

Using Gramene For Maize-Rice Genome Comparisons

49th Annual Maize Genetics Conference

22-25 March 2007

GRAMENE *A Resource for Comparative Grass Genomics*
V24 (March 2007)

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Quick Search

Search a single module or all available modules plus online documentation.
Diversity, Pathways, BLAST and Mart not available in this search.

Have Questions...?

- Gramene now has **tutorials** for every module, also recommended for experienced users.
- Ask questions through **Feedback** or **Email**.
- See **FAQ** for questions and answers.

Gramene Tip:

Refer to module home pages, tutorials, help files and release notes for tips on conducting searches.

- **Browse All Tips**

Quick Start

- 📌 **GENOMES:** Browse sequenced genomes for [Rice](#), [Maize](#) & [Arabidopsis](#); Look for [rice/maize synteny](#); Narrow your search with [GrameneMart](#); Search for sequence alignment with [BLAST](#); search by [Gene Ontology](#).
- 📌 **PROTEINS:** Search by [PFam](#) or [ProSite](#) or Browse by Gene Ontology using [GO Slim](#).
- 📌 **MAPS:** Browse genetic or physical maps for [Rice](#), [Wild Rice](#), [Maize](#), [Wheat](#), [Barley](#), [Oats](#), [Sorghum](#), and other grasses, or use the [Comparative Map Viewer \(CMap\)](#) to compare maps of different types and species.
- 📌 **MARKERS:** Search for Genetic markers (RFLPs, SSRs, etc.), DNA Probes (Primers, Overgos, etc.), Genomic Regions (Clones, FPContigs, etc.), and Sequences (GSSs, ESTs, etc.); Use the [Simple Sequence Repeat Identification Tool \(SSRIT\)](#); or search by species, including [Rice \(*Oryza sativa*\)](#), [Maize](#), [Sorghum](#) and [Others](#).
- 📌 **TRAITS:** Search the [Genes](#) or [QTL](#) database for important phenotype-related loci such as [Rice Genes](#), [Rice QTL](#), [Maize QTL](#). Don't forget to explore traits in [Ontologies](#).
- 📌 **GENETIC DIVERSITY:** Search for SNP and SSR allelic variation on loci of [rice](#), [maize](#), and [wheat](#) germplasms.
- 📌 **BIOCHEMICAL PATHWAYS:** Search for ALL the rice pathways on [starch biosynthesis](#) or get an overview of the [metabolic network](#). Compare [rice](#) and [Arabidopsis](#) pathway datasets.
- 📌 **LITERATURE:** Search the literature for your friends and topics of interest.
- 📌 **SUBMISSION:** Submit a [Rice Gene](#) or [Ontology Term](#) to Gramene.

Gramene is a curated, open-source, web-accessible data resource for comparative genome analysis in the grasses. Our goal is to facilitate the study of cross-species homology relationships using information derived from public projects involved in genomic and EST sequencing, protein structure and function analysis, genetic and physical mapping, interpretation of biochemical pathways, gene and QTL localization and descriptions of phenotypic characters and mutations.

Note! Although we continually work to make Gramene compatible with all browsers, if you're having difficulty viewing Gramene, try using a different browser. Please report any problems with browsers through Gramene Feedback.

Featured News

- NEW March 2007, V 24 [release notes](#).
- NEW [Gramene Jan/Feb Newsletter](#)
- [Rice News Worldwide](#) from IRRI

Visit with us at

- March 15-18, 2007. [CSHL Plant Genome meeting](#)
- March 22-25, 2007. [Maize Genetics Meeting](#)
- April 16-20, 2007. [ITMI](#)
- May 8-12, 2007. [Biology of Genomes](#)
- July 7-11, 2007. [ASPB](#)

[View Previous Gramene Presentations Calendar](#)

SPECIES

Last modified: Thu Mar 8 10:35:21 2007

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Maize Species Pages

[Species](#) | [Rice](#) | [Maize](#) | [Wheat](#) | [Barley](#) | [Oats](#) | [Foxtail Millet](#) | [Pearl Millet](#) | [Rye](#) | [Sorghum](#) | [Wild Rice](#) | [Brachypodium](#)

Zea Introduction

[Zea Species Page: Introduction](#) | [Facts](#) | [Anatomy](#) | [Taxonomy](#) | [Agronomic Statistics](#) | [Research](#) | [Education](#) | [Nutrition](#) | [Recipes](#) | [News](#) | [Germplasm Resources](#) | [Gramene Statistics](#) | [Gramene Queries](#)



Maize roots



Maize ears



Maize tassels



Maize plant

Photos by Molly Fogleman

Maize, commonly referred to as corn in the United States, has been considered a unique plant since the time that the indigenous peoples of the Americas developed it to be their staple food. It is central to many sacred mythologies and creation stories which are still honored today (1, 2). Maize was introduced from the New World to the Old World in the 1400's, and it was planted between the harvesting of spring and winter crops, filling an important niche as a summer crop (1). Today, the United States, China, the European Union, Brazil and Mexico are the world's largest producers of maize (3). Together, the US and China produce approximately 60% of the world maize crop (4). Maize accounts for 15-20% of the total daily calories in the diets of more than 20 developing countries, located mainly in Latin America and Africa (5, 6). 68% of the land devoted to maize is located in the developing world, however only 46% of maize production occurs there, indicating the need for improving yields in developing countries where it is a major source of direct human consumption for many of the poor (7).



