Dietary Protein

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Some slides adapted from Dairy Nutrition & Management (ANSCI 200/492), University of Illinois at Urbana-Champaign, Dr. Mike Hutjens & Jimmy Clark

Protein is Required for:

Supply nitrogen to microbial protein synthesis (i.e., microbial growth)
- **Ammonia**
- **Amino acids**
- **Peptides**

Supply amino acids for synthesis of:
- **Milk protein**
- **Tissue protein**
- **Enzymes, hormones, etc.**

Supply carbon skeletons for glucose synthesis (minor role)

Crude Protein Requirement

pregnant, nonlactating	1.1 kg/day
lactating, nonpregnant	4.4 kg/day
Increase for lactation	3.3 kg/day or 300% increase

600 kg cow; milk yield of 88 #/d of 3.5% FCM

Rumen Degradable Protein (RDP)

1. Rapidly degraded in rumen (NRC, 1989)

Alfalfa Silage	**77%**
Barley	**73%**
Soybean meal	**65%**

2. RDP in diet should be:

- **10 - 12% of dry matter**
- **60 - 66% of CP**

Soluble Protein

1. Crude protein that goes into solution
   - NPN
   - Peptides
   - Protein
2. Protein that is readily available
3. Examples of feeds high in soluble CP
   - Urea 100%
   - Wet Silage 45%
   - Raw Soybeans 40%
4. Soluble CP & degradable CP are not the same
5. Soluble CP in diet should be (Cornell Model)
   - 1/2 of RDP
   - 5 - 6% of Dry Matter
   - 28 - 32% of CP

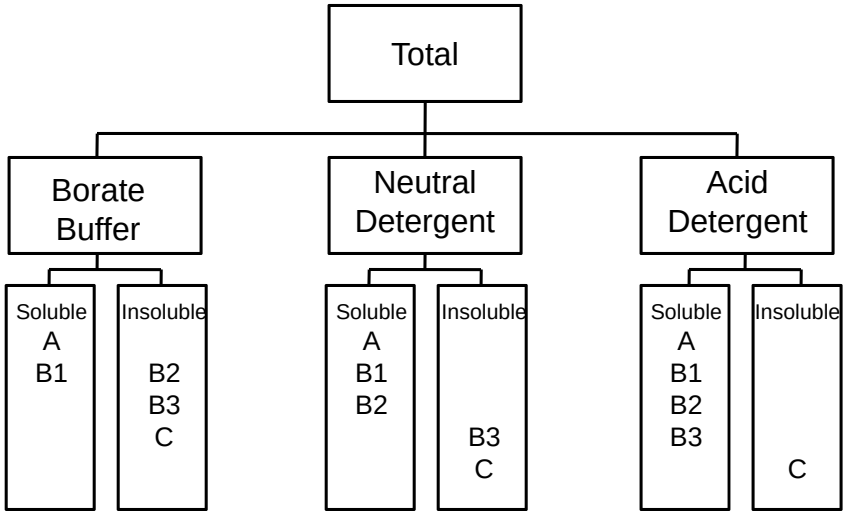
Rumen Undegradable Protein (RUP)

1. Protein not degraded in rumen
2. Examples of feeds with high RUP (NRC,1989)
   - Blood meal 82%
   - Fish meal 60%
   - Corn gluten meal 55%
   - Corn grain 52%
   - Protected amino acids 100%?
3. Feed protein digested in small intestine
4. RUP in diet should be:
   - 5 to 7% of dry matter
   - 34 to 40% of CP

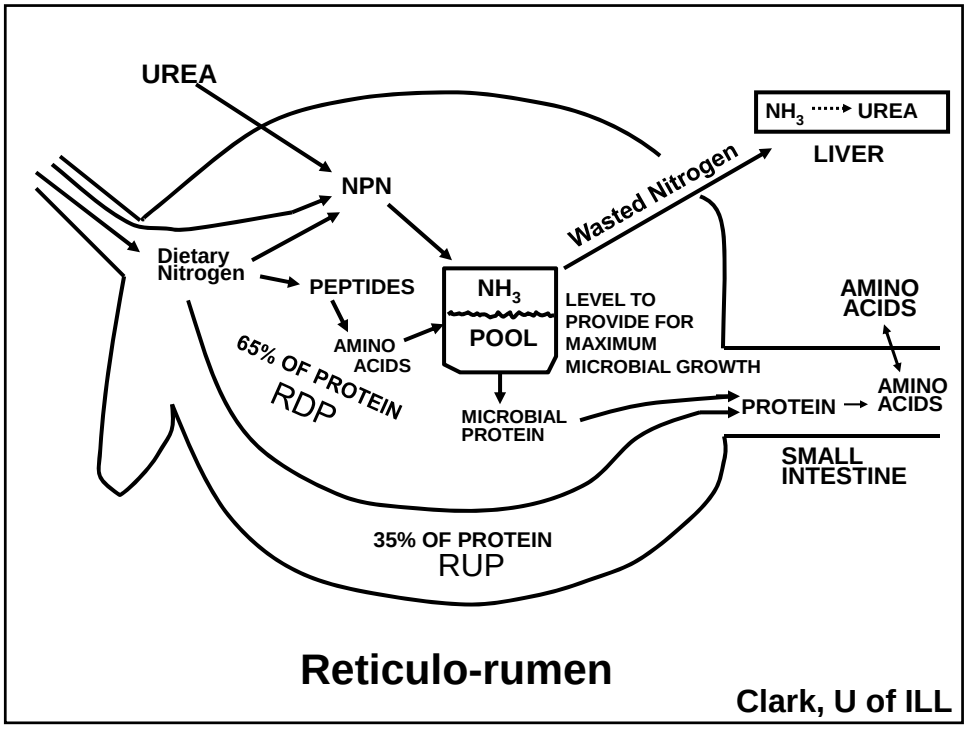
General Recommendations for Concentrations of Protein in Dairy Cow Rations

