

NEUROLEX: A SEMANTIC WIKI FOR NEUROSCIENCE

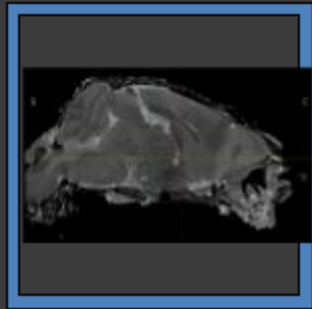
Stephen D. Larson

Implementing 'Big Open Data' in government through
Open Collaboration - case examples and possibilities

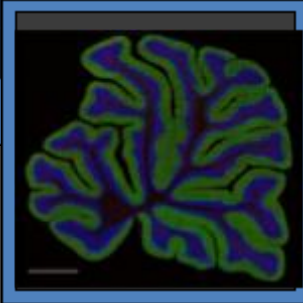
Joint Data.Gov – Ontolog “Big Open Data” Session

05/17/12

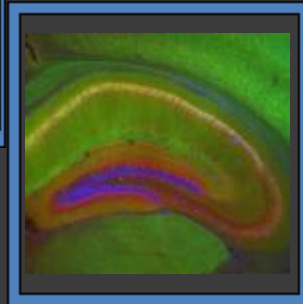
A multi-scale data problem



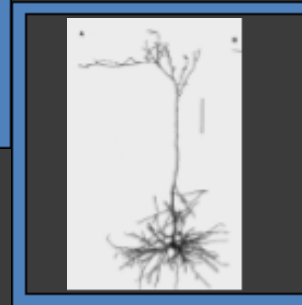
Whole brain data
(20 um
microscopic MRI)



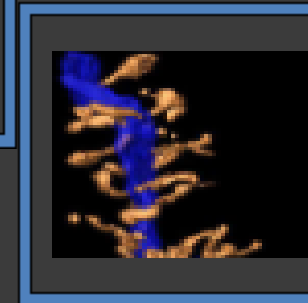
Mosaic LM
images (1 GB+)



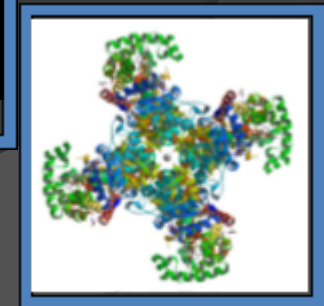
Conventional LM
images



Individual cell
morphologies



EM volumes &
reconstructions



Solved molecular
structures

Scale

Framework of parts

PERIODIC TABLE OF THE ELEMENTS

<http://www.ktf-split.hr/periodni/en/>

PERIOD	GROUP I IA	GROUP IIA	GROUP IUPAC	GROUP CAS	GROUP IIIA	GROUP IVA	GROUP VA	GROUP VIA	GROUP VIIA	GROUP VIIIA								
1	1 1.0079 H HYDROGEN									2 4.0026 He HELIUM								
2	3 6.941 Li LITHIUM	4 9.0122 Be BERYLLIUM			5 10.811 B BORON													
3	11 22.990 Na SODIUM	12 24.305 Mg MAGNESIUM																
4	19 39.098 K POTASSIUM	20 40.078 Ca CALCIUM	21 44.956 Sc SCANDIUM	22 47.867 Ti TITANIUM	23 50.942 V VANADIUM	24 51.996 Cr CHROMIUM	25 54.938 Mn MANGANESE	26 55.845 Fe IRON	27 58.933 Co COBALT	28 58.693 Ni NICKEL	29 63.546 Cu COPPER	30 65.39 Zn ZINC	31 69.723 Ga GALLIUM	32 72.64 Ge GERMANIUM	33 74.922 As ARSENIC	34 78.96 Se SELENIUM	35 79.904 Br BROMINE	36 83.80 Kr KRYPTON
5	37 85.468 Rb RUBIDIUM	38 87.62 Sr STRONTIUM	39 88.906 Y YTTRIUM	40 91.224 Zr ZIRCONIUM	41 92.906 Nb NIObIUM	42 95.94 Mo MOLYBDENUM	43 (98) Tc TECHNETIUM	44 101.07 Ru RUTHENIUM	45 102.91 Rh RHODIUM	46 106.42 Pd PALLADIUM	47 107.87 Ag SILVER	48 112.41 Cd CADMIUM	49 114.82 In INDIUM	50 118.71 Sn TIN	51 121.76 Sb ANTIMONY	52 127.60 Te TELLURIUM	53 126.90 I IODINE	54 131.29 Xe XENON
6	55 132.91 Cs CAESIUM	56 137.33 Ba BARIUM	57-71 La-Lu Lanthanide	72 178.49 Hf HAFNIUM	73 180.95 Ta TANTALUM	74 183.84 W TUNGSTEN	75 186.21 Re RHENIUM	76 190.23 Os OSMIUM	77 192.22 Ir IRIDIUM	78 195.08 Pt PLATINUM	79 196.97 Au GOLD	80 200.59 Hg MERCURY	81 204.38 Tl THALLIUM	82 207.2 Pb LEAD	83 208.98 Bi BISMUTH	84 (209) Po POLONIUM	85 (210) At ASTATINE	86 (222) Rn RADON
7	87 (223) Fr FRANCIUM	88 (226) Ra RADIUM	89-103 Ac-Lr Actinide	104 (261) Rf RUTHERFORDIUM	105 (262) Db DUBNIUM	106 (266) Sg SEABORGIUM	107 (264) Bh BOHRIUM	108 (277) Hs HASSIUM	109 (268) Mt MEITNERIUM	110 (281) Uuq UNUNQUADIUM	111 (272) Uuu UNUNUNIUM	112 (285) Uub UNUNBIUM	114 (289) Uuq UNUNQUADIUM					

RELATIVE ATOMIC MASS (1)

GROUP IUPAC

GROUP CAS

ATOMIC NUMBER

SYMBOL

ELEMENT NAME

- Metal
- Semimetal
- Nonmetal
- 1 Alkali metal
- 2 Alkaline earth metal
- Transition metals
- Lanthanide
- Actinide
- 16 Chalcogens element
- 17 Halogens element
- 18 Noble gas

STANDARD STATE (25 °C; 101 kPa)

Ne - gas Fe - solid Ga - liquid Tc - synthetic

LANTHANIDE

Copyright © 1998-2003 EniG. (eni@ktf-split.hr)

(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)

Relative atomic mass is shown with five significant figures. For elements having no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.

