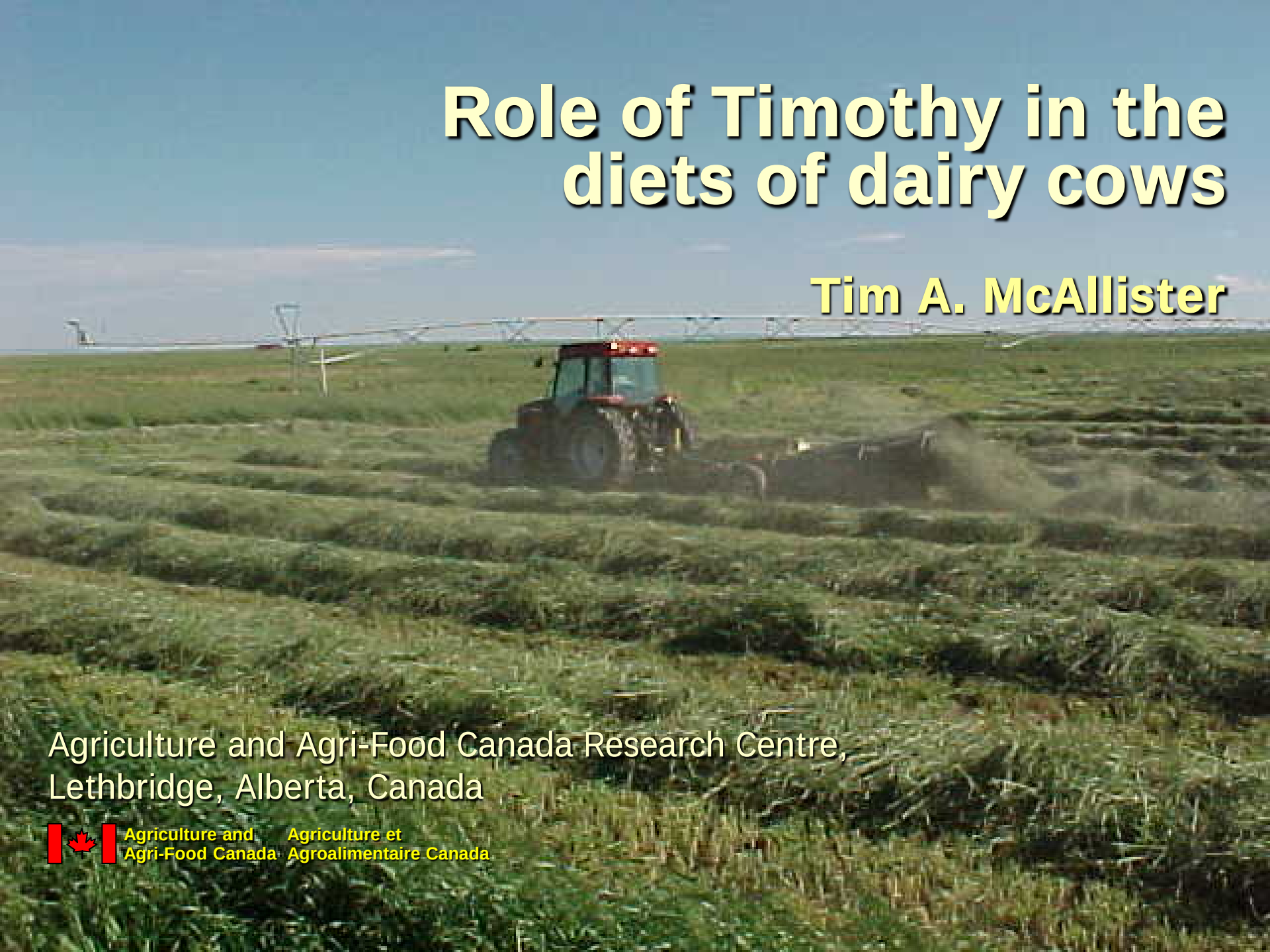


Role of Timothy in the diets of dairy cows

Tim A. McAllister

Agriculture and Agri-Food Canada Research Centre,
Lethbridge, Alberta, Canada

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Credentials

- Senior Research Scientist, M.Sc., Ph.D.
- Young Scientist of Canada Award
- National award in extension and public service
- 120 refereed publications
- 225 national and international presentations
- Leader of a large research team studying aspects of
  - Feed utilization
  - Animal health
  - Biotechnology







