The History of Beer

Beer is as old as civilization itself. One of the most common and popular of beverages, it is made in very corner of the world. It has a long and fascinating history, from ancient Egypt to medieval monks, to (for a time) being outlawed by the U.S. Constitution. It has been part of the daily ration for people whose lives have been long and hard, as well as the symbol of celebration, recreation, and relaxation. The local tavern has been a refuge and social universe to many. The simple combination of barley, water, hops, and yeast produces many different styles of beer. The process has several steps, and although it is simple enough to be made at home with the right equipment, many people would consider brewing to be an art. Beer types range from a pale, sparkling yellow to a dark, rich reddish-brown. The standard light lager commonly found in North America is a light colored, light bodied, lightly hopped beer.

The Story of Beer

Some ancient records suggest the earliest and most primitive forms of beer were produced by tribal aboriginals, using methods quite different than would be “acceptable” today. Women of the tribe would chew mixtures of grain and corn, mixing it with their saliva. They would then spit the contents into a large communal “spittoon”. This spittoon would slowly fill with water and chewed up grain/corn. We now know that saliva contains the enzyme amylase, which is needed to convert the starch (in the grain) into sugar for the yeast. This sugar, water and saliva mixture would then be turned into beer using yeast, obtained by gently scraping the white film from the feces of an un-weaned infant. This white film, an almost pure source or brewer’s yeast, was then stirred into the awaiting mixture. Within a day, the entire mixture was bubbling and churning, and after a week, the “beer” was ready to drink. As legend has it, after a night of drinking the primitive beer, the aboriginals were able to speak with the Gods.

“Modern” beer is one of the oldest products of civilization, and may even have been a stepping stone to the invention of leavened bread and, of course, pizza dough. Historians believe that the ancient Mesopotamians and Sumerians were brewing as early as 10,000 BC. Although the product would have been somewhat different from today’s bottled varieties, it would be recognizable.

Stage 1 – Malting

Barley seeds are soaked and allowed to germinate. This “malting” allows the seed to produce enzymes that break down proteins and starches into nutrients for the embryo. Once germination begins, the barley is cooked in a kiln, halting the growth process, so as to leave the enzymes and starch reserves behind in the seed.

Stage 2 – Mashing

At this stage, large macromolecules are broken down into their subunits. To accomplish this, the grain is crushed and soaked in temperature-controlled water, allowing enzymes to convert protein into amino acids and starches into simple sugars.

Stage 3 – Boiling

After collecting the liquid from the mash (called wort), it is brought to a boil and hops are added. Hops add flavor (bitter resins) and aroma and help preserve the beer.

Stage 4 – Fermentation

After the wort is cooled, yeast is added to begin fermentation, producing alcohol. When the yeast run out of sugar, they become dormant and settle to the bottom of the fermenter. Finally, the beer is separated from the yeast, aged, carbonated, and enjoyed.
**Occupation:** Work as a team of Biochemists and Microbiologists at the Wick Brewhouse™.

**Your Task:** To properly brew your own brand of Wick Brewski in collaboration with your team.

### Day One – The Mash

**Note:** Never leave your water/barley mixture (called the mash) on a hot plate without constantly stirring with the glass stirring rod right to the bottom of the beaker. This will cause scorching, will destroy your enzymes, and ruin your lab.

### Step One: The Mash

1. Send 1 person to the front with your 600 ml beaker to weigh out 100 g of barley.
2. Send 1 person to the front with your 400 ml beaker, hot paws and tongs to grab 350 ml 90°C water from Mr. Wick.
3. Add the 350 ml of 90°C water to the barley in the 600 ml beaker and stir well. This 600 ml beaker is your "mashtun".
4. This next step is optional. If you want to add some color to your beer grind 1 teaspoon of any specialty malts and add to your mash.
5. To keep your enzymes happy maintain your mash temperature between 60-70 °C. You may need to heat your mash on a hot plate if the temperature drops below 60 °C.
6. Hold your mash between 60-70 °C for approximately 30 minutes.

### Step Two: Lautering and Sparging (The process of separating the liquid from the grain)

1. Get approximately 350 ml of hot tap water in your 400 ml beaker.
2. Follow the verbal instructions given to you by Mr. Wick for separating the liquid from the grain.
3. Pour the unfermented beer (now called wort, pronounced “wert”) into a CLEAN 1000 ml beaker and cover with tin foil (don’t tape).
4. Write your period number and an appropriate name for your beer on the foil.
5. CLEAN UP!!!
Day Two - The Boil

Boiling your Wort

1. Carefully pour the clear portion of your wort into a separate container. Be careful to disturb as little sediment as possible. Discard the sediment and return your wort to the larger beaker.

