創価大学

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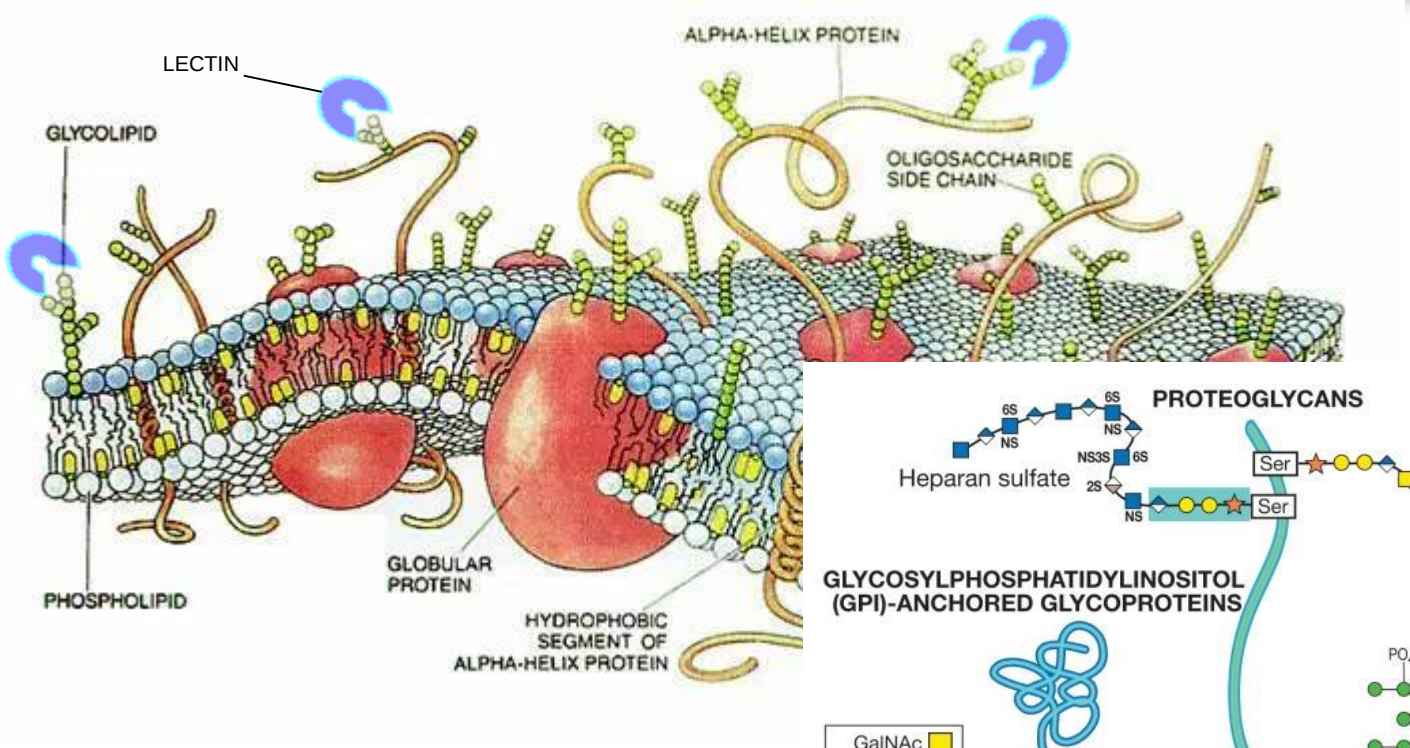
自分力の発見

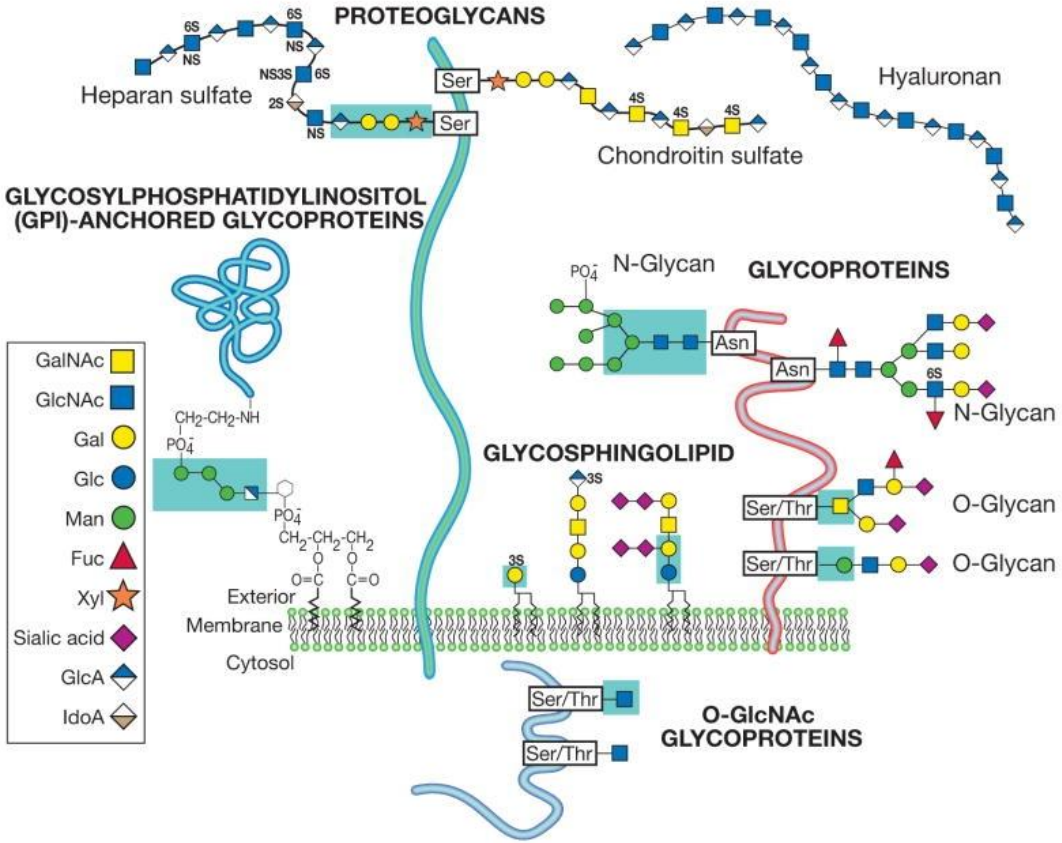
糖鎖関連生命情報を統合化するGlyCosmos Portalの構築

木下聖子

第41回　日本分子生物学会年会
1PW2-09 生命科学のデータベース活用法2018　2018年11月28日

糖鎖が関わる生体内の環境





複合糖質の多様性

糖鎖研究の位置づけ

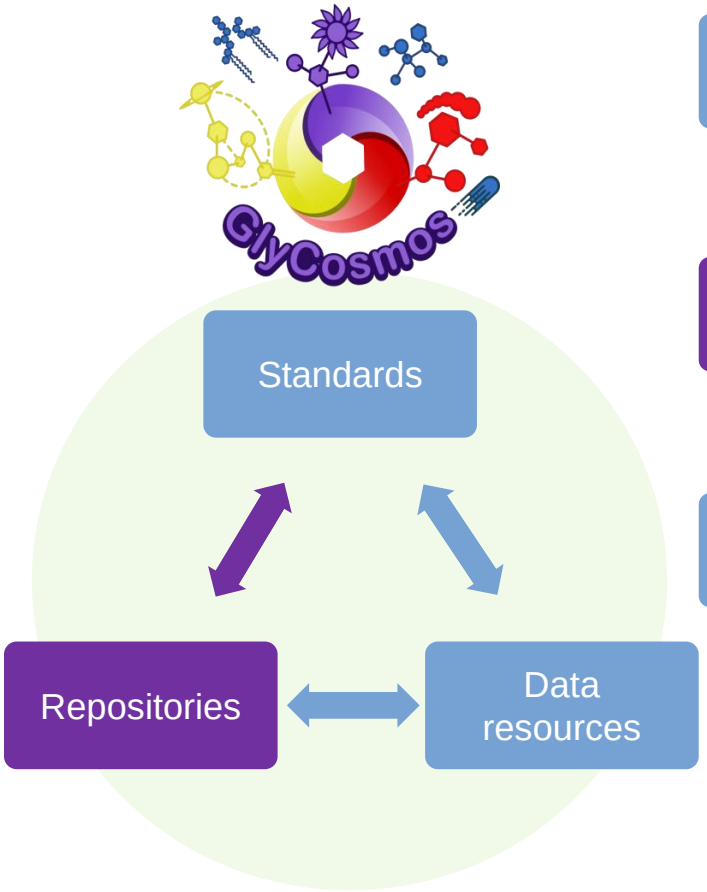
米国では 2012 年に米国学術研究会議(the National Research Council of the National Academies)が報告書 Transforming Glycoscience: A Roadmap for the Future (2012) を発表：

