BEER:
The Foundation Of Civilization
The History Of Beer

Linked with the origins of agriculture ~13,000 years BC
Sumerians were the first brewers ~4,000 years BC
Europeans first used hops ~1,000 A.D.
Germans required winter brewing only after a South American yeast vastly improved the previous native lager yeast in 1500s.
## World Production 2009

<table>
<thead>
<tr>
<th>Country</th>
<th>Production (M mt)</th>
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<tbody>
<tr>
<td>World</td>
<td>173 M mt</td>
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<tr>
<td>USA</td>
<td>23 M mt</td>
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<tr>
<td>China</td>
<td>40 M mt</td>
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<tr>
<td>Russia</td>
<td>11 M mt</td>
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</tbody>
</table>
Basic Ingredients
Water
Barley
Hops
Yeast
OTHER GRAINS
OTHER ADJUNCTS

Reinheitsgebot (German Purity Law) adopted in 1516, is the oldest known provision still enforced to protect the consumer. It specifies Barley, Hops, and Water- no mention of yeast. Much of the law deals with price control and prevention of wheat and rye being used for beer instead of bread.
The Brewing Process

The stages of brewing beer:

1. **Malting Barley**
2. **Mash Tun**
   - Wort
3. **Kettle**
   - Hops are added
4. **Fermenter**
   - Yeast is added
5. **Beer is separated from yeast, carbonated and aged**
6. **Final Product**
Grains Used In Brewing

BARLEY
WHEAT
RYE
OATS
RICE
CORN
Barley
Hordeum Vulgare
Barley seed
The Malting Process

Soaking grain in water
Germination and aeration
Roasting
Malting barley seed

Steeping, by misting or alternating flooding and aeration until root tip appears.

Germination for 5 days at 16C with stirring. Starch is converted to sugar.

Drying at 50C then roast 150 and 200C higher temp creates darker malts. After drying the roots are removed. May be milled or left whole.
Hops

Dioecious (flowers on male and female plants) perennial herbs

FAMILY: Hamemmelidae
GENUS: *Humulus*
SPECIES: *lupulus; americanum*
CULTIVATION

Female vines trained to vertical strings attached to a trellis wire. The unpollinated flowers are harvested and used fresh or dry. Mechanized harvesting is common today. US production in Oregon and Washington. Hops provide bitterness, aroma, and preserves the beer. India Pale Ales have much more hops than other beers were developed by English to preserve beer exported by ship through the tropics to India in the 19th and early 20th centuries.
YEAST
TWO MAIN TYPES
Saccharomyces cerevisiae
Saccharomyces uvarum
Yeast culture in sterile bottle. Yeast converts sugar to alcohol under anaerobic or oxygen free conditions, otherwise carbon dioxide CO2 is made.
Water

Water quality is crucial for good quality beer

Important ions
- Calcium Ca$^{+2}$
- Magnesium Mg$^{+2}$
- Sulfate SO$_4^{-2}$
- Carbonic acid CO$_3^{-2}$
- Chloride Cl$^{-}$
Brewing Process

Mash-in Grains
Lautering & Sparging
Boiling
Cooling
Fermenting
Conditioning
Mash-in Grains

Any additional grains beside the malt barley
Enzymes in malted barley convert starch in other
grains to sugars –mainly maltose in 45-90 minutes
at 64-70 C (147-158 F).
Lautering & Sparging

Lautering is basically a filtering of the “WORT” by the grain husks in the wort, similar to using the coffee grounds to filter coffee in a French Press or press pot..

Sparging is rinsing the grain husks bed with hot 76C water to remove all the sugars.
Lautering & Sparging
Boiling

Wort is boiled to:

Sterilize the wort to kill all microorganisms.

Denature proteins (enzymes).

Dissolve resins from the hops.
Cooling

Hot wort must be cooled rapidly to:
- Minimize contamination of wort
- Prevent oxidation when transferring the wort to fermenter
- To precipitate proteins in the wort which can impact flavor, color, and clarity.
Fermentation

Conversion of sugars to alcohol and carbon dioxide.

Temperature maintenance depends on yeast strain and beer type.

• Lagers: 9-15 C
• Ales: 15-23 C
• Open or closed
Open Fermentation

These are top fermented beers like ales Anchor Steam beer and some Belgium style beers.
Closed Fermentation

The more common type of fermentation. Its easily to keep other yeasts and bacteria out of the ferment. Work area need not be as clean.
Commercial fermenters
Conditioning

A few week to 6 months. LAGERS need prolonged time at near freezing temperatures.
Bottling

Can be naturally carbonated by adding a little sugar when bottling or “carbonated” with compressed CO$_2$ or Nitrogen
Beer Styles

Ales: top fermenting (floating yeast) at 15-23C eg Pale ale, IPA, Dark ale, brown ale, stouts, porters, wheat

Lagers: bottom fermenting (sunken yeast) 7-13C, store cold eg Pilsner, Dunkel, Bock, Dortmunder

Spontaneous fermentation with volunteer yeast, bacteria eg Lambic

Hybrids: fruit, vegetable, herbs, smoked grain

Elements of style:

aroma, flavor, appearance (color, clarity), body (mouth feel), strength (% alcohol), yeast, grain, hops, water, other ingredients