REFERENCES

Albelyan, V. A., Yamamoto, T., and Afrikyan, E. G. 1994. Isolation and characterization of cyclodextrin glucanotransferases using cyclodextrin polymers and their derivatives. Biochem. (Moscow) 59: 573-579.

Amaizo. 1993. Cyclodextrins USA (Mimeographed).

Armbruster, C. F. 1998. Use of cyclodextrin in the production of pure alpha- and beta cyclodextrins. In O. Huber and J. Szejtli (eds.), Proceedings of the Fourth International Symposium on Cyclodextrins, Munich, Kluwer Academic Publisher: 33-39.

Armbruster and Lakaway, W. A. Jr. 1972. US patent 3, 640, 847

Barcza, L. and Seres, G. 1988. Method development for economic production of cyclodextrins by means of tertianary complex formation. In O. Huber and J. Szejtli (eds.), Proceedings of the Fourth International Symposium on Cyclodextrins, Munich, Kluwer Academic Publisher: 81-86.

Bender, H. 1977a. Cyclodextrin- glucanotransferase von *Klebsiella pneumoniae* 1. Synthase, reinguigung und eigenschaften des enzymes von *K. pneumoniae* M 5a1. Arch. Microbiol. 111: 271.

Bender, H. 1977b. Cyclodextrin- glucanotransferase von *Klebsiella pneumoniae* 2. Bedetung des enzyme fur den metabolismus der cyclodextrin bei *K. pneumoniae* M 5a1. Arch. Microbiol. 113: 49.

Bender, H. 1982. Enzymology of the Cyclodextrins. In J. Szejtli (ed.), Proceedings of the First International Symposium on Cyclodextrins,

Budapest, Akademiai Kiado.: 77-87.

Bender, H. 1983. An improve method for the preparation of cyclooctamylose, using starches and the cyclodextrin glycosyltransferase of *Klebsiella pneumoniae* M 5 al. Carbohydr. Res. **124** : 225-231.

Bender, H. 1984. Verfahven zur herstellung von cyclooctaamylose. Ger Patent DE 33,17,064

Bender, H. 1986. Production, characterization and application of cyclodextrins. Adv. Biotech. Proc. 6: 31-71.

Bender, H. 1988. Studies on the reaction mechanism of cyclodextrin glycosyltransferase: subsite analysis. In O. Huber and J. Szejtli (eds.), Proceedings of the Fourth International Symposium on Cyclodextrins, Munich, Kluwer, Academic Publisher: 19-26.

Bender, M.L., Komiyama, M. 1978. Cyclodextrin chemistry spring-verlog, Heidelberg and New York : 2-9.

Benshop, H. P., Van den Berg G. R. 1970. Sterospecific inclusion in cycloamylose; partial resolution of isopropyl methylphosphinate and related compounds. Chem. Commun. : 1431.

Boonchai, J.1995. Determination of cyclodextrin glycosyltransferasegene from *Bacillus* sp. A11, Master's Thesis, Faculty of science, Chulalongkorn University.

Bovetto, L.J., Backer, D.P., Villette, J.R., Sicard, P.J. and Bouqelet, S.J.L. 1992. Cyclomaltodextrin glucanotransferase from *Bacillus circulans* E192. Purification and characterization of enzyme. Biotechnol. Appl. Biochem. 15: 48-58.

Bradford, M. M. 1976. A rapid and sensitive method for the

quatitaatively of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem **72** : 248-254.

Breslow, R. 1984. Enzyme models related to inclusion compounds. Inclusion Comp. **3**: 473.

Casu, B.and Reggiani M. 1979. Methylated cycloamyloses and their inclusion properties. Carbohydr. Res. **76** : 59-68.

Carroll, B. and Cheung, H.C. 1960. Determination of amylose in starch. J. Agric. Food Chem. **8** : 76-85.

Davis, B.J. 1964. Disc electrophoresis II. Ann. N.Y. Acad. Sci. **121** :404-427.

Depinto, J. A. and Campbell, L. L. 1968. Purification and properties of cyclodextrinase of *Bacillus macerans* Biochemistry **7**: 121-125.

Doi, R. H. 1973. Role of protease in sporulation. Current Topics in Cellular Regulation. **7**:1-20.

Englbrecht, A., Harrer, G., Lebert, M., and Schmid, G. 1990. Biochemical and genetic characterization of cyclodextrin glycosyltransferase from an alkalophilic bacteria forming primarily cyclodextrin. In D. Duchene (ed.), Proceedings of the Fifth International Symposium on Cyclodextrins, Paris, Edition de Sante. : 25-31.

Ensuiko 1994. Stabilization of natural colors by cyclodextrin. Japan (Mimeographed).

French, D and Rundle R. E. 1942. The molecular weights of the schardinger alpha and beta dextrin. J.Am.Chem.Soc. **64**:165-172.

French, D, Levine, M. L., Pazur J. H., norberg, E. 1949. Studies on the schardinger dextrins : The preparation and solubility characteristics of alpha-,beta-,and gamma-dextrins. J.Am.Chem. Soc. **71**: 353-359.

French, D, Pulley, O.A., Effenberger, J. A., Rongvie, A.M. and Abdullah, M. 1965. Studies on the schardinger dextrins. The Molecular size and structure of the a, b, and g-dextrins. Arch. Biochem. Biophys., **111** : 153-160.

Freudenberg, K., Cramer, F. 1984. Die konstitution der schardinger dextrin alpha and beta and gamma. Z Naturforsh B **3** : 464-469.

Fuwa, H. 1954. A new method for microdetermination of amylase activity by the use of amylase as the substrate. J. Biochem. **41** : 583-603.

Hellman, J., Wahlberg, M., and Karp, M. 1990. Effects of modification at the C- terminus of cyclodextrin glucanotransferase from *Bacillus circulans* var. *Alkalophilus* on catalytic activity Biotechnol. Appl. Biochem. **12**: 387-396.

Hamamoto, T., Kaneko, T., and Horikoshi, K. 1987 Nucleotide sequence of the cyclomaltodextrin glucanotransferase (CGTase) gene from Alkalophilic *Bacillus* sp. Strain No.38-2 Agric. Biol. Chem. **51**: 2019-2022.

Hashimoto, H. 1988. Application of cyclodextrins to foods, toiletries and other products in Japan. In O. Huber and J. Szejtli (eds.), Proceedings of the Fourth International Symposium on Cyclodextrins, Munich, Kluwer Acadamic Publisher: 81-86.

Horikoshi, K. 1971. Production of alkaline enzymes by alkalophilic microorganisms. Agric. Biol. Chem. **35** : 1783-1791.

Horikoshi, K. 1988. Enzymology and molecular genetic of CD-forming enzyme. In O. Huber and J. Szejtli (eds.), Proceedings of the Fourth International Symposium on Cyclodextrins. Munich, Kluwer Acadamic Publisher: 7-17.

Horikoshi, K., Ando, T., Yohida, K., Tokyo J. P., Nakamura, N., Kunitachi, N. 1982. Enzeugung von cyclodextrin. Ger Patent DE 24, 53, 860

Janssen. 1992. Encapsin HP13 Biotech N.V. Drug Delivery Systems. Belgium (Mimeographed).

Kaneko, T.; Hamamoto, T., and Horikoshi, K. 1988. Molecular cloning and nucleotide sequence of the cyclomaltodextrin glucanotransferase gene from the Alkalophilic *Bacillus* sp. strain No.38-2 J. Gen. Microbiol. **134**: 97-105.

Kalb, A. F. and Sterling, C. 1962. The influence of pH on starch retrogradation. J. Appl. Polymer Sci.**6**: 571-582.

