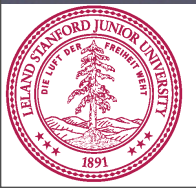


# Collecting Community-Based Mappings in an Ontology Repository

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Stanford University, USA



# Ontologies and Ontology Repositories

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*Which ontology from the  
Semantic Web is appropriate for  
my task?*

# Ontologies and Ontology Repositories

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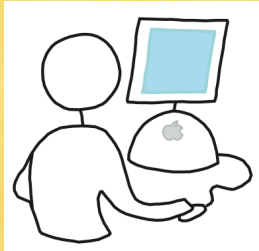


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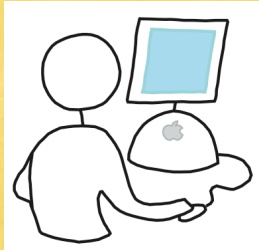


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  - created by crawling the web (e.g., Swoogle, Watson)

# Ontologies and Ontology Repositories

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*Which ontology from the Semantic Web is appropriate for my task?*

- Ask Google for .owl files
- Search an **ontology repository**—a collection of ontologies, possibly limited to a specific domain
  - created by crawling the web (e.g., Swoogle, Watson)
  - created by users submitting ontologies to the repository (e.g., BioPortal)

# NCBO BioPortal

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- **BioPortal:**
  - an open-source repository of ontologies, terminologies, and thesauri of importance in biomedicine
  - developed by the National Center for Biomedical Ontology
  - accessible at <http://bioportal.bioontology.org>
- Users can access the BioPortal content interactively via **Web browsers** or programmatically via **Web services**

# The BioPortal Ontology Repository

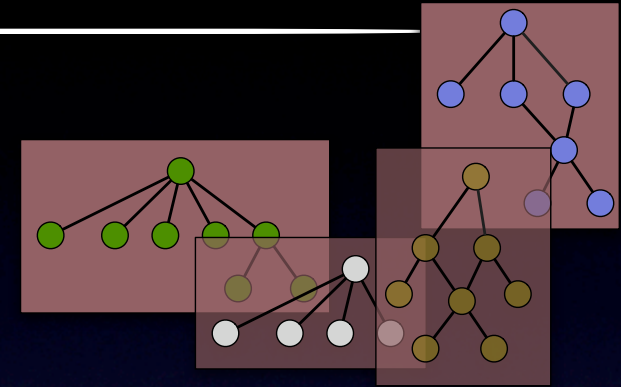
- Open **repository** of ontologies in biomedicine
- Each ontology is described by a set of **metadata**
- Ontologies in different **formats**
  - OWL, RDF(S)
  - OBO
  - Protégé frames
- BioPortal **technology**
  - open-source
  - domain-independent

Home	Browse	Search	Projects	Mappings			
Ontology Name	Format	Version	Author	Date	Related Projects	Reviews	
<a href="#">African Traditional Medicine</a>	OBOF	1.0.1			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">Amino Acid</a>	OWL-FULL	1.2			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">Amphibian gross anatomy</a>	OBOF	1.7			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">Animal natural history and life history</a>	PROTEGE	See Remote Site			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	Exploring Unavailable
<a href="#">Basic Vertebrate Anatomy</a>	OWL-FULL	1.1			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">Biological imaging methods</a>	OBOF	1.1			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">Biological process</a>	OBOF	1.204			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">Biomedical Resource Ontology</a>	OWL-LITE	1.1			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">BIRNLex</a>	OWL-DL	1.3.1			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">BRENDA tissue / enzyme source</a>	OBOF	1.295			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">C. elegans development</a>	OBOF	1.3			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	<a href="#">Explore</a>
<a href="#">C. elegans gross anatomy</a>	OBOF	See Remote Site			<a href="#">1 Related Projects</a>	<a href="#">See All 1 Reviews</a>	Exploring Unavailable
<a href="#">C. elegans phenotype</a>	OBOF	See Remote Site			<a href="#">0 Related Projects</a>	<a href="#">See All 0 Reviews</a>	Exploring Unavailable



