Objective

• To introduce the basic concepts and principles of dairy cattle digestion system and nutrient metabolism feeding and nutrition.

• To learn about the basic requirements, structure and biochemical function of the major nutrients in cows.

• Apply your knowledge of nutrients required by dairy cows to basic ration formulation and feeding on the farm.

Nutrition, Feed, and Feeding

• Ruminant:
  • Multi compartment stomach
  • Ability to digest Fiber
  • Stomachs contains billions of bacteria and protozoa (microbes)
Ruminant Stomach

- Reticulum
- Rumen (reticulo-rumen)
- Omasum
- Abomasum

Digestion

- Process whereby proteins, fats, and complex carbohydrates are broken down into absorbable size
  - Done by digestive enzymes

- Oral digestion
  - Prehension
  - Mastication
  - Deglutition

Oral Digestion

- Teeth aid in digestion
  - Tear and grind food, increasing surface area
  - Only in lower jaw (herbivorous)
- Tongue aids in regurgitation and mastication
  - Elongated, rough papillae
  - Brings food in, mixes food, initiates deglutition (swallowing)
Oral Digestion

- Three pairs of salivary glands
- Salivary glands aid in mastication, formation of bolus, and swallowing
  - Acts as surfactant
  - Buffers the ingesta & enzymes in the rumen
  - Secrete as much as 8-10 gallons daily

Fig 11-2. A diagrammatic representation of the location of the main salivary glands (Courtesy of M.E. Ensminger)
Reticulum (Honeycomb)

Front of the Rumen
Capacity ~ 13 quarts
No digestive enzymes

Functions:
• Regurgitation of food
• Collection of foreign objects
  • Hardware disease
  • Feeding magnets

Fig 11-4. An inside view of the ruminant stomach compartments, clearly showing the honeycomb arrangement of the reticulum (Courtesy of Mark Kirkpatrick)

Rumen

Behind Reticulum
Capacity ~ 45 gallons
No digestive enzymes
Papillae >> finger like projections

General functions
• Storage
• Break down large particles
• Microbial fermentation
Rumen

• Microorganisms break down cellulose to:
  Volatile Fatty Acids (VFA)
  - Acetate C—C 65%
  - Propionate C—C—C 20%
  - Butyrate C—C—C—C 15%

• Digestion of starches, sugar, proteins, and breakdown some fats

Rumen capacity of a 1200 lb. Cow = 300 lbs !!
Omasum

- Right side of the Rumen
- Capacity ~ 15-20 quarts
- No digestive enzymes

**General functions**
- Grinding of feed particles
- Water absorption

Abomasum

- True Stomach
  - Site of gastric juice production (HCL)
  - Site of protein digestion and amino acid absorption
  - Breakdown to peptides and amino acids by the enzyme pepsin
Small Intestine

- ~ 135 Ft. Long in a mature cow!
- Three parts:
  - Duodenum (secretory in nature)
  - Jejunum
  - Ileum
- Functions:
  - Degradation of protein and peptides into AA’s
  - Degradation of starches and CHO’s into Glucose
  - absorption

Digestion

- Large intestine: cecum and colon
  - Muscular, water absorption in colon
  - Cecum in cattle insignificant
Rumen and VFA

- Acetate
  - Building block of FAT in the mammary gland

- Propionate
  - Building block of GLUCOSE and thus MILK SUGAR>>>>> LACTOSE

- Butyrate
  - 4C, building block of Fat (becomes two 2C)

Feed and Feeding

Dairy cattle Nutrition
**Nutrient Requirements**
**(lactating cow)**

- **Water**
  - 3-4 units of H2O for each unit of Dry matter
  - 15-25 gallons

- **Energy**
  - Carbohydrates, dietary fat
  - Provide glucose for energy production and milk sugar
  - > half of dry matter intake (> 20 lbs as DM basis!!)

**Nutrient Requirements**
**(lactating cow)**

- **Protein**
  - Supply of amino acids
  - Body growth, repair, hormone, milk proteins
  - ~ 15-18% of dry matter intake
  - ~ 5-10 lb. Crude protein /day

- **Minerals and Vitamins**

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**Everything is about dry matter (DM)**

- Feed fraction that contains all of the nutrients except water

\[
\%DM = \frac{\text{Dry Weight}}{\text{Wet Weight}} \times 100
\]

Dry matter intake is always less than as fed intake!
How much feed does a cow eat?

• ~ 3.5% of the body weight in DM basis for avg milk yield of ~ 60-80 lb

• Feeding TMR ~1.2 lb. Feed for every lb of milk

Dry Matter Intake Guides

1. 1lb of DM ↑ milk yield 2 - 2.5 lb

2. 13 pounds of DM for maintenance

Typical Cow Ration

• Forages:
  – Alfalfa hay or alfalfa silage
  – Corn silage
  – Orchard grass hay

• Energy feed
  – Corn grain, oats, barley, oats, beat pulp

• Protein feed (concentrate)
  – Soybean, Linseed meal, Cotton seed
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>%</th>
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<tbody>
<tr>
<td>DMI (% BW)</td>
<td>3.2</td>
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<tr>
<td>NEL (Mcal/lb)</td>
<td>0.71</td>
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<tr>
<td>Crude Protein (CP) % DM</td>
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<tr>
<td>ADF, %</td>
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<tr>
<td>NDF, %</td>
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<tr>
<td>Forage NDF, %</td>
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<tr>
<td>NFC, % Max</td>
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<tr>
<td>Crude fat, %</td>
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</tbody>
</table>

Forage : Concentrate → 60%:40%