- 16-18% CP, % DM
- 56-64% RDP, % CP
  - 28-32% Soluble CP, % CP (50% RDP)
- 36-44% RUP, % CP

CP Fraction Analysis



Roe et al. (1990), Sniffen et al. (1992)



Feed protein

– RDP → AA

– NPN → NH_3 → bacteria

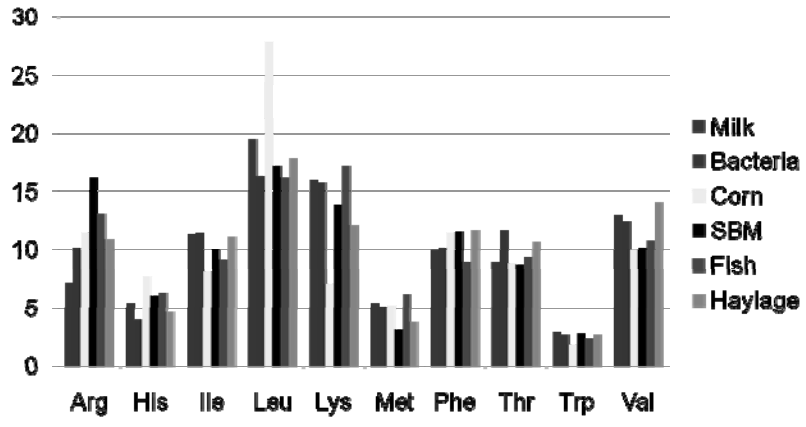
– RUP → SI → peptides → AA for cow

AA=amino acid; SI=small intestine

Microbial CP

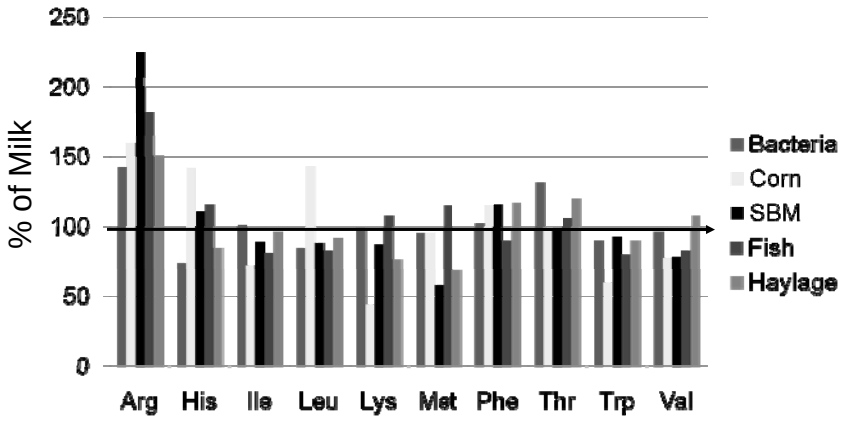
- **~50% CP, of which 80% is AA**
- **~60% of non-ammonia N reaching the SI**
- **very high quality (resembles casein)**
- **diet has little influence on quality (AA profile) of microbial CP**
- **∴ RUP sources are important in protein quality reaching SI**

EAA Profiles of Milk and Feeds



Clark et al. (1992)

EAA in Feeds Relative to Milk



Clark et al. (1992)

Goals of Protein Nutrition

- **Maximize microbial protein synthesis**
- **Provide RUP to small intestine**
- **Assure high absorption of protein reaching small intestine**
- **Absorbed protein should be high quality (AA profile)**

What drives microbial protein synthesis?

- **NRC estimates daily microbial protein using energy intake**
  - **MCP(g) = 6.25 * [-30.93 + (11.45*Mcal/d)]**
  - **ex) 1.7 Mcal/kg, 18% CP diet, 26 kg/d DMI**
    - **1.7 Mcal * 26 kg = 44.2 Mcal/d intake**
  - **6.25*[-30.93 + (11.45*44.2)] = 2970 g = 6.5 #**

Lack of beneficial production responses when rumen undegradable proteins (RUP) or protected amino acids are fed may be attributed to:

1. **Feeding larger amounts of dietary CP than required by the cows.**
2. **Supplemental protein supplies only a small proportion of the total dietary protein that escapes ruminal degradation.**
3. **A shortage of degradable protein in the diet.**
4. **Decreased microbial protein synthesis because of low ruminal availability of N, energy, or other factors.**

Lack of beneficial production responses may be attributed to:

5. **Not supplying the limiting amino acids to the absorption sites in the intestine.**
6. **Low digestibility of protein passing to the small intestine.**
7. **Feeding only one protein supplement that creates an amino acid imbalance.**
8. **Energy, rather than protein & amino acids, was limiting milk & milk protein synthesis.**
9. **Feeding rumen undegradable protein at an improper stage of lactation.**
10. **Mobilization or utilization of nutrients from body tissue, which prevents a nutrient deficiency.**

Advantages for ruminally protected amino acids

1. **RPAA can substitute for ruminally undegradable protein**
2. **More space in ration for other nutrients**
3. **Opportunity to balance supply of absorbable amino acids**
4. **Environmentally friendly (reduce N pollution of surface and ground water)**

Disadvantages for ruminally protected amino acids

1. Cannot accurately predict response
2. Cost