

**Diverse mechanisms of antimicrobial activities of lactoferrins, lactoferricins, and other lactoferrin-derived peptides**

**Cell and molecular life science**

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**Code availability:** Not applicable.

**Supplementary Table S1.** Studies carried out to date on bacteria, viruses, and fungi that are either susceptible or resistant (designated as R) to antimicrobial activity of lactoferrins, lactoferricins, and lactoferrin-derived (Lf peptide) and lactoferricin-derived (Lf-cin peptide) peptides.

Species	Source of lactoferrins used <sup>1</sup>					Peptide fraction <sup>2</sup>	References
	Lactoferrin	Lf peptide	Lactoferricin	Lf-cin peptide	Lf-ampin		
Gram-positive bacteria							
<i>Bacillus cereus</i>			Bovine			f(17-41)	[100]
		I: bovine				f(17-42)	[132]
<i>Bacillus circulans</i>			Bovine			f(17-41)	[100]
<i>Bacillus natto</i>			Bovine			f(17-41)	[100]
<i>Bacillus subtilis</i>			Bovine			f(17-41)	[100, 110]
				15: bovine		f(17-31)	[110, 114]
				11: bovine		f(20-30)	[110, 112]
				9: bovine (R)		f(20-28)	[110]
				6: bovine (R)		f(20-25)	[114]
					Bovine	f(268-284)	[139]
<i>Bifidobacterium bifidum</i>			Bovine (R)			f(17-41)	[100]
<i>Bifidobacterium adolescentis</i>			Bovine			f(17-41)	[100]
<i>Bifidobacterium breve</i>			Bovine			f(17-41)	[100]
<i>Bifidobacterium longum</i>			Bovine			f(17-41)	[100]

<i>Bifidobacterium infantis</i>	Bovine	f(17-41)	[100]
<i>Clostridium perfringens</i>	Bovine	f(17-41)	[100]
<i>Clostridium paraputificum</i>	Bovine	f(17-41)	[100]
<i>Corynebacterium ammoniagenes</i>	Bovine	f(17-41)	[100]
<i>Corynebacterium diphtheriae</i>	Bovine	f(17-41)	[100]
<i>Corynebacterium renal</i>	Bovine	f(17-41)	[100]
<i>Enterococcus faecalis</i>	Bovine (R)	f(17-41)	[100]
<i>Lactobacillus casei</i>	Human (R)	/	[71]
	Bovine	f(17-41)	[100]
<i>Listeria monocytogenes</i>	Bovine	/	[57, 135]
	Bovine	f(17-41)	[57, 100, 230]
	I: bovine	f(17-42)	[132]
	21LF: bovine	f(85-109)	[135]
	38LF: bovine	f(341-366)	[135]
	45LF: bovine	f(282-307)	[135]
<i>Micrococcus flavus</i>	Bovine	/	[231]
	Caprine	/	[231]
	Ovine	/	[231]
	Bovine	f(17-41)	[231]
	Caprine	f(14-42)	[231]
	2: bovine	f(1-11)-(17-47)	[133]
	4: bovine	f(1-16)-(45-48)	[133]
<i>Staphylococcus aureus</i>	Bovine	/	[57]

	Human (R)	/	[71]
	Bovine	f(17-41)	[57, 98, 100, 110, 111]
	15: bovine	f(17-31)	[110, 111]
	11: bovine	f(20-30)	[110, 113]
	9: bovine (R)	f(20-28)	[110]
	Human	f(1-49)	[98]
	Caprine	f(17-41)	[98, 100]
	Murine	f(17-41)	[98]
	P20: porcine	f(18-37)	[99]
	I: bovine	f(17-42)	[132]
<i>Staphylococcus epidermidis</i>	Human (R)	/	[71]
	Bovine	f(17-41)	[100]
<i>Staphylococcus haemolyticus</i>	Bovine	f(17-41)	[100]
<i>Staphylococcus hominus</i>	Bovine	f(17-41)	[100]
<i>Streptococcus bovis</i>	Bovine	f(17-41)	[100]
<i>Streptococcus cremoris</i>	Bovine	f(17-41)	[100]
<i>Streptococcus lactis</i>	Human (R)	/	[71]
	Bovine	f(17-41)	[100]
<i>Streptococcus (mitior) mitis</i>	Human	/	[71]
<i>Streptococcus mutans</i>	Human	/	[59, 60, 71, 72]
	Human	f(1-49)	[100]
	Bovine	f(268-284)	[139]

