

# Brief Overview of Nutrition

August 8, 2016

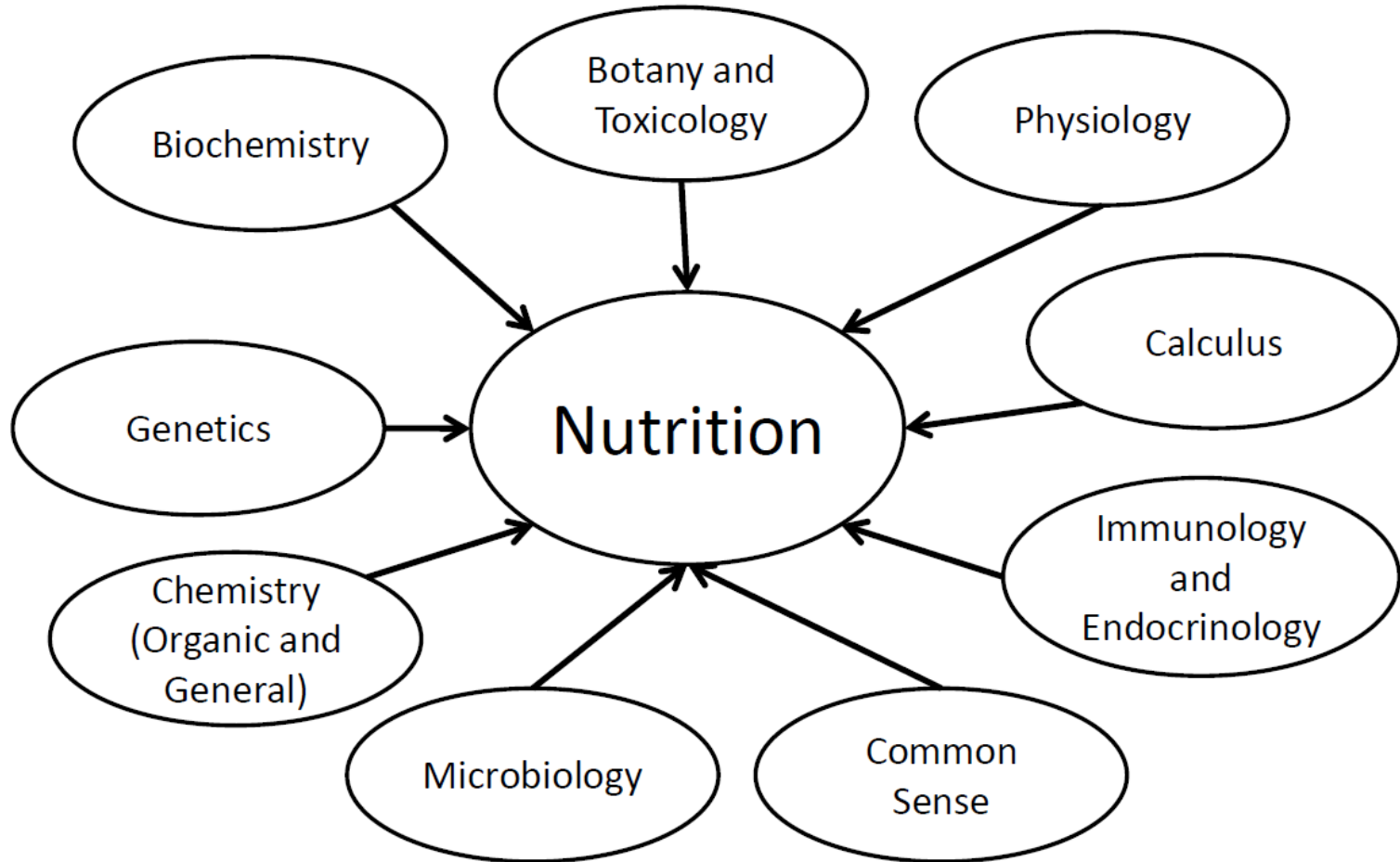
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# Overview of Presentation

- What is nutrition?
- Physiology
- Composition
- Tannins plus
- Energy
- Nitrogen
- Microbiology
- Questions

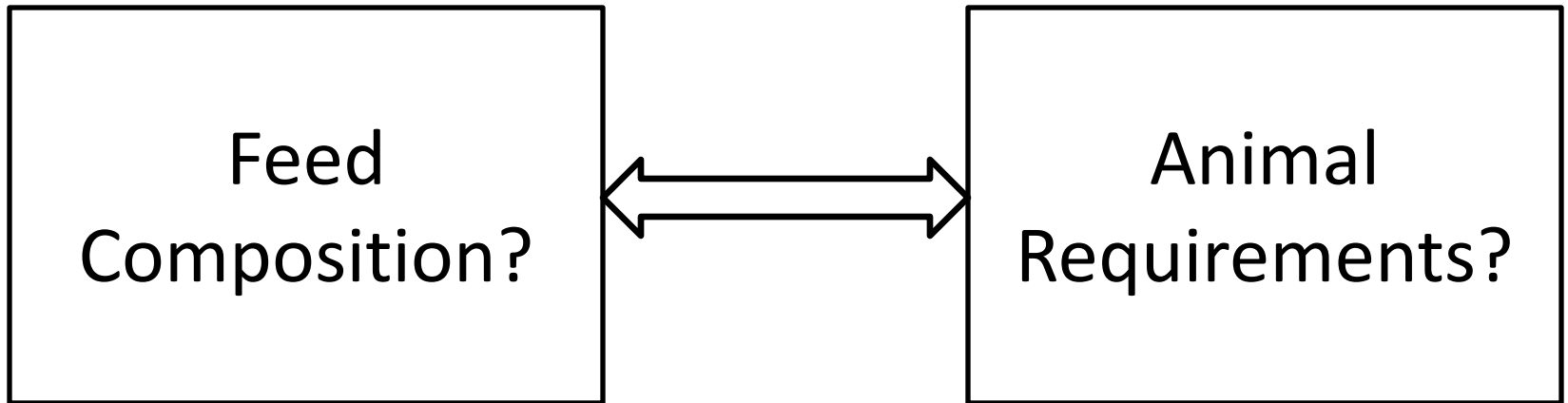
# What is nutrition?



# What is nutrition?

- The study of the food and liquid requirements of human beings or animals for normal physiologic function, including needs for energy, maintenance, growth, activity, reproduction, and lactation.

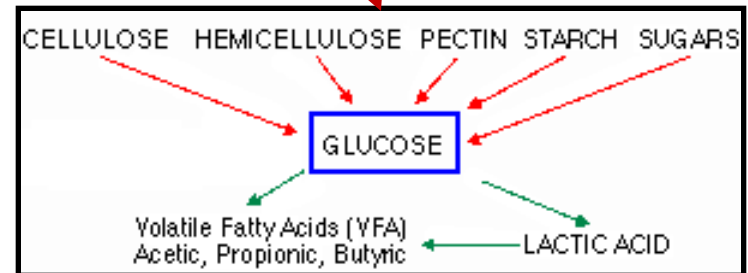
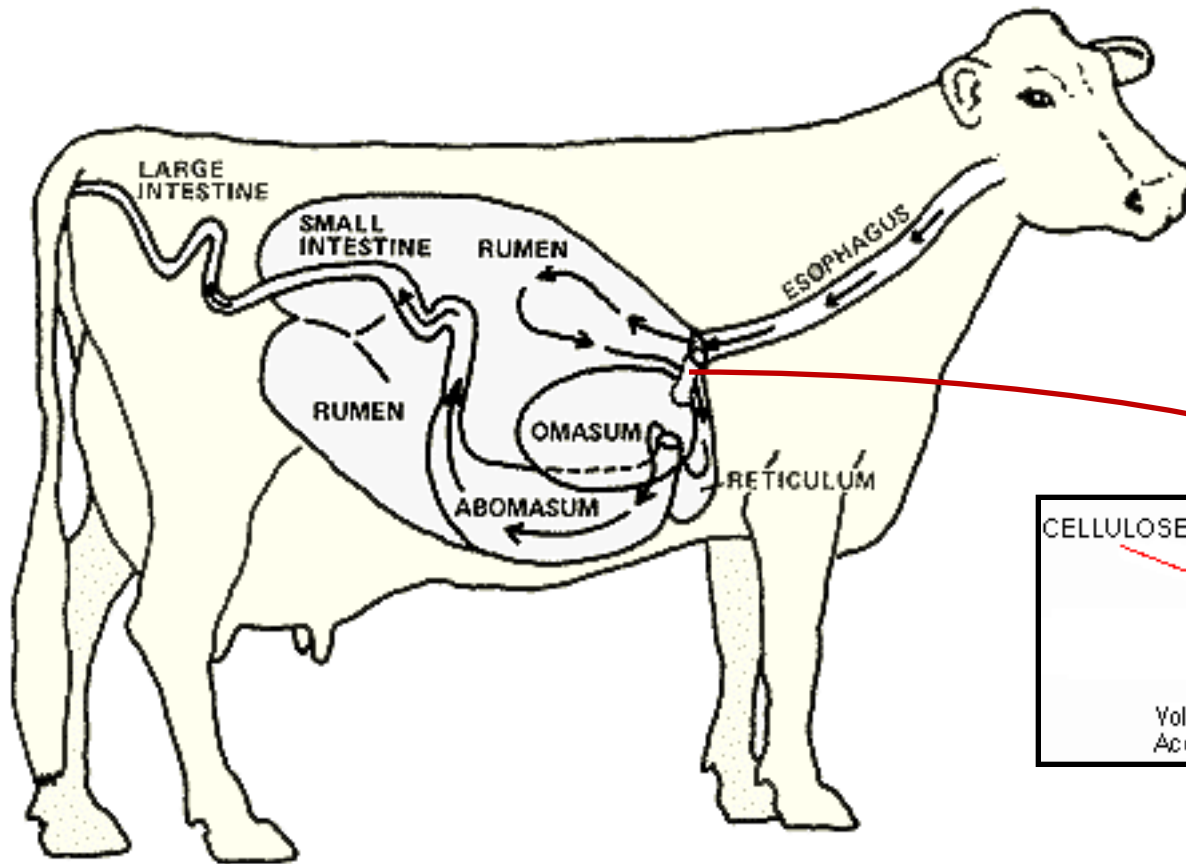
# What are nutritionist always asking?



