Gene List 2001 for Cucumber

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This is the latest version of the gene list for cucumber (*Cucumis sativus* L.). Complete lists and updates of genes for have been published previously (Pierce and Wehner, 1989; Robinson et al., 1976; Robinson et al., 1982; Wehner, 1993; Wehner and Staub, 1997). For the first time, this list includes genes that have been cloned from different plant tissues of cucumber. The genes on the 2001 list are of ten categories as follows: seedling markers, stem mutants, leaf mutants, flower mutants, fruit type mutants, fruit color mutants, resistance genes (mostly to diseases), protein (isozyme) variants, DNA (RFLPs and RAPDs) markers (Table 1), and cloned genes (Table 2).

Revisions to the 1997 cucumber gene list include the addition of nine genes that have been reported during past 5 years, including: *bi-2, mj, msm, Prsv-2, rc-2, wmv-2, wmv-3, wmv-4*, and *zym-Dina*. Six genes for virus resistance (*mwm, zym, Prsv-2, wmv-2, wmv-3*, and *wmv-4*) come from one inbred TMG-1.

Genes that have been published in previous lists but modified in this list are *zymv* (renamed *zym*, and then *zym-TMG1* to distinguish it from *zym-Dina*). The gene *mwm* published in the literature may be the same as *zym-TMG1*. We also corrected the symbol for the flower mutant, *male sterile-2 pollen sterile*, $ms\text{-}2^{(PS)}$ (Zhang et al., 1994), with the superscript in parentheses to indicate an indistinguishable allele.

Isozyme variant nomenclature for this gene list follows the form according to Staub et al. (Staub et al., 1985), such that loci coding for enzymes (e.g. glutamine dehydrogenase, G2DH) are designated as abbreviations, where the first letter is capitalized (e.g. G2dh). If an enzyme system is conditioned by multiple loci, then those are designated by hyphenated numbers, which are numbered from most cathodal to most anodal and enclosed in parentheses. The most common allele of any particular isozyme is designated 100, and all other alleles for that enzyme are assigned a value based on their mobility relative to that allele. For example, an allele at locus 1 of FDP (fructose diphosphatase) which has a mobility 4 mm less that of the most common allele would be assigned the designation *Fdp(1)*-96.

RFLP marker loci were identified as a result of digestion of cucumber DNA with *Dra*I, *Eco*RI, *Eco*RV, or *Hind*III (Kennard et al., 1994). Partial-genomic libraries were constructed using either *Pst*I-digested DNA from the cultivar Sable and from *Eco*RV-digested DNA from the inbred WI 2757. Derived clones were hybridized to genomic DNA and banding patterns were described for mapped and unlinked loci (CsC482/H3, CsP314/E1, and CsP344/E1, CsC477/H3, CsP300/E1).

Clones are designated herein as CsC = cDNA, CsP = *Pst*I-genomic, and CsE = *Eco*RI-genomic. Lower-case a or b represent two independently-segregating loci detected with one probe. Lower-case s denotes the slowest fragment digested out of the vector. Restriction enzymes designated as DI, *Dra*I; EI, *Eco*RI; E5, *Eco*RV; and H3, *Hind*III. Thus, a probe identified as CsC336b/E5 is derived from a cDNA library (from 'Sable') which was restricted using the enzyme *Eco*RV to produce a clone designated as 336 which displayed two independently segregating loci one of which is b. Clones are available in limited supply from Jack E. Staub.

RAPD marker loci were identified using primer sequences from Operon Technologies (OP; Alameda, California, U.S.A.) and the University of British Columbia (Vancouver, BC, Canada). Loci are identified by sequence origin (OP or BC), primer group letter (e.g., A), primer group array number (1-20), and locus (a, b, c, etc.) (Kennard et al., 1994). Information regarding unlinked loci can be obtained from Jack E. Staub.

Because of their abundance, common source (two mapping populations), and the accessibility of published information on their development (Kennard et al., 1994) DNA marker loci are not included in Table 1, but are listed below.

The 60 RFLP marker loci from mapping cross Gy 14 x PI 183967 (Kennard et al., 1994): CsP129/E1, CsC032a/E1, CsP064/E1, CsP357/H3, CsC386/E1, CsC365/E1, CsP046/E1, CsP347/H3, CsC694/E5, CsC588/H3, CsC230/E1, CsC593/D1, CsP193/H3, CsP078s/H3, CsC581/E5, CsE084/E1, CsC341/H3, CsP024/E1, CsP287/H3, CsC629/H3, CsP225s/E1, CsP303/H3, CsE051/H3, CsC366a/E5, CsC032b/E1, CsP056/H3, CsC378/E1, CsP406/E1, CsP460/E1, CsE060/E1, CsE103/E1, CsP019/E1, CsP168/D1, CsC560/H3, CsP005/E1, CsP440s/E1, CsP221/H3, CsC625/E1, CsP475s/E1, CsP211/E1, CsP215/H3, CsC613/E1, CsC029/H3, CsP130/E1, CsC443/H3, CsE120/H3, CsE031/H3, CsC366b/E5, CsC082/H13, CsP094/H3, CsC362/E1, CsP441/E1, CsP280/H3, CsC137/H3, CsC558/H3, CsP037a/E1, CsP476/H3, CsP308/E1, CsP105/E1, and Csc166/E1.

The 31 RFLP marker loci from mapping cross Gy 14 x PI 432860 (Kennard et al., 1994): CsC560/D1, CsP024/E5, CsP287/H3, CsC384/E5, CsC366/E5, CsC611/D1, CsP055/D1, CsC482/H3, CsP019/E1, CsP059/D1, CsP471s/H13, CsC332/E5, CsP056/H3, CsC308/E5, CsP073/E5, CsP215/H3, CsC613/D1, CsP266/D1, CsC443/H3, CsE031/E1, CsE120/H3, CsE063/E1, CsP444/E1, CsC612/D1, Cs362/E1, CsP280/H3, CsC558/H3, CsP008/D1, CsP308/E1, CsC166/E1, and CsP303/H3.

The 20 RAPD marker loci from mapping cross Gy 14 x PI 432860 (Kennard et al., 1994): OPR04, OPW16, OPS17, OPE13a, OPN06, OPN12, OPP18b, BC211b, OPN04, OPA10, OPE09, OPT18, OPA14b, OPU20, BC460a, OPAB06, OPAB05, OPH12, OPA14a, and BC211a.

In addition to the isozymes, RFLPs and RAPDs, nearly 100 cloned genes are listed here (Table 2).

Researchers are encouraged to send reports of new genes, as well as seed samples to the cucumber gene curator (Todd C. Wehner), or to the assistant curators (Jack E. Staub and Richard W. Robinson). Please inform us of omissions or errors in the gene list. Scientists should consult the list as well as the rules of gene nomenclature for the Cucurbitaceae (Robinson et al., 1976; Robinson et al., 1982) before choosing a gene name and symbol. That will avoid duplication of gene names and symbols. The rules of gene nomenclature were adopted in order to provide guidelines for naming and symbolizing genes. Scientists are urged to contact members of the gene list committee regarding rules and gene symbols.

Table 1. The non-molecular genes of cucumber.

