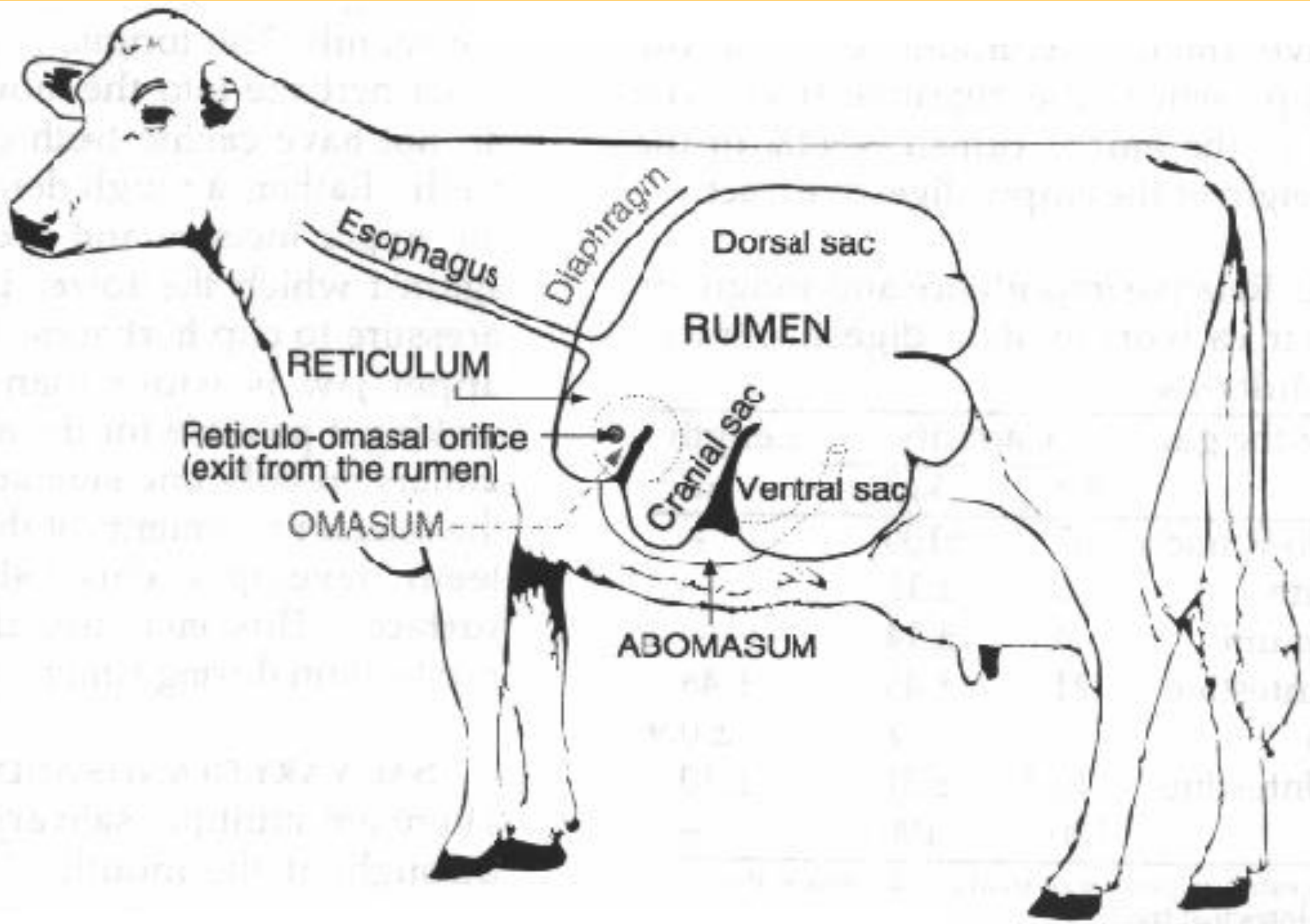


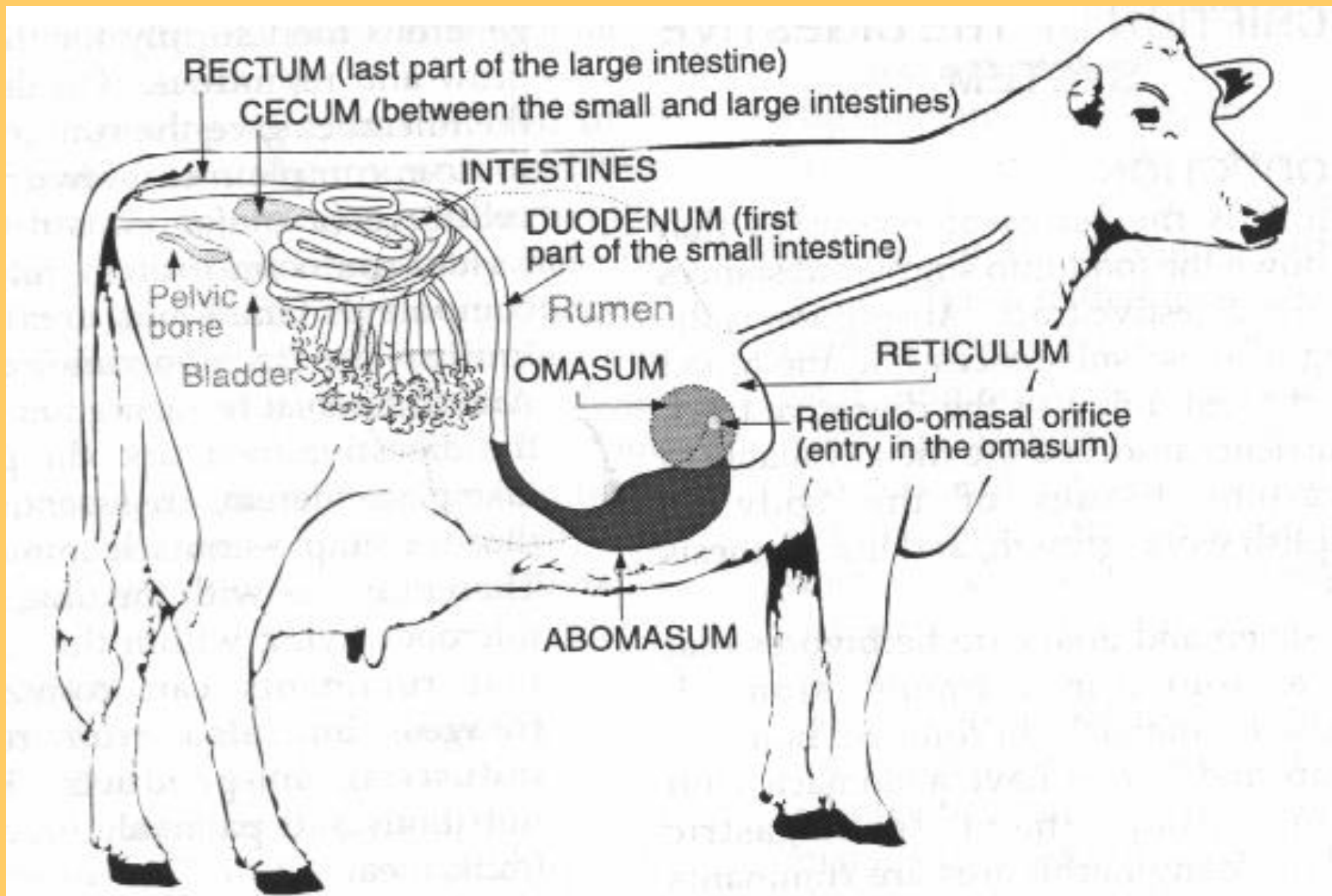
BIOLOGY of RUMEN

Prof.Dr. Gültekin YILDIZ

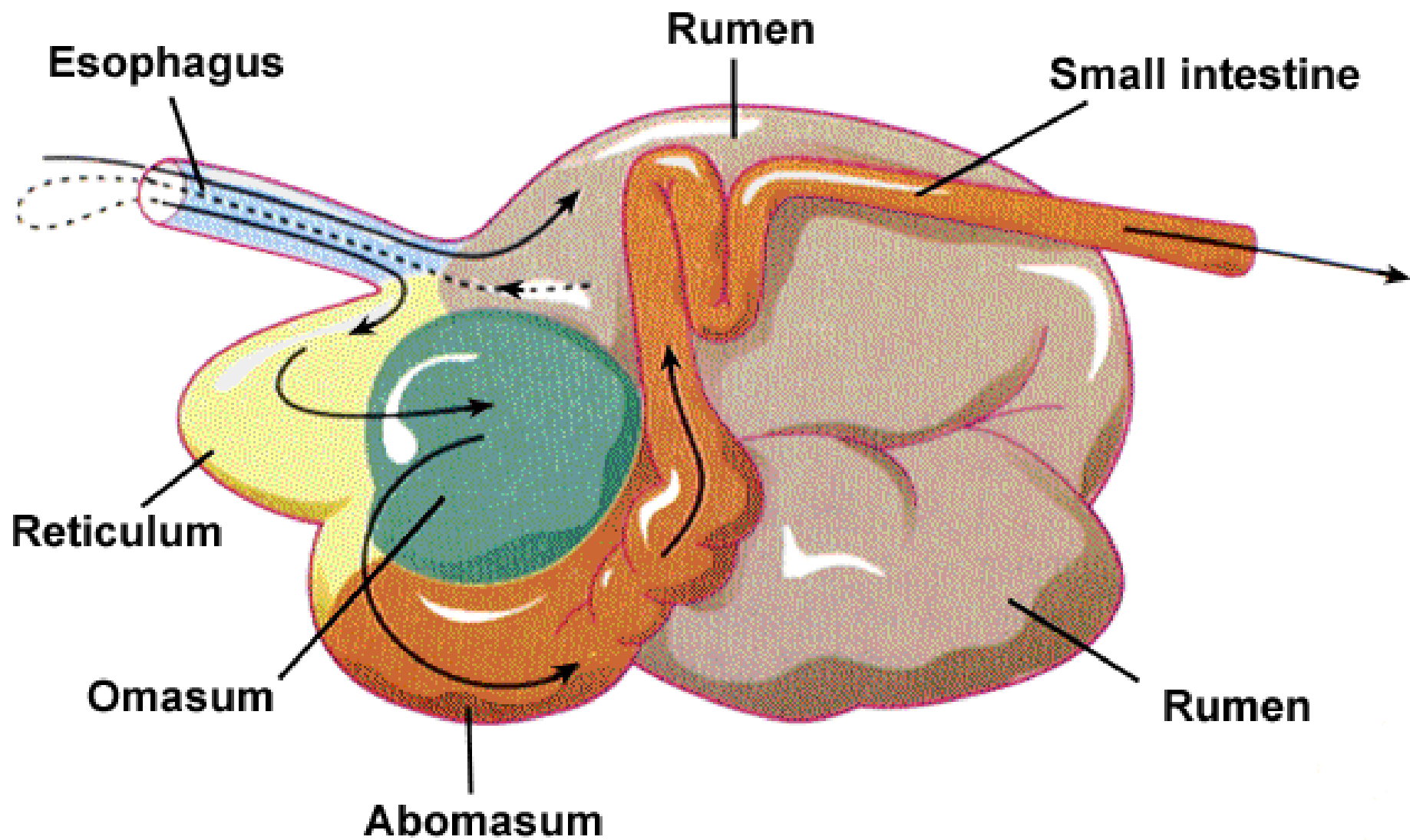




Left view of digestive system



Right view of the digestive system



Parts of the digestive tract	Average capacity, LT
Rumen	202
Reticulum	8
Omasum	19
Abomasum	23
small intestines	66
Sekum	10
large intestines	28
Total	356

Proportion of digestive organs in terms of volume

-67% of the digestive content is found in the rumen.

