Efficient construction of a new ontology for life sciences by sub-classifying related terms in the Japan Science and Technology Agency thesaurus

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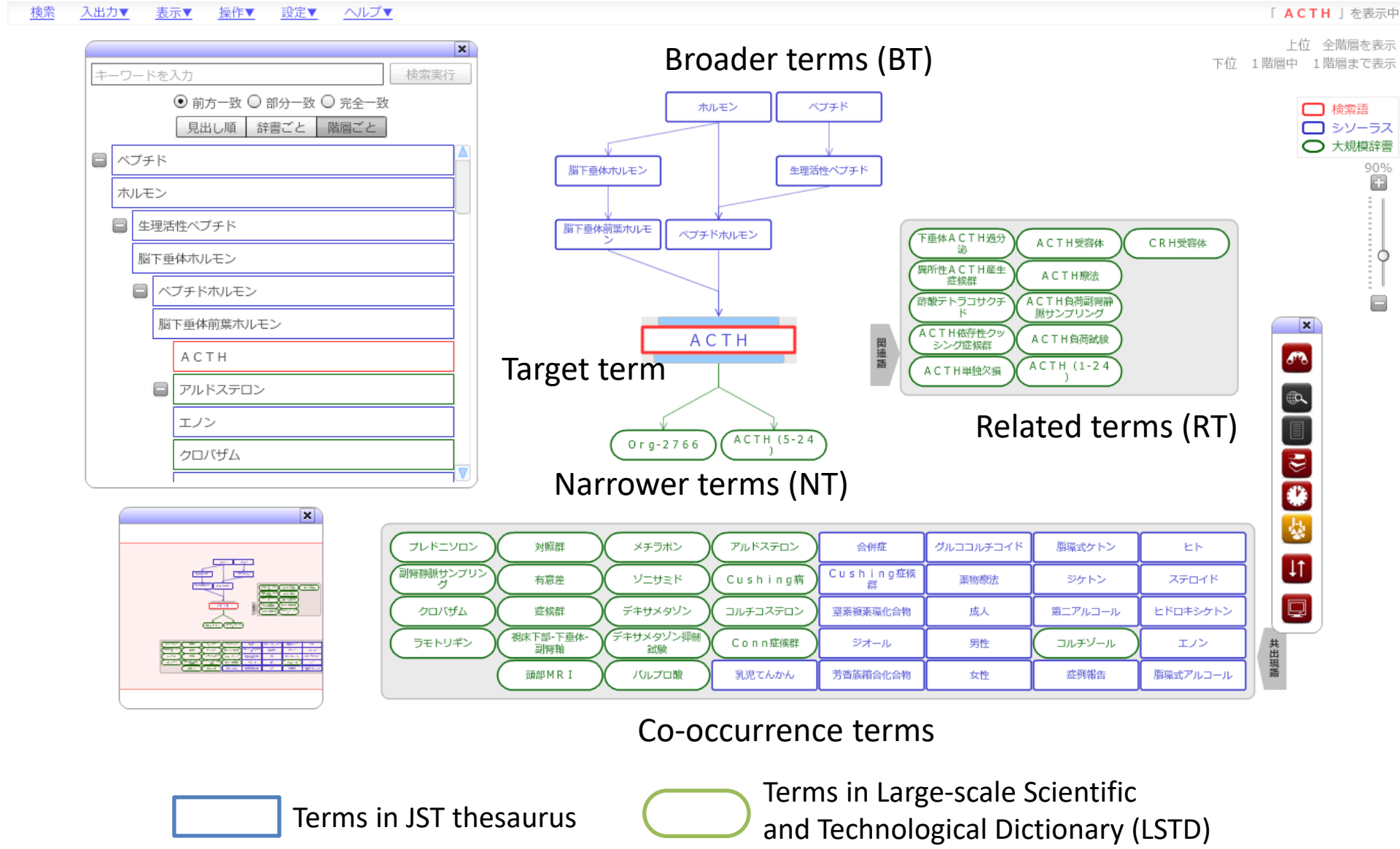
Japan Science and Technology (JST) thesaurus

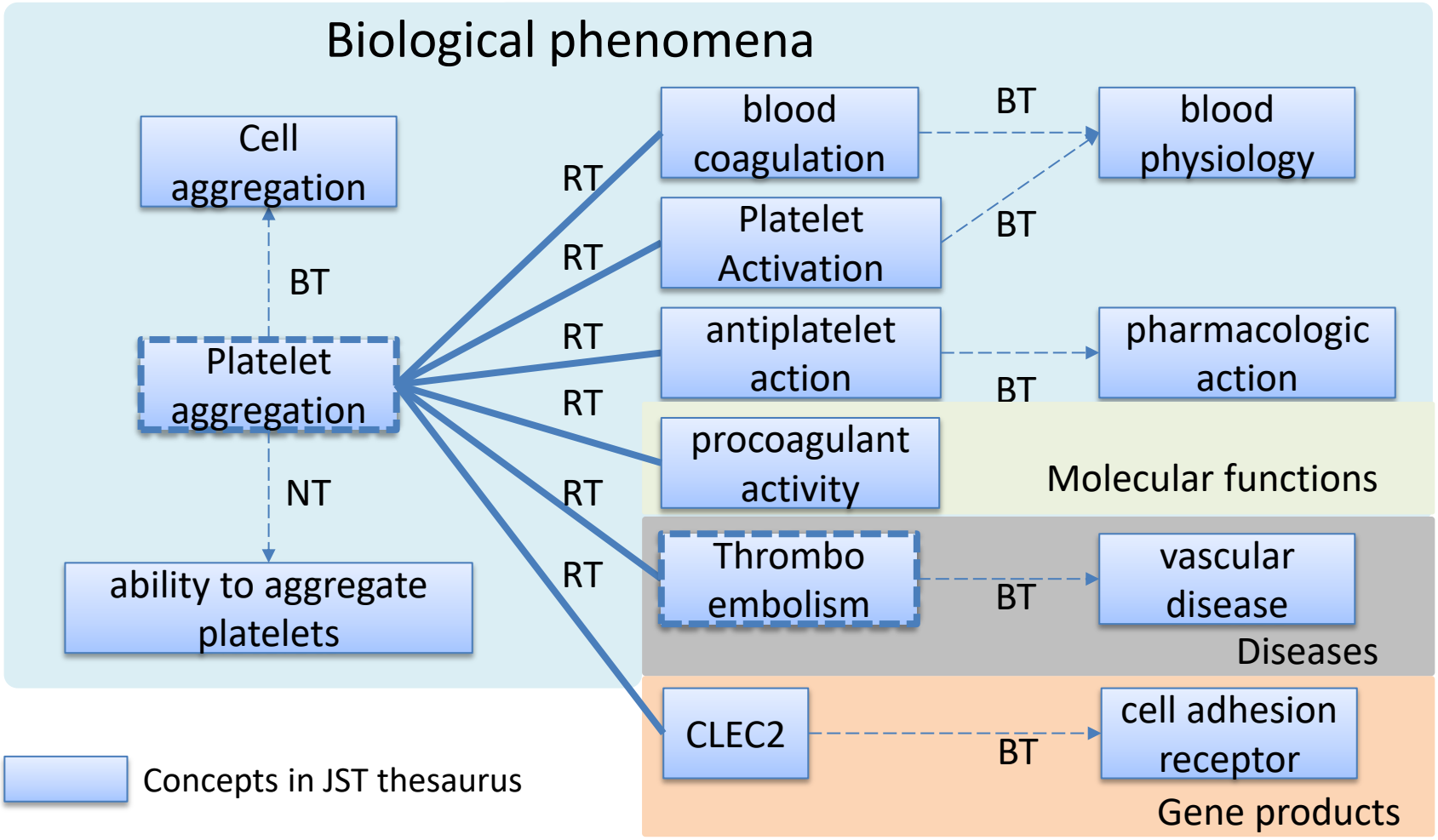
- It is developed and provided by Japan Science and Technology Agency.
- It is mainly used for indexing scientific literatures.
- All of the terms are written in both of English and Japanese languages.
- It contains approximately 245,000 concepts including 90,000 life science concepts.
  - Gene products (e.g. CLEC2)
  - Drugs (e.g. Gefitinib)
  - Biological phenomena (e.g. platelet aggregation)
  - Diseases (e.g. Thromboembolism)
  - Anatomy (e.g. cartilage)
  - ...



