VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE
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Food Chemistry

Spring 2013

GOAL To investigate basic nutrients found in foods.

LESSON OUTLINE

MATERIALS FOR 5 CLASSES

8 well plates with 6 wells (for testing the "known" foods)
32 well plates with 12 wells (for testing "unknowns")
8 – 2oz. Plastic Bottles of Potato Flakes **AND small scoop**
8 – 2oz. Plastic Bottles of Powdered Egg Whites **AND small scoop**
8 – 2oz. Plastic Bottles of Flour **AND small scoop**
8 – 2oz. Plastic Bottles of Milk Powder **AND small scoop**
1 – 4oz. Jar of Banana Chips
1 Ziploc Bag of Crackers
1 Ziploc Bag containing crushed potato chips
8 dropper bottles of copper sulfate $CuSO_4$ (0.1 M)
8 dropper bottles of sodium hydroxide NaOH (0.5 M)
8 – 2oz. Bottles full of Toothpicks

1 Ziploc Bag containing about 150 pieces of brown paper bag
1 Ziploc Bag containing 8 dropper bottles of Iodine I_2
1 - 1oz cup containing butter
32 Food Pyramids plus Food Label page (blue paper) in protector sheets, (1 per student)
1 Student Data sheet (Master) for testing **known** foods (in sheet protector)
1 Student Data sheet (Master) for testing **unknown** foods (in sheet protector)
1 Box of extra toothpicks

ORGANIZE THE CLASS INTO GROUPS OF 3-5 STUDENTS

You might consider numbering the students in each group from 1 - 5. Each time there is a task to do, call on a different number so students have equal opportunity to work on the experiments.
Note: Small scoops are in the plastic bottles of the foods to be tested. Emphasize that scoops need to be put back in the bottles after they are used. They MUST be washed if they get contaminated.

Write the following vocabulary words/phrases on the board:
basic nutrient groups (carbohydrates, fats, proteins, vitamins, minerals, water)
food pyramid,
starch test, iodine
translucent,
Point to these words as you encounter them in the lesson. If time permits, they can be reviewed at the end of the lesson.

I. INTRODUCTION

Materials: Hand out a food pyramid sheet to each student.
Ask, *What is in the food that we eat?*

- Food is made up of nutrients.
- Nutrients are chemical substances in foods that provide the energy and raw materials
- The classes of nutrients are: proteins, vitamins, water, carbohydrates, fats, and minerals.
- We need some of all of these in our diet.

Lead a short discussion on good eating habits, following the food pyramid.

Tell the students that they will test foods for the presence of three of the nutrient groups - starch (one category of carbohydrates), proteins, and fats.

II. TESTING FOR PROTEIN

MATERIALS PER GROUP

1 well-plate (with 6 wells)
1 dropper bottle of copper sulfate $CuSO_4$ (0.1 M)
1 dropper bottle of sodium hydroxide NaOH (0.5 M)
1 plain toothpick
1 2oz. Plastic Bottle of Powdered Egg White **AND small scoop**
1-5 Student Data sheet for testing "knowns" (1 per student).

Give each group the materials for testing protein (egg white) and give each student a Data sheet (for testing the "knowns").

Ask, *Why is protein important?*
Proteins are found in all living things. The function of dietary protein is to provide amino acids for new protein synthesis. These new proteins are important to the structure of cells, hair and other structures, and carry out a number of other functions in our bodies. A number of nutritional disorders are caused by protein deficiencies. Examples of high-protein foods are meat, fish, eggs, cheese, and beans

Tell students to look at the instruction sheet (reverse side of Food Pyramid) and follow along as you demonstrate parts A and B below. Then help the students complete their own test, using the Instruction sheet as a guide.

Place the 6-well plate on the observation sheet

A. Chemicals Used to Test for Protein

- Add 10 drops of 0.5 M NaOH to the first **empty** well.
- Add 3 drops of copper sulfate (0.1 M $CuSO_4$).
- Stir with a toothpick.

Have the students record the color in the well. (It will be compared to the color obtained after protein is added.)

Have the students record the color on their data sheet.

B. Testing Powdered Egg Whites

Add a small scoop of egg white to the next well.

Return the scoop to the bottle.

- Add 10 drops of 0.5 M NaOH to **the well containing powdered egg whites.**
- Stir with a toothpick.
- Add 3 drops of copper sulfate (0.1 M $CuSO_4$).
- Stir again.
- Wait several minutes for a color change to occur.
- What color did it turn? Have the students record the answer on the data sheet.
- Record the answer on the board.

Discard toothpick (break in half).

The solution will turn faintly pink, dark blue or purple in the presence of protein.

III. TESTING FOR FATS

MATERIALS FOR EACH GROUP

1 piece of brown paper per group

MATERIALS FOR THE CLASS

1 1oz. container of butter

1 toothpick (to distribute butter)

Ask, *How is fat used in our body?*

Fat is used to store energy. Sometimes we cannot eat enough to perform daily activities. So, our bodies use the energy that is stored in the form of fats. Fats can be saturated (all carbon-carbon bonds are single bonds) or unsaturated (one or more of the carbon-carbon bonds are double bonds). For example, fats found in butter, cheese, coconut and beef are primarily

saturated fat while fats found in fish, peanuts, corn and soybeans are primarily unsaturated fats. Diets rich in saturated fats can contribute to heart disease. When it comes to fats, moderation is the secret. Any excess energy, whether it is from the intake of fats or the intake of sugar, is stored as fat. Fats also keep our body insulated from the cold and cushion our organs.

Demonstrate the following test for fats and then help the students complete their own test, using the Instruction sheet as a guide.

- Distribute **one** small piece of butter to each **group**. Use the toothpick to put the butter directly on their piece brown paper.

