



**Addis Ababa University**  
**College of Veterinary Medicine and Agriculture**  
**Department of Animal Production Studies**

**Course Title: Animal Nutrition (AnPS 2092)**

**By**

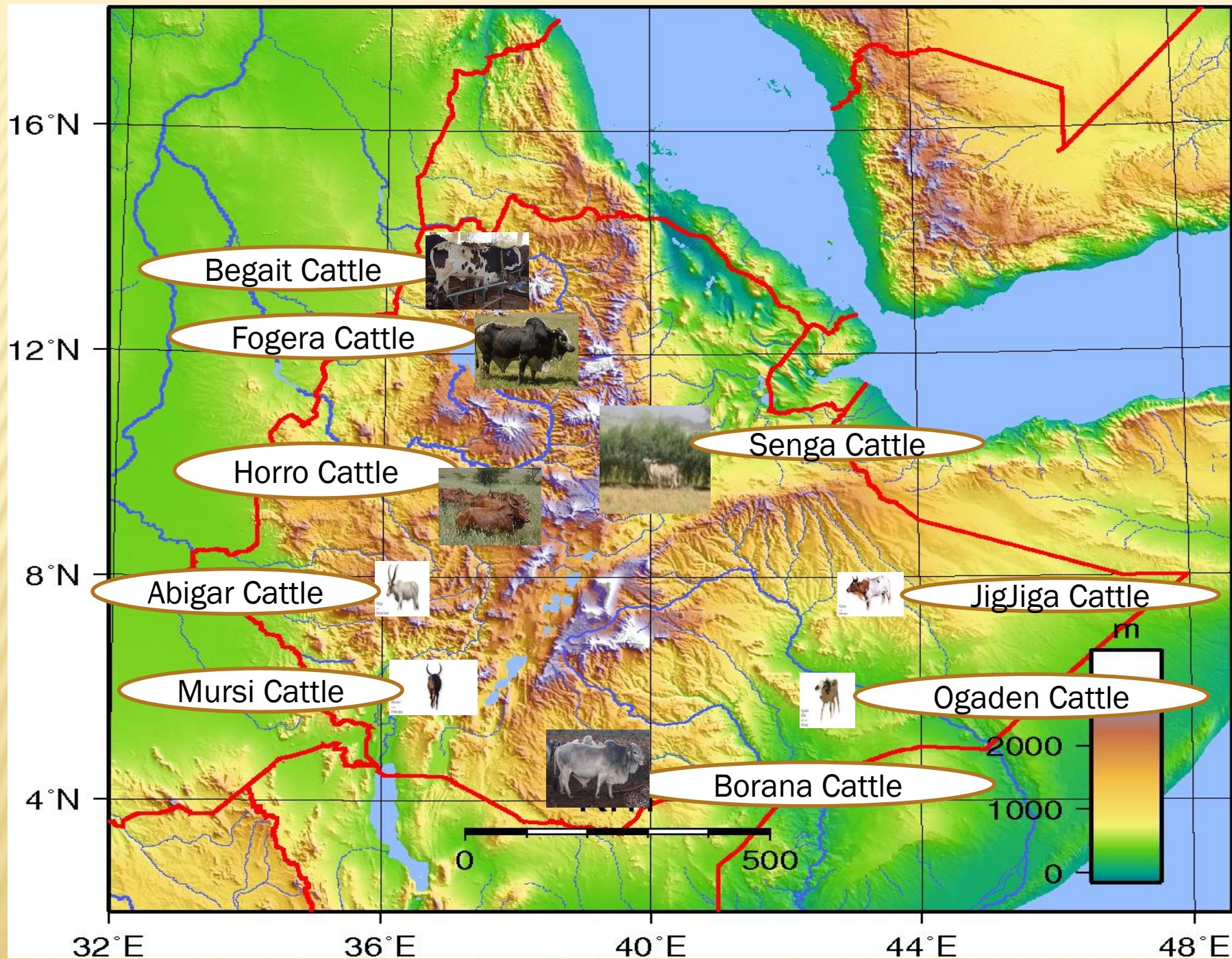
**Gebreyohannes Berhane / PhD, Associate Professor/**



