



# Holy Macromolecule

## A Lesson on Proteins, Lipids, and Complex Carbohydrates

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Lesson # 3

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<http://www.apsarchive.org/resource.cfm?submissionID=3703>.

**Editor's notes:**

Website URLs listed in this resource were current as of publication, but may now be obsolete. If you know of a replacement URL, please suggest it in the resource's "Comments" section <http://www.apsarchive.org/resource.cfm?submissionID=3703>.

The APS encourages teachers to give students a copy of the "ABC" (Appropriate, Beneficial, Caring) rules for use of animals in the classroom, to discuss the rules, and to ask students to sign the "ABC" rules contract (see References). Also, teachers should have a plan for short term care of the animals (with supporting references for appropriate care guidelines) and for disposal or long-term care of all classroom organisms.

Teachers should carefully review any stimulus or environmental change for an animal being used in experiments or observations before students are allowed to use that stimulus. This is especially important if the stimulus could cause pain or distress to the organism. Teachers may be able to identify a less stressful stimulus for the students to use in their experiment.

Although mammals provide excellent opportunities for observational studies, they require particular care in terms of handling and may cause allergic reactions in some students. The teacher should check local and state guidelines before using mammals in the classroom.

**Disclaimer:**

This activity was created by the author and reviewed by the American Physiological Society. Any interpretations, statements, or conclusions in this publication are those of the author and do not necessarily represent the views of either the American Physiological Society or the funding agencies supporting the professional development program in which the author participated.

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<b>PURPOSE</b>	The purpose of this lab is to develop skills in testing for macromolecules. During this lab students will learn about the importance of balanced nutrition and foods found in other ethnic regions, and gain valuable experience in using inquiry.
<b>OBJECTIVES</b>	Upon completion of this activity, the student will be able to understand and describe that the work of the cell is carried out by the many different types of molecules it assembles, such as proteins, lipids, and complex carbohydrates.  <i><b>Teacher Tip:</b> Please note that some of the molecules that are observed and tested in this lab are macromolecules, but we do not test for all macromolecules nor is each molecule a macromolecule. Students will gain the ability of how to test for these nutrients and have a better understanding of what nutrition labels are indicating.</i>
<b>GRADE LEVEL</b>	Grades 9-12
<b>PRIOR KNOWLEDGE</b>	At a cellular level our body is always busy. It is breaking down molecules and compounds to meet the demands of the cells' needs. With the consumption of those chemical elements, our body will soon need more elements to replace the recently processed material. To maintain a cellular homeostasis we must consume food that contains materials that our cells need. So it is true that, "you can't live on bread alone."  Our cells need four different types of large molecules: complex carbohydrates, lipids, proteins and nucleic acids. These <u>macromolecules</u> are responsible for maintaining our cells. To obtain macromolecules we must consume materials that aid in their construction.
<b>TIME REQUIRED</b>	This lab activity will most likely take three to four class periods.
<b>INCLUDING ALL STUDENTS</b>	<ul style="list-style-type: none"><li>• This lab also focuses on the different diets from different parts of the world.</li><li>• Logical-mathematical intelligence, spatial intelligence, and bodily-kinesthetic intelligence.</li></ul>
<b>QUESTIONS TO ASK ALONG THE WAY</b>	<ul style="list-style-type: none"><li>• Why do you think two completely different foods could test positive for the same test?</li><li>• If students are testing positive in every food they brought from home in a single test, you might ask them whether there could be a problem in their common diet due to over-abundance of certain nutrients.</li><li>• After looking at some of the foods that are commonly consumed in the United States, do you understand why we have such a problem with obesity?</li><li>• How could we help prevent obesity?</li><li>• What do you think will happen to cells that are starved of any nutrient (short term and long term)?</li><li>• Why do you think we are testing water in each test cycle?</li></ul>

**NATIONAL  
SCIENCE  
EDUCATION  
STANDARDS**

Science as Inquiry

Abilities necessary to do scientific inquiry

Understanding about scientific inquiry

Life Science

The cell

Matter, energy, and organization of living systems

Science in Personal and Social Perspectives

Personal and community health

Natural and human-induced hazards

Science and technology in local, national, and global challenges

History and Nature of Science

Science as a human endeavor

Nature of scientific knowledge

**INDIANA  
STATE  
STANDARDS**

B.1.4

Understand and describe that the work of the cell is carried out by the many different types of molecules it assembles, such as proteins, lipids, carbohydrates, and nucleic acids.

