STATE SCIENCE STANDARDS:
6th, 7th, and 8th Grade Science:
1.0.A.1.h Use mathematics to interpret and communicate data.
1.0.C.1.b Interpret tables and graphs produced by others and describe in words the relationships they show.
8th Grade Science:
1.0.D.1.b Demonstrate that all control systems have inputs, outputs, and feedback.

7th Grade Health Standards
6.0.D.1.a Describe the function of the six major nutrients.

GOAL STATEMENT:
Students will understand how food ingredients are mixed to provide nutrition and bring about optimum bone and muscle growth of broiler chickens.

OBJECTIVES:
- Describe the function of the six major types of nutrients in the diet of people and animals.
- Identify the major types of grains grown in Maryland.
- Sequence the stages of the growth and processing of a broiler chicken.
- Replicate the mixing of animal feed by mixing the proper ratios of ingredients.
- Calculate animal feed ratios.

REQUIRED MATERIALS:
- Copy of “Feed Basics for a Growing Bird” worksheet (1 per student)
- Copy of “Know Your Ingredients” worksheet (1 per student)
- Copy of “Calculating Feed Mix Ratios” worksheet (1 per student)
- Know Your Ingredients Teacher Key
- Sets of grain seed and plant photos for the lesson activities (1 set per group)
- Sets of chicken growth and processing stages photos (1 set per group)—either in sequence or cut out and scrambled for students to arrange
- Per group, edible option: box of soy cereal (such as Kashi Soybean Grits), corn cereal, and mixed cereal (such as Fruity Pebbles)
- Per group, non-edible option: dried soybeans, popcorn kernels, and mixed dried beans OR white, yellow, blue, green, and red beads
- Large mixing bowl
- Small bowls/cups (edible option only)
- Spoons
- Weight scales, one per group is optimal, but they can be shared
- Milk (optional, for edible option only)
- Map of Maryland

AMOUNT OF TIME TO ALLOW:
75 minutes. Extension activities will take additional time.
Poultry Background - Below are some background facts about poultry. You might want to turn them into true/false statements and have students stand up or sit down, or show thumbs up/thumbs down, depending on whether they think each statement is true or false. Another option would be to separate the statements and have students take turns choosing a statement, reading it aloud to the class, and sharing any relevant information from personal experience.

- The poultry industry is an important part of Maryland’s economy. Each job in the poultry processing industry creates 7.2 jobs elsewhere. In 2009, 40% of Maryland’s cash farm income was from broilers, making broilers Maryland’s leading agriculture product.
- Maryland’s poultry industry ranks eighth in the United States in terms of the number of broilers produced. In 2009, approximately 291,900,000 broilers, with a value of $604,303,000.00, were produced in Maryland.
- Chicken production has a direct relationship to the grain crops produced in Maryland. Most of the corn and soybeans produced on the Eastern Shore of Maryland are used in the production of chicken feed.
- Chickens are raised on family farms where they live in spacious chicken houses, and heat and ventilation are carefully controlled. Most chicken farmers have advanced computer systems that allow them to maintain and monitor optimum chicken house conditions. The house protects the chickens from disease, predators, and bad weather. Broiler chickens are not raised in cages. They roam freely about the chicken house. Feed and fresh water are dispensed automatically.
- The chicken farmer and a chicken company employee manage and monitor the chickens throughout the approximate seven-week growth cycle. The farmer contracts with a chicken company to grow their chickens.

The average live weight of a commercial broiler is 5.4 pounds when it is sent to market. Selective breeding over decades, along with optimal nutrition, allows for chickens to attain such a weight gain in a short period of time. After seven weeks of growth, broiler chickens are

- Sent to be processed and sold at the grocery store. Farmers have approximately two weeks to prepare for the next flock. On average, farmers will raise five flocks a year.
- Farmers own the chicken houses and equipment. They provide the day-to-day care and management needed for optimal growth, welfare, and productivity of their flocks. Farmers not only have the responsibility of raising the birds, but they must also maintain and repair buildings, equipment, and restock any supplies used for raising chickens.
- Farmers are dedicated to caring for the environment, always looking for proactive steps to ensure environmental health through the use of nutrient management plans, manure storage facilities, and on-farm composters. Farmers vigilantly do their part to protect the water, land, and air.
- Chickens are the “hybrid car” of animal agriculture industry. They are the most efficient at converting the feed they eat into pounds of meat similarly to how the hybrid car converts gas to the most miles per gallon.

Feed background - A feed ration is the amount of food an animal eats in a 24-hour period of time. Chickens are fed a balanced diet of corn and soybean meal mixed with vitamin and mineral supplements. No hormones are used in feed for chickens. It is against United States Department of Agriculture (USDA) regulations to add hormones to poultry feed.
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There are six classes of nutrients that must be considered when formulating a feed ration. Nutrients are a group of compounds found in corn, soybeans, and other ingredients. Animals require nutrients to grow and survive. Nutrient requirements and thus feed rations will vary depending on the age, health, sex, and energy requirement of the chicken. Today, feeds are formulated by computers. The feed mill operator will input the ingredients to be used and the nutrient requirements for the birds being fed, and the computer will formulate and create the feed mix. It is similar to following a recipe in a cookbook.

