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**
- **……**
- **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

1300# 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:

…… of dry matter

…… 60 - 66% of CP

Soluble Protein (part of RDP)

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%

Soluble Protein (part of RDP)

4. Soluble CP & degradable CP are not the same

5. Soluble CP in diet should be (CPM)
   - ..... 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%?

Rumen Undegradable Protein (RUP)

3. Feed protein digested in small intestine

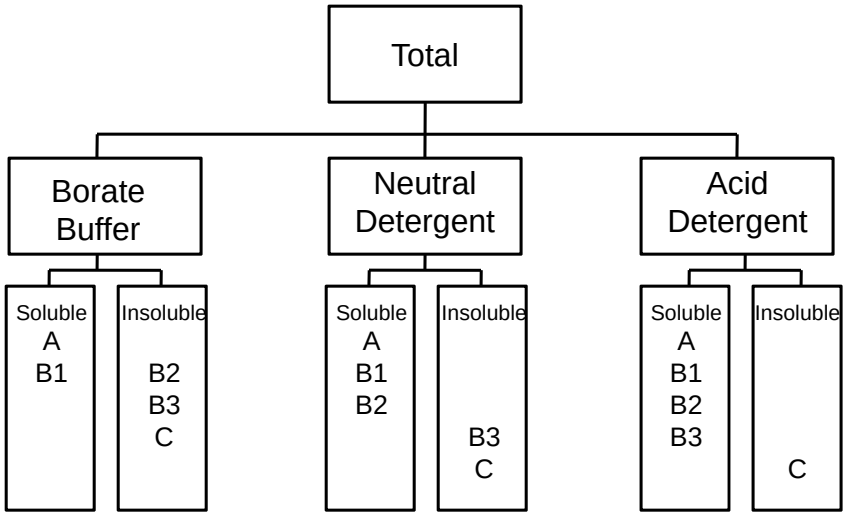
4. RUP in diet should be:
5 to 7% of dry matter

…… of CP

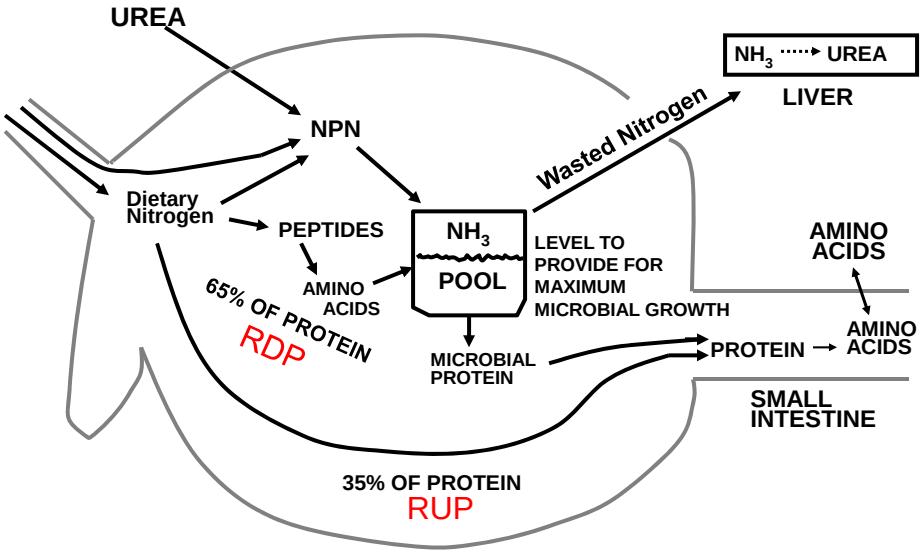
General Recommendations for Concentrations of Protein in Dairy Cow Rations

- ..... % 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)



