

- Amoroso, A., J. Boudet, S. Berzigotti, V. Duval, N. Teller, D. Mengin-Lecreux, A. Luxen, J. P. Simorre & B. Joris, (2012) A Peptidoglycan Fragment Triggers beta-lactam Resistance in *Bacillus licheniformis*. *PLoS Pathog* **8**: e1002571.
- Avison, M. B., P. Niumsup, K. Nurmahomed, T. R. Walsh & P. M. Bennett, (2004) Role of the 'cre/blr-tag' DNA sequence in regulation of gene expression by the *Aeromonas hydrophila* beta-lactamase regulator, BlrA. *J Antimicrob Chemother* **53**: 197-202.
- Avison, M. B., P. Niumsup, T. R. Walsh & P. M. Bennett, (2000) *Aeromonas hydrophila* AmpH and CepH beta-lactamases: derepressed expression in mutants of *Escherichia coli* lacking creB. *J Antimicrob Chemother* **46**: 695-702.
- Berzigotti, S., K. Benlafya, J. Sepulchre, A. Amoroso & B. Joris, (2012) *Bacillus licheniformis* BlaR1 L3 loop is a zinc metalloprotease activated by self-proteolysis. *PLoS One* **7**: e36400.
- Brans, A., P. Filée, A. Chevigne, A. Claessens & B. Joris, (2004) New integrative method to generate *Bacillus subtilis* recombinant strains free of selection markers. *Appl Environ Microbiol* **70**: 7241-7250.
- Borbulevych, O., M. Kumarasiri, B. Wilson, L. I. Llarrull, M. Lee, D. Hesek, Q. Shi, J. Peng, B. M. Baker & S. Mobashery, (2011) Lysine Nzeta-decarboxylation switch and activation of the beta-lactam sensor domain of BlaR1 protein of methicillin-resistant *Staphylococcus aureus*. *J Biol Chem* **286**: 31466-31472.
- Cheng, Q., H. Li, K. Merdek & J. T. Park, (2000) Molecular characterization of the beta-N-acetylglucosaminidase of *Escherichia coli* and its role in cell wall recycling. *J Bacteriol* **182**: 4836-4840.
- Cheng, Q. & J. T. Park, (2002) Substrate specificity of the AmpG permease required for recycling of cell wall anhydro-muropeptides. *J Bacteriol* **184**: 6434-6436.
- Clarke, S. R. & K. G. Dyke, (2001) The signal transducer (BlaRI) and the repressor (Blal) of the *Staphylococcus aureus* beta-lactamase operon are inducible. *Microbiology* **147**: 803-810.
- Duval, V., M. Swinnen, S. Lepage, A. Brans, B. Granier, C. Franssen, J. M. Frère & B. Joris, (2003) The kinetic properties of the carboxy terminal domain of the *Bacillus licheniformis* 749/I BlaR penicillin-receptor shed a new light on the derepression of beta-lactamase synthesis. *Mol Microbiol* **48**: 1553-1564.
- Fernandez-Recio, J., F. Walas, L. Federici, J. Venkatesh Pratap, V. N. Bavro, R. N. Miguel, K. Mizuguchi & B. Luisi, (2004) A model of a transmembrane drug-efflux pump from Gram-negative bacteria. *FEBS Lett* **578**: 5-9.
- Filée, P., C. Vreuls, R. Herman, I. Thamm, T. Aerts, P. P. De Deyn, J. M. Frère & B. Joris, (2003) Dimerization and DNA binding properties of the *Bacillus licheniformis* 749/I Blal repressor. *J Biol Chem* **278**: 16482-16487.
- Filée, P., K. Benlafya, M. Delmarcelle, G. Moutzourelis, J. M. Frère, A. Brans & B. Joris, (2002) The fate of the Blal repressor during the induction of the *Bacillus licheniformis* BlaP beta-lactamase. *Mol Microbiol* **44**: 685-694.

