FOR THE LOVE OF BEER

An overview of Beer and The Brewing Process

Session Number 2

- **The Brewing Process**

12 May 2011

Brewing Process

- Grain Bill
- Dough In
- Mash Regime
- Lautering
- Boiling
- Fermentation
- Finishing
- Packaging
- Storage & Handling

3A. Vienna Lager

- Aroma: Moderately rich German malt aroma (of Vienna and/or Munich malt). A light toasted malt aroma may be present. Similar, though less intense than Oktoberfest. Clean lager character, with no fruity esters or diacetyl. Noble hop aroma may be low to none. Caramel aroma is inappropriate.
- Appearance: Light reddish amber to copper color. Bright clarity. Large, off-white, persistent head.
- Flavor: Soft, elegant malt complexity is in the forefront, with a firm enough hop bitterness to provide a balanced finish. Some toasted character from the use of Vienna malt. No roasted or caramel flavor. Fairly dry finish, with both malt and hop bitterness present in the aftertaste. Noble hop flavor may be low to none.
- Mouthfeel: Medium-light to medium body, with a gentle creaminess. Moderate carbonation. Smooth. Moderately crisp finish. May have a bit of alcohol warming.
- Overall Impression: Characterized by soft, elegant maltiness that dries out in the finish to avoid becoming sweet.
- Comments: American versions can be a bit stronger, drier and more bitter, while European versions tend to be sweeter. Many Mexican amber and dark lagers used to be more authentic, but unfortunately are now more like sweet, adjunct-laden American Dark Lagers.
- History: The original amber lager developed by Anton Dreher shortly after the isolation of lager yeast. Nearly extinct in its area of origin, the style continues in Mexico where it was brought by Santiago Graf and other Austrian immigrant brewers in the late 1800s. Regrettably, most modern examples use adjuncts which lessen the rich malt complexity characteristic of the best examples of this style. The style owes much of its character to the method of malting (Vienna malt). Lighter malt character overall than Oktoberfest, yet still decidedly balanced toward malt.
- Ingredients: Vienna malt provides a lightly toasty and complex, melanoidin-rich malt profile. As with Oktoberfests, only the finest quality malt should be used, along with Continental hops (preferably noble varieties). Moderately hard, carbonate-rich water. Can use some caramel malts and/or darker malts to add color and sweetness, but caramel malts shouldn't add significant aroma and flavor and dark malts shouldn't provide any roasted character.
- Vital Statistics: OG: 1.046 – 1.052 IBUs: 18 – 30 FG: 1.010 – 1.014 SRM: 10 – 16 ABV: 4.5 – 5.5% Commercial Examples: Great Lakes Eliot Ness (unusual in its 6.2% strength and 35 IBUs), Boulevard Bobs 47 Munich-Style Lager, Negra Modelo, Old Dominion Aviator Amber Lager, Gordon Biersch Vienna Lager, Capital Wisconsin Amber, Olde Saratoga Lager, Penn Pilsner

Grain Bill

- Select the proper grist for style
  - Crisp, dry lagers - under modified malt
  - Continental lagers - fully modified malt
  - Dark lagers - fully modified at warm temp. to hydrolyze sugars
  - English ales - over modified malts - proteins reduced & starches more accessible
- Select fresh, sweet smelling malt
- Assure malt is dry and free of contamination
- Select flavors & colors for desired style
- Calculate total extract from potential of different grains

Grain Bill (Cont.)

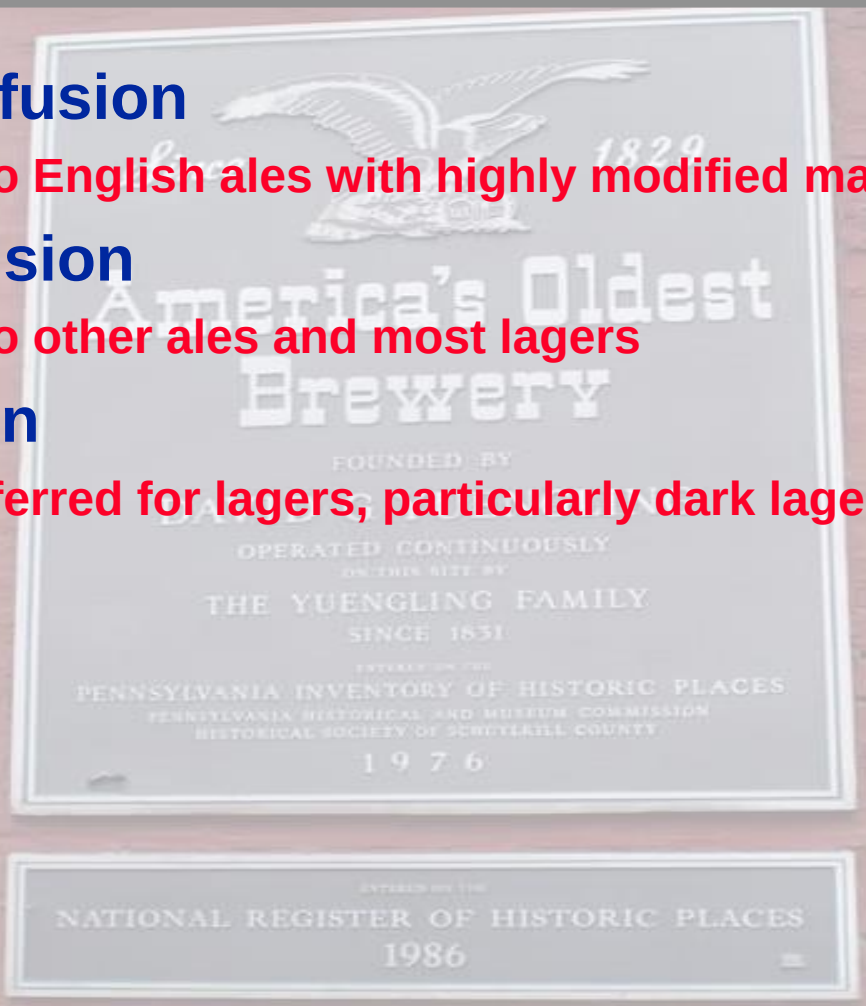
- Mill just prior to mashing
  - Ground malt is readily oxidized
- Mill carefully to preserve husk & crack endosperm
  - Roll milling preferable to assure least damage to the husk
    - » Shattered husks expose more surface area
    - » Causes extraction of more tannins, proteins
    - » Large husk fractions improve flow through Lauter tun
  - Do not over-grind endosperm to produce dusty grist
    - » Difficult to dough in leaving un-mashed starches
- Separate dark grains from rest of grist
  - Rule of thumb - separate grains above 50 °L

Dough In

- Carefully control water temperature
- Dough in rapidly to assure even strike temperature
  - Uneven gradients can destroy desirable enzymes
- Dough in with least water to assure thick mash
  - Increases diastatic enzyme percentage in solution
  - Allows further infusions for step infusion or minor corrections
- Stir carefully to avoid oxidation

Basic mash regimes

- **Single infusion**
  - Suited to English ales with highly modified malt
- **Step infusion**
  - Suited to other ales and most lagers
- **Decoction**
  - » Preferred for lagers, particularly dark lagers



3B. Oktoberfest /Märzen

- **Aroma: Rich German malt aroma (of Vienna and/or Munich malt). A light to moderate toasted malt aroma is often present. Clean lager aroma with no fruity esters or diacetyl. No hop aroma. Caramel aroma is inappropriate.**
- **Appearance: Dark gold to deep orange-red color. Bright clarity, with solid, off-white, foam stand.**
- **Flavor: Initial malty sweetness, but finish is moderately dry. Distinctive and complex maltiness often includes a toasted aspect. Hop bitterness is moderate, and noble hop flavor is low to none. Balance is toward malt, though the finish is not sweet. Noticeable caramel or roasted flavors are inappropriate. Clean lager character with no diacetyl or fruity esters.**
- **Mouthfeel: Medium body, with a creamy texture and medium carbonation. Smooth. Fully fermented, without a cloying finish.**
- **Overall Impression: Smooth, clean, and rather rich, with a depth of malt character. This is one of the classic malty styles, with a maltiness that is often described as soft, complex, and elegant but never cloying.**
- **Comments: Domestic German versions tend to be golden, like a strong Pils-dominated Helles. Export German versions are typically orange-amber in color, and have a distinctive toasty malt character. German beer tax law limits the OG of the style at 14?P since it is a *vollbier,* although American versions can be stronger. "Fest" type beers are special occasion beers that are usually stronger than their everyday counterparts.**
- **History: Origin is credited to Gabriel Sedlmayr, based on an adaptation of the Vienna style developed by Anton Dreher around 1840, shortly after lager yeast was first isolated. Typically brewed in the spring, signaling the end of the traditional brewing season and stored in cold caves or cellars during the warm summer months. Served in autumn amidst traditional celebrations.**
- **Ingredients: Grist varies, although German Vienna malt is often the backbone of the grain bill, with some Munich malt, Pils malt, and possibly some crystal malt. All malt should derive from the finest quality two-row barley. Continental hops, especially noble varieties, are most authentic. Somewhat alkaline water (up to 300 PPM), with significant carbonate content is welcome. A decoction mash can help develop the rich malt profile.**
- **Vital Statistics: OG: 1.050 – 1.057 IBUs: 20 – 28 FG: 1.012 – 1.016 SRM: 7 – 14 ABV: 4.8 – 5.7% Commercial Examples: Paulaner Oktoberfest, Ayinger Oktoberfest-Märzen, Hacker-Pschorr Original Oktoberfest, Hofbräu Oktoberfest, Victory Festbier, Great Lakes Oktoberfest, Spaten Oktoberfest, Capital Oktoberfest, Gordon Biersch Märzen, Goose Island Oktoberfest, Samuel Adams Oktoberfest (a bit unusual in its late hopping)**

Single Infusion

- Dough grist directly into hot water (156-160°F)
  - Must used highly modified malt
  - Must use hard brewing water to assure proper acidification
  - Dough in must be thorough and rapid
- Advantages
  - Quick and easy and requires less energy and capital equipment
- Disadvantages
  - Conversion less effective, lower extract, more soluble proteins, higher hop rates needed