Gene	Synonym	Character	References[z]	Supplemental references[z]	Available[y]
a	-	*androecious*. Produces primarily staminate flowers if recessive for *F*. *A* from MSU 713-5 and Gy 14; *a* from An-11 and An-314, two selections from 'E-e-szan' of China.	Kubicki, 1969		P
Ak-2	-	*Adenylate kinase* (E.C.# 2.7.4.3). Isozyme variant found segregating in PI 339247, and 271754; 2 alleles observed.	Meglic and Staub, 1996		P
Ak-3	-	*Adenylate kinase* (E.C.# 2.7.4.3). Isozyme variant found segregating in PI 113334, 183967, and 285603; 2 alleles observed.	Meglic and Staub, 1996		P
al	-	*albino cotyledons*. White cotyledons and slightly light green hypocotyl; dying before first true leaf stage. Wild type Al from 'Nishiki-suyo'; *al* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
ap	-	*apetalous*. Male-sterile. Anthers become sepal-like. *Ap* from 'Butcher's Disease Resisting'; *ap* from 'Butcher's Disease Resisting Mutant'.	Grimbly, 1980		L

Ar	-	*Anthracnose resistance*. One of several genes for resistance to *Colletotrichum lagenarium*. *Ar* from PI 175111, PI 175120, PI 179676, PI 183308, PI 183445; *ar* from 'Palmetto' and 'Santee'.	Barnes and Epps, 1952		P
B	-	*Black or brown spines*. Dominant to white spines on fruit.	Strong, 1931; Tkachenko, 1935; Wellington, 1913	Cochran, 1938; Fujieda and Akiya, 1962; Hutchins, 1940; Jenkins, 1946; Youngner, 1952	W
B-2	-	*Black spine-2*. Interacts with *B* to produce F_2 of 15 black: 1 white spine. *B-2* from Wis. 9362; *b-2* from PI 212233 and 'Pixie'.	Shanmugasundarum et al., 1971a		?
B-3	-	*Black spine-3*. Interacts with *B-4* to produce an F_2 of nine black: 7 white spine. *B-3* from LJ90430; *b-3* from MSU 41.	Cowen and Helsel, 1983		W
B-4	-	*Black spine-4*. Interacts conversely with *B-3*. *B-4* from LJ90430; *b-4* from MSU 41.	Cowen and Helsel, 1983		W
bi	-	*bitterfree*. All plant parts lacking cucurbitacins. Plants with *bi* less preferred by cucumber beetles. Plants with *Bi* resistant to spider mites in most American cultivars; *bi* in most Dutch cultivars.	Andeweg and DeBruyn, 1959	Cantliffe, 1972; Da Costa and Jones, 1971a, 1971b; Soans et al., 1973	W
bi-2		*bitterfree-2*. Leaves lacking cucurbitacins; *bi-2* from NCG-093 (short petiole mutant).	Wehner et al., 1998a		W
bl	*t*	*blind*. Terminal bud lacking after temperature shock. *bl* from 'Hunderup' and inbred HP3.	Carlsson, 1961.		L
bla	-	*blunt* leaf. Leaves have obtuse apices and reduced lobing and serration. *bla* from a mutant of 'Wis. SMR 18'.	Robinson, 1987a		W
Bt	-	*Bitter fruit*. Fruit with extreme bitter flavor. *Bt* from PI 173889 (Wild Hanzil Medicinal Cucumber).	Barham, 1953		W
bu	-	*bush*. Shortened internodes. *bu* from 'KapAhk 1'.	Pyzenkov and Kosareva, 1981		L
Bw	-	*Bacterial wilt resistance*. Resistance to *Erwinia tracheiphila*. *Bw* from PI 200818; *bw* from 'Marketer'.	Nutall and Jasmin, 1958	Robinson and Whitaker, 1974	W
by	*bu*	*bushy*. Short internodes; normal seed viability. Wild type *By* from 'Borszczagowski'; *by* from induced mutation of 'Borszczagowski'. Linked with *F* and *gy*, not with *B* or *bi*.	Kubicki et al., 1986a		?
c	-	*cream mature fruit color*. Interaction with *R* is evident in the F_2 ratio of 9 red (*RC*) : 3 orange (*Rc*) : 3 yellow (*rC*) : 1 cream (*rc*).	Hutchins, 1940		L
Cca	-	*Corynespora cassiicola resistance*. Resistance to target leaf spot; dominant to susceptibility. *Cca* from Royal Sluis Hybrid 72502; *cca* from Gy 3.	Abul-Hayja et al., 1975		W
Ccu	-	*Cladosporium cucumerinum resistance*. Resistance to scab. *Ccu* from line 127.31, a selfed progeny of 'Longfellow'; *ccu* from 'Davis Perfect'.	Bailey and Burgess, 1934	Abul-Hayja and Williams, 1976; Abul-Hayja et al., 1975, Andeweg, 1956	W

cd	-	*chlorophyll deficient*. Seedling normal at first, later becoming a light green; lethal unless grafted. *cd* from a mutant selection of backcross of MSU 713-5 x 'Midget' F1 to 'Midget'.	Burnham, et al., 1966		L
chp	-	*choripetalous*. Small first true leaf; choripetalous flowers; glossy ovary; small fruits; few seeds. Wild type *Chp* from 'Borszczagowski'; *chp* from chemically induced mutation.	Kubicki and Korzeniewska, 1984		?
cl	-	*closed flower*. Staminate and pistillate flowers do not open; male-sterile (nonfertile pollen).	Groff and Odland, 1963		W
cla	-	*Colletotrichum lagenarium resistance*. Resistance to race 1 of anthracnose; recessive to susceptibility. *Cla* from Wis. SMR 18; *cla* from SC 19B.	Abul-Hayja et al., 1978		W
Cm	-	*Corynespora melonis resistance*. Resistance to *C. melonis* dominant to susceptibility. *Cm* from 'Spotvrie'; *cm* from 'Esvier'.	van Es, 1958		?
Cmv	-	*Cucumber mosaic virus resistance*. One of several genes for resistance to CMV. *Cmv* from 'Wis. SMR 12', 'Wis. SMR 15', and 'Wis. SMR 18'; *cmv* from 'National Pickling' and 'Wis. SR 6'.	Wasuwat and Walker, 1961	Shifriss et al., 1942	W
co	-	*green corolla*. Green petals that turn white with age and enlarged reproductive organs; female-sterile. *co* from a selection of 'Extra Early Prolific'.	Hutchins, 1935	Currence, 1954	L
cor-1	-	*cordate leaves-1*. Leaves are cordate. *cor-1* from 'Nezhinskii'.	Gornitskaya, 1967		L
cor-2	*cor*	*cordate leaves-2*. Leaves are nearly round with revolute margins and no serration. Insect pollination is hindered by short calyx segments that tightly clasp the corolla, preventing full opening. *cor-2* from an induced mutant of 'Lemon'.	Robinson, 1987c		?
cp	-	*compact*. Reduced internode length, poorly developed tendrils, small flowers. *cp* from PI 308916.	Kauffman and Lower, 1976		W
cp-2	-	*compact-2*. Short internodes; small seeds; similar to *cp*, but allelism not checked. Wild type *Cp-2* from 'Borszczagowski'; *cp-2* from induced mutation of 'Borszczagowski' called W97. Not linked with *B* or *F*; interacts with *by* to produce super dwarf.	Kubicki et al., 1986b		?
cr	-	*crinkled leaf*. Leaves and seed are crinkled.	Odland and Groff, 1963a		?
cs	-	*carpel splitting*. Fruits develop deep longitudinal splits. *cs* from TAMU 1043 and TAMU 72210, which are second and fifth generation selections of MSU 3249 x SC 25.	Caruth, 1975; Pike and Caruth, 1977		?
D	*g*	*Dull fruit skin*. Dull skin of American cultivars, dominant to glossy skin of most European cultivars.	Poole, 1944; Strong, 1931; Tkachenko, 1935		W