Begait Cattle - Tigray

# Course Outline

<b>Course title</b>	<b>Animal Nutrition</b>	
<b>Course code</b>	<b>AnPS 2092</b>	
<b>Course credit</b>	<b>5 ECTS / 3 CrHr</b>	
<b>Week</b>	<b>Topics</b>	<b>Instructor</b>
<b>1</b>	<b>Introduction to Animal nutrition: Importance of Animal nutrition: Feed Classification and characterization: Definitions of terms</b>	<b>Dr. Gebreyohannes Berhane</b>
<b>2</b>	<b>Classification of basic nutrients -Water: Function, source and requirements, deprivation, analysis of feed for water composition Chemical composition</b>	
<b>3</b>	<b>-Carbohydrates: Classification, properties, utilization, occurrence and functions, Analysis of feeds for carbohydrates (CF and NFE)</b>	
<b>4</b>	<b>-Lipids: Classification, properties, functions and deficiencies, Analysis of feeds for lipid content</b>	
<b>5</b>	<b>-Proteins: Classification of amino acids and proteins, function of proteins, protein structure and deficiencies of amino acids, analysis of feeds for protein composition</b>	
<b>6</b>	<b>-Vitamins and minerals: Classification, functions, sources and deficiencies</b>	
<b>7</b>	<b>Digestion, Absorption, and Metabolism of nutrients: -In monogastric, - In ruminants</b>	
<b>8</b>	<b>The energy and protein values of feeds</b>	<b>Prof. Berhan Tamir</b>
<b>9</b>	<b>Feed stuffs and their classifications: Roughages. energy and protein supplements, minerals and vitamins supplements, feed additives</b>	
<b>10</b>	<b>Nutrient requirement by livestock: --Requirement for maintenance: -Requirement for production (energy, protein, mineral and vitamin requirements)</b>	
<b>11-13</b>	<b>Ration formulation for different species of domestic animals</b>	
<b>14</b>	<b>Feed Manufacturing technology and Feed quality control</b>	
<b>15</b>	<b>- Laboratory examination</b>	



# Introduction to Animal Nutrition

- ✘ **The science of animal nutrition deals with the animal and its feed**
- ✘ **Animals need the proper nutrition for growth and maintenance, and to provide energy for work**



Begait Cattle - Tigray

# Animal Feeds

- × Food consists of Water and Dry Matter (DM). If the water content in food is 75%, the DM content is 25%.
- × Although water is very important, the DM is crucial to the composition of a ration. More food is needed when it contains more water



Senga Cattle - Afar

# Animal Feeds Cont...

- ✘ **Water is vital to any animal. The bodies of young animals may consist up to 80% of their live weight.**
- ✘ **Older, and especially fat animals, have less water in their bodies (down to 50%).**



Begait Goat and Sheep - Tigray

# Importance of animal nutrition

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- × **Nutrition is important for:**
- × **Maintenance, the nutrition required for an animal to maintain its current weight.**
- × **Energy, the ability of the body to perform functions. Proper nutrition is also needed to maintain body temperature, produce milk, reproduce, and develop proper bone structures.**

# Importance Cont...

- ✘ **Without proper nutrition, animals can develop health problems, which could result in treatment costs or even fatality.**
- ✘ **Good nutrition is essential for all of the systems of an animal to function and work together properly.**



Feeding Comparison



# Feed classification

- × **Carbonaceous concentrates (low protein)**
- × **Carbonaceous roughages (low protein)**
- × **Proteinaceous concentrates**
- × **Proteinaceous roughages**
- × **Additive materials:**
  - + **Nutrients and**
  - + **Non-nutrient additives**