**-The empty weight of the rumen of the entire digestive tract
44%.**



Lips, Tongues and Teeth

- No upper incisors**
- Food is taken to the mouth with tongue**
- To ruminate with oral lateral movements and lateral movements are available.**

Secretion Glands and Esophagus

- There are many salivary glands around the mouth**
- Esophageal has no digestive function.**
and then returned to the mouth for ruminating.
It is a little short tube from 1 m.

**Reticulo-rumen strong muscle structure and internal
The surface has numerous papillae structures.**

**-Papillars of internal rumen by contracting rumen
contact of the surface with the content in a wide area.
provides**

**-Reticulum of the liquid, thin and dense part of
the content light and coarse returns to the rumen.**

OMASUM

- Numerous muscle leaflets on the inner surface has.

- Only 5% of the content is abomasum located.

The liquid part of the content is absorbed here.

- Enzymatic digestion occurs in abomasum and small intestine as in monogastric animals

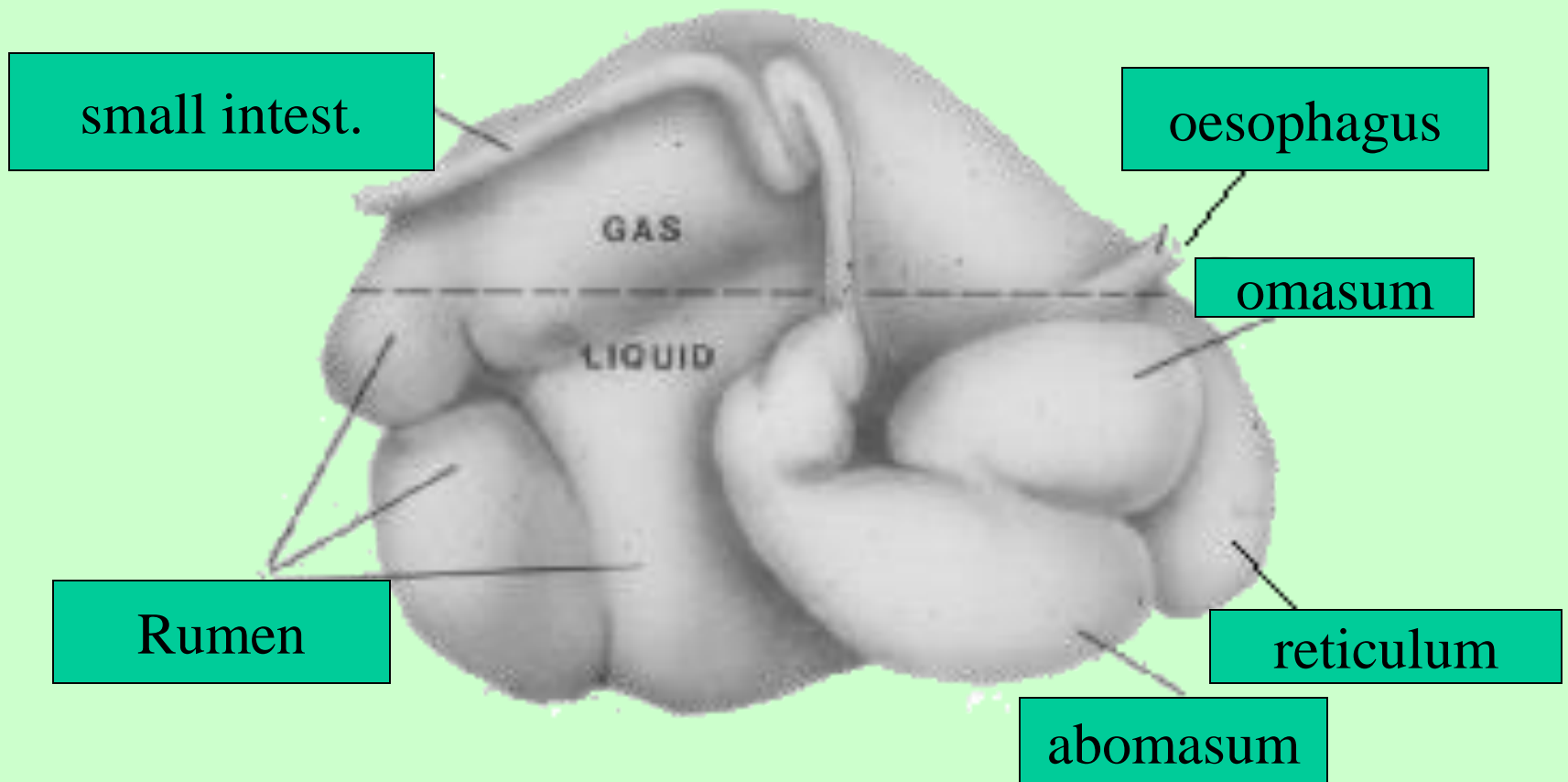


Table 13. Carbohydrate fractions for some common forages and feed ingredients.

INGREDIENT	% DM BASIS NSC	% OF NONSTRUCTURAL CARBOHYDRATES			
		SUGAR	STARCH	PECTINS β-GLUCANS	VFA
Alfalfa haylage	23.0	0.0	40.9	33.0	26.1
Grass hay	17.2	35.4	15.2	49.4	0.0
Corn silage	45.3	0.0	71.3	0.0	28.7
