# Food Science

- Chemistry of food and FOOD GRAINS
- Build a simple calorimeter


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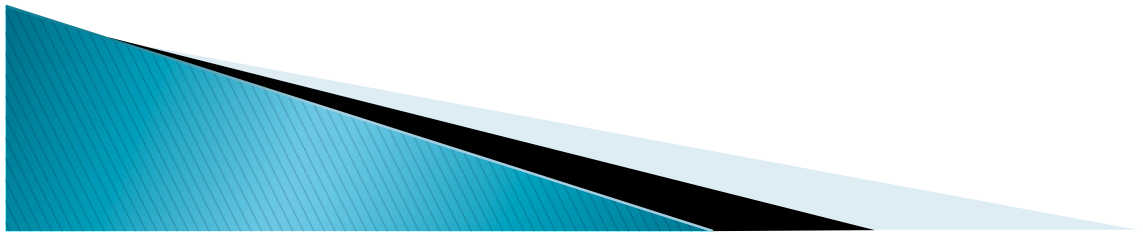
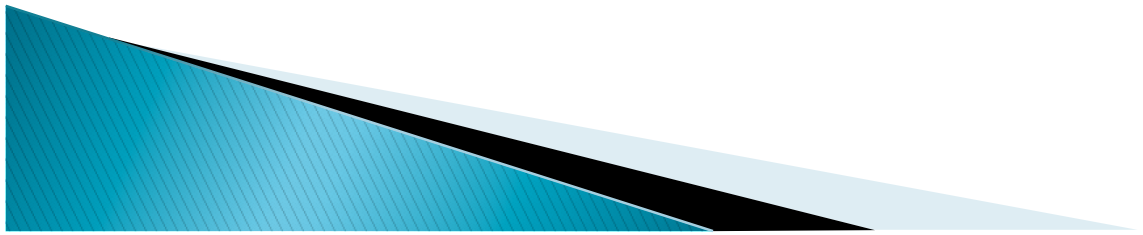


# There are 2 parts to this event.

- Build and use a calorimeter (15 %) include calibration data in the 5 sheets.
- Written test (85 %) (Students are allowed to have 5 sheets of notes front & back. Page protectors allowed.)
- Scoring guidelines are outlined in the event rules (see rulebook).



# Safety Rules for Food Science

- Students must wear closed toe shoes (no sandals, crocs, or ballet flats).
- Clothing must cover arms, torso, and legs (no shorts). Capri pants and longer skirts are OK.
- Arms must be covered. *(Neck to toes = cover up)*
- Lab coats are OK. Aprons are good but won't cover bare arms.
- Long hair (anything that can fall forward) must be clipped or banded back.
- Safety goggles must be worn at ALL times (even in clean up). No welding goggles or engineering glasses. (Goggles MUST be splash guard goggles.)

# Students must bring the following:

- Safety equipment
  (goggles will NOT be provided by supervisor)
- Pen or pencil (with eraser)
- *Calculators*
- *A Calorimeter*
- Activities equipment

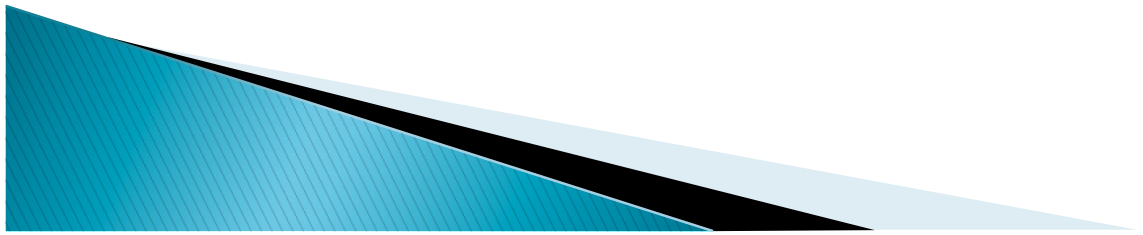
  *see list to right* →

- **Equipment list (things to bring to event) – includes:**
  -- test tubes, brushes, racks, spot plates, well plates, beakers etc
  -- pH paper
  -- paper towel
  -- beakers & test tubes
  -- spoons, spatulas, scoopulas
  -- gloves
  -- container to hold all this stuff

