Cicerone® Certification Program
Master Cicerone® Syllabus

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This syllabus outlines the knowledge required of those preparing for the Master Cicerone® exam. While this list is comprehensive in its scope of content, further study beyond the syllabus is necessary to fully understand each topic. The content tested on the Advanced Cicerone™ exam, the Certified Cicerone® exam, and the Certified Beer Server exam is a subset of the information presented here, and individual syllabi for those tests may be found on the cicerone.org website.

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Full Syllabus

I. Keeping and Serving Beer

A. Purchasing and accepting beer
   1. The three-tier system in the United States and the reasons for its existence
      a. By law, alcoholic beverages sold in the United States must move through the three-tier system. The three tiers are Brewers/Importers, Wholesalers (also known as Distributors), and Retailers
         i. Brewers and importers sell to wholesalers
         ii. Wholesalers sell to both on- and off-premises retailers
         iii. On- and off-premises retailers sell to consumers
      b. Some states have granted exceptions to the three-tier system. Common exceptions include:
         i. Brewpubs that both brew and retail to consumers
         ii. Breweries that brew and sell directly to retailers or consumers
   2. Taxes levied on beer
      a. Specific taxes
         i. Federal Excise Tax – paid by brewers
         ii. State Excise Tax – generally processed and paid by wholesalers
         iii. Sales taxes and other locally required fees – paid by retailers
         iv. Income taxes levied on brewers, distributors, and retailers
   3. Assessing beer shipment: physical condition and age
      a. Date code if available
         i. Meaning
            • Bottling/packaging date
            • Best by date
         ii. Type: Order and number of digits may vary
            • Traditional consumer date codes (e.g., 060912 = June 9, 2012)
            • Julian/ordinal date codes (364-12 = December 30, 2012)
            • Brewery-specific date codes
      b. Physical condition of container
         i. Not dented or broken
         ii. No signs of leakage or box weakness
      c. Temperature
         i. Ideally beer will still be cool when it reaches the retailer—the flavor of beer that is warm or hot to the touch may have changed substantially during shipment

B. Serving alcohol
   1. Alcohol's effects
      a. Absorption and elimination
      b. Physical and behavioral indicators
   2. Responsible serving practices
      a. Provide accurate ABV information to consumers
      b. Adjust serving size based on ABV

C. Beer storage
   1. Beer is best consumed fresh

a. When beer is released from the brewery, it is ready to drink
b. A very few strong or intensely flavored beers may age in ways that make them interesting to drink months or years later if properly cellared

2. Freshness can be preserved and enhanced by wholesaler and retailer actions
   a. Rotate inventory
      i. Ensure that beer is consumed in the order of dating
      ii. Remove out of date products from service inventory
      iii. When beers lack an expiration date:
         - Non-pasteurized draft beer about 45-60 days (refrigerated)
         - Pasteurized draft beer about 90-120 days (refrigerated)
         - Bottled beer:
            - If kept refrigerated, can be good for up to six months
            - When not refrigerated or if subjected to other stresses, may be noticeably off after three months
            - Taste aged product against fresh product to determine deterioration
      iv. Train staff to encourage/sell/promote all beers offered
   b. Store beer properly
      i. Refrigerated storage is best for all beers at all times. Required for draft beer and many craft beers
      ii. Non-refrigerated storage accelerates aging and development of off flavors
         - With time, all beers will develop signs of oxidation (papery, wet cardboard flavors)
         - Possible autolysis of yeast when present (meaty)
         - Possible development of microbial off flavors (sour, buttery, phenolic, other)
      iii. Bottled beers are subject to skunking
         - Caused by sunlight and fluorescent light
         - Most noticeable in the aroma of the beer
         - Brown glass blocks 98% of the wavelengths of light that cause skunking, and therefore offers superior protection to clear and green glass
         - Green glass blocks 20% of the wavelengths that cause skunking
         - Clear glass offers no protection against skunking
         - Skunking may be evident after a few minutes of light exposure
         - Cans, ceramic bottles, and bottles in closed case boxes that completely shield beer from light give maximum protection from skunking
      iv. Bottled beers may pick up moldy flavors
         - Beer stored in damp environments may take on corky (trichloroanisole) and other musty/moldy flavors
   c. Serve beer properly
      i. Draft beer must be served using CO_2 or a CO_2-nitrogen mix at the proper pressure setting

ii. Compressed air should never be used instead of CO_2 or a CO_2-nitrogen mix in a draft dispense system
iii. A party pump limits the flavor stability of the beer to **less than one day** because oxygen and airborne contaminants are put in contact with the beer