	Chimera: bovine	f(17-30)-(265-284)	[137]
<i>Streptococcus pneumoniae</i>	Bovine	/	[84]
	Human	/	[71]
	14: bovine	f(17-30)	[84]
	Bovine	f(268-284)	[84]
	Chimera: bovine	f(17-30)-(265-284)	[84]
<i>Streptococcus pyogenes</i>	Human (R)	/	[71]
	Bovine	/	[135]
	21LF: bovine	f(85-109)	[135]
	38LF: bovine	f(341-366)	[135]
	45LF:bovine	f(282-307)	[135]
<i>Streptococcus thermophilus</i>	Bovine	f(17-41)	[100]
<i>Streptococcus salivarius</i>	Human	/	[71]
<i>Streptococcus sanguis</i>	Human	f(269-285)	[141]
	Chimera: bovine	f(17-30)-(265-284)	[137]
<b>Gram-negative bacteria</b>			
<i>Aggregatibacter actinomycetemcomitans</i>	Human	/	[74]
<i>Bacteroides distasonis</i>	Bovine	f(17-41)	[100]
<i>Bacteroides vulgatus</i>	Bovine	f(17-41)	[100]
<i>Burkholderia pseudomallei</i>	Chimera: bovine	f(17-30)-(265-284)	[144]
<i>Escherichia coli</i>	Bovine	/	[57, 75, 135, 231]
	Human (some R)	/	[60, 64, 71]

Caprine	/	[231]
Ovine	/	[231]
Bovine	f(17-41)	[57, 58, 61, 98, 100, 101, 106, 110, 111, 231]
15: bovine	f(17-31)	[109-111, 114]
B 11: bovine	f(20-30)	[110, 112, 113]
9: bovine (R)	f(20-28)	[110]
6: bovine (R)	f(20-25)	[109, 110, 114]
Human	f(1-49)	[98]
5s: human	f(21-31)	[109]
6s: human	f(19-31)	[109]
Caprine	f(14-42)	[98, 231]
Murine	f(17-41)	[98]
P20: porcine	f(18-37)	[99]
I: bovine	f(17-42)	[132]
II: bovine	f(1-16)-(43-48)	[132]
III: bovine	f(1-42)-(43-48)	[132]
1A: bovine	f(17-41)	[136]
1B: bovine	f(17-42)	[136]
2: bovine	f(17-43)	[136]
3: bovine	f(1-16)-(17-48)	[136]
21LF: bovine	f(85-109)	[135]

	38LF: bovine	f(341-366)	[135]
	45LF: bovine	f(282-307)	[135]
	Bovine	f(268-284)	[139]
	Bovine	f(259–284)	[140]
	Bovine	f(265–296)	[140]
	Bovine	f(265–284)	[140]
	Human (R)	f(269-285)	[141]
	Chimera: bovine	f(17-30)-(265-284)	[137]
<i>Enterobacter cloacae</i>	Human (R)	/	[71]
<i>Campylobacter jejuni</i>	Bovine	f(17-41)	[100]
<i>Helicobacter pylori</i>	Bovine	/	[127]
	Human	/	[127]
	Bovine	f(17-41)	[127]
	14: bovine (R)	f(17-30)	[137]
	Bovine (R)	f(269-285)	[137]
	Chimera: bovine	f(17-30)-(265-284)	[137]
<i>Legionella pneumophila</i>	Human	/	[73]
<i>Proteus mirabilis</i>	B: bovine (R)	f(17-41)	[98]
<i>Proteus vulgaris</i>	Bovine	f(17-41)	[100]
<i>Pseudomonas aeruginosa</i>	Bovine (R)	/	[57]
	Human	/	[71]
	Bovine	f(17-41)	[57, 75, 100, 110]
	15: bovine	f(17-31)	[110]