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# Physiology

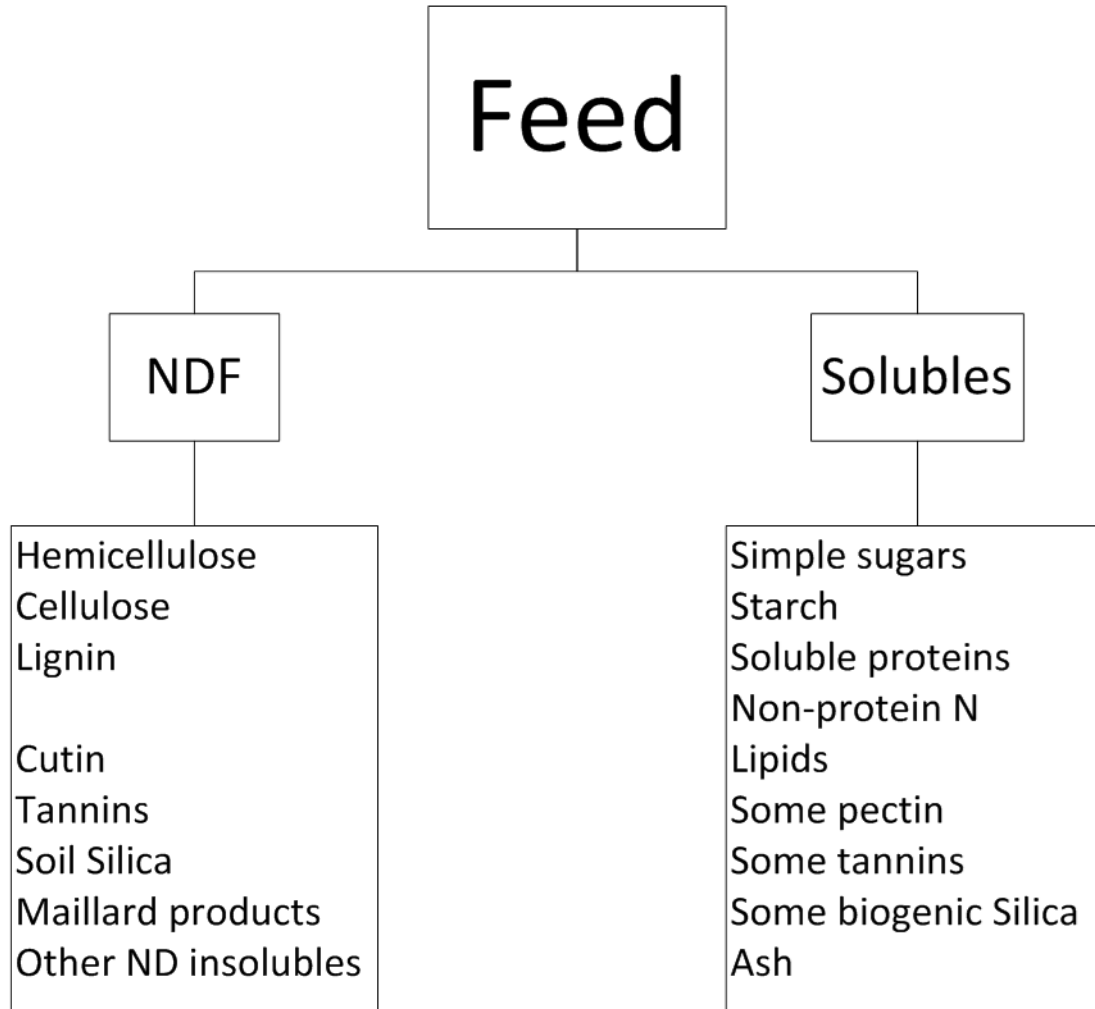


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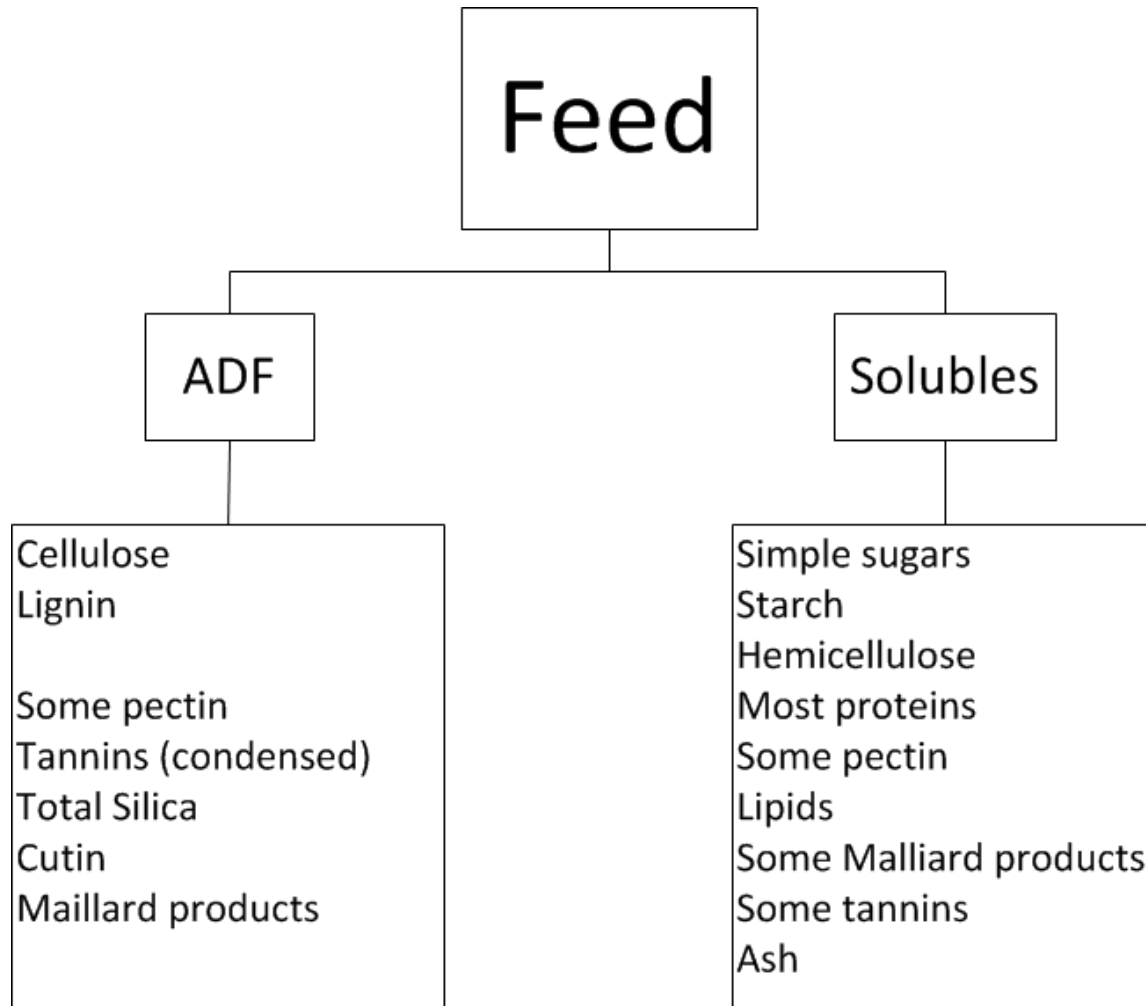
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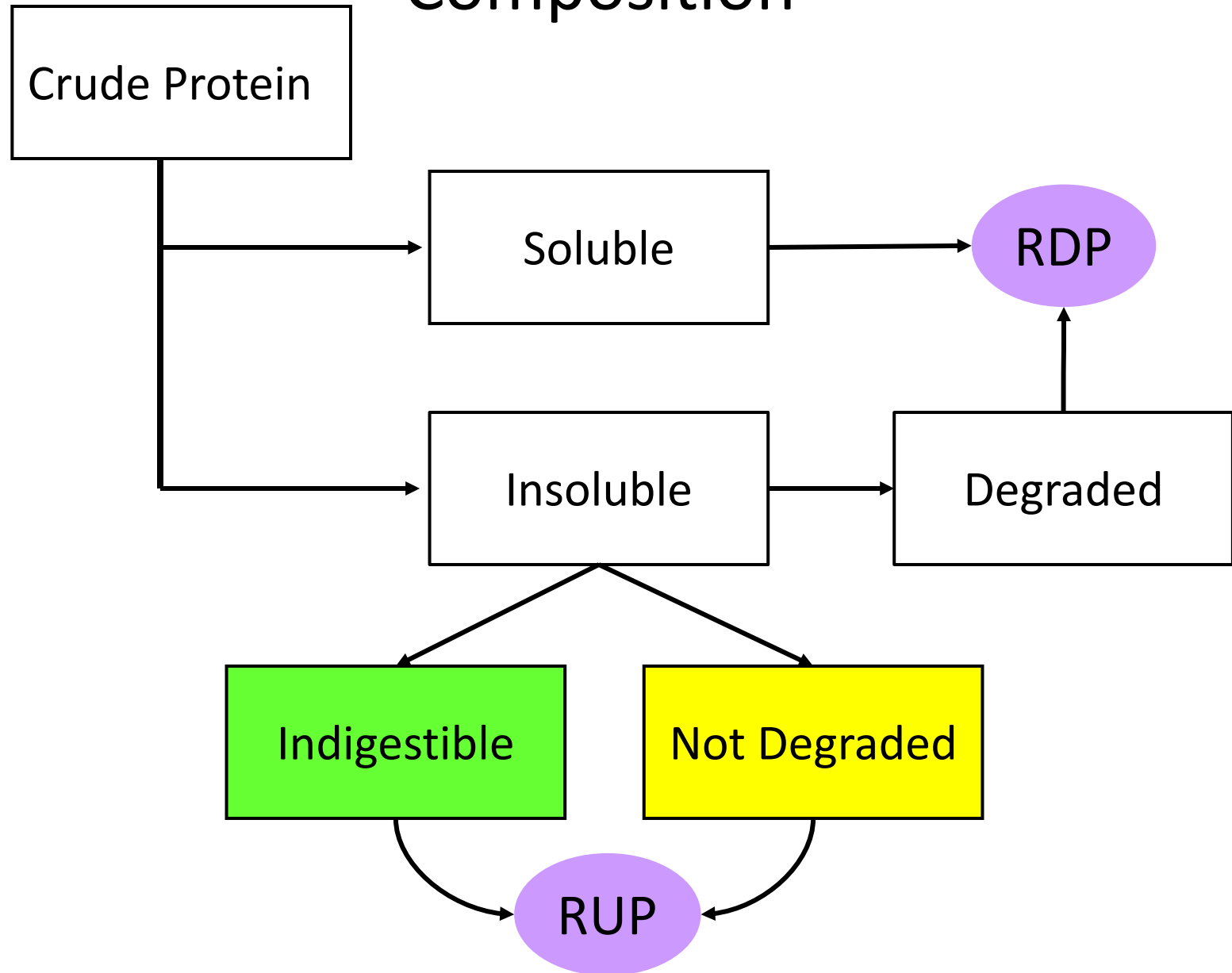
# Composition



# Composition



# Composition



# Composition

- Ether Extract: ~65% of EE of forage is utilized by animal
  - Fatty acids: utilized by animal
  - Non-fatty acids: typically not utilized by animal
    - Wax
    - Chlorophyll
    - Galactose
    - Other unsaponifiable fat

# Composition

- Two plants have exactly the same NDF, ADF, Crude Protein and Ether Extract
  - Do they have the same nutritive value?

