引用文献

Angell, S., Lewis, C. G., Buttner, M. J., and Bibb, M. J. (1994) Glucose repression in *Streptomyces coelicolor* A3(2): a likely regulatory role for glucose kinase. *Mol Gen Genet* **244:** 135-143.

Angell, S., Schwarz, E., and Bibb, M. J. (1992) The glucose kinase gene of *Streptomyces coelicolor* A3(2): its nucleotide sequence, transcriptional analysis and role in glucose repression. *Mol Microbiol* **6:** 2833-2844.

Armand, S., Tomita, H., Heyraud, C., Gey, C., Watanabe, T., and Henrissat, B. (1994) Stereochemical course of the hydrolysis reaction catalyzed by chitinas A1 and D from *Bacillus circulans* WL-12. *FEBS Lett* **343:** 177-180.

Berger, L. R., and Reynolds, D. M. (1958) The chitinase system of a strain of *Streptomyces griseus*. *Biochim Biophys Acta* **29:** 522-534.

Blaak, H., Schnellmann, J., Walter, S., Henrissat, B., and Schrempf, H. (1993) Characteristics of an exochitinase from *Streptomyces olivaceoviridis*, its corresponding gene, putative protein domains and relationship to other chitinases. *Eur J Biochem* **214:** 659-669.

Boot, R. G., Renkema, G. H., Strijland, A., van Zonneveld, A. J., and Aerts, J. M. (1995) Cloning of a cDNA encoding chitotriosidase, a human chtinase produced by macrophages. *J Biol Chem* **270:** 26252-26256.

Bradford, M. M. (1976) A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein dye binding. *Anal Biochem* **72:** 248-254.

Brock, T. D., and Madigan, M. T. (1988). Biology of Microorganisms, Fifth edition Edition (New Jersey: Prentice Hall).

Davies, G., and Henrissat, B. (1995) Structures and mechanisms of glycosyl hydrolases. *Structure* **3:** 853-859.

Delic, I., Robbins, P., and Westpheling, J. (1992) Direct repeat sequences are implicated in the regulation of two *Streptomyces* chitinase promoters that are subjected to carbon catabolite control. *Proc Natl Acad Sci USA* **89:** 1885-1889.

Fisher, S. H., Bruton, C. J., and Chater, K. F. (1987) The glucose kinase gene of *Streptomyces coelicolor* and its use in selecting spontaneous deletions for desired regions of the genome. *Mol Gen Genet* **206:** 35-44.

Fujii, T., and Miyashita, K. (1993) Multiple domain structure in a chitinase gene (*chiC*) of *Streptomyces lividans*. *J Gen Microbiol* **139:** 677-686.

Gal, S. W., Choi, J. Y., Kim, C. Y., Cheng, Y. H., Choi, Y. J., Bahk, J. D., Lee, S. Y., and Cho, M. J. (1997) Isolation and characterization of the 54-kDa and 22-kDa chitinase genes of *Serratia marcescens*. *FEMS Microbiol Lett* **151:** 197-204.

Gal, S. W., Choi, J. Y., Kim, C. Y., Cheong, Y. H., Choi, Y. J., Lee, S. Y., Bahk, J. D., and Cho, M. J. (1998) Cloning of 52-kDa chitinase gene from *Serratia marcescens* KCTC2172 and its proteolytic cleavage into an active 35-kDa enzyme. *FEMS Microbiol Lett* **160:** 151-158.

Gooday, G. W. (1997) The many uses of chitinases in nature. *Chitin and Chitosan Res* **3:** 233-243.

Henrissat, B. (1991) A classification of glycosyl hydrolases based on amino acid sequence similarities. *Biochem J* **280:** 309-316.

Henrissat, B., and Bairoch, A. (1993) New families in the classification of glycosyl hydrolases based on amino acid sequence similarities. *Biochem J* **293:** 781-788.

Hobbs, G., Frazer, C. M., Gardner, D. C. J., Flett, F., and Oliver, S. G. (1989) Dispersed growth of *Streptomyces* in liquid culture. *Appl Microbiol Biotechnol* **31:** 272-277.