Maize Queries

Gramene Database information on *Zea mays*

Zea Species Page: [Introduction](#) | [Facts](#) | [Anatomy](#) | [Taxonomy](#) | [Agronomic Statistics](#) | [Research](#) | [Education](#) | [Nutrition](#) | [Recipes](#) | [News](#) | [Germplasm Resources](#) | [Gramene Statistics](#) | [Gramene Queries](#)

Pre-designed Zea Queries

- [Show me all the maize markers in Gramene.](#)
- [Show me all the maize QTL in Gramene.](#)
- [What are the best maps to use to compare maize to rice?](#)
- [Show me a syntenic region between maize and rice.](#)

Show me all the maize markers in Gramene.

- To perform this query, open the [Markers](#) database by using the main navigation bar of Gramene.
- Use the Marker navigation bar to open the [Marker Search](#) function.
- Type "*" in the "Marker Name" box and select "Maize" from the "Species" drop-down menu.

Show me all the maize QTL in Gramene.

- To perform this query, open the [QTL](#) database by using the main navigation bar of Gramene.
- Use the QTL navigation bar to open the [QTL Simple Search](#) function.
- Type "*" in the "Search for" box and select "Maize" from the "Species" drop-down menu.
- A [QTL search results](#) page will appear with a list of all Maize QTL in Gramene.
- Note: Maize can be replaced by another species to perform similar QTL searches.

- In the "Restrict Reference Sets By" section, select maize from the "All Species" field, and then click on "Submit."
- A [Matrix results table](#) will appear. Down the page vertically, all the maize maps will appear. Across the page horizontally, all the other maps in CMap will appear.
- Scroll horizontally until you reach the rice section. The numbers in the individual cells indicate the number of correspondences the maps contain, i.e., the greater the number, the better the maize map to compare to rice.
- Note: Maize can be replaced with any other species in Gramene to perform similar searches.

Show me a syntenic region between maize and rice.

- Using the above example, examine the numbers in the [Matrix table](#).
- The GR TIGR Assembly and IBM2 Neighbors 2004 have a large number of correspondences. Selecting that number will display a [Matrix table](#) that will display the individual number of correspondences for each chromosome.
- Maize chromosome 1 and rice chromosome 3 have a large number of correspondences. Selecting that number will display a [comparative map view](#) of the two maps.



Gramene Modules

- Genomes [Ensembl]
 - ESTs, markers, genes, etc. from Poaceae on rice, maize & Arabidopsis
- BLAST
 - Sequence similarity search to genomes
- Maps [CMap]
 - Comparative map viewer
 - Genetic, physical, sequence & QTL maps
- Markers
 - Find markers and map positions
 - View marker details
- Proteins
 - Grass proteins from Swissprot & TrEMBL
 - Cellular locations and functions
- Genes
 - Genes and alleles associated with phenotype
- QTL
 - Quantitative trait loci from major cereal crops
- Ontologies
 - Controlled vocabularies
- Literature




Maize Genome Browser

Browse the Maize genome (Zea mays)

Current Release

Assembly



The Gramene Browser for maize presents results from the Maize Genome Sequencing Project. Further details are available from the MaizeSequence.org web site.

Accessioned BAC Browser

- ▶ The BAC database contains the 504 full-length Zea mays clones deposited with GenBank as of 26-Jan-2006.
- ▶ Sequences from various grass species including rice and maize were mapped to the BACs using the Gramene pipeline. E.g. [AC149836](#). Mapping results for the sequence data sets are available in [detailed](#) form.
- ▶ Gene models were predicted using the [FGENESH](#) HMM-based *ab initio* gene prediction program, and their domains annotated using [Interproscan](#). E.g. [FGENESH0005329](#)
- ▶ Putative orthologs between *rice*, *Arabidopsis* and *maize* gene models were generated using [Ensembl's](#) compara pipeline. E.g. [FGENESHG0005329](#)

Maize Agarose FPC Map

- ▶ The FPC database contains the 721 contigs from the AGI 19 Jul 2005 agarose map. [\[more\]](#) [\[citation\]](#)
- ▶ Accessioned BACs within the FPC map have been highlighted. E.g. [ctg3](#)
- ▶ Syntenic regions between the maize FPC map (AGI maize FPC map released on April 5, 2006) and the rice genome ([TIGR v4](#)) were [estimated](#), and loaded into [Ensembl](#). E.g. [Maize chr9 Vs Rice](#)
- ▶ The accessioned BACS will be merged into the FPC map database in the near future.

Entry Points

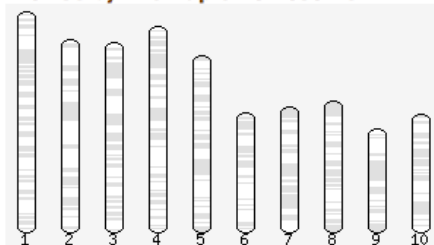
Lookup an Accessioned BAC

BAC:

Lookup an AGI FPContig

FPC:

Browse by FPC Map Chromosome



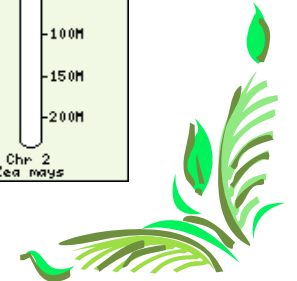
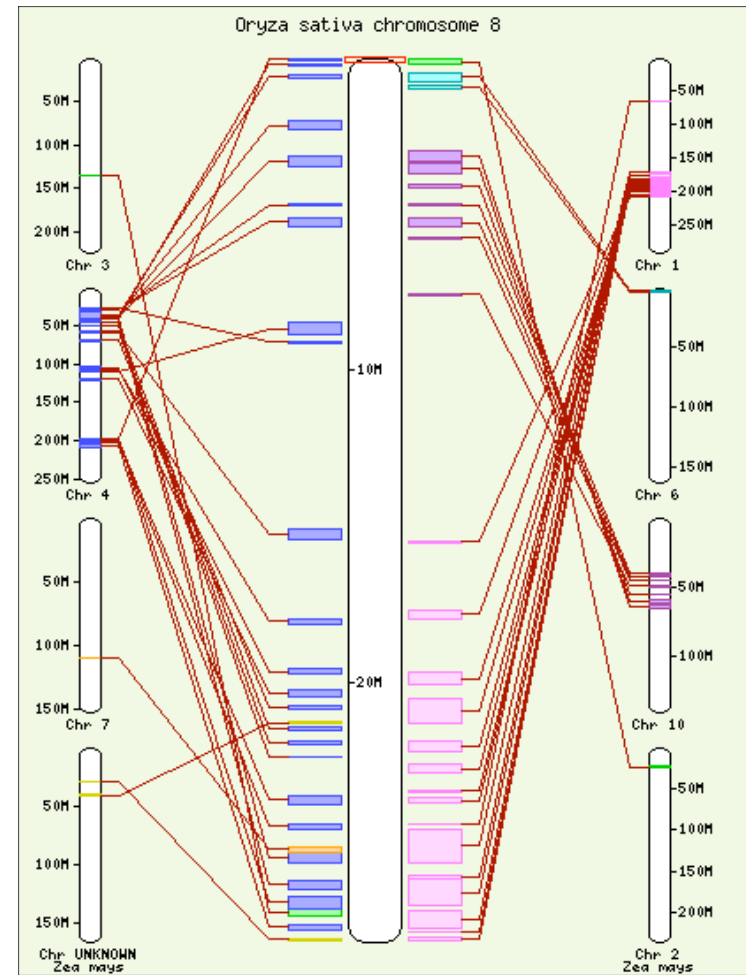
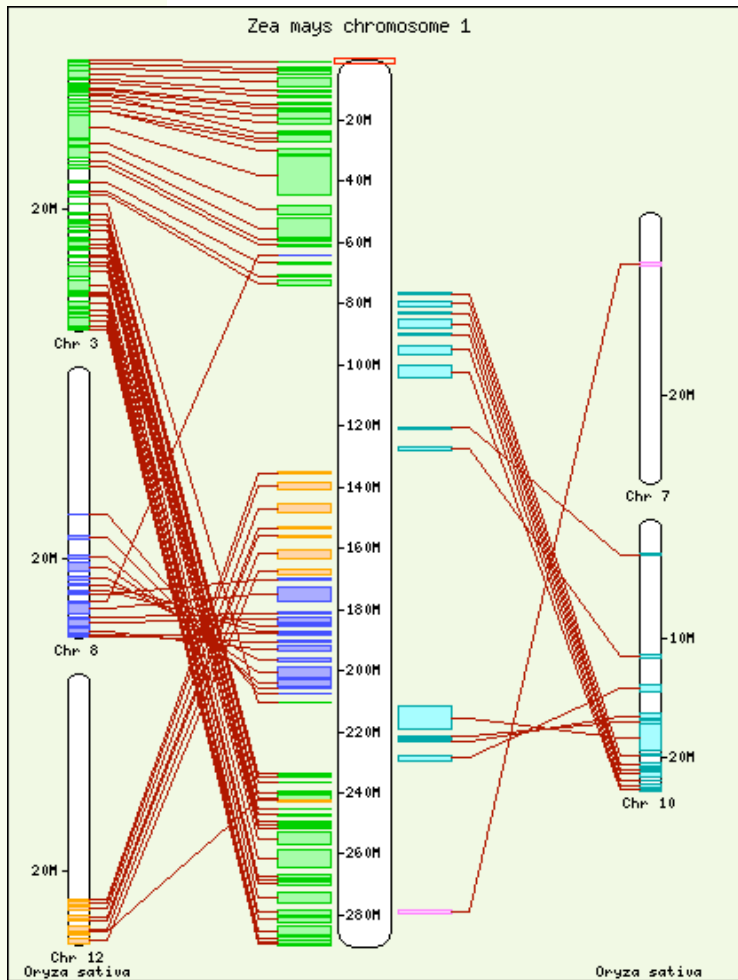
Lookup a Chromosome Location

Chr: from -

FPC Synteny Vs. Rice Genome



Synteny Viewer



Maize Genome Viewer

Chromosome 1

Chr. 1

Detailed view

Features ▾ Comparative ▾ DAS Sources ▾ Decorations ▾ Export ▾ Image size ▾ Help ▾

Jump to region 1 : 174829879 - 175129910 [Refresh](#)

[< 2MB](#) [< 1MB](#) [< Window](#) **Zoom** [Window >](#) [1MB >](#) [2MB >](#)

synteny 8>

Length

DNA(clone)

