博士論文（要約）
糖誘導性プロモーターを用いた植物による異種タンパク質生産系の開発に関する研究

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もくじ

本博士論文の 2、3、4 章はそれぞれ Plant Biotechnology に投稿中および投稿予定であるため公表できない。公表できない。また 1 章と 5 章の記述についても、各投稿論文に引用するため公表できない。5 年以内に出版予定。よってそれ以外の箇所のみを要約として公表する。

20 世紀に確立した遺伝子工学技術は瞬く間に世界中に広がり、様々な産業に応用されて我々の生活を支えている。植物の遺伝子組換え技術は 1983 年に確立して以降、世界中で研究が進められており、2014 年の時点で開発された遺伝子組換え植物、所謂遺伝子組換え作物（GMO）、は主に 2 つのグループに分類されている。1 つ目は病原菌、害虫、除草剤に耐性を示す、第 1 世代の GMO である。第 1 世代の GMO は、農薬散布の労力の軽減や収量の向上など、主に生産者側の利益を目的とした形質を示し、トウモロコシやダイズ、などの国際商用作物を中心に既に実用化されている。2 つ目は植物の物質生産能力を利用して、社会の役に立つ有用物質を生産する形質を導入した第 2 世代の GMO である。

植物の遺伝子組換えに用いられているプロモーターはリフラワーモザイクウイルスの 35SRNA プロモーター（35S）の様に植物体全体で常に遺伝子発現を誘導する常時発現型プロモーターである。常時発現型プロモーターはその利便性から第 1、2 世代の GMO の開発にも用いられているが、遺伝子の常時発現は、①宿主植物の代謝を乱す、③宿主植物の成長抑制や形態異常が誘導される、などの指摘もある。そのため、常時発現型プロモーターの代わりに、導入した遺伝子の発現を特定条件下のみに調節する特異的プロモーターの使用が検討されている。

本研究では、植物バイオリアクターの開発に用いるプロモーターとして、植物の代謝糖であるスクロース誘導性のプロモーターに着目した。スクロースはソース器官で生合成されてシンク器官を含めて植物体全体へと輸送される。そのため、スクロース誘導性プロモーターは、植物組織にスクロース処理を施すことにより宿主植物体全体で遺伝子の発現誘導が可能だと予想される。本研究ではスクロース誘導性プロモーターとして、サツマイモ塊根の貯蔵タンパク質であり、スクロース濃度の向上と共に発現することが解明されているスポラミンのプロモーターの最小領域 Spo^{min} を採用した。また、Spo^{min} によって発現誘導させるタンパク質としてレポータータンパク質である GUS を採用した。Spo^{min} と GUS の発現コンストラクトを植物に導入して、スクロース処理による GUS の発現パターンを解析し、Spo^{min} が植物バイオリアクターの開発に有用な

プロモーターであるか調べることを目的とした。

2章では、世界で始めて遺伝子組換え植物体の作成系が確立され、また組換えが他の植物種に比べて容易であると言われているタバコ属の植物である*Nicotiana plumbaginifolia*を材料に、Spo^{min}によるGUS発現がスクロース溶液処理によって誘導可能であるかを検討した。

3 章では Spo^{min} による毛状根を用いた。毛状根は、①分枝が激しく生育が旺盛な根である、②植物体に比べて増殖が早い、③カルスと異なり、遺伝的に組換えが起こり難く、安定している、④生合成した物質を培地中へ漏出する、⑤微生物や培養細胞の様に醗酵培養槽を用いた長期間の大量培養が可能である、などの特徴がある。つまり、毛状根は植物バイオリアクターの開発に非常に有用な道具だと考えられる。

4 章では食用作物であるサツマイモを用いて、Spo^{min} による物質生産系の開発を目指した。サツマイモの特徴としては、①単位面積当たりの収量が多い（イネの約 3 倍の約 13.4 t/ha）、②主要栽培地域である熱帯から北海道の様な亜寒帯まで栽培可能である、③デンプン、タンパク質、糖、を蓄積する塊根を作る、④塊根以外の部位も食用および飼料用として利用可能である、⑤他の作物に比べて花が咲き難い為、花粉拡散の防除が容易である、⑥生食可能な品種もある、などの特徴がある。つまり、サツマイモは遺伝子組換え体を作成するための植物として非常に魅力的である。そこで 2 章で *N. plumbaginifolia* に導入した Spo^{min} コンストラクトをサツマイモの食用栽培品種高系 14 号に導入して、スクロース溶液処理によって GUS を高発現するサツマイモバイオリアクターの確立を目指した。

資料

Adachi T, Wang X, Murata T, Obara M, Akutsu H, Machida M, Umezawa A, Tomita M. 2010 Production of a non-triple helical collagen alpha chain in transgenic silkworms and its evaluation as a gelatin substitute for cell culture. Biotechnol. Bioeng. 106: 860-870.

Ahmadi N, Dellerme S, Laplaze L, Guermache F, Auguy F, Duhoux E, Bogusz D, Guiderdoni E, Franche C. 2003 The promoter of a metallothionein-like gene from the tropical tree *Casuarina glauca* is active in both annual dicotyledonous and monocotyledonous plants. Transgenic Res. 12: 271-281.

Aida R, Narumi T, Ohtsubo N, Yamaguchi H, Kato K, Shinmyo A, Shibata M. 2008 Improved translation efficiency in chrysanthemum and torenia with a translational enhancer derived from the tobacco *alcohol dehydrogenase* gene. Plant Biotechnol. 25: 69-75.

Aksenovaa N P, Konstantinovaa T N, Golyanovskayaa S A, Sergeevaa L I, Romanova G A. 2012　Hormonal Regulation of Tuber Formation in Potato Plants. Russ. J. Plant Physiol. 59: 451-466.

Alabadí D, Blázquez M A, Carbonell J, Ferrándiz C, Pérez-Amador M A. 2009 Instructive roles for hormones in plant development. Int. J. Dev. Biol. 53: 1597-1608.

Allison R, Johnston R E, Dougherty W G. 1986 The nucleotide sequence of the coding region of tobacco etch virus genomic RNA: evidence for the synthesis of a single polyprotein. Virology 154: 9-20.

Almasia N I, Narhirñak V, Hopp H E, Vazquez-Rovere C. 2010 Isolation and characterization of the tissue and development-specific potato snakin-1 promoter inducible by temperature and wounding. Electron. J. Biotechnol. 13.

Andrali S S, Sampley M L, Vanderford N L, Ozcan S. 2008 Glucose regulation of insulin gene expression in pancreatic beta-cells. Biochem. J. 415: 1-10.

Anwar N, Kikuchi A, Watanabe K N. 2010 Assessment of somaclonal variation for salinity tolerance in sweet potato regenerated plants. Afr. J. Biotechnol. 9: 7256-7265.

Anwar N, Watanabe K N, Watanabe J A. 2011 Transgenic sweet potato expressing mammalian cytochrome P450. Plant Cell Tiss. Organ. Cult 105: 219-231.

Arakawa T, Chong D K, Langridge W H. 1998a Efficacy of a food plant-based oral cholera toxin B subunit vaccine. Nat.

Biotechnol. 16: 292-297.

Arakawa T, Yu J, Chong D K, Hough J, Engen P C, Langridge W H. 1998b A plant-based cholera toxin B subunit-insulin fusion protein protects against the development of autoimmune diabetes. Nat. Biotechnol. 16: 934-938.

Arruda P. 2012 Genetically modified sugarcane for bioenergy generation. Curr Opin Biotechnol. 23: 315-322.

Atlas of the Biosphere http://www.sage.wisc.edu/atlas/（2014 年 11 月の事典）

Avery O T, Macleod C M, McCarty M. 1944 Studies on the chemical nature of the substance inducing transformation of pneumococcal types. Induction of transformation by a desoxyribonucleic acid fraction isolated from Pneumococcus type III. J. Exp. Med. 79: 137-158.

Ayre B G. 2011 Membrane-transport systems for sucrose in relation to whole-plant carbon partitioning. Mol. Plant. 4: 377-394.

Barman A, Kumar P, Kumar V, Doley R, Ray S K. 2013 Heat shock at 37°C with plasmid ligated at 37°C yields more number of *Escherichia coli* transformants than plasmid ligated at 16°C: a possible role of ligated plasmid conformation during heat shock. Curr. Sci. 104: 747-751.

Battaglia M and Covarrubias A A. 2013 Late Embryogenesis Abundant (LEA) proteins in legumes. Front. Plant. Sci. 4: 190-200.

Benchabane M, Goulet C, Rivard D, Faye L, Gomord V, Michaud D. 2008 Preventing unintended proteolysis in plant protein biofactories. Plant Biotechnol. J. 6: 633-648.

Bhalerao R P, Eklöf J, Ljung K, Marchant A, Bennett M, Sandberg G. 2002 Shoot-derived auxin is essential for early lateral root emergence in *Arabidopsis* seedlings. Plant J. 29: 325-332.

Bijvoet A G, Van Hirtum H, Kroos M A, Van de Kamp E H, Schoneveld O, Visser P, Brakenhoff J P, Weggeman M, van Corven E J, Van der Ploeg A T, Reuser A J. 1999 Human acid alpha-glucosidase from rabbit milk has therapeutic effect in mice with glycogen storage disease type II. Hum. Mol. Genet. 8: 2145-2153.

Borisjuk N V, Borisjuk L G, Logendra S, Petersen F, Gleba Y, Raskin I. 1999 Production of recombinant proteins in plant root exudates. Nat. Biotechnol. 17: 466-469.

Boynton J E, Gillham N W, Harris E H, Hosler J P, Johnson A M, Jones A R, Randolf-Anderson B L, Robertson D, Klein

T M, Shark K B, Sanford J C. 1988. Chloroplast transformation in *Chlamydomonas* with high velocity microprojectiles. Science. 240: 1534-1538.

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.

Castañón S, Martín-Alonso J M, Marín M S, Boga J A, Alonsoa P, Parra F, Ordása R J. 2002 The effect of the promoter on expression of *VP60* gene from rabbit hemorrhagic disease virus in potato plants. Plant Sci. 162: 87-95.

Cernac A and Benning C. 2004 WRINKLED1 encodes an AP2/EREB domain protein involved in the control of storage compound biosynthesis in Arabidopsis. Plant J. 40: 575-585.

Chawla R, Shakya R, Rommens C M. 2012 Tuber-specific silencing of asparagine synthetase-1 reduces the acrylamide-forming potential of potatoes grown in the field without affecting tuber shape and yield. Plant Biotechnol. J. 10: 913-924.