# Feed classification cont...

- × **Supplements of vegetable origin**
- × **Supplements of animal origin**
  - + **a. Animal tissue**
  - + **b. Fish products**
  - + **c. Milk products**



Goats and Sheep - Somali

# Definitions of Terms

- × **Common sources of nutrients for agricultural animals include roughages and concentrates.**
- × **Roughages include feed that is high in fiber and low in energy, such as grasses, hays, and silages.**



Senga Cattle - Afar

- × **Concentrates include feed that is high in energy and low in fiber, such as grains.**

# Classification of basic nutrients

- × What nutrients do animals need?
- × There are six major classes of nutrients:
  - × Water
  - × Carbohydrates
  - × Lipids
  - × Protein
  - × Vitamins and
  - × Minerals



Horro Cattle - Oromia

# Classification of basic nutrients

## × Essential Nutrients

- + Water
- + Energy
- + Proteins
- + Minerals
- + Vitamins



Fogera Cattle - Amhara

- × Water soluble (B complex and Vitamin K) => Microbial Synthesis
- × Fat soluble (Vitamin A, D and E ) => External sources
- × Essential fatty acids and minerals => External sources

## × Supplementation for

- + Minerals
- + Vitamins

# Water

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- × **Water is vital for all animals and makes up more than one-half of most animals' bodies! It forms the basis of fluids in the body and is essential for processes such as digestion, blood circulation, and waste elimination.**
  
- × **Water helps dissolve nutrients and also regulates body temperature through perspiration and evaporation.**

# Water Cont...

- ✘ **Animals need a fresh, clean source of water. Most of the water an animal consumes comes from the water it drinks.**
- ✘ **Water also can be obtained from feed sources such as forage. Water is essential, especially for working animals or during hot weather.**



Borana Cattle - Oromia



# Carbohydrates

- × **Carbohydrates are nutrients that provide the main source of energy for body activities**



- × **Carbohydrates provide energy for growth, maintenance, and reproduction. They also help produce body heat for warmth.**



# **Carbohydrates Cont...**

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- × Carbohydrates come from plants and include sugars, starches, and cellulose.**
- × The main sources of carbohydrates in feed are grains such as corn, oats, wheat, barley, rye, and grain sorghum.**
- × Forages and hay are also sources of carbohydrates.**

# Characteristics of common concentrate feedstuffs

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- × **Carbonaceous concentrates (high-energy feeds; mostly feed grains and their by-products. As to NRC nomenclature, these are products containing less than 20% protein and less than 18% fiber.)**
- × **General nutritive characteristics**
- × **High in energy (Total Digestible Nutrient or Net Energy)**
- × **Low in fiber**
- × **Low in protein (in relation to oil seeds and some mill feeds)**
- × **Protein quality is variable and generally quite low**
  - + **Mineral level**
  - + **Vitamin levels**

# Lipids / Fats

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- × **One may not think of fats as being essential, but they are.**
- × **Although fats are needed in small amounts they are a necessary part of the diet.**
- × **Fats provide energy and store excess energy.**
- × **Fats help produce body heat and carry fat-soluble vitamins in the body.**

# Lipids / Fats Cont...

- ✘ Many sources of proteins are also sources of fats.
- ✘ Fats are found in both plants and animals.
- ✘ Plant fats include oils that are within seeds, which are the main source of fats in agricultural feeds.



Borana Cattle - Oromia

# Protein

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- × **Protein is made up of amino acids that are necessary for healthy animals.**
- × **Amino acids are the building blocks of protein and are used for the formation of tissues and muscle production.**
- × **Protein is needed for healthy growth, reproduction, and maintenance.**

# Protein Cont...

- ❑ **Protein can be obtained from both plant and animal sources. Plant proteins are more common in livestock feeds and include soybean, cottonseed, linseed, peanut, and sunflower seed meals. Protein also can be obtained from legume hays such as alfalfa or clover.**
- ❑ **Legumes are plants that produce or fix their own nitrogen. Sources of animal protein include tankage, fish meal, meat scraps, and milk products.**



