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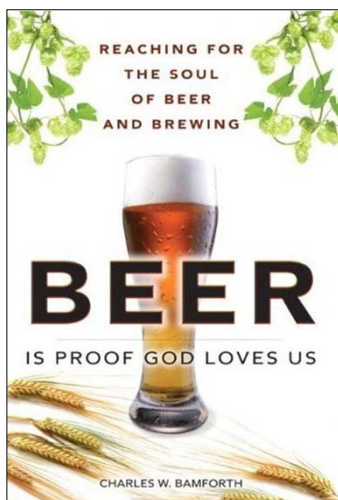
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You could be the lucky winner!



One lucky winner will receive a signed, hardback copy of Charlie's book, *Beer is Proof God Loves Us: Reaching for the Soul of Beer and Brewing!*

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Do You Know a Hero of Chemistry? Nominate them now

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Tuesday, April 5, 2011

Successfully Working with Recruiters – Dos and Don'ts

Patrick Ropella, Ropella, and Don Alexander, Carlyle & Conlan



Thursday, April 7, 2011

Optimizing the Workplace Across Five Generations of Scientists

Tamara Erickson, author and trainer on how to build an innovative organization

ACS WEBINARS™
March 31, 2011



Advanced Chemistry of Beer and Brewing



Charles Bamforth,
UC Davis



Steve Carlo,
Chemist, Homebrewer

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Advanced Chemistry of Beer and Brewing

Charlie Bamforth



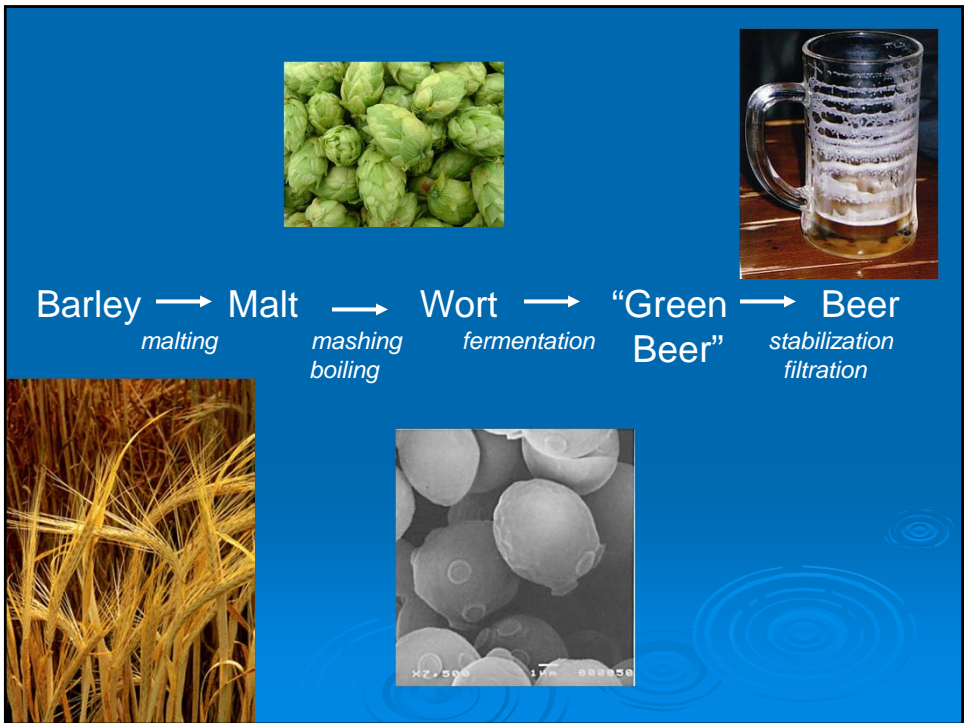
March 31 2011



Quality of Beer

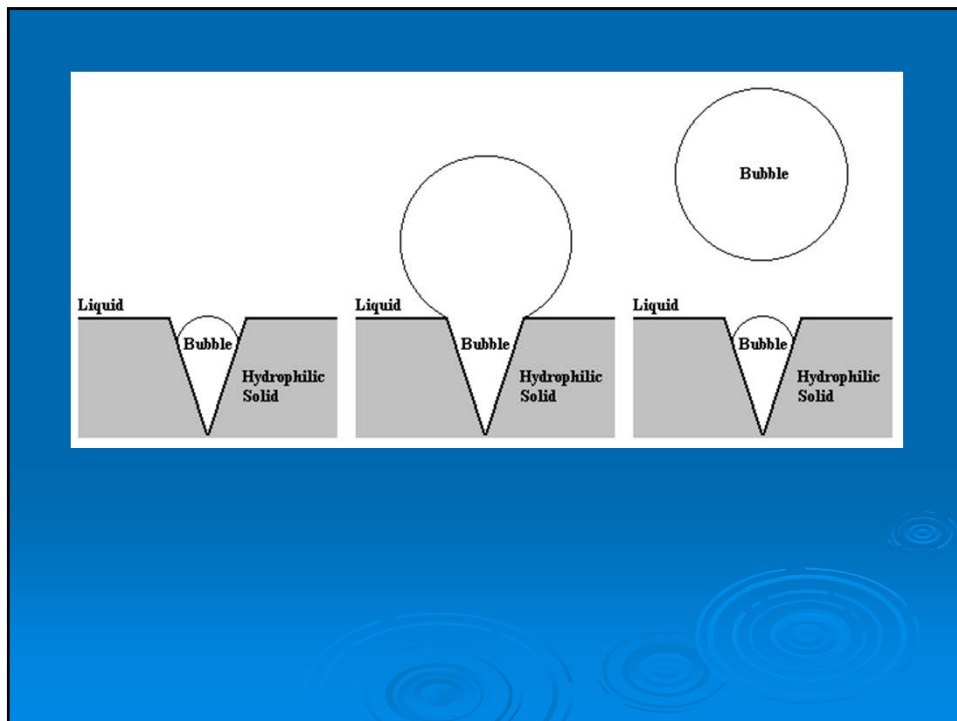
- Package
- Foam
- Gushing
- Clarity
- Color
- Flavor
- Stability
- Safety & wholesomeness