Kato, T., and Horikoshi, K. 1984. Immobilized cyclomaltodextrin glucanotransferase of an alkalophilic *Bacillus* sp. No. 38-2. Biotechnol. Bioeng. **26** : 595-598.

Klein, C., Hollender, J., Bender, H., and Schulz, G.E. 1992. Catalytic center of cyclodextrin glycosyltransferase derived from X-ray structure analysis combined with site- directed mutagenesis Biochemistry **31**: 8740-8746.

Kim, P. 1996. Purification of cyclodextrin glycosyltransferase by immunoaffinity chromatography. Master's Thesis, Chulalongkorn University.

Kimura, K., Kataoka, S., Nakamura, A., Takano, T, and Yamane, K. 1987. Nucleotide sequence of the beta- cyclodextrin glucanotransferase gene of Alkalophilic *Bacillus* sp. #1011 and similarity of its amino acid sequence to those of alpha-amylase J. Bacteriol. : 4399-4402.

Kimura, K., Kataoka, S., Nakamura, A., Takano, T., Kobayashi, S., and Yamane, K. 1989. Function of the COOH- terminal region of cyclodextrin glucanotransferase of Alkalophilic *Bacillus* sp.#1011: Relation to activity and pH stability. Biochem. Biophys. Res.Com. **161**: 1273-1279.

Kitahara, S. and Okada, S. 1974. Action of cyclodextrin glycosyltransferase from *Bacillus megaterium* strain No.5 on starch Agric. Biol. Chem. **28**: 2413-2417.

Kitahara, S. and Okada, S. 1975. Transfer action of cyclodextrin glycodextransferase on starch. Agric.Biol. Chem. **39** : 2195-2197.

Kitahara, S. and Okada, S. 1982a Purification and properties of cyclodextrin glycosyltransferase from *Bacillus stearothermophilus* TC-60. Dempun Kagaku **29**: 7-12.

Kitahara, S. and Okada, S. 1982b. Comparison of action of cyclodextrin glycosyltransferase from *Bacillus megaterium*, *B. circulans*, *B.stearothermophilus* and *B. macerans*. Dempun Kagaku **29**: 13

Kitahara, S. and Okada, S. 1987. Acceptor specificity of transglycosylation catalyzed by cyclodextrin glucanotransferase Agric. Biol. Chem **42**: 2369-2374.

Kitahara, S, Tsuyama N., Okada, S. 1974. Purification and some properties of the cyclodextrin glycosyltransferase from a strain of *Bacillus* sp.Agric. Biol. Chem. **38**: 387-393.

Kitahata, S. And Okada, S. 1982. Comparison of action of cyclodextrin glucanotransferase from *B. circulans, B. stearothermophilus, and B. macerans* J. Jap. Soc. Starch. Sci **29(1)**: 13-18.

Kobayashi S., Kainuma, K. and Suzuki, S. 1977. Purification and properties of the CGTase from *Bacillus macerans* Jpn. Kokai 77, 79,039 (0.4.87:150201)

Kobayashi S., Kainuma, K. and Suzuki, S. 1978. Purification and some properties of *Bacillus macerans* cycloamylose (cyclodextrin) glucanotransferase. Carbohydr. Res. **61**: 229-238.

Kobayashi S., Kainuma, K. and Suzuki, S. 1986. Preparation of large ringed cyclodextrin, Presented in part at the Annual Meeting of Agriculture Chemical Society of Japan, April, Abstracts : 649-662.

Komitani, T., Tanimoto, H., Nishimera, T., and Okada, S. 1993. A new method for precipitation of various glucosides with cyclodextrin glucanotransferase Biosci. Biotech. Biochem. **57**: 1185-1187.

Komiyama, M., and Bender, M. 1984. Cyclodextrin as enzyme model. The chemistry of Enzyme Action, Elsvier Science Publisher B.r.:505-527.

Kubota, M., Mikami, B., Tsujisaka, Y., and Moria, Y. 1988. Crystallization of and preliminary crystallographic data for *Bacillus stearothermophilus* cyclodextrin glucanotransferase J. Biochem **104**: 12-13.

Kuttiarcheewa, W. 1994. Immobilization of cyclodextrin glycosyltransferase on inorganic carriers. Master's Thesis, Faculty of Science, Chulalongkorn University.

Lane, A. G., and Pirt, S. J. 1973. Production of cyclodextrin glycodextransferase by batch and chemostat culture of *Bacillus macerans* in chemically defined medium. J. Appl. Chem. Biotechnol. **23**:309-321.

MacGregor, E. A. and Svensson, B. 1989. A super-secondary structure predicted to be common to several alpha- 1,4-D-glucan-cleaving enzyme J. Biochem **259**: 145-152.

Makela, M. J., Mattsson, P., Schinina, M. E. and Korpela, T. K. 1989. Purification and properties of cyclomaltodextrin glucanotransferase from an alkalophillic Bacillus. Biotechnol. Appl. Biochem. **10** : 414-427.

Mattson, P., Makela, M. and Korpela, T. 1989. Isolation and purification of gamma- cyclodextrin by affinity chromatography. Proceedings of the Fourth International Symposium on Cyclodextrins, Munich, Kluwer Academic publisher: 516-519.

Mattson, P., Susanna, M. and Timo, K. 1990. Analysis of cyclomaltodextrin glucanotransferase isozymes by isoelectric focusing in immobilized pH gradients. J. Biochem. Biophys. **20** : 237-246.

Matsuda H., Ito K., Tanaka. M, Uekawa K. 1994. Application of 2-hydroxypropyl-b- cyclodextrin to perfumes and cosmatics. In T. Osa (ed.), Proceedings of the seventh International Symposium on

Cyclodextrins. Tokyo, Business Center Academic Societies Japan.:516-519.

Matzuzawa, M., Nakamura, N. and Horikoshi, K. 1975. An improve method for the preparation of schardinger beta-dextrin on an industrial scale by cyclodextrin glycosyltransferase of an alkalophilic *Bacillus* sp. ATCC 21783. Starch/Starke 27 : 410-413.

Mc Ilroy, R.J. and Robert, J. 1948. The chemistry of the polysaccharides. Printed in Great Britain by Jarrold & son, Ltd., Norwich.: 102-112.

Miskolci-Torok, M., Seres, L., Vakalin, H., Szejtli, J., Jaria, M. 1980. Cyclodextrin-glucanotransferase enzyme. Hung Patent 17, 926

Moore, S., and Stein, W. H. 1963. Chromatographic determination of amino acids by the use of automatic recorsing equipment Methods in Enzymology 6: 819-831.

Mori, S., Hirose, S., Oya, T., and Kitahata, S. 1994. Purification and properties of cyclodextrin glucanotransferase from *Brevibacterium* sp. No9605. Biosci. Biotech .Biochem. 11: 1968-1972.

Nakamura, A., Haga, K., and Yamane, K. 1993. Three histidine residues in the active center of cyclodextrin glucanotransferase from Alkalophilic *Bacillus* sp. 1011: Effects of the replacement on pH dependence and transition-state stabilization. Biochemistry 32: 6624-6631.

Nakamura, N. and Horikori, K. 1976. Purification and properties of cyclodextrin glycodextransferase of an Alkalophilic *Bacillus* sp. Agric. Biol. Chem. 40(5) : 935-941.

Nakamura, N. and Horikori, K. 1976. Characterization and some cultural conditions of a CGTase- producing Alkalophilic *Bacillus* sp. Agric. Biol. Chem. **40**: 753-757.

