

# صنایع لبنی 1

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**TABLE 2.13**  
**Proteins in Milk**

Protein	mmol/m <sup>3</sup> Milk	g/kg Milk	g/100 g Protein	Molar Mass	g Protein/g N	Remarks
Casein	1120	26	78.3		6.36	IEP ≈ 4.6
α <sub>S1</sub> -Casein	450	10.7	32	~23600	—	Phosphoprotein
α <sub>S2</sub> -Casein	110	2.8	8.4	~25200	—	Same, contains –S–S–
β-Casein	360	8.6	26	23983	—	Phosphoprotein
κ-Casein	160	3.1	9.3	~19550	—	“Glycoprotein”
γ-Casein	40	0.8	2.4	~20500	—	Part of β-casein
Serum proteins	~320	6.3	19	—	~6.3	Soluble at IEP
β-Lactoglobulin	180	3.2	9.8	18283	6.29	Contains cysteine
α-Lactalbumin	90	1.2	3.7	14176	6.25	Part of lactose synthase
Serum albumin	6	0.4	1.2	66267	6.07	Blood protein
Proteose peptone	~40	0.8	2.4	4000–40000	~6.54	Heterogeneous
Immunoglobulins	~4	0.8	2.4	—	~6.20	Glycoproteins
IgG1, IgG2	—	0.65	1.8	~150000	—	Several types
IgA	—	0.14	0.4	~385000	—	
IgM	—	0.05	0.2	~900000	—	Part is cryoglobulin
Miscellaneous	—	0.9	2.7	—	—	
Lactoferrin	~1	0.1	—	86000	6.14	Glycoprotein, binds Fe
Transferrin	~1	0.01	—	76000	6.21	Glycoprotein, binds Fe
Membrane proteins	—	0.7	2	—	~7.1	Glycoproteins, etc.
Enzymes	—	—	—	—	—	

*Note:* Approximate composition. IEP = isoelectric pH.

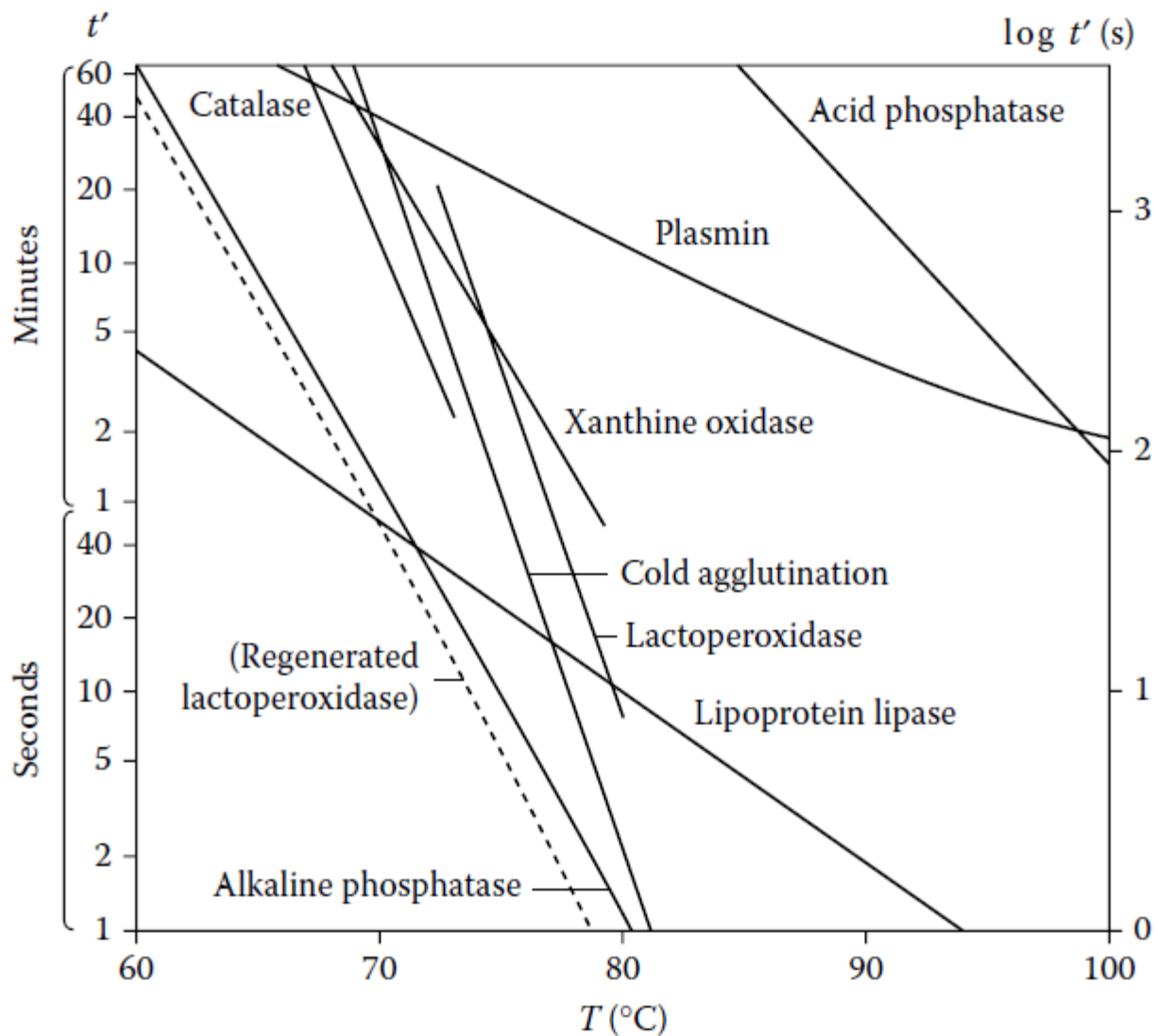
**TABLE 2.16**  
**Some Enzymes in Milk**