Not mutually exclusive



Aspects of beer foam

- Formation (nucleation, beading)
- Stability (head retention)
- Lacing (cling, adhesion)
- Texture, whiteness etc





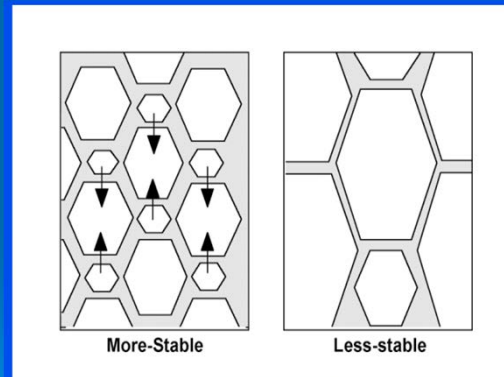
Drainage

$$Q = \frac{2\rho g q \delta}{3\eta}$$

where Q is flow rate
 η is viscosity of film liquid
 ρ is density
 q is length of Plateau border
 g is acceleration due to gravity
 δ is thickness of film

Beer foam Physics

Disproportionation



Beer foam Physics

Disproportionation (continued)

$$r_t^2 = r_o^2 - \frac{4RTDS}{P\theta} \gamma t$$

where

- r_t is the bubble radius at time t
- r_o is bubble radius at the start
- R is the gas constant
- T is absolute temperature
- D is the gas diffusion coefficient
- S is the solubility of the gas
- γ is the surface tension
- P is atmospheric pressure
- θ is the film thickness between bubbles

Foam

- **Positives**
- polypeptide
- iso- α -acids
- Me^{2+}
- N_2
- **Negatives**
- Lipid
- Detergents
- Ethanol

Which proteins?

- Discrete polypeptide hypothesis
- Generalized amphipathic polypeptide hypothesis

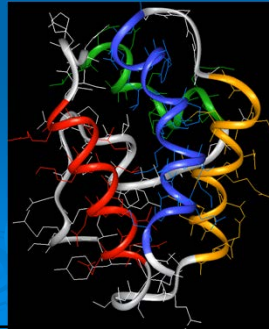
Some proposed foaming proteins

Lipid Transfer Protein (LTP1)

