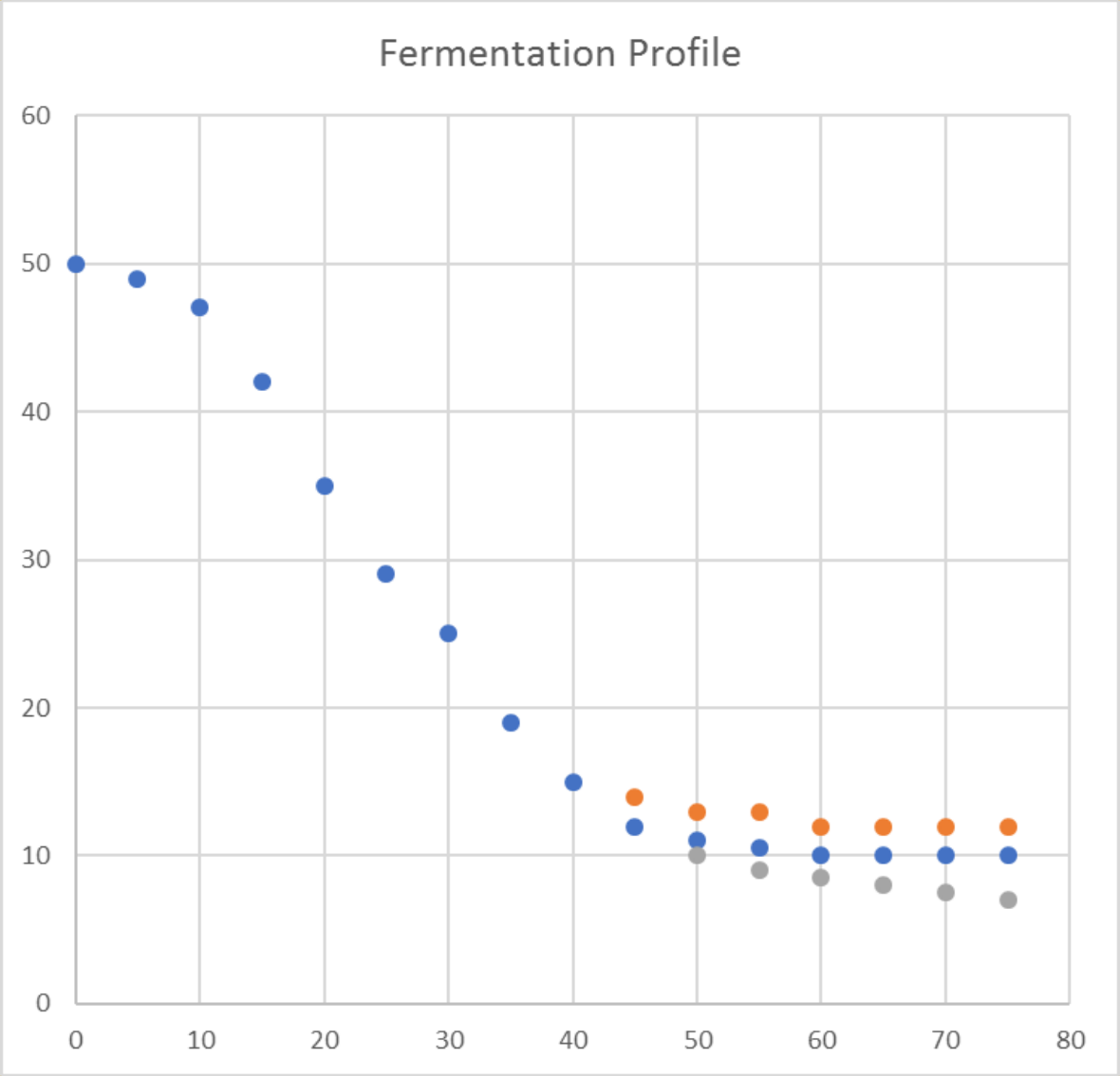
