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Supplementary Information

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AMP PEPTIDE SEQUENCES

(in the order that they appeared in the main text)

Magainin 2:

H-Gly-Ile-Gly-Lys-Phe-Leu-His-Ser-Ala-Lys-Lys-Phe-Gly-Lys-Ala-Phe-Val-Gly-Glu-Ile-Met-Asn-Ser-OH [1]

Magainin 2a:

H-Gly-Ile-Gly-Lys-Phe-Leu-His-Ser-Ala-Lys-Lys-Phe-Gly-Lys-Ala-Phe-Val-Gly-Glu-Ile-Met-Asn-Ser-NH_2 [2]

PGLa:

H-Gly-Met-Ala-Ser-Lys-Ala-Gly-Ala-Ile-Ala-Gly-Lys-Ile-Ala-Lys-Val-Ala-**Leu-**Lys-Ala-Leu-NH_2 [1]

L18W-PGLa:

H-Gly-Met-Ala-Ser-Lys-Ala-Gly-Ala-Ile-Ala-Gly-Lys-Ile-Ala-Lys-Val-Ala-**Trp**-Lys-Ala-Leu-NH_2 [2]

Tachyplesin I:

H-Lys-Trp-Cys-Phe-Arg-Val-Cys-Tyr-Arg-Gly-Ile-Cys-Tyr-Arg-Arg-Cys-Arg-NH_2 [3]

Temporin A: (Also named Temporin 1Ta)*****

H-Phe-Leu-Pro-Leu-Ile-Gly-Arg-Val-Leu-Ser-Gly-Ile-Leu-NH_2 [3]

Temporin B: (Also named Temporin 1Tb)

H-Leu-Leu-Pro-Ile-Val-Gly-Asn-Leu-Leu-Lys-Ser-Leu-Leu-NH_2 [4]

Temporin L: (Also named Temporin 1Tl)

H-Phe-Val-Gln-Trp-Phe-Ser-Lys-Phe-Leu-Gly-Arg-Ile-Leu-NH_2 [4]

Temporin TB-YK:

H-**Lys-Lys-Tyr**-Leu-Leu-Pro-Ile-Val-Gly-Asn-Leu-Leu-Lys-Ser-Leu-Leu-NH_2 [4]

*****Temporins from A to L now re-named temporins 1Ta–1Tl, according to the new nomenclature proposed by reference [5]

RJ1-C: (C-terminal modified)

H-Pro-Phe-Lys-Ile-Asp-Ile-His-Leu-Gly-Gly-Tyr-NH_2

Citropin 1.1:

H-Gly-Leu-Phe-Asp-Val-Ile-Lys-Lys-Val-Ala-Ser-Val-Ile-Gly-Gly-Leu-NH_2 [6]

CA(1–7)M(2–9)NH_2:

H-Lys-Trp-Lys-Leu-Phe-Lys-Lys-Ile-Gly-Ala-Val-Leu-Lys-Val-Leu-NH_2 [6]

Pal-K-G-K-NH2:

Palmitoyl-Lys-Gly-Lys-NH_2 [6]

HNP1:

H-Ala-Cys (&^{1})-Tyr-Cys(&^{2})-Arg-Ile-Pro-Ala-Cys(&)^3-Ile-Ala-Gly-Glu-Arg-Arg-Tyr-Gly-Thr- Cys(&^{2})-Ile-Tyr-Gln-Gly-Arg-Leu-Trp-Ala-Phe-Cys(&^{3})-Cys(&^{1})-OH [7, 8]

HNP2:

H-Cys(&^{1})-Tyr-Cys(&^{2})-Arg-Ile-Pro-Ala-Cys(&^{3})-Ile-Ala-Gly-Glu-Arg-Arg-Tyr-Gly-Thr-Cys(&^{2})-Ile-Tyr-Gln-Gly-Arg-Leu-Trp-Ala-Phe-Cys(&^{3})-Cys(&^{1})-OH [7, 8]

HNP3:

H-Asp-Cys(&^{1})-Tyr-Cys(&^{2})-Arg-Ile-Pro-Ala-Cys(&^{3})-Ile-Ala-Gly-Glu-Arg-Arg-Tyr-Gly-Thr-Cys(&^{2})-Ile-Tyr-Gln-Gly-Arg-Leu-Trp-Ala-Phe-Cys(&^{3})-Cys(&^{1})-OH [7, 8]

HNP4:

H-Val-Cys(&^{1})-Ser-Cys(&^{2})-Arg-Leu-Val-Phe-Cys(&^{3})-Arg-Arg-Thr-Glu-Leu-Arg-Val-Gly-Asn-Cys(&^{2})-Leu-Ile-Gly-Gly-Val-Ser-Phe-Thr-Tyr-Cys(&^{3})-Cys(&^{1})-Thr-Arg -Val-Asp-OH[7, 8]

HD5:

H-Ala-Arg-Ala-Thr-Cys(&^{1})-Tyr-Cys(&^{2})-Arg-Thr-Gly-Arg-Cys(&^{3})-Ala-Thr-Arg-Glu-Ser-Leu-Ser-Gly-Val-Cys(&^{2})-Glu-Ile-Ser-Gly-Arg-Leu-Tyr-Arg-Leu-Cys(&^{3})-Cys(&^{1})-Arg-OH[8]

HD6:

H-Arg-Ala-Phe-Thr-Cys(&^{1})-His-Cys(&^{2})-Arg-Arg-Ser-Cys(&^{3})-Tyr-Ser-Thr-Glu-Tyr-Ser-Tyr-Gly-Thr-Cys(&^{2})-Thr-Val-Met-Gly-Ile-Asn-His-Arg-Phe-Cys(&^{3})-Cys(&^{1})-Leu[8]

hBD-1

H-DHYNC(&^{1})VSSGGQC(&^{2})LYSAC(&^{3})PIFTKIQGTC(&^{2})YRGKAKC(&^{3})C(&^{1})K-OH [8]

hBD-2

H-DPVTC(&^{1})LKSGAIC(&^{2})HPVFC(&^{3})PRRYKQIGTC(&^{2})GLPGTKC(&^{3})C(&^{1})KKP-OH [8]

hBD-3

H-QKYYC(&^{1})RVRGGRC(&^{2})AVLSC(&^{3})LPKEEQIGKC(&^{2})STRGRKC(&^{3})C(&^{1})RRKK-OH [8]

hBD-4

H-ELDRIC(&^{1})GYGTARC(&^{2})RKKC(&^{3})RSQEYRIGRC(&^{2})PNTY C(&^{3})C(&^{1})LRK-OH [8]

Cg-Defm

H-GFGC(&^{1})PGNQLKC(&^{2})NNHC(&^{3})KSISC(&^{4})RAGYC(&^{1})DAATLWLRC(&^{2})TC(&^{3})TDC(&^{4})NGKK-OH [9, 10]

Cg-Defh1

H-GFGC(&^{1})PGDQYEC(&^{2})NRHC(&^{3})RSIGC(&^{4})RAGYC(&^{1})DAVTLWLRC(&^{2})TC(&^{3})TGC(&^{4})SGKK-OH [9, 10]

Cg-Defh2

H-GFGC(&^{1})PRDQYKC(&^{2})NSHC(&^{3})QSIGC(&^{4})RAGYC(&^{1})DAVTLWLRC(&^{2})TC(&^{3})TDC(&^{4})NGKK-OH [9, 10]

Cg-IgPrp

H-Asp-Thr-Gly-Pro-Ile-Arg-Arg-Pro-Lys-Pro-Arg-Pro-Arg-Pro-Arg-Pro-Glu-Gly[10]

Cg-PRP22–36

H-Gly-Pro-Ile-Arg-Arg-Pro-Lys-Pro-Arg-Pro-Arg-Pro-Arg-Pro-Glu-NH_2 [11]

Cg-PRP26–36

H-Arg-Pro-Lys-Pro-Arg-Pro-Arg-Pro-Arg-Pro-Glu-NH_2 [11]

Cg-Prp

H-ILENLLARSTNEDREGSIFDTGPIRRPKPRPRPRPEG-OH[11]

Cg-Defensin

H-GFGC(&^{1})PGNQLKC(&^{2})NNHC(&^{3})KSISC(&^{4})RAGYC(&^{1})DAATLWLRC(&^{2})TC(&^{3})TDC(&^{4})NGKK-OH [12]

PR-39

H-RRRPRPPYLPRPRPPPFFPPRLPPRIPPGFPPRFPPRFP-OH [13]