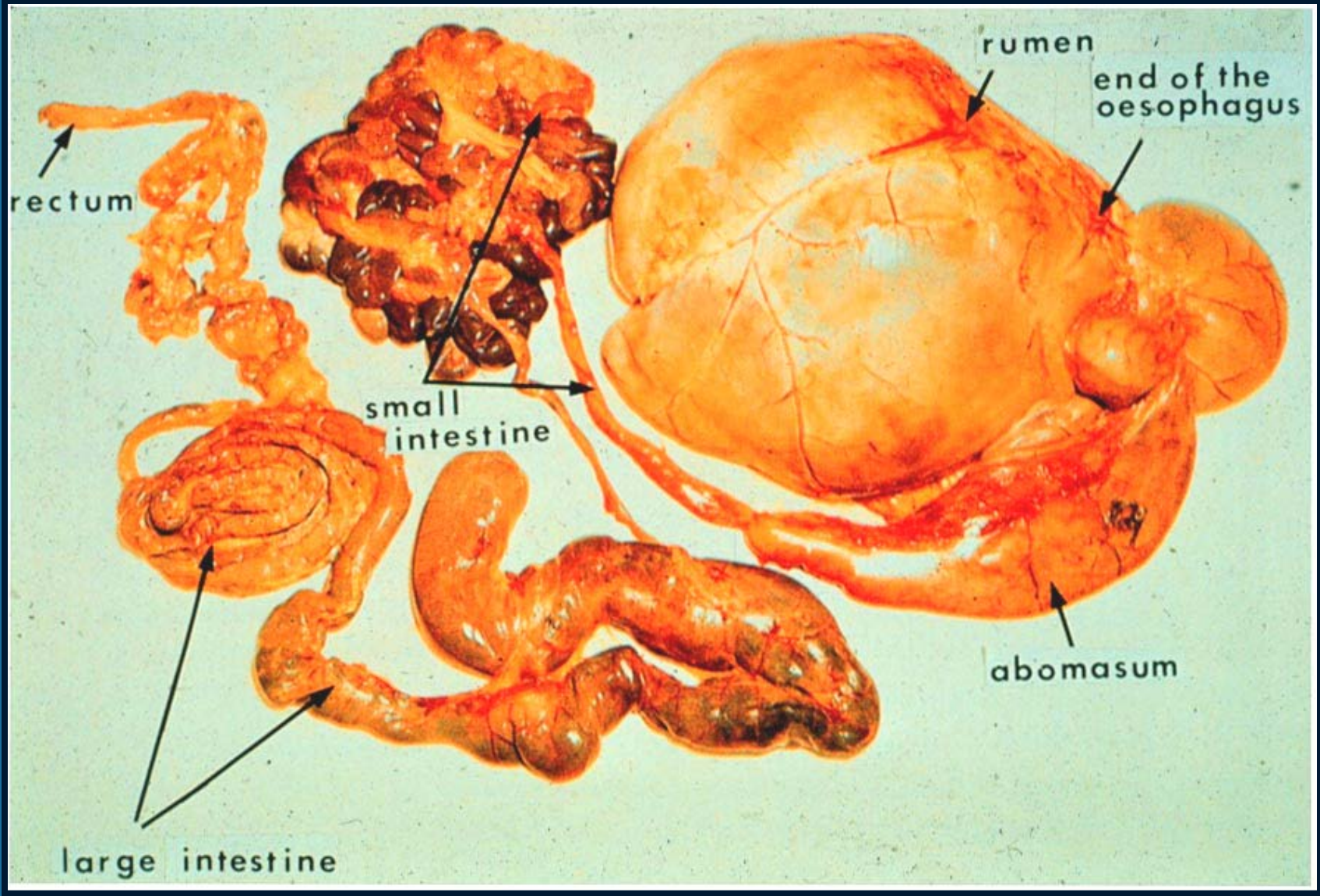


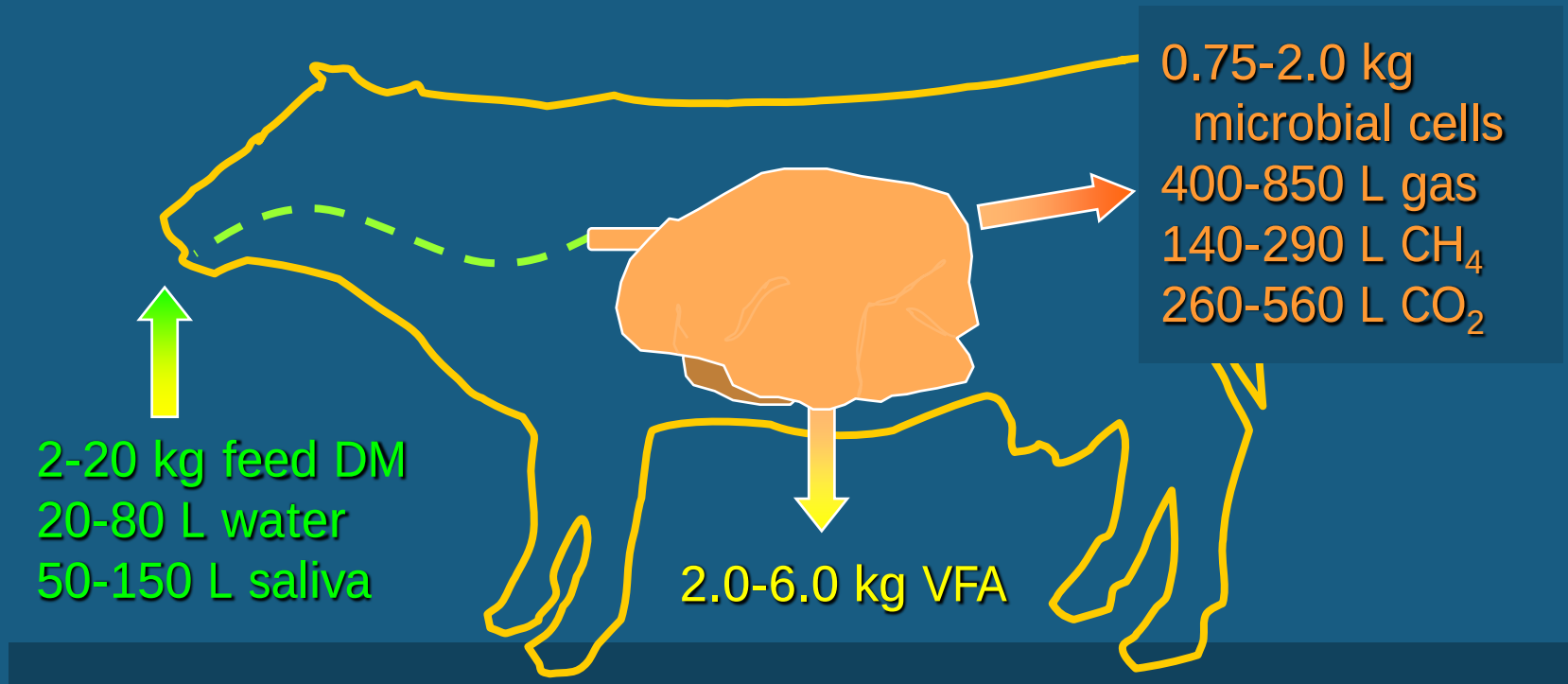






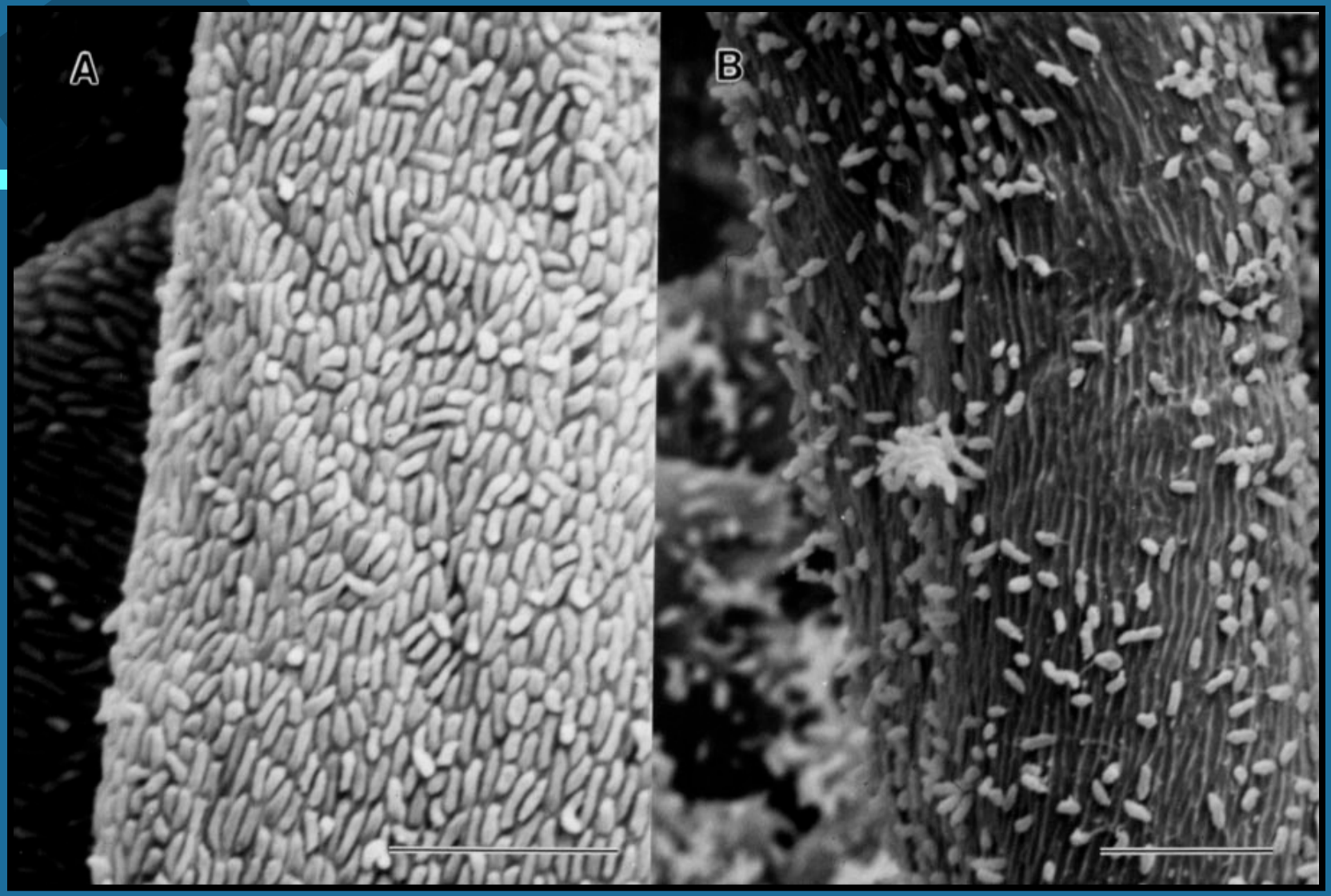


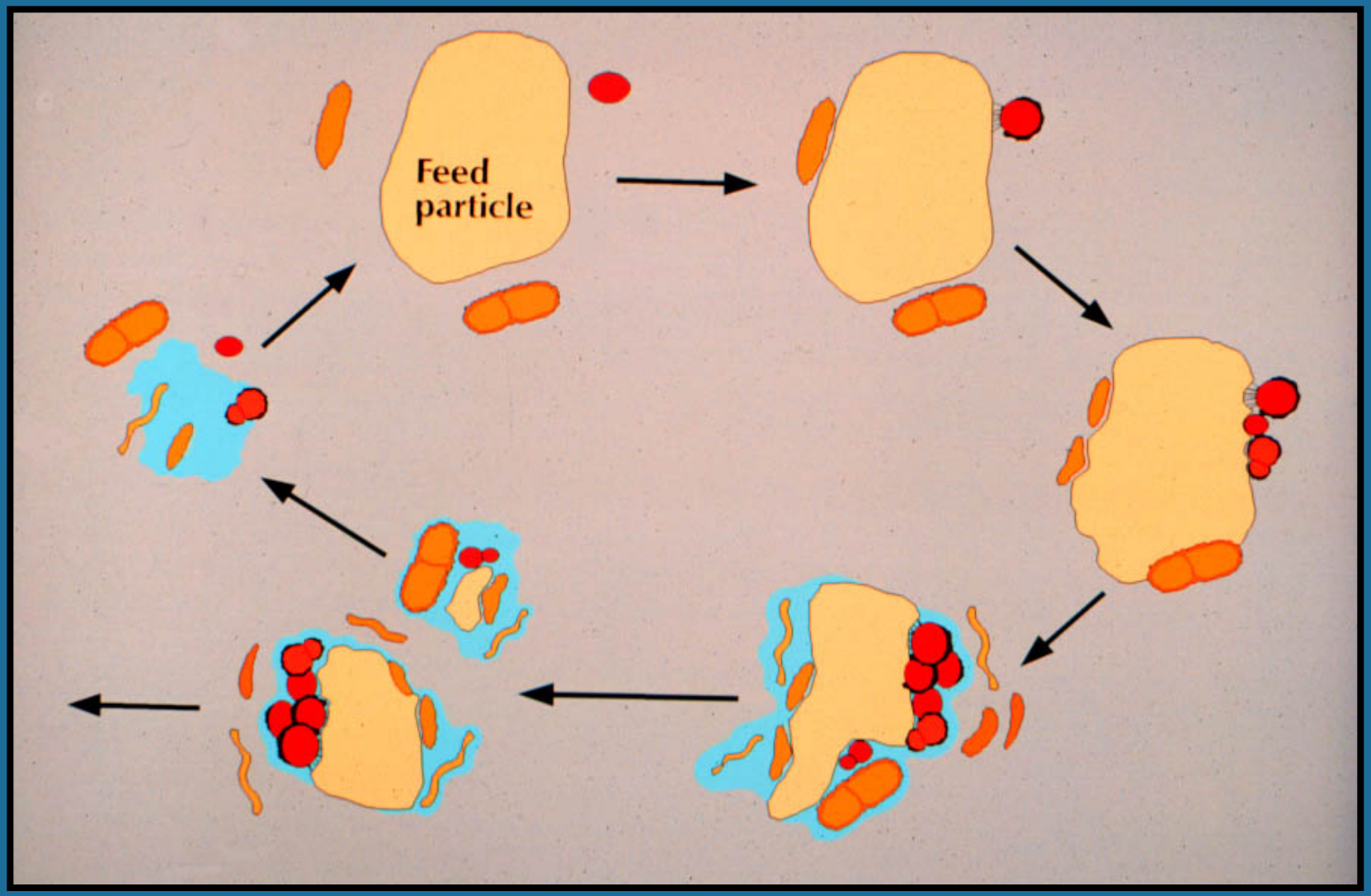

rumen
end of the oesophagus
rectum
small intestine
abomasum
large intestine

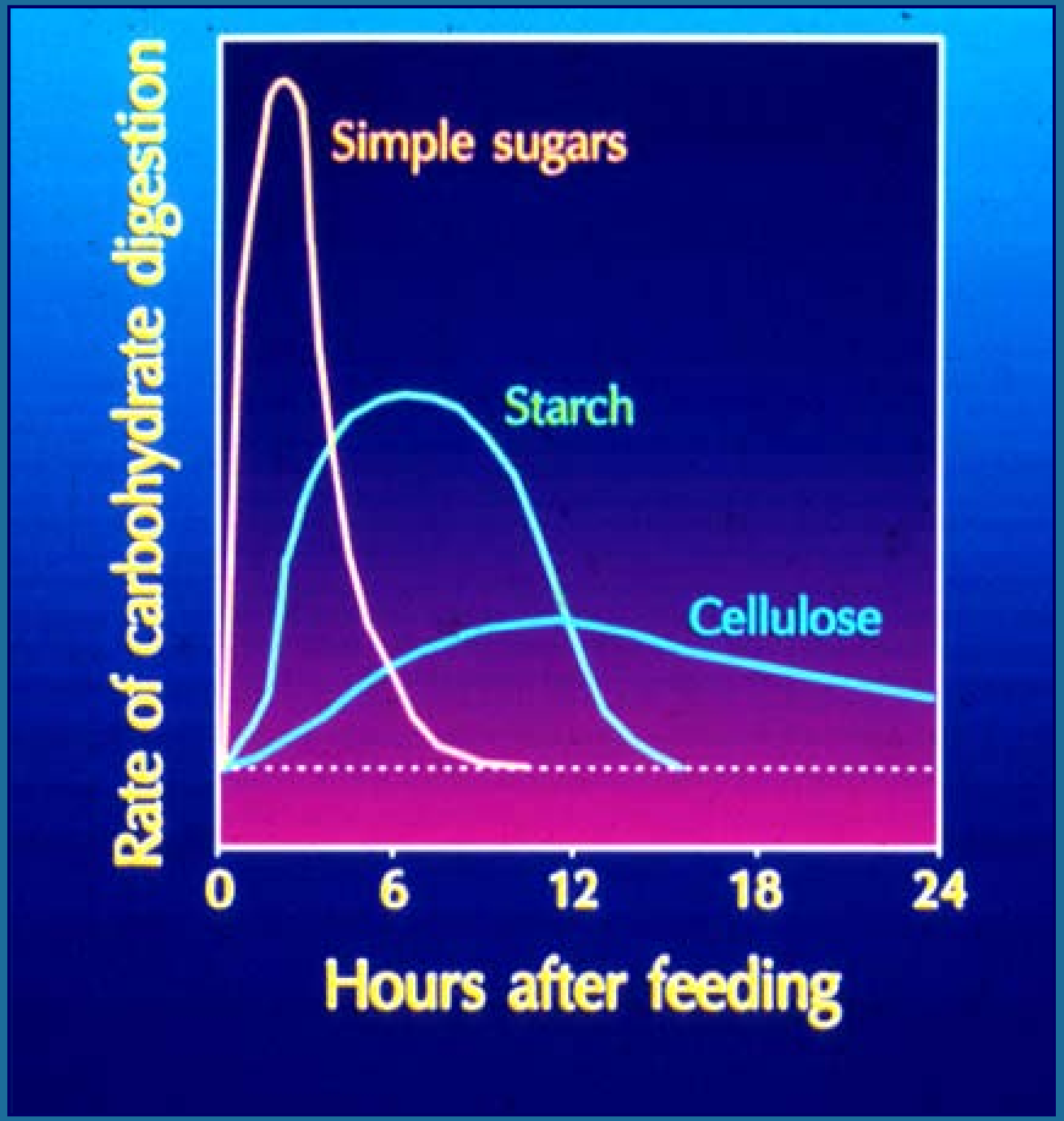

0.75-2.0 kg
microbial cells
400-850 L gas
140-290 L CH_4
260-560 L CO_2
2-20 kg feed DM
20-80 L water
50-150 L saliva
2.0-6.0 kg VFA