JST thesaurus map

http://thesaurus-map.jst.go.jp/

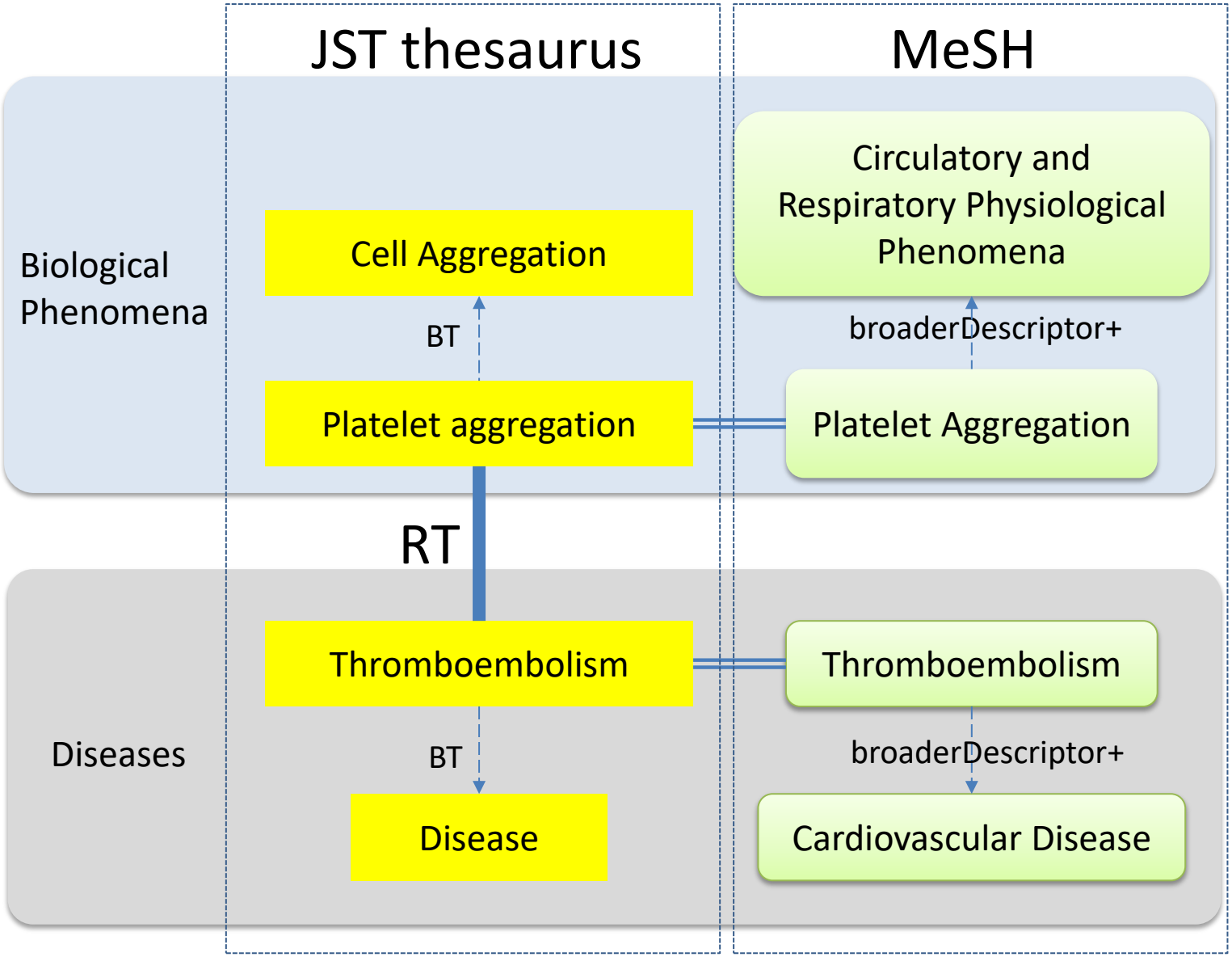
Structure of JST thesaurus



BT: Broader term NT: Narrower term RT: Related term

Comparison between JST thesaurus and MeSH

The advantages of JST thesaurus



+: A path of length one or more

Problems to be solved

Problem

The JST thesaurus has only three kinds of simple relations (BT, NT, and RT).

Therefore, we cannot describe the following relationships,

- Diseases, and the preceding biological phenomena
- Disease states, and the succeeding ones
- Diseases, and gene products regulating them
- …

Motivation, Aim and Approach

Motivation

- To develop an ontology from JST thesaurus to describe more rigorous biological relationships.

Aim

- To establish an efficient ontological development method by the RT sub-classifying based on the majority decision of life-sciences experts

Approach

- To quantitatively estimate the proposed method

Related works 1/2

- Examples of the ontological development from thesauri
  - **YAGO** is constructed by unifying the categories and the infoboxes that are automatically extracted from Wikipedia with synsets of WordNet in a rule-based and heuristic method (Suchanek *et al.*, 2007).
  - **AGROVOC** is a thesaurus of agriculture and in the project, it is converted into the ontology by the refining RT in more specific relation, and the modeling using OWL is conducted (Soergel *et al.*, 2004).

Related works 2/2

- Examples of the ontological development by the life-sciences experts and the crowdsourcing
  - Mortensen *et al*. investigated crowdsourcing's performance for validating the relations among concepts in **SNOMED CT** (2015) and **Gene Ontology** (2016).
  - **LEGO** (http://geneontology.org/page/connecting-annotations-lego-models) is the Gene Ontology relating project where modeling semantic relations among biological processes, molecular functions, cellular components, and the related gene products is performed using expert crowdsourcing.

Our proposal for RT sub-classifying based on the majority decision (1/4)

- Four life-sciences experts, namely three curators and one manager are practically engaged in the RT sub-classifying.
- Initially, three curators sub-classify 2,850 RTs (about 1/20 of all RTs) by using 31 kinds of sub-classified relations following the guideline* created and revised by the manager.
- Next, curators may assign first candidate relation and (if necessary) second candidate relation for each RT.