PR-26

H-Arg-Arg-Arg-Pro-Arg-Pro-Pro-Tyr-Leu-Pro-Arg-Pro-Arg-Pro-Pro-Pro-Phe-Phe-Pro- Pro-Arg-Leu-Pro-Pro-Arg-Ile-OH [13]

Pig Protegrin-3

H-Arg-Gly-Gly-Gly-Leu-Cys(&^{1})-Tyr-Cys(&^{2})-Arg-Arg-Arg-Phe-Cys(&^{2})-Val-Cys(&^{1})-Val-Gly-Arg-NH_2 [14]

L-Ser-Cecropin 6

H-GWLKKFGKKIERVGQHTRDATIQAIGVAQQAANVAATLKG-OH [15]

LSer-Def4

H-LTC(&^{1})NIDRSFC(&^{2})LAHC(&^{3})LLRGYKRGFC(&^{2})TVKKIC(&^{3})VC(&^{1})RH-OH[15]

$PBD\text{-}1_{42}$

H-KNIGNSVSC(&^{1})LRNKGVC(&^{2})MPGKC(&^{3})APKMKQIGTC(&^{2})GMPQVKC(&^{3})C(&^{1})KRK-OH [16]

$PBD\text{-}1_{38}$

H-NSVSC(&^{1})LRNKGVC(&^{2})MPGKC(&^{3})APKMKQIGTC(&^{2})GMPQVKC(&^{3})C(&^{1})KRK-OH [16]

Rabbit granulocytes peptides

NP1

H-VVCACRRALCLPRERRAGFCRIRGRIHPLCCRR-OH [17]

NP-2

H-VVCACRRALCLPLGRRAGFCRIRGRIHPLCCRR-OH [17]

NP-3a

H-GICACRRRFCPNSERFSGYCRVNGARYVRCCSRR-OH [17]

NP-5

H-VFCTCRGFLCGSGERASGSCTINGVRHTLCCR-OH [17]

Hst5

H-Asp-Ser-His-Ala-Lys-Arg-His-His-Gly-Tyr-Lys-Arg-Lys-Phe-His-Glu-Lys-His-His-Ser-His-Arg-Gly-Tyr-OH [7]

LL-37

H-LLGDFFRKSKEKIGKEFKRIVQRIKDFLRNLVPRTES-OH[18]

Cathelicidin-related AMP (CRAMP)

H-Gly-Leu-Leu-Arg-Lys-Gly-Gly-Glu-Lys-Ile-Gly-Glu-Lys-Leu-Lys-Lys-Ile-Gly-Gln-Lys-Ile-Lys-Asn-Phe-Phe-Gln-Lys-Leu-Val-Pro-Gln-Pro-Glu-Gln-OH [19]

Onc72

H-VDKPPYLPRPRPPROIYNO-NH_2 [19]

Onc110

H-VKPPYLPRPRPXRXJYNO-NH_2 [19]

Onc112

H-VKPPYLPRPRPPRrIYNr-NH_2 [19]

Api88

gu-ONRPVYIPRPRPPHPRL-NH_2 [19]

Api134

gu-ONNRPVYIPRPRPPHPOL-NH_2 [19]

Api137

gu-O-NNRPVYIPRPRPPHPRL-OH [19]

J, O, X and gu denote L-tert-leucine, L-ornithine, trans-4-hydroxy-L-proline and N,N,N´,N´-tetramethylguanidino, respectively[19]

Pig Protegrin-1

H-Arg-Gly-Gly-Arg-Leu-Cys(&^{1})-Tyr-Cys(&^{2})-Arg-Arg-Arg-Phe-Cys(&^{2})-Val-Cys(&^{1})-Val-Gly-Arg-NH_2 [14]

Bovine bactenecin

H-Arg-Leu-Cys(&^{1})-Arg-Ile-Val-Val-Ile-Arg-Val-Cys(&^{1})-Arg-OH [20]

Bovine indolicidin

H-Ile-Leu-Pro-Trp-Lys-Trp-Pro-Trp-Trp-Pro-Trp-Arg-Arg-NH_2 [21]

CAP11 is a homodimer of: H-GLRKKFRKTRKRIQKLGRKIGKTGRKVWKAWREYGQIPYPCRI-OH, joined with one disulfide bond [22]

Gallidermin

H-Ile-Ala-Ala(&^{1})-Lys-Phe-Leu-Ala(&^{1})-Abu(&^{2})-Pro-Gly-Ala(&^{2})-Ala-Lys-Dhb-Gly-Ala(&^{3})-Phe-Asn-Ala(&^{4})-Tyr-(&^{4})Ala(&^{3})-NH_2 [23]

Guinea pig defensin

H-Arg-Arg-Cys-Ile-Cys-Thr-Thr-Arg-Thr-Cys-Arg-Phe-Pro-Tyr-Arg-Arg-Leu-Gly-Thr-Cys-Ile-Phe-Gln-Asn-Arg-Val-Tyr-Thr-Phe-Cys-Cys-OH[24]

Nisin

H-Ile-Dhb-Ala(&^{1})-Ile-Dha-Leu-Ala(&^{1})-Abu(&^{2})-Pro-Gly-Ala(&^{2})-Lys-Abu(&^{3})-Gly-Ala-Leu-Met-Gly-Ala(&^{3})-Asn-Met-Lys-Abu(&^{4})-Ala-Abu(&^{5})-Ala(&^{4})-Asn-Ala(&^{5})-Ser-Ile-His-Val-Dha-Lys-OH

The different residues are linked by thioether bonds. Dha, dehydroalanine; Dhb, dehydrobutyrine; Ala-S-Ala, lanthionine; Abu-S-Ala; β-methyllanthionine.

<u>Bicereucin</u>; Bsjα

H-Gln-Arg-Ala-Dhb-Pro-Ala-Dhb-Pro-Ala-Dhb-Pro-Trp-Leu-Ile-Lys-Ala-$_{D}$Ala-Tyr-Val-Val-$_{D}$Ala-Gly-Ala-Gly-Val-$_{D}$Ala-Phe-Val-Ala-$_{D}$Ala-Tyr-Ile-Dhb-Val-Asn-OH [25]

Bsjβ

H-Gln-Arg-Ala-Dhb-Pro- Dhb-Leu-Ala-Dhb-Pro- Leu-Dhb-Pro-His-Dhb -Pro-Tyr-Ala-$_{D}$Abu-Tyr- Val-Val-$_{D}$Ala-Gly- Gly-Val-Val-$_{D}$Ala-Ala -Ile-$_{D}$Ala-Gly-Ile-Phe -R-Ala/S-Ala(&^{1})-Asn-Asn-Lys -Dhb-R-Ala(&^{1})-Leu-Gly-OH [25]

<u>Lichenicidin</u>; Lchα

OBu-Ile-Abu(&^{1})-Leu-Dha-Dhb-Ala(&^{1})-Ala-Ile-Leu-Ala(&^{2})-Lys-Pro-Leu-Gly-Asn-Asn-Gly-Tyr-Leu-Ala(&^{2})-Abu(&^{3})-Val-Abu(&^{4})-Lys-Glu-Ala(&^{3})-Met-Pro-Ser-Ala(&^{4})-Asn-OH [26]

Lchβ

OBu-Dhb-Pro-Ala-Dhb-Dhb-Ala(&^{1})-Dha-Trp-Thr-Ala(&^{1})-Ile-Dhb-Ala-Gly-Val-Dhb-Val-Ala(&^{2})-Ala-Ser-Leu-Ala(&^{2})-Pro-Abu(&^{3})-Dhb-Lys-Ala(&^{3})-Abu(&^{4})-Ser-Arg-Ala(&^{4})-OH [26]

2-oxobutyryl (OBu), lanthionine (Ala-S-Ala), and methyllanthionine (Abu-S-Ala).

<u>Lacticins</u>

LtnA1: H-Ala(&^{1})-Ala(&^{1})-Dbh-Asn-Dhb-Phe-$_{D}$Ala-Leu-Ala(&^{2})-Asp-Tyr-Trp-Gly-Asn-Asn-Gly-Ala-Trp-Ala(&^{2})-Abu(&^{3})-Leu-Abu(&^{4})-His-Glu-Ala(&^{3})-Met-Ala-Trp-Ala(&^{4})-Lys-OH [25, 27]

LtnA2

OBu-Dhb-Pro-Ala-Dhb-Pro-Ala-Ile-$_{D}$Ala-Ile-Leu-$_{D}$Ala-Ala-Tyr-Ile-Ala(&^{1})-Thr-Asn-Thr-Ala(&^{1})-Pro-Abu(&^{2})-Thr-Lys-Ala(&^{2})-Abu(&^{3})-Arg-Ala-Ala(&^{3})-OH [25, 27]

Dha, dehydroalanine; Dhb, dehydrobutyrine; Ala-S-Ala, lanthionine; Abu-S-Ala, β-methyllanthionine.