# Composition

What is one of the most important aspects in managing range land?

# Composition

	Temperature	Light	Nitrogen fertilizer	Water supply	Defoliation harvest
Yield	+	+	+	+	-
Water-soluble carbohydrate	-	+	-	-	+
Nitrate	-	-	+	NA <sup>a</sup>	NA
Cell wall	+	-	±	+	-
Lignin	+	-	+	+	-
Digestion	-	+	±	-	+

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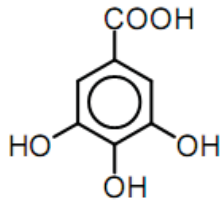
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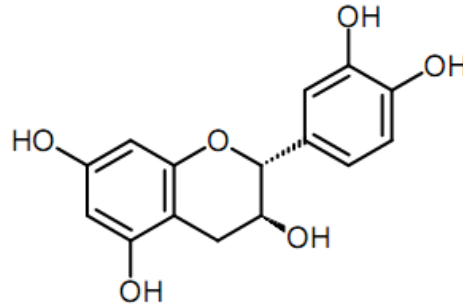
# Tannins

- Rangeland can have plants containing Tannins and other plant secondary compounds.
  - Tannins typically:
    - Decrease palatability, therefore decreased intake
    - Decrease digestibility
    - Decrease protein used in rumen
    - May increase dietary protein absorbed post-ruminally

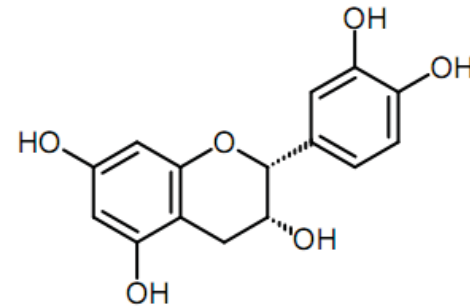
# Tannins



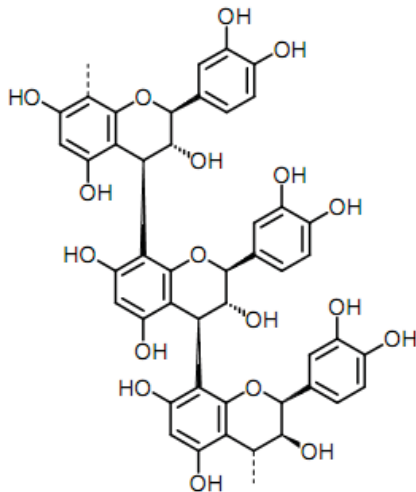
3,4,5-trihydroxybenzoic acid  
Gallic acid (GA)



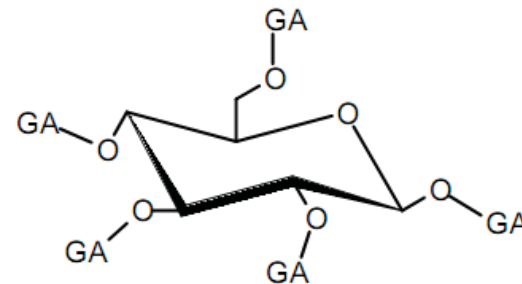
Catechin



Epicatechin



Procyanidin (condensed tannin)  
Epicatechin-(4→8)-epicatechin-(4→8)-catechin



Hydrolyzable tannin  
 $\beta$ -1,2,3,4,6-pentagalloyl-O-D-Glucose  
GA = Gallic acid

Figure 1. Typical Structures of hydrolyzable and condensed tannins.  
In: molecules. 2011. 17:2766-2784

# Tannins

**Table 1.** List of studies in which the presence of Tannin-binding salivary proteins (TBSPs) was referred for sheep, cattle and goats.

Specie	Presence of TBSPs		Reference
	Constitutive <sup>1</sup>	Induced by tannins <sup>2</sup>	
Sheep ( <i>Ovis aries</i> )	No	No	[5,85,117,118]
	Yes (unidentified <sup>3</sup> )	Yes (unidentified)	[107] [118]
	No	No	[5,85,97]
Cattle ( <i>Bos taurus</i> )		Yes (other type <sup>4</sup> )	[98]
	No		[97,103,111,118]
Goat ( <i>Capra hircus</i> )	Yes (unidentified)		[99,102,107]
		Yes (unidentified)	[118]

<sup>1</sup> Presence/absence in saliva produced under consumption of each species regular diets; <sup>2</sup> Presence/absence in saliva produced following stimulation with a tannin-rich diet; <sup>3</sup> The presence of TBSPs was reported but the detailed characteristics have not been investigated; <sup>4</sup> The presence of TBSPs, which are not PRPs, has been reported.

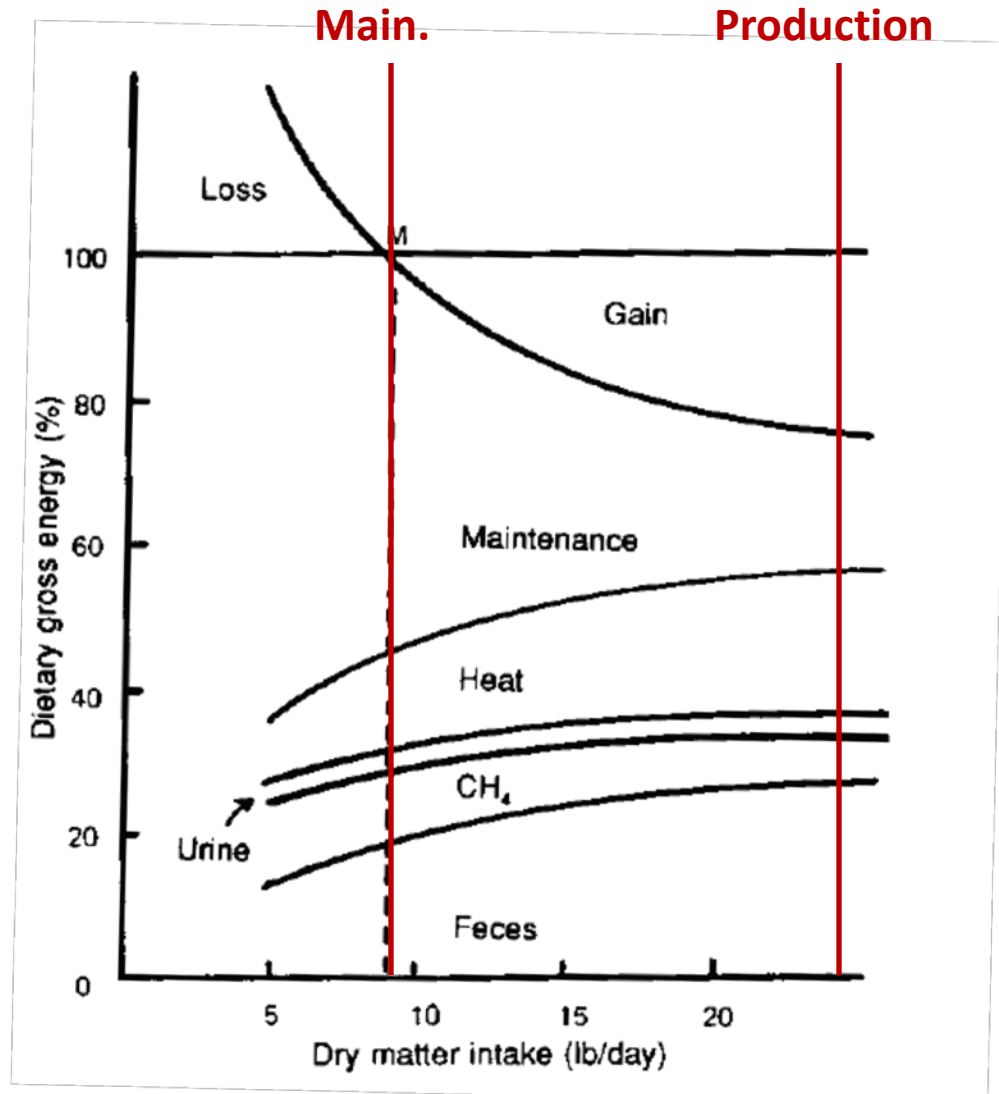
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# Energy

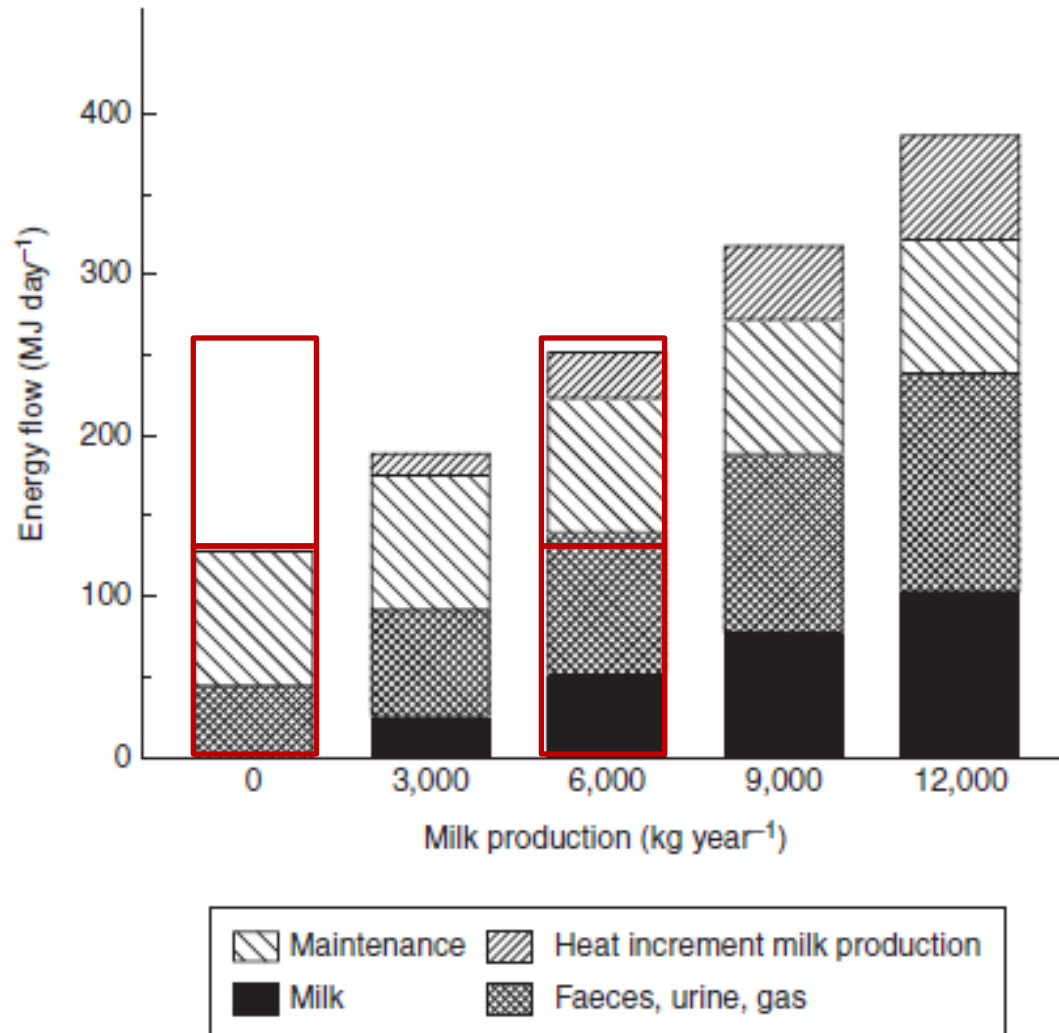
- $IE = FE(\text{fecal } E) + UE(\text{urine } E) + GE(\text{gas } E) + RE(\text{recovered } E) + HE_e(\text{fasting met}) + HE_f + HE(\text{other})$ 
  - RE is sometimes referred to as retained energy or Net Energy (NE)
- $DE = IE - FE$
- $ME = IE - FE - UE - GE - HE_f$  or  $RE + HE_e + HE(\text{other})$
- $IE = FE + UE + GE + HE_f + ME$
- $IE_{\text{forage}} = FE(43\%) + UE(4\%) + GE(6\%) + HE_f(6\%) + ME(41\%)$
- $IE_{\text{conc}} = FE(18\%) + UE(3\%) + GE(6\%) + HE_f(6\%) + ME(67\%)$

