



Cynthia Skema, Ph.D. University of Pennsylvania

Cindy Skema is a botanist at the Morris Arboretum of University of Pennsylvania. She studies the evolution of plants in the field, herbarium, and lab, and enjoys communicating about plant science to the public. Dr. Skema earned her Ph.D. at Cornell University, and has worked in Madagascar and New Zealand.





Quick Guide to the Botany of Beer

Cindy Skema, Botanical Scientist





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Beer is one of them.





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water + starch + fermenter + $\frac{\text{flavor/}}{\text{preservative}}$ = beer





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potato
sorghum
sugar
millet
rye
molasses
rice
corn
agave
hops
cassava
spruce
coffee
chocolate
barley

Barley: What is it?



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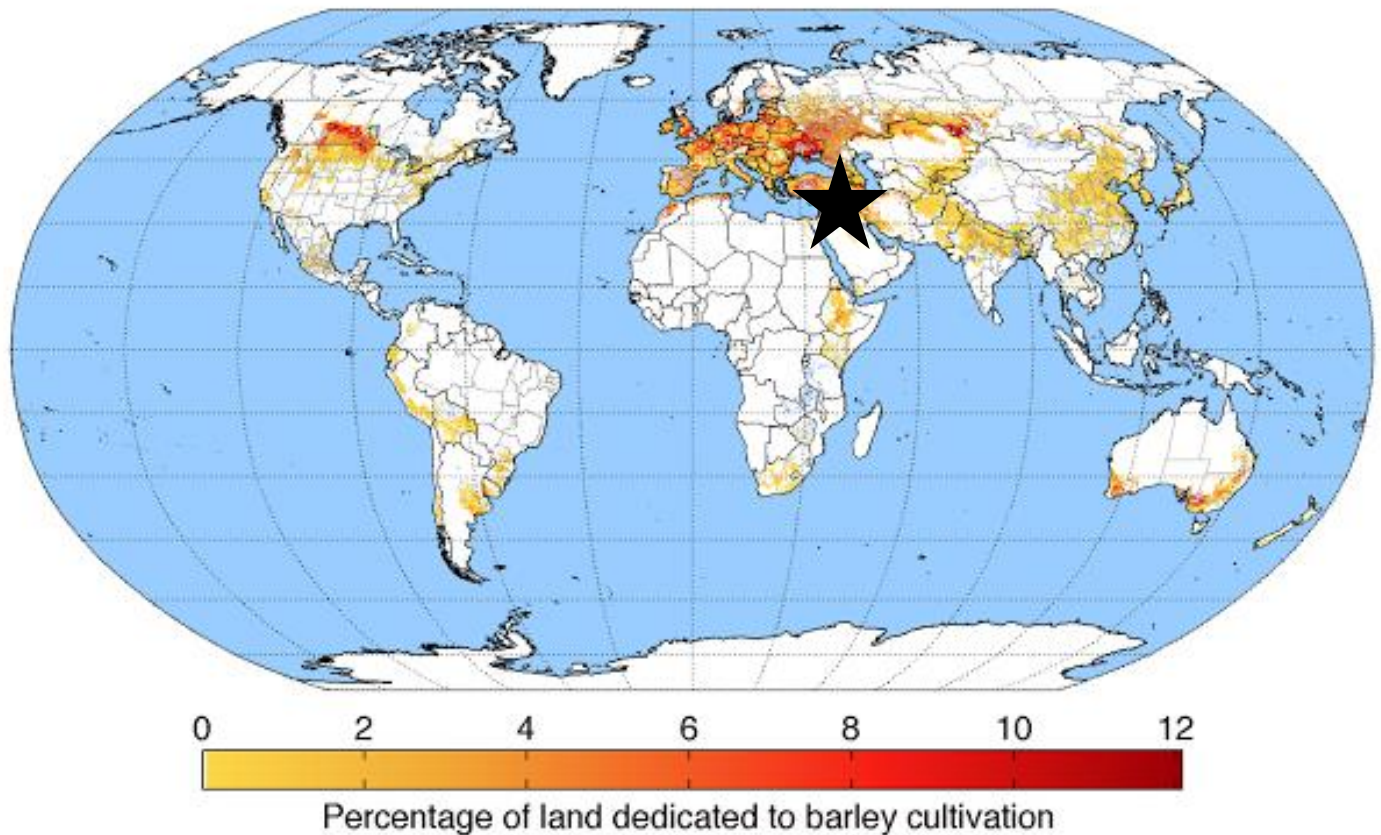
- *Hordeum vulgare*

Barley: What is it?

- *Hordeum vulgare*
- grass! Poaceae (wheat, rye, oats)

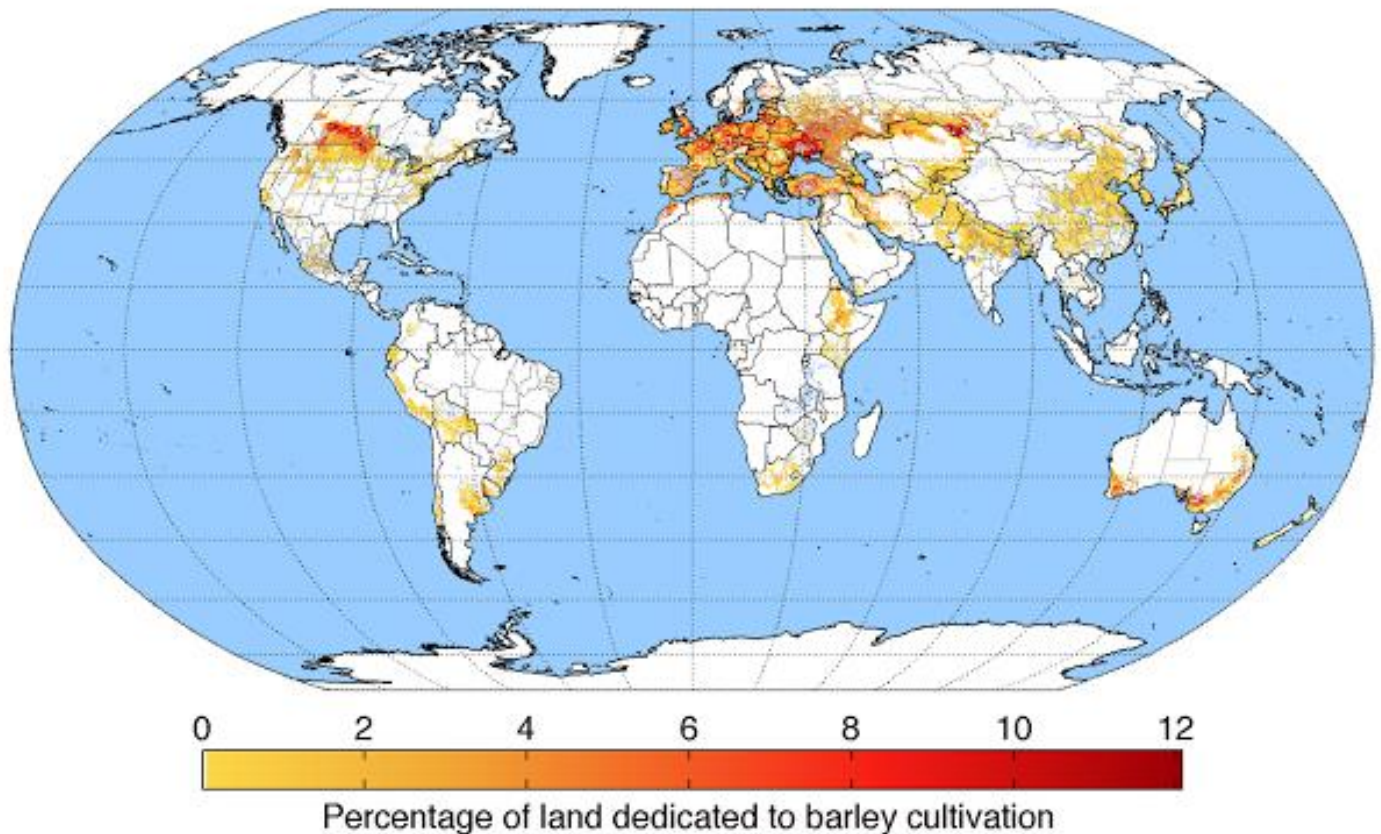
Barley: Where is it?