D. On-premises draft systems and their maintenance
1. Anatomy of a standard keg
a. Common commercial volumes
b. Awareness of variety in keg valve systems/coupler types
c. Internal structure of the keg
2. Pressure side components, anatomy and function
a. Gas sources
b. Cylinder/bulk tank
c. Nitrogen generator
d. Air compressor
i. **Never** use with traditional keg
ii. May be used with "bag-in-ball" type kegs (e.g., KeyKeg)
e. Gas blender
f. Beer pump
g. Primary and secondary regulators
h. Gas line
i. Couplers
3. Beer side components, anatomy and function
a. Couplers
b. Jumper line
c. FOB detectors
d. Wall brackets
e. Beer pumps
f. Trunk line (an insulated bundle of beer line and glycol line)
g. Power packs (glycol chillers)
h. Beer line (vinyl, barrier, stainless, etc.)
i. Choker line and other restriction devices
j. Draft tower
k. Beer faucets
i. Standard (rear shutoff) faucet
ii. Nitro faucet
iii. Ventless, European, Roto-Faucet, and Flow-Control
4. Types of US draft systems
a. Direct draw
b. Air-cooled
c. Glycol-cooled
5. Draft system design
a. Principles and goals, appropriate application of each system type
b. Effect of variations in gas blends and pressures
c. Effect of variations in draw distance
d. Effect of variations in altitude

e. Influences of product mix and volume
f. System balance
    i. Dynamic resistance
    ii. Static resistance

6. Draft system operation
    a. Standard temperature of 38 °F
    b. Troubleshooting (for each system type)
        i. No beer at faucet
        ii. Beer foaming
        iii. Flat beer
        iv. Cloudy beer
        v. False head
7. Draft system maintenance
    a. Cleaning of lines, faucets, couplers and FOBs
    b. Goals of cleaning
    c. Criteria for proper cleaning
        i. Frequency
        ii. Cleaner type
        iii. Concentration
        iv. Temperature
        v. Method and contact time
        vi. Flow rate (for dynamic cleaning)
    d. Manual cleaning of components
    e. Cleaning system components
    f. Operation of line cleaning process
    g. Safety issues: operator, consumer

E. Beer glassware
1. Select appropriate glassware
    a. Size
        i. Based on style and alcohol content (stronger beers, smaller glass)
        ii. Provide room for an appropriately sized head
    b. Shape
        i. Cultural and historical traditions
        ii. Aesthetics of presentation
        iii. Flavor and aroma effects
    c. Brand
        i. Branded glasses matched to beer
2. Use beer clean glassware
    a. Glass cleaning procedure
        i. Empty glass into open drain
        ii. Wash with non-petroleum based (sudsless) cleaner and brush
        iii. Rinse in cold water, heel in, heel out
        iv. Rinse in sanitizer, heel in, heel out
        v. Dry inverted on rack so air circulates inside
        vi. Rinse with cold water immediately before dispense

b. Checking glass for "beer clean"
   i. Without beer
      - Sheeting (wet glass, empty, water should sheet off of glass evenly; formation of droplets or webbing indicates not beer clean)
      - Salt test (wet glass, sprinkle salt throughout; places where salt does not adhere are not beer clean)
   ii. With beer
      - Head size, shape, retention
      - Bubbles clinging to sides of glass (in liquid beer) indicate **not** beer clean
      - During consumption, lace will cling to the side of a beer clean glass following each sip

c. Preparation to serve
   i. Glass temperature
      - Room temperature and chilled glasses are acceptable
      - Frozen/frosted glasses are not recommended: causes foaming, makes beer too cold, frozen water or sanitizer may be present
   ii. Cold water rinse of glass before filling
      - Removes residual sanitizer
      - Cools glasses that may be warm from washing
      - Aids ideal head formation and retention

F. Serving bottled beer
   1. Prepare for service
      a. Bottle-conditioned beer should be stored upright prior to service
      b. If possible, store beer at ideal serving temperature as dictated by style, otherwise store all beer under refrigeration (43 °F or less)
   2. Examine bottle
      a. Look for white flakes (snow-like) which can indicate old, unstable beer. Do not serve beer in this condition
      b. Look for a thin ring of gunk at liquid level in neck—generally indicative of a bad bottle if present. Do not serve beer in this condition
      c. Check for yeast on bottom of bottle
         i. Retain yeast in bottle unless:
            - Consumer requests yeast to be poured
            - Style (e.g., Weissbier) is traditionally poured with yeast
         ii. To pour yeast, rouse by swirling, rolling, or inverting
   3. Opening bottle: twist-off, pry-off, cork, combo
      a. Twist-off caps
         i. Twist off by hand
         ii. Napkin may be used to aid grip and protect hand.
      b. Pry-off caps
         i. Prefer openers with a bar or other lift area at least ¼ inch wide to prevent possibility of breaking the bottle during opening
         ii. Lift in one motion

c. Mushroom cork
    i. Remove wire cage by untwisting the tab
    ii. Remove cork by hand—napkin may aid grip
    iii. Be gentle so as not to disturb sediment and make beer volatile
    iv. Practice cork safety—keep bottle pointed away from consumer at all times
d. Cap plus cork: corkscrew will be required after removing cap
e. Present the cork (always) or the cap of a rare, unusual, or new beer, to the consumer
f. Check bottle lip: do not serve beer from bottles with broken/damaged lips
g. Also examine bottle lip for rust, dried beer, or yeast that could affect flavor or appearance of beer

