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SISON
REVIEW CENTER

Food Technologist Licensure Exam Review

Lecture Module 2

Preface

Lecture Guide 2 is centered on Methods and Techniques in Food Technology. In this lecture guide, you will be brought back to the basics of methodology design and analytical techniques. The topics covered in this LG will encompass all the exams in the Food Technology Licensure Exam (FTLE). A brief description for each major topic and some study tips are as follows:

.

- *Methods of Research in Food Science and Technology* –you are brought back to the basics of conducting scientific research in the context of Food Science and Technology. We will be tackling the basics of the research process, paradigms of research, data collection and analysis as well as the process of developing and evaluating research. In the FTLE, there are sections where you have to evaluate a section of a study and identify which among the slew of words is being asked. You would strongly benefit from practicing your reading and comprehension skills on top of familiarizing yourself with the different aspects of scientific research.
- *Microbiological Analysis of Food* – for this section of the lecture guide, we will focus on one of the core aspects of food technology, microbial analysis. In here, you will cover the techniques used for culture and non-culture based analysis with a focus on routinary microbial analyses and rapid biochemical tests, respectively. You will also review the methods of conducting quantitative and qualitative tests, with emphasis on the methods commonly used in establishing product standards. Try to remember your lab experience with microbiology as this will help in remembering the techniques discussed in this section.·
- *Food Analysis* – Similar to the previous section, this part of the lecture guide focuses on routinary analyses on food, with emphasis on determining composition, and detection of extraneous materials using different methods Pay close attention to the method of detection as some questions in the licensure exam may focus on the principle of the technique.
- *Basic Food Preparation* – for this section of the lecture guide, the focus is on the various techniques associated with preparing food, including the process of recipe development, cooking measurements and national standards for meat cuts and portions. For this section, try to describe and relate the components of the ingredients to a specific attribute which would help you design a relative cooking method for the product made.
- *Food Processing* – This section of the lecture guide focuses on the "bread and butter" of Food Technology, which is Food Processing. It is divided into two sections - thermal and non-thermal methods of processing. The thermal processing section focuses on the different parameters associated with defining the process schedule and heat distribution, as well as understanding how these processes are conducted through different designs. This also contains computational portions associated with determining the defined

parameters and designing the process schedule. The Non-thermal processing focuses on the preservation of food products using methods that either alter the composition of the food product leading to inhibition of biochemical processes or subjecting the food products to conditions that would lead to the inactivation of the former. In this section, the focus should be on how the method preserves the food product and when these methods are most ideal to use in production.

- *Food Engineering* – In this section of the lecture guide, we focus on the aspects of engineering associated with the production of food. This section focuses on the concepts of unit operations, mass and energy balance and fluid flow. For unit operations, the processes and symbols used in denoting the processes will play a key role in your understanding of the concepts. Similar to thermal processing, computation on determining the mass balance between processes is a common niche in questions during the licensure exam. The same is observed in fluid flow wherein flow characteristics during production are also determined via computation. Take note of the process of solving the problem by identifying what is given and what is asked in terms of the associated formulas.
- *Sensory Evaluation* - This section of the lecture guide focuses on the methods and techniques associated with evaluating a food product using the most accessible method of evaluation, our senses. Here, we will tackle the basics and process of sensory evaluation, and the different tests conducted. A key skill that should be nurtured in this lecture guide is knowing which sensory evaluation tests should be conducted based on what data you require. We also discuss the use of statistical methods in the determining differences and the process of panelist training when conducting the relevant sensory tests.

For this Lecture guide, the key to recalling the methods and techniques lies within the association of one component to the other. As a tip, try to create word associations to specific techniques as well as certain methodologies. For example, spectrophotometry involves the use of light in such a way that you can only "generate a photo" when there is light. Associating the process or technique with something familiar can help you remember. Likewise, it would also help that you read up on the latest technology and techniques as the methods stated here are not just the ones that you may encounter. In essence, an overall tip that can be given for this lecture guide is familiarity with the method can ensure your success in a method.

-From the SRC Food Tech Faculty Members (Jin, Mando, Mark, Riann and Sn)

Name:

Lecture Guide 2:

Integration and Application of Food Technology

Lecture Guide 2
Methods and Techniques in Food Technology

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METHODS OF RESEARCH IN FOOD SCIENCE AND TECHNOLOGY

- Research and the Research Process
- Types and Paradigms of Research
- Data Collection and Analysis
- Developing and Evaluating Research
- Ethical Requirements in Research

Research and the Research Process

- Research is a _____, _____, _____, and _____ investigation of hypothetical propositions about the presumed relations among natural phenomena (Kerlinger, 1964)
- Research Process
    1. _____
    2. _____
    3. _____
    4. _____
        - _____ - a logical supposition, a reasonable guess, an educated conjecture; tested explicitly.
        - _____ - condition taken for granted in research; tested implicitly.
    5. _____
    6. _____
    7. _____

Types and Paradigms of Research

- By Application
    - _____ - experimental or theoretical work undertaken primarily to acquire_____ of the underlying foundations of phenomena and observable facts, without any particular application or use.
        - Seeks to analyze properties, structures, and relationships with a view to formulating and testing hypotheses, theories, or laws.
        - Possible that researchers may not know about actual applications of the research.
        - Results are not generally sold but are usually published in scientific journals or circulated to interested colleagues.
        - May be "classified for security reasons.
        - Two categories
            - _____ - carried out for the advancement of knowledge, without seeking long-term economic or social benefits or making any effort to apply the results to practical problems or to transfer the results to sectors responsible for their application.
            - _____ - carried out with the expectation that it will produce a broad knowledge base likely to generate the solution to current or future problems or possibilities.

Name:

- Example/s:
  _____
  _____

- _____- original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective.
  - Seeks to determine either possible uses for the findings of basic research or new methods or ways of achieving specific and predetermined objectives.
  - Involves considering the available knowledge and its extension in order to solve particular problems.
  - Intended primarily to be valid for a single or limited number of products, operations, methods or systems.
  - Example/s:
    _____
    _____

- By Objective
  - _____- attempts to describe systematically a situation, problem, phenomenon, service, or programme, or provides information or describes attitudes towards an issue.
    - Example:
      _____

  - _____- undertaken with the objective either to explore an area where little is known or to investigate the possibilities of undertaking a particular research study.
    - Example:
      _____

  - _____- discover or establish the existence of a relationship/association/interdependence between two or more aspects of a situation
    - Example:
      _____

  - _____- attempts to clarify why and how there is a relationship between two aspects of a situation or phenomenon

- Example:

  _____

- By Research Design
  - _____- the purpose of the study is primarily to describe a situation, phenomenon, problem or event.
    - The information is gathered through the use of variables measured on _____ scales (qualitative measurement scales).
    - Analysis is done to establish the variation in the situation, phenomenon, or problem without quantifying it.
    - Example:

      _____

  - _____- quantifies the variation in a phenomenon, situation, problem or issue; if information is gathered using predominantly quantitative variables; and if the analysis is geared to ascertain the magnitude of the variation.
    - Example:

      _____

  - _____- combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.
    - Example:

      _____

- Philosophical Framework
  - _____- philosophical perspective based on the ideas that progress toward an accurate understanding of a phenomenon is likely to be gradual and probabilistic and a truly complete understanding of the phenomenon may ultimately be impossible.
    - Seeks to reduce bias and increase objectivity.
    - Example:

      _____

  - _____- philosophical perspective based on the idea that any understandings of physical or psychological phenomena are inevitably only human creations and beliefs.

- Researchers construct understandings that can never reflect "true" reality (if such a reality exists).
- Focuses on people's perceptions and interpretations of various phenomena, including individuals' behaviors, group processes, and cultural practices.
- Example:

  _____
  _____

- _____- "transforms" or causes a major change in thought patterns concerning an area of scientific endeavor.
  - takes advantage of unpredictable events leading to novel hypotheses, some that seem implausible.
  - research that restructures and revolutionizes means of inquiry, and thereby enhances knowledge base.
  - Example:

    _____
    _____

- _____- philosophical perspective based on the idea that absolute "truths" about certain phenomena and people's constructed beliefs about those phenomena are both legitimate objects of study.
  - Also known as _____
  - Not bound by philosophical or methodological constraints
  - Allows researchers to conduct research in innovative and dynamic ways to find solutions to research problems.
  - Example:

    _____

Data Collection and Analysis

- Review of Statistics
  - _____ - branch of mathematical science that deals with the collection, presentation, organization, analysis, and interpretation of data.
    - _____ - techniques used in collection, presentation, organization, and analysis of the data on hand.
      - Examples:

        _____

    - _____ - techniques used in analyzing the sample data that will lead to generalizations about a population from which the sample came from

- Examples:
  _____

- Basic Terms in Statistics
  - _____ - collection of all elements under consideration in a statistical inquiry; all objects or subjects that make up a defined group.
    - Examples: _____
  - _____ - subset of a population
    - Examples: _____
  - _____ - characteristic or attribute of the elements in a collection that can assume different values; quantity being measured.
    - Examples: _____
  - _____ - realized value of a variable
    - Examples: _____
    - _____ - a measure of how close an observation/result is to the true value.
    - _____ - agreement of repeated measures under specified conditions
      - _____ – precision under the same conditions
      - _____ – precision under different conditions

Precision and Accuracy			
Illustration			

  - _____ - collection of observations
  - _____ - summary measure describing a specific characteristic of a population.
  - _____ - summary measure describing a specific characteristic of the sample.
  - _____ - process of determining the value or label of a variable based on what is observed.

Name:

Level of Measurement	Nominal	Ordinal	Interval	Ratio
Data Form				
Key Features				
Examples				
Analysis				

- _____ - a variable that can take one of a sequence of numbers, typically integers (e.g. number of people in a room - 1, 2, 4, 7, 10 people)
- _____ - has numbers that can take ANY numeric value on the scale, depending on the precision of the measurement system (e.g. 5.86 g, 27°C)
- _____ - used to describe numeric data from interval or ratio measurements; the population from which the data come from will have certain/assumed well-identified parameters (usually normal distribution)
    - Examples:
      _____
      _____

- _____ - used to describe nominal or ordinal data; no parameters were assumed for the population from which the data originated.
  - Examples: _____ _____
-

- Measures of Central Tendency
  - _____ - also known as average is obtained by summing all of the individual data items then dividing by the number of data.
    - _____ - used when outliers are present by deleting the bottom and top of the specified % of the observations in an array.
  - _____ - middle value in a series of values arranged in order of rank; average of the two middle values when there is uneven number of values.
  - _____ - the observed value that occurs with the greatest frequency in a data set.

Summary of formula for measures of central tendency

	Population	**Sample**
Mean		
Median		
Mode		

Name:

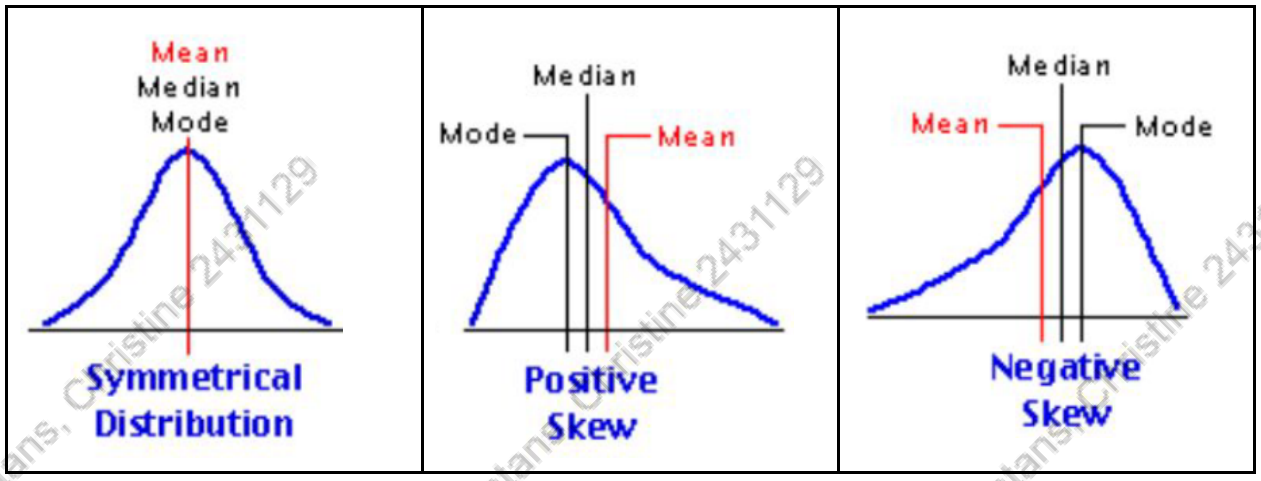
Example:

Calculate for the measures of central tendency of the following data set.

10	11	1	2	5	6	7	9	10	3	6
13	15	16	10	10	8	7	2	1	3	8

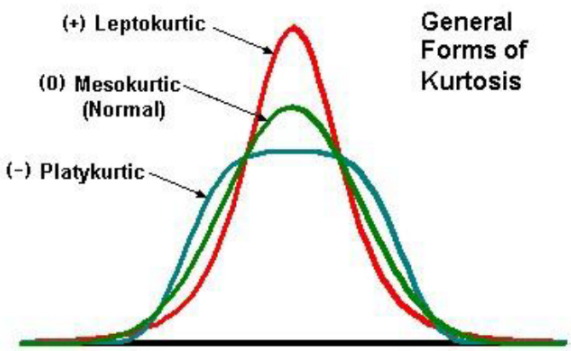
Answer with solutions:

- Skewness and Kurtosis
  - _____ - a graph that shows the frequency of numerical data using rectangles wherein the vertical axis represents the distribution frequency of a variable.
  - _____ - measures whether the histogram looks just the same to the left as the right of the center point (if shape of graph is lopsided); single value that indicates the degree and direction of asymmetry.
    - Sk = 0, _____
    - Sk > 0, _____
    - Sk < 0, _____



  - _____ - describes the concentration of the data around the peak, whether flat or peaked.
    - _____ - hump is the same as the normal curve, neither flat nor too peaked
    - _____ - curve is more peaked and hump is narrower or sharper than the normal curve
    - _____ - curve is less peaked and hump is flatter than normal curve.

Name:



- Measures of Location
  - _____ - divide the ordered observations into 100 equal parts.
  - _____ - divide the ordered observations into 4 equal parts.
  - _____ - divide the ordered observations into 10 equal parts.

- Measures of Dispersion
  - _____ - given by subtracting the smallest value in the series from the highest value.
  - _____ - average squared difference of each observation from the mean
  - _____ - square root of the variance used for easier interpretation since it is the same unit as the data set.
  - _____ - determines the relative position of an observed value in the collection where the observed value came from
  - _____ - also known as relative standard deviation that compares variability of two or more data sets even if they have different means or different unit.

Summary of formula for measures of dispersion

	Population	**Sample**
Range		
Variance		
Standard Deviation		
Z-score		
Coefficient of Variance		

Name:

Example:

Calculate for the measures of dispersion of the following data set.

10	11	1	2	5	6	7	9	10	3	6
13	15	16	10	10	8	7	2	1	3	8

Answer with solutions:

- Sampling and Collection
  - _____ - a process of taking a fraction from a "parent lot", source or population for the following purposes:
    - _____
    - _____
    - _____
  - Factors Affecting Sample Size
    - _____
    - _____
    - _____
    - _____
    - _____
  - _____ - also known as random sampling wherein every possible member or part of the population has an equal chance of being selected.
    - _____ - sampling units are selected completely randomly from the population.
    - _____ - spreads out the random selection process so that no two random samples are too close together and can avoid grouping within the random sample; random starting point is chosen, and a fixed gap is inserted between the sampling units.
    - _____ - involves the division of a population into smaller subgroups known as strata prior to random selection within each strata; units in subgroups are homogenous.
    - _____ - random selection of identified clusters (typically, geographical groups) is performed followed by a further selection within these groups; units in subgroups are not homogenous.
  - _____ - involves the researcher selecting samples based on the subjective judgment of the researcher rather than random selection; results of analysis having less generalization potential to the population.
    - _____ - samples are selected as available or in the case of surveys, those who are willing to participate often at short notice.
    - _____ - non-random selection of predetermined number or proportion of units (quota) from strata similar to the first step in stratified sampling
    - _____ - used when the access to the population of interest is difficult; initial contact is made with a small number of sample units who then pass on the measuring instrument to similar acquaintances, etc.

Name:

- Types of Errors
  - _____ - sources of variation that arise during all investigations.
    - _____ - arises when sample is not a representative of the population from where it comes resulting in lower accuracy of results.
    - _____ -arises when there is high variability between different units resulting in lower precision of results.
    - _____ - made by accident and they can occur at any point such misreading an instrument or incorrect transcription resulting in lower accuracy and precision of results.
    - _____ - also known as bias which occurs when there is some lack of reference point in the measuring system resulting in lower accuracy of results.
    - _____ - variation on repeated readings on same unit or subject due to random variations in environment or sample resulting in lower precision of results; also known as indeterminate error and cannot be eliminated completely.

- **Hypothesis Testing and Statistical Inference**
  - _____ - used in experiments to check statistical significance between differences or relationships of data sets.
  - _____ - assertion or conjecture concerning one or more populations.
    - _____ - the hypothesis being tested expressed using the operations $\geq$, =, or $\leq$.
    - _____ - opposite statement of H_0 and is accepted when H_0 is rejected; expressed using the operation >, $\neq$, or <.
  - _____ - a test of any statistical hypothesis, where the alternative hypothesis is one sided.
    - Examples: _____
  - _____ - a test of any statistical hypothesis where the alternative hypothesis is two sided.
    - Examples: _____
  - _____ - quantity based on sample data used to test between the null and alternative hypothesis.
  - _____ - values of the test statistic for which we reject the null in favor of the alternative hypothesis.

- _____ - values of the test statistic for which we accept the null hypothesis.
- _____ - the last number we observe in passing from the acceptance region into the critical region.
- _____ - rejection of the null hypothesis when it is true; also known as α, producer's risk, and level of significance.
- _____ - acceptance of the null hypothesis when it is false; also known as β and consumer's risk.

	H_0 is True	**H_0 is False**
Accept H_0	Correct Decision	
Reject H_0		Correct Decision

  - The power of the test is determining the probability of rejecting H_0 and is denoted by 1-β
  - ↑ Probability of Type I error; ↓ Probability of Type II error (vice versa)
  - To reduce both types of error:
    - Increase sample size.
    - Decrease variability.
- Procedures for Hypothesis Testing (*Application and examples to be discussed further under Sensory Evaluation)*
  1. _____
  2. _____
  3. _____
  4. _____
  5. _____
  6. _____
  7. _____

Developing and Evaluating Research

- Parts of a Research Paper
  - The research paper should always begin with a title that briefly gives an overview of the whole study followed by the author names and affiliations.
    i. Title should include the dependent and independent variables of the study. _____ - variable that is changed or controlled in a scientific experiment to test the effects on the dependent variable (Acronym: **MIX-** Manipulated, Independent, always in the X-axis of a graph)

Name:

- _____ - variable being tested and measured in a scientific experiment (Acronym: **DRY-** Dependent, Response, always in the Y-axis of a graph)

- _____ - words identified by the author which are central to the article content and theoretical frameworks. This is usually typed by other researchers when looking for related studies.
- _____ - summary of the research article, the research questions, experimental designs and methods, major findings and brief interpretation and conclusion. This section can be used to help the reader quickly grasp the paper's purpose and research contribution.
- _____ - establishes the context of the work being reported by discussing the relevant primary research literature (with citations) and summarizing our current understanding of the problem you are investigating. This also includes the purpose of the study as well possible research questions that need to be answered, hypothesis to be tested, objectives, scope and limitations of the study.
- _____ - a survey of current and relevant knowledge of the theoretical and methodological contributions about a particular topic related to the study.
    i. _____ - introduces and describes the theory/theories underpinning the research problem.
- _____ - outlines the theoretical framework for the research and identifies how the research was carried out including procurement of materials, experimental designs and statistical analysis.
- _____ - objectively presents key results, without interpretation, in an orderly and logical sequence using both text and illustrative materials such as Tables and Figures
- _____ - interprets results in relation to the objective of the study and results from previous studies.
- _____ - answers the research questions through the key results/findings in relation to significance of the study.
- _____ - gives an alphabetical listing (by first author's last name) of the references that was cited in the body of the paper
- _____ - contains information that is non-essential to understanding of the paper, but may present information that further clarifies a point without burdening the body of the presentation
- _____ - recognizes significant assistance given in the study such as funding agencies, reviewers, suppliers and people with valuable contribution that cannot be considered as author of the paper

.

- Evaluation and Interpreting Research Papers (Leedy & Ormrod, 2015)
  - Problem statement
    1. _____
    2. _____
    3. _____
    4. _____
  - Literature review
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____
    6. _____
  - Theoretical and conceptual framework
    1. _____
       _____
       _____
    2. _____
       _____
  - Research variables
    1. _____
    2. _____
  - Hypothesis
    1. _____
    2. _____
    3. _____
  - Sampling
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____
  - Research Design
    1. _____
    2. _____
    3. _____
       _____
  - Data Collection Method
    1. _____
    2. _____
    3. _____

Name:

- Data Analysis
  1. _____
  2. _____
  3. _____
  4. _____
     _____
  5. _____
- Interpretation and Discussion of the Findings
  1. _____
  2. _____
  3. _____
  4. _____
  5. _____
  6. _____
  7. _____
  8. _____

Ethical Requirements in Research

- _____ - norms of conduct that distinguish between acceptable and unacceptable behavior.
- Why do ethics in research?
  - _____
  - _____
  - _____
  - _____
  - _____
- Ethical Principles
  - _____ - act for the benefit of others; maximize benefits.
  - _____ - do not harm and do not put at risk of harm individuals involved in the study; minimize harm.
  - _____ - recognize nature of person by being courteous and obtaining free and informed consent
  - _____ - being fair and giving what is due; no conflict of interest, reduce inequalities and study being non exploitative.
  - _____ - disclose methods, materials, assumptions, analyses, and other information needed to evaluate your research.
  - _____ - refraining from fabricating, falsifying, or misrepresenting data which can lead to deception.

- _____ - avoid bias in experimental design, data analysis, data interpretation, peer review, personnel decisions, grant writing, expert testimony, and other aspects of research where objectivity is expected or required.
- _____ - avoiding discrimination against people on the basis of sex, race, ethnicity, or other factors not related to scientific competence and integrity.
- _____ - know and obey relevant laws and institutional and governmental policies.

- Classification of Risks
  - _____ - research in which there is no foreseeable risk of harm or discomfort; and any foreseeable risk is no more than inconvenience.
    - Example:
      _____
  - _____ - research in which the maximum foreseeable risk is discomfort; involves human participation.
    - Example:
      _____
      _____
  - _____ - research in which the risk for participants is more serious than discomfort; involves human participation and vulnerable groups; harm or danger resulting from the study intervention is very likely for participants.
    - _____ - individuals that may have an increased likelihood of being wronged or of incurring additional harm; any individual who lacks the ability to fully consent to participate in a study.
      - Cognitive/communicative vulnerability: _____
        _____
      - Institutional vulnerability: _____
        _____
      - Deferential vulnerability: _____
        _____
      - Medical vulnerability: _____
        _____
      - Economic vulnerability: _____
        _____
      - Social vulnerability: _____
        _____
      - Legal vulnerability: _____
        _____

Name:

- Study vulnerability: _____

  _____

  - Research with a vulnerable group is only justified if the research is responsive to the health needs or priorities of this group and the research cannot be carried out in a non-vulnerable group.
  - Example:

    _____

- Documentary requirements
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____
  - Informed consent forms (ICF)
    - _____- the process of telling potential research participants about the key elements of a research study and what their participation will involve.
    - Free and informed consent is not:
      - _____
      - _____
      - _____
    - The consent document should be user friendly:
      - _____
      - _____
      - _____
      - _____
      - _____
    - Main parts of an ICF (World Health Organization, 2023)
      - Information Sheet
        - _____

          _____
        - _____

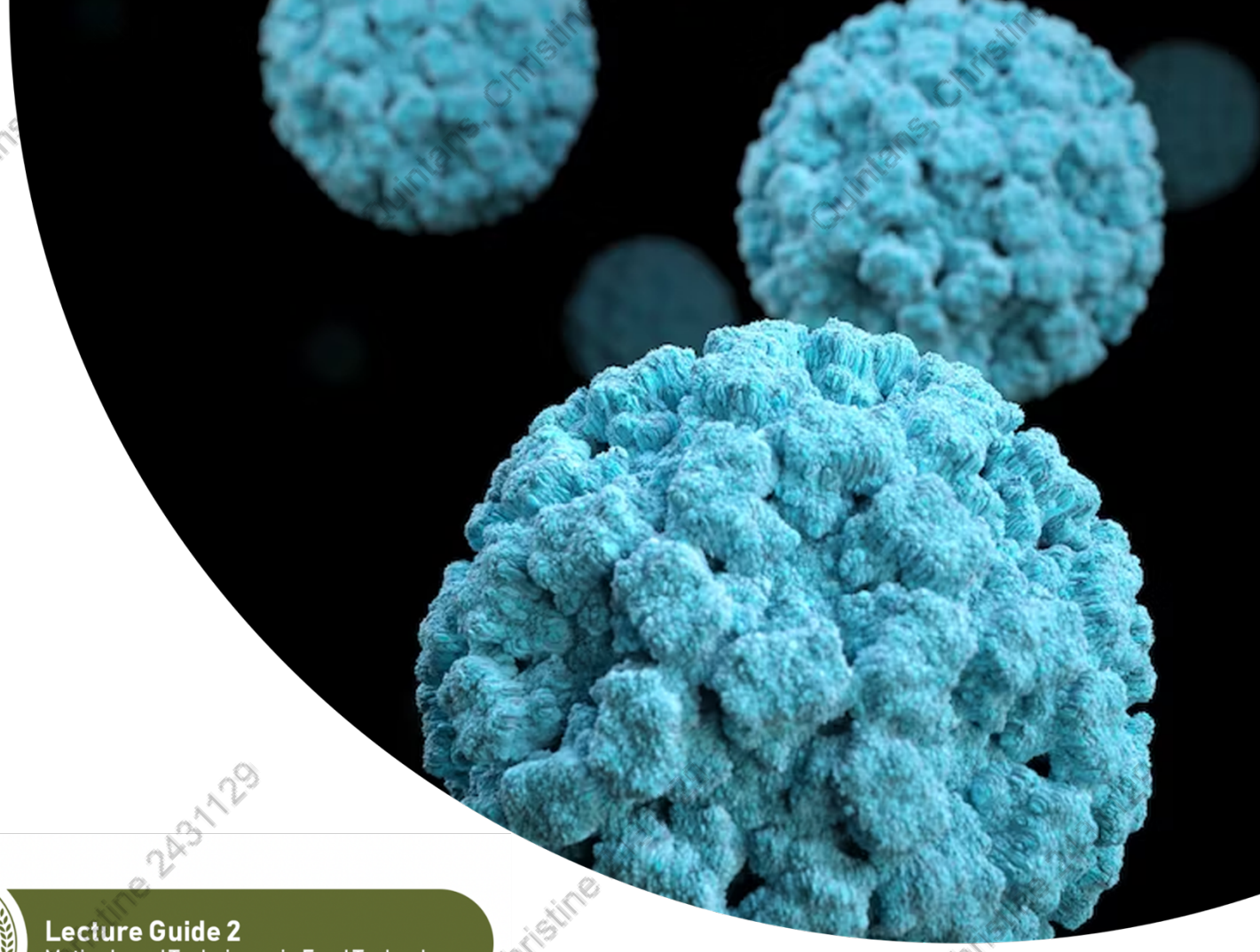
          _____
        - _____

          _____
        - _____

          _____
        - _____

- Procedures and Protocols
  - Unfamiliar procedures
  - Description of the process
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____

- Certificate of Consent – this section should be written in the first person and have a statement (i.e., "I have accurately read out the information sheet to the potential participant….")
  - A separate section is allotted for illiterate participants wherein they can give an oral consent and witness must sign on their behalf.
  - A researcher or the person going over the informed consent must sign each consent.