Nakamura, N. and Horikori, K.1977. Production of schardinger β- dextrin by soluble and immobilized cyclodextrin glycosyltransferase of an alkalophilic *Bacillus* sp. Biotech. & Bioeng. **19**: 87-99.

Nagamoto, S., 1985. Cyclodextrins-expanding the development of their functions and application Chem. Econ. Eng. Rev. **17**: 28-34.

Nitschke, L., *et al.*, 1990. Molecular cloning, nucleotide sequence and expression in *Escherichia coli* of the beta-cyclodextrin glycosyltransferase gene from *Bacillus circulans* strain No.8 Appl. Microbiol. Biotechnol. **33**: 542-546.

Nomoto, M., Chen, C.C, and Shen, D. C. 1986. Purification and characterization of cyclodextrin glycodextransferase of an Alkalophilic bacterium of Taiwan. Agric. Biol. Chem. **50**: 2701-2707.

Okada, S., and Kitahata. 1975. Method of purification of cyclodextrin producing enzyme US Patent **3**, 888, 738.

Park, C.S., Park, K.H. and Kim, S.H. 1988. A rapid screening method for alkaline b-cyclodextrin glucanotransferase using phenolphthalein- methyl orange containing-solid medium. Agric. Biol. Chem. **53**: 1167-1169.

Pongsawasdi, P. and Yagisawa, M. 1987. Screening and identification of a cyclomaltodextrin glycanotransferase producing bacteria, J. Ferment. Technol. **65** : 463-467.

Pulley, O.A., and French, D. 1961. Studies on the schardinger dextrins. XI The isolation of new schardinger dextrins.Biochem. Biophys. Res. Com. 5: 11-15.

Rojtinnakorn, J. 1994. Preparation of antibody against cyclodextrin glycosyltransferase from *Bacillus* sp.A11. Master's Thesis, Faculty of science, Chulalongkorn University.

Ruchtorn, U. 1993. Production of cyclodextrin glucanotransferase in a fermenter and its immobilization on DEAE-cellulose. Master's Thesis, Faculty of science, Chulalongkorn University.

Saenger, W. 1979. Circular hydrogen bonds in alpha-cyclodextrin hexahydrate Nature 279: 343.

Saenger, W. 1980. Cyclodextrin inclusion compound in research and industry. Angew.Chem., Int. Ed. Engl., 19 : 344-362.

Saenger, W. 1982. Structure aspect of cyclodextrin inclusion compounds, In J. Szejtli (ed.), Proceedings of the First International Symposium on Cyclodextrins,Budapest, Akademiai Kiado : 141-145.

Schardinger, F. 1903. Thermophile bakterien ous ver schiedenen nahrungsmittelu und mich, und die geblдeten produtke, wenn diese baskterien in nahrlosungen kultiviert werden, die kohlehydrate enthaten, Z.Untersuch Nahr Genussm 6: 865-880.

Schardinger, F. 1904. *Bacillus macerans* ein aceton bildender rottebacillus, Zbl. Bakter. Parasiten Kande II 14: 772-778.

Schmid, G. Huber, O.S. and Eberle 1988. Selective complexing agent for the production of gamma-cyclodextrin. Proceedings of the

Fourth International Symposium on Cyclodextrins. Munich, Kluwer Academic publisher.: 87-92.

Schmid, G. Huber, O.S. and Eberle. 1989. Cyclodextringlucanotransferase production yield enhancement by overproduction of cloned gene. TIBTECH. 17 : 244-248.

Sin, K. A., Nakamura, A., A., Kobayashi, K., Masaki, H., and Uozamu, T. 1991. Cloning and sequencing of a cyclodextrin glucanotransferase gene from *Bacillus ohbensis* and its expression in *Escherichia coli* Appl. Microbiol. Biotechnol. **35**: 600-605.

Sin, K.A., Nakamura, A., A., Kobayashi, K., Masaki, H., Matsuura, Y., and Uozamu, T. 1994. Replacement of an amino acid residues of cyclodextrin glucanotransferase of *Bacillus ohbensis* doubles the production of gamma-cyclodextrin J. Biotechnol. **32**: 283-288.

Siripornadulsilp, S. 1993. Molecular cloning of cyclodextrin glucanotransferase gene from *Bacillus* sp. A11 in *Escherichia coli* Master's Thesis, Chulalongkorn University.

Smolkova-Keulemansova E. 1982. Cyclodextrins as stationary phases in chromatography. J. Chromatogr. **251**:17-34.

Starnes, R.L., Flint V.M. and katkocin D.M. 1990. Cyclodextrin production with a highly thermostable cyclodextrin glycodextransferase from *Thermoanaerobacter* sp. In D. Duchene (ed.), Minutes of the Fifth International Symposium on Cyclodextrins, Paris, Edition de Sante.: 55-61.

Strokopytov, B., Pennnga, D., Rozeboom, H. J., Kalk, K.H., Dijkhuizen,

L., and Dijkstra, B. W. 1995. X-ray Structure of cyclodextrin glycosyltransferase complex with acarbose. Implications for the catalytic mechanism of glycosidase Biochemistry 34: 2234-2240

Strokopytov, B., Knegtel, R. M. A., Pennnga, D., Rozeboom, H.J., Kalk, K. H., Dijkhuizen, L., and Dijkstra, B. W. 1996. Structure of cyclodextrin glycosyltransferase complexed with a maltononaose inhibitor at 2.6 A° resolution. Implications for product specificity Biochemistry 35: 4241-4249.

Sundararajan P.R., Rao V.S.R. 1970. Conformational studies on cycloamyloses. Carboydr. Res. 13 : 351-358.

Szejtli, J. 1988. Chapter 1 : Cyclodextrin Technology., Netherland : Kluwer Academic Publisher.

Szejtli, J. 1990. Cyclodextrins properties and application.Drug Invest. Z (Suppl.4): 11-21.

Szejtli, J. and Paginton, J. 1991. Cholesterol removal with CDs, Cyclodextrin News May (5) 9: 1-2.

Szejtli, J. 1994. Cyclodextrins in Pharmacy, Kluwer Academic Publisher, Dordreeht:1-4.

Takano, T., Fukuda, M., Kobayashi, S., Kainuma, and Yamane, K. 1986. Molecular cloning, nucleotide sequencing, and expresssion in *Bacillus subtilis* cells of *Bacillus macerans* cyclodextrin glucanotransferase Gene. J. Bacteriol :1118-1122.

Takeo, K., Kondo, Y. and Kuge, T. 1970. Thin layer chormatography of cyclodextrins. Agric. Biol. Chem. 34: 954-956.

Techaiyakul, W. 1991. Production and characterization of cyclodextrin glucanotransferase from *Bacillus* spp. Master's Thesis, Faculty of

science, Chulalongkorn University.

Techaiyakul, W., Pongsawasdi, P., and Mongkolkul, P. 1992. Purification and enzymatic properties of cyclodextrin glycosyltransferase from *Bacillus* sp. A11 In A.R. Hedges (ed.), Minutes of the Sixth International Symposium on Cyclodextrins Chicaco, Edition De Sante, Paris: 34-37.

Tomohiro, E., Haruhis, U., Shoichi, K. and Tsuneji, N. 1994. Purification and characterization of η-cyclodextrin. In T Osa (ed.), Proceedings of the Seventh International Symposium on Cyclodextrins , Tokyo, Business center for Academic Societies Japan.: 66-69.

Villette, J. R., Helbecque, N., and Albani, J. R., Sicard, J. PP., and Bouquelet, S. J. L. 1993. Cyclodextrin glucanotransferase from *Bacillus circulans* E192: nitration with tetranitromethane Biotechnol. Appl. Biochem. 17: 205-216.

