Chartered Institute of Brewers and Distillers

# Diploma in Brewing
# Module 2 Syllabus

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# UNIT 1: YEAST

Candidates are required to have an in-depth understanding of the following:

## Yeast Morphology and Evaluation

1. What is Yeast? Draw a diagram showing the key features of a typical yeast cell.
2. Yeast Cell Structure and Function. Describe the functions of the major yeast organelles.
3. Yeast Growth. Understand how yeast cells replicate and multiply.
4. Yeast Genetics & Wort as a Yeast Growth Medium. Describe some of the classical microbiological tests that brewers use to evaluate yeast and to differentiate between brewing yeast, other yeast, and selected bacteria.
5. Yeast Characterisation and Evaluation. Demonstrate an understanding of the genetic makeup of brewing yeast and describe some of the genetic methods that we use to identify individual strains.
6. Yeast Nutrition. Describe the nutritional requirements of yeast and understand how these relate to yeast health and performance in brewing.
7. Define yeast flocculation and understand how we use the factors that control its expression in order to make yeast handling easier.

## Yeast Biochemistry

1. Describe the carbohydrate nutrients that brewing yeasts are able to utilise and list those they cannot.
2. Describe how carbohydrates are transported into yeast cells.
3. Control of Metabolism. Explain how metabolism is controlled and the effect of the ordered uptake of carbohydrates and other nutrients.
4. Sugar Metabolism. Illustrate the process of glycolysis, including related reactions, and discuss its role in metabolism in brewing yeast.
5. Discuss how pyruvate is metabolised and how it is used by yeast cells in the creation of biosynthetic pathways.
6. Respiratory and Fermentative Metabolism. Show an understanding of the roles of oxygen and fermentable sugars in the regulation of yeast metabolism and their effect on energy generation.
7. Define and illustrate cellular redox control and impact on beer flavour.
8. Explain the formation and function of glycogen and trehalose.

    i) Gluconeogenesis
    ii) Storage Carbohydrates

## Yeast Propagation

1. Understand why most brewers choose to use pure yeast cultures.
2. Explain why some brewers choose to use mixed cultures
3. Explain the practice of serial re-pitching and why this introduces a need for propagation.
4. Define how to manage a propagation schedule and outline its component parts.
5. Yeast supply. List, with an assessment of strengths and weaknesses, the methods used to maintain yeast cultures.

6. Describe a typical protocol for recovering yeast cultures from storage and propagating a new culture in the laboratory.
7. Describe the process of yeast propagation in the brewery together with a critical discussion of the strengths and weaknesses of traditional methods.
8. Demonstrate an understanding of the role of oxygen in yeast propagation and discuss the conse quences on yeast physiology of using wort as the growth medium.
9. Describe the underlying design features of continuously aerobic yeast propagation plant.
10. Understand the likely impact of the physiological condition of newly propagated yeast on subsequent performance in fermentation.

### Yeast Management

1. Measuring Yeast Concentration. Describe how yeast growth is measured.
2. Discuss what viability is and how it is measured in brewing yeast.
3. Distinguish between viability and vitality, give examples of the various methods that are used to assess viability and discuss how the methods might be applied in commercial brewing.
4. Describe, with diagrams, the patterns of growth we would expect to see in a typical brewery fermentation.
5. Explain the basis of the various methods used to pitch and crop brewing fermentations.
6. Yeast Handling and Cropping. Discuss the important factors that need to be considered when storing cropped yeast so that it is fit for re-pitching.
7. Yeast Storage. Describe, with diagrams, the key features of a vessel suitable for storing cropped yeast slurry.
8. Critically assess the acid washing process used by some brewers.

## UNIT 2: FERMENTATION

Candidates are required to have an in-depth understanding of the following:

### Fermentation Principles

1. Understand the role of fermentation in the brewing process.
2. Identify and discuss the factors that influence fermentation performance.
3. Identify typical values for the parameters that are used to control fermentation.
4. Illustrate the main stages in fermentation.
5. Explain what is happening at each stage of fermentation and describe the principal markers.
6. Understand why particular yeast strains are chosen to make different beer styles.

### Fermentation and Beer Flavour

1. Summarise the contribution that yeast makes to beer flavour.
2. Describe the effect of yeast strains and other transforming organisms on beer flavour.

3. List the major groups of yeast metabolites that contribute to beer flavour, describe their impact on flavour, and give typical flavour-threshold concentrations.

    i) Organic Acids and Fatty Acids
    ii) Aldehydes and Ketones
    iii) Vicinal diketones
    iv) Alcohols and Esters
    v) Sulphur Compounds

4. Illustrate the metabolic pathways that lead to the formation of major yeast-derived beer flavour compounds.
5. Describe ways to manipulate fermentation conditions to achieve the desired yeast-derived beer flavour compounds.
6. Describe how mixed populations of non-standard brewing yeast strains and bacteria affect beer flavour.
7. Demonstrate a knowledge of the metabolic pathways used by non-standard brewing yeast and bacteria which lead to the formation of beer flavour compounds.