However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

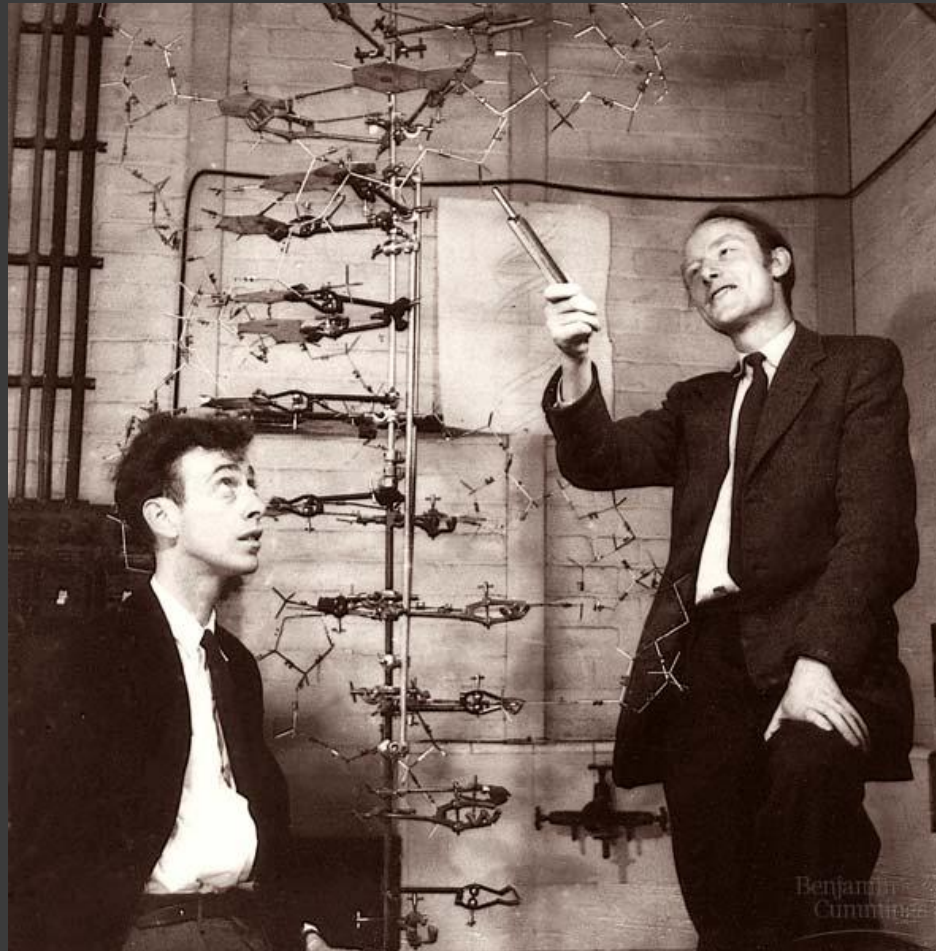
57 138.91 La LANTHANUM	58 140.12 Ce CERIUM	59 140.91 Pr PRASEODYMIUM	60 144.24 Nd NEODYMIUM	61 (145) Pm PROMETHIUM	62 150.36 Sm SAMARIUM	63 151.96 Eu EUROPIUM	64 157.25 Gd GADOLINIUM	65 158.93 Tb TERBIUM	66 162.50 Dy DYSPROSIUM	67 164.93 Ho HOLMIUM	68 167.26 Er ERBIUM	69 168.93 Tm THULIUM	70 173.04 Yb YTTERIUM	71 174.97 Lu LUTETIUM
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ACTINIDE

89 (227) Ac ACTINIUM	90 232.04 Th THORIUM	91 231.04 Pa PROTACTINIUM	92 238.03 U URANIUM	93 (237) Np NEPTUNIUM	94 (244) Pu PLUTONIUM	95 (243) Am AMERICIUM	96 (247) Cm CURIUM	97 (247) Bk BERKELIUM	98 (251) Cf CALIFORNIUM	99 (252) Es EINSTEINIUM	100 (257) Fm FERMIUM	101 (258) Md MENDELEVIUM	102 (259) No NOBELIUM	103 (262) Lr LAWRENCIUM
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Editor: Aditya Vardhan (adivard@netlinux.com)