Hodgson, D. A. (1982) Glucose repression of carbon source uptake and metabolism in *Streptomyces coelicolor* A3(2) and its perturbation in mutants resistant to 2-deoxyglucose. *J Gen Microbiol* **128:** 2417-2430.

Holt, J. G., Krieg, N. R., Sneath, P. H. A., Staley, J. T., and Williams, S. T. (1994). Bergey's Manual of Determinative Bacteriology, nineth edition Edition (Baltimore: Williams and Wilkins).

Hopwood, D. A., Bibb, M. J., Charter, K. F., Kieser, T., Bruton, C. J., Kieser, H. M., Lydiate, D. J., Smith, C. P., Ward, J. M., and Schrempf, H. (1985). Genetic Manipulation Of *Streptomyces*: A Laboratory Manual. (The John Innes Foundation, Norwich, UK: John Innes Foundation).

Hsu, S. C., and Lockwood, J. L. (1975) Powdered chitin as a selective medium for enumerationof actinomycetes in water and soil. *Appl Microbiol* **29:** 422-426.

Ikeda, H., Seno, E. T., Bruton, C. J., and Chater, K. F. (1984) Genetic mapping, cloning, and physiological aspects of the glucose kinase gene of *Streptomyces coelicolor*. *MOl Gen Genet* **196:** 501-507.

Ingram, C., Brawner, M., Youngman, P., and Westpheling, J. (1989) *xylE* functions as an efficient reporter gene in *Streptomyces* spp.: use for the study of *galP1*, a catabolite-controlled promoter. *J Bacteriol* **171:** 6617-6624.

Ingram, C., and Westpheling, J. (1995) The glucose kinase gene of *Streptomyces coelicolor* is not required for glucose repression of the *chi63* promoter. *J Bacteriol* **177:** 3587-3588.

Iseli, B., Armand, S., Boller, T., Neuhaus, J.-M., and Henrissat, B. (1996) Plant chitinases use two different hydrolytic mechanisms. *FEBS Lett* **383:** 186-188.

Janssen, G. R., and Bibb, M. J. (1993) Derivatives of pUC18 that have *Bgl*II sites flanking a modified multiple cloning site and that retain the ability to identify recombinant clones by visual screening of *Escherichia coli* clones. *Gene* **124:** 133-134.

Kataoka, M., Ueda, K., Kudo, T., Seki, T., and Yoshida, T. (1997) Application of the variable region of 16S DNA to create an index for rapid species identification in the genus *Streptomyces*. *FEMS Microbiol Lett* **151**: 249-255.

Koga, D., Hirata, T., Sueshige, N., Tanaka, S., and Ide, A. (1992) Induction patterns of chitinases in yam callus by inoculation with autoclaved Fusarium oxysporum, ethylene, and chitin and chitosan oligosaccharides. *Biosci Biotechnol Biochem* **56**: 280-283.

Kolbe, S., Fischer, S., Becirevic, A., Hinz, P., and Schrempf, H. (1998) The *Streptomyces reticuli* alpha-chitin-binding protein CHB2 and its gene. *Microbiology* **144**: 1291-1297.

Leah, R., Tommerup, H., Svendsen, I., and Mundy, J. (1991) Biochemical and molecular characterization of three barley seed proteins with anti-fungal properties. *J Biol Chem* **266**: 1564-1573.

Leblond, P., Redenbach, M., and Cullum, J. (1993) Physical map of the *Streptomyces lividans* 66 genome and comparison with that of the related strain *Streptomyces coelicolor* A3(2). *J Bacteriol* **175**: 3422-3429.

Lingappa, Y., and Lockwood, J. L. (1962) Chitin media for selective isolation and culture of Actinomycetes. *Phytopathol* **52**: 317-323.

Lloyd, A. B., Noverske, R. L., and Lockwood, J. L. (1965) Lysis of fungal mycelium by *Streptomyces* spp. and their chitinase systems. *Phytopathology* **55**: 871-875.