Have one student in each group do the following:

- Take the piece of brown paper bag with the butter and fold it in half.
- Hold the brown paper between the thumb and forefinger and rub the paper against the piece of butter.
- Let the piece of paper bag sit 1-2 minutes.
- Hold the bag up to the light. What happened?
- Have the students write their observation on the Observation sheet.
- Place brown paper in the **second well**
- Record the answer on the board.

The piece of brown paper will be translucent (light shines through) in the presence of fats.

IV. TESTING FOR STARCH

MATERIALS FOR EACH GROUP

1 2oz. Plastic Bottle of Flour AND small scoop
1 Dropper bottle of Iodine I_2

Ask, *How is starch used in our body?*
Starch is a carbohydrate. Carbohydrates form the basis for our diet. Some foods that are high in carbohydrates include sugar, bread, cereals, rice, and potatoes. The end product of carbohydrate digestion is glucose. Glucose is the fuel molecule that provides energy for our muscles and brain. That is why the USDA suggests 6-11 servings of bread, rice and cereal.

- Distribute a 2oz. Plastic Bottle of Flour, a small spoon, and 1 dropper bottle of iodine to each group.

Demonstrate the following test for starch and then help the students complete their own test, using the Instruction Sheet as a guide.

- Have students put 1-2 drops of the iodine solution in the third well.
- What color is the iodine? (It is a pale yellow.) Have the students record the answer on the data sheet.
- Add a small scoop of flour to the other well.

Return the scoop to the bottle.

- Have students put 1-2 drops of the iodine solution on the flour.
- What color did the iodine turn? **Iodine will turn a dark black/purple color in the presence of starch.**
- Have the students record the answer on the data sheet.
- Record the color change on the board.

Move the 6-well plate on the data sheet to the middle of the group, so they can all refer to it as they do the texts on the following foods.

V. TESTING FOODS FOR NUTRIENTS

MATERIALS FOR EACH GROUP (8 groups)

1 2oz. Plastic Bottle of Milk Powder **AND small scoop**
1 piece of Banana Chip (students need to crush it to smaller pieces)
1 Cracker (students need to crush it to smaller pieces)
1 potato chip (students need to crush it to smaller pieces)
1 2oz. Plastic Bottle of Milk Powder **AND small scoop**
5 pieces of brown paper bag
5 well plates with 12 wells (1 per student)
5 data sheets for testing "unknowns" (1 per student)

Materials from previous testing:

1 dropper bottle of copper sulfate $CuSO_4$ (0.1 M)
1 dropper bottle of sodium hydroxide NaOH (0.5 M)
1 2oz. Bottle full of Toothpicks
1dropper bottle of Iodine I_2

Distribute the food so that each group gets all 5 foods.

Each student will need to use one piece of brown paper and one toothpick and will share the chemicals in the dropper bottles.

Each group conducts **all three of the previous tests** (starch, fats, proteins) on all five foods. (Each student tests at least one food.)
Tell students to crush the potato chips, banana chips and crackers.
Add a few pieces of the crushed or powdered food to the first column of wells.
Do the tests for protein, fats and starch.

Return each scoop to its appropriate bottle.

Students should place the well-plate with their tested food so that all group members can see.
Compare the wells with those on the Data sheet for known foods, and decide which nutrients the food contains.

All group members will record the results on their Data Sheet for Unknowns by underlining if the nutrient is present in their food
Record results from each group on the board to share with the other groups.

Ask, *Why doesn't the potato test for fat if the potato chip does?*
Potato chips contain fat because they are made by cooking sliced potatoes in fat.

Ask, *Are banana chips better for you than potato chips?*
Not really – they contain fats just like potato chips. However, they contain NO salt whereas salt is added to the potato chips.

Food Chemistry Data Sheet

The following is a summary of the nutrients found in the "unknown" foods tested.

Food	Result of Proteins Test	Result of Fats Test	Result of Starch Test
milk powder	yes	no	no
Cracker	Yes (trace)	no	yes
potato flakes	Yes	no	yes
potato chip	Yes (trace)	yes	yes
banana chip	Yes (trace)	yes	yes

FOOD INGREDIENT TABLE

This table is for VSVS member's information. It may be referred to if the students ask questions. There are several reasons why we are not having the students use this table as a guide to predicting nutrients in the foods they test:

1). It is difficult for 5th graders to determine what a "trace" nutrient is.

2). We discuss and test only one kind of carbohydrates – starch. Milk powder also contains sugar that will not give a positive starch test.

1 CUP OF:	Carbohydrates	Protein	Fat	Sodium	Calories
Egg White Powder (1C = 165g)	**4.7g**	**87.7g**	**0**	**1325mg**	**402**
Flour (1C = 115g)	**95.4g**	**12.9g**	**1.2g (Trace)**	**2mg**	**455**
Butter or Margarine (1C = 226g)	**(Trace)**	**2gm (Trace)**	**184g**	**0**	**1630**
Milk Powder (1C = 68g)	**35.4g**	**23.8g**	**0.5g (Trace)**	**374mg**	**243**
Crackers (1C = 28g =10 crackers)	**20g**	**2g (Trace)**	**3g**	**0**	**120**
Potato Flakes (1C = 210g)	**48g**	**6g**	**0**	**60mg**	**210**
Potato Chips (1C = 28g = 20 chips)	**15g**	**2g (Trace)**	**10g**	**180mg**	**150**
Banana Chips (1C = 30g)	**20g**	**1g (Trace)**	**8g**	**0**	**150**

VI. QUESTIONS FOR REVIEW

What are the basic nutrient groups found in foods?
carbohydrates, fats, proteins, vitamins, minerals, water

How is starch used in our body?
Starch makes glucose, which is the fuel molecule that provides energy for our muscles and brain.

How does iodine indicate the presence of starch in foods?
Iodine turns dark black or purple in the presence of starch.

How are fats used in our body?
Fats are used to store energy, insulate our body from cold, and cushion our organs.