Name	EC Number	Optimum		Activity <sup>a</sup>		Where in Milk	Inactivation <sup>b</sup>
		pH	Temperature (°C)	Potential	Actual		
Xanthine oxidase	1.1.3.22	~8	37	>>40	40	Fat globule membrane	7 min 73°C
Sulfhydryl oxidase	1.8.?	~7	~45	?	?	Plasma	3 min 73°C
Catalase	1.11.1.6	7	37?	?	300	Leukocytes	2 min 73°C
Lactoperoxidase	1.11.1.7	6.5	20	?	22000	Serum	10 min 73°C
Superoxide dismutase	1.15.1.1	?	37?	~2000	?	Plasma	65 min 75°C
Lipoprotein lipase	3.1.1.34	~9	33	3000	0.3	Casein micelles	30 s 73°C
Alkaline phosphatase	3.1.3.1	~9	37	500	<<500	Fat globule membrane	20 s 73°C
Ribonuclease	3.1.27.5	7.5	37	( <sup>c</sup> )	?	Serum	?
Plasmin	3.4.21.7	8	37	3	0.05	Casein micelles	40 min 73°C

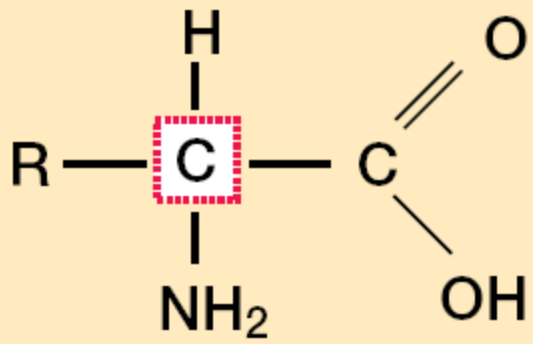
<sup>a</sup>  $\mu\text{mol} \cdot \text{min}^{-1} \cdot \Gamma^{-1}$ .

<sup>b</sup> Heat treatment needed to reduce activity to approximately 1%.