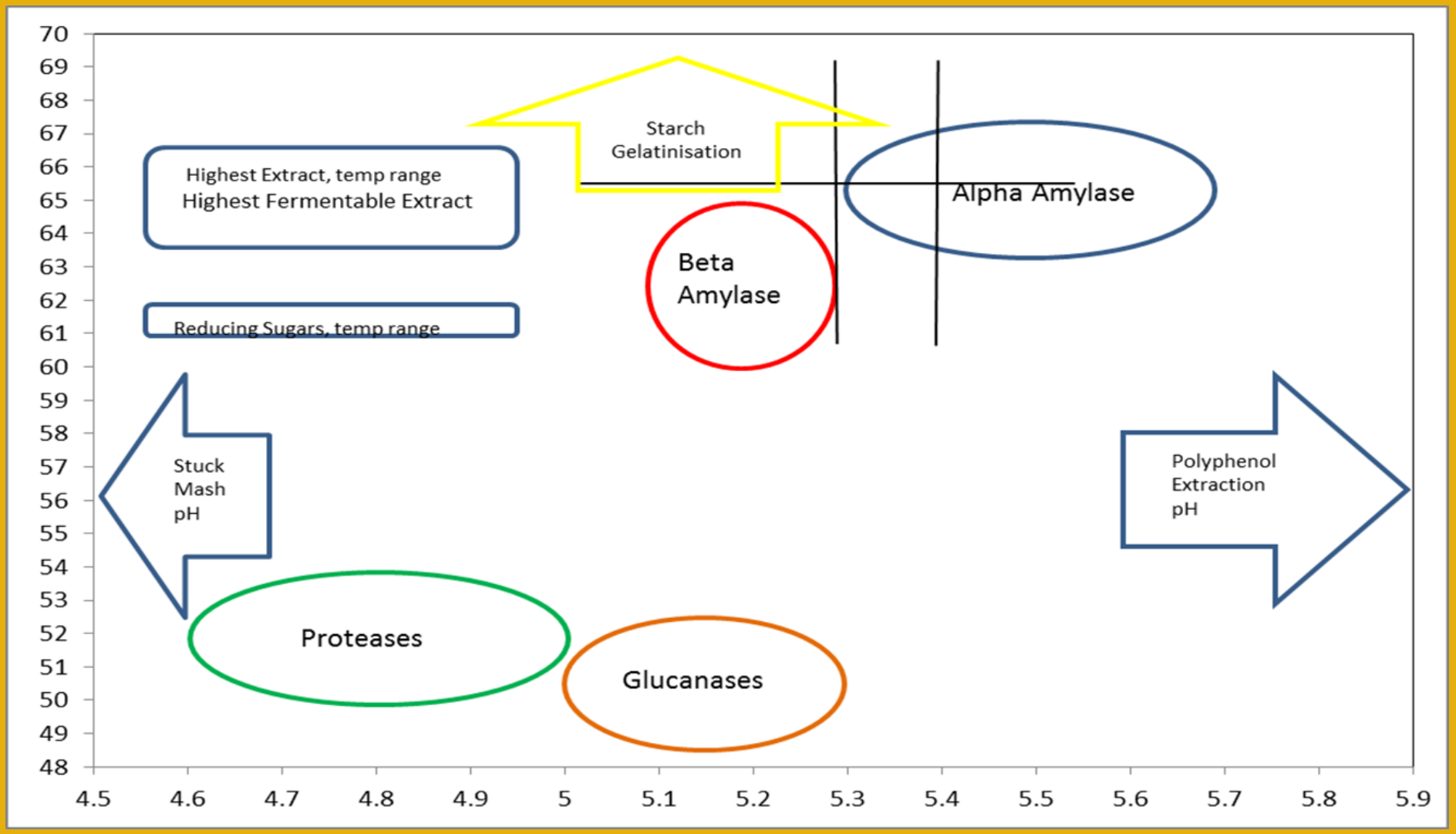