From barley

Unchanged in malting and mashing

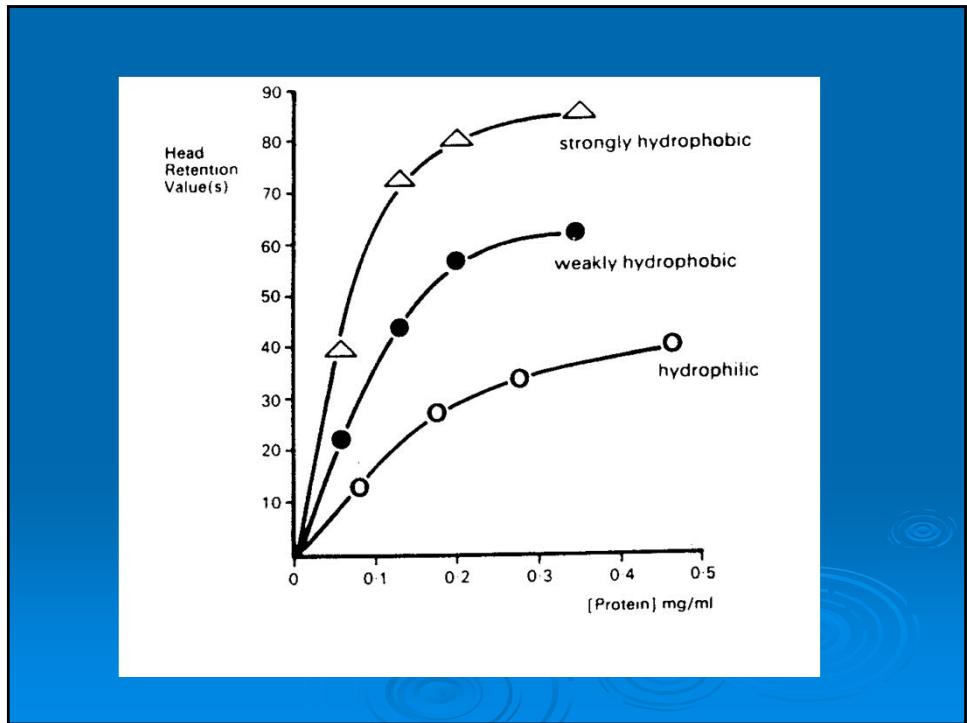
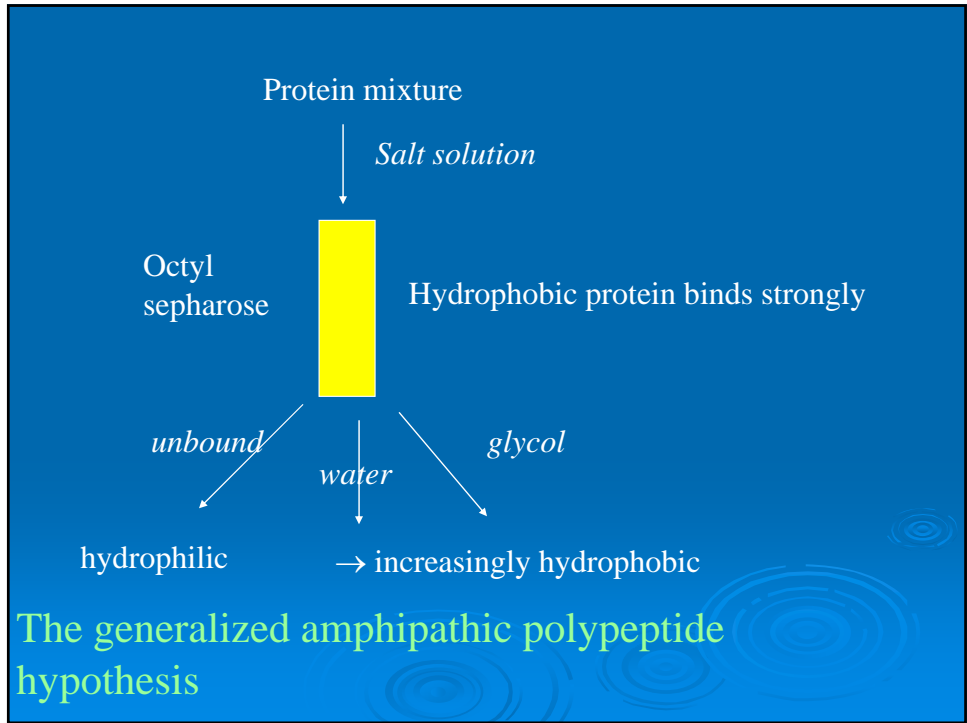
Activated during boiling by denaturation

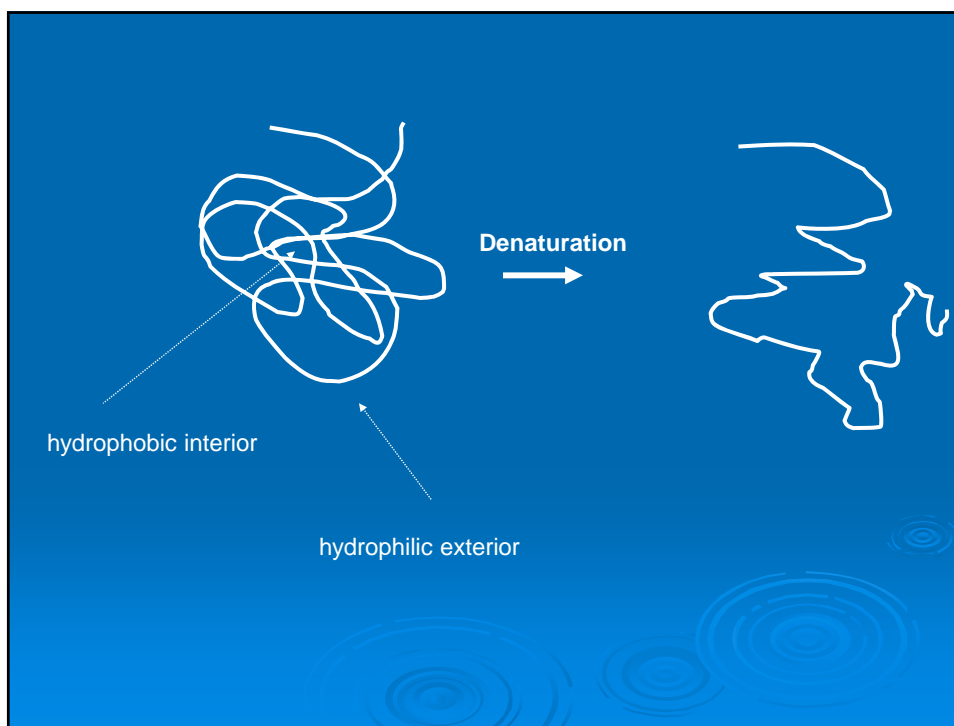


Protein Z (40kD protein)

