

# Avian Academy Module #1

# POULTRY NUTRITION

UGA DEPARTMENT OF POULTRY SCIENCE

## GP STANDARDS ADDRESSED

### AFNR-AAPM

14.4 - Describe the feeding practices and nutritional needs for poultry.

14.7 - Describe the prevention and treatment of nutritional disorders in poultry

## TOPICS/GOALS/OBJECTIVES

The reader will be able to describe the role of energy in the body and how much energy is contained in our foods, correctly identify the key nutrient classes that our bodies require from the foods we eat, and understand the general make-up of a commercial poultry diet.

## SKILLS

Mathematics, critical thinking, data gathering, communication building, and project management.

## KEYWORDS

Basal metabolism, broiler, carbohydrate, caloric expenditure, caloric intake, calorie, deficiency, energy, balance, essential nutrient, fat, genetic selection, heat increment, joule, metabolism, mineral, nutrient, Pearson's square, protein, and vitamin.

## INTRODUCTION

*This publication introduces concepts related to the dietary needs that all animals have for energy, including the six nutrient classes: protein, fat, carbohydrate, vitamins, minerals, and water.*

*To supply poultry with a blend of ingredients that will meet these nutritional requirements, this module also discusses the particular way that poultry are fed commercially.*



# SECTION #1

Take a look at a food label from something you have eaten recently.  
How much do you know about the items listed on the labels of our food?

*Examples: Calories give us energy; fats can be saturated or unsaturated; sodium comes from salt and can affect blood pressure; sugar is a carbohydrate; potatoes and breads have high amounts of carbohydrates; fiber is a type of carbohydrate; protein is used to build our muscles; etc.*

You may also notice that food labels will mention that the average adult should consume about **2,000 calories** per day.

**The primary need of any living thing** (not just chickens, cows, or humans, but also plants and bacteria) **is energy.** About 70 to 85 percent of the dry matter content of a chicken's diet goes to meeting its need for energy. Animals need energy to keep their hearts beating, to breathe, to maintain their body temperature, to digest the food they eat, and for all of the growing and the physical activity they do. Food is how we provide the nutrients that living things use to live, grow, and reproduce.

**NUTRIENTS CAN BE PLACED INTO TWO GROUPS:**

1. The proteins, fats, and carbohydrates that we get energy from.
2. The vitamins, minerals, and water that help the body get all the energy. For a creature to stay alive, it needs to have the right amounts of all six of those nutrient types.

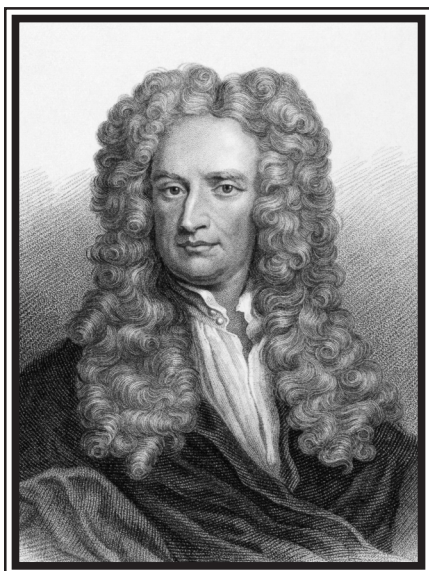
Just like we can measure length in inches and weight in pounds, we measure energy in foods in a unit called "calories." Specifically, a "calorie" is a measure of heat energy: it is the amount of heat required to raise the temperature of 1 gram of water from 14.5 to 15.5 degrees Celsius. It can be difficult to imagine exactly how much energy that really is.

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## EXAMPLE EXERCISE:

Calculate the calories in food items, and determine how that converts to apples falling.

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Just as we can convert length in inches to length in centimeters, or the weight of something in pounds to its weight in kilograms, we can also convert food's energy in calories to its energy in another unit of measure called "joules." A joule measures the energy transferred when something acts on an object. For example, when something falls on your foot, the energy transferred by the falling is what you feel on your toe. In fact, an average size apple falling 1 meter under the force of gravity—maybe out of a tree that you were sitting under—exerts 1 joule of energy upon impact, and we've all had something fall on our heads before.

One calorie equals 4.184 joules, or just a little over 4 apples falling out of the tree and hitting you on the head. You may not know that the "calories" listed on the labels of our food are actually kilocalories. This means that there are 1,000 of these smaller calories in just 1 calorie of our food. So that means that one calorie in a food contains the same amount of energy as 4,184 apples falling!

**With the label from the food item you were looking at earlier:**

- Find the number of calories listed per serving
- Multiply that number by 1,000 (to convert kilocalories into calories)
- Then multiply that by 4.184 (to convert the calories into joules)
- To equal the number of apples falling 1 meter out of the tree.
- To go a step further, multiply that number by 102 (the weight in grams of the average-sized apple) to get the weight of that number of apples in grams.
- Which can then be divided by 454 to get the total weight falling in pounds.