Ask students how many chickens are raised each year in Maryland compared to other animals such as cattle, swine, sheep, and goats. Write the following options on sheets of paper and place them around the classroom: 1) tiny number, 2) small number, 3) same number, 4) larger number, 5) much larger number (compared to other animal species). Have students stand next to the option they consider the best answer. Count the number of students who choose each option.

Tell the class that the actual number of chickens grown in Maryland is many, many times the number of each other animal species raised for meat purposes. Tell the class the state of Maryland is one of the top producers of broiler chickens in the United States. Broiler chickens are young chickens raised for meat. These chickens are different from those that lay eggs, known as layers. Laying hens are the chickens that lay the eggs found in grocery stores.

Have students guess how many pounds of chicken the average U.S. citizen eats each year. List their ideas on the board. According to 2008 data, each person in the United States consumes, on average, 83.5 pounds of chicken! This is more consumption than beef at 64 pounds per person and pork at 49.5 pounds per person. People must love their tasty chicken!

Copy the photos of the chicken industry, cut them out, and have students arrange them in the correct sequence from chick to finished product. After they have had time to work on this put together the correct sequence using input from the groups and talk about each stage as you go.
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Broiler Chicken Growth and Processing Stages, continued

Broiler chicken house on a farm, with feed bin
Source: <extension.umd.edu> (Edwin Remsburg)

Young chickens in poultry house

Partially grown chickens eating from feeder
Source: <ublcorp.com>

Live haul truck delivering chickens to processor
Source: <www.candhlivestock.com>

Chickens being prepared at processing plant
Source: <cbc.ca>

Packaged chicken from grocery store
Now that the group knows the growth stages of chickens this section will focus on what they eat to gain weight and grow.

**Activity 1: Know Your Ingredients**

**Directions:**
Divide students into groups. Have each group match and identify each feed ingredient using a set of laminated pictures (see end of lesson.) Students can fill in the student data sheet located at the end of this lesson. Answers are provided in the Know Your Ingredients Teacher Key. If possible, have students use internet resources to identify counties within the state where that feed ingredient is produced by farmers. (Have a map of Maryland for students to use to help identify and locate each Maryland county).

Steps to follow:
1. Discuss which geographic areas of the state as well other reasons (i.e. proximity to industry) determine where farmers can grow each feed ingredient. For example, grains grow best in level, well-drained soils. Have students identify parts of Maryland with this geography. In addition, most poultry are grown on the Eastern Shore of Maryland; therefore, their main source of nutrition, soybeans, is grown in large quantities around them.

**Activity 2: Making Your Own Feed Mix**

**Directions:**
Remind students that animal feeds contain a variety of ingredients mixed in a specific ratio. Tell students that they will be completing a simulation in which they create a feed mix with percentages similar to those used in chicken feed. Depending on the teacher’s intent, students will use either cereals (if the teacher wants them to eat the snack mix) or dried grains or beads (if the teacher does not want them to eat the mix) to represent the different feed ingredients.

Steps to follow:
1. Divide the class into groups and explain what they will be using to represent soybean, corn, and other ingredients. Each group will be in charge of calculating the ingredients and making a feed mix with the appropriate percentages.
2. If you are using cereal, have each group observe the nutrition label on the cereal boxes. Discuss how the nutrition label is the same as a feed mix label on a bag of feed. A nutrition label lists all of the nutrients available and how much of each ingredient can be found in a serving size from that cereal.
3. Have each group use standard feed mix percentages to determine the amount of each food item and use them to create 1/8 pound of “feed mix”. (Note: To save materials, you might want to have each group mix an amount of feed less than one pound. Groups will adjust ingredients accordingly so that they add up to the desired total volume.)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Replacement</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>popcorn or Corn Chex/Corn Flakes</td>
<td>37%</td>
</tr>
<tr>
<td>Soybeans</td>
<td>soynuts or soy cereal, such as Kashi GoLean Crunch</td>
<td>54%</td>
</tr>
<tr>
<td>Vit/min mix</td>
<td>granola or Fruity Pebbles</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>
A version of this activity that is not intended for student consumption can be made by mixing dried soybeans or other beans, popcorn kernels, and dried mixed beans or differently colored beads to represent soy, corn, and other ingredients.

4. Calculations for standard feed mix

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent</th>
<th>1-Pound mix</th>
<th>½-Pound mix</th>
<th>¼-Pound mix</th>
<th>1/8-Pound Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>54%</td>
<td>.54 pounds</td>
<td>.27 pounds</td>
<td>.135 pounds</td>
<td>.0675 pounds</td>
</tr>
<tr>
<td>Soybean</td>
<td>37%</td>
<td>.37 pounds</td>
<td>.185 pounds</td>
<td>.0925 pounds</td>
<td>.0925 pounds</td>
</tr>
<tr>
<td>Vit/min mix</td>
<td>9%</td>
<td>.09 pounds</td>
<td>.045 pounds</td>
<td>.0225 pounds</td>
<td>.01125 pounds</td>
</tr>
</tbody>
</table>

Note: If scales are not available, you may use scoops or measuring cups with a combined total of ten scoops equaling one “pound”. Students can also count beads to calculate.