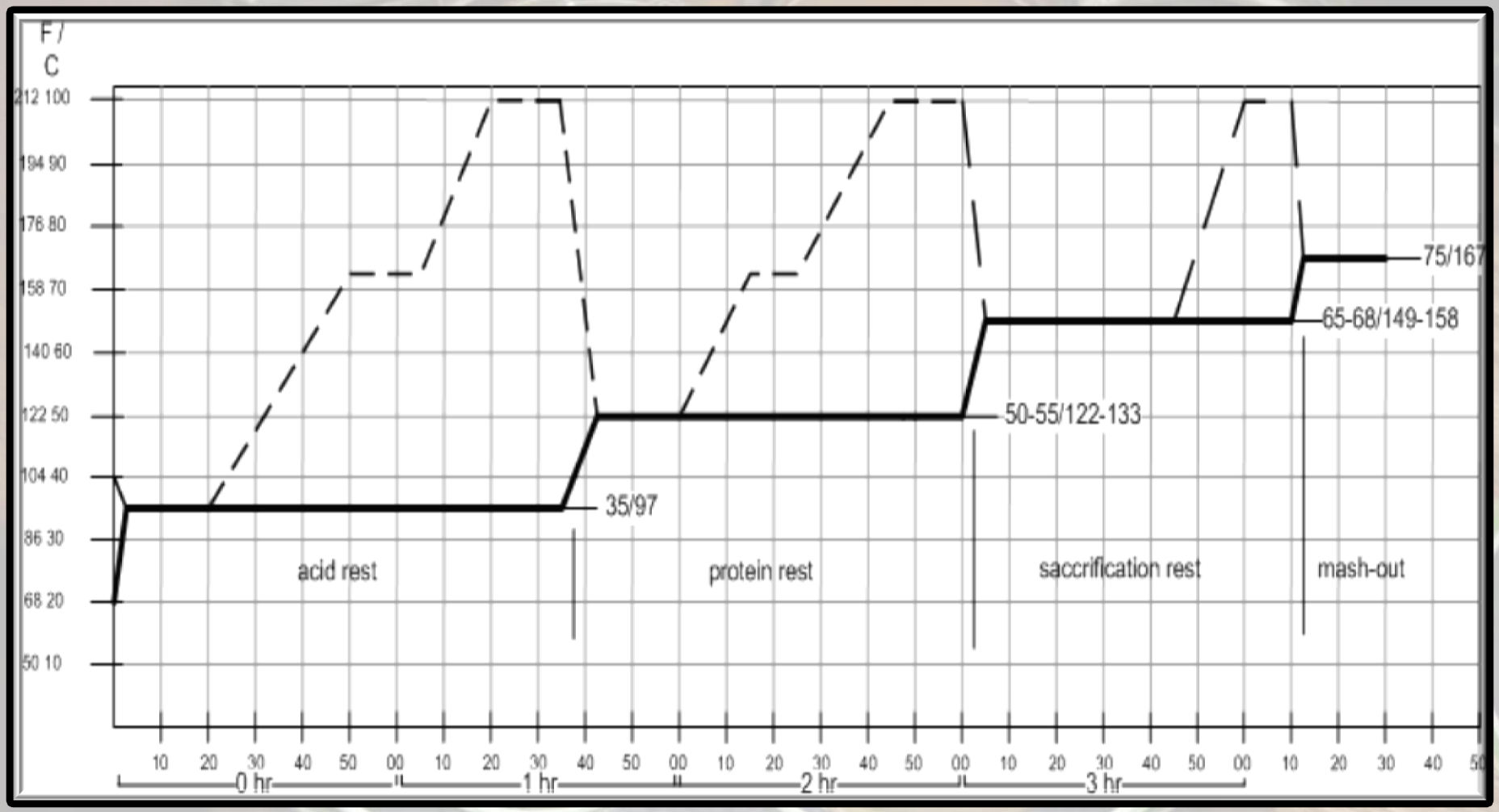
Step Infusion

- Dough grist in at lower temperature
  - For acid rest, ~100-105°F with strike of 95°F
  - For protein rest, ~126-130°F for strike of 122°F
- After desired rest, infuse with boiling water
  - Raises to desired rest temperature
    - » 148-152°F for saccharification rest
    - » 156-160°F (typically 158°F) for dextrination
- Advantages
  - Accomplish all needed mash cycles
- Disadvantages
  - Compromise on dextrination, lower solubility, less gum reduction

Decoction Mashing

- Dough in at lower temperature
- Remove thickest portion of mash (decoct)
  - Typically 40% of thickest mash
- Raise to dextrination temperature & rest
  - 156-158°F and rest for 15 minutes
- Raise decoct to boiling for 15-20 minutes
- Blend back into main mash to raise temp. to strike
  - Add back rapidly and stir thoroughly to avoid temp. gradients
- Repeat for all steps desired up to mash out
- For mash out remove thinnest part of mash for decoct

Example of Triple Decoction



Decoction Mashing (cont.)

- **Advantages**
  - All rest temperatures achieved with precision
  - Diastatic enzymes remain in solution of rest portion
  - Decoct rest at 158°F reduces dextrins, increases extract
  - Gums and large starch particles are gelatinized
  - pH of mash is reduced through boiling (carbonic acid production)
  - Mash is de-oxygenated
  - Some caramelization of sugars occurs - increasing melanoidins
- **Disadvantages**
  - Requires considerably more time
  - More capital intensive and requires close control

4A. Dark American Lager

- Aroma: Little to no malt aroma. Medium-low to no roast and caramel malt aroma. Hop aroma may range from none to light spicy or floral hop presence. Can have low levels of yeast character (green apples, DMS, or fruitiness). No diacetyl.
- Appearance: Deep amber to dark brown with bright clarity and ruby highlights. Foam stand may not be long lasting, and is usually light tan in color.
- Flavor: Moderately crisp with some low to moderate levels of sweetness. Medium-low to no caramel and/or roasted malt flavors (and may include hints of coffee, molasses or cocoa). Hop flavor ranges from none to low levels. Hop bitterness at low to medium levels. No diacetyl. May have a very light fruitiness. Burnt or moderately strong roasted malt flavors are a defect.
- Mouthfeel: Light to somewhat medium body. Smooth, although a highly-carbonated beer.
- Overall Impression: A somewhat sweeter version of standard/premium lager with a little more body and flavor.
- Comments: A broad range of international lagers that are darker than pale, and not assertively bitter and/or roasted.
- Ingredients: Two- or six-row barley, corn or rice as adjuncts. Light use of caramel and darker malts. Commercial versions may use coloring agents.
- Vital Statistics: OG: 1.044 – 1.056 IBUs: 8 – 20 FG: 1.008 – 1.012 SRM: 14 – 22 ABV: 4.2 – 6% Commercial Examples: Dixie Blackened Voodoo, Shiner Bock, San Miguel Dark, Baltika #4, Beck's Dark, Saint Pauli Girl Dark, Warsteiner Dunkel, Heineken Dark Lager, Crystal Diplomat Dark Beer

Details of Rests

- **Acid Rest**
  - Used with very pale malts and/or soft water
  - Rest between 86-128°F (most effective at 95°F
  - Phytase enzyme converts phytin to phytic acid
  - Longer and cool side rests encourage lactic bacteria
    - » Lactobaccilus delbrukii normally present sours mash
    - » Carefully controlled, the rest an effective “sour mash”
  - Care must be taken to avoid contamination

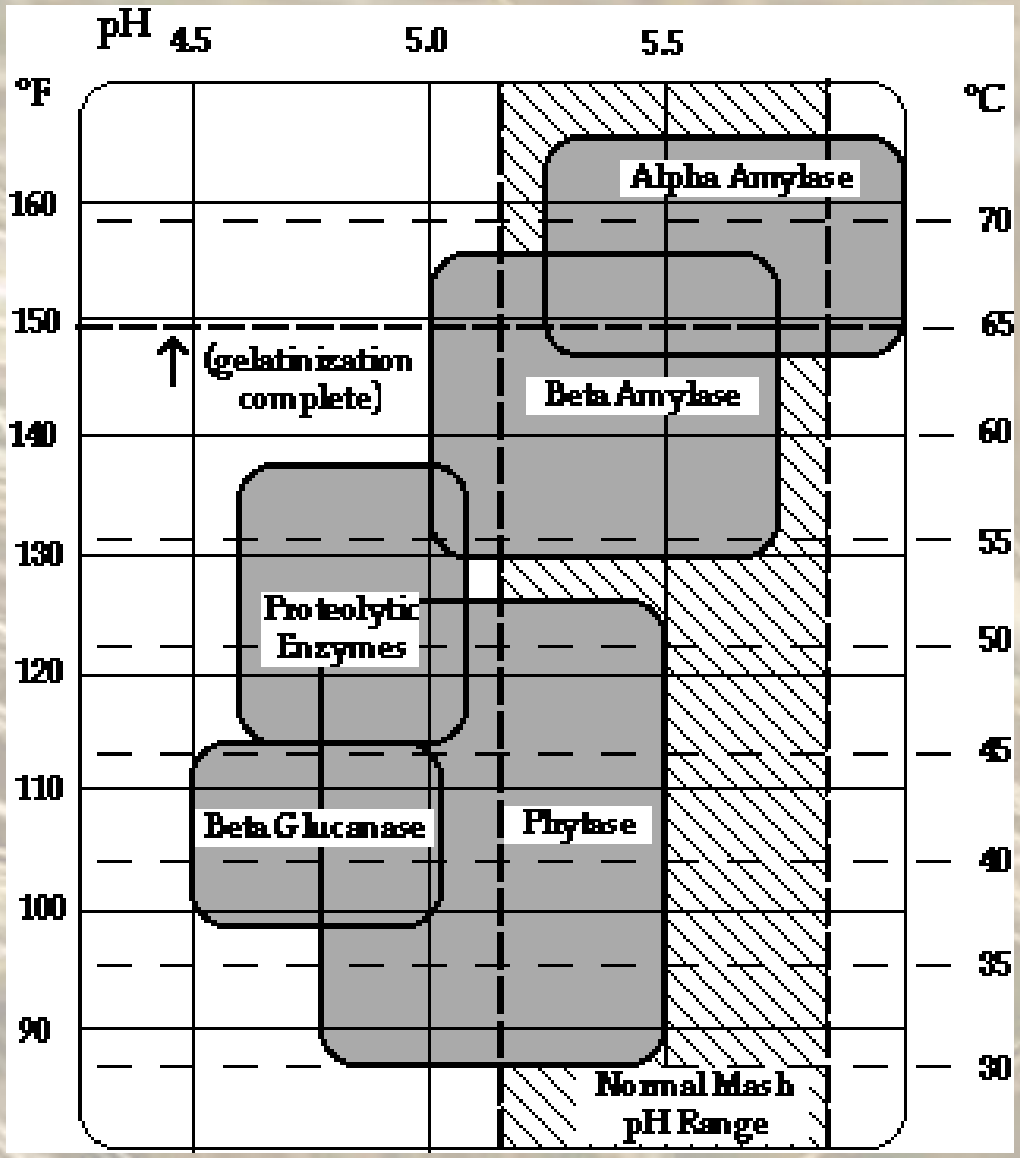
Details of Rests (cont.)