糖鎖研究の対象は**医学（Medicine）**にとどまらず、**エネルギー（Energy）**や**材料科学（Materials）**にまで及ぶとしており、これまでこのような大局的な視点で糖鎖研究の将来が位置づけられたことはなかった。

米国ではNIHにおいて、糖鎖に関連する研究が強力に進められている。

一方、世界で使用されている標準的な糖鎖解析法は日本発であり、また重要な糖鎖構造の解析および６割以上の糖鎖遺伝子のクローニングやその機能解析が我が国の研究者によってなされている。したがって、糖鎖科学は我が国が世界をリードしてきた分野である。

GlyCosmos – Glycoscience Portal



Standards

Glycan Representation
WURCS: Web3 Unique Representation for Carbohydrate Structure

Ontologies
GlycoRDF, GlycoCoO: Glycoconjugate Ontology

Repositories

Glycans - GlyTouCan

Glycoconjugates - GlyComb

MS data - GlycoPOST

Data resources

Pathways

Chemical Structures

Glycomes

Lectins

Genes

Proteins

GlycomeAtlasV5

Glyco-Disease Genes Database (**GDGDB**)

Pathogen Adherence to Carbohydrate Database (**PACDB**)

GlyCosmos Portal (beta version)

創価大学

SUBMISSIONS

GlyTouCan

GlyComb

GlycoPOST

RESOURCES

Genes/Proteins/Lipids

- GGDB - glycogenes
- GDGDB - glycogene diseases
- GlycoProtDB - glycoproteins
- LfDB - lectins
- GlycoAbun
- GlyCosmos Proteins
- GlyCosmos Lectins
- GlyCosmos Lipids

Glycans/Glycoconjugates

- GlyCosmos Glycans
- GlycoProtDB - glycoproteins
- GlycoAbun
- GlyCosmos Glycoconjugates

Glycomes

- Total Glycome Database
- GlycomeAtlas

Pathways/Diseases

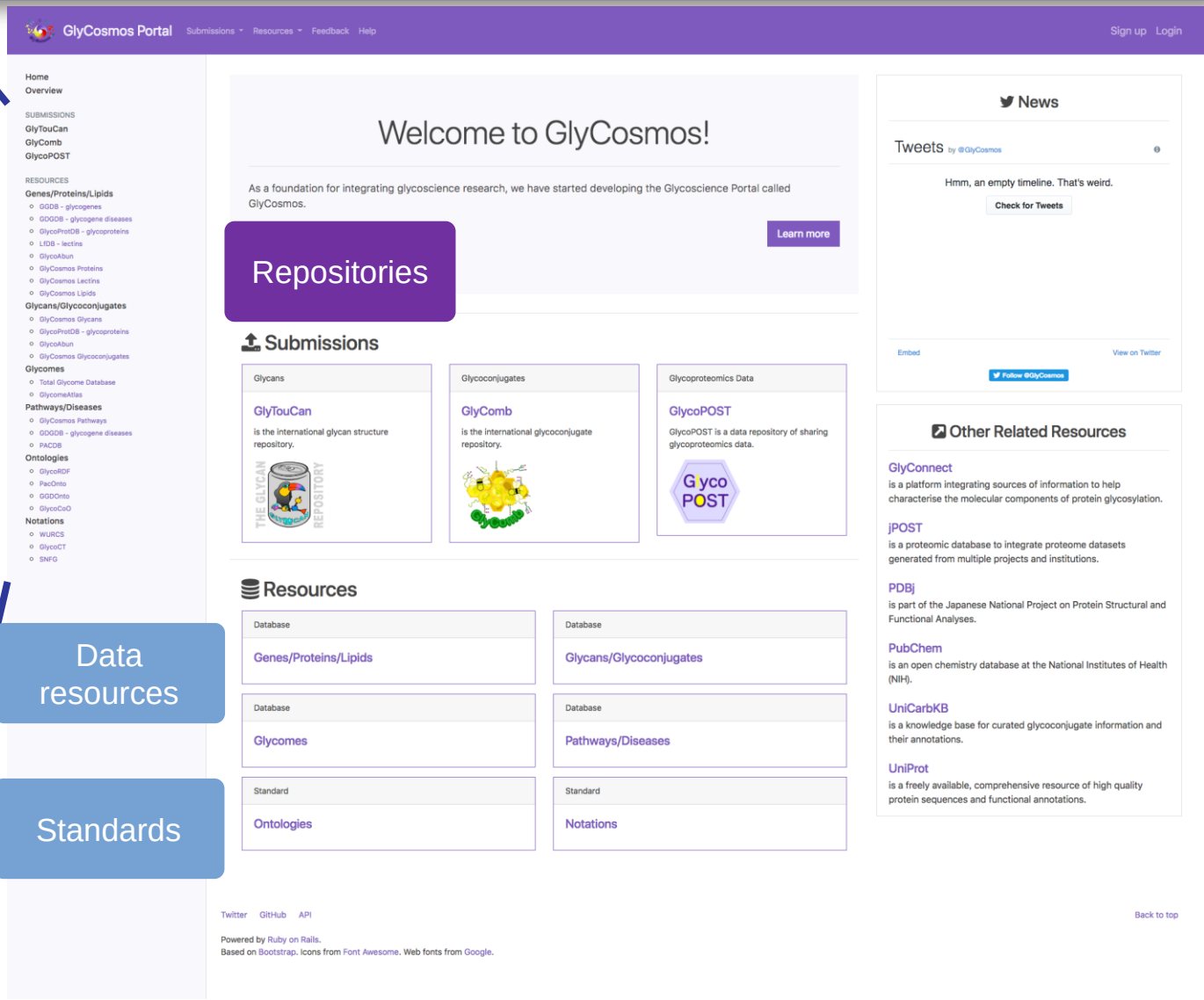
- GlyCosmos Pathways
- GDGDB - glycogene diseases
- PACDB

Ontologies

- GlycoRDF
- PacOnto
- GGDOnto
- GlycoCoO

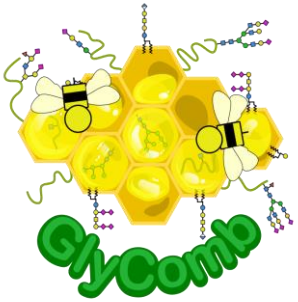
Notations

- WURCS
- GlycoCT
- SNFG



Repositories

糖鎖構造



複合糖質
（糖タンパク質・
糖脂質）

糖鎖・糖タンパク質の
質量分析データ

Glycan Databases

UniCarbKB

GlycomeDB

Bacterial Carbohydrate Structure Database | Plant & Fungal Carbohydrate Structure Database

GLYCOSCIENCES.DE

GlycoPOD | GlycoFarm | JCGGDB | GALA | Glycan | GGdb | LipidBank | GlycoProtDB

MONOSA | CCDB

Unique Glycan ID + Structure Data

Sharing

THE GLYCAN DATA REPOSITORY

GLY糖CAN

② Obtain Unique Glycan ID

① Structure Registration

④Curation

Annotation Data

Knowledge-Sharing of Glycan Knowledge via Internet

Glycan ID

③Manuscript submission

Glycan ID

Research Paper

MIRAGE

Glycan Research

Glycobiology Glycoforum

Glycobiology, 2017, vol. 27, no. 10, 915–919
doi: 10.1093/glycob/cwx066
Glyco-Forum

