

**MODULE I****INTRODUCTION AND NUTRIENT COMPOSITION OF FEEDS AND FEEDSTUFFS****INTRODUCTION**

This module enables to introduce, understand and apply basic concepts in teaching animal nutrition and feeding in the primary grades. It is expected that the content lessons on this module will enable you to gain knowledge and skills in teaching principles of animal nutrition.

**OBJECTIVES**

After studying the module you should be able to:

1. define and understand term related to animal nutrition.
2. appraise the nutrients and it's source.
3. justify the important role of feed nutrients in the whole process.
4. learn and understand the functions of different nutrients in animal production.
5. learn and understand how proximate feed analysis is done in different feedstuff.

**DIRECTIONS / MODULE ORGANIZER**

There are four lessons in the module. Read each lesson carefully.

In case you encounter difficulty, discuss this with your subject professor during the scheduled face-to-face meeting.

Good luck and happy reading!!!

## LESSON 1.



### DEFINITION OF TERMS RELATED TO ANIMAL NUTRITION

Animal nutrients are provided by food. Nutrients are essential for growth and maintenance of the body even some nutrients provide energy. Macro nutrients and micro nutrients both are essential for health. For example nutrition for dogs they need carbohydrates, proteins, and fats in order to gain energy. And for Poultry nutrition should include fats, amino acids, proteins, minerals and water for their growth and development. And for Bovine nutrition should need proteins, phosphorous and pro vitamin A. Water soluble vitamins like B-complex vitamins and c vitamins and Fat soluble vitamins like A, D, E and K are the examples for micro nutrients.

Animal nutrition focuses on the dietary needs of domesticated animals, primarily those in agriculture and food production. Meeting livestock nutritional requirements is extremely important in maintaining acceptable performance of neonatal, growing, finishing and breeding animals.

**Animal Nutrition** is the science that deals with food or feed and the nutrient it contains. This includes the process of providing body cells with the proper amount and balance of nutrients to enable the cells to function in many metabolic and endocrine process involved in growth, maintenance, work, production (meat, milk, wool and egg), reproduction and the optimal formation of the body's defence mechanisms against diseases.

#### Related Terms:

↗ 6 nutrients (water, carbohydrates, lipids, proteins, minerals and vitamins)

**Nutrients** are substances compounds or elements found in feeds that are necessary to support normal life processes of the animals. This includes Carbohydrates, proteins, fat/lipids, minerals, vitamins and water.

**Feed/Food** term given to any materials that embraces both plants and animals including their by-products that provide nutrients to the animals

**Diet** it is the kind of feed/food given to the animals regardless of whatever with balance or unbalance nutrients.

**Ration** the feed given to the animals with balance nutrients needed by the animals within 24 hours.

**Digestion** breakdown of feed/food particles into suitable products for absorption, this includes mechanical, chemical or enzymatic processes.

**Absorption** transfer of digested nutrients from the gastro-intestinal tract (GIT) to the circulatory system (blood or lymph)

**Metabolism** combination of anabolic and catabolic processes occurring in the body of animals with the liberation of energy

**Enzyme** a complex protein produced in living cells that cause changes in other substances within the body without being changed itself (organic catalysts).

**Anabolism** a process of constructive metabolism in which simple substances are converted into more complex substances by living cells

**Catabolism** a process of breaking down of complex substances into more simple compounds by living cells

**ADF** (Acid detergent fiber) - the fraction of a feedstuff not soluble by acid detergent; roughly comparable to a crude fiber plus lignin

**Antioxidant** - a substance that inhibits the oxidation of other compounds.

**Calorie** - The amount of energy required to raise the temperature of water from 14.5° to 15.5°C.

**Crude protein** - total ammoniacal nitrogen x 6.25, based on the fact that feed protein, on the average, contains 16% nitrogen; many non-protein nitrogen compounds may be included.

**Crude fat** - the portion of a feed (or other material) that is soluble in ether; also referred to as ether extract. **Crude fiber** - The fibrous, less digestible portion of a feed

**Dry matter** - the portion of a feed or tissue remaining after water is removed by drying in an oven.

**Metabolizable energy (ME)** - digestible energy minus the energy of the urine and combustible gases from the gastrointestinal tract (primarily methane)

**NDF** - Neutral detergent fiber, the fraction containing mostly cell wall constituents of low biological availability

**NFE (nitrogen-free extract)** - Consists primarily of readily available carbohydrates such as sugars and starches; part of the proximate analysis.

**Non-protein nitrogen (NPN)** - Anyone of a group of N-containing compounds that are not true proteins that can be precipitated from a solution; ammonia and urea are examples.

**Digestible Energy (DE)** - provides an indication of the actual amount of energy from a feed that can be available for use by the animal. It is estimated by subtracting energy lost in the feces (fecal energy or FE) from the gross intake energy (GE), (i.e.,  $DE = GE - FE$ ). Digestible energy is commonly used to evaluate poultry and horse feed. For poultry feed, DE is considered as an appropriate measure of feed quality, because FE is almost the sole form of energy loss during digestion. However, in horses, given that FE only partially accounts for the energy losses (considerable losses also occur via urine and gases) in the process of the utilization of nutrients, DE may over-estimate low quality feeds relative to high quality feeds.

**Digestibility** - refers to the extent to which a feedstuff is absorbed in the animal body as it passes through an animal's digestive tract. It varies greatly with the type of feedstuff and type of animal concerned.

**Digestible Dry Matter (DDM) or Dry Matter Digestibility (DMD)** - is the portion of the dry matter in a feed that is digested by animals at a specified level of feed intake. There is no direct laboratory method for measuring DDM/DMD. It is often estimated by measuring *in vitro* or *in situ* digestibility. Both of these analyses are rather expensive and laborious. So, *in vitro* digestibility is frequently estimated by near infrared reflectance (NIR) analysis and/or estimated from the acid detergent fiber. The DDM can be calculated as follows:  $\%DDM = 88.9 - [0.779 \times \%ADF \text{ (on a dry matter basis)}]$ .

**Dry Matter Basis** - indicates the nutrient levels in a feed sample based on its dry matter content (i.e., excluding its water content). This is also referred to as "Dry Basis," "Dry Results" or "Moisture-free Basis." As there is considerable variation in the water content of forages, excluding the water or expressing the nutrient levels on a dry matter basis eliminates the dilution effect of the water, thereby providing the essential common basis for direct comparison of the nutrient contents across different forages.