**MATERIALS**

- Teacher supplied foods
  - ✓ 1 can tuna
  - ✓ 4 oz. honey
  - ✓ 1 medium sized potato
  - ✓ ½ cup vegetable shortening
- *Also include the following material in their original packaging:*
  - ✓ can of meat
  - ✓ soda pop
  - ✓ instant mashed potatoes
  - ✓ butter
- Teacher supplied ethnic foods
  - Typical foods from Pacific Islands, Hispanic, and Native American foods, save packaging, if bought from a supermarket*
- pipettes (droppers), 1 per container: approx 50 should cover a class
- test tubes, approximately 20 (varies due group size and how many foods are brought from home)
- test tube racks, 1 per group
- tongs and/or heat resistant gloves, 1 tong or 1 pair of gloves
- brown paper bags (newspaper will also work), ½ a bag per group
- Biuret reagent , each group will probably use 100ml
- Benedict's solution, each group will probably use 100ml
- hot plate, 1 per group (6 hot plates)
- water bath, 1 per group (6 water baths)
- iodine, 1 bottle per group (only about 20 ml will be used)
- laboratory apron, 1 per student
- safety goggles, 1 per student
- marker or wax pencil, 1 per group
- masking tape (for reagents), 1 roll to be shared by class
- Role Model sheet with attached handouts, 1 per student
- Video of *Super Size Me* (see References)

## SAFETY

- Caution: Reagents used in this lab are poisonous and caustic. Do not ingest, allow solution to get on skin, or look directly into a heated test tube.
- Remember that hot glassware appears the same as cool glassware.
- Exercise extreme caution during this lab.
  - ✓ Benedict's solution is poisonous
  - ✓ Biuret reagent can damage skin (burning)
  - ✓ Iodine will stain skin or most material it touches
- Also, do not overheat any solution. Overheating will denature the solution and nullify results.

**Teacher Tip:** *Since this lab is used early in the year for most teachers, I use the start of this lab as a learning activity for safety. I start the students in the lab, all the materials are prepared and safety materials are supplied. When the students start working on the lab (in line to get the chemicals) I stop them and tell them to write each lab rule that is being broken (by any and all students). The person that finds the most broken rules gets 5 extra credit points for this lab.*

## PREPARATION

The purpose of this lab is to get students thinking about what they eat, what it is made of, how those components are vital for cell metabolism and finally how diet affects bodily function (focusing on ethnic foods and their components).

You need to purchase your ethnic foods in advance. You will not have these on hand. Also make sure you purchase and puree the tuna, honey, vegetable shortening, and potato. The aforementioned foods test positive for only one test, they will be a very useful food tool in determining what the test tests for. Also provide at least one food that tests positive for only one test. Make sure that the foods have the original packaging for students to observe what the nutrition and components are.

Prior to the lab students should be told to bring a small portion from each food that they had at last night's meal (roughly a cup). When you receive the foods puree them in the blender with water. Please make sure that you tell students to bring in the food before the start of school. If your planning is early in the day you can prioritize by class to order to puree the foods. Be sure to label the students foods and period (since the finished product doesn't look anything like the initial one). Also, ask students to bring in a packaged (original) simple sugar, complex carbohydrate, lipid and protein. This will play an instrumental role in testing their hypothesis.

## PROCEDURE

### I. Role Model Worksheet

To start this lab, students will be given a Role Model Worksheet of Dr. Rudy Ortiz, who focuses on dietary needs and homeostasis. Students should complete the worksheet as an assignment.

### II. Experimental Testing

Students should follow the procedures on the student handout.

**PROCEDURE**

**III. Complete Diagrams and Tables**

Using the results from their macromolecule tests, students should complete the provided Venn diagram. The reverse side of the Venn diagrams has tables that will better illustrate the results and their overlaps.

**IV. Analyze the Data**

Students will analyze the food tested and the results to develop a hypothesis of what each test indicated the presence of which macromolecule. They should mention which food(s) was most instrumental in developing a hypothesis or which food(s) was least instrumental in developing a hypothesis.

Upon completion of the hypothesis, students will test the hypothesis by analyzing foods from home that are labeled and compare the results. This should indicate whether their hypothesis is supported or not.