**EXAMPLE:**

- 140 Calories in a can of soda (X) 1,000 (X) 4.184  
= **585,760 apples falling**
- 585,760 (X) 102 (÷) 454  
= **131,602 pounds (or almost 66 tons)**

That can of soda contains the amount of energy that would be released if you dropped an Abram's tank just one meter and let it hit the ground.

***How do living things get all of that energy out of their food without exploding?*** Those calories are stored in the chemical bonds with carbon that make up the proteins, fats, and carbohydrates in the food. Living things are able to slowly release the energy in those carbon bonds through the process of metabolism, and then store that energy in other chemical bonds to be used later for maintaining life and growing.

To meet the genetic potential for growth and production that modern poultry have, it is important that caloric intake is balanced with caloric expenditure. It takes energy (which we measure in calories) to digest nutrients from the diet and then use those nutrients to grow. The caloric intake is made up of the protein, fat, and carbohydrates in the diet, and the caloric expenditure is made up of basal metabolism—what it takes to keep the animal alive, heart beating, constant body temperature, etc., growth/production—the extra “work” we want the animals to be doing to be productive, and a component called the “heat increment.” The heat increment refers to the increase in heat that occurs as a result of normal metabolism and digestion in animals. If there is a positive energy balance, the caloric intake is higher than caloric expenditure, and any used nutrients will go to storage in the body as fat. Extra fat storage can mean wasted money on feed for animal farmers. However, if there is a negative energy balance, the caloric intake is lower than the caloric expenditure, and the body will have to sacrifice resources that could have gone to growth/production just to maintain basal metabolism. Again, this can lead to wasted money on feed that won't go on to make meat or eggs.

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## EXAMPLE EXERCISE:

Calculate your own caloric intake requirement.

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Because of their higher body temperature, *poultry have a higher metabolic rate than humans, but humans require more calories per day because we are larger animals*. A simple way to calculate basal metabolic needs for humans is to multiply their weight in pounds by 10 (for females) or 11 (for males). The difference in muscle mass between the sexes accounts for the different number. Basal metabolic needs are just the kilocalories per day that it takes to breathe, maintain body temperature, repair cells, deliver nutrients throughout the body, beat the heart, etc. The number accounts for what would keep you at a level of activity just above being asleep.

Any level of activity above lying in bed adds to the number of calories you need from the diet to maintain proper energy balance. A rule of thumb suggests that you can add 30 percent for being “inactive,” 50 percent for an average activity level, and 75 percent for being highly physically active. In addition, everyone needs to add an extra 10 percent to their basal metabolism and activity for the heat increment tied to metabolism.

### EXAMPLE:

- 150 lb. male with average activity level:  $150 (X) 11 = 1,650 \text{ kcals for basal metabolism}$
- $1,650 (X) 0.50 = 825 \text{ kcals for activity level}$
- $(1,650 + 825) (X) 0.10 = 2,723 \text{ kcals for energy balance}$

## SECTION #2

***For a diet to be truly “balanced,”*** not only does caloric intake need to match caloric expenditure, but the nutrients the diet contains need to be in the right proportion to its total energy content, measured in kilocalories. Higher calorie diets will require a higher percentage of protein, vitamins, and other nutrients when compared to lower calorie diets. This is because animals, for the most part, will eat to satisfy their energy requirement. It is then the job of the nutritionist to make sure that there will be adequate amounts of all of the essential nutrients in that diet, given how much the animal will eat and what stage of life they are in.

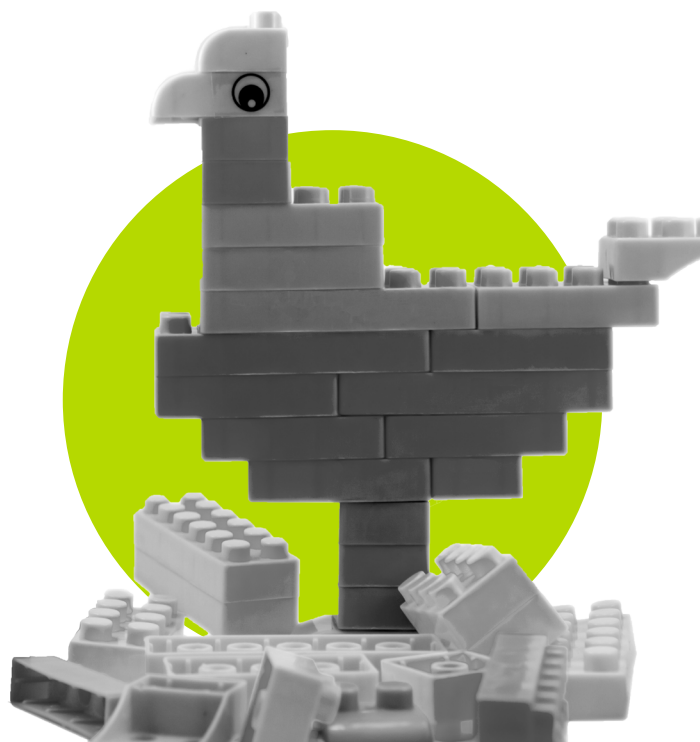
An important component of understanding nutrition is accepting the fact that there is no “perfect food.” Any food naturally contains a variety of the nutrients that an animal needs. However, there is not ever any single food that we could eat to get the exact amounts of the right kinds of protein, fat, carbohydrate, vitamins, minerals, and water we’d need. We have to eat a variety of different foods to get all of the nutrients our bodies need. Some foods, like corn, are high in carbohydrates (like glucose) but have insufficient protein. Other ingredients, like soybeans, are quite high in protein but do not have high amounts of complex carbohydrates. Some ingredients, like limestone or ground oyster shell, might make a fantastic source of a mineral like calcium but don’t provide any other nutrition.