Vittayakitsirikul, V. 1995. Expression of cyclodextrin glycosyltransferase gene In *Bacillus subtilis* MI111 (RM125) and *Escherichia coli*. Master's Thesis, Faculty of science, Chulalongkorn University.

Wanna, S. 1995. Restriction map and localization of the presumed cyclodextrin glycosyltransferase gene cloned from *Bacillus* sp. A11 Master's Thesis, Faculty of science, Chulalongkorn University.

Wolform, M.L., Patin, D.L. and Lederkremer, R.M. 1965. Thin layer chromatography on microcrystalline cellulose. J. Chromatogr. 17 : 488-494.

Yagi, Y., Igushi, H. 1974. Alpha-amylase production by *Bacillus ohbensis* Jap. Patent 14, 124,285

Yamamoto M., Aritumi H.,Ilie T., Hirayama F., and Uekama K. 1990. Pharmaceutical evaluation of branched β-cyclodextrins as parental drugs carriers. In D. Duchene (ed.), Minutes of the Fifth International Symposium on Cyclodextrins, Paris, Edition De Sante.: 541-544.

Yamamoto, M., Takano T., and Horikoshi K. 1972. Alkaline amylase of Alkalophilic bacteria Agric. Biol. Chem. 36: 1819-1823.

APPENDICES

APPENDIX A

Buffers for purification

1) 10 mM Tris-HCl buffer with 10 mM $CaCl_2$ pH 8.5 (TB1)

Tris (hydroxymethyl)-aminomethane	1.21	g
$CaCl_2$	1.11	g

Adjust pH to 8.5 with HCl and final volume to 1 litre

2) 15 mM Tris-HCl buffer pH 8.5 (TB2)

Tris (hydroxymethyl)-aminomethane	1.82	g

Adjust pH to 8.5 with HCl and final volume to 1 litre

APPENDIX B

Preparation for polyacrylamide gel electrophoresis

1) Stock reagents

30% Acrylamide 0.8% bis stock solution

Acrylamide	30.00	g
N, N′-methylene-bis-acrylamide	0.80	g

Adjust volume to 100 ml with distilled water

1.5 M Tris-HCl pH 8.8

Tris (hydroxymethyl)-aminomethane	18.17	g

Adjust pH to 8.8 with 1 N HCl and adjust volume to 100 ml with distilled water

0.5 M Tris-HCl pH 6.8

Tris (hydroxymethyl)-aminomethane	6.06	g

Adjust pH to 6.8 with 1 N HCl and final volume to 100 ml with distilled water

1.25 M Tris-HCl pH 6.8

Tris (hydroxymethyl)-aminomethane	15.14	g

Adjust pH to 6.8 with 1 N HCl and final volume to 100 ml with distilled water

Tris-Glycine electrode buffer stock-solution x5 (25 mM Tris, 192 mM Glycine, pH 8.1)

Tris (hydroxymethyl)-aminomethane	3.03	g
Glycine	14.40	g

Dissolve in distilled water to 200 ml to give final pH of 8.1

2) Non-denaturing PAGE

7.5% Separating gel

30% acrylamide solution	5.0	ml
1.5 M Tris-HCl pH 8.8	5.0	ml
distilled water	10.0	ml
TEMED	7.5	µl
10% $(NH_4)_2S_2O_8$	50.0	µl
total volume	20.0	ml

3.0% Stacking gel

30% acrylamide solution	2.5	ml
0.5 M Tris-HCl pH 6.8	2.5	ml
distilled water	7.5	ml
TEMED	5.0	µl
10% $(NH_4)_2S_2O_8$	50.0	µl
total volume	10.0	ml

Sample buffer

1.25 M Tris-HCl pH 6.8 : glycerol: distilled water = 1: 2: 2 (v/v) were added with trace amount of bromophenol blue. For loading sample, three parts of sample was mixed with one part of sample buffer.

3) SDS-PAGE

7.5% Separating gel		
30% acrylamide solution	5.0	ml
1.5 M Tris-HCl pH 8.8	7.5	ml
10% SDS	0.2	ml
distilled water	9.4	ml
TEMED	10.0	µl
10% $(NH_4)_2S_2O_8$	50.0	µl
total volume	20.0	ml

3.0% Stacking gel		
30% acrylamide solution	1.0	ml
0.5 M Tris-HCl pH 6.8	2.5	ml
10% SDS	0.1	ml
0.2 M EDTA	0.1	ml
distilled water	6.3	ml
TEMED	5.0	µl
10% $(NH_4)_2S_2O_8$	30.0	µl
total volume	10.0	ml

Solubilizing medium		
glycerol	2.0	ml

20% SDS	1.0	ml
1.25 M Tris-HCl pH 6.8	1.0	ml
β-mercaptoethanol	1.0	ml
bromophenol blue		

One part of solubilizing medium was added to three parts of sample. The mixture was heated 1 minute in boiling water before loading to the gel.

APPENDIX C

Stock solutions for colony hybridization

50x Denhardt's solution

Ficoll type 400	10.0	g/l
polyvinylpyrrolidone	10.0	g/l
BSA	10.0	g/l

Disolve Ficoll type 400, polyvinylpyrrolidone and BSA in double distilled water, filter and store at -20 ^{0}C

20xSSC

3 M NaCl	175.3	g/l
0.3M $Na_3C_6H_5O_7.2H_2O$	88.2	g/l

Dissolve NaCl and $Na_3C_6H_5O_7.2H_2O$ in double distilled water and adjust pH to 7.0 with a few drop of HCl. Sterilized by autoclaving and stored at room temperature.

Prehybridization solution

50x Denhardt's solution	20	ml
20xSSC	30	ml

Distilled water to 100 ml

Hybridization solution

10 ml of prehybridization solution plus 4 ml of labelled-oligonucleotide probe.

APPENDIX D

Genotype markers of *E. Coli* strain DH5α

DH5α genotype: F⁻φ80d *lac*ZΔM15Δ (*lac*ZYA-*arg*F) U169 *deo*R *rel*A1 *end*A1 hsdR17(r_K^-, m_K^+) *pho*A *sup*E44 λ⁻thi-^{1} *gry*A96 *rec*A1

Symbol	Description	Effect
*lac*ZΔM15	Partial deletion of β-D-galactosidase gene	Allow complementation of β-D-galactosidase activity by α-complementation sequence in pUC vectors. Allow blue/white selection for recombinant colonies when plated on X-gal.
*deo*R		Involve the ability to grow on a minimal medium and enhance the uptake of larger plasmids.
*end*A1	Endonuclease mutation	Improve the yield and quality of plasmid DNA preparation.
hsdR	Restriction negative and Modification positive (r_K^-, m_K^+)	Methylate the DNA but do not restrict.
*sup*E	Suppressor mutation	Suppress amber (UAG) mutation
thi-^{1}	Mutation in thiamine metabolism	Thiamine required for growth in minimal media
*gry*A96	DNA gyrase mutation	This strain can be isolated by selecting for mutants resistant to nalidixic acid.
*Rec*A1	Recombination deficient	Product of *rec*A gene serves as a master regulator of recombination. The *rec*A mutation stabilizes the DNA in cloning vector.

APPENDIX E

Stock solutions for preparation of sequencing gel

20% Acrylamide solution

Acrylamide	193.0	g/l
N, N′-methylene-bis-acrylamide	6.7	g/l
Urea	46.7	g/l

Dissolve Acrylamide, N, N′-methylene-bis-acrylamide, and urea in double distilled water. Stir on magnetic stirrer for 30 minutes or until the mixture become homogenous. Filter and store at room temperature.