Acc clones

FPContigs

BAC map

Markers

Length

All tracks are currently switched on

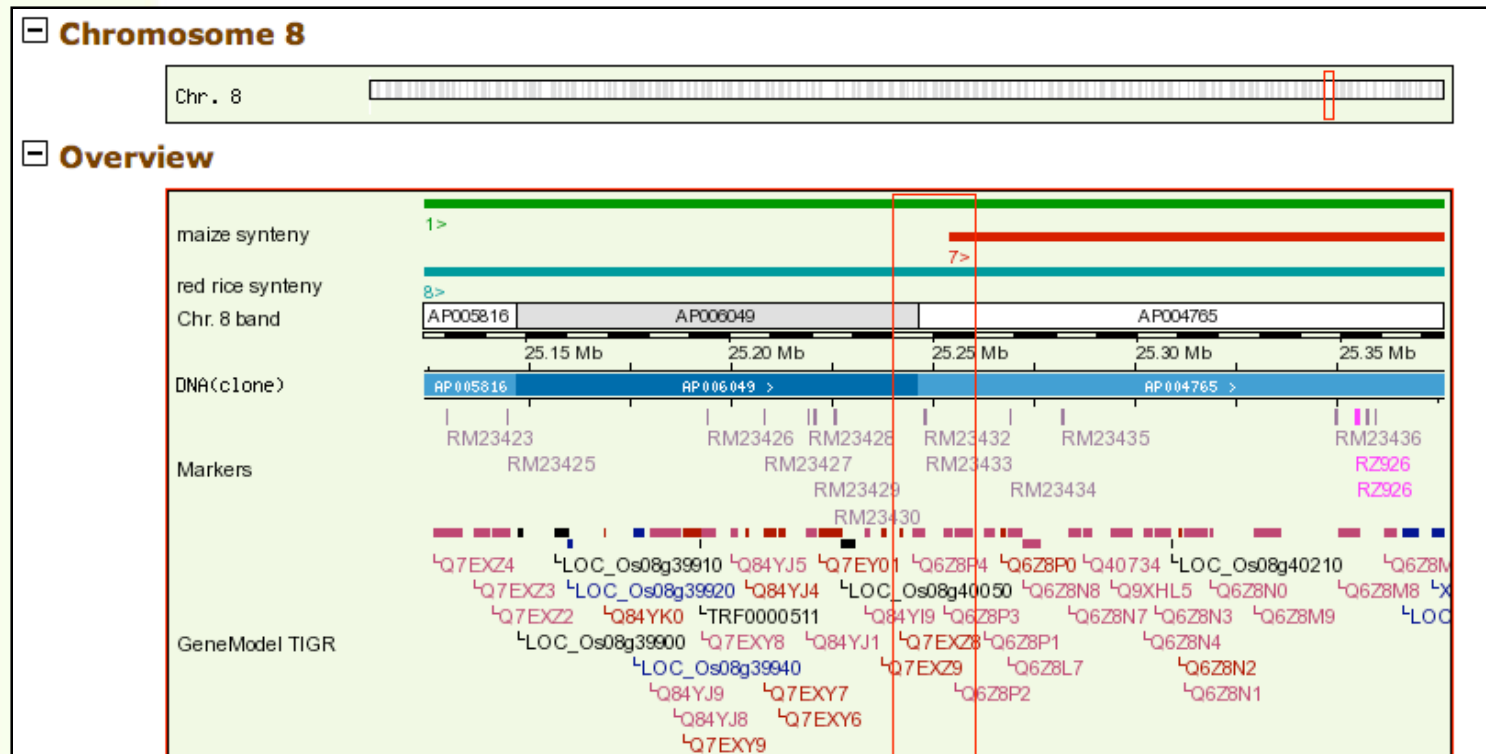
Golden path gap - no contigs to display!