# Multiple and Overlapping Ontologies

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- Ontologies, vocabularies, and terminologies will inevitably overlap in coverage
- An ontology repository can provide declarative mappings
  - found automatically by the **tools** (efficient, but far from perfect)
  - specified by **users** (low throughput, but better quality)
- Users can comment on mappings and discuss them

# Why Would a Mapping Repository Help?

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- Source of data for **automatic algorithms**
  - machine learning
  - algorithms that need a priori alignment
- Use for **annotating and browsing** resources through ontology elements
- Use for finding “**important**” ontologies:
  - If everyone maps to NCI Thesaurus, it must be important
- Accessible through **web services**
  - can be used in other applications

# Functionality for a Mapping Repository

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- Enable users to
  - **upload** bulk mappings in a specified format
  - **download** mappings based on a selection criteria
  - **define** point-to-point mappings interactively
  - **comment** on mappings created by others
  - **refine** and **discuss** existing mappings
  - access mappings through **web services**

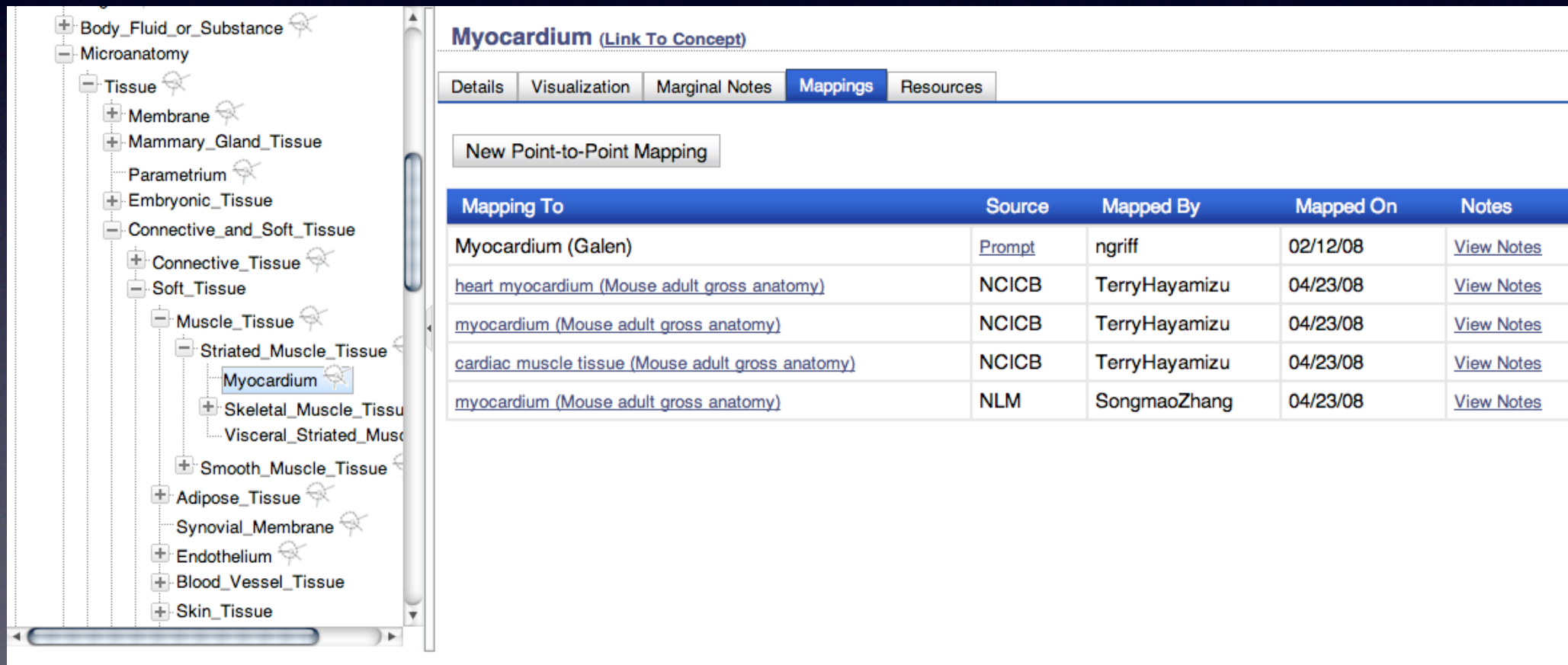
# Mappings as the Product of Community Contribution