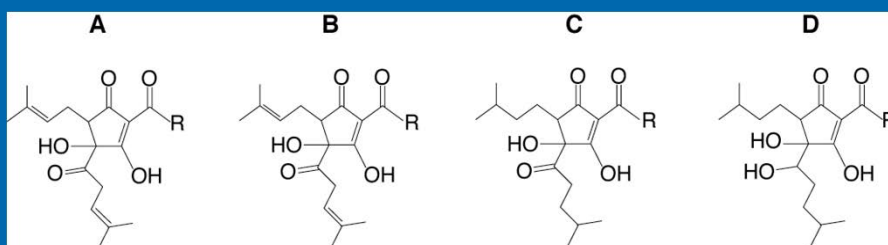
- from barley

- attached to β -amylase





Bitter acids derived from hops

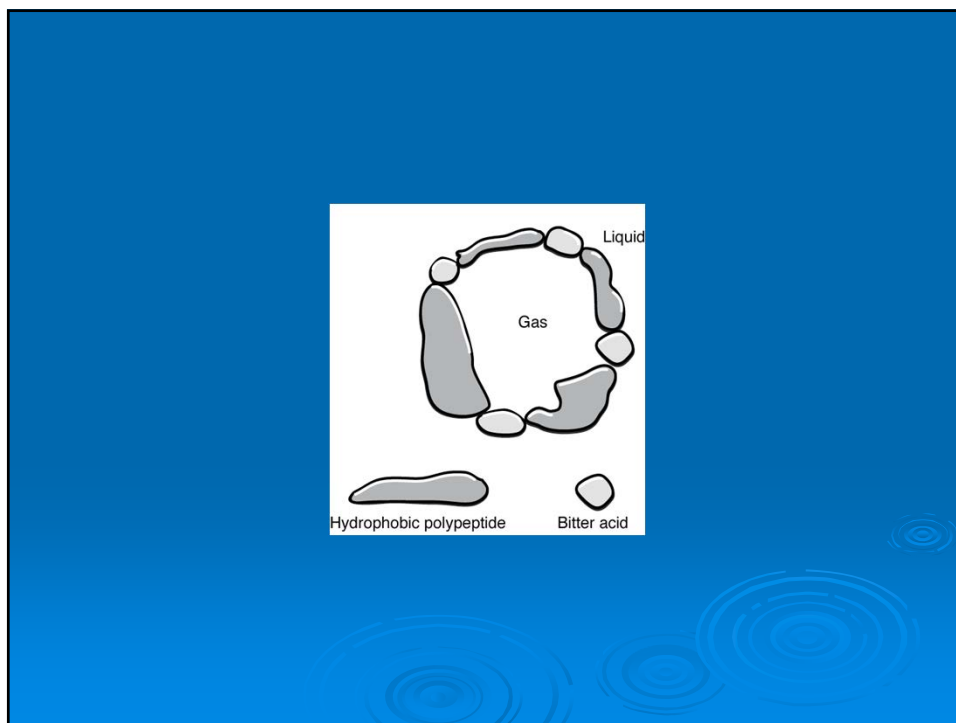
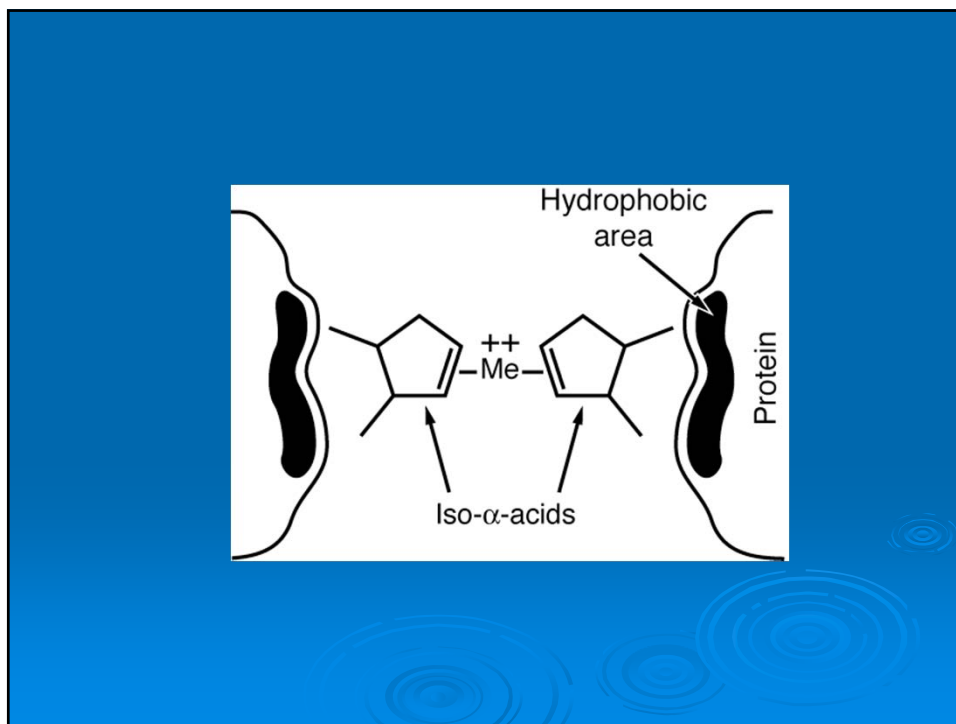