# Protein Cont...

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- × **Animals need different amounts of protein, depending on their needs. For example, young, growing animals need more protein than older animals.**
  
- × **Protein is often the most expensive ingredient in feed. Crude protein refers to the total amount of protein in a feed while digestible protein is the protein that can be digested and used by an animal.**

# Vitamins

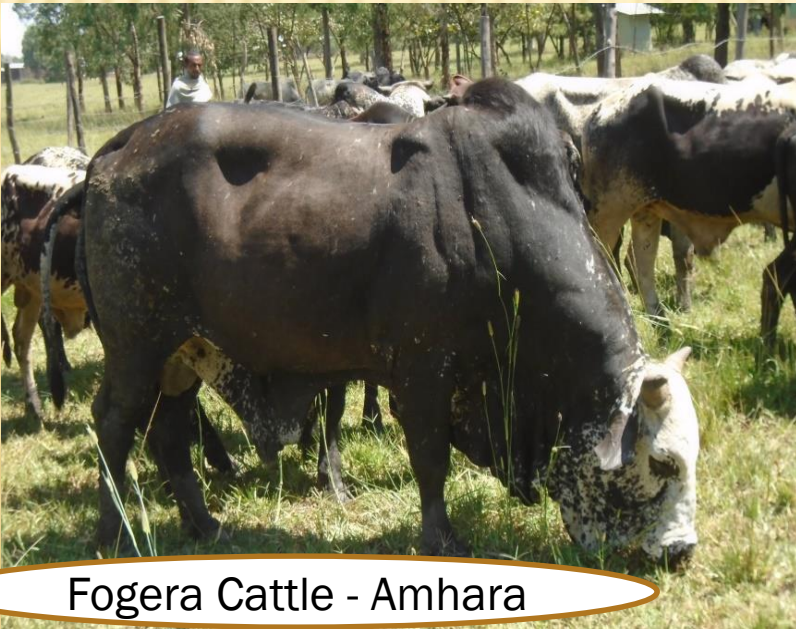
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- × **Vitamins are essential for normal body functions such as digestion, cell metabolism, growth, and reproduction.**
- × **Like minerals, they are also needed in relatively small quantities.**
- × **Vitamins help in tooth and bone formation, assist the body in fighting stress, and prevent infection in the body.**



# Vitamins Cont...

- × **Vitamins can be obtained from many different sources such as forages, hay, and cereal grains.**
- × **Just as in minerals, it is important for the producer to provide the appropriate vitamins.**



Fogera Cattle - Amhara



# Vitamins Cont...

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- × **B-complex vitamins are necessary for growth and reproduction.**
- × **The B-complex vitamins include thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, benzoic acid, choline, and B-12.**
- × **The B-complex vitamins help many body functions such as red blood cell maturation (vitamin B-12) and energy metabolism (riboflavin).**

# Vitamin Deficiencies

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- × **Abnormal bone growth**
- × **Decreased milk production**
- × **Decreased appetite**
- × **Diarrhea**
- × **Digestive disturbances**
- × **Excessive watering of the eyes**
- × **Impaired vision**
- × **Increased susceptibility to infections**
- × **Loss of hair**
- × **Poor blood clotting**
- × **Poor coordination**
- × **Poor growth**
- × **Poor hair coat**
- × **Poor hoof growth**
- × **Reproductive problems**
- × **Respiratory illness**
- × **Rickets**
- × **Scurvy**
- × **Unthrifty appearance**
- × **Weakness**

# Minerals

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- ✘ **Minerals provide material for growth of bones, teeth, and tissue and also help regulate many of the body's chemical processes.**
- ✘ **Minerals also help in muscular activities, reproduction, tissue repair, and body heat.**
- ✘ **Although mineral intake may account for a small portion of the total diet, it is essential.**
- ✘ **Minerals can be categorized as macrominerals or microminerals.**
- ✘ **Macrominerals are needed in larger amounts by the body, and microminerals are needed in smaller amounts.**
- ✘ **Macrominerals include calcium, chlorine, magnesium, phosphorus, potassium, sodium, and sulfur.**

