Greenhouse to Glass

Hannah Turner | Director
Barley, Malt & Brewing Quality Lab

Hannah Turner

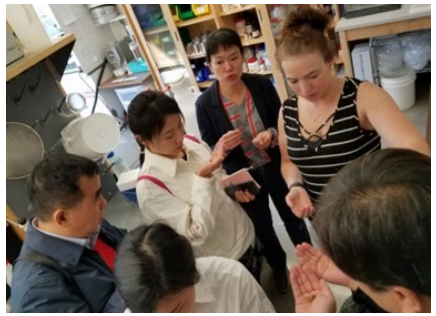
BS 2014 – Plant Science
MS – 2016 – Plant Science

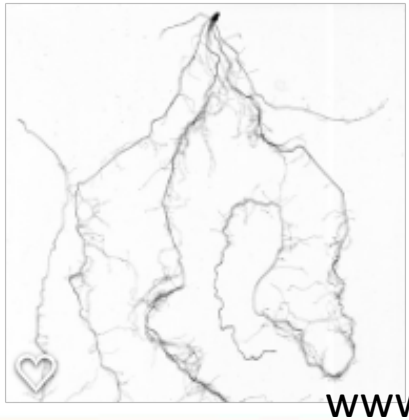
MSU Barley Breeding Program – 2016 to present
Craft Maltster's Guild BOD/Technical Committee – 2018 to present
ASBC – Technical Committee - 2020 to present
Pink Boots Society – MT Chapter Co-Leader 2021 - present

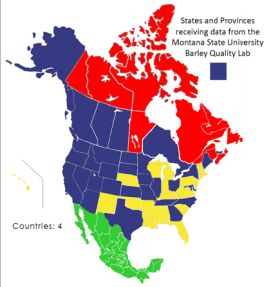
Barley Breeding, Malt & Brewing Quality

Supporting the region and beyond via

Research | Service | Education

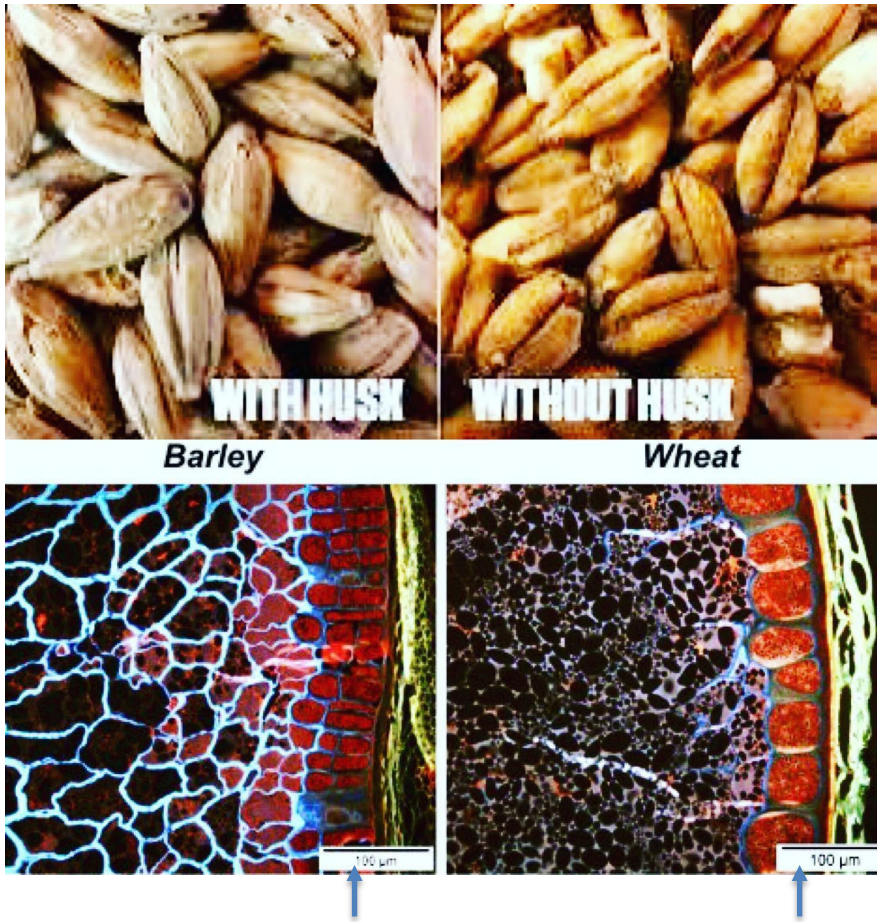






www.montana.edu/barleybreeding

Hulls protect the grain in germination and support mash filtration



Enzyme producing aleurone layer – more cells in barley = more enzymes

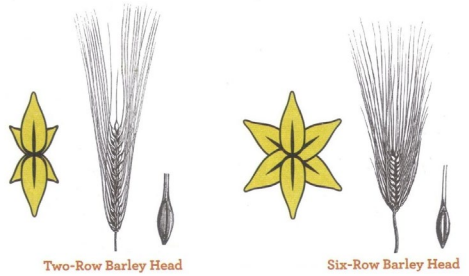
Why Produce Barley Malt?

Two key reasons barley is a critical brewing ingredient (even though many grains can be malted)

- Barley has high enzymatic potential
  - Aleurone layer 2-3 cell layers thick
  - Self convert + convert specialty & alt grains
- Naturally retains it's husk
  - Important wort separation aid
  - No rice hulls needed here!