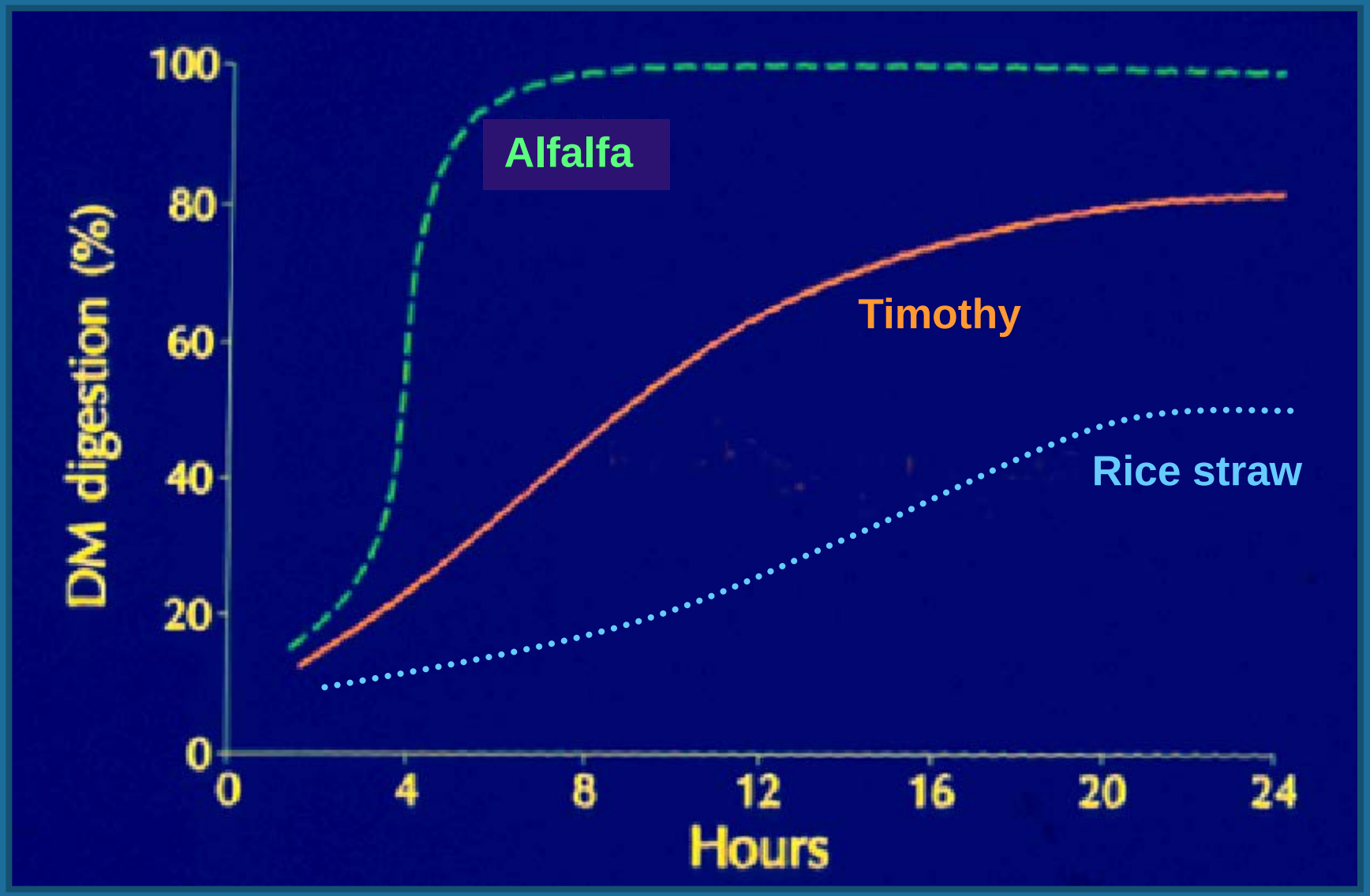
Acetate	70
Propionate	20
Butyrate	10

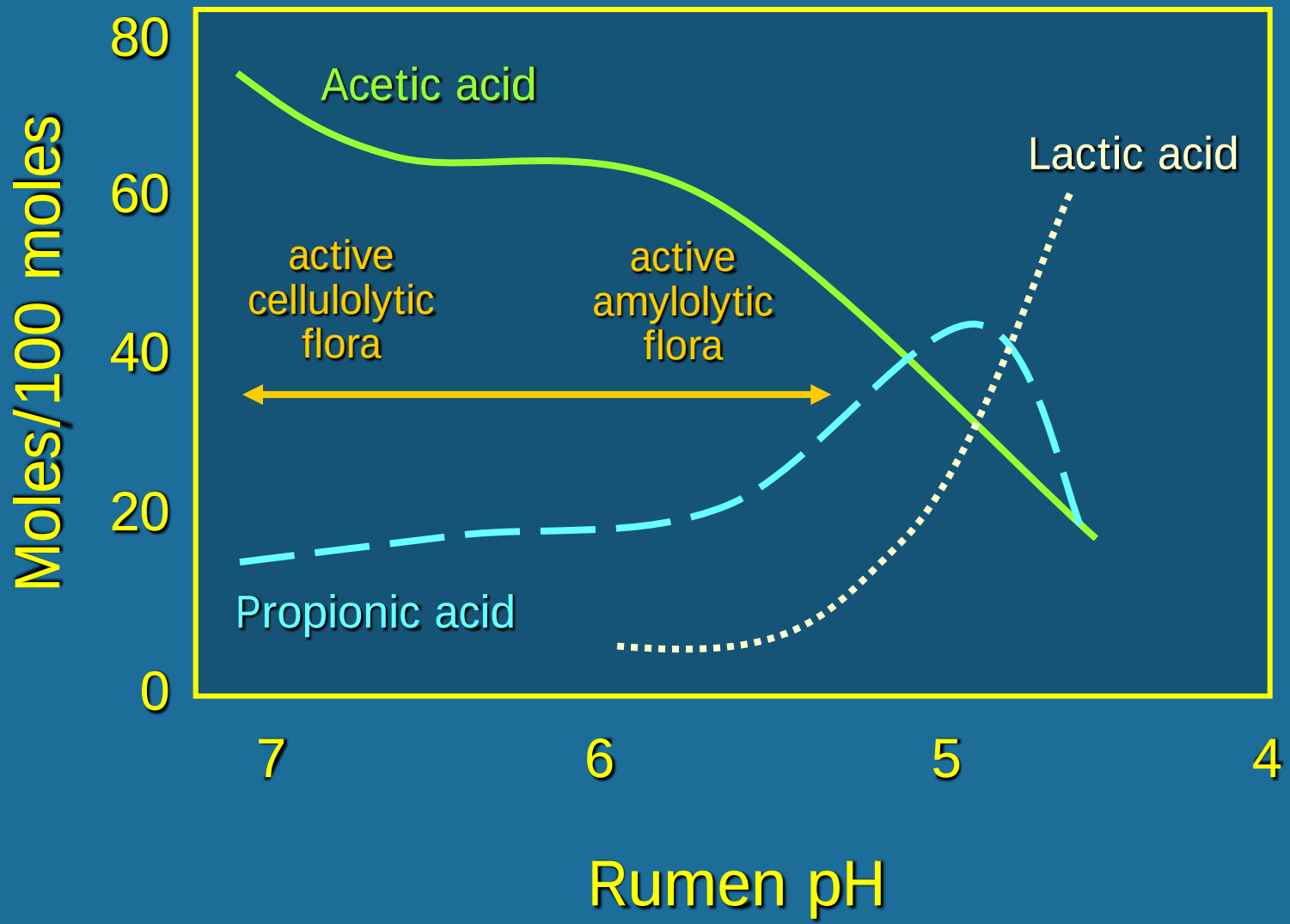
Supply 70% energy requirements

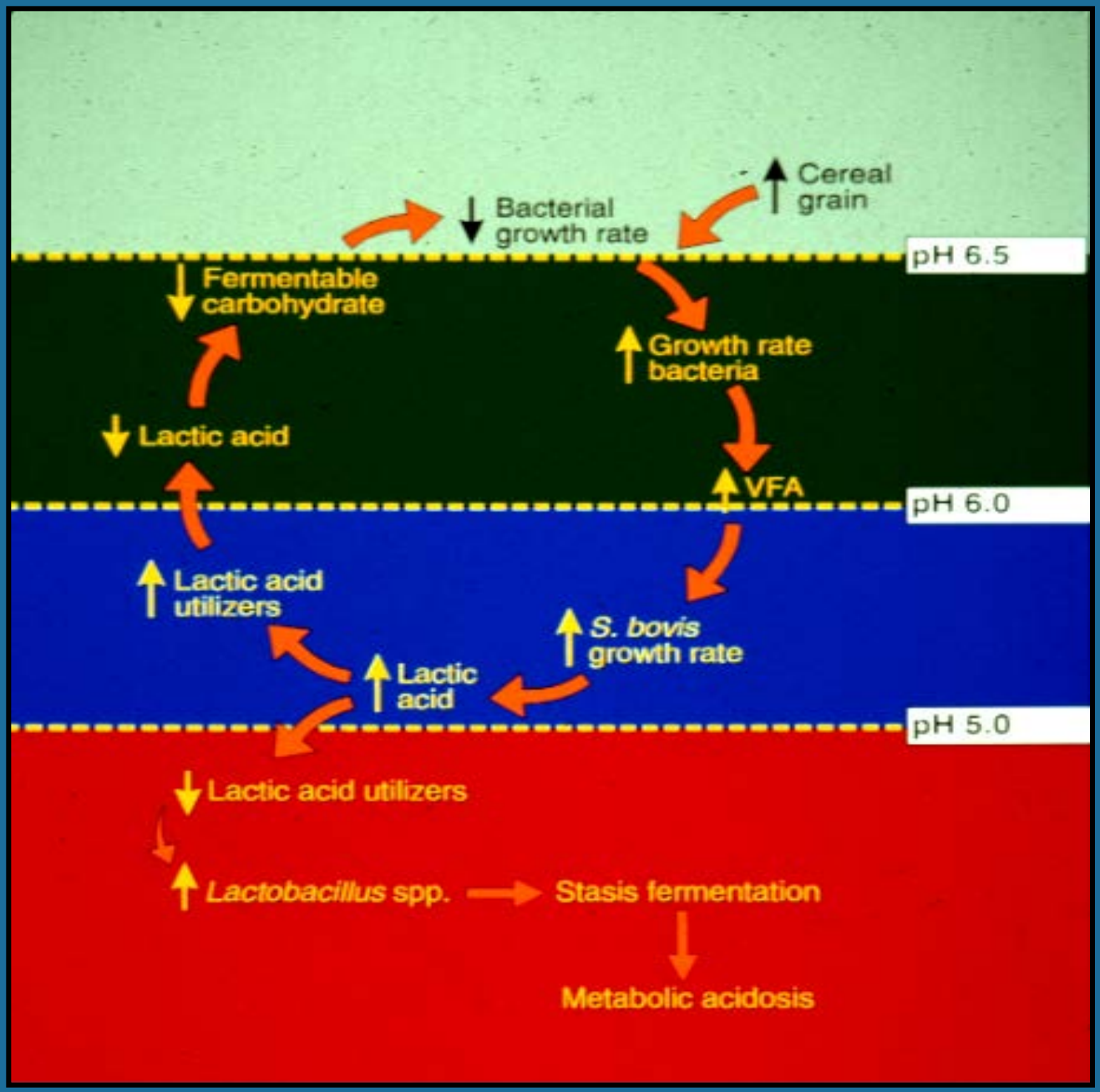

A
B


Feed
particle

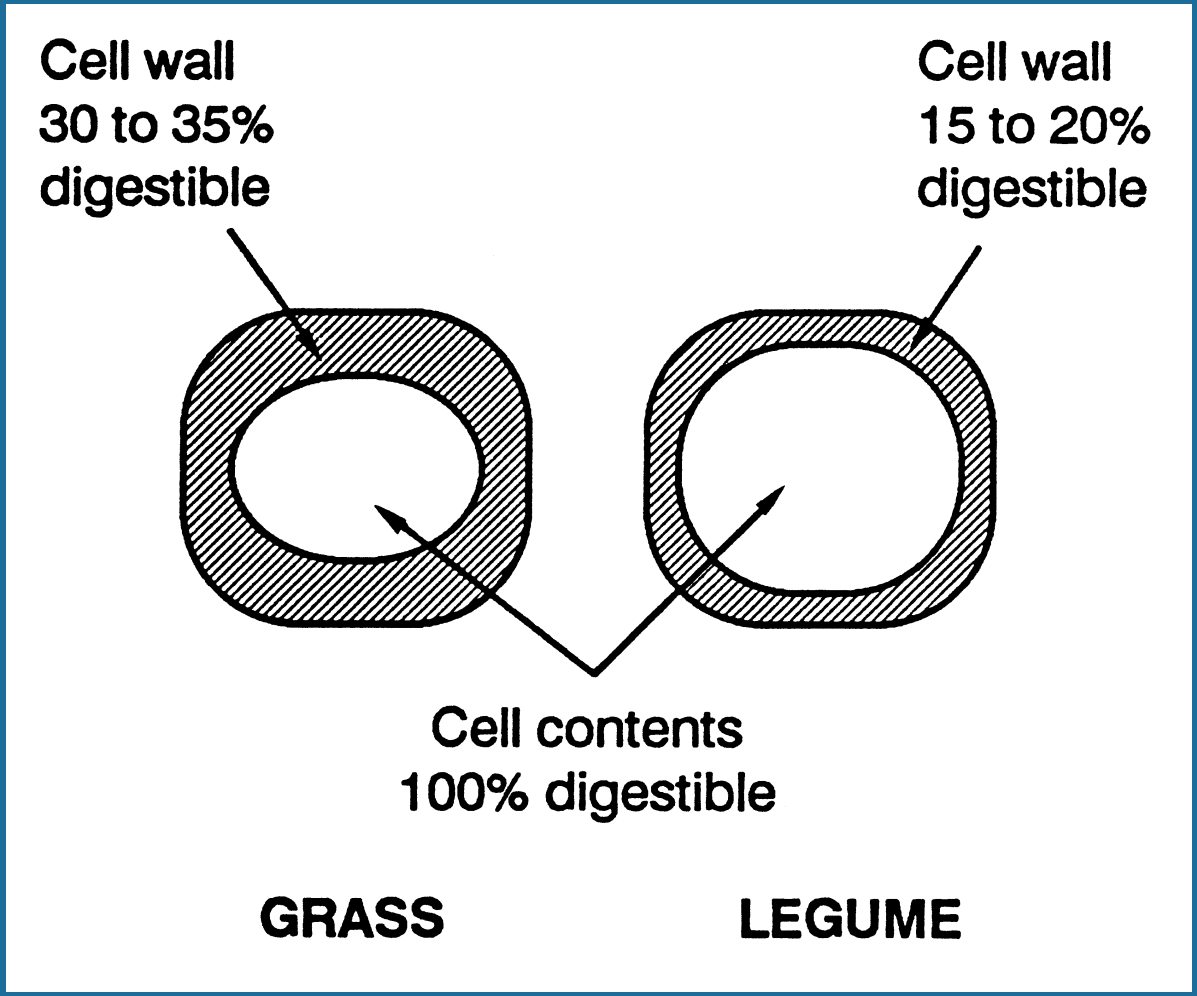

Rate of carbohydrate digestion
Simple sugars
Starch