de	*I*	*determinate habit*. Short vine with stem terminating in flowers; modified by *In-de* and other genes; degree of dominance depends on gene background. *de* from Penn 76.60G[*], Minn 158.60[*], 'Hardin's PG57'[*], 'Hardin's Tree Cucumber'[*], and S_2-1 (and inbred selection from Line 541)[**].	Denna, 1971[*]; George, 1970[**]; Hutchins, 1940	Nutall and Jasmin, 1958	W
de-2	-	*determinate-2*. Main stem growth ceases after 3 to 10 nodes, producing flowers at the apex; smooth, fragile, dark-green leaves; similar to *de*, but not checked for allelism. Wild type *De-2* from 'Borszczagowski'; *de-2* from W-sk mutant induced by ethylene-imine from 'Borszczagowski'.	Soltysiak et al., 1986		?
df	-	*delayed flowering*. Flowering delayed by long photoperiod; associated with dormancy. *df* from 'Baroda' (PI 212896)[*] and PI 215589 (*hardwickii*)[**].	Della Vecchia et al., 1982[*]; Shifriss and George, 1965[**].		W
dl	-	*delayed growth*. Reduced growth rate; shortening of hypocotyl and first internodes. *dl* from 'Dwarf Marketmore' and 'Dwarf Tablegreen', both deriving dwarfness from 'Hardin's PG-57'.	Miller and George, 1979		W
dm	*P*	*downy mildew resistance*. One of several genes for resistance to *Pseudoperonospora cubensis*. *Dm* from Sluis & Groot Line 4285; *dm* from 'Poinsett'.	van Vliet and Meysing, 1977	Jenkins, 1946; Shimizu, 1963	W
dm-1	*dm*	*downy mildew resistance-1*. One of three genes for resistance to downy mildew caused by *Pseudoperonospora cubensis* (Berk & Curt). Wild type *Dm-1* from Wisconsin SMR 18; *dm-1* from WI 4783. Not checked for allelism with *dm*.	Doruchowski and Lakowska-Ryk, 1992		?
dm-2	-	*downy mildew resistance-2*. One of three genes for resistance to downy mildew caused by *Pseudoperonospora cubensis* (Berk & Curt). Wild type *Dm-2* from Wisconsin SMR 18; *dm-2* from WI 4783. Not checked for allelism with *dm*.	Doruchowski and Lakowska-Ryk, 1992		?
dm-3	-	*downy mildew resistance-3*. One of three genes for resistance to downy mildew caused by *Pseudoperonospora cubensis* (Berk & Curt). Wild type *Dm-3* from Wisconsin SMR 18; *dm-3* from WI 4783. Not checked for allelism with *dm*.	Doruchowski and Lakowska-Ryk, 1992		?
dvl	*dl*	*divided leaf*. True leaves are partly or fully divided, often resulting in compound leaves with two to five leaflets and having incised corollas.	den Nijs and Mackiewicz, 1980		W
dvl-2	*dl-2*	*divided leaf-2*. Divided leaves after the 2nd true leaf; flower petals free; similar to *dvl*, but allelism not checked. Wild type *Dvl-2* from 'Borszczagowski'; *dvl-2* from mutant induced by ethylene-imine from 'Borszczagowski'.	Rucinska et al., 1992b		?
dw	-	*dwarf*. Short internodes. *dw* from an induced mutant of 'Lemon'.	Robinson and Mishanec, 1965		?

dwc-1	-	*dwarf cotyledons-1*. Small cotyledons; late germination; small first true leaf; died after 3rd true leaf. Wild type *Dwc-1* from 'Nishiki Suyo'; *dwc-1* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
dwc-2	-	*dwarf cotyledons-2*. Small cotyledons; late germination; small first true leaf. Wild type *Dwc-2* from 'Nishiki Suyo'; *dwc-2* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
Es-1	-	*Empty chambers-1*. Carpels of fruits separated from each other, leaving a small to large cavity in the seed cell. *Es-1* from PP-2-75; *es-1* from Gy-30-75.	Kubicki and Korzeniewska, 1983		?
Es-2	-	*Empty chambers-2*. Carpels of fruits separated from each other, leaving a small to large cavity in the seed cell. *Es-2* from PP-2-75; *es-2* from Gy-30-75.	Kubicki and Korzeniewska, 1983		?
F	*Acr, acr^F, D, st*	*Female*. High degree of pistillate sex expression; interacts with *a* and *M*; strongly modified by environment and gene background. *F* and *f* are from 'Japanese'.	Galun, 1961; Tkachenko, 1935	Kubicki, 1965, 1969a; Poole, 1944; Shifriss, 1961	W
fa	-	*fasciated*. Plants have flat stems, short internodes, and rugose leaves. *fa* was from a selection of 'White Lemon'[*].	Robinson, 1987b[*]; Shifriss, 1950		?
Fba	-	*Flower bud abortion*. Preanthesis abortion of floral buds, ranging from 10% to 100%. *fba* from MSU 0612.	Miller and Quisenberry, 1978		?
Fdp-1	-	*Fructose diphosphatase* (E.C.# 3.1.3.11). Isozyme variant found segregating in PI 192940, 169383 and 169398; 2 alleles observed.	Meglic and Staub, 1996		P
Fdp-2	-	*Fructose diphosphatase* (E.C.# 3.1.3.11). Isozyme variant found segregating in PI 137851, 164952, 113334 and 192940; 2 alleles observed.	Meglic and Staub, 1996		P
Fl	-	*Fruit length*. Expressed in an additive fashion, fruit length decreases incrementally with each copy of *fl* (H. Munger, personal communication).	Wilson, 1968		W
Foc	*Fcu-1*	*Fusarium oxysporum f. sp. cucumerinum resistance*. Resistance to fusarium wilt races 1 and 2; dominant to susceptibility. *Foc* from WIS 248; *foc* from 'Shimshon'.	Netzer et al., 1977; Vakalounakis, 1993, 1995, 1996		W
G2dh	-	*Glutamine dehydrogenase* (E.C.# 1.1.1.29). Isozyme variant found segregating in PI 285606; 5 alleles observed.	Knerr and Staub, 1992		P
g	-	*golden leaves*. Golden color of lower leaves. *G* and *g* are both from different selections of 'Nezhin'.	Tkachenko, 1935		?
gb	*n*	*gooseberry fruit*. Small, oval-shaped fruit. *gb* from the 'Klin mutant'.	Tkachenko, 1935		?
gc	-	*golden cotyledon*. Butter-colored cotyledons; seedlings die after 6 to 7 days. *gc* from a mutant of 'Burpless Hybrid'.	Whelan, 1971		W