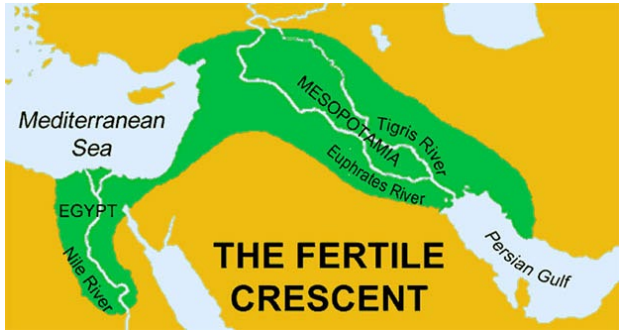
Barley

- Cereal grain and member of the grass family: *Poaceae*
- Wild and cultivated types
- Cultivated barley is *Hordeum vulgare*
- Cultivated barleys:
  - Spike morphology: two and six rowed
  - Growth habit: spring, winter, facultative
  - Kernel types: hulled, hull-less (naked), and hooded (awnless)

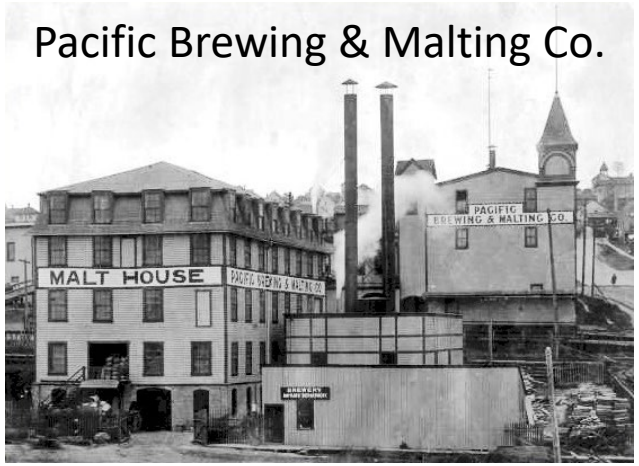


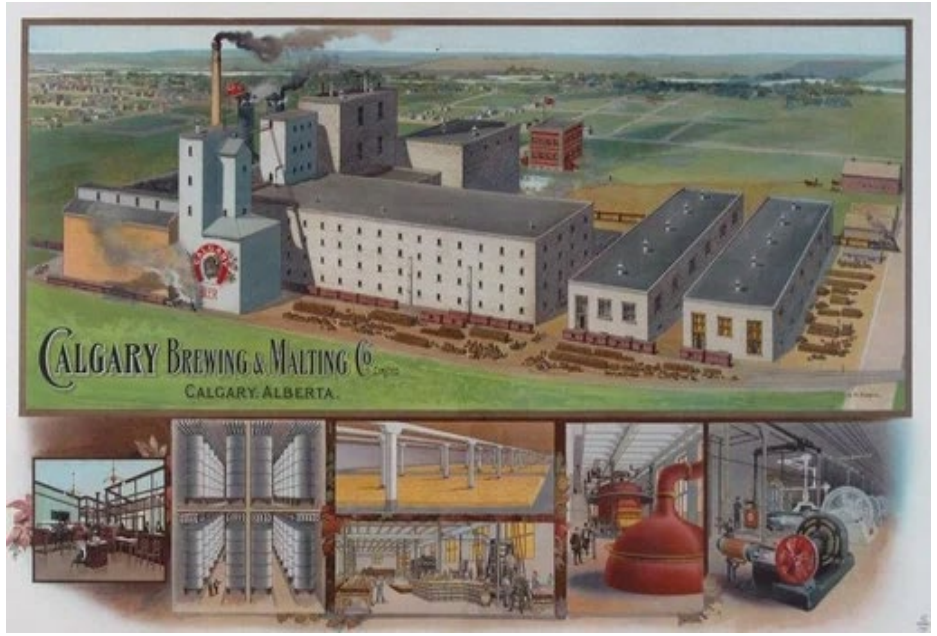
Malting & Brewing History

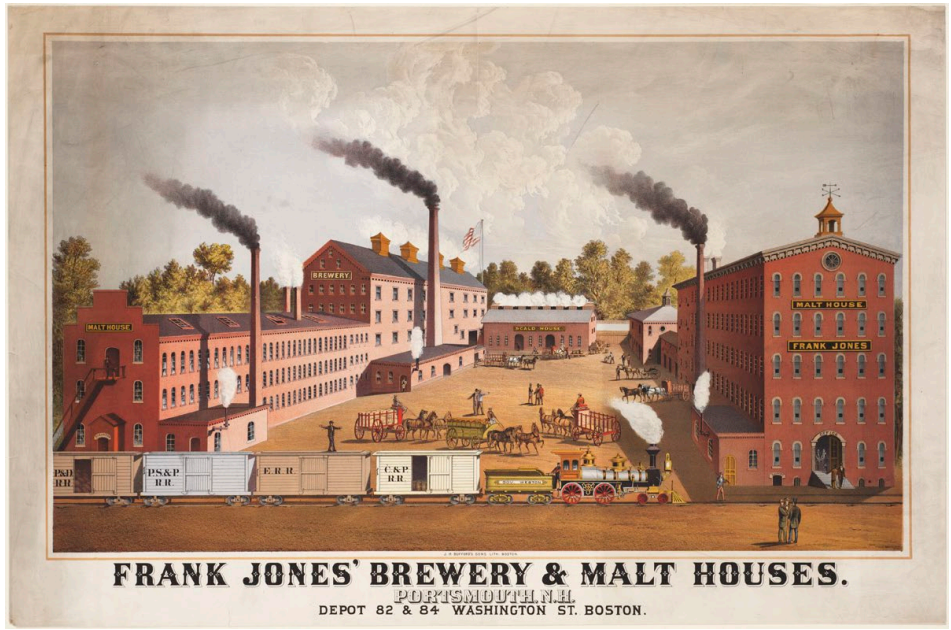
- Evidence of barley consumption in 8000 BC
- Most malting/brewing in the middle ages was small scale
  - basic domestic chore performed by women
- Industrialization brought separation
  - modern day aspect of a once continuous process
- Early manuscripts with detailed malting instructions
  - In ways they are still relevant:
    - A New Art of Brewing Beer – 1690, Tyron
    - The London and Country Brewer – 1736, Ellis