- **Protein Rest**
  - Proteolytic enzymes reduce complex proteins to albuminous fractions (122-140°F)
  - Albumins reduced to amino acids for yeast nutrition (113-122°F)
  - Reduces haze forming proteins and aids in yeast nutrition
  - Produce albuminous proteins which add body & mouth feel
  - Too effective protein rest reduces too many albumins to amino acids
    - » Yields thin taste, mouth feel and poor head retention
    - » hop utilization is reduced

Details of Rests (cont.)

- **Saccharification Rest**
  - Converts soluble native starches to fermentable sugars and dextrins
    - β–amylase active between 126-144°F and pH 5.1
      - » Breaks bonds at end of dextrinous chains to form fermentable simple sugars
    - α-amylase active between 149-153°F and pH 5.7
      - » Reduces complex starches to dextrinous fractions - sweet but not fermentable
  - A-1-6-Glucosidase breaks branching links in amylopectin
  - Most effective compromise for high extract, light bodied wort is 148-152°F at pH 5.4
    - » Typical of most pale ales, bitters, light lagers, etc.
  - Full, rich wort requires 154-158°F yielding higher % dextrinous fractions for sweet, full wort
    - » Typical of Bocks, Old Ale, Barleywine, etc.

Graphic View of Rests



4B. Munich Dunkel

- Aroma: Rich, Munich malt sweetness, like bread crusts (and sometimes toast.) Hints of chocolate, nuts, caramel, and/or toffee are also acceptable. No fruity esters or diacetyl should be detected, but a slight noble hop aroma is acceptable.
- Appearance: Deep copper to dark brown, often with a red or garnet tint. Creamy, light to medium tan head. Usually clear, although murky unfiltered versions exist.
- Flavor: Dominated by the rich and complex flavor of Munich malt, usually with melanoidins reminiscent of bread crusts. The taste can be moderately sweet, although it should not be overwhelming or cloying. Mild caramel, chocolate, toast or nuttiness may be present. Burnt or bitter flavors from roasted malts are inappropriate, as are pronounced caramel flavors from crystal malt. Hop bitterness is moderately low but perceptible, with the balance tipped firmly towards maltiness. Noble hop flavor is low to none. No fruity esters or diacetyl.
- Mouthfeel: Medium to medium-full body, providing a firm and dextrinous mouthfeel without being heavy or cloying. Moderate carbonation. May have a light astringency and a slight alcohol warming.
- Overall Impression: Characterized by depth and complexity of Munich malt and the accompanying melanoidins. Rich Munich flavors, but not as intense as a bock or as roasted as a schwarzbier.
- Comments: Unfiltered versions from Germany can taste like liquid bread, with a yeasty, earthy richness not found in exported filtered dunkels.
- History: The classic brown lager style of Munich which developed as a darker, malt-accented beer in part because of the moderately carbonate water. While originating in Munich, the style has become very popular throughout Bavaria (especially Franconia).
- Ingredients: Grist is traditionally made up of German Munich malt (up to 100% in some cases) with the remainder German Pilsner malt. Small amounts of crystal malt can add dextrins and color but should not introduce excessive residual sweetness. Slight additions of roasted malts (such as Carafa or chocolate) may be used to improve color but should not add strong flavors. Noble German hop varieties and German lager yeast strains should be used. Moderately carbonate water. Often decoction mashed (up to a triple decoction) to enhance the malt flavors and create the depth of color.
- Vital Statistics: OG: 1.048 – 1.056 IBUs: 18 – 28 FG: 1.010 – 1.016 SRM: 14 – 28 ABV: 4.5 – 5.6% Commercial Examples: Ayinger Altbairisch Dunkel, Hacker-Pschorr Alt Munich Dark, Paulaner Alt Münchner Dunkel, Weltenburger Kloster Barock-Dunkel, Ettaler Kloster Dunkel, Hofbräu Dunkel, Penn Dark Lager, König Ludwig Dunkel, Capital Munich Dark, Harpoon Munich-type Dark Beer, Gordon Biersch Dunkels, Dinkel Acker Dark. Hb Bavaria, Ettaler Dunkel, Löwenbräu Dunkel, Hartmann Dunkel, Kneitinger Dunkel, Augustiner Dunkel.

Carbohydrates

Carbohydrates

Compounds containing C, H and O

General formula: $C_x(H_2O)_y$

All have **C=O** and **-OH** functional groups.

Classified based on

- Size of base carbon chain
- Number of sugar units
- Location of C=O
- Stereochemistry

Types of Carbohydrates

Types of carbohydrates

Classifications based on number of sugar units in total chain.

Monosaccharides	single sugar unit
Disaccharides	two sugar units
Oligosccharides	3 to 10 sugar units
Polysaccharides	more than 10 units

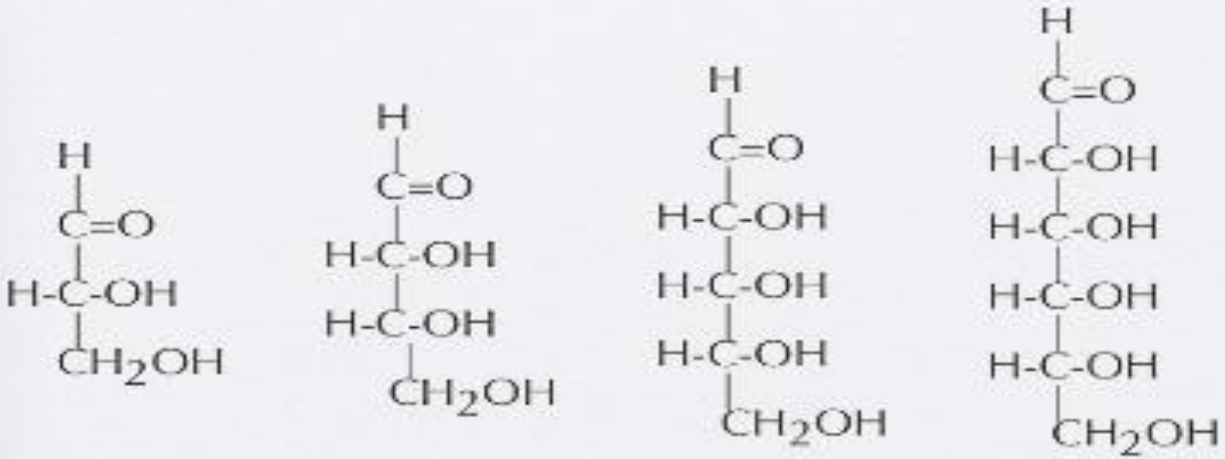
Chaining relies on 'bridging' of oxygen atoms

glycoside bonds

Monosaccharides

Monosaccharide classifications

Number of carbon atoms in the chain



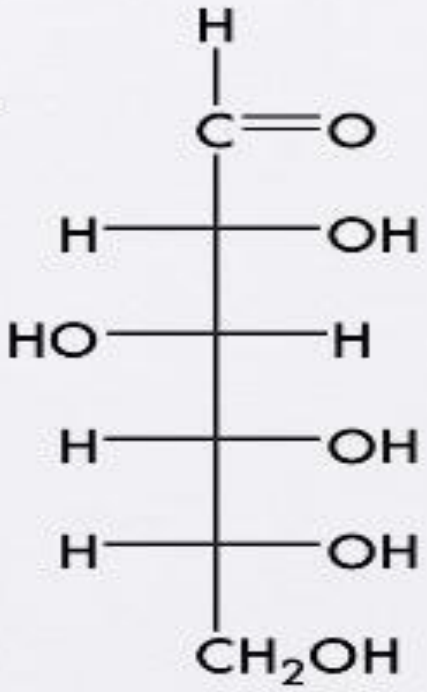
triose tetrose pentose hexose

Can be either aldose or ketose sugar.

Basic Hexose

D-glucose

- Glucose is an aldohexose sugar.
- Common names include dextrose, grape sugar, blood sugar.
- Most important sugar in our diet.
- Most abundant organic compound found in nature.
- Level in blood can be as high as 0.1%



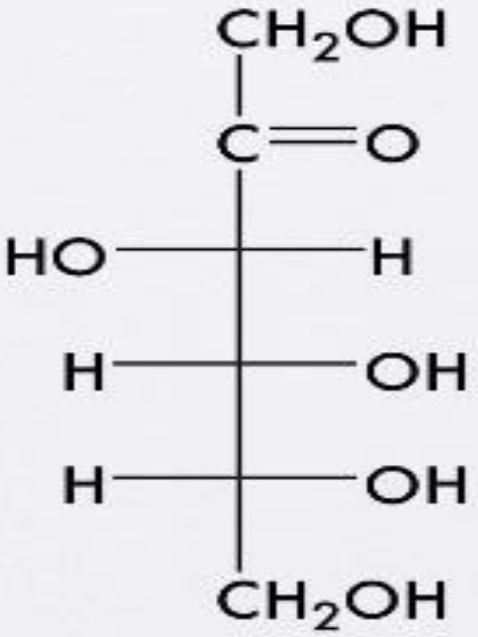
Fructose

D-fructose

Another common sugar.

It is a ketohexose.