Letter to Glycoforum

GlyTouCan: an accessible glycan structure repository

Michael Tiemeyer[2], Kazuhiro Aoki[2], James Paulson[3], Richard D Cummings[4], William S York[2], Niclas G Karlsson[5], Frederique Lisacek[6], Nicolle H Packer[7,8], Matthew P Campbell[7], Nobuyuki P Aoki[9], Akihiro Fujita[9], Masaaki Matsubara[2], Daisuke Shinmachi[9], Shinichiro Tsuchiya[8], Issaku Yamada[10], Michael Pierce[2], René Ranzinger[2], Hisashi Narimatsu[11], and Kiyoko F Aoki-Kinoshita[9,1]

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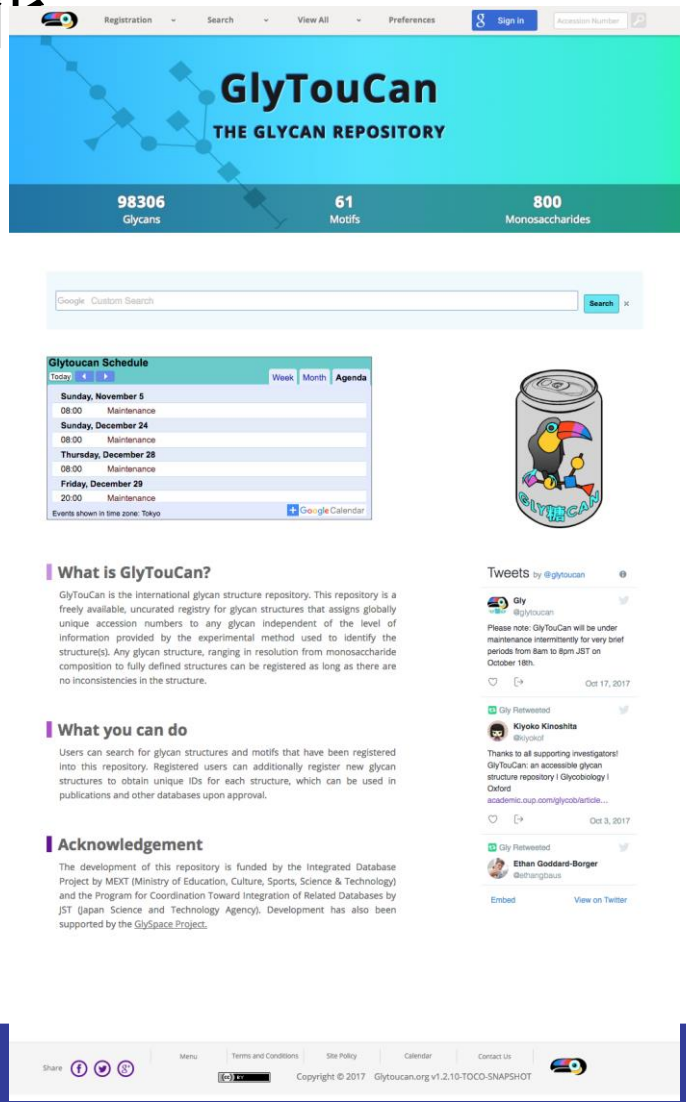
64. Heng Yin, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China
65. Joseph Zaia, Boston University, USA

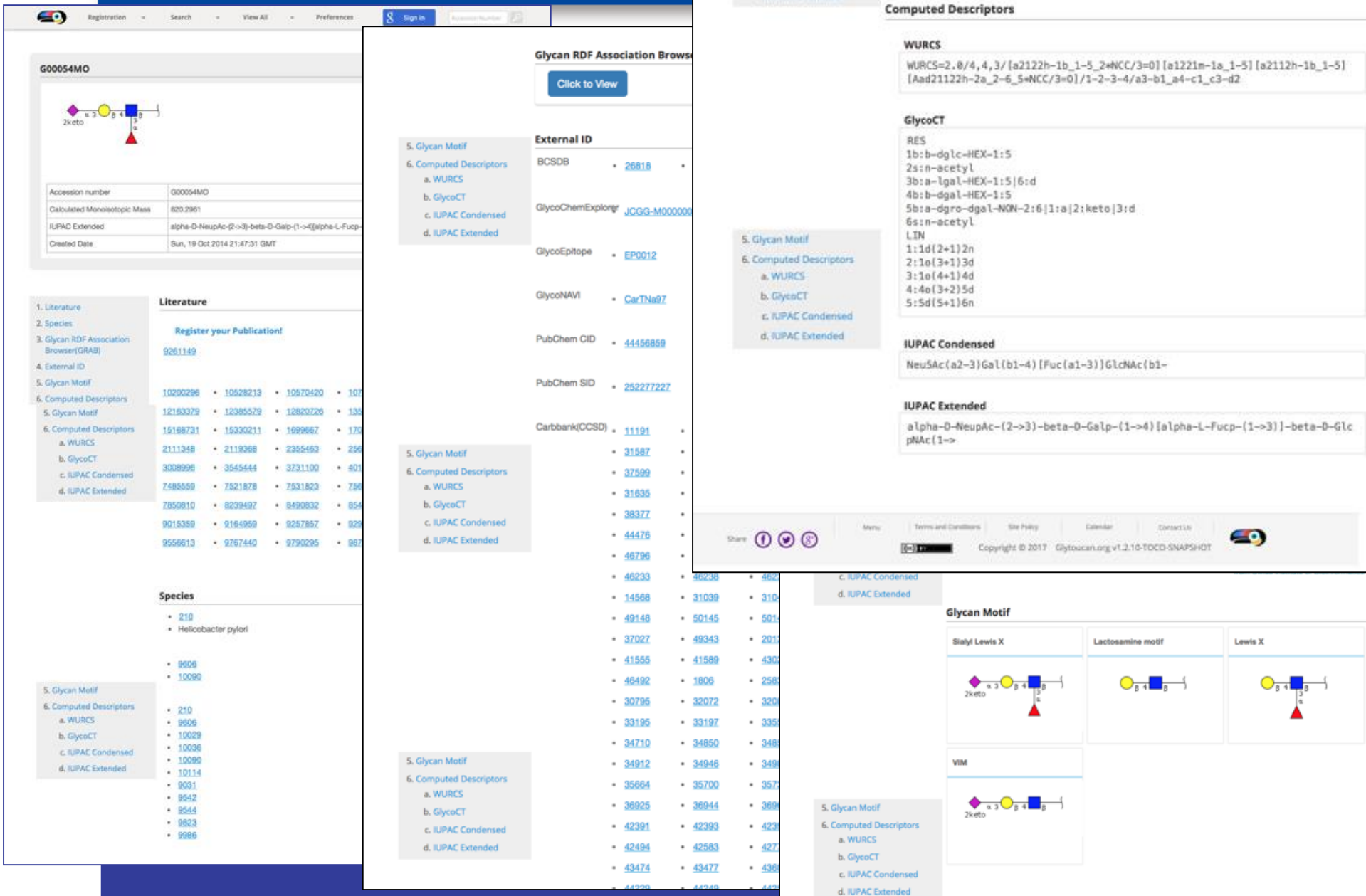
現在11万件以上の糖鎖構造が登録済み

- GlyTouCan Partners やBCSDB, GlycoEpitope などのデータベースを統合化

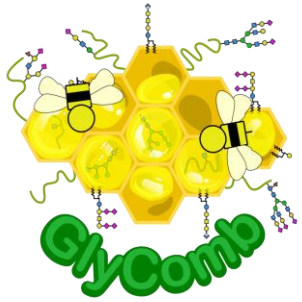
BCSDB (5428)
CFG (6374)
Carbbank(CCSD) (14840)
GLYCOSCIENCES.de (15905)
GlyConnect (3219)
GlycoChemExplorer (8021)
GlycoEpitope (169)
GlycoNAVI (91)
GlycoStore (23)
Glycobase (199)
GlycomeDB (39053)
JCGGDB (22039)
JCGGDB AIST (7867)
JMSDB (911)
KEGG (10134)
PDB (894)
PDBe CC (264)
PDBj CC (264)
PubChem CID (21356)
PubChem SID (21356)
RCSB PDB CC (264)
SugarBindDB (173)
UniCarb-DB (865)
UniCarbKB (171)