Plantaricin EF is a class-IIb two-peptide bacteriocin that consists of the 33-residue PlnE and the 34-residue PlnF peptides [28]

PlnE

H-Phe-Asn-Arg-Gly-Gly-Tyr-Asn-Phe-Gly-Lys-Ser-Val-Arg-His-Val-Val-Asp-Ala-Ile- Gly-Ser-Val-Ala-Gly-Ile-Arg-Gly-Ile-Leu-Lys-Ser-Ile-Arg-OH [28]

PlnF

H-Val-Phe-His-Ala-Tyr-Ser-Ala-Arg-Gly-Val-Arg-Asn-Asn-Tyr-Lys-Ser-Ala-Val-Gly-Pro-Ala-Asp-Trp-Val-Ile-Ser-Ala-Val-Arg-Gly-Phe-Ile-His-Gly-OH [28]

PlnJ

H-Gly-Ala-Trp-Lys-Asn-Phe-Trp-Ser-Ser-Leu-Arg-Lys-Gly-Phe-Tyr-Asp-Gly-Glu-Ala-Gly-Arg-Ala-Ile-Arg-Arg[29]

PlnK

H-Arg-Arg-Ser-Arg-Lys-Asn-Gly-Ile-Gly-Tyr-Ala-Ile-Gly-Tyr-Ala-Phe-Gly-Ala-Val-Glu- Arg-Ala-Val-Leu-Gly-Gly-Ser-Arg-Asp-Tyr-Asn-Lys[29]

L50A

H-MGAIAKLVAKFGWPIVKKYYKQIMQFIGEGWAINKIIEWIKKHI-OH [30]

L50B

H-MGAIAKLVTKFGWPLIKKFYKQIMQFIGQGWTIDQIEKWLKRH-OH [30]

Enterocin 7A

H-MGAIAKLVAKFGWPIVKKYYKQIMQFIGEGWAINKIIDWIKKHI-OH [31]

Enterocin 7B

H-MGAIAKLVAKFGWPFIKKFYKQIMQFIGQGWTIDQIEKWLKRH-OH [31]

Thuricin D-alpha

H-Gly-Met-Ala-Ala-Cys(&^{1})-Val-Ile-Gly-Cys(&^{2})-Ile-Gly-Ser-Cys(&^{3})-Val-Ile-Ser-Glu-Gly-Ile-Gly-Ser(&^{1})-Leu-Val-Gly-Thr(&^{2})-Ala-Phe-Thr(&^{3})-Leu-GlyOH [32]

Thuricin D-beta

H-Gly-Trp-Val-Ala-Cys(&^{1})-Val-Gly-Ala-Cys(&^{2})-Gly-Ser-Val-Cys Cys(&^{3})-Leu-Ala-Ser-Gly-Gly-Thr(&^{1})-Glu-Phe-Ala-Ala(&^{2})-Ala-Ser-Tyr(&^{3})-Phe-Leu-OH [32]

Thiols are linked to the α-C of the corresponding amino acids

Cbnx: H-Trp-Gly-Trp-Lys-Glu-Val-Val-Gln-Asn-Gly-Gln-Thr-Ile-Phe-Ser-Ala-Gly-Gln-Lys-Leu-Gly-Asn-Met-Val-Gly-Lys-Ile-Val-Pro-Leu-Pro-Phe-Gly-OH [33]

Cbny: H-Ser-Ala-Ile-Leu-Ala-Ile-Thr-Leu-Gly-Ile-Phe-Ala-Thr-Gly-Tyr-Gly-Met-Gly-Val-Gln-Lys-Ala-Ile-Asn-Asp-Arg-Arg-Lys-Lys-OH [33]

Plantaricin alpha: H-Lys-Cys-Lys-Trp-Trp-Asn-Ile-Ala-Cys-Asp-Leu-Gly-Asn-Asn-Gly-His-Val-Ala-Abu-Leu-Ala-His-Glu-Ala-Gln-Val-Ser-Ala-Asn-OH [34]

Plantaricin beta: Pyr-Gly-Ile-Pro-Cys-Dhb-Ile-Gly-Ala-Ala-Val-Ala-Ala-Ala-Ile-Ala-Val-Ala-Pro-Abu-Abu-Lys-Ala-Dha-Lys-Arg-Ala-Gly-Lys-Arg-Lys-Lys-OH [34]

Dermcidin (DCD)-derived peptides

DCD-1L

H- SSLLEKGLDGAKKAVGGLGKLGKDAVEDLESVGKGAVHDVKDVLDSVL[35]

DCD-1

H-SSLLEKGLDGAKKAVGGLGKLGKDAVEDLESVGKGAVHDVKDVLDSV-OH [35]

Bombinin

H-Ala-Lys-Gly-Leu-Gly-Ile-Gly-Gly-Ala-Leu-Leu-Ser-Ala-Ala-Lys-Val-Gly-Leu-Lys-Gly-Leu-Ala-Glu-His-Phe-Asn-NH_2 [36, 37]

Novel bombinin

H-Gly-Ile-Gly-Gly-Ala-Leu-Leu-Asn-Val-Gly-Lys-Val-Ala-Leu-Lys-Gly-Leu-Ala-Lys-Gly-Leu-Ala-Glu-His-Phe-Ala-Asn-NH_2[36, 37]

Bombinin HL

H-Leu-Leu-Gly-Pro-Val-Leu-Gly-Leu-Val-Ser-Asn-Val-Leu-Gly-Gly-Leu-Leu-NH_2 [36]

Protonectin

H-Ile-Leu-Gly-Thr-Ile-Leu-Gly-Leu-Leu-Lys-Gly-Leu-NH_2 [38, 39]

Protonectin (1–6)

H-Ile-Leu-Gly-Thr-Ile-Leu-NH_2 [39]

Abaecin (Bombus pascuorum)

H-FVPYNPPRPGQSKPFPSFPGHGPFNPKIQWPYPLPNPGH-OH[40]

Feleucin-BV1

H-Phe-Leu-Gly-Leu-Leu-Gly-Gly-Leu-Leu-NH_2[37]

feleucin (BV1-FLGLLGGLL or BV2-FLGLIGSLL) occupying positions 124–132. The name feleucins was coined to phonetically represent their structural features of possessing N-terminal Phe (F) residues and C-terminal Leu (L) amide residues. Note that the two feleucins differ in primary structure by conservative substitutions at positions

Gal7

H-FSRSPRYHMQCGYRGTFCTPGKCPYGNAYLGLCRPKYSCCRWL-OH [41]

Gal9

H-RGLPQDCERRGGFCSHKSCPPGIGRIGLCSKEDFCCRSRWYS-OH [41]

Moronecidin: H-Phe-Phe-His-His-Ile-Phe-Arg-Gly-Ile-Val-His-Val-Gly-Lys-Thr-Ile-His-(Lys/Arg)Leu-Val-Thr-Gly-Thr-NH_2 [42]

Bass hepcidin: (Gly-Cys(&^{1})-Arg-Phe-Cys(&^{2})-Cys(&^{3})-Asn-Cys(&^{4})-Cys(&^{4})-Pro-Asn-Met-Ser-Gly-Cys(&^{3})-Gly-Val-Cys(&^{2})-Cys(&^{1})-Arg-Phe) with eight putative [43]

Hymenoptaecin:

H-QERGSIVIQGTKEGRNRPSLDIDYKQRVYDKNGMTGNAYGGVNIRPGQPTRQHAGFEFGKEYKNGFIRGQSEVQRGPGGRLSPYVGINGGFRF-OH [44]

SMAP29

H-Arg-Gly-Leu-Arg-Arg-Leu-Gly-Arg-Lys-Ile-Ala-His-Gly-Val-Lys-Lys-Tyr-Gly-Pro-Thr-Val-Leu-Arg-Ila-Ile-Arg-Ile-Ala-NH_2 [45]