gi	-	*ginkgo*. Leaves reduced and distorted, resembling leaves of Ginkgo; male- and female-sterile. Complicated background: It was in a segregating population whose immediate ancestors were offspring of crosses and backcrosses involving 'National Pickling', 'Chinese Long', 'Tokyo Long Green', 'Vickery', 'Early Russian', 'Ohio 31' and an unnamed white spine slicer.	John and Wilson, 1952		L
gi-2	-	*ginkgo-2*. Spatulate leaf blade with reduced lobing and altered veins; recognizable at the 2nd true leaf stage; similar to gi, fertile instead of sterile. Wild type *Gi-2* from 'Borszczagowski'; *gi-2* from mutant in the Kubicki collection.	Rucinska et al., 1992b		?
gig	-	*gigantism*. First leaf larger than normal. Wild type *Gig* from 'Borszczagowski'; *gig* from chemically induced mutation.	Kubicki et al., 1984		?
gl	-	*glabrous*. Foliage lacking trichomes; fruit without spines. Iron-deficiency symptoms (chlorosis) induced by high temperature. *gl* from NCSU 75[*] and M834-6[**].	Robinson and Mishanec, 1964[*]	Inggamer and de Ponti, 1980[**]; Robinson, 1987b	W
glb	-	*glabrate*. Stem and petioles glabrous, laminae slightly pubescent. *glb* from 'Burpless Hybrid'.	Whelan, 1973		W
gn	-	*green mature fruit*. Green mature fruits when *rr gngn*; cream colored when *rr GnGn*; orange when *R_ __*. Wild type *Gn* from 'Chipper', SMR 58 and PI 165509; *gn* from TAMU 830397.	Peterson and Pike, 1992		W
Gpi-1	-	*Glucose phosphate isomerase* (E.C.# 5.3.1.9). Isozyme variant found segregating (1 and 2) in PI 176524, 200815, 249561, 422192, 432854, 436608; 3 alleles observed.	Knerr and Staub, 1992		P
Gr-1	-	*Glutathione reductase-1* (E.C.# 1.6.4.2). Isozyme variant found segregating in PI 109275; 5 alleles observed.	Knerr and Staub, 1992		P
gy	-	*gynoecious*. Recessive gene for high degree of pistillate sex expression.	Kubicki, 1974		W
H	-	*Heavy netting of fruit*. Dominant to no netting and completely linked or pleiotropic with black spines (*B*) and red mature fruit color (*R*).	Hutchins, 1940; Tkachenko, 1935		W
hl	-	*heart leaf*. Heart shaped leaves. Wild type *Hl* from Wisconsin SMR 18; *hl* from WI 2757. Linked with *ns* and *ss* in the linkage group with *Tu-u-D-pm*.	Vakalounakis, 1992		W
hn	-	*horn like cotyledons*. Cotyledons shaped like bull horns; true leaves with round shape rather than normal lobes; circular rather than ribbed stem cross section; divided petals; spineless fruits; pollen fertile, but seed sterile. Wild type *Hn* from 'Nishiki-suyo'; *hn* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
hsl	-	*heart shaped leaves*. Leaves heart shaped rather than lobed; tendrils branched. Wild type *Hsl* from 'Nishiki-suyo'; *hsl* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?

I	-	*Intensifier of P*. Modifies effect of *P* on fruit warts in *Cucumis sativus* var. *tuberculatus*.	Tkachenko, 1935		?
Idh	-	*Isocitrate dehydrogenase* (E.C.# 1.1.1.42). Isozyme variant found segregating in PI 183967, 215589; 2 alleles observed.	Knerr and Staub, 1992		P
In-de	*In(de)*	*Intensifier of* de. Reduces internode length and branching of *de* plants. *In-de* and *in-de* are from different selections (S_5-1 and S_5-6, respectively) from a determinant inbred S_2-1, which is a selection of line 541.	George, 1970		?
In-F	*F*	*Intensifier of female sex expression*. Increases degree of pistillate sex expression of *F* plants. *In-F* from monoecious line 18-1; *in-F* from MSU 713-5.	Kubicki, 1969b		?
l	-	*locule number*. Many fruit locules and pentamerous androecium; five locules recessive to the normal number of three.	Youngner, 1952		W
lg-1	-	*light green cotyledons-1*. Light green cotyledons, turning dark green; light green true leaves, turning dark green; poorly developed stamens. Wild type *Lg-1* from 'Nishiki-suyo'; *lg-1* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
lg-2	-	*light green cotyledons-2*. Light green cotyledons, turning dark green (faster than lg-1; light green true leaves, turning dark green; normal stamens. Wild type *Lg-2* from 'Nishiki-suyo'; *lg-2* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
lh	-	*long hypocotyl*. As much as a 3-fold increase in hypocotyl length. *lh* from a 'Lemon' mutant.	Robinson and Shail, 1981		W
ll	-	*little leaf*. Normal-sized fruits on plants with miniature leaves and smaller stems. *ll* from Ark. 79-75.	Goode et al., 1980; Wehner et al., 1987		W
ls	-	*light sensitive*. Pale and smaller cotyledons, lethal at high light intensity. *ls* from a mutant of 'Burpless Hybrid'.	Whelan, 1972b		L
ls	*gc*	*light sensitive*. Yellow cotyledons, lethal in high light. Abstract gave *gc* as symbol; article that followed gave *ls* as symbol. Mutant *ls* from a selection of 'Burpless Hybrid'.	Whelan, 1971, 1972		?
m	*a, g*	*andromonoecious*. Plants are andromonoecious if (*mf*); monoecious if (*Mf*); gynoecious if (*MF*) and hermaphroditic if (*mF*). *m* from 'Lemon'[*].	Rosa, 1928[*]; Tkachenko, 1935	Shifriss, 1961; Wall, 1967; Youngner, 1952	W
m-2	*h*	*andromonoecious-2*. Bisexual flowers with normal ovaries.	Iezzoni, 1982; Kubicki, 1974		?
Mdh-1	-	*Malate dehydrogenase-1* (E.C.# 1.1.1.37). Isozyme variant found segregating in PI 171613, 209064, 326594; 3 alleles observed.	Knerr and Staub, 1992		P
Mdh-2	-	*Malate dehydrogenase-2* (E.C.# 1.1.1.37). Isozyme variant found segregating in PI 174164, 185690, 357835, 419214; 2 alleles observed.	Knerr and Staub, 1992		P
Mdh-3	-	*Malate dehydrogenase-3* (E.C.# 1.1.1.37).	Knerr et al., 1995		P