GlyTouCan エントリー



GlyComb



- Glycoconjugate Structure Repository

ex) GC00011

<u>Glycoproteins</u>

+Glycolipids+Glycosides+…

UniProt ID

- Glycosylation site
- Glycosylation site
- Glycosylation site

Sequence

MSALGAVIALLLWGQLFAVDSGNDVTDIADDGCPKPPEIAHGYVEHSVRYQCKNYYKLRTEGDGVYTLNDKKQ
WINKAVGDKLPECEADDGCPKPPEIAHGYVEHSVRYQCKNYYKLRTEGDGVYTLNNEKQWINKAVGDKLPECEA
VCGKPKNPANPVQRILGGHLDAKGSFPWQAKMVSHHNLTTGATLINEQWLLTTAKNLFLNHSENATAKDIAPTL
TLYVGKKQLVEIEKVVLHPNYSQVDIGLIKLKQKVSVNERVMPICLPSKDYAEVGRVGYVSGWGRNANFKFTDHL
KYVMLPVADQDQCIRHYEGSTVPEKKTPKSPVGVQPILNEHTFCAGMSKYQEDTCYGDAGSAFAVHDLEEDTW
YATGILSFDKSCAVAEYGVYVKVTSIQDWVQKTIAEN

Glycosylation site & Glycan Structure(s)

#	Site	GlyTouCan Accession	Image
1	184	G22340YC	
2	184	G74508NJ	
3	184	G73006TR	

GlyComb ID

4141ea8e28983831eea82f9896e7726f0833cba222c4fe16c6ed6861dfdd9e33

UniProt ID

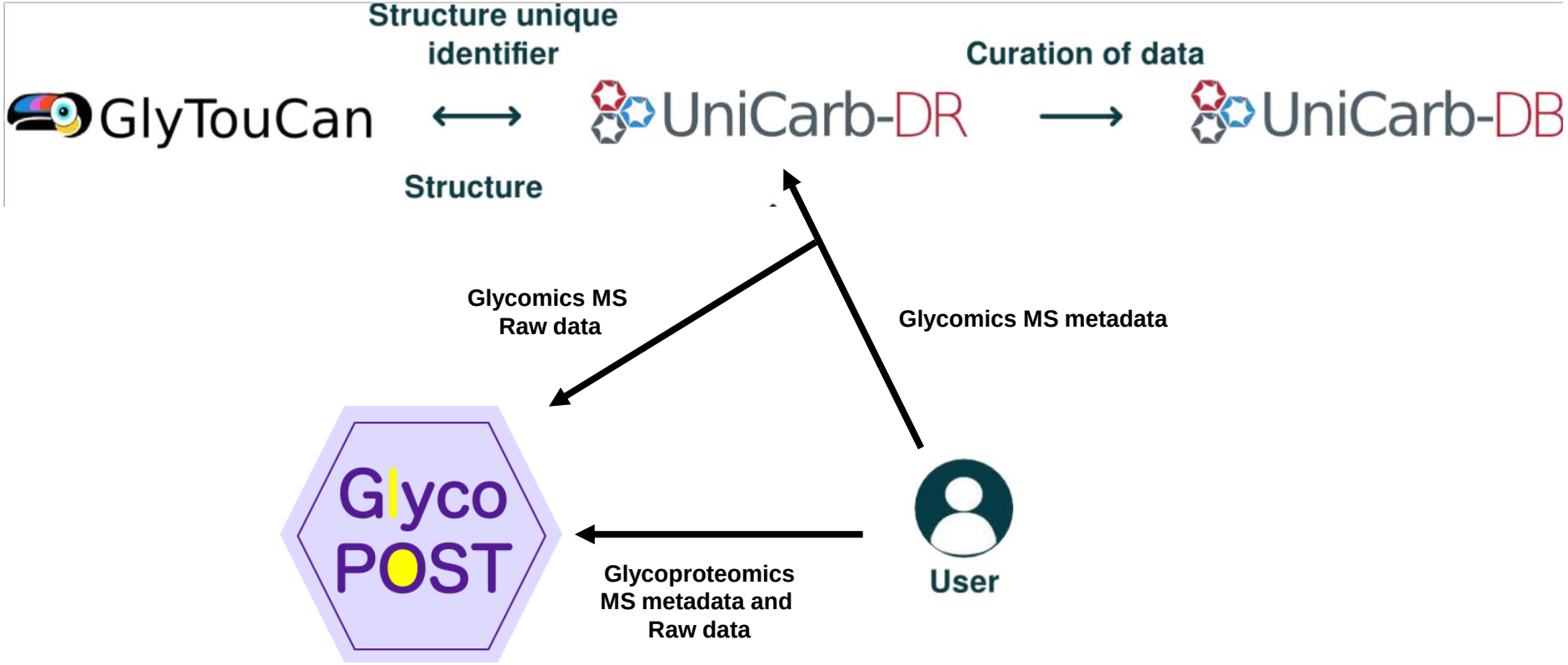
P00738

GlycoPOST

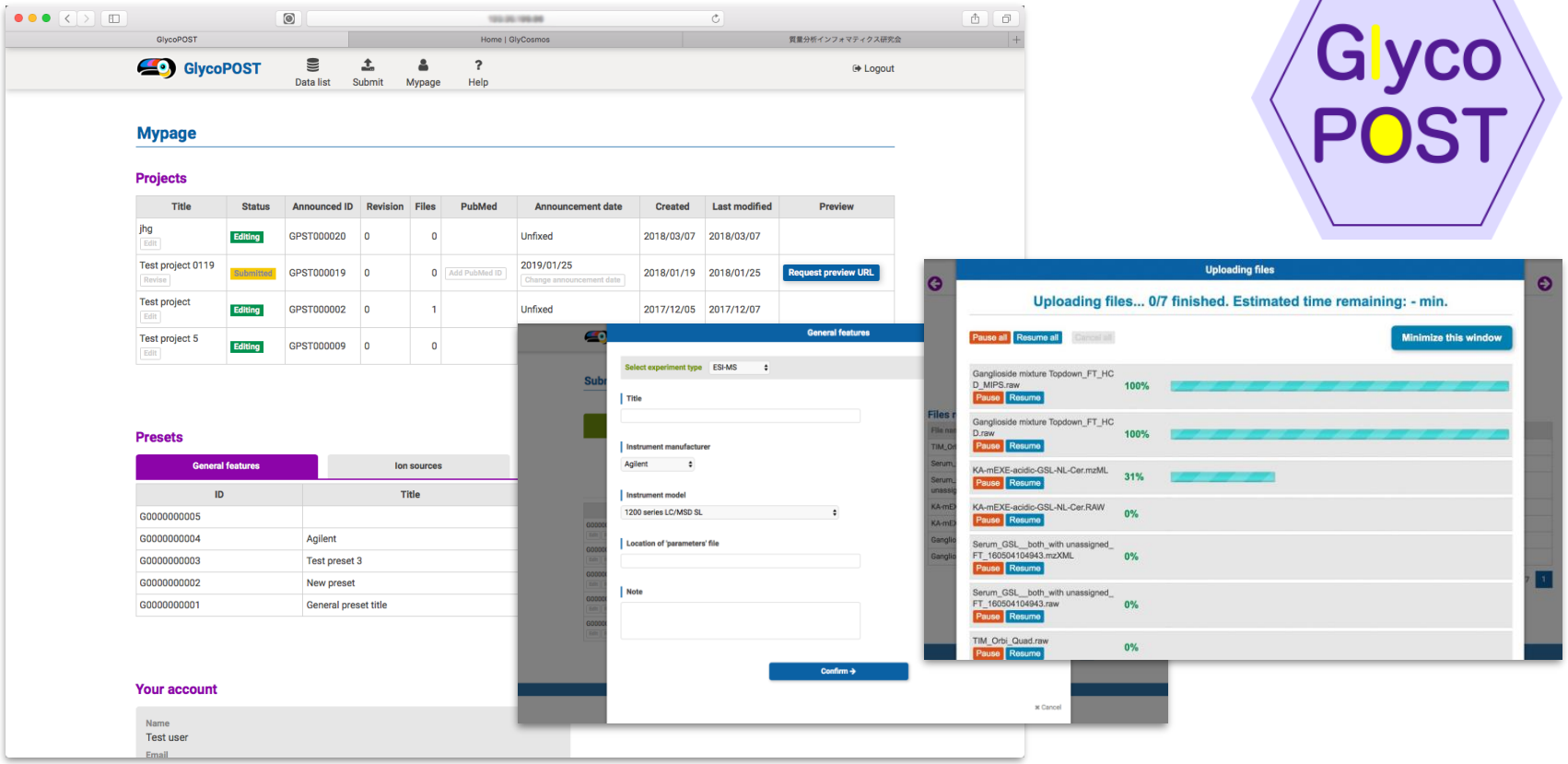
MIRAGE

Standards

Repositories



Web application development



Functionality to reuse input parameters and high-speed file transfer to accumulate useful data while minimizing user effort