**Make sure you follow the list of items to bring shown in the rules.**

# Event supervisor will provide:

- Food, water, matches
- Balance [scale] (may or may not be electronic)
- Thermometers (may or may not be digital)
- Reagents or equipment for lab activities



# The Calorimeter

- Research!  Understand the science first
- Experiments
  - Make a calorimeter

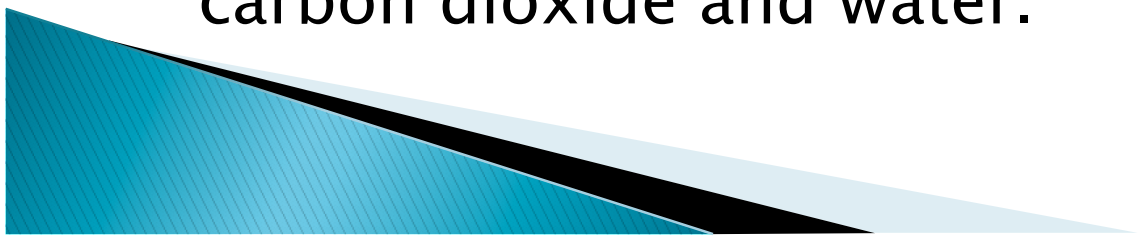
  - Calibrate the calorimeter – multiple trials
  - Experiment with the calorimeter with different foods (do this under a hood or outside)

# Calorimetry

- http://www.virtualsciencefair.org/2010/nogixn2
- http://www.education.com/science-fair/article/how-much-potential-energy-do-different/

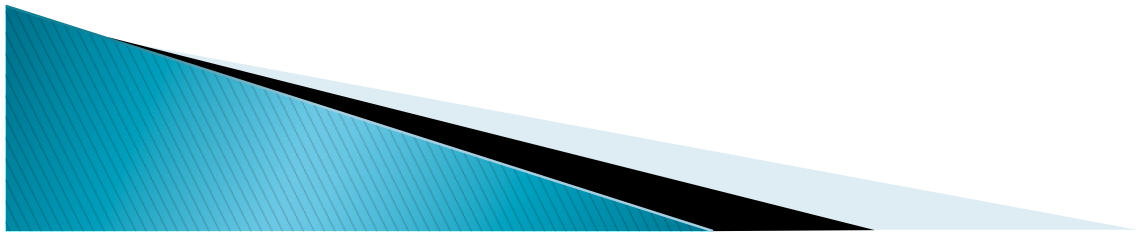
# Calorimetry

- Designed to measure the amount of heat energy in the chemicals of the food that is available to the body.
- What is being burned are the fats, proteins, carbohydrates, DNA, etc. in the cells.
- In our body, this burning is done in a controlled fashion to extract the energy in the bonds.
- In the calorimeter it is an uncontrolled reaction.
- The products of the reaction of oxygen and the food, in either the calorimeter or our body is carbon dioxide and water.



# Energy in Food

- Calorie – amount of heat required to raise the temperature of 1 gram of water 1 degree Celsius.
- Kilocalorie (1000 calories) is the unit commonly used to represent energy values of foods –or Calorie with a C instead of a c
- Not all carbohydrates (or fats, or proteins) yield the exact same amount of energy when burned in a calorimeter, so common averages from studies (in kcal/g) are used
- Carbohydrates average 4.1 kcal/gram in a bomb calorimeter, are about 98% digestible and yield 4 kcal/g when consumed
- Proteins average 5.7 kcal/g in a bomb calorimeter, are not as easily digested and yield an average of 4 kcal/g when consumed
- Lipids average 9.5 kcal/g in a bomb calorimeter, are 95% digested and yield an average of 9 kcal/g when consumed
- Fats (lipids) are the most concentrated source of food calories
- Carbohydrates are the cheapest source of calories, proteins the most expensive