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- Mappings can **contradict** each other
  - application context may be different
  - trust and provenance is key
- A mapping repository should be able to handle **inconsistency and different points of view** for mappings

# Representing Mappings in BioPortal

- A mapping in BioPortal is a **concept-to-concept** mapping
- Mappings have an associated set of **metadata**

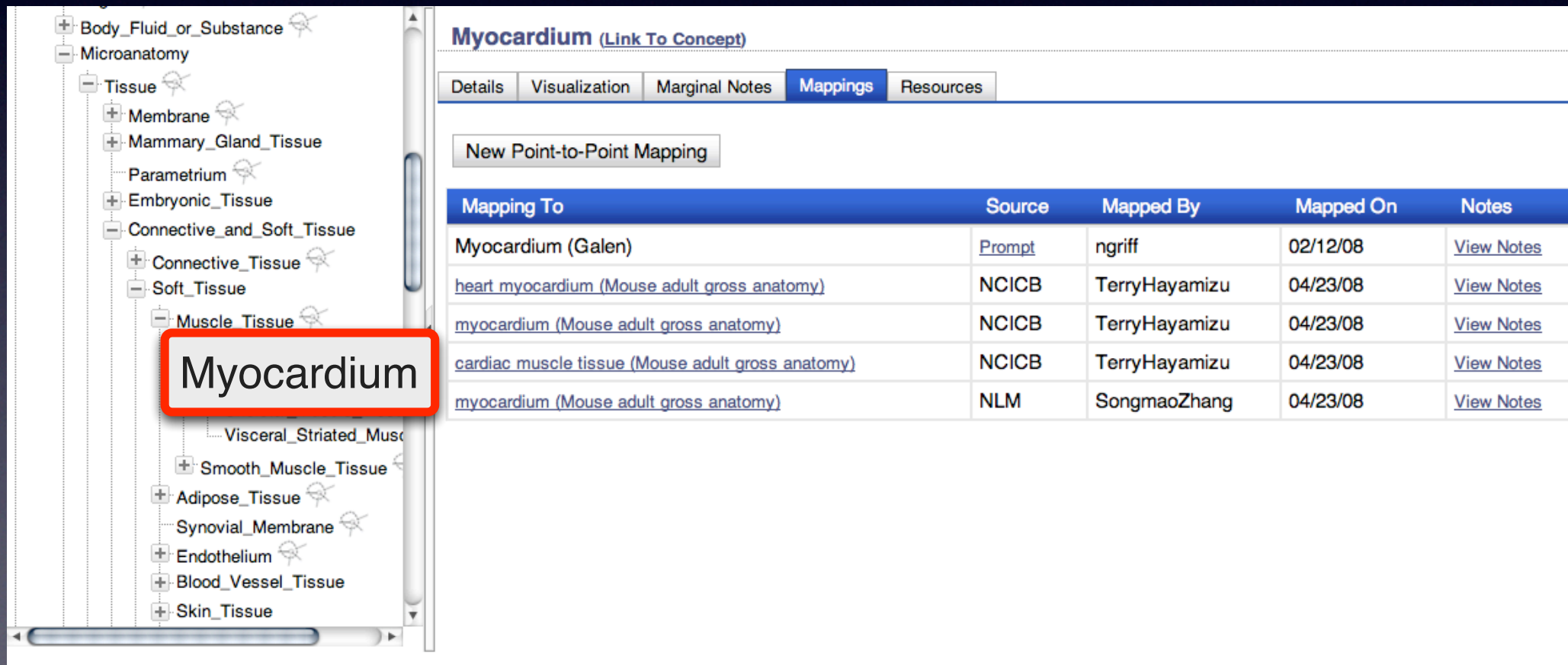


The screenshot displays the BioPortal interface. On the left is a hierarchical tree of anatomical concepts, with 'Myocardium' selected under 'Striated\_Muscle\_Tissue'. The main panel shows the 'Myocardium (Link To Concept)' page with tabs for 'Details', 'Visualization', 'Marginal Notes', 'Mappings', and 'Resources'. The 'Mappings' tab is active, showing a 'New Point-to-Point Mapping' button and a table of existing mappings.