## Design of Fermentation Vessels

1. Identify the range of materials used for fermentation vessels.
2. Understand how the behaviour of different yeast strains influences fermenter design.
3. Describe and illustrate the most commonly used fermentation vessels including Unitanks.

    i) Vessels for Top Cropping Yeasts
    ii) Vessels for Bottom Cropping Yeast

4. Discuss the economics which underpin the choice of type, capacity, and number of fermentation vessels for different brewing scenarios.
5. Explain why cylindroconical fermenters are the most popular choice of vessel.
6. Describe the processes of wort cooling and oxygenation and explain how the major fermentation variables are used to control these processes.
7. Discuss the principles that underpin continuous fermentation and describe some examples of commercial systems using free and immobilised yeast.

    i) Controlling Fermentation Progression
    ii) Combined Fermentation and Cold Conditioning
    iii) Criteria for Selecting a Fermentation System
    iv) High Gravity Brewing
    v) Continuous Fermentation
    vi) Immobilised Yeast

# UNIT 3: BEER MATURATION AND FINISHING

Candidates are required to have an in-depth understanding of the following:

## Warm and Cold Maturation

1. Describe the range of maturation vessels available and explain how both a vessel's design and its requirements affect beer quality.
2. Identify the sizing requirements of maturation vessels based on fermentation vessel volumes and maturation duration.
3. Discuss the principles of warm maturation; understand the process of flavour development and describe the impact of process control.
4. Compare batch and continuous maturation; describe their impact on the maturation process.
5. Discuss the principles of cold maturation and show an understanding of its impact on colloidal stability.

    i) Cold Maturation
    ii) Stokes' Law

6. Explain the use of wood during maturation; describe its impact on final beer flavour.

## Clarification – Centrifugation

1. Identify the key requirements of a centrifugation system in processing and recovering beer.
2. Explain centrifugal sedimentation principles.

i) Turbidity Control
ii) Theory of Centrifugal Sedimentation

3. Explain the design and operational principles of centrifuge technologies.

i) The Design and Operational Principles of Centrifuges – Self Cleaning Clarifiers
ii) The Design and Operational Principles of Centrifuges – Decanter Clarifiers
iii) Advantages and Disadvantages of Using Centrifuges

4. Describe the principles of process control during centrifugation and identify their impact on beer quality parameters.

i) Key Beer Quality Parameters Post-Centrifugation
ii) Beer Recovery

## Process Aids and Additions

1. Understand the origins of beer haze; identify the different types of haze.
2. Explain why process aids are used in the brewing process and describe how they benefit both product quality and the production process.

3. Describe the technologies used for process aid addition including design, ancillary equipment, and process control.

   i) Finings
   ii) Silicates and Silica Gels
   iii) Polyvinylpolypyrrolidone (PVPP)
   iv) Tannic Acid
   v) Enzymes
   vi) Other Treatment – Controlled Stabilisation System (CSS)

4. Identify the purpose, function, and application of post-fermentation additions.
5. Summarise the operational principles, function, and points of use of deaerated water in the brewery.
6. Outline the critical deaerated water quality parameters and describe their impact on final beer quality.

## UNIT 4: BEER PROPERTIES

Candidates are required to have an in-depth understanding of the following:

### Beer Foam

1. Understand the mechanics of foam formation, foam collapse and lacing.

   i) Physics of Foam Formation and Collapse
   ii) Chemistry of Beer Foam

2. Explain methods for measuring foam quality with comparison to consumer experience of foam.

   i) Foam Measurement
   ii) Beer Processing
   iii) Dispense
   iv) Nibem Foam Stability Measurement

3. Discuss the key factors affecting foam performance.

   i) Raw Materials Influence on Foam
   ii) Wort Production Influences on Foam

4. Understand causes and remedial action of gushing.

### Beer Haze

1. Understand the nature and typical composition of biological, chill and permanent hazes.
2. Explain the scientific principles behind, and relevance of, process factors in non-biological haze formation.
3. Understand the methods and principles for the measurement of non-biological haze.

4. Explain the prediction of shelf-life, using accelerated haze formation techniques.

   i) Predictive Tests
   ii) Protein Precipitation Tests
   iii) Polyphenol Precipitation and measurement

### Beer Flavour and Stability

1. Understand the nature and contribution of raw materials to beer flavour.

   i Beer Flavour Description
   ii Primary Beer Flavours
   iii Barley and Other Malts
   iv Adjuncts
   v Hops
   vi Residual Carbohydrates
   vii Water and Inorganic Ions
   viii Yeast

2. Explain the nature and origin of common flavour taints.

   i Microbial Contamination
   ii Taints in Beer
   iii Taints from Cleaning Materials
   iv Taints from Contact Materials
   v Taints from the Brewing Plant

3. Understand the nature of flavour changes which occur during beer storage.
4. Explain the importance of oxidation in causing flavour instability.

   i Reactive Oxygen Species (ROS)
   ii Oxidation Reactions and Flavour Instability
   iii Oxidation of Hop Acids

5. Understand the nature, purpose, function and application of anti-oxidants.
6. Understand the control of oxidation throughout the brewing process.