46.7% Urea solution

Urea	476.0	g/l

Dissolve urea in double distilled water. Stir on manetic stirrer for 30 minutes or until the solution become homogenous. Filter and store at room temperature.

10xTBE

Tris base	121.0	g/l
EDTA	7.4	g/l
Boric acid	53.4	g/l

Dissolve Tris base, EDTA, and Boric acid in double distilled water and adjust pH to 8.3. Store at room temperature.

10% Ammonium persulfate

Dissolve 1g of ammonium persulfate in 10 ml of double distilled water. The solution may be stored for several weeks at 4 ^{0}C.

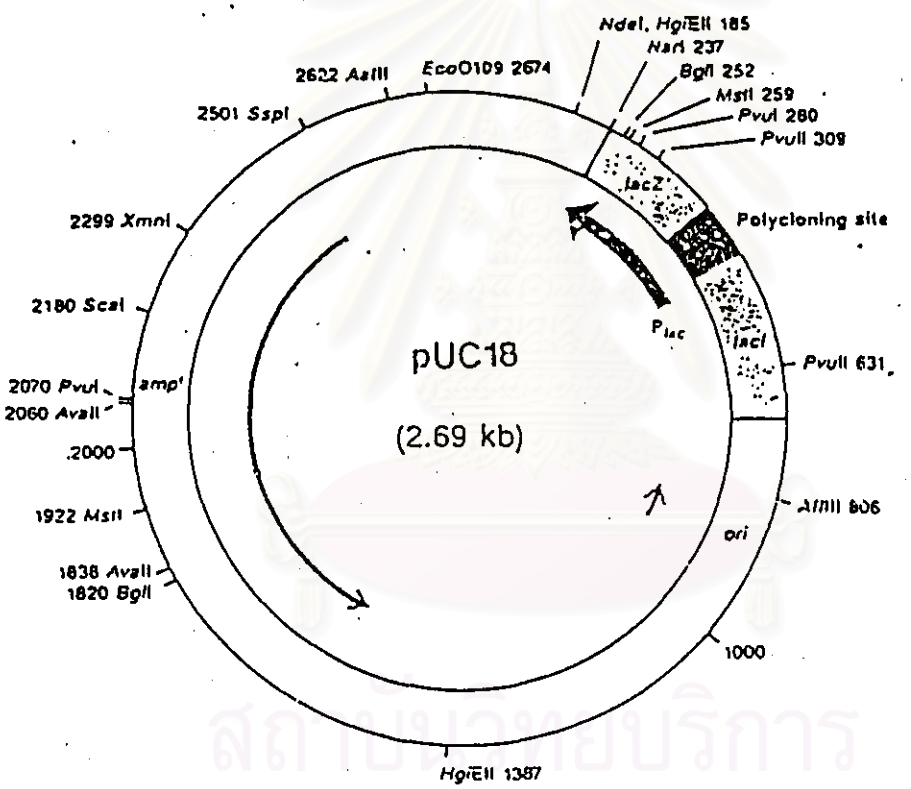
8% Acrylamide gel solution

20% acrylamide solution	35	ml
46.7% urea solution	44	ml
10xTBE	9	ml
TEMED	85	µl
10% ammonium persulfate	425	µl

Mix all above except 10 %ammonium persulfate until ready to pour gel.

APPENDIX F

Restriction map of pUC18



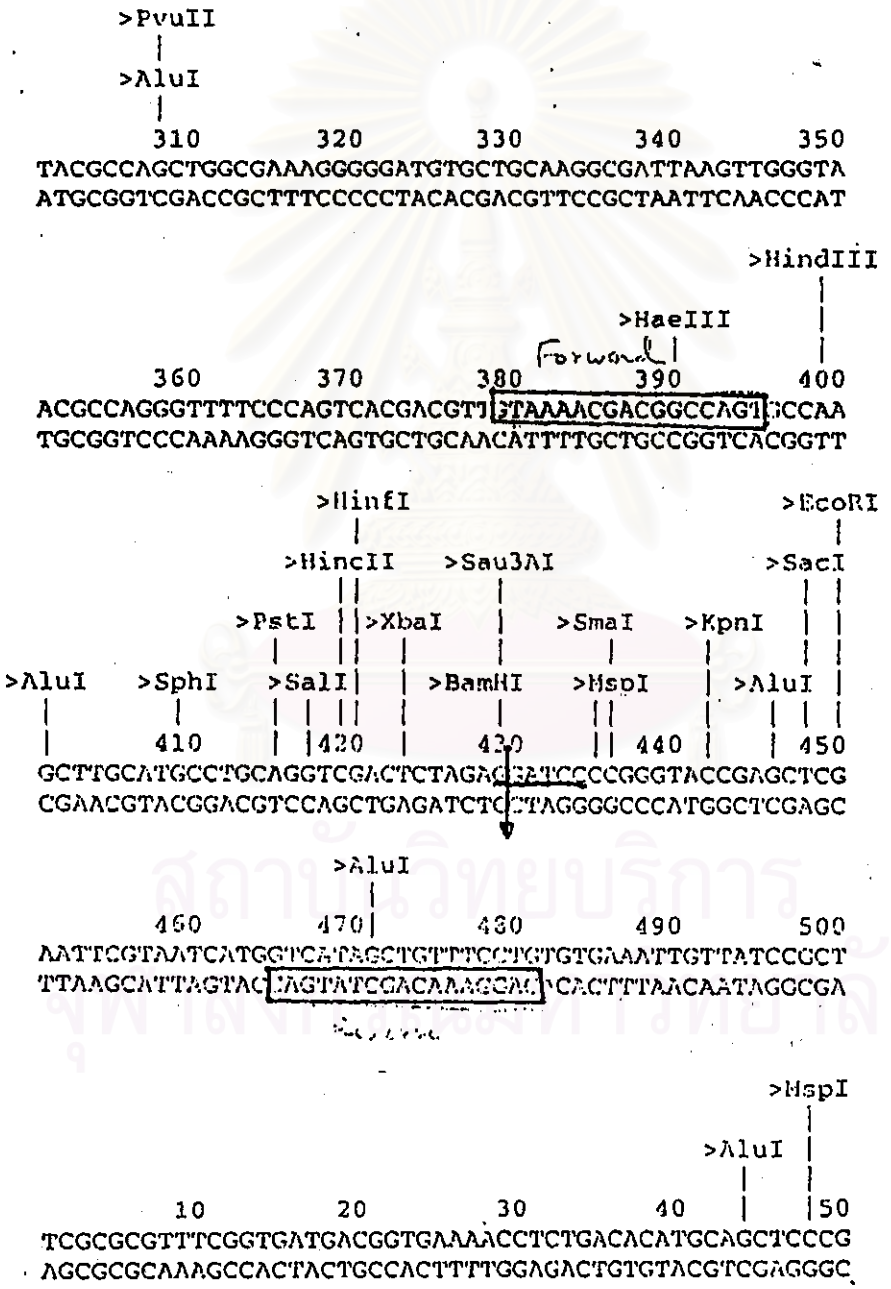
Ioning Sites

1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	7	8
Thr	Met	=	Thr	Asn	Ser	Ser	Ser	Val	Pro	Gly	Asp	Pro	Leu	Glu	Ser	Thr	Cys	Arg	His	Ala	Ser	Leu	Ala	Leu	Ala
ACC	ATG	ATT	ACG	AAT	TCG	AGC	TCG	GTA	CCC	GGG	GAT	CCT	CTA	GAG	TCG	ACC	TGC	AGG	CAT	GCA	AGC	TTG	GCA	CTG	GCC