- distribution: wild

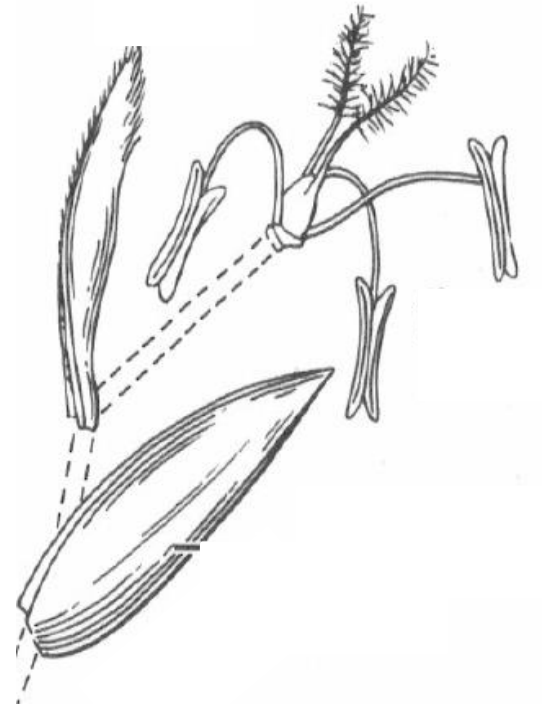
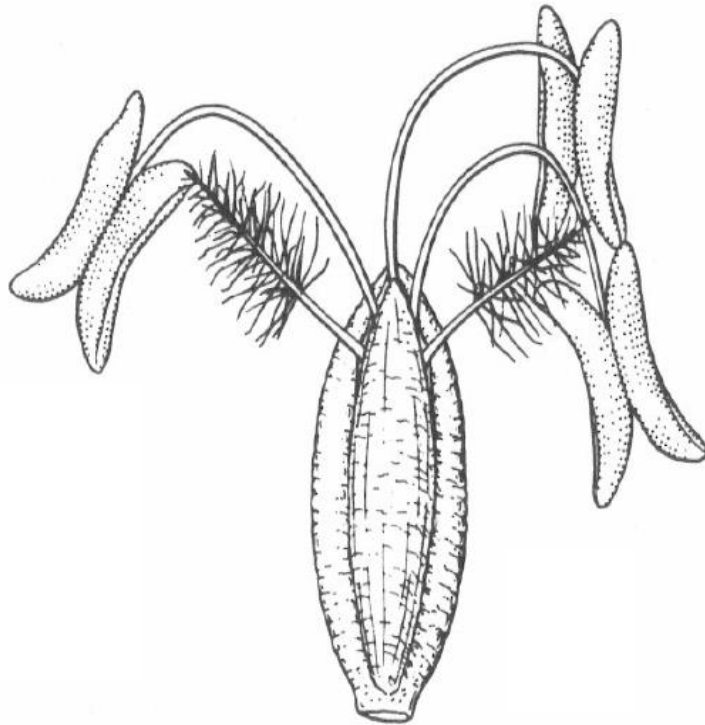


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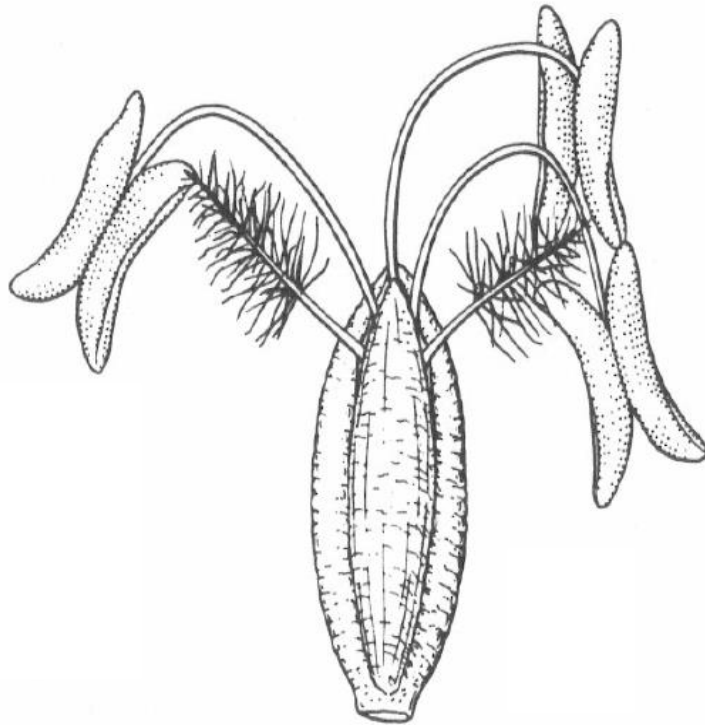
- distribution: wild vs. cultivated



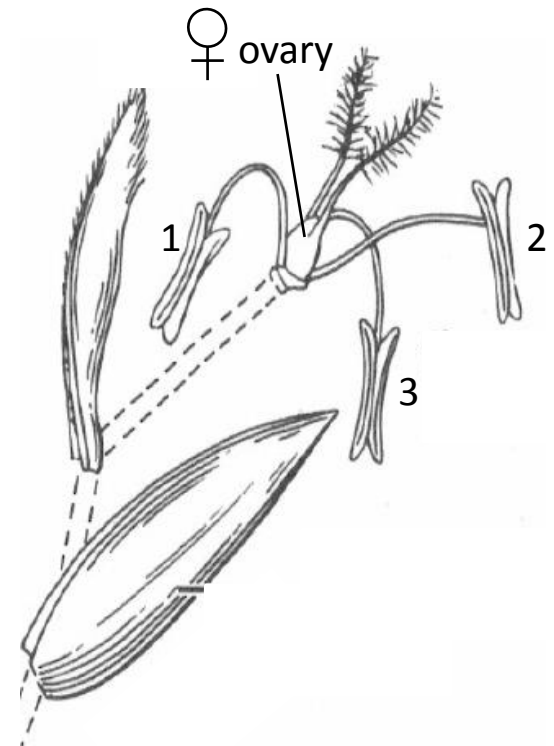
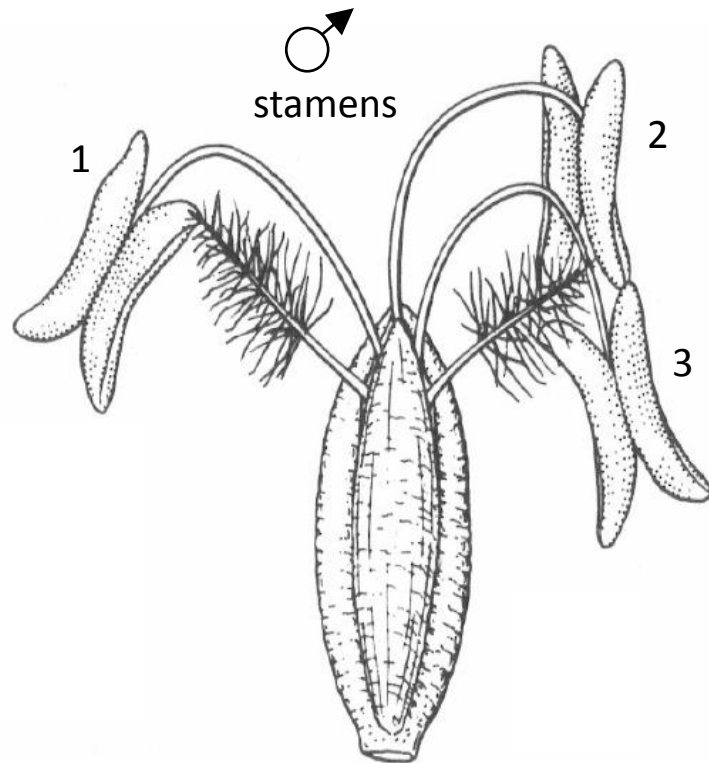
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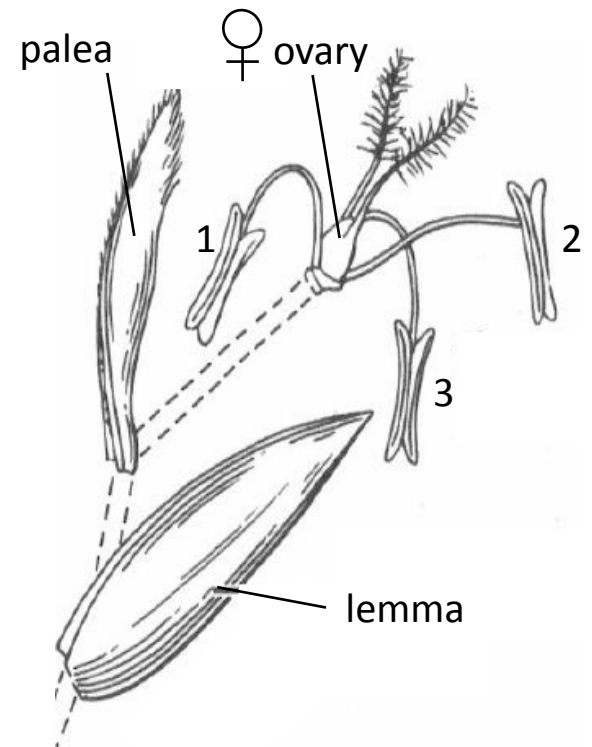
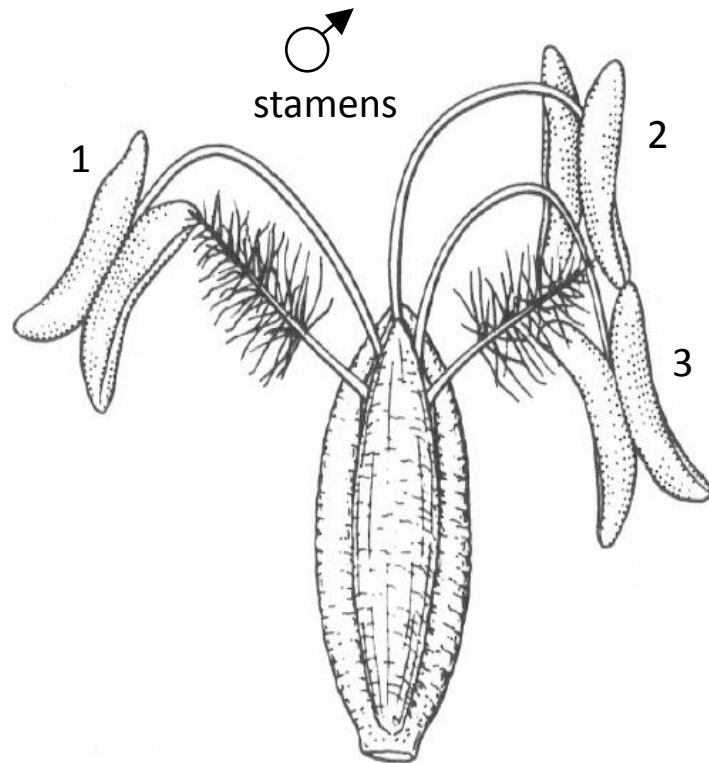
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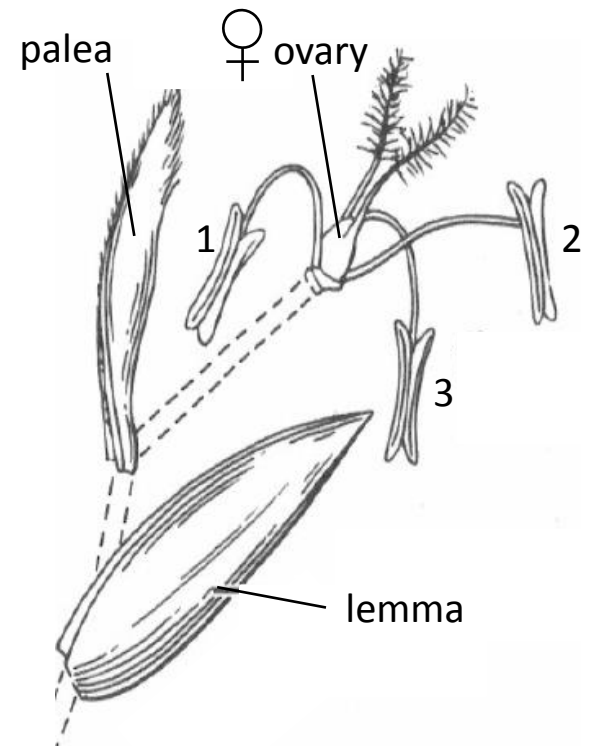
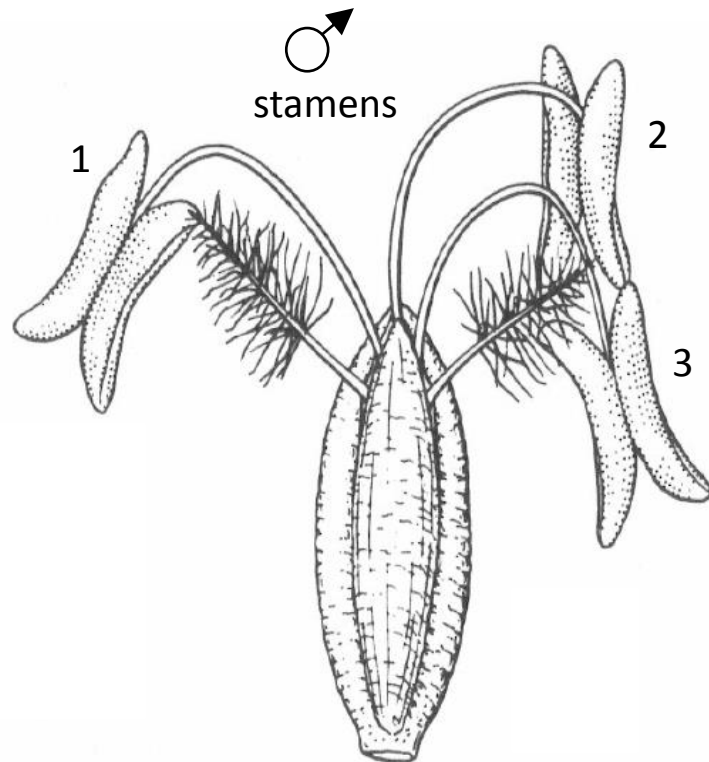