5. Weigh each ingredient, then mix all cereal ingredients together in a large bowl.
6. Once well blended, remind students that this is the same concept used in mixing feed. Using available ingredients, calculate how much of each ingredient is needed and mix ingredients together to create a feed ration.
7. If using edible items, have students divide the ration in portions for each student to enjoy! If using cereals, you may add milk to the mix and eat it with a spoon.
8. If using inedible items, separate the ingredients according to color and type before collecting and re-storing them.

Activity 3: Calculating Feed Mix Ratios

It is very important for poultry companies to provide growers with food which includes the proper nutrients to help the birds grow, develop, and mature to their optimum weight. This process involves making calculations that are sometimes simple and sometimes more complicated, depending on the situation. The student data sheet at the end of the lesson has several calculations for students to try. The answers to these problems are provided below. Use with student activity sheet (attached).

An average chicken house can hold 25,000 chickens. Each chicken will eat about 12 pounds of feed during a seven-week growing period.

1. How much feed is needed to feed all of the chickens for the entire seven weeks?
   25,000 chickens X 12 pounds of feed = \textbf{300,000 pounds of feed}
   How many pounds of feed will the chickens eat in one week? In one day?

2. A feed mill needs to mix 300,000 pounds of chicken feed that contains 54% soybean meal, 37% corn and 9% vitamins and minerals. How much of each ingredient do they need to make 300,000 pounds (lbs) of feed?

   \textit{Soybean meal:} 300,000 lbs of chicken feed needed X 0.54 = \textbf{162,000 lbs of soybean meal}
   \textit{Corn:} 300,000 lbs of chicken feed needed X 0.37 = \textbf{111,000 lbs of corn}
   \textit{Vitamins and Minerals:} 300,000 pounds of chicken feed needed X 0.09 = \textbf{27,000 lbs of vitamins and minerals}
Do you have the correct amount of each ingredient to make 300,000 pounds of chicken feed?

162,000 pounds of soybean meal
+ 111,000 pounds of corn
+ 27,000 pounds of vitamin and minerals
300,000 pounds of chicken feed

3. If there was a farm that had four chicken houses (25,000 chickens in each house), how much feed would be needed?
   
   300,000 pounds of feed needed for one house
   x 4 houses
   
   1,200,000 pounds of feed needed to feed 4 houses of chickens.

4. How much of each ingredient (54% soybean meal, 37% corn, and 9% vitamins and minerals) is needed to make 1,200,000 pounds of feed?

   1,200,000 lbs of chicken feed x 0.54 = 648,000 lbs of Soybean meal
   1,200,000 lbs of chicken feed x 0.37 = 444,000 lbs of corn
   1,200,000 lbs of chicken feed x 0.09 = 108,000 lbs of vitamins and minerals

Do you have the correct amount of each ingredient to make 1,200,000 pounds of chicken feed?
   
   648,000 lbs of Soybean meal
   + 444,000 lbs of corn
   + 108,000 lbs of vitamins and minerals
   
   1,200,000 lbs of chicken feed

5. How many chickens can be raised in one flock on a four-house farm?

   25,000 chickens in each house x 4 houses = 100,000 chickens per flock

Ask students to explain why poultry farmers need to give the birds a feed mix with carefully balanced ingredients. Let them discuss ideas, and lead the discussion to the idea of maximizing rate of growth and bird nutrition. Farmers strive to have the healthiest, most productive birds possible by feeding them the best nutritional diet available. Grain crops, such as soybeans and corn, are the main ingredients used when creating and mixing poultry feed. As with any diet, all the ingredients must be balanced to meet the nutrient requirements for the birds. Without adequate nutrition, the birds will not gain as much weight. If the birds do not grow and gain weight, the farmer will not make as much money when the birds are sent to be processed. The farmer is paid on a per-pound basis.

Further information: As a final part of eating and digesting feed, chickens create manure. Chicken manure and litter inside the chicken house must be cleaned periodically. When the chicken house is cleaned out, farmers have several options for using the poultry litter (mixture of manure and wood shavings). This “locally produced organic fertilizer” can be incorporated into farm fields as fertilizer or sold to be made into heating pellets.
Below are advanced calculations that can be used as extension activities:

Determine the basic nutrient content in a starter feed ration for broiler chickens. A starter feed is a diet that is fed to young chicks between 0-4 weeks of age. The biggest difference in the starter diet for broilers is the amount of protein in the diet (See Table 1). **A starter diet for broiler chickens contains 23% protein compared to a finisher broiler chicken diet which contains 20% protein** (Table 1).

Young growing animals require more protein for muscle development and weight gain. Calculate a feed ration mix that contains 23% protein using corn and soybean meal (SBM) based on the nutrient content level of these two ingredients (Table 2) using the Pearson Square method. This is a method that has been used for many years to calculate simple feed rations. Once calculations are complete, have the students discuss how different amounts of the same feed can impact the nutritional content of a feed ration. Once the feed mix has been completed, use cereal or beads in Activity 2 as physical examples of mixing feed.