Applying their findings of what are in the ethnic foods, students will write a paragraph which describes possible nutrients that are either present in high quantities or lacking in a typical meal from the ethnic groups of interest. In the following class, they will do an Internet search that will reveal the possible problems or complications of that diet over a long period of time. While doing the Internet searches, they will also focus on common disorders and self-inflicted eating disorders and their effects on health.

**V. DVD Chapters**

After the lab show the first and last 5 minutes of *Super Size Me* to show the change in the lead actor. This will allow the greatest impact while using the least amount of time. Take advantage of the situation; this sparks great discussions.

**WHERE TO GO FROM HERE**

This lab covers many topics and could open avenues for discussion or further studies on many issues. Issues that could be considered are:

- childhood obesity
- anorexia and bulimia
- malnutrition (lack of variety in food aid for developing countries)
- diabetes
- anemia
- arteriosclerosis
- hypertension
- stroke
- cardiovascular disease

**SUGGESTIONS FOR ASSESSMENT**

- Grade students on categorizing appropriately, whether they brought food (participation), if their data table was complete, and hypothesis development (analytical thinking) for each reagent.
- Type of assessment: Performance-based assessment

**REFERENCES AND RESOURCES**

1. *Analysis of Potatoes, Liver, Cream, and Soybean for Starch, Lipids, Proteins, and Reducing Sugars*  
<http://www.uwrf.edu/~ss4u/reducing%20sugars.htm>  
This website provides a very clear-cut cookbook version of the macromolecule lab. It does not have a flow that would benefit my classroom, but it is clearly written.

REFERENCES  
AND  
RESOURCES

2. *Biography of Rudy Martin Ortiz, Ph.D.*  
[http://bio.research.ucsc.edu/people/ortiz/public\\_html/](http://bio.research.ucsc.edu/people/ortiz/public_html/)  
This site focuses on Dr. Ortiz's dissertation in which covers kidney function and metabolism of hormones in fasting animals. His research leads to a better understanding of anorexia, diabetes, obesity, and renal dysfunctions in humans.  
<https://eng.ucmerced.edu/FacultyBio/rortiz>  
This site provides Dr. Ortiz's research interest along with methods to reach him.  
<http://www.ucmerced.edu/spotlightdetail.asp?spotlightid=13>  
This site provides a history of Dr. Ortiz and how he became interested in his topic area. Also included are snippets of his research and how he arrived studying that specific area.
3. *Biology 101, Department of Biology, Edmonds Community College*  
[http://biology.edcc.edu/biology\\_101\\_rev.htm](http://biology.edcc.edu/biology_101_rev.htm)  
This website provides another approach for the macromolecule lab which includes different methods and other ways to test for the same molecules.
4. *Explorations Biomolecule*  
[http://www.coe.missouri.edu/~pgermann/EAGLES/Under\\_Construction/Andrea/Explorations/explorations.html](http://www.coe.missouri.edu/~pgermann/EAGLES/Under_Construction/Andrea/Explorations/explorations.html)  
This website includes a cookbook version of the macromolecule lab and a few questions to ask students in the process. It is a good lab the breaks down each part into counterparts.
5. *General Biochemistry, Macromolecule Lab*  
<http://www.spx.org/departments/science/teachers/barnett/documents/Biochemlab.pdf>  
This site focuses at a deeper level on the macromolecule lab. It is over most of my students' head in understanding. If you have an above average student or a student that is inspired in this lab and is looking for a deep understanding, this would be the site to recommend.
6. *Indiana Academic Standards for Science*  
<http://www.doe.state.in.us/asap/standards/science/science.html>  
Indiana Department of Education.
7. Spurlock, M. (Producer and Director). (2004). *Super Size Me* [Motion Picture]. United States: Showtime Networks, Inc. A movie that shows the process and results of only eating fast food (from McDonalds). If you have time it is a film worth showing in its entirety. However, the first chapter of the DVD and the last chapter of the DVD will suffice in explaining initial concept and final result.
8. Ward's Natural Science, P.O. Box 92912, Rochester, NY 14692-9012 , 1-800-962-2660, <http://wardsci.com>

## Assignment

### I. Role Model Worksheet

Complete the Science Role Model Worksheet in your group.