OaBac5mini

H-Arg-Phe-Arg-Pro-Pro-Ile-Arg-Arg-Pro-Pro-Ile-Arg-Pro-Pro-Phe-Arg-Pro-Pro-Phe-Arg-Pro-Pro-Val-Arg-NH_2 [45]

OaBac7.5mini

H-Arg-Arg-Ile-Pro-Arg-Pro-Ile-Leu-Leu-Pro-Trp-Arg-Pro-Pro-Arg-Pro-Ile-Pro-Arg-Pro-Gln-Pro-Gln-Pro-Ile-Pro-Arg-Trp-Leu-OH [45]

<u>FLUCONAZOLE</u>

Cc-GRP

H-Gly-Asn-Glu-Gly-Gly-Gly-His-Gly-Gly-His-Gly-Gly-Tyr-Gly-Gly-Tyr-His-His-His- Gly-Gly-Gly-Gly-Gly-Gly-Tyr-Gly-Gly-Tyr-His-Gly-Gly-Gly-Gly-Ser-OH[46]

DS6

H-Cys-Lys-Tyr-Lys-Ala-Arg-Trp-Lys-Leu-Leu-OH [47]

KU4

H-Gly-Ile-Trp-Lys-Lys-Trp-Ile-Lys-Lys-Trp-Leu-Lys-Lys-Leu-Lys-Asn-Leu-Phe-NH_2[48]

Upnlys6

H-Gly-Val-Ile-Lys-Ala-Ala-Lys-Lys-Val-Val-Lys-Val-Leu-Lys-Lys-Leu-Phe-NH_2 [48]

KABT-AMP

H-Gly-Ile-Trp-Lys-Lys-Trp-Ile-Lys-Lys-Trp-Leu-Lys-Lys-Leu-Leu-Lys-Lys-Leu-Trp-Lys-Lys-Gly-OH [48]

Uperin 3.6

H-Gly-Val-Ile-Asp-Ala-Ala-Lys-Lys-Val-Val-Asn-Val-Leu-Lys-Asn-Leu-Phe-NH_2[48]

Upn-Lys5

H-Gly-Val-Ile-Lys-Ala-Ala-Lys-Lys-Val-Val-Lys-Val-Leu-Lys-Asn-Leu-Phe-NH_2 [48]

IB-367: H-Arg-Gly-Gly-Leu-Cys(&^{1})-Tyr-Cys(&^{2})-Arg-Gly-Arg-Phe-Cys(&^{2})-Val-Cys(&^{1})-Val-Gly-Arg-NH_2 [49]

Hepcidin 20

H-Ile-Cys(&)^1-Ile-Phe-Cys(&)^2-Cys(&)^3-Gly-Cys(&)^4-Cys(&)^4-His-Arg-Ser-Lys-Cys(&)^3-Gly-Met-Cys(&)^2-Cys(&)^1-Lys-Thr-OH [50].

Short lipopeptide palmitoyl

PAL-Lys-Lys-NH_2 [51]

Dodecapeptide

H-Arg-Trp-Trp-Arg-$_D$Trp-$_D$Phe-Ile-$_D$Phe-His-Trp-Arg-Trp-NH_2 [52]

RWWRWFIFH

H-Arg-Trp-Trp-Arg-$_D$Trp-$_D$Phe-Ile-$_D$Phe-His-NH_2 [53]

h-Lf1-11

H-Gly-Arg-Arg-Arg-Arg-Ser-Val-Gln-Trp-Cys-Ala-OH [55]

DsS3

H-Ala-Leu-Trp-Lys-Asn-Met-Leu-Lys-Gly-Ile-Gly-Lys-Leu-Ala-Gly-Lys-Ala-Ala-Leu-Gly-Ala-Val-Lys-Lys-Leu-Val-Gly-Ala-Glu-Ser-OH [56]

MUC7 12-mer-$_L$

H-Arg-Lys-Ser-Tyr-Lys-Cys-Leu-His-Lys-Arg-Cys-Arg-OH [57]

Tyrocidine A

&Val-Orn-Leu-$_D$Phe-Pro-Phe-$_D$Phe-Asn-Gln-Tyr& [58]

Tyrocidine B

&Val-Orn-Leu-$_D$Phe-Pro-Trp-$_D$Phe-Asn-Gln-Tyr& [58]

Tyrocidine C

&Val-Orn-Leu-$_D$Phe-Pro-Trp-$_D$Trp-Asn-Gln-Tyr& [58]

Plant defensin rHsAFP1

H-DGVKLCDVPSGTWSGHCGSSSKCSQQCKDREHFAYGGACHYQFPSVKCFCKRQC-OH [59]

HsLin06

H-Glu-His-Phe-Ala-Tyr-Gly-Gly-Ala-Xaa-His-Tyr-Gln-Phe-Pro-Ser-Val-Lys-Xaa-Phe-Xaa-Lys-Arg-Gln-Xaa-OH [59]

MSI-78

H-Gly-Ile-Gly-Lys-Phe-Leu-Lys-Lys-Ala-Lys-Lys-Phe-Gly-Lys-Ala-Phe-Val-Lys-Ile-Leu-Lys-Lys-NH_2 [60]

Cecropin B

H-KWKVFKKIEKMGRNIRNGIVKAGPAIAVLGEAKAL-NH_2 [60]

Dq-1319

H-Phe-Trp-Gly-Thr-Leu-Ala-Lys-Trp-Ala-Leu-Lys-OH [61]

Dq-1503

H-Phe-Trp-Gly-Thr-Leu-Ala-Lys-Trp-Ala-Leu-Lys-Ala-Ile-OH [61]

Dq-2562

H-Phe-Trp-Gly-Thr-Leu-Ala-Lys-Trp-Ala-Leu-Lys-Ala-Ile-Pro-Ala-Ala-Met-Gly-Met-Lys-Gln-Asn-Lys-OH [61]

Dq-3162

H-Gly-Leu-Lys-Asp-Trp-Trp-Asn-Lys-His-Lys-Asp-Lys-Ile-Val-Lys-Val-Val-Lys-Glu-Met-Gly-Lys-Ala-Gly-Ile-Asn-Ala-Ala-NH_2 [61]

Bacillomycin D

H-Ser-Thr-Asn-Tyr-Asn-Pro-Glu-OH [62]

KU1

H-Gly-Ile-Trp-Lys-Lys-Trp-Ile-Lys-Lys-Val-Val-Asn-Val-Leu-Lys-Asn-Leu-Phe-NH_2 [48]

KU2

H-Gly-Ile-Trp-Lys-Lys-Trp-Ile-Lys-Lys-Trp-Leu-Asn-Val-Leu-Lys-Asn-Leu-Phe-NH_2 [48]

KU3

H-Gly-Ile-Trp-Lys-Lys-Trp-Ile-Lys-Lys-Trp-Leu-Lys-Val-Leu-Lys-Asn-Leu-Phe-NH_2 [48]

KU4

H-Gly-Ile-Trp-Lys-Lys-Trp-Ile-Lys-Lys-Trp-Leu-Lys-Lys-Leu-Lys-Asn-Leu-Phe-NH_2 [48]

Upn-lys4

H-Gly-Val-Ile-Lys-Ala-Ala-Lys-Lys-Val-Val-Asn-Val-Leu-Lys-Asn-Leu-Phe-NH_2 [48]

Upn-lys5

H-Gly-Val-Ile-Lys-Ala-Ala-Lys-Lys-Val-Val-Lys-Val-Leu-Lys-Asn-Leu-Phe-NH_2 [48]

Upn-lys6

H-Gly-Val-Ile-Lys-Ala-Ala-Lys-Lys-Val-Val-Lys-Val-Leu-Lys-Lys-Leu-Phe-NH_2 [48]

Histatin 5

H-Asp-Ser-His-Ala-Lys-Arg-His-His-Gly-Tyr-Lys-Arg-Lys-Phe-His-Glu-Lys-His-His-Ser-His-Arg-Gly-Tyr-OH [63]

dhvar4

H-Lys-Arg-Leu-Phe-Lys-Lys-Leu-Leu-Phe-Ser-Leu-Arg-Lys-Tyr-OH [63]

dhvar5

H-Leu-Leu-Leu-Phe-Leu-Leu-Lys-Lys-Arg-Lys-Lys-Arg-Lys-Tyr-OH [63]

Short lactoferrin peptide Pep2

H-Phe-Lys-Cys-Arg-Arg-Trp-Gln-Trp-Arg-Met-OH [64]