		11: bovine	f(20-30)	[110]
		9: bovine (R)	f(20-28)	[110]
		Bovine	f(268-284)	[139]
	Chimera: bovine		f(17-30)-(265-284)	[137]
<i>Pseudomonas fluorescens</i>		Bovine (R)	f(17-41)	[100, 134]
		I: bovine	f(17-42)	[132]
		Bovine (R)	f(308-317)	[134]
<i>Pseudomonas putida</i>	Bovine		/	[75]
<i>Pseudomonas syringae</i>		Bovine	f(17-41)	[134]
		Bovine	f(308-317)	[134]
<i>Salmonella choleraesuis</i>		Bovine	f(17-41)	[110]
		15: bovine	f(17-31)	[110]
		11: bovine	f(20-30)	[110]
		9: bovine (R)	f(20-28)	[110]
<i>Salmonella enteritidis</i>		Bovine	f(17-41)	[100]
<i>Salmonella montevideo</i>		Bovine	f(17-41)	[61]
<i>Salmonella newport</i>	Human (R)		/	[71]
<i>Salmonella salford</i>		I: bovine	f(17-42)	[132]
<i>Salmonella typhimurium</i>	Human		/	[64]
		Bovine	f(17-41)	[61, 106, 110]
		15: bovine	f(17-31)	[110]
		11: bovine	f(20-30)	[110]
		9: bovine (R)	f(20-28)	[110]



<i>Shigella sonnei</i>	Human (R)	/	[71]
<i>Shigella flexneri</i>	Bovine	f(17-41)	[106]
<i>Klebsiella pneumoniae</i>	Bovine (R)	/	[57]
	Bovine	f(17-41)	[57, 100]
<i>Vibrio cholerae</i>	Bovine	/	[142, 232]
	Human	/	[60, 64, 71]
	14: bovine (R)	f(17-30)	[142]
	Bovine (R)	f(265-284)	[142]
	Chimera: bovine	f(17-30)-(265-284)	[142]
<i>Vibrio parahaemolyticus</i>	Bovine	/	[142]
	14: bovine (R)	f(17-30)	[142]
	Bovine (R)	f(265-284)	[142]
	Chimera: bovine	f(17-30)-(265-284)	[142]
<i>Yersinia enterocolitica</i>	Bovine	/	[135]
	Bovine (some R)	f(17-41)	[98, 100]
	21LF: bovine	f(85-109)	[135]
	38LF: bovine	f(341-366)	[135]
	45 LF: bovine	f(282-307)	[135]
	14: bovine	f(17-30)	[143]
	Bovine	f(265-284)	[143]
	Chimera: bovine	f(17-30)-(265-284)	[143]
	14: bovine (R)	f(17-30)	[143]
<i>Yersinia pseudotuberculosis</i>	Bovine (R)	f(265-284)	[143]

	Chimera: bovine	f(17-30)-(265-284)	[143]
<b>Enveloped viruses</b>			
Coronavirus			
SARS CoV (pseudovirus)	Bovine	/	[189]
SARS CoV 2	Human	/	[193, 194]
	Bovine	/	[191-193]
Feline calicivirus	Bovine	/	[171]
	Bovine	f(17-41)	[171]
Hantavirus	Bovine	/	[233]
Hepatitis B virus	Bovine	/	[151]
	Human	/	
Hepatitis C virus	Bovine	/	[150, 234, 235]
	Human	/	[150, 235]
	Bovine (R)	f(17-41)	[234]
	Bovine	f(600-632)	[180]
Hepatitis G virus	Bovine	/	[234]
Herpes simplex virus-1	Bovine	/	[146, 152, 154, 155, 173]
	Human	/	[146, 152, 154, 155]
	Caprine	/	[146]
	Bovine	f(17-41)	[146, 152]