### II. Experimental Testing

#### *Safety*

Goggles, apron, unobstructed fire extinguisher, eye wash free from debris, backpacks and/or books away from lab area, closed toed shoes only, baggy clothing secured, long hair secured, procedures for how to treat injuries occurring from Benedict's solution, biuret reagent and iodine.

#### *Directions*

This lab is developed to show you how to test for different molecules found in common and uncommon foods (food from different ethnic regions). You should now have two different data sheets. The first data sheet has a list of food types on the left and reagents on the top of each column. Using the keys provided in the lab write the result of each food and reagent in the corresponding box.

*Note: Even though the title implies that this lab tests for the presence of macromolecules, it does not test for all macromolecules nor does it test only macromolecules. Please note that in this lab activity we do not test for the presence of nucleic acids.*

### III. Complete Diagrams and Tables

After finishing the experimental part of the lab fill in the diagram that has the four circles on it. The circles each represent a positive test for that reagent. The circle diagrams are to be used as Venn diagrams that will show foods that test positive for multiple reagents. The Venn diagram will merely aid in organizing of your food analysis.

### IV. Analyze the Data

Upon completion of the lab you should be able to develop a hypothesis which identifies what each reagent tests for. Furthermore, your hypothesis should be tested to confirm or prove that it is correct.

### V. DVD Chapter

Intently watch the sections of *Super Size Me* and try to think about how important diet is to health. Notice that he is receiving high quantities of certain bodily needs, but lacking others.



Name: \_\_\_\_\_ Date: \_\_\_\_\_

## I. Science Role Model Worksheet

1. Title or Role Model Activity Page: Dr. Rudy Ortiz and Nutrition
2. Purpose/Objectives: For students to understand the importance of nutrition and how it affects our body. Secondly, students will be able to see how the study of nutrition can be fascinating along with being a career.
3. Directions: For the following websites, read the article and write three interesting facts that you learned from that site. Secondly, write three questions that you would ask Dr. Ortiz if he was here.

### Resource #1

Title of Website: **Rudy Martin Ortiz biography**

Web Address [http://bio.research.ucsc.edu/people/ortiz/public\\_html/](http://bio.research.ucsc.edu/people/ortiz/public_html/)

This site focuses on Dr. Ortiz's dissertation which covers kidney function and metabolism of hormones in fasting animals. His research leads to a better understanding of anorexia, diabetes, obesity, and renal dysfunctions in humans.

### Resource #2

Title of Website: **Rudy Martin Ortiz**

Web Address <https://eng.ucmerced.edu/FacultyBio/rortiz>

Website provides Dr. Ortiz's research interest along with methods to reach him.

### Resource #3

Title of Website: **UC Merced - About UC Merced**

Web Address <http://www.ucmerced.edu/spotlightdetail.asp?spotlightid=13>

This site provides a history of Dr. Ortiz and how he became interested in his topic area. Also included are snippets of his research and how he arrived at studying that specific area.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## II. Experimental Testing

### A. Testing with Benedict's Solution

1. Use a pipette to take Benedict's solution from the main beaker. Put two squirts of Benedict's Solution into a test tube (10 drops) then add two squirts of water from the pipette (this is your control). Create a test tube for each type of food to be tested. Be very careful, Benedict's solution is poisonous.
2. Next, add 2 squirts of a single puréed food to one test tube containing Benedict's solution. Go to the second test tube and add 2 squirts of the second food to Benedict's solution. Repeat process with each food type.
3. Upon completion of the preparation notify your teacher that you are ready to heat your solutions. Remember, never point a heated test tube at yourself or anyone else. Place you test tubes into the hot water bath for 2-3 minutes. DO NOT OVERHEAT! Remove the test tubes using test tube tongs and place them in the test tube rack. Caution: hot glass appears the same as cool glass and glass holds heat for a long period of time.

Quantity of Macromolecule in food	-	+	++	+++	++++
Color of solution	Blue	Blue-green	Green	Yellow	Brick Red

*Hold a solid white sheet of paper behind the test tube to get a more accurate color perception. Once you have results record the observation as previously indicated on the handout that has all the food types on it. Record your observations for each food type on that sheet.*

### B. Testing with Biuret reagent

1. Use a pipette to take Biuret reagent from the main beaker. Put two squirts of Biuret reagent into a test tube (10 drops) then add two squirts of water from the pipette (this is your control). Create a test tube for each type of food to be tested. Be very careful, Biuret reagent can burn your skin.
2. Next, add 2 squirts of a single puréed food to one test tube containing Biuret reagent. Go to the second test tube and add 2 squirts of the second food to Biuret reagent. Repeat process with each food type.