Clone: c0243P11

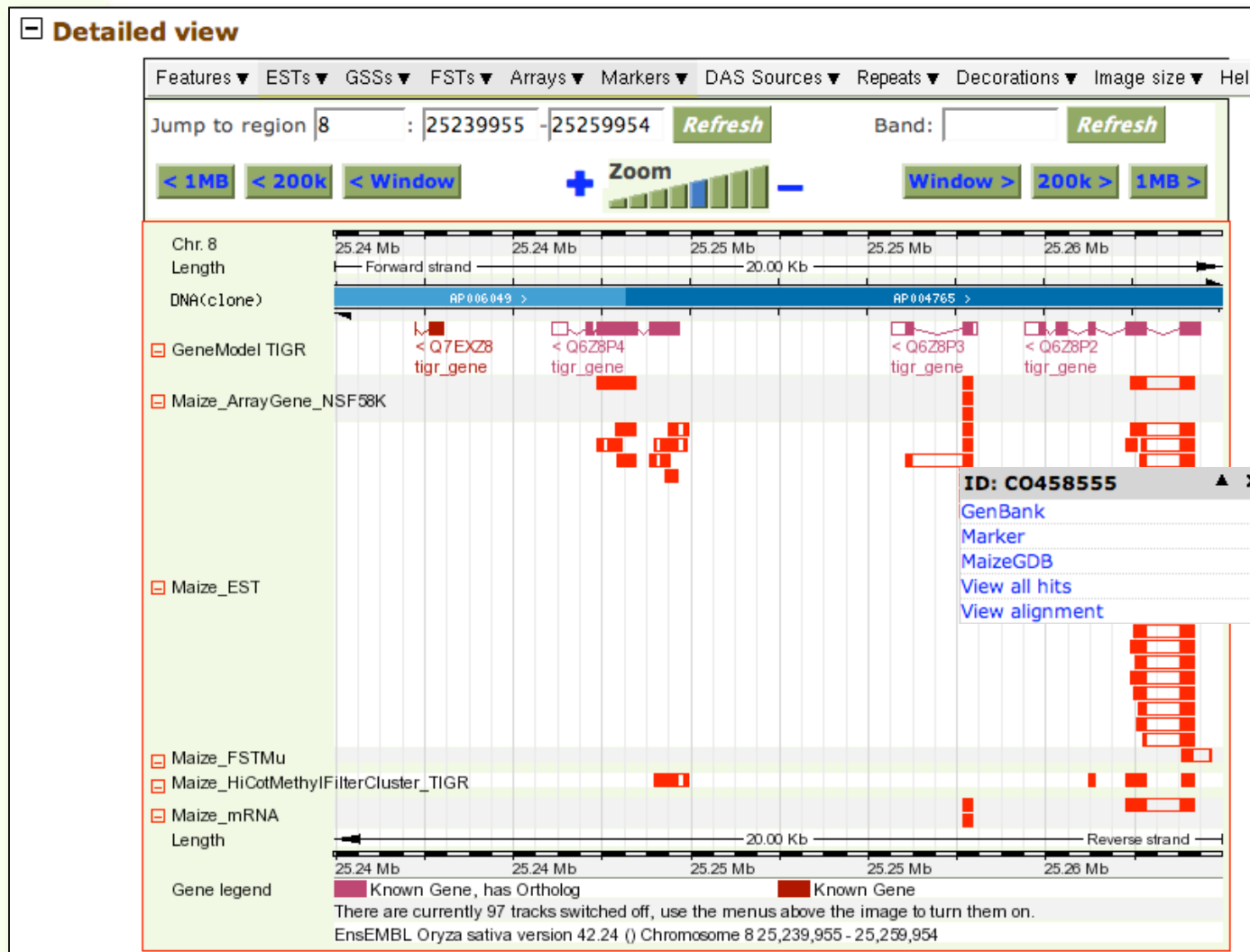
- Centre on clone
- MaizeGDB: c0243P11
- Jump to BAC Browser
- Jump to Gramene: c0243P11
- Jump to CMap: c0243P11
- Accession: AC186625
- bp: 174773200-174964300
- length: 191101
- State: Accessioned
- Seq length: 211696
- FPContig: ctg38



