

## Профессор, д-р Бен Люгтенберг (Лейден, Нидерланды)

(родился 16 марта 1941 года в Ольсте, Нидерланды)

### Образование и повышение квалификации

1965: степень дотора наук по химии (Утрехтский Университет)  
1971: защита диссертации (PhD) по биохимии синтеза пептидогликанов у *Escherichia coli* (Утрехтский Университет, у проф., д-ра P.G. de Haan)  
1972/1973: Постдокторантура в Health Center Коннектикутского Университета Farmington, CN, USA, у проф. д-ра M.-J. Osborn).

### Занимаемые должности

1973-1983: Утрехтский Университет. Руководитель группы «Структура, биогенез и функции внешней мембраны грамотрицательных бактерий».  
1983-2006: Лейденский Университет Профессор микробиологии.  
2006- до настоящего времени Почетный профессор Отделения молекулярной микробиологии и биотехнологии Института биологии Лейденского Университета

### Научная и организаторская работа

- Сопредседатель Гордонской научной конференции по поверхностным структурам бактериальной клетки (Gordon Research Conference on Bacterial Cell Surfaces, NH, USA, 1984)
- Организатор двух семинаров NATO (1986 и 1989)
- Организатор 3-й Европейской конференции по азотфиксации (1997)
- Директор Центра по фитотехнологиям RUL/TNO (Лейден) (1986-1996)
- Получатель и координатор многих грантов EU (Human Capital and Mobility; Biotech; Training and Mobility of Researchers; Marie Curie).
- Получатель множества голландских грантов (BION/ ALW; CW; STW; EET)
- Руководитель примерно 45 кандидатских диссертаций.
- Директор по науке Института молекулярных исследований растений (1999-2001)
- Президент Международного общества по изучению молекулярных взаимодействий растений и микроорганизмов (2001-2003) (1500 членов)
- Член Консультативного совета Института Макса Планка по селекции растений (Cologne, DE, 1988-1993)
- Член Совета по науке INTAS (Brussels; сотрудничество EU со странами бывшего СССР) (2003-2008)
- Координатор 3 программ INTAS со странами бывшего СССР
- Консультативная помощь компаниям: Astra, Varenbrug, DSM, Dupont, Grodan, Groen Agro Control, Incotec, Heineken, Koppert Biological Systems, Nitrigen (now Novozymes) en Norsk Hydro
- Член Консультативного совета Немецкого общества геномики микроорганизмов (2004-2007)
- Избран иностранным действительным членом Российской академии сельскохозяйственных наук (2000)

### Деятельность с 2006 года

#### Кроме того:

Координирование проекта INTAS-Узбекистан Uzbekistan по биоконтролю при засолении в условиях пустыни

Проект по применению микроорганизмов, подавляющих развитие болезней  
Руководство обучением студентов Российско-Голландского центра по повышению квалификации (the Russian-Dutch Center of Excellence)

Чтение лекций (в том числе ключевые курсы в Китае, Германии и России);

Написание обзоров и книжных глав

Член группы Научного европейского совета (European Research Council, ERC) по экологической биотехнологии (с 2008 года по настоящее время) (выделение грантов в размере Eur 2 500 000).

Член группы по оценке работы нескольких отделов биологии и биотехнологии Левенского Университета (Leuven University)

Член Консультативного совета Бельгийского нанотехнологического общества  
Рецензирование рукописей для научных журналов, экспертные оценки научной деятельности

Консультант по проблемам контроля бактериальных болезней растений

### Publications

#### А. Публикации в рецензируемых журналах

#### 1971

Lugtenberg E.J.J., De Haan P.G. A simple method for following the fate of alanine-

containing components in murein synthesis in *Escherichia coli*. *Antonie van Leeuwenhoek J. Microbiol. Serol.*, 1971, 37: 537-552.