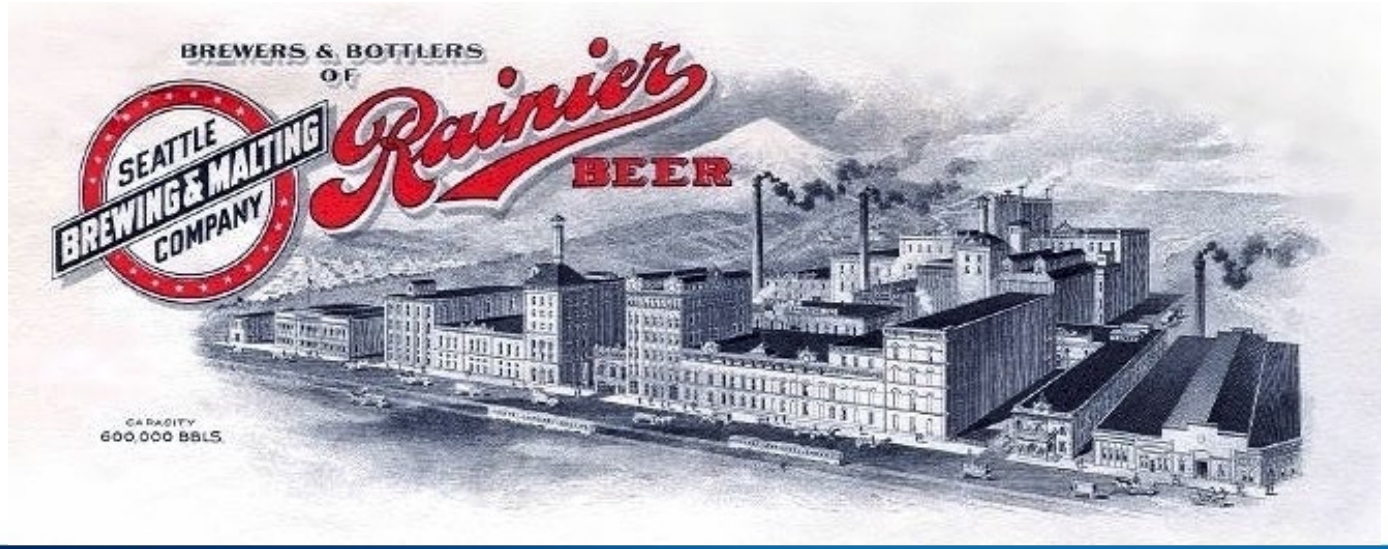


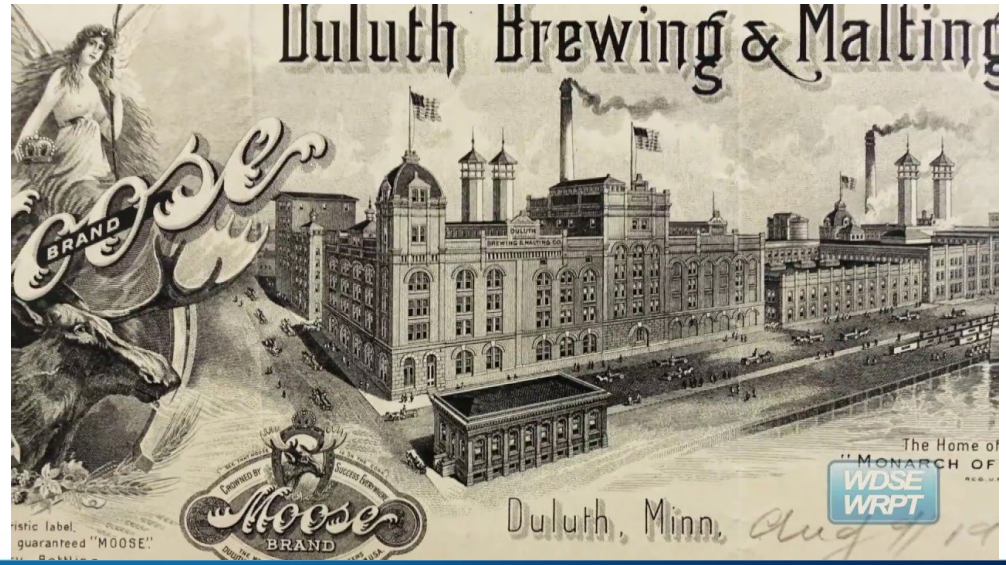
Pacific Brewing & Malting Co.











Greenhouse to Glass

Barley is Specifically Bred for Brewing!

Process:

- Determine end goal objective
  - Trait such as malt quality, disease resistance etc
- Obtain genetic variability for the trait
  - Cross appropriate parents
    - Ex: Desired trait/non-adapted x locally adapted
- Select the best lines over a 10-12 year process

  -Conventional and modern methods of selection

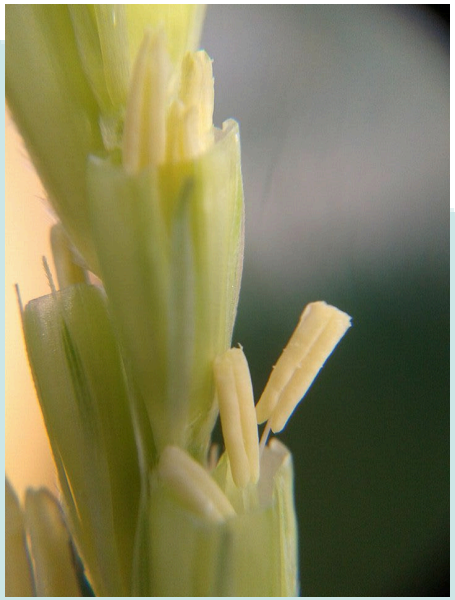
  -No GMO methods used for barley

There are no GMO barleys!