Our proposal for RT sub-classifying based on the majority decision (2/4)

- **[Case 1]** In the first candidates, a relation is agreed by three curators, we name the relation "**1st-III**," and we adopt the agreed relation for the corresponding RT.
- **[Case 2]** In the first candidates, a relation is agreed by two curators, and in the first and second candidates, a relation is agreed by three curators, we name the relation "**1st-II:2nd-III**," and we adopt the agreed relation.

Our proposal for RT sub-classifying based on the majority decision (3/4)

- **[Case 3]** In the first candidates, a relation is agreed by two curators, and in the first and second candidates, a relation is agreed by two curators, we name the relation "**1st-II:2nd-II**," and we adopt the agreed relation.
- **[Case 4]** In the first candidates, candidate's relations which the three curators propose are split, and in the first and second candidates, a relation is agreed by two curators, we name the relation "**1st-Split:2nd-II**," and we adopt the agreed relation.

Our proposal for RT sub-classifying based on the majority decision (4/4)

- **[Case 5]** In both of the first and the second candidates, candidate's relations which the three curators propose are split, we name the case "**1st-Split:2nd-Split**," and in this case, the manager decides on an appropriate relation in consultation with three curators.
- Then, the manager confirms whether each of the adopted relations (**1st-III, 1st-II:2nd-III, 1st-II:2nd-II, 1st-Split:2nd-II**) is correct or not.
- Finally, the manager decides on a relation for each RT.

An example in RT sub-classification process

	1st candidate	2nd candidate
Curator A	RT	-
Curator B	subClassOf	-
Curator C	part Of	subClassOf

1st-Split:2nd-II

Curators propose a relation based on majority decision.

subClassOf

The manager confirms the proposed relation (mainly ontological consistency)

Correct

Not correct

The manager decides a relation

subClassOf

part Of

Revision of the guideline and the procedure for the RT sub-classifying

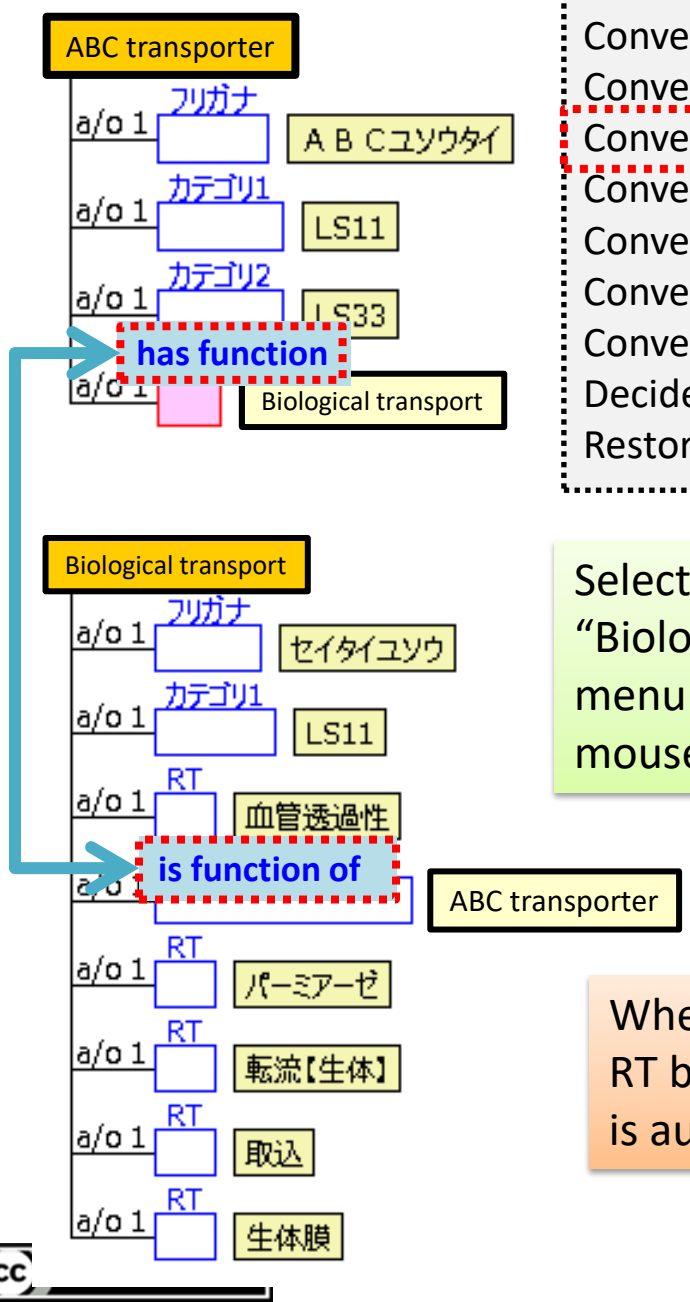
- Revisions
  - Adding the domain and range information for each of 31 sub-classified relations (see Table)
  - Making it possible that curators assign first and second candidate relation for a RT
  - Improving the graphical ontology editor Hozo with the revision of the guideline
  - Executing the curators training for the RT sub-classifying

Table Examples of the domain and range information

Relation	Domain	Range
sio:SIO_000217 (has quality)	Continuant and Occurent	Quality
sio:SIO_000225 (has function)	Continuant (Material, Component, Localization, Organism)	Occurent (Event, Process, State)
sio:SIO_000228 (has role)	Continuant (Material)	Continuant (Material)
sio:SIO_001279 (has phenotype)	Occurent (Disease)	Occurent (Symptom)
sio:SIO_001154 (regulates)	Occurent (Event, Process, State)	Occurent (Event, Process, State)
xkos:precedes	Occurent (Event, Process, State)	Occurent (Event, Process, State)

xkos: <http://rdf-vocabulary.ddialliance.org/xkos#> *: Revised (20170831)

RT sub-classifying using the graphical ontology editor Hozo (in Japanese language)



Convert to “BT”
Convert to “NT”
Convert to “has part”
Convert to “is part of”
Convert to “has function”
Convert to “is function of”
Convert to “has attribute”
Convert to “is attribute of”
Convert to “antonym”
Decide “RT”
Restore to “RT”

Ho - zo 法造 an Environment for Building/Using Ontologies www.hozo.jp

http://www.hozo.jp/

Select the sub-classifying RT between “ABC transporter” and “Biological transport” with mouse left click, open the popup menu with mouse right click, and select “**has function**” on mouse left click in the popup window

When the RT is converted to “**has function**”, the inverse RT between “Biological transport” and “ABC transporter” is automatically converted to “**is function of**.”