What is one test to determine if a food contains fat?
Rub the food on a brown paper sack to see if the paper becomes translucent (lets light pass through).

How are proteins used in our body?
The function of dietary protein is to provide amino acids for new protein synthesis. These new proteins are important to the structure of cells, hair, and other structures, and to carry out a number of other functions in our bodies.

VII. OPTIONAL ACTIVITIES

Food Labels

- Tell the students to look at the copy of the food label sheet and discuss how to read a label to determine what is present.

Point out that carbohydrates include several different sugars [examples include glucose, lactose (milk), sucrose (table sugar)], starch, and cellulose (dietary fiber). Both starch and cellulose are polymers of glucose, but humans cannot digest cellulose because its structure is slightly different from that of starch. This illustrates the specificity of enzymes since we have an enzyme that catalyzes the breakdown of starch to glucose, but not one that catalyzes the breakdown of cellulose to glucose. However, termites and ruminant mammals such as cows, sheep, goats, and camels do have the proper digestive enzyme for cellulose.

Since the test with iodine only works with starch and not with sugars or cellulose, today's results only indicate whether starch is present or absent, and do not give any information about the amount of sugar or the amount of dietary fiber that is present.

The blue-purple color that develops when drops of iodine solution are added to starch is attributed to a complex formed between starch and iodine. The iodine molecules fit into the open spaces of the starch helical structure.

Lesson written by Dr. Melvin Joesten, Chemistry Department, Vanderbilt University
Susan Clendenen, Teacher Consultant, Vanderbilt University
Pat Tellinghuisen, Coordinator of VSVS, Vanderbilt University

Food Chemistry Instruction Sheet

Name_____

vocabulary words/phrases:
basic nutrient groups (carbohydrates, fats, proteins, vitamins, minerals, water)
food pyramid,
starch test, iodine
translucent,

I. INTRODUCTION

Look at the food pyramid sheet.
What is in the food that we eat?
Discuss good eating habits, following the food pyramid.

You will test foods for the presence of three of the nutrient groups - starch, proteins, and fats.

II. TESTING FOR PROTEIN

Why is protein important?
Follow the instruction sheet and complete the tests.
Place the 6-well plate on the observation sheet

A. Chemicals Used to Test for Protein

- Add 10 drops of 0.5 M NaOH to the first empty well.
- Add 3 drops of copper sulfate (0.1 M $CuSO_4$).
- Stir with a toothpick.
- Record the color in the well. (It will be compared to the color obtained after protein is added.)

B. Testing Powdered Egg Whites

- Add a small scoop of egg white to the next well. **Return the scoop to the bottle**.
- Add 10 drops of 0.5 M NaOH to the well containing powdered egg whites.
- Stir with a toothpick.
- Add 3 drops of copper sulfate (0.1 M $CuSO_4$).
- Stir again.
- Wait several minutes for a color change to occur.
- Record the answer on the data sheet.

Discard toothpick (break in half).

III. TESTING FOR FATS

How is fat used in our body?
Watch the teacher demonstrate the **test for fats and complete your own test.**

- Put the butter directly on the piece of brown paper.
- Fold it in half.
- Hold the brown paper between the thumb and forefinger and rub the paper against the piece of butter.
- Let the piece of paper bag sit 1-2 minutes.
- Hold the bag up to the light. What happened?

• Record your observation and then **<u>place brown paper in the second well.</u>**

IV. TESTING FOR STARCH

Follow the demonstration for the test for starch and then complete your own test.

- Put 1-2 drops of the iodine solution in the third well.
- Record the answer on the data sheet.
- Add a small scoop of flour to the other well. **Return the scoop to the bottle**.
- Put 1-2 drops of the iodine solution on the flour.
- Record the answer on the data sheet.

Move the 6-well plate on the data sheet to the middle of the group so your group can all refer to it as you do the tests on the following foods.

V. TESTING FOODS FOR NUTRIENTS

Each group gets all 5 foods.
Each group conducts **<u>all three of the previous tests</u>** (starch, fats, proteins) on all five foods.
Note: crush the potato chips, banana chips and crackers before testing.
After each test, return each scoop to its appropriate bottle.

Place the well-plate with your tested food so that all group members can see.
Compare the wells with those on the Data sheet for known foods, and decide which nutrients the food contains.
All group members will record the results on their Data Sheet for Unknowns by underlining if the nutrient is present in their food.

Discuss the following questions:
Why doesn't the potato test for fat if the potato chip does?

Are banana chips better for you than potato chips?

What are the basic nutrient groups found in foods?

How is starch used in our body?.

How does iodine indicate the presence of starch in foods?

How are fats used in our body?

What is one test to determine if a food contains fat?

How are proteins used in our body?

VII. **OPTIONAL ACTIVITIES**

- **L**ook at the copy of the food label sheet and discuss how to read a label to determine what is present.