Chen C Y and Shyu A B. 1995 AU-rich elements: characterization and importance in mRNA degradation. Trends Biochem. Sci. 20: 465-470.

Chen F Q, Fu Y, Wang D L, Gao X, Wang L. 2007 The effect of plant growth regulators and sucrose on the micropropagation and microtuberization of *Dioscorea nipponica* Makino. J. Plant Growth Regul. 26: 38-45.

Chen H J, Wang S J, Chen C C, Yeh K W. 2006 New gene construction strategy in T-DNA vector to enhance expression level of sweet potato sporamin and insect resistance in transgenic Brassica oleracea. Plant Sci. 171: 367-374.

Cheng X, Ruyter-Spira C, Bouwmeester H. 2013 The interaction between strigolactones and other plant hormones in the regulation of plant development. Front. Plant Sci. 4:199.

Chiesa M A, Ruiz O A, Sánchez D H. 2004 Lotus hairy roots expressing inducible arginine decarboxylase activity. Biotechnol. Lett. 26: 729-733.

Christensen B, Müller R. 2009 The Use of Agrobacterium rhizogenes and its rol -Genes for Quality Improvement in Ornamentals. Europ.J.Hort.Sci. 74: 275-287.

Costa C N M,Brígida A B S, Borges B N, Neto M A M, Carvalho L J C B, de Souza C R B. 2011 Levels of MeLEA3, a cDNA Sequence Coding for an Atypical Late Embryogenesis Abundant Protein in Cassava, Increase Under In Vitro Salt Stress Treatment. Plant Mol. Biol. Rep. 29: 997-1005.

De Guzman G, Walmsley A M, Webster D E, Hamill J D. 2012 Use of the wound-inducible NtQPT2 promoter from Nicotiana tabacum for production of a plant-made vaccine. Biotechnol. Lett. 34: 1143-1150.

Demain A L and Vaishnav P. 2009 Production of recombinant proteins by microbes and higher organisms. Biotechnol. Adv. 27: 297-306.

Derksen H, Rampitsch C, Daay F. 2007 Signaling cross-talk in plant disease resistance. Plant Sci. 207: 79-87.

Deryabin A N, Trunova T I, Dubinina I M, Burakhanova E A, Sabel'nikova E P, Krylova E M, Romanov G A. 2003 Chilling tolerance of potato plants transformed with a yeast-derived invertase gene under the control of the B33 patatin promoter. Russ. J. Plant Physiol 50: 449-454.

Desoignies N, Legreve A. 2011 In vitro dual culture of *Polymyxa betae* in *Agrobacterium rhizogenes* transformed sugar beet hairy roots in liquid media. J. Eukaryot. Microbiol. 58: 424-425.

Dhital S P and Lim H T. 2012 Microtuberization of Potato (*Solanum tuberosum* L.) as Influenced by Supplementary Nutrients, Plant Growth Regulators, and In Vitro Culture Conditions. Potato Res. 42: 489-498.

Dinant, S. 2008 Phloem, transport between organs and long-distance signalling. C. R. Biol. 331: 334-346.

Donnelly D J, Coleman W K, Coleman S E. 2003 Potato Microtuber Production and Performance: A Review. Amer. J. of Potato Res. 80: 103-115.

Eady C C, Kamoi T, Kato M, Porter N G, Davis S, Shaw M, Kamoi A, Imai S. 2008 Silencing onion lachrymatory factor synthase causes a significant change in the sulfur secondary metabolite profile. Plant Physiol. 147: 2096-2106.

Egea I, Barsan C, Bian W, Purgatto E, Latché A, Chervin C, Bouzayen M, Pech J C. 2010 Chromoplast differentiation: current status and perspectives. Plant Cell Physiol. 51: 1601-1611.

Elkind Y, Edwards R, Mavandad M, Hedrick S A, Ribak O, Dixon R A, Lamb C J. 1990 Abnormal plant development and down-regulation of phenylpropanoid biosynthesis in transgenic tobacco containing a heterologous phenylalanine ammonia-lyase gene. Proc Natl Acad Sci U S A. 87: 9057-9061.

Elson C O and Ealding W. 1984 Generalized systemic and mucosal immunity in mice after mucosal stimulation with cholera toxin. J. Immunol. 132: 2736-2741.

Falcone D and Andrews D W. 1991 Both the 5' untranslated region and the sequences surrounding the start site contribute to efficient initiation of translation in vitro. Mol. Cell Biol. 11: 2656-2664.

Farshad Ashraf M, Abd Aziz M, Abdul Kadir M, Stanslas J, Farokhian E. 2013 In vitro tuberization of *Chlorophytum Borivilianum* Sant & Fern (Safed musli) as influenced by sucrose, CCC and culture systems. Plant Cell Physiol. 54: 1356-1364.

Firek S, Whitelam G C, Draper J. 1994 Endoplasmic reticulum targeting of active modified beta-glucuronidase (GUS) in transgenic tobacco plants. Transgenic Res. 3: 326-331.

Fischer R and Schillberg S (Eds.). 2004 Molecular Farming: Plant-made Pharmaceuticals and Technical Proteins. WILEY-VCH Verlag GmbH & Co., KGaA, Weinheim.

Focks N and Benning C. 1998 *wrinkled1*: A novel, low-seed-oil mutant of Arabidopsis with a deficiency in the seed-specific regulation of carbohydrate metabolism. Plant Physiol. 118: 91-101.

Fraley R T, Rogers S G, Horsch R B, Sanders P R, Flick J S, Adams S P, Bittner M L, Brand L A, Fink C L, Fry J S, Galluppi G R, Goldberg S B, Hoffmann N L, Woo S C. Expression of bacterial genes in plant cells. Proc. Natl. Acad. Sci. U S A. 80: 4803-4807.

Finer J J. 1999 Plant protein secretion on tap. Nat. Biotechnol. 17: 427.

Fukutomi D, Yoshinaka K, Kawamoto S, Mitsunari T, Kajita S, Kawai S. 2013 High-level fructooligosaccharide production in transgenic tobacco plants. Plant Biotechnol. 30: 77-81.

Furuki T, Shimizu T, Kikawada T, Okuda T, Sakurai M. 2011 Salt Effects on the structural and thermodynamic properties of a group 3 LEA protein model peptide. Biochemistry. 50: 7093-7103.

Gallie D R, Sleat D E, Watts J W, Turner P C, Wilson T M. 1987 The 5'-leader sequence of tobacco mosaic virus RNA enhances the expression of foreign gene transcripts in vitro and in vivo. Nucleic Acids Res. 15: 3257-3273.

Gallie D R, Tanguay R L, Leathers V. 1995 The tobacco etch viral 5' leader and poly(A) tail are functionally synergistic regulators of translation. Gene 165: 233-238.

Gardner M J, Hal N, Fung E, White O, Berriman M, Hyman R W, Carlton J M, Pain A, Nelson K E, Bowman S, Paulsen I T, James K, Eisen J A, Rutherford K, Salzberg S L, Craig A, Kyes S, Chan M S, Nene V, Shallom S J, Suh B, Peterson J, Angiuoli S, Pertea M, Allen J, Selengut J, Haft D, Mather M W, Vaidya A B, Martin D M, Fairlamb A H, Fraunholz M

J, Roos D S, Ralph S A, McFadden G I, Cummings L M, Subramanian G M, Mungall C, Venter J C, Carucci D J, Hoffman S L, Newbold C, Davis R W, Fraser C M, Barrell B. 2002 Genome sequence of the human malaria parasite *Plasmodium falciparum*. Nature 419: 498-511.

Gatz C. 1996 Chemically inducible promoters in transgenic plants. Curr. Opin. Biotechnol. 7: 168-172.

Gnanasambandam A, Polkinghorne I G, Birch R G. 2007 Heterologous signals allow efficient targeting of a nuclear-encoded fusion protein to plastids and endoplasmic reticulum in diverse plant species. Plant Biotechnol. J. 5: 290-296.

Gomord V and Faye L. 2004 Posttranslational modification of therapeutic proteins in plants. Curr. Opin. Plant Biol. 7: 171-181.

Gomord V, Fitchette A C, Menu-Bouaouiche L, Saint-Jore-Dupas C, Plasson C, Michaud D, Faye L. 2010 Plant-specific glycosylation patterns in the context of therapeutic protein production. Plant Biotechnol. J. 8: 564-587.

Goto F, Yoshihara T, Shigemoto N, Toki S, Takaiwa F. 1999 Iron fortification of rice seed by the soybean ferritin gene. Nat. Biotechnol. 17: 282-286.

Gould J, Devey M, Hasegawa O, Ulian E C, Peterson G, Smith R H. 1991 Transformation of *Zea mays* L. Using *Agrobacterium tumefaciens* and the Shoot Apex. Plant Physiol. 95: 426-434.

Griffith F. 1928 The Significance of Pneumococcal Types. J. Hyg. (Lond) 27: 113-159.

Guan Z J, Guo B, Huo Y L, Guan Z P, Dai J K, Wei Y H. 2013 Recent advances and safety issues of transgenic plant-derived vaccines. Appl. Microbiol. Biotechnol. 97: 2817-2840.

Häkkinen S T, Raven N, Henquet M, Laukkanen M L, Anderlei T, Pitkänen J P, Twyman R M, Bosch D, Oksman-Caldentey K M, Schillberg S, Ritala A. 2014 Molecular farming in tobacco hairy roots by triggering the secretion of a pharmaceutical antibody. Biotechnol. Bioeng. 111: 336-346.

Han S I, Aramata S, Yasuda K, Kataoka K. 2007 MafA stability in pancreatic beta cells is regulated by glucose and is dependent on its constitutive phosphorylation at multiple sites by glycogen synthase kinase 3. Mol. Cell Biol. 27: 6593-6605.

Harbers M. 2014 Wheat germ systems for cell-free protein expression. FEBS Lett. 588: 2762-2773.

Hamorsky K T, Kouokam J C, Bennett L J, Baldauf K J, Kajiura H, Fujiyama K, Matoba N. 2013 Rapid and scalable plant-based production of a cholera toxin B subunit variant to aid in mass vaccination against cholera outbreaks. PLoS Negl. Trop. Dis. 7: e2046.

Hattori T, Fukumoto H, Nakagawa S, Nakamura K. 1991 Sucrose-induced expression of genes coding for tuberous root storage protein, sporamin, of sweet potato in leaves and petioles. Plant Cell Physiol. 32: 79-86.

Haas I G and Wabl M. 1983. Immunoglobulin heavy chain binding protein. Nature. 306: 387-389.

Hattori T, Matsuoka K, Nakamura K. 1988. Subcellular localization of the sweet potato tuberous root storage protein. Agric. Biol. Chem. 52: 1057-1059.