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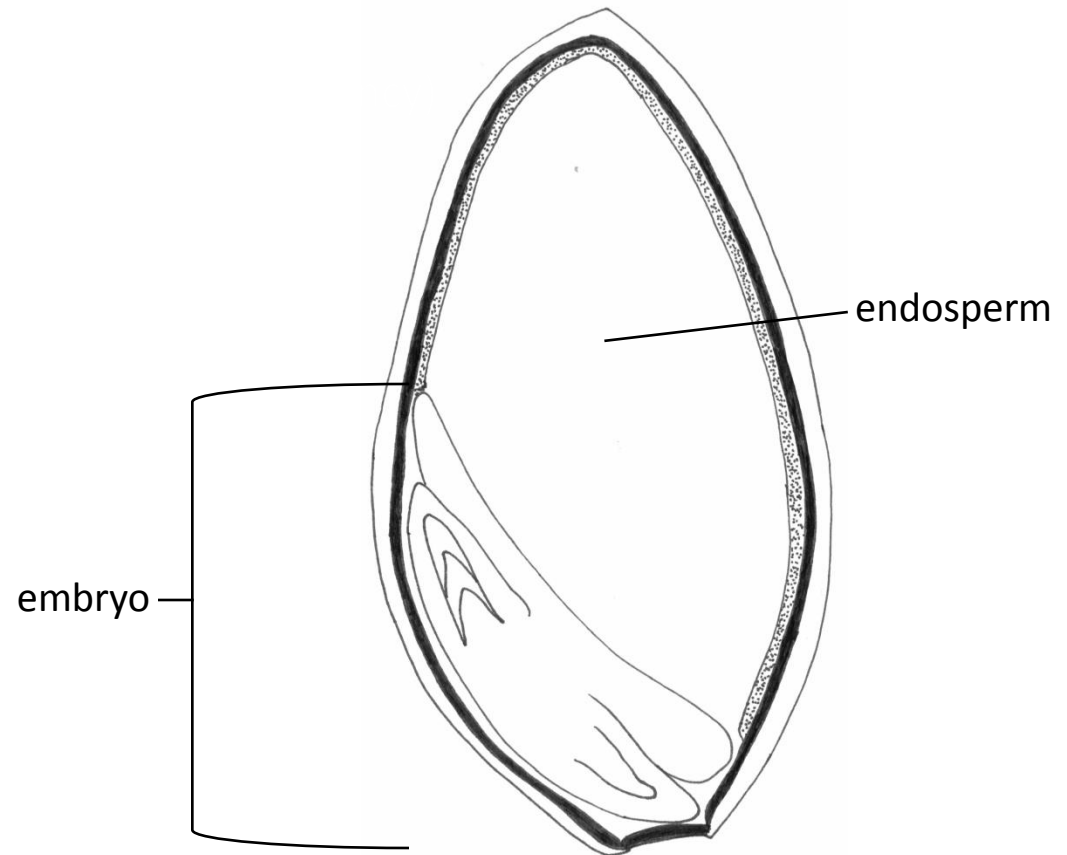
Barley: What we use...

- ovary of grass flower → fruit, or 'grain'