Crossing Barley

1. Make head female

Timing, timing, timing!



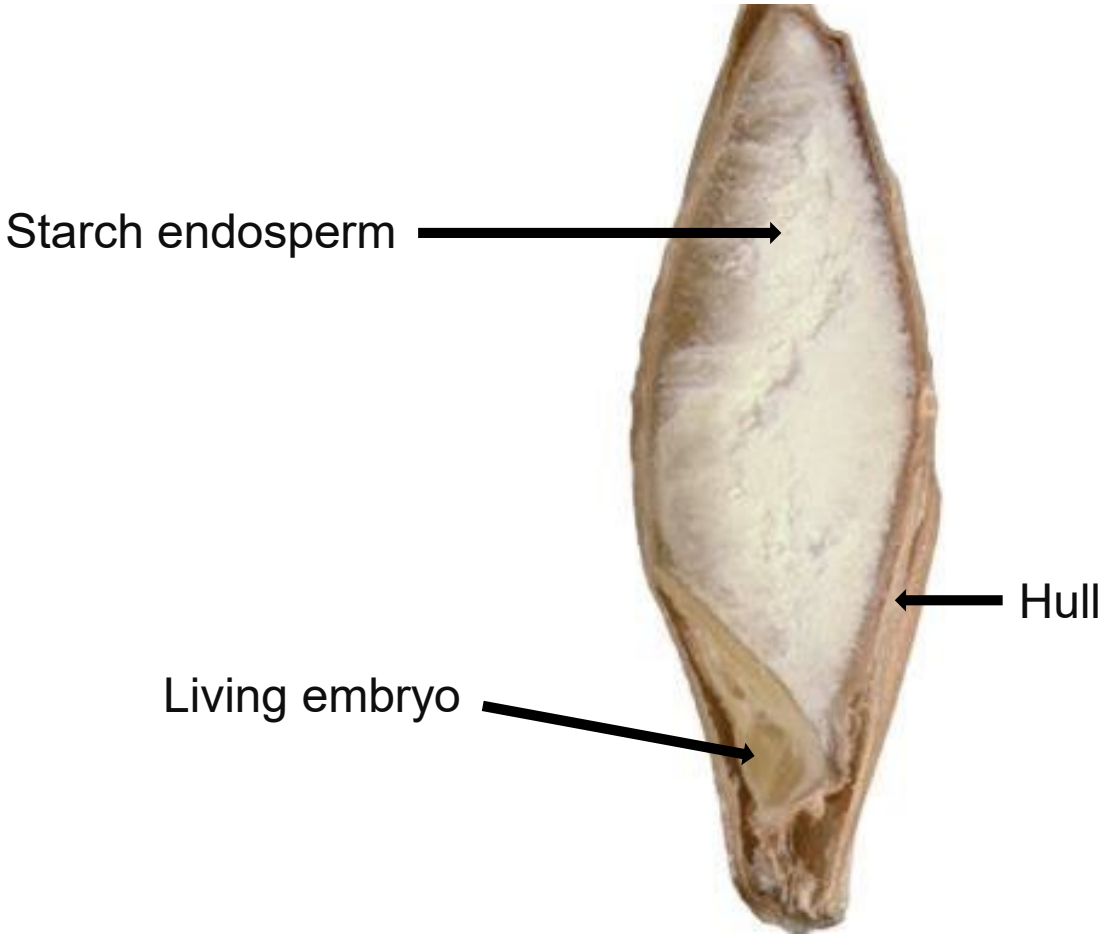
2. Bag head, wait… pollinate

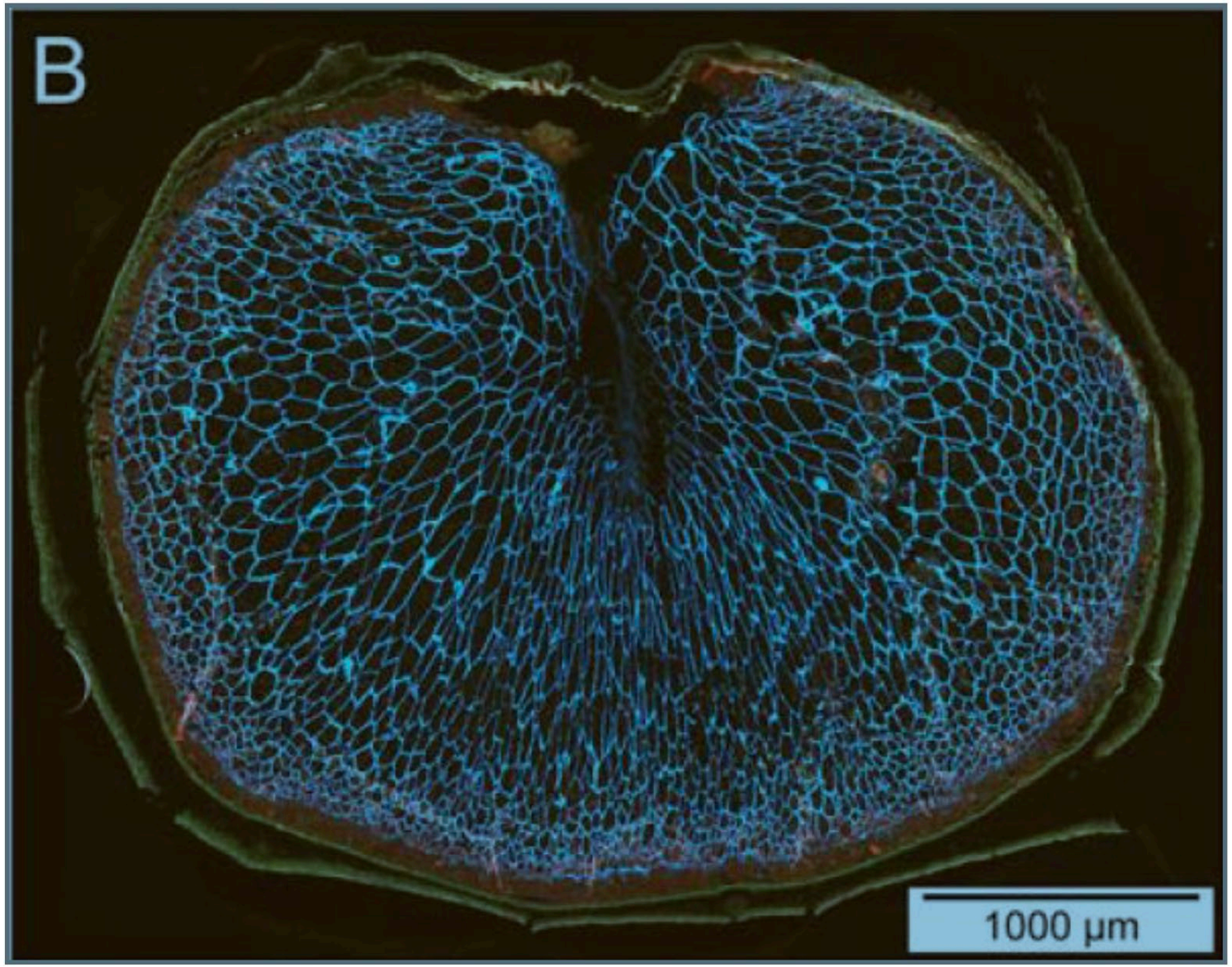
3. Wait for seed

Check out this video in our Resource Center for greater process detail! https://vimeo.com/48607613