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Lecture Guide 2
Methods and Techniques in Food Technology

MICROBIOLOGICAL ANALYSIS OF FOODS

- Basic Concepts in Food Microbiology Analysis
  - Laboratory culture Media
  - Sampling Techniques
- Quantitative Tests
  - Plating Techniques
  - The MPN Method
  - Rapid and other novel methods of enumeration
- Qualitative Tests
  - Tests for the Presence or Absence of Specific Food Pathogens
  - Biochemical Tests
  - Rapid and Other Novel Methods of Identification

BASIC CONCEPTS IN FOOD MICROBIOLOGY ANALYSIS

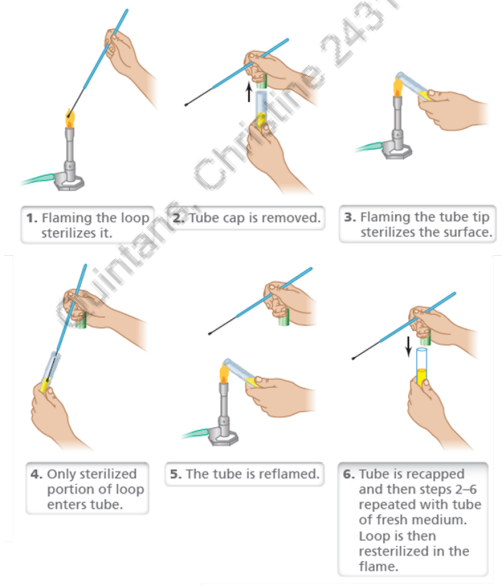
- **Microbial Cultivation in the Laboratory**
  - To cultivate microbes in the lab, it's crucial to provide the necessary macronutrients, trace metals, and growth factors.
  - If the required nutrients are not available, the microbe will not grow or thrive in the laboratory setting.
  - A cell's chemical composition includes a high percentage of water and a small cell dry weight, mainly comprising a few key elements.
    - The elements _____, _____, _____, _____, _____, and _____ make up 96% of the average bacterial cell's dry weight.
    - Additional elements, such as _____, _____, _____, _____, _____, _____, and _____, contribute to the remaining 3.7% of a cell's dry mass.
    - Cells are majorly composed of macromolecules like _____, _____, _____, and _____.
  - Carbon, Nitrogen, and Other Macronutrient requirements
    - Carbon and nitrogen are found in high amounts in cells, essential for _____
    - Heterotrophs derive carbon from _____, while autotrophs derive carbon from _____.
    - Nitrogen sources include proteins, ammonia, nitrate, and nitrogen gas.
    - Phosphorus, sulfur, potassium, magnesium, calcium, and sodium are required in smaller quantities for various cellular functions.
  - Micronutrients: Trace Metals and Growth Factors
    - Trace metals, including iron and other metals, serve as cofactors for various enzymatic reactions in cells.
    - Growth factors, which include vitamins, serve as organic micronutrients and are necessary for growth.
      - Microbes need to assimilate diverse growth factors from their environment for growth and biosynthesis.
- **Laboratory Culture Media**
  - Culture media are specialized nutrient solutions for growing microorganisms, and these require careful selection and preparation.
  - Different microorganisms have varied nutritional needs, which require proper understanding of their physiology and the necessary nutrients in the correct form and amount for successful cultivation.
  - Culture media can either be liquid and solid culture media.
    - Liquid media are used to allow microorganisms to grow while suspended in a broth with easily accessible nutrient supply.

Name:

- Solid media are usually solidified by _____,
  - This facilitates the surface or subsurface growth and visualization of isolated cell masses called _____.
- Classes of Culture Media
  - _____ are media that have a precisely known composition.
    - The carbon source is of paramount importance, and its nature and concentration depend on the organism to be cultured.
    - It can be simple, containing a single carbon source, enabling biosynthesis of cellular materials.
  - _____ media are derived from digests of microbial, animal, or plant products. Their exact nutritional composition is unknown.
    - Commercially available dehydrated forms of complex media are reconstituted with water to form culture media.
  - _____ are media that can inhibit the growth of certain microorganisms but not others. These facilitate the isolation of specific pathogens like *Salmonella*.
  - _____ are media that contain indicators like dyes, which help distinguish bacteria based on metabolic reactions, widely used in clinical diagnostics and taxonomy.

- **Sampling techniques**
  - _____ are a set of routine measures used to prevent contamination of cultures, sterile media, and other regents by unwanted microorganisms in laboratory conditions.
    - These involve creating and maintaining a sterile environment by employing practices that minimize the risk of introducing contamination or infectious agents from samples.
      - Absolute sterility - _____
      - Commercial sterility - _____
    - Objectives of Aseptic Technique
      1. _____
      2. _____
      3. _____
      4. _____
    - Elements of Aseptic Technique
      - Sterile workspace
        - Area must be uncluttered and contain only important items for the analysis.
        - Surfaces must be sanitized either through UV radiation, alcohols or disinfecting aerosols.
        - Work within a sterile culture hood, when available.

- Good personal hygiene
    - Conduct of proper hand washing
    - Wearing of personal protective equipment
    - Remove accessories and jewelries.
    - Trimmed/maintained hair, facial hair, and other body hairs.
- Sterile equipment, reagents, and media
    - Everything to be used in microbial analysis must be sanitized or sterilized according to preparation instructions.
- Most media are autoclaved at _____ conditions.
- Sterile Handling
    - Work close to an open flame is practiced preventing contamination
    - Avoid talking as much as possible.
    - Avoid cross contamination between inoculation tools.
    - Working efficiently to minimize exposure time of cultures.



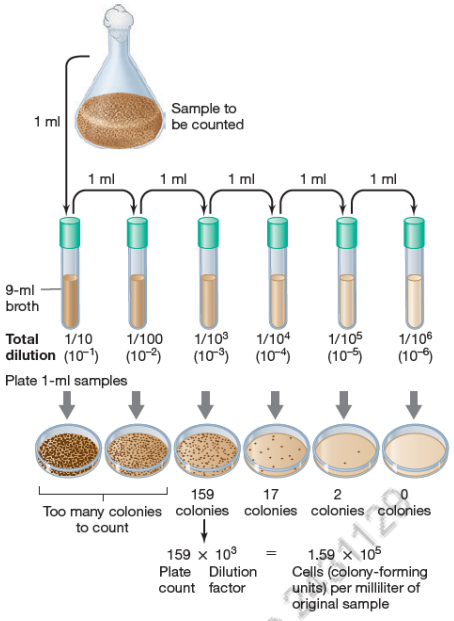
Example of using aseptic techniques in collecting culture samples.

QUANTITATIVE TESTS

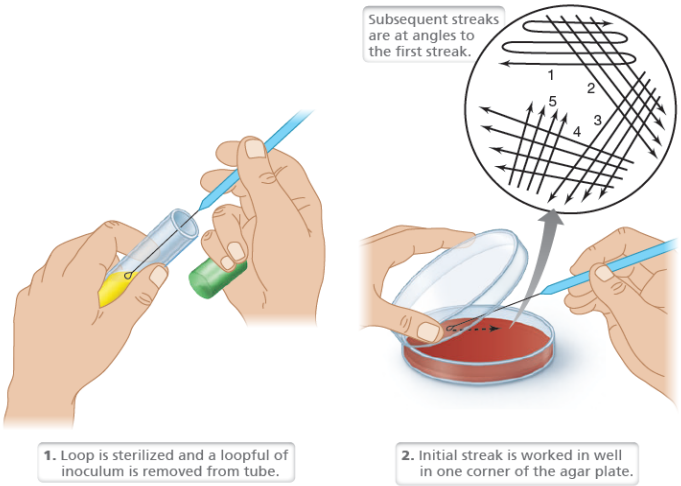
- **Enumeration, Isolation, and Identification**
    - Viable Count Methods -Viable cells are those alive and capable of growth. However, microscopic counts may not distinguish between viable and dead cells.
        - Viable counts are usually determined using culture media.

Name:

- _____ uses multiple 10-fold dilutions to reduce cell numbers from a stock solution and attain countable colonies.

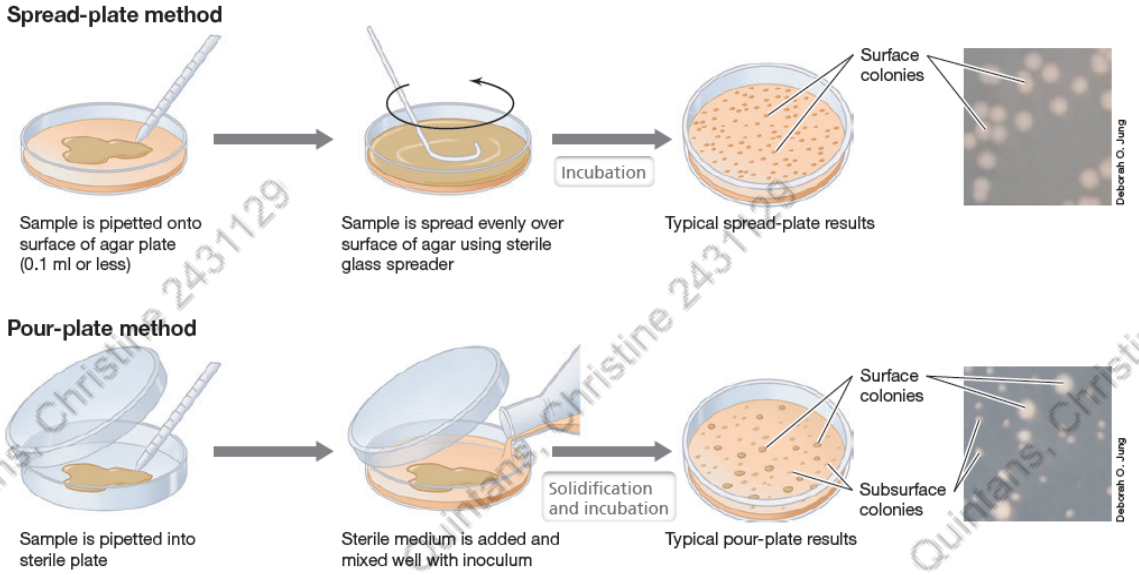


- _____ - Utilizes solid culture media to isolate or quantify colonies formed by viable cells or colony forming units.
  - Streak Plate Technique
    - Use: _____
    - Inoculum size/volume: _____
    - Type of colony growth: _____



- Pour Plate Technique
  - Use: _____
  - Inoculum size/volume: _____
  - Type of colony growth: _____

- Spread Plate Technique
  - Use: _____
  - Inoculum size/volume: _____
  - Type of colony growth: _____



- Processing of counts for pour plating and spread plating are done using the following formula:

$$\frac{\sum colonies}{[(1 \times n_1) + (0.1 \times n_2) + (0.01 \times n_3)]} \times \frac{1}{d} \times \frac{1}{aliquot}$$

Where: $\mathbf{n_x}$: number of plates within the range for the k^{th} dilution with count within range
d: dilution where first count within the range was obtained.
aliquot: amount of inoculum dispensed on plate.

- Countable range for microbial counts:
  - Aerobic plate/bacterial counts: _____
  - Yeasts and molds: _____

- Assumptions and adjustments of plate techniques:
  - Each viable cell should grow and form a single colony.
  - Adjustments like Colony-Forming Units (CFU) account for clusters or biofilm-forming cells.

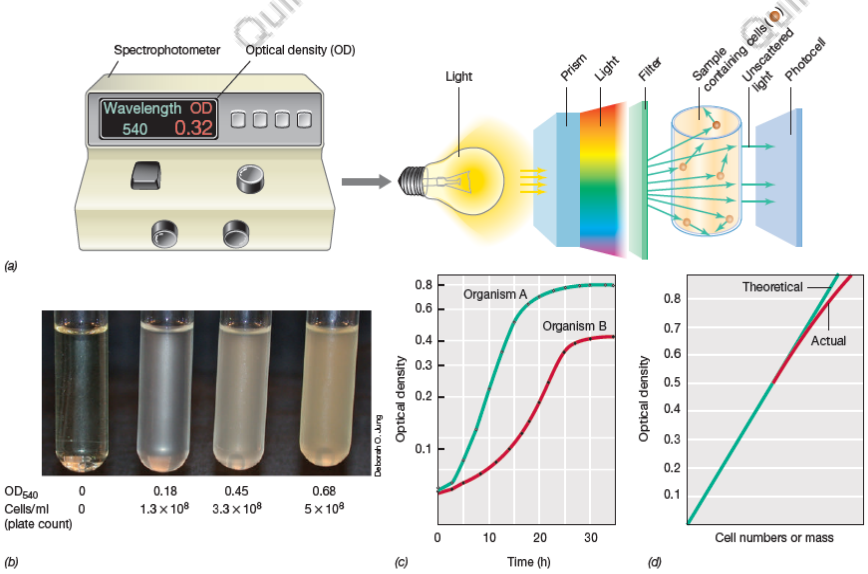
- Applications of Plate Count
  - Widely used in various fields such as food, dairy, medical, and aquatic microbiology.
  - High sensitivity allows detection of even a single viable cell.
  - Selective Culture Media allows targeting of specific species in a mixed sample.
  - Useful for qualitative and quantitative assessments of food quality and safety.
- Caveats and Limitations of Plate Counts
  - Microscopic counts reveal more microbes than plate counts recover on culture media.
  - Different organisms have diverse growth requirements, which limits their growth and recovery on a single medium.
  - Plate counts may miss a significant portion of viable cell populations due to growth limitations.

- **Most Probable Number (MPN) Method**
  - A statistical method using ten-fold dilutions and liquid broth to estimate the number of viable microorganisms in a sample.
    - This is particularly applicable when samples contain particulate matter that may interfere with traditional plate count enumeration methods.
  - Most common microorganism analyzed with the MPN method is *Escherichia coli* in water quality testing for fecal coliforms.
    - The MPN test is performed in three steps:
      - Presumptive test - Screens samples for coliform organisms
        - Required media: _____
        - Positive reaction: _____
      - Confirmatory test - Differentiates fecal coliforms from other organisms that produce acid or gas.
        - Required media: _____
        - Positive reaction: _____
      - Completed test - Differentiates *E. coli* from other coliforms.
        - Required media: _____
        - Positive reaction: _____

- MPN Table - a statistical table used in the MPN test to determine the most probable number of microorganisms present in a sample based on the observed pattern of positive results obtained from multiple dilutions.
- Advantages of MPN:
  - Ease of interpretation, particularly by gas emission observation.
  - Effective for analyzing turbid samples not suitable for membrane filtration.
  - Toxin dilution in samples.
- Disadvantages of MPN:
  - Time-consuming process for results.
  - Results might lack precision.
  - Requires additional glassware and media.
  - Possibility of false-positive results.

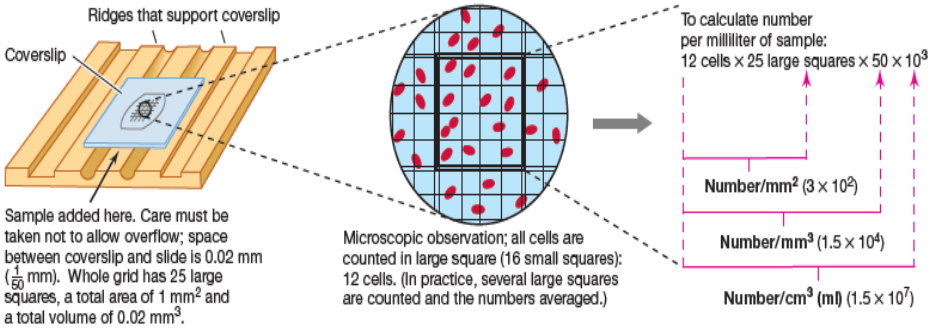
- **Other methods for enumeration of microbial quantity**

  - Direct Measurement through culture-independent methods
    - _____ - A method of measurement of cells in suspension through optical density
      - Measurements of turbidity are made in a _____.
      - The photocell measures incident light scattered by cells in suspension and gives readings in _____.



    - _____ - Specialized microscopy slides containing gridded "chambers" that can be used to observe and quantify cells in a culture.

Name:



- _____ - Method used to measure the desiccated mass of the sample organisms and used when traditional methods, such as plate count are less satisfactory. This is mostly applied for fungi and some filamentous organisms.

QUALITATIVE TESTS

- The Food and Drug Administration's Bacteriological Analytical Manual (BAM) presents the agency's preferred laboratory procedures for microbiological detection and analyses of foods.
- **Tests for presence or absence of food pathogens**
  - Yeast and Mold Counts
    - Media/Reagents: _____
    - Incubation conditions: _____
    - Positive response: _____
  - Total Aerobic Microbes
    - Media/Reagents: _____
    - Incubation conditions: _____
    - Positive response: _____
  - Test for Coliforms
    - Total Coliforms
      - Media/Reagents: _____
      - Incubation conditions: _____
      - Positive response: _____
    - Fecal Coliforms
      - Media/Reagents: _____
      - Incubation conditions: _____
      - Positive response: _____
    - *Escherichia coli*
      - Media/Reagents: _____

- Incubation conditions: _____
- Positive response: _____

- Test for *Salmonella* sp.
  - Media/Reagents: _____
  - Incubation conditions: _____
  - Positive response: _____
- Test for *Staphylococcus aureus*
  - Media/Reagents: _____
  - Incubation conditions: _____
  - Positive response: _____
- Test for *Vibrio* spp.
  - Media/Reagents: _____
  - Incubation conditions: _____
  - Positive response: _____
- Test for *Shigella* spp.
  - Media/Reagents: _____
  - Incubation conditions: _____
  - Positive response: _____
- Test for Campylobacter spp.
  - Media/Reagents: _____
  - Incubation conditions: _____
  - Positive response: _____
- Test for *Listeria monocytogenes*
  - Media/Reagents: _____
  - Incubation conditions: _____
  - Positive response: _____
- Test for *Clostridium* spp.
  - Media/Reagents: _____
  - Incubation conditions: _____
  - Positive response: _____

- **Biochemical Tests**
  - _____: An initial step to classify bacteria as Gram-positive or Gram-negative based on cell wall characteristics.

Name:

- Gram staining procedure

Reagent/Dye	Gram Positive bacteria	Gram Negative bacteria

- Catalase test: Helps differentiate between bacteria that produce catalase (bubbles with hydrogen peroxide) and those that do not.
  - Staphylococci are catalase-_____
  - Streptococci are catalase-_____
- Coagulase Test: Identifies the ability of bacteria, especially *Staphylococcus aureus,* to produce coagulase, a clotting enzyme.
- _____: Detects the ability of bacteria to produce indole from tryptophan. It helps differentiate between members of Enterobacteriaceae (such as *Escherichia coli*, which produces indole) and other bacteria.
- Sugar Fermentation Tests: Determines the ability of bacteria to ferment specific sugars like glucose, lactose, sucrose, etc. This is indicated by acid or gas production in the medium, helping in the identification of organisms like *Salmonella, Shigella*, and Enterobacteriaceae.
- Methyl Red and Voges-Proskauer Tests (MR-VP test)
  - MR test detects _____
  - VP test detects _____
- Oxidase Test: Detects the presence of _____ in bacteria. It's often used to differentiate between Gram-negative rods like Pseudomonas (positive) and Enterobacteriaceae (negative).
- Urease Test: Identifies the ability of microorganisms to hydrolyze urea to produce _____ and _____. For instance, *Proteus* species are urease positive. *Salmonella* spp. is urease-negative

        - Positive result: _____
        - Negative result: _____
    - Lysine Decarboxylase Test: Tests the ability to decarboxylate lysine, an amino acid. It's helpful in identifying Enterobacteriaceae species like *Salmonella* and *Shigella.*
    - Citrate Utilization Test: detects the ability of microorganisms to use citrate as their sole carbon source.
        - Simmons Citrate Agar: Agar mixture with citrate as the sole carbon source, buffers, and _____ ____ as indicator
            - Positive result: _____
            - Negative result: _____
            - Result is based on the utilization of citrate and subsequent production of CO_2, which reacts with the media to produce an alkali compound.
    - IMViC tests: Series of four tests used to differentiate _____
        - _____ Test, __-__ Test, _____ _____ Test
        - Results of IMViC Tests are usually reported as x/x/x/x (x = + or -)
            - Escherichia coli = +/+/-/-
            - Salmonella spp. = -/+/-/+
            - Shigella spp. . = -/+/-/-
            - Proteus vulgaris = +/+/-/-

- **Rapid and other novel methods**
    - _____ - a rapid analytical technique to detect the presence of an antigen or antibody from a specific microbial pathogen or foodborne-causing disease.
    - _____ - involves directing cells into a narrow stream within a sheath fluid, allowing for individual cell analysis. Photomultipliers then capture light scattering and fluorescence, providing details about the cell's dimensions and structure.
    - _____ - method operates by utilizing the light emitted from a reaction involving adenosine triphosphate (ATP). This emitted light is then measured to quantify the amount of ATP present, providing a means to determine levels of biological activity or cleanliness in a sample.
    - _____ - used to detect microorganisms by amplification of the target DNA and detecting the target products, which can be detected by gel electrophoresis, fluorescent probes, special dyes or molecular beacons.

Photo from Vedrana Filipović I
https://unsplash.com/photos/round-clear-glass-on-white-paper-jxqTaXF5WmY

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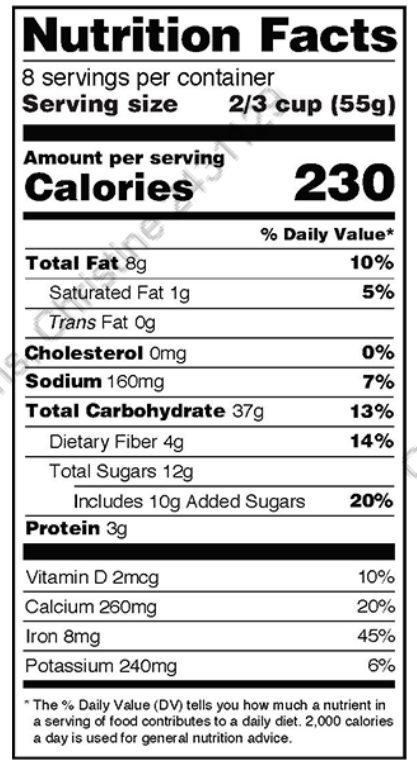
Lecture Guide 3
Integration and Application of Food Technology

FOOD ANALYSIS

- Proximate Analysis
  - Basic Principles
  - Moisture
  - Crude Fat
  - Crude Protein
  - Ash
  - Crude Fiber
  - Total Available Carbohydrates
- Analysis of Extraneous Material
- Basic Instrumental Methods
  - Potentiometry
  - Hygrometry
  - Colorimetry
  - Densimetry
  - Viscometry
  - Refractometry
  - Texturometry
  - Thermal Analysis
- Advanced Instrumental Methods
  - Spectroscopic Techniques
  - Chromatographic Techniques

Proximate Analysis

- **Basic Principles**
- Analysis that _____ the _____ components of food products
    - These components consist of **moisture, crude fat, crude protein, ash, crude fiber,** and **total available carbohydrates.**
- The six components combined are assumed to be **equal to a total of 100%**
- Proximate composition affects various quality characteristics of food and are important for:
    - product development,
    - _____ control (QC)
    - compliance with _____ guidelines.



Nutrition Facts

8 servings per container
Serving size **2/3 cup (55g)**

Amount per serving
Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 240mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

The different proximate components are related but not directly.
equivalent to different terms used in nutritional labeling.
(ex. Crude Fat ≅ Total Fat, Crude Protein ≅ Protein,
Total Minerals ≅ Ash, Dietary Fiber ≅ Crude Fiber,
Total Carbohydrates ≅ Total Carbohydrates)

- **Moisture Content**
- The quantity of _____ in a food product.
- Usually the _____ component measured during proximate analysis.
- Proximate components are reported as a percentage the wet (_____ or as-is) sample (**wet basis**) or as a percentage of the sample less the amount of _____ in the sample (**dry basis**) using the following equations:

Name:

- **Moisture Content (Wet Basis)**

$$MC_{wb} = \frac{\text{mass}_{water}}{\text{mass}_{sample}} \times 100\%$$

- **Moisture Content (Dry Basis)**

$$MC_{wb} = \frac{\text{mass}_{water}}{\text{mass}_{sample\ dry}} \times 100\%$$

- These equations are also used for other proximate components, replacing mass_{water} with the mass of each component (ex. $\text{mass}_{\text{Crude Fat}}$, mass_{Ash})
- The relationship between wet and dry basis moisture can be described by the following equations:

- Methods for obtaining the moisture content may be generally classified as follows.
  - ***Direct methods***
  - Methods which **directly measure** the amount of water in a sample
  - Measurement is usually done in terms of _____ (*volumetric*) or in terms of _____ (*gravimetric*) of water.
  - Direct methods include the following:
    - **Distillation methods**
      - Generally, uses an _____ solvent at _____ temperatures to liberate water from food samples
      - Solvent used is _____ in water and can be observed separately.
      - Examples:
        - _____-Stark Method
          - Also known as _____ distillation method based on the solvent used.
        - _____-Duvel Distillation
          - Uses _____ ____ as the solvent.
  - ***Indirect methods***
  - Measures a parameter that is **indirectly related** to the moisture context

.

Method	Parameter measured	Examples	Notes
Gravimetric Methods (Drying or Evaporation)	Weight loss	Conventional Air Oven Drying	▪ **<u>"Gold standard" method.</u>** ▪ ____-____°C overnight or until _____ weight.
		_____ Oven Drying	▪ ____-____°C at __-__ mmHg overnight or until _____ weight. ▪ Based on lowering of boiling point due to _____ pressure. ▪ Used for _____-sensitive foods (ex. high-sugar)
Thermogravimetric	Weight loss over time	_____ _____ _____ (RMA)	▪ Main advantage is the high _____ of analysis. ▪ _____ and _____ takes place simultaneously
Chemical Methods	Reaction related to water	Karl-_____ titration	▪ Used for ultra-____ moisture foods such as _____ ▪ Based on reduction of _____ by_____ _____ in the presence of water:
Physical Methods	Physical characteristics which may be related to moisture content.	▪ Refractometry ▪ Density ▪ Viscosity ▪ Freezing point ▪ Electrical properties	▪ Measurement of characteristics which may be related to moisture content ▪ Best for _____ food matrices, especially those with two components (_____ systems) ▪ Examples: refractometry (°____) in winemaking, measurement of milk _____

- **Crude Fat**
  - Defined as **"_____" lipids that can be extracted using less polar solvents.**
    - Usually _____ ether and/or _____ ether
  - Composed of a mixture of acylglycerols (TAGs, DAGs, MAGs), ____ _____ _____ (FFA), phospholipids, sterols, carotenoids and vitamins (_, _, _, _)

Name:

Methods (Types)		Parameter measured	Examples	Notes
Extraction Methods	Dry	Weight of Crude Fat extracted (_____) or Weight loss assumed as loss of Crude Fat (_____)	Soxhlet	▪ **<u>"Gold standard" method</u>** ▪ semi-_____ immersion in solvent
			Goldfisch	▪ _____ exposure to solvent ▪ Uneven flow of solvent can lead to incomplete extraction ('_____')
	Wet		Babcock	▪ Digestion of non-fat milk components using _____ ▪ Use of ____ water to release fat for _____ measurement.
			Bligh and Dyer	▪ Extraction of fat with _____ and _____ ▪ Filtration, separation, desolvation, and drying prior _____ measurement.
Physical Methods		Physical characteristics which may be related to crude fat content	▪Refractive Index ▪ Density ▪ Viscosity ▪ Freezing point ▪ Electrical properties	▪ Similar considerations as physical methods for water

- **Crude Protein**
  - Estimates the amount of protein present based on the amount of _____ measured.
    - Based on **"gold standard"** of the **Kjeldahl method**

  - ***Kjeldahl method***
    - **Step 1. Digestion** of organic matter with **____** to liberate **protein-bound nitrogens**

$$\text{Sample} + \underline{\quad} \xrightarrow[\text{catalyst}]{\text{heat}} CO_2 + H_2O + SO_2 + \underline{\quad\quad} + \text{other ions}$$

- Done at high temperatures from _____ to _____ °C

- **Step 2. Distillation** with **_____ to release nitrogen as _____ gas**

$$(NH_4)_2SO_4 + \_\_\_\_\_ \longrightarrow \_\_\_\_\_ + H_2O + 2\ Na^+ + SO^{4-}$$

  - _____ gas passes through a known **excess** volume of standard acid (usually a weak acid like _____acid (_____))

$$\_\_\_\_\_ + \_\_\_\_\_ \leftrightarrow NH_4^+ + H_2BO_3^-$$

- **Step 3. Titration** with a standard strong acid

$$H_2BO_3^- + H_3O \leftrightarrow \_\_\_\_\_ + H_2O$$

- **%Nitrogen** may be calculated stoichiometrically using the equation:

  - where ***x* is the moles of the titrant (ex. Molarity or Normality);**
    v_s is the titration volume for the sample;
    v_b is the titration volume for the blank; and,
    ***m* is the mass of the food sample analyzed**
  - Note that **this equation may vary** depending on the exact method used for Kjeldahl digestion (*i.e.* standard acids used for Steps 2 and 3)

- **%Protein** may then be calculated using the equation:

$$\%N \times F$$

  - Where ***%N* is the %Nitrogen as calculated above; and,**
    ***F* is the nitrogen conversion factor ("_____' factors")**

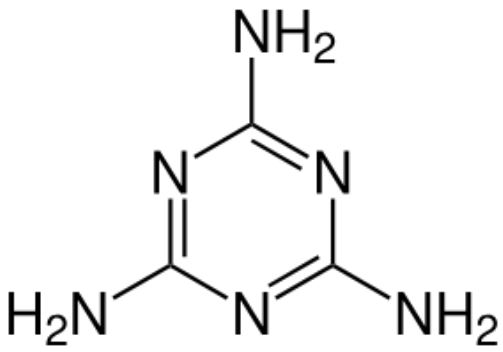
- The **nitrogen conversion factor** varies slightly based on the nature of the food product (most commonly used = _____)

Name:

Food	Factor
Animal origin	
Eggs	6.25
Meat	6.25
Milk	6.38
Vegetable origin	
Barley	5.83
Corn (maize)	6.25
Millets	5.83
Oats	5.83
Rice	5.95
Rye	5.83
Sorghums	6.25
Wheat: Whole kernel	5.83
Bran	6.31
Endosperm	5.70
Beans: Castor	5.30
Jack, lima, navy, mung	6.25
Soybean	5.71
Velvet beans	6.25
Peanuts	5.46

List of nitrogen conversion factors for selected foods. (FAO, 2020)

- **Advantages of the Kjeldahl method**
  - **universal** - "gold standard" of crude protein determination
  - High **precision**
  - Good reproducibility
- **Disadvantages of the Kjeldahl method**
  - Non-protein substances containing _____ are **also detected** (false _____ results)
    - Ammonium compounds
    - Urea
    - ____ _____ _____ (FAAs)
    - Nitrates and nitrites
    - **Melamine**
  - Time-consuming
  - Use of hazardous reagents (hot strong acids and bases)
- Adulteration of _____ _____ with toxic melamine to artificially elevate crude protein content is based on the mechanisms of the Kjeldahl method
  - Example issue of food _____



A nitrogen-containing aromatic core and various amine side chains, which all appear as protein nitrogen after Kjeldahl analysis, has resulted in the use of melamine in food adulteration.