Tachyplesin III

H-Lys-Trp-Cys(&^{1})-Phe-Arg-Val-Cys(&^{2})-Tyr-Arg-Gly-Ile-Cys(&^{2})-Tyr-Arg-Lys-Cys(&^{1})-Arg-NH_2 [65]

WLBU2

H-Arg-Arg-Trp-Val-Arg-Arg-Val-Arg-Arg-Trp-Val-Arg-Arg-Val-Val-Arg-Val-Val-Arg-Arg-Trp-Val-Arg-Arg-OH [66]

L12

H-Val-Arg-Ile-Ile-Trp-Ala-Val-Arg-Ile-Trp-Arg-Arg-OH [67]

D-LL-31

H-Leu-Leu-Gly-Asp-Phe-Phe-Arg-Lys-Ser-Lys-Glu-Lys-Ile-Gly-Lys-Glu-Phe-Lys-Arg-Ile-Val-Gln-Arg-Ile-Lys-Asp-Phe-Leu-Arg-Asn-Leu-OH [68]

LfcinB (20–25)

H-Arg-Arg-Trp-Gln-Trp-Arg-NH_2 [69]

LfcinB (20–30)

H-Arg-Arg-Trp-Gln-Trp-Arg-Met-Lys-Lys-Leu-Gly-NH_2 [69]

LfcinB (17–31)

H-Phe-Lys-Ala-Arg-Arg-Trp-Gln-Trp-Arg-Met-Lys-Lys-Leu-Gly-Ala-NH2 [69]

LfcinB

H-Phe-Lys-Cys-Arg-Arg-Trp-Gln-Trp-Arg-Met-Lys-Lys-Leu-Gly-Ala-Pro-Ser-Ile-Thr-Cys-Val-Arg-Arg-Ala-Phe-NH_2 [69]

L11W

H-Ile-Lys-Lys-Ile-Leu-Ser-Lys-Ile-Lys-Lys-Trp-Leu-Lys-NH_2 [70]

L12W

H-Ile-Lys-Lys-Ile-Leu-Ser-Lys-Ile- Lys-Lys-Leu-Trp-Lys-NH_2 [70]

I1WL5W

H-Trp-Lys-Lys-Ile-Trp-Ser-Lys-Ile-Lys-Lys-Leu-Leu-Lys-NH_2 [70]

I4WL5W

H-Ile-Lys-Lys-Trp-Trp-Ser-Lys-Ile-Lys-Lys-Leu-Leu-Lys-NH_2 [70]

SLAY-P1

H-Arg-Leu-Val-Arg-Ile-Leu-Val-Ser-Lys-Arg-Pro-Val-Ala-Ile-Lys-Pro-Tyr-Phe-Arg-Leu-OH[71]

Melimine

H-Thr-Leu-Ile-Ser-Trp-Ile-Lys-Asn-Lys-Arg-Lys-Gln-Arg-Pro-Arg-Val-Ser-Arg-Arg-Arg-Arg-Arg-Arg-Gly-Gly-Arg-Arg-Arg-Arg-OH [72]

Mel4

H-Lys-Asn-Lys-Arg-Lys-Arg-Arg-Arg-Arg-Arg-Arg-Gly-Gly-Arg-Arg-Arg-Arg-OH [72]

AamAP1 lysine

H-Phe-Leu-Phe-Lys-Leu-Ile-Pro-Lys-Ala-Ile-Lys-Lys-Leu-Ile-Ser-Lys-Phe-Lys-OH [73]

UP-5

H-Arg-B-Arg-B-Arg-COOH, where B represents biphenylalanine [74]

HYL

H-Gly-Ile-Met-Ser-Ser-Leu-Met-Lys-Lys-Leu-Ala-Ala-His-Ile-Ala-Lys-NH_2 [75]

I(LLKK)2I

H-Ile-Leu-Leu-Lys-Lys-Leu-Leu-Lys-Lys-Ile-NH_2 [76]

M(LLKK)2M

H-Met-Leu-Leu-Lys-Lys-Leu-Leu-Lys-Lys-Met-NH_2 [76]

W(LLKK)2W

H-Trp-Leu-Leu-Lys-Lys-Leu-Leu-Lys-Lys-Trp-NH_2 [76]

Plectasin

H-GFGCNGPWDEDDMQCHNHCKSIKGYKGGYCAKGGFVCKCY-OH [77]

Plectasin NZ2114:

H-GFGCNGPWNEDDLRCHNHCKSIKGYKGGYCAKGGFVCKCY-OH [78]

PL-5

Ac-Lys-Trp-Lys-Ser-Phe-Leu-Lys-Thr-Phe-Lys-Ser-Ala-Ala-Lys-Thr-Val- Leu -His-Thr-Ala-Leu-Lys-Ala-Ile-Ser-Ser-NH_2 [79]

PL-31

Ac-Lys-Trp-Lys-Ser-Phe-Leu-Lys-Thr-Phe-Lys-Ser-Leu-Lys-Lys-Thr-Val- Leu -His-Thr-Leu-Leu-Lys-Ala-Ile-Ser-Ser -NH_2 [79]

PL-32

Ac-Lys-Trp-Lys-Ser-Phe-Leu-Lys-Thr-Phe-Lys-Ser-Leu-Lys-Lys-Thr-Val-Leu-His-Thr-Leu-Leu-Lys-Ala-Ile-Ser-Ser-NH_2 [79]

PL-18

Ac-Phe-Lys-Lys-Leu-Lys-Lys-Leu-Phe-Ser-Lys-Leu-Trp-Asn-Trp-Lys-NH_2 [79]

PL-29

Ac-Phe-Lys-Lys-Leu-Lys-Lys-Leu-Phe-Ser-Lys-Leu-Phe-Ser-Phe-Lys-NH_2 [79]

PL-26

Ac- Lys-Lys-Val-Val-Phe-Lys-Val-Lys-Phe-Lys-Lys-$_{NH2}$ [79]

PRW4

Arg-Phe-Arg-Arg-Leu-Arg-Trp-Lys-Thr-Arg-Trp-Arg-Leu-Lys-Lys-Ile[80]

PMAP-36

H-GRFRRLRKKTRKRLKKIGKVLKWIPPIVGSIPLGCG-OH [80]

Coprisin

H-VTCDVLSFEAKGIAVNHSACALHCIALRKKGGSCQNGVCVCRN-NH_2 [81]

Pleurocidin

H-Gly-Trp-Gly-Ser-Phe-Phe-Lys-Lys-Ala-Ala-His-Val-Gly-Lys-His-Val-Gly -Lys-Ala-Ala-Leu-Thr-His-Tyr-Leu-NH_2 [82]

Protegrin 1: H-Arg-Gly-Gly-Arg-Leu-Cys(&^{1})-Tyr-Cys(&^{1})-Arg-Arg-Arg-Phe-Cys(&^{1})-Val-Cys(&^{1})-Val-Gly-Arg-OH [83]

Cathelicidin-BF

H-Lys-Phe-Phe-Arg-Lys-Leu-Lys-Lys-Ser-Val-Lys-Lys-Arg-Ala-Lys-Glu- Phe-Phe-Lys-Lys-Pro-Arg-Val-Ile-Gly-Val-Ser-Ile-Pro-Phe-OH [83]

BA250-C10

Arg-Trp-Arg-Trp-Arg-Trp-Lys-(C10) synthetic lipoAMP, a lipidated peptide with a C10-lipid chain attached to the C-terminus [84]

Bactenecin

H-Arg-Leu-Cys(&)^1-Arg-Ile-Val-Val-Ile-Arg-Val-Cys(&)^1-Arg-OH [85]

BP100

H-Lys-Lys-Leu-Phe-Lys-Lys-Ile-Leu-Lys-Tyr-Leu-NH_2 [86]

GA-K4

H-Phe-Leu-Lys-Trp-Leu-Phe-Lys-Trp-Ala-Lys-Lys-NH_2 [87]

HRAP1/HRAP2

Ac-Phe-Lys-Lys-Leu-Lys-Lys-Leu-Phe-Ser-Lys-Leu-Trp-Asn-Trp-Lys-NH_2 [88]

Parasin I

H-Lys-Gly-Arg-Gly-Lys-Gln-Gly-Gly-Lys-Val-Arg-Ala-Lys-Ala-Lys-Thr-Arg-Ser-Ser-OH [89]

Synoeca-MP peptide

H-Ile-Asn-Trp-Leu-Lys-Leu-Gly-Lys-Lys-Ile-Ile-Ala-Ser-Leu-NH_2 [90]