EcoRI | SacI | KpnI | SmaI XmaI | BamHI | XbaI | SalI AccI HincII | PstI | SphI | HindIII

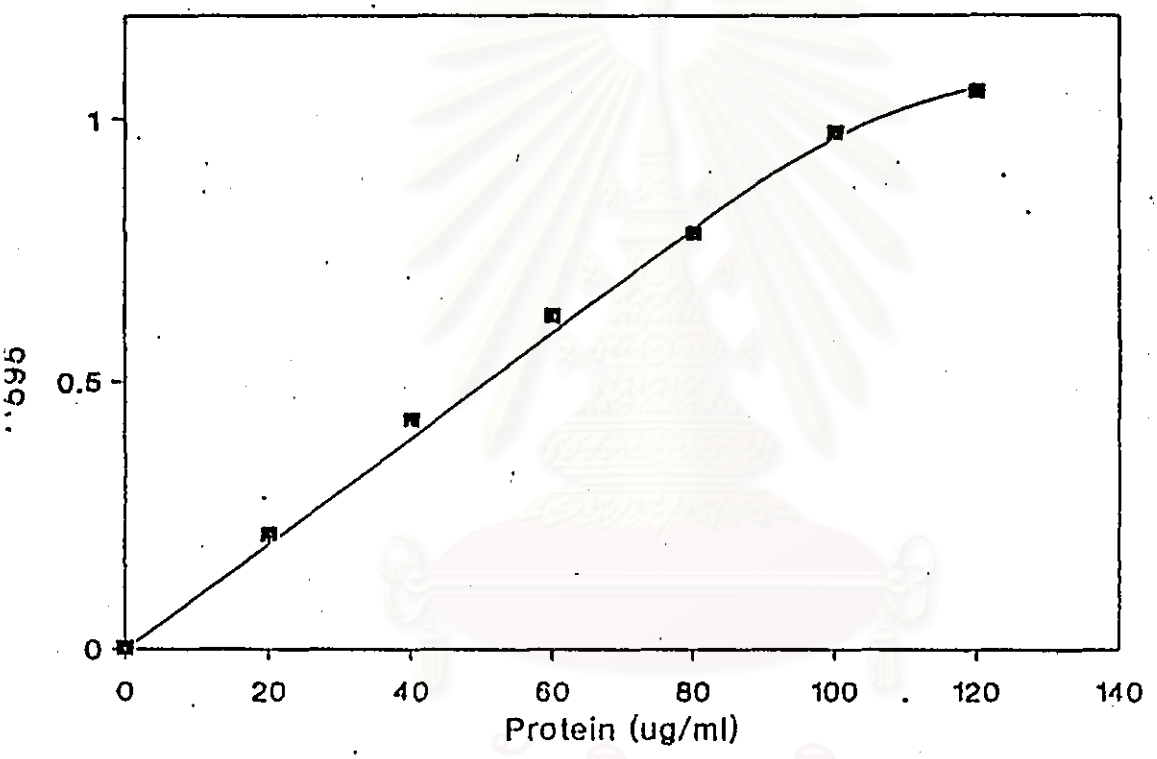
APPENDIX G

Annealing sites of forward and reverse universal primers in pUC18



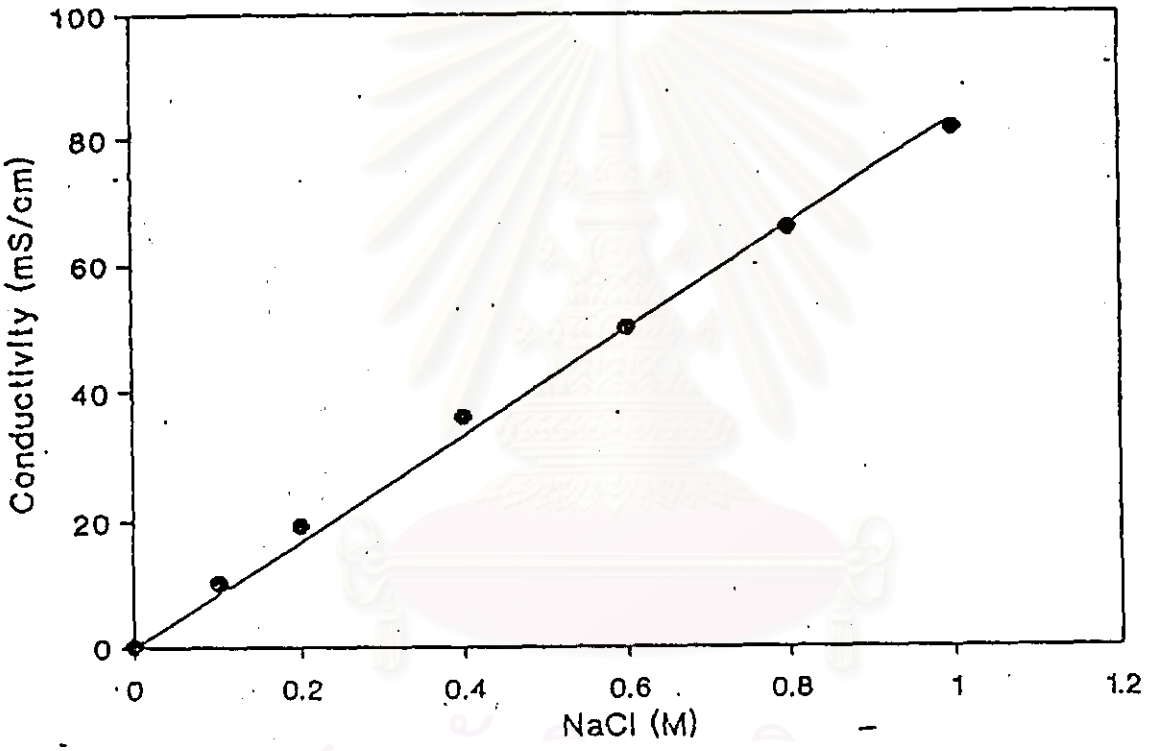
APPENDIX H

Standard curve for protein determination by Bradford's method.