Cellulose
0
6
12
18
24
Hours after feeding


DM digestion (%)
100
80
60
40
20
0
0
4
8
12
16
20
24
Hours
Alfalfa
Timothy
Rice straw

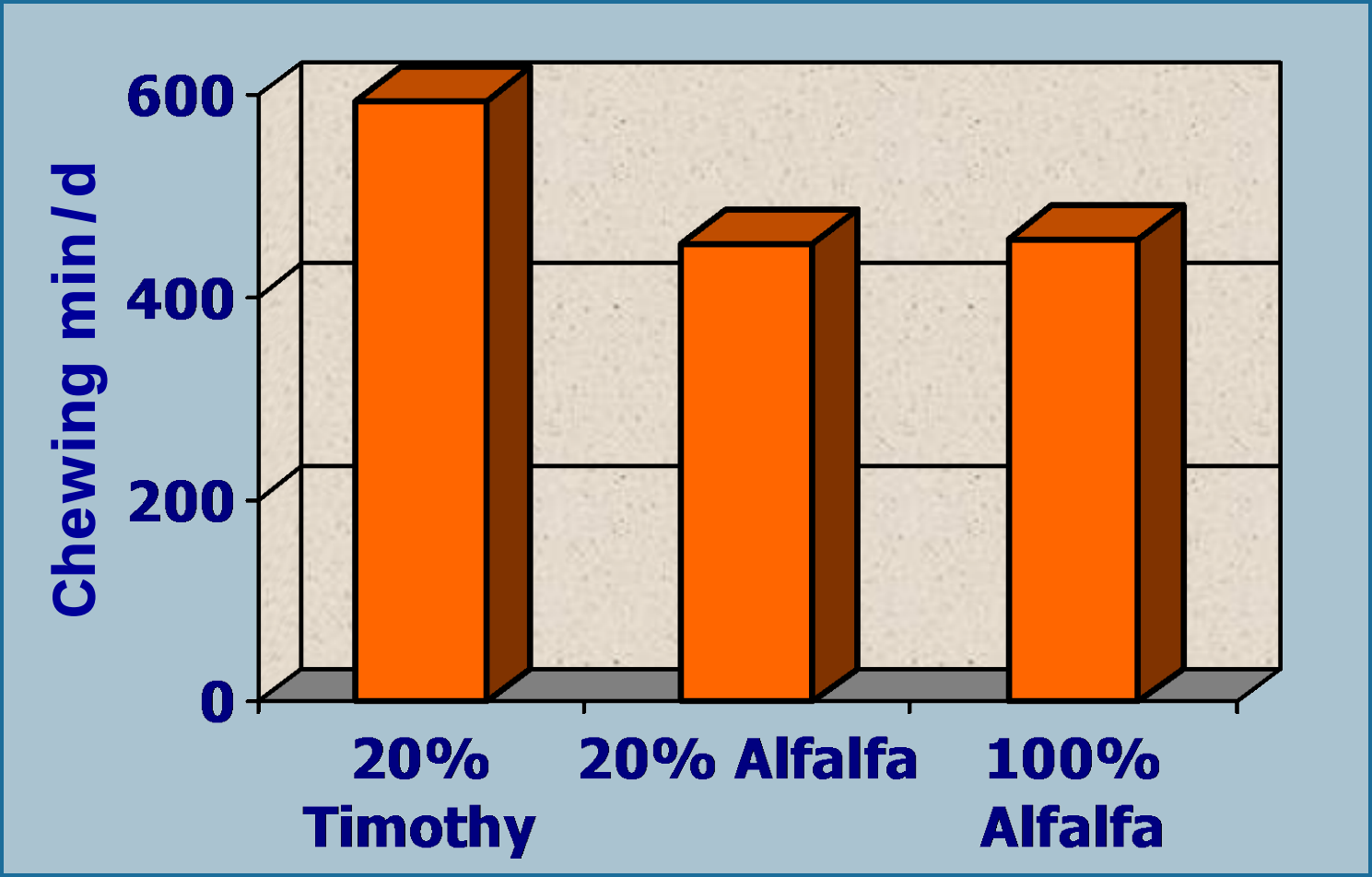

Moles/100 moles
80
60
40
20
0
Acetic acid
Lactic acid
active cellulolytic flora
active amylolytic flora
Propionic acid
7
6
5
4
Rumen pH