Bacillomycin D

&Asn-Pro-Glu-Ser-Thr-βXaa-Asp-Tyr& [91]

It is a mixture of two homologous lipopeptides: the lipid moiety consists of 3-amino-12-methyltridecanoic acid or 3-amino-12-methyltetradecanoic acid (βXaa)

Gramicidin-S

(&Val-Orn-Leu-D-Phe-Pro&)$_2$ [92]

Gramicidin A

HCO-L-Val-Gly-L-Ala-D-Leu-L-ala-D-Val-L-Val-D-Val-L-Trp-D-Leu-Trp-D-Teu-L-trp-D-leu-L-trp-$NHCH_2CH_2OH$ [93]

Thionin

H-KSCCRNTWARNCYNVCRLPGTISREICAKKCDCKIISGTTCPSDYPK-OH [94]

STF(1-37)

H-KIRTRRSQARKCSRGNGGGIRCPGGGIRLGGGSLIGR-OH [95]

D2A21

H-Phe-Ala-Lys-Lys-Phe-Ala-Lys-Lys-Phe-Lys-Lys-Phe-Ala-Lys-Lys-Phe-Ala-Lys-Phe-Ala-Phe-Ala-Phe-OH [96]

Clavanin A

H-Val-Phe-Gln-Phe-Leu-Gly-Lys-Ile-Ile-His-His-Val-Gly-Asn-Phe-Val-His-Gly-Phe-Ser-His-Val-Phe-NH_2 [97]

MBP-1

H-RSGRGECRRQCLRRHEGQPWETQECMRRCRRRG-OH [98]

Melittin

H-Gly-Ile-Gly-Ala-Val-Leu-Lys-Val-Leu-Thr-Thr-Gly-Leu-Pro-Ala-Leu-Ile-Ser-Trp-Ile-Lys-Arg-Lys-Arg-Gln-Gln-NH_2 [99]

Cecropin A

H-KWKLFKKIEKVGQNIRDGIIKAGPAVAVVGQAT-OH [100]

References

1. Zerweck, J., et al., *Molecular mechanism of synergy between the antimicrobial peptides PGLa and magainin 2.* Sci. Rep., 2017. **7**(1): p. 1-21.
2. Kabelka, I., et al., *Magainin 2 and PGLa in bacterial membrane mimics II: membrane fusion and sponge phase formation.* Biophysical journal, 2020. **118**(3): p. 612-623.
3. Capparelli, R., et al., *Synergistic antibacterial and anti-inflammatory activity of temporin A and modified temporin B in vivo.* PLoS One, 2009. **4**(9): p. No pp. given.
4. Bhunia, A., et al., *NMR structures and interactions of temporin-1Tl and temporin-1Tb with lipopolysaccharide micelles: mechanistic insights into outer membrane permeabilization and synergistic activity.* J Biol Chem, 2011. **286**(27): p. 24394-406.
5. Conlon, J.M., *Reflections on a systematic nomenclature for antimicrobial peptides from the skins of frogs of the family Ranidae.* Peptides, 2008. **29**(10): p. 1815-1819.

6. Ciandrini, E., et al., *Synergistic combinations of antimicrobial peptides against biofilms of methicillin-resistant Staphylococcus aureus (MRSA) on polystyrene and medical devices.* Journal of Global Antimicrobial Resistance, 2020. **21**: p. 203-210.
7. De Smet, K. and R. Contreras, *Human antimicrobial peptides: defensins, cathelicidins and histatins.* Biotechnology letters, 2005. **27**(18): p. 1337-1347.
8. Chairatana, P. and E.M. Nolan, *Human α-defensin 6: a small peptide that self-assembles and protects the host by entangling microbes.* Accounts of chemical research, 2017. **50**(4): p. 960-967.
9. Schmitt, P., et al., *The Antimicrobial Defense of the Pacific Oyster, Crassostrea gigas. How Diversity may Compensate for Scarcity in the Regulation of Resident/Pathogenic Microflora.* Front Microbiol, 2012. **3**: p. 160.
10. Schmitt, P., et al., *Expression, tissue localization and synergy of antimicrobial peptides and proteins in the immune response of the oyster Crassostrea gigas.* Dev. Comp. Immunol., 2012. **37**(3-4): p. 363-370.
11. Yannick, G., et al., *Oyster hemocytes express a proline-rich peptide displaying synergistic antimicrobial activity with a defensin.* Mol. Immunol., 2009. **46**(4): p. 516-522.
12. Gueguen, Y., et al., *Characterization of a defensin from the oyster Crassostrea gigas: recombinant production, folding, solution structure, antimicrobial activities, and gene expression.* Journal of Biological Chemistry, 2006. **281**(1): p. 313-323.
13. Shi, J., et al., *Antibacterial activity of a synthetic peptide (PR-26) derived from PR-39, a proline-arginine-rich neutrophil antimicrobial peptide.* Antimicrobial Agents and Chemotherapy, 1996. **40**(1): p. 115-121.
14. Lai, J.R., et al., *Design of non-cysteine-containing antimicrobial β-hairpins: Structure− activity relationship studies with linear protegrin-1 analogues.* Biochemistry, 2002. **41**(42): p. 12835-12842.
15. Poeppel, A.-K., et al., *Antimicrobial peptides expressed in medicinal maggots of the blow fly Lucilia sericata show combinatorial activity against bacteria.* Antimicrob. Agents Chemother., 2015. **59**(5): p. 2508-2514.
16. Shi, J., et al., *Porcine epithelial β-defensin 1 is expressed in the dorsal tongue at antimicrobial concentrations.* Infect. Immun., 1999. **67**(6): p. 3121-3127.
17. Selsted, M.E., et al., *Primary structures of six antimicrobial peptides of rabbit peritoneal neutrophils.* Journal of Biological Chemistry, 1985. **260**(8): p. 4579-4584.
18. Bedran, T.B.L., et al., *Synergistic anti-inflammatory activity of the antimicrobial peptides human beta-defensin-3 (hbD-3) and cathelicidin (LL-37) in a three-dimensional co-culture model of gingival epithelial cells and fibroblasts.* PLoS One, 2014. **9**(9): p. e106766/1-e106766/10, 10 pp.
19. Knappe, D., et al., *Insect-derived short proline-rich and murine cathelicidin-related antimicrobial peptides act synergistically on Gram-negative bacteria in vitro.* Future Med. Chem., 2016. **8**(10): p. 1035-1045.
20. Romeo, D., et al., *Structure and bactericidal activity of an antibiotic dodecapeptide purified from bovine neutrophils.* Journal of Biological Chemistry, 1988. **263**(20): p. 9573-9575.
21. Rozek, A., C.L. Friedrich, and R.E. Hancock, *Structure of the bovine antimicrobial peptide indolicidin bound to dodecylphosphocholine and sodium dodecyl sulfate micelles.* Biochemistry, 2000. **39**(51): p. 15765-15774.
22. Nagaoka, I., et al., *Synergistic actions of antibacterial neutrophil defensins and cathelicidins.* Inflamm Res, 2000. **49**(2): p. 73-9.
23. Bierbaum, G., et al., *The biosynthesis of the lantibiotics epidermin, gallidermin, Pep5 and epilancin K7.* Antonie Van Leeuwenhoek, 1996. **69**(2): p. 119-127.
24. Selsted, M.E. and S. Harwig, *Purification, primary structure, and antimicrobial activities of a guinea pig neutrophil defensin.* Infection and Immunity, 1987. **55**(9): p. 2281-2286.