**Dry Matter Intake (DMI)** - is the amount of (or prediction of the amount of) dry matter consumed by the animal and is a central concept to any discussion of animal nutrition. Typically, intake increases as the digestibility of the forage increases. However, anti-quality components such as tannins and alkaloids in feeds and forages may decrease intake. Scientists have consistently observed that as the percent of neutral detergent fiber (NDF) increases in the feed, animals consume less (i.e., DMI is less).

**Gross Energy (GE)** - refers to the total energy in a feed before accounting for losses due to normal digestive, metabolic and productive functions. It is determined by measuring the amount of heat produced when a feed is completely oxidized in a bomb calorimeter. It is not a very useful measure since the gross energy in most common feeds is about the same, but they do not result in similar animal performance. For example, GE in oat grain = GE in oat straw.

**Metabolizable Energy (ME)** - equals the gross feed energy minus the energy lost in the feces, urine and gaseous product of digestion:

- $ME = GE - FE \text{ (energy in feces)} - \text{(energy in urine)} - \text{(energy in gases)}$
- $ME = DE \text{ (digestible energy)} - \text{(energy in urine)} - \text{(energy in gases)}$
- Because,  $DE = GE - FE$

**Net Energy (NE)** - refers to the amount of feed energy actually available for animal maintenance, growth and production. Conceptually, total NE is the portion of metabolizable energy (ME) remaining after the energy expended in body heat (or "heat increment of feeding") is deducted, (i.e.,  $NE = ME - \text{heat increment of feeding}$ ).

**Neutral Detergent Fiber (NDF)** - is the residue or insoluble fraction left after boiling a feed sample in neutral detergent solution. The NDF contains plant cell wall components except for some pectins. The NDF is considered a close estimate of

the total fiber constituents of feedstuffs since it measures cellulose, hemicellulose, lignin, silica, tannins and cutins.

**Total Digestible Nutrients (TDN)** - is a measure of the energy value in a feedstuff.

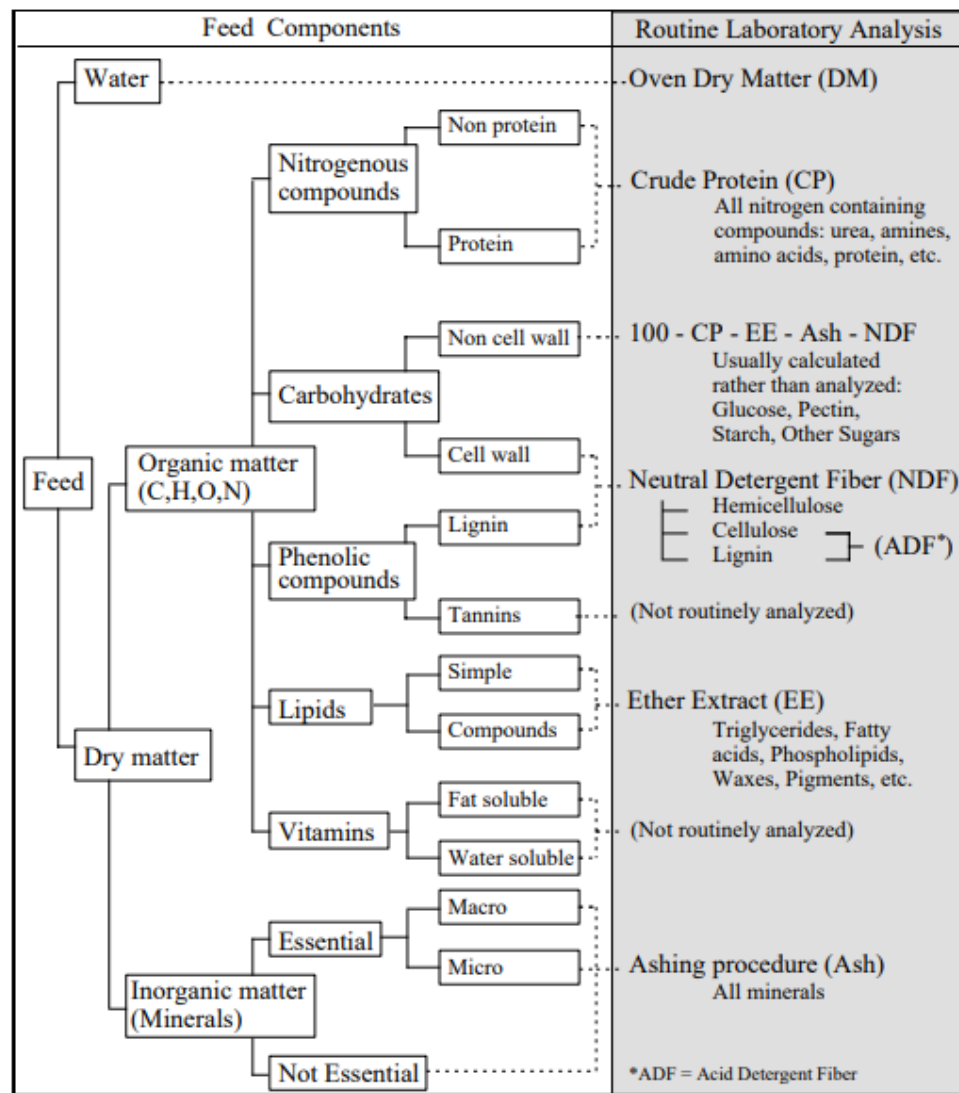
The term TDN has its origins in an older system of measuring available energy in feeds and is very hard to measure directly. Today, reported TDN values are calculated, not measured values. Formulas for calculating TDN originally were based on ADF and frequently varied by region and the nutritionist doing the calculation. The National Research Council (NRC) suggested a more accurate and robust procedure of estimating TDN than those based solely on ADF (NRC, 2001). Their procedure is based on the assumption that forage classes (legumes, cool season grasses, warm season grasses, etc.) have more uniform and predictable digestion coefficients.