- Upon completion of the preparation notify your teacher that you are ready to heat your solutions. Remember, never point a heated test tube at yourself or anyone else. Place your test tubes into the hot water bath for 1-2 minutes. **DO NOT OVERHEAT!** Remove the test tubes using test tube tongs and place them in the test tube rack. Caution: hot glass appears the same as cool glass and glass holds heat for a long period of time.

Quantity of Macromolecule in food	-	+	++	+++	++++
Color of solution	Blue	Purple	Purplish-Pink	Pinkish-Purple	Pink

*Hold a solid white sheet of paper behind the test tube to get a more accurate color perception. Once you have results record the observation as previously indicated on the handout that has all the food types on it. Record your observations for each food type on that sheet.*

### **C. Testing with Iodine**

- Use a pipette to take iodine from the main beaker. Put 2-3 drops of iodine into a test tube then add two squirts of water from the pipette (this is your control). Create a test tube for each type of food to be tested. Be very careful, iodine will stain your skin.
- Next, add 2 squirts of a single puréed food to one test tube containing iodine. Go to the second test tube and add 2 squirts of the second food to the iodine. Repeat process with each food type.
- The iodine reacts with the foodstuffs without heating the solution. You may want to gently swirl the test tube to assure complete mixture of the iodine with the foodstuff.

Presence of Macromolecule in food	-	+
Color of solution	Opaque (same color) or only change due to color of food	Black, purple or dark blue

*Once you have results, record the observation as previously indicated on the handout that has all the food types on it. Record your observations for each food type on that sheet.*

**D. Testing with Cardboard (or newspaper or brown paper bag)**

1. Take a ball point pen and write what each food type is on the small piece of paper that is provided.
2. Place 2 drops of foodstuffs onto the paper on the location of the written word. Let set for 30 seconds.
3. Positive (+) results will be shiny and translucent.  
Negative (-) results will also appear translucent, but not shiny.

*Once you have results record the observation as previously indicated on the handout that has all the food types on it. Record your observations for each food type on that sheet.*

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**II. Data Table**

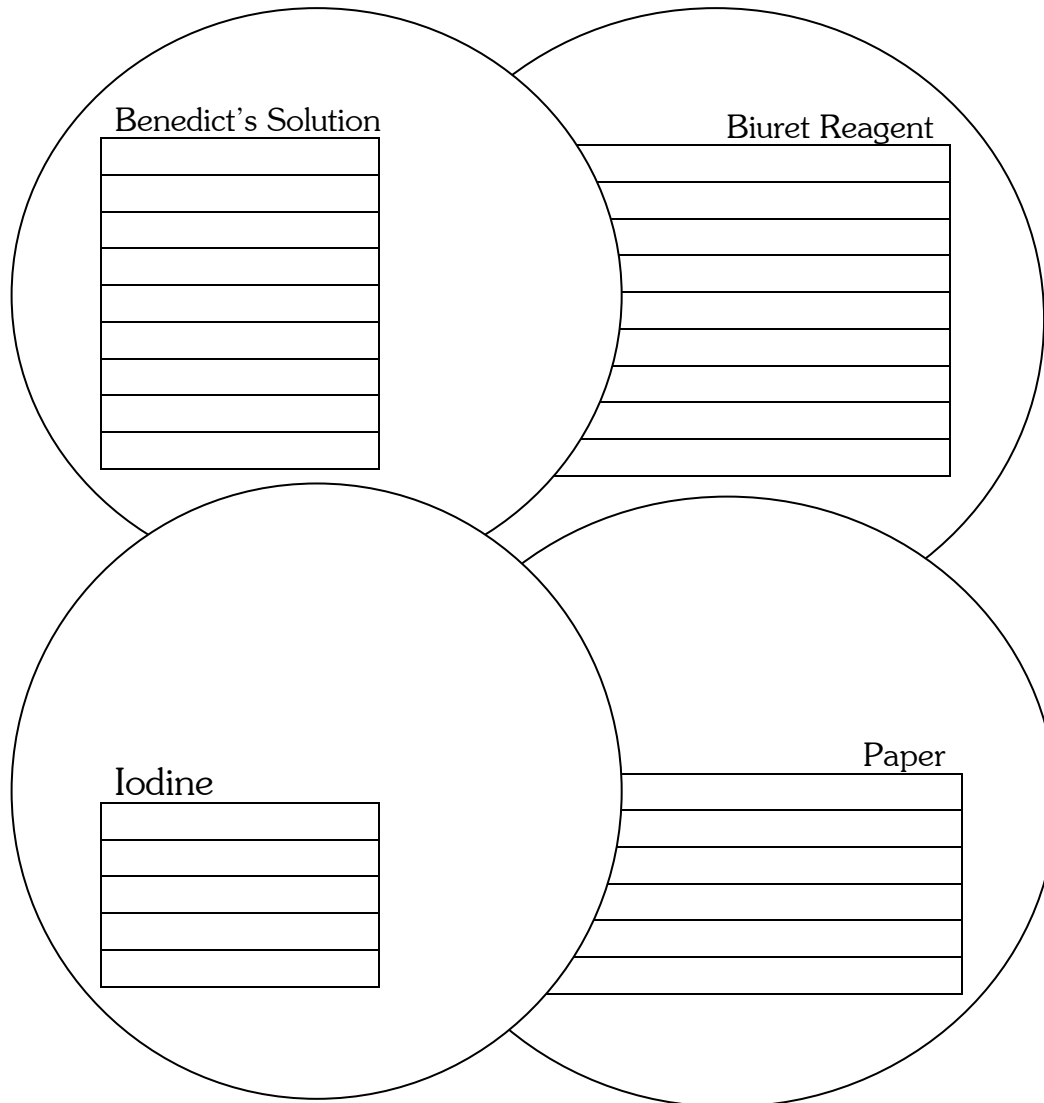
Please fill the table below according to your results for each test that you performed. Align each reagent with the food tested and fill in the result.