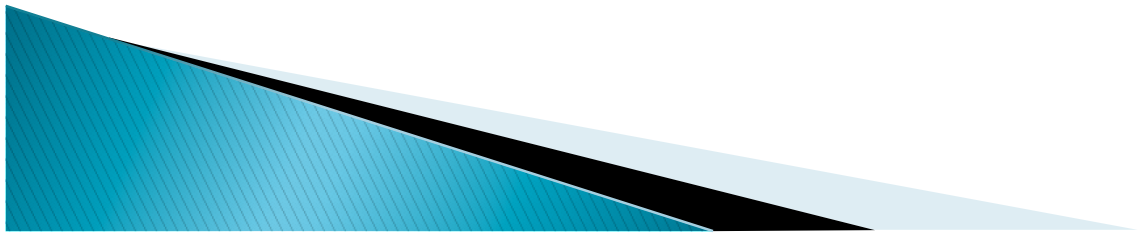
# The Written Test

- ***Food and food grains (any seed)***

- Identify carbohydrates, lipids, proteins in food
- Measure mass, volume, temperature and pH
- Determine density, moisture content and percent composition
- Qualitative tests for proteins, lipids or carbohydrates
  - Biurets test, Benedicts test, Iodine test, Brown paper test

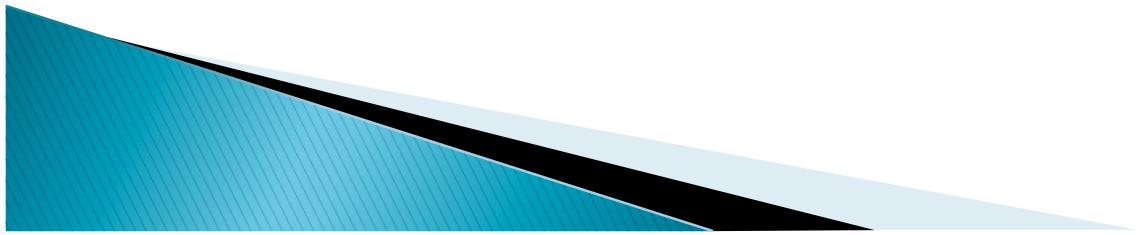
- Chemical structures should be reviewed (Structural diagrams from basic chemistry text are good to use.)

- What are the purposes of carbohydrates in food? Protein purpose? Fat? (*What purposes or functions do these molecules serve in the human body?*)



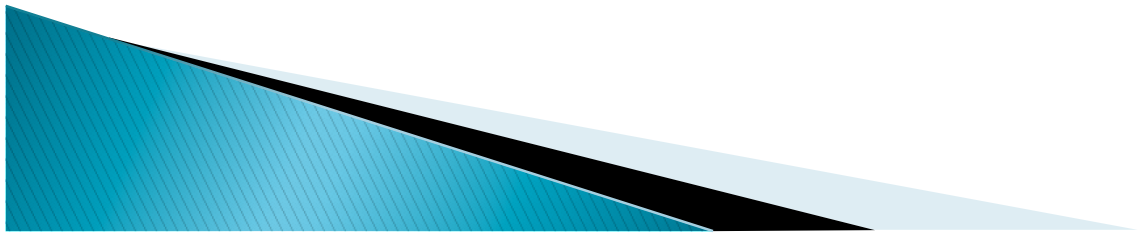
# Chemistry of Food

- Identify GMO's, how & why they are used in foods
- Identify gluten and gluten free foods
- Identify common food additives & why they are used in foods



# Chemistry of food -- continued

- How cooking changes food chemically?
  - Heat can alter molecular structures (ex: heat denatures protein, like when an egg white solidifies)