Each living thing needs a very specific amount of certain compounds that are in the six nutrient classes that we call “essential nutrients.” ***If those essential nutrients are not in the diet, the animal will not be able to grow and develop the way genetics are telling them to.***

All commercial poultry can trace their genetic ancestry back to the wild jungle fowl found in India and Southeast Asia. Just as humans have used genetic selection with wild wolves and the American maize plant, we have been able to make significant improvements in the wild chicken’s growth rate and feed efficiency in the last century. In the 1920s, a market-age broiler would be about 16 weeks old, weigh 2.5 pounds, and eat about 12 pounds of feed in its lifetime. Today, the average bird gets to be about 5.3 pounds in 6 weeks while eating about 10 pounds of feed. It is estimated that 85 to 90 percent of the differences between chickens today and chickens a few generations ago is due to the genetic selection brought about by commercial breeding companies.

What are genetics, and what makes them important to the study of nutrition? Genes code for proteins in a living creature. ***Genes function as the instructions for arranging the building blocks of life that make a worm look like a worm, a chicken look like a chicken, and a human look like a human.*** The same nutrients are being used, but the variations in genetic instruction determine how those nutrients are arranged into a specific living organism.

Let’s keep discussing nutrients as building blocks. Each of the amino acids in a protein, the fatty acids and carbohydrates, the vitamins, minerals, and water are all like differently shaped bricks. And the genes of any living thing are the instructions. A very specific type of building block (nutrient) needs to be available when the instructions (genes) ask for it, otherwise you won’t be able to complete that step of the construction process. Without the right amount of the right kind of bricks, we simply can’t construct a chicken according to the genetic instructions.



## SECTION #3

### NUTRIENT REQUIREMENTS OF DIFFERENT POULTRY:

**Most U.S. poultry diets have the following makeup:**

Cereal grain  
Oilseed meal  
By-product meal  
Liquid fat source  
Calcium source  
Inorganic phosphorous source  
Salt  
Purified amino acids  
Vitamin and Mineral premix

They may also contain non-nutritive feed additives that help prevent disease, make less digestible ingredients more nutritious, impart color to the skin or egg yolk, improve the handling qualities of the feed, etc.

***You may have noticed that one component wasn't listed here: hormones.*** While there is technically no such thing as “hormone-free” chicken—since no animal would grow without the hormones its own body produces—there are three essential reasons that poultry have never been given a diet with added hormones. Those reasons are legal, scientific, and economical. Legally, all “hormone-free” poultry products contain the necessary label claim that “Federal regulations prohibit the use of hormones or steroids in poultry.” However, even if feeding added growth hormones were legal in poultry—and it's not—the fact that the hormones would need to travel through the gastrointestinal tract means that the molecules would lose their growth-promoting function. That leads to the third reason why poultry have never been fed added growth hormones: economics. For hormones to have any potential growth-promoting effect, they would have to be injected, not eaten. The price of injecting billions of chickens with growth hormones every day would simply be a cost of

production that could never be recouped, especially when you consider that the current rate of growth in modern poultry can be obtained with good genetic selection, environmental management, and nutrition. In short, even if hormones were legal to use (which they aren't), and it made scientific sense to use them (which it doesn't), we still would never treat poultry with growth hormones.

- Refer to UGA YouTube video “Hormones and Poultry” by Nick Dale: <https://youtu.be/mpxMdqUKP5U>

***It's important to remember that the nutritionist's first goal is to meet the animal's energy requirements.*** After that, the caloric content of the diet affects the animal's feed intake, so higher calorie diets will require a higher percentage of protein, vitamins, and other nutrients when compared to lower calorie diets. The goal of the diet is to supply the animal with all of the essential nutritional building blocks that their genes are asking for to fuel growth and production. Therefore, poultry raised for different purposes (laying hens versus broilers, for example) and birds of different ages (newly hatched chicks versus market age broilers) will have different requirements from their food.