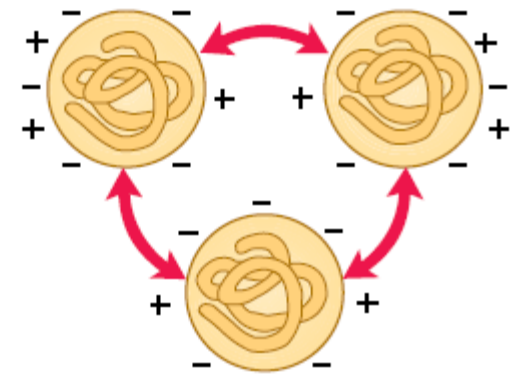
<sup>c</sup> 11–25 mg enzyme per kg of milk.



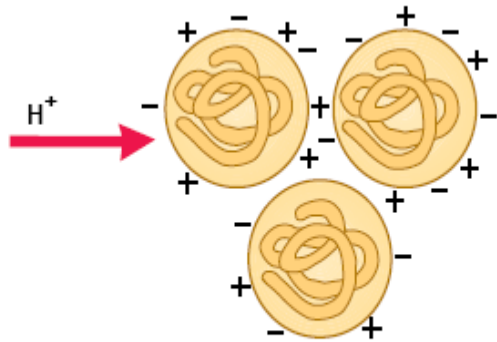
**FIGURE 2.31** Time ( $t'$ ) and temperature ( $T$ ) of heating milk needed to inactivate some enzymes (i.e., reduce the activity by about 99%) and to prevent cold agglutination. Approximate examples. (Modified after P. Walstra and R. Jenness, *Dairy Chemistry and Physics*, New York, Wiley, 1984.)



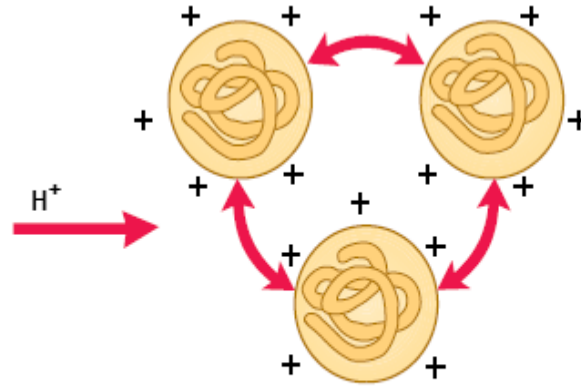
The structure of a general amino acid. *R* in the figure stands for organic material bound to the central carbon atom.



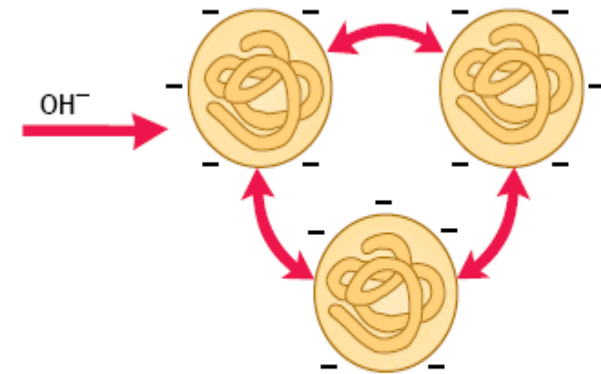
**Fig 2.25** A protein molecule at pH 6.6 has a net negative charge.