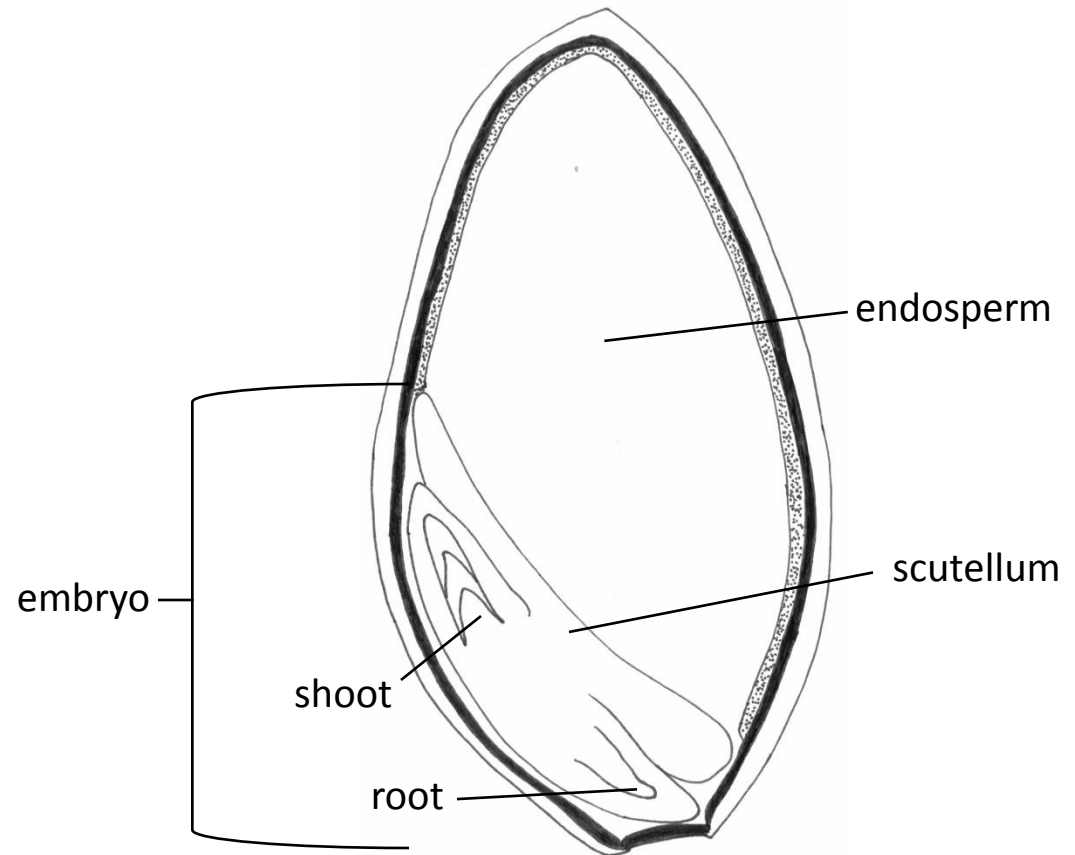
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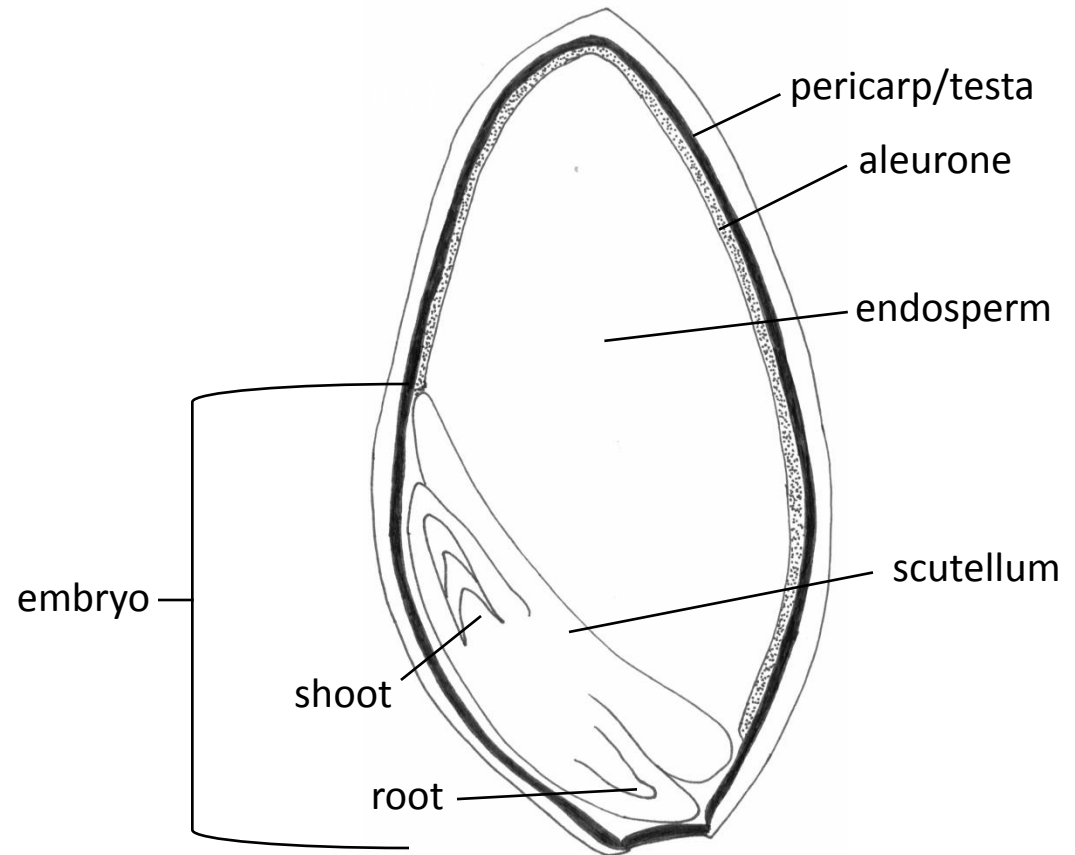
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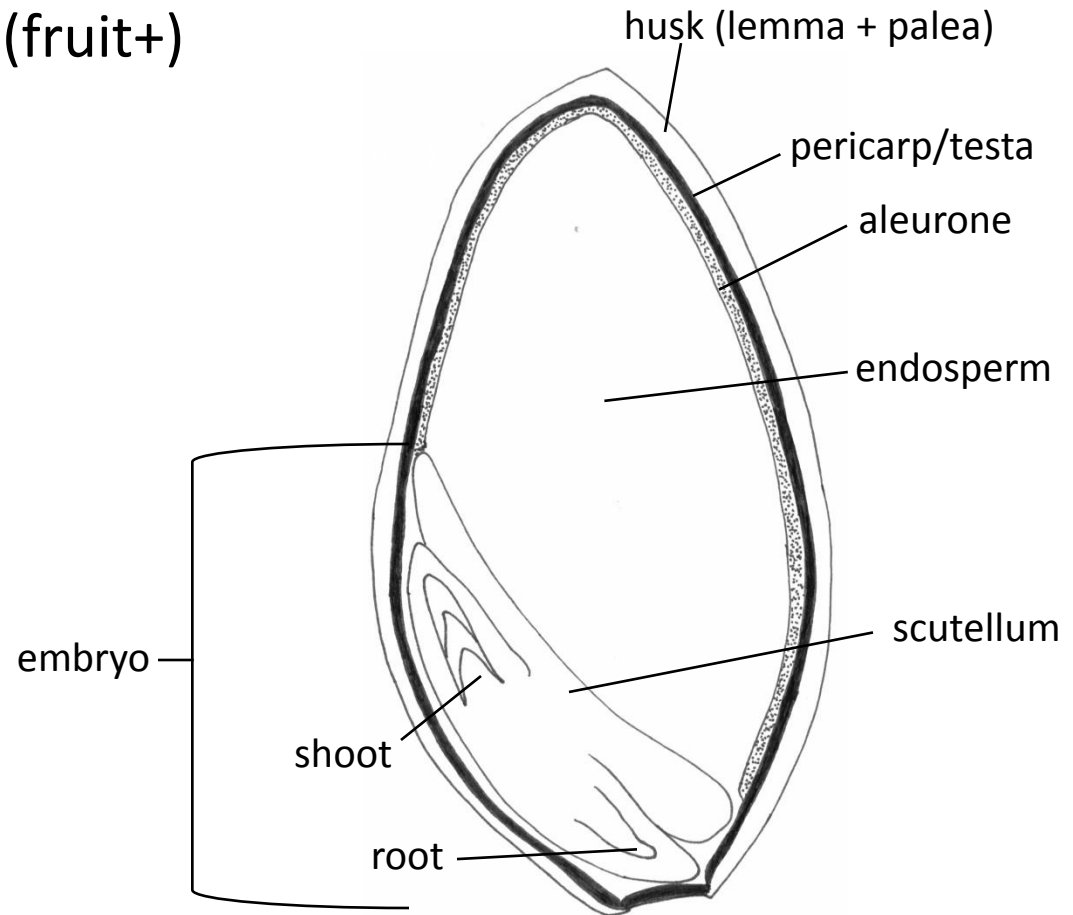
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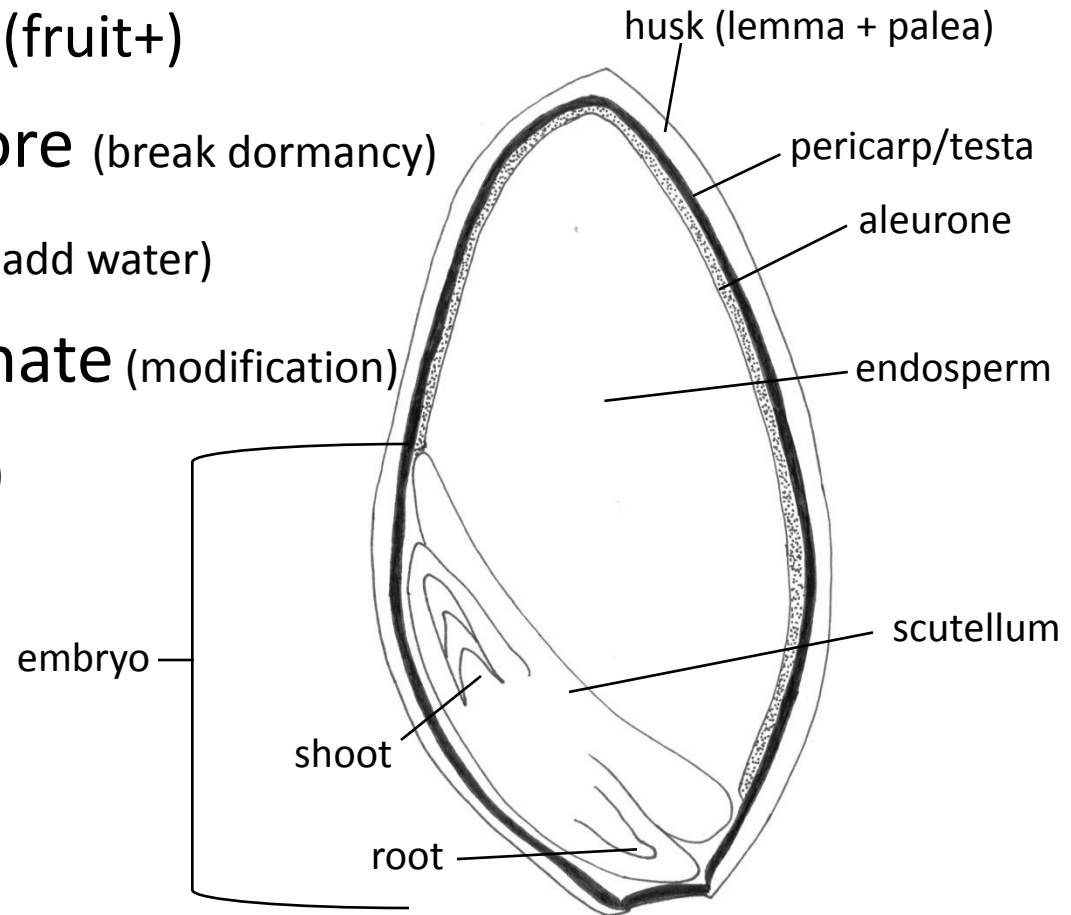
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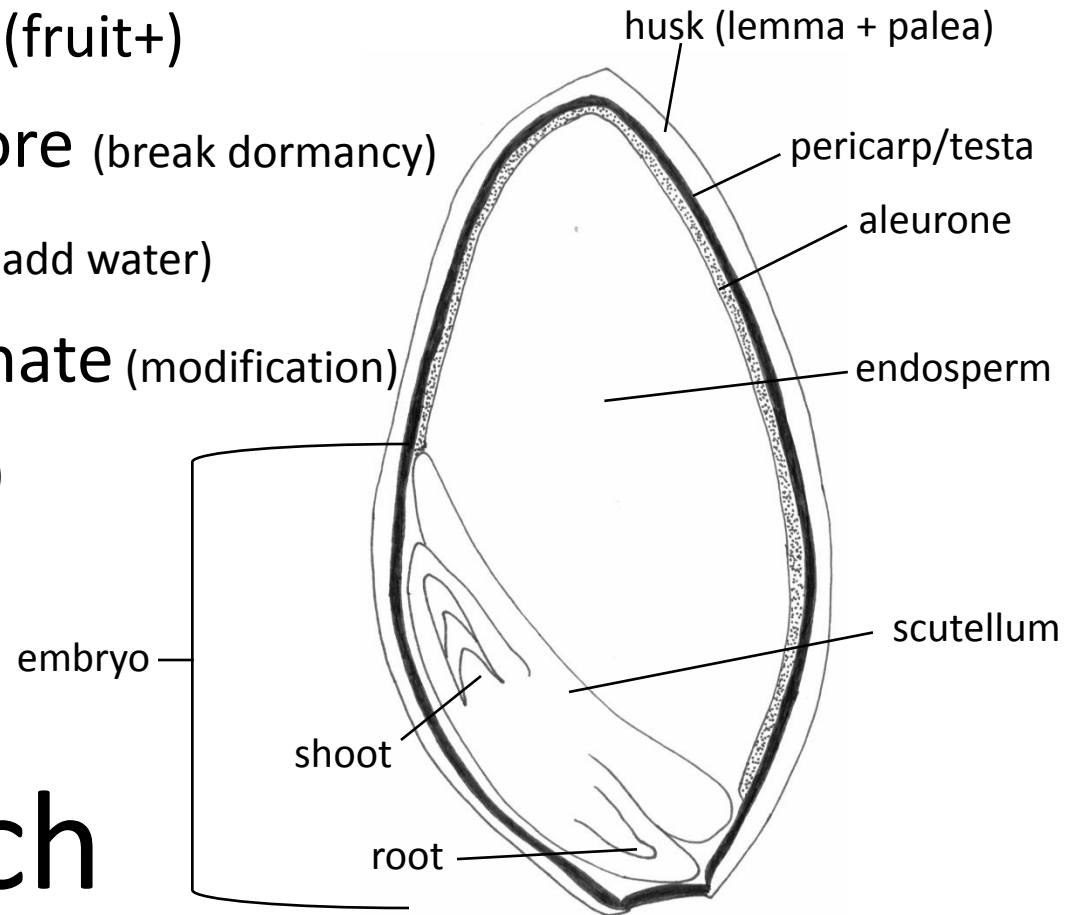
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 - dry store (break dormancy)
 - steep (add water)
 - germinate (modification)
 - dry (kill)