## LESSON 2.

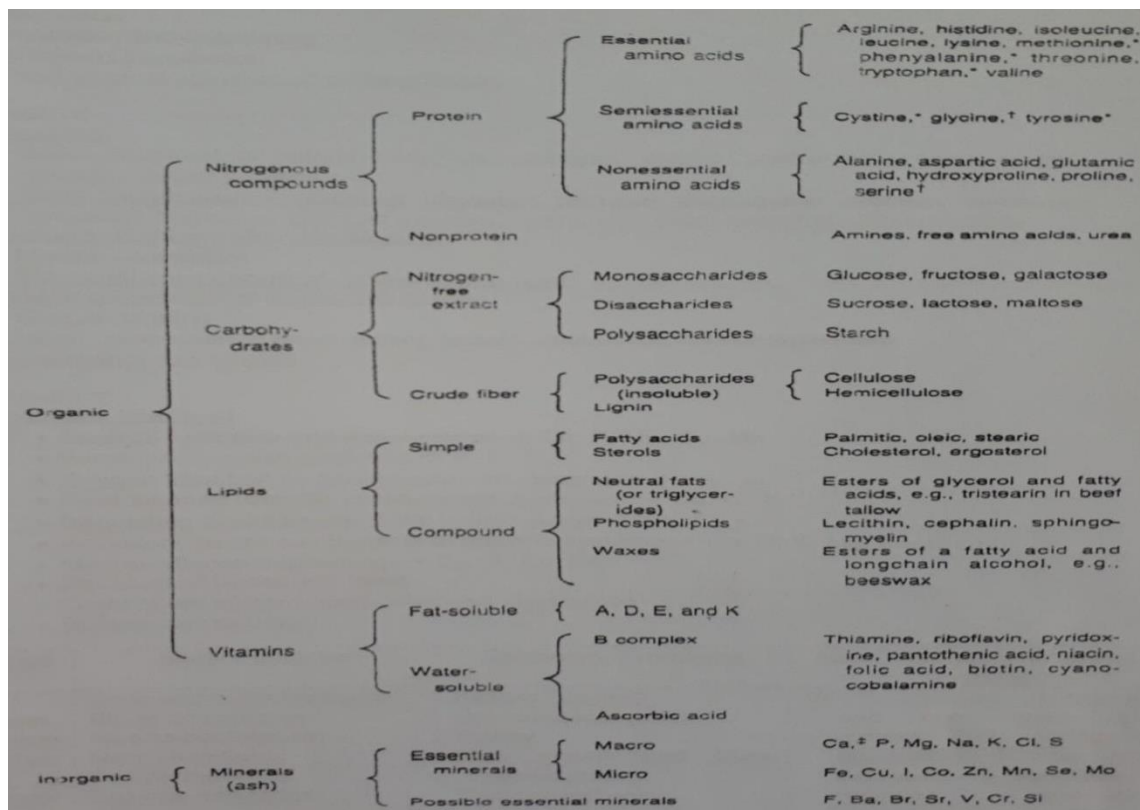


### CLASSES OF NUTRIENTS, THEIR COMPOSITIONS AND FUNCTIONS

In the operation of any animal production enterprises, feeds constitute a large volume of expenses. They account for as much as 80% in animal productions (swine and poultry). Therefore, a good knowledge of feed greatly influences the success or failure of such enterprises. Knowledge on feeds and feedstuff such as when and how to use them for different species and classes of farm animals is important prior to engaging in animal production.



**Figure 1.** Feed Composition and routine laboratory analysis



**Figure 2.** Schematic diagram of the six nutrients

## I. WATER

### A. General

- Cheapest and most abundant nutrient.
- Makes up to 65-85% of animal body weight at birth and 45-60% of adult body weight.
- Accounts for 90-95% of blood and many tissues contain 70-90% water.
- Percentage of body water decreases with animal age and has an increase relationship with body fat.
- Found in the animal body as:
  - Intracellular water – mainly in muscles and skin
  - Extracellular water – mainly in interstitial fluids, blood plasma, lymph, synovial and cerebrospinal fluids.

### B. Functions and Deficiencies

#### a. Functions

- Transport of nutrients and excretions
- Chemical reactions and solvent properties
- Body temperature regulations

4. Maintain shape body cells
  5. Lubricates and cushion joints and organs of the body cavity.
- b. Deficiencies
1. Reduced feed intake and reduced feed palatability
  2. Weight loss due to dehydration
  3. Increased secretions of nitrogen and electrolytes such as Na and K
- C. Sources of Water in the Animal
1. Drinking water – consumption affected by many factors
  2. Water contained in or on feed – about 8 – 30% water
  3. Metabolic process – may account for 5 – 10% total water intake
- D. Water Losses from the Animal Body
1. Urine
  2. Feces
  3. Vaporization from lungs
  4. Sweat from sweat glands

## II. CARBOHYDRATES

- A. General
1. Made up of C (40%), H (7%), and O (53%) by molecular weight.
  2. Include sugar, starch, cellulose and gums.
  3. Very little occurs as such in animal body.
  4. CHO make up approximately  $\frac{3}{4}$  of plant dry weight and thus the large part of animals food supply.
  5. Form by photosynthesis in plants.
- B. Structure
1. Structure consists of C atoms arranged in chains to which H and O are attached.
  2. May contain an aldehyde or ketone group in their structure.
- C. Functions
1. Source of energy
  2. Source of heat
  3. Building stone of other nutrients
  4. Stored in animal body when converted to fats

### III. FATS (LIPIDS or ETHER EXTRACTS)

#### A. Functions

1. Energy supply
2. Source of heat, insulation and protection for animal body.
3. Source of essential fatty acids
  - + Linoleic (C18:2) and Linolenic (C18:3) apparently cannot be synthesized by animal tissues, or at least not in sufficient amounts to prevent pathological changes and so must be supplied in the diet.
  - + Arachidonic acid (C20:4) can be synthesized from C18:2 and therefore, is required in the diet only if C18:2 is absent.
4. Serve as a carrier for absorption of fat soluble vitamins.
5. Storage fuel
  - + Contains no water, more compact energy storage substance
  - + Contains twice as much energy as carbohydrates
6. Plasma membrane structure
7. Hormone production
8. Myelin sheaths of nerve fibers
9. Bile salts
10. Insulation and cushioning
11. Vitamin D synthesis
12. Production of some blood clotting factors

### IV. PROTEIN

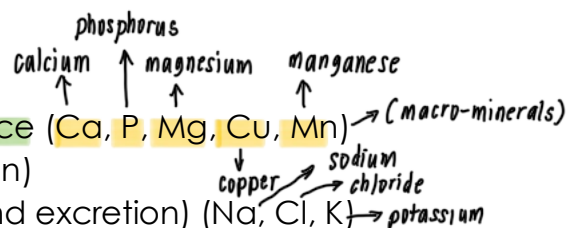
#### A. Functions

1. Basic structure of animal body (collagen, elastin, contractile protein, keratin protein, blood proteins)
2. Body metabolism – enzymes (digestion process, degradative process, synthesis process) hormones and lipid transport, immune bodies, hereditary transmissions.
3. Source of energy after deamination
4. Muscle contraction
5. Structural components of cellular membranes
6. Major component of connective tissues
7. Emergency fuel source
8. Oxygen binding
9. Major component of blood clotting factors, antibodies, neurotransmitters.