Cereal grain
Bacterial growth rate
pH 6.5
Fermentable carbohydrate
Growth rate bacteria
Lactic acid
VFA
pH 6.0
Lactic acid utilizers
S. bovis growth rate
Lactic acid
pH 5.0
Lactic acid utilizers
Lactobacillus spp.
Stasis fermentation
Metabolic acidosis

Plant cell structure



Effect of source and level of dietary neutral detergent fiber on chewing by steers during eating and ruminating



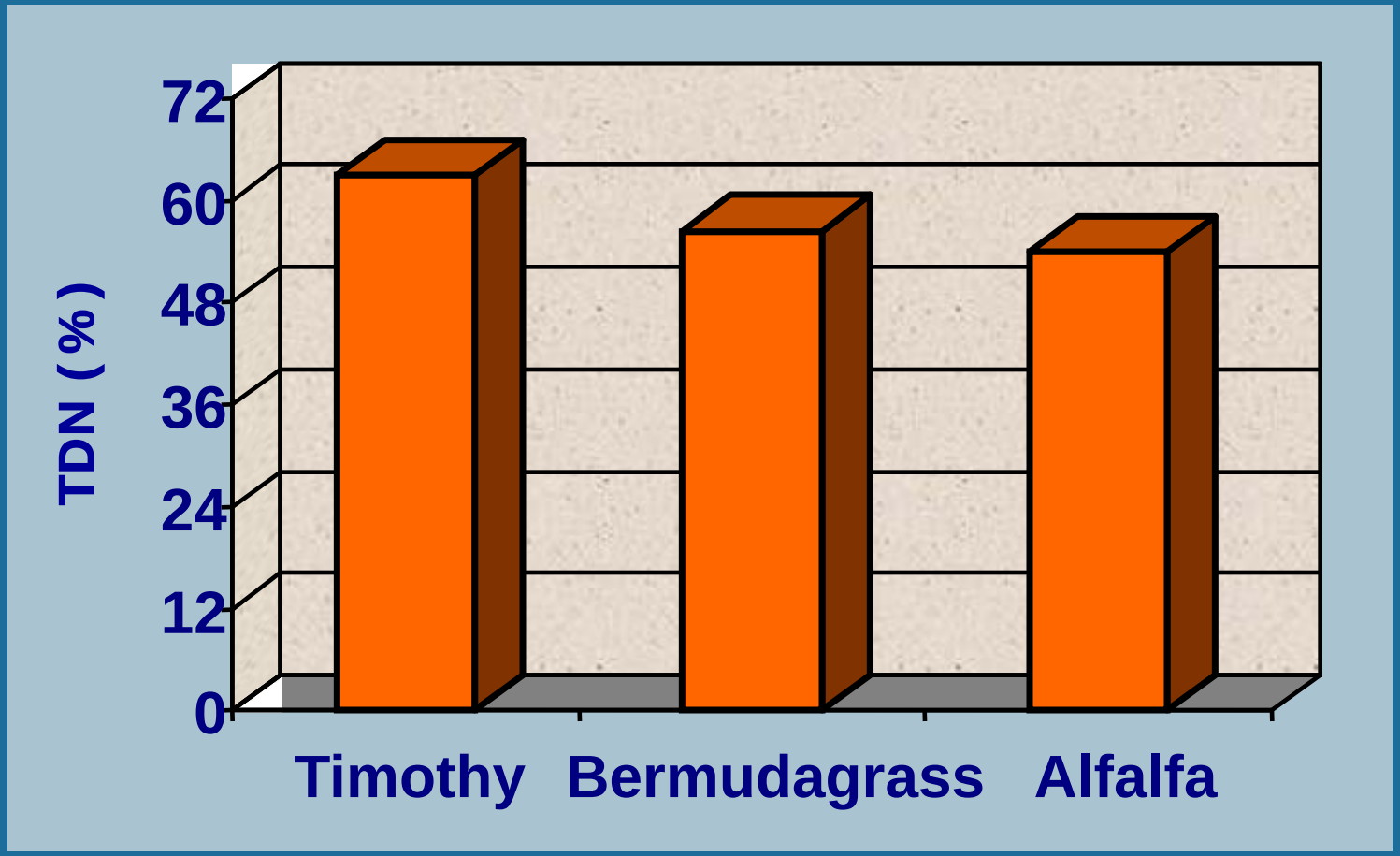
Chewing stimulates salivation

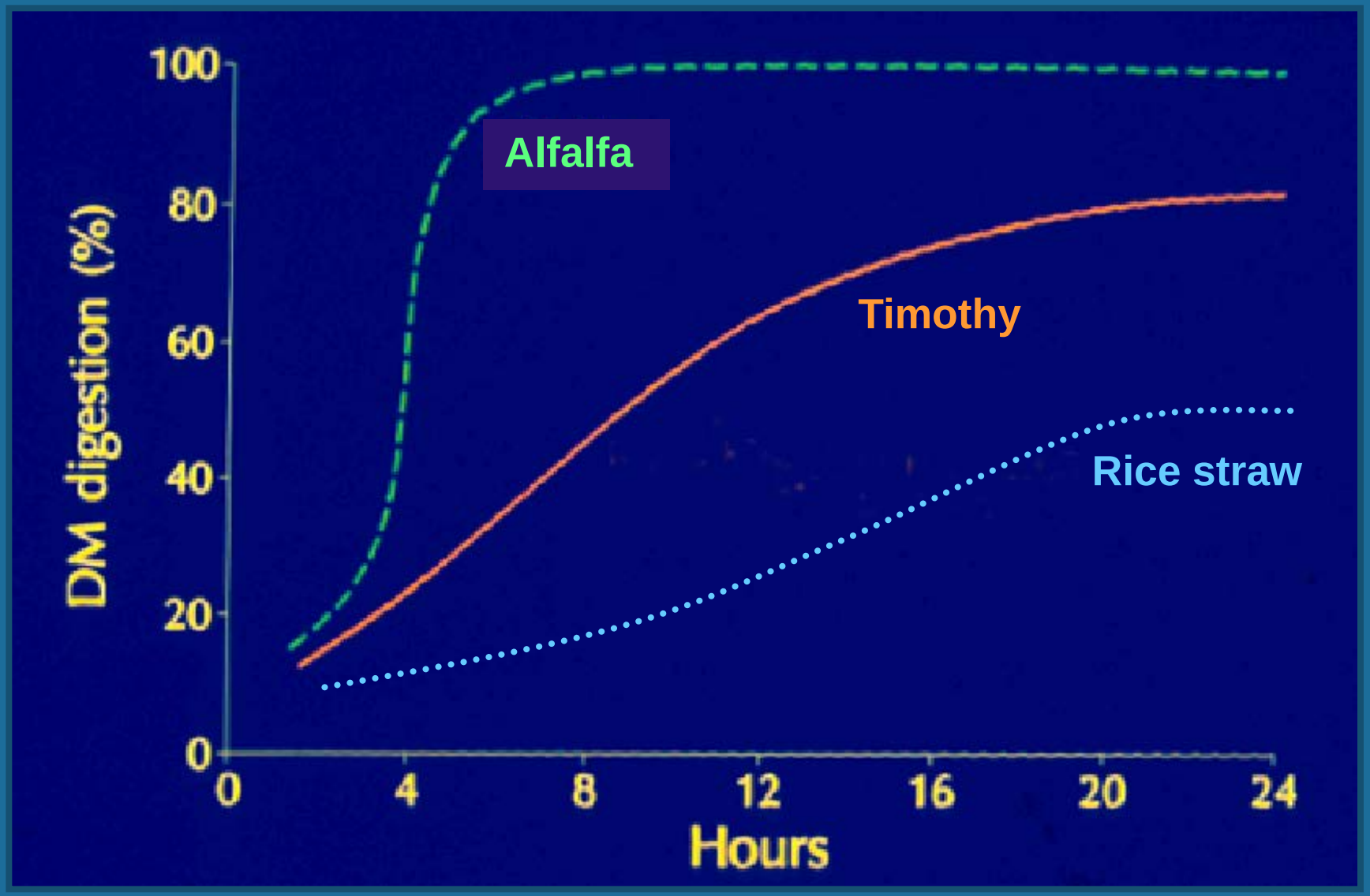
Structured roughage	Concentrates
Longer chewing time (20-25 min per lb DM)	Shorter chewing time (10-15 min per lb DM)
High saliva production (4-5 litres per lb DM)	Low saliva production (3-4 litres per lb DM)
High rumen pH (pH 6-6.8)	Low rumen pH (pH 5.4-6)
Fiber-digesting microbes predominate	Starch-digesting microbes predominate
More acetic acid Less propionic acid	Less acetic acid More propionic acid
Higher milk fat %	Lower milk fat %