4. Pouring bottled beer
    a. Filtered beer
        i. Beers bottled without yeast or other sediment—the entire contents of the bottle can be poured into the glass
        ii. Hold glass at 45-degree angle, pour down the side until glass is half full
        iii. Gently tilt glass upright and pour down the middle to create approximately one inch of foam head on the beer as the pour finishes. Weizens and Belgian ales traditionally have two to four inches of head
    b. Unfiltered beers
        i. Some beers are packaged with yeast in the bottle or completely unfiltered
        ii. Unfiltered beer should still be poured using the method described above in section I.F.4.a
        iii. In most cases, yeast should be retained in the bottle. Be prepared to stop pouring when the yeast moves toward the top of the bottle
        iv. When in doubt about pouring yeast, ask the consumer their preference

G. Serving draft beer
1. Pouring a beer
    a. Hold glass at 45-degree angle, one inch below the tap faucet
    b. Grip faucet handle near the base, pull forward to the fully open position to start the flow of beer—when a faucet is only open partially, beer will pour foamy
    c. Pour down the side until glass is half full
    d. While continuing to pour gently tilt glass upright and pour down the middle to create appropriate amount of head on the beer as the pour finishes
    e. Close faucet as foam cap reaches the top of the glass to prevent beer waste
    f. **Never** put faucet in contact with the glass or allow any part of the faucet to become immersed in beer in the glass
2. Changing a keg (same product)
    a. Kegs must be chilled to draft system operating temperature (generally 38 °F) before tapping and serving—general guideline is 24 hours in cooler before serving
    b. On common American and import Sankey kegs: grip keg coupler handle, pull out and raise to the "up" or "off" position to disengage. Turn the coupler a quarter turn (90 degrees) counterclockwise to unseat. Lift off of the keg

c. Seat the coupler on a new keg. Turn clockwise a quarter turn (90 degrees) to lock the coupler in place, then lower the coupler handle to the "down" or "on" position to engage
d. In long-draw systems that use them, the foam-on-beer (FOB) detector for the keg needs to be reset after a keg change. This is usually done by venting the FOB mechanism to release foam and gas from the chamber

3. Changing products on a line
   a. Ensure that the proper coupler for the new product is correctly installed
   b. If necessitated based on contrast between products:
      i. Rinse or clean lines
      ii. Replace jumper hose (in extreme cases)
   c. Ensure that gas blend and pressure are properly set for the new product

H. Special situations
1. Growlers and draft beer to go
   a. Filling techniques and shelf life
   b. Closures (open container laws)
   c. Cleaning and reusing growlers
   d. Safety considerations
2. Temporary draft systems
   a. Picnic pump/party tap
      i. Hand pumped
      ii. Single-use CO_2 cartridge
   b. Jockey box
      i. Coil style
         • Setup
         • Gas and pressure settings
      ii. Cold plate
         • Setup
         • Gas and pressure settings
      iii. Cleaning and maintenance
3. Real ale from cask
   a. Definition of real ale (CAMRA)
   b. Ingredients required to achieve carbonation
   c. Real ale serving systems and their use
      i. Gravity dispense
      ii. Beer engine
         • Short spout
         • Swan neck
   d. Anatomy of a cask, anatomy of beer engine
   e. Real ale process from brewer to customer
   f. Cellaring real ale: soft and hard spiles, tapping, assessing readiness for service
   g. Serving life of cask ale: assessing product quality, cask breathers
   h. Use of sparklers
4. KeyKeg/one-way keg/"bag-in-ball" keg
5. Party pigs, mini-kegs and other containers
   a. Filling techniques, product quality and shelf life

b. Serving setups: CO_2 or hand pump and implications for product quality and serving life
c. Cleaning and refilling

I. Economics of beer
1. Margins and markups
2. Raw material cost and supply volatility

II. Beer Styles

A. Understanding beer styles
1. The historical development of beer styles
a. First driven by available ingredients, equipment, and water
b. Shaped by technology, taxes and regulations, culture, consumer appeal, etc.
2. Cataloged today in the US, principally by
a. Beer Judge Certification Program[1]
b. Brewers Association[2]

B. Style parameters
1. Knowledge requirements
a. Upper and lower quantitative limits for all quantitative values for all styles
b. Nuanced understanding of qualitative properties for all styles
c. Five commercial examples covering classic producers, American producers, and other notable producers of the style globally
d. Familiarity with BA style guidelines
2. Quantitative parameters of beer character
a. Alcohol content
b. International Bitterness Units
c. Color
i. SRM
ii. EBC
d. Carbonation
e. Original Gravity
f. Final Gravity
g. Apparent attenuation
3. Qualitative parameters of beer character
a. Aroma
b. Flavor
c. Aftertaste
d. Mouthfeel
e. Perceived bitterness
f. Appearance

C. History, characteristics, and flavor attributes of styles by region
1. Belgium and France

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[1] The Cicerone® Certification Program uses the 2015 BJCP Style Guidelines as the reference source for all matters related to style in its exams. You can access the guidelines online at www.bjcp.org and through their mobile device apps.