- ***Other protein determination methods***

Methods (Types)	Examples	Notes
Direct Distillation Method		• **Very similar to Kjeldahl method** without the _____ step • **Direct distillation** of ammonia from the side chains of _____ AAs • Like Kjeldahl, **ammonia is then trapped** with a _____ acid (ex. _____ acid) before being **titrated** with a standard acid • **Disadvantage**: Variation in _____ AA content of food products (may require prior calibration)
Thermal Combustion (Dumas) Method		• _____ + O_2 + sample with protein → $N_{2\,(g)}$ • $N_{2(g)}$ detected by thermal _____
Spectro metric methods	UV absorption	• Based on direct absorption of UV with A_{max} at: ○ ____ nm (_____ AAs) ○ ____ nm (_____ bonds)
	Biuret	• $^{2+}$ + peptide bonds + OH^- → Deep _____ peptide-_____ complex • A_{max} at ____ nm
	Lowry	• Biuret + _____-_____ phenol reagent → blue complex with A_{max} between ___-____ nm • 50-100x more _____ than Biuret method

- **Ash**
  - _____ **residue** remaining after all organic matter has been **oxidized**
  - Roughly equivalent to the **amount of** _____ in a food sample
  - '*Ash*' are generally **_____ volatile** and **_____ stable** than other food components
  - Methods for analysis ('*ashing*') can be generally classified into **wet** and **dry** methods
  - **Sample preparation**: Samples with excessively high water or fat contents must first be dried or defatted respectively to prevent violent reactions during ashing

  - ***Dry Ashing***
  - **"Gold standard"** method for ashing wherein organic components are oxidized by very high temperatures (_____ - ____°C) for long periods of time (__-___ hrs)
    - Usually achieved using a _____ _____

Name:

- Ash residue are converted to stable forms like mineral oxides, sulfates, phosphates, chlorides or silicates'
- All-white appearance of resulting ash is desired and indicates _____ oxidation of organic materials
- Some _____ ash components like Cu, Fe, Pb, Hg, Ni, and Zn may be lost during dry ashing

- ***Wet Ashing***
- Use of concentrated acids (usually _____ acid) and/or strong _____ agents at _____ temperatures to oxidize organic components
- Ash residue is _____ in extraction solution
  - May be dried and weighed to get Ash content
  - May use other instrumental methods (ex. AAS) to get amount of specific ash components

- ***Other methods***
- Similar to other proximate components, ash content can also be related to _____ characteristics
  - Works best for simple food matrices
    - Ex. Measurement of ash in brine solutions by _____

- **Crude Fiber**
  - Defined as the **remaining residue after solvent extraction** followed by stepwise **digestion in dilute _____** and **_____**
    - Differentiated from **dietary fiber**, which are defined as _____ _____ which cannot be digested by the body

  - ***Weende Method***
  - **'Gold standard'** for Crude Fiber analysis
  - Uses food samples which have been previously _____ and _____
    - Sample is digested at elevated temperatures in _____ acid (H_2SO_4)
    - Sample is filtered and rinsed with hot water
    - Remaining sample is digested at elevated temperatures in _____ alkali conditions (NaOH)
    - Sample is filtered and rinsed with hot water
    - Sample is collected and **dried** prior to **constant weighing**
    - Ashing is **also performed** as part of the *Weende Method*
      - Determined ash content is **then subtracted from obtained Crude Fiber residue**

- **Deviations from "Dietary Fiber":**
  - _____-_____ _____ _____ (WSUC) are **lost** with each step
  - Some _____-_____ _____ _____ (WIUC), such as **hemicellulose** and **lignin**, are soluble in alkali solutions and are therefore lost during NaOH digestion

- **Total Carbohydrates**
  - **Organic compounds** containing **certain proportions of the elements _, _, & _**
  - Methods **vary significantly** depending on the specific group of carbohydrates being analyzed

  - ***Total available carbohydrates (by difference)***
    - **"Gold standard" method** for TAC determination
      - Used for labeling _____
    - %TAC = 100 – ($\%_{moisture}$ + $\%_{protein}$ + $\%_{lipid}$ +$\%_{ash}$)
    - Disadvantages: propagation of _____ from all proximate analysis steps,
    -
  - ***Physical methods***

Methods (Types)	Examples	Notes
Physical Methods	Hydrometry	• Based on direct absorption of UV with A_{max} at: ○ ____ nm (_____ AAs) ○ ____ nm (_____ bonds)
	Refractometry	• $___^{2+}$ + peptide bonds + OH^- → Deep _____ peptide-_____ complex • A_{max} at ____ nm
	Polarimetry-	• Biuret + _____-_____ phenol reagent → blue complex with A_{max} between ___-____ nm • 50-100x more _____ than Biuret method
Colorimetric Methods	Anthrone	• *sugar + ___ + heat* → hydroxymethylfurfural • *HMF + anthrone* → ____-_____ complex ○ A_{max} at ____-___ nm • Calibration curve required due to differing hues of HMF-anthrone complexes
	Phenol-sulfuric acid	• *sugar + H_2SO_4 + heat* → hydroxymethylfurfural • *HMF* + _____→ _____-_____ complex ○ A_{max} at ____ nm • Calibration curve required

Name:

Titrimetric Methods	Lane and Eynon	• Uses boiling _____'s solution ○ Contains _____ blue and $CuSO_4$ • Titration with standard sugar solution • Endpoint: blue → _____

Analysis of Extraneous Material

- **Extraneous Material**
  - Any _____ in product associated with _____ in production storage or distribution
    - Objectionable matter contributed by insects, rodents, and birds
    - Decomposed material
    - Miscellaneous matter: _____
  - Importance
    - _____
    - _____
    - _____
    - _____
    - _____

- **Defect Action Levels**
  - Levels of natural or unavoidable defects in foods that present no health hazards for humans.
  - Considered unavoidable under GMP.
  - Accessible through the US FDA
  - Example

PEANUT BUTTER	Insect filth (AOAC 968.35)	Average of 30 or more insect fragments per 100 grams
	Rodent filth (AOAC 968.35)	Average of 1 or more rodent hairs per 100 grams
	Grit (AOAC 968.35)	Gritty taste and water insoluble inorganic residue is more than 25 mg per 100 grams

CHOCOLATE	Insect filth (AOAC 965.38)	Average is 60 or more insect fragments per 100 g when 6 100-g subsamples are examined OR Any 1 subsample contains 90 or more insect fragments
	Rodent filth (AOAC 965.38)	Average is 1 or more rodent hairs per 100 g in 6 100-g subsamples examined OR Any 1 subsample contains 3 or more rodent hairs

- **Purpose of Analysis**
  - Ensure protection of the consuming public from harmful or filthy food products
  - Meet regulatory requirements of the FDA
  - Comply with defect action levels

- **Filth**
  - Contributed by animal contamination or by unsanitary conditions
    - Heavy filth - _____
    - Light filth - _____
    - Sieved filth - _____

- **Characteristics of Extraneous Material**
  - Molds
    - Parallel hyphal walls
    - Septation
    - Granular appearance of cell contents
    - Branching hyphae
    - Blunt end of hyphal filaments
    - Non-refracted appearance of hyphae
  - Insect fragments
    - Recognizable shape, form, or surface sculpture, articulation or joint, setae or setal pits, sutures
  - FIlth
    - Rodent hairs
    - Feathers
    - Insect-damaged grains and packaging materials

Name:

- Animal urine and excrement

- **Methods**
  - Sources
    - AACC International Approved Methods
    - Official Methods of Analysis of AOAC International
    - Macroanalytical Procedures Manual of the US FDA
  - Sieving method
    - Based on separation of particle size of product and contaminant using test sieve
      - Ex.
        - 20 mesh sieve: _____
        - 10-12 mesh sieve: _____
    - Contaminants identified using microscope
  - Sedimentation method
    - Based on differences in densities of product, contaminant, and immersion fluid
    - Specific gravity of immersion solution (e.g. CCl_4, Chloroform) allows heavier shells, sand, glass, metal, or excreta contaminants to settle, less dense floats
    - High fat sample requires defatting step
  - Floatation method
    - Based on the principle of affinity for oleophilic solvents
    - Isolate microscopic filth by floating the filth upward, typically in an oil/water-phased system
    - Insect fragments, mites, and hairs float with oil

- **Information Collected**
  - Whole or equivalent insects
  - Insect fragments (identified or unidentified)
  - Aphids, scale insects, mites, spiders, etc. and their fragments
  - Rodent hairs (state the length of the hairs)

- **Factors Affecting Objectivity of Methods**
  - Insect parts, rodent hairs and feather barbules
    - Reported as the total number of filth elements counted of each kind encountered per sample unit
  - Requires training and supervised practice to achieve competence and consistency
  - Loss of fragments during isolation
  - Insect fragment count in relation to fragment size

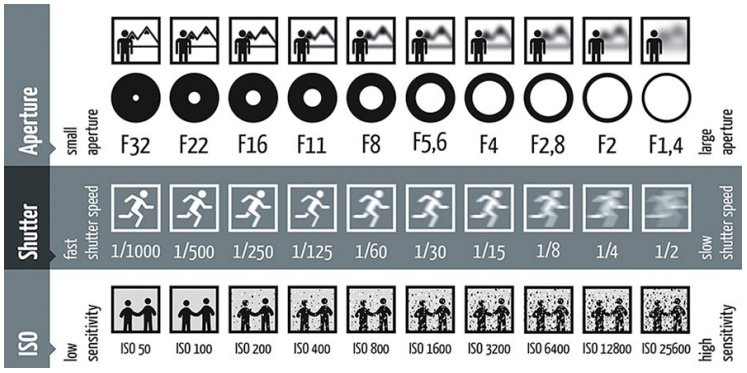
- **Other Techniques**
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____

INSTRUMENTAL METHODS

- **Ink imprinting and xerography -** Methods used to record the _____
  - Ink imprinting uses _____
  - Xerography uses _____. This is normally conducted in 5 steps:
    - Charging - _____
    - Exposure - _____
    - Development - _____
    - Transfer - _____
    - Fusing - _____
- **Photography** - _____
  - 2 kinds of Camera
    - Film - _____
    - Digital - _____

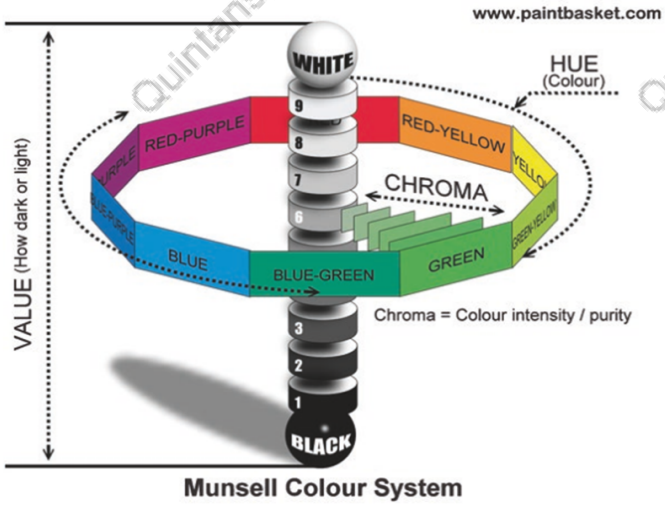
Name:

- Camera settings that affect image quality



  - Aperture - _____
  - Shutter Speed - _____
  - ISO - _____
- Other factors for consideration when taking specimen images:
  - Orientation, Ratio/size, Background, Luminance, Framing, Overlays

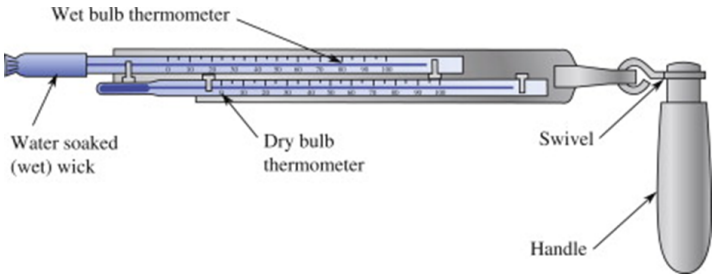
- **Colorimetry** - _____
  - Dimensions of color: _____, _____, _____, and _____,
  - Three types of colorimetry:
    - Stimulimeters - _____
      - Examples: Lovibond tintometer, Munsell color system, CIE color system



Munsell Colour System

    - Color comparators - _____
      - Examples: Duboscq calorimeter
    - Color absorptometer - _____
      - Filter Photometer - _____
      - Spectrophotometer - _____

- **Hygrometry** - _____
  - Relative humidity - _____
    - Sling psychrometers - _____



  - Water Activity - _____
    - Hygrometer - _____
- **Densimetry** - _____
  - Measured using either pycnometric or buoyancy methods
    - _____ - used to measure the weight of a specific volume of liquid at a specific temperature to determine its density
    - _____ - used to measure the specific gravity of a liquid by determining its difference from the density of a reference liquid, usually water.
    - For solid samples, some methods include actual measurements of dimensions, or using displacement measurements to determine the volume.
- **Viscometry** - _____
  - Viscosity - _____

    Viscosity coefficient = $\frac{shear\ stress}{rate\ of\ flow}$
  - Examples of ways to measure viscosity:
    - Botswick consistometer - _____
    - Brookfield viscometer - _____
    - Hoeppler viscometer - _____
    - Line Spread test - _____
    - Zahn viscosity cup - _____
- **Texturometry** - _____
  - Examples of texturometers:
    - Penetrometer - _____
    - Warner-Bratzler Shear Press - _____
    - All-purpose Shear Press - _____
    - Bloom gelometer - _____
    - Compressimeter - _____

Name:

    - Farinograph - _____
    - Shortograph - _____
    - Texturometer - _____
    - Masticometer - _____
- **Thermal Analysis** - _____
    - Different techniques for thermal analysis
        - Differential thermal analysis (DTA) - _____
        - Differential Scanning Calorimetry - _____
        - Thermogravimetry - _____
- **Refractometry** - _____
    - Refractive index - _____

      Refractive index = $\frac{sin\ angle\ of\ incidence}{sin\ angle\ of\ refraction}$
    - Refractometer - _____
- **Thermometry** - _____
    - Temperature - _____
    - Examples of thermometers
        - Liquid-in-glass thermometer - _____
        - Thermocouple - _____
        - Infrared thermometer - _____

ADVANCED METHODS FOR FOOD ANALYSIS

- _____- used to analyze materials by measuring their interactions with electromagnetic radiation through absorption, emission, and scattering to gain insights into their molecular structure, chemical composition and other physical properties.
    - Types of spectroscopic methods
        - Based on species analyzed:
            - _____
            - _____
        - Based on the type of radiation-matter interaction:
            - _____
            - _____

- Based on the region of electromagnetic spectrum used:

Wavelength Region	*Wavelength Limits*	*Type of Spectroscopy*	*Usual Wavelength Range*	*Types of Transitions in Chemical Systems with Similar Energies*
Gamma rays	0.01–1 Å	Emission	<0.1 Å	Nuclear proton/neutron arrangements
X-rays	0.1–10 nm	Absorption, emission, fluorescence, and diffraction	0.1–100 Å	Inner-shell electrons
Ultraviolet	10–380 nm	Absorption, emission, and fluorescence	180–380 nm	Outer-shell electrons in atoms, bonding electrons in molecules
Visible	380–750 nm	Absorption, emission, and fluorescence	380–750 nm	Same as ultraviolet
Infrared	0.075–1000 μm	Absorption	0.78–300 μm	Vibrational position of atoms in molecular bonds
Microwave	0.1–100 cm	Absorption	0.75–3.75 mm	Rotational position in molecules
		Electron spin resonance	3 cm	Orientation of unpaired electrons in an applied magnetic field
Radiowave	1–1000 m	Nuclear magnetic resonance	0.6–10 m	Orientation of nuclei in an applied magnetic field

- Properties of electromagnetic waves
  - _____ - particles of energy that move through space with wave-like and particle-like properties
  - _____ (v) - numbers of cycles per second (Hertzs)
  - _____ (T) - time required to complete a cycle: T = 1/v
  - _____ (λ) - distance between successive wave maximum (nm)
  - _____ - numbers of cycles per unit distance (1/λ)
  - _____ (A) - maximum magnitude of waves
  - Energy of the photons is computed with the formula:

$E = hv = h/T = hc/\lambda$;

where, h = Planck's constant (6.6262×10^{-34} J s)

  - _____ - radiation that ranges in wavelength from 10^{-12}m (high energy) to 10^{4}m (low energy)
- _____ - Transfer of energy from an electromagnetic wave to an atom or molecule and causes it to move to an excited state
  - _____ - Plot of the transmittance or absorbance vs wavelength
- _____ - release of energy from atom or molecule as it relaxes back to ground state

Name:

- Beer - Lambert Law shows the relationship between the attenuation of light through a substance and the properties of the substance.
  - It states that there is a linear relationship between the concentration and the absorbance of the solution, which enables the concentration of a solution to be calculated by measuring its absorbance.
  - This is represented by the formula:

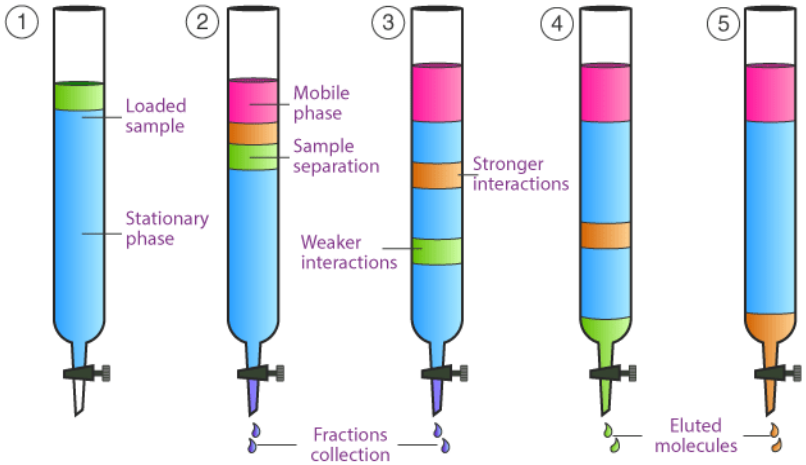
$A = \varepsilon cl$;

Where: A = Absorbance,
ε = molar absorption coefficient ($M^{-1}cm^{-1}$),
c = molar concentration, and
l = optical path length

- Different kinds of spectroscopy techniques:
  - _____ - uses analytical signal based on the absorption of radiation in the range of ultraviolet and visible spectrum
    - Ultraviolet range: _____
    - Visible range: _____
  - _____ - focuses on the infrared region which is useful for identification of functional groups of molecules
    - Infrared range: _____
  - _____ - Analyzes the mass-to-charge ratio of ions to identify and quantify chemical compounds.
  - _____ - Utilizes the interaction of radiofrequency radiation with nuclei in a magnetic field to determine molecular structures
  - _____ - works based on the absorption of light by free atoms in the gaseous state to determine the concentration of specific elements in a sample.

- **Chromatography** - operates on the fundamental principle of separating molecules within a mixture by applying them onto a solid surface or within a stable fluid phase, with the aid of a mobile phase.
  - _____ - composed of a solid phase or a layer of liquid that is adsorbed on the surface of a solid support.
  - _____ - composed of a liquid or gaseous component that flows over the stationary phase.
  - Types of chromatography
    - _____ - Used for purifying biomolecules, which involves a stationary phase column where the sample is applied, followed by a mobile phase wash buffer. The flow through the column material

separates molecules, accumulating at the bottom based on time and volume.



- _____ - relies on electrostatic interactions between charged protein groups and a solid support material. The matrix, with an ion load opposite to the protein, forms ionic ties with the proteins.
- _____ - Utilizes a layer of cellulose-saturated filter paper as the stationary liquid phase. A developing tank holds an appropriate fluid as the mobile phase for separation.
- _____ - Employs a solid adsorbent substance coated on glass plates as the stationary phase, separating compounds as the solvent travels up the plate via capillary action and used to separate analytes based on their polarity.
- _____ - utilizes a column with a liquid stationary phase adsorbed onto an inert solid, separating components in a gaseous mobile phase under high pressure. This is highly sensitive and efficient for separating minute molecules.
- _____ - Operates with a high-pressure pump and small particles for enhanced separation and faster analysis which enables the structural and functional analysis, as well as the purification of various biologically active molecules such as amino acids, carbohydrates, lipids, and more.

Photo by Kevin Doran I
https://unsplash.com/photos/sliced-cucumber-and-green-vegetable-on-brown-wooden-chopping-board-PBt7ok7ygt0

BASIC FOOD PREPARATION

- Mise En Place
  - Recipe development
  - Measurements
  - Cooking Utensils/containers/Vessels
- Minimal Processing Techniques/Initial Preparation
  - Cleaning and Dressing
  - Size Modification
- Cooking Methods
  - Wet heat
  - Dry heat
  - Non-heat and other methods
- Plating and Presentation
  - Concepts and Criteria

Mise en place

- **"Mise en place" = "To Set up"**
  - To prepare everything prior to cooking
  - The Four principles of Mise En Place
    - Assemble Tools (Recipe, equipment, utensils)
    - Assemble ingredients
    - Wash, trim, cut, prepare and measure raw materials
    - Prepare equipment (pre-heat oven or pan, line sheet pan with parchment, etc.)
- **Recipe Development**
  - Elements of a Recipe
    - _____- Descriptive or creative depiction of the dish
    - _____- Quantity or number of servings a dish has based on a set amount of ingredients
      - Expressed as either _____, _____, _____
      - Should be realistic and easy to measure
      - Ingredients should be adjusted such that the yield is easily measurable or a whole number
      - When changing yield, use a **Factor**

$$\textbf{Factor} = \frac{\textbf{Desired yield}}{\textbf{Original yield}}$$

    - _____- Amount of food equivalent to a single serving of the recipe
      - Crucial for costing and nutrient analysis
    - _____- Metrics for the cooking process associated with the recipe
      - Includes preparation time, cooking time and temperatures used during cooking
      - Helps the users of the recipe gauge the duration needed for entire preparation and cooking process
    - _____- List of necessary ingredients and components of the dish
      - Should be listed in chronological order of introduction to the dish
      - If several ingredients are used in a single step, list in a _____ order

Name:

- If an ingredient is used twice in a recipe, list the ingredient as divided
- Each ingredient should have their own line and should be described properly
    - Wording matters in terms of function
        - 1 cup peanuts, chopped vs 1 cup chopped peanuts is different from each other
    - Segregate numbers properly using parentheses
        - 2 240 mL can of creamer X
        - 2 (240 mL) can of creamer ✓✓
    - Indicate state of ingredient if the ingredient can exist as whether _____, _____, or _____
- Alternatively, you can list the equipment and tools needed after the ingredient list.
- For quality indices on ingredient selection, refer to **Post-harvest quality and practices** (Lecture Guide 3)

- _____- list of instructions/procedures indicating the steps for cooking
    - Should be _____, _____, and _____
    - _____names can be condensed to the base component but _____ or _____should be described if mentioning for the first time
    - Include the _____, _____, _____, and if possible _____.
    - _____- Set of final instructions after cooking for serving the final product.

- **Measurements**
  - Methods of measuring

Item measured	System of Measurement	Unit of Measurement (metric)	Unit of Measurement (Household measure)	Instruments used for measuring
Solid Ingredients				
Liquids				
Powders				
Temperature				

  - Equivalent Measures for Volume

Household Measurement	Other Household measurement equivalence	Metric Equivalent (estimation)
	-	5 mL
	_____ tsp	15 mL
	_____ tbsp	30 mL
	_____ tbsp _____ fl. oz	250 mL

Name:

	_____ fl. oz _____ C	500 mL
	_____ pt _____ C _____ fl. oz	1000 mL/1 L
	_____ qt _____ pt _____ C _____ fl. Oz	4000 mL / 4L

- Equivalent Measures for Solids

Household Measurement	Customary equivalent	Metric Equivalent (estimation)
		28 g
	_____ oz	454 g
	_____ oz	1000 g

- Temperature control and terms

Description	Fahrenheit (◦F)	Celsius (◦C)
Cool		

Very Slow		
Slow		
Moderately Slow		
Moderate		
Moderately hot		
Hot		
Very Hot		

- **Cooking Equipment/Utensils**
  - _____- Large Equipment used for the Main preparation steps, storage and after
    - _____- Main equipment used for cooking
    - _____- Main equipment for storage after and before cooking
  - _____-Smaller Equipment used as tools/utensils for ingredient preparation
    - _____ - Flat smooth plate used as supplement to an oven top (Used for frying)
    - _____ - Open heat source used for radiating heat either from below (Grilling) or above (Broiling)
    - _____ - Steaming vessel used for cooking food with moist heat
    - _____- Deep vessels with hot oil used for full immersion frying
    - _____- Slow cooking ceramic vessels used for long duration cooking at low temperatures
    - _____- Mechanized cutting equipment for size reduction
    - _____- Mechanized equipment for mixing
      - _____- Mixing equipment with cutting fixtures used for further homogenization
    - _____-Primary Cooking Vessels used for dish preparation
      - _____- Cooking vessels with two handles used for cooking larger quantities
      - _____- Cooking vessels with only one or no handle used for small quantity cooking
    - _____- Small hand-held equipment used for preparation and cooking

Name:

- _____- Bladed utensil used for size reduction and shaping
- _____- Flat-headed utensils used for scraping and turning food and sometimes transferring proteins
- _____- Utensils with two movable arms used for picking up and turning
- _____- pronged utensils used for holding down meat while being cut or turn meat during cooking
- _____- Balloon shaped wire utensil used for incorporating air and mixing
- _____- Curved head utensil used for stirring
- _____- Hand held mesh used for straining or skimming

Minimal Processing Techniques/Initial Preparation

- **Cleaning**
  - Washing and cleaning
    - Wash vegetables thoroughly, make sure free from dirt, insects and filth
    - Meat and poultry should be pat dried to be free from moisture and trimmed of fat prior to cooking
      - Avoid washing meat with water to avoid splashing and contamination of surface bacteria within the work area
    - Shellfish and fish should be kept dry with a paper towel as well to avoid damp meat and accelerated spoilage
- **Size Modification**
  - **Cutting Techniques**
    - _____- Cutting food in a sliding motion, without lifting the tip of the knife from the board
    - _____- To further refine sliced food into thinner strips by cutting lengthwise
    - _____- The act of rolling sheets of ingredients then cutting into thin strips. This can also be done through manually tearing the sheet shaped ingredient
    - _____- To cut the food into even-sized cubes
    - _____- To consecutively chop the cut ingredient until it is reduced to fine pieces
    - _____- To remove the outer layer or skin using a knife or a peeler
  - **Dressing of appropriate cuts and edible portions**
    - Fruits and Vegetables
      - Removal of roots, peels and inedible parts (old woody stalks, bruised leaves, etc.)