# Energy, another way visualize

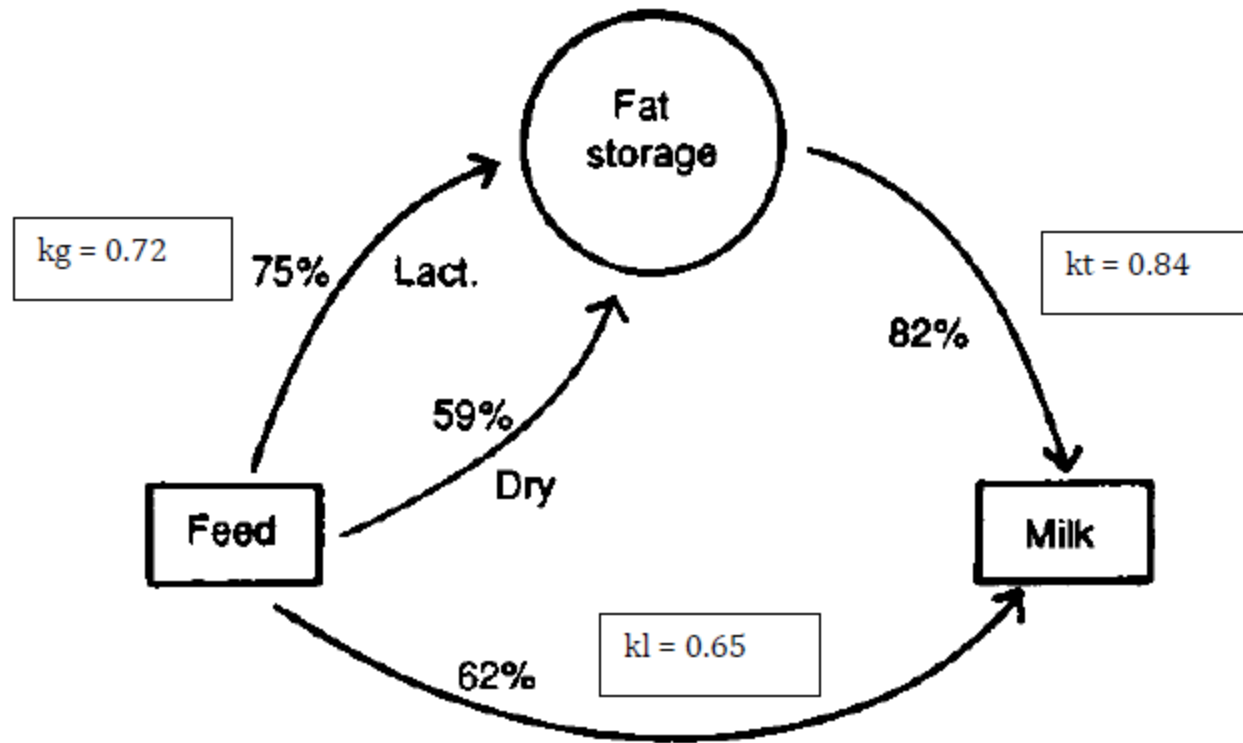


Van Soest, 1994

# Energy, another way to visualize



# Energy, another way visualize





# Efficiency

- Total efficiency =  
(total energy or protein human-edible output)/  
(total energy or protein input with feed)
- Human edible efficiency =  
(total energy or protein human-edible output)/  
(total energy or protein **human-edible** input with feed)
- Ideal to have ratio over 1.0

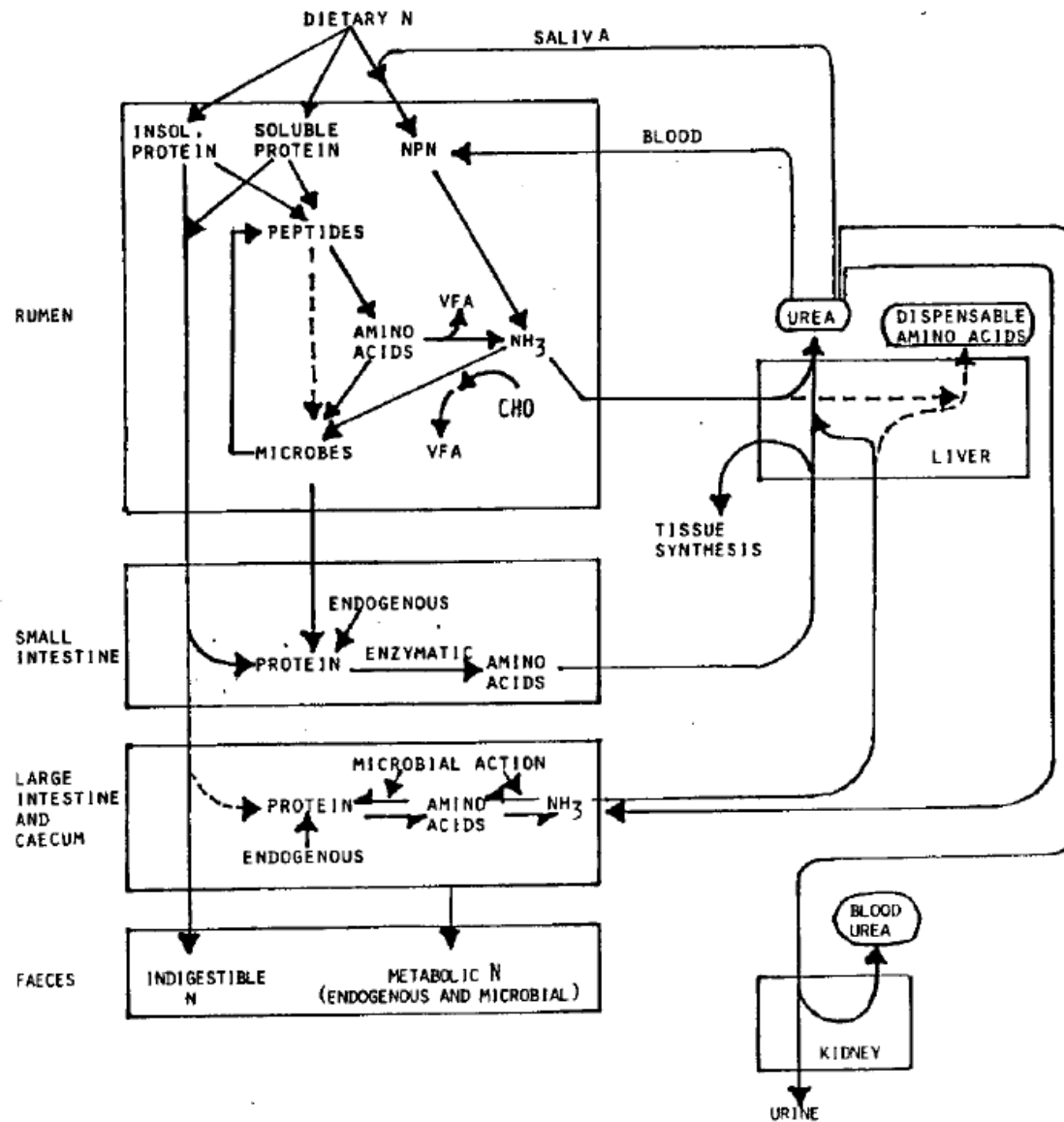
# Efficiency

Reference	System	<u>Total efficiency</u>		<u>Human edible efficiency</u>	
		Energy	Protein	Energy	Protein
Baldwin (1984)	Milk	0.23	0.29	1.01	1.81
	Beef	0.04	0.04	0.71	1.15
	Swine	0.23	0.38	0.58	0.86
CAST (1999)	Milk	0.25	0.21	1.07	2.08
	Beef	0.07	0.08	0.65	1.19
	Swine	0.21	0.19	0.31	0.29
	Poultry	0.19	0.31	0.28	0.61