Lugtenberg EJJ, Van Schijndel-Van Dam A., Van Bellegem T.H.M. In vivo and in vitro action of new antibiotics interfering with the utilization of N-acetylglucosamine-N-acetyl-muramyl-pentapeptide. *J. Bacteriol.*, 1971, 108: 20-29.

### 1972

Lugtenberg E.J.J., De Haas-Menger L., Ruyters W.H.M. Murein synthesis and identification of cell wall precursors of temperature sensitive lysis mutants of *Escherichia coli*. *J. Bacteriol.*, 1972, 109: 326-335.

Lugtenberg, E. J. J. Studies on *Escherichia coli* enzymes involved in the synthesis of uridine diphosphate-N-acetyl-muramyl-pentapeptide. *J. Bacteriol.*, 1972, 110: 26-34.

Lugtenberg E.J.J., Van Schijndel-van Dam A. Temperature-sensitive mutants of *Escherichia coli* K-12 with low activities of the L-alanine adding enzyme and the D-alanyl-D-alanine adding enzyme. *J. Bacteriol.*, 1972, 110: 35-40.

Lugtenberg, E. J. J., and A. Van Schijndel-van Dam. Temperature-sensitive mutants of *Escherichia coli* K-12 with a low activity of the diaminopimelic acid adding enzyme. *J. Bacteriol.*, 1972, 110: 41-46.

### 1973

E. J. J. Lugtenberg and Arna van Schijndel-van Dam. Temperature-Sensitive Mutant of *Escherichia coli* K-12 with an Impaired D-Alanine: D-Alanine Ligase. *J. Bacteriol.*, 1973, 113: 96-104.

Venkateswaran, PS, Lugtenberg EJJ and Wu, HC. Inhibition of phosphoenolpyruvate:uridine diphosphate N-acetylglucosamine enolpyruvyltransferase by uridine diphosphate N-acetylmuramyl peptides. *Biochim Biophys Acta*, 1973, 293: 570-574.

Lugtenberg EJJ, Wijsman HJW and Van Zaane D. Properties of a D-Glutamic acid – requiring mutant of *Escherichia coli*. *J. Bacteriol.*, 1973, 114: 499-506.

### 1974, 1975

Lugtenberg, B., J. Meyers, R. Peters, P. Van der Hoek, and L. Van Alphen. Electrophoretic resolution of the "major outer membrane protein" of *Escherichia coli* K12 into four bands. *FEBS Lett.*, 1975, 58: 254-258.

### 1976

Havekes, LM, Lugtenberg, BJJ and Hoekstra, WPM. Conjugation Deficient *E. Coli* K12 F- Mutants with Heptose-less Lipopolysaccharide. *Mol. Gen. Genet.*, 1976, 146, 43-50.

Lugtenberg, B., R. Peters, H. Bernheimer, and W. Berendsen. Influence of culture conditions and mutations on the composition of the outer membrane proteins of *Escherichia coli*. *Mol. Gen. Genet.*, 1976, 147: 251-262.

Lugtenberg, EJJ, Peters, R. Distribution of lipids in cytoplasmic and outer membranes of *Escherichia coli* K12. *Biochimica et Biophysica Acta*, 1976, 441: 38-47.

Van Alphen, W; Lugtenberg, B; Berendsen, W. Heptose-deficient mutants of *Escherichia coli* K 12 deficient in up to 3 major outer membrane proteins. *Mol. Gen. Genet*, 1976, 147: 263-269.

Verkleij, AJ; Lugtenberg, EJJ; Ververgaert, PH. Freeze-etch morphology of outer membrane mutants of *Escherichia coli*- K 12. *Biochimica et Biophysica Acta*, 1976, 426: 581-586.

## 1977

Havekes, L, Tommassen, J, Hoekstra, WPM, and Lugtenberg B. Isolation and Characterization of Escherichia coli K-12 F Mutants Defective in Conjugation with an I-Type Donor. J. Bacteriol., 1977, 129: 1-8.

Lugtenberg, B., H. Bronstein, N. Van Selm, and R. Peters. Peptidoglycan-associated outer membrane proteins in Gramnegative bacteria. Biochim. Biophys. Acta, 1977, 465: 571-578.