	<b>Benedict's Reaction</b>	<b>Biuret Reaction</b>	<b>Paper Result</b>	<b>Iodine Result</b>
Control (water)				
Tuna				
Crisco spray				
honey				
potato				
Pacific Islander Food				
Hispanic Food				
Native American Food				
(food from home)				
(food from home)				
(food from home)				
(food from home)				
(food from home)				
(food from home)				
(food from home)				
(food from home)				
(food from home)				

Name: \_\_\_\_\_ Date: \_\_\_\_\_

**III. Complete Diagrams and Tables**

Fill in the Venn diagram using the results that are listed on the reagent/food page. Do not include the variation of food; only include the results as positive and negative. Use this diagram to show the overlap and relationships of different foods and what they test positive for.



**IV. Analyze the data**

Analyze the food tested and the results to develop a hypothesis of what each test indicated the presence of which macromolecule. Also mention which food(s) was most instrumental in developing a hypothesis or which food(s) was least instrumental in developing a hypothesis. Upon completion of the hypothesis, test the hypothesis by analyzing foods from home that are labeled and compare the results. This should indicate whether your hypothesis is supported or not.

**IV. Hypotheses**

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. Hypothesis for Benedict's reagent
  - a. Labeled food to be tested \_\_\_\_\_
  - b. Why this food was tested to prove your hypothesis?
  
  - c. Was your hypothesis supported or not? If not, why?
  
2. Hypothesis for Biuret's solution
  - a. Labeled food to be tested \_\_\_\_\_
  - b. Why this food was tested to prove your hypothesis?
  
  - c. Was your hypothesis supported or not? If not, why?
  
3. Hypothesis for cardboard test
  - a. Labeled food to be tested \_\_\_\_\_
  - b. Why this food was tested to prove your hypothesis?
  
  - c. Was your hypothesis supported or not? If not, why?
  
4. Hypothesis for iodine test
  - a. Labeled food to be tested \_\_\_\_\_
  - b. Why this food was tested to prove your hypothesis?
  
  - c. Was your hypothesis supported or not? If not, why?

Applying your findings of what are in the ethnic foods, write a paragraph which describes possible nutrients that are either present in high quantities or lacking in a typical meal from the ethnic groups of interest. In the next class, we will do an Internet search that will reveal the possible problems or complications of that diet over a long period of time. While doing our Internet searches, we will also focus on common disorders and self-inflicted eating disorders and their affects on health.