## UNIT 5: HYGIENE

Candidates are required to have an in-depth understanding of the following:

### Cleaning Systems and Control

1. Explain the design, concept and operational principles of hygienic brewing plants.
2. Understand the overview of design and operational principles of Cleaning-in-Place (CIP) systems.

   i Cleaning-In-Place (CIP) Systems
   ii Nature of Soils

iii Sinner's Circle – The Four Cleaning Factors
iv Design of a CIP Plant
v CIP Operational Principles
vi Multiple Use Systems
vii CIP Plant Optimisation

3. Recognise the nature, purpose, function, and application of detergents and sanitisers.

i Detergents and Disinfectants
ii Detergent Additives
iii Caustic Soda
iv Acids
v Disinfectants
vi Selection of Detergents and Disinfectants

4. Summarise the measurement of cleaning effectiveness.

## Types of Microorganisms

1. Explain which microorganisms can be intentionally added to wort and beer and their application in speciality beers.

i Speciality Microorganisms

2. Describe spoilage microorganisms and their effects on beer quality.

i Classification Of Beer Spoilage Organisms

3. Outline beer production processes and their contaminating organisms.

i Gram-positive Bacteria
ii Gram-negative Bacteria
iii Wild Yeast

## Microorganism Detection and Control

1. Explain the principles of detection, identification, and quantification of brewery microorganisms, and evaluate both traditional and rapid methods.

i Traditional Methods
ii Rapid Methods
iii Rapid Physical Methods
iv Rapid Biochemical Methods
v Rapid Molecular Methods

2. Describe the occurrence of brewery contaminating microorganisms within the beer production process and the factors determining their susceptibility to or tolerance of these environments.

i Biochemical – Culture Media
ii Microorganism Growth in Brewing Raw Materials
iii Factors Affecting Microbial Growth in Wort and Beer

3. Discuss the impact that contaminating microorganisms can have on final beer quality.

# UNIT 6: QUALITY MANAGEMENT

Candidates are required to have an in-depth understanding of the following:

## Quality Assurance and Quality Management

1. Contrast different definitions of quality and apply these to beer.

    i Definitions of Quality

2. Compare and contrast approaches to quality control and quality assurance.
3. Explain the components of the quality management system.

    i Quality Management
    ii Quality Management Systems (QMS)
    iii ISO 9000 Standards
    iv Quality Assurance Tools

4. Utilise the tool of HACCP to control food safety hazards.

    i Food Safety
    ii Hazard Analysis and Critical Control Points (HACCP)
    iii TACCP and VACCP

## Wort and Beer Analysis

1. Compare laboratory methods for measuring the key attributes of beer.

    i Analyses Principally on Wort
    ii Analyses on Wort and Beer (SG and pH)
    iii Analyses on Wort and Beer (Bitterness and Colour)
    iv Analyses on Wort and Beer (Ions)
    v Analyses on Wort and Beer (Haze)
    vi Analyses Principally on Beer (ABV)
    vii Analyses Principally on Beer (Foam)
    viii Analyses Principally on Beer (Sulphur Dioxide)
    ix Analyses Principally on Beer (Vicinal Diketones)
    x Analyses Principally on Beer ($CO_2$)
    xi Analyses Principally on Beer (Oxygen)
    xii Analyses Principally on Beer (Calorific Content of Beer)
    xiii Analyses Principally on Beer (Beer Stability)

2. Utilise simple statistical methods to interpret analytical data.
3. Develop specifications based on process and analytical variables.
4. Demonstrate an understanding of Laboratory Accreditation and Interlaboratory Collaborative Schemes.

# Sensory Analysis

1. Demonstrate an understanding of the importance of sensory analysis.

   i How We Taste Things

2. Demonstrate how to plan and organise the setting up of a sensory panel.

   i The Sensory Panel
   ii The Tasting Process

3. Compare and contrast different sensory tests.

   i Difference Tests
   ii The Triangle test
   iii Tetrad test
   iv Paired comparison test
   v Duo-Trio test
   vi A – not-A test
   vii Two-out-of-Five test
   viii Descriptive Analysis
   ix Other Sensory Tests

4. Describe the components of flavour and methods of presenting sensory information.

   i Results Handling
   ii Presentation of Results
   iii Beer Flavour Compounds