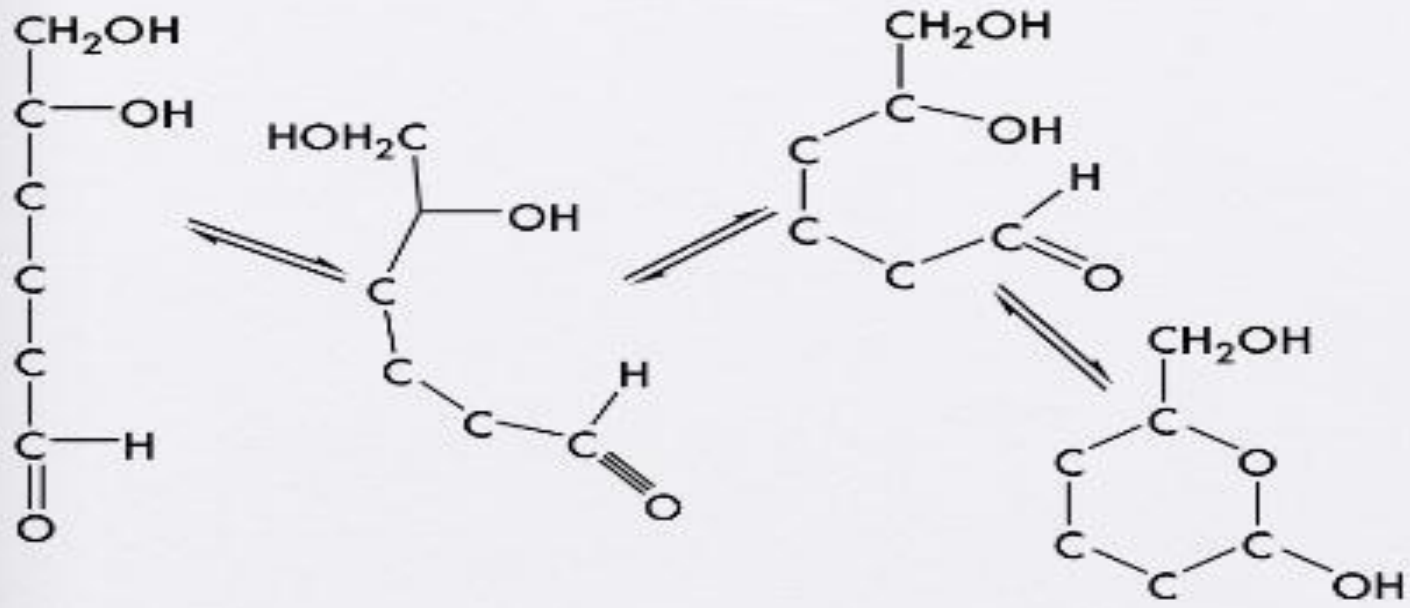
Sweetest of all sugars



Cyclization of Saccharides

Intramolecular cyclization

Cyclization - chains can bend and rotate.



Formation of Molecular Anomers

Intramolecular cyclization

The -OH group that forms can be above or below the ring resulting in two forms - anomer.

We use α and β to identify these anomers.

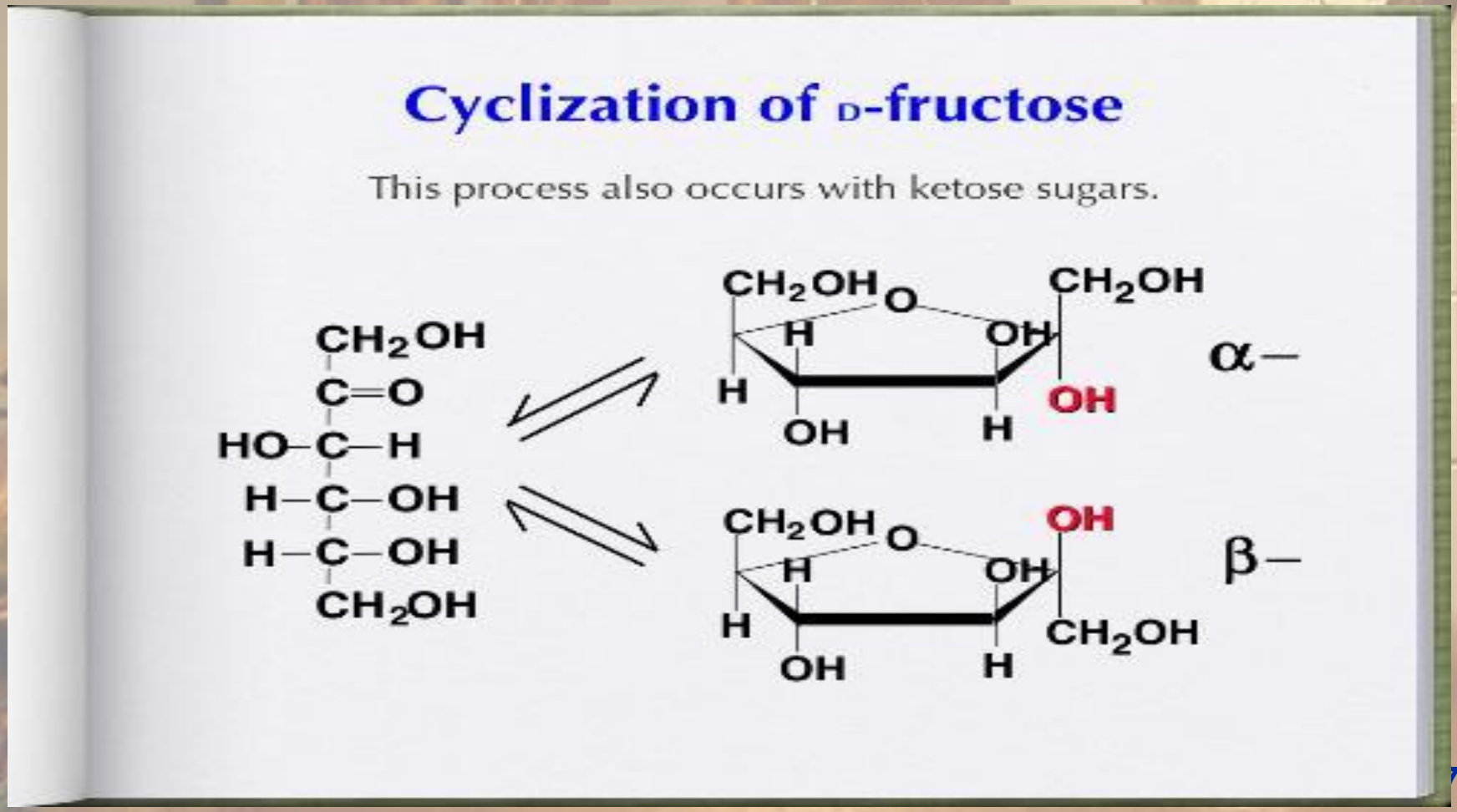
α - OH group is down compared to CH_2OH (trans).

β - OH group is up compared to CH_2OH (cis).

The α and β forms are in equilibrium so one form can convert to the other - mutarotation.

Haworth projections can be used to help see α and β orientations.

Cyclization of α-Fructose



Oligosaccharides

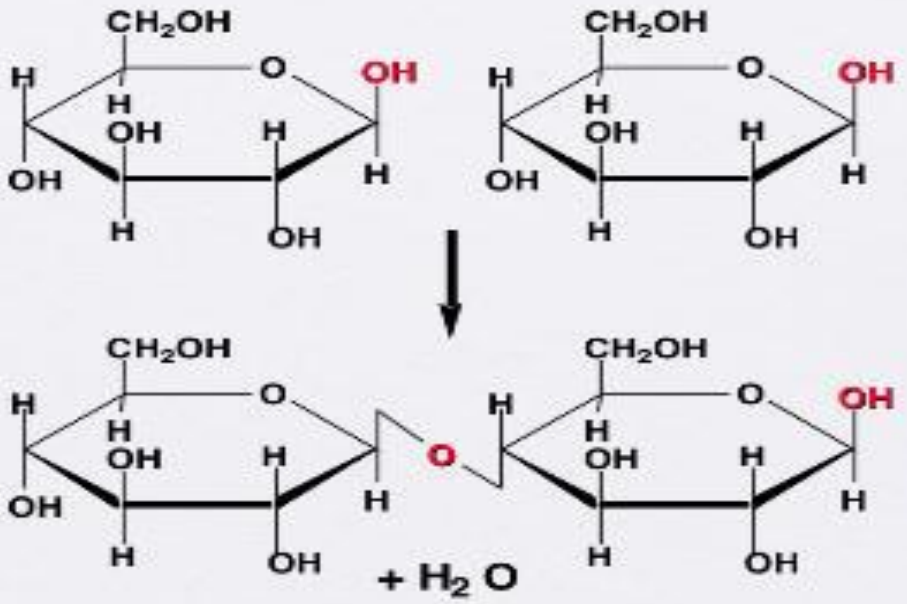
Oligosaccharides

α or β -OH group of cyclic monosaccharide can form a link with another one (or more).

glycosidic bond

sugar -O- sugar

oxygen bridge



Glycosidic Bonding

Glycosidic bonds

Type is based on the position of the C-1 OH

α glycosidic bond
linkage between a C-1 α OH and a C-4 OH

β glycosidic bond
linkage between a C-1 β OH and a C-4 OH

C-4 end can be either up or down depending on the orientation of the monosaccharide.

Glycosidic Bonding (cont.)

Glycosidic bonds

General format used to describe bond.

OH type (α or β) (Carbon # of 1st sugar → Carbon # of 2nd sugar)

As we work through the next few examples this will become clear.

For disaccharides - the sugar is either α or β based on form of the remaining C-1 OH.

4C. Schwarzbier (Black Beer)