**TABLE 1**

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>BROILER DIETS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Starter (0-4 weeks old)</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>23.0%</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1.0%</td>
</tr>
<tr>
<td>Available Phosphorus (%)</td>
<td>0.45%</td>
</tr>
<tr>
<td>Metabolizable Energy (kcal)</td>
<td>3,200</td>
</tr>
</tbody>
</table>

Table 2 includes the cost and nutrient content of the feed ingredients that we will include in the activity. In the case of this activity, we will be using the metric system, and everything will be measured in grams or kilograms (kg). The conversion factors are as follows:

1 lb = 453 grams = 0.453 kg
1 ton = 2000 lbs
1 bushel corn = 54 lbs
1 bushel soybeans = 60 lbs

**TABLE 2**

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>NUTRIENT CONTENT</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Energy</td>
<td>Protein</td>
</tr>
<tr>
<td>Corn</td>
<td>3,400 kcal/kg</td>
<td>9.0%</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>2,400 kcal/kg</td>
<td>49.0%</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0 kcal/kg</td>
<td>0.0%</td>
</tr>
<tr>
<td>Limestone (a form of calcium)</td>
<td>0 kcal/kg</td>
<td>0.0%</td>
</tr>
<tr>
<td>Fat</td>
<td>8,500 kcal/kg</td>
<td>0.0%</td>
</tr>
<tr>
<td>Vitamin-Mineral premix</td>
<td>0 kcal/kg</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

<sup>1</sup>All of the phosphorus in plant ingredients is not available for the chickens to use for growth and maintenance. Therefore the requirement for phosphorus is listed as available phosphorus. (We will focus on **Corn** and **Soybean Meal** in this activity.)
*Teachers Note
During Activity 3, students need to only determine and calculate the highlighted red values. Carry the decimal out three places during calculations.

Determine the protein requirement for a broiler chicken starter diet. (See Table 1)
Protein Requirement for 0-4 week old broiler chickens = 23% of final ration

Use the Pearson Square method to determine the amount of corn and soybean meal needed in the diet to meet the 23% protein requirement.

All of the ingredients added to the diet should equal 100%. There are some ingredients in the diet that do not have any protein but need to be accounted for in this Pearson Square method. Therefore, we first need to determine the amount of space to be left in the diet for the following ingredients to ensure our diet will equal 100%. For the following ingredients: limestone & phosphate, fat, and vitamin mineral premix (vit-min mix).

In this exercise, corn and soybean meal are the only ingredients that contain protein (Table 2). However, space must be left in the diet for other ingredients (vitamin and mineral premix, limestone, phosphate and fat) so the total for all ingredients in the diet equals 100%. Therefore, we first need to determine the amount of space to be left in the diet for these ingredients to ensure our diet will equal 100%. For this example, you want to add:

- Vitamin mineral premix: 0.5%
- Limestone and phosphate: 2.75%
- Fat: + 5.75%

9.0% total space left in the diet

Subtract the level of pre-determined space from the above ingredients from 100%.
100% - 9.0% = 91%

The protein requirement for a starter broiler chicken diet is 23% (Table 1). Divide the protein requirement in the final ration by the amount of space you will need to allow.
23% ÷ 0.91 = 25.27% protein

*Teacher’s Note
The 9.0% of pre-determined ingredients does not contain any protein to provide 23% protein in the final ration.

Now let’s begin to draw the Pearson Square.
Step 1: Draw a 1 inch to 2 inch square. Place diagonal lines across the square.
Step 2: Write the percent of protein needed in the center of the square.

Step 3: Write the ingredients to be used at each corner and the percent protein contained in each ingredient.

Step 4: Going diagonally, subtract the smaller numbers from the larger numbers.

Step 5: After subtracting, the numbers at the two right corners are parts of the two ingredients needed in the diet. In this example, we need 16.27 parts SBM and 23.73 parts corn which gives us a total of 40 parts.
Step 6: In this example, the percentage of each ingredient needed in the diet can be found by dividing the number of parts for each ingredient by the total parts. Next multiply this value by 91 (amount of space in the diet for corn and soybean meal; see #3 above).

\[
\begin{align*}
23.73 \text{ parts/40} & = 0.59325 \times 91\% = 53.986\% \text{ corn} \\
16.27 \text{ parts/40} & = 0.40675 \times 91\% = 37.014\% \text{ SBM}
\end{align*}
\]

Step 7: The amount of each ingredient is determined by multiplying the percentage of each ingredient by the total amount of feed desired.

For Example: 50 lbs of starter feed would require:

\[
\begin{align*}
50 \text{ lbs} \times 0.53986 & = 26.993 \text{ lbs of corn} \\
50 \text{ lbs} \times 0.37014 & = 18.507 \text{ lbs of SBM}
\end{align*}
\]

45.500 lbs of corn and SBM***

Teacher’s Note
*** Remember we had 9% of space left in the diet for limestone, fat, phosphate, and vitamin mineral premix.

\[
50 \text{ lbs} \times 0.09 = 4.5 \text{ lbs of these additional ingredients that do not add protein to the diet.}
\]

45.500 lbs of corn and SBM

+ 4.500 lbs of limestone, fat, vit-min, phosphate

50.000 lbs of starter feed

*The remaining ingredients necessary to complete the feed formulation have been calculated for you.