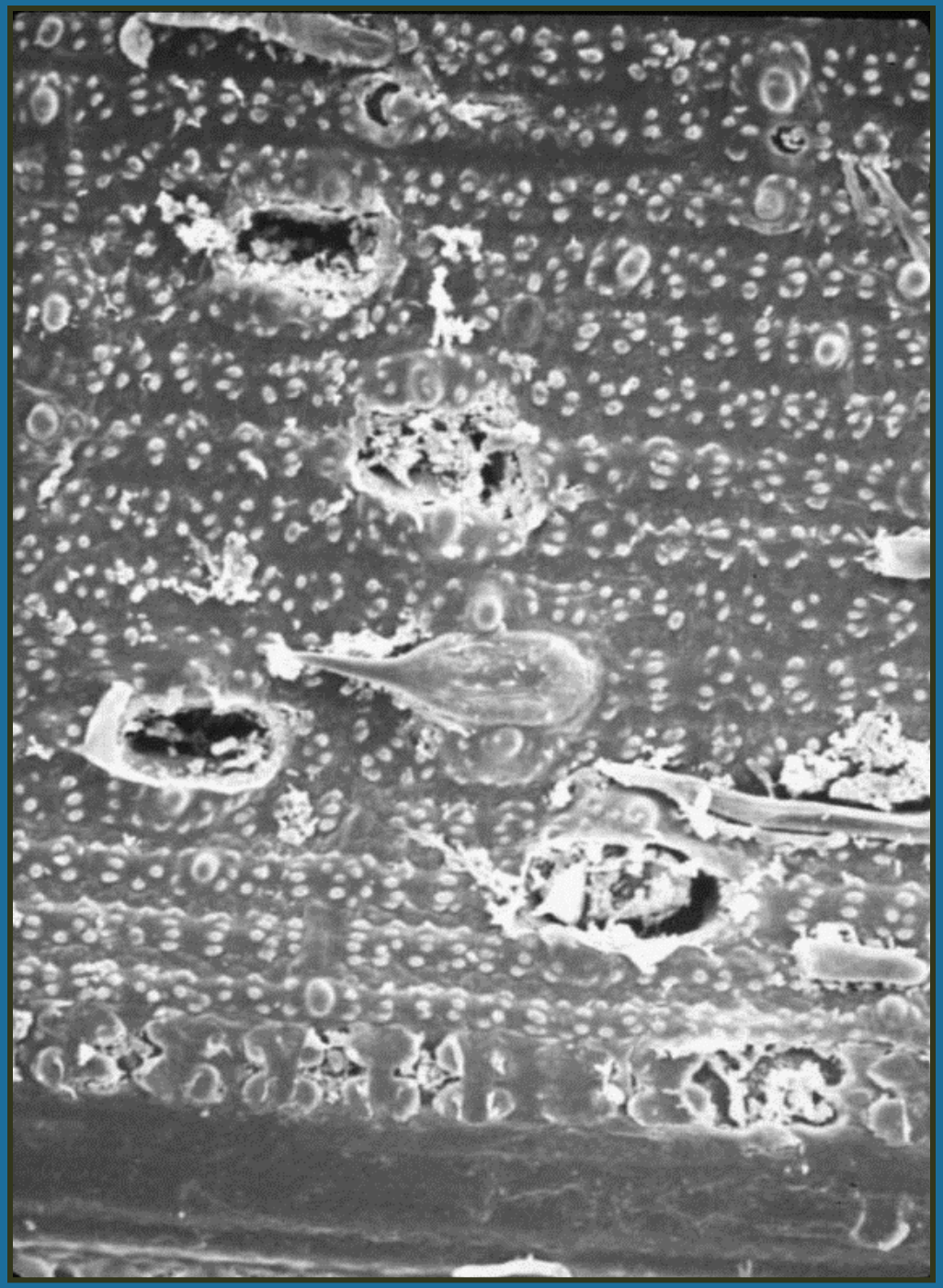
Effective fiber

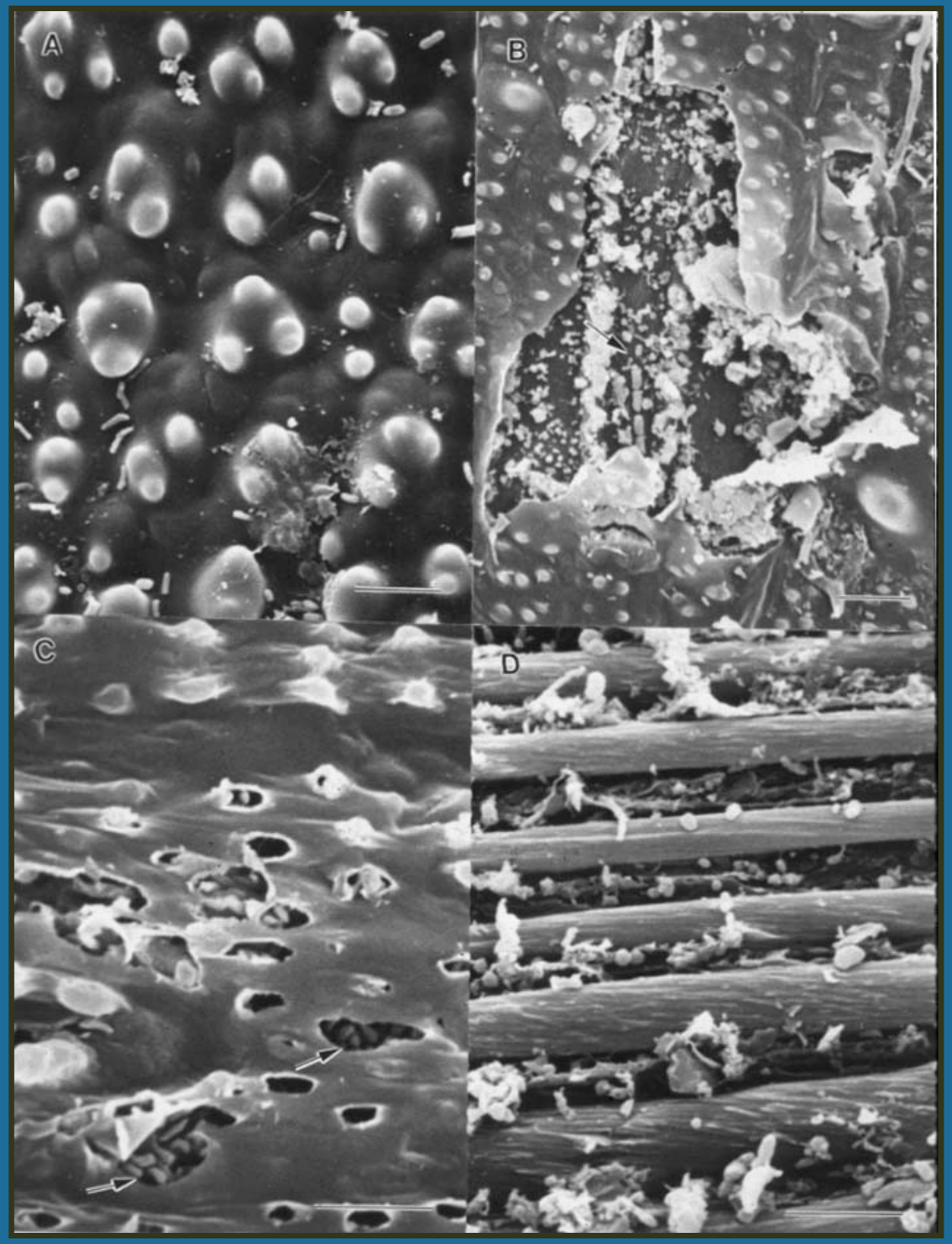
- Length of fiber
  - Longer length  effective fiber
- Fiber composition
  - Higher NDF or ADF level,  effective fiber
- Effective fiber should be digestible fiber
- Requirement for NDF at 25 - 28% DM
  - 75% from forage

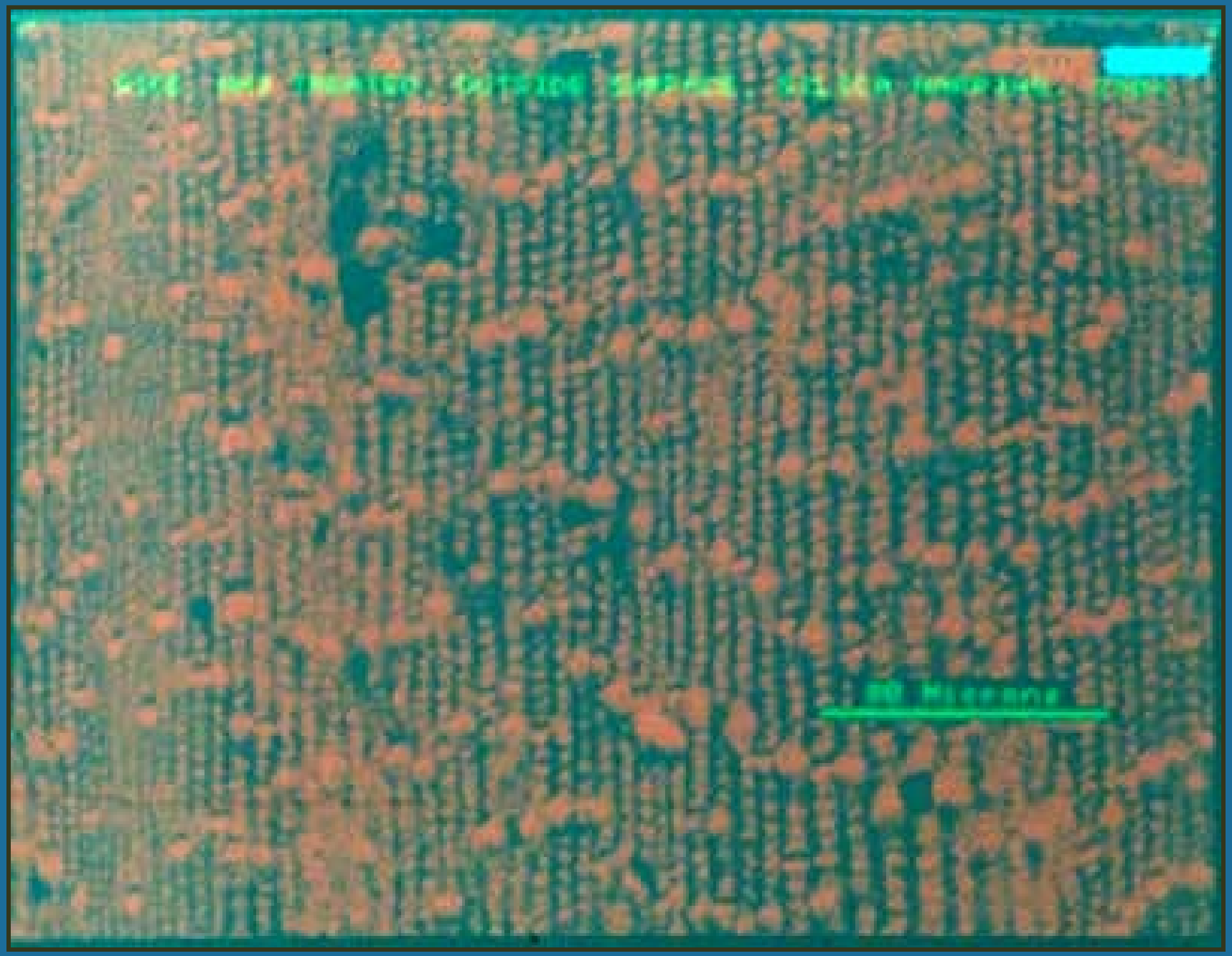
Digestibility of forage nutrients by dairy goats




DM digestion (%)
100
80
60
40
20
0
0
4
8
12
16
20
24
Hours
Alfalfa
Timothy
Rice straw




A
B
C
D



Sources of long fiber

C_3 grasses

"Cool Season Grasses"

- Optimum range of temperatures for growth 16-22°C
- Temperate regions
- Typically 4 seasons
- Examples: timothy, bromegrass, ryegrass, orchardgrass