Thirty-one relations used for the RT sub-classifying

rdfs:subClassOf
skos:narrower (has narrower)
sio:SIO_000028 (has part)
sio:SIO_000068 (is part of)
sio:SIO_000218 (is quality of)
sio:SIO_000217 (has quality)
sio:SIO_000226 (is function of)
sio:SIO_000225 (has function)
sio:SIO_000123 (antonym)
sio:SIO_000228 (has role)
sio:SIO_000227 (is role of)
sio:SIO_001279 (has phenotype)
nbdc:isPhenotypeOf
sio:SIO_001154 (regulates)
sio:SIO_001155 (is regulated by)

xkos:succeeds
xkos:precedes
sio:SIO_000657(is transformed from)
sio:SIO_000655 (transforms into)
sio:SIO_000203 (is connected to)
sio:SIO_000365 (is creator of)
sio:SIO_000364 (has creator)
sio:SIO_000145 (is location of)
sio:SIO_000061 (is located in)
obo:RO_0002234 (has output)
obo:RO_0002353 (output of)
sio:SIO_000064 (is provider of)
sio:SIO_000066 (has provider)
sio:SIO_000122 (synonym)
sio:SIO_000283 (is similar to)
skos:related (RT)

To evaluate the validity of the RT sub-classifying method

- $Precision = \frac{true\ positive*}{(true\ positive + false\ positive)**}$
- $Recall = \frac{true\ positive*}{(true\ positive + false\ negative)***}$

*: The number of correct relations in the relations that are agreed by three or two curators

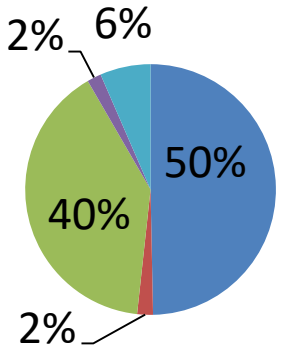
**: The number of the relations that are agreed by three or two curators

***: The number of correct relations

Performance of the RT sub-classification in 1st-III, 1st-II:2nd-III, 1st-II:2nd-II, and 1st-Split:2nd-II

	1st-III				1st-II:2nd-III				1st-II:2nd-II				1st-Split:2nd-II			
Relation	P	R	CR	N	P	R	CR	N	P	R	CR	N	P	R	CR	N
rdfs:subClassOf	0.95	1	1.06	161	0.93	1	1.08	13	0.83	0.99	1.19	104	0.80	1	1.25	4
skos:narrower (has narrower)	0.95	1	1.06	161	0.93	1	1.08	13	0.83	0.99	1.19	104	0.80	1	1.25	4
sio:SIO_000028 (has part)	1	0.74	0.74	23	-	-	-	0	1	0.89	0.89	18	1	1	1	7
sio:SIO_000068 (is part of)	1	0.74	0.74	23	-	-	-	0	1	0.89	0.89	18	1	1	1	7
sio:SIO_000218 (is quality of)	0.83	1	1.20	5	1	1	1	2	0.86	1	1.17	12	1	1	1	1
sio:SIO_000217 (has quality)	0.83	1	1.20	5	1	1	1	2	0.86	1	1.17	12	1	1	1	1
sio:SIO_000226 (is function of)	0.94	1	1.06	16	-	-	-	0	0.91	0.64	0.70	33	-	-	-	0
sio:SIO_000225 (has function)	0.94	1	1.06	16	-	-	-	0	0.91	0.63	0.69	32	-	-	-	0
sio:SIO_000123 (antonym)	1	1	1	14	-	-	-	0	1	1	1	4	-	-	-	0
sio:SIO_000228 (has role)	1	0.50	0.50	6	1	0.25	0.25	4	1	0.30	0.30	57	1	1	1	3
sio:SIO_000227 (is role of)	1	0.50	0.50	6	1	0.25	0.25	4	1	0.30	0.30	57	1	1	1	3
skos:related (RT)	0.99	0.99	1	962	0.57	0.80	1.40	10	0.87	0.95	1.09	627	1	0.75	0.75	8
Sum (Mean) of relations	0.98 (0.90)		1.00	1416	0.83 (0.80)		1.00	58	0.87 (0.82)		1.00	1138	0.88 (0.86)		1.00	52

Proportion of each case



- 1st-III (1416/2850 RTs)
- 1st-II:2nd-III (58/2850 RTs)
- 1st-II:2nd-II (1138/2850 RTs)
- 1st-Split:2nd-II (52/2850 RTs)
- 1st-Split:2nd-Split (186/2850 RTs)

Comparison of the precision and the recall in this study (2017) with that in the previous study (2016)

	Previous study (2016)		This study (2017)	
	1st -III	1st-II	1st -III	1st-II*
Precision	0.79 (1148/1453)	0.51 (74/145)	0.98 (1388/1416)	0.87 (1036/1196)
Recall	0.37 (n=10)	0.36 (n=10)	0.90 (n=16)	0.82 (n=36)

*: The sum of "1st-II:2nd-III," and "1st-II:2nd-II"

The effects of the revising the guideline, and executing the curators training on improving the precision and the recall

Evaluation of effects of the second candidate information on the RT sub-classification

	Precision	Recall*	No. of relations disagreed by 3 curators
Using first candidate	0.93 (2376/2554)	0.85 (n=75)	238
Using both of first and second candidate	0.93 (2470/2664)	0.85 (n=68)	186

*: Recall was calculated as means of each relation's recall

The effect of the second candidate information on the reducing the number of disagreed relations

Publication

- At present, the new developed life-sciences ontology (RT sub-classified JST thesaurus) is published by a tentative public SPARQL endpoint with CC BY-NC license (http://lod.hozo.jp/repositories/JstNbcdOnt).

Conclusions

- We attempted to evaluate a method of constructing a new life-sciences ontology from the JST thesaurus by the RT sub-classifying based on the majority decision of life-sciences experts.
- The manager created the guideline for the RT sub-classifying which contained the definitions, the usage, the domain, and the range information for 31 relations.
- The curators performed the RT sub-classifying following the guideline by using improved Hozo tool with which curators could assign both of 1st candidate and 2nd candidate relations for a RT.
- Finally, the manager decided on a relation for each RT based on the majority decision.
- As a result of the evaluation, we conclude that the RT sub-classification is appropriately conducted and the method is both effective and practical.