Fill in chart below to determine final formulation of starter feed for broiler chickens. Values can be rounded to two decimal places.

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>% IN DIET</th>
<th>% IN DIET (rounded values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORN</td>
<td>54.136%</td>
<td>54.14%</td>
</tr>
<tr>
<td>SOYBEAN MEAL</td>
<td>37.014%</td>
<td>37.01%</td>
</tr>
<tr>
<td>FAT</td>
<td>5.600%</td>
<td>5.60%</td>
</tr>
<tr>
<td>VIT-MIN MIX</td>
<td>0.500%</td>
<td>0.50%</td>
</tr>
<tr>
<td>PHOSPHATE</td>
<td>1.911%</td>
<td>1.91%</td>
</tr>
<tr>
<td>LIMESTONE</td>
<td>0.839%</td>
<td>0.84%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

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Additional Practice
If time allows, calculate the energy contribution made by each ingredient.

1. Calculate energy contribution made by each of the ingredients. The energy values for each ingredient can be found in Table 2.

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>% IN DIET</th>
<th>% IN DIET (rounded values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>.53986</td>
<td>53.986% in diet</td>
</tr>
<tr>
<td></td>
<td>X 3400 kcal/kg =</td>
<td>(1835.524) kcal</td>
</tr>
<tr>
<td>SBM</td>
<td>.37014</td>
<td>37.014% in diet</td>
</tr>
<tr>
<td></td>
<td>X 2400 kcal/kg =</td>
<td>(888.336) kcal</td>
</tr>
<tr>
<td>Phosphate</td>
<td>.01811</td>
<td>1.911%</td>
</tr>
<tr>
<td></td>
<td>X 0 kcal/kg =</td>
<td>0 kcal</td>
</tr>
<tr>
<td>Limestone</td>
<td>.00813</td>
<td>0.839%</td>
</tr>
<tr>
<td></td>
<td>X 0 kcal/kg =</td>
<td>0 kcal</td>
</tr>
<tr>
<td>VitMin Mix</td>
<td>.005</td>
<td>0.500%</td>
</tr>
<tr>
<td></td>
<td>X 0 kcal/kg =</td>
<td>0 kcal</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Calculate how much fat you will have to add to meet the energy requirement (3,200 kcal; see Table 1). Divide the amount to be added by the energy value of the ingredient, then multiply by 100 to convert to a percentage.

\[
3,200 - 2,723.86 = 476.14 \text{ kcal/kg needed}
\]

\[
\frac{476.14 \text{ kcal/kg needed}}{8500 \text{ kcal/kg of fat}} \times 100 = 5.60\% \text{ fat required}
\]

\[
(\text{Use Table 2 to find this value for fat})
\]

3. Now that we know we need 5.6% (instead of 5.75%) fat in the diet, we need to make up the 0.15% difference, so the total percentage of all ingredients equals 100%. This is done by using one of the ingredients we have available which is inexpensive and which will result in the least change to the overall nutrient composition of the final diet. (Use corn to make up the difference). **Calculate the total corn in the diet.**

\[
0.15\% + 53.986\% = 54.136\%
\]

Fill in the chart below to determine final formulation of starter feed for broiler chickens. Values can be rounded to two decimal places.

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>% IN DIET</th>
<th>% IN DIET (rounded values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORN</td>
<td>54.136%</td>
<td>54.14%</td>
</tr>
<tr>
<td>SOYBEAN MEAL</td>
<td>37.014%</td>
<td>37.01%</td>
</tr>
<tr>
<td>FAT</td>
<td>5.600%</td>
<td>5.60%</td>
</tr>
<tr>
<td>VIT-MIN MIX</td>
<td>0.500%</td>
<td>0.50%</td>
</tr>
<tr>
<td>PHOSPHATE</td>
<td>1.911%</td>
<td>1.91%</td>
</tr>
<tr>
<td>LIMESTONE</td>
<td>0.839%</td>
<td>0.84%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.00%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
Teacher’s Note: We have calculated all of the ingredients that are going to be used to create this feed mix. To make sure we have left enough space for supplements, we must be in the range of 99.5% to 100.0%. Did we stay within the range? (ask students) Yes!

The total cost for one ton of this feed mix would be $243.86 (See Table 2).

Percentage of fat is a given value in the chart above. Percentage of fat can be calculated by completing the additional activity for Activity 3.

**Career Connections**

- **Farmer** — This person raises chickens in a safe and healthy environment.
- **Truck driver** — This person delivers processed chicken to grocery stores and restaurants where it can be consumed.
- **Veterinarian** — This person ensures the health of all chickens and takes care of any that may become ill.
- **Nutritionist** — This is a person who develops a diet that will maximize the chicken’s potential growth.
- **Meat inspector** — This person inspects chicken meat to ensure quality and safety.
- **Poultry scientist** — This scientist researches various areas of poultry production and use.
- **Product marketer** — This person advertises for the chicken producer.