# Minerals Cont...

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- ✘ **Microminerals include chromium, cobalt, copper, fluorine, iron, iodine, manganese, molybdenum, nickel, selenium, silicon, and zinc.**
- ✘ **Minerals are often added to animal feed or fed free choice, which means animals are able to access at any time.**
- ✘ **For example, salt and mineral blocks are fed free-choice where animals are able to lick them anytime they want.**
- ✘ **Animals may be able to tolerate minerals in excess of recommended quantities; however, excess minerals in some species can cause toxicity, even leading to death. Producers should always ensure that minerals are given in the appropriate amount to animals.**

# Minerals Cont...

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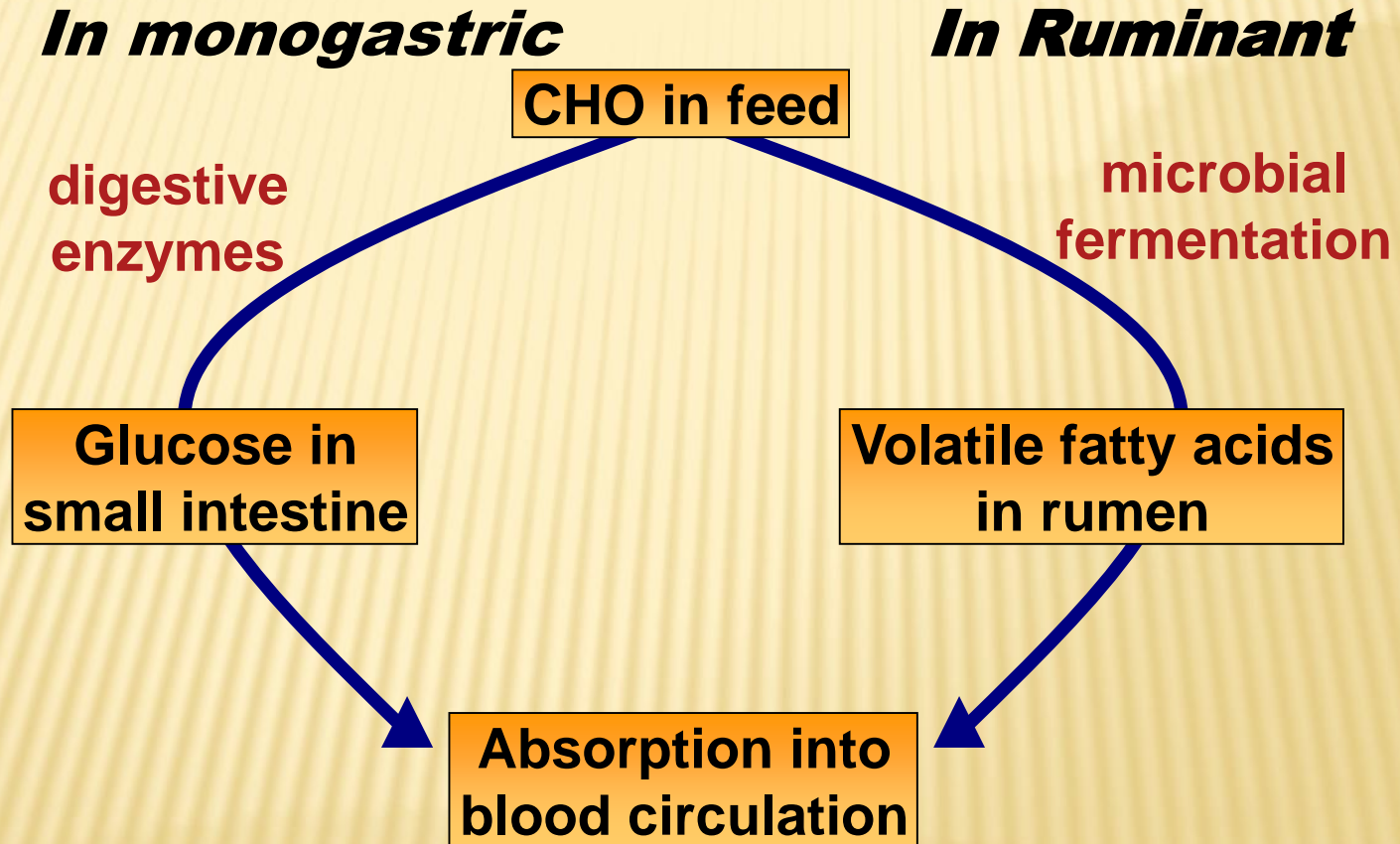
- ✘ **Sheep are susceptible to copper toxicity, which can lead to death.**
- ✘ **Symptoms of copper toxicity in sheep include lethargy, anemia, pale membranes, thirst, and jaundice.**
- ✘ **Excess of some minerals can cause weight loss and slower rates of gain in some animals.**
- ✘ **Hogs that are given excess minerals may have slower gains, and cattle that have an excess of sodium and chloride can have reduced milk production and weight loss.**
- ✘ **Selenium toxicity in horses can cause appetite loss,**