C_4 grasses

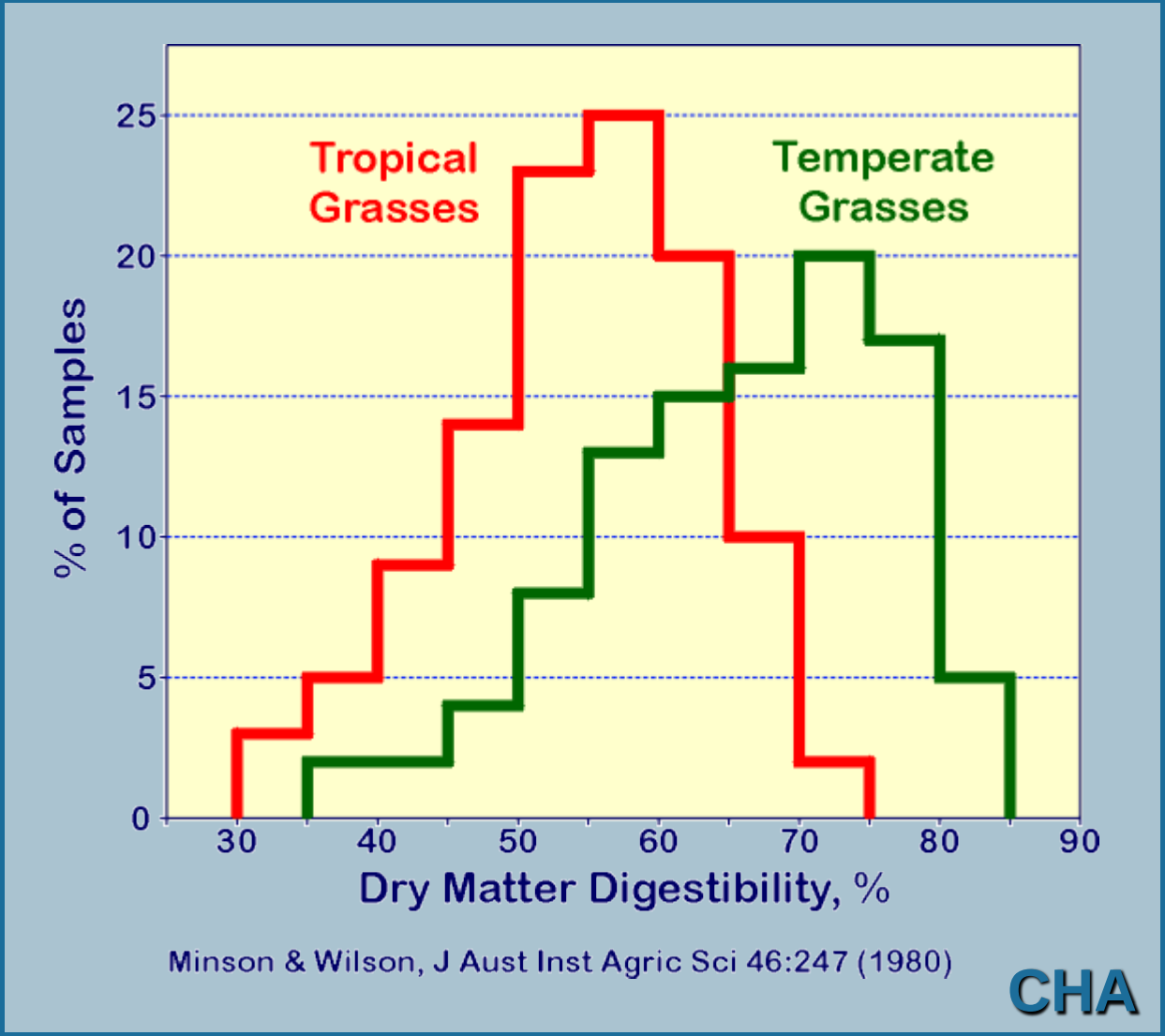
"Warm Season Grasses"

- Optimum range of temperatures for growth 28-34°C
- Tropical regions
- Typically 4 seasons
- 2 dry and 2 rainy periods
- Areas free from frost
- Examples: sudangrass, bermudagrass, corn

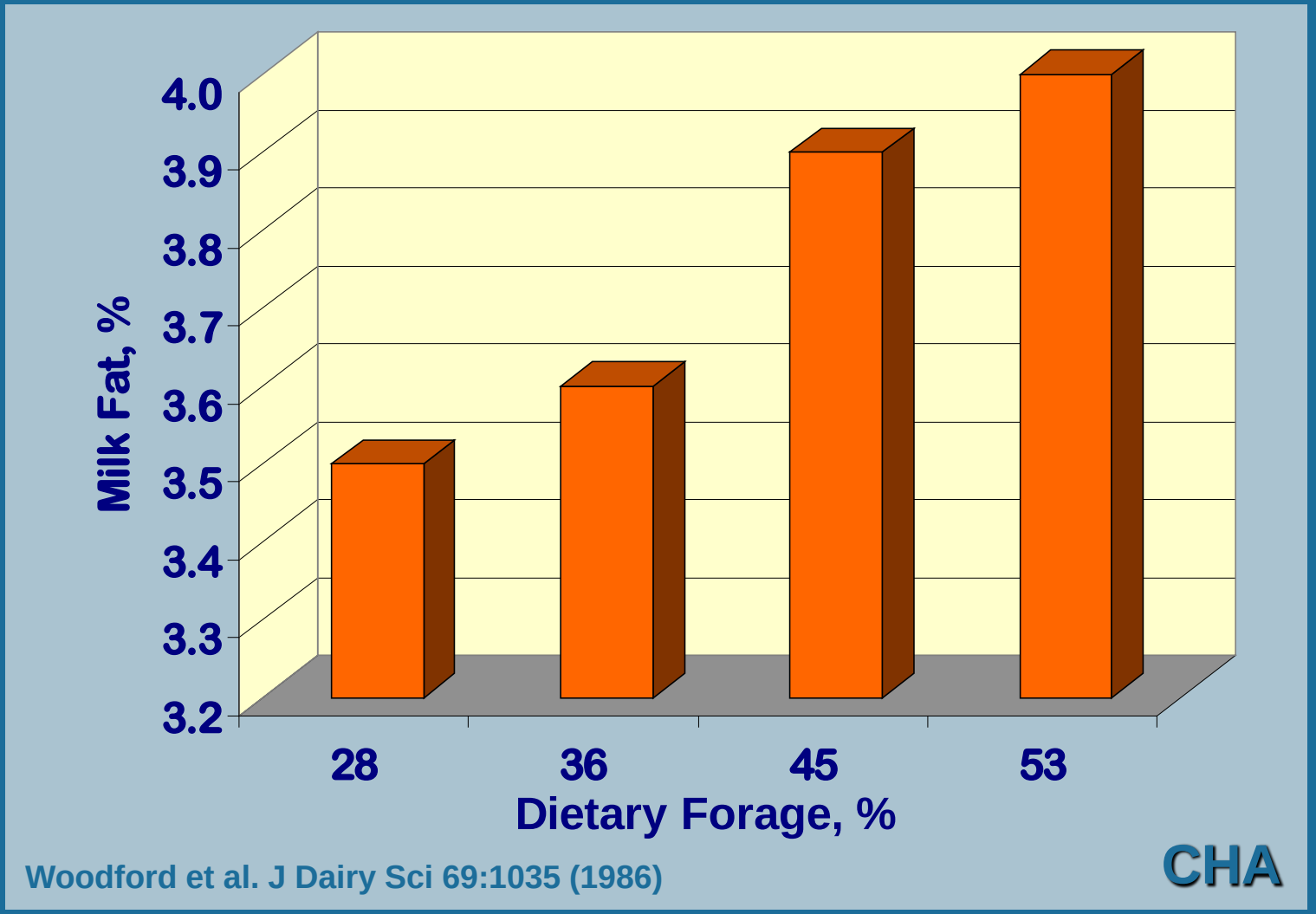
Timothy hay vs bermudagrass hay

- Cool season grasses have higher digestibility
- Cool season grasses have lower levels of hemicellulose and lignin
- Cool season grasses have higher leaf/stem ratios

Digestibility of temperate vs tropical grasses



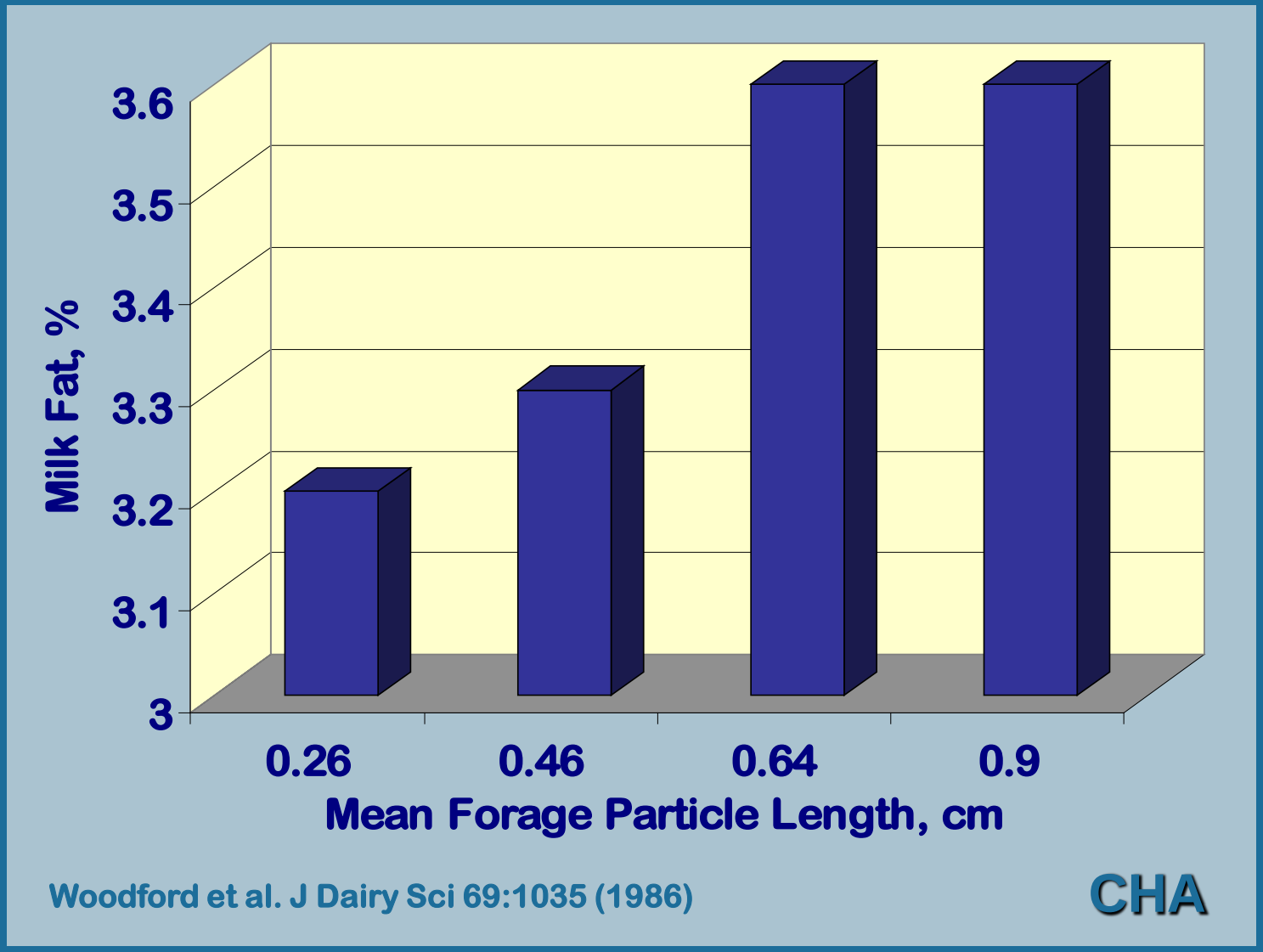
Forage increases milk fat %



Woodford et al. J Dairy Sci 69:1035 (1986)