Can you list other careers that would be connected to raising chickens?

**Evaluation**

A pre/post test should be completed with the lesson plan. Student understanding of concepts can also be evaluated through class discussion as well as through evaluation of completed activity data sheets. Analysis/conclusion questions that are answered incorrectly by a large number of students should be addressed in a follow-up discussion.

**References**

Delmarva Poultry Industry. <www.dpichicken.org/>


Background Information
A feed ration is the amount of food an animal ingests in a 24-hour period of time. Chickens are fed a balanced diet of corn and soybean meal mixed with vitamin and mineral supplements. No hormones are used in feed for chickens. It is against United States Department of Agriculture (USDA) regulations to add hormones to poultry feed.

There are six classes of nutrients that must be considered when formulating a feed ration. Nutrients are a group of compounds found in corn, soybeans, and other ingredients required to grow and survive. Nutrient requirements and thus feed rations will vary depending on the age, health, sex, and energy requirement of the chicken. Today, feeds are formulated by computers. The feed mill operator will input the ingredients to be used, the nutrient requirements for the birds being fed, and the computer will formulate and create the feed mix. It is similar to following a recipe in a cookbook.

Classes of Nutrients

- **Protein** — is needed to build and maintain body proteins. Without protein there would be no body weight gain.

- **Carbohydrates** — provide energy. Energy is the fuel that keeps all body functions working.

- **Fats** — provide energy. If fat is fed in excess of energy requirements, it is converted to fat and stored in the body.

- **Minerals** — are required for various functions in the body. For example, minerals are involved in the body’s enzyme systems, oxygen transport, and are structural components of skeleton. There are two groups of minerals: macrominerals and microminerals. Microminerals are required in the diet at a much lower amount than macrominerals. Some macrominerals are calcium, phosphorus, magnesium, potassium, sodium and sulfur. Examples of microminerals include: copper, iron, zinc and manganese.

- **Vitamins** — help regulate biological processes and reactions in the body. Fat soluble vitamins include Vitamins A, D, E and K, and water soluble vitamins include the B vitamins and Vitamin C.

- **Water** — aids with many body functions and processes. Water represents about 70% of the total body weight for poultry and about 65% of the total weight of eggs.
It is the policy of the University of Maryland Extension that no person shall be subjected to discrimination on the grounds of race, color, sex, religion, disability, age or national origin.

Identify each feed ingredient by matching photos from the set you have been given. Identify parts of the state where you have seen this ingredient growing. Discuss the geographic layout of this area and other reasons why the feed ingredient might grow here.

<table>
<thead>
<tr>
<th>Answer Key</th>
<th>Ingredient</th>
<th>Where have you seen it growing?</th>
<th>Crude Protein</th>
<th>Energy</th>
<th>Market Price per Bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image]</td>
<td>Crude Protein</td>
<td>![Image]</td>
<td>49.0%</td>
<td>2400 kcal/kg</td>
<td>$11.50</td>
</tr>
<tr>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
<td>9.0%</td>
<td>3400 kcal/kg</td>
<td>$5.50</td>
</tr>
<tr>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
<td>9.0%</td>
<td>1400 kcal/kg</td>
<td>$6.50</td>
</tr>
<tr>
<td>![Image]</td>
<td>![Image]</td>
<td>![Image]</td>
<td>13.0%</td>
<td>3000 kcal/kg</td>
<td>$6.00</td>
</tr>
</tbody>
</table>

1. Using the set of laminated pictures, match the pictures of seeds to its mature plant.
2. Identify each feed ingredient from the crops selection below.
   - Sorghum
   - Soybean
   - Corn
   - Wheat
   - Millet
   - Marigolds
3. Name at least two counties where each of these feed ingredients is produced. There may be one or more correct counties for each.
It is very important for poultry companies to provide growers with food that includes proper nutrients to help the birds grow, develop, and mature to their optimum weight. This process involves making calculations that are sometimes simple and sometimes more complicated, depending on the situation. Below are a few calculations for you to try.

An average chicken house can hold 25,000 chickens. Each chicken will eat 12 pounds of feed during the 7 weeks it lives in the house.

1. How much feed is needed to feed all of the chickens for the entire seven weeks?

2. A feed mill needs to mix 300,000 pounds of chicken feed that contains 54% soybean meal, 37% corn and 9% vitamins and minerals. How much of each ingredient do they need to make 300,000 pounds (lbs) of feed?

Do you have the correct amount of each ingredient to make 300,000 pounds of chicken feed? Show how you would check your answer.

3. If there was a farm that had four chicken houses (25,000 chickens in each house), how much feed would be needed?

4. How much of each ingredient (54% soybean meal, 37% corn, and 9% vitamins and minerals) is needed to make 1,200,000 pounds of feed?

Do you have the correct amount of each ingredient to make 1,200,000 pounds of chicken feed? Check your answer.