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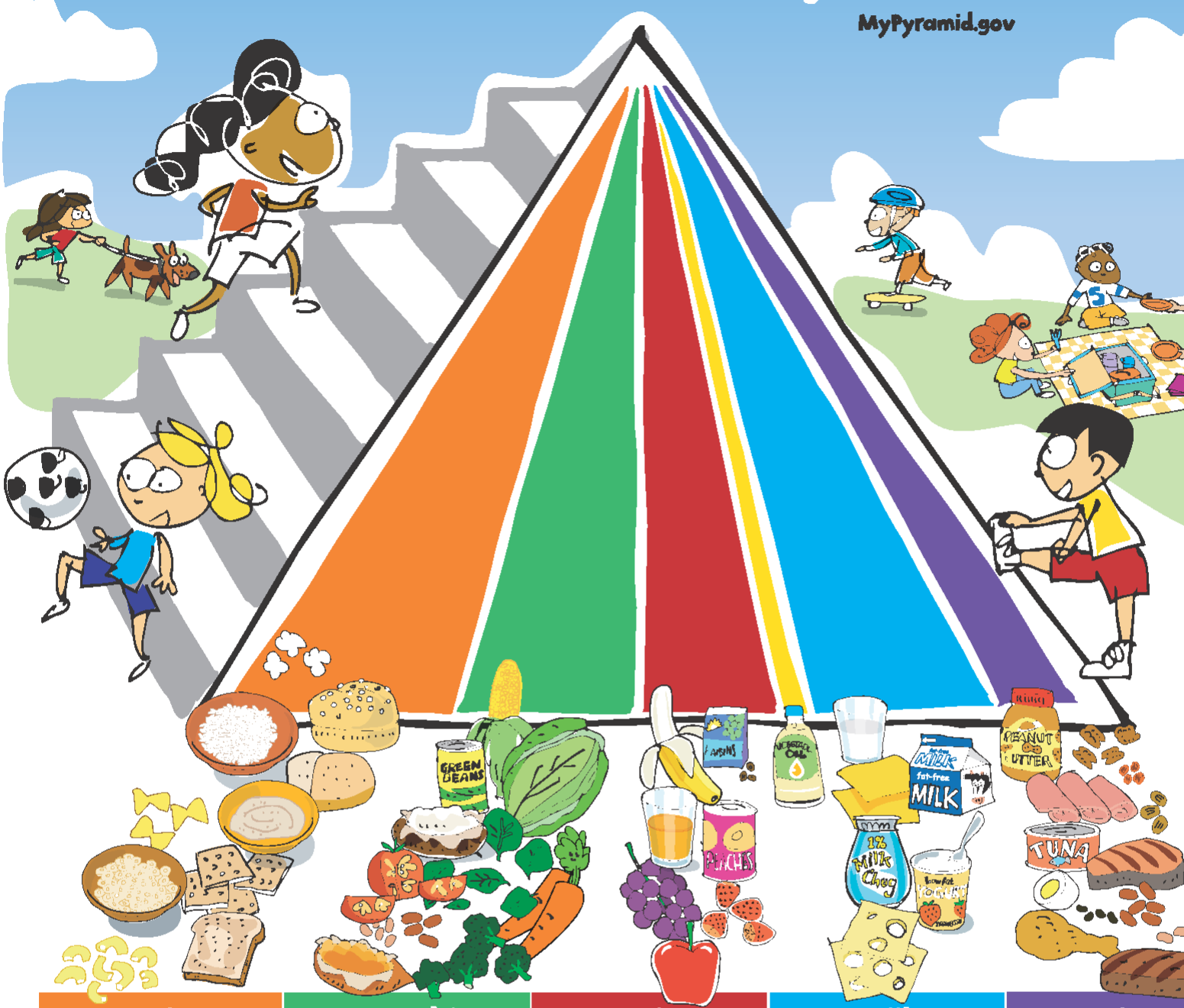


Grains

Make half your grains whole

Start smart with breakfast. Look for whole-grain cereals.

Just because bread is brown doesn't mean it's whole-grain. Search the ingredients list to make sure the first word is "whole" (like "whole wheat").

Vegetables

Vary your veggies

Color your plate with all kinds of great-tasting veggies.

What's green and orange and tastes good? Veggies! Go dark green with broccoli and spinach, or try orange ones like carrots and sweet potatoes.

Fruits

Focus on fruits

Fruits are nature's treats – sweet and delicious.

Go easy on juice and make sure it's 100%.

Milk

Get your calcium-rich foods

Move to the milk group to get your calcium. Calcium builds strong bones.

Look at the carton or container to make sure your milk, yogurt, or cheese is lowfat or fat-free.

Meat & Be

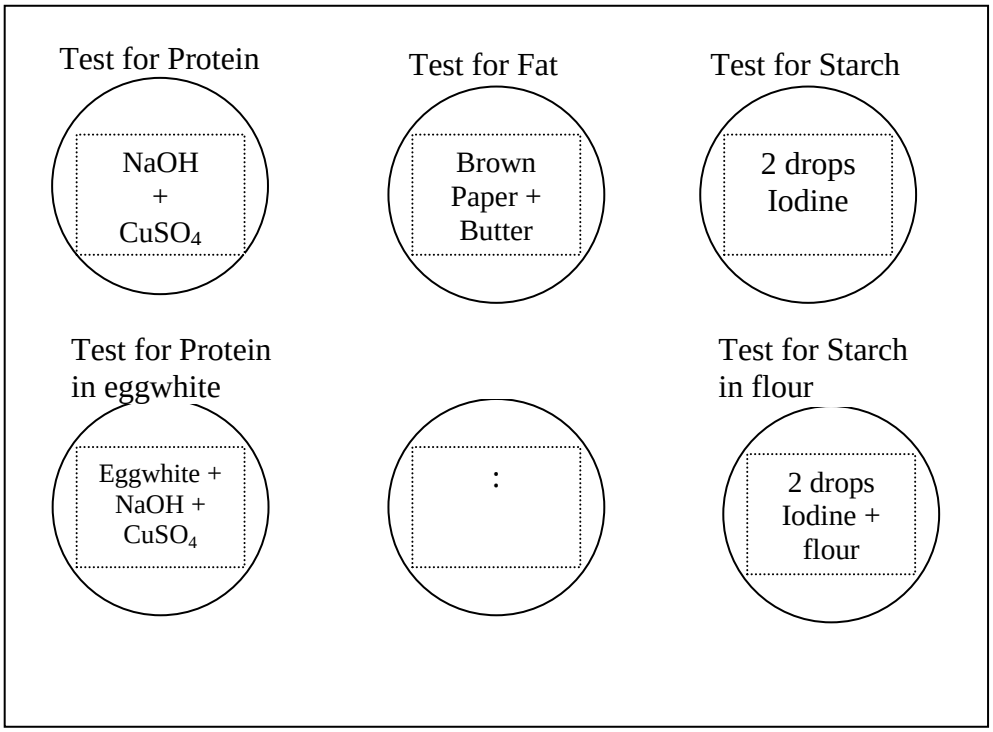
Go lean with prote

Eat lean or lowfat me chicken, turkey, and f Ask for it baked, broi or grilled – not fried.