- Filée, P., M. Delmarcelle, I. Thamm & B. Joris, (2001) Use of an ALFexpress DNA sequencer to analyze protein-nucleic acid interactions by band shift assay. *Biotechniques* **30**: 1044-1048, 1050-1041.
- Frère, J. M., (1995) Beta-lactamases and bacterial resistance to antibiotics. *Mol Microbiol* **16**: 385-395.
- Frère, J. M., C. Duez, J. M. Ghuyse & J. Vandekerckhove, (1976) Occurrence of a serine residue in the penicillin-binding site of the exocellular DD-carboxy-peptidase-transpeptidase from *Streptomyces R61*. *FEBS Lett* **70**: 257-260.
- Frère, J. M., B. Joris, O. Dideberg, P. Charlier & J. M. Ghuyse, (1988) Penicillin-recognizing enzymes. *Biochem Soc Trans* **16**: 934-938.
- Garcia-Castellanos, R., G. Mallorqui-Fernandez, A. Marrero, J. Potempa, M. Coll & F. X. Gomis-Ruth, (2004) On the transcriptional regulation of methicillin resistance: Mecl repressor in complex with its operator. *J Biol Chem* **279**: 17888-17896.
- Garcia-Castellanos, R., A. Marrero, G. Mallorqui-Fernandez, J. Potempa, M. Coll & F. X. Gomis-Ruth, (2003) Three-dimensional structure of Mecl. Molecular basis for transcriptional regulation of staphylococcal methicillin resistance. *J Biol Chem* **278**: 39897-39905.
- Gao, X., J. Wang, D. Q. Yu, F. Bian, B. B. Xie, X. L. Chen, B. C. Zhou, L. H. Lai, Z. X. Wang, J. W. Wu & Y. Z. Zhang, (2010) Structural basis for the autoprocessing of zinc metalloproteases in the thermolysin family. *Proc Natl Acad Sci U S A* **107**: 17569-17574.
- Ghuyse, J. M. & C. Goffin, (1999) Lack of cell wall peptidoglycan versus penicillin sensitivity: new insights into the chlamydial anomaly. *Antimicrob Agents Chemother* **43**: 2339-2344.
- Goffin, C. & J. M. Ghuyse, (1998) Multimodular penicillin-binding proteins: an enigmatic family of orthologs and paralogs. *Microbiol Mol Biol Rev* **62**: 1079-1093.
- Goodell, E. W., (1985) Recycling of murein by *Escherichia coli*. *J Bacteriol* **163**: 305-310.
- Green, D. W., (2002) The bacterial cell wall as a source of antibacterial targets. *Expert Opin Ther Targets* **6**: 1-19.
- Gregory, P. D., R. A. Lewis, S. P. Curnock & K. G. Dyke, (1997) Studies of the repressor (Blal) of beta-lactamase synthesis in *Staphylococcus aureus*. *Mol Microbiol* **24**: 1025-1037.
- Gulick, A. M., D. M. Schmidt, J. A. Gerlt & I. Rayment, (2001) Evolution of enzymatic activities in the enolase superfamily: crystal structures of the L-Ala-D/L-Glu epimerases from *Escherichia coli* and *Bacillus subtilis*. *Biochemistry* **40**: 15716-15724.
- Hackbarth, C. J. & H. F. Chambers, (1993) blal and blaR1 regulate beta-lactamase and PBP 2a production in methicillin-resistant *Staphylococcus aureus*. *Antimicrob Agents Chemother* **37**: 1144-1149.
- Hakenbeck, R., (1998) Mosaic genes and their role in penicillin-resistant *Streptococcus pneumoniae*. *Electrophoresis* **19**: 597-601.