	Human	f(1-49)	[146]
	19: bovine	f(86-258)	[182]
	28: bovine	f(345-689)	[182]
	30: bovine	f(1-280)	[182]
Herpes simplex virus-2	Bovine	/	[146, 236]
	Human	/	[146]
	Caprine	/	[146]
	Bovine	f(17-41)	[146]
	Human	f(1-49)	[146]
Human cytomegalovirus	Bovine	/	[154, 158, 159]
	Human	/	[154, 158, 159]
	Caprine	/	[158]
	Human	f(1-49)	[158]
Human immunodeficiency virus, type 1	Bovine	/	[159-162]
	Human	/	[159, 162]
	Bovine	f(17-41)	[160, 185]
Human immunodeficiency virus, type 2	Bovine	/	[162]
Influenza virus A (H1N1; H3N2)	Bovine	/	[147, 149]
	1: bovine	f(418-429)	[149]
	2: bovine	f(506-522)	[149]
	3: bovine	f(552-563) *	[149]

		14: bovine	f(426-429)	[178]
		15: bovine	f(422-425)	[178]
		17: bovine	f(418-421)	[178]
Respiratory syncytial virus	Human		/	[237]
<b>Naked viruses</b>				
Adenovirus	Bovine		/	[163-165]
	Human		/	[163, 164]
		Bovine	f(17-41)	[164]
Echovirus	Bovine		/	[148, 169]
		Bovine	f(17-41)	[148]
Enterovirus 71	Bovine		/	[238]
	Human		/	[238]
Human papillomavirus	Bovine		/	[166, 167]
	Human		/	[166, 167]
		15: bovine	f(17-31)	[167]
		16: bovine	f(17-42)	[167]
		Human	f(1-49)	[167]
Rotavirus	Bovine		/	[170, 198]
		Bovine	f(86-258)	[198]
		Bovine	f(324-329)	[198]
Poliovirus	Bovine		/	[168, 171]
		Bovine (R)	f(17-41)	[171]
<b>Yeast</b>				

<i>Candida albicans</i>	Bovine	/	[135]
	Human	/	[71, 199, 200]
	Bovine	f(17-41)	[98, 139, 202-204]
	14: bovine	f(17-30)	[139]
	15: bovine	f(17-31)	[114]
	6: bovine	f(20-25)	[114]
	2: bovine	f(17-26)	[205]
	P20: porcine	f(18-37)	[99]
	21LF: bovine	f(85-109)	[135]
	38LF: bovine	f(341-366)	[135]
	45LF: bovine	f(282-307)	[135]
	Bovine	f(268-284)	[139]
	Bovine	f(259-284)	[140]
	Bovine	f(265-296)	[140]
	Bovine	f(265-284)	[140]
	Human (R)	f(269-285)	[141]
<i>Candida glabrata</i>	Bovine (some R)	f(17-41)	[203]
<i>Candida guilliermondii</i>	Bovine	f(17-41)	[203]
<i>Candida kefyr</i>	Bovine	f(17-41)	[203]
<i>Candida krusei</i>	Human	/	[200]
	Bovine	f(17-41)	[203]
<i>Candida parapsilosis</i>	Bovine	f(17-41)	[203]
<i>Candida tropicalis</i>	Bovine	f(17-41)	[98, 203]

<i>Cryptococcus albidus</i>	Bovine	f(17-41)	[204]
<i>Cryptococcus curvatus</i>	Bovine	f(17-41)	[204]
<i>Cryptococcus neoformans</i>	Bovine	f(17-41)	[98, 203]
<i>Cryptococcus uniguttulatus</i>	Bovine	f(17-41)	[204]
<i>Saccharomyces cerevisiae</i>	Bovine	f(17-41)	[203]
	15: bovine	f(17-31)	[114]
	6: bovine (R)	f(20-25)	[114]
<i>Trichosporon cutaneum</i>	Bovine	f(17-41)	[203, 204]
<b>Filamentous fungi</b>			
<i>Absidia corymbifera</i>	Bovine (some R)	f(17-41)	[203]
<i>Aspergillus clavatus</i>	Bovine (R)	f(17-41)	[203]
<i>Aspergillus flavus</i>	Bovine	f(17-41)	[203]
<i>Aspergillus fumigatus</i>	Bovine (some R)	f(17-41)	[203, 204]
<i>Aspergillus nidulans</i>	15: bovine	f(17-31)	[114]
	6: bovine	f(20-25)	[114]
<i>Aspergillus niger</i>	Bovine (some R)	f(17-41)	[203, 204]
<i>Aspergillus versicolor</i>	Bovine	f(17-41)	[203]
<i>Botrytis cinerea</i>	15:bovine	f(17-31)	[114]
	6: bovine	f(20-25)	[114]
<i>Cladosporium trichoides</i>	Bovine	f(17-41)	[203]
<i>Epidermophyton floccosum</i>	Bovine	f(17-41)	[203]
<i>Exophiala dermatitidis</i>	Bovine	f(17-41)	[203]
<i>Fonsecaea pedrosoi</i>	Bovine	f(17-41)	[203]

