Table 4.2.2.1. *Potentially useful detergents for membrane-protein crystallizations with molecular weights and CMCs [in water, from Michel (1991) or as provided by the vendor]*

The lengths of the alkyl or alkanoyl side chains are given as C_6 to C_{16}.

Detergent	Molecular weight	CMC (m*M*)
Alkyl dihydroxypropyl sulfoxide		
C_8	238	20.6
N,*N*-Dimethylalkylamine-*N*-oxides		
C_8	173	162
C_9	187	50
C_{10}	201	20
C_{12}	229	1–2
n-Dodecyl-*N*,*N*-dimethylglycine (zwitterionic)	271	1.5
N-Alkyl-β-D-glucopyranosides		
C_6	264	250
C_7	278	79
C_8	292	30
C_9	306	6.5
C_{10}	320	2.6
n-Alkanoyl-*N*-hydroxyethylglucamides ('HEGA-*n*')		
C_8	351	109
C_9	365	39
C_{10}	379	7.0
C_{11}	393	1.4
Alkyl hydroxyethyl sulfoxide		
C_8	222	15.8
n-Alkyl-β-D-maltosides		
C_6	426	210
C_8	454	19.5
C_9	468	6
C_{10}	483	1.8
C_{11}	497	0.6
C_{12}	511	0.17
C_{13}	525	0.033
C_{14}	539	0.01
C_{16}	567	0.006
cyclohexyl-C_1	438	340
cyclohexyl-C_2	452	120
cyclohexyl-C_3	466	34.5
cyclohexyl-C_4	480	7.6
cyclohexyl-C_5	494	2.4
cyclohexyl-C_6	508	0.56
cyclohexyl-C_7	522	0.19
n-Alkanoyl-*N*-methylglucamides ('MEGA-*n*')		
C_8	321	79
C_9	335	25
C_{10}	349	6
Methyl-6-*O*-(*N*-heptylcarbamoyl)-α-D-glucopyranoside ('HECAMEG')	335	19.5
n-Alkylphosphocholines (zwitterionic)		
C_8	295	114
C_9	309	39.5
C_{10}	323	11
C_{12}	315	1.5
C_{14}	379	0.12
C_{16}	407	0.013
Polyoxyethylene monoalkylethers (C_nE_m)		
C_8E_4	306	7.9
C_8E_5	350	7.1
$C_{10}E_6$	422	0.9
$C_{12}E_8$	538	0.071
n-Alkanoylsucrose		
C_{10}	497	2.5
C_{12}	525	0.3
n-Alkyl-β-D-thioglucopyranosides		
C_7	294	29
C_8	308	9
C_9	322	2.9
C_{10}	336	0.9
n-Alkyl-β-D-thiomaltopyranosides		
C_8	471	8.5
C_9	485	3.2
C_{10}	499	0.9
C_{11}	513	0.21
C_{12}	527	0.05

aqueous phase. The membrane proteins are found exclusively in the viscous phase and crystals – if formed – are difficult to handle. Some detergents, *e.g.* those with polyoxyethylene head groups, undergo a phase separation at higher temperatures. This phenomenon has been used to separate solubilized membrane proteins, which are found in the detergent-rich phase, from the water-soluble proteins. The latter are concentrated in the detergent-depleted phase (Bordier, 1981). Other detergents, *e.g.* octyl-β-D-glucopyranoside, show this phase separation at lower temperatures. Therefore, if phase separation causes problems, a change of the crystallization temperature may help.

The polar head groups of the detergents influence their usage in many ways. One would like to have a small polar head group, because the head group 'covers' the part of the protein's polar surface that is adjacent to the hydrophobic surface belt. The bigger the head group the more of the polar surface is covered and unavailable for the polar interactions needed to form the crystal lattice. Unfortunately, detergents with small polar head groups are rather denaturing. Detergents with charged head groups cannot be used, but detergents with zwitterionic head groups, *e.g.* sulfobetaines, can be tried with more stable proteins. The head group of a very successful detergent, *N*,*N*-dimethyldodecylamine-*N*-oxide, is of zwitterionic nature. I estimate that it can only be used with about 20% of all membrane proteins. Detergents with sugar residues as head groups have been used successfully. Octyl-β-D-glucopyranoside also tends to be denaturing. The lifetime of many membrane proteins can be prolonged by a factor of three by the use of nonyl-β-D-glucopyranoside instead of the shorter homologue. Such behaviour is observed within each series of homologous detergents; an increase in the alkyl chain by one methylene group leads to an increase in stability by a factor of three, an increase by two methylene groups leads to an increase in stability by a factor of about ten. Unfortunately, decyl-β-D-glucopyranoside is too insoluble to be used as detergent. For less stable membrane proteins, alkylmaltoside detergents or alkanoylsucrose detergents have to be tried. There is one special problem when using alkyl-β-D-

references