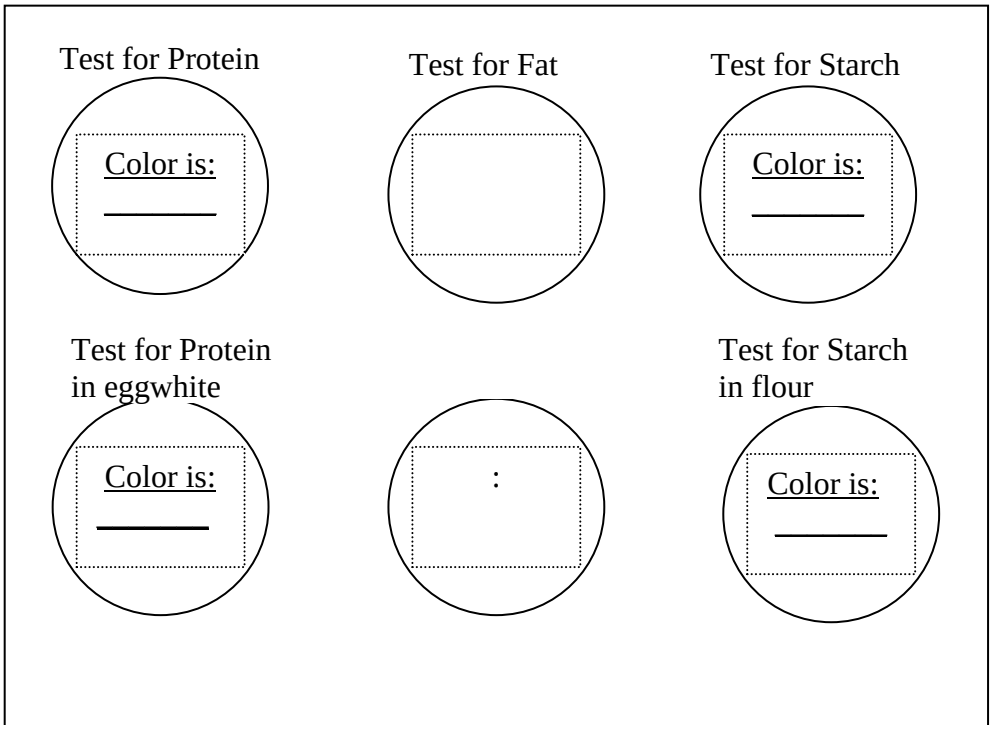
It's nutty, but true. Nuts, seeds, peas, ar beans are all great sources of protein, to

Student Data Sheet For "Knowns"

Place well plate on top of diagram, and place solutions in each well as labeled.

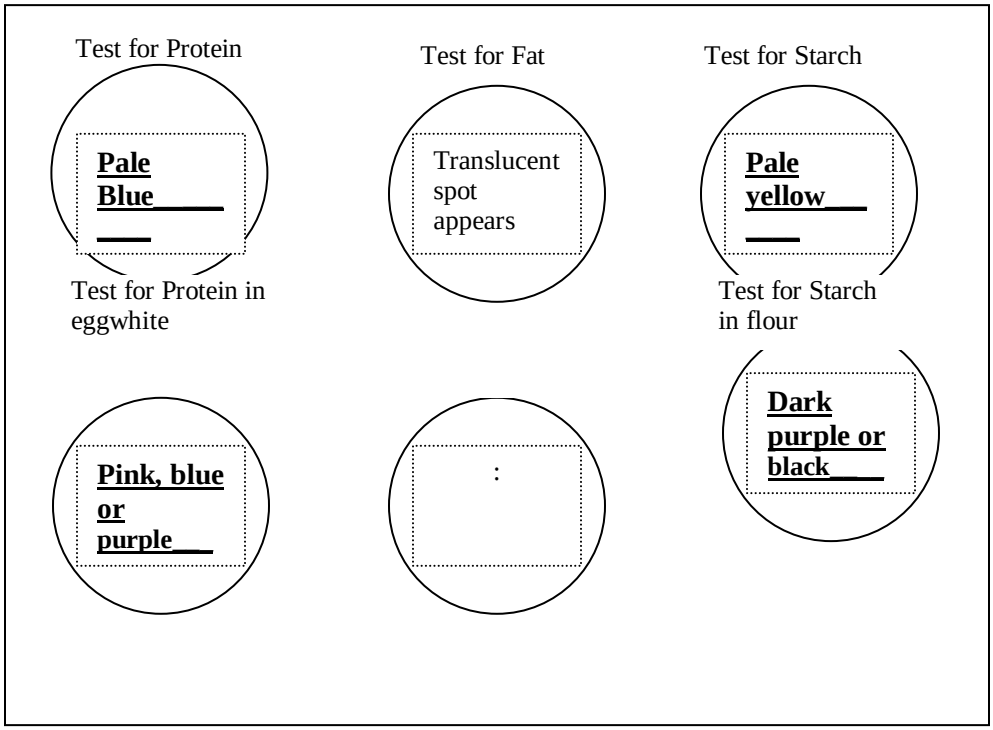


Record your data/observations below:



Answer Sheet (for "knowns"