[2] Certified Cicerone® and Advanced Cicerone™ candidates should be aware of the Brewers Association guidelines. Master Cicerone® candidates should have familiarity with the general differences between the BA and BJCP guidelines, and should have knowledge of BA categories that do not exist in the BJCP guidelines.

a. Lambic beers
    i. Lambic
    ii. Gueuze
    iii. Fruit Lambic (Kriek, Framboise, etc.)
b. Flanders ales
    i. Flanders Red Ale
    ii. Oud Bruin
c. Trappist and abbey ales
    i. Trappist Single
    ii. Belgian Dubbel
    iii. Belgian Tripel
    iv. Belgian Dark Strong Ale
d. Pale Belgian beers
    i. Blond Ale
    ii. Belgian Pale Ale
    iii. Belgian Golden Strong Ale
e. Unique beers
    i. Saison
    ii. Bière de Garde
    iii. Witbier

2. Britain and Ireland
    a. England
        i. Pale ales
            - Ordinary Bitter
            - Best Bitter
            - Strong Bitter
            - British Golden Ale
            - English IPA
        ii. Dark ales
            - Dark Mild
            - British Brown Ale
            - London Brown Ale
            - English Porter
            - Sweet Stout
            - Oatmeal Stout
            - Tropical Stout
            - Foreign Extra Stout
        iii. Strong ales
            - British Strong Ale
            - Old Ale
            - English Barleywine
    b. Scotland
        i. Scottish Light
        ii. Scottish Heavy
        iii. Scottish Export
        iv. Wee Heavy

c. Ireland
    i. Irish Red Ale
    ii. Irish Stout
    iii. Irish Extra Stout

3. Germany, Czech Republic, and Austria
    a. Lagers
        i. Pale
            - German Leichtbier
            - German Pils
            - Munich Helles
            - German Helles Exportbier
            - Czech Pale Lager
            - Czech Premium Pale Lager
        ii. Amber or dark
            - Vienna Lager
            - Czech Amber Lager
            - Czech Dark Lager
            - Festbier
            - Märzen
            - Munich Dunkel
            - Schwarzbier
            - Rauchbier
        iii. Bocks
            - Helles Bock
            - Dunkles Bock
            - Doppelbock
            - Eisbock
        iv. Specialty
            - Kellerbier
    b. Ales
        i. Wheat/rye beers
            - Weissbier
            - Dunkles Weissbier
            - Weizenbock
            - Berliner Weisse
            - Gose
            - Lichtenhainer
            - Roggenbier
        ii. Rhine Valley ales
            - Altbier
            - Kölsch

4. United States
    a. Pale lagers
        i. American Light Lager
        ii. American Lager

b. Pale ales
    i. American Wheat Beer
    ii. American Blonde Ale
    iii. American Pale Ale
    iv. American Amber Ale
c. IPAs
    i. American IPA
    ii. Double IPA
    iii. Specialty IPA
        • Belgian IPA
        • Black IPA
        • Brown IPA
        • Red IPA
        • Rye IPA
        • White IPA
d. Dark ales
    i. American Brown Ale
    ii. American Porter
    iii. American Stout
    iv. Imperial Stout
e. Strong ales
    i. American Strong Ale
    ii. American Barleywine
    iii. Wheatwine
f. Historic styles
    i. Cream Ale
    ii. California Common
    iii. Kentucky Common
    iv. Pre-Prohibition Lager
    v. Pre-Prohibition Porter
g. Beers made with special ingredients or processes
    i. Alternate grains and malts (e.g., rye)
    ii. Smoked malts
    iii. Sugars and other non-malt fermentables (e.g., honey)
    iv. Fruits and vegetables
    v. Herbs, spices, and natural flavorings (e.g., coffee, chocolate)
    vi. Fermentation with non-Saccharomyces organisms (e.g., *Brettanomyces* species)
    vii. Fermentation or aging with barrels/wood of various types

5. Other regions
    a. Australia
        i. Australian Sparkling Ale
    b. International
        i. International Pale Lager
        ii. International Amber Lager
        iii. International Dark Lager

c. Poland
    i. Piwo Grodziskie
d. Scandinavia
    i. Baltic Porter
    ii. Sahti