**Fig 2.26** Protein molecules at pH  $\approx$  4.7, the isoelectric point.



**Fig 2.27** Protein molecules at pH  $\approx$  1



**Fig 2.28** Protein molecules at pH  $\approx$  14

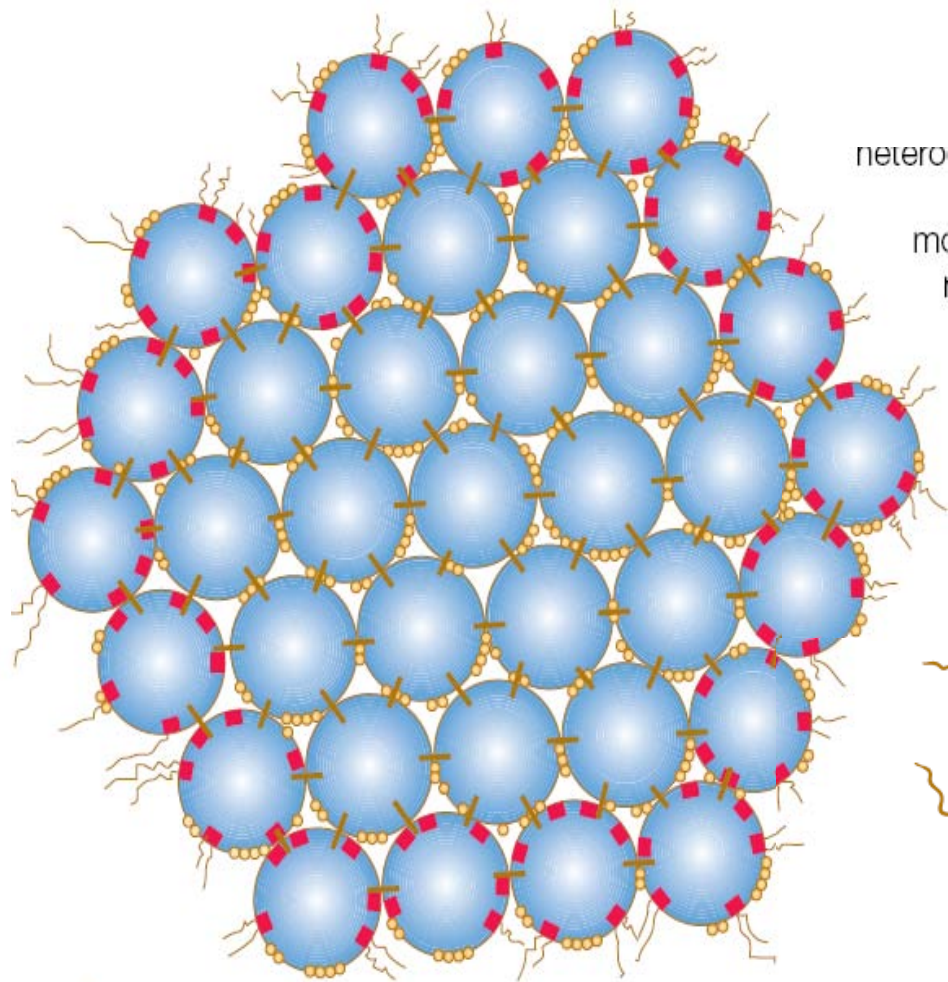
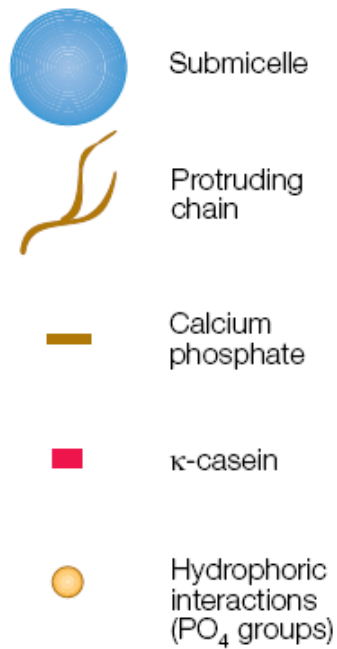
**Table 2.5****Concentration of proteins in milk**