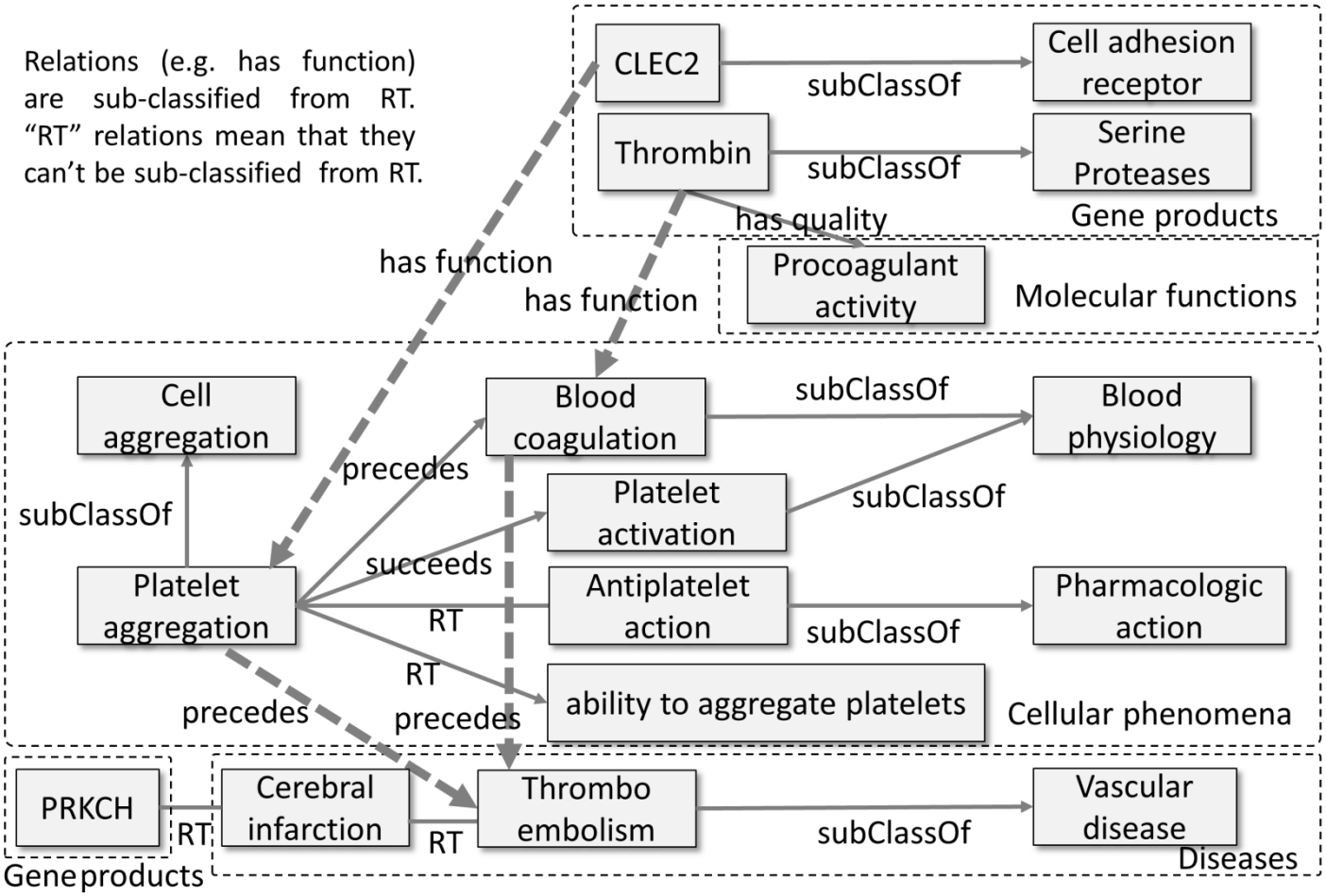
Future work

- We will attempt to evaluate the validity of the crowdsourcing in the RT sub-classification process and the effect of cost reduction using crowdsourcing in our future research.

Acknowledgement

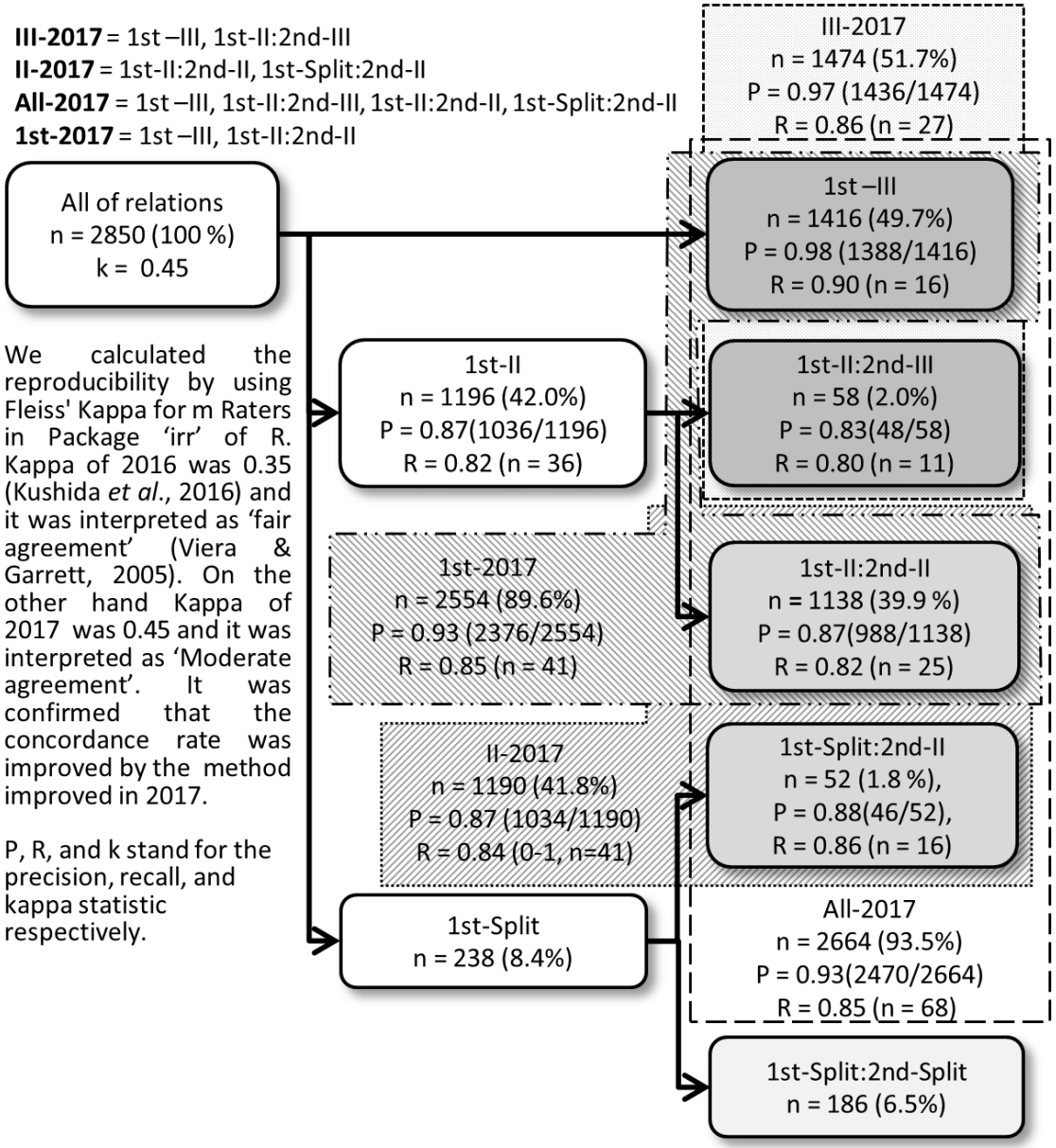
- This work was supported by an operating grant from the Japan Science and Technology Agency and JSPS KAKENHI Grant Number JP17H01789.

We also publish a poster in ICBO2017.