III. Beer Flavor and Evaluation

A. Taste and flavor
1. How we perceive flavor
a. Aroma
    i. Orthonasal
    ii. Retronasal
b. Taste
    i. Established
        • Sweet
        • Salty
        • Sour
        • Bitter
        • Umami
    ii. Emerging
        • Fat
c. Mouthfeel
    i. Body
    ii. Carbonation
    iii. Astringency
    iv. Creaminess
    v. Alcoholic warming
2. Variations in taste perception
a. Genetic and biological differences
b. Physiological factors
c. Personal/behavioral factors
    i. Smoking, coffee, food preferences
    ii. Consumption habits
d. Mental and psychological factors
3. Beer evaluation
a. Setting and tools
    i. Environment for tasting
    ii. Drinking vessels and other accessories
    iii. Beer temperature
b. Components of evaluation
    i. Appearance
    ii. Flavor profile
        • Aroma
        • Taste
        • Mouthfeel
        • Aftertaste
c. Key evaluation techniques

i. Aroma techniques
- Distant Sniff: Swirl beer while holding glass six to eight inches away from nose and take one to two short sniffs
- Short Sniff: Swirl beer; bring glass to nose and take one to two short sniffs
- Long Sniff: Swirl beer; bring glass to nose and take one long sniff
- Covered Sniff: Cover glass with hand; swirl beer for three to five seconds; bring glass to nose, remove hand, and sniff

ii. Use consistent background to assess color and clarity
iii. Beer should reach all parts of tongue during tasting
iv. Flavor perception continues after swallowing

B. Identify normal flavors of beer and their source
1. Malt and grain flavors
a. Pale beer: Uncooked flour, bread dough
b. Golden beer: White bread, wheat bread, water cracker
c. Light amber beer: Bread crust, biscuit, graham cracker
d. Amber beer: Toast, caramel, pie crust
e. Brown beer: Nutty, toffee, chocolate, dark/dried fruit
f. Black beer: Roast, burnt, coffee
2. Hops
a. Bitterness, flavor and aroma effects
b. Traditional regional hop traits
i. American: Piney, citrus, resiny, tropical fruit, catty
ii. English: Earthy, herbal, woodsy
iii. German/Czech: Floral, perfumy, peppery, minty
c. Familiarity with flavors of specific hop varieties from each region
3. Fermentation flavors
a. Ale versus lager flavors
b. Weizen yeast flavor
c. Acidic fermentation (lactic, acetic)
d. Brettanomyces

C. Identify common beer flavors by name and source
1. From *Saccharomyces cerevisiae*
a. Diacetyl
b. Sulfur flavors
i. H_2S (hydrogen sulfide)
ii. Sulfitic
c. Acetaldehyde
d. Phenols
i. Know range of flavors associated with phenols
ii. 4-vinylguaiacol
iii. 4-ethylphenol
iv. Other phenols
e. Esters
i. Know range of flavors associated with esters
ii. Isoamyl acetate

iii. Ethyl acetate
iv. Ethyl butyrate
v. Ethyl hexanoate

2. From other organisms
   a. Diacetyl
   b. Phenols (see 1d above)
   c. Acetic acid
   d. Lactic acid
   e. Butyric acid
   f. Indole
   g. Caprylic acid
   h. Mercaptan
   i. H_2S
   j. DMS
   k. Acetaldehyde
3. Packaging and storage
   a. Oxidation/aging flavors
      i. Honey
      ii. Papery/wet cardboard (trans-2-nonenal)
      iii. Waxy/lipstick
      iv. Sherrylike
      v. Damascenone
      vi. Increased toffee/caramel
      vii. Decreased bitterness
   b. Lightstruck/skunky
   c. Autolysis
   d. Trichloroanisole (TCA)/cork taint
4. Process and ingredients
   a. Isovaleric acid
   b. Metallic
   c. Chlorophenol
   d. DMS
   e. Astringent/tannic
   f. Grainy
   g. Malty-biscuity
   h. Catty/ribes
   i. Leathery (Isobutylquinoline)
   j. Geosmin/earthy
   k. Vanillin

D. Perform the following under test conditions:
   1. By taste, detect and identify full range of off flavors by comparing spiked samples to a control beer
   2. By taste, identify beer styles of unknown samples
   3. Based on your sensory analysis of an unknown sample, write a consumer oriented profile of the beer suitable for a menu or shelf-talker, providing detailed and specific flavor descriptors

4. Based on your sensory analysis of an unknown sample, write a complete description of all flavors and characteristics present