5. How many chickens can be raised in one flock on a four-house farm (if each house can accommodate 25,000 chickens)?

6. How many pounds of feed does a chicken eat per day? Per week?
EXPLANATION
Farmers strive to have the healthiest, most productive birds possible by feeding them the most nutritious diet available. Grain crops, such as soybeans and corn, are the main ingredients used in mixing poultry feed. As with any diet, all the ingredients must be balanced to meet the nutrient requirements for the birds. Without adequate nutrition, the birds will not gain as much weight. If the birds do not grow and gain weight, the farmer will not make as much money when the birds are sent for processing. The farmer is paid on a per-pound basis.

EXTENSION ACTIVITY (Advanced Calculations)
Determine the basic nutrition content in a Starter feed ration for broilers chickens. A Starter feed is a diet that is fed to young chicks between 0-4 weeks of age. The biggest difference in the Starter diet for broilers is the amount of protein in the diet (See Table 1). The Starter diet for broiler chickens contains 23% protein compared to a finisher broiler chicken diet which contains 20% protein. (See Table 1) Young growing animals require more protein for muscle development and weight gain. Calculate a feed ration mix that contains 23% protein using corn and soybean meal (SBM) based on the nutrient content level of these two ingredients (see Table 2) using the Pearson Square method. This is a method that has been used for many years to calculate simple feed rations.

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>BROILER DIETS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Starter (0-4 weeks old)</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>23.0%</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1.0%</td>
</tr>
<tr>
<td>Available Phosphorus (%)</td>
<td>0.45%</td>
</tr>
<tr>
<td>Metabolizable Energy (kcal)</td>
<td>3,200</td>
</tr>
</tbody>
</table>

1A calorie (kcal) is a form of heat where we get our energy from food.
TABLE 2

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>NUTRIENT CONTENT</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Energy</td>
<td>Protein</td>
</tr>
<tr>
<td>Corn</td>
<td>3,400 kcal/kg.</td>
<td>9.0%</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>2,400 kcal/kg.</td>
<td>49.0%</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0 kcal/kg</td>
<td>0.0%</td>
</tr>
<tr>
<td>Limestone (a form of calcium)</td>
<td>0 kcal/kg</td>
<td>0.0%</td>
</tr>
<tr>
<td>Fat</td>
<td>8,500 kcal/kg.</td>
<td>0.0%</td>
</tr>
<tr>
<td>Vitamin-Mineral premix</td>
<td>0</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

\(^1\)Only one third of the phosphorus in plant ingredients is available for the chickens to use for growth and maintenance. Therefore, the requirement for phosphorus is listed as available phosphorus.

Use Corn and Soybean Meal in this activity.

1. Determine the protein requirement for a broiler chicken starter diet (See Table 1).

Use the Pearson Square method to determine the amount of corn and soybean meal needed in the diet to meet the 23% protein requirement.

2. In this exercise, corn and soybean meal are the only ingredients that contain protein (Table 2). However, space must be left in the diet for other ingredients (vitamin and mineral premix, limestone, phosphate, and fat) so the total for all ingredients in the diet equals 100%. Therefore, we first need to determine the amount of space to be left in the diet for these ingredients to ensure our diet will equal 100%.

For this example, the space left for each of these ingredients is:

3. Subtract the amount of pre-determined space, from the above ingredients, from 100%.

4. The protein requirement for a starter broiler chicken diet is 23% (Table 1).

5. Divide the protein requirement in the final ration by the amount of space you will need to allow.
Now let’s begin to draw the Pearson Square.

Step 1: Draw a 1 inch to 2 inch square. Place diagonal lines across the square.

Step 2: Write the percent of protein needed in the center of the square.

Step 3: Write the ingredients to be used at each corner and the percent protein contained in each ingredient.

Soybean Meal (SBM) 25.27
CORN 25.27

Step 4: Going diagonally, subtract the smaller numbers from the larger numbers.

CORN 9.0%
SBM 49.0%
Step 5: After subtracting, the numbers at the two right corners are parts of the two ingredients needed in the diet. In this example, we need **16.27 parts SBM** and **23.73 parts corn** which gives us a total of **40 parts**.

\[
\begin{array}{c}
\text{SBM 49.0}\% \\
\downarrow \\
25.27 \\
\downarrow \\
\text{CORN 9.0}\% \\
\end{array}
\]

Parts total

Step 6: The percentage of each ingredient needed in the diet can be found by dividing the number of parts by the total parts, and then multiply by 91% (amount of space in the diet for corn and soybean meal; see #3 above).

\[
\begin{align*}
23.73 \text{ parts}/40 &= 0.59325 \times 91\% = \text{__________} \\
16.27 \text{ parts}/40 &= 0.40675 \times 91\% = \text{__________}
\end{align*}
\]

Step 7: The amount of each ingredient is determined by multiplying the percentage of each ingredient by the total amount of feed desired.

For Example: 50 lbs of starter feed would require:

\[
\begin{align*}
50 \text{ lbs} \times 0.53986 &= \text{__________} \\
50 \text{ lbs} \times 0.37014 &= \text{__________}
\end{align*}
\]

\[
\text{Total lbs of corn and SBM}
\]

The remaining ingredients necessary to complete the feed formulation have been calculated for you (see Number 2).
Additional Practice
If time allows, calculate the energy contribution made by each ingredient.