Mdh-4	*Mdh-3*	*Malate dehydrogenase-4* (E.C.# 1.1.1.37). Isozyme variant found segregating in PI 255236, 267942, 432854, 432887; 2 alleles observed.	Knerr and Staub, 1992		P
mj		A single recessive gene for resistance to the root-knot nematode (*Meloidogyne javanica*) from *Cucumis sativus* var. *hardwickii*; *mj* from NC-42 (LJ 90430).	Walters et al., 1996; 1997	Walters and Wehner, 1998	W
mp	pf^{+}, pf^{d}, pf^{p}	*multi-pistillate*. Several pistillate flowers per node, recessive to single pistillate flower per node. *mp* from MSU 604G and MSU 598G.	Nandgaonkar and Baker, 1981	Fujieda et al., 1982	W
Mp-2	-	*Multi-pistillate-2*. Several pistillate flowers per node. Single dominant gene with several minor modifiers. *Mp-2* from MSU 3091-1.	Thaxton, 1974		?
Mpi-1	-	*Mannose phosphate isomerase* (E.C.# 5.3.1.8). Isozyme variant found segregating in PI 176954, and 249562; 2 alleles observed.	Meglic and Staub, 1996		P
Mpi-2	-	*Mannose phosphate isomerase* (E.C.# 5.3.1.8). Isozyme variant found segregating in PI 109275, 175692, 200815, 209064, 263049, 354952; 2 alleles observed.	Knerr and Staub, 1992		P
mpy	*mpi*	*male pygmy*. Dwarf plant with only staminate flowers. Wild type *Mpy* from Wisconsin SMR 12; *mpy* from Gnome 1, a selection of 'Rochford's Improved'.	Pyzhenkov and Kosareva, 1981		?
ms-1	-	*male sterile-1*. Staminate flowers abort before anthesis; partially female-sterile. *ms-1* from selections of 'Black Diamond' and 'A & C'.	Shifriss, 1950	Robinson and Mishanec, 1967	L
ms-2	-	*male sterile-2*. Male-sterile; pollen abortion occurs after first mitotic division of the pollen grain nucleus. *ms-2* from a mutant of 'Burpless Hybrid'.	Whelan, 1973		?
$ms\text{-}2^{(PS)}$	-	*male sterile-2 pollen sterile*. Male-sterile; allelic to *ms-2*, but not to *ap*. $ms\text{-}2^{(PS)}$ from a mutant of Sunseeds 23B-X26.	Zhang et al., 1994		?
mwm	-	Moroccan watermelon mosaic virus resistance single recessive gene from Chinese cucumber cultivar 'TMG-1'	Kabelka and Grumet, 1997		W
n	-	*negative geotropic peduncle response*. Pistillate flowers grow upright; *n* from 'Lemon'; *N* produces the pendant flower position of most cultivars.	Odland, 1963b		W
ns	-	*numerous spines*. Few spines on the fruit is dominant to many. *ns* from Wis. 2757.	Fanourakis, 1984; Fanourakis and Simon, 1987		W
O	*y*	*Orange-yellow corolla*. Orange-yellow dominant to light yellow. *O* and *o* are both from 'Nezhin'.	Tkachenko, 1935		?
opp	-	*opposite leaf arrangement*. Opposite leaf arrangement is recessive to alternate and has incomplete penetrance. *opp* from 'Lemon'.	Robinson, 1987e		W
P	-	*Prominent tubercles*. Prominent on yellow rind of *Cucumis sativus* var. *tuberculatus*, incompletely dominant to brown rind without tubercles. *P* from 'Klin'; *p* from 'Nezhin'.	Tkachenko, 1935		W

Pc	*P*	*Parthenocarpy*. Sets fruit without pollination. *Pc* from 'Spotvrie'*; *pc* from MSU 713-205*.	Pike and Peterson, 1969; Wellington and Hawthorn, 1928; Whelan, 1973	de Ponti and Garretsen, 1976	?
Pe	-	*Palisade epidermis*. Epidermal cells arranged perpendicular to the fruit surface. Wild type *Pe* from 'Wisconsin SMR 18', 'Spartan Salad' and Gy 2 compact; *pe* from WI 2757.	Fanourakis and Simon, 1987		W
Pep-gl-1	-	*Peptidase with glycyl-leucine* (E.C.# 3.4.13.11). Isozyme variant found segregating in PI 113334, 212896; 2 alleles observed.	Meglic and Staub, 1996		P
Pep-gl-2	-	*Peptidase with glycyl-leucine* (E.C.# 3.4.13.11). Isozyme variant found segregating in PI 137851, 212896; 2 alleles observed.	Meglic and Staub, 1996		P
Pep-la	-	*Peptidase with leucyl-leucine* (E.C.# 3.4.13.11). Isozyme variant found segregating in PI 169380, 175692, 263049, 289698, 354952; 5 alleles observed.	Knerr and Staub, 1992		P
Pep-pap	-	*Peptidase with phenylalanyl-L-proline* (E.C.# 3.4.13.11). Isozyme variant found segregating in PI 163213, 188749, 432861; 2 alleles observed.	Knerr and Staub, 1992		P
Per-4	-	*Peroxidase* (E.C.# 1.11.1.7). Isozyme variant found segregating in PI 215589; 2 alleles observed.	Knerr and Staub, 1992		P
Pgd-1	-	*Phosphogluconate dehydrogenase-1* (E.C.# 1.1.1.43). Isozyme variant found segregating in PI 169380, 175692, 222782; 2 alleles observed.	Knerr and Staub, 1992		P
Pgd-2	-	*Phosphogluconate dehydrogenase-2* (E.C.# 1.1.1.43). Isozyme variant found segregating in PI 171613, 177364, 188749, 263049, 285606, 289698, 354952, 419214, 432858; 2 alleles observed.	Knerr and Staub, 1992		P
Pgm-1	-	*Phosphoglucomutase* (E.C.# 5.4.2.2). Isozyme variant found segregating in PI 171613, 177364, 188749, 263049, 264229, 285606, 289698, 354952; 2 alleles observed.	Knerr and Staub, 1992		P
pl	-	*pale lethal*. Slightly smaller pale-green cotyledons; lethal after 6 to 7 days. *Pl* from 'Burpless Hybrid'; *pl* from a mutant of 'Burpless Hybrid'.	Whelan, 1973		L
pm-1	-	*powdery mildew resistance-1*. Resistance to *Sphaerotheca fuliginia*. *pm-1* from 'Natsufushinari'.	Fujieda and Akiya, 1962; Kooistra, 1971	Shanmugasundarum et al., 1972	?
pm-2	-	*powdery mildew resistance-2*. Resistance to *Sphaerotheca fuliginia*. *pm-2* from 'Natsufushinari'.	Fujieda and Akiya, 1962; Kooistra, 1971	Shanmugasundarum et al., 1972	?
pm-3	-	*powdery mildew resistance-3*. Resistance to *Sphaerotheca fuliginia*. *pm-3* found in PI 200815 and PI 200818.	Kooistra, 1971	Shanmugasundarum et al., 1972	W
pm-h	*s, pm*	*powdery mildew resistance expressed by the hypocotyl*. Resistance to powdery mildew as noted by no fungal symptoms appearing on seedling cotyledons is recessive to susceptibility. *Pm-h* from 'Wis. SMR 18'; *pm-*	Fanourakis, 1984; Shanmugasundarum et al., 1971b		W