Relations (e.g. has function) are sub-classified from RT. "RT" relations mean that they can't be sub-classified from RT.
CLEC2
subClassOf
Cell adhesion receptor
Thrombin
subClassOf
Serine Proteases
has quality
Gene products
has function
has function
Procoagulant activity
Molecular functions
Cell aggregation
Blood coagulation
subClassOf
Blood physiology
precedes
Platelet activation
subClassOf
subClassOf
succeeds
Platelet aggregation
Antiplatelet action
Pharmacologic action
RT
subClassOf
RT
precedes
precedes
ability to aggregate platelets
Cellular phenomena
PRKCH
Cerebral infarction
Thrombo embolism
Vascular disease
RT
RT
subClassOf
Gene products
Diseases

Relation	III-2016				II-2016				All-2016		
	P	R	CR	N	P	R	CR	N	P	R	CR
rdfs:subClassOf	0.88	0.25	0.28	60	0.83	0.46	0.56	123	0.84	0.39	0.47
skos:narrower (has narrower)	0.88	0.25	0.29	59	0.83	0.46	0.56	123	0.84	0.40	0.47
sio:SIO_000028 (has part)	1	0.04	0.04	53	0.83	0.11	0.14	44	0.88	0.07	0.08
sio:SIO_000068 (is part of)	1	0.04	0.04	54	0.83	0.11	0.14	44	0.88	0.07	0.08
sio:SIO_000218 (is quality of)	1	0.50	0.50	2	-	0	0	2	1	0.25	0.25
sio:SIO_000217 (has quality)	1	0.50	0.50	2	-	0	0	2	1	0.25	0.25
sio:SIO_000226(is function of)	1	0.23	0.23	73	0.95	0.44	0.47	45	0.97	0.31	0.32
sio:SIO_000225 (has function)	1	0.23	0.23	73	0.95	0.46	0.48	46	0.97	0.32	0.33
sio:SIO_000123 (antonym)	1	0.67	0.67	6	0.8	0.67	0.83	6	0.89	0.67	0.75
skos:related (RT)	0.78	1	1.28	1071	0.33	0.93	2.63	145	0.68	0.98	1.44
Sum (Mean) of relations	0.79	(0.37)	1.00	1453	0.51	(0.36)	1.00	580	0.71	(0.37)	1.00

rdfs: <http://www.w3.org/2000/01/rdf-schema#>, skos: <http://www.w3.org/2004/02/skos/core#>, sio: <http://semanticscience.org/resource/>



We calculated the reproducibility by using Fleiss' Kappa for m Raters in Package 'irr' of R. Kappa of 2016 was 0.35 (Kushida *et al*., 2016) and it was interpreted as 'fair agreement' (Viera & Garrett, 2005). On the other hand Kappa of 2017 was 0.45 and it was interpreted as 'Moderate agreement'. It was confirmed that the concordance rate was improved by the method improved in 2017.

P, R, and k stand for the precision, recall, and kappa statistic respectively.

	1st-III				1st-II:2nd-III				1st-II:2nd-II				1st-Split:2nd-II			
Relation	P	R	CR	N	P	R	CR	N	P	R	CR	N	P	R	CR	N
rdfs:subClassOf	0.95	1	1.06	161	0.93	1	1.08	13	0.83	0.99	1.19	104	0.80	1	1.25	4
skos:narrower (has narrower)	0.95	1	1.06	161	0.93	1	1.08	13	0.83	0.99	1.19	104	0.80	1	1.25	4
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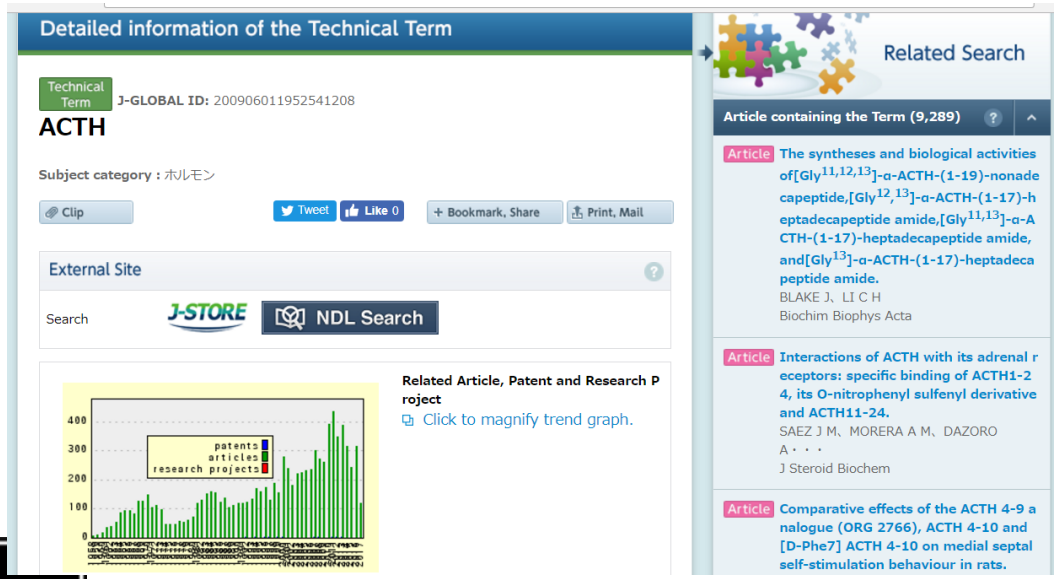
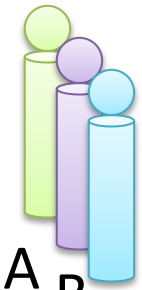
sio:SIO_000068 (is part of)	1	0.74	0.74	23	-	-	-	0	1	0.89	0.89	18	1	1	1	7
sio:SIO_000218 (is quality of)	0.83	1	1.20	5	1	1	1	2	0.86	1	1.17	12	1	1	1	1
sio:SIO_000217 (has quality)	0.83	1	1.20	5	1	1	1	2	0.86	1	1.17	12	1	1	1	1
sio:SIO_000226 (is function of)	0.94	1	1.06	16	-	-	-	0	0.91	0.64	0.70	33	-	-	-	0
sio:SIO_000225 (has function)	0.94	1	1.06	16	-	-	-	0	0.91	0.63	0.69	32	-	-	-	0
sio:SIO_000123 (antonym)	1	1	1	14	-	-	-	0	1	1	1	4	-	-	-	0
sio:SIO_000228 (has role)	1	0.50	0.50	6	1	0.25	0.25	4	1	0.30	0.30	57	1	1	1	3
sio:SIO_000227 (is role of)	1	0.50	0.50	6	1	0.25	0.25	4	1	0.30	0.30	57	1	1	1	3
sio:SIO_001279 (has phenotype)	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
nbdc:isPhenotypeOf	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
sio:SIO_001154 (regulates)	-	-	-	0	-	-	-	0	1	1	1	2	-	-	-	0
sio:SIO_001155 (is regulated by)	-	-	-	0	-	-	-	0	1	1	1	2	-	-	-	0
xkos:succeeds	1	1	1	8	0.75	0.75	1	4	0.90	1	1.11	19	1	1	1	2
xkos:precedes	1	1	1	8	0.75	0.75	1	4	0.90	1	1.11	19	1	1	1	2
sio:SIO_000657(is transformed from)	1	1	1	1	1	1	1	1	1	1	1	2	-	-	-	0
sio:SIO_000655 (transforms into)	1	1	1	1	1	1	1	1	1	1	1	2	-	-	-	0
sio:SIO_000203 (is connected to)	-	-	-	0	-	-	-	0	1	1	1	2	-	-	-	0
sio:SIO_000365 (is creator of)	-	-	-	0	-	-	-	0	-	0	0	2	-	0	0	2
sio:SIO_000364 (has creator)	-	-	-	0	-	-	-	0	-	0	0	2	-	0	0	2
sio:SIO_000145 (is location of)	-	-	-	0	-	-	-	0	1	1	1	2	0.33	1	3.00	1
sio:SIO_000061 (is located in)	-	-	-	0	-	-	-	0	1	1	1	2	0.33	1	3.00	1
obo:RO_0002234 (has output)	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
obo:RO_0002353 (output of)	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
sio:SIO_000064 (is provider of)	-	-	-	0	-	-	-	0	0	-	-	0	-	-	-	0
sio:SIO_000066 (has provider)	-	-	-	0	-	-	-	0	0	-	-	0	-	-	-	0
sio:SIO_000122 (synonym)	-	-	-	0	-	-	-	0	1	1	1	2	1	1	1	4
sio:SIO_000283 (is similar to)	-	-	-	0	-	-	-	0	0.33	1	3.00	2	-	-	-	0
skos:related (RT)	0.99	0.99	1	962	0.57	0.80	1.40	10	0.87	0.95	1.09	627	1	0.75	0.75	8
Sum (Mean) of relations	0.98	(0.90)	1.00	1416	0.83	(0.80)	1.00	58	0.87	(0.82)	1.00	1138	0.88	(0.86)	1.00	52