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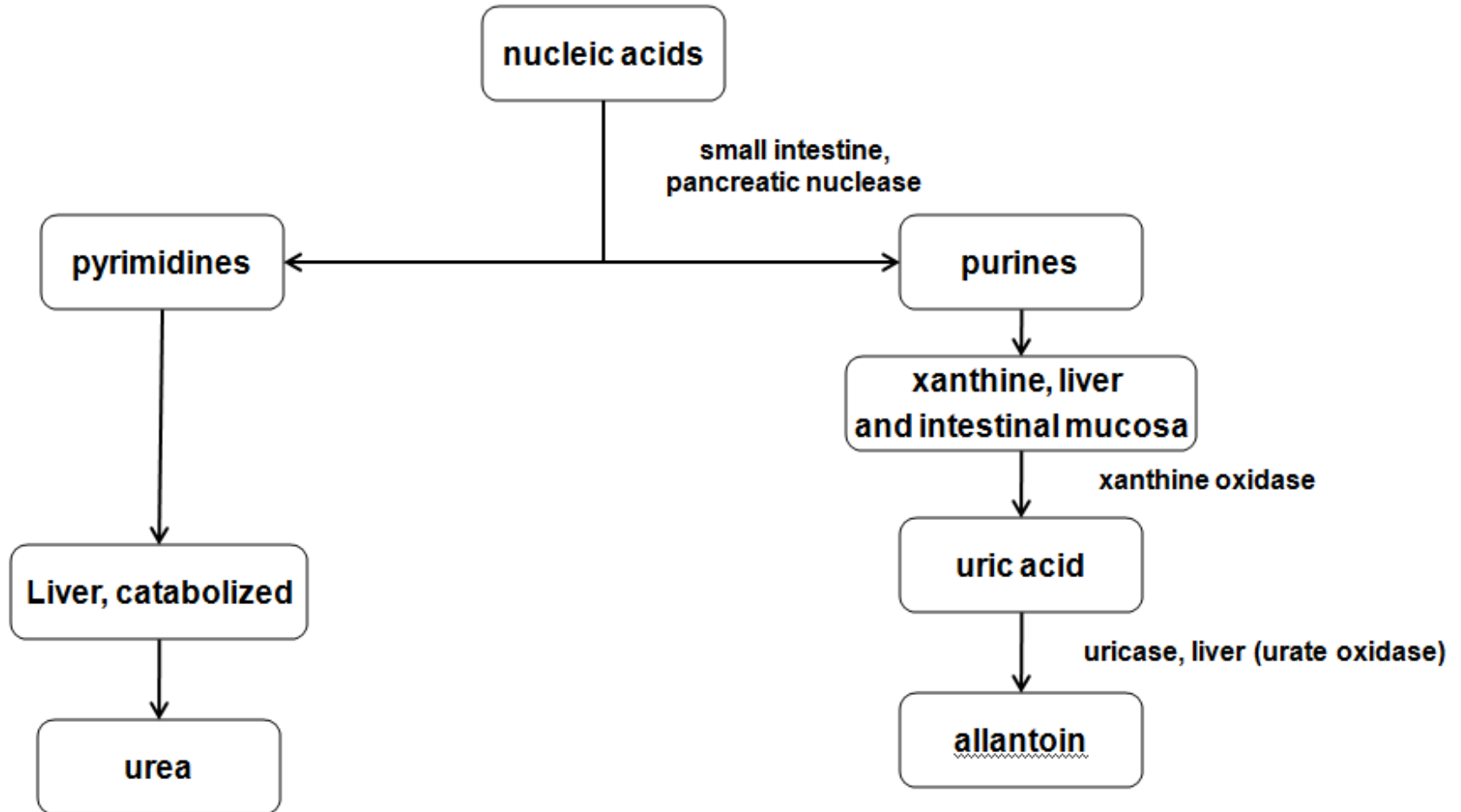
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# Nitrogen



Above figure modified from Animal Nutrition 7<sup>th</sup> ed, Maynard/Loosli/Hintz/Warner, 1979, page 160

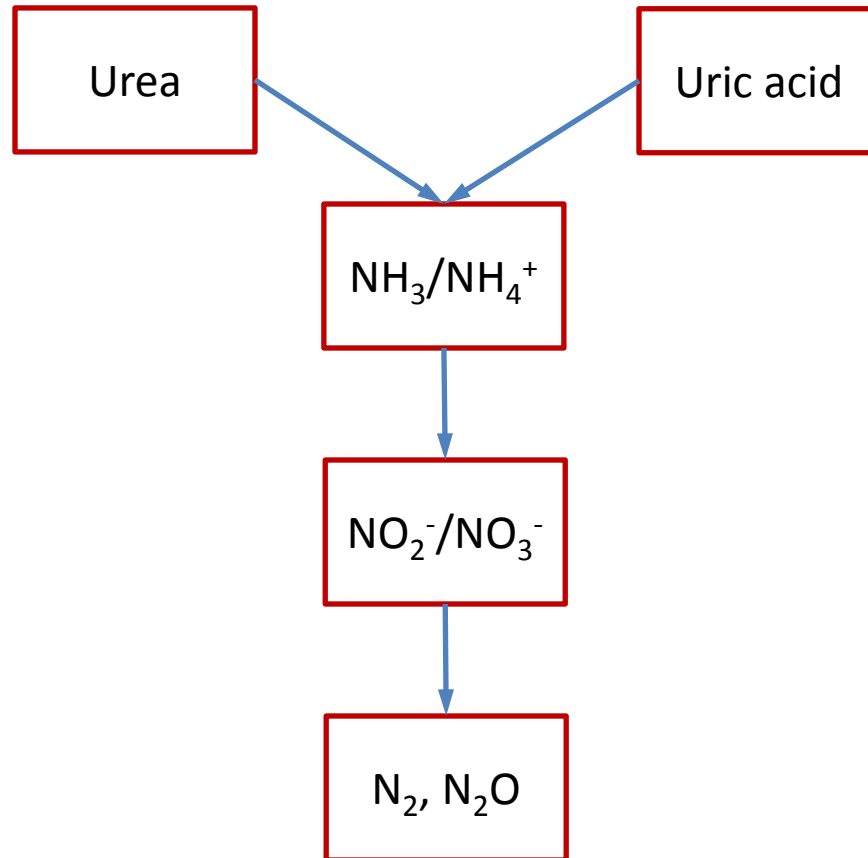
# Nitrogen



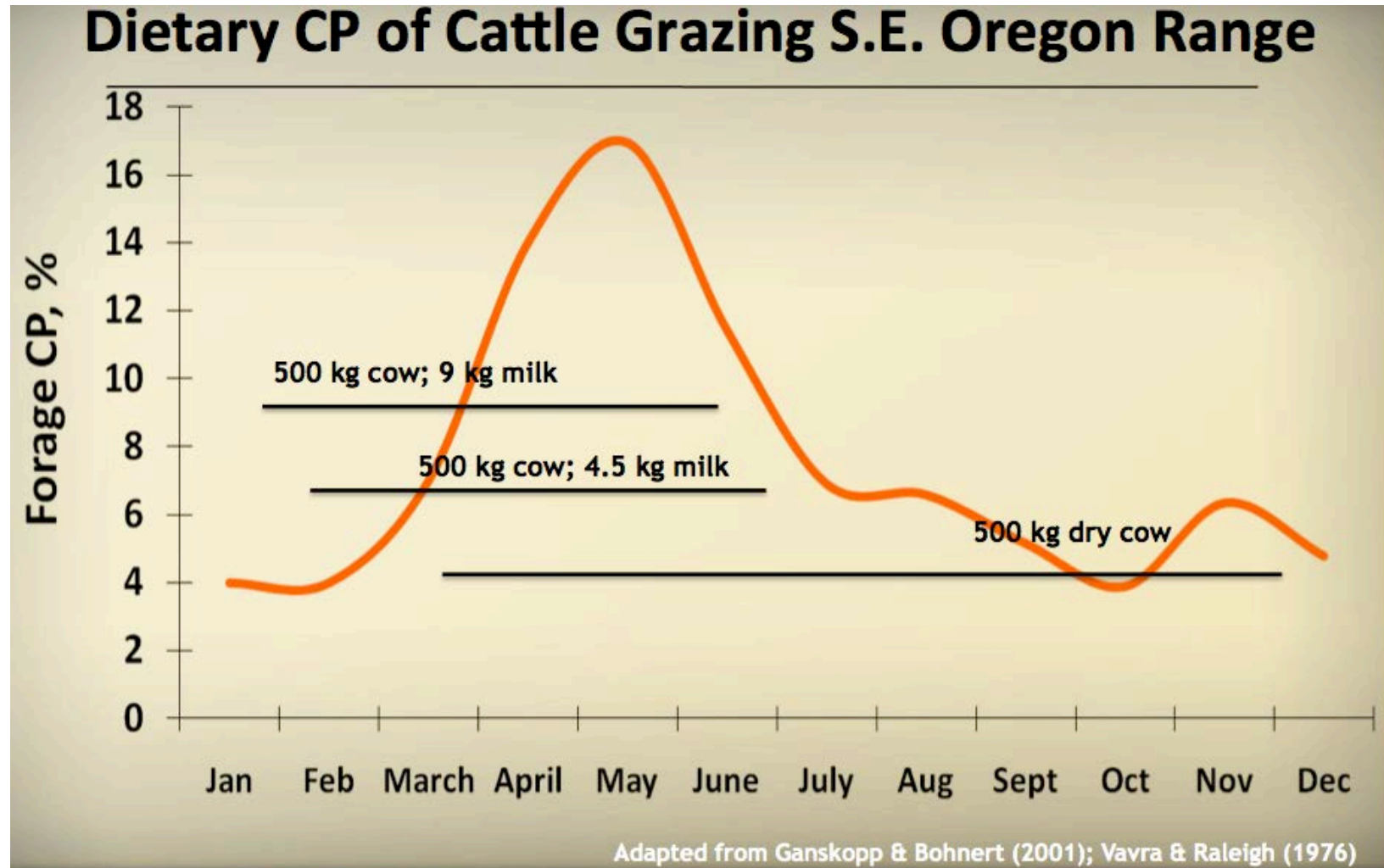
# Nitrogen in Cattle Urine

Source	Proportion (%)	Precursor(s)
Urea	72	NH <sub>3</sub> , aa catabolism, pyrimidines
Allantoin + Uric acid	8	Purines, in ruminants mainly from microbes
Hippuric acid	5	Phenolic acids
Other	15	Various