- _____- The process of cutting the sides of vegetables to prepare for uniform cuts. Normally involves creating a uniform dimension block and discarding off cuts.

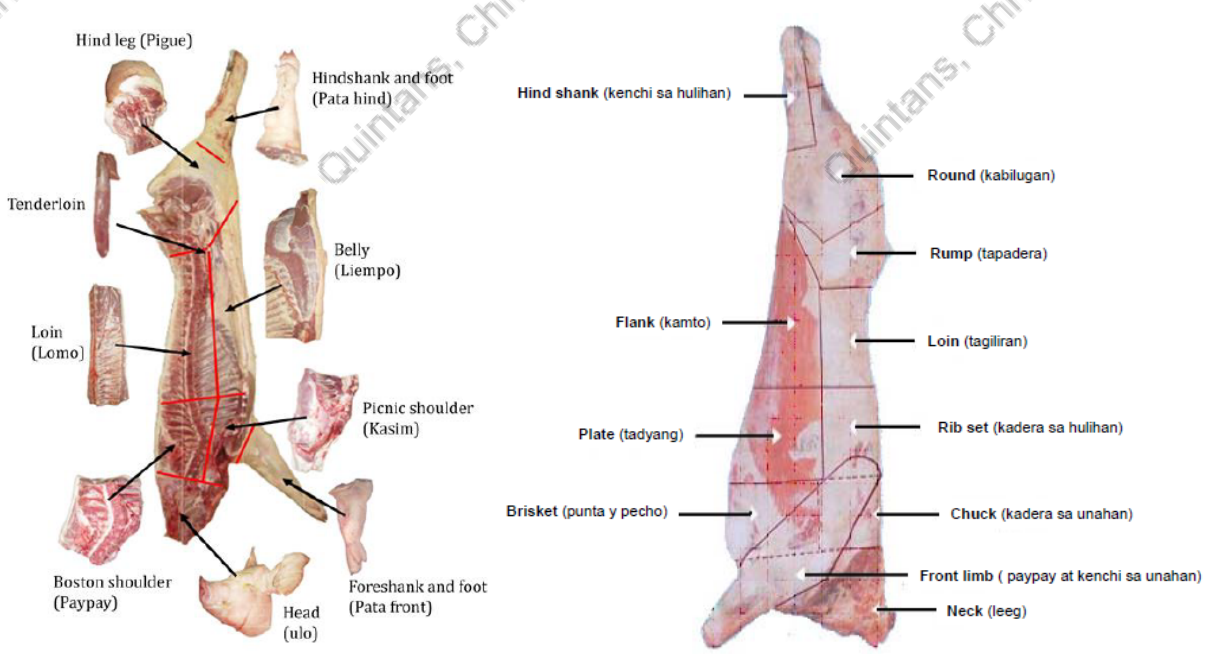
■ Meat and Poultry

- Beef is commonly divided into two main cuts based on toughness

Tender Cuts (Dry heat cooking)	Tough Cuts (Moist Heat cooking)
Rib Short Loin Sirloin Chuck Round	Flank Short Plate Brisket Foreshank

  - Primary cuts are further broken down into smaller more manageable cuts for specific applications
  - Depending on the application, Wholesale cuts (primary cuts) can be broken down into 3-4 specific retail cuts

- Pork wholesale cuts are mostly tender all throughout and are cut depending on the distribution of fat.



Breakdown of Primal Cuts of Pork (left) and Beef (right) (Philippine National Standard)

Name:

- Poultry Household cutting scheme

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Cooking Methods

- **Reasons for cooking**
  - Makes food **more appealing, palatable,** and **easier to eat** (_____ quality)
  - Can make foods **more digestible** (_____ quality)
  - Can **extend the shelf-life** of some foods (_____ quality)
  - Renders foods **safe** to eat (safety)

Doneness	Serving Temperature	Color In Center, Texture, Moisture
Beef, Lamb, Venison Steaks, Chops, Roasts		**USDA Minimum 145°F (63°C)**
Bleu, Blue, Pittsburgh	110-120°F (43-49°C)	Dark purple-red, cool, stringy, slippery, slightly juicy
Rare	120-130°F (49-54°C)	Bright purple-red, warm, tender, juicy
CHEF TEMP Medium Rare	130-135°F (54-57°C)	Bright red, warm, tender, very juicy
Medium	135-145°F (57-63°C)	Rich pink, yielding, slightly juicy
Medium Well	145-155°F (63-68°C)	Tan with slight pink, firm, slightly fibrous, some juice
Well Done	155°F (68°C) plus	Tan to brown, no pink, chewy, little juice
Pork & Veal Steaks, Chops, Roasts, Fresh Hams		**USDA Minimum 145°F (63°C)**
Rare	120-130°F (49-54°C)	Pale pink center, warm, tender, very juicy
Medium Rare	130-135°F (54-57°C)	Creamy pink colored, tender, juicy
CHEF TEMP Medium	135-145°F (57-63°C)	Cream colored, some pink, yielding, juicy
Medium Well	145-155°F (63-68°C)	Cream colored, firm, some clear juices
Well Done	155°F (68°C) plus	Cream colored, tough, dry
Fish		**USDA Minimum 145°F (63°C)**
CHEF TEMP Medium	130-145°F (57-63°C)	Slightly translucent, flaky, tender
Chicken & Turkey, Whole Or Ground Including Stuffing		**USDA Minimum 165°F (74°C)**
CHEF TEMP	165°F (74°C)	Cream colored, slightly tender, moist, clear juices
Ground Meats, Burgers, Meat Loaf, Sausages, Except Chicken & Turkey		**USDA Minimum 160°F (71°C)**
To be safe, cook these risky meats to USDA minimum and make them juicy by using 80% lean meat		
Pre-Cooked Hams, Hot Dogs, Sausages		**USDA Minimum 140°F (60°C)**
CHEF TEMP	140°F (60°C) or more	Clear juices, tender, juicy
Pork Ribs, Pork Shoulders, Beef Briskets		**USDA Minimum 145°F (63°C)**
CHEF TEMP	190-205°F (88-96°C)	High in fat & collagen, these are best cooked low & slow
Casseroles & Leftovers		**USDA Minimum 165°F (74°C)**

Recommended cooking and serving temperatures for safety ('USDA Minimum') and quality ('CHEF TEMP') of various foods.

- **Wet heat**
- **Wet heat** or **_____ heat** cooking methods utilize _____ or other _____-based liquid like broths, stocks, sauces, and wines as a _____ for heat transfer
  - Temperatures are limited to a maximum of ____ °C (at sea level), except in the case of _____ cooking
  - These methods therefore rely on the flow of water or steam by _____ as the main method of heat transfer
- **Advantages**
  - Liquid medium can be a source of _____
  - No to little ____ added during cooking (less _____)

Name:

- **Disadvantages**
  - Possible loss of _____-soluble compounds such as:
    - Nutrients (vitamins and minerals)
    - Flavors
    - Color
  - Some desirable chemical reactions may be inhibited due to the ___ temperature or the presence of _____, such reactions include:
    - _____ browning of proteins
    - _____ of sugars
- **Wet heat methods include:**
- ***Poaching***
  - a "**___ and slow**" approach that uses low temperatures of ___ to ___ °C for gentle, gradual cooking
  - Generally maintains the basic _____ and _____ of food products
  - allows _____ to gently denature without too much loss of _____
  - used for _____ foods like ____, fish, poultry, and _____.
- ***Simmering***
  - Cooking in a gentle boil that uses temperatures _____ than poaching but _____ than that of a rolling boil (____ °C)
    - Distinguished by the appearance of small bubbles that gently break the liquid surface
  - Usually involves **low temperatures** for _____ periods of time
  - Used for _____ tough cuts of meat
  - ***Stewing***
    - a subcategory of simmering wherein a flavorful liquid (ex. _____ or sauce) is used to barely cover a mixture of chopped up _____ and vegetables and simmered while covered. Foods prepared by stewing are generally served with the liquid _____.
  - ***Braising***
    - From the French word _____
    - a subcategory of simmering that **combines wet and dry heat cooking methods**. Commonly follows the following steps:
      - _____ of food by dry heat (sautéeing or searing)
      - **Addition of liquid** (usually with an _____ component) to cover ⅓ to ½ of the food
      - **Gentle simmering** of food, covered, until _____
    - the liquid from braising is often used to prepare a pan _____ or **gravy**

- ***Boiling***
  - Use of water at a _____ boil (100°C)
  - Due to the _____ temperature and the vigorous _____ of the water, boiling may only be used to quickly cook dry pasta, beans, and _____ vegetables
  - ***Parboiling***
    - A subcategory of boiling and a type of _____, wherein a food is **partially cooked**
    - Used in food service establishments or in food processing to pre-cook food in advance to make later cooking much _____
  - ***Blanching***
    - A subcategory of boiling wherein foods are _____ submerged in boiling water before being cooled with an ice or water bath
    - Commonly used to preserve the color of _____ vegetables
    - Also used as ___-_____ before further food processing
      - Slows down _____ of many fruits and vegetables
      - _____ outer covering (*i.e.* peels and skins) of products like tomatoes, nuts, and various fruits.

- ***Steaming***
  - Cooking with hot steam at temperatures of _____ °C
    - Higher temperatures are possible with _____ cooking
  - _____ loss of color, flavor, and nutrients as less water is directly in contact with the food
  - Generally uses ____ water than other wet heat cooking methods

- ***Sous vide***
  - French for 'under _____'
  - a ____-_____, ____-_____ **(LTLT)** cooking method that uses **food sealed in a plastic bag** or other appropriate container before cooking at particularly ___ temperatures for _____ periods of time
  - **Advantages:**
    - very ____ cooking without overcooking or excessive moisture loss
    - _____ control over cooking conditions
    - _____ nutrients, colors, flavors, and aromas
  - **Disadvantages**
    - Low temperatures _____ many desirable chemical reactions
    - Requires special equipment
    - Possible concerns with food _____ especially with improper temperature control
    - Much _____ cooking time than most methods

Name:

- ***'En papillote'***
  - French for 'enveloped in _____'
  - Food is enclosed in an envelope before cooking
    - Envelope is usually _____ _____, but other materials like aluminum foil, paper bag, and more commonly in Asian cuisine - large leaves are also used
    - Cooking may be through **moist heat** (ex. Steaming, boiling, simmering) or **dry heat methods** (commonly baking)
      - Primarily a **moist heat** method even as the envelope traps _____ from the food for further cooking

- **Dry heat**
- Cooking methods without the addition of added moisture
  - Modes of heat transfer include _____ from the heat source, by convection through hot air, as well as through _____ from a cooking surface
    - _____ and _____ may be used as a medium of heat transfer
  - Allows for temperatures greater than 100°C
    - Up to ___ °C (___ °F) or more for some baked products
- **Advantages**
  - High temperatures enable chemical reactions that achieve certain quality characteristics
    - Ex. _____ of potato chips after frying, _____ of seared meat, _____ marks on grilled hamburgers
  - Generally takes a much _____ time compared to wet heat methods
  - Lower loss of water-soluble compounds
  - Can help retain nutrients, color, texture, and taste
- **Disadvantages**
  - Possible loss of _____-soluble compounds such as:
    - Nutrients (Vitamins _, _, _, and _)
    - Flavors
    - Color
  - Possible production of harmful compounds
    - _____ in fried starchy foods like French fries
    - _____ in roasted coffee
  - Health and dietary concerns when added ____ is used

Dry heat methods include:

- **Baking / Roasting**
  - Primarily uses hot air (_____) and secondarily direct _____ from a heat source (_____) to cook foods

        - Heat source = open flame (more common for _____) or other heating element
    - The **temperature** used sometimes distinguishes baking and roasting, though the term is **often used interchangeably**
        - **Baking** = _____ temperatures up to ___°C (___ °F)
        - **Roasting** = _____ temperatures greater than ___°C (___ °F)
    - The **food being cooked** is may also distinguish the two terms:
        - **Baking** is commonly used for **dough** and **batter-based goods ('_____ goods') and pastries**
        - **Roasting** is commonly used for **meat, root vegetables**, and **bulb vegetables**.
        - **Both terms** are used for **seafood** depending on the temperature
- **Grilling / Broiling**
    - Primarily uses direct _____ from a heat source (_____) and secondarily hot air (_____) to cook foods
        - Heat source = open flame, hot coals, or electric/infrared heating elements
    - Temperature is controlled by changing the _____ of the heat source or the _____ of the food from the heat source
    - The **location of the heat source** distinguishes grilling and broiling
        - **Grilling** = heat source is located _____ the food
            - **Grilling** may be used as the source cooking method or as a finishing step to add _____ and _____
        - **Broiling** = heat source is located _____ the food
            - **Broiling** is usually used as a finishing step to add _____ and _____ to a food after other cooking methods like baking or roasting
    - These methods are commonly used for ____ tender and ____ expensive cuts of meat that can be quickly cooked
- **Frying**
    - Cooking methods which use ____ or _____ as a heat transfer medium
        - Can reach temperatures much higher than 100 °C (up to ___°F/___°C)
    - Quickly sears the food surface resulting in a distinct flavor and texture
        - _____ of sugars
        - _____ of proteins
    - Penetration with oil or fat also contributes to _____
    - Possible _____ concerns due to added ____ and _____ in the diet
    - ***Deep-frying***
        - Foods are submerged entirely in hot oil or fat
            - Typically between ____ °F (____ °C) and ____ °F (____ °C),
        - May involve coating of foods with _____ or _____
        - Used to provide _____ to foods

Name:

- ***Pan-frying***
  - Uses minimal oil or fat
    - May not be necessary to add oil or fat for greasy or fatty foods
  - _____ heat than sauteing to preserve moisture and ensure even cooking
    - Ingredients are generally kept whole
  - Uses _____ pan compared to deep frying
  - May also involve coating of foods with _____ or _____
- ***Sauteing / Stir-frying***
  - From French *'sauté'* meaning _____
  - Uses _____ amount of oil or fat in a _____ pan over ____ heat in a usually _____ period of time
  - Usually involves ingredients cut into small pieces to maximize the _____ _____ exposed during cooking
  - _____ ingredients while _____ texture, moisture, and flavor
  - Sauteing and stir-frying are very similar and are sometimes used interchangeably
    - Usually, stir-frying uses _____ heat for a _____ amount of time and is traditionally done with a ___

Non-heat and other methods

- **Curing**
  - Use of any combination of ____, _____, _____, and curing agents to process foods
    - Most common: potassium _____ (*'salitre'*) and sodium _____
    - _____ salt / _____ powder: mixture of salt and curing agents used for meat processing, usually dyed _____ to distinguish them from table salt
  - Adds **flavor** to food and usually renders them **safe** for consumption with an _____ shelf-life
  - The individual and combination effects of the above ingredients work together to control _____
    - Can also lead to the denaturation of _____
  - Flavors are also added in the form of _____ and _____
  - Milder curing times are also used for ready-to-eat foods
    - Seafood are briefly cured/marinated in acid (from citrus fruits and/or vinegar) and spices to prepare _____ / *'kinilaw'*
  - Cured foods are commonly further processed by **smoking**
- **Smoking**
  - Use of smoke from burning or smoldering material (usually _____) to _____, _____, _____, and/or **preserve** foods

- Can be generally classified by **temperature:**
  - _____ smoking:
    - Between __ °C and __ °C,
    - adds flavor but **does not cook foods**
    - Used for _____ or **already-cooked** foods
  - _____ smoking:
    - Between __ °C and __ °C
  - _____ smokings:
    - Between __ °C and __ °C for up to 24 hours
    - Sufficient time and temperature to cook foods
- The flavor of smoke may also be added to foods without smoking using _____ _____

- **Drying**
  - Foods are commonly dried to _____ shelf-life
    - Removal of water lowers _____ _____ and prevents _____ _____
    - May be facilitated by air, sun, wind or specialized drying and dehydration equipment
    - Commonly involves the addition of salt ____ to assist in moisture removal
      - Products like *tuyo* and *danggit* are salted before being ____-dried
  - Generally safe for fruits and vegetables as long as sanitary guidelines are followed
  - Not sufficient for rendering ____ and _____ safe without other processing steps (*i.e.* curing, smoking, prior cooking)
- **Plating and Presentation**
- **Concepts and Criteria**
  - Essentials of food presentation
    - _____
      - Proper cutting and cooking of food is a necessary prerequisite to good presentation
    - _____
      - Cleanliness and professionalism should be maintained in presentation of the food items
    - _____
      - Presentation of food with correct elements such as balance, arrangement and garniture
  - Balance
    - Components of a plated arrangement: _____, _____, _____, _____. This can also be applied to pre-packaged food or meals

- Proper offering of variety and contrast while avoiding awkwardness and jarring arrangement
    - Color - Avoid single color or monotonous themes, use 2 or 3 colors within a single plate
    - Shape- Multiple shapes creates flexibility within a plate but should be controlled as to avoid awkwardness
    - Texture- Combination of several textured food to avoid a single dimension of mouthfeel
    - Flavors- Combination of complementary flavors to ensure the experience of dining is more wholesome

- Unity
    - Avoidance of randomness and prioritization of cohesion within the components
    - Designing towards the role of the components
        - In a dish, normally the _____ is the center of attention.
        - Highlighting The flavor of the main ingredient known as the _____ while using other flavors from supporting or secondary flavors to enhance, harmonize or create contrast.
        - Primary design element revolving around the main ingredient with side dishes, garnishes and sauces as supporting design elements
        - Avoid unnecessary elements such as inedible garnishes or components not intended to be eaten

Lecture Guide 2
Methods and Techniques in Food Technology

Photo from Food Manufacture I
https://www.foodmanufacture.co.uk/Article/2023/04/21/food-processing-is-here-to-stay

FOOD PROCESSING

- Thermal Processing
  - Basic Principles of Thermal Processing
- Thermal Processing Schedules
  - Lethality
  - Thermal Processing Parameters (d-, z-, and F- values)
  - Heat Penetration and Distribution
  - In-package Processing
  - Aseptic Processing
- Non-thermal Processing
  - Fermentation
  - Low-Temperature Processing
  - Chilling
  - Freezing
  - Moisture Removal
  - Concentration
  - Drying
  - Dehydration
  - Chemical Preservatives
  - Combination and Novel Methods

Thermal Processing

Basic Principles of Thermal Processing

- Definition: The application of the combination of _____ and elevated _____ in food products.
- Objectives
    - Reduce the level of _____ and relevant biological compounds (_____) to acceptable levels
        - Note the concept of "_____ _____", the state in which a product is free of microorganisms capable of growing at ambient conditions
    - Modify _____ characteristics such that the product reaches a target quality
        - In essence: **quality** and **safety**
- Often, the general term thermal processing is used interchangeably with '_____', in which foods are _____ (airtight) sealed in a container before being subjected to a (often thermal) process that achieves commercial sterility
    - Conventional containers like metal cans and glass jars as well as more modern alternatives like plastic, laminated (_____) pouches, and ____-in-___ (BiB) containers.
- Thermally-processed products may be categorized by **temperature category** and by **pH level**.

- **By temperature category:**
    - **_____**
        - _____ thermal processing method which is not solely intended to preserve products
            - Most commonly done by scalding food in hot water or steam for short periods of time
        - Usually used as a ____-treatment for further processing or for _____-_____ foods (MPF)
        - Primary purpose is to inactivate _____ to slow down quality deterioration
            - Commonly used in _____ and _____
        - Also serves to reduce _____ ____ of the product surface and soften tissues or remove air from intercellular spaces to facilitate further processing or packaging, and
    - _____
        - Relatively _____ thermal processing method primarily intended to eliminate _____ microorganisms
            - Can slightly extend shelf-life, ex. By a few days for _____, and a few months for _____
            - Many products still require _____ storage (ex. Pasteurized eggs)

Name:

- Involves temperatures of _____ or lower
- Survival of _____-resistant microorganisms is expected

Temperature	Time
63°C	For 30 min (low temperature long time LTLT)
72°C	For 15 sec (primary high temperature short time, HTST method)
89°C	For 1.0 sec
90°C	For 0.5 sec
94°C	For 0.1 sec
100°C	For 0.01 sec

Sample time-temperature schedules for the thermal processing of milk products.

  - _____
- Most _____ thermal processing method which aims to achieve _____ _____
- Thermal processing schedule must sufficiently inactivate the most heat-resistant microorganisms (ex. Bacterial _____ of the genus _____ and _____)
- Usually uses temperatures greater than _____, most commonly _____
  - These temperatures are achieved using _____ under high _____

- **By pH level:**
  The pH level of ____ is an important boundary for canned foods due to the potential growth of _____ _____. This microorganism is of particular concern due to the following characteristics:
  - Heat resistance due to its ability to form bacterial _____
  - Pathogenicity due to its ability to produce botulinum toxin, which causes the disease _____
  - It is ubiquitous in nature, being commonly found in soil and water
  - Canned foods may be classified by pH level into the following:
    - **Low-Acid Canned Foods (LACF)**
      - Foods with pH higher than ___, common for meat, poultry, and seafoods
      - Generally requires ____ severe thermal processing
        - Usually requires a ____ schedule for elimination of _____ _____ _____

- **High-Acid Canned Foods:** requires ____ severe thermal processing in order to reduce or eliminate ____-resistant microorganisms or bioactive compounds such as bacteria, fungi, or enzymes (ex. _____ _____ (PPO), which can cause browning in most fruits)

  High-acid canned foods may be further classified into:
  - **Acidified Low-Acid Foods:** foods which are formulated or treated with food-safe acids or acid foods to ensure that the finished products has a pH of ____ or lower within 24 hours of thermal processing
    - Examples: vegetables treated with vinegar (_____)
  - **Acid Foods:** foods with a natural pH lower than ____
    - Examples: most _____ products, jams, jellies

Thermal Processing Schedules

- In the context of thermal processing, the term ***process*** refers to a certain ____-_____ _____. This refers to the _____ of the heating medium and the ____ which it is to be sustained. To avoid confusion, this shall be referred to in this lecture guide as the ***process schedule***.
- Processors must ensure that the process schedule is sufficient to achieve the previously mentioned objectives (to produce safe and quality products)
  - In general, process schedules are designed to achieve the necessary level of quality and safety using the _____ possible process
  - To achieve these objectives, the process schedule must take into consideration the _____ characteristics of a reference microorganism and the _____ characteristics of a food product.
    - Given these, process schedules are usually _____ to each SKU and should be recalculated with changes in formulation or even packaging.

Lethality

- Calculation of thermal process schedules are performed such that the process delivers the **required lethality** of a certain microorganism
  - **Lethality:** measure of the ability of a process to destroy a target microorganism.

_____ / _____ Microorganisms

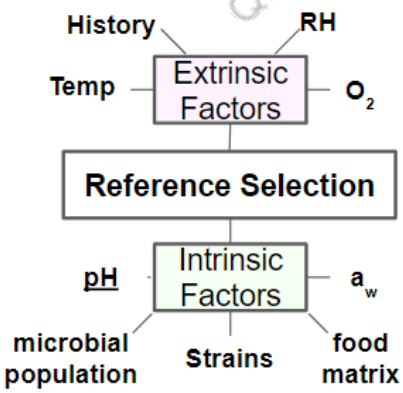
- Relevant _____ microorganisms which pose the greatest risk or challenge for a certain food product

Name:

A list of some reference microorganisms and enzymes used for different kinds of foods

Microorganism	Category	Problem / Risk	Max T
Gram-Positive _____-forming Bacteria (most heat-resistant)			
_____ _____	LACF	Pathogenic (_____), very-heat resistant, ubiquitous in soil	121°C, 3 min
Geobacillus stearothermophilus	LACF	Spoilage-causing, ~20x more heat resistant than above,	121°C, 30 min
Clostridium _____	HACF	Pathogenic, heat resistant, ubiquitous in soil	95°C,
Other reference microorganisms and enzymes			
Salmonella spp. (Gram-negative bacteria)	____ Products	Pathogenic, commonly associated with poultry and poultry products	60°C
Byssochlamys fulva (fungus)	____ _____	Spoilage-causing, produces the mycotoxin _____, resistant ascospores	90°C
_____ _____ (PPO) (enzyme)	Acid Foods, MPF	Spoilage-causing, causes enzymatic _____ in fruits and vegetables	75°C

- Note that the **heat-resistance characteristics** of a certain microorganisms are **dependent on the food matrix**
    - presence/absence of certain nutrients, pH level, water activity, etc



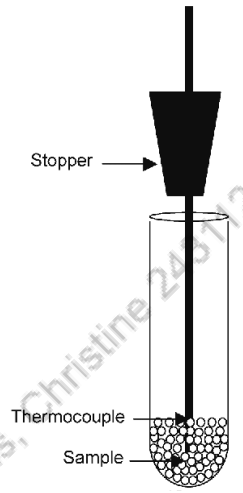
Some considerations for the selection of reference microorganisms.

- Calculation of lethality requires knowledge of a thermal processing (____-_____) curve and some predetermined thermal processing parameters for a specific _____ _____ in a specific food matrix.

Thermal Processing Parameters (D-, z-, and F- values)

A variety of terms are used to describe the heat-resistance of microorganisms

- ***TDP & TDT***
  - **_____ ____ ___ (TDP)**
    - ____ needed to kill a certain number of microorganisms at a set _____ (usually ___ _____)
  - **_____ ____ ___ (TDT)**
    - ____ needed to kill a certain number of microorganisms at a set _____
- Certain thermal processing parameters can be calculated successively, as follows
  TDT → D-value –multiple D-values→ z-value –d-values and z-value → F-value

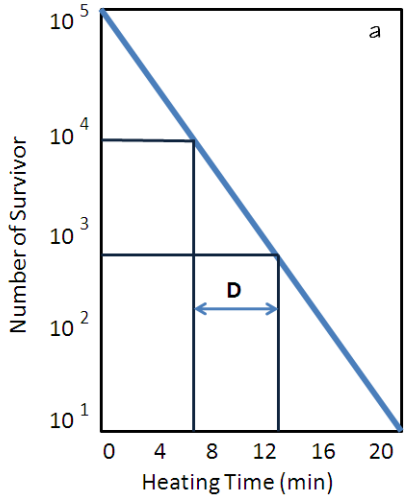


Small stoppered test tubes (colloquially known as TDT tubes) are commonly used by food microbiologists to determine the various thermal processing parameters of different combinations of microorganisms and food samples.