Barley	61.8	9.1	81.7	9.2	0.0
Corn	71.4	20.0	80.0	0.0	0.0
Hominy	59.9	8.9	80.4	10.7	0.0
Oats	42.4	4.4	95.6	0.0	0.0
Wheat	73.8	8.9	80.2	10.9	0.0
HMEC	70.8	0.0	94.8	0.0	5.2
HMSC	75.9	0.0	97.2	0.0	2.8
Canola	25.8	11.4	45.6	43.0	0.0
Distillers	10.3	0.0	100.0	0.0	0.0
Corn gluten feed	24.7	3.7	71.2	25.1	0.0
Corn gluten meal	17.3	0.0	69.4	30.6	0.0
Soyhulls	14.1	18.8	18.8	62.4	0.0
Soybean meal, 44%	34.4	25.0	25.0	50.0	0.0
Wheat midds	31.2	10.0	90.0	0.0	0.0

Source: Adapted from T. Miller, J. Grimmett, and W. Hoover, West Virginia University, 1993.

Table 22. Guide to protein composition in rations for high-producing dairy cows.

	STAGE OF LACTATION		
	EARLY	MID	LATE
Crude protein, % DM	17-18	16-17	15-16
Soluble protein, % CP	30-34	32-36	32-38
Degradable protein, % CP	62-66	62-66	62-66
Undegradable protein, % CP	34-38	34-38	34-38

Source: Use of Total Mixed Rations (TMR) for Dairy Cows. Penn State Dairy and Animal Science Extension Fact Sheet 94-25.

Table 16. Guide to carbohydrate composition in rations for high-producing dairy cows.

ITEM	STAGE OF LACTATION		
	EARLY	MID	LATE
Forage NDF, % DM	21-24	25-26	27-28
Total NDF, % DM	28-32	33-35	36-38
NSC, % DM	32-38	32-38	32-38

Source: Use of Total Mixed Rations (TMR) for Dairy Cows. Penn State Dairy and Animal Science Extension Fact Sheet 94-25.

Table 12. Classification of concentrate ingredients.