Breeding is Resource Intensive

The barley kernel

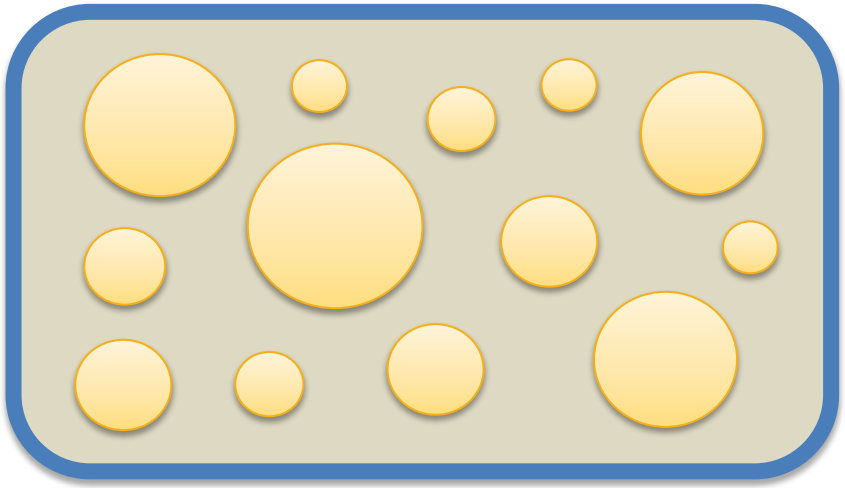



B
1000 µm

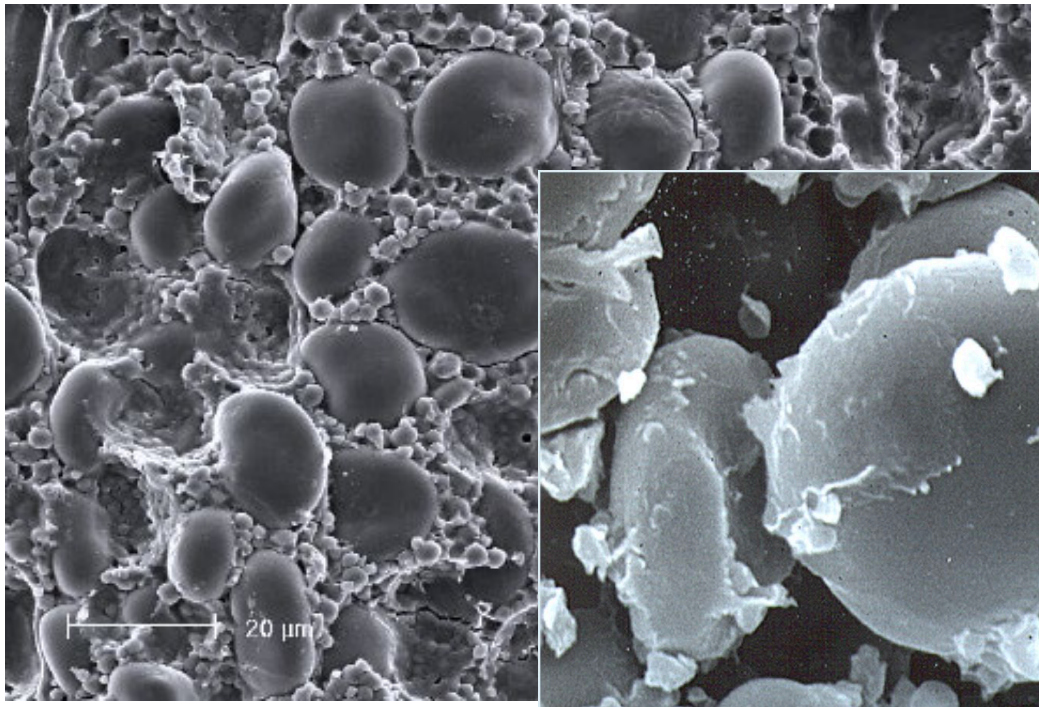
Very simplified analogy

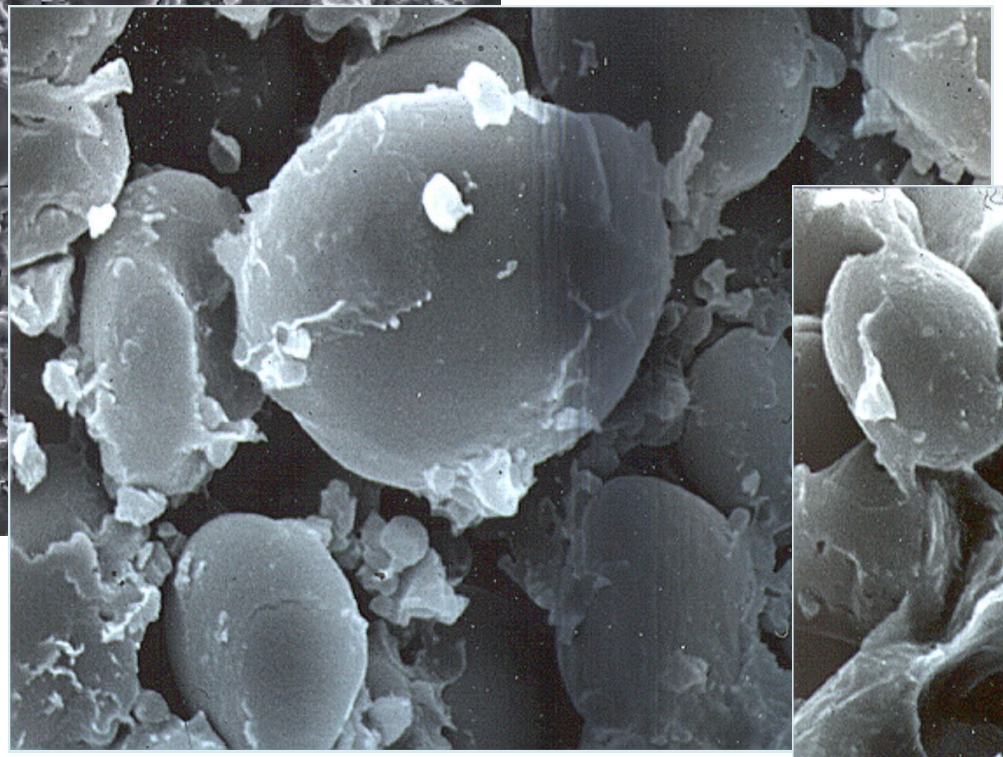
<u>Think of a fruit and nut chocolate bar:</u>

-Cell wall = wrapper
-Protein matrix = chocolate
-Small starch granules = fruit