For example, if we want a bird to produce an egg per day, we need to make sure we provide it with all of the nutritional components that a laying hen will need to produce that egg. In this case, that's protein, fat, calcium, and other vitamins/minerals. If we want our meat-type birds to grow at their maximum genetic potential, there has to be enough protein, energy, and other nutrients to meet that requirement.

***In general, smaller birds require less energy and more protein in their diet.*** A day-old chick doesn't require very many calories to maintain its body, but it will quadruple its body weight in the first week of life, eating about 10 to 12 percent of its body weight per day. This means its energy needs are at the lowest, whereas protein (and other nutrients) need to be at their highest. As the bird ages and gets bigger, its growth rate slows down. Thus, its diet will need less protein (and other nutrients) but will need more energy to maintain the larger body size that it has now. When we are feeding birds that are intended to produce eggs, not only do we need to supply the nutrition for their growth and maintenance, we need to provide a diet that also supplies the extra nutrients required to make an egg every day. For this reason, what you'll see in commercial laying hen feeding programs is a small increase in protein at the onset of laying (because every egg contains about 6 grams of protein) and a large increase in calcium (to supply the material needed to make the egg shell).

***What's important about poultry is that they are able to take what are (to us) inedible ingredients, and turn those things into lean meat and nutritious eggs. But that's only possible when we provide them with a diet that is balanced with respect to their needs for energy (to stay alive) and nutrients (to grow and reproduce).***

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### **EXAMPLE EXERCISE:**

Use these simple feed formulation questions as practice:

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**If corn contains 7.8 percent protein, how many pounds of protein are in 100 pounds of corn?**

7.8 percent protein = ***7.8 lbs of protein per 100 lbs of corn***

**If corn costs \$6.56 per 100 pounds and sorghum costs \$5.89 per 100 pounds, which is the more economical source of energy? Which is the more economical source of protein?**

Corn contains 1523 kcal/lb., ***so it provides 23,216 kcal per dollar.*** (1523/0.0656)

Sorghum contains 1495 kcal/lb., ***so it provides 25,382 kcal per dollar.*** (1495/0.0589)

Corn contains 7.8 percent protein, ***so it provides 1.19 lb. of protein per dollar.*** (7.8/6.56)

Sorghum contains 8.8 percent protein, ***so it provides 1.49 lb. of protein per dollar.*** (8.8/5.89)

Using the Pearson's square method (Figure 1), determine how many pounds of corn and soybean meal should be mixed to get 2000 pounds of a diet containing 23 percent protein.

How many pounds of corn and soybean meal should be mixed to get 2000 pounds of a diet containing about 18 percent protein?

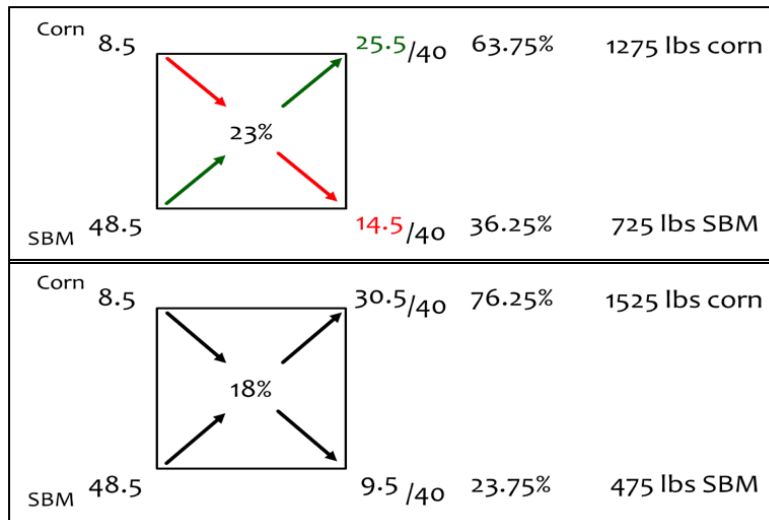


Figure 1. Examples of the Pearson's square method.

What is the calcium and phosphorous content of a mixture of 12 pounds of limestone and 4 pounds of dicalcium phosphate?

- Limestone contains 38 percent Ca and 0 percent P.
- Dicalcium phosphate contains 22 percent Ca and 18.8 percent P.
- So 75 percent limestone is 28.5 percent Ca and 0 percent P.
- And 25 percent dicalcium phosphate is 5.5 percent Ca and 4.7 percent P.
- Therefore, **12 pounds of limestone and 4 pounds of dicalcium phosphate is 34 percent Ca and 4.7 percent P.**

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