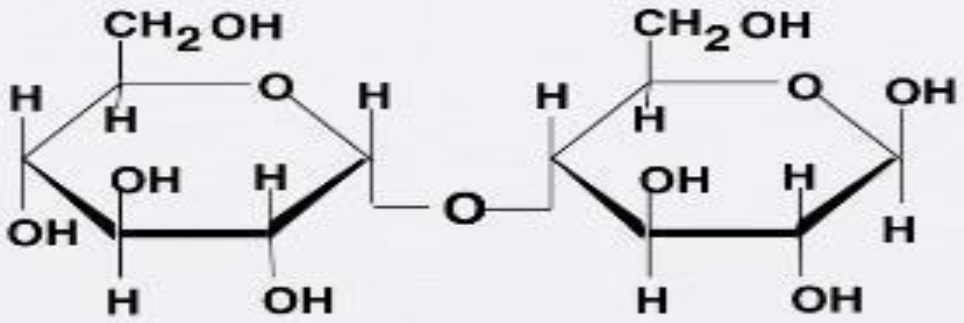
- Aroma: Low to moderate malt, with low aromatic sweetness and/or hints of roast malt often apparent. The malt can be clean and neutral or rich and Munich-like, and may have a hint of caramel. The roast can be coffee-like but should never be burnt. A low noble hop aroma is optional. Clean lager yeast character (light sulfur possible) with no fruity esters or diacetyl.
- Appearance: Medium to very dark brown in color, often with deep ruby to garnet highlights, yet almost never truly black. Very clear. Large, persistent, tan-colored head.
- Flavor: Light to moderate malt flavor, which can have a clean, neutral character to a rich, sweet, Munich-like intensity. Light to moderate roasted malt flavors can give a bitter-chocolate palate that lasts into the finish, but which are never burnt. Medium-low to medium bitterness, which can last into the finish. Light to moderate noble hop flavor. Clean lager character with no fruity esters or diacetyl. Aftertaste tends to dry out slowly and linger, featuring hop bitterness with a complementary but subtle roastiness in the background. Some residual sweetness is acceptable but not required.
- Mouthfeel: Medium-light to medium body. Moderate to moderately high carbonation. Smooth. No harshness or astringency, despite the use of dark, roasted malts.
- Overall Impression: A dark German lager that balances roasted yet smooth malt flavors with moderate hop bitterness.
- Comments: In comparison with a Munich Dunkel, usually darker in color, drier on the palate and with a noticeable (but not high) roasted malt edge to balance the malt base. While sometimes called a “black Pils,” the beer is rarely that dark; don’t expect strongly roasted, porter-like flavors.
- History: A regional specialty from southern Thuringen and northern Franconia in Germany, and probably a variant of the Munich Dunkel style.
- Ingredients: German Munich malt and Pilsner malts for the base, supplemented by a small amount of roasted malts (such as Carafa) for the dark color and subtle roast flavors. Noble-type German hop varieties and clean German lager yeasts are preferred.
- Vital Statistics: OG: 1.046 – 1.052 IBUs: 22 – 32 FG: 1.010 – 1.016 SRM: 17 – 30 ABV: 4.4 – 5.4% Commercial Examples: Köstritzer Schwarzbier, Kulmbacher Mönchshof Premium Schwarzbier, Samuel Adams Black Lager, Krušovice Cerne, Original Badebier, Einbecker Schwarzbier, Gordon Biersch Schwarzbier, Weeping Radish Black Radish Dark Lager, Sprecher Black Bavarian

β-Maltose

β-Maltose

Malt sugar.

Not common in nature except in germinating grains.

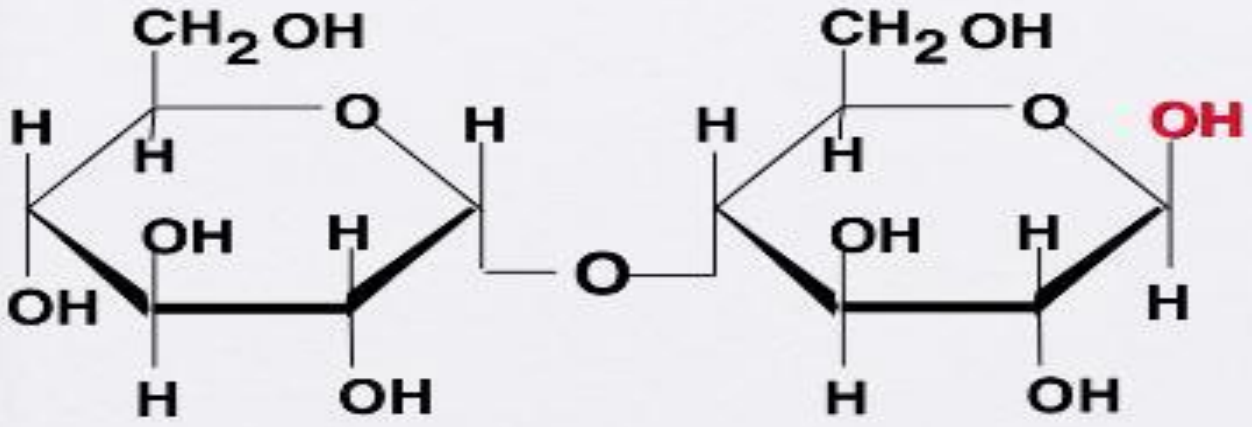


α-D-glucose and β-D-glucose, α (1 ⟶ 4) linkage.

β-Maltose (cont.)

β-Maltose

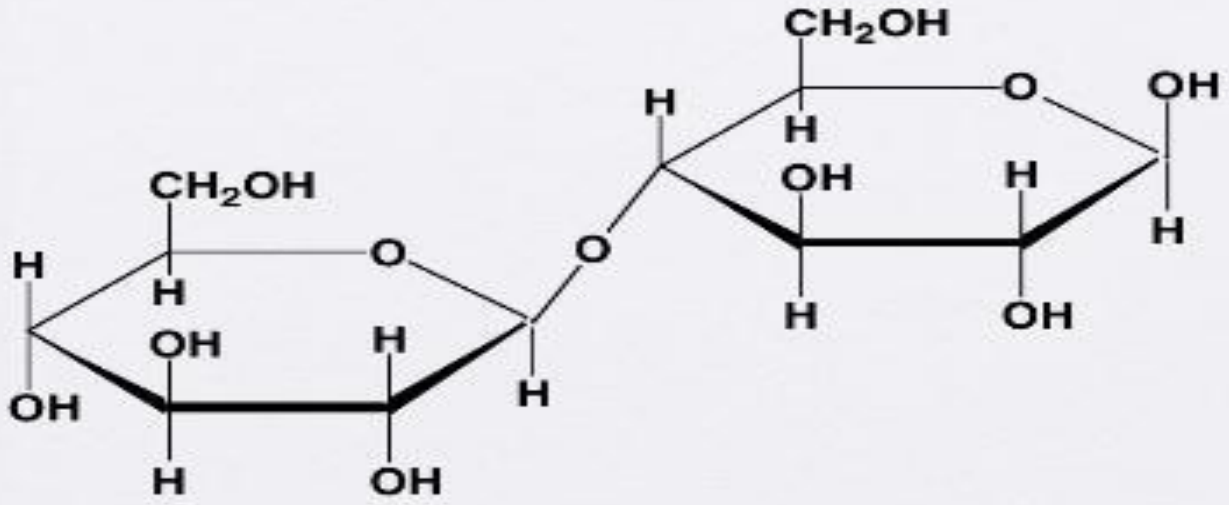
It is referred to as β-maltose because the unreacted C-1 on β-D-glucose is in the β position.



Cellobiose

Cellobiose

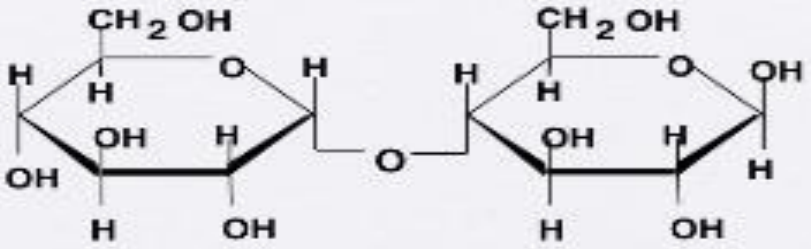
Like maltose, it is composed of two molecules of D-glucose - but with a β (1 ⟶ 4) linkage.



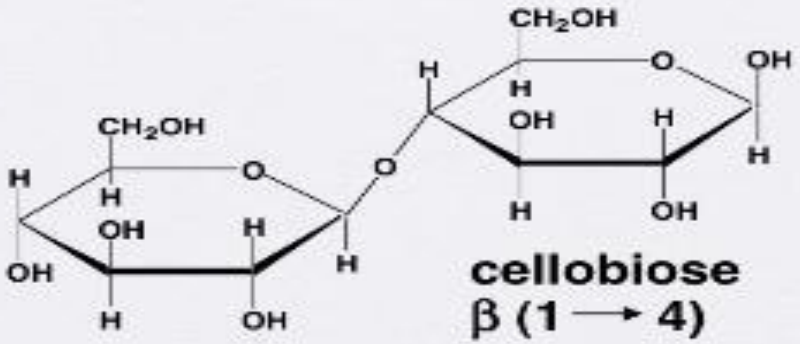
Maltose vs Cellobiose

Cellobiose

The difference in the linkage results in cellobiose being unusable.



We lack an enzyme that can hydrolyze cellobiose.

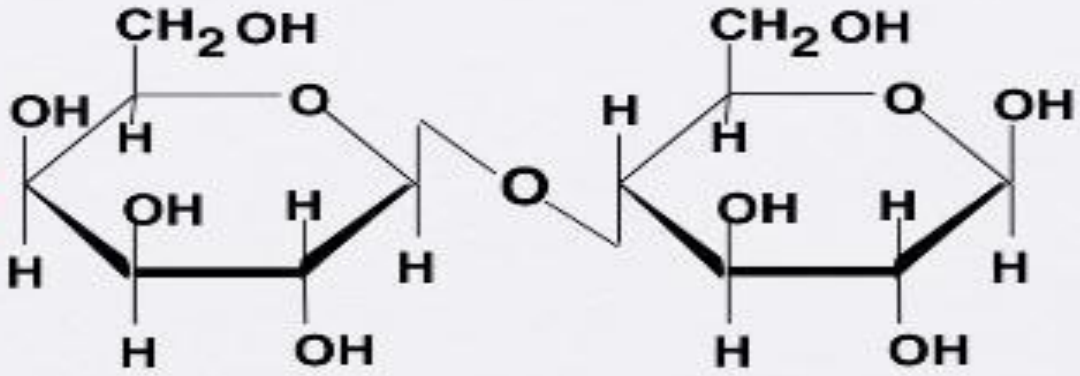


Lactose

Lactose

Milk sugar - dimer of β-D-galactose and either the α or β -D-glucose.

β-Lactose



β (1 ⟶ 4) linkage, β disaccharide.

Sucrose

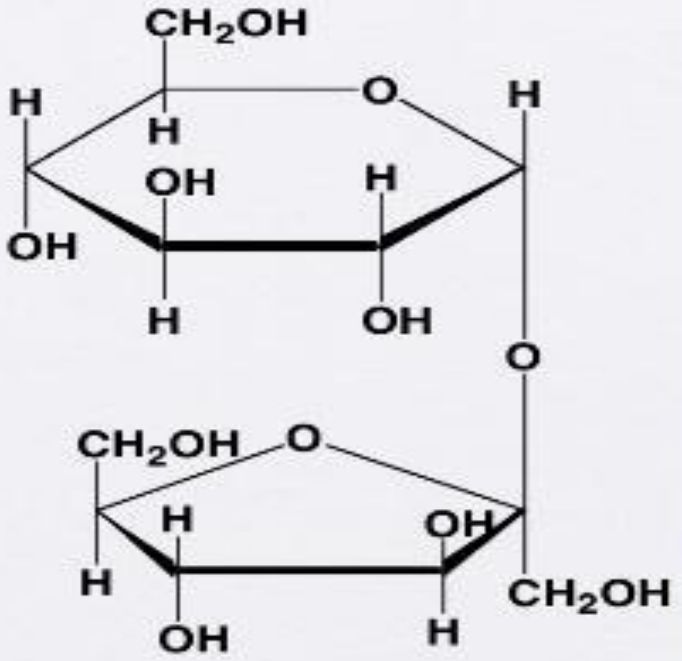
Sucrose

Table sugar - most common sugar in all plants.