IV. Beer Ingredients and Brewing Processes

A. Ingredients
   1. Grains
      a. Malted barley
         i. Why barley used for brewing
         ii. Species of barley, cultivation areas, varieties of barley
         iii. Malting: process stages and steps, floor malting
         iv. Process variations that lead to different malt types
            - Kilned: Pils, Pale Ale, Vienna, Munich, Victory
            - Stewed: Crystal/caramel malts
            - Roasted: Chocolate, Black Patent
      b. Wheat, oats, rye and other specialty grains
         i. Forms used: raw, malted, flaked, torrified, roasted
         ii. Impact on brewing process
         iii. Sensory contributions to finished product
      c. The use of corn and rice in beer
         i. Contributions to wort and beer
         ii. Requirements for processing
         iii. Styles where used
   2. Hops
      a. Anatomy of hop plant and cone
      b. Cultivation
         i. Structure and layout of hop field
         ii. Life cycle of hop plants
         iii. Attending to the hop plant: pruning, training
         iv. Factors affecting yield
            - Pests and diseases
            - Climate, agronomic considerations
            - Pollination
         v. Harvesting, drying and baling
         vi. Storage and delivery to breweries
         vii. Agricultural economics of hops
      c. Major growing regions
         i. Continental Europe
            - Germany
            - Czech Republic
            - Belgium
            - Slovenia
            - Poland
            - France
            - Spain
         ii. Britain
         iii. United States

- Yakima Valley, Washington
- Oregon
- Idaho
- Other US growing areas

iv. Australia and New Zealand
v. Other areas: China, Japan

d. Categories of hops
i. Bittering hops (high alpha acid)
ii. Aroma hops (desirable flavor and aroma properties)
- Noble hops (Hallertau Mittelfruh, Spalt, Tettnang, Saaz)

iii. Dual use hops (possessing properties of both bittering and aroma hops)
iv. US cultivars of classic European hops

e. Chemistry
i. Alpha acids, isomerization, and IBUs
ii. Hop oils determine flavor and aroma
- Four major oils
- Many additional compounds
- Role of oxidation in hop flavor

f. Hop forms and products used in brewing
i. Whole hops
ii. Pellet hops (90/45)
iii. Extracts
- Alpha acid
- Hydro-isomerized alpha acid (skunk resistant)
- Isomerized alpha acid
- Essential oils

g. Uses and effects during brewing
i. Bittering contribution of hops added at different times during the boil
ii. Flavor and aroma hop additions and effects
- Boil
- Hot wort steep/whirlpool
- Dry hopping

iii. Novel uses: mash hopping, first wort hopping, wet hopping, hop back

3. Yeast
a. Taxonomy
i. Ale yeast
- *Saccharomyces cerevisiae*
- Generally produce esters in levels which give fruity flavors to finished beers
- Some possess a phenolic off-flavor gene (POF+) which results in production of phenolic flavors such as clove, nutmeg, white pepper

ii. Lager yeast
- *Saccharomyces pastorianus* also known as *Saccharomyces carlsbergensis*
- Generally do not produce esters or phenols in appreciable quantities, resulting in a focus on malt and hop character

iii. Wild yeast
- Non-brewing strains of *Saccharomyces* can cause off flavors or excessive attenuation

b. Factors required for healthy fermentation: aeration, pitching rate, yeast health
c. Non-*Saccharomyces* organisms
i. Important organisms
- *Brettanomyces* species:
  - *B. bruxellensis*
  - *B. anomalus*
  - Some strains of these species are commercially available under the following names:
    - *B. lambicus* (a strain of *B. bruxellensis)*
    - *B. claussenii* (a strain of *B. anomalus)*
- *Acetobacter* species
- *Lactobacillus* species
- *Pediococcus* species
- Other organisms

ii. Intentional use
iii. Unintentional appearance

4. Water
a. The importance of water in brewing
b. Chemistry of water
i. Chlorine
- Off flavors associated with chlorine
- Common techniques for removal

ii. Water cycle and sources of salts
iii. Water traits of classic brewing cities: Munich, Pilsen, Burton-on-Trent, London, Dublin, Dortmund
iv. Permanent and temporary hardness
v. Alkalinity

c. Common water minerals and their flavor impact in beer
d. Possible adjustment of brewing water for the production of specific beer styles and their flavor effects

5. Other ingredients
a. Specialty ingredients
i. Sugars
- Fermentable
  - Common household sugars
  - Corn sugar/dextrose/glucose
  - Candi sugar/invert sugar syrup
    - Non-caramelized
    - Caramelized to various degrees
  - Specialty sugars (Demerara, jaggery, piloncillo, etc.)
  - Honey, molasses
- Non-fermentable
  - Lactose

ii. Fruits and vegetables
iii. Herbs and spices
- Common cooking herbs/spices
- Chili peppers
- Coffee, cocoa, chocolate, teas
- Gruit/traditional herbs

iv. Other flavorings

b. Considerations in their addition to beer: when and how added, likely effects on process
c. Historical precedent for addition of non-traditional ingredients