Rice Genome Viewer



Rice Genome - Detailed View

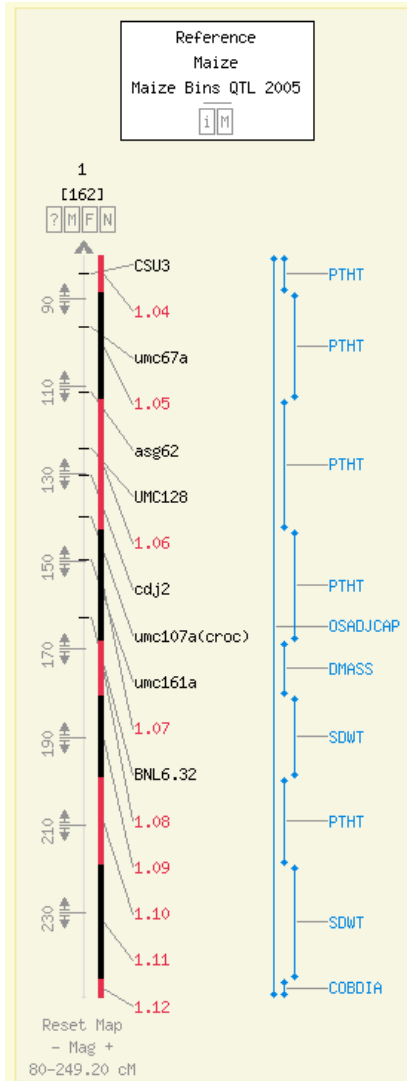


Maize Maps

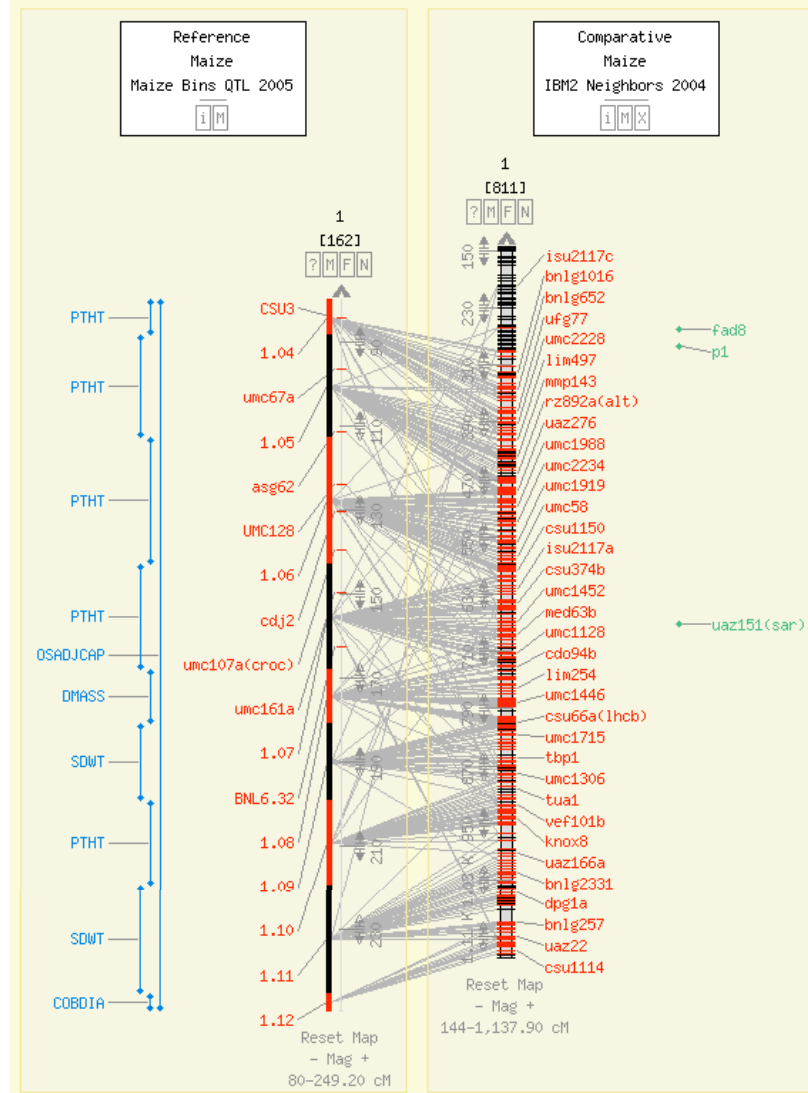
- Physical
- Genetic
 - IBM 2002
 - IBM neighbors 2002
 - IBM2 neighbors 2004
 - SSR IBM 2001
 - BNL 1996
 - UMC 1998
 - CU 1999
- Bin
- QTL
 - MISCO H123/AG19 BC1 QTL 2003
 - NCSU B73/Mo17 QTL 1992
 - INRA Io/F2 Composite QTL 1996
 - Iowa Mo17/H99 RI QTL 1996
 - CIMMYT Ac7729/Ac7643S QTL 1996
 - Bologna Os420/lab78 QTL 1998



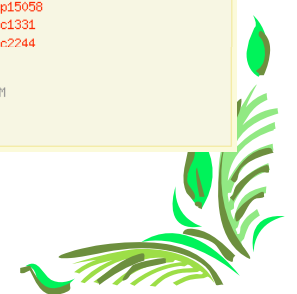
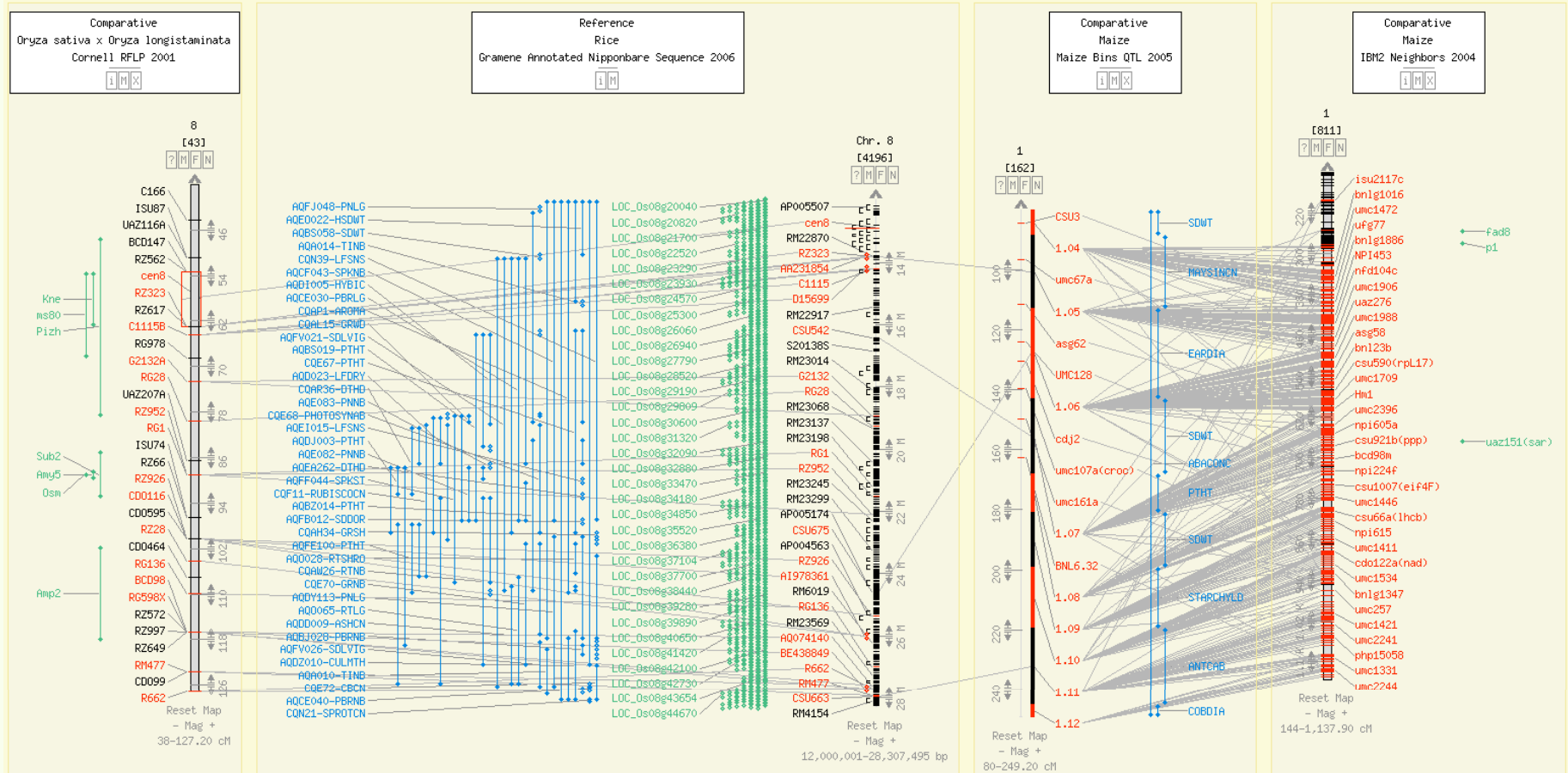
Maize chr 1



