Bio 120 Laboratory 3: Nutrition and Biological Molecules

Part 1: Nutrition

We all need to eat to obtain energy and maintain your body functions. Deciding what to eat depends on your culture, individual needs, tastes, time constraints, and convenience. Nutritionists have designed food pyramids to guide you. There are many versions of the food pyramid. The figure below is an example of a food pyramid designed by the USDA.

In this plan, the majority of your diet (6 – 7 servings/day) should be from grain products (bread, cereals, pasta). The next largest portion of your diet should be from fruits and vegetables. They recommend that you should consume 2 – 4 servings/day of fruits and 3 – 5 servings of vegetables. The meat and dairy portions of the pyramid are relatively small. The USDA recommends that you eat 2 to 3 servings of meat (lean meats, poultry, fish, beans, and eggs) and 2 servings of dairy products. The USDA also recommends that you limit your consumption of added fats and sugars, this would include soft drinks, salad dressings, and butter.

The key to the food pyramids is understanding what constitutes a serving size. For instance one serving of meat is 2 - 3 ounces of cooked lean meat. Do you think hamburger is a lean meat?

When planning your meals it is important to understand the different components of food. Nutritional labels identify components of the food, including protein, fat, and sugars. This lab will help you identify the different components of a meal.
Part 2: Food Chemistry

A. Carbohydrates

Carbohydrates contain mostly carbon, hydrogen and oxygen and serve as a source of quick energy for life. The word saccharide comes from the Greek word meaning sugar. Monosaccharides are the simplest carbohydrates consisting of a single sugar molecule. Monosaccharides are also referred to as simple sugars. Two sugar molecules connected together are called disaccharides. Large chains of sugars are known as polysaccharides, these are also known as complex carbohydrates.

1. Simple Sugars

Benedicts’s solution is used to test for simple sugars. Benedicts solution contains cupric ions (Cu²⁺). Benedict’s solution changes color from blue to brick red when the cupric ion is reduced to Cu⁺. Only sugars that are able to reduce the cupric ion will produce the color change. Reducing sugars contain a free aldehyde (CHO). Glucose is a reducing sugar (see figure below), the free aldehyde is carbon #1 in this figure. In solution the ring configuration is favored but the chain configuration is the structure that is the reducing sugar. There is enough of the chain configuration in the solution to make glucose a strong reducing agent. The benedict’s reagent will produce a positive response for glucose but not for fructose (see figure below). This is because fructose does not have a free aldehyde. This means that Benedict’s test for sugars will only be positive for some of the sugars.

![Glucose and Fructose Structures](image-url)
Reducing sugars (aldoses) act as reductants when heated with a weakly alkaline solution of copper (II) sulfate (e.g. Benedict’s solution) to form an orange-brown precipitate of copper (I) oxide. In this reaction the Cu$^{2+}$ is reduced to Cu$^{+}$, which reacts with OH$^-$ to give Cu$_2$O.

$$2\text{Cu}^{2+}(aq) + 2e^- + \text{H}_2\text{O}(l) \rightarrow \text{Cu}_2\text{O}(s) + 2\text{H}^+(aq)$$

Aldehyde (-CHO) group in a reducing sugar can be the source of electrons that reduces copper (II) to copper (I)

$$\text{R-CHO} (aq) + \text{H}_2\text{O}(l) \rightarrow \text{R-COOH} (aq) + 2\text{H}^+(aq) + 2e^-$$

**Procedure 1: Using Benedict’s solution to test for simple sugars**

**Step 1:** Place 2 ml of Benedict's solution into six test tubes.
**Step 2:** Add about 5 mL of glucose solution in one tube, this will be your positive control.
**Step 3:** Add about 5 mL of water to one tube, this will be your negative control.
**Step 4:** Add about 5 mL of each blended item to separate test tubes. For example the blended hamburger will be added to one tube and the blended bun will be added to another tube.
**Step 5:** Add two boiling chips to each tube. (Note Boiling chips are a safety precaution which should be used with all rapid heating within a confined vessel to prevent rapid boiling over. They do not interfere with the reaction.)
**Step 6:** Place each tube in a boiling water bath for about five minutes.
**Step 7:** Remove tubes (using metal clamps) and allow them to cool for three minutes.
**Step 8:** Record the results and observations in the table. You should record color changes for each food item in the column “Benedict’s” and record if you think there is sugar present in the food under “Conclusions”
2. Starch

Starch is a polysaccharide, it is a coiled chain of glucose molecules (See figure). We can test for the presence of starch using iodine which only stains coiled polysaccharides.

![Starch](image)

**Procedure 2:** Testing food items for the presence of starch

**Step 1:** Place 5 mL of each blended food item into four test tubes.

**Step 2:** Place 5 mL of starch solution into one test tube, this is your positive control.

**Step 3:** Place 5 mL of water into another test tube, this is your negative control.

**Step 4:** To each test tube, add a few drops of Lugol's iodine solution. You do not need to shake your tube.

**Step 5:** Record your results in the table, see above.

B. Proteins

Proteins are a diverse group of biological molecules. They include enzymes that make reactions proceed faster. There are structural proteins that make spider webs strong and there are proteins that transport things in cells. This laboratory deals with nutritional proteins. All proteins are made up of amino acids that are linked together to form a chain. The structure of an amino acid is shown below, there are 20 amino acids, each with a different substitution for R. For example, when R is CH$_3$ then the amino acid is alanine. Below is pictured a dipeptide (two peptides bound together)

![Amino Acid](image)
The chemical ninhydrin can react with the end amino acid in the chain, producing a purple colored product by the following reaction:

\[
\text{ninhydrin} + \text{R-CO}_2\text{NH}_3^+ \rightarrow \text{HCO}_2\text{R} + \text{NH}_3 + \text{H}_2\text{O}
\]

Procedure 3: Testing for the presence of amino acids and proteins.

**Step 1:** Place 5 mL of each blended food item in separate test tubes.
**Step 2:** Place 5 mL of albumin (egg white protein) in a separate test tube (positive control).
**Step 3:** Place 5 mL of water in another test tube (negative control).
**Step 4:** Add 10 drops of 0.3% Ninhydrin to each test tube.
**Step 5:** Heat the test tube to boiling and then allow it to cool.
**Step 6:** Record the results in the table below.

Under each test indicate the color change you observed, under the conclusion note what biological molecules are found in each food item.

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Benedict’s</th>
<th>Iodine</th>
<th>Ninhydrin</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (- control)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamburger</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bun</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>French Fries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soda</td>
<td></td>
<td></td>
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</tbody>
</table>
Bio 120 Nutrition Homework
Worth 10 points

You will keep a food diary for one day.

1. Record the day, time, food eaten, and the amount of food eaten.

The food diary does not need to be typed.

Example of the food diary:

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Amount eaten</th>
<th>Description of food eaten</th>
</tr>
</thead>
</table>

2. Go to the website: mypyramid.gov. Go to my pyramid tracker on the mypyramid.gov website.
3. Then go to assess your diet. You can register or sign in as a guest.
4. Enter your foods and amounts, then hit save and analyze.
5. Calculate your dietary guidelines comparison and your nutrient intake.
6. You can copy the results into a word document and save then print or just print out results.