Mapping To	Source	Mapped By	Mapped On	Notes
Myocardium (Galen)	<a href="#">Prompt</a>	ngriff	02/12/08	<a href="#">View Notes</a>
<a href="#">heart myocardium (Mouse adult gross anatomy)</a>	NCICB	TerryHayamizu	04/23/08	<a href="#">View Notes</a>
<a href="#">myocardium (Mouse adult gross anatomy)</a>	NCICB	TerryHayamizu	04/23/08	<a href="#">View Notes</a>
<a href="#">cardiac muscle tissue (Mouse adult gross anatomy)</a>	NCICB	TerryHayamizu	04/23/08	<a href="#">View Notes</a>
<a href="#">myocardium (Mouse adult gross anatomy)</a>	NLM	SongmaoZhang	04/23/08	<a href="#">View Notes</a>

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**Myocardium**

**Myocardium (Link To Concept)**

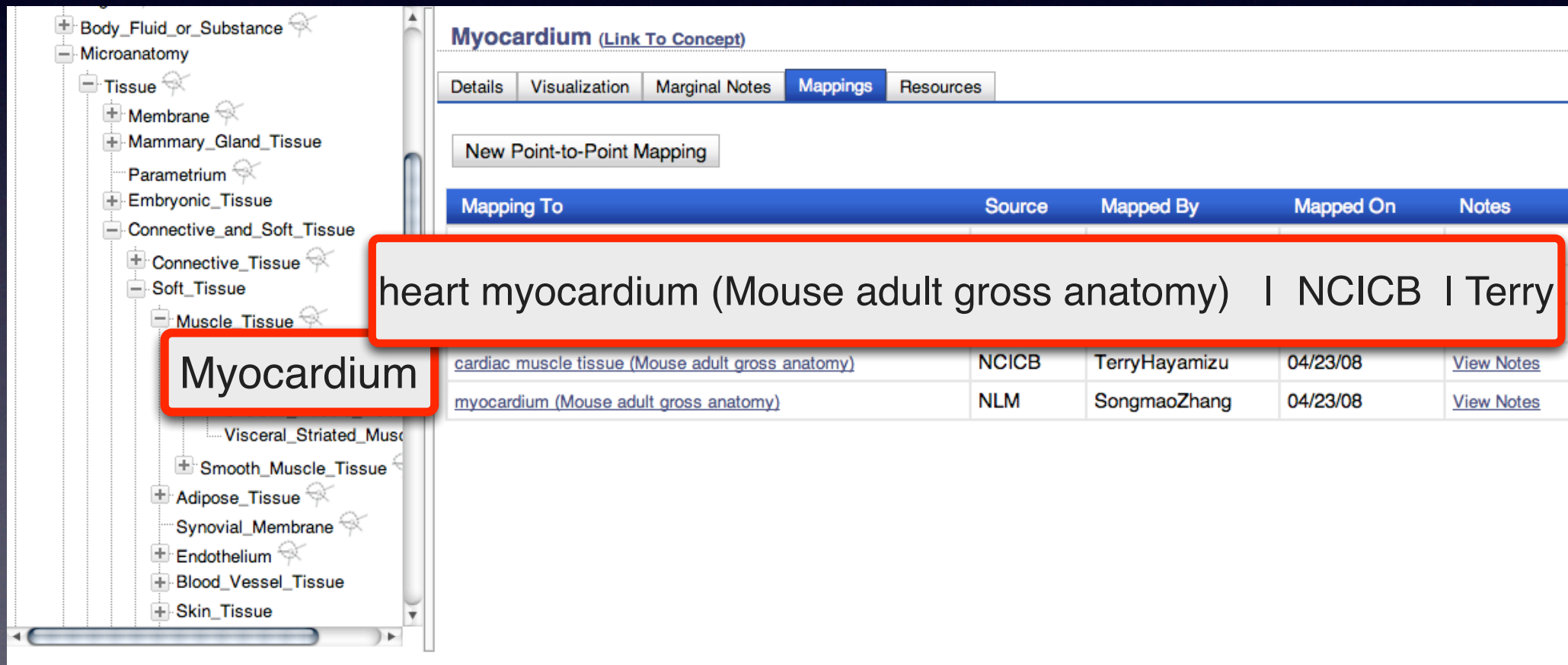
Details Visualization Marginal Notes **Mappings** Resources