Maize chr 1



Rice chr 8 - maize chr 1



Marker Database

View Maize RFLP "CSU675"

Details | **Source/Library** | **Map Positions (8)** | **Associations (5)** | **Images (0)**

ID	4273
Name	CSU675
	csu675a(prh) csu675b(prh)
	CSU675E3 csuh00675

Details | **Source/Library** | **Map Positions (8)** | **Associations (5)** | **Images (0)**

Species	Map Type	Map Set	Name	Map	Start	Stop	Map Links	Comments
Oryza sativa (Rice)	Sequence	Gramene Annotated Nipponbare Sequence 2006	CSU675	Chr. 8	24,568,487 bp	24,568,660 bp	View in Genome Browser View Comparative Map	
Sorghum bicolor (sorghum)	Genetic	Paterson 2003	CSU675	J	3.8 cM		View Comparative Map	
Zea mays (Maize)	Genetic	IBM neighbors	csu675a(prh)	1	479 cM		View Comparative	

Details | **Source/Library** | **Map Positions (8)** | **Associations (5)** | **Images (0)**

Direction	Name	Type	Species	Analysis	Assoc. Type
To	AA072449	EST	Zea mays	gss_poaceae	shared_synonym
To	SOG0631	OVERGO	Zea mays	SOG_OVERGO	related_probe
From	AA072449	EST	Zea mays	gss_poaceae	shared_synonym
From	Bin 1.06	Maize Bin	Zea mays subsp. mays	bin_marker	bin_marker
From	Bin 8.01	Maize Bin	Zea mays subsp. mays	bin_marker	bin_marker



Ontologies

- Plant ontology
 - Plant structure (morphology, organs, tissue and cell types)
 - Growth stages
- Trait ontology
 - Plant traits and phenotypes
- Gene ontology
 - Molecular functions
 - Biological processes
 - Cellular components
- Environment ontology
- Taxonomy ontology



Taxonomy Ontology

Summary for Gramene taxonomy Term: <i>Zea mays</i> (GR_tax:014450)	
Term Name	<i>Zea mays</i>
Synonym	<i>Zea mays</i> var. <i>japonica</i> .
Aspect	Taxonomy
External References	NCBI_taxid:4577
Derivation	
<ul style="list-style-type: none"> • all (all) #512041 <ul style="list-style-type: none"> ◦ [i] Magnoliophyta (GR_tax:017502) #117906 <ul style="list-style-type: none"> ▪ [i] Liliopsida (GR_tax:017503) #117905 <ul style="list-style-type: none"> ▪ [i] commelinids (GR_tax:017504) #117904 <ul style="list-style-type: none"> ▪ [i] Poales (GR_tax:014481) #117904 <ul style="list-style-type: none"> ▪ [i] Poaceae (GR_tax:013969) #117904 <ul style="list-style-type: none"> ▪ [i] PACCAD clade (GR_tax:013697) #16260 <ul style="list-style-type: none"> ▪ [i] Panicoideae (GR_tax:013699) #15589 <ul style="list-style-type: none"> ▪ [i] Andropogoneae (GR_tax:012443) #14562 <ul style="list-style-type: none"> ▪ [i] Zea (GR_tax:014447) #12988 <ul style="list-style-type: none"> ▪ [i] Zea mays (GR_tax:014450) #12713 <ul style="list-style-type: none"> ▪ [i] Zea mays subsp. huehuetenangensis (GR_tax:014451) #0 ▪ [i] Zea mays subsp. mexicana (GR_tax:014452) #0 ▪ [i] Zea mays subsp. parviglumis (GR_tax:014453) #45 ▪ [i] Zea mays subsp. ramosa (GR_tax:014454) #0 ▪ [i] Zea mays subsp. mays (GR_tax:014546) #6757 ▪ [i] Zea mays subsp. mays x Zea mays subsp. parviglumis (GR_tax:017762) #0 ▪ [i] Zea mays subsp. mays x Zea perennis (GR_tax:017763) #0 	
Parent Term (1)	Child Terms (7)
• [i] Zea (GR_tax:014447)	<ul style="list-style-type: none"> • [i] Zea mays subsp. huehuetenangensis (GR_tax:014451) • [i] Zea mays subsp. mexicana (GR_tax:014452) • [i] Zea mays subsp. parviglumis (GR_tax:014453) • [i] Zea mays subsp. ramosa (GR_tax:014454) • [i] Zea mays subsp. mays (GR_tax:014546) • [i] Zea mays subsp. mays x Zea mays subsp. parviglumis (GR_tax:017762) • [i] Zea mays subsp. mays x Zea perennis (GR_tax:017763)