- Hanique, S., M. L. Colombo, E. Goormaghtigh, P. Soumillion, J. M. Frère & B. Joris, (2004) Evidence of an intramolecular interaction between the two domains of the BlaR1 penicillin receptor during the signal transduction. *J Biol Chem* **279**: 14264-14272.
- Hanson, N. D. & C. C. Sanders, (1999) Regulation of inducible AmpC beta-lactamase expression among *Enterobacteriaceae*. *Curr Pharm Des* **5**: 881-894.
- Hardt, K., B. Joris, S. Lepage, R. Brasseur, J. O. Lampen, J. M. Frère, A. L. Fink & J. M. Ghuyzen, (1997) The penicillin sensory transducer, BlaR, involved in the inducibility of beta-lactamase synthesis in *Bacillus licheniformis* is embedded in the plasma membrane via a four-alpha-helix bundle. *Mol Microbiol* **23**: 935-944.
- Hausrath, A. C. & B. W. Matthews, (1994) Redetermination and refinement of the complex of benzylsuccinic acid with thermolysin and its relation to the complex with carboxypeptidase A. *J Biol Chem* **269**: 18839-18842.
- Hertz, G. Z. & G. D. Stormo, (1999) Identifying DNA and protein patterns with statistically significant alignments of multiple sequences. *Bioinformatics* **15**: 563-577.
- Hiard, S., R. Maree, S. Colson, P. A. Hoskisson, F. Titgemeyer, G. P. van Wezel, B. Joris, L. Wehenkel & S. Rigali, (2007) PREDetector: a new tool to identify regulatory elements in bacterial genomes. *Biochem Biophys Res Commun* **357**: 861-864.
- Holtje, J. V., D. Mirelman, N. Sharon & U. Schwarz, (1975) Novel type of murein transglycosylase in *Escherichia coli*. *J Bacteriol* **124**: 1067-1076.
- Hooper, N. M., (1994) Families of zinc metalloproteases. *FEBS Lett* **354**: 1-6.
- Howell, A., S. Dubrac, K. K. Andersen, D. Noone, J. Fert, T. Msadek & K. Devine, (2003) Genes controlled by the essential YycG/YycF two-component system of *Bacillus subtilis* revealed through a novel hybrid regulator approach. *Mol Microbiol* **49**: 1639-1655.
- Jacobs, C., J. M. Frère & S. Normark, (1997) Cytosolic intermediates for cell wall biosynthesis and degradation control inducible beta-lactam resistance in gram-negative bacteria. *Cell* **88**: 823-832.
- Jacobs, C., L. J. Huang, E. Bartowsky, S. Normark & J. T. Park, (1994) Bacterial cell wall recycling provides cytosolic muropeptides as effectors for beta-lactamase induction. *EMBO J* **13**: 4684-4694.
- Jacobs, C., B. Joris, M. Jamin, K. Klarskov, J. Van Beeumen, D. Mengin-Lecreux, J. van Heijenoort, J. T. Park, S. Normark & J. M. Frère, (1995) AmpD, essential for both beta-lactamase regulation and cell wall recycling, is a novel cytosolic N-acetylmuramyl-L-alanine amidase. *Mol Microbiol* **15**: 553-559.
- Joris, B., J. M. Ghuyzen, G. Dive, A. Renard, O. Dideberg, P. Charlier, J. M. Frère, J. A. Kelly, J. C. Boyington, P. C. Moews & et al., (1988) The active-site-serine penicillin-recognizing enzymes as members of the *Streptomyces* R61 DD-peptidase family. *Biochem J* **250**: 313-324.