## V. MINERALS

### A. Functions (General)

1. **Skeletal formation and maintenance** (Ca, P, Mg, Cu, Mn) → (macro-minerals)
2. Function of protein synthesis (P, S, Zn)
3. Fluid balance (osmotic pressure and excretion) (Na, Cl, K) → potassium
4. Oxygen transport by hemoglobin and myoglobin (Fe, Cu)
5. Regulating acid-balance of the entire system (Na, Cl, K)
6. Activators and/or components of enzyme systems (Ca, P, K, Mg, Fe, Cu, Mn, Zn)
7. Mineral-vitamin relationship (Ca, P, Co, Se)
8. **Structure of bones and teeth**
9. Component of macromolecules and electrolytes
10. Buffer stomach acid



**Table 1.** Summary on Different Minerals

Minerals/Sources	Major Functions	Deficiency/Symptoms	Major Interrelationship and Toxicities
<b>Calcium</b> (Milk, legumes, steamed bone meal, calcium phosphate, ground oyster shell)	<b>Bone and tooth formation</b> , Blood coagulation, Muscle contraction, Nerve functions, Cell permeability, Enzyme activation	Rickets (young) <b>Osteomalacia (adult)</b> Tetany Slow growth and bone development, Thin-shelled egg	<b>Vit. D</b> involved absorption and bone deposition, Excess $PO_4$ decrease absorption, Excess Mg decrease absorption, replaces Ca in bone and increases Ca excretion
<b>Phosphorous</b> (Milk and egg, oilseeds and hulls cereals, steamed bone meal, Dicalcium phosphate,	<b>Bone and tooth formation</b> , Phosphorylation, High energy phosphate bond, $PO_4$ chief anion radical of	Rickets (young) Osteomalacia (adult) Rough hair coat, pica Lowered appetite Slow growth and low utilization of feed Lower blood plasma	Vit. D involved in renal absorption and bone deposition, Excess Ca and Mg causes

Tripoly-phosphate)	intercellular fluid Acid base balance, Enzyme synthesis, Released body energy, Part of DNA and RNA	phosphorous	decrease in absorption
<b>Magnesium</b> (All feeds particularly plant products – leafy vegetable and cereal grains)	<b>Enzymes activator</b> primarily in glycolytic system; Bone formation	<b>Vasodilation,</b> Hyperirritability with convulsions, loss of equilibrium and trembling, Tetany, Lowered appetite (anorexia), Profuse salivation	Excess upsets Ca and P metabolism
<b>Sodium</b> (Common salts, cured meats, cheese)	<b>Major cation of extracellular fluid</b> where it is involved in osmotic pressure and acid-base equilibrium, Preservation of normal muscle cell irritability, Cell permeability, Component of bile which aids in fat digestion	<b>Reduced growth or loss weight</b> Eye disturbance with corneal lesions, Reproduction impairment (infertility – males, delayed sexual maturity – female) Craving of salt or eating of soil Reduced appetite	Salt toxicity readily occurs in non-ruminants with levels above 8% in the diet, Staggering gait, blindness and other nervous disorders
<b>Chlorine</b> (Common salt)	Major anion involved in osmotic pressure and acid-base balance, Hydrochloric acid in digestion	Hydrochloremic alkalosis	

<p><b>Potassium</b> (Normal rations)</p>	<p>Major cation of intracellular fluid where it is involved in osmotic pressure and acid-base balance, muscle activity, Maintenance of electrolytes balance, Enzyme activator</p>	<p>Hypokalemia: lethargic condition with high incidence of comas and death, Diarrhea, distended abdomen and untidy appearance Heart lesions, Loss weight and reduced appetite Muscle weakness Poor wool growth</p>	
<p><b>Sulfur</b> (Protein supplements, forages, cereals)</p>	<p>Sulfur containing amino acid SH group function in tissue respiration Synthesis of amino acids in ruminants</p>	<p>Primarily growth effect due to sulfur amino acids requirement for protein synthesis Low feed efficiency Slow wool growth</p>	
<p><b>Iron</b> (Egg, soil, forages, grains, iron injection, liver, ferrous sulfate)</p>	<p><b>Cellular respiration</b> (hemoglobin) Component of many enzymes</p>	<p>Hypochromic-microcytic anemia Thumps in pigs Diarrhea/ loss of appetite</p>	<p>Ca-P ratio influence absorption Cu required for proper metabolism Pyridoxine deficiency decrease absorption</p>
<p><b>Copper</b> (Feedstuff, CuSO<sub>4</sub>)</p>	<p>Cofactor in several oxidation-reduction enzyme synthesis, Hemoglobin synthesis, Bone Formation,</p>	<p><b>Fading hair coat o lack of wool</b> Nervous symptoms or atoxia Lameness, swelling of joints, fragility of bones Anemia Stunted growth</p>	<p>Excess Mo, Zn inhibits its utilization and storage Toxicity (above 250 ppm)</p>

	Erythropoises, Co-enzymes system, Hair pigmentation, Reproduction, Collagen and elastin synthesis, iron utilization	Diarrhea or ataxic gait Loss condition Aortic pressure in swine and poultry Depraved appetite	
<b>Zinc</b> (Forages, ZnO, ZnCO <sub>3</sub> or ZnSO <sub>4</sub> )	Cofactor of several enzymes systems (peptidases, carbonic anhydrase)	Poor hair or feather development, Rough and thickened skin or parakeratosis, Anorexia, Hyperkeratosis in chicks	High Ca and P level requirement
<b>Manganese</b> (Feed, nuts, seeds, milk, legumes and cereals)	Activator of enzymes systems (oxidative phosphorylation, amino acid metabolism, fatty acid synthesis, cholesterol metabolism) Bone formation (organic matrix) Growth and reproduction	Poor growth Shortened long bones Impaired reproduction (testicular degeneration in males, defective ovulation in female) Perosis or slipped tendon in chicken Lower hatchability, egg shell strength, lameness, stiffness	Excess Ca and P decreases absorption
<b>Cobalt</b> (Cobalt pellets/salts)	Components of Vit. B12	Anemia	
<b>Iodine</b> (Iodized salts, cod-liver oil)	Thyroxine	Goiter, still births, hair less pigs, wool less lambs	Chronic toxicity Blind staggers (10-20 ppm) Alkali disease (5-10 ppm) Acute toxicity (20 ppm)

**VI. VITAMINS** - organic substance essential for the maintenance of health and life of farm animal though needed in very minute amounts.