nbdc: <http://purl.jp/4/ontology/>, obo: <http://purl.obolibrary.org/obo/>


jglobal.jst.go.jp/en/search/#%7B%22keyword%22%3A%22ACTH%22%2C%22synonym%22%3Anull%2C%22category%22%3A6%2C%22...
J-GLOBAL
科学技術総合リンクセンター
J-GLOBAL home
My J-GLOBAL login
Help
Japan Science and Technology Agency
日本語
About J-GLOBAL
Font size
A
A
ACTH
Technical Term
Thesaurus map
Help
Other names and Synonyms (11)
"Technical Term:ACTH" 's othernames and synonyms(11)
Select All
Clear all
アドレノコルチコトロピン
コルチコトロピン
副じん皮質刺激ホルモン
副腎皮質刺激ホルモン
Adrenocorticotropic Hormone
adrenocorticotrophic hormone
adrenocorticotrophin
adrenocorticotropic hormone
adrenocorticotropin
corticotrophin
corticotropin
Search result of "ACTH"
Add to your search terms to get more hits
ALL 10,089
Researcher 568
Article 9,289
Patent 45
Research Project 4
Organization 0
Technical Term 55
Chemical Subsutance 122
Gene 2
Material 4
Research Resource 0


Detailed information of the Technical Term
Technical Term
J-GLOBAL ID: 200906011952541208
ACTH
Subject category : ホルモン
Clip
Tweet
Like 0
+ Bookmark, Share
Print, Mail
External Site
Search
J-STORE
NDL Search
Related Article, Patent and Research Project
Click to magnify trend graph.
patents
articles
research projects
Related Search
Article containing the Term (9,289)
Article The syntheses and biological activities of[Gly11,12,13]-α-ACTH-(1-19)-nonadecapeptide,[Gly12,13]-α-ACTH-(1-17)-heptadecapeptide amide,[Gly11,13]-α-ACTH-(1-17)-heptadecapeptide amide, and[Gly13]-α-ACTH-(1-17)-heptadecapeptide amide.
BLAKE J、LI C H
Biochim Biophys Acta
Article Interactions of ACTH with its adrenal receptors: specific binding of ACTH1-24, its O-nitrophenyl sulfenyl derivative and ACTH11-24.
SAEZ J M、MORERA A M、DAZORO A・・・
J Steroid Biochem
Article Comparative effects of the ACTH 4-9 analogue (ORG 2766), ACTH 4-10 and [D-Phe7] ACTH 4-10 on medial septal self-stimulation behaviour in rats.
Related terms (11)
Technical Term Pituitary ACTH Hypersecretion
Subject category : 病気・病理・症状
Technical Term ACTH Syndrome, Ectopic
Subject category : 病気・病理・症状
Technical Term Receptors, Corticotropin-Releasing Hormone
Subject category : 組織・器官
Technical Term Receptors, Corticotropin
Subject category : 組織・器官
Technical Term ACTH(1-24)
Subject category : 有機化合物, 薬物
Broader terms (2)
Technical Term anterior pituitary hormone
Subject category : ホルモン
Technical Term peptide hormone
Subject category : 蛋白質・ペプチド, ホルモン
Narrower terms (2)
Technical Term Org-2766
Subject category : 有機化合物
Technical Term ACTH(5-24)
Subject category : 有機化合物

RT Sub-classification into 31 kinds of relations by **four life-sciences experts** (1/3)

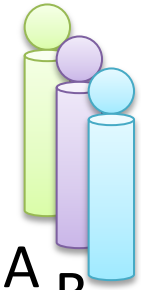


Initially, three life-sciences experts (Curator A, B, and C) sub-classify 2065 RTs to **10** different kinds of relations

- **Example:** “has part”, “is part of”, “has function”, “is function of”, “has attribute”, “is attribute of”, and “antonym” along with BT, NT, and RT.

Each of the sub-classified 2065 RTs were checked by all three experts.

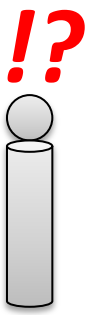
1st trial: RT Sub-classification based on majority decision (in 2016)



- Initially, three life-sciences experts (Curator A, B, and C) sub-classify 2065 RTs to **10** different kinds of relations such as “has part”, “has function.”
- Each of the sub-classified 2065 RTs were checked by all three experts.

RT Sub-classification into 31 kinds of relations by **four life-sciences experts** (2/3)

Next, the remaining life-science experts (Manager) checked the results obtained by the three other curators.



Manager

As a result, two issues were recognized.
First, the usage of some relations differed among the three curators.

- **Example:** The relation between “blood” and “ blood corpuscle” was either “has narrower”, or “has part”.

Second, it is possible and sometimes necessary to sub-classify RT to more than 10 relations.

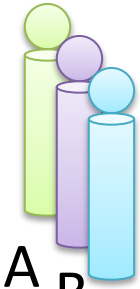
- **Example:** has role, has phenotype, etc.

Subsequently, the manager created a **guideline** which contained **31** different kinds of relations with examples and definitions.

Sub-classification of RT into 31 kinds of relation by **four life-sciences experts** (3/3)

Manager

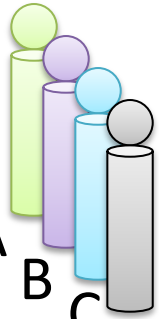
Again, the manager sub-classified 2065 RTs into **31** different kinds of relations using the **guideline**.



Curator A B C

The results were reviewed and revised by the three curator.