		h from 'Gy 2 *cp cp*', 'Spartan Salad', and Wis. 2757.			
pr	-	*protruding ovary*. Exerted carpels. *pr* from 'Lemon'.	Youngner, 1952.		W
prsv	*wmv-1-1*	*watermelon mosaic virus 1 resistance*. Resistance to papaya ringspot virus (formerly watermelon mosaic virus 1). Wild type *Prsv* from WI 2757; *prsv* from 'Surinam'.	Wang et al., 1984		
Prsv-2		Resistance to papaya ringspot virus; *Prsv-2* from TMG-1.	Wai and Grumet, 1995	Wai et al., 1997	W
psl	*pl*	Pseudomonas lachrymans *resistance*. Resistance to *Pseudomonas lachrymans* is recessive. *Psl* from 'National Pickling' and 'Wis. SMR 18'; *psl* from MSU 9402 and Gy 14.	Dessert et al., 1982		W
R	-	*Red mature fruit*. Interacts with *c*; linked or pleiotropic with *B* and *H*.	Hutchins, 1940		W
rc	-	*revolute cotyledon*. Cotyledons are short, narrow, and cupped downwards; enlarged perianth. *rc* from 'Burpless Hybrid' mutant.	Whelan et al., 1975		L
rc-2		recessive gene for revolute cotyledons; rc-2 fro NCG-0093 (short petiole mutant)	Wehner et al., 1998b		W
ro	-	*rosette*. Short internodes, muskmelon-like leaves. *ro* from 'Megurk', the result of a cross involving a mix of cucumber and muskmelon pollen.	de Ruiter et al., 1980		W
s	*f, a*	*spine size and frequency*. Many small fruit spines, characteristic of European cultivars is recessive to the few large spines of most American cultivars.	Strong, 1931; Tkachenko, 1935	Caruth, 1975; Poole, 1944	W
s-2	-	*spine-2*. Acts in duplicate recessive epistatic fashion with *s-3* to produce many small spines on the fruit. *s-2* from Gy 14; *s-2* from TAMU 72210.	Caruth, 1975		?
s-3	-	*spine-3*. Acts in duplicate recessive epistatic fashion with *s-2* to produce many small spines on the fruit. *S-3* from Gy 14; *s-3* from TAMU 72210.	Caruth, 1975		?
sa	-	*salt tolerance*. Tolerance to high salt levels is attributable to a major gene in the homozygous recessive state and may be modified by several minor genes. *Sa* from PI 177362; *sa* from PI 192940.	Jones, 1984		P
sc	*cm*	*stunted cotyledons*. Small, concavely curved cotyledons; stunted plants with cupped leaves; abnormal flowers. *Sc sc* from Wis. 9594 and 9597.	Shanmugasundarum and Williams, 1971; Shanmugasundarum et al., 1972.		W
Sd	-	*Sulfur dioxide resistance*. Less than 20% leaf damage in growth chamber. *Sd* from 'National Pickling'; *sd* from 'Chipper'.	Bressan et al., 1981		W
sh	-	*short hypocotyl*. Hypocotyl of seedlings 2/3 the length of normal. Wild type *Sh* from 'Borszczagowski'; *sh* from khp, an induced mutant from 'Borszczagowski'.	Soltysiak and Kubicki 1988		?

shl	-	*shrunken leaves*. First and 2nd true leaves smaller than normal; later leaves becoming normal; slow growth; often dying before fruit set. Wild type *Shl* from 'Nishiki-suyo'; *shl* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
Skdh	-	*Shikimate dehydrogenase* (E.C.# 1.1.1.25). Isozyme variant found segregating in PI 302443, 390952, 487424; 2 alleles observed.	Meglic and Staub, 1996		P
sp	-	*short petiole*. Leaf petioles of first nodes 20% the length of normal. *sp* from Russian mutant line 1753.	den Nijs and de Ponti, 1983		W
sp-2	-	*short petiole-2*. Leaf petioles shorter, darker green than normal at 2-leaf stage; crinkled leaves with slow development; short hypocotyl and stem; little branching. Not tested for allelism with *sp*. Wild type *Sp-2* from 'Borszczagowski'; *sp-2* from chemically induced mutation.	Rucinska et al., 1992a		?
ss	-	*small spines*. Large, coarse fruit spines is dominant to small, fine fruit spines. *Ss* from 'Spartan Salad', 'Wis. SMR 18' and 'GY 2 *cp cp*'; *ss* from Wis. 2757.	Fanourakis, 1984; Fanourakis and Simon, 1987		W
T	-	*Tall plant*. Tall incompletely dominant to short.	Hutchins, 1940		?
td	-	*tendrilless*. Tendrils lacking; associated with misshapen ovaries and brittle leaves. *Td* from 'Southern Pickler'; *td* from a mutant of 'Southern Pickler'.	Rowe and Bowers, 1965		W
te	-	*tender skin of fruit*. Thin, tender skin of some European cultivars; recessive to thick tough skin of most American cultivars.	Poole, 1944; Strong, 1931		W
Tr	-	*Trimonoecious*. Producing staminate, perfect, and pistillate flowers in this sequence during plant development. *Tr* from Tr-12, a selection of a Japanese cultivar belonging to the Fushinari group; *tr* from H-7-25. MOA-309, MOA-303, and AH-311-3.	Kubicki, 1969d		P
Tu	-	*Tuberculate fruit*. Warty fruit characteristic of American cultivars is dominant to smooth, non-warty fruits characteristic of European cultivars.	Strong, 1931; Wellington, 1913	Andeweg, 1956; Poole, 1944	W
u	*M*	*uniform immature fruit color*. Uniform color of European cultivars recessive to mottled or stippled color of most American cultivars.	Strong, 1931	Andeweg, 1956	W
ul	-	*umbrella leaf*. Leaf margins turn down at low relative humidity making leaves look cupped. *ul* source unknown.	den Nijs and de Ponti, 1983		W
v	-	*virescent*. Yellow leaves becoming green.	Strong, 1931; Tkachenko, 1935		L
vvi	-	*variegated virescent*. Yellow cotyledons, becoming green; variegated leaves.	Abul-Hayja and Williams, 1976		L
w	-	*white immature fruit color*. White is recessive to green. *W* from 'Vaughan', 'Clark's Special', 'Florida Pickle' and 'National Pickling'; *w* from 'Bangalore'.	Cochran, 1938		W

wf	-	*White flesh*. Intense white flesh color is recessive to dingy white; acts with *yf* to produce F_2 of 12 white (*Wf Yf* and *wf Yf*) : 3 yellow (*Wf yf*) : 1 orange (*wf yf*). *Wf* from EG and G6, each being dingy white (*Wf Yf*): *wf* from 'NPI ' which is orange (*wf yf*).	Kooistra, 1971		?
wi	-	*wilty leaves*. Leaves wilting in the field, but not in shaded greenhouse; weak growth; no fruiting. Wild type *Wi* from 'Nishiki-suyo'; *wi* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
Wmv	-	*Watermelon mosaic virus resistance*. Resistance to strain 2 of watermelon mosaic virus. *Wmv* from 'Kyoto 3 Feet'; *wmv* from 'Beit Alpha'.	Cohen et al., 1971		P
wmv-1-1	-	*watermelon mosaic virus-1 resistance*. Resistance to strain 1 of watermelon mosaic virus by limited systemic translocation; lower leaves may show severe symptoms. *Wmv-1-1* from Wis. 2757; *wmv-1-1* from 'Surinam'.	Wang et al., 1984	Provvidenti, 1985	?
wmv-2	-	*watermelon mosaic virus resistance*. Expressed in the cotyledon and throughout the plant; *wmv-2* from TMG-1.	Wai et al., 1997		W
wmv-3	-	*watermelon mosaic virus resistance*. Expressed only in true leaves; *wmv-3* from TMG-1.	Wai et al., 1997		W
wmv-4	-	*watermelon mosaic virus resistance*. Expressed only in true leaves; *wmv-4* from TMG-1.	Wai et al., 1997		W
wy	-	*wavy rimed cotyledons*. Wavy rimed cotyledons, with white centers; true leaves normal. Wild type *Wy* from 'Nishiki-suyo'; *wy* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
yc-1	-	*yellow cotyledons-1*. Cotyledons yellow at first, later turning green. *yc-1* from a mutant of Ohio MR 25.	Aalders, 1959		W
yc-2	-	*yellow cotyledons-2*. Virescent cotyledons. *yc-2* from a mutant of 'Burpless Hybrid'.	Whelan and Chubey, 1973; Whelan et al., 1975		W
yf	*v*	*yellow flesh*. Interacts with *wf* to produce F_2 of 12 white (*Wf Yf* and *wf Yf*) : 3 yellow (*Wf yf*) : 1 orange (*wf yf*). *Yf* from 'Natsufushinari', which has an intense white flesh (*Yf wf*); *yf* from PI 200815 which has a yellow flesh (*yf Wf*).	Kooistra, 1971		P
yg	*gr*	*yellow-green immature fruit color*. Recessive to dark green and epistatic to light green. *yg* from 'Lemon'.	Youngner, 1952		W
yp	-	*yellow plant*. Light yellow-green foliage; slow growth.	Abul-Hayja and Williams, 1976		?
ys	-	*yellow stem*. Yellow cotyledons, becoming cream-colored; cream-colored stem, petiole and leaf veins; short petiole; short internode. Wild type *Ys* from 'Borszczagowski'; *ys* from chemically induced mutation.	Rucinska et al., 1991		?
zym-Dina	-	zucchini yellow mosaic virus resistance; *zym-Dina* from Dina-1.	Kabelka et al., 1997	Wai et al., 1997	P