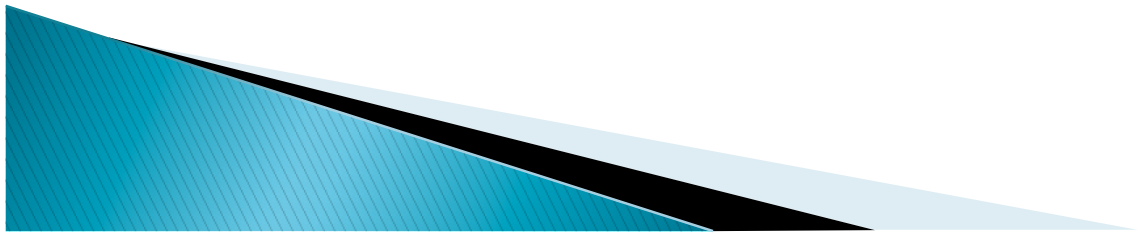
# Chemistry of food -- continued

- ***Students will want to study basic food molecule chemical reactions such as:***

  --- esterification process that forms fat molecules

  --- peptide bond formation (linking amino acids into protein chains)

  --- carbohydrate bonds (dehydration synthesis) *(such as monosaccharides bonding to form disaccharides)*



# Other facts to study about foods include:

- Standard food labels (look at examples)
- Allergens found in food
- Essential fats, vitamins, proteins
- Sweeteners
- Food Preservation
- Leavening Agents
- RDA (recommended daily allowance) of essential minerals and vitamins and the consequences of not having them

# Carbohydrates

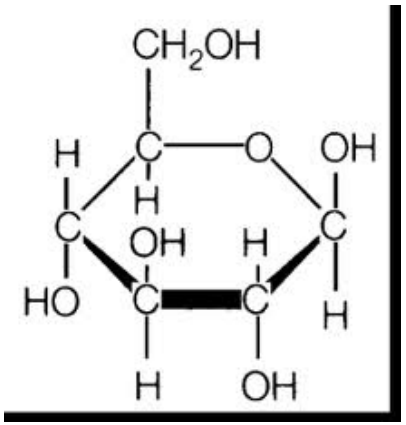
- Students will need to know names, molecular structures, and purpose for the molecule in the food.
- Basic molecular structures will include: monosaccharides, disaccharides, and polysaccharides. (*SEE next slide for examples.)*

Students might be asked what the results of a qualitative carbohydrate test or protein test show. Benedict's test and Biuret test would be good to study. Also study the iodine test for starch.

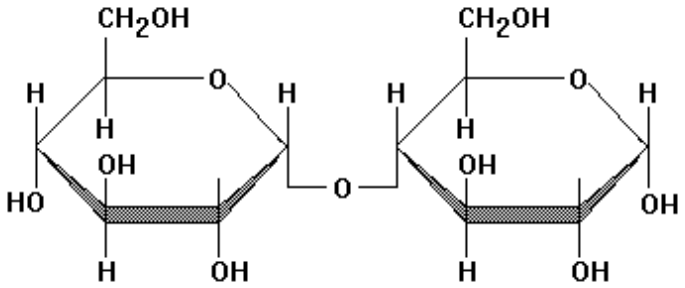
Maybe practice these tests in lab with the students so they will have a better idea of what their results actually mean.

# Carbohydrates

- Sugars
  - Monosaccharides
    - Glucose, Fructose
  - Disaccharides
    - Lactose (glucose and galactose) – milk
    - Maltose (glucose and glucose) –
    - Sucrose (glucose and fructose –table sugar