- Joris, B., P. Ledent, T. Kobayashi, J. O. Lampen & J. M. Ghuyse, (1990) Expression in *Escherichia coli* of the carboxy terminal domain of the BLAR sensory-transducer protein of *Bacillus licheniformis* as a water-soluble Mr 26,000 penicillin-binding protein. *FEMS Microbiol Lett* **58**: 107-113.
- Joris, B., S. Englebert, C. P. Chu, R. Kariyama, L. Daneo-Moore, G. D. Shockman & J. M. Ghuyse, (1992) Modular design of the Enterococcus hirae muramidase-2 and Streptococcus faecalis autolysin. *FEMS Microbiol Lett* **70**: 257-264.
- Kelly, J. A., A. P. Kuzin, P. Charlier & E. Fonze, (1998) X-ray studies of enzymes that interact with penicillins. *Cell Mol Life Sci* **54**: 353-358.
- Kerff, F., P. Charlier, M. L. Colombo, E. Sauvage, A. Brans, J. M. Frère, B. Joris & E. Fonze, (2003) Crystal structure of the sensor domain of the BlaR penicillin receptor from *Bacillus licheniformis*. *Biochemistry* **42**: 12835-12843.
- Kidwai, M., P. Sapra & K. R. Bhushan, (1999) Synthetic strategies and medicinal properties of beta-lactams. *Curr Med Chem* **6**: 195-215.
- Kobayashi, K., S. D. Ehrlich, A. Albertini, G. Amati, K. K. Andersen, M. Arnaud, K. Asai, S. Ashikaga, S. Aymerich, P. Bessieres, F. Boland, S. C. Brignell, S. Bron, K. Bunai, J. Chapuis, L. C. Christiansen, A. Danchin, M. Debarbouille, E. Dervyn, E. Deuerling, K. Devine, S. K. Devine, O. Dreesen, J. Errington, S. Fillinger, S. J. Foster, Y. Fujita, A. Galizzi, R. Gardan, C. Eschevins, T. Fukushima, K. Haga, C. R. Harwood, M. Hecker, D. Hosoya, M. F. Hullo, H. Kakeshita, D. Karamata, Y. Kasahara, F. Kawamura, K. Koga, P. Koski, R. Kuwana, D. Imamura, M. Ishimaru, S. Ishikawa, I. Ishio, D. Le Coq, A. Masson, C. Mauel, R. Meima, R. P. Mellado, A. Moir, S. Moriya, E. Nagakawa, H. Nanamiya, S. Nakai, P. Nygaard, M. Ogura, T. Ohanan, M. O'Reilly, M. O'Rourke, Z. Pragai, H. M. Pooley, G. Rapoport, J. P. Rawlins, L. A. Rivas, C. Rivolta, A. Sadaie, Y. Sadaie, M. Sarvas, T. Sato, H. H. Saxild, E. Scanlan, W. Schumann, J. F. Seegers, J. Sekiguchi, A. Sekowska, S. J. Seror, M. Simon, P. Stragier, R. Studer, H. Takamatsu, T. Tanaka, M. Takeuchi, H. B. Thomaides, V. Vagner, J. M. van Dijl, K. Watabe, A. Wipat, H. Yamamoto, M. Yamamoto, Y. Yamamoto, K. Yamane, K. Yata, K. Yoshida, H. Yoshikawa, U. Zuber & N. Ogasawara, (2003) Essential *Bacillus subtilis* genes. *Proc Natl Acad Sci U S A* **100**: 4678-4683.
- Lamotte-Brasseur, J., G. Dive, O. Dideberg, P. Charlier, J. M. Frère & J. M. Ghuyse, (1991) Mechanism of acyl transfer by the class A serine beta-lactamase of *Streptomyces albus* G. *Biochem J* **279 (Pt 1)**: 213-221.
- Le Moual, H., B. P. Roques, P. Crine & G. Boileau, (1993) Substitution of potential metal-coordinating amino acid residues in the zinc-binding site of endopeptidase-24.11. *FEBS Lett* **324**: 196-200.
- Lenzini, V. M., J. Magdalena, C. Fraipont, B. Joris, A. Matagne & J. Dusart, (1992) Induction of a *Streptomyces cacaoi* beta-lactamase gene cloned in *S. lividans*. *Mol Gen Genet* **235**: 41-48.
- Lim, D. & N. C. Strynadka, (2002) Structural basis for the beta lactam resistance of PBP2a from methicillin-resistant *Staphylococcus aureus*. *Nat Struct Biol* **9**: 870-876.
- Lindberg, F., S. Lindquist & S. Normark, (1987) Inactivation of the ampD gene causes semiconstitutive overproduction of the inducible *Citrobacter freundii* beta-lactamase. *J Bacteriol* **169**: 1923-1928.