Lugtenberg, B; Bronstein, H; vVnseim, N; et al. Peptidoglycan-associated outer membrane proteins in gram-negative bacteria. Biochim. Biophys. Acta, 1977, 465: 571-578.

Van Alphen, L; Havekes, L; Lugtenberg, B. Major outer membrane protein-D of Escherichia coli K 12 - purification and in vitro activity of bacteriophage-K 3 and F-pilus mediated conjugation. FEBS Letters, 1977, 75: 285-290.

Van Alphen, L; Lugtenberg, B; van Boxtel, R; et al. Architecture of outer membrane of Escherichia coli-k12 .1. Action of phospholipases a2 and c on wild-type strains and outer membrane mutants. Biochim. Biophys. Acta, 1977, 466: 257-268.

Van Alphen, W; Lugtenberg, B.. Influence of osmolarity of the growth medium on the outer membrane protein pattern of Escherichia coli. J. Bacteriol., 1977, 131: 623-630.

Verhoef, C; de Graaff, PJ; Lugtenberg, EJJ. Mapping of a gene for a major outer membrane-protein of Escherichia coli-K 12 with aid of a newly isolated bacteriophage. Mol. Gen. Genet., 1977, 150: 103-105.

Verkleij, A; van Alphen, L; Bijvelt, j; et al. Architecture of outer membrane of escherichia coli-k12 .2. Freeze fracture morphology of wild-type and mutant strains. Biochim. Biophys. Acta, 1977, 466: 269-282.

## 1978

Lugtenberg, B; van Boxtel, R; Verhoef, C; et al.. Pore protein-e of outer membrane of Escherichia coli-k12. FEBS Lett., 1978, 96: 99-105.

Van Alphen, L; Verkleij, A; Leunissen-Bijvelt, J; et al. Architecture of outer membrane of Escherichia coli .3. Protein-lipopolysaccharide complexes in intramembraneous particles. Journal of Bacteriology, 1978, 134: 1089-1098.

Van Alphen, W; van Selm, N; Lugtenberg, B. Pores in outer membrane of Escherichia coli-k12: involvement of protein-b and protein-e in functioning of pores for nucleotides. Mol. Gen. Genet., 1978, 159: 75-83.

Van Alphen, W; van Boxtel, R; van Selm, N; et al. Pores in outer membrane of Escherichia coli-k12: involvement of protein-b and protein-c in permeation of cephaloridine and ampicillin. FEMS Microbiology Letters, 1978, 3: 103-106.

## 1979

Van Alphen, L; Lugtenberg, B; Rietschel, et; et al. Architecture of the outer-membrane of Escherichia coli-k12 - phase-transitions of the bacteriophage-k3 receptor complex. European Journal of Biochemistry, 1979, 101: 571-579.

Van Alphen, L; van Alphen, W; Verkleij, A; et al. Architecture of the outer-membrane of Escherichia coli-k12 .4. Relationship between outer-membrane particles and aqueous pores. Biochim. Biophys. Acta, 1979, 556: 233-243.

Van Alphen, L., Lugtenberg, B., Van Boxtel, R., Hack, A-M., Verhoef, C. And Havekes, L. *Meoa* is the structural gene for outer membrane protein c of Escherichia coil K12. Mol. Gen. Genet., 1979, 169: 147- 155.

Verhoef, C., B. Lugtenberg, R. Van Boxtel, P. De Graaff, and H. Verhey. Genetics

and biochemistry of the peptidoglycan associated proteins b and c of Escherichia coli K12. Mol. Gen. Genet., 1979, 169:137-146.

### 1980

Burnell, E; Van Alphen, L; Verkleij, A; et al. P-31 nuclear magnetic-resonance and freeze-fracture electron-microscopy studies on Escherichia coli. 3. The outer-membrane. Biochim. Biophys. Acta, 1980, 597: 518-532.