	Conc. in milk g/kg	% of total protein w/w
Casein		
$\alpha_{s1}$ -casein*)	10.0	30.6
$\alpha_{s2}$ -casein*)	2.6	8.0
$\beta$ -casein**)	10.1	30.8
$\kappa$ -casein	3.3	10.1
Total Casein	26.0	79.5
Whey Proteins		
$\alpha$ -lactalbumin	1.2	3.7
$\beta$ -lactoglobulin	3.2	9.8
Blood Serum Albumin	0.4	1.2
Immunoglobulins	0.7	2.1
Miscellaneous (including Proteose-Peptide)	0.8	2.4
Total Whey Proteins	6.3	19.3
Fat Globule Membrane Proteins	0.4	1.2
Total Protein	32.7	100

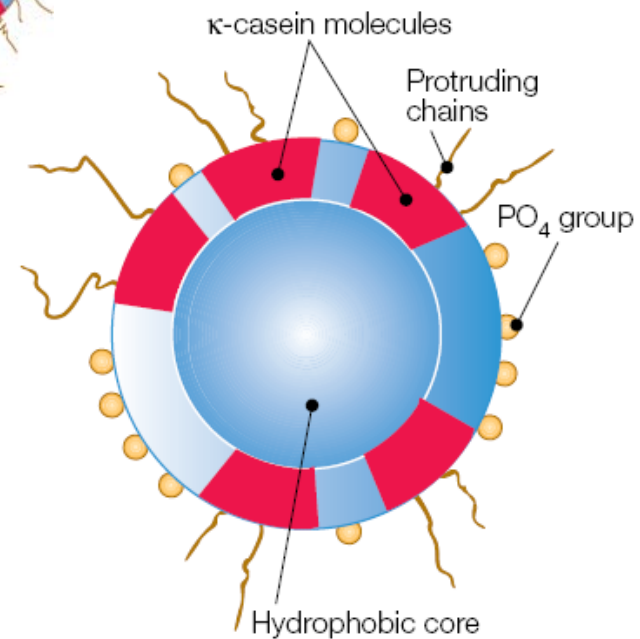
\*) Henceforth called  $\alpha_s$ -casein

