FOOD SCIENCE

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EVENT DESCRIPTION

- 45 minutes; 2 students (divide & conquer or work together)
- Participants will answer questions on food chemistry focused in:
  - Fermentation
  - Pickling
- Participants will build a salinometer/hydrometer capable of measuring salt concentration (m/v) 1-10%

EVENT PARAMETERS

- Each participant may **bring one 8.5" x 11" sheet of paper,** which may be in a sheet protector sealed by tape or laminated, that may contain information on both sides in any form and from any source without any annotations or labels affixed along with writing utensils, and a stand-alone non-programmable, non-graphing calculator.
- Each team may bring any or all of the items listed as Recommended lab equipment for Division B Chemistry Events, posted on soinc.org. Teams not bringing these items will be at a disadvantage. The Supervisor will not provide them.
- Teams may bring only specified items. Other items not listed are prohibited. The Event Supervisors will check each team's equipment, confiscate non-allowed items, and have the right to penalize the team up to 10% if additional equipment is brought to the event.

EVENT PARAMETERS

- Each team must bring a participant-made salinometer/hydrometer capable of measuring salt concentrations between 1-10% (mass/volume). Any salinometer/hydrometer calibration data **must** be included on the 8.5” x 11” sheet(s) of paper mentioned previously.
- Participants **must wear goggles, an apron or a lab coat and have skin covered from the neck down to the wrist and toes**. Gloves are optional, but if the host requires a specific type they will notify teams. Pants should be loose fitting; if the host has more specific guidelines they will notify teams in advance of the tournament.
- Shoulder length or longer hair must be tied back. Participants **removing safety clothing/goggles** or unsafely handling materials or equipment **will be penalized or disqualified**.
- The Event Supervisor will provide chemicals, foodstuff, a source of water and balances/equipment/ materials to do laboratory activities.

CONSTRUCTING A SALINOMETER

- Simple Salinometer Build (there is more than one way to construct a simple salinometer)
- Calibration data MUST be on your single notes page
- Salinometer should be made to measure salt concentrations (w/v) between 1-10%
  - Device must be built to operate in **500mL beaker with at least 400mL** saltwater solution
- Scoring of percent salinity estimation:
  - Estimation to the nearest tenth of a percent
  - Full credit given within +/-1% @ Regionals; +/-.5% @ State/Nationals

PART I: WRITTEN/LAB TEST (60% OF SCORE)

- types of fermented foods and pickles
- food preservation processes
- types of fermentation processes (aerobic respiration, homolactic fermentation, heterolactic fermentation, ethanol fermentation)
- types of sugars & enzymes
- citric acid cycle
- standard of identity of acidified foods
- nutrition labeling regulations
- food safety of fermented and acidified vegetable products
- health benefits of fermented foods
- production of chemical feedstocks
- yeast and bacteria identification and behaviors
- water activity
- density

PART II: HANDS-ON TESTING (30% OF SCORE)

- **Three Tests**
  - Determine salt content in 1-2 samples using participant-made salinometer/hydrometer
  - Determine % moisture of a pickle
  - Determine pH of a pickle
- Perform **at least** 1 test at Regionals
- Perform **at least** 2 tests at States
- Perform all 3 tests at Nationals

OVERALL SCORING

- Part I: Written Test = 60% of score
- Part II: Hands-On Testing = 30% of score
  - One test done = 30% of score
  - Two tests done = 15% of score each
- Bringing a salinometer = 10% of score
- Tiebreakers decided by the written test, not hands-on.

- Penalties up to 10% may be given if:
  - Area is not cleaned as instructed
  - A team brings prohibited lab equipment to the event
    - Recommended lab equipment

PREPARING STUDENTS

- Practice with homemade salinometer/hydrometer
- Practice determining % moisture
- Practice determining pH of pickles
- Study material listed in “Part I”

WHAT IS FERMENTATION?

- "Good bacteria" produce an acid that inhibits "bad bacteria" from growth
- Often started in brine solution (salty water) using natural bacteria
- Pickling doesn't always mean acidification
- Some foods that can be fermented:
  - Vegetables: cucumber → pickles; cabbage → sauerkraut; chocolate; tea → Kombucha
  - Meats: salami
  - Milk → yogurt, cheese, crème fraiche
  - Bread: sourdough; white bread
  - Fruits: apple cider; wine