Data resources

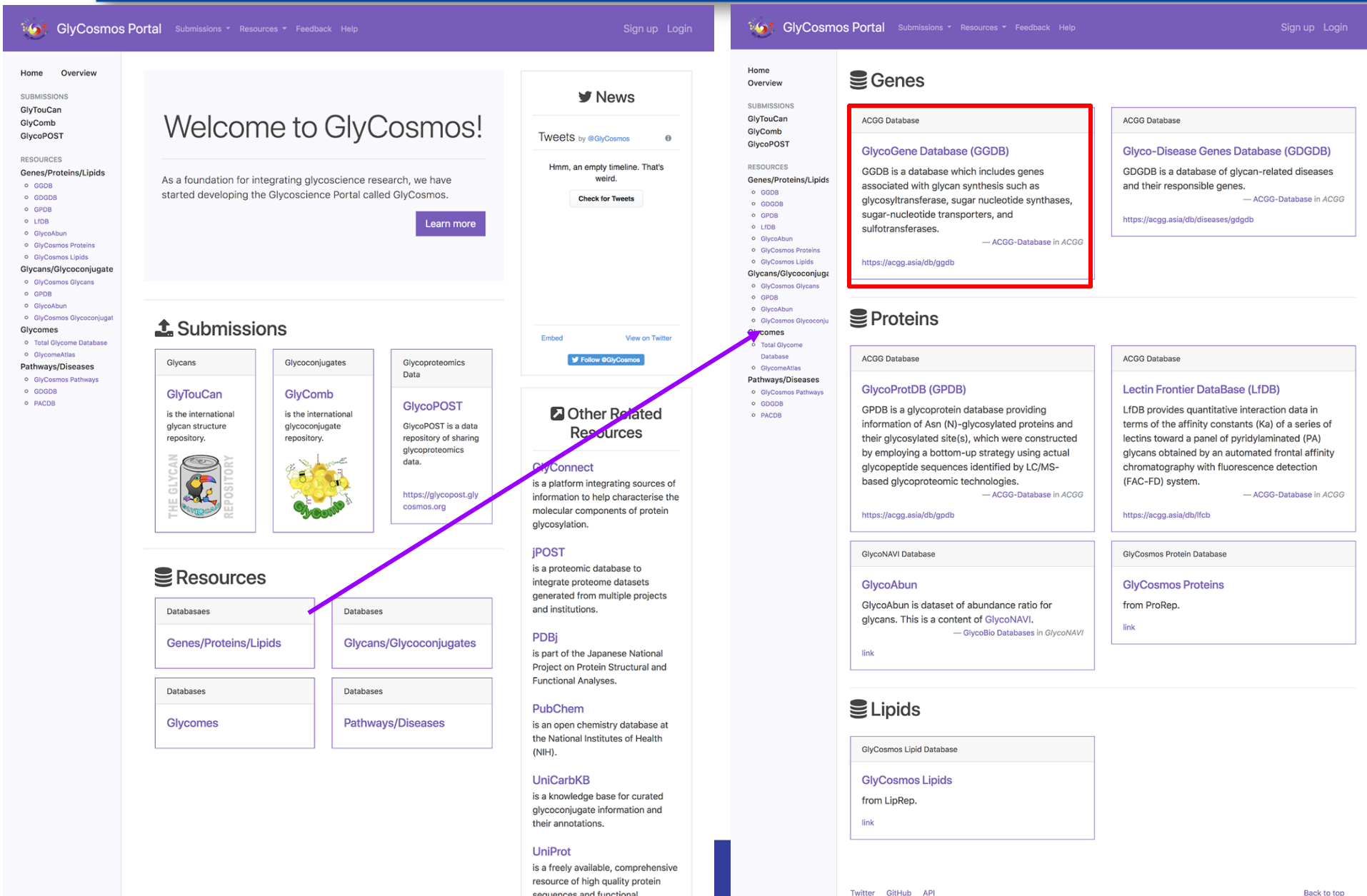
Genes/Proteins/Lipids

Glycans/Glycoconjugates

Glycomes

Pathways/Diseases

GlyCosmos Portal: glycogenes



Search

Family
- 18 (missing this field)
- 13 Fucosyltransferase
- 16 Galactosyltransferase
- 8 Glucosyltransferase
- 6 Glucuronyltransferase
- 5 Glucuronyltransferase N-

PathWay Class
- 13 glycolipid, ganglio series
- 10 glycolipid, globo series
- 27 glycolipid, lacto/neolacto series
- 19 Glycosaminoglycan, chondroitin sulfate
- 24 Glycosaminoglycan, heparan sulfate
- 16 Glycosaminoglycan, keratan sulfate

Keyword
- 80 (missing this field)
- 2 3'-phosphoadenosine 5'-phosphosulfate transporter
- 1 A blood type
- 1 a1,3-N-acetylgalactosaminyltransferase
- 2 alpha1,3-xylosyltransferase
- 1 asialo-GM2 (GA2)

Donor
- 45 (missing this field)
- 1 (not applicable)
- 1 ATP
- 2 CDP-Rbo
- 20 CMP-Neu5Ac
- 3 Dol-P-Glc

Expression
- 73 (missing this field)
- 1 aderenal gland
- 1 adipose
- 1 adrenal cortex
- 1 adrenal gland
- 31 adrenal glands

221 List of GlycoGenes

sorted by: GeneSymbol; then by... • grouped as sorted

A(ABO)

Pathway Class	glycolipid, lacto/neolacto series
Keyword	A blood type, Histo-Blood group antigen, a1,3-N-acetylgalactosaminyltransferase
Designation	alpha 1,3-N-acetylgalactosaminytransferase
Donor	UDP-GalNAc
Modify Date	2017-03-27

A4GALT

Pathway Class	glycolipid, globo series
Keyword	CD77, Gb3, globotriaosylceramide, glycolipid, glycosphingolipid
Designation	alpha 1,4-galactosyltransferase
Donor	UDP-Gal
Modify Date	2017-03-27

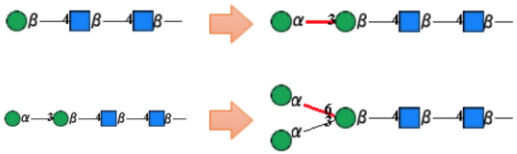
A4GNT

Pathway Class	O-glycan, mucin-type
Keyword	
Designation	alpha-1,4-N-acetylglucosaminyltransferase
Donor	UDP-GlcNAc
Modify Date	