2. Before you boil your wort you must find its initial specific gravity (specific gravity is the ratio of the density of any substance to the density of water). This is measured by pouring a sample of your unfermented beer into the cylinder and floating a hydrometer in it. Record the value on a sheet of loose leaf as you will need it later for a calculation which you will be marked on! It’s usually between 1.020 and 1.050

3. Top your wort up to 800 ml with tap water.

4. Add 1 boiling chip and 3-6 hop pellets of your choice to your wort.

5. Get your wort on your hot plate and bring it to a boil.

6. Boil the wort for 15-20 minutes.
   DO NOT LET THE WORT BOIL OVER OR YOU WILL BE CLEANING A SMELLY BURNT MESS!!!

7. Remove from the heat, immediately cover with foil and leave to cool.

8. Once it cools to room temperature, Mr. Wick will aerate the wort by stirring vigorously for 1 minute.

9. He will then add a pinch of brewers yeast.

10. It is now technically “beer” ☺️
Day Three – Distillation

Distillation

1. Although we will not be bottling or kegging our beer, that is what would happen next.
2. Your beer is too flat and cloudy to drink but you may smell it if you wish. If it does not smell like beer you likely ran into contamination issues sometime during the process.
3. Next you must find the final specific gravity of your beer. Record this value next to where you recorded the initial specific gravity on day 2 of the lab.
4. As a final step, perform a distillation using the set-up pictured below.
5. Bring your distillate to the front to perform a flame test on the alcohol you’ve distilled. This is worth a large portion of your team mark!
1. Beer is the combination of what 4 simple ingredients?
2. According to historians, who and when was beer first made? (use the handout provided)
3. List the 4 stages of the brewing process.
4. What is malting?
5. Why do we have to malt the barley? (Why not just grind up un-malted barley straight from the farmer?)
6. Why is it important not to let the seeds grow too large before kilning them?
7. How do we get the different colors of beers that exist?
8. The proteolytic (protein breaking) enzymes are active during the mash.
   a. What are the "building blocks" of protein?
   b. Why do yeast need this building blocks?
   (Hint: think back to a major biochemical process from last unit...need another hint...think ribosomes 😊)
9. Diastatic enzymes (starch breakers) are active during the mash. They are also found in your saliva.
   a. What are the "building blocks" of the starch?
   b. Why do yeast need these building blocks?
10. Why was it crucial NOT to let the temperature of the mash go much above 70 °C?
11. Why would we have to mash our grain for MUCH longer than 30 minutes if the temp of our mash was well below 60 °C?
12. The pH of the mash should be around 5.5 (slightly acidic). Professional brewers monitor the pH and add dilute phosphoric acid if necessary. Why are they so concerned with the pH at this point?
13. a. Suggest why water is poured over the grain during Sparging?
   b. As a brewer, why would you select hot rinse water over cold water? (use the word solubility in your answer)
14. List 3 reasons why hops are added to the beer?
15. After your wort cools, Mr. Wick will aerate the wort by shaking vigorously for 1 minute. What important gas gets mixed into the liquid at this point?
16. Keeping the previous answer in mind, what type of respiration is the yeast performing in the very early stages of fermentation when this gas is still present in the liquid? This allows the yeast to multiply quickly so they can out number and out compete any bacteria that may be present.
17. What causes the yeast to switch to anaerobic respiration?
18. Keeping in mind the previous 4 answers, explain how you might be able to produce non-alcoholic beer.
19. a. Write the word equation for Anaerobic Respiration (alcohol fermentation).
   b. Write the word equation for Aerobic Respiration:
20. Why would it be dangerous to place an airtight lid on the fermentation vessel during fermentation?
21. Why, after many days of vigorous activity, does the fermentation begin to slow and yeast begin to settle to the bottom?
22. Use the formula provided below to calculate the % ethanol (alcohol) of your beer.
   \[
   \% \text{ Alcohol (Ethanol)} = \frac{\text{Initial Gravity} - \text{Final (post distillation) Gravity}}{0.0075}
   \]
   Initial specific gravity (unfermented beer) = ____________
   Final specific gravity (fermented beer) = _________________
   % Alcohol (Ethanol) in Your Beer = _________________
23. After distillation, you used a flame test to determine if you made alcohol.
   Write the chemical equation for the Combustion of Ethanol.
1. Beer is the combination of what 4 simple ingredients? **WATER, HOPS, YEAST, BARLEY**