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✓ starch





PHILADELPHIA
SCIENCE
FESTIVAL

Hops: What is it?



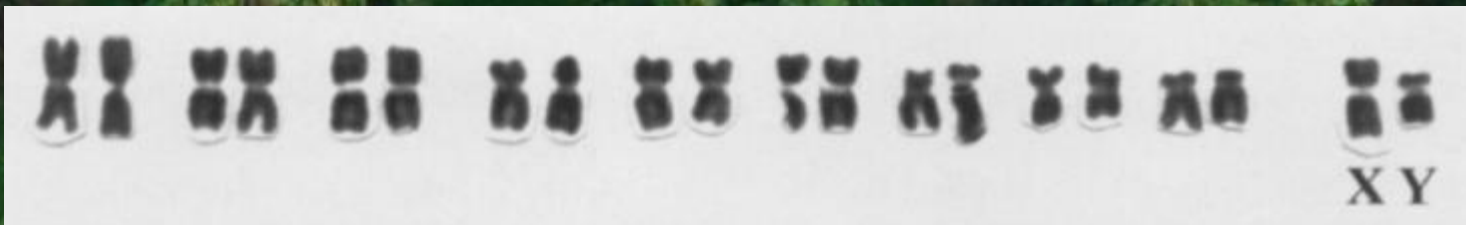
Hops: What is it?

- The Hemp Family, Cannabaceae
 - *Humulus*, 2 spp.
 - *Humulus lupulus*, 5 varieties
 - *Humulus lupulus* var. *lupulus*



Hops: How is it?

- natural history:
 - temperate perennial, twining herb (not a vine!) supported by trees, wind-pollinated
 - dioecious, with heterogametic sex chromosomes





Hops: What we use...

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 - bracts, bracteoles





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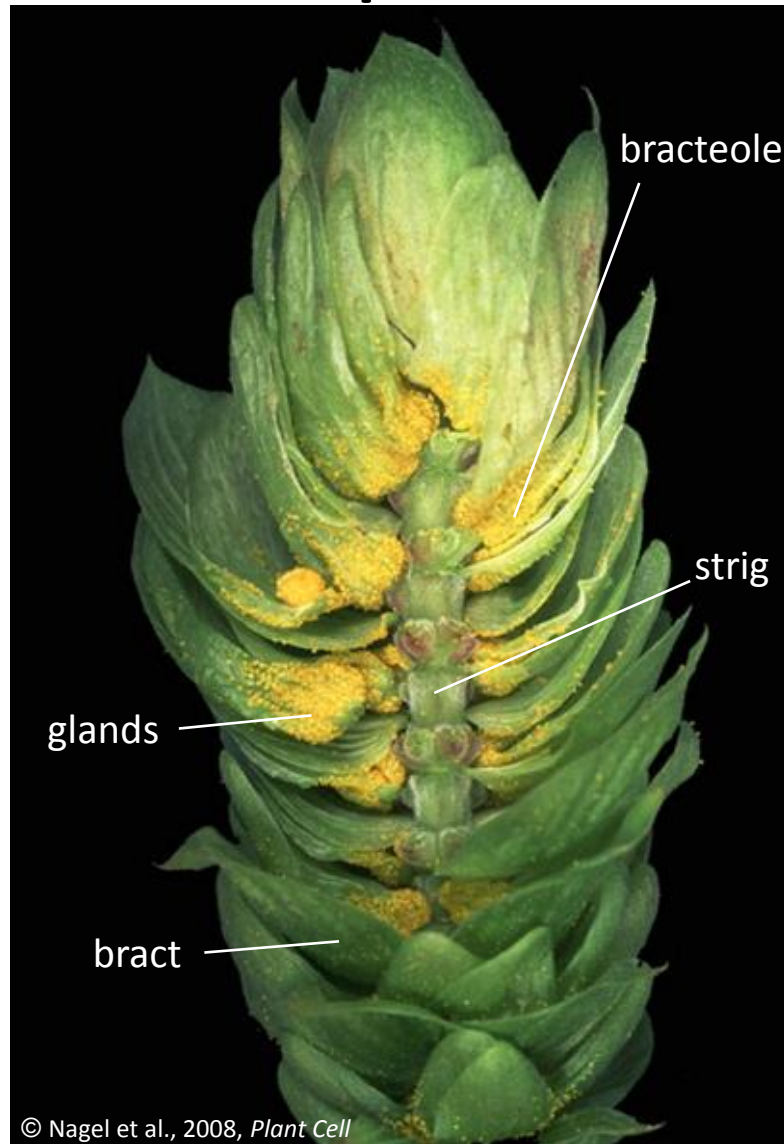
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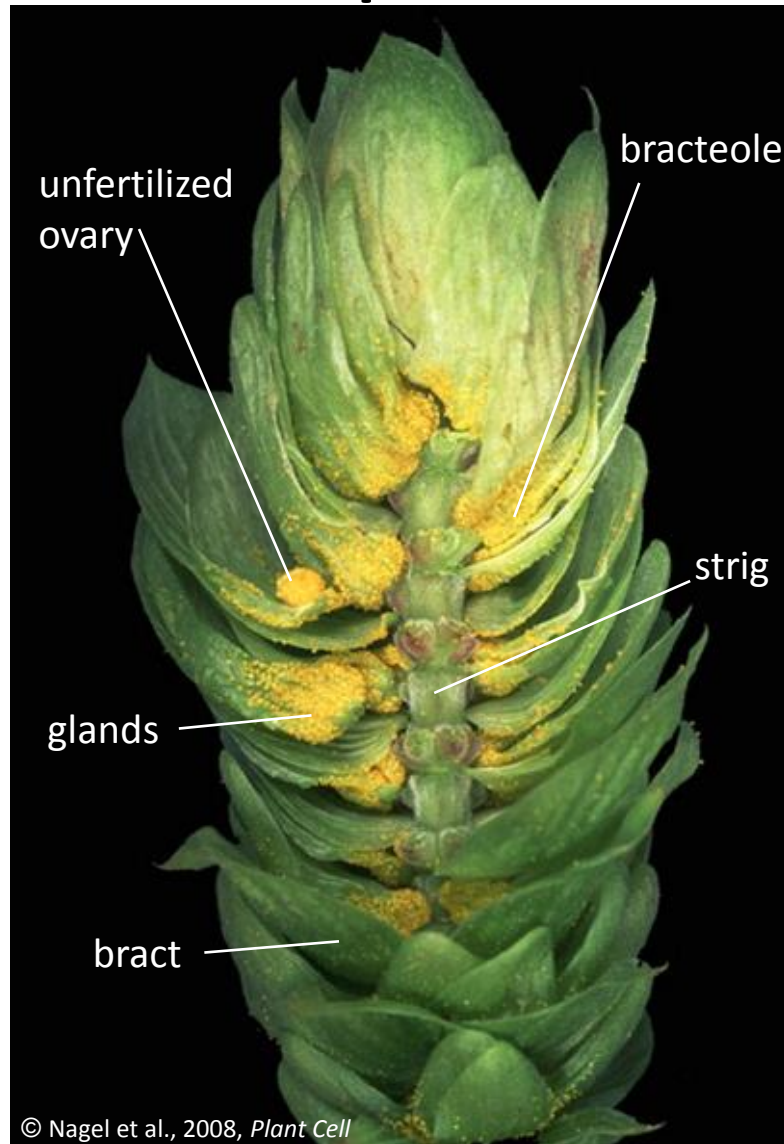