-Large starch granules = nuts



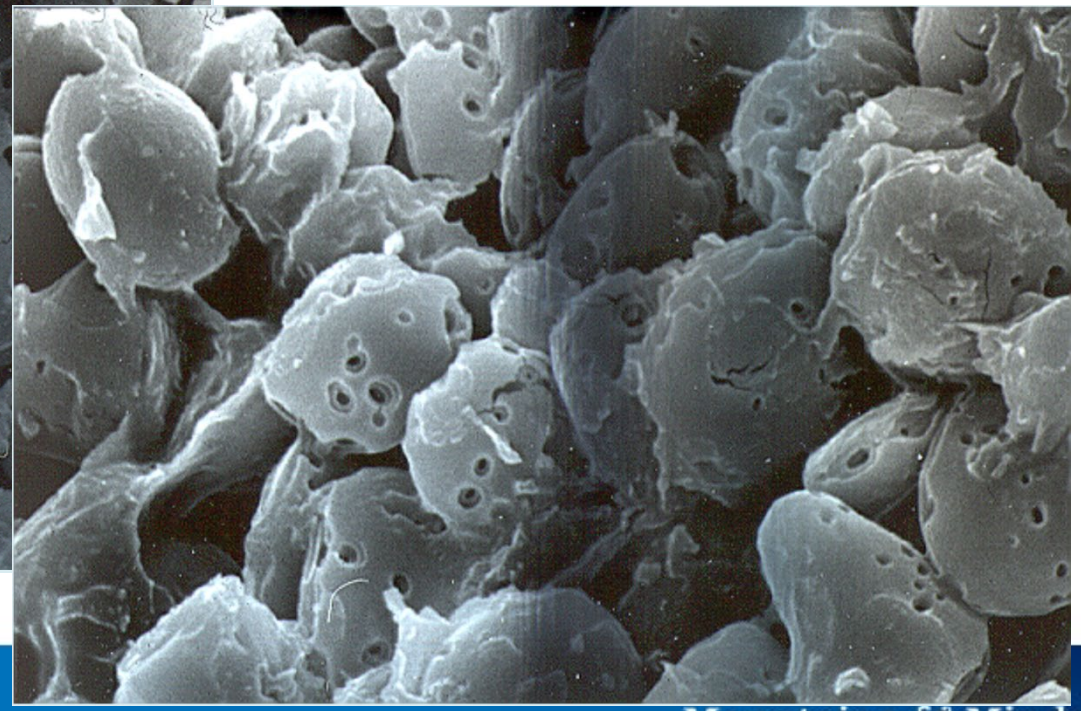
Levels of Endosperm Modification





Starch is accessible for brewing

Starch degradation decreases extract



Malting Stages

Steep

-24-48 hours, involves grain submersions and air rests
-hydrate grain up to 42-46% moisture
-Triggers grain into germination like spring rains