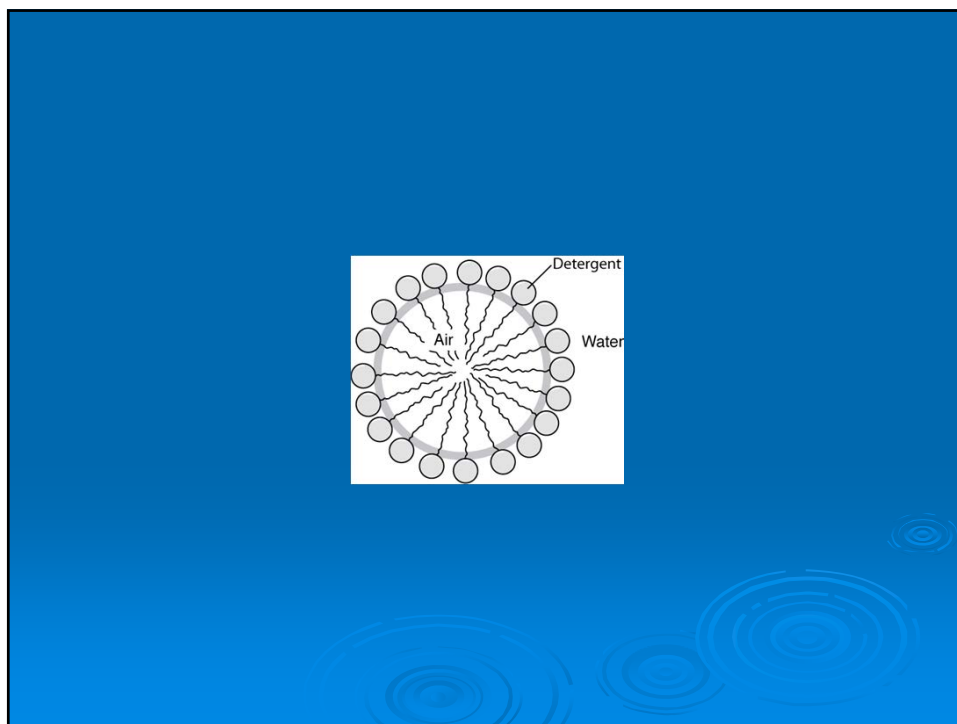
iso

rho

tetra

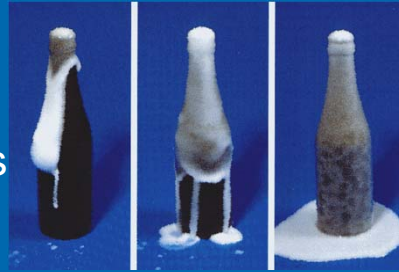
hexa





Gushing

Presence of nucleation sites



Proteins from Fusarium

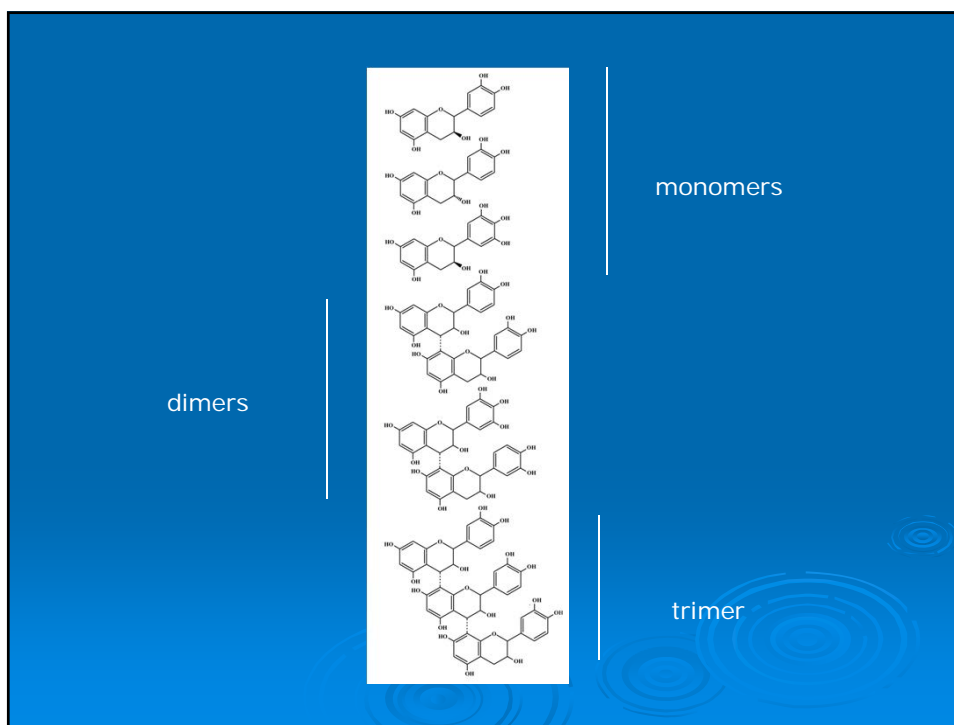
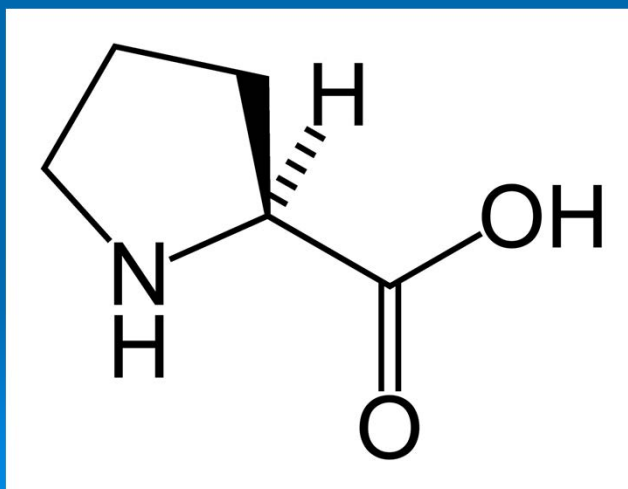
Particles in the beer - e.g. slivers of glass, oxalate