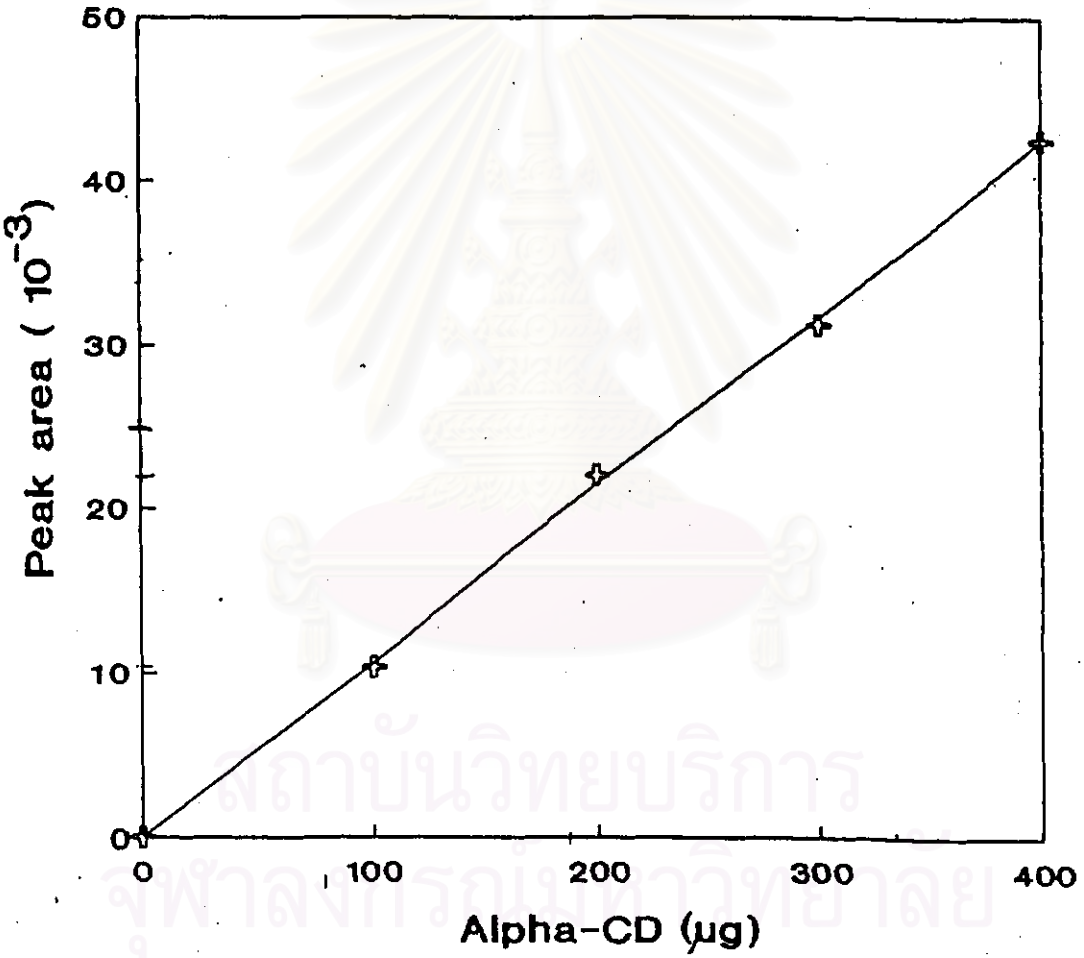
APPENDIX I

Standard curve of conductivity against NaCl concentration



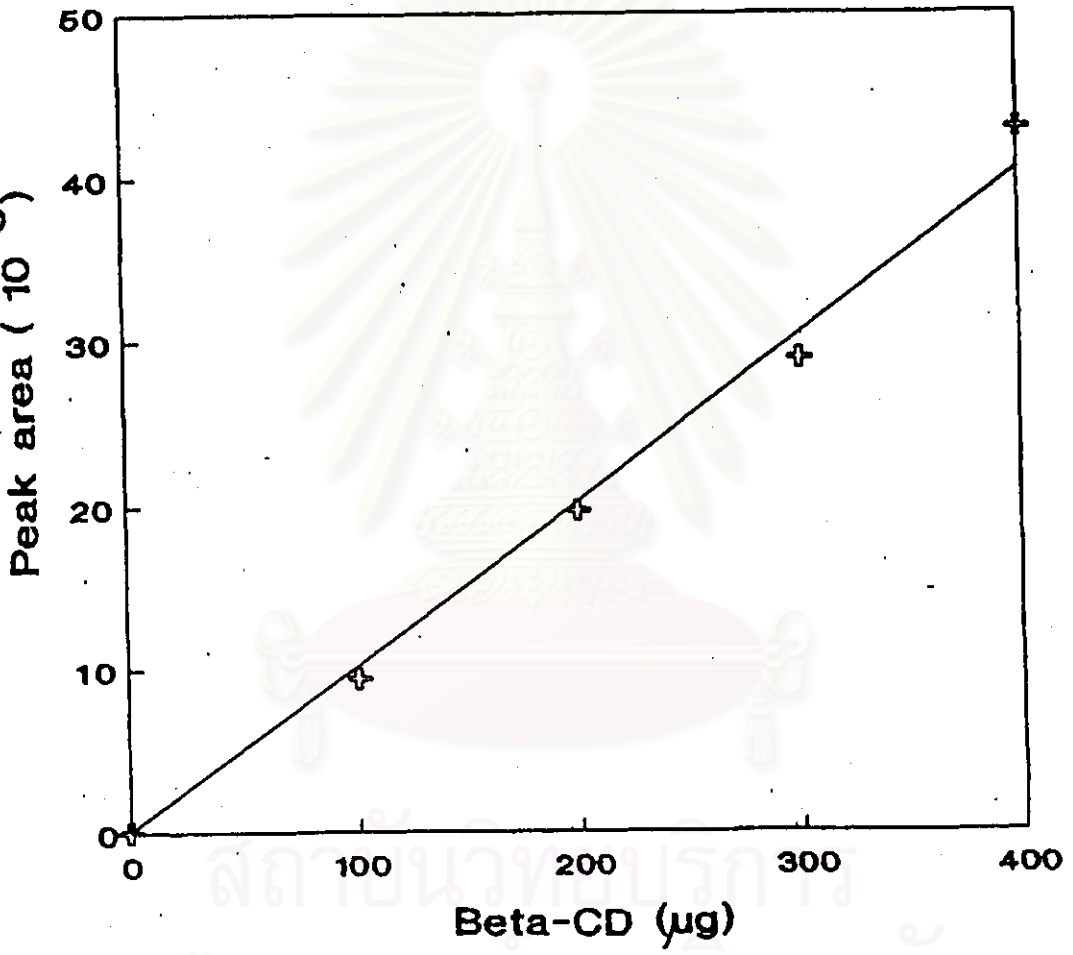
APPENDIX J

Standard curve of α-CD (by HPLC)