A. Functions

1. Coenzymes for many metabolic pathways
2. Antioxidants
3. Component of visual pigment
4. Hormone (Vitamin D)

**Table 2. Summary on Different Vitamins**

Vitamins/Sources	Main Function	Deficiency/Symptoms	Major Interrelationship and Toxicities
<b>A</b> (Yellow corn, grasses, egg yolk, liver, fish liver oil, milk fat, green vegetables)	<b>Bone formation</b> <b>Vision (rhodopsin)</b> Epithelial tissue (digestive, respiratory, reproductive) Glucose synthesis Growth or cellular metabolism Proper function of immune system	Xerophthalmia Night blindness Hyperkeratosis Skeletal lesions, bone remodeling Reproductive failures Muscle incoordination Rough haircoat, plumage	Hyperostosis Hyperkeratosis
<b>D (Sterol)</b> <b>D<sub>2</sub></b> – ergocalciferol <b>D<sub>3</sub></b> – cholecalciferol (Fish liver oil, irradiated yeast, egg yolk, milk fat, field cured hays, exposure to sunlight, commercial preparations)	<b>Bone formation</b> (Ca, P absorption from renal tubules, osteoblast formation, calcification) CHO metabolism (phosphorylation) Growth	Rickets (growing period) Osteomalacia (adults) Soft egg shells, reduced egg production, hatchability	Decalcification of skeleton, calcification of tissue
<b>E (tocopherol)</b> (Cereal grains, egg yolk, oils of soybeans, peanuts, cotton)	<b>Antioxidants</b> <b>Muscle structure</b> (dystrophy) Reproduction (semiferous)	Muscle dystrophy Encephalomalacia Reproductive failures Liver necrosis Cardiac muscle	Relatively non-toxic

seed, beef liver, wheat germ oil, commercial preparations)	tubules) Hatchability of eggs Cell nucleus activity	abnormalities Dental depigmentation	
<b>K</b> (Green leafy plants, liver, egg yolk, fish meal, synthetic forms (menadione))	Prothrombin (normal blood clotting formation)	Spontaneous hemorrhage, increase blood clotting time	Relatively non-toxic
<b>Thiamine (B<sub>1</sub>)</b> (Milk and milk products, brewer's yeast, wheat germ, unmilled cereals, grain by-products, lean pork, liver, good quality hay, synthetic forms)	Coenzyme (Thiamine pyrophosphate) Decarboxylation of $\alpha$ -keto acids Promote normal appetite and digestion Nervous system healthy, prevent irritability	Polyneuritis, convulsions Cardiovascular disturbances Beri-beri (man) Anorexia, emaciation Hyperirritability Reproductive failure in horses	Relatively non-toxic
<b>Riboflavin (B<sub>2</sub>)</b> (Milk, cheese, liver, kidney, eggs, fish, green forage, oil meals, fermentation products, commercial preparations)	Coenzyme (Flavin mononucleotide, Oxidize Adenine dinucleotide) Dehydrogenase Energy transfer Protein metabolism Xanthine oxidase Healthy skin	Ectodermal and nervous system lesions Dermatitis, hair loss Curled toe paralysis Depressed appetite, retarded growth	Non-toxic
<b>Pantothenic acid</b> (liver, egg yolk, milk, hay, peanut meal, cane molasses, yeast, rice, wheat brans, cereal grains and by-products, royal jellies of bees)	Coenzyme A (Acyl transfer)	Dermatitis, loss of hair, graying of hair, spastic gait, goose stepping, paralysis Enteritis Poor growth, reproduction Skin, nervous system, adrenal gland lesions Gastrointestinal trouble	Relatively non-toxic

<p><b>Niacin</b> or <b>Nicotinic acid</b> (Milk, meat, eggs, green vegetables, peanut butter, animal and fish by-products, distiller's grain and yeast, fermentation soluble, oil meals)</p>	<p>Coenzyme (DPN, TPN) Hydrogen transport Spared by the amino acid tryptophan Health of digestive, nervous system</p>	<p>Dermatitis, diarrhea, dementia Irritability Inflammation, ulceration of mouth, tongue, digestive tract Vomiting Anemia Loss of appetite</p>	<p>Vasodilation with itching and burning of skin Fatty liver</p>
<p><b>Pyridoxine (B<sub>6</sub>)</b> (Yeast, liver, muscle, meat, egg yolk, milk, cereal grains, vegetables)</p>	<p>Coenzyme (Pyridoxal phosphate) Amino acid decarboxylation, transamination, removal of sulfhydryl groups</p>	<p>Convulsions, neuritis, hyperirritability Hypochromic-microcytic anemia Increased excretion xanthurenic acid</p>	<p>Convulsion, death</p>
<p><b>Biotin</b> (Yeast, organ meats, whole grains, molasses, milk)</p>	<p>Coenzyme – carboxylase Carboxylation Fat synthesis Deamination of certain enzyme</p>	<p>Dermatitis Loss of hair Disturbance of nervous system</p>	<p>Non-toxic</p>
<p><b>Folic acid</b> (Green leafy plants, organ meats, cereals, animal by-products, soybeans)</p>	<p>One carbon carrier Synthesis purines, certain methyl groups Erythropoiesis</p>	<p>Macrocytic anemia, leucopenia Cervical paralysis in turkeys Retarded growth Poor feathering, pigmentation of feathers</p>	<p>Non-toxic</p>
<p><b>Choline</b> (Milk, egg, meat, fish, fats)</p>	<p>Methyl donor Lipotropic substance: Acetylchloride, phospholipids Essential in building ,maintenance of cell structure</p>	<p>Fatty liver, kidney degeneration Poor reproduction, lactation Renal tubular degeneration Enlarged spleen Peorsis in chicks</p>	<p>Persistent diarrhea</p>

	Transmission of nerve impulses Fat metabolism in the liver		
<b>Cynocobalamine (B<sub>12</sub>)</b> (Milk, meat, fish meal, animal by-product, commercial preparations)	Labile methyl, purine group synthesis CHO, fats metabolism Isomerization reactions Nucleic acid synthesis Known as animal protein factor (APF)	Macrocytic anemia Neurological disturbances Hatching problems Reduced growth Posterior incoordination Unsteadiness of gait	Non-toxic
<b>Vit. C</b> (Citrus fruits, tomatoes, green leafy materials, potatoes, synthetic preparations)	Collagen formation Formation, maintenance of intracellular materials in bones, soft tissues Tissue catalyst Antioxidant	Scurvy – slow wound healing Spongy gums Swollen joints Hemorrhage Anemia Loss of teeth	Non-toxic
Related compounds			
<b>Inositol</b> (Plant products in the organic phosphorous substance phytin)	Lipotropic action – rat diets	Alopecia	
<b>Para-aminobenzoic acid (PABA)</b> (synthetic preparation)	Anti-gray-hair factor on mice, rats Growth stimulant in chicks	Graying of hair	

## LESSON 3.



### CLASSIFICATION OF FEEDSTUFF

Feeding farm animals is a process of priority decision-making involving at least two general conditions. The first is an abundance of food material which is not in a usable form or aesthetically acceptable as human food, and the second is a surplus of food material accompanied by a standard of living sufficiently high that the nutrient losses involved in feeding animals are compensated for by the increased desirability and nutritional excellence of foods of animal origin.