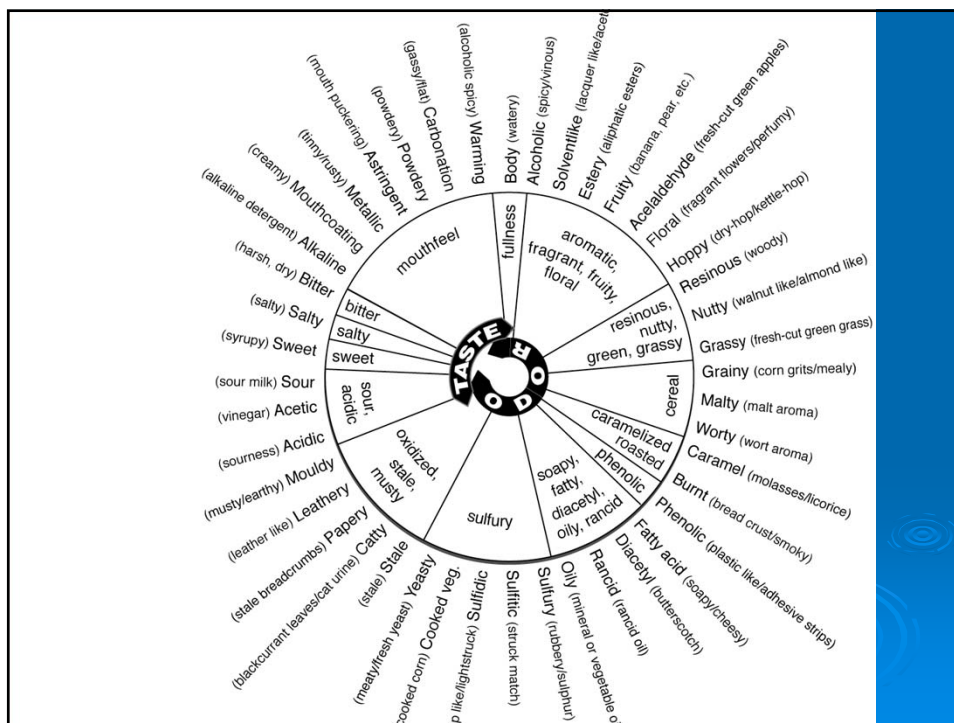
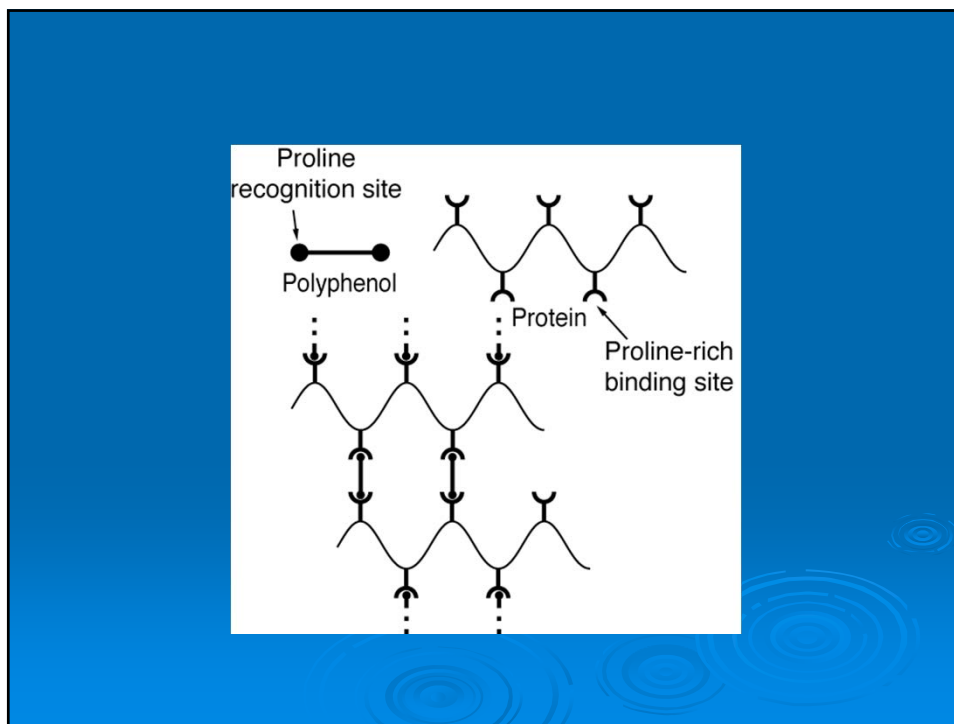
Agitation