Hattori T, Nakagawa S, Nakamura K. 1990 High-level expression of tuberous root storage protein genes of sweet potato in stems of plantlets grown in vitro on sucrose medium. Plant Mol. Biol. 14: 595-604.

Hattori T and Nakamura K. 1988 Genes coding for the major tuberous root protein of sweet potato: Identification of putative regulatory sequence in the 5' upstream region. Plant Mol. Biol. 11: 417-426.

Hattori T, Yoshida N, Nakamura K. 1989 Structural relationship among the members of a multigene family coding for the sweet potato tuberous root storage protein. Plant Mol. Biol. 13: 563-572.

Hershey A D, Chase M. 1952 Independent functions of viral protein and nucleic acid in growth of bacteriophage. J. Gen. Physiol. 36: 39-56.

Hiatt A, Cafferkey R, Bowdish K. 1989 Production of antibodies in transgenic plants. Nature 342: 76-78.

Hirai T, Kurokawa N, Duhita N, Hiwasa-Tanase K, Kato K, Kato K, Ezura H. 2011a The HSP terminator of *Arabidopsis thaliana* induces a high level of miraculin accumulation in transgenic tomatoes. J. Agric. Food Chem. 59: 9942-9949.

Hirai T, Kim Y W, Kato K, Hiwasa-Tanase K, Ezura H. 2011b Uniform accumulation of recombinant miraculin protein in transgenic tomato fruit using a fruit-ripening-specific E8 promoter. Transgenic Res. 20: 1285-1292.

Hiwasa-Tanase K, Nyarubona M, Hirai T, Kato K, Ichikawa T, Ezura H. 2011 High-level accumulation of recombinant miraculin protein in transgenic tomatoes expressing a synthetic miraculin gene with optimized codon usage terminated by the native miraculin terminator. Plant Cell Rep. 30: 113-124.

Holden M J, Levine M, Scholdberg T, Haynes R J, Jenkins G R. 2010 The use of 35S and Tnos expression elements in the measurement of genetically engineered plant materials. Anal. Bioanal. Chem. 396: 2175-2187.

Hong Y F, Liu C Y, Cheng K J, Hour A L, Chan M T, Tseng T H, Chen K Y, Shaw J F, Yu S M. 2008 The sweet potato sporamin promoter confers high-level phytase expression and improves organic phosphorus acquisition and tuber yield of transgenic potato. Plant Mol. Biol. 67: 347-361.

Honma Y and Yamakawa T. 2014 International Association for Plant Biotechnology Congress 2014 ANALYSIS OF GUS GENE EXPRESSION DRIVEN BY SUGAR INDUCIBLE MINIMAL PROMOTER IN TRANSGENIC SWEET POTATO.

Houdebine L M. 2000 Transgenic animal bioreactors. Transgenic Res. 9: 305-320.

Houdebine L M. 2009 Production of pharmaceutical proteins by transgenic animals. Comp. Immunol. Microbiol. Infect. Dis. 32: 107-121.

Huet Y, Ekouna J P, Caron A, Mezreb K, Boitel-Conti M, Guerineau F. 2014 Production and secretion of a heterologous protein by turnip hairy roots with superiority over tobacco hairy roots. Biotechnol. Lett. 36: 181-190.

Hughes E H, Hong S B, Shanks J V, San K Y, Gibson S I. 2002 Characterization of an inducible promoter system in *Catharanthus roseus* hairy roots. Biotechnol. Prog. 18: 1183-1186.

Ibl V, Stoger E. 2012 The formation, function and fate of protein storage compartments in seeds. Protoplasma 249: 379-392.

Ionkova I, Sasheva P, Ionkov T, Momekov G. 2013 Linum narbonense: A new valuable tool for biotechnological production of a potent anticancer lignan Justicidine B. Pharmacogn. Mag. 9: 39-44.

Ishihara K, Satoh I, Nittoh T, Kanaya T, Okazaki H, Suzuki T, Koyama T, Sakamoto T, Ide T, Ohuchi K. 1999 Preparation of recombinant rat interleukin-5 by baculovirus expression system and analysis of its biological activities. Biochim. Biophys. Acta. 1451: 48-58.

Ishikawa K, Kamada H, Yamaguchi I, Takahashi N, Harada H. 1988 Morphology and Hormone Levels of Tobacco and Carrot Tissues Transformed by *Agrobacterium tumefaciens* I. Auxin and Cytokinin Contents of Cultured Tissues Transformed with Wild-Type and Mutant Ti Plasmids. Plant Cell Physiol. 29: 461-466.

Ishizaki T, Maruyama K, Obara M, Fukutani A, Yamaguchi-Shinozaki K, Ito Y, Kumashiro T. 2013 Expression of Arabidopsis DREB1C improves survival, growth, and yield of upland New Rice for Africa (NERICA) under drought.

Mol. Breeding 31: 255-264.

Islam M M, Hossain M A, Jannat R, Munemasa S, Nakamura Y, Mori I C, Murata Y. 2010 Cytosolic alkalization and cytosolic calcium oscillation in Arabidopsis guard cells response to ABA and MeJA. Plant Cell Physiol. 51: 1721-1730.

Itakura K, Hirose T, Crea R, Riggs A D, Heyneker H L, Bolivar F, Boyer H W. 1977 Expression in *Escherichia coli* of a chemically synthesized gene for the hormone somatostatin. Science. 198: 1056-1063.

Ishii T, Beppu A, Nakanishi A, Moriki H, Yasuda K, Tabara N, Yamanaka N. 2012 Detection of Ipomeamarone in Feed Sweet Potatoes on the Poisoning by Moldy Sweet Potatoes. J. Jpn. Vet. Med. Assoc. 65: 355-359.

Iturriaga G, Jefferson R A, Bevan M W. 1989 Endoplasmic reticulum targeting and glycosylation of hybrid proteins in transgenic tobacco. Plant Cell. 1: 381-390.

Iwashita K, Terado S, Kawauchi M, Toyoura R. 2014 New sorbitol inducible promoter useful for inducing desired gene expression contains DNA of specified base pair sequence, or DNA having promoter activity and capable inducing gene expression in presence of sorbitol. JP2014093954-A.

Jackson D A ,Symons R H, Berg P. 1970 Biochemical method for inserting new genetic information into DNA of Simian Virus 40: circular SV40 DNA molecules containing lambda phage genes and the galactose operon of *Escherichia coli*. Proc. Natl. Acad. Sci. U S A. 69: 2904-2909.

Jang I C, Oh S J, Seo J S, Choi W B, Song S I, Kim C H, Kim Y S, Seo H S, Choi Y D, Nahm B H, Kim J K. 2003 Expression of a bifunctional fusion of the *Escherichia coli* genes for trehalose-6-phosphate synthase and trehalose-6-phosphate phosphatase in transgenic rice plants increases trehalose accumulation and abiotic stress tolerance without stunting growth. Plant Physiol. 131: 516-524.

Jänne J, Hyttinen J M, Peura T, Tolvanen M, Alhonen L, Halmekytö M. 1992 Transgenic animals as bioproducers of therapeutic proteins. Ann. Med. 24: 273-280.

Jefferson R A, Kavanagh T A, Bevan M W. 1987 GUS fusions: beta-glucuronidase as a sensitive and versatile gene fusion marker in higher plants. EMBO J. 6: 3901-3907.

Jin M and Klionsky D J. 2014 Regulation of autophagy: modulation of the size and number of autophagosomes. FEBS Lett. 588: 2457-2463.

Jing G, Wang J J, Zhang S X. 2012 ER stress and apoptosis: a new mechanism for retinal cell death. Exp. Diabetes Res. 2012: 589589-589600.

Jobling S A and Gehrke L. 1987 Enhanced translation of chimaeric messenger RNAs containing a plant viral untranslated leader sequence. Nature 325: 622-625.

Joung Y H, Youm J W, Jeon J H, Lee B C, Ryu C J, Hong H J, Kim H C, Joung H, Kim H S. 2004 Expression of the hepatitis B surface S and preS2 antigens in tubers of Solanum tuberosum. Plant Cell Rep. 22: 925-930.

Kajiura H, Wasai M, Kasahara S, Takaiwa F, Fujiyama K. 2013 N-glycosylation and N-glycan moieties of CTB expressed in rice seeds. Mol. Biotechnol. 54: 784-794.

Kamada H, Okamura N, Satake M, Harada H, Shimomura K. 1986 Alkaloid production by hairy root cultures in *Atropa belladonna*. Plant Cell Rep. 5: 239-242.

Kang T J, Kim B G, Yang J Y, Yang M S. 2006 Expression of a synthetic cholera toxin B subunit in tobacco using ubiquitin promoter and bar gene as a selectable marker. Mol. Biotechnol. 32: 93-100.

Kanamori Y, Saito A, Hagiwara-Komoda Y, Tanaka D, Mitsumasu K, Kikuta S, Watanabe M, Cornette R, Kikawada T, Okuda T. 2010 The trehalose transporter 1 gene sequence is conserved in insects and encodes proteins with different kinetic properties involved in trehalose import into peripheral tissues. Insect Biochem. Mol. Biol. 40: 30-37.

Kato T, Kajikawa M, Maenaka K, Park E Y. 2010 Silkworm expression system as a platform technology in life science. Appl. Microbiol. Biotechnol. 853: 459-470.

Kawakatsu T, Takaiwa F. 2010 Cereal seed storage protein synthesis: fundamental processes for recombinant protein production in cereal grains. Plant Biotechnol. J. 8: 939-953.

Ketchum R E B, Warren R S, Klima L J, Lopez-Gutiérrez F, Nabors M W. 1991 The mechanism and regulation of proline accumulation in suspension cell cultures of the halophytic grass *Distichlis spicata* L. J. Plant Physiol. 137: 368-374.

Kelly T J Jr and Smith H O. 1970 A restriction enzyme from *Hemophilus influenzae*. II. J. Mol. Biol. 51: 393-409.

Kim D H, Jin Y H, Jung E A, Han M J, Kobashi K. 1995 Purification and characterization of beta-glucuronidase from *Escherichia coli* HGU-3, a human intestinal bacterium. Biol. Pharm. Bull. 18: 1184-1188.

Kim K Y, Kwon S Y, Lee H S, Hur Y, Bang J W, Kwak S S. 2003 A novel oxidative stress-inducible peroxidase promoter from sweetpotato: molecular cloning and characterization in transgenic tobacco plants and cultured cells. Plant Mol. Biol. 51: 831-838.

Kim S Y, May G D, Park W D. 1994 Nuclear protein factors binding to a class I patatin promoter region are tuber-specific and sucrose-inducible. Plant Mol. Biol. 26: 603-615.