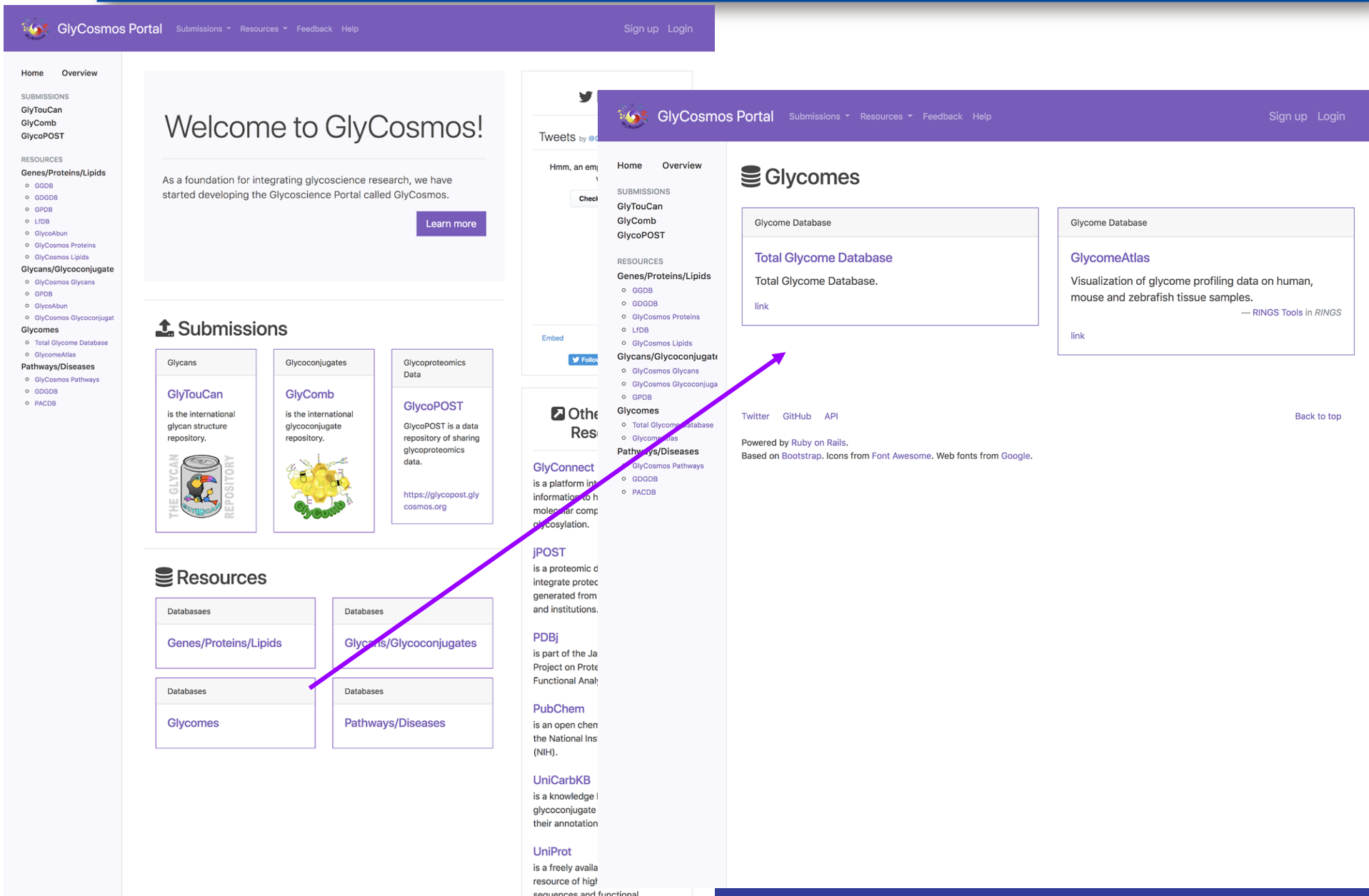
ALG1

Pathway Class	N-glycan
Keyword	congenital disorders of glycosylation, lipid-linked oligosaccharide
Designation	GDP-Mannose:GlcNAc2-PP-dolichol beta-1,4-mannosyltransferase
Donor	GDP-Man
Modify Date	2016-08-10