# Mineral Deficiencies

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- × **Abnormal bone growth**
- × **Anemia**
- × **Decreased growth**
- × **Decreased milk or wool production**
- × **Deformed bones**
- × **Enlarged thyroid gland**
- × **Heart failure**
- × **Lameness**
- × **Loss of hair**
- × **Milk fever**
- × **Paralysis**
- × **Poor feed efficiency**
- × **Poor hair coat**
- × **Reduced feed intake**
- × **Reproductive problems**
- × **Rickets**
- × **Skin disorders**
- × **Stiffness in the joints**
- × **Unthrifty appearance**
- × **Weakening of the bones**

# Digestion, absorption, and metabolism of nutrients





# Carbohydrate digestion in ruminants

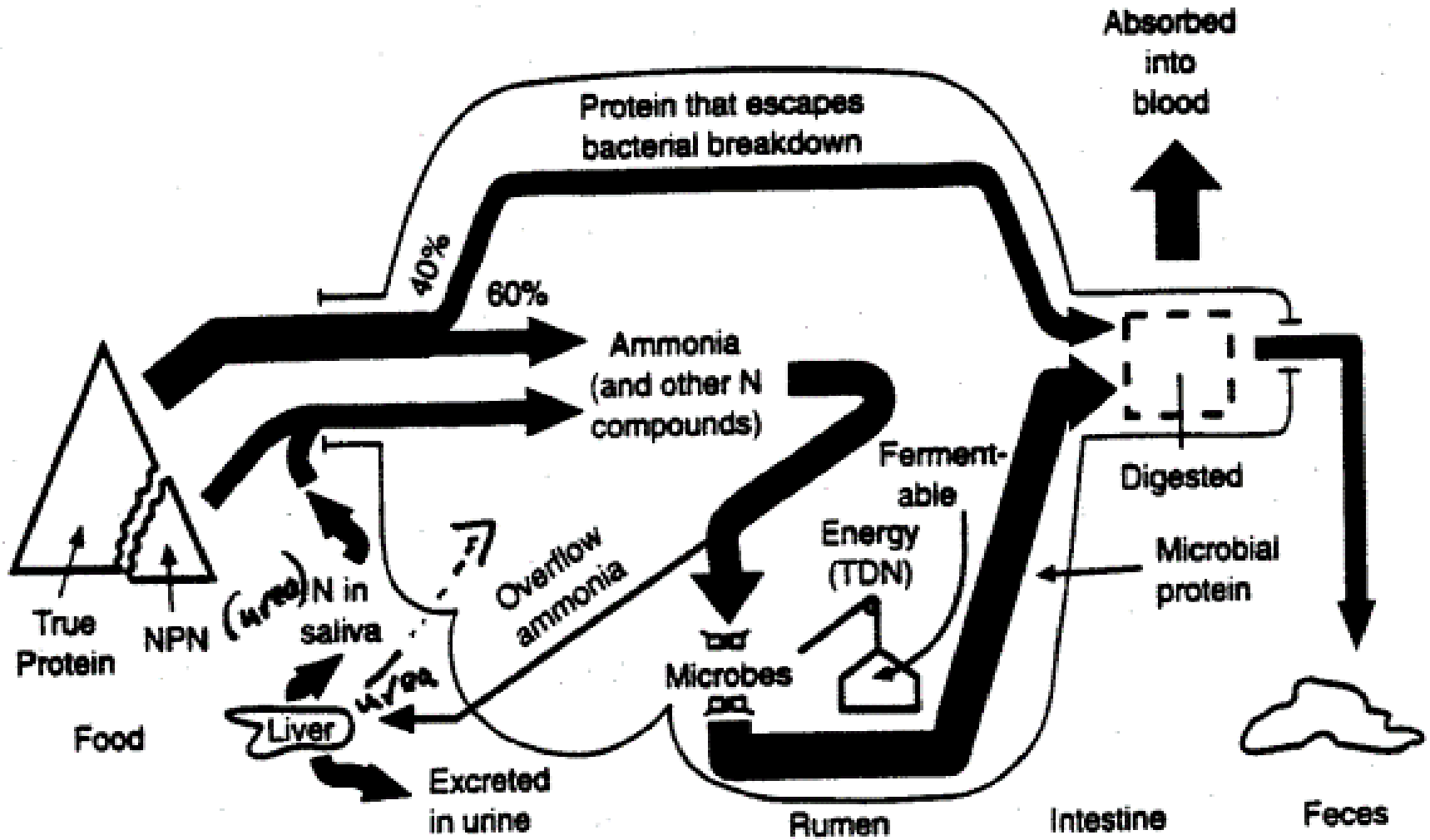
- ✗ **Ingested carbohydrates are exposed to extensive pre-gastric fermentation**
- ✗ **Rumen fermentation is highly efficient considering the feedstuffs ingested**



Begait Cattle - Tigray

- **Most carbohydrates fermented by microbes**

# Protein digestion and absorption in ruminants



# Overview monogastric carbohydrate digestion

<u>Location</u>	<u>Enzymes</u>	<u>Form of Dietary CHO</u>