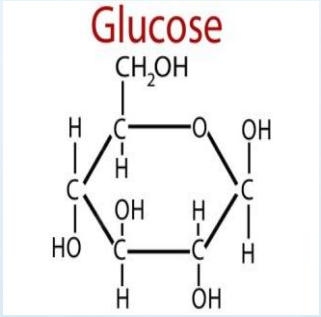
FOOD PRESERVATION

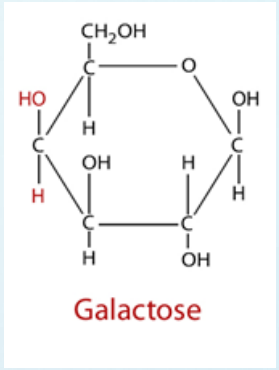
- "…prevents growth of microorganisms (like yeast) as well as slowing the oxidation of fats that cause rancidity."
- Drying/Dehydration → fruits, jerky
- Freezing → lower water activity
- Freeze drying → salting & drying fish
- Preservation in salt & sugar → jams, acidifying with acids

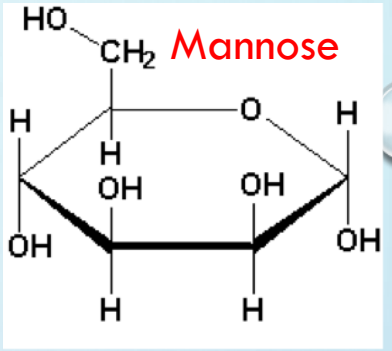
FERMENTATION PROCESSES

- Definition, conditions, and products
  - aerobic respiration → ATP formation in presence of O_2; produces CO_2, H_2O, and energy (~38 ATP formed)
  - homolactic fermentation
  - heterolactic fermentation
  - ethanol fermentation

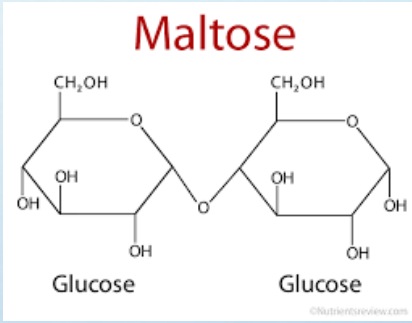
TYPES OF SUGARS & ENZYMES

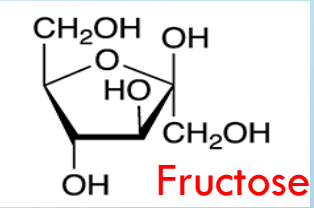


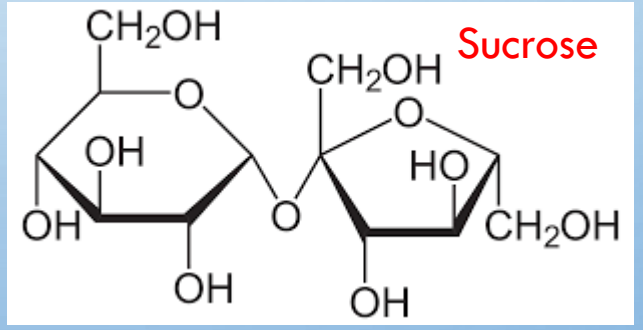


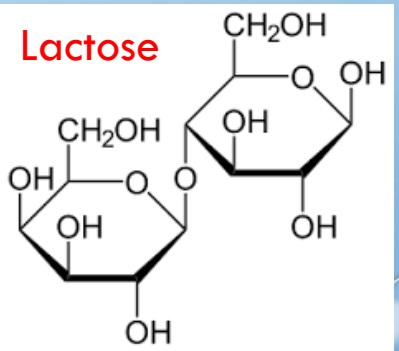


- Monosaccharides
  - 6 membered rings → glucose, galactose, mannose
  - 5 membered rings → fructose, ribose
- Disaccharides
  - sucrose, lactose, maltose
- Reducing sugars
  - Monosaccharides, lactose, maltose
- Non-reducing sugars
  - Sucrose