Decisions relevant to the first set of conditions include determining the optimum numbers and kinds of animals that can be productively supported by the available feedstuffs. Efforts should be made to maximize production; but also to allocate nutrient supplies in a competitive situation for the maximum benefit to the society concerned. These decisions are among the most critical that civilization faces today. Decisions can be made only on the basis of reliable information concerning the composition of all feed materials used in animal feeding. This information is fundamental in assigning priorities to the use of available feed supplies in animal agriculture (FAO, n. d.).

The various feeds and fodders used in livestock feeding are broadly classified as: A) Roughages; B) Concentrates; C) Feed supplements and Feed additives. Roughages – Roughages are the feed stuffs which contain more than 18 percent crude fiber and less than 60 percent Total Digestible Nutrients. Due to higher crude fiber content, they are more bulky and have low digestibility as compared to concentrates. 1) Maintenance type – Containing 3-5 percent DCP e.g. Green maize, oat. 2) Non-maintenance type – containing less than 3 percent DCP e.g. Straw,. 3) Production type – containing more than 5 percent DCP e.g. Berseem, lucerne. (DCP – Digestible Crude Protein) The roughages are further classified into two major group as: 1) Green / succulent roughages – They contain about 60-90 percent moisture eg. Pastures, cultivated fodders, tree leaves, root crops and silages. 2) Dry roughages – They contain about 10-15 percent moisture e.g. Straw, and Hay.

#### Classification of Feedstuff

A. Concentrate Feeds – are feed materials usually having low moisture and fiber content (less than 18%) with relatively high digestibility.

Concentrates are classified into:

i. Basal (carbonaceous) concentrates – those feed materials rich in energy (less than 20% CP)

Example: Cereal grains – yellow corn, rice bran (D1), sorghum,

barley, oats, wheat pollard

Root crops – cassava, gabi, camote

Oil/Fats – coconut oil, fish oil, tallow

Molasses – sugarcane

ii. **Protein concentrates** – those feed materials either pure or mixed rich in protein either plant or animal origin (more than 20% CP).

Example: Plant protein – soybean meal, peanut meal, cotton seed



meal, copra meal, ipil-ipil meal, sunflower seed meal, rubber seed meal, etc.

Animal protein – meat and bone meal, blood meal, Feather meal, tankage, skimmilk, animal waste

Marine protein – fish meal, shrimp meal

Single cell protein – produced by yeast or Bacteria

Non-protein nitrogen – urea may be fed to ruminants but not for swine or poultry

- biuret is a mixture of the nitrogen compounds resulting from controlled pyrolysis (chemical change due to heat) of urea.

iii. **Minerals and Vitamins Supplements**

**Minerals – (Macro)** – limestone, oyster shell, bone meal, Dicalcium phosphate, Tricalcium phosphate, Mono Dicalcium phosphate, calcium bicarbonate, salt;

**(Micro)** – are either synthetic preparations which are available commercially in premixes.

**Vitamins** – are either pure or synthetic preparations which are available commercially in premixes.

**Feed additives (non-nutritive feed)** – feed ingredients with no nutrient value added usually in small quantity to the basic feed mix for the purpose of fortifying to improve its digestion and utilization. Example: antibiotics, prebiotics, probiotics, antioxidants, hormones, enzymes, mold inhibitors, flavouring, coloring, toxic binders, pellet binders and acidifiers.

B. **ROUGHAGES** – are feed materials with high proportion of fiber or non-digestible materials (more than 18%) with relatively poor digestibility.

Roughages are classified into:

a) **Degree of Water Content**

+ **Succulent roughages** – high in water content and more digestible

- **Soilage** – green fodder that are cut by human and feed to the animal fresh

- Pasture – green fodder/grasses that are graze by the animal in the field

Establishment: cleaning or clearing, land preparation, (plowing, harrowing, furrowing), planting, care and management (weeding, fertilizer application), harvesting (cut and carry or grazing or tethering)

Some pasture species (grass or legumes)

- ✓ Napier grass – *Pennisetum purpureum*
- ✓ Guinea grass – *Panicum maximum*
- ✓ Para grass – *Brachiaria mutica*
- ✓ Signal grass – *Brachiaria decumbens*
- ✓ Star grass – *Cynodon plectostachyus*
- ✓ Bagochoc – *Themeda triadra*
- ✓ Cogon – *Imperata cylindrica*
- ✓ Alabang X – *Andropogon nodosus*
- ✓ Centrosema – *Centrosema pubescens*
- ✓ Kudzu – *Peuraria phaseoloides*
- ✓ Calopogonium – *Calopogonium muconoides*
- ✓ Stylo – *Stylosanthes guyanensis*
- ✓ Pinto peanut – *Arachis pintoii*
- ✓ Ipil-ipil – *Leucaena leucocephala*
- ✓ Kakawate – *Glyricidia sepium*



- Silage – grass or crop residues that are being process (compressed and stored under anaerobic condition in a container called silo) thru fermentation before being fed to animals.

✦ Dry roughages – contain less water content

- Hay – are either grasses or legumes consisting of the leaves, flowers and stems being cut and cured either by sun or air drying, by dehydrating green forages to a moisture content of 15% or less.
- Straw – are mostly from cereal crop residues which contain high percentage of indigestible fiber and are low in digestible carbohydrates, protein, vitamins and minerals

b) Level of Contents

- ✦ Proteinaceous roughages – contain more than 10% CP (dry matter basis); made-up primarily of legumes and some immature grass
- ✦ Carbonaceous roughages – contain less than 10% CP (dry matter basis); made-up primarily of non-legumes and low quality roughages.

## LESSON 4



### NUTRIENT REQUIREMENTS FOR VARIOUS PHYSIOLOGICAL ACTIVITIES

"Nutrition involves various chemical and physiological activities which transform food elements into body elements." This simple (Maynard, 1979) definition describes the science of nutrition, a chemistry-based discipline interacting to varying degrees with many of the other physical and biological sciences. This definition also implicates nutrition as one of the environmental factors that influences the ability of animals to attain their genetic potential for growth, reproduction, longevity, or response to stimuli. Therefore, the nutritional status of animals involved in biomedical research has a profound effect on the quality of experimental results. The process of supplying adequate nutrition for laboratory animals involves establishing requirements for approximately 50 essential nutrients, formulating and manufacturing diets with the required nutrient concentrations, and managing numerous factors related to diet quality. Factors potentially affecting diet quality include the bioavailability of nutrients, palatability or acceptance by animals, procedures involved in preparation or storage, and the concentration of chemical contaminants (Lewis, 2006).