ALG2

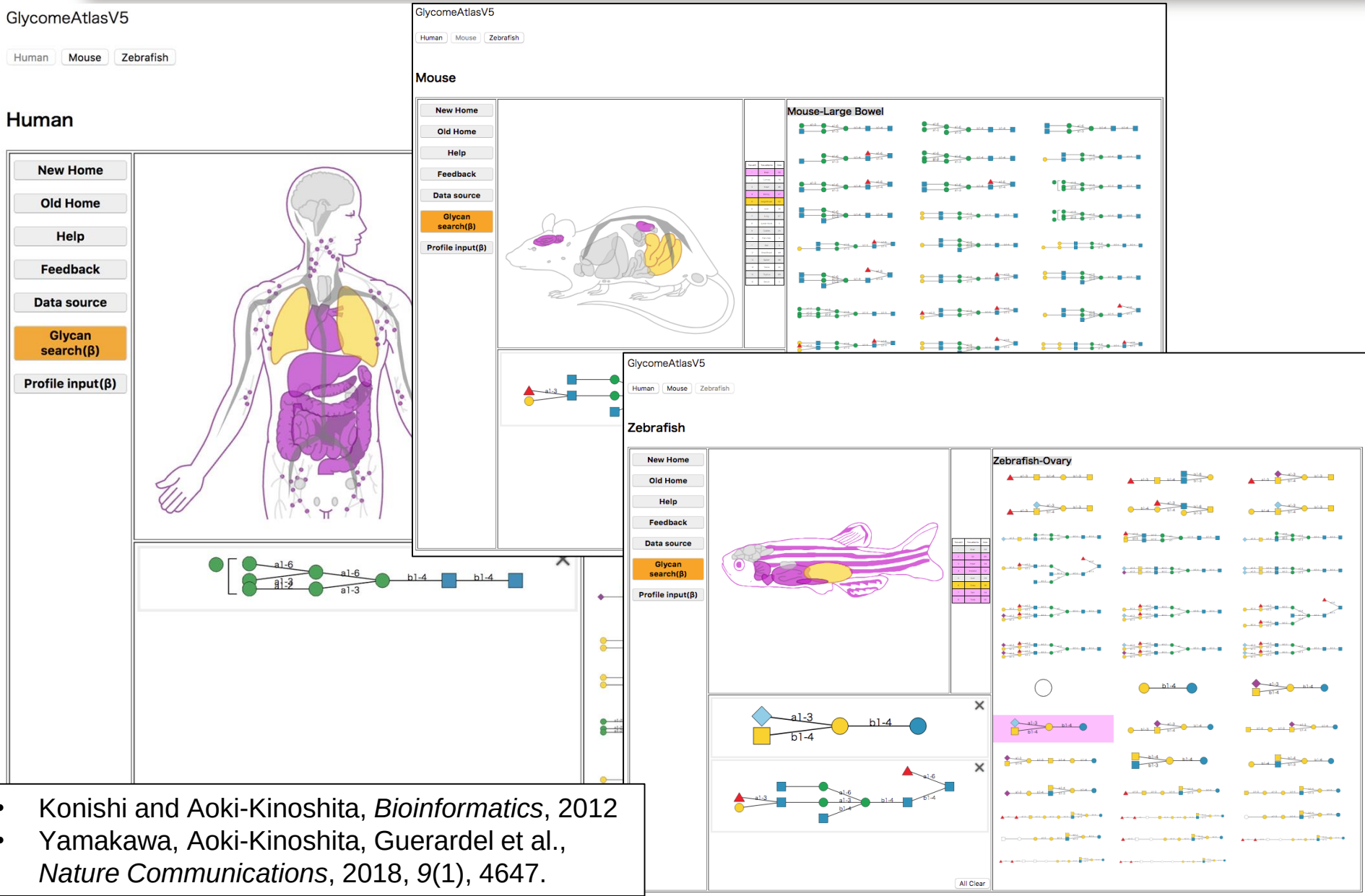


GlyCosmos Portal: glycomes



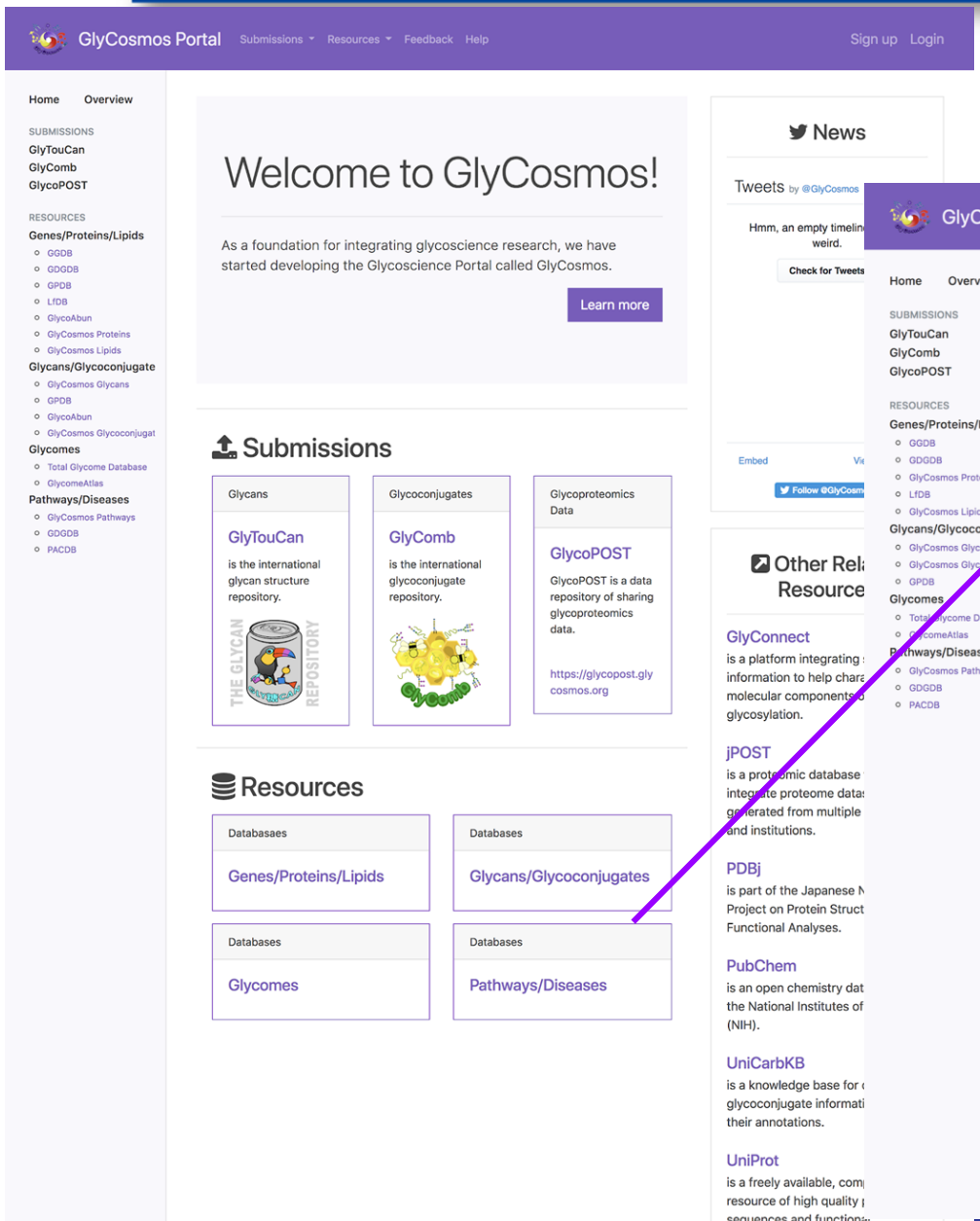
GlycomeAtlas

From RINGS http://www.rings.t.soka.ac.jp



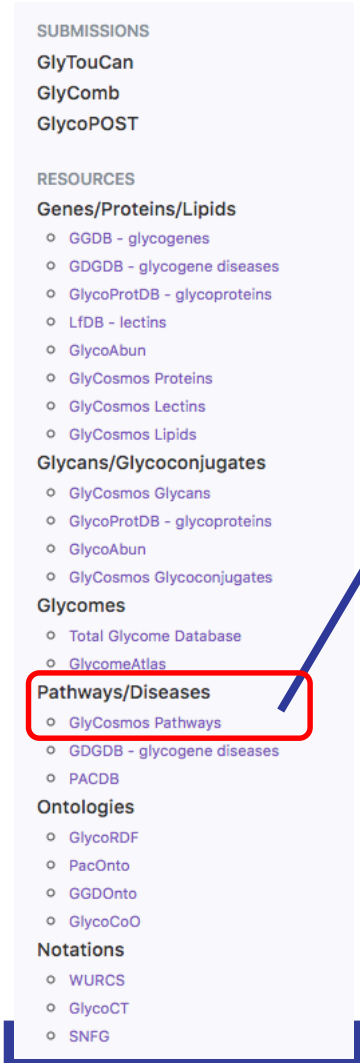
- Konishi and Aoki-Kinoshita, *Bioinformatics*, 2012
- Yamakawa, Aoki-Kinoshita, Guerardel et al., *Nature Communications*, 2018, *9*(1), 4647.

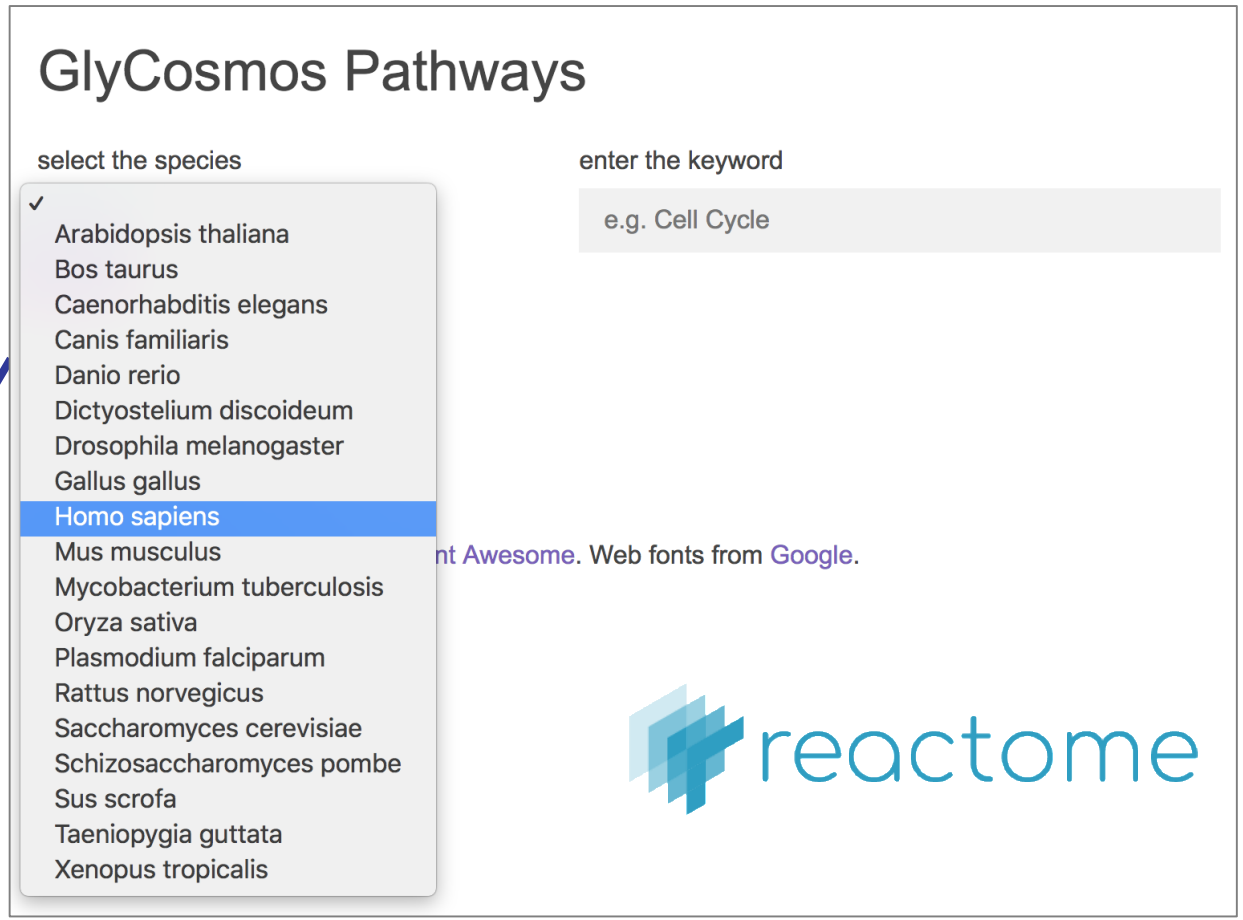
GlyCosmos Portal: pathways



GlyCosmos Pathways

- Retrieved data from Reactome (Ver. 63)
  Extracted 33,134 glycoproteins from UniProt, and used these to obtain 7,151 pathways in RDF format





GlyCosmos Pathways

Data resources

SUBMISSIONS
- GlyTouCan
- GlyComb
- GlycoPOST

RESOURCES

Genes/Proteins/Lipids
- GGDB - glycogenes
- GDGDB - glycogene diseases
- GlycoProtDB - glycoproteins
- LfDB - lectins
- GlycoAbun
- GlyCosmos Proteins
- GlyCosmos Lectins
- GlyCosmos Lipids

Glycans/Glycoconjugates
- GlyCosmos Glycans
- GlycoProtDB - glycoproteins
- GlycoAbun
- GlyCosmos Glycoconjugates