New Point-to-Point Mapping

Mapping To	Source	Mapped By	Mapped On	Notes
Myocardium (Galen)	<a href="#">Prompt</a>	ngriff	02/12/08	<a href="#">View Notes</a>
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# Representing Mappings in BioPortal

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The screenshot displays the BioPortal interface for the concept 'Myocardium'. On the left is a hierarchical tree of anatomical terms, with 'Myocardium' highlighted. The main content area shows the 'Myocardium (Link To Concept)' page with tabs for 'Details', 'Visualization', 'Marginal Notes', 'Mappings', and 'Resources'. The 'Mappings' tab is active, showing a 'New Point-to-Point Mapping' button and a table of existing mappings. A red box highlights the first row of the table, which is: 'heart myocardium (Mouse adult gross anatomy) | NCICB | Terry'. Another red box highlights the 'Myocardium' label in the left-hand tree.

Mapping To	Source	Mapped By	Mapped On	Notes
heart myocardium (Mouse adult gross anatomy)	NCICB	TerryHayamizu	04/23/08	<a href="#">View Notes</a>
cardiac muscle tissue (Mouse adult gross anatomy)	NCICB	TerryHayamizu	04/23/08	<a href="#">View Notes</a>
myocardium (Mouse adult gross anatomy)	NLM	SongmaoZhang	04/23/08	<a href="#">View Notes</a>

# What's in a Link?

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- The relationship between the source and the target of a mapping
  - is rarely true **logical equivalence** (in the sense of `owl:equivalentOf`)
  - is usually a **similarity** relationship
    - useful for data aggregation, but not necessarily for reasoning
  - in theory, can be **any** relationship in the ontology language
    - *and, in biomedical ontologies, often is:*  
`ZFA:heart is a CARO:cavitated compound organ`