Results for Controls

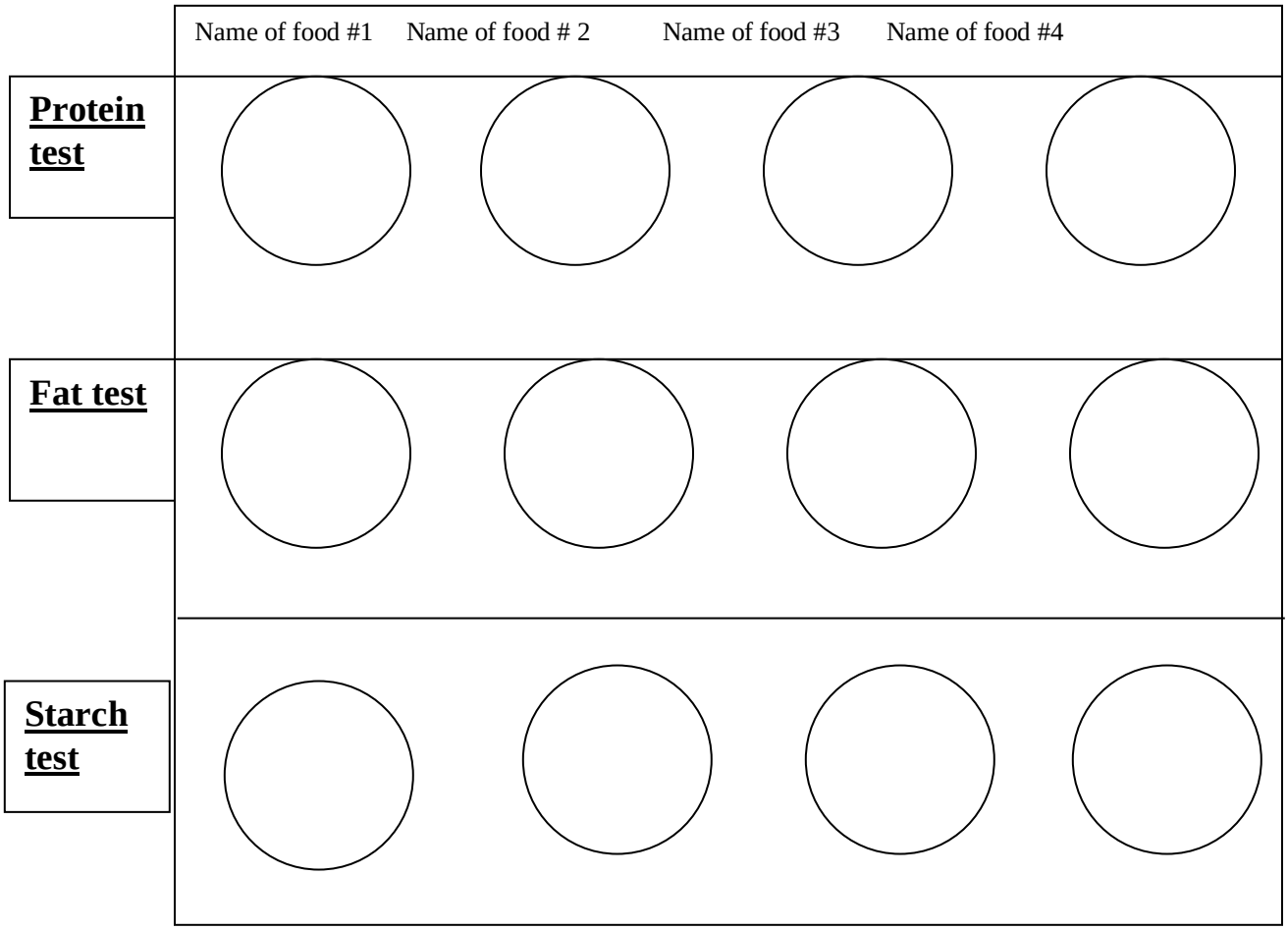


Underline the correct answers:

Milk Powder contains:	**Protein**	~~Fat~~	~~Starch~~
Crackers contain:	**Protein**	~~Fat~~	**Starch**
Potato Flakes contain:	**Protein**	~~Fat~~	**Starch**
Potato chips contain:	**Protein**	**Fat**	**Starch**
Banana chips contain:	**Protein**	**Fat**	**Starch**

Student Data Sheet for "Unknowns"

Test each food for protein, fat and starch, and enter your observations in the circles .



Circle the correct answers:

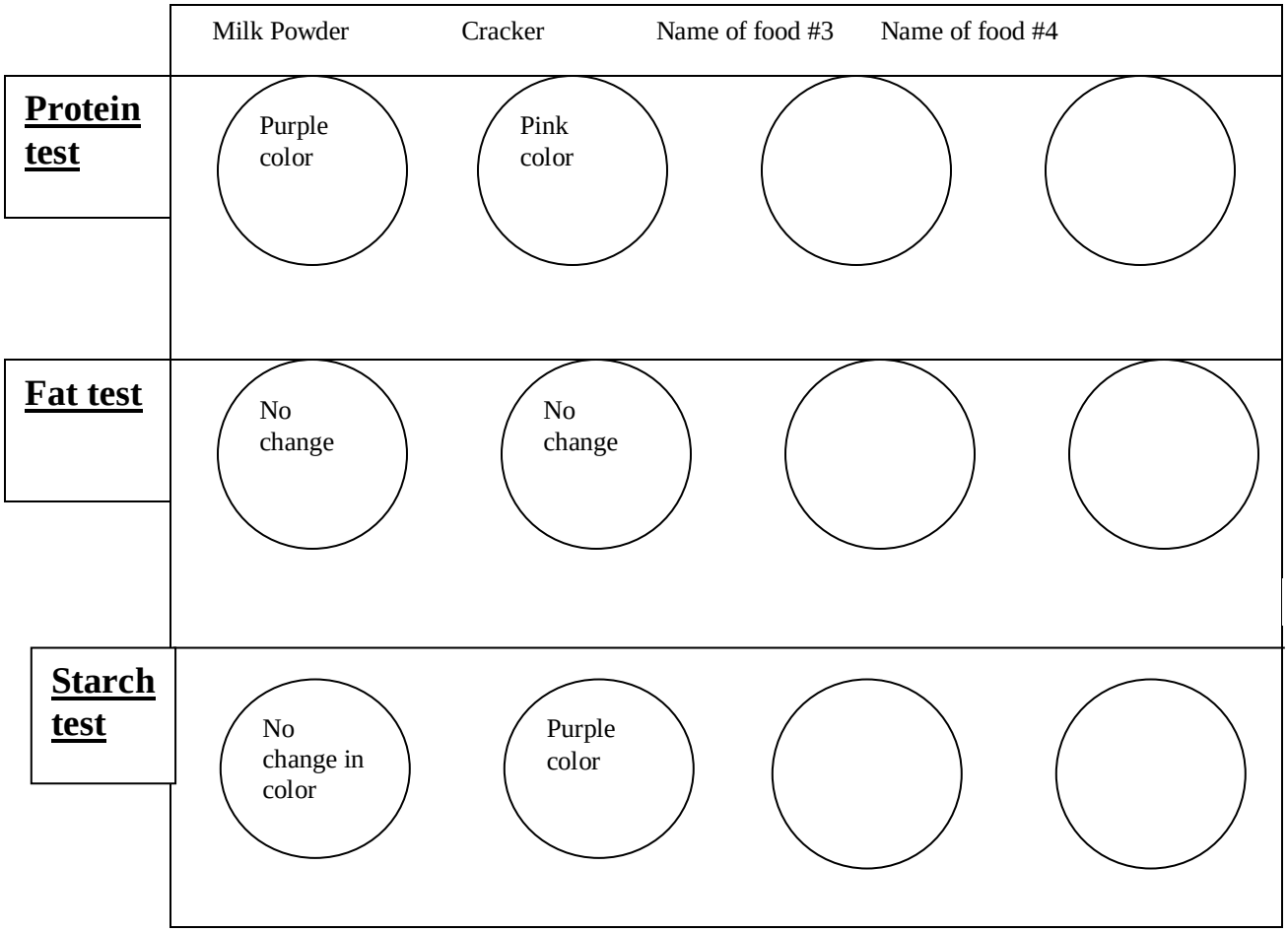
Milk Powder contains:	Protein	Fat	Starch
Crackers contain:	Protein	Fat	Starch
Potato Flakes contain:	Protein	Fat	Starch
Potato chips contain:	Protein	Fat	Starch
Banana chips contain:	Protein	Fat	Starch

List other food you test:

Protein	Fat	Starch
Protein	Fat	Starch

Sample Answer Data Sheet for “unknowns”

Test each food for protein, fat and starch, and enter the observations in the circles .



Food Chemistry Instruction Sheet

vocabulary words/phrases:
basic nutrient groups (carbohydrates, fats, proteins, vitamins, minerals, water)
food pyramid,
starch test, iodine
translucent,

I. INTRODUCTION

Look at the food pyramid sheet.
What is in the food that we eat?
Discuss good eating habits, following the food pyramid.

You will test foods for the presence of three of the nutrient groups - starch, proteins, and fats.

II. TESTING FOR PROTEIN

Why is protein important?
Follow the instruction sheet and complete the tests.
Place the 6-well plate on the observation sheet

A. Chemicals Used to Test for Protein

- •Add 10 drops of 0.5 M NaOH to the first empty well.
- • Add 3 drops of copper sulfate (0.1 M $CuSO_4$).
- • Stir with a toothpick.
- •Record the color in the well. (It will be compared to the color obtained after protein is added.)

B. Testing Powdered Egg Whites

- •Add a small scoop of egg white to the next well. **Return the scoop to the bottle**.
- •Add 10 drops of 0.5 M NaOH to the well containing powdered egg whites.
- • Stir with a toothpick.
- • Add 3 drops of copper sulfate (0.1 M $CuSO_4$).
- • Stir again.
- • Wait several minutes for a color change to occur.
- • Record the answer on the data sheet.

Discard toothpick (break in half).

III. TESTING FOR FATS

How is fat used in our body?
Watch the teacher demonstrate the **test for fats and complete your own test.**

- • Put the butter directly on the piece of brown paper.
- • Fold it in half.
- • Hold the brown paper between the thumb and forefinger and rub the paper against the piece of butter.
- • Let the piece of paper bag sit 1-2 minutes.
- • Hold the bag up to the light. What happened?
- • Record your observation and then **<u>place brown paper in the second well.</u>**

IV. TESTING FOR STARCH

Follow the demonstration for the test for starch and then complete your own test.

- Put 1-2 drops of the iodine solution in the third well.
- Record the color on the data sheet.
- Add a small scoop of flour to the other well. **Return the scoop to the bottle**.
- Put 1-2 drops of the iodine solution on the flour.
- Record the color on the data sheet.

Move the 6-well plate on the data sheet to the middle of the group so your group can all refer to it as you do the tests on the following foods.

V. TESTING FOODS FOR NUTRIENTS

Each group gets all 5 foods.
Each group conducts **all three of the previous tests** (starch, fats, proteins) on all five foods.
Note: crush the potato chips, banana chips and crackers before testing.
After each test, return each scoop to its appropriate bottle.

Place the well-plate with your tested food so that all group members can see.
Compare the wells with those on the Data sheet for known foods, and decide which nutrients the food contains.
All group members will record the results on their Data Sheet for Unknowns by underlining if the nutrient is present in their food.

Discuss the following questions:
Why doesn't the potato test for fat if the potato chip does?

Are banana chips better for you than potato chips?

What are the basic nutrient groups found in foods?

How is starch used in our body?.

How does iodine indicate the presence of starch in foods?

How are fats used in our body?

What is one test to determine if a food contains fat?

How are proteins used in our body?

VII. OPTIONAL ACTIVITIES

- **L**ook at the copy of the food label sheet and discuss how to read a label to determine what is present.