Glycomes
- Total Glycome Database
- GlycomeAtlas

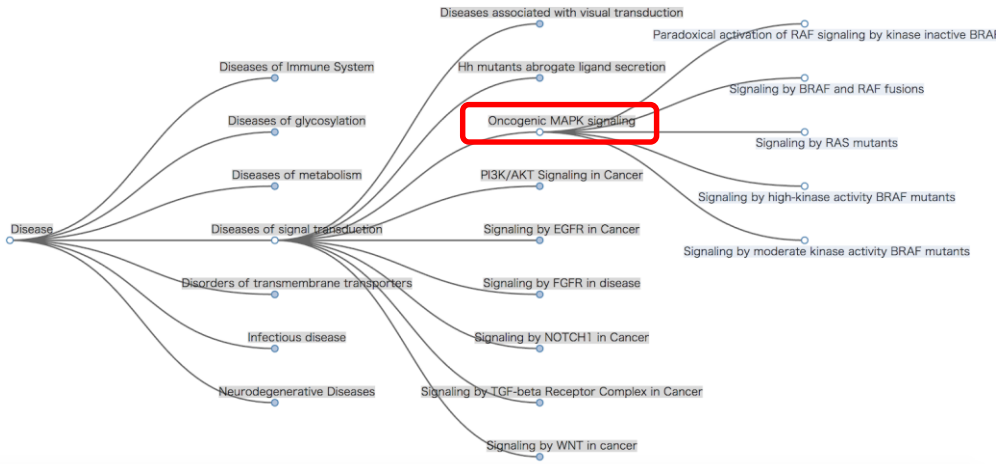
Pathways/Diseases
- GlyCosmos Pathways
- GDGDB - glycogene diseases
- PACDB

Ontologies
- GlycoRDF
- PacOnto
- GGDOnto
- GlycoCoO

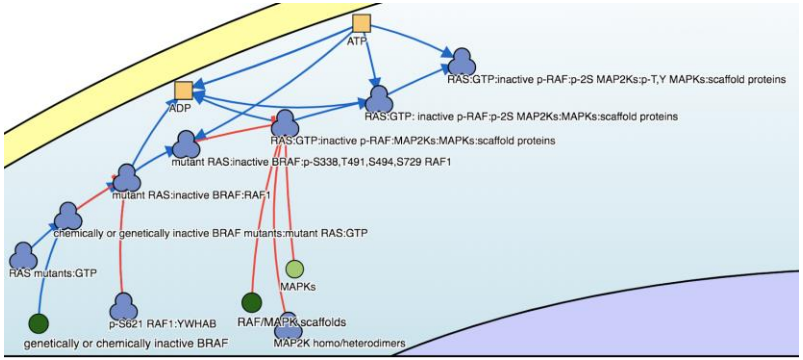
Notations
- WURCS
- GlycoCT
- SNFG

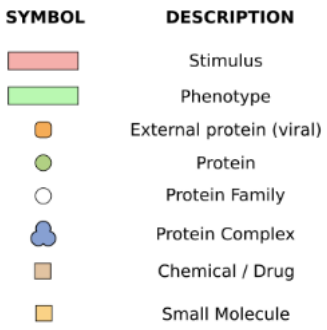
Selected species : Homo sapiens

Cell Cycle
Cell-Cell communication
Cellular responses to external stimuli
Chromatin organization
Circadian Clock
DNA Repair
DNA Replication
Developmental Biology
Digestion and absorption
Disease
Extracellular matrix organization
Gene expression (Transcription)
Hemostasis
Immune System
Metabolism
Metabolism of RNA
Metabolism of proteins
Muscle contraction
Neuronal System
Organelle biogenesis and maintenance
Programmed Cell Death
Reproduction
Signaling Pathways
Transport of small molecules
Vesicle-mediated transport



Oncogenic MAPK signaling
- Paradoxical activation of RAF signaling by kinase inactive BRAF



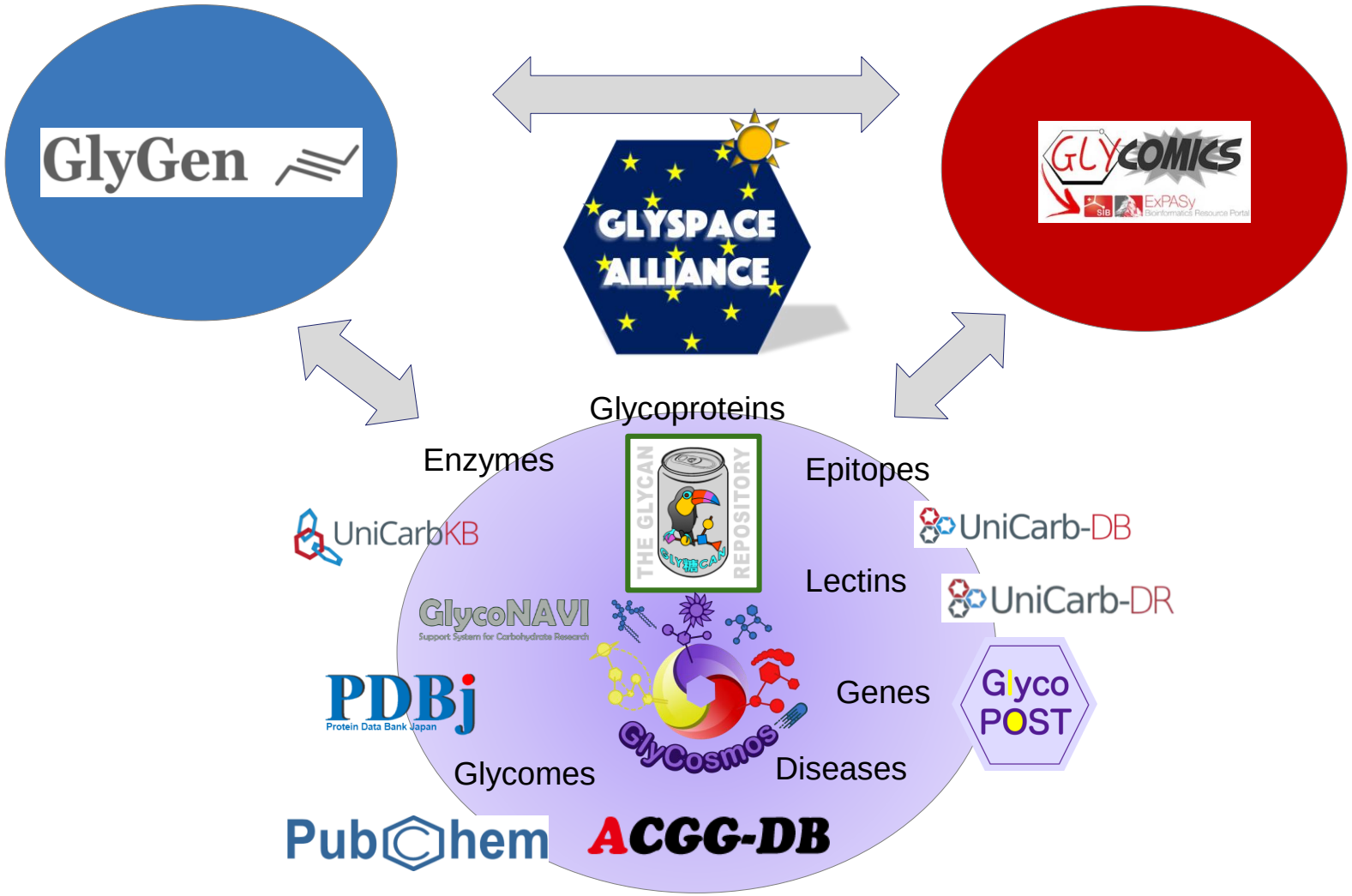


GlyCosmos Summary

- A foundational infrastructure for data generated by the glycoscience community to promote glycoscience research
- A user-friendly Web portal where beginners from a wide variety of fields can browse glycoscientific data
- By using Semantic Web technologies, all data will be made available by a SPARQL endpoint in RDF format and linked easily with many data resources

- Beta version has been released today (October 5, 2018 JST)
  - https://glycosmos.org
  - @GlyCosmos

GlySpace Alliance



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