Lorkiewics, Z. (1997) Nodulation genes in the *Rhizobium*-plant signal exchange. *Acta Biochem Pol* **44**: 1-12.

Maidak, B. L., Olsen, G. J., Larsen, N., Overbeek, R., McCaughey, M. J., and Woese, C. R. (1997) The RDP (Ribosomal Database Project). *Nucleic Acids Res* **25**: 109-111.

Mitchell, R., and Alexander, M. (1962) Microbiological processes associated with the use of chitin for biological control. *Proc Soil Sci Soc America* **26**: 556-558.

Miyashita, K., and Fujii, T. (1993) Nucleotide sequence and analysis of a gene (*chiA*) for chitinase from *Streptomyces lividans* 66. *Biosci Biotech Biochem* **57**: 1691-1698.

Miyashita, K., Fujii, T., and Kajiwara, T. (1998) Unpublished data. .

Miyashita, K., Fujii, T., and Sawada, Y. (1991) Molecular cloning and characterization of chitinase genes from *Streptomyces lividans* 66. *J Gen Microbiol* **137**: 2065-2072.

Miyashita, K., Fujii, T., Watanabe, W., and Ueno, H. (1997) Nucleotide sequence and expression of a gene (*chiB*) for a chitinase from *Streptomyces lividans*. *J Ferm Bioengin* **83**: 26-31.

Muzzarelli, R. A. A. (1977). Chitin (New York: Pergamon Press).

Neugebauer, E., Gamache, B., D ry, C. V., and Brzezinski, R. (1991) Chitinolytic properties of *Streptomyces lividans*. *Arch Microbiol* **156**: 192-197.

Ni, X., and Westpheling, J. (1997) Direct repeat sequences in the *Streptomyces* chitinase-63 promoter direct both glucose repression and chitin induction. *Proc Natl Acad Sci USA* **94**: 13116-13121.

Ohno, T., Armand, S., Hata, T., Nikaidou, N., Henrissat, B., Mitsutomi, M., and Watanabe, T. (1996) A modular family 19 chitinase found in the prokaryotic organism *Streptomyces griseus* HUT 6037. *J Bacteriol* **178**: 5065-5070.

Pernodet, L. L., Boccard, F., Alegre, M. T., Gagnat, J., and Gu rineau, M. (1989) Organization and nucleotide sequence analysis of a ribosomal RNA gene cluster from *Streptomyces ambofaciens*. *Gene* **79**: 33-46.

Postma, P. W., Lengeler, J. W., and Jacobson, G. R. (1993) Phosphoenolpyruva te:carbohydrate phosphotransferase system of bacteria. *Microbiol Rev* **57**: 543-594.

Redenbach, M., Kieser, H. M., Denapaite, D., Eicher, A., Cullum, J., Kinashi, H., and Hopwood, D. A. (1996) A set of ordered cosmid library and a detailed genetic and physical map for the 8 Mb *Streptomyces coelicolor* A3(2) chromosome. *Mol Microbiol* **21**: 77-96.

Robbins, P. W., Oberbye, K., Albright, C., Benfield, B., and Pero, J. (1992) Cloning and high-level expression of chitinase-encoding gene of *Streptomyces plicatus*. *Gene* **111:** 69-76.

Romaguera, A., Menge, U., Breves, R., and Diekmann, H. (1992) Chitinase of *Streptomyces olivaceoviridis* and significance of processing for multiplicity. *J Bacteriol* **174:** 3450-3454.

Saier, M. H. J., Chauvaux, S., Cook, G. M., Deuscher, J., Paulsen, I. T., Reiser, J., and Ye, J. J. (1996) Carabolite repression and inducer control in Gram-positive bacteria. *Microbiology* **142:** 217-230.

Saitou, N., and Nei, M. (1987) The neighbor joining method: a new method for reconstructing phylogenetic trees. *Mol Biol Evol* **4:** 406-425.