Multi-scale synthesis in biology



Watson & Crick, 1953

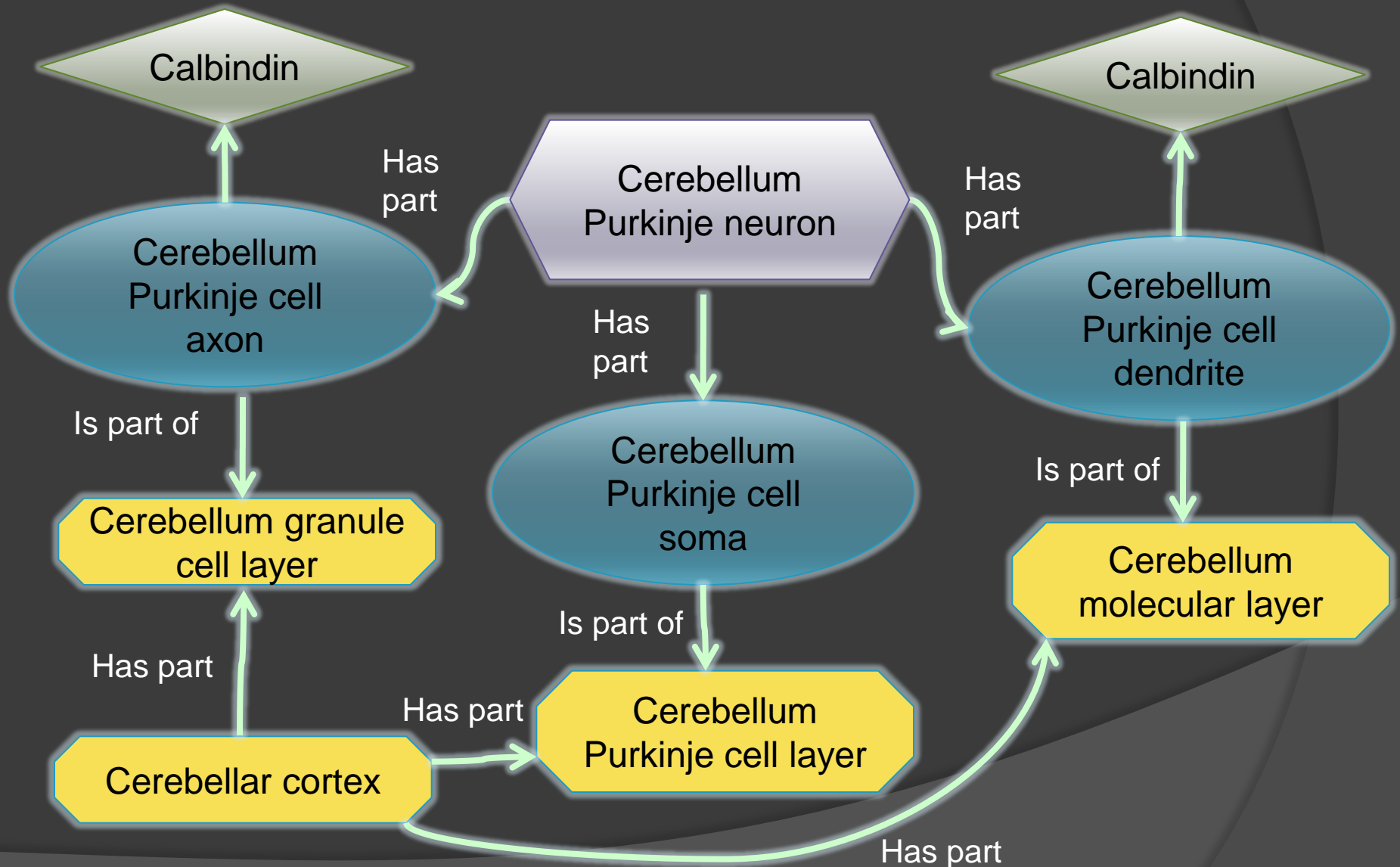
Organizing frameworks for knowledge

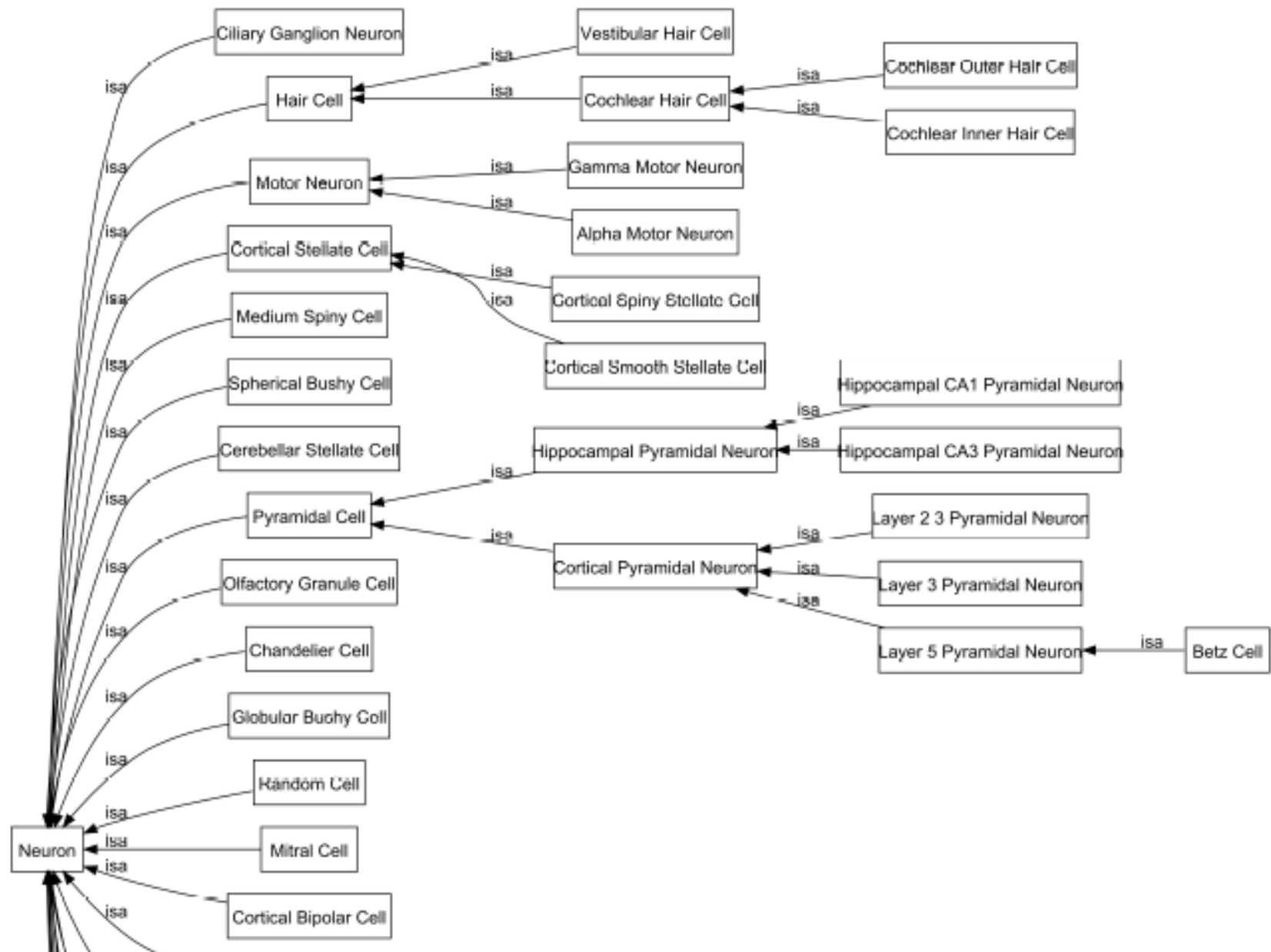


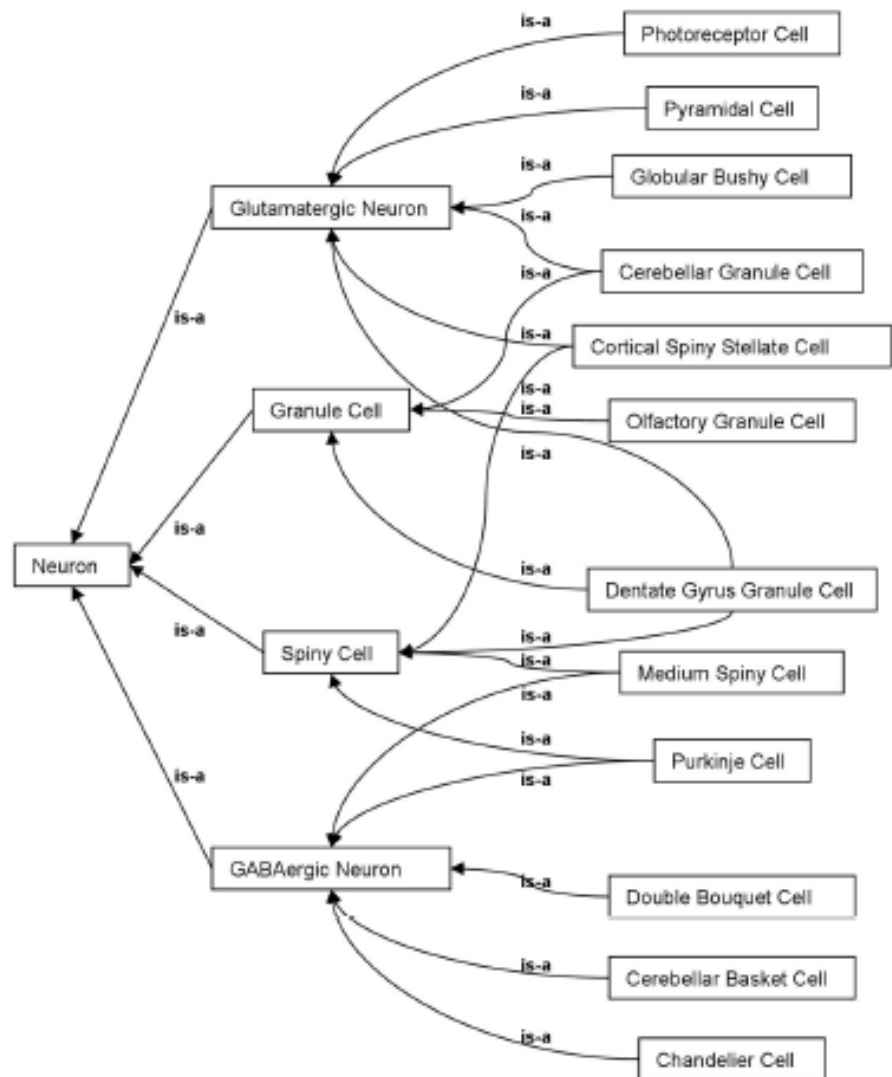
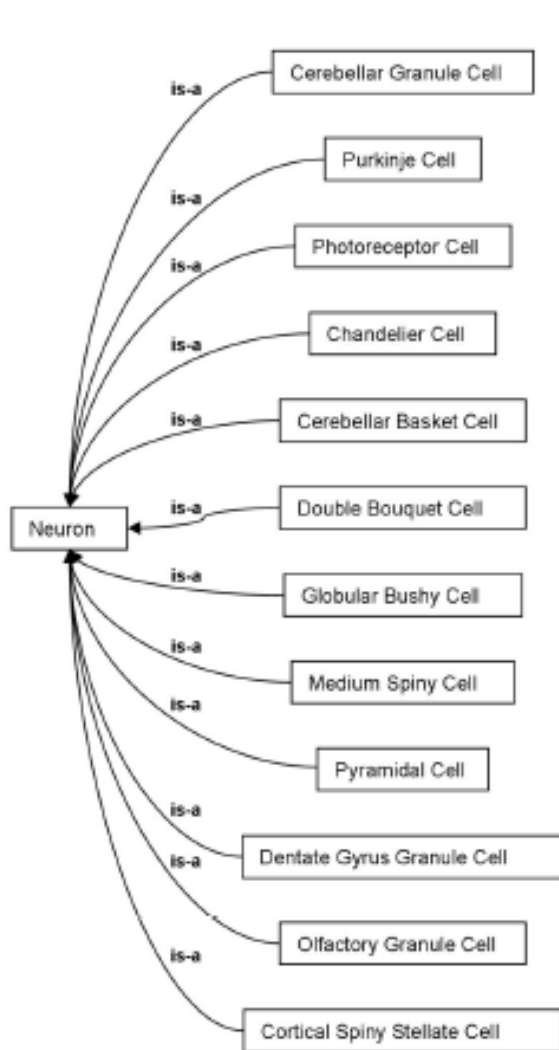
Knowledge in words, terminologies and logical relationships (the “what”)

Past

Shared building blocks







Present

Organizing knowledge online

NIF

NEUROSCIENCE INFORMATION FRAMEWORK



▼ ABOUT

About NIF

People

Publications

Presentations

Brochures

Testimonials

Release Notes 4.0

FAQ

► NIF PRODUCTS

► NIF DATA SHARING

► NIF SYSTEM

► SOCIAL MEDIA

NEUROLEX

HELP

Registered with NIF?
Place this icon on your site.



[Find out how.](#)

Search for All Things Neuroscience

Search Data Federation

SEARCH TIPS | WHAT IS THIS? (example searches: cerebellum, "pulvinar nucleus", gene:gmt1)

Search NeuroLex

NIF

Find What You are Looking for.

Faster.

NIF

NIF NAVIGATOR

LITERATURE →

PubMed (21210473)

DATA TYPE →

Animals (271504)

Antibodies (935642)

Biospecimen (35833)

Brain Activation Foci (56581)

Clinical Trials (107560)

Connectivity (132460)

Dataset (611)

Disease (27067)

Drugs (656465)

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Images (591097)

Microarray (312252579)

Models (705)

Multimedia (14005)

Pathways (497035)

People (377)

Plasmids (21152)

Software (1116)

NERVOUS SYSTEM LEVELS →

Brain Regions (50083)

Cellular Level (29509)

Genes (64754164)

Molecular Level (697691)

Multi-Level (2850991)

Nervous System Function
(66226)

NIF REGISTRY (4718) →

Community News & Events

NIF Top 25 Accessed Databases for February 2012

February 24th, 2012 02:57 PM

What are the top 25 accessed databases for February 2012? Find out here! [read more >](#)

Twitter

One Mind for Research announces
General Peter W. Chiarelli (US Army,
ret) as Chief Executive Officer @
<http://t.co/g1uoW6Hu> about 17 hours