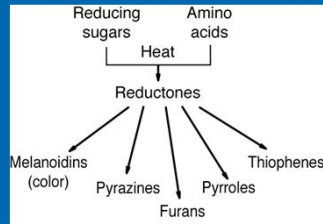
Haze forming materials

- Yeast
- Spoilage organisms
- Oxalic acid
- Cell wall polysaccharides from barley
- Starch
- **Proteins and polyphenols**

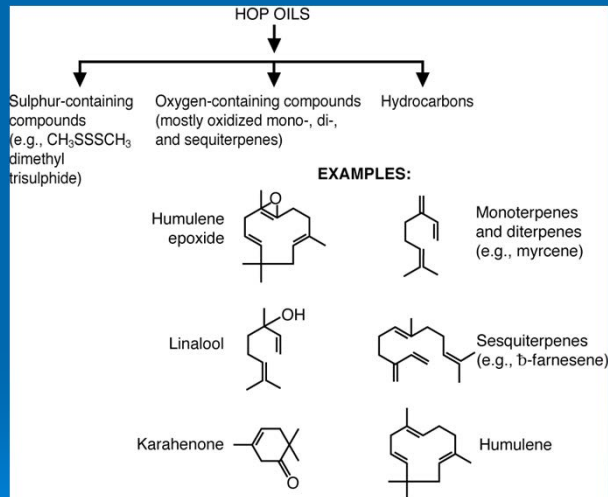
Barley hordeins – rich in proline

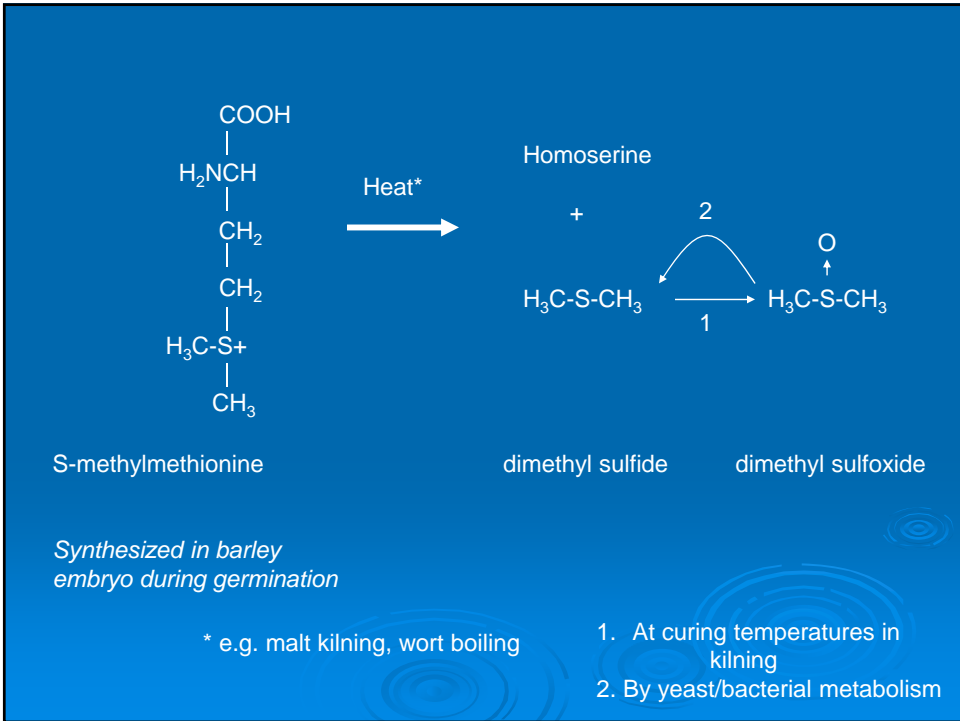
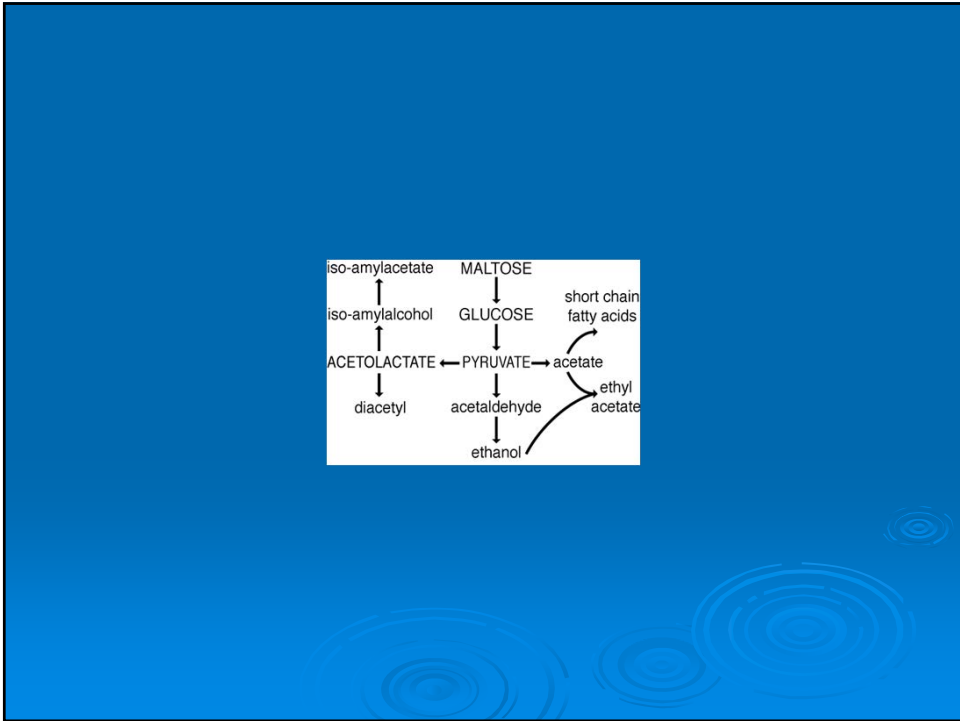