CP ^a > 40%	UIP ^a > 45% OF CP	SP ^a > 30% OF CP
Corn gluten meal	Blood meal	Corn gluten feed
Urea	Corn gluten meal	Whole cottonseed
Raw soybeans	Fish meal	Wheat midds
Canola meal	Animal protein blends	Raw soybeans
Cottonseed meal	Brewers grains (wet and dry)	Urea
Heat-treated soybeans	Distillers grains	
Soybean meal (44% or 48%)	Heat-treated soybeans	
NSC ^a >55%	FAT >18%	NDF ^a >35%
Bakery product (i.e., bread)	Chocolate	Beet pulp
Barley	Bakery waste products	Corn gluten feed
Milo	Raw soybeans	Distillers grain
Rye	Whole cottonseed	Wheat midds
Corn	Candy waste products	Brewers grain (wet and dry)
Hominy	Tallow	Whole cottonseed
Oats	Heat-treated soybeans	Soyhulls
Wheat		

Source: Concentrates for Dairy Cattle. Penn State Dairy and Animal Science Extension Fact Sheet 94-06.

^a CP = crude protein; UIP = undegradable intake protein; SP = soluble protein; NSC = nonstructural carbohydrates; NDF = neutral detergent fiber. All values are listed on a dry matter basis.

Changes in cellulose digestion and microbial concentrations during fermentation of pure cellulose in rumen contents with and without antibiotics*

	non Antibiotics			with Antibiotics		
Periot (s)	cellulose, %	Bacteria ($\times 10^7$)	fungi ($\times 10^2$)	diges cellulose, %	bacteria ($\times 10^7$)	fungi ($\times 10^2$)
0	0	9	12	0	9	12
24	38	1000	0.01	1	0.0004	16
30	51	451	0.02	3	0.002	50
48	57	290	0	17	0.004	230
72	70	38	0	47	0.003	510

*Dehority ve Tirabasso (1993). Concentration in fermentation medium / ml

Bacterial Growth in Rumen

age of the animal	Total anaerobic bacteria (10 ⁹ /ml)	cellulose- degrading bacteria	lactat degrading bacteria
1. week	3.8	1.2	680
2. week	3.3	110.0	310
9. week	2.9	430.0	16

Rumen siliataları ve karakteristik özellikleri

	Holotriche Siliata		Oligotricha Siliata	
Tür	Isotricha	Dasitricha	Diplodinium	Entodinium
Cins	I.prostoma I.intestinalis	D.ruminantium	Eudiplodinium medium	E.caudatum
Organizmada hangi Rasyonda gözlenirler	Kuru ot ve Pancar	Kaba yem	Konsantre yem	
gerekli substrat	çözünebilir CHO	HS'dan zengin	Nişasta	
gerçek Met.ürünü	Asetat,Butirat,Laktat, H ₂ ,Amilopektin,CO ₂	UYA,CO ₂ ,H ₂	UYA,Laktat, CO ₂ ,depo CHO	

- The microbial population in the rumen consists of bacteria, protozoa, and fungi. The majority of the concentration is as bacteria, which can number 10^{10} to 10^{11} cells/gram of rumen contents. Bacteria can be grouped according to their three main shapes (cocci, rods, and spirilla), according to their size (generally from 0.3 to 50 μm), and according to their different structures

BACTERIA

The rumen contains heterogeneous microbial populations including bacteria, protozoa and anaerobic fungi.

Bacteria constitute the largest proportion of rumen fluid.

A calf can produce rumen microorganisms from 1 kg to 1.5 kg per day.

Grouping of rumen bacterial species according to the type of substrates fermented

- **Major Cellulolytic Species**

- Bacteroides succinogenes
Ruminococcus flavefaciens Ruminococcus
albus Butyrivibrio fibrisolvens

- **Major Pectinolytic Species**

- Butyrivibrio fibrisolvens Bacteroides
ruminicola Lachnospira multiparus
Succinivibrio dextrinosolvens Treponema
bryantii Streptococcus bovis

- **Major Ureolytic Species**

- Succinivibrio
dextrinosolvens Selenomonas sp. Bacteroides
ruminicola Ruminococcus
bromii Butyrivibrio sp. Treponema sp.