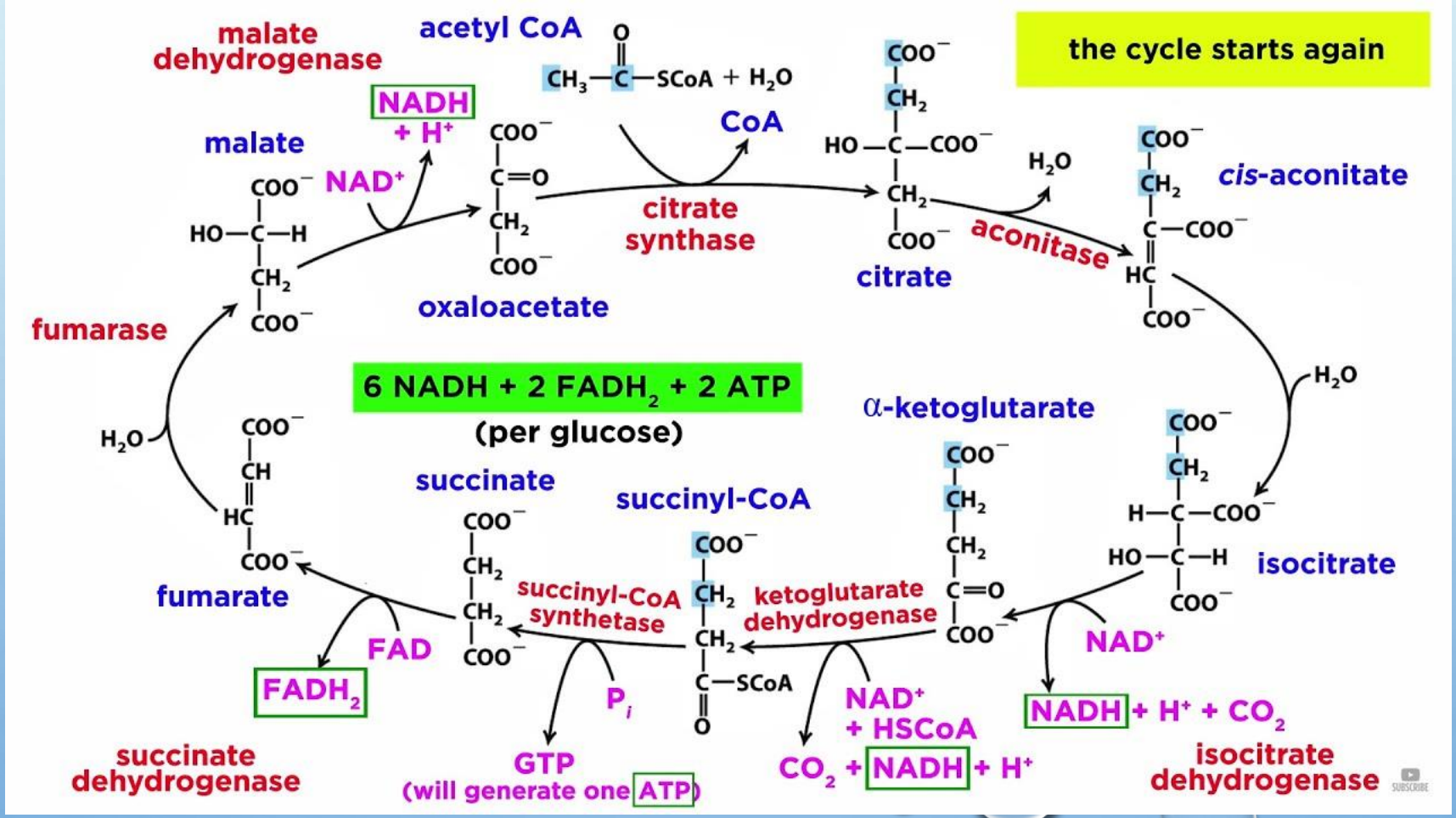








CITRIC ACID CYCLE



STANDARD OF IDENTITY OF ACIDIFIED FOODS

- Code of Federal Regulations
  - How and why are acidified foods labeled?
  - Standard Identity of Acidified Foods
    - pH <4.6
    - pH >4.0 special tasting is required
    - Aw < 0.85

NUTRITION LABELING REGULATIONS

- Working under rules established in 2016 based on a 2000 calorie diet
- Allergens need to be listed
- Minimum font size requirements
- Ingredients must be listed in order by what there is the most of.
- Need to look at the size of a single serving
  - Can often be a third of a cookie or half the candy bar
- New labels coming in 2021
  - Featuring more realistic serving sizes
  - Differentiating between natural sugars in foods and added sugars

FOOD SAFETY OF FERMENTED AND ACIDIFIED VEGETABLE PRODUCTS

- Following code of federal regulation guidelines is safest way to produce these foods
- Low pH (acidity) prevents “bad bacteria” from growing
- Improperly fermented foods may be unsafe (spoilage)
- Traditional heat treatment kills the fermenting microbes also and hence negates the health effects of fermented foods
- Safe Fermented Food Production

HEALTH BENEFITS OF FERMENTED FOODS

- Improved digestive health and microbiome
- Boosts immune system (probiotic-rich foods)
- Make food easier to digest
- Potential benefits (research evidence)
  - Mental health
  - Heart health
  - Weight loss

WATER ACTIVITY (AW)

- BOUND WATER VS. FREE WATER
- Definition: % of free water compared to pure water at any given temperature. (This is based on vapor pressures)
- Affect of water activity on microbial growth
- Machines used to measure Aw

DENSITY

- Mass/volume = Density
- Manipulation of the equation

ADDITIONAL RESOURCES

- Science Olympiad Store
- Event Page