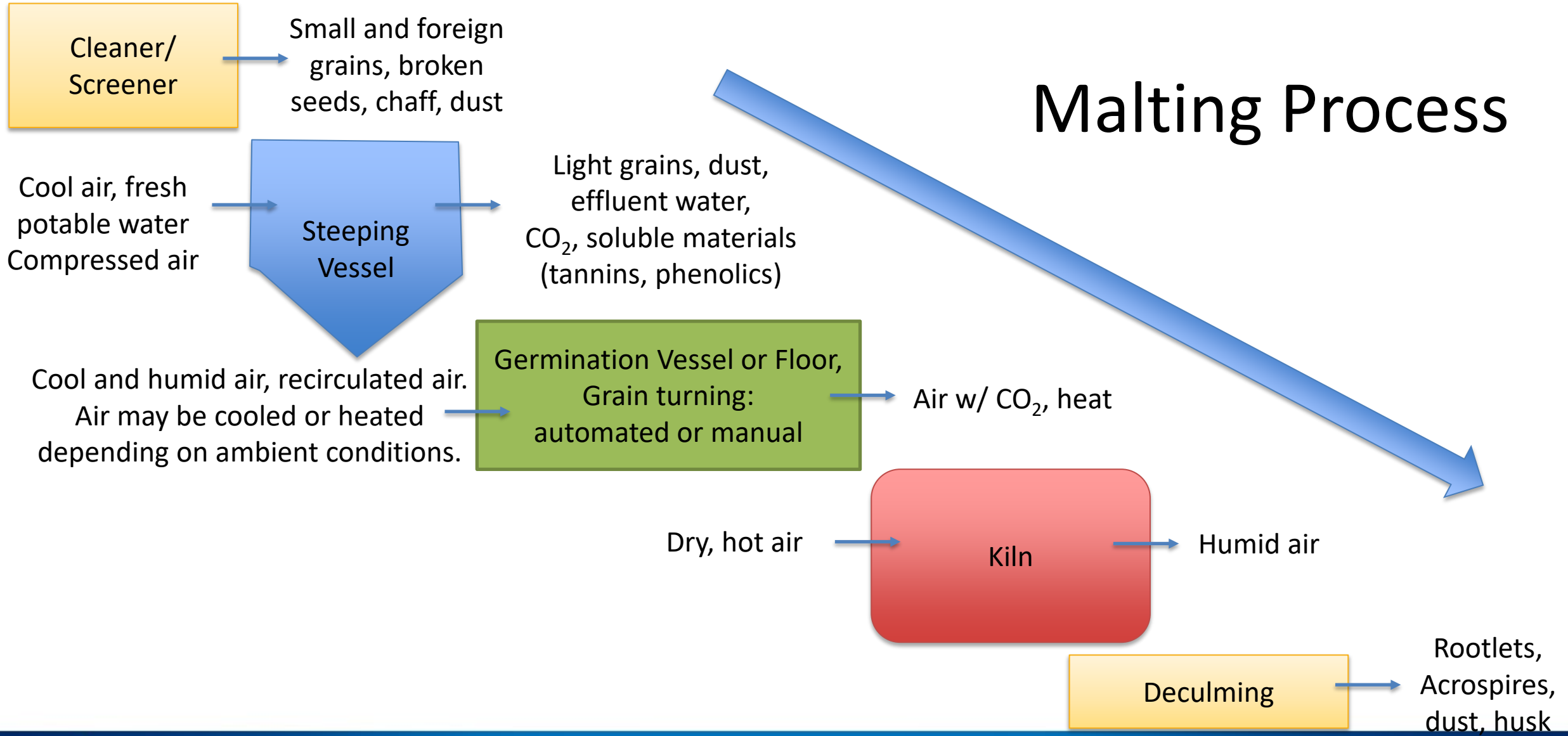
Germination

~3-5 day process where grain is kept at high humidity
    -moisture maintained at 44-46%
-aerobic, cool conditions must be maintained
-intermittent turning to prevent root matting and evenly treat the grain

Kiln

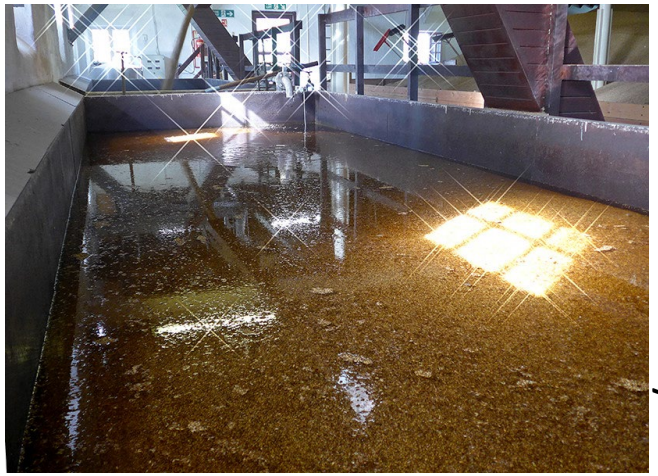
- Typically ~ 24 hours
    -Base malts: low slow heat with high airflow to preserve enzymes, higher temps/lower airflow later for curing/some flavor & color
        -Kilning pauses enzymatic process
    -Specialty malts: involve variations of temperature and moisture
-Malt Should be dried to 4-6% moisture for stability