#### A. MAINTENANCE

1. Each animal has a maintenance requirement for feed/ration on the various nutrients for the following purposes:
  - a. To maintain body weight or size (no gain or loss)
  - b. To support the essential life processes (respiration, circulation, normal muscle activity, etc.)
  - c. To maintain body temperature
  - d. To maintain the different body secretions
2. Basal metabolism or Fasting Catabolism – refers to the minimum energy expenditure to maintain essential life processes. The starting point in determining the maintenance requirements for energy of an animal. Basal metabolism (BM) is measured in kilocalories and can be estimated using the following formula derived from experimental data:

$$\text{BM (kilocalories)} = 70 W_{\text{kg}}^{0.75}$$

Where:  $W_{\text{kg}}$  = animal's body wt. in kg  
 $W_{\text{kg}}^{0.75}$  = body wt raised to the  $\frac{3}{4}$  power

It has been established that each animal has a fairly constant BM per unit metabolic body size (MBS) which is equal to 70 kcal.

**Table 3.** Portion of body weights and corresponding MBS (Maynard et. al., 1979)

W <sub>kg</sub>	MBS
1.0	5.62
50.0	18.80
100.0	31.62
150.0	42.86
200.0	53.18
300.0	72.08
400.0	89.44
500.0	105.74
1,000.0	177.80

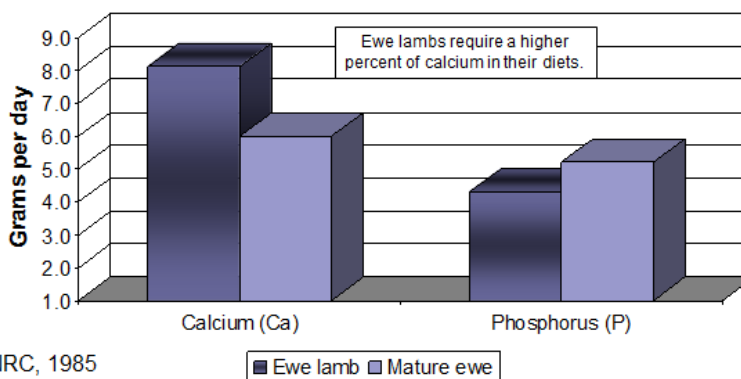
3. Energy requirement for maintenance is related to the body surface area or metabolic body size, ex.  $\frac{3}{4}$  power of the live weight. This made up of the net energy (for Basal metabolism) and a so-called "activity increment" (refers to the energy expenditure due to normal body movements and associated activities. E.g. for chicken, + 50%; cattle and swine, +20-30%; grazing cattle, another + 40%.
4. Protein requirement for maintenance is made up of two portions:
  - a. Endogenous urinary nitrogen (EUN) = the normal wear and tear of the body organs and tissues. On an energy adequate, N-free diet, EUN is about 2 mg N per basal kilocalorie.
  - b. The "adult growth" functions – e.g. feathers, hairs, hoofs, nails, etc.

## B. GROWTH

1. Growth is the correlated increase in the mass of the body to reach the size at maturity fixed by heredity. In practical terms, growth is reflected in increased weight and size. This characterized by:

### Age

Nutrient requirements for ewe lambs and mature ewes (132-lb. ewes, late gestation, 150% lambing rate)



- a. Increase in the number of cells
- b. Increase in size of the cells. This consists primarily of the build-up of skeletal structure, muscles and organs, and fat tissues.

Nutritionally, it means largely increase in minerals (mainly Ca and P) and protein.

2. Protein requirements for growth.

High protein level and good protein quality (essential aa make-up) are both needed for optimum growth. These may gradually be lowered with age. For example, broiler starter and pig starter mash may require more than 20% CP (with good quality proteins like fish meal, meat meal, soybean meal, skimmilk powder, etc.) whereas the hog/broiler finisher mash may contain only 14% protein (with little amount of the good quality protein feeds).

3. Energy requirements for growth.

Energy (mainly from CHO, provided also by fats and proteins) is the driving force for tissue synthesis or anabolism. Even with adequate aa, minerals, vitamins, growth cannot take place at the optimal rate without sufficient energy (measured by kilocalories of gross energy, digestible energy, ME or NE, or as TDN)

4. Ways of energy restriction – to limit the energy intake of an animal, either or both of these ways may be followed:

- a. Limit the total feed intake
- b. Lower the energy content or density of the ration – example, make the ration bulky

The first method would also lower the intake of the other nutrients relative to the animal's requirements. In the second method, you may still enable the animal to consume adequate levels of the other nutrients in spite of the energy restriction up to a certain point.

The energy: protein ratio is an important factor in the efficiency and economy of growth.

5. Growth rates and feed efficiency

The practical measures of growth performance of farm animals are average daily gain in weight (ADG) and feed efficiency ratio (FCR). The values are greatly affected by two major factors:

- a. Hereditary (breed or strain of the animal)
- b. Environment (nutrition and management). Under Philippine conditions, following are the normal values for reasonably good rations.

Category		ADG (kg)	FCR (kg feed/kg live weight gain)
Growing (crossbred)	pigs	0.4 – 0.6	2.5 – 3.5
Growing (native)	cattle	0.4 – 0.5	11.0 – 12.0
Growing (native grades)	cattle x zebu	0.5 – 0.7	10.0 – 11.0
Broilers (modern strains)	(modern)	2.5 – 1.8 (6 – 7 wks)	2.0 – 2.3

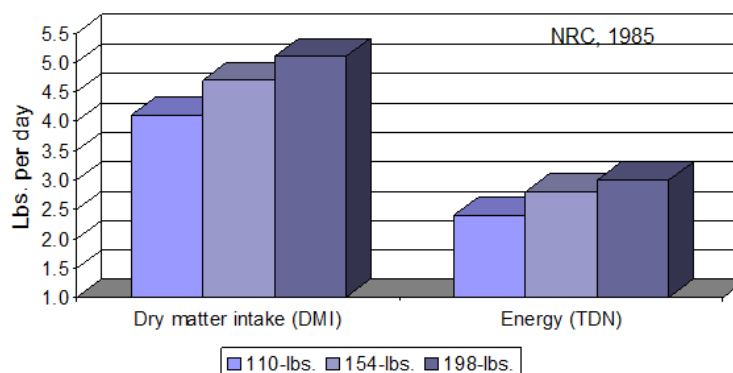
### C. REPRODUCTION

- The nutrient requirements for reproduction represent the additional amounts of the various nutrients needed for:
  - Female's coming into estrus, subsequent conception and development of the fetus until birth.
  - Male's maintenance of the integrity of the reproductive organs and its sperm cells and sex hormones.