Overbeeke, N., and B. Lugtenberg. Major outer membrane proteins of Escherichia coli strains of human origin. J. Gen. Microbiol., 1980, 121:373-380.

Overbeeke, N; van Scharrenburg, G; Lugtenberg, B. Antigenic relationships between pore proteins of Escherichia coli-K 12. Eur. Journal Biochem., 1980, 110: 247-254.

Overbeeke, N; Lugtenberg, B. Expression of outer-membrane protein-e of Escherichia coli-k12 by phosphate limitation. FEBS Letters, 1980, 112: 229-232.

Tommassen, J; Lugtenberg, B. Outer-membrane protein-e of Escherichia coli K-12 is co-regulated with alkaline-phosphatase. J. Bacteriol., 1980, 143: 151-157.

Van Alphen, L; Verkleij, A; Burnell, E; et al. P-31 nuclear magnetic-resonance and freeze-fracture electron-microscopy studies on Escherichia coli. 2. Lipopolysaccharide and lipopolysaccharide-phospholipid complexes. Biochim. Biophys. Acta, 1980, 597: 502-517.

### 1981

Lugtenberg, B. Transport through the outer-membrane of gram-negative bacteria. Antonie van Leeuwenhoek Journal of Microbiology, 1981, 4: 580-581.

Lugtenberg, B. Composition and function of the outer-membrane of Escherichia coli. Trends in Biochemical Sciences, 1981, 6: 262-266.

Tommassen, J; Lugtenberg, B. Localization of phoe, the structural gene for outer-membrane protein-e in Escherichia coli K-12. Journal of Bacteriology, 1981, 147: 118-123.

Tommassen, J; Vanderley, P; Lugtenberg, B. Genetic and biochemical-characterization of an Escherichia coli K-12 mutant with an altered outer-membrane protein. Antonie van Leeuwenhoek Journal of Microbiology, 1981, 47: 325-337.

### 1982

Evenberg, D; Vanboxtel, R; Lugtenberg, B. et al. Cell-surface of the fish pathogenic bacterium Aeromonas salmonicida .1. Relationship between autoagglutination and the presence of a major cell-envelope protein. Trends in Biochemical., 1982, 684: 241-248.

Korteland, J; Tommassen, J; Lugtenberg, B.. Phoe protein pore of the outer-membrane of Escherichia coli-K12 is a particularly efficient channel for organic and inorganic-phosphate. Biochimica et Biophysica Acta, 1982, 690: 282-289.

Overbeeke, N; Lugtenberg, B. Recognition site for phosphorus-containing compounds and other negatively charged solutes on the phoe protein pore of the outer-membrane of Escherichia coli-K 12. European Journal of Biochemistry, 1982, 126: 113-118.

Tommassen, J; de Geus, P; Lugtenberg, B. et al. Regulation of the pho regulon of Escherichia coli K-12 - cloning of the regulatory genes phob and phor and identification of their gene-products. Journal of Molecular Biology, 1982, 157: 265-274.

Tommassen, J; Lugtenberg, B. Pho-regulon of Escherichia coli K12 - a minireview.

Annales de Microbiologie, 1982, 133: 243-249.

Tommassen, J; Overduin, P; Lugtenberg, B. et al. Cloning of *phoe*, the structural gene for the *Escherichia coli* phosphate limitation-inducible outer-membrane pore protein. *J. Bacteriol.*, 1982, 149: 668-672.

Tommassen, J; van der Ley, P; van der Ende, A; et al. Cloning of *ompf*, the structural gene for an outer-membrane pore protein of *Escherichia coli*-K 12 — physical localization and homology with the *phoe* gene. *Mol. Gen. Genet.*, 1982, 185: 105-110.

### 1983

Lugtenberg, B.J.J., van Alphen, L. Molecular architecture and functioning of the outer membrane of *Escherichia coli* and other gram-negative bacteria. *Biochim. Biophys. Acta*, 1983, 737:51–115.