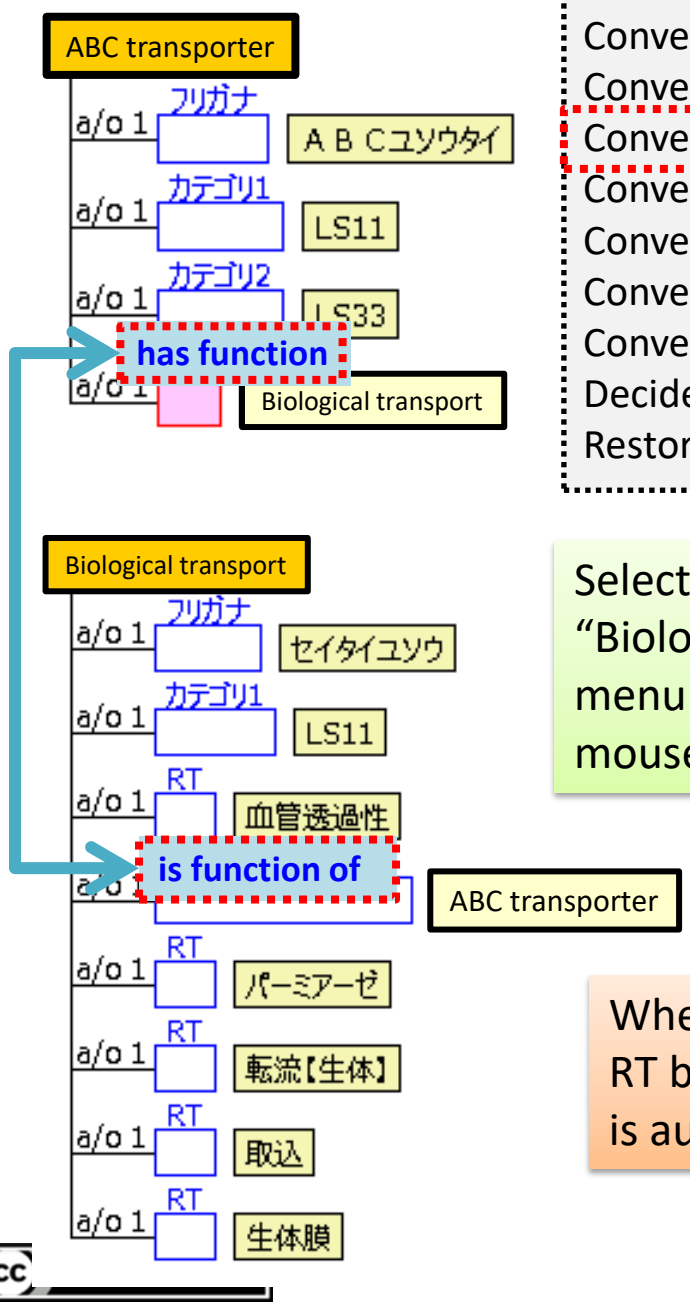
OK!



Curator A B C Manager

Ultimately, all four of life-sciences experts finalized them.

Sub-classifying RT using the graphical ontology editor Hozo (in Japanese language)



Convert to “BT”
Convert to “NT”
Convert to “has part”
Convert to “is part of”
Convert to “has function”
Convert to “is function of”
Convert to “has attribute”
Convert to “is attribute of”
Convert to “antonym”
Decide “RT”
Restore to “RT”

Ho - zo 法造 an Environment for Building/Using Ontologies www.hozo.jp

http://www.hozo.jp/

Select the sub-classifying RT between “ABC transporter” and “Biological transport” with mouse left click, open the popup menu with mouse right click, and select “**has function**” on mouse left click in the popup window

When the RT is converted to “**has function**”, the inverse RT between “Biological transport” and “ABC transporter” is automatically converted to “**is function of**.”

Performance of the RT sub-classification in 1st-III, 1st-II:2nd-III, 1st-II:2nd-II, and 1st-Split:2nd-II

Relation	1st-III				1st-II:2nd-III				1st-II:2nd-II				1st-Split:2nd-II			
	P	R	CR	N	P	R	CR	N	P	R	CR	N	P	R	CR	N
rdfs:subClassOf	0.95	1	1.06	161	0.93	1	1.08	13	0.83	0.99	1.19	104	0.80	1	1.25	4
skos:narrower (has narrower)	0.95	1	1.06	161	0.93	1	1.08	13	0.83	0.99	1.19	104	0.80	1	1.25	4
sio:SIO_000028 (has part)	1	0.74	0.74	23	-	-	-	0	1	0.89	0.89	18	1	1	1	7
sio:SIO_000068 (is part of)	1	0.74	0.74	23	-	-	-	0	1	0.89	0.89	18	1	1	1	7
sio:SIO_000218 (is quality of)	0.83	1	1.20	5	1	1	1	2	0.86	1	1.17	12	1	1	1	1
sio:SIO_000217 (has quality)	0.83	1	1.20	5	1	1	1	2	0.86	1	1.17	12	1	1	1	1
sio:SIO_000226 (is function of)	0.94	1	1.06	16	-	-	-	0	0.91	0.64	0.70	33	-	-	-	0
sio:SIO_000225 (has function)	0.94	1	1.06	16	-	-	-	0	0.91	0.63	0.69	32	-	-	-	0
sio:SIO_000123 (antonym)	1	1	1	14	-	-	-	0	1	1	1	4	-	-	-	0
sio:SIO_000228 (has role)	1	0.50	0.50	6	1	0.25	0.25	4	1	0.30	0.30	57	1	1	1	3
sio:SIO_000227 (is role of)	1	0.50	0.50	6	1	0.25	0.25	4	1	0.30	0.30	57	1	1	1	3
sio:SIO_001279 (has phenotype)	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
nbdc:isPhenotypeOf	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
sio:SIO_001154 (regulates)	-	-	-	0	-	-	-	0	1	1	1	2	-	-	-	0
sio:SIO_001155 (is regulated by)	-	-	-	0	-	-	-	0	1	1	1	2	-	-	-	0
xkos:succeeds	1	1	1	8	0.75	0.75	1	4	0.90	1	1.11	19	1	1	1	2
xkos:precedes	1	1	1	8	0.75	0.75	1	4	0.90	1	1.11	19	1	1	1	2
sio:SIO_000657(is transformed from)	1	1	1	1	1	1	1	1	1	1	1	2	-	-	-	0
sio:SIO_000655 (transforms into)	1	1	1	1	1	1	1	1	1	1	1	2	-	-	-	0
sio:SIO_000203 (is connected to)	-	-	-	0	-	-	-	0	1	1	1	2	-	-	-	0
sio:SIO_000365 (is creator of)	-	-	-	0	-	-	-	0	-	0	0	2	-	0	0	2
sio:SIO_000364 (has creator)	-	-	-	0	-	-	-	0	-	0	0	2	-	0	0	2
sio:SIO_000145 (is location of)	-	-	-	0	-	-	-	0	1	1	1	2	0.33	1	3.00	1
sio:SIO_000061 (is located in)	-	-	-	0	-	-	-	0	1	1	1	2	0.33	1	3.00	1
obo:RO_0002234 (has output)	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
obo:RO_0002353 (output of)	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0
sio:SIO_000064 (is provider of)	-	-	-	0	-	-	-	0	0	-	-	0	-	-	-	0
sio:SIO_000066 (has provider)	-	-	-	0	-	-	-	0	0	-	-	0	-	-	-	0
sio:SIO_000122 (synonym)	-	-	-	0	-	-	-	0	1	1	1	2	1	1	1	4
sio:SIO_000283 (is similar to)	-	-	-	0	-	-	-	0	0.33	1	3.00	2	-	-	-	0
skos:related (RT)	0.99	0.99	1	962	0.57	0.80	1.40	10	0.87	0.95	1.09	627	1	0.75	0.75	8
Sum (Mean) of relations	0.98 (0.90)		1.00	1416	0.83 (0.80)		1.00	58	0.87 (0.82)		1.00	1138	0.88 (0.86)		1.00	52

nbdc: <http://purl.jp/4/ontology/>, obo: <http://purl.obolibrary.org/obo/>