B. Processes
1. Milling
a. Possible flavor impact of milling on finished beer
b. Purpose and objectives of milling
c. Variations in mills and milling techniques
d. Qualitative traits of a proper grind
2. Mashing
a. General description and goals
b. Major enzymes active during mashing and their impact on beer attributes
c. Types of mash regimens and when they might be used, impact on flavor and beer character (infusion, step-infusion, decoction, cereal, historical methods)
3. Lautering
a. Objectives of lautering
b. General process of lautering
i. Initiate wort run-off
ii. Vorlauf (recirculation)
iii. Begin collection of wort for boiling
iv. Sparge
c. Potential impacts of lautering on beer character
4. Boiling
a. Process and objectives of boiling
i. Inputs and outputs
ii. Significant physical and chemical changes
b. Flavor impacts of boil
c. Heating methods, equipment variations, and potential flavor impacts
5. Whirlpool
a. Objectives of whirlpool
b. General operation of whirlpool including wort removal
c. Alternatives to whirlpooling: wort strainer, cold flotation, hop back, coolship
6. Chilling
a. Modern methods of wort chilling
i. Heat exchanger
ii. Coolship
b. Historical methods of wort chilling
c. Flavor issues associated with wort chilling
7. Aeration and pitching

a. When wort is aerated in the brewing process
b. Reasons for wort aeration
c. Potential flavor impact of aeration

8. Fermentation (*Saccharomyces cerevisiae or Saccharomyces pastorianus*)
   a. General description of fermentation
      i. Ale fermentation
      ii. Lager fermentation
         • Diacetyl rest
   b. Major biochemical inputs and outputs
      i. Input: Sugars
      ii. Outputs: Alcohol and carbon dioxide
   c. Resulting flavor compounds (see flavor section, III.C.1)
   d. Equipment used for fermentation
   e. Variations in fermentation temperature and their flavor impact
   f. Potential flavor impacts of fermentation vessels
   g. Hybrid fermentations and other variations and their possible effects on beer character
   h. Maturation
9. Lagering
   a. Objectives of lagering
   b. Lagering temperature and duration
   c. Impact on finished beer characteristics
   d. Use of wood strips or chips
10. Aging
   a. Flavor impacts of aging
      i. In stainless steel
      ii. In new wood
      iii. In previously used wood
   b. Factors influencing flavors produced
      i. Prior use of vessel
         • Residual flavors from other liquids
         • Microflora
      ii. Porosity and micro-aeration (surface to volume ratio)
      iii. Char or toast of wood
      iv. Time and temperature
11. Clarification
   a. Common methods used for beer clarification
      i. Filtration
      ii. Finings
      iii. Settling/aging
      iv. Centrifugation
   b. Consumer issues (dietary restrictions)
12. Carbonation
   a. Carbonation levels found in beer (by style or type) in volumes of CO_2
   b. Methods of achieving carbonation in beer, when and how used
      i. Capture during fermentation

ii. Forced carbonation
iii. Secondary fermentation in serving vessel
c. Sensory impact of carbonation on finished beer
13. Packaging and pasteurization
a. Package types
i. Draft
ii. Bottles
iii. Cans
b. Force-carbonated vs. package conditioned (e.g., bottle conditioned)
c. Quality control
i. Cleaning/sanitizing of containers
ii. Importance of air exclusion during packaging
iii. Cap-on-foam
d. Pasteurization and its impact on beer
i. Types: flash versus package
ii. Pasteurization conditions
iii. Impact on stability and flavor

V. Pairing Beer with Food

No single model perfectly explains all the dynamics of beer and food pairing. This syllabus draws from various sources to present common concepts and widely accepted principles. Master candidates will be expected to demonstrate a broad knowledge of foods and cuisines and to confidently create pairings based on their own experience and learned knowledge of what works well.

A. Possible outcomes of successful beer and food pairings
1. Desirable flavors are highlighted in both the beer and the dish
2. Combination of the two invokes memory, emotion, and/or deeper thought
3. Pairing creates new flavors not originally present in either the beer or the dish
B. Beer and food vocabulary
1. Beer vocabulary
a. For common beer flavor descriptors, see section III.B
2. Food vocabulary
a. Describe specific food tastes beyond basic identification of key ingredients and preparation (e.g., instead of "seared scallop", use "scallop has a caramelized, crispy sear with rich toasted and toffee flavors, while the dense interior has a buttery sweetness")
b. Understand basic cooking techniques and their effects on flavor (e.g., poaching, roasting, frying, etc.)
c. Familiarity with a range of commonly encountered foods and ingredients (e.g., vegetables, fruits, herbs, spices, etc.)
d. Familiarity with a wide range of cuisines and common dishes
C. Pairing concepts
1. Intensity (referred to as "impact" by Garrett Oliver, called "weight" in wine)
a. A beer's intensity is determined by the levels of several characteristics
i. Malt flavor
ii. Hop bitterness

iii. Sweetness/body (note that these are related)
iv. Alcohol content
v. Carbonation
vi. Tartness/sourness
vii. Fermentation derived flavors (esters, phenols, etc.)
viii. Hop flavor/aroma
ix. Special ingredients/processes (e.g., fruit, coffee, barrel-aging, etc.)

b. A dish's intensity is determined by the interplay of several characteristics
i. Flavor impact of individual ingredients
ii. Preparation/cooking method
iii. Spices used
iv. Sauces served alongside
v. Levels of fat, umami, sweetness, bitterness, saltiness, sourness, etc.