25. Huo, L. and W.A. van der Donk, *Discovery and characterization of bicereucin, an unusual D-amino acid-containing mixed two-component lantibiotic.* J. Am. Chem. Soc., 2016. **138**(16): p. 5254-5257.
26. Shenkarev, Z.O., et al., *Isolation, Structure Elucidation, and Synergistic Antibacterial Activity of a Novel Two-Component Lantibiotic Lichenicidin from Bacillus licheniformis VK21.* Biochemistry, 2010. **49**(30): p. 6462-6472.
27. Cotter, P.D., et al., *Complete alanine scanning of the two-component lantibiotic lacticin 3147: generating a blueprint for rational drug design.* Mol. Microbiol., 2006. **62**(3): p. 735-747.
28. Ekblad, B., et al., *Structure–function analysis of the two-peptide bacteriocin plantaricin EF.* Biochemistry, 2016. **55**(36): p. 5106-5116.
29. Rogne, P., et al., *Three-dimensional structure of the two-peptide bacteriocin plantaricin JK.* Peptides, 2009. **30**(9): p. 1613-1621.
30. Izquierdo, E., et al., *Production of enterocins L50A, L50B, and IT, a new enterocin, by Enterococcus faecium IT62, a strain isolated from Italian ryegrass in Japan.* Antimicrobial agents and chemotherapy, 2008. **52**(6): p. 1917-1923.
31. Lohans, C.T., et al., *Solution Structures of the Linear Leaderless Bacteriocins Enterocin 7A and 7B Resemble Carnocyclin A, a Circular Antimicrobial Peptide.* Biochemistry, 2013. **52**(23): p. 3987-3994.
32. Sit, C.S., et al., *The 3D Structure of Thuricin CD, a Two-Component Bacteriocin with Cysteine Sulfur to α-Carbon Cross-links.* J. Am. Chem. Soc., 2011. **133**(20): p. 7680-7683.
33. Acedo, J.Z., et al., *Identification and three-dimensional structure of carnobacteriocin XY, a class IIb bacteriocin produced by Carnobacteria.* FEBS Lett, 2017. **591**(10): p. 1349-1359.
34. Holo, H., et al., *Plantaricin W from Lactobacillus plantarum belongs to a new family of two-peptide lantibiotics.* Microbiology (Reading, U. K.), 2001. **147**(3): p. 643-651.
35. Steffen, H., et al., *Naturally processed dermcidin-derived peptides do not permeabilize bacterial membranes and kill microorganisms irrespective of their charge.* Antimicrobial agents and chemotherapy, 2006. **50**(8): p. 2608-2620.
36. Xiang, J., et al., *The synergistic antimicrobial effects of novel bombinin and bombinin H peptides from the skin secretion of Bombina orientalis.* Biosci. Rep., 2017. **37**(5): p. BSR20170967.
37. Bai, B., et al., *Feleucins: novel bombinin precursor-encoded nonapeptide amides from the skin secretion of Bombina variegata.* Biomed Res Int, 2014. **2014**: p. 671362.
38. Wang, K., et al., *Antimicrobial peptide protonectin disturbs the membrane integrity and induces ROS production in yeast cells.* Biochimica et Biophysica Acta (BBA)-Biomembranes, 2015. **1848**(10): p. 2365-2373.
39. Baptista-Saidemberg, N.B., et al., *Protonectin (1–6): A novel chemotactic peptide from the venom of the social wasp Agelaia pallipes pallipes.* Toxicon, 2010. **56**(6): p. 880-889.
40. Rahnamaeian, M., et al., *Insect antimicrobial peptides show potentiating functional interactions against Gram-negative bacteria.* Proceedings of the Royal Society B: Biological Sciences, 2015. **282**(1806): p. 20150293.
41. Milona, P., et al., *The chicken host peptides, gallinacins 4, 7, and 9 have antimicrobial activity against Salmonella serovars.* Biochem. Biophys. Res. Commun., 2007. **356**(1): p. 169-174.
42. Lauth, X., et al., *Discovery and characterization of two isoforms of moronecidin, a novel antimicrobial peptide from hybrid striped bass.* Journal of Biological Chemistry, 2002. **277**(7): p. 5030-5039.
43. Shike, H., et al., *Bass hepcidin is a novel antimicrobial peptide induced by bacterial challenge.* European Journal of Biochemistry, 2002. **269**(8): p. 2232-2237.
44. Xu, P., M. Shi, and X.-x. Chen, *Antimicrobial peptide evolution in the Asiatic honey bee Apis cerana.* Plos one, 2009. **4**(1): p. e4239.

45. Anderson, R.C. and P.-L. Yu, *Factors affecting the antimicrobial activity of ovine-derived cathelicidins against E. coli O157:H7.* Int. J. Antimicrob. Agents, 2005. **25**(3): p. 205-210.
46. Zottich, U., et al., *An antifungal peptide from Coffea canephora seeds with sequence homology to glycine-rich proteins exerts membrane permeabilization and nuclear localization in fungi.* Biochimica et Biophysica Acta (BBA)-General Subjects, 2013. **1830**(6): p. 3509-3516.
47. Singh, K., et al., *DS6: anticandidal, antibiofilm peptide against Candida tropicalis and exhibit synergy with commercial drug.* Journal of Peptide Science, 2017. **23**(3): p. 228-235.
48. Lum, K.Y., et al., *Activity of Novel Synthetic Peptides against Candida albicans.* Sci. Rep., 2015. **5**: p. 9657.
49. Simonetti, O., et al., *In vitro activity of the protegrin IB-367 alone and in combination compared with conventional antifungal agents against dermatophytes.* Mycoses, 2014. **57**(4): p. 233-239.
50. Hunter, H.N., et al., *The Solution Structure of Human Hepcidin, a Peptide Hormone with Antimicrobial Activity That Is Involved in Iron Uptake and Hereditary Hemochromatosis* 210.* Journal of Biological Chemistry, 2002. **277**(40): p. 37597-37603.
51. Kamysz, E., et al., *In vitro activity of the lipopeptide PAL-Lys-Lys-NH2, alone and in combination with antifungal agents, against clinical isolates of Candida spp.* Peptides, 2011. **32**(1): p. 99-103.
52. Duggineni, S., et al., *A novel dodecapeptide from a combinatorial synthetic library exhibits potent antifungal activity and synergy with standard antimycotic agents.* Int. J. Antimicrob. Agents, 2007. **29**(1): p. 73-78.
53. Kumar, M., et al., *Identification of a novel antifungal nonapeptide generated by combinatorial approach.* International journal of antimicrobial agents, 2005. **25**(4): p. 313-320.
54. Mora-Navarro, C., et al., *Synthetic antimicrobial β-peptide in dual-treatment with fluconazole or ketoconazole enhances the in vitro inhibition of planktonic and biofilm Candida albicans.* Journal of Peptide Science, 2015. **21**(12): p. 853-861.
55. Lupetti, A., et al., *Candidacidal activities of human lactoferrin peptides derived from the N terminus.* Antimicrobial Agents and Chemotherapy, 2000. **44**(12): p. 3257-3263.
56. Mor, A., K. Hani, and P. Nicolas, *The vertebrate peptide antibiotics dermaseptins have overlapping structural features but target specific microorganisms.* Journal of Biological Chemistry, 1994. **269**(50): p. 31635-31641.
57. Wei, G.-X. and L.A. Bobek, *Human salivary mucin MUC7 12-mer-L and 12-mer-D peptides: antifungal activity in saliva, enhancement of activity with protease inhibitor cocktail or EDTA, and cytotoxicity to human cells.* Antimicrobial agents and chemotherapy, 2005. **49**(6): p. 2336-2342.
58. Troskie, A.M., et al., *Synergistic activity of the tyrocidines, antimicrobial cyclodecapeptides from Bacillus aneurinolyticus, with amphotericin B and caspofungin against Candida albicans biofilms.* Antimicrobial agents and chemotherapy, 2014. **58**(7): p. 3697-3707.
59. Vriens, K., et al., *Synergistic activity of the plant defensin HsAFP1 and caspofungin against Candida albicans biofilms and planktonic cultures.* PloS one, 2015. **10**(8): p. e0132701.
60. Denardi, L.B., et al., *Activity of MSI-78, h-Lf1-11 and cecropin B antimicrobial peptides alone and in combination with voriconazole and amphotericin B against clinical isolates of Fusarium solani.* Journal of Medical Mycology, 2021. **31**(2): p. 101119.
61. Dodou Lima, H.V., C.S. de Paula Cavalcante, and G. Rádis-Baptista, *Antifungal in vitro activity of pilosulin-and ponericin-like peptides from the giant ant Dinoponera quadriceps and synergistic effects with antimycotic drugs.* Antibiotics, 2020. **9**(6): p. 354.
62. Olfa, T., et al., *Synergistic fungicidal activity of the lipopeptide bacillomycin D with amphotericin B against pathogenic Candida species.* FEMS Yeast Research, 2015. **15**(4): p. fov022.