D-value

- Also known as the _____ _____ _____
- measures the ___ needed to destroy 90% (1 log) of the _____ of a certain microorganism at a certain temperature
- Sometimes written as D_T, where T is the _____ at which the D-value is obtained
- the **D-value** gives the thermal resistance of a microorganism in a certain substrate at a certain temperature

Name:



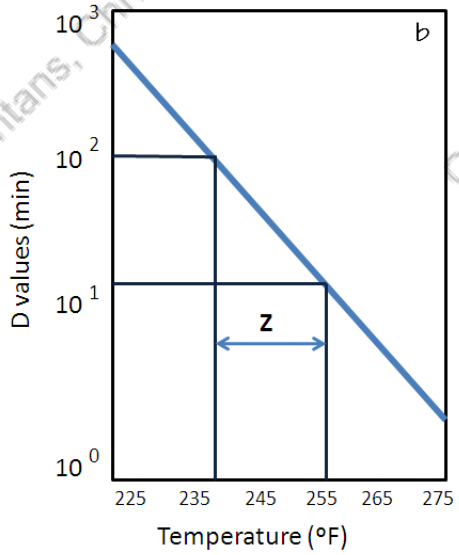
In a semi-logarithmic _____ vs ____ curve, the D-value is equal to the ____ ***needed for the _____ to traverse one log cycle*** *or the* ***negative reciprocal of the _____. Multiple D-values are used to establish the z-value*** *of a certain microorganism in a certain substrate..*

Given two time points (t) with their corresponding population of viable microorganisms (D), the D- value may also be calculated as:

$$D = \frac{t_1 - t_2}{\log P_1 - \log P_2}$$

z-value

- measures the _____ needed to reduce the _____ of a certain microorganism in a certain substrate by by 90% (1 log)
- the **z-value** gives the resistance of a microorganism to increasing temperatures



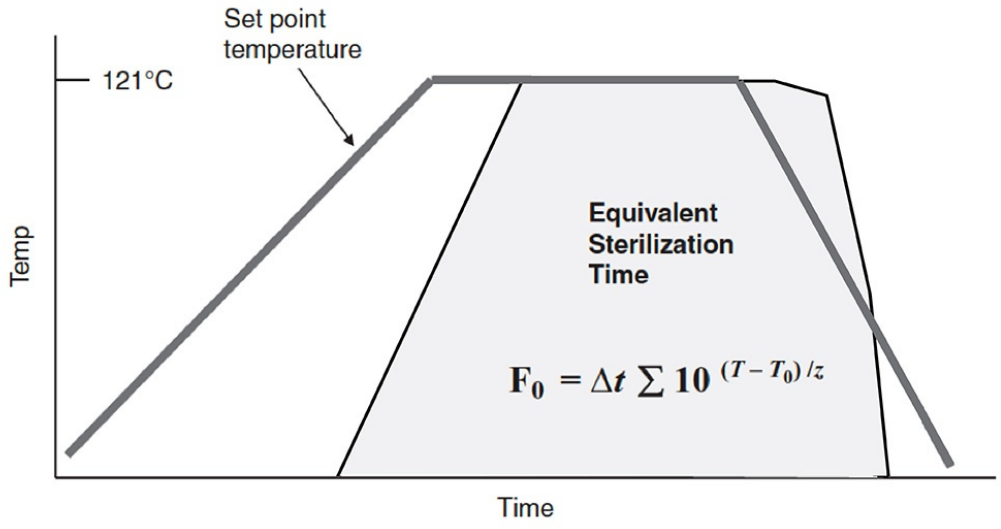
In a semi-logarithmic _____ vs _____ curve, the z-value is equal to the_____ ***needed for the _____*** *to traverse* ***one log cycle*** *or the* ***negative reciprocal of the _____.***

Given two temperature points (T) with their corresponding D-values (D), the Z- value may also be calculated as:

$$Z = \frac{T_1 - T_2}{\log D_1 - \log D_2}$$

F-value

- A predetermined number indicating the ____ required to kill a known population of microorganisms in a given food under specified conditions
    - *i.e.* for a certain product to be considered to have an **adequate process schedule**
    - Usually expressed in multiples of D-values (ex. 12D reduction of *Clostridium botulinum* at 121°C (250°F) = D_{250} ☒ 12 = F_{250} = F_{121} = F_0 = F)
        - 12D (*botulinum kill*) = time needed to reduce the number of _____ _____ spores by 12 log cycles (reduce by 99.9999999999%)
        - Not
- Set by _____ and/or ____ _____ to ensure an acceptable margin of _____ for a certain food product
    - Usually based on the _____-_____ scenario that assumes ____ levels of microbial contamination
- The F-value (F_x) indicates the minimum ____ at the designated temperature (x) needed to safely process the product
    - Note that this time-temperature must be achieved **in all parts of the product**
        - **Importance of _____ characteristics (*i.e.* Heat penetration and distribution)**
    - **the actual processing time in a retort is always _____ than the F value**
- The **actual lethality F** (a value from 0 to 1) may also be calculated given a ____(*t*)-_____(*T*) curve of a thermal process, a reference temperature (T_0), and a reference z-value (*z*).
    - This gives the **actual cumulative lethality** of your process schedule relative to the **target lethality F**



    - **Take note of how the subscripts F and F_0 are used** in sample problems as they are sometimes **used interchangeably to refer to both actual and target lethality.**

Name:

Heat Penetration and Distribution

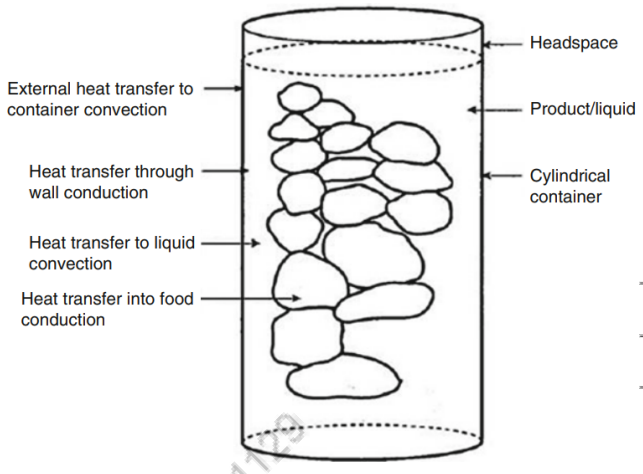
- The heat resistance of a reference microorganisms is only one aspect of thermal processing schedules, with _____ characteristics such as **heat penetration and distribution within the food product as well as the heating chamber** being equally important

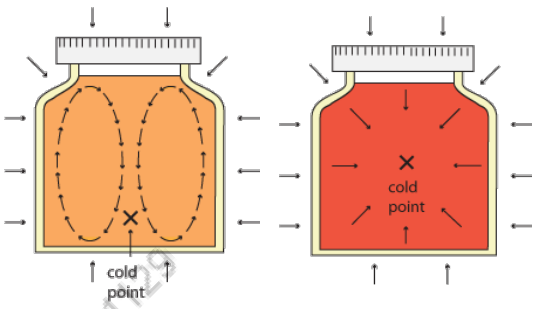
Slowest Heating Point (SHP),

- the point with the slowest temperature _____ during processing
- Consider the SHP **within the food product itself** (heat _____, _____-related) as well as **within the heating chamber** (heat _____, _____-related)
- Ideally: Obtain product temperatures from the SHP of a product located in the SHP of the heating chamber

Heat Penetration

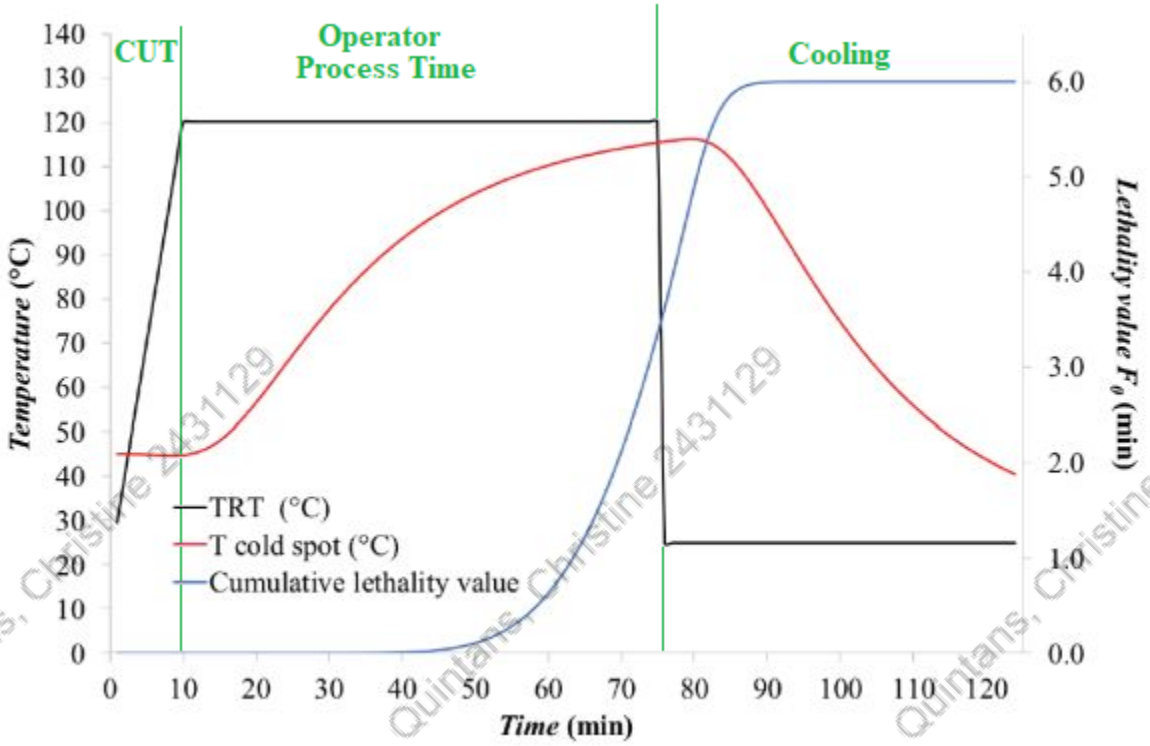
- Heat transfer within food products (_____-based) are dictated by the _____ characteristics of the food matrix and the material and dimensions of the _____
- Primary **modes of heat transfer** in conventional thermal processing are:
  - _____: heat transfer within **liquid products**, mostly **dictated by thickness** of the liquid **(thicker = _____ heat transfer)**,
    - **SHP is around the _____ _____ (GC)** of the product
  - _____: heat transfer within **solid or very thick liquid products**,
    - **SHP is generally _____ _____ _____ (BGC)** of the product
  - _____ heating: heat transfer in products which experience both _____ and _____ modes of heat transfer, occurs in **solid-liquid mixtures** and **products which thicken or solidify during heating** (ex. High-_____ products can undergo gelation),
    - **SHP somewhere _____ the GC and BGC**





Illustrations showing modes of heat transfer in a mixed liquid-solid food matrix and the SHP ('cold point') of a product depending on the primary mode of heat transfer.

- The **materials** and **dimensions** of the product will also affect the heat transfer rate
  - **low conductivity** and **thick material** = ____ heat transfer
  - **high surface area** and **thin dimensions** = ____ heat transfer



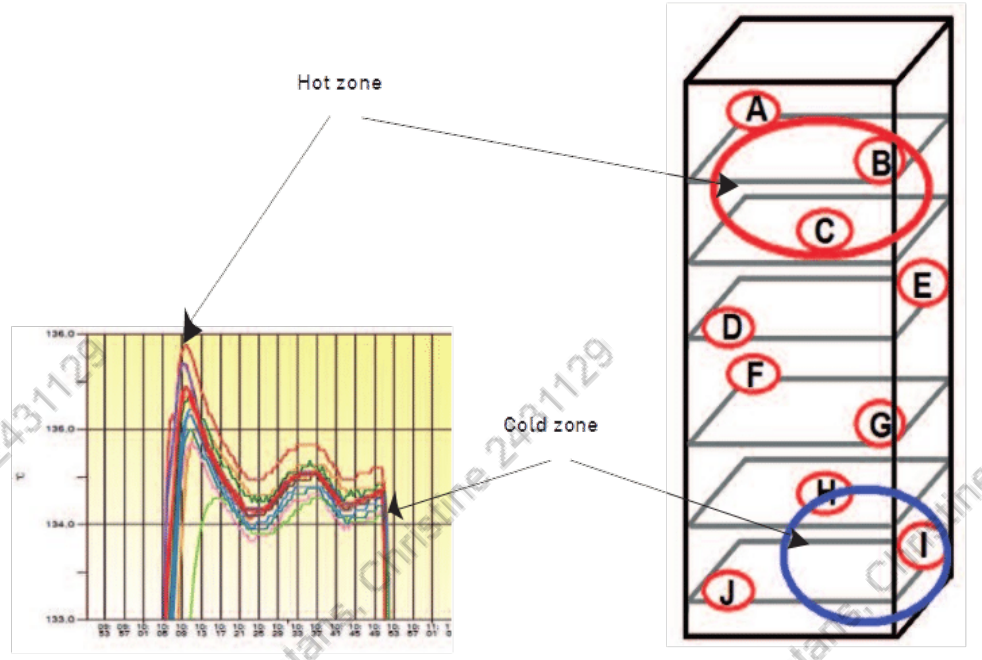
*Temperature profiles for a typical thermal process, where TRT is the Retort Temperature. The time required for the TRT to reach the target temperature of 121 °C is known as the ____-__ ____ **(CUT)** and the time the retort is at the target temperature is the operator process time. Note how the calculated cumulative lethality does not immediately increase during the operator process time, begins to increase _____ the target temperature is reached by the product and _____ increasing during cooling.*

Heat Distribution

- Heat transfer within the heating chamber (_____-based) are dictated by factors like **retort equipment, retort temperature, process time, heat transfer medium,** and **container agitation**
  - **Retort equipment**: The CUT is _____ in continuous _____ _____ compared to batch _____ retorts and continuous _____ retorts
  - **Retort temperature:** higher retort temperature = _____ heat transfer
  - **Process time**: longer process time = _____ heat transfer

Name:

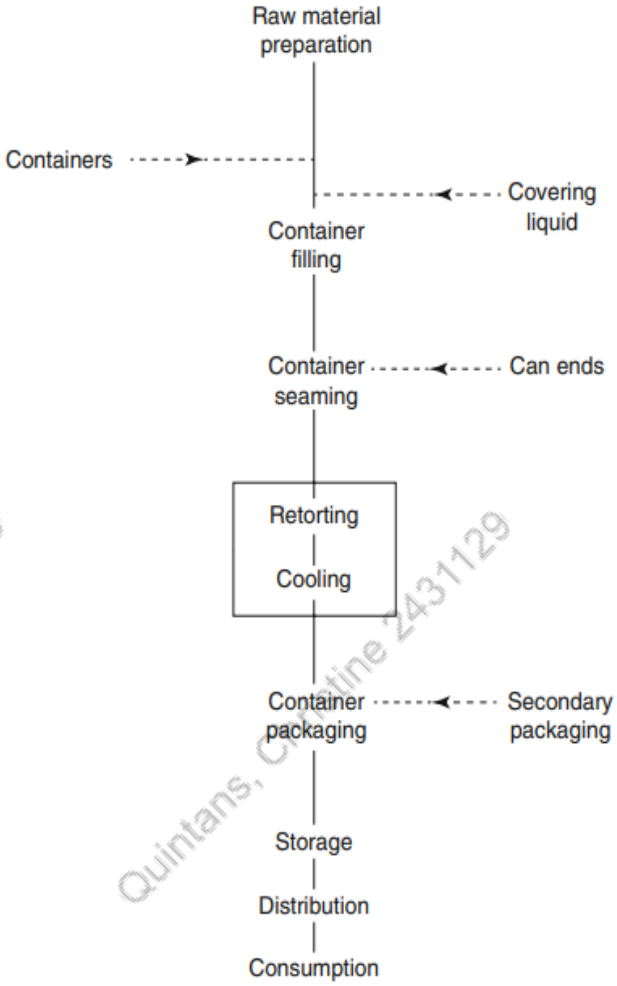
- **Heat transfer medium**: steam has very high heat transfer coefficient, [dry (_____) steam > wet (_____) steam > water]
  - The **speed** of the medium and the **geometry of the heating chamber** also affects the efficiency of the heat transfer medium
- **Container agitation**: Increasing agitation of food product containers (ex. With _____ retorts) _____ the rate of heat transfer



Heat distribution diagram of a top-loading static batch retort. Cold and hot zones in heating chambers depend on factors like chamber dimensions, heating medium, heat source, agitation, and even amount of products loaded.

In-package Processing

- **Most of the above discussion is based on conventional in-package thermal processing**



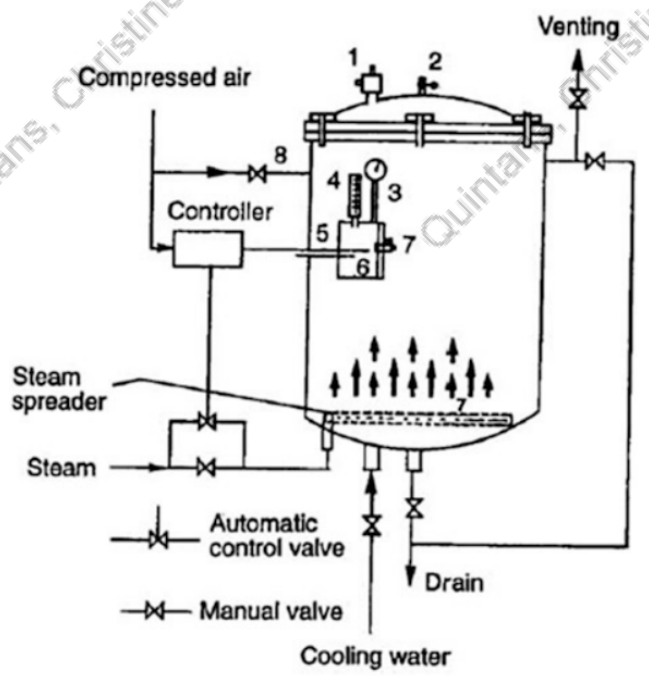
General process flow diagram for conventional in-package thermal processing. (Lifted from Holdsworth and Simpson, 2016).

- **In-package processing,** also known as **_____ processing** or **conventional canning**: process in which food are hermetically sealed in a container before being subjected to a (thermal) processing
    - Examples: fish, meat, and vegetables in metal cans or retortable pouches

Name:

Both of these products are manufactured using conventional canning methods using either metal cans (left) or retort pouches (right).

- Traditionally, in-package processing is done by _____ in static retorts, though continuous systems such as _____ and _____ retorts now exist.
- Static retorts have also been improved through the incorporation of _____ through rotation or vibration

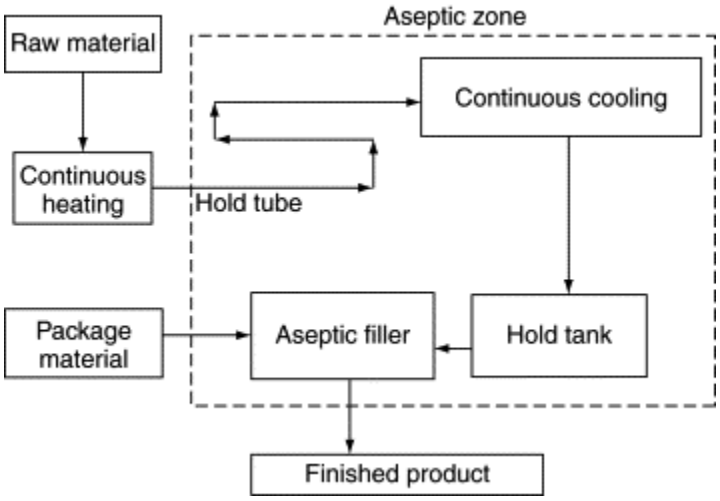


Equipment diagram of conventional vertical batch retort with (1) safety valve, (2) valve to allow steam release during processing, (3) pressure gauge, (4) thermometer, (5) sensing element, (6) thermo-box, (7) steam-spreader, and (8) air inlet for pressure cooling. (Lifted from Holdsworth and Simpson, 2016).

Aseptic Processing

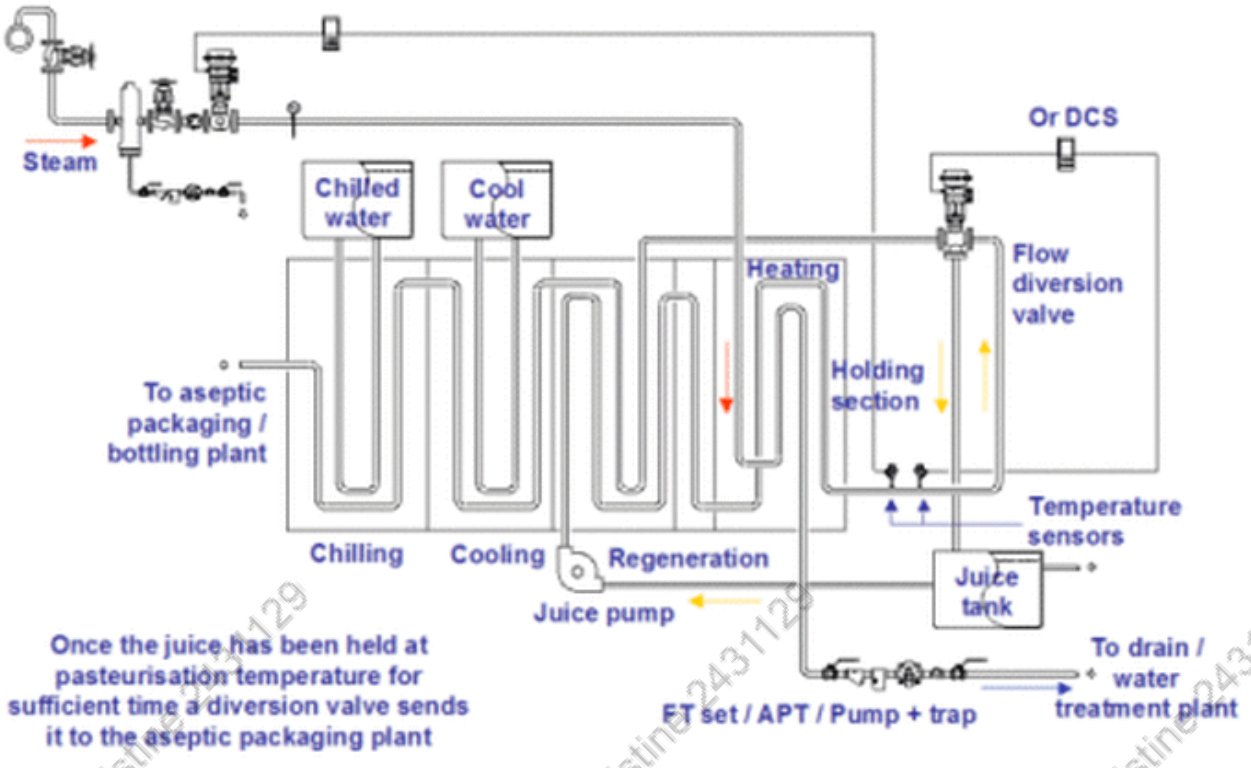
- However, modern thermal processing also use **aseptic processing systems** : in which products are **(thermally) processed before being filled and sealed aseptically in a pre-sterilized container**
    - *Advantages*: very efficient ____ transfer, control over product quality, variety of packaging dimensions and materials (does not need to be ____ resistant, production is usually _____ instead of by batches,
    - *Disadvantages:* expensive, complex, applicable only for _____ fluids, each processing system is only suitable for certain product types

Heat-sensitive products treated by _____-____-_____ (UHT) or ____-Temperature _____-Time (HTST) schedules, like juice and dairy, are produced by _____ processing.

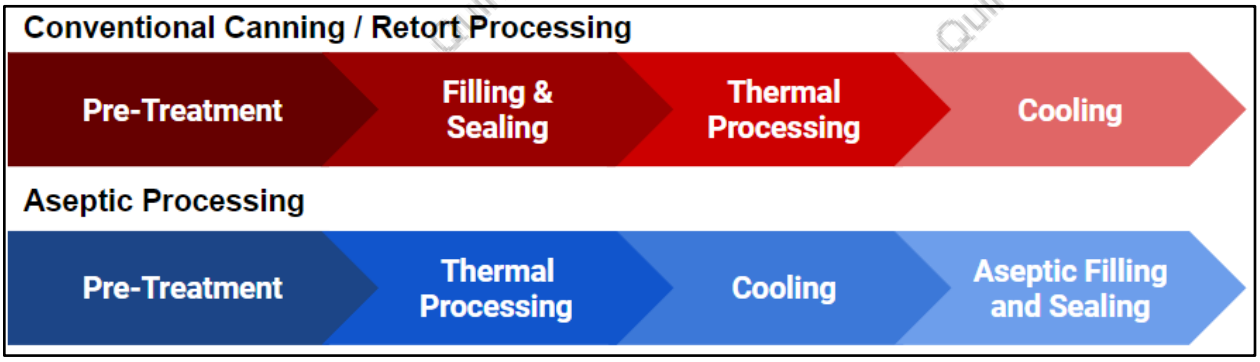


General process flow diagram for aseptic thermal processing. (Lifted from Mauer, 2003).

Name:



Sample equipment diagram for aseptic thermal processing of juice products. (Lifted from Food Product Development, n.d.).



Comparison of general process flow of conventional canning vs aseptic processing.

Non-thermal Processing

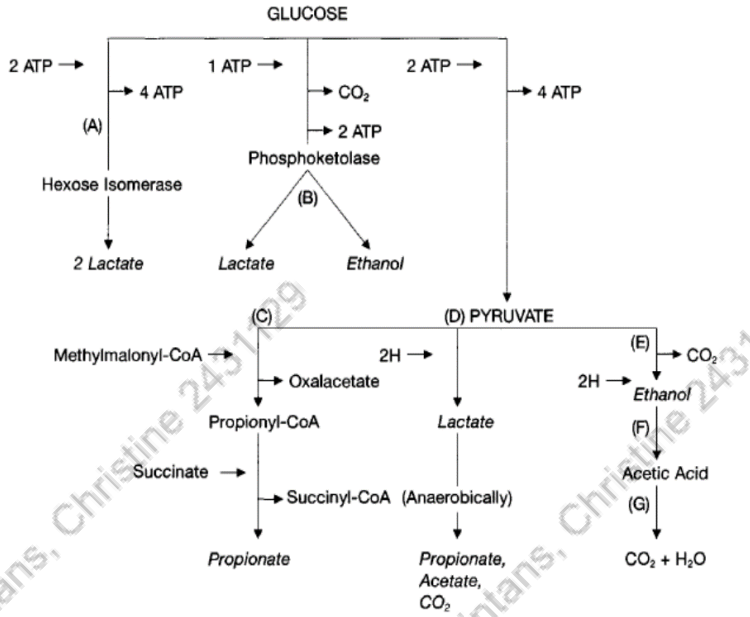
- **Fermentation**
  - The utilization of the _____ and_____ microorganisms in a specific food medium to produce a product with different attributes and characteristics to the raw material
  - Functions of Fermentation

- _____
- _____
- _____
- _____

- Conditions of Fermentation
  - Presence of fermenting organism
  - Adequate presence of macronutrients (_____,_____,_____) and micronutrients (trace minerals, phosphorus and sulfur), water and in some conditions, oxygen
  - Appropriate physicochemical parameters
    - Optimum Temperature: Mostly in the mesophilic range (_____)
    - Optimum pH: more acidic for fungi as compared to bacteria
    - Optimum water activity: greater than _____ required for growth of bacteria, _____ for fungi
    - Presence of Oxygen: _____ requires no oxygen present for fermentation to proceed while _____ requires oxygen for growth of the organism and conversion of the substrate
- Classification of Fermentation
  - By Organism:
    - _____ - Cheeses, sausages, yoghurt, sauerkraut, kimchi
    - _____ - alcoholic fermentation, tempeh
    - _____ - Natto, gochujang
    - _____ - Cacao, Miso, nata de coco

Name:

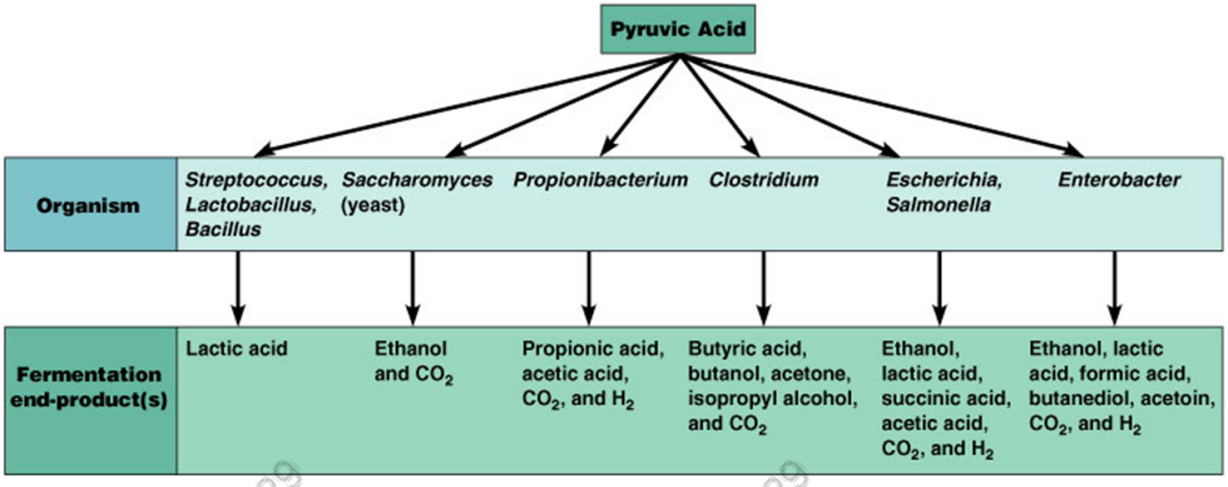
- By Medium composition
  - _____ - Growth on surface of water insoluble substrate
  - _____ - Growth on liquid medium mixed with water insoluble substrate
- By organic product and organism



(A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____

Generalized pathways for the production of some fermentation products from glucose by various organisms (Jay, 2005)

- Primarily, Anaerobic metabolism of microorganisms leads to the production of fermentation products from **Pyruvic acid**



- Common locally fermented food

Food Item	Substrate	Primary Fermenting Organism	Fermenting Conditions
Bagoong	Raw fish	Lactic acid bacteria	Anaerobic, high salt
Burong Isda			
Burong Gulay/Atsara			
Basi			

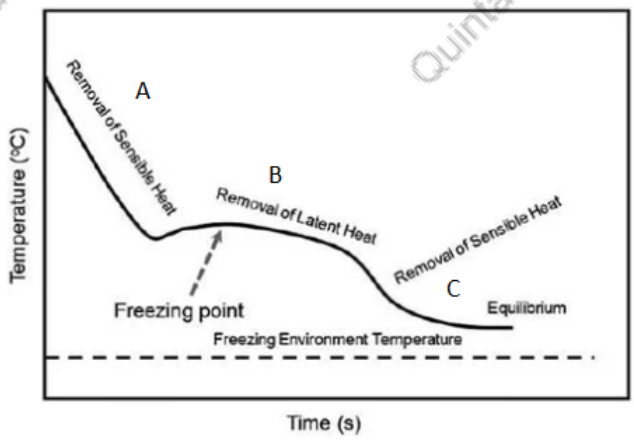
Name:

Suka			
Nata de coco			
Puto/Bibingka			
Patis			
Tapuy			

- **Low Temperature Processing**
  - ***Chilling and Refrigeration***
    - Lowered temperature leads to retarded growth of microorganisms and reduced biochemical activity
    - Refrigeration: Storage of food at temperatures ranging from -2 °C to 16°C
    - Chilling: Storage of food at temperatures ranging from 0 to 8 °C
    - Short term storage (Days to weeks only)
    - No inactivation of organisms, but reduction in activity
    - Requirements:
      - Controlled low temperature
      - Air Circulation
      - Humidity Control
      - Modified Atmospheric gas composition
    - Widely applicable to non-cold sensitive food
      - Perishables- Fruit, vegetables, meat, dairy, eggs
      - Processed or cooked food
      - Beverages
    - Disadvantages
      - Probability of "chill injury" - reddening of leaves and/or wilting
      - Storage of produce such as tomato and banana leads to poor ripening
      - Improper packaging can lead to flavor and aroma migration

Temperature	Commodity
0-1 °C	Meat, Poultry, Seafood
0-5 °C	Processed food, pre-cooked food, pastries, cakes, salads, yogurts, milk, salads, soup
0-8 °C	Fully cooked meat, butter, fruits, vegetables, cooked viands, cooked rice, etc.