CHA

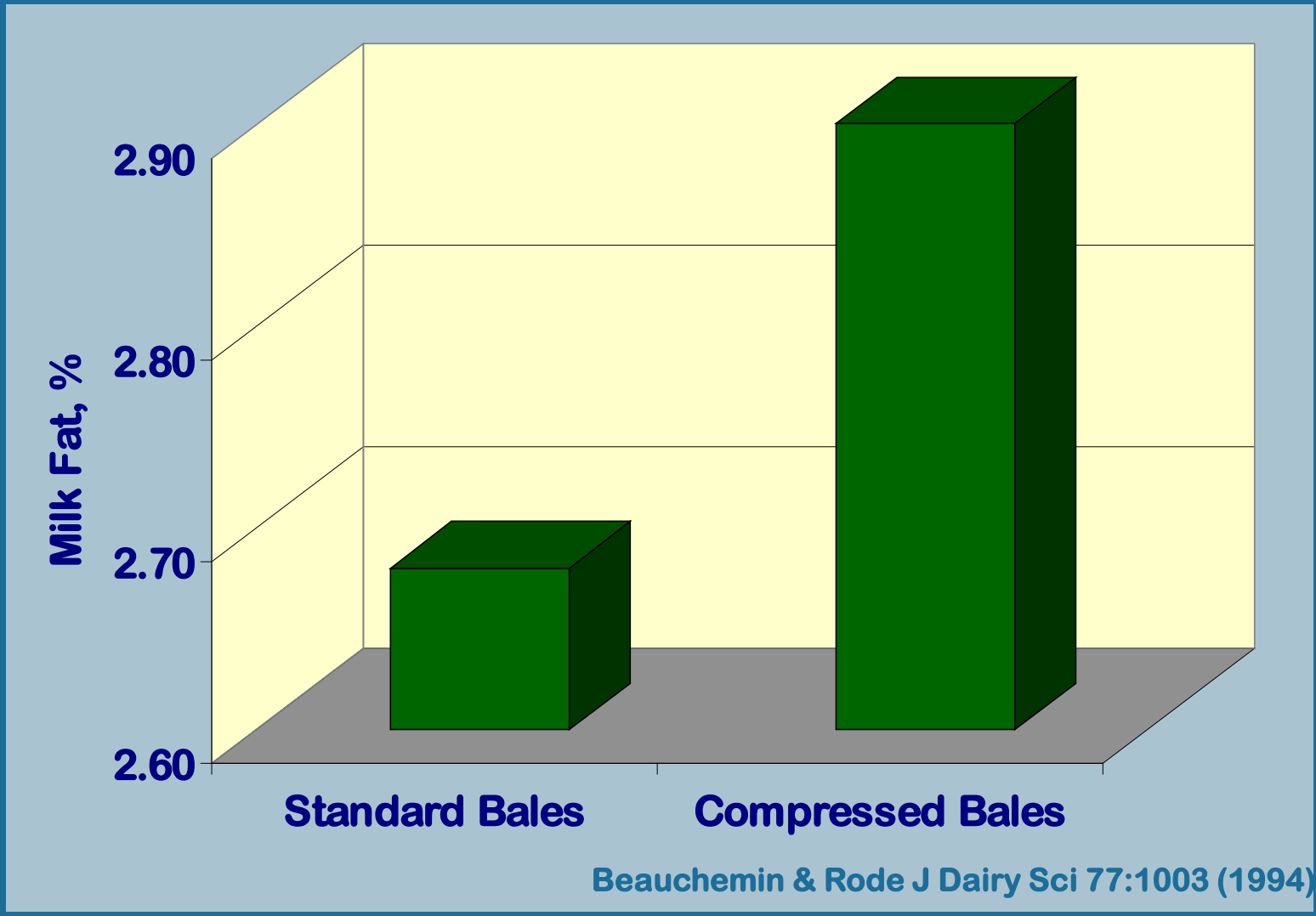
Long fiber increases milk fat %



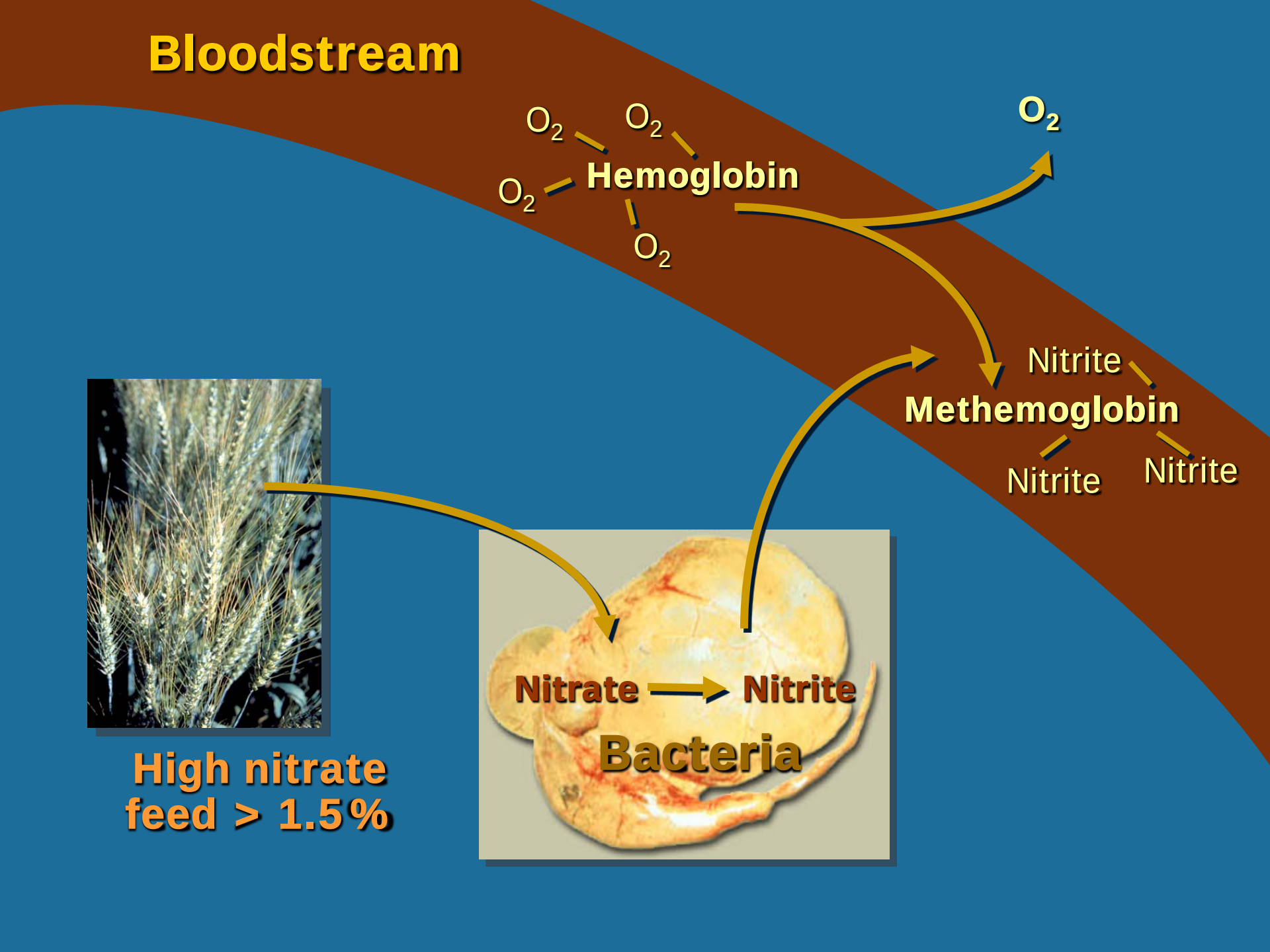
Woodford et al. J Dairy Sci 69:1035 (1986)

CHA

Compressing forages increased milk fat %



Beauchemin & Rode J Dairy Sci 77:1003 (1994)


Bloodstream
O_2
O_2
O_2
O_2
Hemoglobin
O_2
Nitrite
Methemoglobin
Nitrite
Nitrite
Nitrate → Nitrite
Bacteria
High nitrate feed > 1.5%

Levels of nitrates in forages

	Nitrate level (dry matter basis) Method of reporting			
	% NO_3	% NO_3-N	% KNO_3	Comments
Less than	0.5	0.12	0.81	Generally “safe” with no adverse effect on performance expected
	0.5 to 1.0	0.12 to 0.23	0.81 to 1.63	Caution: may cause reduced growth or milk production, possibly a few abortions
Greater than	1.0	0.23	1.63	High nitrate feed: expect reduced growth and milk production, possibly abortion and death loss

Source: Yaremcio, B., 1991. “Using High Nitrate Feeds”, Alberta Agriculture

Nitrate poisoning

- **Symptoms**
  - Impaired growth
  - Sudden death
  - Abortion
- **Prevention**
  - Adaptation
  - Cut forage higher
  - Mix forage off with low nitrate feed (e.g., Timothy)

Examples of feeds with potentially high nitrate

- Cereal grains → oats, barley and corn
- Sorghum-sudangrass
- Oat hay (reported as high as 7%)

Advantages of Timothy hay

- Excellent source of effective fiber
  - Prevention of acidosis, lameness, displaced abomasum and bloat
- Fiber is still digestible
- Low risk of nitrate poisoning

Chewing stimulates salivation

Structured roughage	Concentrates
Longer chewing time (20-25 min per lb DM)	Shorter chewing time (10-15 min per lb DM)
High saliva production (4-5 litres per lb DM)	Low saliva production (3-4 litres per lb DM)
High rumen pH (pH 6-6.8)	Low rumen pH (pH 5.4-6)
Fiber-digesting microbes predominate	Starch-digesting microbes predominate
More acetic acid Less propionic acid	Less acetic acid More propionic acid
Higher milk fat %	Lower milk fat %