\*\*\*) Including  $\gamma$ -casein

Ref: Walstra & Jenis

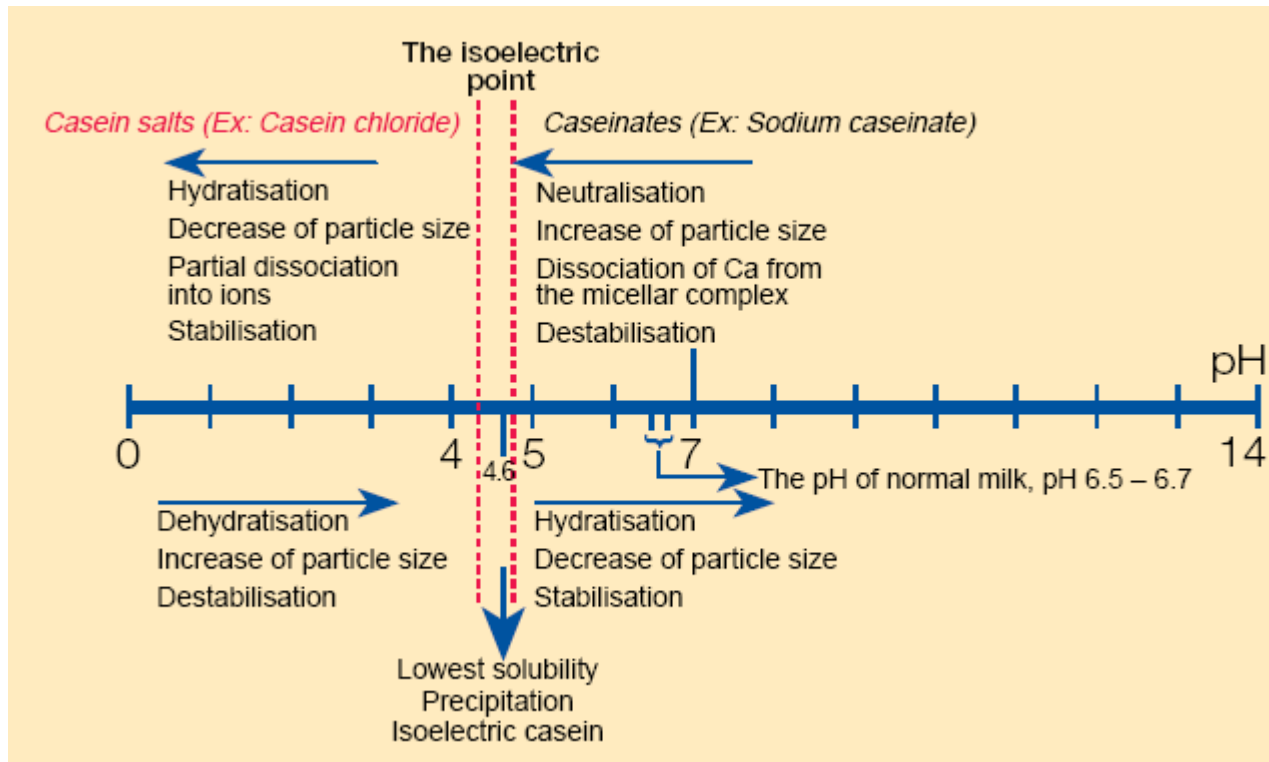
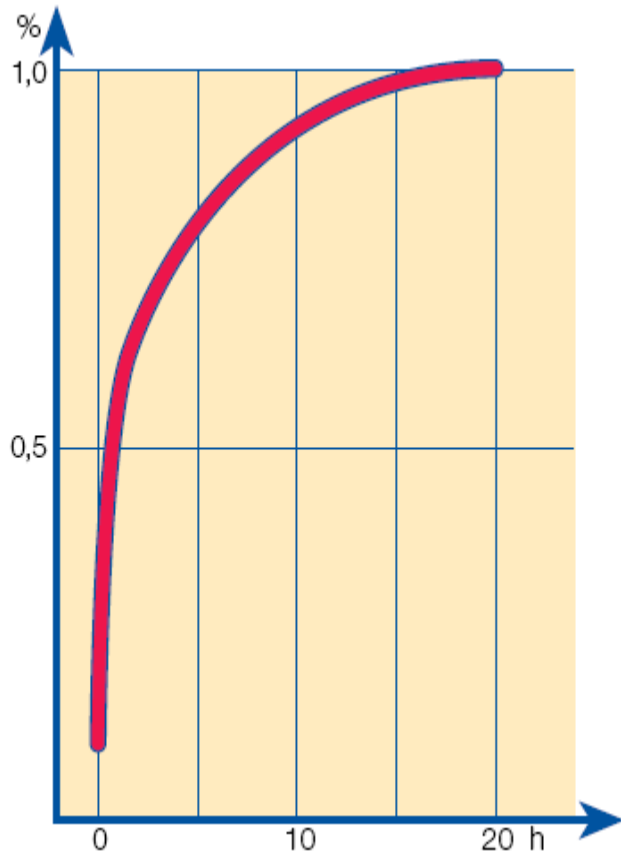


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**Buildup and stabilisation of casein micelles.**