Kim T W, Goo Y M, Lee C H, Lee B H, Bae J M, Lee S W. 2009 The sweet potato ADP-glucose pyrophosphorylase gene (*ibAGP1*) promoter confers high-level expression of the GUS reporter gene in the potato tuber. C. R. Biol. 332: 876-885.

Kim Y-W, Hirai T, Kato K, Hiwasa-Tanase K, Ezura H. 2010. Gene dosage and genetic background affect miraculin accumulation in transgenic tomato fruits. Plant Biotechnol. 27: 333-338.

Kikawada T, Nakahara Y, Kanamori Y, Iwata K, Watanabe M, McGee B, Tunnacliffe A, Okuda T. 2006 Dehydration-induced expression of LEA proteins in an anhydrobiotic chironomid. Biochem. Biophys. Res. Commun. 15: 56-61.

Kim I-J, Lee J, Han J-A, Kim C-S, Hur Y. 2011 Citrus *Lea* promoter confers fruit-preferential and stressinducible gene expression in *Arabidopsis*. Can. J. Plant Sci. 91: 459-466.

Kleiger G, Mayor T. 2014 Perilous journey: a tour of the ubiquitin–proteasome system. Trends Cell Biol. 24: 352-359.

Kowyama Y, Hattori T, Asahi T, Nakamura K 1992 Sweetpotato Technology forthe 21st Century. ed by Hill A W, Bonsi C K, Loretan P A. Tuskegee University. 72-77.

Ku S, Zheng H, Park M S, Ji G E. 2011. Optimization of β-Glucuronidase Activity from *Lactobacillus delbrueckii* Rh2 and Its Use for Biotransformation of Baicalin and Wogonoside. J. Korean Soc. Appl. Biol. Chem. 54: 275-280.

Kubo T, Mori G, Oda M. 2005 Factors Affecting the Formation and Growth of Microtubers in *Zantedeschia* Plantlets. J. Japan. Soc. Hort. Sci. 74: 47-50.

Kues W A and Niemann H. 2004 The contribution of farm animals to human health. Trends Biotechnol. 22: 286-294.

Kurihara H, Sezutsu H, Tamura T, Yamada K. 2007 Production of an active feline interferon in the cocoon of transgenic silkworms using the fibroin H-chain expression system. Biochem. Biophys. Res. Commun. 355: 976-980.

Kurusu T, Kuchitsu K, Nakano M, Nakayama Y, Iida H. 2013 Plant mechanosensing and Ca^{2+} transport. Trends Plant Sci. 18: 227-233.

Kusnadi A R, Nikolov Z L, Howard J A. 1997 Production of recombinant proteins in transgenic plants: Practical considerations. Biotechnol. Bioeng. 56: 473-484.

Kwak M S, Noh S A, Oh M J, Huh G H, Kim K N, Lee S W, Shin J S, Bae J M. 2006 Two sweetpotato ADP-glucose pyrophosphorylase isoforms are regulated antagonistically in response to sucrose content in storage roots. Gene. 366: 87-96.

Lagrimini L M, Bradford S, Rothstein S. 1990 Peroxidase-Induced Wilting in Transgenic Tobacco Plants. Plant Cell. 2: 7-18.

Lee S K, Hwang S K, Han M, Eom J S, Kang H G, Han Y, Choi S B, Cho M H, Bhoo S H, An G, Hahn T R, Okita T W, Jeon J S. 2007 Identification of the ADP-glucose pyrophosphorylase isoforms essential for starch synthesis in the leaf and seed endosperm of rice (*Oryza sativa* L.). Plant Mol. Biol. 65: 531-546.

Lee K T, Chen S C, Chiang B L, Yamakawa T. 2007 Heat-inducible production of beta-glucuronidase in tobacco hairy root cultures. Appl. Microbiol. Biotechnol. 73: 1047-1053.

Lee K-T, Suzuki T, Yamakawa T, kodama T, Igarashi Y, Shimomura K. 1999 Production of tropane alkaloids by transformed root cultures of *Atropa belladonna* in stirred bioreactors with a stainless steel net. Plant Cell Rep. 18: 567-571.

Liang J, Zhou M, Zhou X, Jin Y, Xu M, Lin J. 2013 JcLEA, a novel LEA-like protein from Jatropha curcas, confers a high level of tolerance to dehydration and salinity in *Arabidopsis thaliana*. PLoS One. 8: e83056.

Linsmaier E M and Skoog F. 1965 Organic Growth Factor Requirements of Tobacco Tissue Cultures. Physiol. Plant. 18: 100-127.

Lillico S G, McGrew M J, Sherman A, Sang H M. 2005 Transgenic chickens as bioreactors for protein-based drugs. Drug Discov. Today. 10: 191-196.

Liu C, Towler M J, Medrano G, Cramer C L, Weathers P J. 2009 Production of mouse interleukin-12 is greater in tobacco hairy roots grown in a mist reactor than in an airlift reactor. Biotechnol. Bioeng. 102: 1074-1086.

Liu M S, Chien C T, Lin T P. 2008 Constitutive components and induced gene expression are involved in the desiccation tolerance of *Selaginella tamariscina*. Plant Cell Physiol. 49: 653-663.

Liu X J, Prat S, Willmitzer L, Frommer W B. 1990 *Cis* regulatory elements directing tuber-specific and sucrose-inducible expression of a chimeric class I patatin promoter/GUS-gene fusion. Mol. Gen. Genet. 223: 401-406.

Liu Y, Liu M, Li X, Cao B, Ma X. 2014 Identification of differentially expressed genes in leaf of *Reaumuria soongorica* under PEG-induced drought stress by digital gene expression profiling. PLoS One. 9: e94277.

Lloyd A M, Barnason A R, Rogers S G, Byrne M C, Fraley R T, Horsch R B. 1986 Transformation of *Arabidopsis thaliana* with *Agrobacterium tumefaciens*. Science 234: 464-466.

Lyu J I, Min S R, Lee J H, Lim Y H, Kim J-K, Bae C-H, Liu J R. 2012 Overexpression of a trehalose-6-phosphate synthase/phosphatase fusion gene enhances tolerance and photosynthesis during drought and salt stress without growth aberrations in tomato. Plant Cell Tiss. Organ Cult. 112: 257-262.

Ma J K, Hiatt A, Hein M, Vine N D, Wang F, Stabila P, van Dolleweerd C, Mostov K, Lehner T. 1995 Generation and assembly of secretory antibodies in plants. Science 268: 716-719.

Ma J K, Lehner T, Stabila P, Fux C I, Hiatt A. 1994 Assembly of monoclonal antibodies with IgG1 and IgA heavy chain domains in transgenic tobacco plants. Eur. J. Immunol. 24: 131-138.

Maeda S, Kawai T, Obinata M, Fujiwara H, Horiuchi T, Saeki Y, Sato Y, Furusawa M. 1985 Production of human alpha-interferon in silkworm using a baculovirus vector. Nature 315: 592-594.

Maeo K, Tomiya T, Hayashi K, Akaike M, Morikami A, Ishiguro S, Nakamura K. 2001 Sugar-responsible elements in the promoter of a gene for beta-amylase of sweet potato. Plant Mol. Biol. 46: 627-637.

Maeshima M, Sasaki T, Asahi T. 1985 Characterization of major proteins in sweet potato tuberous roots. Phytochemistry 24: 1899-1902.

Makanae K, Kintaka R, Makino T, Kitano H, Moriya H. 2013 Identification of dosage-sensitive genes in *Saccharomyces cerevisiae* using the genetic tug-of-war method. Genome Res. 23: 300-311.

Mano Y, Nabeshima S, Matsui C, Ohkawa H. 1986 Production of Tropane Alkaloids by Hairy Root Cultures of *Scopolia japonica*. Agric. Biol. Chem. 50: 2715-2722.

Mariscal A, Gómez-Aracena J, Varo M C, Fernández-Crehuet J. 1998 Interference by carbohydrate substrates, flavonoids, and monosaccharide derivatives on bacterial beta-D-glucuronidase assays. Arch. Environ. Contam. Toxicol. 35: 588-593.

Martin T, Woehner R V, Hummel S, Willmitzer L, Frommer W B. 1992 The GUS reporter system as a tool to study plant gene expression. In: Gallagher SR (eds) GUS protocols: using the GUS gene as a reporter of gene expression Academic Press, London, pp 23-43.

Maruyama D, Endo T, Nishikawa S. 2010 BiP-mediated polar nuclei fusion is essential for the regulation of endosperm nuclei proliferation in *Arabidopsis thaliana*. Proc. Natl. Acad. Sci. U S A. 107: 1684-1689.

Masaki T, Mitsui N, Tsukagoshi H, Nishii T, Morikami A, Nakamura K. 2005a ACTIVATOR of Spomin::LUC1/WRINKLED1 of *Arabidopsis thaliana* transactivates sugar-inducible promoters. Plant Cell Physiol. 46: 547-556.

Masaki T, Tsukagoshi H, Mitsui N, Nishii T, Hattori T, Morikami A, Nakamura K. 2005b Activation tagging of a gene for a protein with novel class of CCT-domain activates expression of a subset of sugar-inducible genes in *Arabidpsis thaliana*. Plant J. 43: 142-152.

Masuda H, Usuda K, Kobayashi T, Ishimaru Y, Kakei Y, Takahashi M, Higuchi K, Nakanishi H, Mori S, Nishizawa N K. 2009 Overexpression of the Barley Nicotianamine Synthase Gene *HvNAS1* Increases Iron and Zinc Concentrations in Rice Grains. Rice 2: 155-166.

Matsui T, Asao H, Ki M, Sawada K, Kato K. 2009 Transgenic lettuce producing a candidate protein for vaccine against edema disease. Biosci. Biotechnol. Biochem. 73: 1628-1634.

Matsui T, Takita E, Sato T, Aizawa M, Ki M, Kadoyama Y, Hirano K, Kinjo S, Asao H, Kawamoto K, Kariya H, Makino S, Hamabata T, Sawada K, Kato K. 2011 Production of double repeated B subunit of Shiga toxin 2e at high levels in transgenic lettuce plants as vaccine material for porcine edema disease. Transgenic Res. 20: 735-748.

Matsuoka K, Watanabe N, Nakamura K. 1995 O-glycosylation of a precursor to a sweet potato vacuolar protein, sporamin, expressed in tobacco cells. Plant J. 8: 877-889.