Total Number of Annotations:	12713 objects, 12713 associations
	QTL(1681) Marker species(3) Gene(6680) Protein(4330)
QTL:	Zea mays(1681)
Marker species:	Zea mays(1) Zea mays subsp. mays(2)
Gene:	Zea mays subsp. mays(6680)
Protein:	Zea mays(4210) Zea mays subsp. mays(75) Zea mays subsp. parviglumis(45)



Gene Ontology

Summary for GO Term: *defense response* (GO:0006952)

Term Name	defense response
Synonym	antimicrobial peptide activity, defence response, defense/immunity protein activity, GO:0002217, GO:0042829, physiological defense response.
Aspect	Biological Process
Definition	Reactions, triggered in response to the presence of a foreign body or the occurrence of an injury, which result in restriction of damage to the organism attacked or prevention/recovery from the infection caused by the attack.
External References	GOC:go_curators
Source Ontology Database Link	The GO browser of Gene Ontology Database.

- [!] [evasion or tolerance of defense response of other organism during symbiotic interaction \(GO:0051007\) #0](#)
- [!] [cell wall thickening during defense response \(GO:0052482\) #0](#)
- [!] [callose deposition during defense response \(GO:0052542\) #0](#)

Total Number of Annotations:	1346 objects, 1359 associations Gene(9) Ensembl rice gene(470) Ensembl maize gene(18) Ensembl arabidopsis gene(368) Protein(481)				
Gene:	Oryza sativa(9)				
Ensembl rice gene:	Oryza sativa(470)				
Ensembl maize gene:	Zea mays(18)				
Ensembl arabidopsis gene:	Arabidopsis thaliana(368)				
Protein:	Aegilops tauschii(7)	Aegilops ventricosa(7)	Avena sativa(7)	Hordeum vulgare(72)	Hordeum vulgare subsp. vulgare(3)
	Lolium perenne(13)	Oryza meyeriana(6)	Oryza officinalis(2)	Oryza rufipogon(7)	Oryza sativa(26)
	Oryza sativa (indica cultivar-group)(14)	Oryza sativa (japonica cultivar-group)(196)	Pennisetum glaucum(3)	Saccharum sp.(1)	Secale cereale(1)
	Secale strictum(1)	Sorghum bicolor(17)	Thinopyrum intermedium(3)	Triticum aestivum(48)	Triticum aestivum/Thinopyrum intermedium alien addition line(2)
	Triticum monococcum(2)	Triticum turgidum subsp. durum(5)	Zea mays(38)		



Defense response proteins in maize

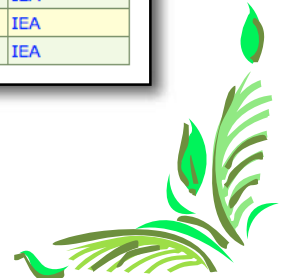
Term *defense response* (GO:0006952) Associations

Items 1 to 25 of 38.

Page 1 of 2. | Next

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Term Name	Object Type	Object Accession	Term	Object	Species	Evidence	
<i>defense response</i>	Protein	Q8S455	Rust resistance-like protein RP1-2				IEA
<i>defense response</i>	Protein	Q8S458					IEA
<i>defense response</i>	Protein	Q8S454	206C17.1	Rust resistance-like protein RP1-3	Zea mays	IEA	
<i>defense response</i>	Protein	Q8S453	206C17.8	Rust resistance-like protein RP1-4	Zea mays	IEA	
<i>defense response</i>	Protein	Q9AY31	es1	Female gametophyte-specific protein ES1 precursor	Zea mays	IEA	
<i>defense response</i>	Protein	Q9AY30	es2	Female gametophyte-specific protein ES2 precursor	Zea mays	IEA	
<i>defense response</i>	Protein	Q9AY29	es3	Female gametophyte-specific protein ES3 precursor	Zea mays	IEA	
<i>defense response</i>	Protein	Q9AY28	es4	Female gametophyte-specific protein ES4 precursor	Zea mays	IEA	
<i>defense response</i>	Protein	P81008	Not available	Gamma-zeathionin 1	Zea mays	IEA	
<i>defense response</i>	Protein	P81009	Not available	Gamma-zeathionin 2	Zea mays	IEA	
<i>defense response</i>	Protein	Q6PT59	Not available	Rust resistance protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8GS26	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6U5	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6U6	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6U7	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6U8	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6U9	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6V0	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6V1	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6V2	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6V3	Not available	Putative rp3 protein	Zea mays	IEA	
<i>defense response</i>	Protein	Q8H6V4			ys	IEA	
<i>defense response</i>	Protein	Q9AT65			ys	IEA	
<i>defense response</i>	Protein	Q9AT66			ys	IEA	
<i>defense response</i>	Protein	Q9AT73	Not available	Rust resistance Rp1-D-like protein	Zea mays	IEA	



Gramene Staff

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