- ***Freezing***
  - Storage of Food item below freezing point (Generally -18 °C)
    - -18 °C encompasses inhibition of pathogenic bacteria (<3.3°C), food spoilage bacteria (<9.5 °C), retardation of enzymatic activity and to some extent, reduction of nonenzymatic reactions
  - Can preserve food for months to years, based on proper packaging
  - Works on the principle of removal of available water to prevent biochemical activity by converting water into ice crystals, thus reducing water activity.
  - Reduced temperatures lead to lower enzymatic activity, leading to reduced autolytic activity or microbial growth.
  - Stages of Freezing:



A- Cooling of food/ removal of sensible heat (Above freezing point)

B- Removal of Latent Heat/ Phase transition (Liquid water to solid ice)

C- Continued removal of sensible heat (Ice crystal formation)

- Rapid vs. Slow Freezing

Process Characteristic	Rapid Freezing	Slow Freezing
Rate of Temperature drop	≥ 10 °C/min	≤ 2 °C/min

Name:

Ice crystals	Small, rapid forming	Large, slow forming
Location of ice crystals	intracellular	extracellular
Cell characteristics	General shape is kept intact	Reduction in size, loss of shape
Drip loss	low	high
Quality	Almost retained, better texture and flavor	reduced/less quality compared to fresh

- Types of Conventional Freezing
  - Plate Freezing- Direct contact with cooled **surface**
  - Immersion freezing- Direct contact with cooled **liquid**
  - Cabinet Freezing- Direct contact with cooled **gas**
  - Cryogenic Freezing- Submersion or exposure to **cryogenic fluid**
- Quality determinants of Frozen food
  - Quality prior to freezing
  - Food composition
  - Pretreatment methods
  - Freezing method
  - Freezing rate
  - Hygiene and manufacturing practices
  - Packaging conditions
  - Thawing post-freezing

- **Moisture Removal**
  - ***Concentration***
    - Increase in solid content of food through vaporization of water via transfer of latent heat from a heat source to the liquid being concentrated.
    - Leads to a reduction in moisture content, but not to a point of equilibrium
    - Mostly functions as a pre-processing step
    - Applicable for most liquids with high solute concentration

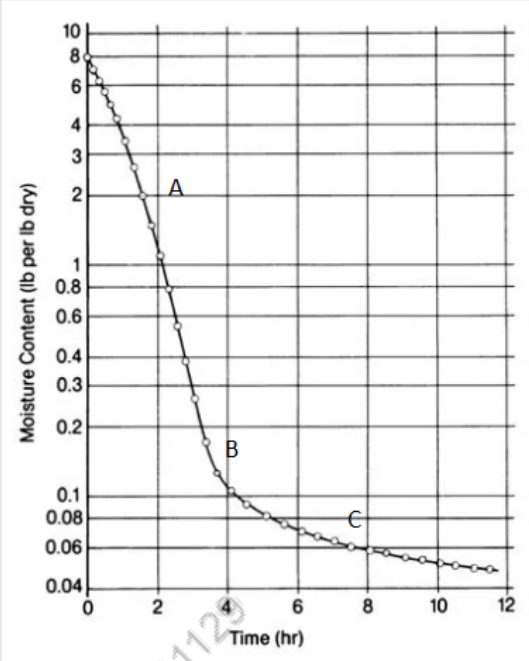
- Methods of concentration

Method	Principle	Advantage	Disadvantage
Solar/Sun evaporation	Liquid is exposed to direct sunlight	Low-cost, simple setup	Slow, mostly applicable for high salt solutions
Open Kettle	Jacketed vessel with heating element usually steam	Good for caramelization and flavor development	High temp, long time can damage food, uneven heating with respect to proximity to kettle wall
Flash Evaporation	Superheated steam (150 °C) is injected to food then pumped into an evaporation tube. Boiling mixture is separated through a vessel.	Rapid, high volume capacity	Loss of volatiles due to high heat
Thin Film Evaporation	Food is placed in a vertical cylinder with a rotating element that spreads the fluid into a thin layer on a jacketed heating wall. Water is rapidly removed as steam while food product is collected at the bottom of the vessel	Rapid, high volume capacity, product does not reach 100 °C, thus heat damage is minimal	Relatively high cost, requires low viscosity
Vacuum Evaporation	Similar to thin film evaporators but utilizes a vacuum chambers for product collection and transfer	Heat from previous chambers is recycled for heating next vessel, thus maximizing energy efficiency. Relatively lower temp since evaporation is assisted using a vacuum	Relatively high cost, requires low viscosity
Ultrafiltration	Use of specialized membranes	Ensures specificity	Highly specific

Name:

/Reverse osmosis	to separate components or filter liquid. Selective removal of large particles (ultrafiltration) and smaller solute removal (reverse osmosis)	based on membrane used	membrane for medium and solute

- ***Drying and Dehydration***
  - Drying- The process of removal of volatile components via exposure to heat or air
  - Dehydration- specific to moisture removal, a subset of drying
  - Purpose of Drying
    - For preservation and extension of shelf-life
    - Reduction of water activity
    - Reduction of bulk volume and weight
  - Effects of Drying on Nutrient content
    - Vitamins- Oxidative damage to Vit. A and C, Loss in Vit. D
    - Proteins- High temperatures can lead to denaturation
    - Fats- Oxidation at higher temperatures and levels of dehydration
    - Carbohydrates- browning due to enzymatic and non-enzymatic processes
  - Works on the principle of removal of moisture content, primarily free water
  - Stages of Drying
    - Constant Rate period
      - Rate of moisture migration from interior to surface of food product is the same as evaporation on the surface.
      - Moisture removal is relatively rapid, resulting in sharp decrease in weight of sample
      - Surface of the food remains wet until critical moisture is reached
    - Falling Rate Period
      - Rate of moisture migration to surface slows down after critical moisture is reached, leading to a slower drying rate.
      - Moisture of food enters equilibrium with the drying air
      - Moisture is harder to remove



A: _____

B: _____

C: _____

- Types of Dryers
  - Solid Surface Dryer- Heat is transferred through a solid surface in contact with the food
    - _____- Product slurry is deposited on the drum and heat is transferred through the drum wall
    - _____- Product is placed in hollow shelves within pans and is subjected to a closed environment with vacuum
    - _____- Product is placed on a stainless steel belt and the heat is transferred through the belt into the film. It is conducted in a closed setup under a vacuum
  - Adiabatic Dryers- Heat is transferred through a hot gas and carries out water vapor.
    - _____- Food Products are placed in a chamber with hot air generated from a heating element and circulated with a fan.

- _____- Food product passes through a 10-20m long tunnel-like structure with hot air being blown against them.

- _____- Two storey structure with a furnace in the bottom layer, generating hot air to pass through the top storey where the food products are placed in narrow slat structures.

- _____- Products are dispersed as small droplets and are dried along with the drying air.

- _____- Food Product granules are mixed with hot air and and are carried through a narrow column. The upward thrust generates air velocity, pushing the upward. At the top of the column, air velocity is decreased allowing the product to settle in a collector

- _____- liquids are pre-formed into foams using a foaming agent. The foam is then spread on a mat and dried using hot air

- Freeze Drying- Method of Dehydration involving freezing of the moisture content followed by sublimation
  - Used for preserving high value food with natural aroma and textures
  - Can have complete and rapid rehydration based on drying quality

- **Chemical Preservation**
  - Use of food grade additives as a processing aid
    - ***For a full set of preservatives and their function, refer to Lecture Guide 1: Additives***
    - Additives functions
      - Prevention of Microbial Activity
      - Reduction of Oxidation damage
      - Inactivation of Biological enzymes
      - Improve other downstream processes
      - Enhance existing characteristics of ingredients

- **Combination and Novel Methods**
  - Novel Non-thermal methods
    - High Pressure Processing
      - Subjecting food to high pressures between _____ and _____ MPa
      - Temperature is controlled to minimize thermal damage to food product (Ranges from _____ to _____ °C)
        - Taking into consideration temperature increase due to Compression (approx. 3 °C per 100 MPa)
      - Commercial exposure time varies
        - From pulse (millisecond) to continuous compression (≤ 20 mins)
      - Affects pH, Water activity
      - Occurs in batch production since HPP has not been documented in continuous production
      - Applied mostly for Juices and some fruits
      - Difficulty in design of vessels due to effects of pressurization and depressurization cycles which chan withstand cycles
    - Pulsed Electric Field
      - High voltage (_____ kV cm^{-1}) pulses of electricity at ambient or slightly above ambient temperatures for 1 second
      - Leads to microbial inactivation and enzymes
        - Electrical breakdown of biochemical charges within enzymes and microorganisms
        - Electroporation (semi-permanent enlargement of microbial pores) leading to destruction of the cell
        - Factors that affect inactivation are process factors, microbial entity factors, and media factors
      - Minimized loss in energy and reduced damage to sensorial properties of food
    - Pulsed light Technology
      - Intense short-duration pulses of broad spectrum “white light” (_____ to the _____ region)
      - Designed for surface sterilization of microorganisms
      - Generated using gas-filled flash lamps or spark gap discharge apparatuses

Name:

- Ultraviolet light
    - Technology applied mostly to semi-transparent liquids such as juices, disinfection of water and surface sterilization
    - UV irradiation at 200-280 nm
    - Measured based on transmissivity of the product, the geometric configuration of the reactor, power, wavelength and physical arrangement of the UV source, flow characteristics, and path length
    - Mostly combined with oxidizing preservation methods
- Oscillating Magnetic Fields
    - OMFs can be applied in the form of constant amplitude or decaying amplitude sinusoidal waves, or in the form of pulses.
    - Preservation utilizes sealed food in a plastic bag and subjecting it to one to 100 pulses in an OMF with a frequency of _____ kHz at a temperature of _____°C for a total exposure time ranging from _____ ms.
    - The effects of magnetic fields on microbial populations have produced controversial results, and more consistent results are needed before considering this technology for food preservation purposes.
    - One of the attractive features of using magnetic fields for food preservation is that the food can be packaged prior to processing, reducing the possibility of cross-contamination during packaging.
- Pulsed X-rays
    - Pulsed X-rays are a new alternative technology for food preservation that utilizes a solid-state opening switch to generate an electron beam.
    - The use of pulsed X-rays allows for precise control over the direction and geometry of the radiation field, accommodating different package sizes and ensuring high reproducibility and versatility.
    - The practical application of food irradiation by pulsed X-rays is further facilitated by its compatibility with existing food-processing equipment.
- Ultrasound
    - Inactivation using sound waves in the form of ultrasound
    - Used in combination with other inactivation methods

- Microbial inactivation via generation of intracellular cavitation caused by high-frequency vibrations leading to cellular disruption of components
- Effectivity is based on ultrasound wave amplitude, exposure/contact time with microorganisms, type of microorganisms, volume of food, composition of food, and treatment temperature.

- Microwave/ Radio-frequency heating
  - Use of electromagnetic waves of certain frequencies.
  - Preferred over conventional heating as it requires less time to reach the desired process temperature, especially for solid and semisolid foods.
  - The design of the equipment used in microwave sterilization can significantly impact the critical process parameters, such as the location and temperature of the coldest point.
  - The combination of microwave and radio-frequency processing with other preservation methods, such as heat and mild pressure
  - Factors that affect the effectiveness of microwave and radio-frequency processing include the amplitude of the waves, exposure/contact time with microorganisms, type of microorganisms, volume and composition of the food, and the temperature of treatment.

■ Combination of processing methods
- _____- combination of nonthermal processes with traditional or novel processing methods to ensure microbial stability and safety of food
  - _____- adjusted physical or chemical parameters that deter microbial growth
    - Physical Hurdles
      - _____
      - _____
      - _____
      - _____
    - Chemical Hurdles
      - _____
      - _____

Lecture Guide 3
Integration and Application of Food Technology

Photo from Axil Integrated Services I
https://axil-is.com/blogs-articles/reduci
ng-waste-in-food-manufacturing/

FOOD ENGINEERING

- Unit Operations
  - Types
  - Common Machinery
  - Process Flow Diagrams
- Mass and Energy Balance
  - Basic Concepts
  - Thermodynamics
  - Equipment and Instrumentation
  - Problem Solving
- Fluids and Fluid Flow
  - Basic Fluid Mechanics
  - Equipment and Instrumentation
  - Problem Solving

Unit Operations

- Definition
  - "A unit of a more complex operating plant"
  - May involve physical, biological, or chemical changes in food
  - Transforms matter into highly desired food products from inexpensive raw materials

- List of Common Unit Operations

Drying	Mixing	Filtration		
Evaporation	Extraction			
Distillation	Crystallization			

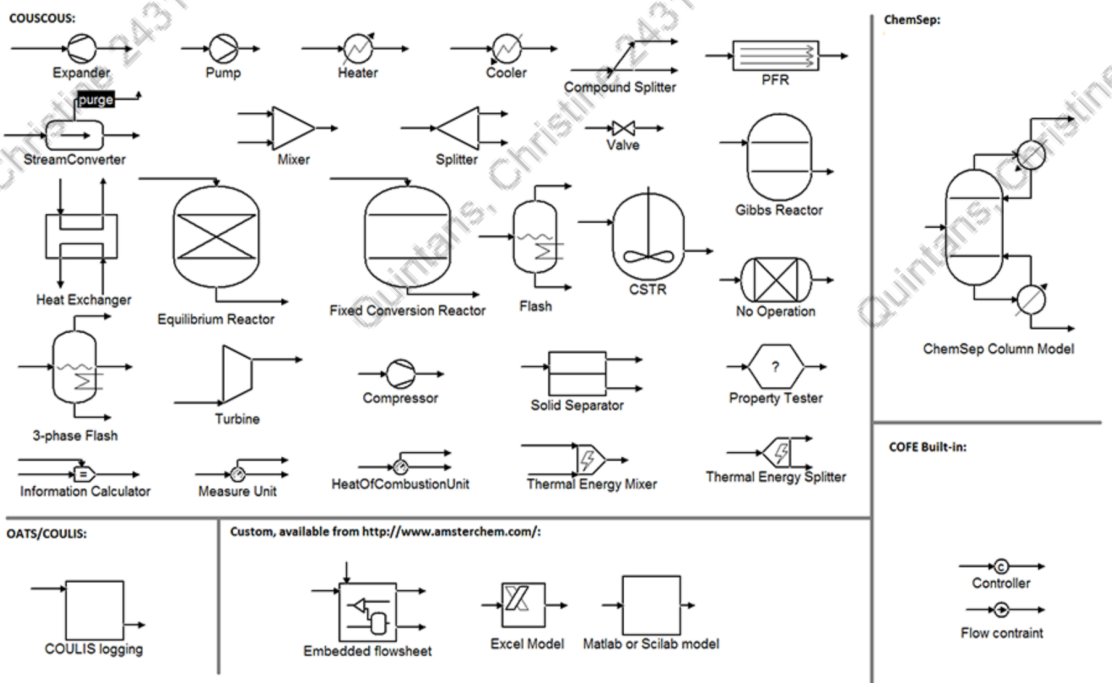
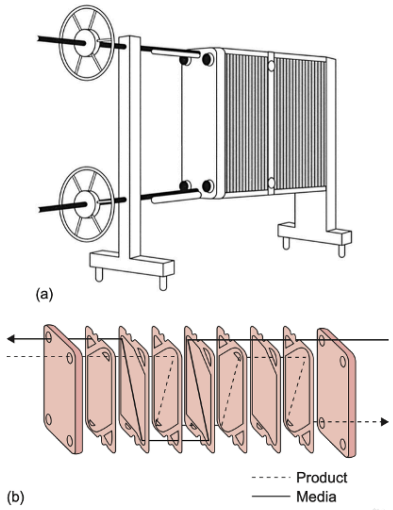


Figure X. Diagramming symbols for common unit operations

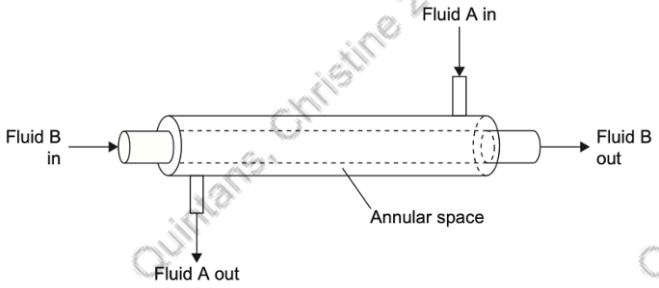
Name:

- Mixing
  - Dispersing components in a mixture
  - One of the most common unit operation in a food processing plant
  - Goal is to obtain a "well mixed mixture"
    - Samples occur in proportions whose _____ _____ _____
  - Involves dispersion, homogenization, dissolution, paste formation
  - Sample equipment:
    - Drum blender - _____
    - Tumble mixer - _____
    - _____ - _____
    - _____ - _____
    - _____ - _____
    - _____ - _____
    - _____ - _____
    - _____ - _____
- Heat Exchangers and Refrigeration
  - Heat Transfer
    - One of the most common unit operation in a food processing plant
    - Involved in _____
  - Heat Exchanger
    - Equipment where heating and cooling takes place
    - Either contact or non-contact type
      - Non-contact type

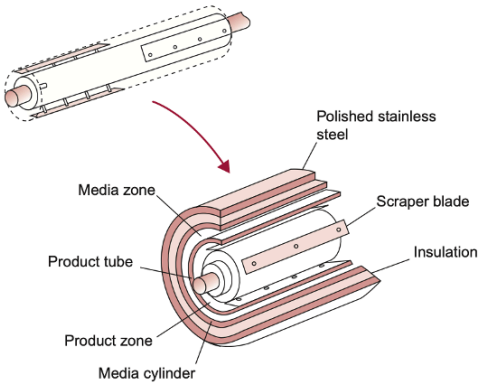
Plate heat exchangers



Tube heat exchangers

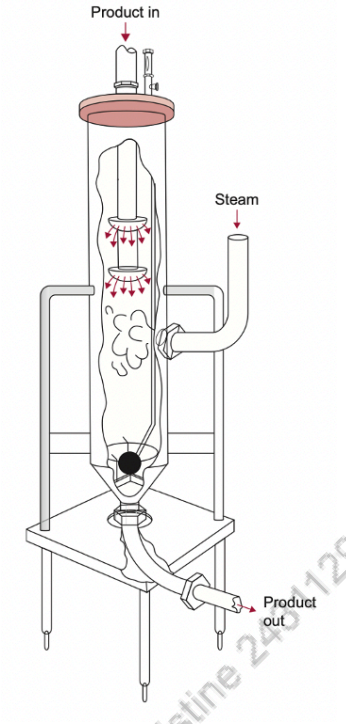


Scraped surface heat exchanger



Name:

Steam infusion heat exchanger



- Refrigeration
  - Maintenance of a temperature lower than that of the _____
  - Use of a mechanical refrigeration system to extract heat from the surrounding environment
  - Sample equipment: _____
  - _____

- Process Flow Diagrams
  - Graphic illustration of the processes that the inputs undergo in a process
  - Helps in visualizing the process and in setting up boundaries for the balances or equations
  - Should show important information and ALL input and output streams
  - Ex:

Mass and Energy Balance

- **Mass/Material Balance**
  - The application of the law of conservation of mass in solving specific problems through the use of equations relating inputs and outputs
  - Useful in:
    - Product formulation
    - Evaluating final yield and its composition
  - Law of Conservation of Mass
    - "Mass is neither created nor destroyed"
    - What comes in must come out
    - **INPUT = OUTPUT**
  - Ex.

  - Component mass balance
    - Total mass balance but is applied to individual components
    - Obtained by enumerating all final input and output streams of a certain component
  - Tie material or component
    - Material or component used to relate the quantities of two processes
    - A component that is unchanged from one process to another
  - Problem solving:
    - Basis of computation
      - Used to visualize exactly the object or process in consideration
      - Can be a unit of time and/or quantity
      - Can be changed for the sake of convenience depending on which part of the process is being considered

Name:

- Steps in problem solving:
    1. Sketch the process flow diagram
    2. Choose a basis
    3. Apply overall mass balance and component balance
    4. Use energy balance (if applicable)
    5. Apply the known equilibrium relations
    6. Retrace the steps and interrelate them as constructively as possible

- Example 1:
  Orange juice with 10% solids is to be converted into a 45% concentrate using an evaporator. How much orange juice is needed to make 300 kg of 45% concentrate? How long will it take if the evaporator can process 220 kg of orange juice per hour?

- Example 2:
  Tomato juice flowing through a pipe at a rate of 100 kg/min is salted by adding saturated salt solution (26% salt w/w) to the pipeline at a constant rate. Draw the process flow diagram, complete with boundaries, labels, and flow rates. Compute for the flow rate of the saturated salt solution if the product is to have a 2% salt concentration.

- **Thermodynamics and Energy Balance**
  - Energy balance in a closed system
    - Example 1:
    - A tubular water blancher is being used to process lima beans. The product mass flow rate is 860 kg/h. It is found that the theoretical energy consumed for the blanching process amounts to 1.19 GJ/h. The energy lost due to lack of insulation around the blancher is estimated to be 0.24 GJ/h. If the total energy input to the blancher is 2.71 GJ/h, calculate the energy required to reheat the water. Determine the percent energy associated with each stream.

Name:

- Heat Capacity
  - Indicated the ability of a material to hold and store energy
  - Quantified by specifying amount of heat needed to raise the temperature by a specified amount
  - For real solids, it is assumed that the heat capacities are additive

- Water as an Energy Source
  - Steam
    - Vapor state of water
    - Used as an energy source in food processing
      - Increasing the temperature of other substances
    - Produced by the addition of energy from other sources
  - Forms of Water
    - Saturated Liquid
      - Liquid water that is in equilibrium with its vapor
      - Pressure above liquid = vapor pressure
    - Vapor-liquid Mixtures
      - Steam with <100% quality
        - Steam quality = _____
      - P and T correspond to the boiling point
      - Water exists as either saturated liquid or saturated vapor
    - Saturated vapor/steam
      - Vapor is at boiling temperature of liquid
      - Lowering T at constant P = condensation
    - Superheated steam
      - Water vapor at a T higher than the boiling point
      - When heat is removed, T will lower until it becomes a vapor-liquid mixture

- Steam Tables
  - Tabulated values for properties of saturated and superheated steam

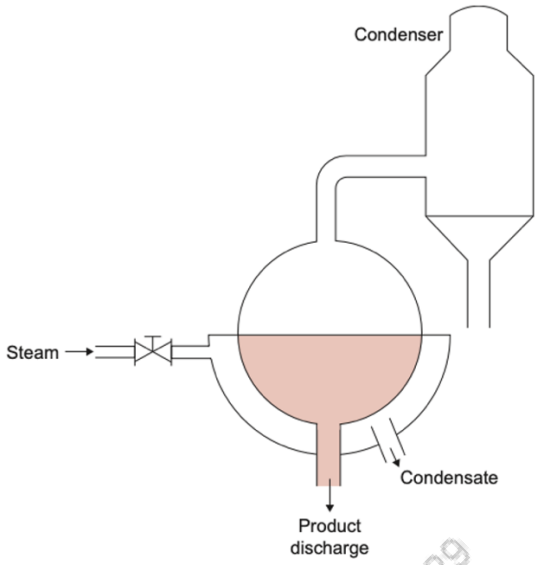
Table A.4.2 Properties of Saturated Steam

Temperature (°C)	Vapor pressure (kPa)	Specific volume (m^3/kg)		Enthalpy (kJ/kg)		Entropy (kJ/[kg °C])	
		Liquid	Saturated vapor	Liquid (H_c)	Saturated vapor (H_v)	Liquid	Saturated vapor
0.01	0.6113	0.0010002	206.136	0.00	2501.4	0.0000	9.1562
3	0.7577	0.0010001	168.132	12.57	2506.9	0.0457	9.0773
6	0.9349	0.0010001	137.734	25.20	2512.4	0.0912	9.0003
9	1.1477	0.0010003	113.386	37.80	2517.9	0.1362	8.9253
12	1.4022	0.0010005	93.784	50.41	2523.4	0.1806	8.8524
15	1.7051	0.0010009	77.926	62.99	2528.9	0.2245	8.7814
18	2.0640	0.0010014	65.038	75.58	2534.4	0.2679	8.7123
21	2.487	0.0010020	54.514	88.14	2539.9	0.3109	8.6450
24	2.985	0.0010027	45.883	100.70	2545.4	0.3534	8.5794
27	3.567	0.0010035	38.774	113.25	2550.8	0.3954	8.5156
30	4.246	0.0010043	32.894	125.79	2556.3	0.4369	8.4533
33	5.034	0.0010053	28.011	138.33	2561.7	0.4781	8.3927
36	5.947	0.0010063	23.940	150.86	2567.1	0.5188	8.3336

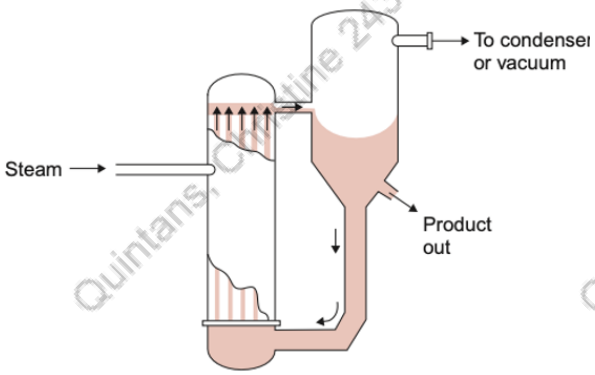
- Evaporation and Evaporators
  - Evaporation
    - Involves the removal of water to concentrate liquids
    - Evaporation vs Dehydration
      - Evaporation removes some amount of water
      - Dehydration involves the complete removal of water
    - Evaporators
      - Equipment used in evaporation

Name:

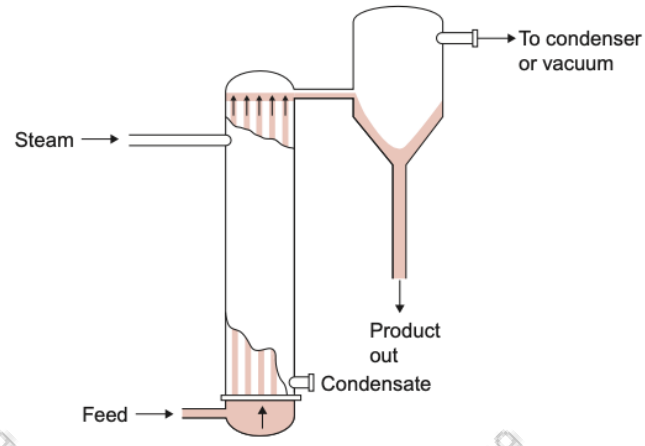
Batch type pan evaporator



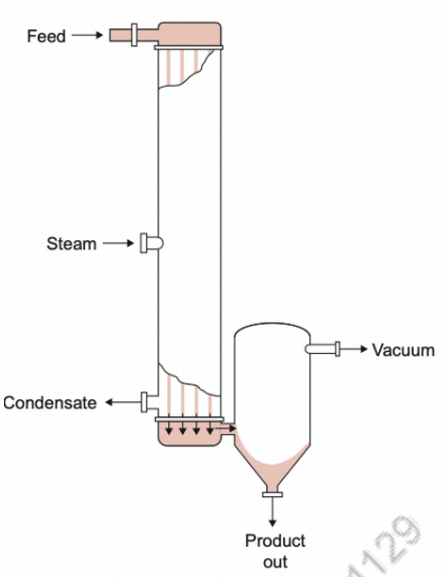
Natural circulation



Rising film

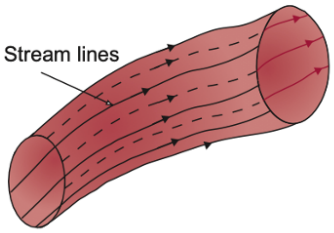


Falling film



Fluids and Fluid Flow

- Fluid Flow in Food Processing
    - Product itself
    - Cleaning agents
    - Aids in transport of materials
    - Heating media, refrigeratns, brine
- Handling Newtonian Fluids
    - Stream Lines
        - Imaginary curve of fluid along which it moves
        - Movement is along the line's direction, not across



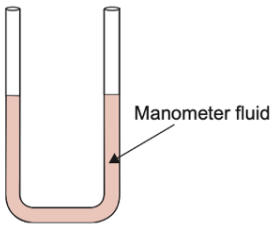
    - Continuity equation
        - Describes the transport of a fluid in a steady, 1-D flow

Name:

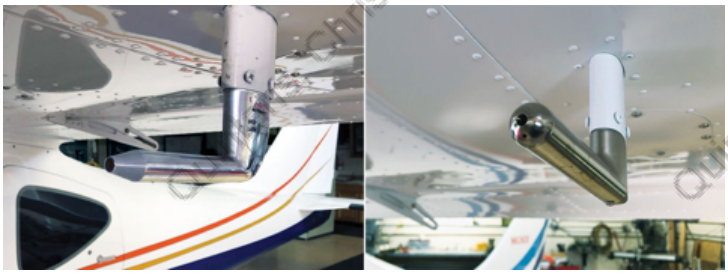
- Example.
  - The volumetric flow rate of a beer flowing in a pipe is 1.8 L/s. The inside diameter of the pipe is 3 cm. The density of beer is 1100 kg/m^3. Calculate the average velocity of beer and its mass flow rate in kg/s. If another pipe with a diameter of 1.5 cm is used, what will be the velocity for the same volumetric flow rate?