zym-TMG1	*zymv*	*zucchini yellow mosaic virus resistance*. Inheritance is incomplete, but usually inherited in a recessive fashion; source of resistance is 'TMG-1'.	Provvidenti, 1987; Kabelka et al., 1997	Wai et al., 1997	W

[z] Asterisks on cultigens and associated references indicate the source of information for each.

[y] W = Mutant available through T.C. Wehner, cucumber gene curator for the Cucurbit Genetics Cooperative; P = mutants are available as standard cultivars or accessions from the Plant Introduction Collection; ? = availability not known; L = mutant has been lost.

* Isozyme nomenclature follows a modified form of Staub et al. (1985) previously described by Richmond (1972) and Gottlieb (1977).

Table 2. The cloned genes of cucumber and their function.[z]

Gene accession	Tissue source	Function	Clone type	Reference
Genes involved in seed germination or seedling development				
X85013	Cotyledon cDNA library	Encoding a T-complex protein	cDNA	Ahnert et al., 1996
AJ13371	Cotyledon cDNA library	Encoding a matrix metalloproteinases	cDNA	Delorme et al., 2000
X15425	Cotyledon cDNA library	Glyoxysomal enzyme malate synthase	Genomic DNA fragment	Graham et al., 1989; 1990
X92890	Cotyledon cDNA library	Encoding a lipid body lipoxygenase	cDNA	Höhne et al., 1996
L31899	Senescing cucumber cotyledon cDNA library	Encoding an ATP-dependent phosphoenolpyruvate carboxykinase (an enzyme of the gluconeogenic pathway)	cDNA	Kim and Smith, 1994a
L31900	Cotyledon cDNA library	Encoding microbody NAD(+)-dependent malate dehydrogenase (MDH)	cDNA	Kim and Smith, 1994b
L44134	Senescing cucumber cDNA library	Encoding a putative SPF1-type DNA binding protein	cDNA	Kim et al., 1997
U25058	Cotyledons	Encoding a lipoxygenase-1 enzyme	cDNA	Matsui et al., 1995; 1999
Y12793	Cotyledon cDNA library	Encoding a patatin like protein	cDNA	May et al., 1998
X67696	Cotyledon cDNA library	Encoding the 48539 Da precursor of thiolase	cDNA	Preisig-Muller and Kindl, 1993a
X67695	Cotyledon cDNA library	Encoding homologous to the bacterial dnaJ protein	cDNA	Preisig-Muller and Kindl, 1993b
X79365	Seedling cDNA library	Encoding glyoxysomal tetrafunctional protein	cDNA	Preisig-Muller et al., 1994
X79366	Seedling cDNA library	Encoding glyoxysomal tetrafunctional protein	cDNA	Preisig-Muller et al., 1994
Z35499	Genomic library	Encoding the glyoxylate cycle enzyme isocitrate lyase	Genomic gene	Reynolds and Smith, 1995
M59858	Cotyledon cDNA library	Encoding a stearoyl-acyl-carrier-protein (ACP) desaturase	cDNA	Shanklin and Somerville, 1991
M16219	Cotyledon cDNA library	Encoding glyoxysomal malate synthase	cDNA	Smith and Leaver, 1986
Genes involved in photosynthesis and photorespiration activities				

M16056	Cotyledon cDNA library	Encoding ribulose bisphosphate carboxylase/oxygenase	cDNA	Greenland et al., 1987
M16057	Cotyledon cDNA library	Encoding chlorophyll a/b-binding protein	cDNA	Greenland et al., 1987
M16058	Cotyledon cDNA library	Encoding chlorophyll a/b-binding protein	cDNA	Greenland et al., 1987
X14609	cotyledon cDNA library	Encoding a NADH-dependent hydroxypyruvate reductase (HPR	cDNA	Greenler et al., 1989
Y09444	Chloroplast genomic library	tRNA gene	Chloroplast DNA fragment	Hande and Jayabaskaran, 1997
X75799	Chloroplast genomic library	Chloroplast tRNA (Leu) (cAA) gene	Genomic DNA fragment	Hande et al., 1996
D50456	Cotyledon cDNA library	Encoding 17.5-kDa polypeptide of cucumber photosystem I	cDNA	Iwasaki et al., 1995
S69988	Hypocotyls	Cytoplasmic tRNA (Phe)	cytoplasmic DNA fragment	Jayabaskaran and Puttaraju, 1993
S78381	Cotyledon cDNA library	Encoding NADPH-protochlorophyllide oxidoreductase	cDNA	Kuroda et al., 1995
D26106	Cotyledon cDNA library	Encoding ferrochelatase	cDNA	Miyamoto et al., 1994
U65511	Green peelings cDNA library	Encoding the 182 amino acid long precursor stellacyanin	cDNA	Nersissian et al., 1996
AF099501	Petal cDNA library	Encoding the carotenoid-associated protein	cDNA	Ovadis et al., 1998
X67674	Cotyledon cDNA library	Encoding ribulosebisphosphate carboxylase/oxygenase activase	cDNA	Preisig-Muller and Kindl, 1992
X58542	Cucumber genomic library	Encoding NADH-dependent hydroxypyruvate reductase	Genomic DNA fragment	Schwartz et al., 1991
U62622	Seedling cDNA library	Encoding monogalacto-syldiacylglycerol synthase	cDNA	Shimojima et al., 1997
D50407	Cotyledon cDNA library	Encoding glutamyl-tRNA reductase proteins	cDNA	Tanaka et al., 1996
D67088	Cotyledon cDNA library	Encoding glutamyl-tRNA reductase proteins	cDNA	Tanaka et al., 1996
D83007	Cotyledon cDNA library	Encoding a subunit XI (psi-L) of photosystem I	cDNA	Toyama et al., 1996
Genes expressed mainly in roots.				
AB025717	Root RNA	Lectin-like xylem sap protein	cDNA	Masuda et al., 1999
U36339	Root cDNA library	Encoding root lipoxygenase	cDNA	Matsui et al., 1998
AB015173	Root cDNA library	Encoding glycine-rich protein-1	cDNA	Sakuta et al., 1998
AB015174	Root cDNA library	Encoding glycine-rich protein-1	cDNA	Sakuta et al., 1998
Flower genes				
AF035438	Female flower cDNA library	MADS box protein CUM1	cDNA	Kater et al., 1998
AF035439	Female flower cDNA library	MADS box protein CUM10	cDNA	Kater et al., 1998
D89732	Seedlings	Encoding 1-aminocyclo-propane-	cDNA	Kamachi et al.,