# Nitrogen



# Nitrogen, fall calving

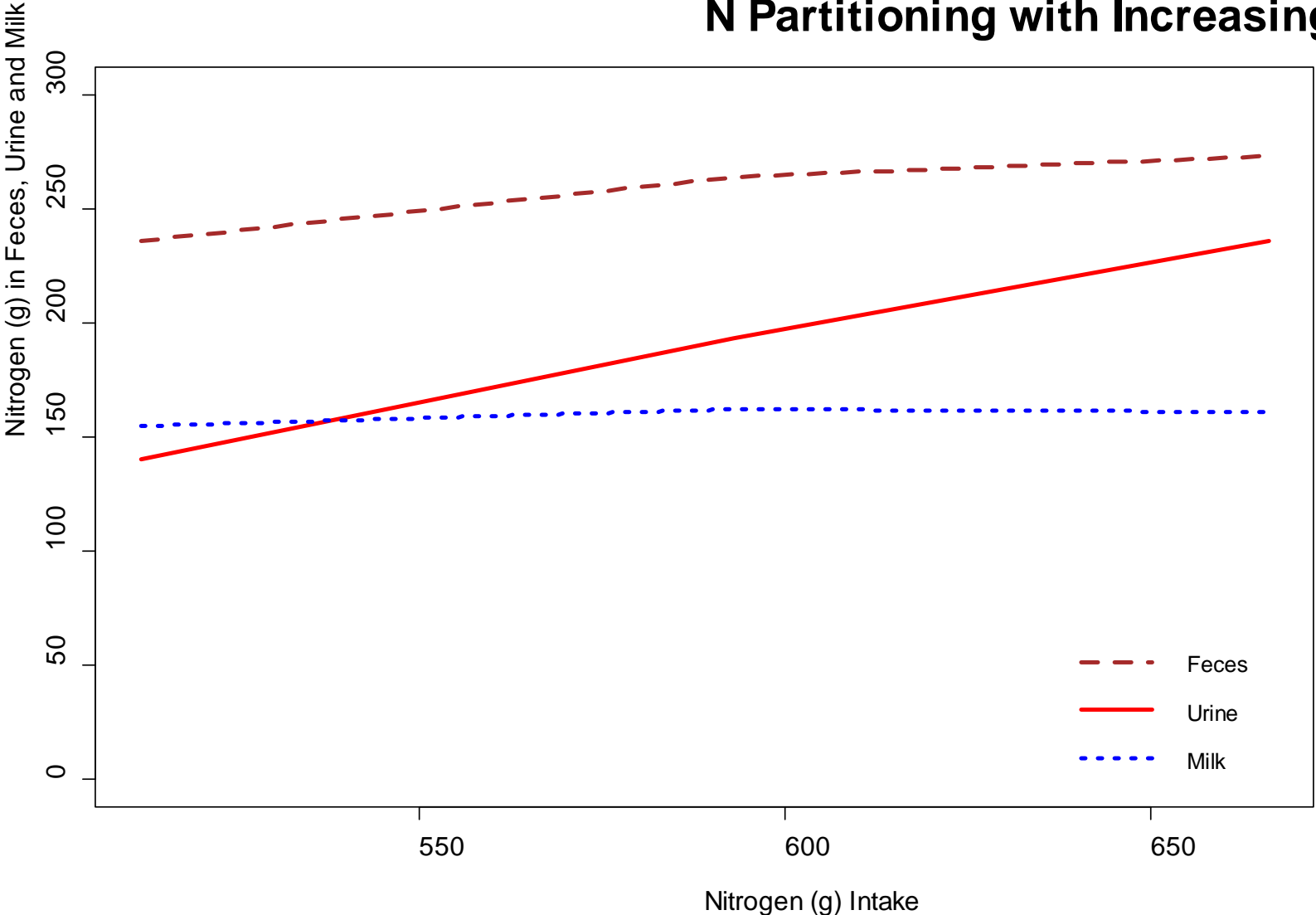




# Nitrogen and Energy

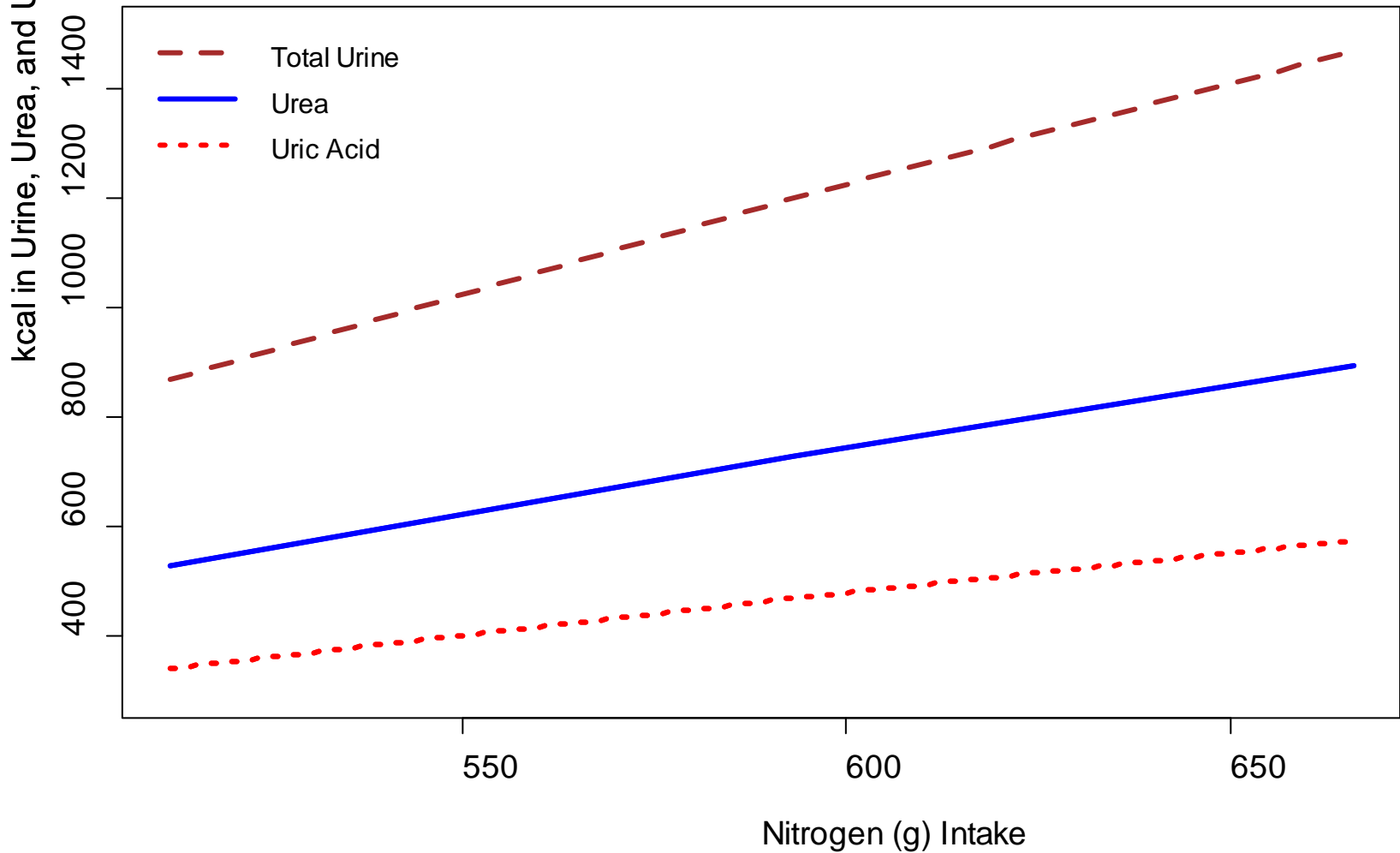
- Urea =  $\text{CH}_4\text{N}_2\text{O}$ 
  - 5.4 kcal/g urea-N
- Uric acid =  $\text{C}_5\text{H}_4\text{N}_4\text{O}_3$ 
  - 8.11 kcal/g uric acid-N
- Methane =  $\text{CH}_4$ 
  - 13.9 kcal/g
- Glucose =  $\text{C}_6\text{H}_{12}\text{O}_6$ 
  - 3.7 kcal/g