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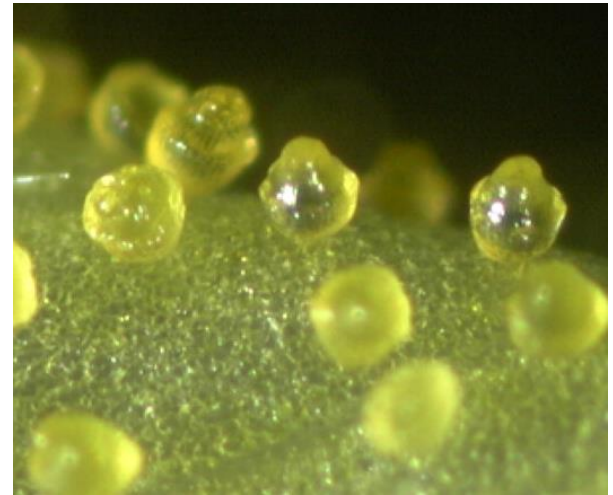
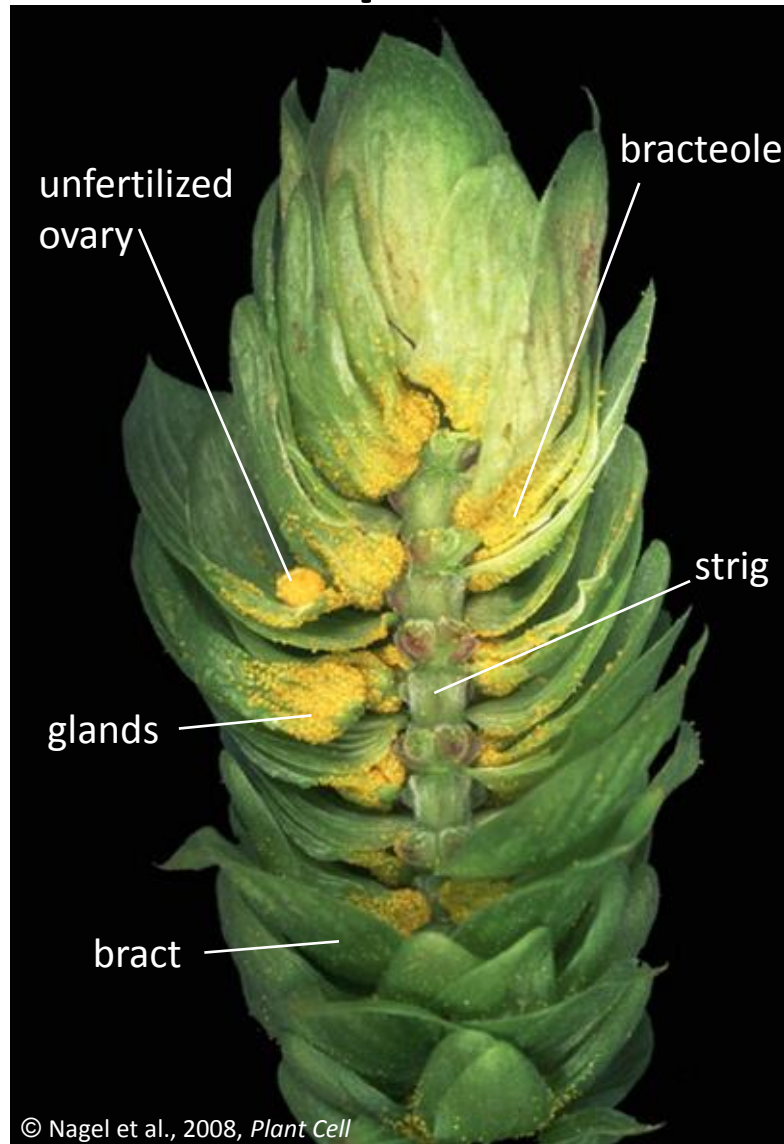


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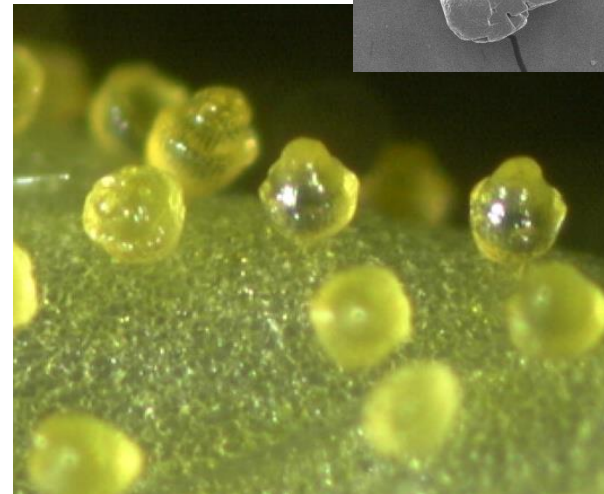
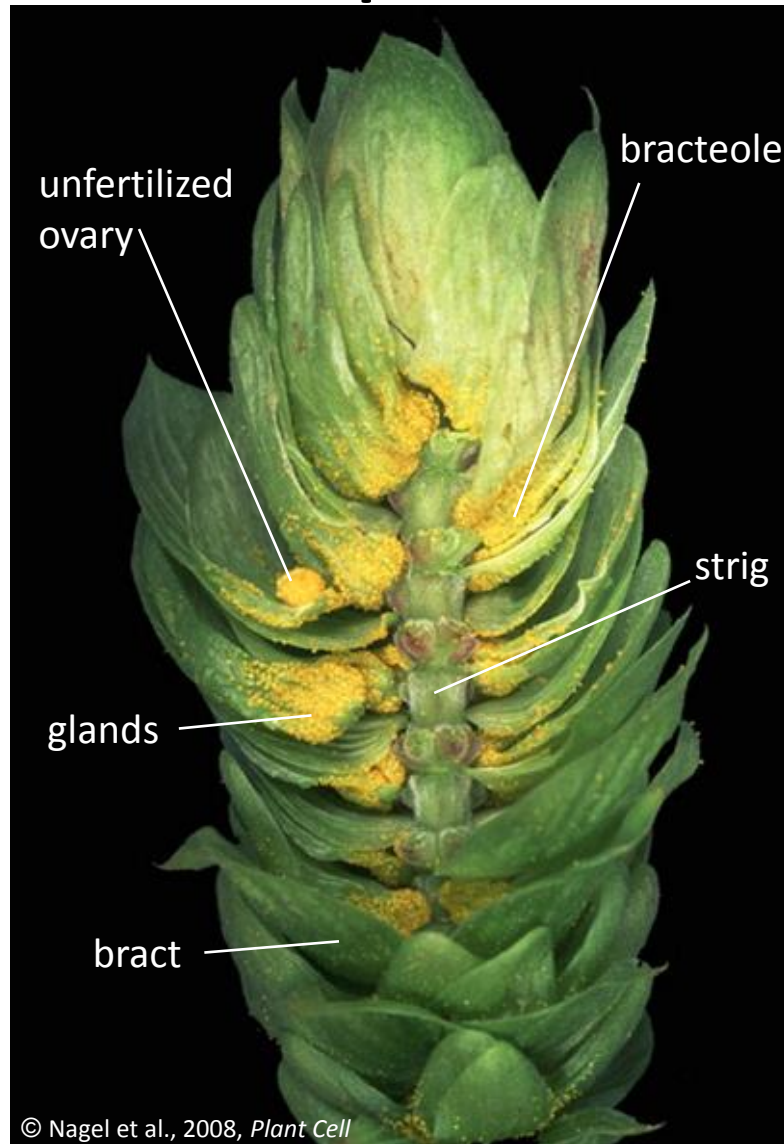
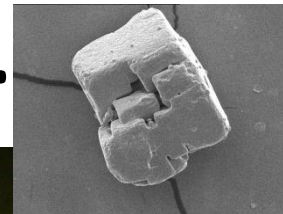