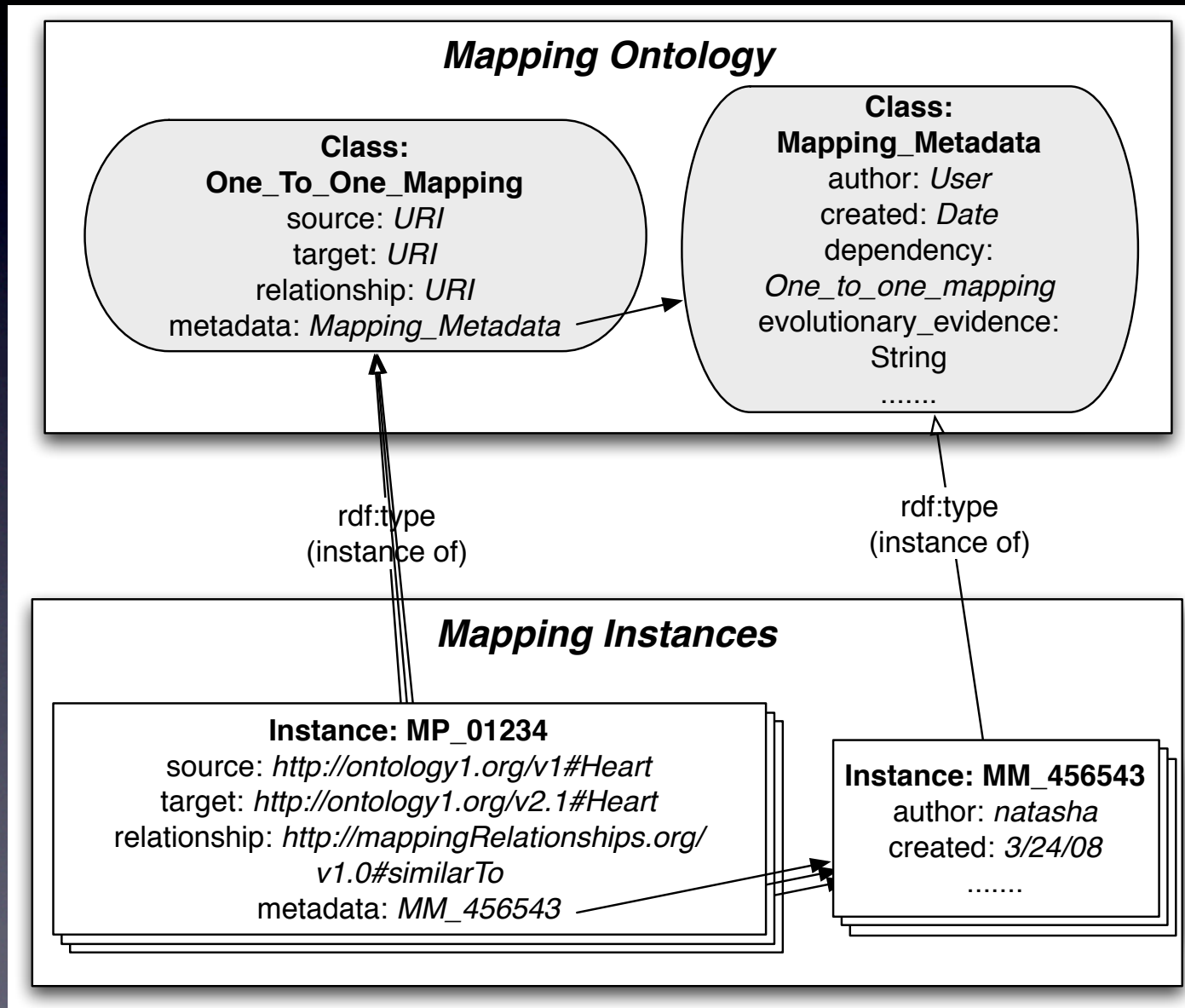


# Mapping Metadata

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- Users require a comprehensive set of metadata to augment mappings
  - mapping relationship
  - provenance (who created the mapping and when)
  - discussion and comments
  - application context
  - mapping dependency
  - algorithm used to create the mapping (configuration, parameters, etc.)
  - external references