# N Partitioning with Increasing N



Broderick. JDS. 2003. 86:1370-1381

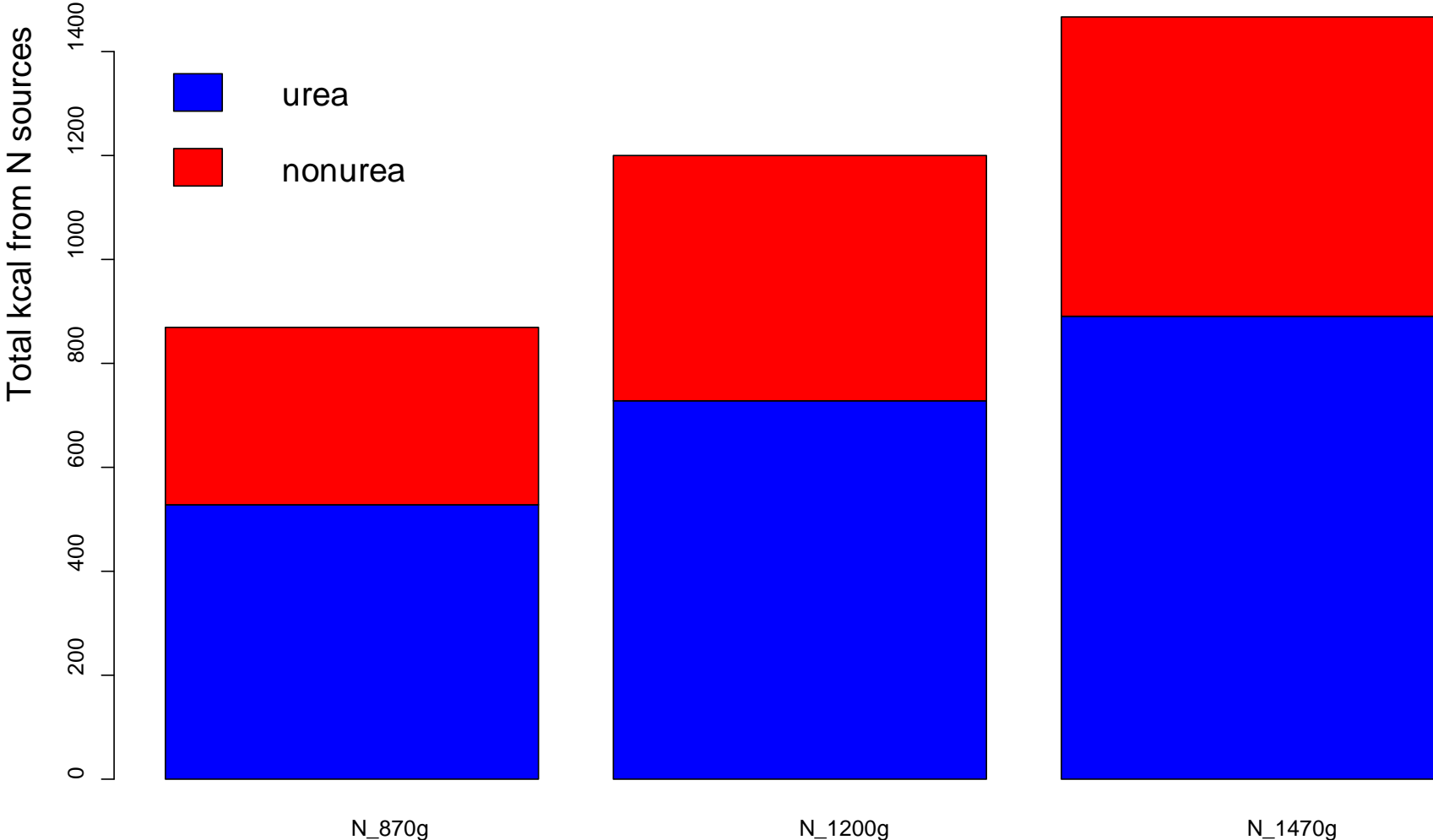
# kcal in Urine with Increasing



Broderick. JDS. 2003. 86:1370-1381

Dijkstra et al., Animal. 2013. pp 292-302

# kcal in Urine with Increasing N Intake



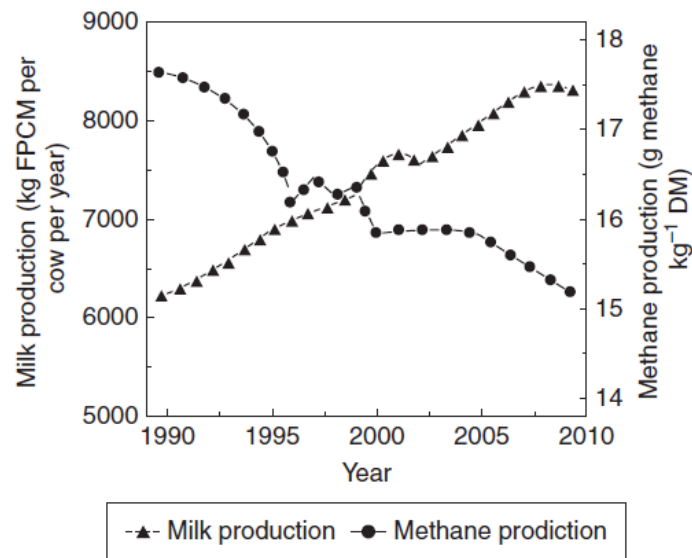
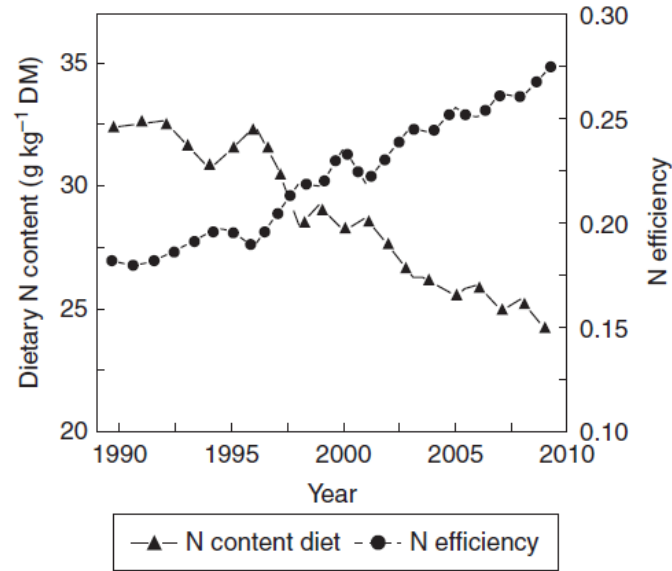
Broderick. JDS. 2003. 86:1370-1381

Dijkstra et al., Animal. 2013. pp 292-302

# Methane vs. Urine loses

- Some rough calculations. Assume:
  - 20 kg intake, 4.8 kcal/g:
    - 96000 kcal intake energy
- UE/IE as N increases and intake fixed (%)
  - 1, 1.2, 1.5 %
- GE/IE as N increases and intake fixed (%)
  - Range from 3 to 5%; select ~3, 4 and 5 for ranges:
- UE/GE as N increases and intake fixed (%)
  - 30 to 50%; 22 to 38%; and 18 to 30%

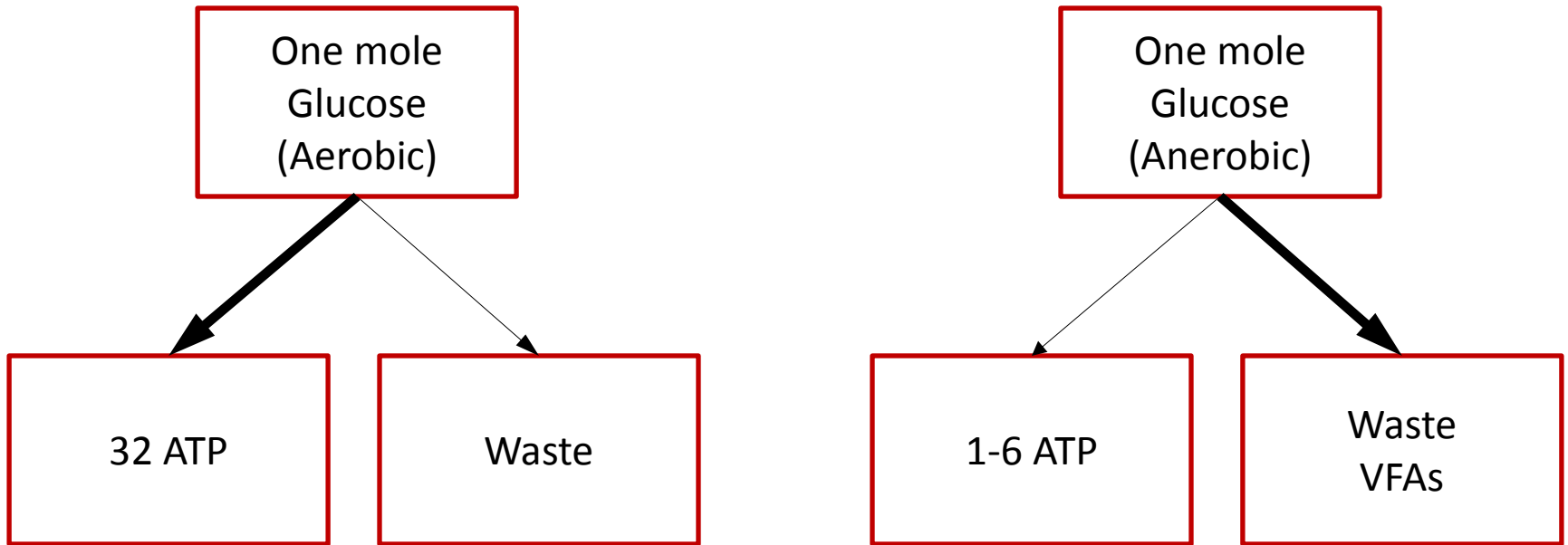
# Production, Methane, & Nitrogen



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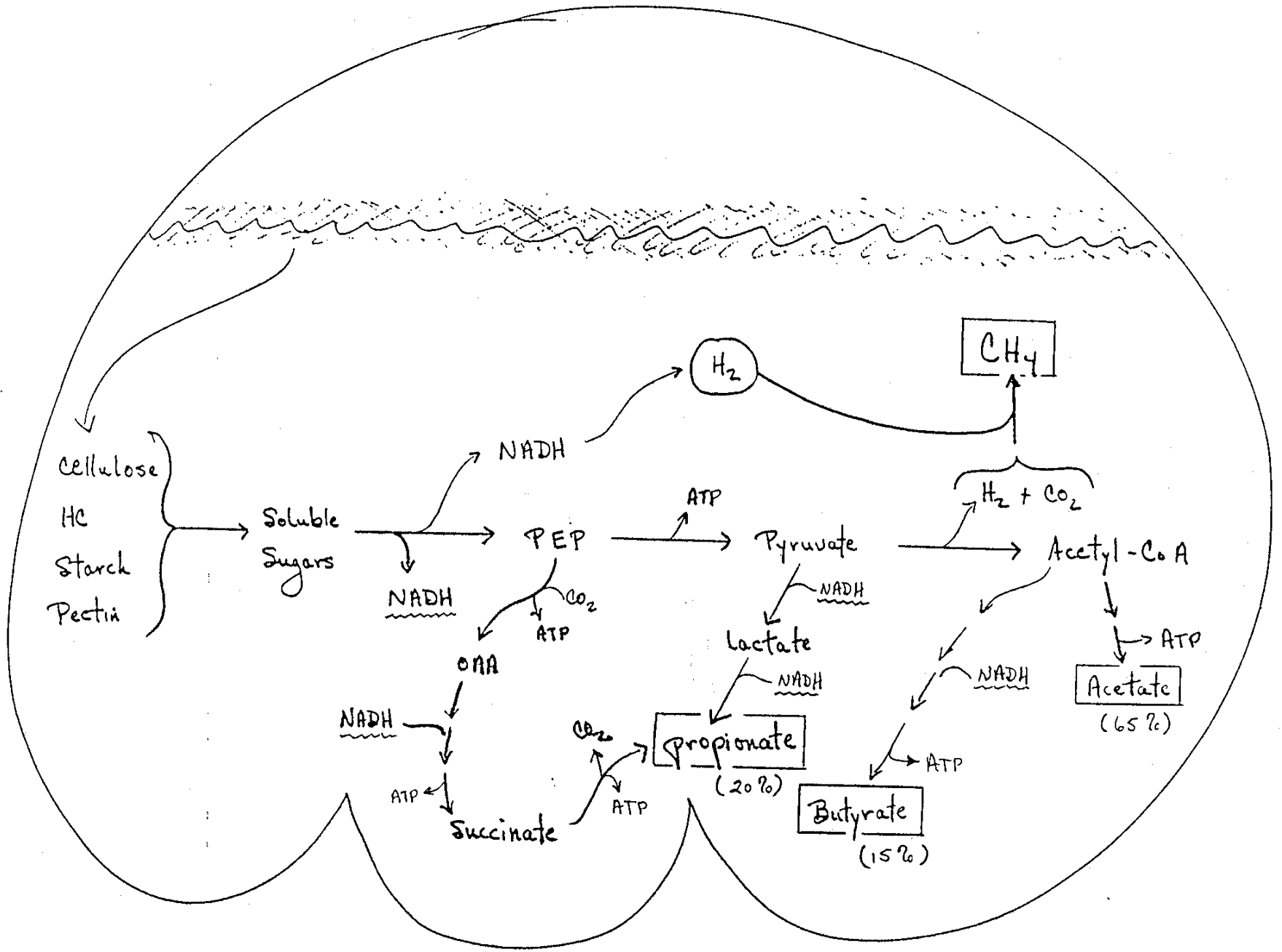
# Microbes