Lugtenberg, B. Cell-wall deficient bacteria — basic principles and clinical-significance (edited by G.J. Domingue). *Trends in Biochemical Sciences*, 1983, 8: 338-338.

Overbeeke, N; Bergmans, H; van Mansfeld, F; et al. Complete nucleotide-sequence of *phoe*, the structural gene for the phosphate limitation inducible outer-membrane pore protein of *Escherichia coli* K12. *Journal of Molecular Biology*, 1983, 163: 513-532.

Tommassen, J; van Tol, H; Lugtenberg, B. The ultimate localization of an outer-membrane protein of *Escherichia coli* K12 is not determined by the signal sequence. *EMBO Journal*, 1983, 2: 1275-1279.

### 1984

Korteland, J; Lugtenberg, B. Increased efficiency of the outer-membrane *phoe* protein pore in *Escherichia coli* K-12-mutants with heptose-deficient lipopolysaccharide. *Biochim. et Biophys. Acta*, 1984, 774: 119-126.

Korteland, J; de Graaff, P; Lugtenberg, B. *Phoe* protein pores in the outer-membrane of *Escherichia coli* K-12 not only have a preference for  $\text{pi}$  and  $\text{pi}$ -containing solutes but are general anion-preferring channels. *Biochim. et Biophys. Acta*, 1984, 778: 311-316.

Leunissen, J; van Damme-Jongsten, M; Tommassen, J; et al. The localization of *phoe* and beta-galactosidase antigens in wild-type and *phoe/lacz* hybrid *Escherichia coli*. *Cell Biology International Reports*, 1984, 8: 187-187.

Lugtenberg, B ; van Boxtel, R; van den Bosch, R; et al. Biochemical and immunological analyses of the cell surface of *Bordetella bronchiseptica* isolates with special reference to atrophic rhinitis in swine. *Vaccine*, 1984, 2: 265-73.

Lugtenberg, B., R. Van Boxtel, and M. De Jong. Atrophic rhinitis in swine: correlation of *Pasteurella multocida* pathogenicity with membrane protein and lipopolysaccharide patterns. *Infect. Immun.*, 1984, 46: 48-54.

Okker, R.J.H; Spaink, H; Hille, J; et al. Plant-inducible virulence promoter of the *Agrobacterium tumefaciens* Ti plasmid. *Nature*, 1984, 312: 564-566.

Tommassen, J; Hiemstra, P; Overduin, P; et al. **1984.** Cloning of *phom*, a gene involved in regulation of the synthesis of phosphate limitation inducible proteins in *Escherichia coli*-K12. *Mol. Gen. Genet.*, 1984, 195: 190-194.

Tommassen, J; Lugtenberg, B. Amino terminus of outer-membrane *phoe*-protein — localization by use of a *bla-phoe* hybrid gene. *J. Bacteriol.*, 1984, 157: 327-329.

Tommassen, J; Pugsley, A.P; Korteland, J; et al. Gene encoding a hybrid *ompf-phoe* pore protein in the outer-membrane of *Escherichia coli* K 12. *Mol. Gen.*

Genet., 1984, 197: 503-508.

Verhoef, C; Vankoppen, C; Overduin, p; et al. Cloning and expression in *Escherichia coli* K-12 of the structural gene for outer-membrane phoe protein from *Enterobacter cloacae*. *Gene*, 1984, 32: 107-115.

#### 1985

Van Brussel, AAN; Zaat, SAJ; Wijffelman, CA; et al. Bacteriocin small of fast-growing Rhizobia is chloroform soluble and is not required for effective nodulation. *J. Bacteriol.*, 1985, 162: 1079-1082.

Evenberg, D; Versluis, R; Lugtenberg, B, Biochemical and immunological characterization of the cell-surface of the fish pathogenic bacterium *Aeromonas salmonicida*. *Biochim. Biophys. Acta*, 1985, 815: 233-244.