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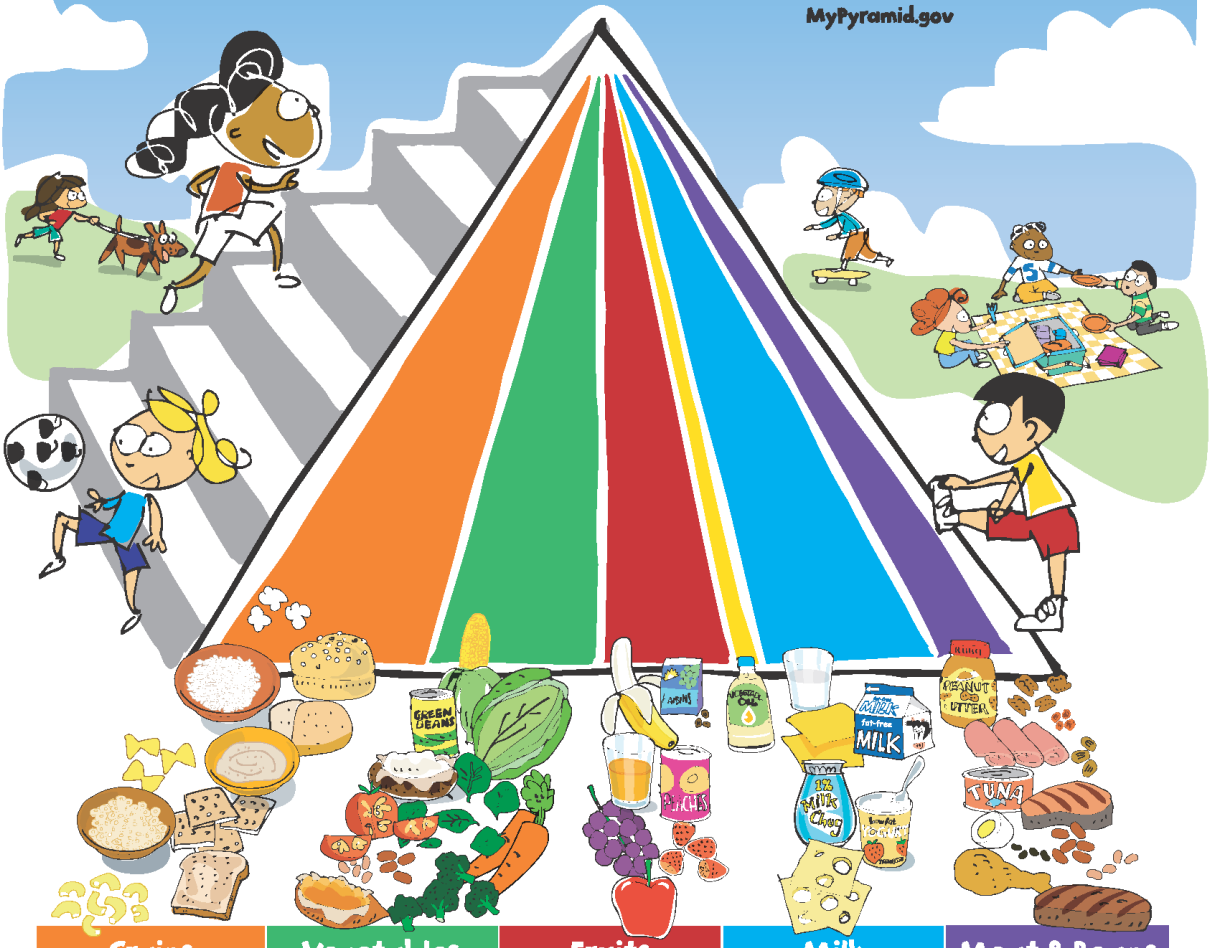


Grains
Make half your grains whole

Start smart with breakfast. Look for whole-grain cereals.

Just because bread is brown doesn't mean it's whole-grain. Search the ingredients list to make sure the first word is "whole" (like "whole wheat").

Eat 6 oz. every day;
at least half should be whole

Vegetables
Vary your veggies

Color your plate with all kinds of great-tasting veggies.

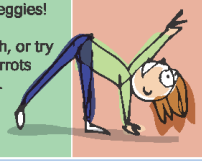
What's green and orange and tastes good? Veggies! Go dark green with broccoli and spinach, or try orange ones like carrots and sweet potatoes.

Eat 2 ½ cups every day

Fruits
Focus on fruits

Fruits are nature's treats – sweet and delicious.

Go easy on juice and make sure it's 100%.



Eat 1 ½ cups every day

Milk
Get your calcium-rich foods

Move to the milk group to get your calcium. Calcium builds strong bones.

Look at the carton or container to make sure your milk, yogurt, or cheese is lowfat or fat-free.

Get 3 cups every day;
for kids ages 2 to 8, it's 2 cups

Meat & Beans
Go lean with protein

Eat lean or lowfat meat, chicken, turkey, and fish. Ask for it baked, broiled, or grilled – not fried.

It's nutty, but true. Nuts, seeds, peas, and beans are all great sources of protein, too.

Eat 5 oz. every day

For an 1,800-calorie diet, you need the amounts below from each food group. To find the amounts that are right for you, go to MyPyramid.gov.

Oils Oils are not a food group, but you need some for good health. Get your oils from fish, nuts, and liquid oils such as corn oil, soybean oil, and canola oil.

Find your balance between food and fun

- Move more. Aim for at least 60 minutes everyday, or most days.
- Walk, dance, bike, rollerblade – it all counts. How great is that!

Fats and sugars – know your limits

- Get your fat facts and sugar smarts from the Nutrition Facts label.
- Limit solid fats as well as foods that contain them.
- Choose food and beverages low in added sugars and other caloric sweeteners.

MyPyramid.gov
STEPS TO A HEALTHIER YOU

U.S. Department of Agriculture
Food and Nutrition Service
September 2005
FNS-381

USDA