2. According to historians, who and when was beer first made?

3. List the 4 stages of the brewing process.

4. What is malting?

5. Why do we have to malt the barley? **TO PRODUCE ENZYMES**

6. Why is it important not to let the seeds grow too large before kilning them?

7. How do we get the different colors of beers that exist? **BY ADDING ROASTED MALTS.**

8. The proteolytic (protein breaking) enzymes are active during the mash.
   a. What are the "building blocks" of protein? **AMINO ACIDS**
   b. Why do yeast need this building blocks? (Hint: think back to a major biochemical process from last unit...need another hint....think ribosomes ☺️) **FOR THEIR OWN PROTEIN SYNTHESIS**

9. Diastatic enzymes (starch breakers) are active during the mash. They are also found in your saliva.
   a. What are the "building blocks" of the starch? **SUGAR**
   b. Why do yeast need these building blocks? **ENERGY/FOOD**

10. Why was it crucial NOT to let the temperature of the mash go much above 70 °C? **ENZYMES GET DAMMAGED**

11. Why would we have to mash our grain for MUCH longer than 30 minutes if the temp of our mash was well below 60 °C?

12. The pH of the mash should be around 5.5 (slightly acidic). Professional brewers monitor the pH and add dilute phosphoric acid if necessary. Why are they so concerned with the pH at this point? **ENZYMES ARE pH SENSITIVE**

13. a. Suggest why water is poured over the grain during Sparging?
   b. As a brewer, why would you select hot rinse water over cold water? (use the word solubility in your answer)

14. List 3 reasons why hops are added to the beer?

15. After your wort cools, Mr. Wick will aerate the wort by shaking vigorously for 1 minute. What important gas gets mixed into the liquid at this point?

16. Keeping the previous answer in mind, what type of respiration is the yeast performing in the very early stages of fermentation when this gas is still present in the liquid? This allows the yeast to multiply quickly so they can out number and out compete any bacteria that may be present. **AEROBIC**

17. What causes the yeast to switch to anaerobic respiration? **RUN OUT OF OXYGEN**

18. Keeping in mind the previous 4 answers, explain how you might be able to produce non-alcoholic beer. **ADD OXYGEN TO FERMENTING BEER**

19. a. Write the word equation for Anaerobic Respiration (alcohol fermentation).
   b. Write the word equation for Aerobic Respiration:

20. Why would it be dangerous to place an airtight lid on the fermentation vessel during fermentation?

21. Why, after many days of vigorous activity, does the fermentation begin to slow and yeast begin to settle to the bottom?

22. Use the formula provided on the Report to calculate the % ethanol (alcohol) of your beer.
   - Initial specific gravity (unfermented beer) = ____________
   - Final specific gravity (fermented beer) = ____________
   - % Alcohol (Ethanol) in Your Beer = _____________________________
   - % Alcohol (Ethanol) = [Initial Gravity - Final (post distillation) Gravity] ÷ 0.0075

23. After distillation, you used a flame test to determine if you made alcohol.
   Write the chemical equation for the Combustion of Ethanol.
Pre-Lab Day

Start with the first page of this doc and the 4 ingredients and the 4 steps.

Then get into the history/story of beer.

Pass around the GROUND MALT, VARIOUS ROASTED MALTS, HOP PELLETS, HOPS, YEAST.

The science of beer 6 min
https://www.youtube.com/watch?v=TQtqwWGuFk

BEER AND PIZZA TRIVIA
25 questions (male vs female...in desks...go down rows...if u get it right your team keeps control and the next player on your team goes, if not the next member of the other teams gets to guess between 2 remaining answers...if neither gets it right, control switches to other team.

Barley to Beer Hawkshead Brewery Tour 9 min
https://www.youtube.com/watch?v=BvUOESDVfuI

SciShow The Science of Alcohol From Beer to Bourbon 9 minutes
https://www.youtube.com/watch?v=zP21LH3T9yQ

Allow them to pick out and grind 1 TSP of specialty malts for their brew if they desire.

Next go over detailed pre-lab procedure while projecting lab directions.

If time. How to make beer animation 2 min
https://www.youtube.com/watch?v=Wxo9PHc3jNw

Have NOT shown.

Beer 101 - Part 1 and 2 (40 min total)
https://www.youtube.com/watch?v=SpmjLoXE6M
https://www.youtube.com/watch?v=xCEsd3F9z-E