Organizing knowledge online



Top 25 accessed databases in NIF

- 1.Grants.gov / Opportunity
- 2.SumsDB / Activation Foci
- 3.CCDB / All Information
- 4.Antibody Registry / Abs
- 5.GENSAT / GENSAT
- 6.Research Crossroads / Grants
- 7.BrainInfo /Brain Region
- 8.Drug Related Gene Database
- 9.NIF Integrated Nervous System/Connectivity
- 10.RePORTER / CurrentNIHGrants
- 11.AllenInstitute / MouseBrainAtlas
- 12.OneMind / BioBanks
- 13.ClinicalTrials / ClinTr
- 14.OMIM / Genes
- 15.DrugBank / Drugs
- 16.ModelDB / Models
- 17.NIF Integrated Animals / Available
- 18.Gemma / Microarray
- 19.NIF Integrated Brain Gene/Expression
- 20.EntrezGene / NCBI Gene
- 21.NIF Integrated Software / Info
- 22.NIF Integrated Video / Videos
- 23.GeneNetwork / Info
- 24.NeuroMorpho / NeuronInfo
- 25.Human Brain Atlas / Michigan

Need for an online parts list

“We need a parts catalog for the brain” – Society for Neuroscience Keynote lecture, 2009

Parts of Cerebellum

Click the + next to "Cerebellum" to see its parts



[-] Cerebellum

- + Cerebellum
 - + Posterior lobe of the cerebellum
 - + Flocculonodular lobe
 - + Anterior lobe of the cerebellum
 - + Deep cerebellar nuclear complex
 - + Cerebellar cortex
 - [-] Climbing fiber
 - + Cerebellar Corticopontine Projection
 - + Cerebellar Pontocerebellar Projection
 - [-] Cerebellar Serotonergic Afferents
 - [-] Prepositus Nuclear Complex

Inferred incoming projections for Cerebellum

Receives projections from Central cervical spinocerebellar tract, Cerebellar Serotonergic Afferents, Climbing fiber, Posterior spinocerebellar tract, and Rostral spinocerebellar tract

Neurons in Cerebellum

Cerebellum Golgi cell, Cerebellum Lugaro cell, Cerebellum Purkinje cell, Cerebellum basket cell, Cerebellum granule cell, Cerebellum stellate cell, Cerebellum unipolar brush cell, and Golgi II cell are neurons that can be found in Cerebellum or its parts.



Larry Swanson,
University of Southern
California

Organizing knowledge online

- Built on Semantic MediaWiki
- Uses Semantic Forms to Structure data
- Originally populated from 8-10 community ontologies
- Allows anyone to edit or create new concepts
- ~18,000 concepts

The screenshot shows the NeuroLex website. The header features the 'NEURO LEX' logo and the title 'THE NEUROSCIENCE LEXICON' with the subtitle 'POWERED BY THE NEUROSCIENCE INFORMATION FRAMEWORK'. A search bar is located in the top right. Below the header, there are navigation tabs for 'Neurons' and 'Brain Regions', and a 'Main Page' link. A 'Page' tab is active, and a 'Discussion' tab is also visible. The main content area displays a welcome message: 'Welcome to NeuroLex, the Neuroscience Lexicon.' followed by a description: 'A dynamic lexicon of 15,993 neuroscience terms supported by The Neuroscience Information Framework'. Below this, there are links for 'About', 'What's new', 'FAQs', 'NIFSTD ontologies', 'How to Contribute', 'Curation policies', and 'Subscribe to Neurolex mailing list'. A search box with a 'Find a Term!' button is present. There are also buttons for 'Show me a Random Term!' and 'All Categories' with an alphabet list. At the bottom, there are three input fields with buttons to 'Create a new cell', 'Create a new brain region', and 'Create a new resource'. On the right side, there are two columns: 'HIERARCHIES' and 'TABLES', each containing a list of categories and terms.

NEURO LEX

THE NEUROSCIENCE LEXICON POWERED BY THE NEUROSCIENCE INFORMATION FRAMEWORK

Search this wiki

Neurons Brain Regions

Main Page

Page Discussion History More

Welcome to **NeuroLex**, the Neuroscience Lexicon.

A dynamic lexicon of 15,993 neuroscience terms supported by [The Neuroscience Information Framework](#)

[About](#) • [What's new](#) • [FAQs](#) • [NIFSTD ontologies](#) • [How to Contribute](#) • [Curation policies](#) • [Subscribe to Neurolex mailing list](#)

Find a Term!

Show me a Random Term!

All Categories [A](#) [B](#) [C](#) [D](#) [E](#) [F](#) [G](#) [H](#) [I](#) [J](#) [K](#) [L](#) [M](#) [N](#) [O](#) [P](#) [Q](#) [R](#) [S](#) [T](#) [U](#) [V](#) [W](#) [X](#) [Y](#) [Z](#)

Create a new cell

Create a new brain region

Create a new resource

HIERARCHIES

- Behavioral Activity
- Behavioral Paradigms
- Brain Regions
- Cells
- Neurons
- Diseases
- Molecules
- Nervous System Function
- Subcellular Parts
- Resource Types
- Qualities

TABLES

- Behavioral Activity
- Brain Regions
- Cell Types
- Diseases
- Molecules
- Nervous System Function
- Neurons
- Neurons by Neurotransmitter
- Organisms
- Resources and Information Entities
- Subcellular Parts
- Qualities

Warning: You are not logged in. Your IP address will be recorded in this page's edit history.

Cerebellum granule cell

BASIC DETAIL REFERENCES ADVANCED



NIF Standard

Definition: Small, numerous neuron in the granule cell layer of the vertebrate cerebellar cortex, characterized by a very small soma and several short dendrites which terminate with claw-shaped endings. In the transmission electron microscope, these cells are characterized by a darkly stained nucleus surrounded by a thin rim of cytoplasm. The axon ascends into the molecular layer where it bifurcates

Definition Pub Med Id:

Synonym(s): Cerebellar granule neuron, Cerebellar granule cell

Synonym Pub Med Id:

Related to:

Related to Pub Med Id:

Has role:

Has role Pub Med Id:

Intrinsic Properties

Neurotransmitter released:

Neurotransmitter receptors:

Molecular constituents:

Molecular constituents Pub Med Id:

This is a minor edit Watch this page

Save page Show preview Show changes Cancel

Save page

Glutamatergic neuron

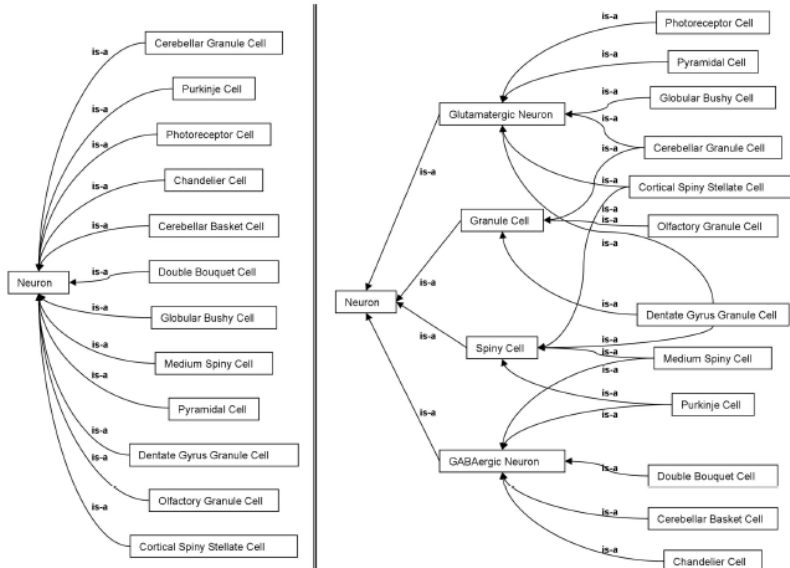
C	N	R
<ul style="list-style-type: none"> Cerebellum granule cell Cerebellum unipolar brush cell Cochlea hair cell inner Cochlea hair cell outer 	<ul style="list-style-type: none"> Neocortex pyramidal cell Neocortex pyramidal cell layer 5-6 	<ul style="list-style-type: none"> Retina bipolar cell Retina ganglion cell
D	O	S
<ul style="list-style-type: none"> Dentate gyrus granule cell Dorsal root ganglion cell 	<ul style="list-style-type: none"> Olfactory bulb (accessory) mitral cell Olfactory bulb (main) mitral cell Olfactory bulb (main) tufted cell (middle) Olfactory cortex large multipolar cell Olfactory cortex pyramidal cell Olfactory cortex semilunar cell Olfactory epithelium main sensory cell Olfactory epithelium main supporting cell 	<ul style="list-style-type: none"> Spinal cord ventral horn interneuron VoG Spinal cord ventral horn interneuron V3 Subiculum pyramidal cell
G	T	V
<ul style="list-style-type: none"> Gracilis nucleus principal cell 	<ul style="list-style-type: none"> Thalamus relay cell 	
H		
<ul style="list-style-type: none"> Hippocampus CA1 pyramidal cell Hippocampus CA2 pyramidal neuron Hippocampus CA3 pyramidal cell 		<ul style="list-style-type: none"> Vestibular ganglion cell Vestibular hair cell

Cerebellum neuron

BASIC ADVANCED FACTBOX

Name:	Cerebellum neuron
Description:	Neuron whose soma lies in any part of the cerebellum or cerebellar cortex
Synonym(s):	cerebellar cell, cerebellar neuron
Super-category:	Defined neuron class
Id:	nlx_cell_0912002
Link to OWL / RDF:	Download this content as OWL/RDF

Cerebellum granule cell	nifext_128	Cerebellar granule neuron Cerebellar granule cell
-------------------------	------------	--