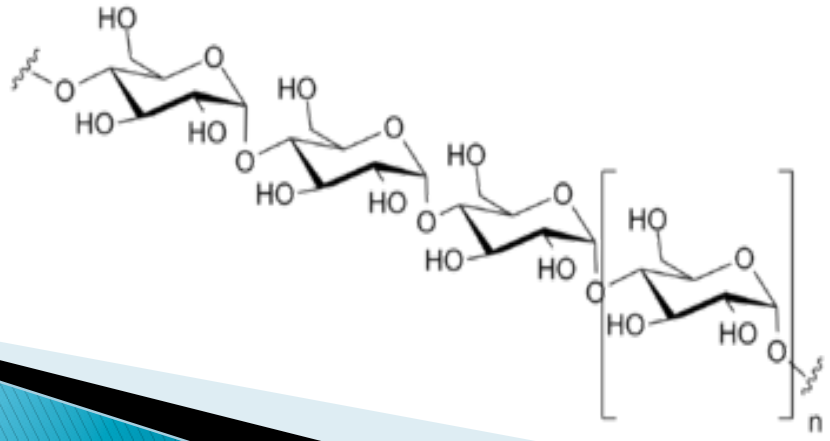


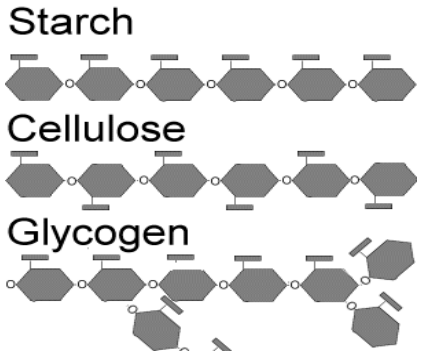

- Reducing sugars
  - Examples: glucose, lactose, fructose
- Non-reducing sugars
  - Example: sucrose



# *Complex Carbohydrates (polysaccharides)*

- **Examples:**
  - starch – glucose polymers, found in plants
  - cellulose –found in plant fibers, insoluble
  - Pectin–units are sugar acids rather than simple sugars, found in vegetables and fruits
- **Branched vs. linear**
  - Starches are a mixture of branched (amylopectin) and linear (amylose) polysaccharides



# Fats – (some common facts)

- Present as fats extracted from plants or animals (**butter**, vegetable oil) or as constituents of food (chocolate)
- Contributions to foods: texture and flavor
- Contain only Carbon, hydrogen and oxygen
- Most common form for lipid in foods is as a triglyceride
- Saturated fats VS unsaturated fats ***(Students will need to recognize structural differences.)***

# Proteins

- Protein molecules contain the element nitrogen. (Sulfur may also be present depending on the protein type.)
- Protein molecules are composed of varying numbers of amino acid molecules bonded together by peptide bonds.
- Casein and whey are common dairy proteins.
- Be sure to look at molecular structures for amino acid molecules and how they bond together to form the protein molecular chain.

# Nutritional labeling – Gather examples of labels from dairy food containers. Have students practice interpreting information from them as in the following examples.

(1) Fill in the following blank spaces.
There are ___ Calories/gram of fat.
There are ___ Calories/gram of carbohydrate.
There are ___Calories/gram of protein.
There are ___Calories/gram of water.

(2) Use the nutritional label given for information to answer the following questions.

Calculate the following Calories found in one serving of this product.
(a) Calories from Fat
(b) Calories from Protein
(c) Total Calories in one serving

(3) What percent of the carbohydrate Calories come from fiber?

(4) If the daily (RDA) value of iron is 18 mg per day, calculate the amount (in mg) of iron in one bar of this product.

**Nutrition Facts**

Serving Size 1 bar (48g)
Servings Per Container 12

Amount [redacted] Serving [redacted]

**Calories** 200 Calories from Fat 74

| | % Daily Value* |
|---|---|
| **Total Fat** 8g | **13%** |
| Saturated Fat 2.5g | **14%** |
| *Trans* Fat 0g | |
| **Cholesterol** 0mg | **0%** |
| **Sodium** 70mg | **3%** |
| **Potassium** 165mg | **5%** |
| **Total Carbohydrate** 26g | **9%** |
| Dietary Fiber 5g | **18%** |
| Sugars 11g | |
| **Protein** 8g | **16%** |

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 10%