Lindquist, S., M. Galleni, F. Lindberg & S. Normark, (1989a) Signalling proteins in enterobacterial AmpC beta-lactamase regulation. *Mol Microbiol* **3**: 1091-1102.

Lindquist, S., F. Lindberg & S. Normark, (1989b) Binding of the *Citrobacter freundii* AmpR regulator to a single DNA site provides both autoregulation and activation of the inducible ampC beta-lactamase gene. *J Bacteriol* **171**: 3746-3753.

Lodge, J., S. Busby & L. Piddock, (1993) Investigation of the *Pseudomonas aeruginosa* ampR gene and its role at the chromosomal ampC beta-lactamase promoter. *FEMS Microbiol Lett* **111**: 315-320.

Magdalena, J., C. Gerard, B. Joris, M. Forsman & J. Dusart, (1997) The two beta-lactamase genes of *Streptomyces cacaoi*, blaL and blaU, are under the control of the same regulatory system. *Mol Gen Genet* **255**: 187-193.

Magdalena, J., B. Joris, J. Van Beeumen, R. Brasseur & J. Dusart, (1995) Regulation of the beta-lactamase BlaL of *Streptomyces cacaoi*: the product of the blaB regulatory gene is an internal membrane-bound protein. *Biochem J* **311 (Pt 1)**: 155-160.

Massova, I. & S. Mobashery, (1998) Kinship and diversification of bacterial penicillin-binding proteins and beta-lactamases. *Antimicrob Agents Chemother* **42**: 1-17.

Matagne, A., A. Dubus, M. Galleni & J. M. Frère, (1999) The beta-lactamase cycle: a tale of selective pressure and bacterial ingenuity. *Nat Prod Rep* **16**: 1-19.

McKinney, T. K., V. K. Sharma, W. A. Craig & G. L. Archer, (2001) Transcription of the gene mediating methicillin resistance in *Staphylococcus aureus* (mecA) is corepressed but not coinduced by cognate mecA and beta-lactamase regulators. *J Bacteriol* **183**: 6862-6868.

Melckebeke, H. V., C. Vreuls, P. Gans, P. Filée, G. Llabres, B. Joris & J. P. Simorre, (2003) Solution structural study of BlaL: implications for the repression of genes involved in beta-lactam antibiotic resistance. *J Mol Biol* **333**: 711-720.

Mohammadi, T., V. van Dam, R. Sijbrandi, T. Vernet, A. Zapun, A. Bouhss, M. Diepeveen-de Bruin, M. Nguyen-Disteche, B. de Kruijff & E. Breukink, (2011) Identification of FtsW as a transporter of lipid-linked cell wall precursors across the membrane. *EMBO J* **30**: 1425-1432.

Niumsup, P., A. M. Simm, K. Nurmahomed, T. R. Walsh, P. M. Bennett & M. B. Avison, (2003) Genetic linkage of the penicillinase gene, amp, and blrAB, encoding the regulator of beta-lactamase expression in *Aeromonas* spp. *J Antimicrob Chemother* **51**: 1351-1358.

Okazaki, A. & M. B. Avison, (2008) Induction of L1 and L2 beta-lactamase production in *Stenotrophomonas maltophilia* is dependent on an AmpR-type regulator. *Antimicrob Agents Chemother* **52**: 1525-1528.

Park, J. T., D. Raychaudhuri, H. Li, S. Normark & D. Mengin-Lecreux, (1998) MppA, a periplasmic binding protein essential for import of the bacterial cell wall peptide L-alanyl-gamma-D-glutamyl-meso-diaminopimelate. *J Bacteriol* **180**: 1215-1223.

Park, J. T. & T. Uehara, (2008) How bacteria consume their own exoskeletons (turnover and recycling of cell wall peptidoglycan). *Microbiol Mol Biol Rev* **72**: 211-227, table of contents.