Optimal Conditions



Water

$$H_2O \Leftrightarrow H^+ + OH^-$$

$$pH = \log_{10}\{1/H^+\}$$

Water

- pH is the logarithm of the reciprocal of the hydrogen ion concentration.
- The pH of the incoming water has little effect upon the pH of wort and beer.
- The critical factor is alkalinity (bicarbonate) of brewing liquor
- The whole of the brewing process is pH dependent

Water

	pH
Liquor	6.0 – 8.0
Mash	5.2 – 5.5
1st Runnings	4.8 – 5.2
Last Runnings	< 5.6
Wort at Copper Up	5.1 – 5.4
Wort at Copper Out	4.9 – 5.2
Beer post fermentation	3.8 - 4.2

pH control in the Mash

- $CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow HCO_3^- \Leftrightarrow CO_3^{2-}$
- ←
- The presence of Carbonates in the mash removes Hydrogen ions, raising the pH
- $H_3PO_4 \Leftrightarrow H_2PO4^- \Leftrightarrow HPO_4^{2-} \Leftrightarrow PO_4^{3-} \Rightarrow Ca_3(PO_4)_2$
- →
- The presence of Calcium in the mash adds Hydrogen ions, lowering the pH
- For an infusion mash using a standard Pale Ale Malt we target 200ppm of Calcium and less than 40ppm alkalinty as Calcium Carbonate in the liquor to achieve pH of 5.2-5.4

Mashing Process Oveview

- Grist particles hydrate, starch granules swell and gelatinise
- Low MW particles solubilise and are degraded by enzymes
- Enzymes disperse through the mash liquor to reach substrate
- Enzymes breakdown the large polymers that are then solubilised and degraded t
- Enzymes become deactiva

Mashing Process

- Therefore the following parameters will contribute to the composition of the wort produced
  - Milling
  - Mashing
  - Liquor to grist ratio
  - The mash stand temperature
  - The mash pH
  - The duration of the mash star

Milling

- Pre milled against own mill
- Extract against run off
  - Degree of crush is a balance
  - Low crush gives best run off
  - High crush gives best extract

  - Sieves, 40:25:25:10, Husk: Coarse: Fine: Flour
  - Husk open but in large pieces
  - Endosperm broken but not all flour

Mashing

- Aim is to hydrate the crushed malt and form a floating bed at a predetermined temperature
- Preparation:
    - Preheat insulated mash tun, then drain
    - Cover the plates with liquor
- Ensure plenty of treated liquor for mash and sparge is available at a controlled flow rate
- Use cold liquor to hit ‘Strike’ temperature
- Target mash at 65°C, liquor:grist 2.5Litres:1kg
- Ensure grist and liquor mix efficiently

Mashing

- Mash Thickness
  - Increased liquor to grist ratios, thinning the mash:
    - Reduces the stability of mash enzymes
    - Dilutes enzymes and substrates
    - Leads to quick conversion but rapid destruction of enzymes
    - Used in Decoction systems as mash is pumped and roused
  - Thicker mashes are stable but risk poor hydration