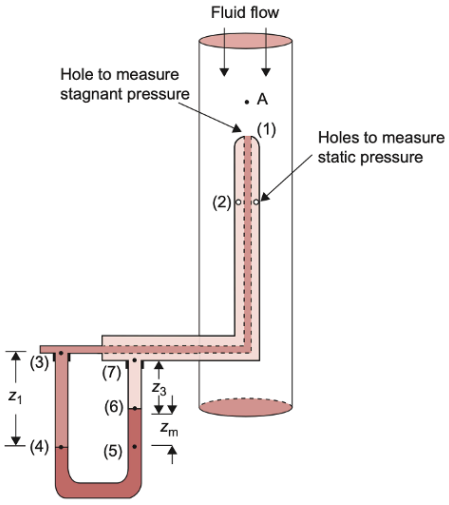
- Reynolds number
  - A dimensionless quantity describing the flow characteristics of a fluid flowing either in a pipe or on the surface of objects of different shapes
  - Ratio of inertial to the viscous forces
    - Laminar: _____
    - Transition: _____
    - Turbulent: _____
  - Example.
    - A 3-cm inside diameter pipe is being used to pump liquid food into a buffer tank. The tank is 1.5 m diameter and 3 m high. The density of the liquid is 1040 kg/m^3 and viscosity is 1600 x 10^{-6} Pa·s. What is the minimum time to fill the tank if the liquid is flowing under laminar conditions in the pipe? What will be the maximum time to fill the tank if the flow is turbulent.

- Flow Measurements
  - U-tube manometer
    - Most commonly used
    - U-shaped tube with small, constant diameter
    - Partially-filled with fluids which is (1) different and (2) much denser from fluid of interest



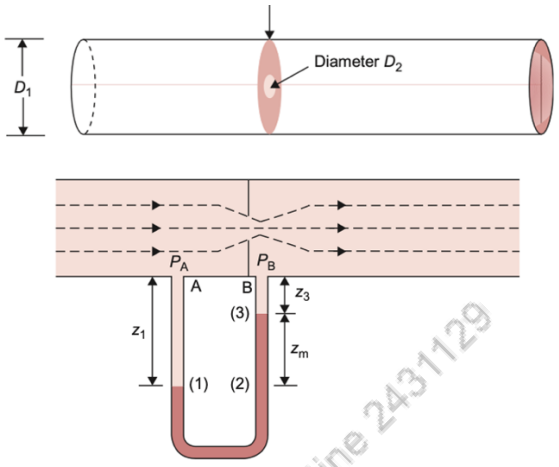
  - Pitot Tube
    - Invented by Henri Pitot during the 1700s
    - Sensor for measuring fluid velocity
    - Used in aircrafts to measure air velocity





Name:

- Orifice Meter
  - Ring introduced into a pipe or tube that reduces cross-sectional area of a tube by a known amount
  - Flow rate measured from the properties of liquid that passes through a reduced diameter orifice of known dimension
  - May have frictional losses



- Venturi Tube
  - Orifice meters suffer from frictional losses due to sudden expansion and contraction
  - Similar in principle to orifice meter but has tapered appearance

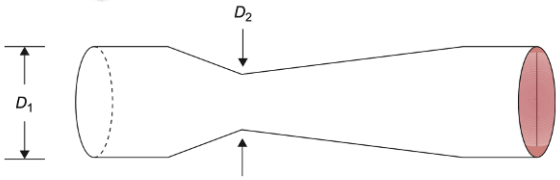


Photo from Tamara Gakl
https://unsplash.com/photos/stainless-steel-spoons-and-spices-on-gray-wooden-table-1VSK-jsU_co

Lecture Guide 2
Methods and Techniques in Food Technology

SENSORY EVALUATION

- Basic Principles in Sensory Evaluation
- Factors Affecting Sensory Measurement
- Difference Test
- Descriptive Test
- Affective Test
- Other Sensory Evaluation Methods and Summary of Applications

Basic Principles in Sensory Evaluation

- Sensory Evaluation- a _____ used to _____, _____, _____, and _____ those responses to products perceived through the senses of _____, _____, _____, _____, and _____ (Stone & Sidel, 2004; Lawless & Heymann, 1998)
    - To evoke- to elicit from the panelists an appropriate response based on study objectives
    - To measure- to quantify and/or gauge the responses from the panelists
    - To analyze- to process (statistically) the data measured
    - To interpret- to make sense of the data so as to convey the meaning of the study results

- Uses of Sensory Evaluation
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____

- Review of Senses
    - Sight - using our eyes is necessary to describe and evaluate appearance and color differences between products
        - General Principle
            1. _____
            2. _____
            3. _____
                - _____ - yield only achromatic (black/white) information
                - _____ - provides chromatic (colored) information
            4. _____
        - Color - perception in the brain that results from the detection of light after it has interacted with an object
            - Affected by three entities: (1) _____ _____, (2) _____ ,and (3) _____ _____.

Name:

- The three dimensions of color are hue (aka "color"), lightness and saturation (Lecture Guide 1)
- _____ - result of lacking one or more of the three color-sensitive pigments in the cone
  - Genes responsible for the cones sensitive to red and green light are on the X-chromosome, thus more men (1 X-chromosome only) are color blind than women

■ Characteristics evaluated

- Color
  - _____
  - _____
  - _____
  - _____
- Appearance
  - _____
  - _____
  - _____
  - _____
- Texture
  - _____
  - _____
  - _____

○ Smell- using our nose is necessary to describe and evaluate the odor differences between products

■ _____ - odor of perfume, cosmetics or flowers
■ _____ - odor of a food product
■ General Principle

1. _____
2. _____
3. _____
4. _____

■ _____ - the ability of the olfactory receptors to sense flavors arising from the mouth and passing through the nasal cavity; highlights the dual role of olfaction as both an external and internal sensory system
■ _____ - the partial or total loss of the sense of smell caused by nasal diseases, sinus infections, viral respiratory diseases, aging, or congenital reasons

○ Taste and Flavor - using our tongue is necessary to describe and evaluate the taste and flavors differences between products

- _____ - gustatory perception (salty, sweet, sour, umami and bitter) caused by soluble substances in the mouth
- _____ - combination of 5 basic tastes; feeling factors and volatile components which reach the olfactory area
- General Principles
  - _____ - nodules or bumps on the surface of the tongue containing the taste buds
  - Taste buds consist of a number of taste cells grouped together in a bud like structure
  - Nerve fibers from the taste cells carry electrical impulses to the brain
  - Mechanisms of taste substances are already discussed in Lecture Guide 1
- _____ - genetically based condition based on the ability of mammals to react to a wide range of molecular structures among various bitter substances
- Effects of taste on another taste
  - NaCl _____ strength of acid; _____ sweetness
  - Acids may _____ sweetness
  - Sugars _____ saltiness and some tastes
- Characteristics evaluated
  - _____
  - _____
  - _____
  - _____ - taste sensation elicited by long chain fatty acids

○ Touch - using several types of nerve endings in the skin; epidermis, dermis and subcutaneous tissues is necessary to describe and evaluate the feel of food products

- _____ - the sensitivity of mucosal surfaces to environmental chemicals; some chemical substances can stimulate the _____ situated in the skin, mouth and nose to give hot, stinging, burning, tingling, cooling, numbing or astringent sensations
  - When sensed in the oral cavity, they form part of what are collectively known as mouth-feel attributes.
- Characteristics evaluated
  - _____ - is an attribute of a substance resulting from a combination of physical properties and perceived by the senses of _____, _____, and _____.
    - Oral texture characteristics
      - _____

Name:

        - _____
        - _____
    - Skin feel texture characters
        - _____
        - _____
        - _____
- Hearing - also affects the acceptability of food products in combination with other senses
    - Same with touch which is used to assess the texture of food products

Factors Affecting Sensory Measurement

- Individual differences
    - _____
        - More females are “supertasters” than males
        - Females tend to have more highly developed language skills
        - Measurements and judgements made by female assessors, particularly in relation to flavor and odor properties, were shown to be more inconsistent (related to pregnancy or menstrual cycle)
    - _____
        - Taste, smell, sound, and sight sensitivities decrease with age
        - Young children and babies may have strong reactions to some odors and flavors
    - _____
        - Hungry people were shown to find certain foods more acceptable and to be more influenced by odors
        - Illness can markedly affect perception
        - Dentition has an effect in chewing behavior
    - _____
        - Likely to influence sensory perceptions
        - Sensitivity to phenylthiocarbamide (PTC) and 6-n-propylthiouracil (PROP)
    - _____
        - People tend to crave for sugary snacks when under stress
        - In focus group discussions and descriptive analysis, extroverted people are more outspoken when it comes to their opinion on the food being evaluated
        - Participants who are people pleasing might give more positive responses just to prevent the analyst from being upset

- Biases and errors
  - _____ - human mind tries to relate the current stimulus perception when the same sensation was encountered
  - _____ - arises when an assessor is keen to note a difference in products, expects to find difference and feels that he or she has the right answer
  - _____ - there should be a standard format for product presentation and panelist should not have any background information about the test
  - _____ - should be balanced so that each of the possible order combinations is presented an equal number of times and randomized so that each panelists' presentation order is allocated at random
  - _____ - happens when there is more than one question being asked about the food quality which lead to having a possibility that responses will not be completely independent
  - _____ - comes from assessors believing that two or more product attributes are logically linked
  - _____ - when there is short-term exposure to a given sensory stimulus or when too many samples are presented with a given stimulus
  - _____ - loss of sensitivity due to long-term exposure to a given sensory stimulus
  - _____ - assessors might try to provide answers which they think will make the panel leader happy
  - _____ - answer of one panelist may be influence through the verbal and facial expression of the other panelist
  - _____ - when assessors are distracted, the accuracy of their judgments is diminished
  - _____ - assessors rate samples using the middle point of scale and avoid using the extreme ends
  - _____ - subjects rate the differences between samples greater (or lesser) than they actually are

- Personality and attitude
  - _____ - social background, cultural experiences, and religious belief can affect sensory perceptions
  - _____ -assessor's performance in group activities will be greatly influenced by an introvert or extrovert personality
  - _____ -innate aspect of an individual's personality but is highly influenced by the environment
  - _____ -subconsciously influences an assessor's performance by reducing their concentration, and therefore, their ability to discrimination

Name:

General Requirements for Sensory Evaluation

- Sensory testing environment
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____
    6. _____
    7. _____
    8. _____
    9. _____
- Test protocol
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____
    6. _____
    7. _____
    8. _____
    9. _____
    10. _____
    11. _____
    12. _____
    13. _____
    14. _____
    15. _____
    16. _____
    17. _____
    18. Consider the use of _____ [materials that form a base or vehicle for the food being tested such as breads (for sandwich spreads) and rice (for viands)] when evaluating samples

- **Experimental design**
    - Consider the following when choosing the experimental design:
        - Stating the objectives of the study
        - Test techniques
        - Check for time and cost constraints
        - Scrutinize step by step process, determine possible problems and control such problems

- Statistical requirements

- _____
  - Consists of one large block of experiment units
  - Single product being evaluated at several locations by distinct group of respondents
  - Statistical analysis: _____

- _____
  - If the number of samples is sufficiently small so that sensory fatigue is not a concern
  - Each panelist evaluates all of the samples
  - For ratings: _____
  - For ranks: _____

- _____
  - Compensates for two sources of variability (i.e. judge and session effects)
  - Number of samples must be small enough so that all can be evaluated in each session (< 5)
  - Each panelist must return repeatedly for a number of sessions equal to the number of samples in the study
  - For each panelist, each sample is presented once in each session
  - Across each session, each sample is presented once in each serving position
  - ANOVA considering the judges, sessions, order and the samples

- _____
  - When the total number of samples in the study is greater than the number that can be evaluated before sensory fatigue sets in
  - Panelists evaluate only a portion of the total number of samples
  - Every sample is evaluated an equal number of times, and all pairs of samples are evaluated together an equal number of times
  - If the number of blocks/panelists is relatively small (4 or 5), it is possible to have a small number of panelist return several times until each panelist has completed an entire repetition of the design
  - For large blocks, call upon a large number of panelists and each panelist evaluate the samples in a single block

Name:

- Cochran and Cox (1957) presents some BIB plans
  - t= treatment; k= number of samples per block; b= number of blocks; r= replicates; λ= [r (k-1)]/(t-1), an integer

Plan 11.1 $t = 4, k = 2, r = 3, b = 6, \lambda = 1, E = .67$, Type V

Block	Rep. I		Block	Rep. II		Block	Rep. III	
(1)	1	2	(3)	1	3	(5)	1	4
(2)	3	4	(4)	2	4	(6)	2	3

Plan 11.2 $t = 5, k = 2, r = 4, b = 10, \lambda = 1, E = .62$, Type V

Block	Reps. I and II		Block	Reps. III and IV	
(1)	1	2	(6)	1	4
(2)	3	4	(7)	2	3
(3)	2	5	(8)	3	5
(4)	1	3	(9)	1	5
(5)	4	5	(10)	2	4

- **Panelist consideration**
  - Consider giving incentives to panelist after participating in the sensory evaluation which maybe in the form of treat or snacks depending on the level of participation
  - Ethical considerations should be in place when planning and implementing sensory evaluation (Recall Ethical Requirements in Research)
  - Panelists should be screened and properly selected when conducting analytical tests
    - Matching and description tests:: _____
    - Detection or discrimination tests: : _____
    - Ranking/ Rating Tests: _____
  - Panelist should be trained when conducting analytical tests which may be dependent on the task and level of acuity of individual panelist
  - Panelist performance should be assessed during analytical test by comparing scores of individual to the mean score of the whole panel
  - Other panelist requirements for analytical tests
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____

- _____
- _____
- _____
- _____
- _____
- _____
- _____

- Consider the following factors when looking for untrained panelist for consumer tests:
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____

- **Procedures used in sensory tests**
  - Identifying the problem
    - State objectives
    - Select appropriate methods for sensory evaluation and experimental design
  - Recruit, screen, and select panelists
    - Recruit based on health condition, required demographics, general familiarity with the food, food and eating habits, interest and willingness to participate, availability
    - Screening will determine taste and odor acuity; texture intensity
    - Selection will be based on the screened candidates' ability to discriminate differences in the specific attribute that is being studied at the required level of sensitivity and the ability to repeat this discrimination
    - Performance evaluation will be done to determine potential panelists for further training
  - Training for analytical test
    - Familiarization with the objectives
    - Familiarization with training products
    - Lecture on physiological basis of sensory evaluation, procedures and requirements for sensory
    - Development of descriptive terminology

- Development of descriptive score sheets
- Actual sensory evaluation of training products

- For affective tests of panelists
  - Select untrained panelists from the company staff who are familiar with the qualities of the product being tested
  - A statistically significant size of_____ panelists is recommended in affective tests
  - A panel size of _____ can be used to find acceptability or preference of experimental products prior to large scale consumer testing, this is called _____
- Implementation of sensory tests
  - Prepare score sheets, consent forms, supply list, sign-in sheets, utensils and containers
  - Generate random codes from table of random numbers or by the use of a calculator and label serving containers
  - Determine order of sample presentation and record in worksheet
  - Prepare sensory evaluation room/booths
  - Conduct dry run
  - Serve samples
  - Gather score sheets after each session
  - Analyze the results
- General procedures
  - Evaluate sensory attributes in the order of how they are perceived: _____
  - When reference is presented, always evaluate it first
  - Fill out score sheet as completely as possible
  - Color evaluation
    - Place product under the light source, evaluate at an angle of _____
    - Do color evaluation preferable by placing a sample against a white background
    - Volume presented for color evaluation of liquid should be constant
    - For translucent liquid products, it is best to evaluate color by placing the sample in a white container with a flat bottom, a relatively large surface area, and of small height
    - If there are color difference which can affect the perception on taste or other attributes, use colored lights or darken the room
      - Red light to mask differences in unevenly dark colored products

    - Green or blue light to mask difference in pale products
- Odor evaluation
    - Evaluate odor samples from covered containers in an odorless room
    - Bend body forward until the nose is approximately one inch from the sample
    - As much as possible, avoid holding the sample by the end to avoid interference of ever-present skin odors
    - Smell in short sniffs of about 2-3 seconds using both nostrils, sniff 1-2 times with mouth closed while sniffing
    - Unknown sample: First wave a little of the aroma toward the nose and sniff continuously
    - Rest for at least 30 seconds in-between evaluation of successive samples
- Taste and flavor evaluation
    - Taste the sample slowly so that there is time to characterize the taste/flavor
    - Liquid foods: (1) Sip the liquid; (2) Hold the nose then swirl the liquid around the tongue to test for taste; (3) Exhale, while the liquid is still around the tongue to test the for flavor
    - Solid foods: (1) Hold the nose; (2) Bite a small portion of the sample and chew it to test for taste; (3) Exhale to test for flavor; (4) Spit out or swallow the food
    - Rest for 10 seconds in-between evaluation of successive samples and for at least 60 seconds in-between evaluation of thick-flowing products and those with strong taste
    - Clear the palate to remove all traces of flavor especially after assessing hot, spicy or strong flavored foods
- Texture evaluation
    - Texture of solid products by **finger feel**
        - Hold the sample with the fingers
        - Press or touch it lightly to determine if it is moist, sticky, etc.
        - Wipe the fingers with tissue to remove any traces of product
    - Texture of solid products by **mouth feel**
        - Take a portion, bite and chew
        - Follow instructions, if any, regarding the number of chews to take
        - Take a portion, bite and chew
        - Follow instructions, if any, regarding the number of chews

Name:

to take

- Consistency of liquid products by **mouth feel**
  - Sip and swirl it around the tongue

Difference Test

- Conducted to know if 2 samples are perceptively different or similar especially when differences between samples are subtle
- Examples include Paired Comparison, A not A, Duo-trio, Triangle test, n-AFC (Alternative Forced Choice), Two out of Five

Type of Test	Samples	Instruction	Probability of Correct Response
Difference Paired Comparison			
Degree of Difference			
A not A			
Duo-trio			
Triangle			
n-Alternative Forced Choice (nAFC)			
Two out of five			

- **Paired comparison tests**
  - Two samples are assigned codes
  - Samples may be presented at the same time or one after the other
  - Samples are presented in a random order
  - Panelist is asked to _____ _____ and indicate answer on a score sheet
  - Probability of selecting a specific product, by chance alone (guessing): _____
  - Probability of getting a correct answer by chance alone is _____ since there are only 2 samples being evaluated
  - Directional Paired Comparison (the 2-Alternative Forced Choice)
    - To determine the degree of difference in a specific attribute
    - Results indicate the direction of the specified difference between the two samples
    - The sensory specialist must be sure that the two samples only differ in the single specified sensory dimension
    - Possible serving combination: _____
  - Difference Paired Comparison (Simple Difference Test; Same/Different Test)
    - Samples are presented at the same time
    - To determine whether two samples differ without specifying the dimension of the potential difference
    - Combination of samples in simple difference tests: _____
  - Degree of Difference (Direction of Difference)
    - To determine whether two samples differ in a specific attribute or dimension such as sweetness, crispiness, specific flavor
    - Analyst must be sure that the two samples differ in the single specified sensory dimension
- **A not A tests**
  - Panelists receive and evaluate the first sample and then removed and then presented with the second sample
  - Used when the experimenter cannot make two formulations that have exactly the same color or shape or size despite these attributes (i.e. color, shape, and size) being irrelevant to the objective of the study
  - Alternate A not A test
    - Sequential monadic same/difference test
    - Four serving combinations: _____
    - Used when _____ _____
  - Standard A-not-A Test
    - Training Phase: Panelists receive samples that are A and not A
    - Four versions (after training phase)
      - Monadic: Single sample (A or not A)

Name:

- Paired A-not-A Test (Counterbalanced)
- Replicated (Series of either A or not A samples but not both) *rarely used*
- Replicated (mix of A and not A samples)

- **Duo-trio test**
  - An experimental sample is compared with a reference sample to determine if a significant difference exists between them
  - Three samples are compared instead of two
  - Two samples are reference samples and are identical while the third sample is the odd sample
  - Two coded samples make up a duo and together with the reference or R, the three make up trio hence the name "duo-trio"
  - Of the two identical samples, one sample is coded R to indicate that it is the reference
  - Identification of the reference sample reinforces the panelist's ability to detect difference between two samples
  - Samples must be as homogeneous as possible and as in the paired-comparison test, the difference between the characteristics being evaluated must be small/subtle
  - Probability of getting correct answer by chance (guess alone) is _____, since only two of the three samples are evaluated
  - Panelist are asked to identify the odd sample and indicate their choice in the score sheet
- **Triangle test**
  - Tests similar to duo-trio except reference sample is not identified
  - Panelists are actually evaluating three samples thus probability of getting correct answer is _____
  - Only shows presence and absence of difference
- **n-Alternative Forced Choice (nAFC)**
  - Similar to a directional triangle method
  - Panelists receive 3 samples and they will choose which sample is higher or lower on a specified dimension
- **Two out of five test**
  - Panelists receive 5 samples and they have to sort the samples into 2 groups
  - One group contains the 2 samples that are the same and 3 other samples in one group
  - Probability of choosing the correct answer is _____
  - Main disadvantage is possibility of sensory fatigue (panelists need to do replicate evaluations)

- Useful when comparing samples on tactile and appearance properties but not flavor or aroma

- **Statistical considerations for discrimination tests**

	Examples	**Minimize**
Testing for difference	Formulation of a better product	Type I error Rejecting the null hypothesis (new product is the same as the old product) when it is true Desired Outcome: The new product is different from the current product which might actually be better given the evidence
Testing for similarity	Substitution of more expensive ingredient with cheaper alternative	Type II error Accepting the null hypothesis (cheaper ingredient can replace the premium ingredient) when it is false Desired Outcome: The cheaper ingredient can actually replace the premium ingredient given the evidence

	Examples	**Consideration**
Testing for difference (to know whether there is perceptible difference between 2 samples)	Fresh VS Stored Samples Control VS Treated Sample	Assumption that only the α-risk matters. β-risk and proportion of distinguishers (p_d) are ignored A small value for the α-risk and accepts arbitrarily large values for the β-risk and p_d (by ignoring them) to keep the required number of assessors within reasonable limits
Testing for similarity	Substitution of a more expensive ingredient with a cheaper alternative -Use of a premium mango flavor with a cheaper mango	Selecting a value for p_d and then specifying a small value for β-risk to ensure that there is only a small chance of missing that difference—if it really exists The α-risk is allowed to become large to keep the number of assessors within reasonable limits

α-risk and (β-risk)	**Maximum allowable proportion of distinguishers, P_D**
• 10-5% (0.10-0.05)- moderate evidence that a difference is apparent (not	• P_D < 25% represent small values • 25% < P_D < 35% represent medium-

Name:

apparent) ● 5%-1% (0.05-0.01)- strong evidence ● 1%-0.1% (0.01-0.001)–very strong evidence ● Below 0.1% (<0.001)- extremely strong evidence	sized values ● P_D > 35% represent large values

- Adjusted Chi-square (X^2) test
  - Continuity correction needed as X^2 distribution is continuous and observed frequencies from discrimination tests are integers
  - Not possible for ½ person to get the right answer and so the statistical approximation can be off by as much as ½ , maximally

Example: Using adjusted chi-square, assess whether there is a significant difference between two juice samples subjected to simple difference test wherein 26 out of 50 respondents were able to give correct responses.

- Binomial test

Example: Using binomial test, assess whether there is a significant difference between two juice samples subjected to simple difference test wherein 26 out of 50 respondents were able to give correct responses.

- Z-test on proportion
  - Used when n ≥ 30

Example: Using Z-test on proportion, assess whether there is a significant difference between two juice samples subjected to simple difference test wherein 26 out of 50 respondents were able to give correct responses.

- Use of tables based on minimum number of correct judgments
  - Based on binomial distribution

Example: Using the table of minimum number of correct judgements on the next page, assess whether there is a significant difference between two juice samples subjected to simple difference test wherein 26 out of 50 respondents were able to give correct responses.