<b>Mouth</b> <b>Sucrose</b>	<b>Salivary Amylase</b> <b>Lactose</b>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">↓</div> <div style="text-align: center;">↓</div> <div style="text-align: center;">↓ <b>Starch</b> ↓</div> <div style="text-align: center;">↓ <b>Maltose</b> ↓</div> <div style="text-align: center;">↓</div> </div>
<b>Stomach</b>	<b>(amylase from saliva)</b>	<b>Dextrin → Maltose</b> ↓
<b>Small Intestine</b>	<b>Pancreatic Amylase</b>	<b>Maltose</b> ↓
	<b>Brush Border Enzymes</b>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <b>Glucose</b> + <b>Glucose</b> </div> <div style="text-align: center;"> <b>Fructose</b> + <b>Glucose</b> </div> <div style="text-align: center;"> <b>Galactose</b> + <b>Glucose</b> </div> </div>
<b>Large Intestine</b>	<b>None</b>	<b>Bacterial Microflora Ferment Cellulose</b>

# Rumen fermentation

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- × **Gases (carbon dioxide and methane) are primary byproducts of rumen fermentation**
- × **Usually these gases are eructated or belched out**
  - **if not, bloat occurs**
- × **Bloat results in a severe distension of the rumen typically on the left side of the ruminant and can result in death**