Salzer, P., H bner, B., Sirrenberg, A., and Hager, A. (1997) Differential effect of purified spruce chitinases and γ-1,3-glucanases on the activity of elicitors from Ectomycorrhizal fungi. *Plant Physiol* **114:** 957-968.

Sambrook, J., Fritsch, E. F., and Maniatis, T. (1989). Molecular Cloning: a Laboratory Manual, Second Edition (New York: Cold Spring Harbor Laboratory).

Schnellmann, J., Zeltins, A., Blaak, H., and Schrempf, H. (1994) The novel lectin-like protein CHB1 is encoded by a chitin-inducible *Streptomyces olivaceoviridis* gene and binds to specifically to crystalline alpha-chitin of fungi and other organisms. *Mol Microbiol* **13:** 807-819.

Seno, E. T., and Chater, K. F. (1982) Glycerol catabolic enzymes amd their regulation in wild-type and mutant strains of *Streptomyces coelicolor* A3(2). *J Gen Microbiol* **129:** 1403-1413.

Shimosaka, M., Fukumori, Y., Zhang, X.-Y., and Okazaki, M. (1998) Studies on chitinase and chitosanase from the bacterium, *Acinetobacter* sp. CHB101 isolated from soil. *Chitin and Chitosan Res* **4:** 202-203.

Shiro, M., Ueda, M., Kawaguchi, T., and Arai, M. (1996) Cloning of a cluster of chitinase genes from *Aeromonas* sp. No. 10S-24. *Biochem Biophys Acta* **1305**: 44-48.

Skujins, J., Pukite, A., and McLaren, A. D. (1970) Chitinase of *Streptomyces* sp.: purification an properties. *Enzymologia* **39**: 353-370.

Skujins, J. J., Potgieter, H. J., and Alexander, M. (1965) Dissolution of fungi cell walls by a streptomycete chitinase and beta-(1,3)-glucanase. *Arch Biochem Biophys* **111**: 358-364.

Smucker, R. A., and Pfister, R. M. (1978) Characteristics of Streptomyces coelicolor A3(2) aerial spore rodlet mosaic. *Can J Microbiol* **24**: 397-408.

Sneh, B., Katan, J., and Henis, Y. (1971) Mode of inhibition of *Rhizoctonia solani* in chitin amended soil. *Phytopathology* **63**: 1113-1117.

Strauch, E., Takano, E., Baylis, H. A., and Bibb, M. J. (1991) The stringent response in *Streptomyces coelicolor* A3(2). *Mol Microbiol* **5**: 289-298.

Suzuki, K., Suzuki, M., Taiyoji, M., Nikaidou, N., and Watanabe, T. (1998) Chitin binding protein (CBP21) in the culture supernatant of *Serratia marcescens* 2170. *Biosci Biotechnol Biochem* **62**: 128-135.

Titgemeyer, F., Reizer, J., Reizer, A., and Saier, M. H., Jr (1994) Evolutionary relationships between sugar kinases and transcriptional repressors in bacteria. *Microbiology* **140**: 2349-2354.

Tominaga, Y., and Tsujisaka, Y. (1976) Purification and some properties of two chitinases from *Streptomyces orientalis* which lyse *Rhizopus* cell wall. *Agr Biol Chem* **40**: 2325-2333.

Tracy, M. V. (1957) Chitin. *Rev Pure Appl Chem* **7**: 1.

Tsujibo, H., Endo, H., Minoura, K., Miyamoto, K., and Inamori, Y. (1993) Cloning and sequence analysis of the gene encoding a thermostable chitinase from *Streptomyces thermoviolaceus* OPC-520. *Gene* **134**: 113-117.

Tsujibo, H., Orisaki, H., Shiotani, K., Hayashi, M., Umeda, J., Miyamoto, K., Imada, C., Okami, Y., and Inamori, Y. (1998) Characterization of chitinase C from a marine bacterium, *Alteromonas* sp. strain O-7, and its corresponding gene and domain structure. *Appl Environ Microbiol* **64:** 472-478.