Molecular layer of cerebellar cortex

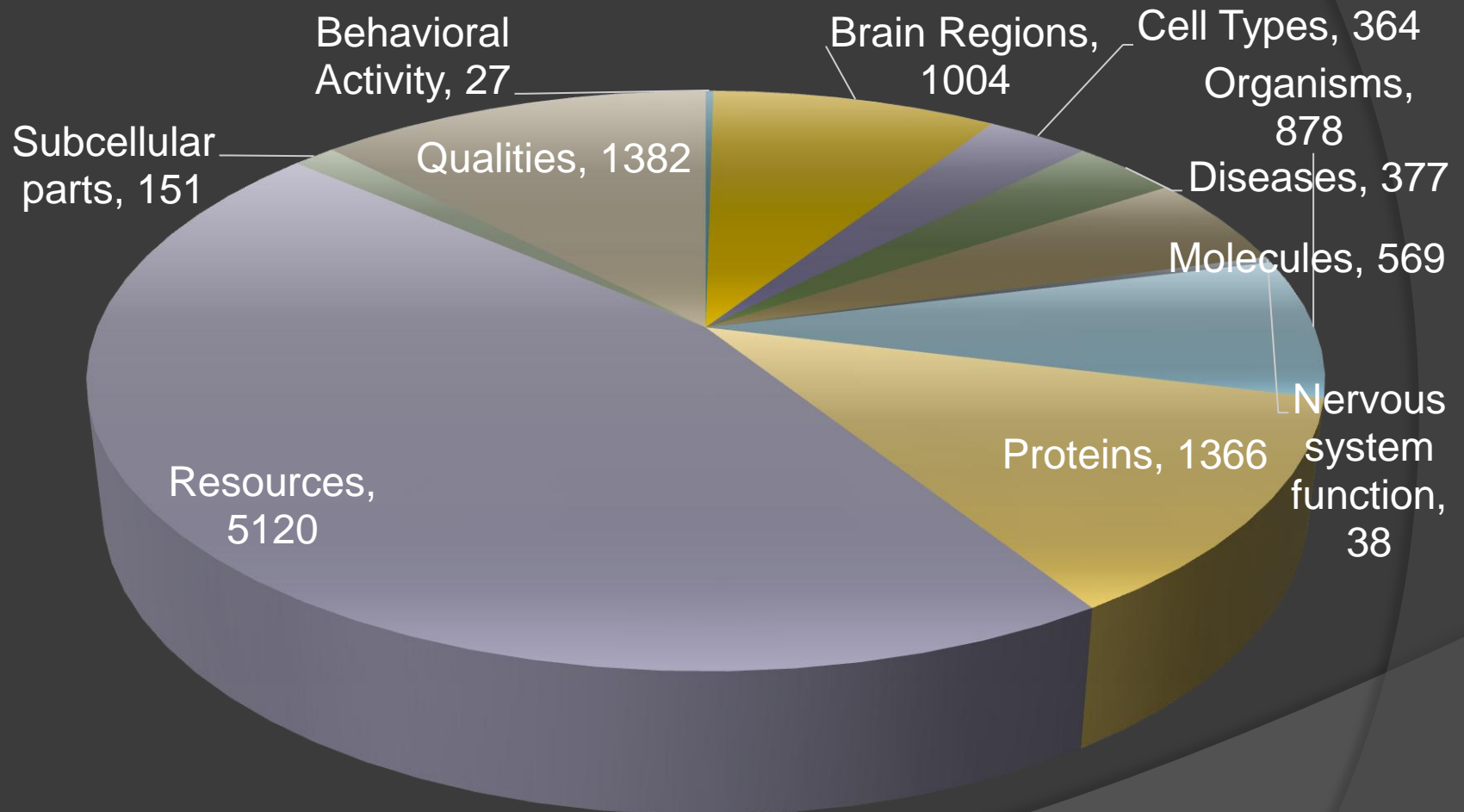
BASIC ADVANCED FACTBOX

Name:	Molecular layer of cerebellar cortex
Description:	The term molecular layer of cerebellar cortex is a cytoarchitectural term denoting the most superficial layer of the cerebellar cortex. This layer is characterized by basket and stellate cells. The term plexiform layer of cerebellar cortex is a synonym based on the myeloarchitecture, which consists of thin, densely packed axons coursing parallel to the long axis of the cerebellar folia, delicate terminal axons and rich dendritic ramifications (Carpenter-83).
Is part of:	Cerebellar cortex
Super-category:	Cytoarchitectural part of the cerebellar cortex
Id:	birnlex_810
Defining criteria:	cyto-architecture
Organism:	Mammal
Link to OWL / RDF:	Download this content as OWL/RDF

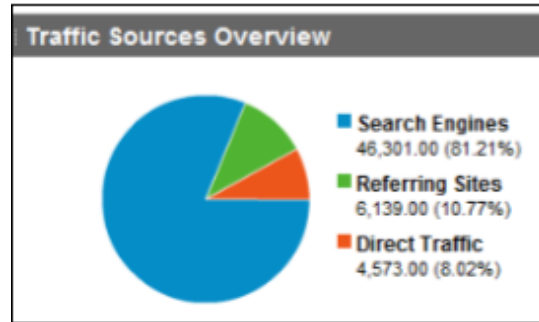
Axons in Molecular layer of cerebellar cortex

Cerebellum granule cell, Cerebellum stellate cell, Climbing fiber are neurons whose axons can be found in Molecular layer of cerebellar cortex or its parts.

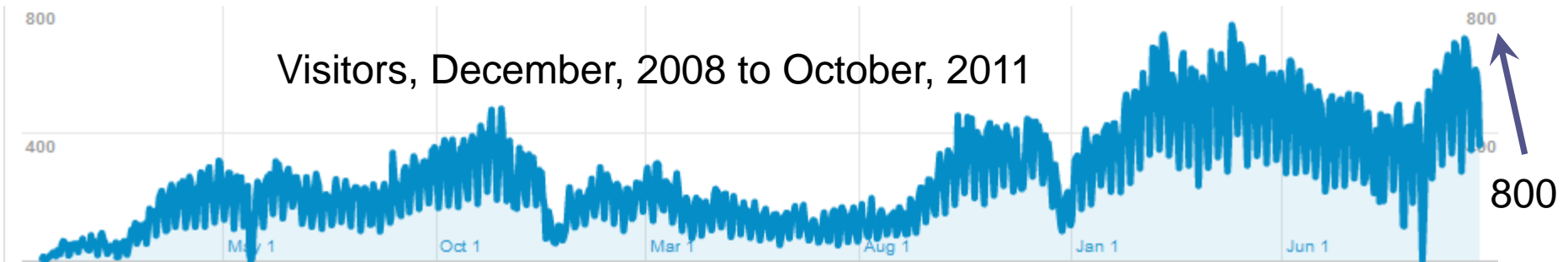
NeuroLex Entities



Organizing knowledge online



Visitors, December, 2008 to October, 2011



Organizing knowledge online

Search queries



Impact: NeuroLex being found spontaneously online

Hippocampus CA1 pyramidal cell X Search



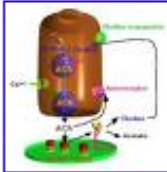
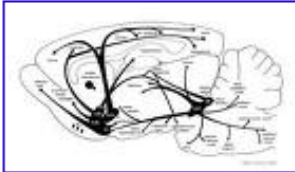
Google X Search

About 427,000 results (0.10 seconds) Advanced search

▶ [Cholinergic neuron - NeuroLex](#) ☆ 🔍
Apr 13, 2010 ... Structured knowledge about **Cholinergic neuron**, which is a Defined neuron class. Date: 4-14-2010.
neurolex.org/wiki/Category:Cholinergic_neuron - Cached

[Choline and cholinergic neurons.](#) ☆ 🔍
by JK Blusztajn - 1983 - Cited by 291 - Related articles
When **cholinergic neurons** are activated, acetylcholine release can be enhanced by treatments that increase plasma choline (for example, consumption of ...
www.ncbi.nlm.nih.gov/pubmed/6867732 - Similar

[Images for cholinergic neurons](#) - Report images



[cholinergic neuron - definition of cholinergic neuron by the Free ...](#) ☆ 🔍
Any of the impulse-conducting cells that constitute the brain, spinal column, and nerves, consisting of a nucleated cell body with one or more dendrites and ...
www.thefreedictionary.com/cholinergic+neuron - Cached - Similar

[cholinergic neuron - definition of cholinergic neuron in the ...](#) ☆ 🔍
neuron /neu-ron/ (noor'on) nerve cell; any of the conducting cells of the ...
medical-dictionary.thefreedictionary.com/cholinergic+neuron - Cached - Similar

[+](#) Show more results from thefreedictionary.com

Everything

- Images
- Videos
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San Diego, CA