# Representing Mappings in BioPortal

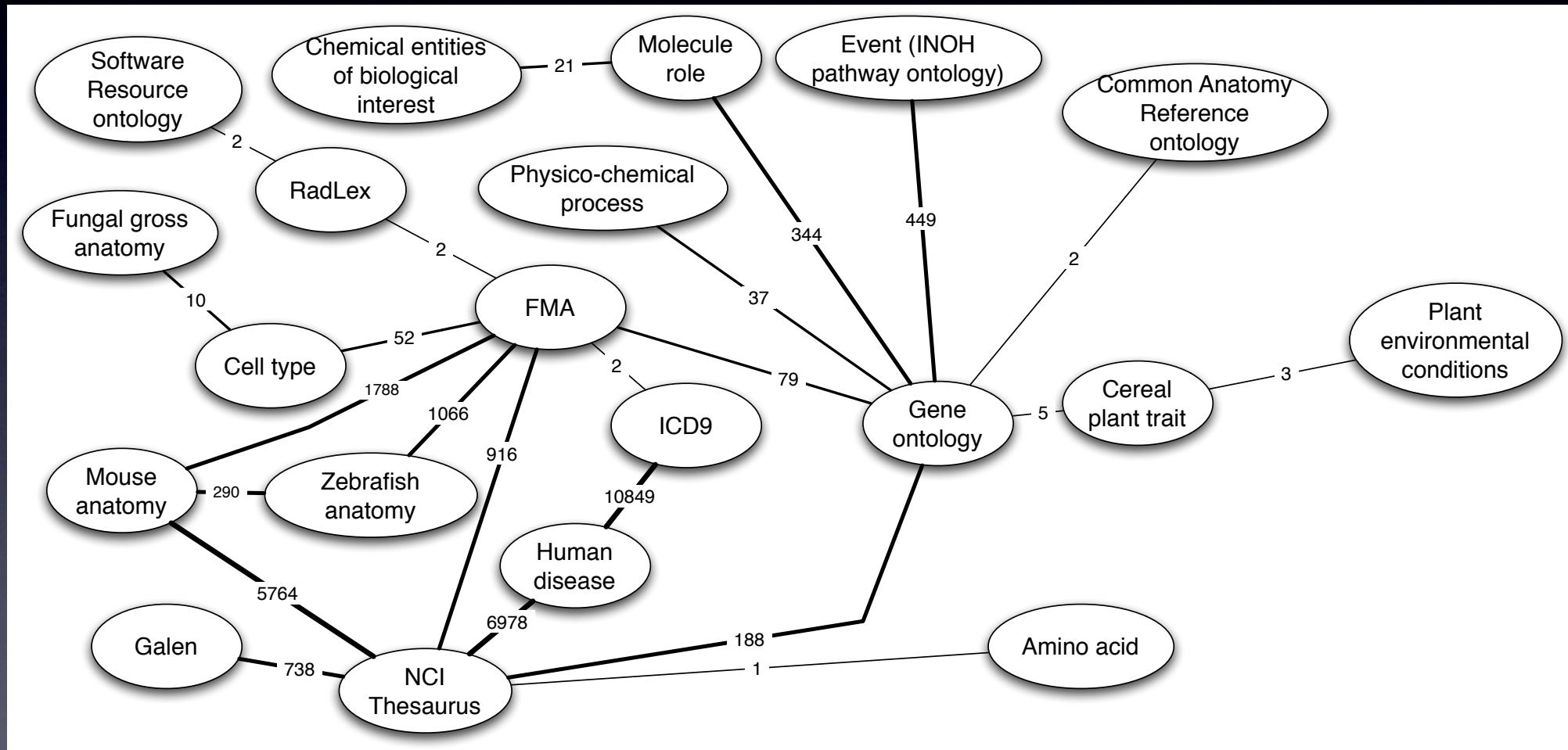


# Validating the Model: Current Mappings in BioPortal

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- Mappings is just another type of ontology metadata
- More than 30,000 mappings
  - created manually
    - as part of concept definition (OBO xref, UMLS)
    - as a mapping (NCI Mouse-Human anatomy)
  - created automatically
    - Using algorithms such as Prompt

# A snapshot Of Current Mappings



# Analyzing Mappings

Filter

User:

Source:

« Previous **1** 2 3 4 5 6 7 8 9 ... 15 16 Next »

Concept	Maps To
<a href="#">NCI Thesaurus : Pelvic Bone --&gt;</a>	<a href="#">Mouse adult gross anatomy : pelvis bone (1)</a> Mapped By TerryHayamizu
	<a href="#">Mouse adult gross anatomy : hip bone (1)</a> Mapped By SongmaoZhang
	<a href="#">Mouse adult gross anatomy : pelvic girdle bone (1)</a> Mapped By SongmaoZhang
<a href="#">NCI Thesaurus : Sural Artery --&gt;</a>	<a href="#">Mouse adult gross anatomy : external sural artery (2)</a> Mapped By TerryHayamizu , SongmaoZhang
	<a href="#">Mouse adult gross anatomy : sural artery (1)</a> Mapped By SongmaoZhang
	<a href="#">Mouse adult gross anatomy : superficial sural artery (1)</a> Mapped By SongmaoZhang
<a href="#">NCI Thesaurus : Spermatic Vein --&gt;</a>	<a href="#">Mouse adult gross anatomy : spermatic vein (2)</a> Mapped By TerryHayamizu , SongmaoZhang
	<a href="#">Mouse adult gross anatomy : testicular vein (1)</a> Mapped By SongmaoZhang
	<a href="#">Mouse adult gross anatomy : internal spermatic vein (1)</a> Mapped By SongmaoZhang

# Mappings in BioPortal

Home Browse Search Projects Mappings NCI Thesaurus

Middle Colic Artery  
Perineal Artery  
Popliteal Artery  
Popliteal Artery Branch  
Azygos Articular Artery  
Inferior External Articular Artery  
Inferior Internal Articular Artery  
Superior External Articular Artery  
Superior Internal Articular Artery  
Sural Artery  
Posterior Tibial Artery  
Posterior Tibial Artery Branch  
Pulmonary Artery  
Pulmonary Artery Branch  
Radial Artery  
Retinal Artery  
Spiral Artery of the Endometrium  
Splenic Trabecular Artery  
Straight Artery of the Endometrium