Sugar cane and beet, are up to 20% by mass sucrose.

Disaccharide of α-glucose and β-fructose.

α (1 ⟶ 2) linkage



Starches

Starch

Energy storage used by plants
Long repeating chain of α-D-glucose
Chains up to 4000 units

Amylose
straight chain

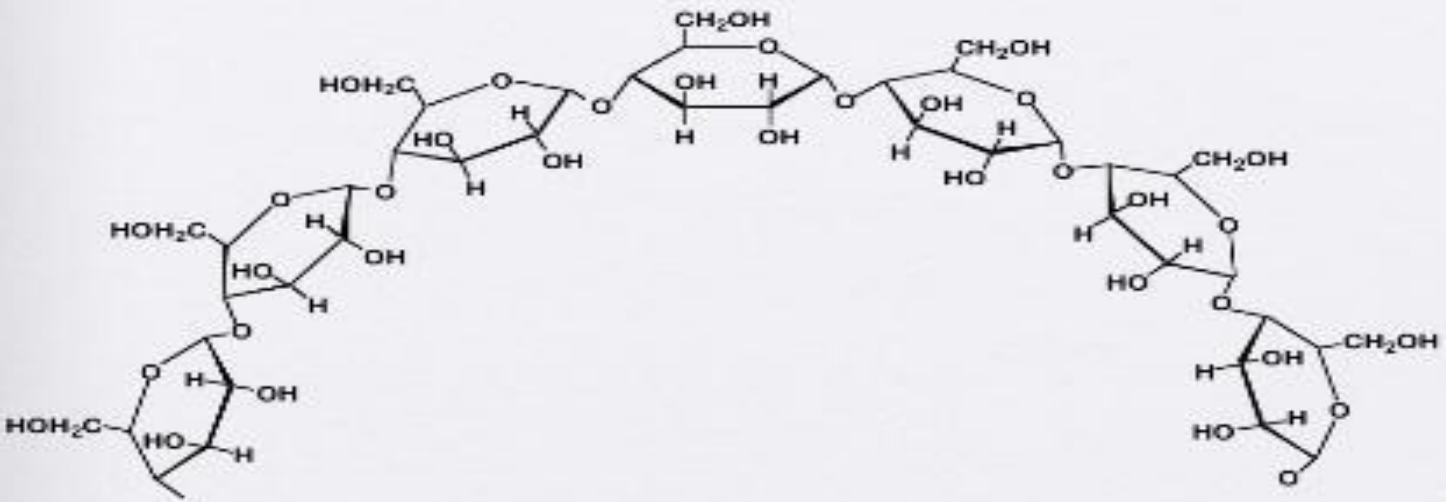
Amylopectine
branched structure
major part of starch

Great for making gravy, jam and jelly.

Amylose

Amylose starch

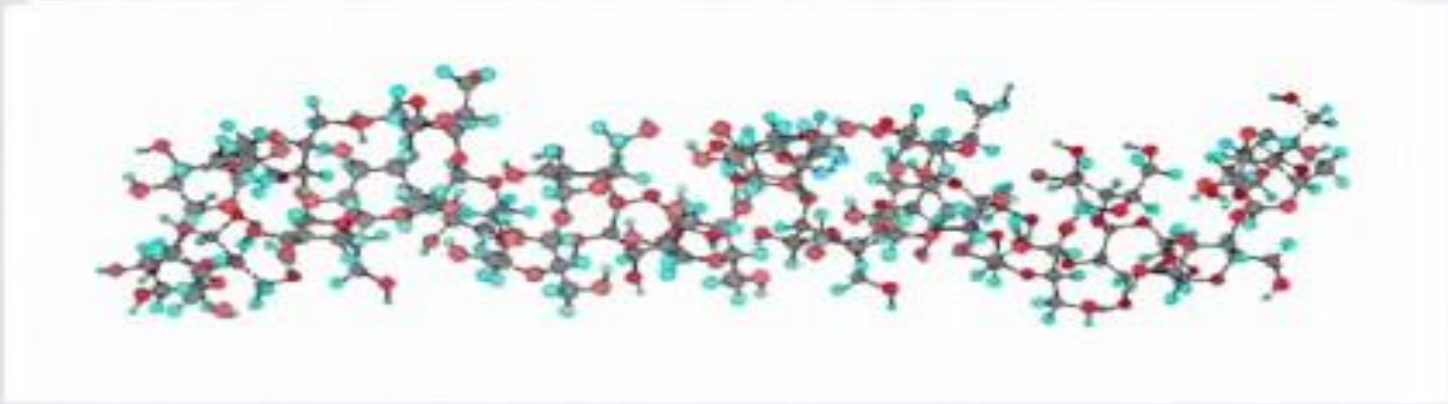
Straight chain that forms coils: α (1 → 4) linkage.



Amylose Structure

Amylose starch

Example showing coiled structure
- 12 glucose units
- hydrogens and side chains are omitted.



Amylopectin

Amylopectin starch

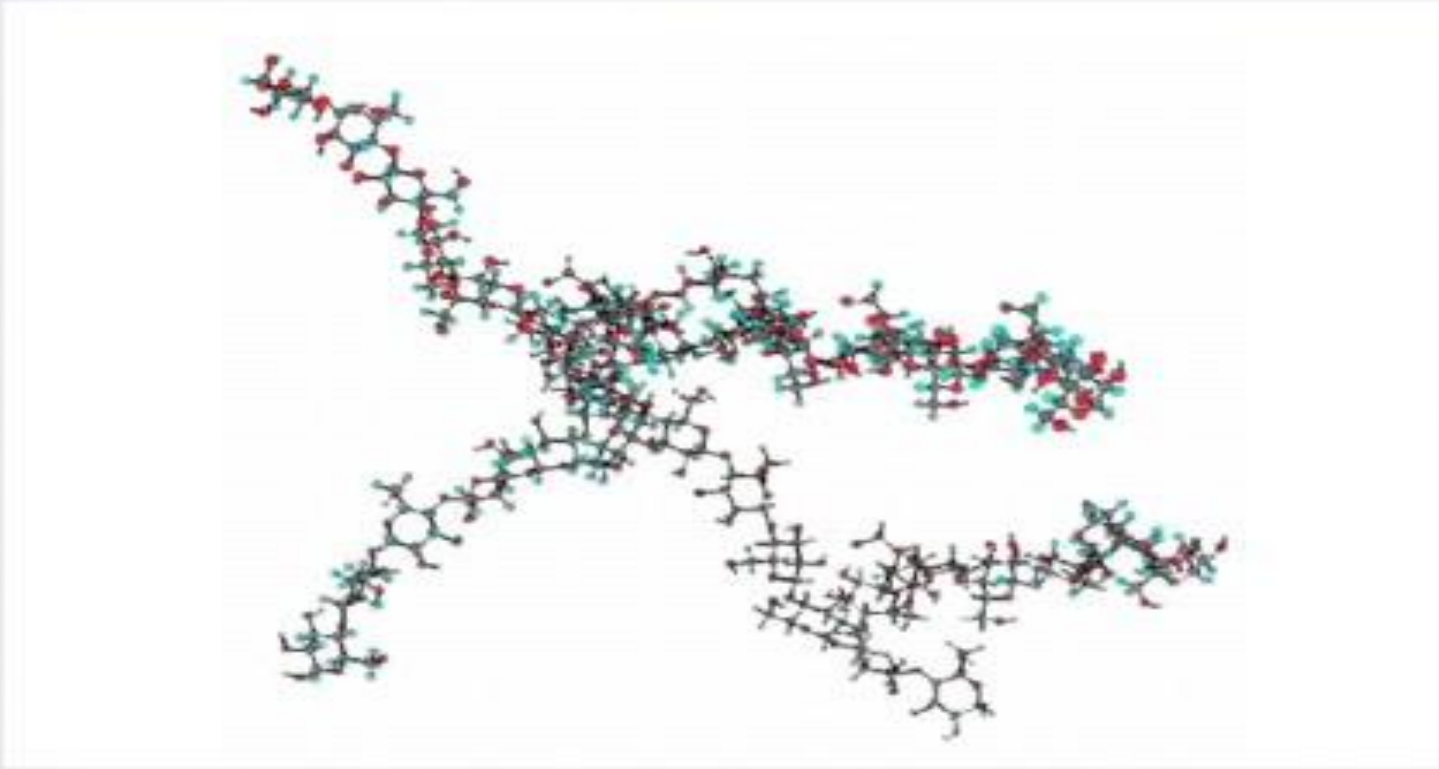
Amylopectin differs from amylose only in that it has side chains. These are formed from

α (1 → 6) links

Side chains occur every 24-30 units.

Starch is stored as starch grains. They cannot diffuse from the cell and have little effect on the osmotic pressure of the cell.

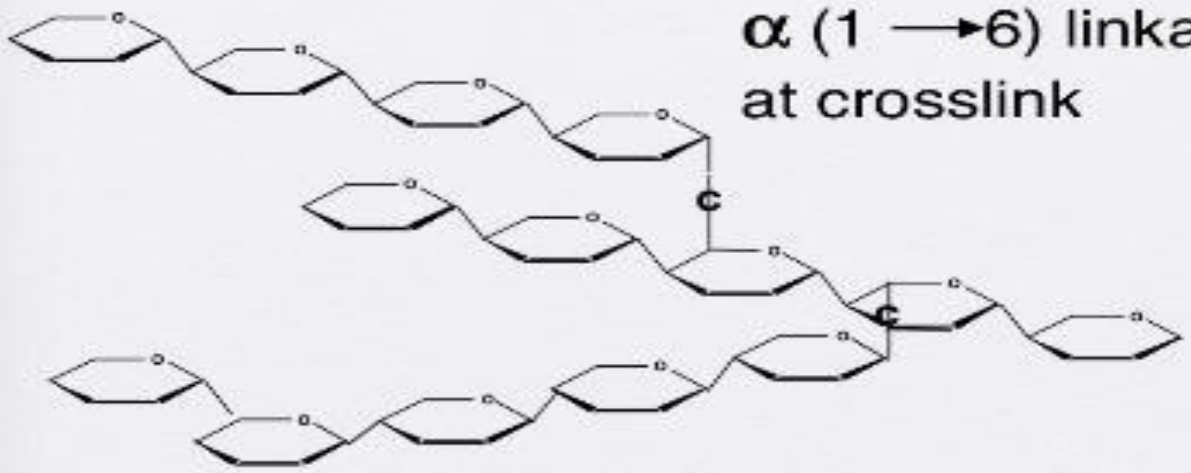
Amylopectin Structure



Glycogen

Glycogen

- Energy storage of animals.
- Stored in liver and muscles as granules.
- Similar to amylopectin.