- The substantial requirement, especially of energy, protein, calcium, phosphorous is for the development of the fetus ("pre-natal growth" but considered part of reproduction requirement of the dam) particularly during the last quarter of the gestation period.

#### Size (weight)

Nutrient requirements for different mature size ewes in late gestation, carrying twin lambs.



- Too severe nutrient deficiencies for a long period can be lead to permanent sterility. However, usual cases are those of not too severe nutrient deficiencies giving rise to low level of fertility manifested by the following symptoms:
  - Cessation of estrus
  - Resorption of fetus
  - Abortion
  - Stillbirth or weak young

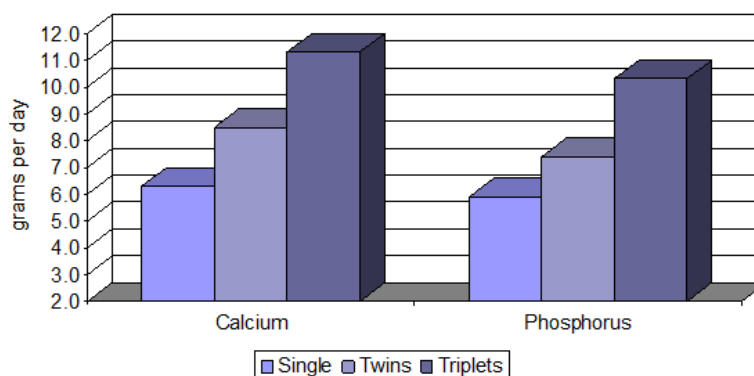
The principal nutrient deficiencies involved in these symptoms are protein, calcium, phosphorous, vitamin A.

#### D. MILK PRODUCTION

1. Lactation in any species requires substantial nutrients for synthesis of adequate amount of milk to nourish the young. This additional requirement above those for maintenance and possibly growth in the case of still growing breeding female is much more pronounced in the dairy animal, especially the dairy cow. Dairy type animals produce milk for human consumption and relatively very much less for the nourishment of their young.

### Level of Production

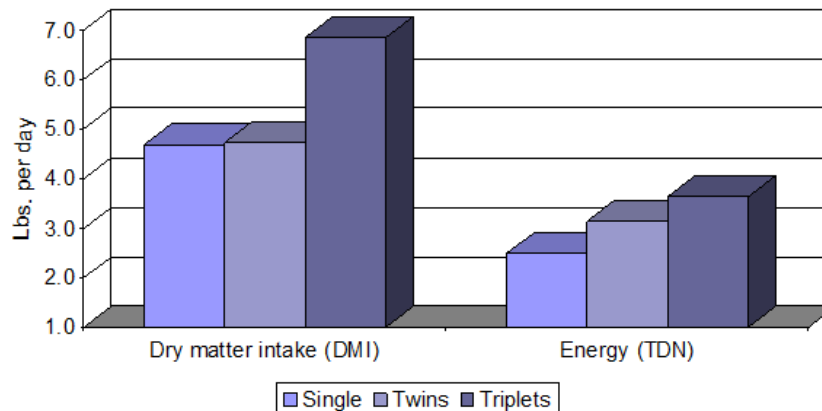
Nutrient requirements of 176-lb. lactating ewe.



2. Good dairy cows in the temperate countries like US yield about 25-30 kg milk daily in a 305 day lactation period. Relatively good dairy cows in the Philippines and in most of the tropics correspondingly yield only about 8-12 kg daily. Genetics and climate (direct and indirect effects) have very much to do with this difference.
3. Commercial dairying would generally need intensive grazing management or intensive forage production, compared with extensive pasture or range grazing in cattle ranching for beef production. Dairy cows need improved forages for efficient and economical production. As much of good quality forage that a dairy cow can and should consume, would generally be able to meet only the requirements for maintenance and the production of not more than 5 kg milk daily in the Philippines. Energy rather than CP seems to be more critical problem in meeting adequate needs of the dairy cows in the Philippines. Concentrate would be needed to provide that energy deficit. A common "rule of thumb" is to feed 1 kg of good concentrate mixture for every 2.5 kg of milk in excess of 5 kg if the forage is of good quality.

## Level of Production

Nutrient requirements of a 176-lb. lactating ewe.



#### 4. Milk constituents and blood sources:

Casein	Blood amino acids
Immune globulins	Blood globulins
Fat	Fatty acids, acetate
Lactose	Glucose
Minerals	Minerals in blood
Vitamins	Vitamins in blood

### E. EGG PRODUCTION

- The major factors affecting nutrient requirements are:
  - Rate of egg production
  - Egg size or weight
  - Egg shell thickness
  - Body size of layer
- The principal factor affecting egg shell quality is dietary calcium. Egg shell quality can be measured by specific gravity of egg, shell thickness, shell smoothness, breaking strength, percentage of crack or shell appearance.  
Low dietary calcium levels, less than 2%, decrease egg shell quality in chickens.

### 3. Portion of nutrient requirements of egg type chicken.\*\*\*

<b>Nutrients</b>	<b>0-6 weeks</b>	<b>6-14 weeks</b>	<b>24-30 weeks</b>	<b>Lying</b>
CP, %	19	16	14	17
ME	2,800	2,750	2,700	2,750
Lysine, %	0.85	0.60	0.45	0.65
Methionine, %	0.30	0.25	0.20	0.32
Methionine + Cystine, %	0.60	0.50	0.40	0.55
Ca, %	0.80	0.70	0.60	3.40
Avail. P, %	0.40	0.35	0.30	0.32

\*\*\* Source: US NRC, 1984. Nutrient requirements of poultry, 8<sup>th</sup> revised edition. National Research Council, Washington, D.C.



## MODULE SUMMARY

In this module you have learned about the nutrient composition of feeds and feedstuffs.

Lesson 1 explained the terms related to animal nutrition

Lesson 2 identified and discussed classes of nutrients, their compositions and functions

Lesson 3 familiarized and collected samples based on the classification of feedstuff

Lesson 4 explained and correlate the nutrient requirements for various physiological activities of different stages in life cycle of animals