# Microbes in Rumen

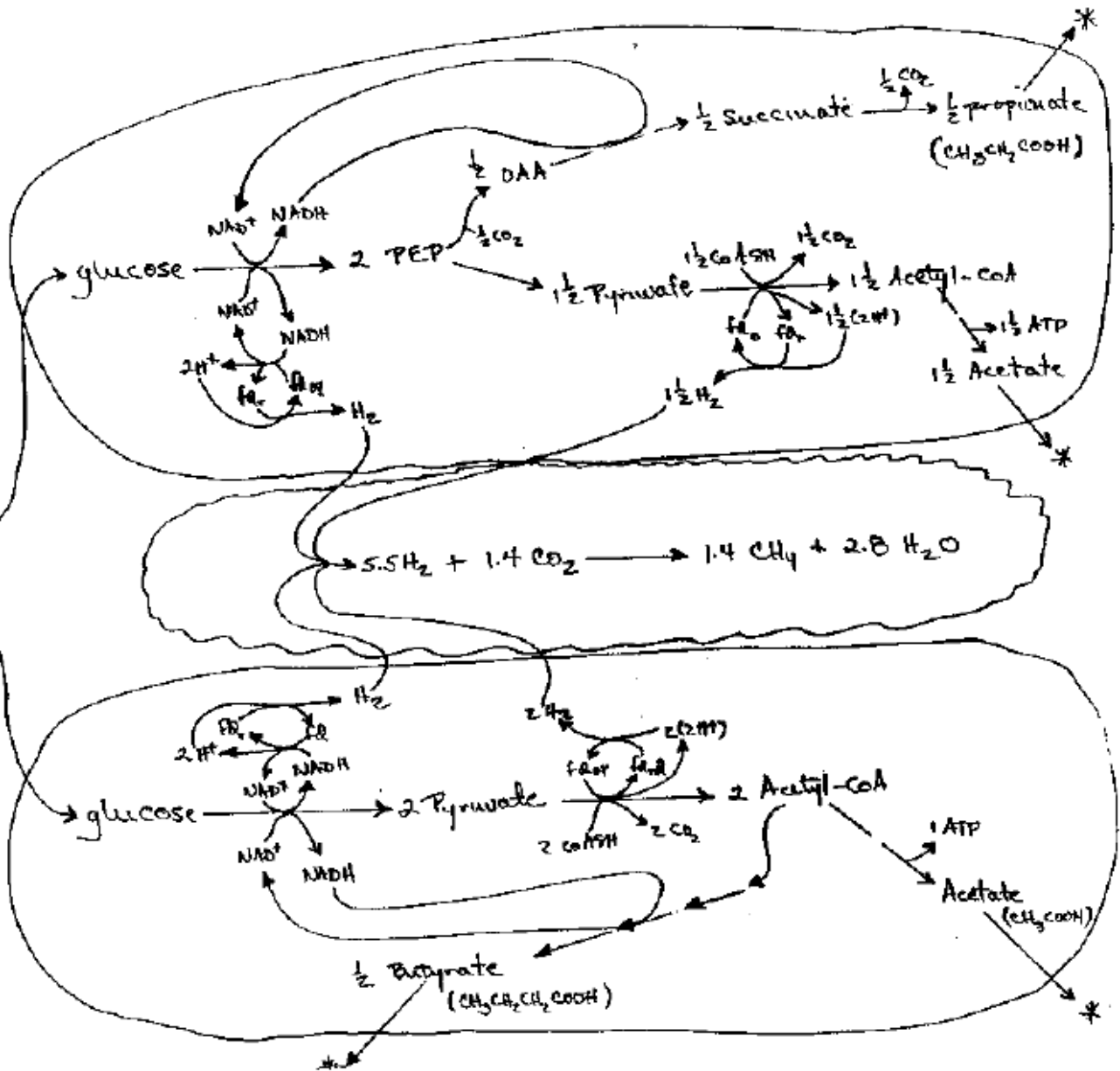
- Bacteria
- Protozoa
  - Holotrich (isotrichid)
  - Entodinomorphs
- Fungi
- Archaea (methanogens)



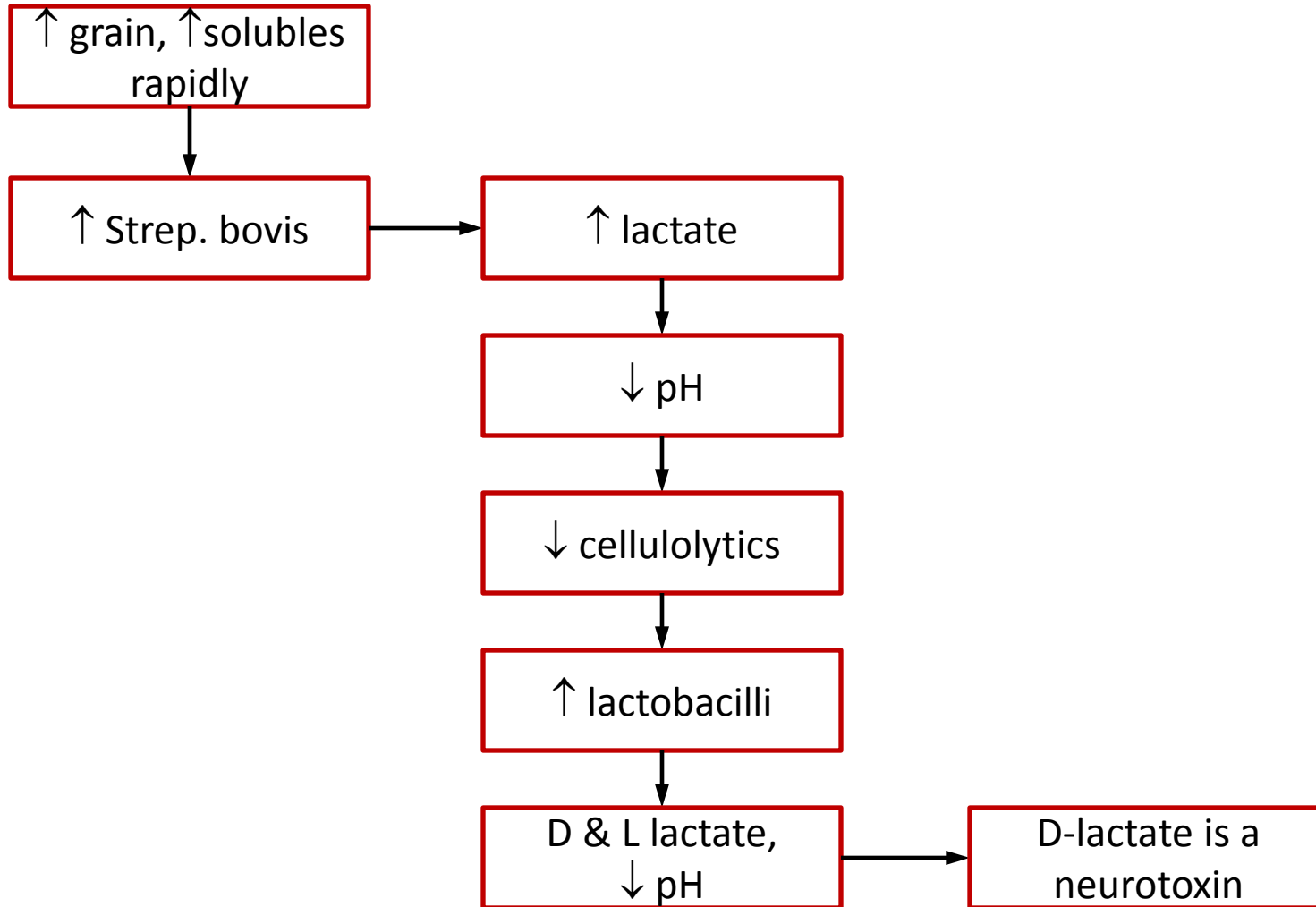
Rumen

\* Absorbed

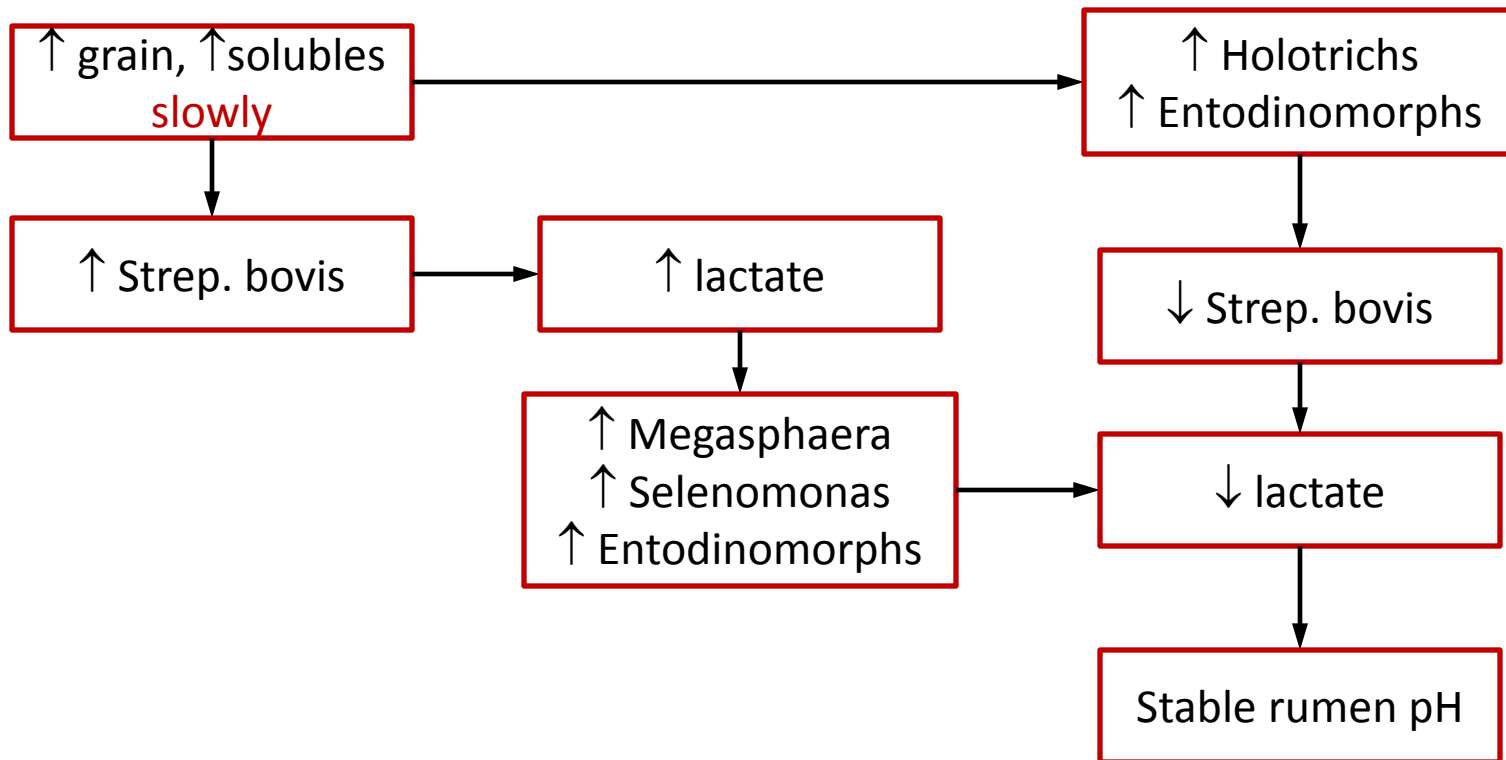
Cellulose  
( $C_6H_{10}O_5$ )



# Transition from forage to grain



# Transition from forage to grain



Questions?  
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