Reticulo-rumen

Clark, U of ILL

Feed protein

– RDP → AA

– NPN → NH_3 → bacteria

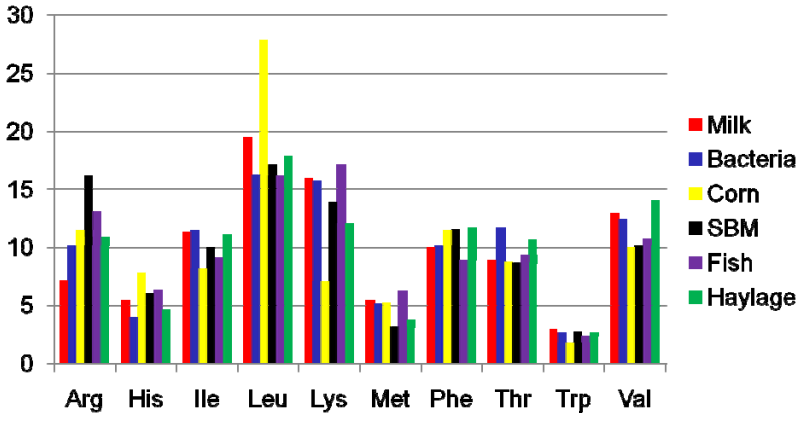
– RUP → SI → peptides → AA for cow

AA=amino acid; SI=small intestine

Microbial CP

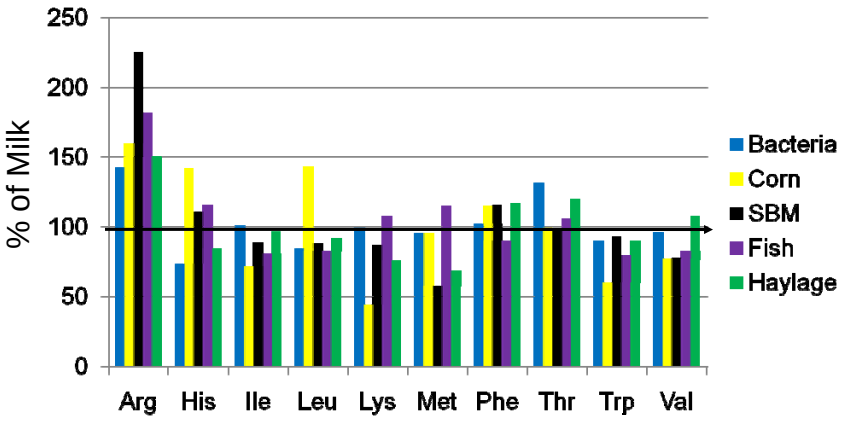
- ~50% CP, of which 80% is AA
- ~60% of non-ammonia N reaching the SI
- very high quality (resembles casein)
- diet has little influence on quality (AA profile) of microbial CP
- ∴ RUP sources are important in protein quality reaching SI

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**
  - **Maximize fermentation!!**
- **Assure high absorption of protein reaching small intestine**
  - **Avoid heat damaged protein (unavailable)**
- **Provide …….. to small intestine**
- **Absorbed protein should be high quality (AA profile)**

What drives microbial protein synthesis?

- **NRC estimates daily microbial protein production (MCP) 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 #**

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. **……**

Disadvantages for ruminally protected amino acids

1. Can one accurately predict when beneficial?
2. Cost

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.
   - Reduce total CP to <18%; suggested target = 16%
2. Supplemental protein supplies only a small proportion of the total dietary protein that escapes ruminal degradation.
   - Imbalance of RDP to RUP

Lack of beneficial production responses may be attributed to:

3. **Decreased microbial protein synthesis because of low ruminal availability of N, energy, or other factors.**
4. **Not supplying the limiting amino acids to the absorption sites in the intestine.**
   - **poor biological value of protein reaching small intestine**

Lack of beneficial production responses may be attributed to:

5. **Low digestibility of protein passing to the small intestine.**
   - **unavailable heat damaged protein**
6. **Energy, rather than protein & amino acids, limiting milk & milk protein synthesis.**

   ALMOST ALWAYS TRUE!!