- **Major Sugar-utilizing Species**

- Treponema bryantii Lactobacillus
vitulinus Lactobacillus ruminus

- **Major Proteolytic Species**

- Bacteroides amylophilus Bacteroides
ruminicola Butyrivibrio fibrisolvens
Streptococcus bovis

- **Major Lipid-utilizing Species**

- Anaerovibrio lipolytica Butyrivibrio
fibrisolvens Treponema bryantii
Eubacterium sp. Fusocillus sp. Micrococcus
sp.

- **Major Hemicellulolytic Species**

- Butyrivibrio fibrisolvens Bacteroides
ruminicola Ruminococcus sp.

- **Major Amylolytic Species**

- Bacteroides amylophilus Streptococcus
bovis Succinimonas amylolytica
Bacteroides ruminicola

- **Major Methane-producing Species**

- Methanobrevibacter ruminantium
- Methanobacterium formicicum
- Methanomicrobium mobile

- **Major Acid-utilizing Species**

- Megasphaera elsdenii Selenomonas ruminantium

- **Major Ammonia-producing Species**

- Bacteroides ruminicola Megasphaera elsdenii Selenomonas ruminantium

- Source: Church, D. C., ed. The Ruminant Animal: Digestive Physiology and Nutrition. Englewood Cliffs, N.J.: Prentice Hall, 1988.

Effect of ration on eating rate and on saliva production.

Chemical composition of saliva from cattle.

Eating rate		SALIVARY PRODUCTION
FEED	POUNDS OF FEED/MIN	TEASPOONS/POUND OF FEED
Pelleted	.79	1.0
Fresh grass	.62	1.5
Silage	.55	2.0
Dried grass	.18	5.0
Hay	.15	6.0