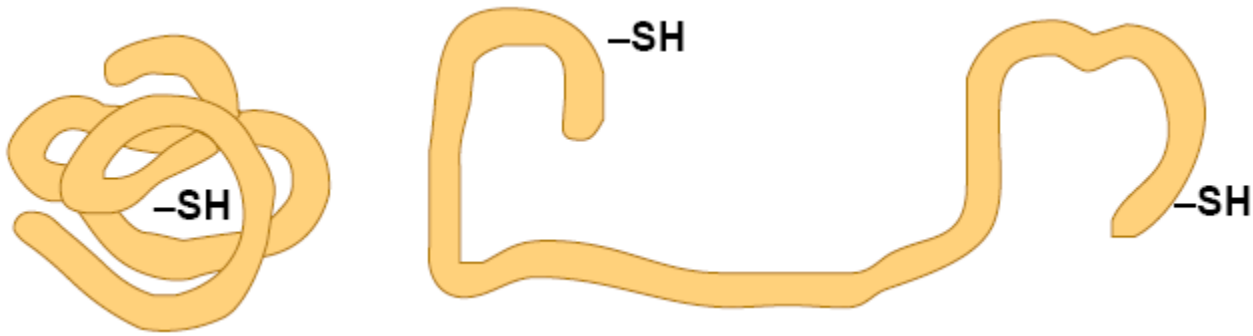
**Structure of a casein submicelle.**



$\beta$ -casein in milk serum at +5°C

Three simplified stages of influence on casein by an acid and alkali respectively

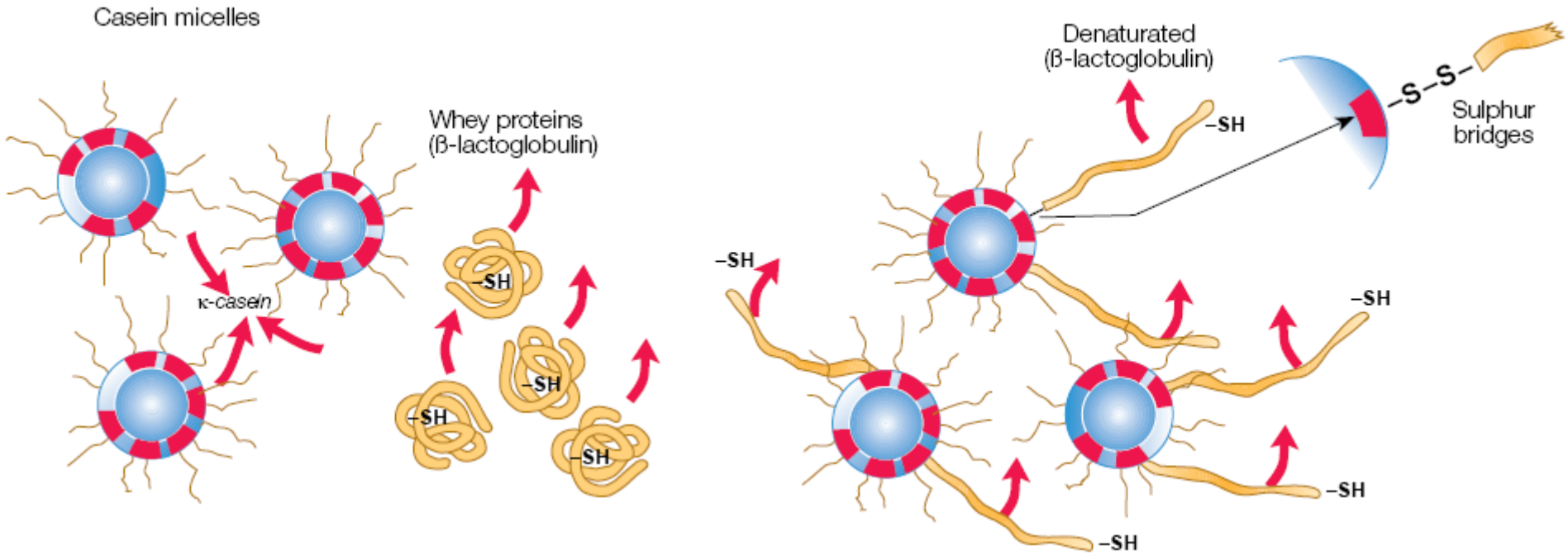




**Part of a whey protein in native (left) and denatured state**

*Vitamins in milk and daily requirements*

Vitamin	Amount in 1 litre of milk, mg		Adult daily requirement mg	
A	0.2	- 2	1	- 2
B <sub>1</sub>	0.4		1	- 2
B <sub>2</sub>	1.7		2	- 4
C	5	- 20	30	- 100
D	0.002		0.01	



**During denaturation κ-casein adheres to β-lactoglobulin**