- Pearce, S. R., M. L. Mimmack, M. P. Gallagher, U. Gileadi, S. C. Hyde & C. F. Higgins, (1992) Membrane topology of the integral membrane components, OppB and OppC, of the oligopeptide permease of *Salmonella typhimurium*. *Mol Microbiol* **6**: 47-57.
- Pennartz, A., C. Genereux, C. Parquet, D. Mengin-Lecreulx & B. Joris, (2009) Substrate-induced inactivation of the *Escherichia coli* AmiD N-acetylmuramoyl-L-alanine amidase highlights a new strategy to inhibit this class of enzyme. *Antimicrob Agents Chemother* **53**: 2991-2997.
- Prescott, L. M., H. J. P., Klein D. A. (1995). *Microbiologie*. Bruxelles.
- Raskin, C., C. Gerard, S. Donfut, E. Giannotta, G. Van Driessche, J. Van Beeumen & J. Dusart, (2003) BlaB, a protein involved in the regulation of *Streptomyces cacaoi* beta-lactamases, is a penicillin-binding protein. *Cell Mol Life Sci* **60**: 1460-1469.
- Rohrer, S. & B. Berger-Bachi, (2003) FemABX peptidyl transferases: a link between branched-chain cell wall peptide formation and beta-lactam resistance in gram-positive cocci. *Antimicrob Agents Chemother* **47**: 837-846.
- Rowland, S. J. & K. G. Dyke, (1990) Tn552, a novel transposable element from *Staphylococcus aureus*. *Mol Microbiol* **4**: 961-975.
- Sala, C., A. Haouz, F. A. Saul, I. Miras, I. Rosenkrands, P. M. Alzari & S. T. Cole, (2009) Genome-wide regulon and crystal structure of Blal (Rv1846c) from *Mycobacterium tuberculosis*. *Mol Microbiol* **71**: 1102-1116.
- Safo, M. K., Q. Zhao, T. P. Ko, F. N. Musayev, H. Robinson, N. Scarsdale, A. H. Wang & G. L. Archer, (2005) Crystal structures of the Blal repressor from *Staphylococcus aureus* and its complex with DNA: insights into transcriptional regulation of the bla and mec operons. *J Bacteriol* **187**: 1833-1844.
- Salerno, A. J. & J. O. Lampen, (1988) Differential transcription of the bla regulatory region during induction of beta-lactamase in *Bacillus licheniformis*. *FEBS Lett* **227**: 61-65.
- Sambrook, J., E.F. Fritsch, et al. (1989) Molecular cloning: a laboratory manual. Cold Spring Harbor Laboratory, Cold Spring Harbor, New York.
- Sanger, F., S. Nicklen & A. R. Coulson, (1977) DNA sequencing with chain-terminating inhibitors. *Proc Natl Acad Sci U S A* **74**: 5463-5467.
- Sauvage, E., F. Kerff, E. Fonze, R. Herman, B. Schoot, J. P. Marquette, Y. Taburet, D. Prevost, J. Dumas, G. Leonard, P. Stefanic, J. Coyette & P. Charlier, (2002) The 2.4-A crystal structure of the penicillin-resistant penicillin-binding protein PBP5fm from *Enterococcus faecium* in complex with benzylpenicillin. *Cell Mol Life Sci* **59**: 1223-1232.
- Sauvage, E., F. Kerff, M. Terrak, J. A. Ayala & P. Charlier, (2008) The penicillin-binding proteins: structure and role in peptidoglycan biosynthesis. *FEMS Microbiol Rev* **32**: 234-258.
- Schmidt, D. M., B. K. Hubbard & J. A. Gerlt, (2001) Evolution of enzymatic activities in the enolase superfamily: functional assignment of unknown proteins in *Bacillus subtilis* and *Escherichia coli* as L-Ala-D/L-Glu epimerases. *Biochemistry* **40**: 15707-15715.
- Shah, I. M. & J. Dworkin, (2010) Induction and regulation of a secreted peptidoglycan hydrolase by a membrane Ser/Thr kinase that detects muropeptides. *Mol Microbiol* **75**: 1232-1243.