<i>Fusarium moniliforme</i>	Bovine	f(17-41)	[203]
<i>Fusarium oxysporum</i>	15: bovine	f(17-31)	[114]
	6: bovine	f(20-25)	[114]
<i>Magnaporthe grisea</i>	15: bovine (R)	f(17-31)	[114]
	6: bovine (R)	f(20-25)	[114]
<i>Microsporum canis</i>	Bovine	f(17-41)	[203]
<i>Microsporum gypseum</i>	Bovine	f(17-41)	[203]
<i>Mucor circinelloides</i>	Bovine (R)	f(17-41)	[203]
<i>Mucor racemosus</i>	Bovine	f(17-41)	[203]
<i>Nannizzia gypsea</i>	Bovine	f(17-41)	[204]
<i>Nannizzia incurvata</i>	Bovine	f(17-41)	[204]
<i>Nannizzia otae</i>	Bovine	f(17-41)	[204]
<i>Paracoccidioides brasiliensis</i>	Bovine	f(17-41)	[203]
<i>Penicillium digitatum</i>	Bovine	f(17-31)	[114]
	Bovine	f(20-25)	[114]
<i>Penicillium expansum</i>	Bovine (R)	f(17-41)	[203]
	15: bovine	f(17-31)	[114]
	6: bovine	f(20-25)	[114]
<i>Penicillium italicum</i>	15: bovine	f(17-31)	[114]
	6: bovine	f(20-25)	[114]
<i>Penicillium notatum</i>	Bovine (R)	f(17-41)	[203]
<i>Penicillium pinophilum</i>	Bovine	f(17-41)	[204]
<i>Penicillium vermiculatum</i>	Bovine	f(17-41)	[204]

<i>Phialophora verrucosa</i>		Bovine		f(17-41)	[203]
<i>Rhizopus oryzae</i>		Bovine (R)		f(17-41)	[203, 204]
<i>Sporothrix schenckii</i>		Bovine		f(17-41)	[203]
<i>Trichophyton mentagrophytes</i>		Bovine (some R)		f(17-41)	[203, 204]
<i>Trichophyton rubrum</i>		Bovine		f(17-41)	[203, 204]
<i>Trichophyton tonsurans</i>		Bovine		f(17-41)	[203]
<i>Trichophyton shoenleinii</i>		Bovine (R)		f(17-41)	[203]
<i>Trichophyton violaceum</i>		Bovine (some R)		f(17-41)	[203]
<b>Parasites</b>					
<i>Babesia caballi</i>	Bovine			/	[208]
<i>Giardia intestinalis</i>	Bovine			/	[212]
		Bovine		f(17-41)	[212]
			Bovine	f(268-284)	[212]
	Chimera: bovine			f(17-30)-(265-284)	[212]
<i>Giardia lamblia</i>	Bovine			/	[210, 211, 213]
		Bovine		f(17-41)	[210, 211, 213]
<i>Toxsoplasma gondii</i>	Bovine (R)			/	[225, 226]
		Bovine		f(17-41)	[225, 228, 229]



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<sup>1</sup> Lactoferrin-derived peptides are named as in original articles; <sup>2</sup>sequence of peptide fraction correspond to the sequence of the source lactoferrin

\*Due to the poor stability of the TNGESTADWAKN f(552-563) peptide, a modified sequence (NGESSADWAKN) was designed where the first threonine was removed and the other one was replaced by serine.