2. Flavor interactions
a. Interactions between similar flavors
i. Complement/resonance—Similar or compatible flavors present in both the beer and the food complement one another (e.g., an Indian curry with cloves resonates with the clove flavors found in a Dunkels Weissbier)
ii. Accentuating—A flavor from one side of the pairing highlights a flavor from the other side. (e.g., light diacetyl in a beer coaxes out a faint caramel note in cooked meat)
iii. Canceling—Similar flavors in both sides of the pairing can seem to eliminate perception of that flavor in one side of the pairing. (e.g., smoky flavors seem diminished when a smoky beer is paired with smoked foods; fruit flavors seem bland when a fruit beer is paired with a fruit dessert)

b. Interactions between dissimilar flavors
i. Contrast—By offering an opposing flavor, the beer highlights a flavor in the dish or vice versa. (e.g., mussels served with Gueuze seem richer and sweeter due to the acidity of the beer)
ii. Cut—Some beer traits help refresh the palate by lifting, cleansing or removing rich or fatty flavors from the palate. Common "cutting" beer traits include carbonation, sourness, and bitterness, and to a lesser extent, alcohol and roastiness
iii. Accentuating—A dissimilar flavor in the beer heightens the perception of a flavor in the dish or vice versa (e.g., bitterness in a beer accentuates capsaicin heat from chili peppers)
iv. Softening—A flavor in the beer diminishes the intensity of a flavor in the dish, or vice versa (e.g., malt sweetness soothes spicy capsaicin "heat")
v. Clashing—A flavor present in the beer creates an unpleasant juxtaposition with a flavor in the dish (e.g., high bitterness and briny fish create clashing, metallic flavors)

D. Common beer and food interactions
1. Malt flavors
a. Complement toasted and caramelized flavors in a variety of foods
b. Soothe/soften capsaicin "heat"

2. Hop flavors
    a. Depending on hop variety, can complement fruit, citrus, herb, and spice flavors
3. Fermentation-derived flavors
    a. Esters
        i. Harmonize with fruit flavors
        ii. Harmonize with dairy
    b. Phenols (clove and peppercorn flavors)
        i. Resonate with spices
        ii. Contrast fat and umami
        iii. Can become harsh in some pairings
4. Carbonation
    a. Cuts fat, umami, and sweetness
    b. Accentuates capsaicin "heat"
5. Bitterness
    a. Cuts fat, umami, and sweetness
    b. Accentuates capsaicin "heat"
    c. Can create harsh or metallic effects with certain foods (e.g., oily fish)
    d. Can harmonize with, soften, or cancel bitter foods (e.g., bitter salad greens)
6. Roastiness
    a. Complements chocolate, caramelized, and burnt flavors
    b. Cuts fat
    c. Contrasts sweetness
    d. Accentuates umami
7. Alcohol
    a. Can cut fat
    b. Generally resonates with sweetness
    c. Can accentuate capsaicin "heat"
8. Tartness/sourness
    a. Can brighten some food flavors
    b. Can complement or accentuate sour flavors
    c. May favorably contrast fat, umami, or salt
9. Sweetness
    a. Soothes capsaicin "heat" and other spices
    b. Accentuated by saltiness

E. Creating a pairing
    1. Match intensities of both beer and dish so that neither overpowers the other
    2. Consider the flavor interactions listed in sections V.C.2 and V.D to hone the pairing
F. Designing a meal
    1. Intensity of dishes and pairings generally increases as the meal progresses
    2. Plan meal around a unifying theme
G. Classic beer and food pairings
    1. European traditions
        a. Belgium
        b. Germany
        c. England

2. Recommended literature
    a. *Brewmaster's Table*, Garrett Oliver
    b. *Tasting Beer*, Randy Mosher

H. Cooking with beer
1. Common uses
    a. Used in place of water or other liquid as an ingredient or cooking medium
        i. Batters and baked goods
        ii. Marinades, brines, and dressings
        iii. Braising, roasting, deglazing, and sauces
        iv. Soups or stews
        v. Desserts
2. Flavor effects
    a. Concentrating beer through cooking intensifies non-volatile flavors
        i. Bitterness can intensify exponentially and may become unpleasant
        ii. Malt flavors and sweetness increase, sugars caramelize
        iii. Volatile hop and ester flavors decrease and may disappear entirely
        iv. Astringent/burnt flavors of roasted malt can increase and may become unpleasant
    b. Delicate hop and fermentation flavors in beer can be brought to a dish by not cooking the beer (e.g., using an IPA in a salad dressing)