5A. Maibock/Helles Bock

- **Aroma: Moderate to strong malt aroma, often with a lightly toasted quality and low melanoidins. Moderately low to no noble hop aroma, often with a spicy quality. Clean. No diacetyl. Fruity esters should be low to none. Some alcohol may be noticeable. May have a light DMS aroma from Pils malt.**
- **Appearance: Deep gold to light amber in color. Lagering should provide good clarity. Large, creamy, persistent, white head.**
- **Flavor: The rich flavor of continental European pale malts dominates (Pils malt flavor with some toasty notes and/or melanoidins). Little to no caramelization. May have a light DMS flavor from Pils malt. Moderate to no noble hop flavor. May have a low spicy or peppery quality from hops and/or alcohol. Moderate hop bitterness (more so in the balance than in other bocks). Clean, with no fruity esters or diacetyl. Well-attenuated, not cloying, with a moderately dry finish that may taste of both malt and hops.**
- **Mouthfeel: Medium-bodied. Moderate to moderately high carbonation. Smooth and clean with no harshness or astringency, despite the increased hop bitterness. Some alcohol warming may be present.**
- **Overall Impression: A relatively pale, strong, malty lager beer. Designed to walk a fine line between blandness and too much color. Hop character is generally more apparent than in other bocks.**
- **Comments: Can be thought of as either a pale version of a traditional bock, or a Munich helles brewed to bock strength. While quite malty, this beer typically has less dark and rich malt flavors than a traditional bock. May also be drier, hoppier, and more bitter than a traditional bock. The hops compensate for the lower level of melanoidins. There is some dispute whether Helles ("pale") Bock and Mai ("May") Bock are synonymous. Most agree that they are identical (as is the consensus for Märzen and Oktoberfest), but some believe that Maibock is a "fest" type beer hitting the upper limits of hopping and color for the range. Any fruitiness is due to Munich and other specialty malts, not yeast-derived esters developed during fermentation.**
- **History: A fairly recent development in comparison to the other members of the bock family. The serving of Maibock is specifically associated with springtime and the month of May.**
- **Ingredients: Base of Pils and/or Vienna malt with some Munich malt to add character (although much less than in a traditional bock). No non-malt adjuncts. Noble hops. Soft water preferred so as to avoid harshness. Clean lager yeast. Decoction mash is typical, but boiling is less than in traditional bocks to restrain color development.**
- **Vital Statistics: OG: 1.064 – 1.072 IBUs: 23 – 35 FG: 1.011 – 1.018 SRM: 6 – 11 ABV: 6.3 – 7.4% Commercial Examples: Ayinger Maibock, Mahr's Bock, Hacker-Pschorr Hubertus Bock, Capital Maibock, Einbecker Mai-Urbock, Hofbräu Maibock, Victory St. Boisterous, Gordon Biersch Blonde Bock, Smuttynose Maibock**

Mash Out

- Raise mash temperature to 167-170°F
  - Terminates enzyme activity
  - Optimum temperature for lautering
  - Addition of dark grains preferred at mash out
- Do not exceed 170°F
  - Complex proteins and tannins are more soluble
  - Can impart burnt or scorched flavors
- Mix thoroughly to assure even temperature

Use of Adjuncts

- Used to reduce cost & lighten body
  - Rice, corn grits, raw wheat & barley, flaked corn & barley
- Whole rice and corn grits must be gelatinized
  - Cooked in cereal cooker to swell & burst starch cells
- Raw wheat & barley must be milled then gelatinized
- Flaked grain is pre-gelatinized, rolled and dried
- Other adjuncts are raw sugars, molasses, candi sugar

Lautering

- Separation of sweet wort from grain
- Requires carefully controlled filter bed
  - Typically 6-12 inches deep
  - Large particles of husk essential for filtration
  - Sublet lauter plate with sparge water (170°F)
  - Allow to rest and settle 10-15 minutes
- Careful control of flow to avoid “set mash”
- Recirculate sweet wort until it runs clear
  - Vorlauf

Lautering (cont.)

- Begin sparge with 170°F brew water
- Distribute water gently and evenly over surface
- Never let surface become dry
- Continue sparge until run off gravity drops to 1.008
- OR pH raises to 6.0 which occurs first
- Stop sparge and collect remaining wort
  - Continued sparge extracts undesirable tannins
- Must keep temperature between 160°F and 170°F
  - Too cool causes set mash and potential bacteria contamination
  - Too high extracts tannins and un-dissolved starches

Boiling

- What occurs when boiling
  - Sterilizes wort
  - Isomerizes α-acids and dissolves into wort
  - Reduces pH of wort
  - Increases gravity to final fermentation level
  - Increases formation of melanoidins and caramelization
  - Causes proteins to coagulates to form hot break
- Begin boil when bottom of kettle (copper) is covered
- Bring to full, hard, rolling boil
- Boil for at least one full hour, 1.5 to 2 hours preferred

Hop Additions

- **Add 5 to 10% of Hops at start of boil**
  - **Reduces surface tension of wort and avoid boil over**
  - **Unless First Wort Hopping**
    - » **Flavor/aroma hops added to first wort in kettle**
- **Boil hard for 15 to 30 minutes to precipitate proteins**
  - **Particularly for single infusion , not as much for decoction mashes**
  - **Must be done to avoid excessive loss in hop utilization**
- **Add first hops to kettle - primarily for bittering**
  - **Must be boiled for 60-90 minutes for full utilization (25-30%)**
  - **Creates greatest bitterness and stability but also causes course and unpleasant hop flavors**

Hop Additions (cont.)

- Subsequent hop additions compromise between utilization and flavor
  - Normally additional hops are added between 45 to 15 minutes before end of boil
- Aroma & Flavor hops added at end of boil
  - 15 minutes before end of boil yields practically no bitterness
  - Aroma and flavors are contained in volatile oils
  - Most oils retained at end of boil or from “hop back”
- Noble or Kent hops used for these additions
- Hop flowers used to strain wort from hot break
  - Hop Back

Break Separation

- Precipitation of hot break
  - Hot break is coagulation of HMW proteins caused by boil
  - Enhanced by additions such as “Irish Moss”
  - Must have long and vigorous boil
- Separation of hot break
  - Allow to settle after boil and rack wort from top
- Whirlpool and allow to settle 15 minutes
  - Draw wort from hot break trub at the side
- Run hot wort through Hop Back
  - Strainer lined with hop flowers

Wort Cooling

- **Immersion cooler**
  - Cold Water Coils placed in kettle before end of boil
    - » Advantages -Quickly cools wort & avoids hot side aeration
    - » Disadvantages - Does not allow separation of hot break
- **Counter-flow cooler**
  - Hot wort flows in one direction, cool water in the other
    - » Advantages - Quickly cools wort
    - » Disadvantages - Requires hot break separation & more difficult to clean and sanitize
- **Coolship**
  - Large, shallow pan allowing much surface for cooling
    - » Disadvantages - Impractical for home brewer & open to contamination

Separation of Cold Break

- Rapid cooling is essential for good break
- Cold break is 15-20% of hot break
- Cool wort to below 50°F for optimum break
  - Allow to settle and rack from trub
  - Wort can be aerated and yeast pitched before separation
  - Must be removed before respiration phase is complete
- Cold break trub contains certain yeast nutrients
- Causes excessively astringency and haze
  - Slow cooling increases proteins & tannins in suspension

5B. Traditional Bock

- Aroma: Strong malt aroma, often with moderate amounts of rich melanoidins and/or toasty overtones. Virtually no hop aroma. Some alcohol may be noticeable. Clean. No diacetyl. Low to no fruity esters.
- Appearance: Light copper to brown color, often with attractive garnet highlights. Lagering should provide good clarity despite the dark color. Large, creamy, persistent, off-white head.
- Flavor: Complex maltiness is dominated by the rich flavors of Munich and Vienna malts, which contribute melanoidins and toasty flavors. Some caramel notes may be present from decoction mashing and a long boil. Hop bitterness is generally only high enough to support the malt flavors, allowing a bit of sweetness to linger into the finish. Well-attenuated, not cloying. Clean, with no esters or diacetyl. No hop flavor. No roasted or burnt character.
- Mouthfeel: Medium to medium-full bodied. Moderate to moderately low carbonation. Some alcohol warmth may be found, but should never be hot. Smooth, without harshness or astringency.
- Overall Impression: A dark, strong, malty lager beer.
- Comments: Decoction mashing and long boiling plays an important part of flavor development, as it enhances the caramel and melanoidin flavor aspects of the malt. Any fruitiness is due to Munich and other specialty malts, not yeast-derived esters developed during fermentation.
- History: Originated in the Northern German city of Einbeck, which was a brewing center and popular exporter in the days of the Hanseatic League (14th to 17th century). Recreated in Munich starting in the 17th century. The name “bock” is based on a corruption of the name “Einbeck” in the Bavarian dialect, and was thus only used after the beer came to Munich. “Bock” also means “billy-goat” in German, and is often used in logos and advertisements.
- Ingredients: Munich and Vienna malts, rarely a tiny bit of dark roasted malts for color adjustment, never any non-malt adjuncts. Continental European hop varieties are used. Clean lager yeast. Water hardness can vary, although moderately carbonate water is typical of Munich.
- Vital Statistics: OG: 1.064 – 1.072 IBUs: 20 – 27 FG: 1.013 – 1.019 SRM: 14 – 22 ABV: 6.3 – 7.2% Commercial Examples: Einbecker Ur-Bock Dunkel, Pennsylvania Brewing St. Nick Bock, Aass Bock, Great Lakes Rockefeller Bock, Stegmaier Brewhouse Bock

Fermentation

- Molecular oxygen essential for respiration
  - Must have from 4 to 14% oxygen dissolved in cool wort
- Viable yeast is essential
  - Yeast which has recently undergone vigorous fermentation
  - Pure strain (or strains) without bacterial contamination
- Adequate yeast is essential
  - Minimum of 0.5 to 0.6 fl. oz. of yeast (12-15 million cells per liter) needed
  - Avoid over pitching as yeast autolysis and yeasty, sulfury flavors result
- Wort at proper temperature

Fermentation (cont.)