Matsumoto Y, Suzuki S, Nozoye T, Yamakawa T, Takashima Y, Arakawa T, Tsuji N, Takaiwa F, Hayashi Y. 2008 Oral immunogenicity and protective efficacy in mice of transgenic rice plants producing a vaccine candidate antigen (As16) of *Ascaris suum* fused with cholera toxin B subunit. Transgenic Res. 18:185-192.

Matsuoka K, Matsumoto S, Hattori T, Machida Y, Nakamura K, 1990 Vacuolar targeting and post-translational processing of the precursor to the sweet potato tuberous-root storage protein in heterologous plant cells. J. Biol. Chem. 265: 19750-

19767.

Matsuoka K and Nakamura K. 1991 Propeptide of a precursor to a plant vacuolar protein required for vacuolar targeting. Proc. Natl. Acad. Sci. USA 88: 834-838.

Maxmen A. 2012 Drug-making plant blooms. Nature 485: 160.

Mazumder B, Seshadri V, Fox P L. 2003 Translational control by the 3'-UTR: the ends specify the means. Trends Biochem. Sci. 28: 91-98.

McKee C, Gibson A, Dalrymple M, Emslie L, Garner I, Cottingham I. 1998 Production of biologically active salmon calcitonin in the milk of transgenic rabbits. Nat. Biotechnol. 16: 647-651.

Mervat M M El Far, El Mangoury K, Heba E M E. 2009 Novel Plant Regeneration for Egyptian Sweetpotato (*Ipomoea Batatas* (L.) Lam.) Abees Cultivar *via* Indirect Organogenesis Stimulated by Initiation Medium and Cytokinin Effects. Aust. J. Basic. Appl. Sci. 3: 543-551.

Meyers A, Chakauya E, Shephard E, Tanzer F L, Maclean J, Lynch A, Williamson A L, Rybicki E P. 2008 Expression of HIV-1 antigens in plants as potential subunit vaccines. BMC Biotechnol. 8: 53.

Mignery G A, Pikaard C S, Park W D. 1988 Molecular characterization of the patatin multigene family of potato. Gene 62: 27-44.

Mitsumasu K, Kanamori Y, Fujita M, Iwata K, Tanaka D, Kikuta S, Watanabe M, Cornette R, Okuda T, Kikawada T. 2010 Enzymatic control of anhydrobiosis-related accumulation of trehalose in the sleeping chironomid, *Polypedilum vanderplanki*. FEBS J. 277: 4215-4228.

Miura K, Takashima E, Deng B, Tullo G, Diouf A, Moretz S E, Nikolaeva D, Diakite M, Fairhurst R M, Fay M P, Long C A, Tsuboi T. 2013 Functional comparison of *Plasmodium falciparum* transmission-blocking vaccine candidates by the standard membrane-feeding assay. Infect. Immun. 81: 4377-4382.

Miwa Y, Yamamoto K, Onishi A, Iwamoto M, Yazaki S, Haneda M, Iwasaki K, Liu D, Ogawa H, Nagasaka T, Uchida K, Nakao A, Kadomatsu K, Kobayashi T. 2010 Potential value of human thrombomodulin and DAF expression for coagulation control in pig-to-human xenotransplantation. Xenotransplantation. 17: 26-37.

Moreno A A and Orellana A. 2011 The physiological role of the unfolded protein response in plants. Biol. Res. 44: 75-80.

Mori K. 2000 Tripartite management of unfolded proteins in the endoplasmic reticulum. Cell. 101: 451-454.

Morikami A, Masaki T, Tsukagoshi H, Mitsui N, Maeo K, Nakamura, K. 2005a Transcription factors for sugar-inducible genes. Plant Biotechnol. 22: 371-378.

Morikami A, Matsunaga R, Tanaka Y, Suzuki S, Mano S, Nakamura K. 2005b Two *cis*-acting regulatory elements are involved in the sucrose-inducible expression of the sporamin gene promoter from sweet potato in transgenic tobacco. Mol. Genet. Genomics. 272: 690-699.

Moriwaki M, Yamakawa T, Washino T, Kodama T, Igarashi Y. 1999a Organ-specific expression of β-glucuronidase activity driven by the *Arabidopsis* heat-shock promoter in heat-stressed transgenic *Nicotiana plumbaginifolia*. Plant Cell Rep. 19: 92-95.

Moriwaki M, Yamakawa T, Washino T, Kodama T, Igarashi, Y. 1999b Delayed recovery of β-glucuronidase activity driven by an *Arabidopsis* heat shock promoter in heat-stressed transgenic *Nicotiana plumbaginifolia*. Plant Cell Rep 19: 96-100.

Mullis K B and Faloona F A. 1987 Specific synthesis of DNA in vitro via a polymerase-catalyzed chain reaction. Methods Enzymol. 155: 335-350.

Nagaya S, Kawamura K, Shinmyo A, Kato K. 2010 The HSP terminator of *Arabidopsis thaliana* increases gene expression in plant cells. Plant Cell Physiol. 51: 328-332.

Nakamura K, Ohto M, Yoshida N, Nakamura K. 1991 Sucrose-induced accumulation of β-amylase occurs concomitant with the accumulation of starch and sporamin in leaf-petiole cuttings of the sweet potato. Plant Physiol. 96: 902-909.

Nakashima K, Yamaguchi-Shinozaki K, Shinozaki K. 2014 The transcriptional regulatory network in the drought response and its crosstalk in abiotic stress responses including drought, cold, and heat. Front. Plant Sci.5: 3389.

Nakatani M. 1994 In Vitro Formation of Tuberous Roots in Sweet Potato. Jpn. J. Crop Sci. 63: 158-159.

Nausch H, Mikschofsky H, Koslowski R, Meyer U, Broer I, Huckauf J. 2012 High-level transient expression of ER-targeted human interleukin 6 in *Nicotiana benthamiana*. PLoS One 7.

Nehls R, Kraus J, Matzk A, Jansen, R. 2010 Transgenic Varieties: Sugarbeet. Sugar Tech 12: 194-200.

Newell C A, Lowe J M, Merryweathera A, Rooke L M, Hamiltona W D O. 1995 Transformation of sweet potato (*Ipomoea* *batatas* (L.) Lam.) with *Agrobacterium tumefaciens* and regeneration of plants expressing cowpea trypsin inhibitor and snowdrop lectin. Plant Sci. 107: 215-227.

Nishijima K and Iijima S. 2013 Transgenic chickens. Dev. Growth Differ. 55: 207-216.

Nishizawa N and Mori S. 1980. Electronmicroscope-autoradiographical evidence for the incorporation of exogenous protein into rice root cells. Plant Cell Physiol. 21: 493-496.

Noh S A, Lee H S, Huh G H, Oh M J, Paek K H, Shin J S, Bae J M. 2012 A sweetpotato *SRD1* promoter confers strong root-, taproot-, and tuber-specific expression in Arabidopsis, carrot, and potato. Transgenic Res. 21: 265-278.

Nochi T, Takagi H, Yuki Y, Yang L, Masumura T, Mejima M, Nakanishi U, Matsumura A, Uozumi A, Hiroi T, Morita S, Tanaka K, Takaiwa F, Kiyono H. 2007 Rice-based mucosal vaccine as a global strategy for cold-chain- and needle-free vaccination. Proc. Natl. Acad. Sci. USA. 104: 10986-10991.

Nozawa A, Ogasawara T, Matsunaga S, Iwasaki T, Sawasaki T, Endo Y. 2011 Production and partial purification of membrane proteins using a liposome-supplemented wheat cell-free translation system. BMC Biotechnol. 11: 35.

Nishiyama Y and Yamakawa T. 2001 Light-controlled expression of β-glucuronidase gene driven by palg2b promoter from *Populus kitakamiensis* in *Nicotiana plumbaginifolia*. Plant Biotechnol. 18: 67-70.

Oey M, Lohse M, Kreikemeyer B, Bock R. 2009 Exhaustion of the chloroplast protein synthesis capacity by massive expression of a highly stable protein antibiotic. Plant J. 57: 436-445.

Ohta S, Hattori T, Morikami A, Nakamura K. 1991 High-level expression of a sweet potato sporamin gene promoter: beta-glucuronidase (GUS) fusion gene in the stems of transgenic tobacco plants is conferred by multiple cell type-specific regulatory elements. Mol. Gen. Genet. 225: 369-378.

Ohto M, Hayashi K, Isobe M, Nakamura K. 1995 Involvement of Ca^{2+} signalling in the sugar-inducible expression of genes coding for sporamin and β-amylase of sweet potato. Plant J. 7: 297-307.

Ohto M and Nakamura K. 1995 Sugar-Induced Increase of Calcium-Dependent Protein Kinases Associated with the Plasma Membrane in Leaf Tissues of Tobacco. Plant Physiol. 109: 973–981.

Ohto M, Nakamura-Kito K, Nakamura K. 1992 Induction of Expression of Genes Coding for Sporamin and β-Amylase by Polygalacturonic Acid in Leaf-Petiole Cuttings of Sweet Potato. Plant Physiol. 99: 422-427.

Okada Y, Saito A, Nishiguchi M, Kimura T, Mori M, Hanada K, Sakai J, Miyazaki C, Matsuda Y, Murata T. 2001 Virus resistance in transgenic sweetpotato [*Ipomoea batatas* L. (Lam)] expressing the coat protein gene of sweet potato feathery mottle virus. Theor. Appl. Genet. 103: 743-751.

Olivier K A, Konan K N, Anike F N, Agbo G N, Dodo H W. 2012 In vitro induction of minitubers in yam (*Dioscorea cayenensis- D. rotundata* complex). Plant Cell Tiss. Organ Cult. 99: 55–59.

Otani M, Mii M, Handa T, Kamadad H, Shimada T. 1993. Transformation of sweet potato (*Ipomoea batatas* (L.) Lam.) plants by *Agrobacterium rhizogenes*. Plant Sci. 94: 151-159.

Otani M, Shimada T, Kimura T, Saito A. 1998 Transgenic Plant Production from Embryogenic Callus of Sweet Potato (*Ipomoea batatas* (L.) Lam.) Using *Agrobacterium tumefaciens*. Plant Biotechnol. 15: 11-16.

Otani M and Shimada T. 1996 Efficient embryogenic callus formation in sweet potato [*Ipomoea batatas* (L.) Lam.]. Breed. Sci. 46: 257-260.

Paine J A, Shipton C A, Chaggar S, Howells R M, Kennedy M J, Vernon G, Wright S Y, Hinchliffe E, Adams J L, Silverstone A L, Drake R. 2005 Improving the nutritional value of Golden Rice through increased pro-vitamin A content. Nat. Biotechnol. 23: 482-487.

Paiva E, Lister R M, Park W D. 1983 Induction and accumulation of major tuber proteins of potato in stems and petioles. Plant Physiol. 71: 161-168.