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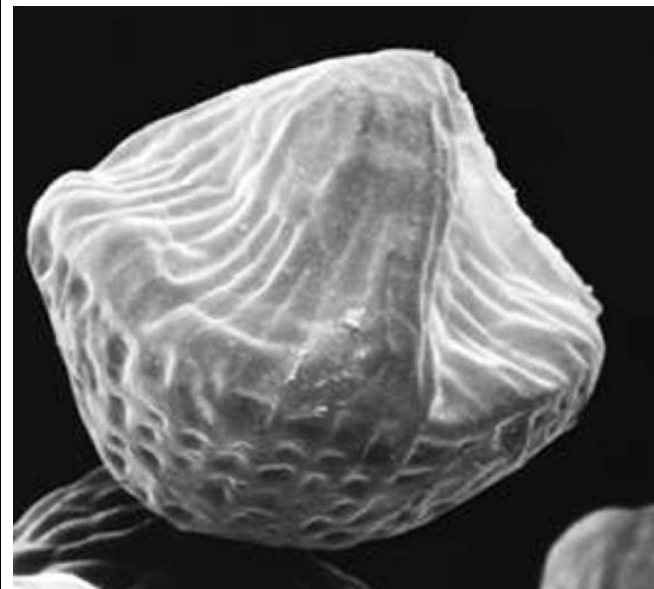
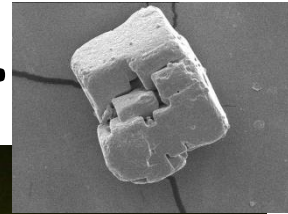
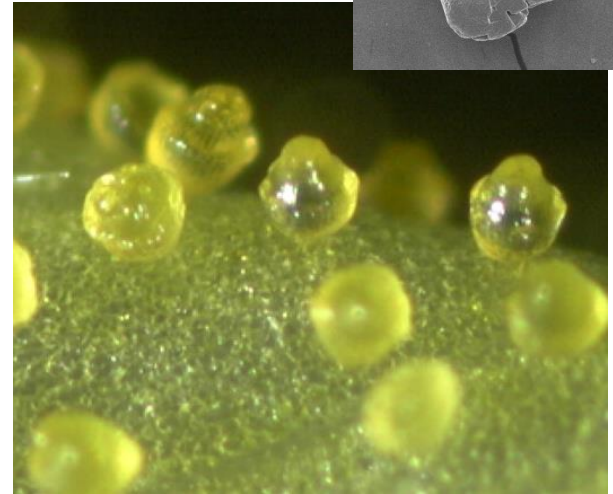
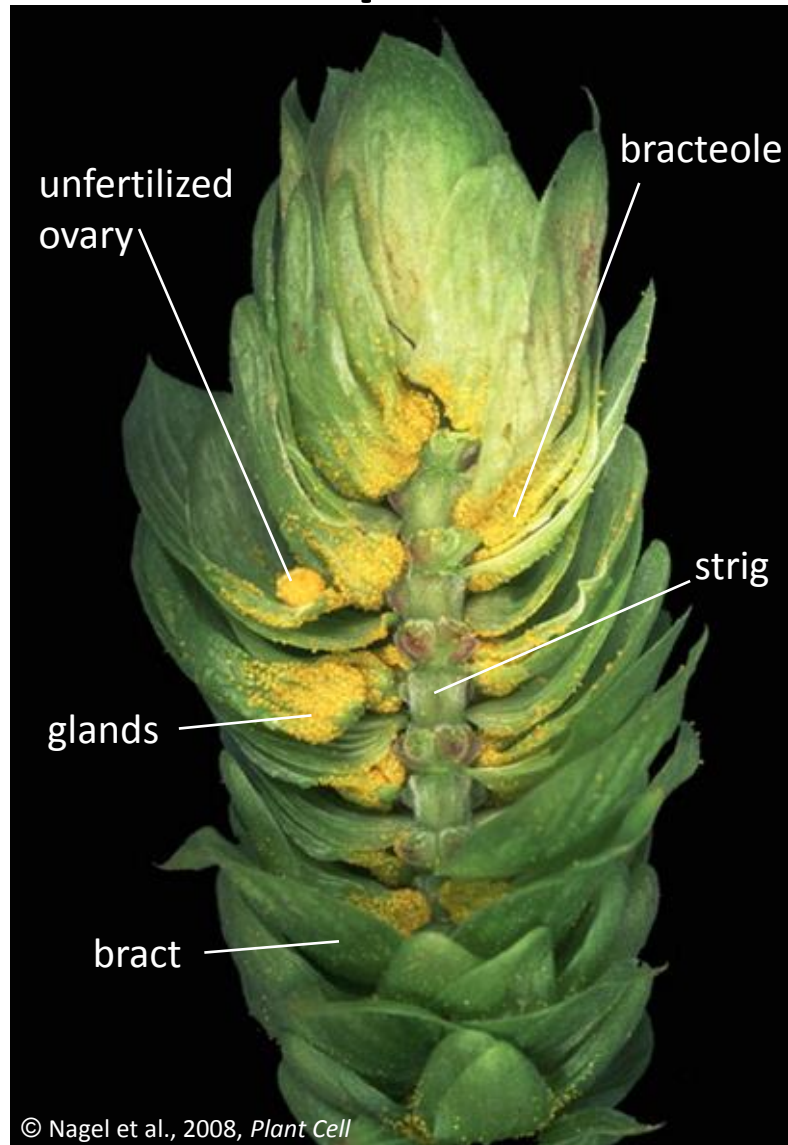


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 - it's all about the glands → lupulin resin (lupulone, humulone acids)
 - why so many glands?
female only, bitterness





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✓ flavor/preservative



The End
Thank You!



Morris Arboretum
UNIVERSITY of PENNSYLVANIA





Franklin Winslow **Yards Brewing Company**



At age 9, Franklin began home brewing with his father. Years later, he finally figured out why his dad was in the doghouse with Mom after Frank got into the special soda one afternoon. After several years of cancer, HIV, and Anthrax research at the University of Pennsylvania, Frank realized he would always regret it if he did not give professional brewing a shot. In 2004, he took a brewing position at Manayunk Brewery and Restaurant, and later moved on to work as a brewer at Flying Fish in NJ. In 2007, Frank joined the Yards team and has been there ever since, though, he wears his brewers' boots a lot less and the lab coat a lot more these days as the Director of Quality Assurance.





Matt Hall

Yards Brewing Company



Matt joined Yards in May 2010, after studying brewing science at the Siebel Institute of Technology and a brief stint selling beer for a local wholesaler . He started out on the bottling line hand loading bottles and moved on to the brewhouse as an assistant after only 8 months. After a few months as an assistant there, he moved into a full-time brewer position where he has been working since. Matt's diploma course at Siebel involved intensive classroom study and hands on brewing experience in Chicago and at the Doemens Academy in Munich Germany. Matt brings this passion for the craft and technical knowledge to Yards every day, and has been a significant asset to the brewing team since he joined them in 2011.





Matthew Farber, Ph.D. **University of the Sciences**



Dr. Matthew Farber is the creator and program director of the new Brewing Science Certificate Program at the University of the Sciences where he is a Teaching Postdoctoral Fellow under Dr. Peter Berget. His research focuses on the science of beer with a focus on yeast proteases and their influence on beer quality. He has a B.S. in Biology from Seton Hall University and a Ph.D. in Molecular, Cellular, and Developmental Biology from the University of Pittsburgh. An active member of the American Society of Brewing Chemists, Master Brewers Association, and American Homebrewers Association, Matt aspires to brew better beer through innovative applications of biotechnology.





Tim Roberts

Yards Brewing Company



Tim Roberts is currently the Head Brewer and Production Manager at Yards Brewing Company, and has been brewing professionally for over 15 years. His first exposure to craft beer was at the White Horse on Parson's Green in London, where he worked as a cellarman and barman in 1996. And in fact it was there where he first decided to make brewing a career. Tim joined Yards in 2008 where he is responsible for recipe formulation, handling and ordering of raw ingredients, scheduling the brewing and maintenance staff, and logistics for shipping. Also over the past years, Yards has garnered numerous awards for their beers, including World Beer Cup and Great American Beer Festival medals.





Fred Schaefer, Ph.D. **University of the Sciences**



Fred Schaefer is an associate professor at the University of the Science in the Department of Chemistry and Biochemistry, a faculty member in the Brewing Science Program and Interim Director of the Forensic Science Program. By training, he is analytical chemist specializing in techniques for characterizing macromolecules. He received his B.A. from Franklin and Marshall College and his Ph.D. from the University of Wisconsin - Madison. He is interested in science activities for the general public; recent efforts include the activity-based "Table Top Science."