7. Calculate energy contribution made by each of the ingredients.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Energy Contribution (kcal/kg)</th>
<th>Energy Contribution (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>3400</td>
<td>X</td>
</tr>
<tr>
<td>SBM</td>
<td>2400</td>
<td>X</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.01811</td>
<td>X 0</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.00813</td>
<td>X 0</td>
</tr>
<tr>
<td>VitMin Mix</td>
<td>0.005</td>
<td>X 0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Calculate how much fat you will have to add to meet the energy requirement (3,200 kcal; see Table 1). Divide the amount to be added by the energy value of the ingredient, then multiply by 100 to convert to a percentage.

476.14 kcal/kg needed = __________ x 100 = __________ fat required

(Use Table 2 to find this value for fat)

9. Now that we know we need 5.6% (instead of 5.75%) fat in the diet, we need to make up the 0.15% difference; so the total percentage of all ingredients equals 100%. This is done by using one of the ingredients we have available which is inexpensive and which will result in the least change to the overall nutrient composition of the final diet. (Use corn to make up the difference). **Calculate the total corn in the diet.**

Fill in the chart below to determine final formulation of starter feed for broiler chickens. Values can be rounded to two decimal places.

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>% IN DIET</th>
<th>% IN DIET (rounded values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOYBEAN MEAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAT</td>
<td>5.600%</td>
<td></td>
</tr>
<tr>
<td>VIT-MIN MIX</td>
<td>0.500%</td>
<td></td>
</tr>
<tr>
<td>PHOSPHATE</td>
<td>1.811%</td>
<td></td>
</tr>
<tr>
<td>LIMESTONE</td>
<td>0.813%</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Know Your Ingredients

**Teacher Key**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Location Grown</th>
<th>Protein</th>
<th>Energy</th>
<th>Average Market Price per Bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOYBEAN</td>
<td>All Maryland Counties</td>
<td>49.0%</td>
<td>2400 kcal/kg</td>
<td>$11.50</td>
</tr>
<tr>
<td>CORN</td>
<td>All Maryland Counties</td>
<td>9.0%</td>
<td>3400 kcal/kg</td>
<td>$5.50</td>
</tr>
<tr>
<td>SORGHUM</td>
<td>All Maryland Counties</td>
<td>9.0%</td>
<td>1400 kcal/kg</td>
<td>$6.50</td>
</tr>
<tr>
<td>WHEAT</td>
<td>All Maryland Counties</td>
<td>13.0%</td>
<td>3000 kcal/kg</td>
<td>$6.00</td>
</tr>
</tbody>
</table>
Teacher’s Note: Pictures are used as part of Activity 1. Copies are included in the curriculum kit. Note: Separate name of seeds and plants from photos. Students will be asked to match the seeds with corresponding plant photo and match the names with the photos.
PRE-Evaluation: Poultry — Feed Basics for a Growing Bird

1. How old are you? ______________

2. Are you...(Select one.)
   □ A Boy   □ A Girl

3. Are you....(Select ALL that apply.)
   □ African American/Black   □ Asian
   □ Native American/Alaskan Native   □ Hispanic/Latino
   □ White   □ Native Hawaiian/Other Pacific Islander
   □ Other

4. What type of school do you go to? (Select one.)
   □ Public school   □ Private school   □ Religious school (Catholic, etc.)   □ Home school

Your Science and Agriculture Opinions and Knowledge

5. **BEFORE going through the AGsploration Program**, please circle the degree to which you agree or disagree with the following statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I feel that Maryland agriculture is a part of science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Science is useful for solving everyday problems.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Maryland agriculture is beneficial to me, my family, and my community.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>When I graduate from high school, I would like to have a job</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>in agricultural science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can name three jobs in the agriculture industry.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

6. **BEFORE going through the AGsploration Program**, please circle your knowledge level about the topics listed below.

<table>
<thead>
<tr>
<th>Topic</th>
<th>None</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryland agriculture</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Stages of chicken growth</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>How chicken feed is made</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Types of nutrients</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

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POST-Evaluation: Poultry – Feed Basics for a Growing Bird

Your Science and Agriculture Opinions and Knowledge

5. **AFTER going through the AGsplosion Program**, please circle the degree to which you agree or disagree with the following statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
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<td>4</td>
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<td>When I graduate from high school, I would like to have a job in agricultural science.</td>
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<td>2</td>
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</tr>
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<td>I can name three jobs in the agriculture industry.</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

7. As a result of participating in this activity, tell one new thing you will try or one thing you will find information about.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
**SUPPLEMENTAL - Evaluation: Poultry — Feed Basics for a Growing Bird**

**Directions:** If you are teaching more than one lesson plan in one day, you may attach this to the pre/post evaluation form for the other lesson you are teaching. Please have the student fill out these during the pre and post evaluation times. In addition, only have the student fill out the post evaluation questions Q5 – Q7 at the completion of all lessons.

**PRE-Evaluation**

*BEFORE going through the AGsploration Program*, please **circle** your knowledge level about the topics listed below.

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**POST-Evaluation**

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