Paleyanda R K, Velander W H, Lee T K, Scandella D H, Gwazdauskas F C, Knight J W, Hoyer L W, Drohan W N, Lubon H. 1997 Transgenic pigs produce functional human factor VIII in milk. Nat. Biotechnol. 15: 971-975.

Park S-C, Kim Y-H, Jeong J C, Kim C Y, Lee H-S, Bang J-W, Kwak S-S. 2011 Sweetpotato late embryogenesis abundant 14 (*IbLEA14*) gene influences lignification and increases osmotic- and salt stress-tolerance of transgenic calli. Planta 233: 621–634.

Peebles C A, Gibson S I, Shanks J V, San K Y. 2007a Long-term maintenance of a transgenic *Catharanthus roseus* hairy root line. Biotechnol. Prog. 23: 1517-1518.

Peebles C A, Gibson S I, Shanks J V, San K Y. 2007b Characterization of an ethanol-inducible promoter system in *Catharanthus roseus* hairy roots. Biotechnol. Prog. 23: 1258-1260.

Penno C A, Kawabe Y, Ito A, Kamihira M. 2010 Production of recombinant human erythropoietin/Fc fusion protein by genetically manipulated chickens. Transgenic Res. 19: 187-195.

Pelosi A, Piedrafita D, De Guzman G, Shepherd R, Hamill J D, Meeusen E, Walmsley A M. 2012 The effect of plant tissue and vaccine formulation on the oral immunogenicity of a model plant-made antigen in sheep. PLoS One 7: e52907.

Perrone-Bizzozero N and Bolognani F. 2002 Role of HuD and other RNA-binding proteins in neural development and plasticity. J. Neurosci. Res. 68: 121-126.

Petrides D, Sapidou E, Calandranis J. 1995 Computer-aided process analysis and economic evaluation for biosynthetic human insulin production-A case study. Biotechnol. Bioeng. 48: 529-541.

Potenza C, Aleman L, Sengupta-Gopalan, C. 2004 Targeting transgene expression in research, agricultural, and environmental applications: Promoters used in plant transformation. In Vitro Cell. Dev. Biol. 40:1-22.

Prakash C S and Varadarajan U. 1992 Genetic transformation of sweet potato by particle bombardment. Plant Cell Rep. 11: 53-57.

Preiszner J, VanToai T, Huynh L, Bolla R, Yen H. 2001 Structure and activity of a soybean *Adh* promoter in transgenic hairy roots. Plant Cell Rep. 20: 763-769.

Prodromou C and Pearl L H. 1992 Recursive PCR: a novel technique for total gene synthesis. Protein Eng. 5: 827-829.

Rashidi B, Mehrabi S, Demchenko K, Pawlowski K. 2011 The *Casuarina glauca metallothionein I* promoter in nodulated transgenic hairy roots of the actinorhizal plant *Datisca glomerata*. Funct. plant biol. 38: 728-737.

Rapp J C, Harvey A J, Speksnijder G L, Hu W, Ivarie R. 2003 Biologically active human interferon alpha-2b produced in the egg white of transgenic hens. Transgenic Res. 12: 569-575.

Rhodes M J C, Hilton M, Parr A J, Hamill J D, Robins R J. 1986 Nicotine production by "hairy root" cultures of *Nicotiana rustica*: Fermentation and product recovery. Biotech. Lett. 8: 415-420.

Rudolph N S. 1999 Biopharmaceutical production in transgenic livestock. Trends Biotechnol. 17: 367-374.

Ruhlman T, Verma D, Samson N, Daniell H. 2010 The Role of Heterologous Chloroplast Sequence Elements in Transgene Integration and Expression Plant Physiol. 152: 2088-2104.

Saed Taha R, Ismail I, Zainal Z, Abdullah S N. 2012 The stearoyl-acyl-carrier-protein desaturase promoter (*Des*) from oil palm confers fruit-specific GUS expression in transgenic tomato. J. Plant Physiol. 169: 1290-1300.

Sakamoto T, Masuda D, Nishimura K, Ikeshita Y. 2014 Relationship between invertase gene expression and sucrose concentration in the tuberous roots of sweet potato (*Ipomoea batatas* L. Lam.) during cold storage. J. Hortic. Sci. Bio. 89: 229-235.

Sakurai M, Furuki T, Akao K, Tanaka D, Nakahara Y, Kikawada T, Watanabe M, Okuda T. 2008 Vitrification is essential for anhydrobiosis in an African chironomid, *Polypedilum vanderplanki*. Proc. Natl. Acad. Sci. U S A. 105: 5093-5098.

Salleh F M, Evans K, Goodall B, Machin H, Mowla S B, Mur L A, Runions J, Theodoulou F L, Foyer C H, Rogers H J. 2012 A novel function for a redox-related LEA protein (*SAG21*/*AtLEA5*) in root development and biotic stress responses. Plant Cell Environ. 35: 418-429.

Satoh J, Kato K, Shinmyo A. 2004 The 5'-untranslated region of the tobacco *alcohol dehydrogenase* gene functions as an effective translational enhancer in plant. J. Biosci. Bioeng. 98: 1-8.

Satoh R, Nakashima K, Seki M, Shinozaki K, Yamaguchi-Shinozaki K. 2002 ACTCAT, a novel cis-acting element for proline- and hypoosmolarity-responsive expression of the *ProDH* gene encoding proline dehydrogenase in Arabidopsis. Plant Physiol. 130: 709-719.

Sauer N. 2007 Molecular physiology of higher plant sucrose transporters. FEBS Lett. 581: 2309-2317.

Schneider J C and Rosner B. 2009 Mannitol induced promoter systems in bacterial host cells. US 07476532。

Schwember A R. 2008 An update on genetically modified crops. Cienc. Investig. Agrar. 35: 231-250.

Senchi K, Matsunaga S, Hasegawa H, Kimura H, Ryo A. 2013 Development of oligomannose-coated liposome-based nasal vaccine against human parainfluenza virus type 3. Front Microbiol. 4: 346.

Sharp J M and Doran P M. 1999 Effect of bacitracin on growth and monoclonal antibody production by tobacco hairy roots and cell suspensions. Biotechnol. Bioprocess Eng. 4: 253-258.

Shen B, Jensen R G, Bohnert H J. 1997 Increased resistance to oxidative stress in transgenic plants by targeting mannitol biosynthesis to chloroplasts. Plant Physiol. 113: 1177-1183.

Shewry P R. 2003 Tuber storage proteins. Ann. Bot. 91: 755-769.

Shimizu M, Igasaki T, Yamada M, Yuasa K, Hasegawa J, Kato T, Tsukagoshi H, Nakamura K, Fukuda H, Matsuoka K.

2005 Experimental determination of proline hydroxylation and hydroxyproline arabinogalactosylation motifs in secretory proteins. Plant J. 42: 877-889.

Shimomura K, Sudo H, Saga H, Kamada H. 1991. Shikonin production and secretion by hairy root cultures of *Lithospermum erythrorhizon*. Plant Cell Rep. 10: 282-285.

Song G Q, Honda H, Yamaguchi K. 2007 Expression of a rice chlorophyll a/b binding protein promoter in sweet potato. J. Ameri. Soc. Hort. Sci. 132: 1-6.

Streatfield S J, Lane J R, Brooks C A, Barker D K, Poage M L, Mayor J M, Lamphear B J, Drees C F, Jilka J M. 2003 Corn as a production system for human and animal vaccines. Vaccine 21: 812-815.

Sugio T, Matsuura H, Matsui T, Matsunaga M, Nosho T, Kanaya S, Shinmyo A, Kato K. 2010 Effect of the sequence context of the AUG initiation codon on the rate of translation in dicotyledonous and monocotyledonous plant cells. J. Biosci. Bioeng. 109: 170-173.

Sugio T, Satoh J, Matsuura H, Shinmyo A, Kato K. 2008 The 5'-untranslated region of the *Oryza sativa* alcohol dehydrogenase gene functions as a translational enhancer in monocotyledonous plant cells. J. Biosci. Bioeng. 105: 300-302.

Tajima H and Koizumi N. 2006 Induction of BiP by sugar independent of a *cis*-element for the unfolded protein response in *Arabidopsis thaliana*. Biochem. Biophys. Res. Commun. 346: 926-930.

Takahashi H, Takahashi C, Moreland N J, Chang Y T, Sawasaki T, Ryo A, Vasudevan S G, Suzuki Y, Yamamoto N. 2012 Establishment of a robust dengue virus NS3-NS5 binding assay for identification of protein-protein interaction inhibitors. Antiviral Res. 96: 305-314.

Takahashi T, Naito S, Komeda Y. 1992 The *Arabidopsis HSP18.2* promoter/GUS gene fusion in transgenic *Arabidopsis* plants: a powerful tool for the isolation of regulatory mutants of the heat-shock response. Plant J. 2: 751-761.

Takahata Y, Noda T, Nagata T. 1992 Varietal Diversity of Free Sugar Composition in Storage Root of Sweet Potato. Japan. J. Breed 42: 515-521.

Takai K, Sawasaki T, Endo Y. 2010. Practical cell-free protein synthesis system using purified wheat embryos. Nat. Protoc. 5: 227-238.

Takai A, Satoh M, Matsuyama T, Ito A, Nakata R, Aoyama T, Inoue H. 2013 Secretion of miraculin through the function of a signal peptide conserved in the Kunitz-type soybean trypsin inhibitor family. FEBS Lett. 587: 1767-1772.

Takeda S, Mano S, Ohto M, Nakamura K. 1994 Inhibitors of Protein Phosphatases 1 and 2A Block the Sugar-Inducible Gene Expression in Plants. Plant Physiol. 106: 567-574.

Tarczynski M C, Jensen R G, Bohnert H J. 1993 Stress protection of transgenic tobacco by production of the osmolyte mannitol. Science. 259: 508-510.

Todaka D, Nakashima K, Shinozaki K, Yamaguchi-Shinozaki K. 2012 Toward understanding transcriptional regulatory networks in abiotic stress responses and tolerance in rice. Rice 5: 6. Nakashima K, Shinozaki K, Yamaguchi-Shinozaki K. 2012 Toward understanding transcriptional regulatory networks in abiotic stress responses and tolerance in rice. Rice 5: 6.

Tsuboi T, Takeo S, Arumugam T U, Otsuki H, Torii M. 2010 The wheat germ cell-free protein synthesis system: a key tool for novel malaria vaccine candidate discovery. Acta. Trop. 114: 171-176.