Element

mEq/l

Sodium

126

Potassium

6

Phosphate

26

Chloride

7

Bicarbonate

126

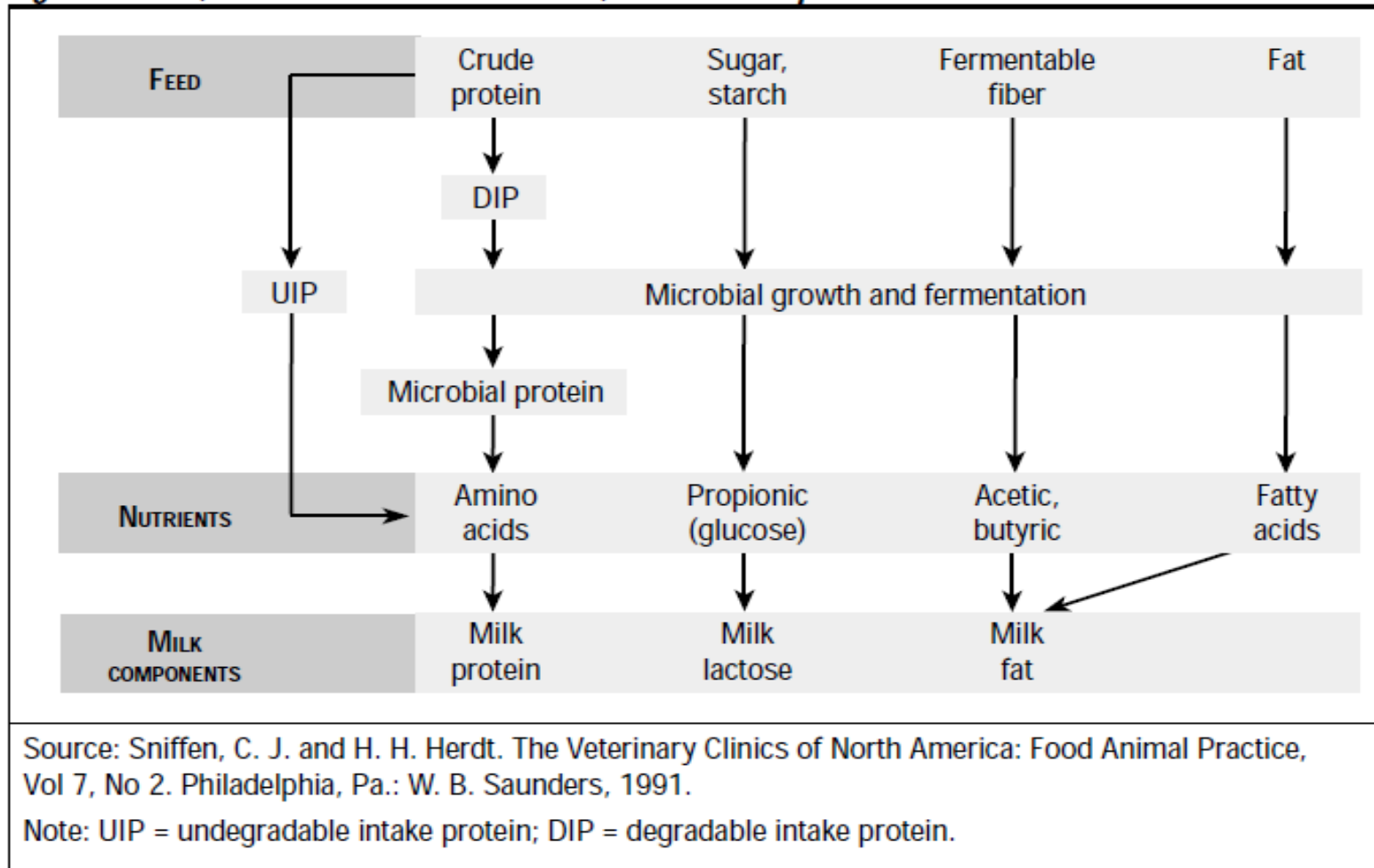
<u>İçerik</u>	<u>Miktar,%</u>
Hidrojen	0.2
Oksijen	0.5
Nitrojen	7.0
Metan	26.8
Karbondioksit	65.5

Rumen gazlarının tipik kompozisyonu

**Rumende her gün 500 ile 1000 lt arasında
gaz üretilir !!!**

- There are two basic groups of bacteria which function at various pH's.
- The fiber digesters are most active at a pH of 6.2 to 6.8.
- Cellulolytic bacteria and methanogenic bacteria can be reduced when the pH begins to fall below 6.0.
- The starch digesters prefer a more acidic environment, a pH of 5.2 to 6.0.
- Certain species of protozoa can be greatly depressed with a pH under 5.5.
- To accommodate all these needs, normal feeding practices should maintain a pH range between 5.8 to 6.4.

Figure 3. Feed, nutrient flow from the rumen, and milk components.



Eating, rumination behavior, rumen pH, volatile fatty acids (VFA's), average milk yield, and milk composition as influenced by particle size of the ration.

ITEM	RATION		
	FINE	MEDIUM	COARSE
Eating, min./24 hr	195.3	204.4	204.7
Ruminating, min./24 hr	374.4 ^a	466.3 ^b	530.7 ^c
Total chewing time, min./24 hr	569.7 ^a	670.7 ^b	735.4 ^c
pH	5.3 ^a	5.9 ^b	6.0 ^b
VFA, molar %			
Acetic	58.33 ^c	61.24 ^d	61.82 ^d
Propionic	22.34 ^c	20.16 ^{c, d}	19.46 ^d
Actual milk, lb/day	69.3	70.6	68.4
4% FCM, lb/day	60.5 ^a	66.6 ^{b, c}	64.9 ^{a, c}
Milk fat, %	3.0 ^a	3.6 ^{b, c}	3.8 ^c
Milk protein, %	3.0	3.0	3.1