Korteland, J; Overbeeke, N; de Graaff, P; et al. Role of the arg158 residue of the outer-membrane phoe pore protein of *Escherichia coli* K12 in bacteriophage-tc45 recognition and in channel characteristics. *Eur. Journal Biochem*, 1985, 152: 691-697.

Van der Ley, P., H. Amesz, J. Tommassen, and B. Lugtenberg. Monoclonal antibodies directed against cell-surfaceexposed part of phoe pore protein of the *Escherichia coli* K-12 outer membrane. *Eur. J. Biochem.*, 1985, 147: 401-407.

Wijffelman, CA; Pees, E; van Brussel, AAN; et al. **1985.** Genetic and functional-analysis of the nodulation region of the *Rhizobium leguminosarum* sym plasmid prl1ji. *Archives of Microbiology* 143: 225-232.

#### 1986

De Maagd, RA; Lugtenberg, B. **1986.** Fractionation of *Rhizobium leguminosarum* cells into outer-membrane, cytoplasmic membrane, periplasmic, and cytoplasmic components. *J. Bacteriol.* 167: 1083-1085.

De Weger LA, van Boxtel R, van der Burg B, Gruters RA, Geels FP, Schippers B, Lugtenberg B. Siderophores and outer membrane proteins of antagonistic, plant-growth-stimulating, root-colonizing *Pseudomonas* spp. *J Bacteriol.* **165: 585-594.**

Diaz, CL; van Spronsen, PC; Bakhuizen, R; et al. **1986.** Correlation between infection by *Rhizobium leguminosarum* and lectin on the surface of *Pisum sativum* L roots. *Planta* 168: 350-359.

Lugtenberg, B; van der Ley, P; Kuipers, O; et al. **1986.** O-antigenic chains of lipopolysaccharide prevent binding of antibody molecules to an enterobacterial outer-membrane pore protein. *Eos-rivista di immunologia ed immunofarmacologia* 6: 59-61.

Lugtenberg B, van Boxtel R, Evenberg D, de Jong M, Storm P, and Frik J. 1986. Biochemical and immunological characterization of cell surface proteins of *Pasteurella multocida* strains causing atrophic rhinitis in swine. *Infection and immunity*, 52: 175-182.

Pees, E; Wijffelman, C; Mulders, I; et al. **1986.** Transposition of tn1831 to sym plasmids of *Rhizobium leguminosarum* and *Rhizobium trifolii*. *FEMS Microbiology Letters* 33: 165-171.

Smit, G; Kijne, JW; Lugtenberg, BJJ. **1986.** Correlation between extracellular fibrils and attachment of *Rhizobium leguminosarum* to pea root hair tips. *J. Bacteriol.* 168: 821-827.

Smit, G; van der Baan, AA; Kijne, JW; et al. **1986.** The attachment mechanism of rhizobium. *Antonie van Leeuwenhoek Journal of Microbiology* 52: 362-363.

Van Brussel, ANN; Zaat, SAJ; Canter Cremers, HCJ; et al. **1986.** Role of plant-

root exudate and sym plasmid-localized nodulation genes in the synthesis by *Rhizobium leguminosarum* of tsr factor, which causes thick and short roots on common vetch. J. Bacteriol. 165: 517-522.

Van der Ley, P; Kuipers, O; Tommassen, J; et al. **1986.** O-antigenic chains of lipopolysaccharide prevent binding of antibody molecules to an outer-membrane pore protein in enterobacteriaceae. Microbial Pathogenesis 1: 43-49.

### **1987**

De Maagd, R A; Lugtenberg, B J. **1987.** Outer membranes of gram-negative bacteria. Biochemical Society transactions 15 Suppl : 54S-62S

De Weger, LA; Lugtenberg, B; Bakker, PAHM; et al. **1987.** Potato-plant-growth stimulating pseudomonas spp. Acta Botanica Nederlandica 36: 183-183.

De Weger, L.A., Jann, B., Jann, K., and Lugtenberg, B.J.J. **1987.** Lipopolysaccharides of *Pseudomonas* spp. That stimulate plant growth: Composition and use for strain identification. J. Bacteriol., 169:1441–1446.