Malting Process



Malting Process –> Grain Modification

Steeping



Balvenie Distillery

Germination

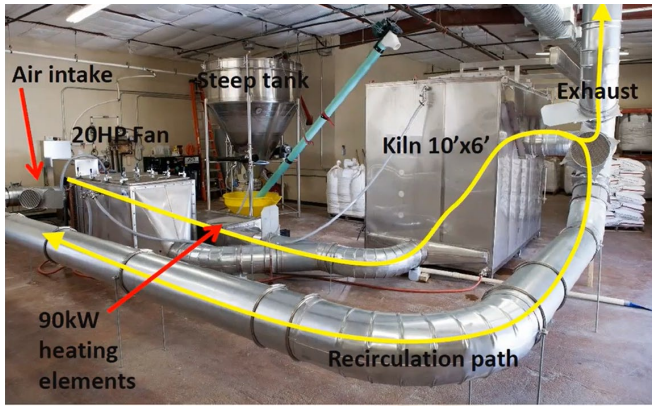
Rahr Malting

Kilning

Briess Malting

Root Shoot Malting

Leopold Brothers

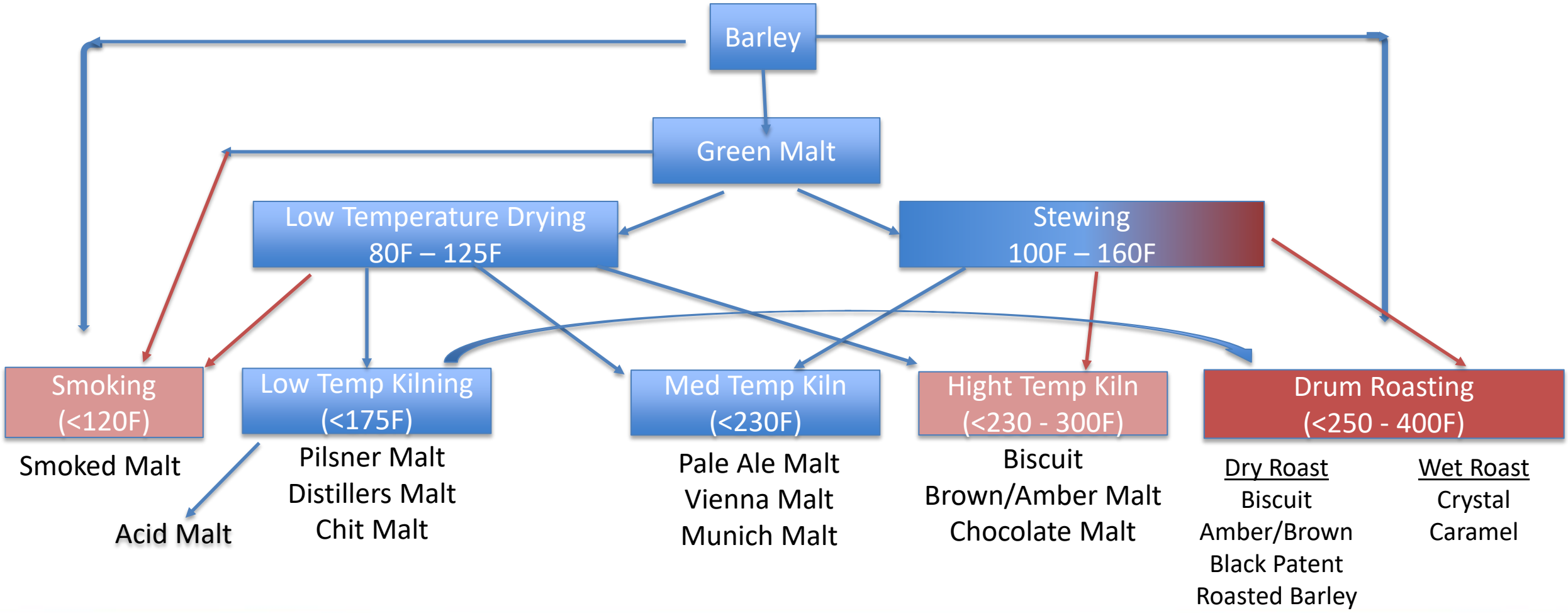


Blacklands Malt

The Doig Ventilator

- Iconic structure of Scottish whiskey malthouses
- Charles Doig - designer
- Special chimney
  - ✓ significantly improved hot air and smoke evacuation
  - ✓ largely unhindered by the weather
- Reminiscent of the pagoda roof and also referred to as a Doig pagoda
- Many of the original structures were lost to fires – but a few designed by Doig and his sons still exist

Schematic of Malt Style Production



Brewers Grist Bill (Recipe)

- Large proportion of base barley malt
  - Sugar
  - Enzymes
  - Husks for filtering
- Small proportion specialty malts
  - Barley or adjunct grains
  - Color, flavor, body, haze etc

MASH →

Mashing milled ingredients with warm water allows enzymatic process to convert starch into sugar → Wort produced for fermentation

1 All brews start in the cereal cooker where water, corn grits, & malted barley are added & cooked for 2 hours at 210° F.

2 More water & malted barley are added. Here the starches are converted into sugars that can be fermented. Light beers are cooked longer & at lower temperatures to reduce sugar content.

3 At this point the sugar-rich liquid, known as wort, is moved to the Lauter Tun. Here the grain & liquid separate through the sieve-like base of the vessel.

4 Once the sweet wort is transferred to the Brew Kettle, the hops are added which gives the brew flavor, aroma & bitterness.

5 The Wort is cooled & moved to the Fermenting Cellars where yeast is added or "pitched". The yeast converts sugars from the malt into alcohol & carbon dioxide.

6 After active fermentation, the brew is cooled & moved to the Aging Tank for about 20 days. At this stage, the yeast settles & the beer's flavor becomes smoother.

7 The beer is then filtered to purge the remaining yeast & stabilize the flavor. Carbon dioxide is adjusted to ensure superior flavor. The beer is then moved to the finishing tanks.

8 Once the brew is finished, it is pumped to the can line, bottle line, or kegged for our beer loving fans.

Yuengling Brewing

Impact of Malt on Beer

- Beer flavor/aroma
  - Kiln byproducts
  - Fermentation
  (malt is food for yeast)
    - Esters
    - Higher alcohols
    - Sulfurs
    - Acidity
  - Mouthfeel
  - Finishing gravity
  - Astringency

- Beer Aesthetics
  - Haze
  - Head retention
  - Color

- Brewery Efficiency
  -Conversion time
  -Lauter time
  -Brewhouse yield
  -Filter time

Thank You!
Questions?

Hannah Turner | Hannah.turner2@montana.edu

Check our Learning Center: montana.edu/barleybreeding

Coming to Bozeman? Come tour our lab!