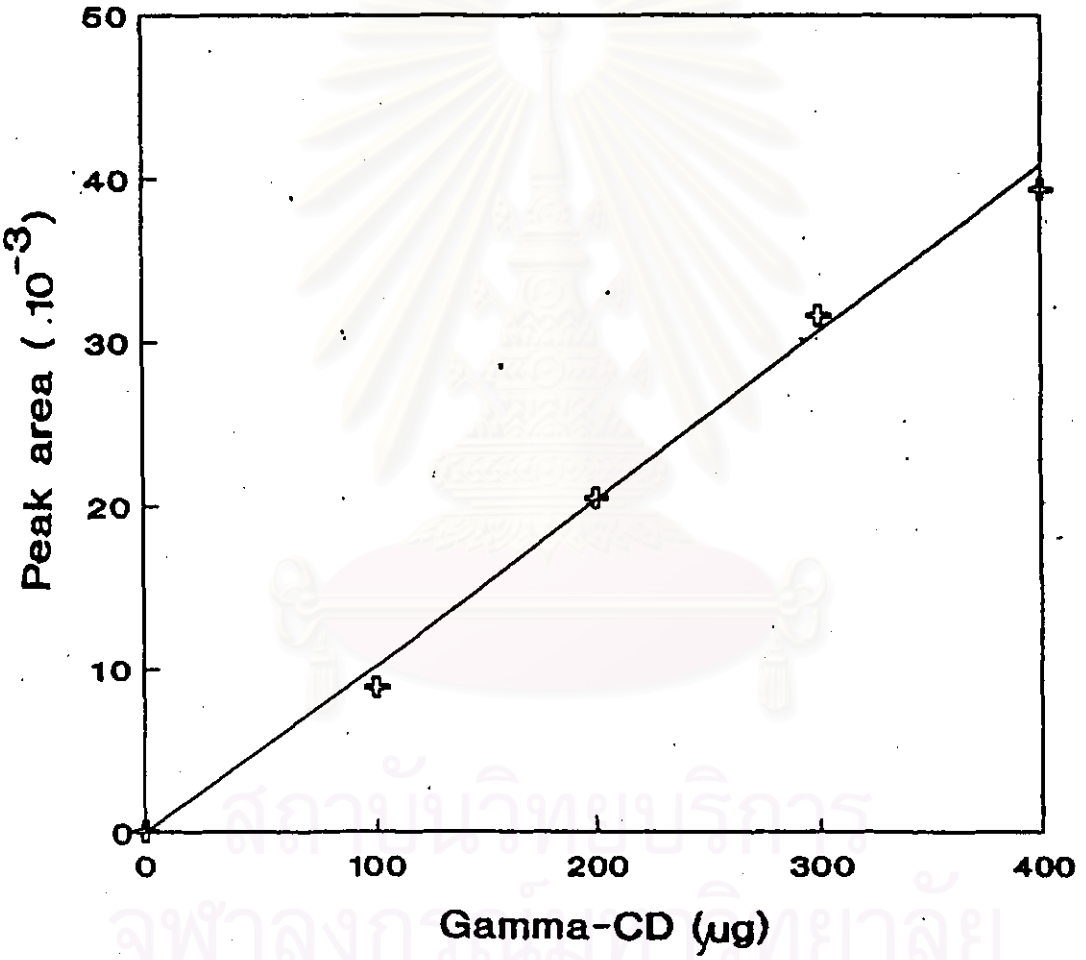
APPENDIX K

Standard curve of β-CD (by HPLC)



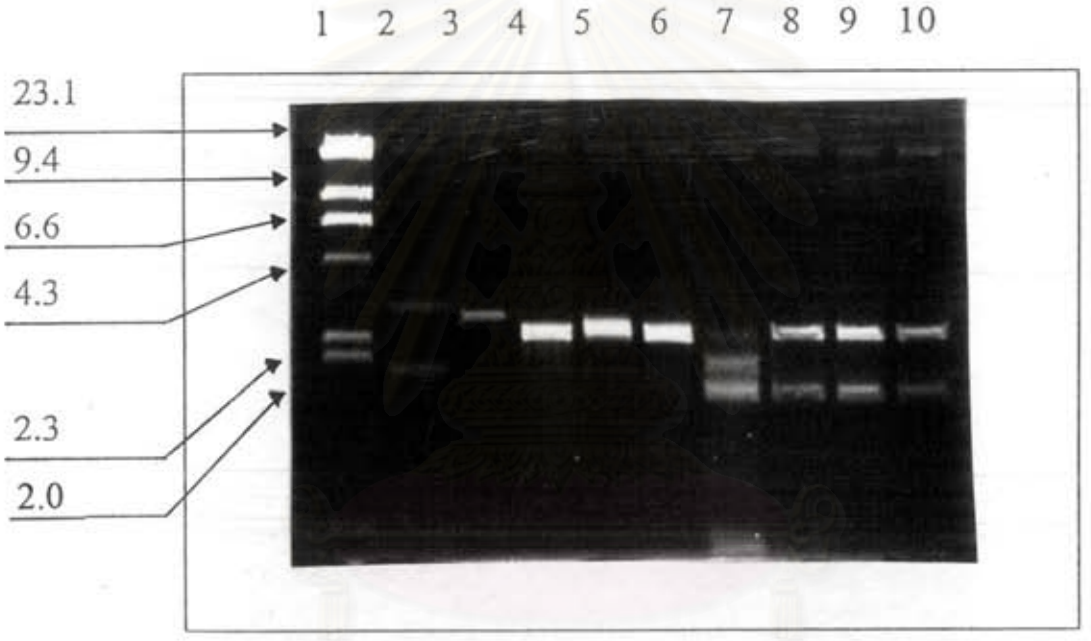
APPENDIX L

Standard curve of γ-CD (by HPLC)



APPENDIX M

Restriction analysis of recombinant plasmid 909 by various restriction endonuclease



Lane 1.size standard marker λ/*Hin*dIII

2. pUC18 uncut

3. pUC18/*Bam*HI

4. 909/ *Nde*I

5. 909/*Sca*I

6. 909/*Pvu*II

7. 909/*Pvu*II+*Sca*I

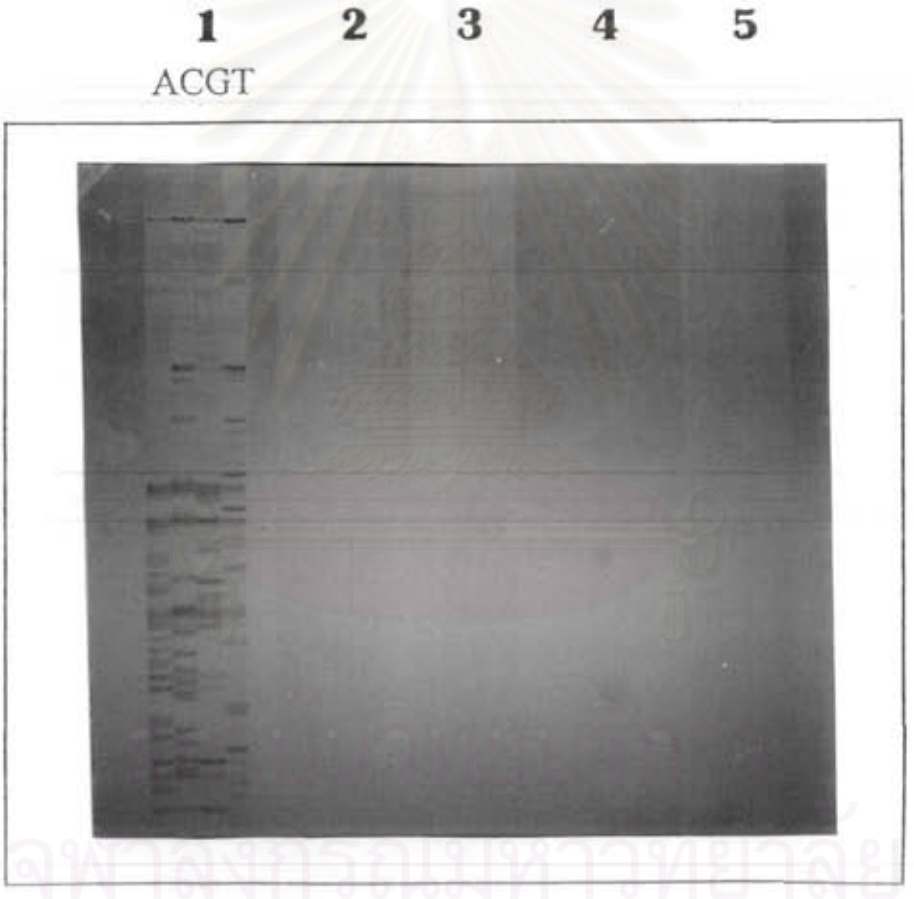
8. 909 uncut

9. 909/*Eco*RI

10. 909/*Hin*dIII

APPENDIX N

DNA sequencing of pUC18 and plasmid 909, using synthetic oligonucleotide probes as primers as well as universal forward and reverse primer



Lane 1. pUC18 with universal forward primer

2-5. 909 with universal forward primer , reverse primer, PNB, and PCC, respectively.

BIOGRAPHY

Mr. Surasak Laloknam was born on May 23 (1972) in Bangkok, Thailand. He graduated with a Bachelor of Science Degree in Biology Faculty of Science, Srinakarinwirot at Bangkhen in 1995. He was enrolled in the M.Sc.Biochemistry Program since 1995.