De Weger, L.A., van der Vlugt, C.I.M., Wijffjes, A.H.M., Bakker, P.A.H.M., Schippers, B., and Lugtenberg, B.J.J. **1987** Flagella of a plant growth stimulating *Pseudomonas fluorescens* strain are required for colonization of potato roots. J. Bacteriol., 169:2769–2773.

Smit, G; Kijne, JW; Lugtenberg, BJJ. **1987.** Involvement of both cellulose fibrils and a ca-2+-dependent adhesin in the attachment of *Rhizobium leguminosarum* to pea root hair tips. J. Bacteriol. 169: 4294-4301.

Spaink, H. P., Okker, R. J. H., Wijffelman, C. A., Pees, E., and Lugtenberg, B. J. J. **1987.** Promoters in the nodulation region of the *Rhizobium leguminosarum* sym plasmid pr1ji. Plant Mol. Biol. 9:27-37.

Spaink, H. P., Wijffelman, C. A., Pees, E., Okker, R. J. H., and Lugtenberg, B. J. J. **1987.** *Rhizobium* nodulation gene *nodd* as a determinant of host specificity. Nature (London) 328:337-340.

Zaat, S. A. J., Wijffelman, C. A., Spaink, H. P., van Brussel, A. A. N., Okker, R. J. H., and Lugtenberg, B. J. J. **1987.** Induction of the *noda* promoter of *Rhizobium leguminosarum* Sym plasmid pr1ji by plant flavanones and flavones. J. Bacteriol. 169:198-204.

Zaat, SAJ; van Brussel, AAN; Tak, T; et al. **1987.** Flavonoids induce *Rhizobium leguminosarum* to produce nod dabc gene-related factors that cause thick, short roots and root hair responses on common vetch. J. Bacteriol., 1987, 169: 3388-3391.

### **1988**

Canter Cremers, HCJ; Wijffelman, CA; Pees, E; et al. **1988.** Host specific nodulation of plants of the pea cross-inoculation group is influenced by genes in fast growing rhizobium downstream nod c. Journal of Plant Physiology 132: 398-404.

De Maagd, RA; Wijffelman, CA; Pees, E; et al. **1988.** Detection and subcellular-localization of 2 sym plasmid-dependent proteins of *Rhizobium leguminosarum* biovar viciae. J. Bacteriol. 170: 4424-4427.

De Maagd, RA; van Rossum, C; Lugtenberg, BJJ. **1988.** Recognition of individual strains of fast-growing rhizobia by using profiles of membrane-proteins and lipopolysaccharides. J. Bacteriol. 170: 3782-3785.

De Weger, LA; van Arendonk, JJCM; Recourt, K; et al. **1988.** Siderophore-mediated uptake of fe-3+ by the plant growth-stimulating *Pseudomonas putida* strain WCS358 and by other rhizosphere microorganisms. J. Bacteriol. 170: 4693-

4698.

Evenberg, D; de Graaff, P; Lugtenberg, B. et al. **1988**. Vaccine-induced protective immunity against *Aeromonas salmonicida* tested in experimental carp erythrodermatitis. Journal of fish diseases 11: 337-350.

Kijne, JW; Smit, G; Diaz, CL; et al. **1988**. Lectin-enhanced accumulation of manganese-limited *Rhizobium leguminosarum* cells on pea root hair tips. J. Bacteriol. 170: 2994-3000.

Okker, R J; Spaink, H P; Zaat, S A; et al. **1988**. Flavonoids in the *Rhizobium*-legume symbiosis. Progress in clinical and biological research 280: 71-76.

Zaat, SAJ; Wijffelman, CA; Mulders, IHM; et al. **1988**. Root exudates of various host plants of *Rhizobium leguminosarum* contain different sets of inducers of rhizobium nodulation genes. Plant physiology 86: 1298-1303.

### **1989**

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