		1-carboxylate synthase		1997
AB003683	Seedlings	Encoding 1-aminocyclo-propane-1-carboxylate synthase	cDNA	Kamachi et al., 1997
AB003684	Seedlings	Encoding 1-aminocyclo-propane-1-carboxylate synthase	cDNA	Kamachi et al., 1997
AB035890	Fruit RNA	Encoding polygalacturonase	cDNA	Kubo et al., 2000
AF022377	Floral buds	Encoding agamous-like putative transcription factor (CAG1) mRNA	cDNA	Perl-Treves et al., 1998
AF022378	Floral buds	Encoding agamous like putative transcription factor (CAG2) mRNA	cDNA	Perl-Treves et al., 1998
AF022379	Floral buds	Encoding agamous-like putative transcription factor (CAG3) mRNA	cDNA	Perl-Treves et al., 1998
U59813	Genomic DNA	Encoding 1-aminocyclo-propane-1-carboxylate synthase	Genomic DNA fragment	Trebitsh et al., 1997
X95593	Corolla cDNA library	Encoding carotenoid-associated protein	cDNA	Vishnevetsky et al., 1996
AB026498	Shoot apex RNA	Ethylene-receptor-related gene	cDNA	Yamasaki et al., 2000
Genes involved in fruit development and maturation				
AB010922	Fruit cDNA library	Encoding the ACC synthase	cDNA	Mathooko et al., 1999
J04494	Fruit cDNA library	Encoding an ascorbate oxidase	cDNA	Ohkawa et al., 1989; 1990
AB006803	Fruit cDNA library	Encoding ACC synthase	cDNA	Shiomi et al., 1998
AB006804	Fruit cDNA library	Encoding ACC synthase	cDNA	Shiomi et al., 1998
AB006805	Fruit cDNA library	Encoding ACC synthase	cDNA	Shiomi et al., 1998
AB006806	Fruit cDNA library	Encoding ACC oxidase	cDNA	Shiomi et al., 1998
AB006807	Fruit cDNA library	Encoding ACC oxidase	cDNA	Shiomi et al., 1998
AB008846	Pollinated fruit cDNA library	Corresponding genes preferentially expressed in the pollinated fruit	cDNA	Suyama et al., 1999
AB008847	Pollinated fruit cDNA library	Corresponding genes preferentially expressed in the pollinated fruit	cDNA	Suyama et al., 1999
AB008848	Pollinated fruit cDNA library	Corresponding genes preferentially expressed in the pollinated fruit	cDNA	Suyama et al., 1999
Genes involved in cell wall loosening and cell enlargement				
AB001586	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases (for CsPK1.1)	cDNA	Chono et al., 1999
AB001587	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases (for CsPK1.2)	cDNA	Chono et al., 1999
AB001588	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases (for CsPK2.1)	cDNA	Chono et al., 1999
AB001589	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases	cDNA	Chono et al., 1999

		(for CsPK2.2)		
AB001590	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases (for CsPK3)	cDNA	Chono et al., 1999
AB001591	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases (for CsPK4.1)	cDNA	Chono et al., 1999
AB001592	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases (for CsPK4.2)	cDNA	Chono et al., 1999
AB001593	Hypocotyl RNA	Encoding homologous to serine/threonine protein kinases (for CsPK5)	cDNA	Chono et al., 1999
U30382	Hypocotyl cDNA library	Encoding expansins	cDNA	Shcherban et al., 1995
U30460	Hypocotyl cDNA library	Encoding expansins	cDNA	Shcherban et al., 1995
Genes induced or repressed by plant hormones				
D49413	Hypocotyl cDNA library	Corresponding to a gibberellin-responsive gene encoding an extremely hydrophobic protein	cDNA	Chono et al., 1996
AB026821	Seedling RNA	Encoding IAA induced nuclear proteins	cDNA	Fujii et al., 2000
AB026822	Seedling RNA	Encoding IAA induced nuclear proteins	cDNA	Fujii et al., 2000
AB026823	Seedling RNA	Encoding IAA induced nuclear proteins	cDNA	Fujii et al., 2000
M32742	Cotyledon cDNA library	Encoding ethylene-induced putative peroxidases	cDNA	Morgens et al., 1990
D29684	Cotyledon cDNA library	Cytokinin-repressed gene	cDNA	Teramoto et al., 1994
D79217	Genomic library	Cytokinin-repressed gene	Genomic DNA fragment	Teramoto et al., 1996
D63451	Cotyledon cDNA library	Homologous to Arabidopsis cDNA clone 3003	cDNA	Toyama et al., 1995
D63384	Cotyledon cDNA library	Encoding catalase	cDNA	Toyama et al., 1995
D63385	Cotyledon cDNA library	Encoding catalase	cDNA	Toyama et al., 1995
D63386	Cotyledon cDNA library	Encoding catalase	cDNA	Toyama et al., 1995
D63387	Cotyledon cDNA library	Encoding lectin	cDNA	Toyama et al., 1995
D63388	Cotyledon cDNA library	Encoding 3-hydroxy-3-methylglutaryl CoA reductase	cDNA	Toyama et al., 1995
D63389	Cotyledon cDNA library	Encoding 3-hydroxy-3-methylglutaryl CoA reductase	cDNA	Toyama et al., 1995
D63388	Cotyledon cDNA library	Encoding a basic region/helix-loop-helix protein	cDNA	Toyama et al., 1999
Resistance genes				
M84214	Genomic library	Encoding the acidic class III chitinase	cDNA	Lawton et al., 1994
M24365	Leave cDNA library	Encoding a chitinase	cDNA	Metraux et al., 1989

D26392	Seedling cDNA library	Encoding FAD-Enzyme monodehydroascorbate (MDA) reductase	cDNA	Sano and Asada, 1994
Somatic embryo gene.				
X97801	Embryogenic callus cDNA library	MADS-box gene	cDNA	Filipecki et al., 1997
Repeated DNA sequences				
X03768	Genomic DNA	Satellite type I	Genomic DNA fragment	Ganal et al., 1986
X03769	Genomic DNA	Satellite type II	Genomic DNA fragment	Ganal et al., 1986
X03770	Genomic DNA	Satellite type III	Genomic DNA fragment	Ganal et al., 1986
X69163	Genomic DNA	Satellite type IV	Genomic DNA fragment	Ganal et al., 1988a
X07991	rDNA	Ribosomal DNA intergenic spacer	Genomic DNA fragment	Ganal et al., 1988b
X51542	Cotyledons	Ribosomal DNA intergenic spacer	Genomic DNA fragment	Zentgraf et al., 1990

[z] Only the sequences published in both journals and the genebank database are listed.

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