Light Struck Beer

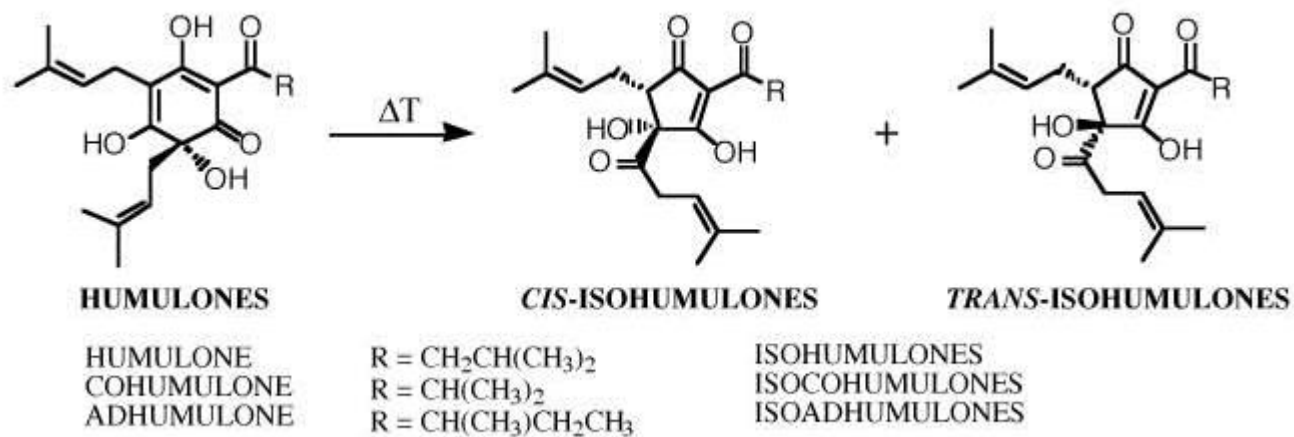
The Photochemistry of Skunked Beer



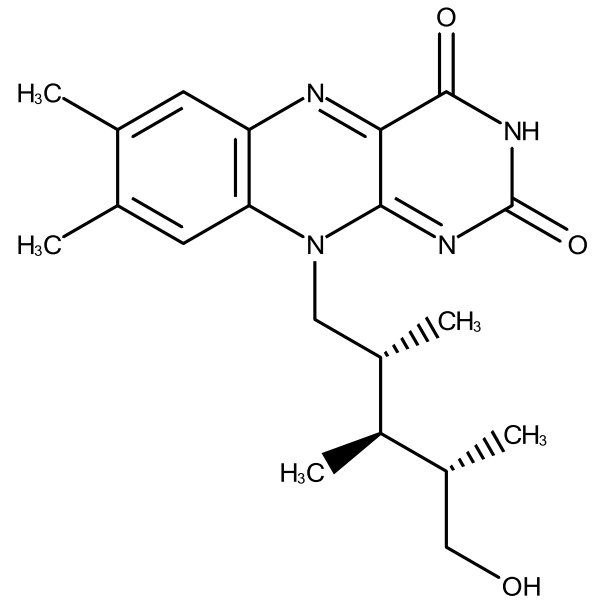
Fred Schaefer

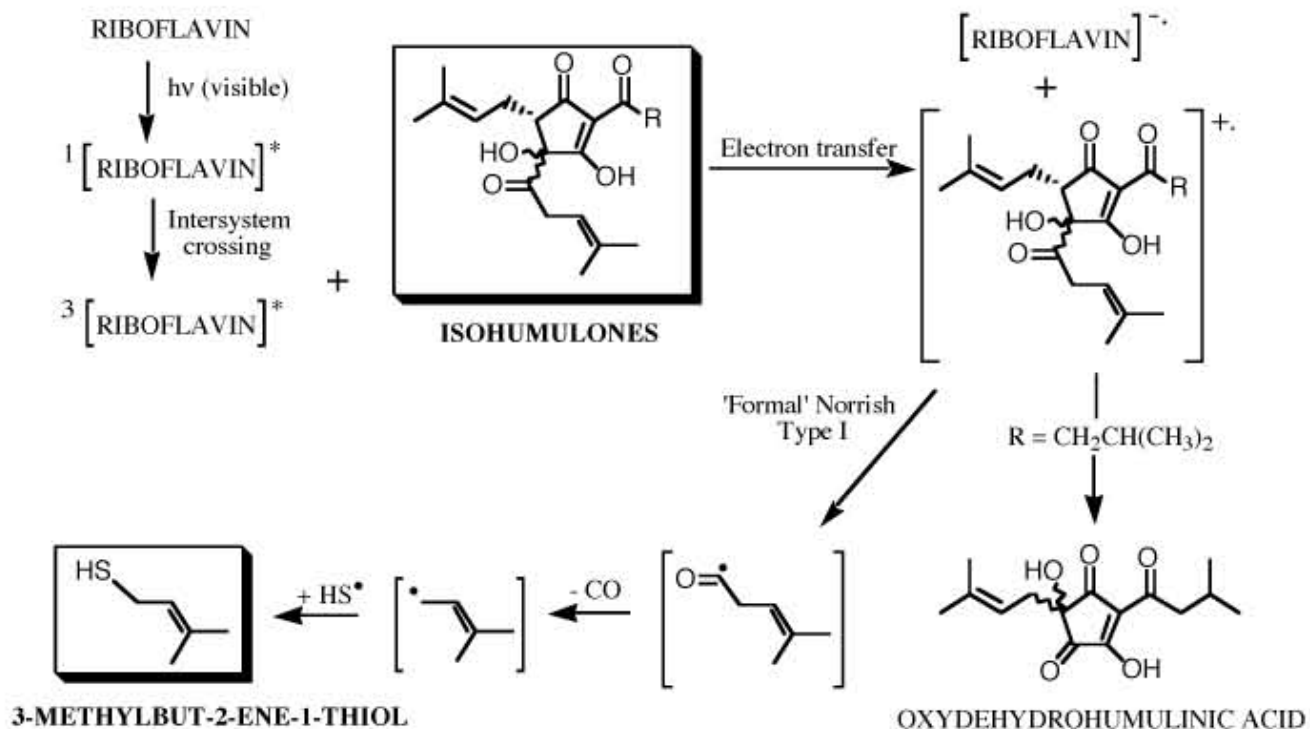
Department of Chemistry & Biochemistry
University of the Sciences





Denis De Kekuleire, Interplay of Photochemistry and Beer: How Lightstruck Flavor Is Formed and How It Can Be Prevented, The Spectrum, Center for Photochemical Science, Bowling Green State University, Spring 2001.



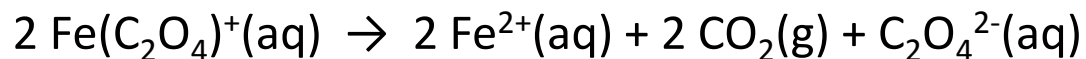


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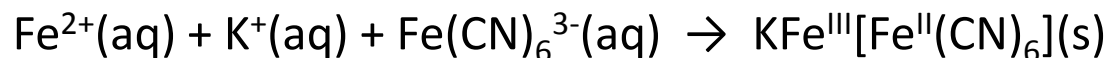


Iron(III) Oxalate Actinometer

Photochemistry



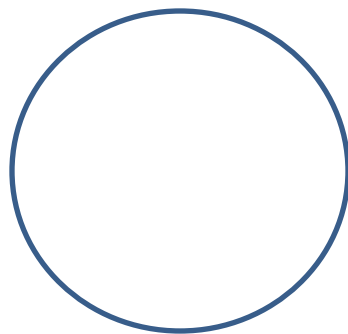
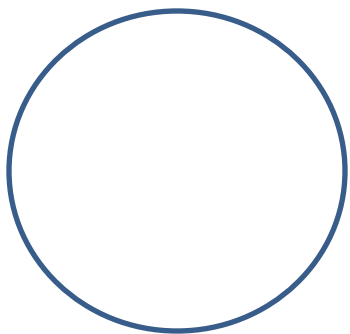
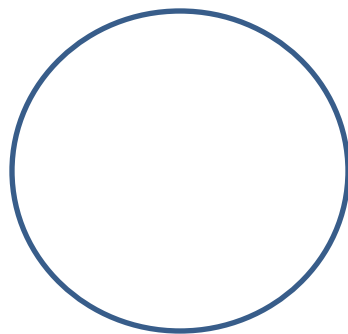
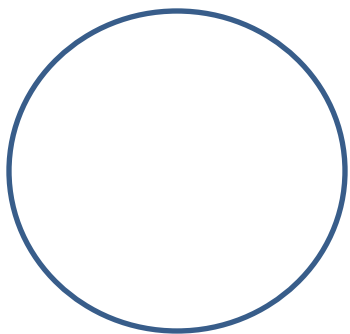
Color Development



(Prussian Blue)



B.Z. Shakhshari, Chemical Demonstrations, vol. 5, University of Wisconsin Press, Madison (2011).



Glass for bottles

Brown Glass

- Iron, sulfur and carbon
 - Sulfur replaces some oxygen
 - High carbon content gives reduced glass
 - Color from Fe^{2+} - Fe^{3+} charge transfer
 - Absorbs wavelength less than 450nm

Green Glass

- Chromium oxide
- Reduced glass gives uv protection.