# Uses of Volatile Fatty Acids (VFAs)

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- × **Acetate**

- + **Energy**
- + **Fatty acid synthesis**

- × **Propionate**

- + **Energy**
- + **Gluconeogenic – glucose synthesis**

- × **Butyrate**

- + **Energy**
- + **Rumen epithelial cells convert to ketone (beta hydroxybutyrate)**

***Proportions produced depends on diet***

# Absorption of VFAs

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- × **All simple passive diffusion**
- × **VFA metabolism in the rumen wall**
  - + **Cells use most of the butyrate for their own energy needs**
  - + **Acetate and propionate are 'exported' to blood**

# Metabolism of VFAs

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## × Overview

- + **Acetate and butyrate are the major energy sources (through oxidation)**
- + **Propionate is reserved for gluconeogenesis**
- + **Acetate is the major substrate for lipogenesis**
- + **Propionate is also lipogenic (through glucose)**

# FUNCTIONS OF A GOOD RATION

- ✘ **Maintenance of vital body processes to keep animal alive**
- ✘ **Growth by increasing the size of bones, muscles, organs, and connective tissue**
- ✘ **Fattening by storing nutrients not used for maintenance, growth, or other functions**





# Function Cont...

- × **Production of milk, meat, eggs, wool, hair, etc**
- × **Reproduction- adequate nutrition is necessary**
- × **Work-other needs are met before nutrients are available for work**
- × **From 1/3 to 1/2 of the ration fed is used for maintenance**



# FEED TYPES

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- × **Roughages**
- × **Feeds that contain more than 18% crude fiber when they are dry**
  
- × **Example: hay, pasture grasses, silage, hulls, straw, fodder**



# Protein supplement



# CONT...

## Concentrates

- × Feeds that contain less than 18% crude fiber when they are dry
  
- × Examples:
  - + Grains- corn, oats, barley, wheat
  - + Processed by products- wheat bran
  - + Liquid supplements:
    - × molasses, urea
  - + Animal/Plant proteins



Black Head Ogaden Sheep Somali

# Characteristics of a good ration

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## × **Balanced**

- + **has all nutrients needed in the right amounts and proportions**

## × **Palatable**

- + **tastes good so that animals will eat it**

# CONT...

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## Low cost

- × **Best nutritional value possible at lowest cost**
- × **Feed costs are about 75% of the total costs of raising livestock**



# CONT...

- ✘ **Not harmful to health or quality of animal products**
- ✘ **Proper proportions of concentrates and roughages for type and age of animal**
- ✘ **Uniformly mixed especially micro-nutrients and feed additives**



Abigar  
cow  
Ethiopia/Sudan

# General principles

- ✘ **Nutrients in the ration should be balanced to meet animal's needs at the least expense**
- ✘ **The ration should include a variety of feeds to be palatable and to make it easier to balance**





# CONT...

- ✘ **Should be succulent to make it fresh and appealing and more palatable**
- ✘ **Should be palatable or agreeable to the taste in order for animals to eat it**



# For stall feeding



Begait Heifer

# Feed to the animals

- ✘ **Be bulky to satisfy hunger and to help the digestive system function properly**
- ✘ **Slightly laxative to improve feed efficiency and to prevent constipation**



Not Animals to the Feed

# CONT...

- × **Be economical**
  - + **Price per unit of energy and digestible protein determine if ration is economical**
- × **Should be suited to the species and age of animal**
  - + **More roughages for cattle,**
  - + **more concentrates for swine/poultry**
  - + **higher protein for younger animals**



# 100% DRY MATTER BASIS

× All moisture removed from feed

× Formula

+ **Kg of feed on 100% dry matter basis = Kg of feed on as-fed basis X % of dry matter in feed**



# Rules in beef cattle rearing

- ✘ **Fattening ration should include 1.5 - 2 kg of air-dried roughage and 2 kg of concentrate per 100 kg of body weight**
- ✘ **Cows nursing calves should be fed about 50% more than dry cows**



# Thank You



Feed and respect them, They will respond