Tsuboi T, Takeo S, Iriko H, Jin L, Tsuchimochi M, Matsuda S, Han E T, Otsuki H, Kaneko O, Sattabongkot J, Udomsangpetch R, Sawasaki T, Torii M, Endo Y. 2008 Wheat germ cell-free system-based production of malaria proteins for discovery of novel vaccine candidates. Infect. Immun. 6: 1702-1708.

Tusé D. 2011 Safety of plant-made pharmaceuticals: product development and regulatory considerations based on case studies of two autologous human cancer vaccines. Hum. Vaccin. 7: 322-330.

Tsukagoshi H, Saijo T, Shibata D, Morikami A, Nakamura K. 2005 Analysis of a sugar response mutant of *Arabidopsis thaliana* identified a novel B3 domain protein that functions as an active transcriptional repressor. Plant Physiol. 138: 675-685.

Tsugawa H, Kagami T, Suzuki M. 2004 High-frequency transformation of *Lobelia erinus* L. by *Agrobacterium*-mediated gene transfer. Plant Cell Rep. 22: 759-764.

Ueda Y. 2012 Master Thesis Laboratory of Plant biotechnology Department of Global Agriculturral Sciences Graduated School of Agricultural and Life Sciences The University of Tokyo.

Ueda Y, Sakurai T, Kasama K, Satoh Y, Atsumi K, Hanawa S, Uchino T, Yanai A. 1993 Pharmacokinetic properties of recombinant feline interferon and its stimulatory effect on 2', 5'-oligoadenylate synthetase activity in the cat. J. Vet. Med. Sci. 55: 1-6.

Urade R. 2007 Cellular response to unfolded proteins in the endoplasmic reticulum of plants. FEBS J. 274: 1152-1171.

Vandekerckhove J, Van Damme J, Van Lijsebettens M, Botterman J, De Block M, Vandewiele M, De Clercq A, Leemans J, Van Montagu M, Krebbers E. 1989 Enkephalins Prouduced in Transgenic Plants Using Modified 2S Seed Storage Proteins. Nat. Biotechnol. 7: 929-932.

Verma S S; Chinnusamy V; Asif M; Bansal K C. 2013 Synergistic effect of C2H2 type Zinc-finger protein with LEA promoter to enhance abiotic stress tolerance in *Brassica juncea*. Plant Omics 6: 208-214.

Villordon A Q, Ginzberg I, Firon N. 2014 Root architecture and root and tuber crop productivity. Trends Plant Sci. 19: 419-425.

Vuković R, Bauer N, Curković-Perica M. 2013 Genetic elicitation by inducible expression of β-cryptogein stimulates secretion of phenolics from *Coleus blumei* hairy roots. Plant Sci. 199-200:18-28.

Waditee R, Bhuiyan N H, Rai V, Aoki K, Tanaka Y, Hibino T, Suzuki S, Takano J, Jagendorf A T, Takabe T, Takabe T. 2005 Genes for direct methylation of glycine provide high levels of glycinebetaine and abiotic-stress tolerance in *Synechococcus* and *Arabidopsis*. Proc. Natl. Acad. Sci. U S A. 102: 1318-1323.

Wagner T E, Hoppe P C, Jollick J D, Scholl D R, Hodinka R L, Gault J B. 1981 Microinjection of a rabbit beta-globin gene into zygotes and its subsequent expression in adult. Proc. Natl. Acad. Sci. U S A. 78: 6376-6380.

Wakasa Y, Yasuda H, Oono Y, Kawakatsu T, Hirose S, Takahashi H, Hayashi S, Yang L, Takaiwa F. 2011 Expression of ER quality control-related genes in response to changes in BiP1 levels in developing rice endosperm. Plant J. 65: 675-689.

Wang X G, Zhang G H, Liu C X, Zhang Y H, Xiao C Z, Fang R X. 2001 Purified cholera toxin B subunit from transgenic tobacco plants possesses authentic antigenicity. Biotechnol. Bioeng. 72: 490-494.

Wang Y, Zhao S, Bai L, Fan J, Liu E. 2013 Expression systems and species used for transgenic animal bioreactors. Biomed. Res. Int. 2013: 580463.

Watanabe M, Kikawada T, Okuda T. 2003 Increase of internal ion concentration triggers trehalose synthesis associated with cryptobiosis in larvae of *Polypedilum vanderplanki*. J. Exp. Biol. 206: 2281-2286.

Wenzler H C, Mignery G A, Fisher L M, Park W D. 1989 Analysis of a chimeric class-I patatin-GUS gene in transgenic potato plants: High-level expression in tubers and sucrose-inducible expression in cultured leaf and stem explants. Plant Mol. Biol. 12: 41-50.

Winnick T. 1950 Studies on the mechanism of protein synthesis in embryonic and tumor tissues. II. Inactivation of fetal rat liver homogenates by dialysis, and reactivation by the adenylic acid system. Arch. Biochem. 28: 338-347.

Wise A A, Liu Z, Binns A N. 2006 Three methods for the introduction of foreign DNA into *Agrobacterium*. Methods Mol. Biol. 343: 43-53.

Wei S. 2009 Utility of tetracycline-inducible promoter system in transgenic *Catharanthus roseus* hairy roots. Int. J. Plant Sci. 170: 829-833.

Wongsamuth R, Doran P M. 1997 Production of monoclonal antibodies by tobacco hairy roots. Biotechnol. Bioeng. 54: 401-415.

Woods R R, Geyer B C, Mor T S. 2008 Hairy-root organ cultures for the production of human acetylcholinesterase. BMC Biotechnol. 8: 95.

Wright G, Carver A, Cottom D, Reeves D, Scott A, Simons P, Wilmut I, Garner I, Colman A. 1991 High level expression of active human alpha-1-antitrypsin in the milk of transgenic sheep. Biotechnology (N Y). 9: 830-834.

Wycoff K L. 2005 Secretory IgA antibodies from plants. Curr. Pharm. Des. 11: 2429-2437.

Xiao F-H and Xue G-P. 2001 Analysis of the promoter activity of late embryogenesis abundant protein genes in barley seedlings under conditions of water deficit. Plant Cell Rep. 20: 667–673.

Xu H. 2014 The advances and perspectives of recombinant protein production in the silk gland of silkworm Bombyx mori. Transgenic Res. 23: 697-706.

Xu H, Zhou X, Lu J, Wang J, Wang X. 2006 Hairy roots induced by *Agrobacterium rhizogenes* and production of regenerative plants in hairy root cultures in maize. Sci. China C. Life Sci. 49: 305-310.

Yamazaki Y, Sudo H, Yamazaki M, Aimi N, Saito K. 2003 Camptothecin biosynthetic genes in hairy roots of *Ophiorrhiza pumila*: cloning, characterization and differential expression in tissues and by stress compounds. Plant Cell Physiol. 44:

395-403.

Yang J, Barr L A, Fahnestock S R, Liu Z B. 2005 High yield recombinant silk-like protein production in transgenic plants through protein targeting. Transgenic Res. 14: 313-324.

Yang L, Wakasa Y, Kawakatsu T, Takaiwa F. 2009 The 3'-untranslated region of rice glutelin *GluB-1* affects accumulation of heterologous protein in transgenic rice. Biotechnol. Lett. 31: 1625-1631.

Yasuda M, Ishikawa A, Jikumaru Y, Seki M, Umezawa T, Asami T, Maruyama-Nakashita A, Kudo T, Shinozaki K, Yoshida S, Nakashita H. 2008 Antagonistic interaction between systemic acquired resistance and the abscisic acid-mediated abiotic stress response in *Arabidopsis*. Plant Cell. 20:1678-1692.

Ye C, Dickman M B, Whitham S A, Payton M, Verchot J. 2011 The Unfolded Protein Response Is Triggered by a Plant Viral Movement Protein. Plant Physiol. 156: 741-755.

Ye X, Al-Babili S, Klöti A, Zhang J, Lucca P, Beyer P, Potrykus I. 2000 Engineering the provitamin A (beta-carotene) biosynthetic pathway into (carotenoid-free) rice endosperm. Science. 287: 303-305.

Yevtushenkoa D P, Sidorovb V A, Romeroa R, Kaya W W, Misraa S. 2004 Wound-inducible promoter from poplar is responsive to fungal infection in transgenic potato. Plant Sci. 167: 715-724.

Yokoyama R, Hirose T, Fujii N, Aspuria E T, Kato A, Uchimiya H. 1994 The *rolC* promoter of *Agrobacterium rhizogenes* Ri plasmid is activated by sucrose in transgenic tobacco plants. Mol. Gen. Genet. 244: 15-22.

Yoshihara T, Omer E-S A, Koshino H, Sakamura S, Kikuta Y, koda Y. 1989 Structure of a Tuber-inducing Stimulus from Potato Leaves (*Solanum tuberosum* L.). Agric. Biol. Chem. 53: 2835-2837.

Yusibov V, Streatfield S J, Kushnir N. 2011 Clinical development of plant-produced recombinant pharmaceuticals: vaccines, antibodies and beyond. Hum. Vaccin. 7: 313-321.

Zambryski P, Joos H, Genetello C, Leemans J, Van Montagu M, Schell J. 1983 Ti plasmid vector for the introduction of DNA into plant cells without alteration of their normal regeneration capacity. EMBO J. 2: 2143-2150.

Zhang P, Bohl-Zenger S, Puonti-Kaerlas J, Potrykus I, Gruissem W. 2003 Two cassava promoters related to vascular expression and storage root formation. Planta 218: 192-203.

Zhang T, Liu Y, Yang T, Zhang L, Xu S, Xue L, An L. 2006 Diverse signals converge at MAPK cascades in plant. Plant

Physiol. Biochem. 44: 274-283.

Zimmerman S B, Little J W, Oshinsky C K, Gellert M. 1967 Enzymatic joining of DNA strands: a novel reaction of diphosphopyridine nucleotide. Proc. Natl. Acad. Sci. U S A. 57: 1841-1848.

Zuo J, Niu Q W, Chua N H. 2000 Technical advance: An estrogen receptor-based transactivator XVE mediates highly inducible gene expression in transgenic plants. Plant J. 24: 265-273.