Change location

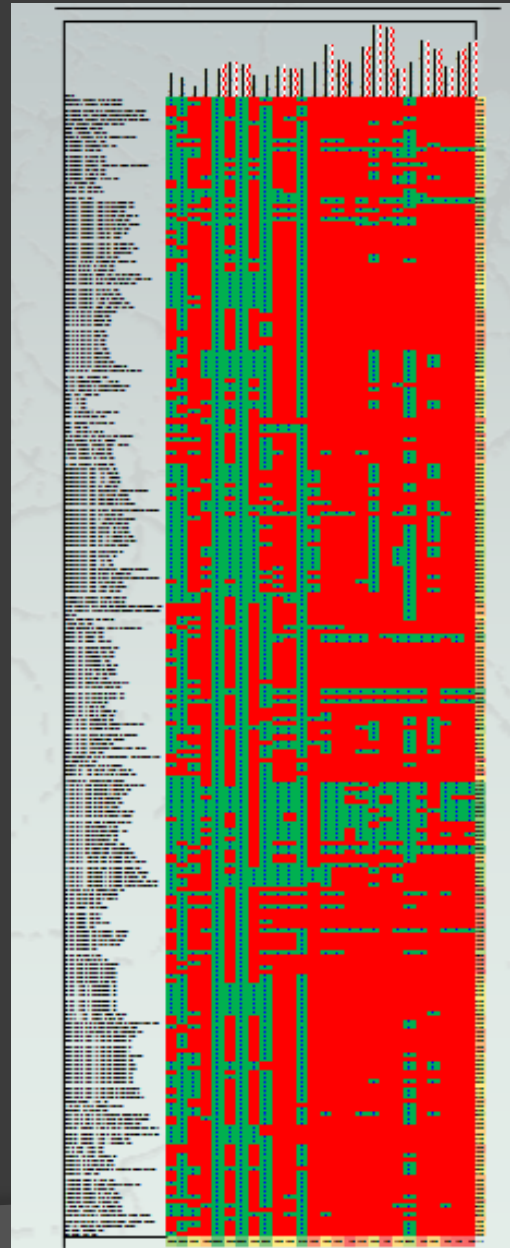
All results

- Sites with images
- More search tools

Something different

- dopaminergic neurons
- dopamine neurons
- interneurons
- glial cells
- gabaergic neurons

Master table of neurons?



The current list of candidate neurons and their properties, as defined in collaboration with the RDP Program as a component of the Brain Structure, each line. Find the and return the completeness of the data. The table is oriented vertically on the page.

Master table of neurons?

Name	Definitions	Synonyms	Roles	Abbreviations	Super Category	Definition Citation	Unique Identifier	PubMed IDs	Organism	Cell Soma Shape	Cell Soma Size	Soma Location	Dendrite Location	Suine Density On Dendrites	Branching Metrics	Axon Myelination	Axon Projection Laterality	Location Of Distant Axon Arborization	Location Of Local Axon Arborization	Origin Of Axon	Neurotransmitter	Neurotransmitter Receptors	Molecular Constituents	Firing Patterns	Spontaneous Firing Rate	Spontaneous Firing Patterns	
Abducens nucleus motor neuron	x	x																								27%	
Accessory nucleus motor neuron	x	x																									23%
Amygdala basolateral nucleus pyramidal neuron		x																									19%
Amygdala cortico-medial nucleus pyramidal cell		x																									19%
Amygdaloid nucleus parvocapsular intercalated cell	x										x										x						27%
Basalis nucleus cholinergic neuron	x	x																x		x							35%
BNST beaded neuron		x																									19%
BNST triangular neuron	x	x																									27%
Caudate nucleus matrix medium spiny cell	x																										23%
Cerebellum basket cell	x	x	x												x	x					x						54%
Cerebellum candelabrum cell	x																										27%
Cerebellum Golgi cell	x	x	x												x	x	x	x	x	x	x						81%
Cerebellum granule cell	x	x	x																		x						38%
Cerebellum Lugaro cell	x																										31%
Cerebellum nucleus reciprocal projections neuron	x	x																			x	x					38%
Cerebellum Purkinje cell	x	x																			x						31%
Cerebellum stellate cell	x	x																			x						31%
Cerebellum unipolar brush cell	x	x																									50%
Ciliary ganglion cell		x																			x						27%
Cochlea hair cell inner		x																									19%
Cochlea hair cell outer	x	x																									38%
Cochlea hair cell	x	x	x																								46%
Cochlear nucleus (dorsal) cartwheel cell	x	x													x	x				x							81%
Cochlear nucleus (dorsal) gabaergic cell		x																									23%
Cochlear nucleus (dorsal) giant cell		x																									58%
Cochlear nucleus (dorsal) glutamatergic cell		x																									19%
Cochlear nucleus (dorsal) granule cell	x														x	x	x				x						62%
Cochlear nucleus (dorsal) pyramidal neuron	x	x																									46%
Cochlear nucleus (dorsal) vertical cell	x	x																									23%
Cochlear nucleus (ventral) bushy cell		x																									19%
Cochlear nucleus (ventral) D cell	x	x																									23%
Cochlear nucleus (ventral) multipolar cell		x																									19%
Cochlear nucleus (ventral) multipolar T cell	x																										23%

Master table of neurons?

Name	<u>Definitions</u>	<u>Synonyms</u>	<u>Roles</u>	<u>Abbreviations</u>	<u>SuperCategory</u>	<u>DefiningCitation</u>	<u>UniqueIdentifier</u>	<u>PubMedIds</u>	<u>Organism</u>	<u>CellSomaShape</u>	<u>CellSomaSize</u>	<u>SomaLocation</u>	<u>DendriteLocation</u>	<u>SpineDensityOnDendrites</u>
Abducens nucleus motor neuron	X	X			X		X		X			X		
Accessory nucleus motor neuron	X	X	X		X		X							
Amygdala basolateral nucleus pyramidal neuron		X			X		X		X			X		
Amygdala corticomедial nucleus pyramidal cell		X			X		X		X			X		
Amygdaloid nucleus paracapsular intercalated cell	X				X	X	X		X		X			
Basalis nucleus cholinergic neuron	X	X			X		X	X	X			X		
BNST beaded neuron		X			X		X		X			X		
BNST triangular neuron	X	X			X		X		X			X		
Caudate nucleus matrix medium spiny cell	X				X		X		X			X		
Cerebellum basket cell	X	X	X		X		X		X	X	X	X		X
Cerebellum candelabrum cell	X				X		X		X			X		
Cerebellum Golgi cell	X	X	X		X		X		X	X	X	X		X
Cerebellum granule cell	X	X	X		X		X		X			X		
Cerebellum Lugaro cell	X	X			X	X	X	X	X			X		
Cerebellum nucleus reciprocal projections neuron	X	X			X		X		X			X		
Cerebellum Purkinje cell	X	X			X	X	X	X	X			X		
Cerebellum stellate cell	X	X			X		X		X			X		

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Partnerships & Community



NEUROSCIENCE INFORMATION FRAMEWORK



International Neuroinformatics
Coordinating Facility

Curators with the NIH-funded Neuroscience Information Framework and volunteers with the International Neuroinformatics Coordinating Facility



Community

Contributions

- Described work to represent neuroscience using ontologies
- Provided an introduction to NIF and NeuroLex.org and their use for creating structured data in neuroscience
- Outlined some examples of use of structured data within NeuroLex.org

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