63. van't, H.W., et al., *Synergistic effects of low doses of histatin 5 and its analogues on amphotericin B anti-mycotic activity.* Antonie Van Leeuwenhoek, 2000. **78**(2): p. 163-9.
64. Tanida, T., et al., *Antimicrobial peptides enhance the candidacidal activity of antifungal drugs by promoting the efflux of ATP from Candida cells.* Journal of Antimicrobial Chemotherapy, 2006. **57**(1): p. 94-103.
65. Simonetti, O., et al., *In vitro activity of Tachyplesin III alone and in combination with terbinafine against clinical isolates of dermatophytes.* Peptides, 2009. **30**(10): p. 1794-1797.
66. Ryder, M.P., et al., *Binding interactions of bacterial lipopolysaccharide and the cationic amphiphilic peptides polymyxin B and WLBU2.* Colloids and Surfaces B: Biointerfaces, 2014. **120**: p. 81-87.
67. Xiong, F., et al., *Effects of the antimicrobial peptide L12 against multidrug-resistant Staphylococcus aureus.* Mol. Med. Rep., 2019. **19**(4): p. 3337-3344.
68. Wongkaewkhiaw, S., et al., *D-LL-31 in combination with ceftazidime synergistically enhances bactericidal activity and biofilm destruction in Burkholderia pseudomallei.* Biofouling, 2019. **35**(5): p. 573-584.
69. Vargas-Casanova, Y., et al., *Synergistic bactericide and antibiotic effects of dimeric, tetrameric, or palindromic peptides containing the RWQWR motif against Gram-positive and Gram-negative strains.* RSC Adv., 2019. **9**(13): p. 7239-7245.
70. Shang, D., et al., *Synergistic Antibacterial Activity of Designed Trp-Containing Antibacterial Peptides in Combination With Antibiotics Against Multidrug-Resistant Staphylococcus epidermidis.* Front Microbiol, 2019. **10**: p. 2719.
71. Liu, Y., et al., *Antagonizing Vancomycin Resistance in Enterococcus by Surface Localized Antimicrobial Display-Derived Peptides.* ACS Infect. Dis., 2019: p. Ahead of Print.
72. Kampshoff, F., M.D.P. Willcox, and D. Dutta, *A pilot study of the synergy between two antimicrobial peptides and two common antibiotics.* Antibiotics 2019. **8**(2): p. 60.
73. Almaaytah, A., A. Abualhaijaa, and O. Alqudah, *The evaluation of the synergistic antimicrobial and antibiofilm activity of AamAP1-Lysine with conventional antibiotics against representative resistant strains of both Gram-positive and Gram-negative bacteria.* Infect. Drug Resist., 2019. **12**: p. 1371-1380.
74. Almaaytah, A., et al., *Antimicrobial and antibiofilm activity of UP-5, an ultrashort antimicrobial peptide designed using only arginine and biphenylalanine.* Pharmaceuticals, 2018. **11**(1): p. 3/1-3/18.
75. Nesuta, O., et al., *Antimicrobial Peptide from the Wild Bee Hylaeus signatus Venom and Its Analogues: Structure-Activity Study and Synergistic Effect with Antibiotics.* J. Nat. Prod., 2016. **79**(4): p. 1073-1083.
76. Khara, J.S., et al., *Designing α-helical peptides with enhanced synergism and selectivity against Mycobacterium smegmatis: Discerning the role of hydrophobicity and helicity.* Acta Biomater., 2015. **28**: p. 99-108.
77. Mygind, P.H., et al., *Plectasin is a peptide antibiotic with therapeutic potential from a saprophytic fungus.* Nature, 2005. **437**(7061): p. 975-980.
78. Li, Z., et al., *Research advances on plectasin and its derivatives as new potential antimicrobial candidates.* Process Biochemistry, 2017. **56**: p. 62-70.
79. Feng, Q., et al., *Functional synergy of α-helical antimicrobial peptides and traditional antibiotics against Gram-negative and Gram-positive bacteria in vitro and in vivo.* Eur. J. Clin. Microbiol. Infect. Dis., 2015. **34**(1): p. 197-204.
80. Wang, Z., et al., *Synergistic interaction of PMAP-36 and PRW4 with aminoglycoside antibiotics and their antibacterial mechanism.* World J. Microbiol. Biotechnol., 2014. **30**(12): p. 3121-3128.
81. Hwang, I.-s., et al., *Synergistic Effect and Antibiofilm Activity Between the Antimicrobial Peptide Coprisin and Conventional Antibiotics Against Opportunistic Bacteria.* Curr. Microbiol., 2013. **66**(1): p. 56-60.

82. Choi, H. and D.G. Lee, *Antimicrobial peptide pleurocidin synergizes with antibiotics through hydroxyl radical formation and membrane damage, and exerts antibiofilm activity.* Biochim. Biophys. Acta, Gen. Subj., 2012. **1820**(12): p. 1831-1838.
83. Liu, Y.-F., et al., *Antibacterial Activity, Cytotoxicity and Mechanisms of action of Cathelicidin Peptides against Enteric Pathogens in Weaning Piglets.* Int. J. Pept. Res. Ther., 2011. **17**(3): p. 175-184.
84. de Gier, M.G., et al., *Synergistic activity of a short lipidated antimicrobial peptide (lipoAMP) and colistin or tobramycin against Pseudomonas aeruginosa from cystic fibrosis patients.* MedChemComm, 2016. **7**(1): p. 148-156.
85. Wu, M. and R.E. Hancock, *Interaction of the cyclic antimicrobial cationic peptide bactenecin with the outer and cytoplasmic membrane.* Journal of Biological Chemistry, 1999. **274**(1): p. 29-35.
86. Cabrefiga, J. and E. Montesinos, *Lysozyme enhances the bactericidal effect of BP100 peptide against Erwinia amylovora, the causal agent of fire blight of rosaceous plants.* BMC Microbiol., 2017. **17**: p. 39/1-39/10.
87. Kang, S.-J., H.-Y. Ji, and B.-J. Lee, *Anticancer activity of undecapeptide analogues derived from antimicrobial peptide, Brevinin-1EMa.* Arch. Pharmacal Res., 2012. **35**(5): p. 791-799.
88. Zhao, J., et al., *In vitro characterization of the rapid cytotoxicity of anticancer peptide HPRP-A2 through membrane destruction and intracellular mechanism against gastric cancer cell lines.* PLoS One, 2015. **10**(9): p. e0139578.
89. Park, I.Y., et al., *Parasin I, an antimicrobial peptide derived from histone H2A in the catfish, Parasilurus asotus.* FEBS letters, 1998. **437**(3): p. 258-262.
90. Dantas, E.M.G.L., et al., *Synergistic activity of chlorhexidine and synoeca-MP peptide against Pseudomonas aeruginosa.* J. Cell. Physiol., 2019. **234**(9): p. 16068-16079.
91. PEYPOUX, F., et al., *Structure of bacillomycin D, a new antibiotic of the iturin group.* European journal of biochemistry, 1981. **118**(2): p. 323-327.
92. Nagamurthi, G. and S. Rambhav, *Gramicidin-S: Structure-activity relationship.* Journal of biosciences, 1985. **7**(3): p. 323-329.
93. Wallace, B., *Structure of gramicidin A.* Biophysical journal, 1986. **49**(1): p. 295-306.
94. Vila-Perelló, M., et al., *Synthetic and structural studies on Pyrularia pubera thionin: a single-residue mutation enhances activity against Gram-negative bacteria.* FEBS letters, 2003. **536**(1-3): p. 215-219.
95. D'Este, F., et al., *Antimicrobial and host cell-directed activities of Gly/Ser-rich peptides from salmonid cathelicidins.* Fish Shellfish Immunol., 2016. **59**: p. 456-468.
96. Ballweber, L., et al., *In vitro microbicidal activities of cecropin peptides D2A21 and D4E1 and gel formulations containing 0.1 to 2% D2A21 against Chlamydia trachomatis.* Antimicrobial agents and chemotherapy, 2002. **46**(1): p. 34-41.
97. Duay, S.S., et al., *Molecular dynamics investigation into the effect of zinc (II) on the structure and membrane interactions of the antimicrobial peptide Clavanin A.* The Journal of Physical Chemistry B, 2019. **123**(15): p. 3163-3176.
98. Slavokhotova, A.A. and E.A. Rogozhin, *Defense peptides from the α-hairpinin family are components of plant innate immunity.* Frontiers in Plant Science, 2020. **11**: p. 465.
99. Deng, Z., et al., *Lipid-specific interactions determine the organization and dynamics of membrane-active peptide melittin.* Soft Matter, 2020. **16**(14): p. 3498-3504.
100. Merrifield, R., L. Vizioli, and H. Boman, *Synthesis of the antibacterial peptide cecropin A (1-33).* Biochemistry, 1982. **21**(20): p. 5020-5031.