## Sural Artery

Visualization Details Marginal Notes Mappings Resources Annotations

New Point-to-Point Mapping

Mapping To	Source	Mapped By	Mapped On
<a href="#">external sural artery (Mouse adult gross anatomy)</a>	NCICB	TerryHayamizu	04/23/08
<a href="#">sural artery (Mouse adult gross anatomy)</a>	NLM	SongmaoZhang	04/23/08
<a href="#">external sural artery (Mouse adult gross anatomy)</a>	NLM	SongmaoZhang	04/23/08
<a href="#">superficial sural artery (Mouse adult gross anatomy)</a>	NLM	SongmaoZhang	04/23/08

# Mappings in BioPortal

The screenshot shows the BioPortal interface for the 'Sural Artery' concept. The left sidebar contains a hierarchical tree of anatomical terms, with 'Sural Artery' selected. The main content area has a navigation bar with tabs for 'Visualization', 'Details', 'Marginal Notes', 'Mappings', 'Resources', and 'Annotations'. The 'Mappings' tab is active, and a 'New Point-to-Point Mapping' button is highlighted with a red circle. Below this is a table listing existing mappings.

Mapping To	Source	Mapped By	Mapped On
<a href="#">external sural artery (Mouse adult gross anatomy)</a>	NCICB	TerryHayamizu	04/23/08
<a href="#">sural artery (Mouse adult gross anatomy)</a>	NLM	SongmaoZhang	04/23/08
<a href="#">external sural artery (Mouse adult gross anatomy)</a>	NLM	SongmaoZhang	04/23/08
<a href="#">superficial sural artery (Mouse adult gross anatomy)</a>	NLM	SongmaoZhang	04/23/08

# Creating Point-to-Point Mappings

Home Browse Search Projects **Mappings** NCI Thesaurus ✕

**Point-to-Point Mapping from Sural Artery to :**

Ontology: Galen ▼  
Search: artery

- RenalAnteriorSegmentalArtery
- RenalAnteriorSuperiorSegment
- RenalArtery
- RenalInferiorSegmentalArtery
- RenalInferiorSupraRenalArtery
- RenalPosteriorSegmentalArtery
- RenalSuperiorSegmentalArtery
- RightColicArtery
- RightGastricArtery
- RightGastroepiploicArtery
- RightHepaticArtery
- RightInferiorPhrenicArtery
- RightPulmonaryArtery
- SplenicArtery
- SuperiorMesentericArtery
- SuperiorRectalArtery
- SupraduodenalArtery**
- UlnarArtery

Preview of [SupraduodenalArtery.SupraduodenalArtery](#)

```
graph TD; NAMEDArtery([NAMEDArtery]) -- hasSubclass --> SupraduodenalArtery([SupraduodenalArtery]);
```

The diagram illustrates a class hierarchy. At the top is a green oval labeled "NAMEDArtery". A downward-pointing arrow labeled "hasSubclass" connects it to a yellow oval labeled "SupraduodenalArtery".



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- Enable researchers to **reconcile and merge** ontologies collaboratively
- Provide an infrastructure for reaching **consensus** on mappings (cf. the consensus workshop at OM-2008)

# Technical Challenges

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- Handling the mappings as new ontology **versions** are submitted
  - Should mappings be associated with specific version?
  - Should mappings be associated with a “virtual” concept?
- **Invalidating and deleting** mappings
  - Who should be able to invalidate mappings?
  - Should mappings be deleted permanently or archived?
- **Visualizing** mappings—including multiple and contradicting mappings—between concepts
- Enabling applications (and users) to **filter** mappings

# Future Work

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- Understand the dynamics of ontology mapping as a collaborative and open process
  - How much disagreement do users in biomedical domain have about the mappings?
  - Does experience makes consensus easier to reach or harder?
  - How much do ontology mappings differ based on application context?
  - How significant is the cumulative-advantage effect?
  - Do the dynamics vary across different domains?



# Thank you!

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<http://biportal.bioontology.org>



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