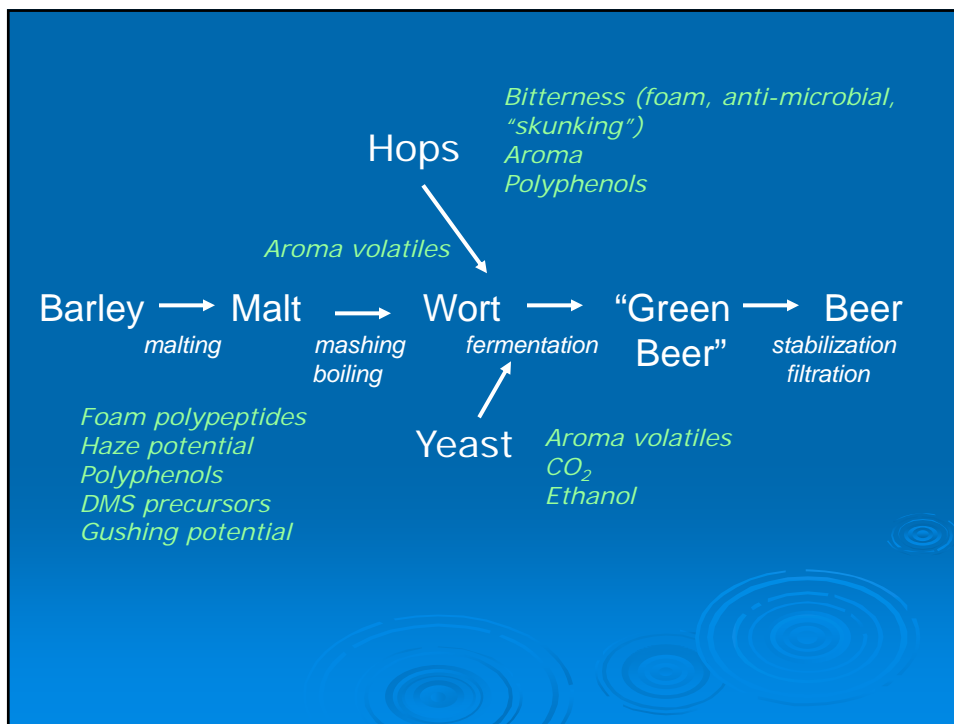




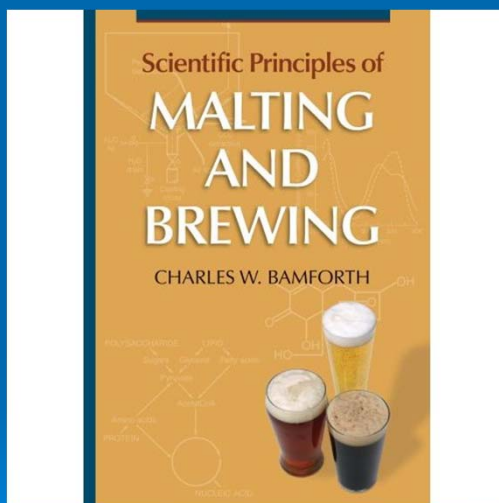
n.b. color also produced by oxidation of polyphenols







cwbamforth@ucdavis.edu



American Society of Brewing Chemists

Q&A SESSION



Advanced Chemistry of Beer and Brewing



Charles Bamforth,
UC Davis



Steve Carlo,
Chemist, Homebrewer

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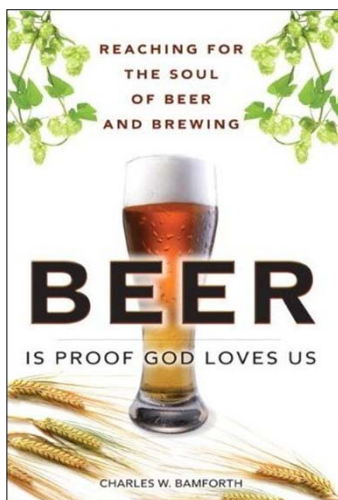
Optimizing the Workplace Across Five Generations of Scientists

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