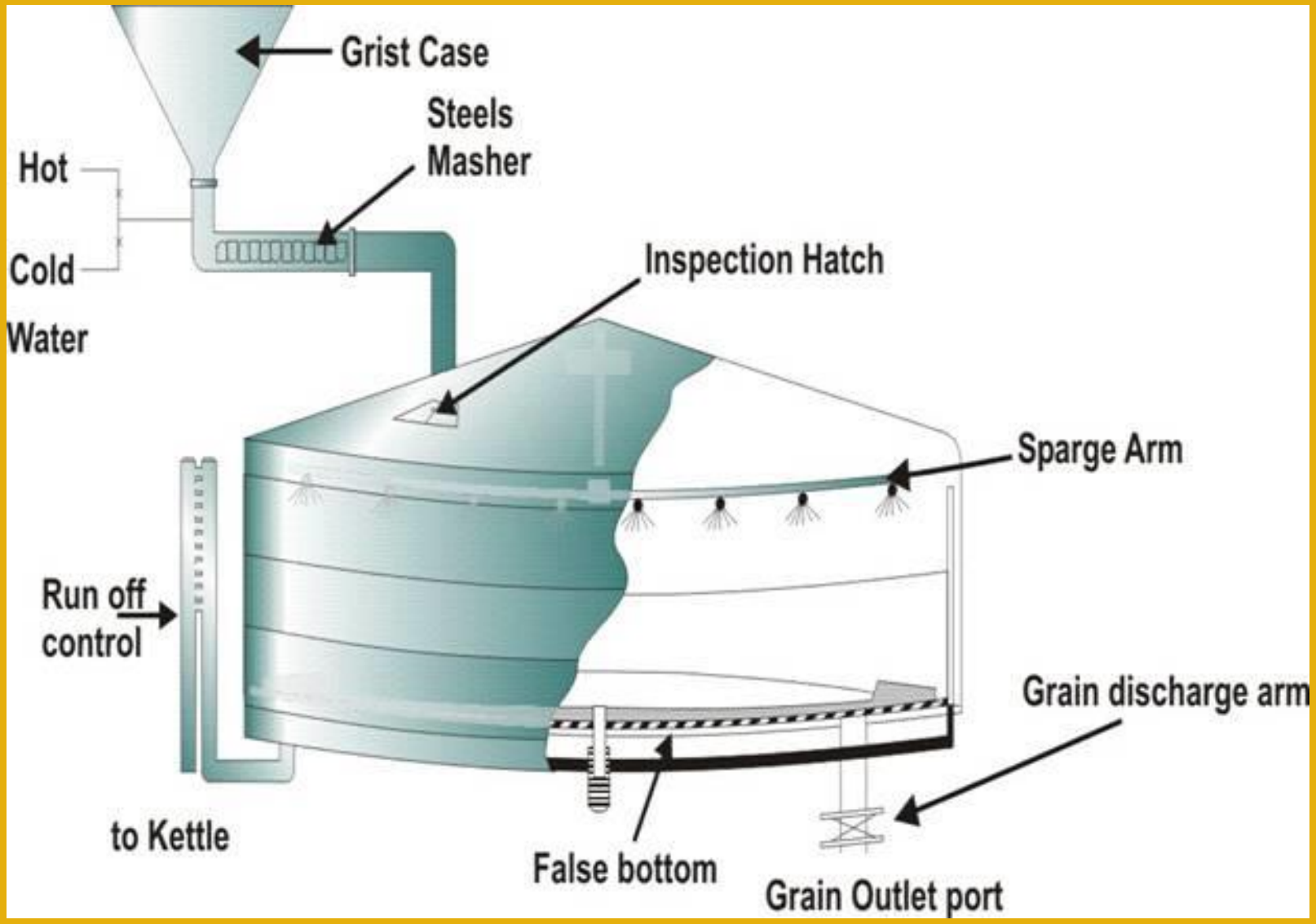
Mashing

- Strike Heat

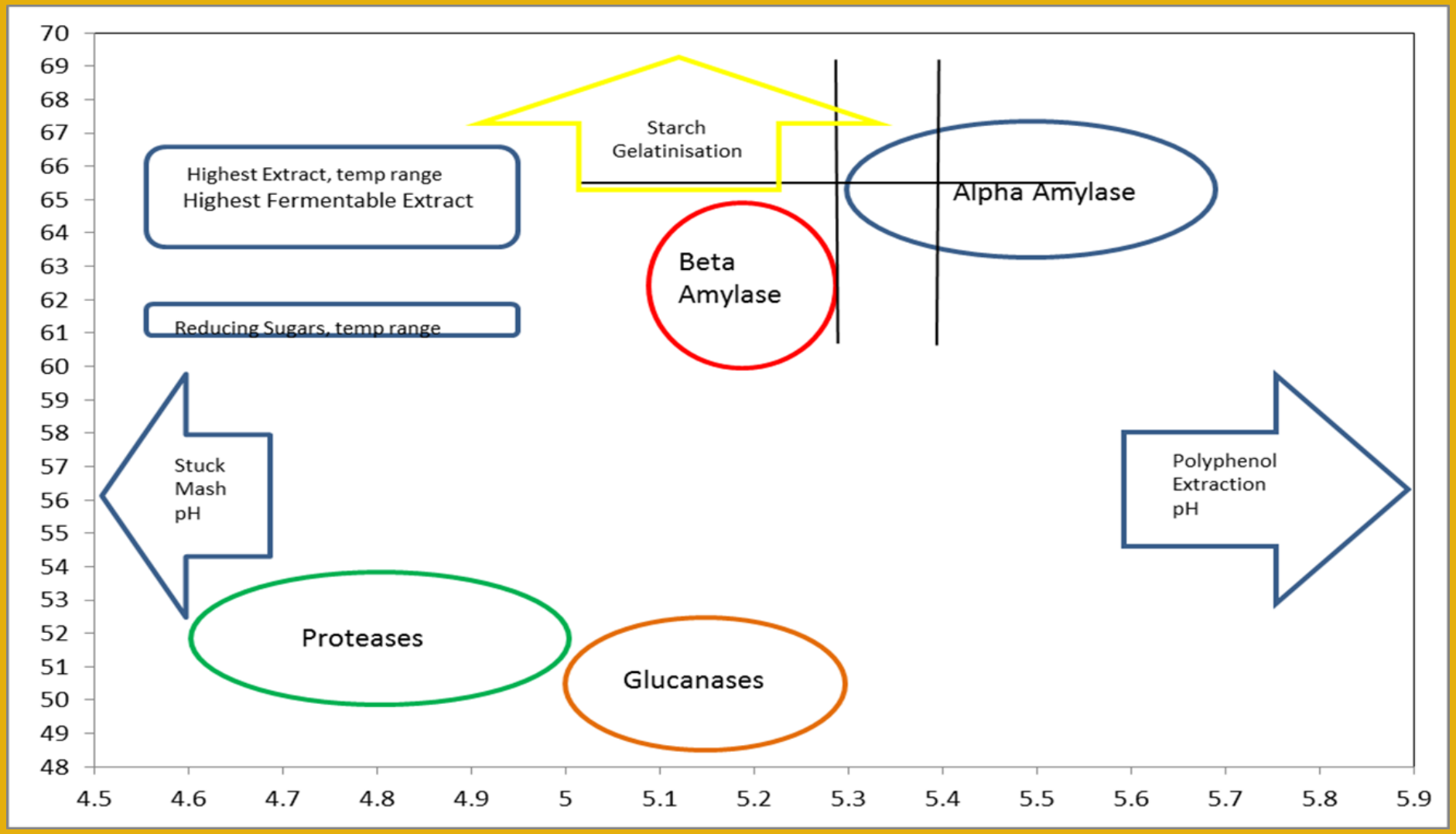
$$\text{Initial Heat} = \frac{St + RT}{S + R} + \frac{1/2H}{S + R}$$

  - S specific heat of malt
  - T temperature of malt
  - R liquor to grist ratio
  - H is slaking heat of malt
    - Strike heat can be above 69°C for a 65°C Mash Stand

Mashing


Grist Case
Steels
Masher
Hot
Cold
Water
Inspection Hatch
Sparge Arm
Run off
control
Grain discharge arm
to Kettle
False bottom
Grain Outlet port

Mash Conditions



Mash Conditions

	pH	Temperature
Highest Extract	5.2-5.4	65-68
Most Fermentable	5.3	65
alpha amylase max activity	5.3-7.2	70
Beta amylase max activity	5.1-5.3	60-65

Mash Conditions

- Increased Mash temperature
  - Gelatinises starch and hydrates grist particles quickly
  - Speeds up enzyme action
  - Reduces the viscosity of the wort
  - Inactivates the enzymes

- A 1 hour infusion mash at optimal temperature, pH and thickness will give greatest extract and an attenuation of approximately 80%

Sparge

- Time and Temperature
  - To halt enzyme action and fix sugars 75-80°C
  - Wort less viscous
- Flow rate
  - To wash out sugars efficiently
  - 1.5 hrs standard
- End of run off
  - pH control
- Bed depth
  - The need to recirculate

Good Mashing

Control

- Raw materials
- pH
- Temperature
- Hydration
- Time

Means

- Quality Malt
- Liquor treatments
- Measured and Controlled
- Volume and Flow Rate
- Measured and consistent

Consequenses

- Poor extract
- High or low attenuation
- Excess polyphenol and silicate
- Starch
- Beta gluten and protein issues

SIMPSONS MALT

The home of good malt

Any Questions

Jamie Ramshaw M Brew