- **Primary Fermentation**
  - Respiration or lag phase
    - » Little visible activity
    - » Usually requires 6 hours (ales) to 18 hours (lagers)
  - Initial fermentation or “Low Kraeusen”
    - » Wisps of foam appear on surface
    - » Slow bubbling of fermentation lock begins

Fermentation (cont.)

- **Primary Fermentation (continued)**
  - **High kraeusen**
    - » **Thick layer of foam forms on surface**
    - » **Skim contains tannins, dead yeast, proteins, etc.**
    - » **Temperature rises 5 to 10 degrees**
    - » **Yeast concentration rises to 60-70 million cells per liter**
  - **Lasts typically 3 days (ales) to 10 days (lagers)**
  - **Normally racked at the end of this stage**

Fermentation (cont.)

- **Secondary Fermentation**
  - **Fermentation slows**
    - » **Lasts typically 5 days (ales) to 3 weeks (lagers)**
    - » **Yeast precipitates from suspension**

Problems in Fermentation

- **Poor temperature control**
  - Too high causes excessive ester, diacetyl formation
  - Too low slows fermentation causing poor attenuation
  - Off flavors formed such as acetyldehyde, H_2S, phenols etc.
- **Low yeast viability or insufficient yeast**
  - Poor attenuation - sweet finish
  - Prolonged fermentation producing excessive esters, diacetyl
  - Potential for contamination from wild yeasts, bacteria

5C. Doppelbock

- **Aroma: Very strong maltiness. Darker versions will have significant melanoidins and often some toasty aromas. A light caramel flavor from a long boil is acceptable. Lighter versions will have a strong malt presence with some melanoidins and toasty notes. Virtually no hop aroma, although a light noble hop aroma is acceptable in pale versions. No diacetyl. A moderately low fruity aspect to the aroma often described as prune, plum or grape may be present (but is optional) in dark versions due to reactions between malt, the boil, and aging. A very slight chocolate-like aroma may be present in darker versions, but no roasted or burned aromatics should ever be present. Moderate alcohol aroma may be present.**
- **Appearance: Deep gold to dark brown in color. Darker versions often have ruby highlights. Lagering should provide good clarity. Large, creamy, persistent head (color varies with base style: white for pale versions, off-white for dark varieties). Stronger versions might have impaired head retention, and can display noticeable legs.**
- **Flavor: Very rich and malty. Darker versions will have significant melanoidins and often some toasty flavors. Lighter versions will a strong malt flavor with some melanoidins and toasty notes. A very slight chocolate flavor is optional in darker versions, but should never be perceived as roasty or burnt. Clean lager flavor with no diacetyl. Some fruitiness (prune, plum or grape) is optional in darker versions. Invariably there will be an impression of alcoholic strength, but this should be smooth and warming rather than harsh or burning. Presence of higher alcohols (fusels) should be very low to none. Little to no hop flavor (more is acceptable in pale versions). Hop bitterness varies from moderate to moderately low but always allows malt to dominate the flavor. Most versions are fairly sweet, but should have an impression of attenuation. The sweetness comes from low hopping, not from incomplete fermentation. Paler versions generally have a drier finish.**
- **Mouthfeel: Medium-full to full body. Moderate to moderately-low carbonation. Very smooth without harshness or astringency.**
- **Overall Impression: A very strong and rich lager. A bigger version of either a traditional bock or a helles bock.**

5C. Doppelbock (continued)

- Comments: Most versions are dark colored and may display the caramelizing and melanoidin effect of decoction mashing, but excellent pale versions also exist. The pale versions will not have the same richness and darker malt flavors of the dark versions, and may be a bit drier, hoppier and more bitter. While most traditional examples are in the ranges cited, the style can be considered to have no upper limit for gravity, alcohol and bitterness (thus providing a home for very strong lagers). Any fruitiness is due to Munich and other specialty malts, not yeast-derived esters developed during fermentation.
- History: A Bavarian specialty first brewed in Munich by the monks of St. Francis of Paula. Historical versions were less well attenuated than modern interpretations, with consequently higher sweetness and lower alcohol levels (and hence was considered "liquid bread" by the monks). The term "doppel (double) bock" was coined by Munich consumers. Many doppelbocks have names ending in "-ator," either as a tribute to the prototypical Salvator or to take advantage of the beer's popularity.
- Ingredients: Pils and/or Vienna malt for pale versions (with some Munich), Munich and Vienna malts for darker ones and occasionally a tiny bit of darker color malts (such as Carafa). Noble hops. Water hardness varies from soft to moderately carbonate. Clean lager yeast. Decoction mashing is traditional.
- Vital Statistics: OG: 1.072 – 1.112 IBUs: 16 – 26 FG: 1.016 – 1.024 SRM: 6 – 25 ABV: 7 – 10% Commercial Examples: Paulaner Salvator, Ayinger Celebrator, Weihenstephaner Korbinian, Andechser Doppelbock Dunkel, Spaten Optimator, Tucher Bajuvator, Weltenburger Kloster Asam-Bock, Capital Autumnal Fire, EKU 28, Eggenberg Urbock 23º, Bell's Consecrator, Moretti La Rossa, Samuel Adams Double Bock

Finishing

- **Conditioning**
  - Sedimentation begins
    - » Yeast and proteins precipitate from suspension
    - » Aided by additives such as isinglass, gelatin, wood chips
    - » Dry hops added for selected styles
  - Clarification
    - » Bright beer is racked from sediment
    - » Filtration occurs in most commercial beers and some homebrew
  - Carbonation
    - » Natural carbonation by addition of prime, speise or kraeusen
    - » Pressure carbonation by reintroducing CO_2 into cooled beer
  - Final Conditioning
    - » Final conditioned in cask at publicans cellar (~50°F) (real ales)
    - » Lagered or cold stored (35°F) 4 to 12 weeks in bulk (lagers)

Packaging

- **Storage in Kegs**
  - Sanitize keg with chlorine free sanitizer
  - Purge keg with CO_2 prior to filling
  - Fill and pressurize to proper pressure (8 to 15psig) depending on desired carbonation level and temperature of beer
  - Store kegs under pressure at proper temperature
    - » 40 to 50°F for ales
    - » 30 to 35°F for lagers
  - Agitate kegs to accelerate CO_2 absorption

Packaging (cont.)

- **Bottling**
  - Sanitize and rinse BROWN bottles
  - Sanitize caps
  - Prime beer with speise or sugar solution
  - OR have beer fully conditioned in keg for counter pressure filling
  - Purge bottles with CO_2 if possible (required for counter pressure)
  - Fill bottles without splashing to avoid oxidation
  - Fill to within .75 inch of top of bottle
  - Agitate top of beer in bottle to generate foam
  - Cap immediately using oxygen absorbing caps if possible

Storage & Handling

- **Always store at cool to cold temperatures**
  - **Do not allow bottled beer to raise above 70°F**
  - **Store keg beers cold until ready to serve**
  - **Warm temperatures cause oxidation and staling**
- **ALWAYS store away from any light**
  - **Sunlight is deadly**
  - **Artificial light is less but still a problem**
    - » **causes serious mercaptan formation or skunking of beer**

Serving

- **Always serve at proper temperature**
  - Typically 50 to 55°F for real ales
  - 45 to 50°F for Scotch ales, stouts, most Belgians
  - 40 to 45°F for most Continental lagers
- **Serve in clear and "Beer Clean" glasses**
  - Carefully clean and rinse to avoid "head killing" residue
  - Properly shaped glasses for the style
    - » Pilsner glasses, Berliner Weisse bowl, Belgian wide mouths, etc.
  - Pour slowly into the center of the glass to properly form head
    - » Beauty and persistence of head are developed
    - » High aromatics are released for first sampling of nose
- ***ENJOY!***

5D. Eisbock

- Aroma: Dominated by a balance of rich, intense malt and a definite alcohol presence. No hop aroma. No diacetyl. May have significant fruity esters, particularly those reminiscent of plum, prune or grape. Alcohol aromas should not be harsh or solventy.
- Appearance: Deep copper to dark brown in color, often with attractive ruby highlights. Lagering should provide good clarity. Head retention may be impaired by higher-than-average alcohol content and low carbonation. Off-white to deep ivory colored head. Pronounced legs are often evident.
- Flavor: Rich, sweet malt balanced by a significant alcohol presence. The malt can have melanoidins, toasty qualities, some caramel, and occasionally a slight chocolate flavor. No hop flavor. Hop bitterness just offsets the malt sweetness enough to avoid a cloying character. No diacetyl. May have significant fruity esters, particularly those reminiscent of plum, prune or grape. The alcohol should be smooth, not harsh or hot, and should help the hop bitterness balance the strong malt presence. The finish should be of malt and alcohol, and can have a certain dryness from the alcohol. It should not by sticky, syrupy or cloyingly sweet. Clean, lager character.
- Mouthfeel: Full to very full bodied. Low carbonation. Significant alcohol warmth without sharp hotness. Very smooth without harsh edges from alcohol, bitterness, fusels, or other concentrated flavors.
- Overall Impression: An extremely strong, full and malty dark lager.
- Comments: Eisbocks are not simply stronger doppelbocks; the name refers to the process of freezing and concentrating the beer. Some doppelbocks are stronger than Eisbocks. Extended lagering is often needed post-freezing to smooth the alcohol and enhance the malt and alcohol balance. Any fruitiness is due to Munich and other specialty malts, not yeast-derived esters developed during fermentation.
- History: A traditional Kulmbach specialty brewed by freezing a doppelbock and removing the ice to concentrate the flavor and alcohol content (as well as any defects).
- Ingredients: Same as doppelbock. Commercial eisbocks are generally concentrated anywhere from 7% to 33% (by volume).
- Vital Statistics: OG: 1.078 – 1.120 IBUs: 25 – 35 FG: 1.020 – 1.035 SRM: 18 – 30 ABV: 9 – 14% Commercial Examples: Kulmbacher Reichelbräu Eisbock, Eggenberg Urbock Dunkel Eisbock, Niagara Eisbock, Capital Eisphyre, Southampton Eisbock