秋田重誠　吉田智彦　窪田文武　俣野敏子　国分牧衛　石井龍一　今井 勝　岩間和人　共著　2000 年　文永堂　作物学（I）　－食用作物編－

畦地昭二　1984 年　植物組織培養　第 1 巻　第 2 号　47-52　タバコ植物細胞 の大量培養

畦地昭二　橋本寿夫　中静素子　村田章　石井比呂志　1985a 年　日本専売公社小田原製塩試験場試験報告　第 20 巻　61-71　高濃度培地によるタバコ植物細胞の回分培養

畦地昭二　橋本寿夫　村田章　宮北一朗　石井比呂志　1985b 年　日本専売公社小田原製塩試験場試験報告　第 20 巻　73-85　タバコ植物細胞培養における酸素移動容量係数 kLa の測定

畦地昭二　橋本壽夫　湯山二男　永塚敏　中静素子　西山告　村田章　1983 年　醗酵工学　第 61 巻　第 3 号　117-128　工業規模装置によるタバコ植物細胞の連続培養

居在家義昭　岡成美　町井博明　編　2005 年　NIAS アグリバイオサイエンス・シリーズ No. 2. 有用物質生産のための動植物昆虫工場

一般財団法人いも類振興会　編　2010 年　サツマイモ事典

伊藤友子 2014 年　（公社）日本べんとう振興協会技術顧問　アレルギー物質を含む食品表示の現場 http://www.caa.go.jp/foods/pdf/syokuhin1258.pdf（2014 年 10 月の時点）

瓜谷郁三　編　2001 年　学会出版センター　ストレスの植物生化学・分子生物学 熱帯性イモ類とその周辺

牛房知香　2012 年　修士論文　東京大学大学院農学生命科学研究科農学国際専攻新機能植物開発学研究室

遠藤弥重太　澤崎達也　2007 年　生化学　第 79 巻　第 3 号　229-238　特集：無細胞生命科学の創成

大嶋保大　1997 年　神奈川県農業総合研究所研究報告　第 138 号　15-20　葉柄食用サツマイモ‘エレガントサマー’の生育収量と品質

太田喜元　秋田求　2002 年　近畿大学生物理工学部紀要　11：1-23　植物による異種タンパク質生産

かずさ DNA 研究所　Codon Usage Database　http://www.kazusa.or.jp/codon/（2014 年 11 月の時点）

加藤陽　1982 年　醗酵工学　第 60 巻　第 2 号 105-118　タバコ細胞の工業培養生産に関する研究

門脇正行　重田真理子　窪田文武　2003 年　日本作物学会紀事　71 巻別 2 号　182-183　サツマイモの根への糖溶液供給が塊根生産に及ぼす影響

茅野充男　林浩昭　藤原徹　1988 年　化学と生物　26 巻 5 号　318-324　篩管による物質転流と生長

清川繁人　菊池泰弘　鎌田博　原田宏　1992 年　植物組織培養　9 巻 2 号　94-98　PCR 法による Ri プラスミド *rol* 遺伝子の検出と形質転換確認への応用

国立予防衛生研究所学友会編　1994 年　ワクチンハンドブック　丸善出版

清野宏　2007 年　「日本発のワクチン開発をめざして」シンポジウム　講演資料

国際連合食糧農業機関　http://www.fao.or.jp/index.html（2014 年 11 月の時点）

国分禎二　1973 年　鹿児島大學農學部學術報告　第 23 巻　1-126　甘しょ品種の塊根の組織構造とでん粉蓄積能力との関係に関する育種学的研究

権純一　山川隆　2009 年　植物の根に関する諸問題　184　植物の毛状根の大量培養と物質生産

斉藤和季　山崎真巳　1993 年　生物の科学　遺伝　裳華房　第 47 巻 7 号　53-59　特集 II : 毛状根の誘導とその利用　遺伝子組換え系としての毛状根の利用　Ri プラスミドによるトランスジェニック植物の作製

斎藤力　半田高　鎌田博　1993 年　生物の科学　遺伝　裳華房　第 47 巻 7 号　46-52　特集 II : 毛状根の誘導とその利用　毛状根の誘導機作と毛状根からの植物体再生

下村講一郎　1996 年　生薬学雑誌　50 巻 1 号　1-8　薬用植物の形質転換体（毛状根）による有用物質の生産制御

下村講一郎　吉松嘉代　石丸幹二　1993 年　生物の科学　遺伝　裳華房　第 47 巻 7 号　53-59　特集 II : 毛状根の誘導とその利用　毛状根による有用物質生産

食品成分データベース　http://fooddb.mext.go.jp/index.pl（2014 年 10 月の時点）

菅沼俊彦　2008 年　国際農林業協力　31 巻 3 号　38-56　サツマイモの資源作物としての可能性

杉田静雄　党弘之　山崎嘉也　伊豆浦美春　1983 年　日本専売公社小田原製塩試験場試験報告　第 19 巻 49-54　フラスコ半連続培養法によるタバコ培養細胞の培養条件の検討-1-フラスコ半連続培養法とその培養

特性

生命科学系 DB・ツール使い倒し系チャンネル　http://togotv.dbcls.jp/ja/（2014 年 11 月の時点）

関口晋　1996 年　博士論文　東京大学大学院農学生命科学研究科応用生命工学専攻応用微生物学研究室　トウガラシ細胞におけるフェニルプロパノイド化合物代謝に関する研究

關光　村中俊哉　2006 年　バイオサイエンスとインダストリー　64 巻 5 号　262-266　毛状根培養系の新展開－物質生産研究 20 年目に当たり

巽 二郎　堀江 武　石井龍一　稲永 忍　伊東睦泰　石井康之　藤本文弘　共著　2000 年　文永堂　作物学（II）－工芸・飼料作物編－

田村隆明著　2006 年　羊土社　バイオ実験法＆必須データポケットマニュアルラボですぐに使える基本操作といつでも役立つ重要データ

田村隆明著　2003 年　羊土社　バイオ試薬調製ポケットマニュアル欲しい試薬がすぐにつくれる基本操作と注意・ポイント

動物用ワクチン・バイオ医薬品研究会編　2011 年　動物用ワクチン－その理論と実際－　文永堂

独立行政法人　農業生物資源研究所　2014 年遺伝子組換え作物のほ場試験 HP http://www.nias.affrc.go.jp/gmo/sakumotuken2014/20141010/（2014 年 10 月の時点）

独立行政法人　農業生物資源研究所　遺伝子組換えセンター　昆虫機能研究開発ユニット　乾燥耐性研究グループ HP（2014 年 10 月の時点）http://www.nias.affrc.go.jp/anhydrobiosis/

中静素子　橋本寿夫　畦地昭二　1983 年　試験報告　専売公社小田原製塩試験場　第 19 号　171-178　タバコ細胞培養液中の糖について

中村研三　服部束穂　松岡健　1988 年　化学と生物　26 巻　391-398　サツマイモ塊根における蛋白質の蓄積機構とその制御

中村研三　石川敦司　武田真　大藤雅章　1991 年　植物細胞工学　3 巻 7 号　577-587　イモの形成と主要タンパク質遺伝子の発現制御

西島謙一　2011 年　バイオサイエンスとバイオインダストリー　69 巻 5 号　371-374　ニワトリ卵白に生産させた医薬用タンパク質の糖鎖制御

西村いくこ　中野明彦　佐藤直樹　監修　2002 年　細胞工学別冊 植物オルガネラの分化と多様性　細胞内の輸送系から高次機能へ　秀潤社
野原恵子　2007 年　独立行政法人　国立環境研究所　環境健康研究領域・分子細胞毒性研究室 HP トキシコゲノミクスを利用した環境汚染物質の免疫毒性評価法　http://www.nies.go.jp/health/toxicogm/riyo/nohara-6.html（2014 年 11 月の時点）
橋本寿夫　湯山二男　永塚敏　中静素子　西山告　村田章　畦地昭二　鈴木清　1985　日本専売公社小田原製塩試験場試験報告　第 20 巻　45-49　大型および小型培養槽によるタバコ植物細胞の回分培養
服部束穂　中村研三　1987 年　蛋白質核酸酵素　別冊 30 巻　261-276　サツマイモ塊根主要蛋白質スポラミン遺伝子の構造とその発現
樋浦誠　1943 年　岐阜高等農林學校學術報告　第五十號　5-10　甘藷の貯蔵並に腐敗に關する研究（第 2 報）
藤山和仁　2013 年　生物工学会誌　90 巻 9 号　563-566　植物を使った医療用タンパク質生産の挑戦
フナコシ HP　http://www.funakoshi.co.jp/contents/4031（2014 年 10 月の時点）
本間洋平　山川隆　2014 年　第 32 回日本植物分子細胞生物学会大会　糖誘導性プロモーターを利用したサツマイモにおける GUS の高発現
本間洋平　牛房知香　申英燮　山川隆　2014 年　第 32 回日本植物分子細胞生物学会大会　サツマイモの再分化効率と組換え体作成効率の向上の検討
山木昭平　編　著　2007 年　園芸生理学 分子生物学とバイオテクノロジー　文永堂
松本安喜、辻尚利、新川武、山川隆　2001 年　生物の科学　遺伝　裳華房　55 巻 6 号　39-45　食べるワクチン－遺伝子組換え植物にワクチンを作らせる－
丸山伸之、石本政男、長谷川久和　2013 年　バイオサイエンスとバイオインダストリー71 巻 2 号　118-123　種子貯蔵タンパク質を利用したバイオ医薬品の生産
村上高　大橋祐子　1993 年　植物細胞工学　5 巻 5 号　407-413　遺伝子発現の組織・細胞レベルでの検出法④　GUS 遺伝子の組織特異的発現の検出と試料準備法
村上高　大橋祐子　1992 年　植物細胞工学　4 巻 4 号　281-286　形質転換植物の組織切片中における GUS レポーター遺伝子発現の検出法

森和俊　2005年　実験医学　23巻18号　2760-2765　小胞体ストレスの概念と小胞体ストレス応答の分子機構

森脇将光　2000 年　博士論文　東京大学大学院農学生命科学研究科応用生命工学専攻応用微生物学研究室

吉原照彦　幸田泰則　1989 年　化学と生物　27 巻 1 号　53-58　バレイショ塊茎形成物質の生理と化学

陸軍獸醫學校研究部　1940 年　陸軍獸醫團報　中毒牛飼料の寄生物調査　主として甘藷黒斑病に就て

謝辞

　本論文は筆者が東京大学大学院　農学生命科学研究科　農学国際専攻　博士後期課程在学中に新機能植物開発学研究室において行った研究を纏めた物である。本研究に関して、テーマの検討から日々の細かな実験指導や学会発表、など終始御指導御鞭撻を賜りました山川隆教授に厚く御礼申し上げます。並びに本論文の審査を快く引き受けて下さいました農学生命科学研究科　農学国際専攻　岡田謙介教授、黒倉寿教授、松本安喜准教授、農学生命科学研究科　生圏システム学専攻　吉田薫准教授、にこの場を借りて厚く御礼申し上げます。

　最後になりますが博士課程進学後に手厚い御支援をして下さった両親に心から御礼申し上げます。