Name:

Table 4.3 Minimum numbers of correct judgments[a] to establish significance at probability levels of 5 and 1% for paired difference and duo–trio tests (one tailed, $p = 1/2$) and the triangle test (one tailed, $p = 1/3$)

Paired difference and duo–trio tests			Triangle test		
Number of trials (n)	Probability levels		Number of trials (n)	Probability levels	
	0.05	0.01		0.05	0.01
5	5	–	3	3	–
6	6	–	4	4	–
7	7	7	5	4	5
8	7	8	6	5	6
9	8	9	7	5	6
10	9	10	8	6	7
11	9	10	9	6	7
12	10	11	10	7	8
13	10	12	11	7	8
14	11	12	12	8	9
15	12	13	13	8	9
16	12	14	14	9	10
17	13	14	15	9	10
18	13	15	16	9	11
19	14	15	17	10	11
20	15	16	18	10	12
21	15	17	19	11	12
22	16	17	20	11	13
23	16	18	21	12	13
24	17	19	22	12	14
25	18	19	23	12	14
26	18	20	24	13	15
27	19	20	25	13	15
28	19	21	26	14	15
29	20	22	27	14	16
30	20	22	28	15	16
31	21	23	29	15	17
32	22	24	30	15	17
33	22	24	31	16	18
34	23	25	32	16	18
35	23	25	33	17	18
36	24	26	34	17	19
37	24	26	35	17	19
38	25	27	36	18	20
39	26	28	37	18	20
40	26	28	38	19	21
41	27	29	39	19	21
42	27	29	40	19	21
43	28	30	41	20	22
44	28	31	42	20	22
45	29	31	43	20	23
46	30	32	44	21	23
47	30	32	45	21	24
48	31	33	46	22	24
49	31	34	47	22	24
50	32	34	48	22	25
60	37	40	49	23	25
70	43	46	50	23	26

Descriptive Test

- Defines the sensory properties of a target product for new product development
- Defines the characteristics/specifications for a control or standard for QA/QC and R&D applications
- Document product attributes before a consumer test to help in the selection of attributes to be included in the consumer questionnaire and help in the explanation of results of consumer tests
- Track a product's sensory changes over time with respect to understanding shelf-life, packaging, etc.
- Correlation with instrumental and physico-chemical properties of a product
- Need for trained panel
    - Most usual type for conducting descriptive testing
    - More capable of describing the subtle differences between samples
    - Used in discrimination tests in the assessment of larger number of products or tests involving complex instruction, because they are less likely to suffer fatigue
    - Cannot be used in acceptability or preference tests
- Requirements for Descriptive Tests
    - _____
    - _____
    - _____
    - _____
- Components of Descriptive Tests
    - Qualitative Aspects - Characteristics
        - Words used: attributes, characteristics, character notes, descriptive terms, descriptors, terminology
        - Include terms which define the sensory profile or picture of the sample
        - Validity and reliability are dependent on:
            - _____ _____ _____
            - _____ _____ _____
            - _____ _____ _____
            - _____ _____ _____

Name:

- Quantitative Aspects - Intensity
  - Expresses the degree to which each of the characteristic is present
  - Expressed by the assignment of some value along a measurement scale
  - Validity and reliability are dependent on:
    - _____
      _____
      _____
    - _____
      _____
      _____
    - _____
      _____
      _____
- Order of appearance
  - Panels can often detect differences among products in the order in which certain parameters manifest themselves

- Selection of sensory panel members for descriptive tests
  - Prerequisite
    - _____
      _____
      _____
      _____
    - _____
      _____
      _____
  - Recruitment procedures
    - _____
    - _____
    - _____
    - _____
  - Recruitment criteria
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____

- Screening of panelists: Guidelines
  1. _____
     _____
  2. _____
     _____
  3. _____
     _____
  4. _____
     _____
  5. _____
     _____
  6. _____
     _____
  7. _____
     _____
  8. _____
     _____

- Screening of panelists: Test methods
  - Basic taste recognition test
    - 2% sucrose, 0.07% citric acid, 0.2% sodium chloride and 0.07% caffeine
    - Plus one or two taste replicates to prevent guessing of taste qualities (same time presentation)
    - Include blank taste (distilled water)
    - Score of _____ is required
  - Odor recognition test
    - Five to ten odorants per session (e.g. coffee, orange, peppermint)
    - Presenting more familiar odors within initial sessions
    - Ratings of pleasant or unpleasant are unacceptable
  - Intensity ranking
    - Rank the samples in order of increasing concentration
    - Performance of the tested: find deviation from average of the group
    - Low deviation does not mean that judge is reliable
    - Can also indicate lack of discrimination between samples
    - When mean scores are different and there is low deviation from the mean, the judge may be considered reliable

- Training of panelists for descriptive tests
  - To familiarize an individual with test procedures
  - Improve ability to recognize and identify sensory attributes in complex food system

Name:

- Improve sensitivity and memory to be able to provide precise, consistent, and standardized sensory measurements which can be reproduced
- Panel member orientation
  - Should be provided with a suitable training environment
  - Should understand importance of the test
  - Should concentrate and allow sufficient time to complete the tasks
  - Test participants should avoid strong taste sensation and contact with odorous materials for at least 30 min prior to an evaluation (e.g. smoking, drinking, coffee, using mouthwash)
  - Should wash their hands with an odorless soap prior to the odor evaluations
  - Should avoid the use of perfumed cosmetics or lotions and may be requested to remove lipstick before testing
  - Panelists should report illnesses such as colds, nasal congestion, allergies, headaches or the use of medication
  - Panelists should learn to be objective and to disregard likes and dislikes (in case of evaluating distasteful products)
- Training in the use of test methods
  - Should be familiarized with the product being tested and the specific procedure of the test
  - This may require individual and group sessions, use of reference samples and discussion and exchange of information
  - Training time is a function of the product, the test procedure being used and the capability of the panelists
  - Preliminary training includes an introduction to the fundamental principles of chemical, physiological, and psychological information affecting sensory evaluation
  - Training is followed by actual product evaluations, the use of reference samples and open discussion of results
  - The training continues with the development of a product attribute vocabulary, intensity scaling, the order of appearance of attributes, aftertaste and total product effect “amplitude”
  - After a vocabulary is defined by the group, specially prepared samples may be introduced which show specific variations in certain attributes such as sweet taste, floral fragrance, or crisp texture.
  - In developing a general vocabulary, panelists are exposed to samples which are representative of the product to be described and thus develop terminology or vocabulary to describe normal products
  - As training proceeds, samples of ingredients may be introduced to serve as reference material defining certain sensory characteristics. However,

these are not presented until they are thoroughly familiar with the product, due to the bias that the group will expect certain attributes

- Samples of competitive products may also prove useful in increasing training groups experience with product being described in certain attributes
- If age or packaging in any way affect the sensory characteristics of the products being described, it is desirable to examine products which demonstrate these variables.
- The scale used depends on the sensory analyst (i.e., line or category scale)
- The performance of the judges and the effectiveness of the descriptive terms developed by the group are checked through statistical analysis of about 4 replicated sets of training data.
- One or more corrective sessions are then held to clarify any confusion by the judges or the usage of terms.

- Training for specific techniques
  - Sniffing techniques
    - Panelists should take short sniffs and avoid long, deep inhalations
    - Judges should sniff enough times to reach a decision but not so often as to become confused or desensitized
    - For most samples, three short sniffs are recommended
    - Judges should keep mouths shut while sniffing
    - Panelist may sniff his or her own unscented arm or hand as a blank between samples
    - The adaptive time will vary depending upon the product being tested but will generally be less than 30 s
  - Tasting techniques
    - The amount of sample a judge puts in his mouth should be standardized and must be adequate for evaluation
    - For some samples, such as those with slow-developing flavors, it is important that the sample be kept in the judge's mount a certain amount of time before being swallowed or expectorated
    - All judges should retain the sample for the same amount of time
    - Swallowing is desirable for taste and odor release but can cause fatigue when several samples are evaluated
    - Safety considerations would also affect the test
    - Rinsing should be standardize - each panel member within a test should rinse between samples or no one should rinse at all
    - If a judge rinses before one sample, he/she should rinse before all samples Interval between samples should be standardized
  - **Texture evaluation techniques**

- Standard terminology used by panelists is based on the classification of mechanical and geometric characteristics
- Standard procedure for evaluation of a product are also developed by the panel
- Forces used in the mouth to manipulate and masticate the product must also be standardized

- **Monitoring: Training of panelists**
  - During the training period, data are collected from individual panel member's evaluations of repeated samples
  - These data enable the panel leader to monitor the performance of the individual panelists and of the panel as a whole
  - The panel leader can check on consistent use of terms, intensities, and the order of appearance
  - If any panel member or the entire panel has difficulties in any of these areas, additional training sessions can be conducted to examine and correct areas of difficulty
  - The treatment of the responses is accomplished by means of one-way and two-way ANOVA as well as by measuring the amount of interaction associated with each subject's responses
  - Before considering whether there are product differences, it is appropriate to consider the results of the one-way ANOVA across samples for each subject for each characteristic
  - The probability values derived from F-ratios of the one-way analyses indicate the individual contribution to the discrimination of differences among products for each individual scale (characteristic)
  - The smaller the probability value, the more contribution the individual makes in the discrimination of differences among the products
- **Actual testing**
  - When the panel leader decides that the group is ready to begin formal descriptive analysis, the judges start replicated evaluations of the coded test products in individual taste panel booths under controlled conditions
  - Samples are presented one at a time in a balanced random order
  - The number of replicated judgments obtained varies with the degree of experience of the group but is usually between six to ten replications.
  - A group being used for the first time may require _____ replications whereas experienced groups may produce reliable descriptive data with _____ replications

- Traditional methods of descriptive analysis

- _____
  - Trademarked to Arthur D. Little and Co., MA in the late 1940s
  - A consensus technique
  - The vocabulary used to describe the product and its evaluation itself are achieved by reaching an agreement among the panel members
  - It considers the overall flavor and the individual detectable flavor components of a food system
  - Profile describes the overall flavor and flavor notes and estimates the intensity and amplitude (overall impression) of these descriptors
  - Provides tabulation of the perceived flavors, their intensities, order of perception, their aftertastes and overall impression (amplitude)
    - _____ - one or two flavor impressions that are left on the palate after swallowing (panel rates aftertaste 1 min after food is swallowed
    - _____ - overall impression of balance and blending of the product
  - General procedure
    1. _____
       _____
    2. _____
       _____
    3. _____
       _____
    4. _____
       _____
    5. _____
       _____

Name:

- Intensities of the perceived flavor notes are rated on the following scale (has been expanded with up to 17 symbols including the use of arrows, ½'s or plus or minus symbols)

Rating	Explanation
0	Not present
)(	Threshold or just recognizable
1	Slight
2	Moderate
3	Strong

- Order in which the flavor notes are perceive are indicated on the tabulated profile
- Consensus is made not by averaging scores but by discussion and reevaluation of the products by the panelists and panel leader
- _____ - is another form of FP in which data can be statistically analyzed (e.g. ANOVA) but is also possible to derive a FP-type consensus description
- Proper training of panel and panel leader is critical in both PAA and FP to produce accurate results

- _____
  - Developed during 1970s to correct some perceived problems associated with Flavor Profile Analysis
  - Data are **not generated by consensus discussions**, panel leaders are not active participants (only facilitator) and unstructured line scales are used to describe the intensity of rated attributes
  - General procedure
    1. _____
       _____
       _____
    2. _____
       _____
       _____

3. _____
_____
_____
4. _____
_____
_____
5. _____
_____
_____
6. _____
_____
_____
7. _____
_____
_____

- A graphic line scale (6-inch) anchored with word generated by the panel is used during evaluation
- Data can be analyzed using ANOVA and other multivariate statistical techniques.
- It is necessary for judges to replicate judgements up to 6 times in some cases
- May be used to completely describe the sensory sensations with a product from initial visual assessment to aftertaste
- QDA trainings take less time than FP
- Graphical presentation of data often involves the use of "cobweb" graphs (a.k.a. radar)
- Advantages include panelists being able to perform individual judgements, results are not consensus derived, panel language development being free of panel leader's influences and based on consumer language descriptions

○ _____

- Sensory analysis of the texture complex of a food in terms of its mechanical, geometrical, fat and moisture characteristics, the degree of each present and the order in which they appear from first bite through complete mastication (Civille and Liska ,1975)
- Created during the 1960s and subsequently modified by several sensory specialists
- Devised using engineering principles
- Rating scales associated with the textural terms are standardized

- Within each scale, the full range of a specific parameter is anchored by products having the specific characteristic as a major component
- Reference product must be instrumentally evaluated to determine whether it conforms to the intensity increments for the specified scale
- Reference scale anchors both the range and concept for each term
- It's important that the frame of reference for all panelists be the same

- _____
  - Developed by Gail Civille while working at General Foods (1970s)
  - Panelists do not generate a panel specific vocabulary to describe sensory attributes of products but that they use a standardized lexicon of terms.
  - Language used to describe a particular product is chosen prior and remains the same for all products within a category over time
  - Scales are standardized and anchored with multiple reference points
  - Panelists are trained to use the scales identically
  - Panel leader has a more directive role and provides extensive information on the product ingredients
  - Judges are exposed to a wide variety of the products in the specific category
  - Panelists are provided word lists (lexicons) that may be used to describe perceived sensations associated with the samples
  - Panelists use intensity scales that are absolute and numerical, usually 15-pt scales
  - Scales are created to have equi-intensity across scales (e.g. 5 on the sweetness scale is equal in intensity to a 5 on the salty scale and equal in intensity to a 5 on the fruity scale)
  - Reference points are chosen to represent different intensities on the scale continuum
  - Panelists are "tuned" to act like true instruments
  - After training, all panelists must use the scales in an identical fashion
  - Testing is performed in isolated booths

- _____
  - Created by British sensory scientists during the 1980s
  - Requires that each panelist creates his or her own **idiosyncratic** list of descriptive terms
  - Panelist are allowed to evaluate the products in different ways
  - The individually generated terms need only be understood by the specific panelist

- Each sensation is rated on a scale using terms of the panelists own devising
- Evaluations are performed in individual booths, under standard conditions
- Statistical treatment of the score are mathematically manipulated through the use of a procedure known as the Generalized Procrustes Analysis (GPA)
- GPA usually provides a consensus picture of the data from each individual panelist in 2 or 3 dimensional space
- Advantages include no panel training required, fasted and less expensive, and panelists' potential to use words with unique meaning may allow for a more complete analysis
- Major disadvantage of having an idiosyncratic nature of the vocabularies which may make interpretation of the sources of individual flavor notes difficult

  - _____
    - Employs general guidelines used in QDA and Sensory Spectrum
    - General procedure
      - Training (Calibration of Panelists)- mean, standard deviation
      - Evaluation of samples- means
        a. To eliminate panelists : One way ANOVA across attributes of all samples per panelist ($p < 0.05$)
        b. Samples: One way ANOVA across panelist per attribute ($p < 0.05$)

- Novel methods of descriptive analysis
  - _____ builds on _____ so assessors are allowed to use their own attributes; generates direct description of the products without the attributed and scaling alignment
    - _____
      - Developed in 2000 by Siefermann (France)
      - Participants rank the attributes instead of measuring their intensities
      - Involves 2 sessions with 1 inter-session where samples are presented simultaneously: (1) Generate attributes sufficiently discriminant to permit ranking; (2) Rank order from least to most per attribute
    - _____
      - Originated from Coomb in 1964
      - Assessors should select all attributes (generated from FGDs or open-ended questions) appropriate to describe the product

Name:

- Attributes not constrained to sensory aspects but could also be related to hedonic and emotional aspects
- Products presented one at a time

- _____ - rely on the global perceptual step first then verbalization of the differences between products occur in the second step or can be omitted
  - _____
    - All samples presented simultaneously and randomly displayed on a table with a different order per assessor
    - Assessors sort samples in mutually exclusive groups based on product perceived similarities
    - Assessors use own criteria and can make as many groups as they want and put as many products as they want in each group
    - After grouping, assessors provide a few terms to characterize each group
    - Pre-established list can be provided
  - _____
    - Process in which panelists group samples on a two-dimensional plane according to their similarity
    - All samples presented simultaneously and randomly displayed on a table with a different order per assessor
    - Assessors are asked to evaluate all products and position the products on an A3 white sheet of paper (60 cm x 40 cm) according to similarities and dissimilarities between these products
    - If perceived identical, products should be placed very close to each other and far apart if different
    - Each assessor chooses own criteria
    - After positioning, describe each product by writing a few words in the sheet near the product

- _____ - addresses the issue of previous methods not enabling data aggregation as all samples need to be presented at the same time
  - _____
    - Replaces a large number of sensory attributes by a few prototypical products or references that will act as "meta-attributes"
    - Assessors first receive the 3 reference products and products are presented one at a time

- Assessors evaluate each product and the 3 references on a continuous scale
- Dissimilarity between products and references are revealed

■ _____

- Allows for a rich description of the products but data interpretation calls upon textual analyses which is difficult and time consuming
- Assessors receive first the reference product and products are presented one at a time
- Assessors evaluate each product and the reference
- Assessors write down each attribute that the product has in smaller or larger amount than the reference product
- Assessors are asked to use only descriptive words without any sentence and negative form not allowed
- Reference is chosen within the range of products to be evaluated

Comparing novel and traditional methods of descriptive analysis

Traditional Methods	**Novel methods**

Name:

Consumer/Affective Test

- To assess the personal response (preference or acceptance) of current or potential customers to a product, a product idea, or specific product characteristics
- Used in product maintenance, product improvement/optimization, development of new products, assessment of market potential, product category review or benchmarking, and support for advertising claims (ex. *9 out of 10 moms prefer Brand X over Brand Y*)

- Types of Consumer/Affective Test

Quantitative	**Qualitative**

- **Quantitative tests**
  - _____
    - Acceptance is defined as the experience or feature of experience characterized by a positive attitude toward the food
    - Actual utilization (such as purchasing or eating) by food consumers
    - Measurement is inferred from scale ratings
    - Can be made on single products and do not require comparison to another product
    - Questions asked " How much do you like the product?" or "How acceptable is the product?"
    - Gives an estimate of product acceptance based on the product's sensory properties without the effect of the other factors, which can enhance its acceptance
    - _____ including 5-, 7-, and 9-point facial scale for children
    - _____ measures acceptance of a product by a population; measure of general attitude toward a product; includes action as well as affective type
    - Statistical analysis
      - Up to 7 point hedonic scale: non parametric tests
      - 9 point hedonic scale: parametric tests
  - _____
    - Refer to all affective tests based on a measurement of preference or measurement from which relative preference may be determined
    - Defined as an expression of higher degree of liking, choice of one object over others and psychological continuum of affectivity (pleasantness/unpleasantness) upon which such choices are based
    - Measure the appeal of one food or food product over another
    - Questions asked are "Which sample do you prefer?" or "Which sample do you like better?"
    - Useful when one product is compared directly against another, such as in product improvement or against competing products
    - _____
      - Two samples are presented simultaneously or rarely sequentially, and panelists are asked to indicate which of the two products is preferred

- Tests instructions may or may not force the panelist to make a decision
- Easy to organize and implement
- Two orders of presentation: AB and BA
- Provides less information than a rating test, less efficient
- Analysis: _____

- _____
  - Three or more samples are presented simultaneously, and the panelists are asked to assign an order to the samples according to his or her preference
  - Can only give relative preference among samples tested at any one time
  - Amount of liking for individual samples cannot be adequately determined (high ranked sample does not necessarily correspond to a high acceptance rating
  - Analysis: _____t

- Quantitative Test by location
  - _____- done within the premises of the laboratory or company
  - _____- conducted in one or more, often several locations away from the sensory laboratory and are accessible to the public; Variation - use of mobile laboratory
  - _____- requires research to be conducted in the participant's own homes

- **Qualitative tests (Focus group discussion)**
  - Small groups (3-12) of consumers are used to obtain information about their reaction to products and concepts, and investigate various other aspects of respondent's perceptions and reactions
  - Determine product attributes that consumers think are important and should be maximized in the product, characteristics that consumers do not like
  - Distinguishing feature is the unstructured approach
  - Can be used for optimization of a product's acceptance, early assessment of a concept or prototype, facilitating quantitative research, and gathering extensive information about a product category
  - Advantages
    - Flexibility
    - Provides observation of real consumers in an interactive setting

- Involves fewer participants compared to quantitative methods
- Can be arranged on short notice and at a lower cost
- Statistical analysis is unnecessary

- Disadvantages
  - Results are not quantitative
  - Sample size is small thus results are not projectable
  - Participants do not represent the target market
  - Topics and direction of the discussion are moderator dependent
  - Careful interpretation of the data is crucial
- Requirements
  - Basic structural requirements for sensory evaluation
  - Panel moderator
    - Qualified and objective
    - Friendly and a good listener
    - Can handle diverse opinions and personalities
    - Flexible and responsive
    - Assertive but diplomatic
- General procedure
  1. _____
  2. _____
  3. _____
  4. _____
  5. _____
- Problems in focus groups
  - Dominant participants
  - Nonparticipants
  - Unqualified respondents
  - Low energy groups
  - Legal issues
  - Misuse of focus group results

Other Sensory Evaluation Methods and Summary of Applications

- Threshold tests
  - _____- concentration range existing which the odor or taste of a substance will not be detectable under any practical circumstance, and above which individuals with a normal sense of smell or taste would readily detect the presence of the substance
    - _____- is the lowest sensation capable of producing a sensation; weakest taste, softest sound

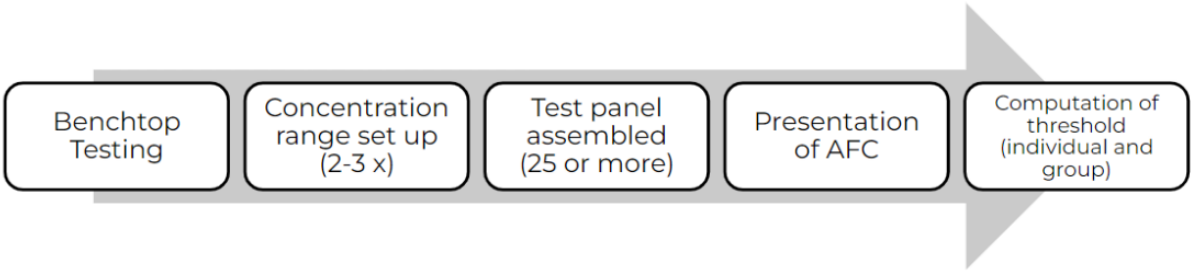
Name:

- _____- is the level of stimulus at which the specific stimulus can be recognized and identified; usually higher than the absolute threshold
- _____- is the extent of change in the stimulus necessary to produce a noticeable difference; present a variable stimulus compared to a standard stimulus
- _____- is the magnitude of stimulus above which there is no increase in the perceived intensity of the appropriate quality of the stimulus

- Application of threshold tests
  - _____
  - _____
  - _____
  - _____

- Complications encountered when conducting threshold tests.
  - _____
  - _____
  - _____
  - _____

- Methods for threshold tests
  - _____
    - Subjects choose the target sample among 3 samples, 2 of which are blank.
    - Based on ASTM E-679 (Standard Practice for Determining Threshold)
    - To find the minimum level (minimum concentration) of a substance that is detected by 50% of the sample group.



        - _____ is the geometric mean of last incorrect answer and 1st correct answer with succeeding correct answers.
        - _____ is the geometric mean of individual threshold; antilog of the mean of logs (individual threshold)
    - _____
        - 5 correct pairs required to score the concentration as correctly detected.
        - Threshold: Lowest correct set with confirmation at next concentration
- _____
    - Use of combination gas chromatography with odor port sniffing of a dilution series
    - Subjects respond to an odor perceived when sniffing the exit port during a GC run
    - Threshold: Nonresponse on descending concentration runs

- Time Intensity Methods
    - An attempt to provide the panelists with the opportunity to scale their perceived sensations over time
    - Provides potentially important temporal information about perceived sensations
    - Sensory scientist can quantify the continuous perceptual change that occur in the specified attribute over time
    - Applications include: (1) Flavor sensation tracking, (2) Texture and phase changes, (3) Taste and odor adaptation, (4) Flavor release, and (5)Temporal aspects of hedonics
    - TI obtains the following:
        - _____
        - _____
        - _____
        - _____
    - Approach I
        - _____
          _____

Name:

_____
_____
_____
_____

- Approach II
  - _____
    _____
    _____
    _____
    _____
    _____
- Approach III
  - _____
    _____
    _____
    _____
    _____
    _____

- Summary of applications

Type of Problem	Type of Challenge	Test Applicable
How do I know what kind of products I should make?	New product development—the product development team needs information on the sensory characteristics and also on consumer acceptability of experimental products as compared with existing products in the market	
How do I match my product to an existing product on the market?	Product matching—here the focus is on proving that no difference exists between an existing and a developmental product	
How do I determine the direction in which I need to move my product to improve it?	Product improvement: 1. Define exactly what sensory characteristics need improvement. 2. Determine that the experimental product is indeed different. 3. Confirm that the experimental product is liked better than the control	
If my company changes the manufacturing	Process change: 1. Confirm that no difference exists.	

process, how do I know if this will affect my product?	2. If a difference does exist, determine how consumers view the difference.	
If I substitute a lower-cost ingredient with a more expensive one, how do I know if my product has changed?	Cost reduction and/or selection of new source of supply: 1. Confirm that no difference exists. 2. If a difference does exist, determine how consumers view the difference	
How do I ensure that the quality of my product is maintained during all stages of production?	Quality control—Products sampled during production, distribution, and marketing are tested to ensure that they are as good as the standard: Descriptive tests (well-trained panel) can monitor many attributes simultaneously	

Type of tests	Application
	Two samples not visibly different; one of the most used difference tests; **statistically efficient, but somewhat affected by sensory fatigue and memory effects**; generally 20– 40 subjects, can be used with as few as 5–8 subjects; brief training required.
	Two samples not visibly different; **test has low statistical efficiency but is less affected by fatigue than the triangle test;** useful where product well known to subjects can be employed as the reference; generally 30 or more subjects, can be used with as few as 12–15; brief training required.
	Two samples not visibly different; **test has low statistical efficiency but is suitable for samples of strong or lingering flavor**, samples that need to be applied to the skin in half-face tests, and samples that are very complex stimuli and are therefore confusing to the subjects; generally 30 or more subjects, can be used with as few as 12–15; brief training required
	Similar to simple difference test but **used where one of the samples has importance as a standard or reference product**, is familiar to the subjects, or is essential to the project as the current sample against which all other samples are measured.
	Use triangle test, duo-trio and two-out of five tests; when the test objective is to prove that no perceptible difference exists between two products; used in situations such as (1) the substitution of a new ingredient for an old one that has become too expensive or unavailable or (2) a change in processing brought about by replacement of an old or inefficient piece of equipment
	One of the most used attribute difference tests; used to show which of two samples has more of the attribute under test ("directional difference test") or which of two

Name:

	samples is preferred ("paired preference test"); test exists in one- or two-sided applications; generally 30 or more subjects, **can be used with as few as 15 panelists**
	Similar to 2-AFC but **more stimuli are presented**; used to show which of the samples has more of the attribute under test or which of the samples are preferred; test exists in one- or two-sided applications; number of subjects depends in part on the number of stimuli presented
	Used to rank three to six, certainly no more than eight, samples according to one attribute; ranking is simple to perform, but results are not as actionable as those obtained by rating; two samples of small or large difference in the attribute will show the same difference in rank (i.e., one rank unit); **ranking is useful to presort or screen samples for more detailed tests;** generally 16 or more subjects, can be used with as few as 8
	Similar to simple difference test but **used where one of the samples has importance as a standard or reference product**, is familiar to the subjects, or is essential to the project as the current sample against which all other samples are measured.
	In situations where many and varied samples must be judged by a few highly trained tasters
	In situations such as quality assurance in a large company, where large numbers of the same kind of products must be judged day in and day out by a well-trained panel; in product development in situations where reproducibility over time and place is not required
	In consumer testing when it is desirable not to teach the subjects a common scale. Consumers rate the intensities of the attribute.
	A custom-design system for most applications, including those under the FP, TPA and QDA; suitable where reproducibility over time and place is needed
	In consumer testing when it is desirable not to teach the subjects a common scale. Consumers order the products by the intensities of specific attributes.
	In testing when it is desirable not to teach the subjects a common scale. Consumers place similar products near each other and dissimilar products far from each other on a matrix. Consumers are asked to describe the samples but are instructed to avoid hedonic terms.
	In testing when it is desirable not to teach subjects a common scale. Subjects group samples into categories that make sense to them as individuals. Subjects may be asked to regroup samples according to different criteria.

	One or more products to study how acceptance is distributed in the population represented by the subjects
	Same as Hedonic rating but questions pertain to actions
	Comparison of two products
	Comparison of 3 or more products

Name:

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