- Sherratt, D. J. & J. F. Collins, (1973) Analysis by transformation of the penicillinase system in *Bacillus licheniformis*. *J Gen Microbiol* **76**: 217-230.
- Stapleton, P. D. & P. W. Taylor, (2002) Methicillin resistance in *Staphylococcus aureus*: mechanisms and modulation. *Sci Prog* **85**: 57-72.
- Tayler, A. E., J. A. Ayala, P. Niumsup, K. Westphal, J. A. Baker, L. Zhang, T. R. Walsh, B. Wiedemann, P. M. Bennett & M. B. Avison, (2010) Induction of beta-lactamase production in *Aeromonas hydrophila* is responsive to beta-lactam-mediated changes in peptidoglycan composition. *Microbiology* **156**: 2327-2335.
- Templin, M. F., A. Ursinus & J. V. Holtje, (1999) A defect in cell wall recycling triggers autolysis during the stationary growth phase of *Escherichia coli*. *EMBO J* **18**: 4108-4117.
- Tesch, W., C. Ryffel, A. Strassle, F. H. Kayser & B. Berger-Bachi, (1990) Evidence of a novel staphylococcal mec-encoded element (mecR) controlling expression of penicillin-binding protein 2'. *Antimicrob Agents Chemother* **34**: 1703-1706.
- Trepanier, S., A. Prince & A. Huletsky, (1997) Characterization of the penA and penR genes of *Burkholderia cepacia* 249 which encode the chromosomal class A penicillinase and its LysR-type transcriptional regulator. *Antimicrob Agents Chemother* **41**: 2399-2405.
- Uehara, T. & J. T. Park, (2007) An anhydro-N-acetylmuramyl-L-alanine amidase with broad specificity tethered to the outer membrane of *Escherichia coli*. *J Bacteriol* **189**: 5634-5641.
- Uehara, T. & J. T. Park, (2008) Growth of *Escherichia coli*: significance of peptidoglycan degradation during elongation and septation. *J Bacteriol* **190**: 3914-3922.
- Urabe, H. & H. Ogawara, (1992) Nucleotide sequence and transcriptional analysis of activator-regulator proteins for beta-lactamase in *Streptomyces cacaoi*. *J Bacteriol* **174**: 2834-2842.
- Vagner, V., E. Dervyn & S. D. Ehrlich, (1998) A vector for systematic gene inactivation in *Bacillus subtilis*. *Microbiology* **144 (Pt 11)**: 3097-3104.
- van Heijenoort, J., (1998) Assembly of the monomer unit of bacterial peptidoglycan. *Cell Mol Life Sci* **54**: 300-304.
- van Heijenoort, J., (2001) Formation of the glycan chains in the synthesis of bacterial peptidoglycan. *Glycobiology* **11**: 25R-36R.
- van Heijenoort, J., (2007) Lipid intermediates in the biosynthesis of bacterial peptidoglycan. *Microbiol Mol Biol Rev* **71**: 620-635.
- van Straaten, K. E., B. W. Dijkstra, W. Vollmer & A. M. Thunnissen, (2005) Crystal structure of MltA from *Escherichia coli* reveals a unique lytic transglycosylase fold. *J Mol Biol* **352**: 1068-1080.
- Wittman, V., H. C. Lin & H. C. Wong, (1993) Functional domains of the penicillinase repressor of *Bacillus licheniformis*. *J Bacteriol* **175**: 7383-7390.
- Wittman, V. & H. C. Wong, (1988) Regulation of the penicillinase genes of *Bacillus licheniformis*: interaction of the pen repressor with its operators. *J Bacteriol* **170**: 3206-3212.

Zhang, H. Z., C. J. Hackbarth, K. M. Chansky & H. F. Chambers, (2001) A proteolytic transmembrane signaling pathway and resistance to beta-lactams in *staphylococci*. *Science* **291**: 1962-1965.