Tsujibo, H., Orisaki, H., Tanno, H., Fujimoto, K., Miyamoto, K., Imada, C., Okami, Y., and Inamori, Y. (1993) Cloning, sequence, and expression of a chitinase gene from a marine bacterium, *Alteromonas* sp. strain O-7. *J Bacteriol* **175:** 176-181.

Waksman, A. W. (1959). The Actinomycetes (Baltimore: Waverly press, inc.).

Waksman, S. A., and Woodruff, H. B. (1940) Bacteriostaaric and bacterial substances produced by a soil actinomyces. *Proc Soc Exptl Biol Med* **53:** 233-239.

Waksman, S. A., and Woodruff, H. B. (1940) The soil as a source of microorganisms antagonistic to disease-producing bacteria. *J Bacteirol* **40:** 581-600.

Watanabe, T., Ito, Y., Yamada, T., Hashimoto, M., Sekine, S., and Tanaka, H. (1994) The roles of the C-terminal domain and type III domains of chitinase A1 from *Bacillus circulans* WL-12 in chitin degradation. *J Bacteriol* **176:** 4465-4472.

Watanabe, T., Kimura, K., Sumiya, T., Nikaidou, N., Suzuki, K., Suzuki, M., Taiyoji, M., Ferrer, S., and Regue, M. (1997) Genetic analysis of the chitinase system of *Serratia marcescens* 2170. *J Bacteriol* **179:** 7111-7117.

Watanabe, T., Kobori, K., Miyashita, K., Fujii, T., Sakai, H., Uchida, M., and Tanaka, H. (1993) Identification of glutamic acid 204 and aspartic acid 200 in chitinase A1 of *Bacillus circulans* WL-12 as essential residues for chitinase activity. *J Biol Chem* **268:** 18567-18572.

Watanabe, T., Oyanagi, W., Suzuki, K., Ohnishi, K., and Tanaka, H. (1992) Structure of the gene encoding chitinase D of *Bacillus circulans* WL-12 and possible homology of the enzyme to other prokaryotic chitinases and class III plant chitinases. *J Bacteriol* **174:** 408-414.

Watanabe, T., Suzuki, K., Oyanagi, W., Ohnishi, K., and Tanaka, H. (1990) Gene cloning of chitinase A1 from *Bacillus circulans* WL-12 revealed its evolutionary relationship to *Serratia* chitinase and to the type III homology units of fibronectin. *J Biol Chem* **265**: 15659-15665.

Williams, S. T., and Robinson, C. S. (1981) The role of Streptomycetes in deconposition of chitin in acidic soils. *J Gen Microbiol* **127**: 55-63.

Zukowski, M. M., Gaffney, D. F., Speck, D., Kauffmann, M., Findeli, A., Wisecup, A., and Lecocq, J.-P. (1983) Chromogenic identification of genetic regulatory signals in *Bacillus subtilis* based on expression of a cloned *Pseudomonas* gene. *Proc Natl Acad Sci USA* **80**: 1101-1105.

大野剛、金井亮、二階堂直樹、渡辺剛士、藤井毅、宮下清貴、田辺俊朗、光富勝 (1997) *Streptomyces griseus* HUT6037のfamily18のキチナーゼの存在と原核生物におけるfamily19キチナーゼの探索. *1997年度 日本農芸化学会講演要旨集*、p. 44.

堀田国元と堀之内末治 (1994) バイオサイエンスと放線菌. (東京：医学出版センター).

キチンキトサン研究会編 (1988) 最後のバイオマス キチン、キトサン. (東京: 技報堂出版).

古賀大三 (1994) 植物キチナーゼと生体防御. *化学と生物* 32: 712-722.

下坂誠、福盛康宏、張孝勇、岡崎光雄 (1998) 土壌からの分離細菌 Acinetobacter sp. CHB101株のキチナーゼ・キトサナーゼについて. (キチンキトサン学会1998年度大会要旨集) キチン・キトサン*研究* 4: 202-203

渡邊剛士 (1997) 生物界において多様な役割を果たすキチナーゼ. *化学と生物* 35: 408-414.