

# BERTによるPubMedの解釈と 毒性、疾患標的への活用

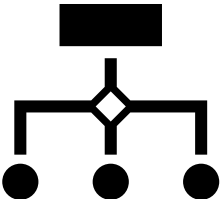
2022/10/26

緑川 淳

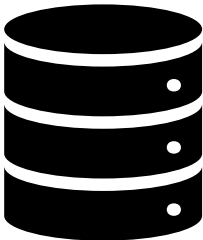
株式会社ワールドフュージョン

# LSKB is scientific web

Ontology



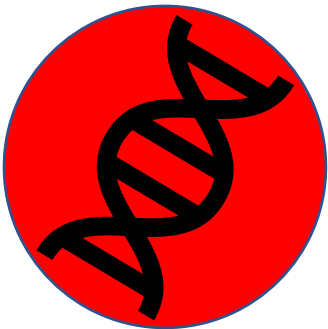
Contents



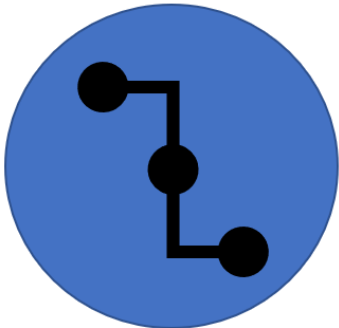
Analysis



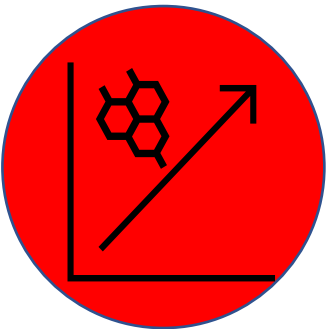
Bioinformatics



Interaction



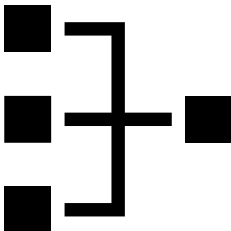
Cheminformatics



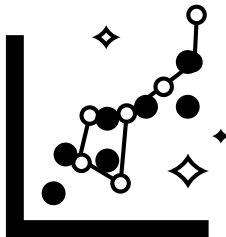
Structure



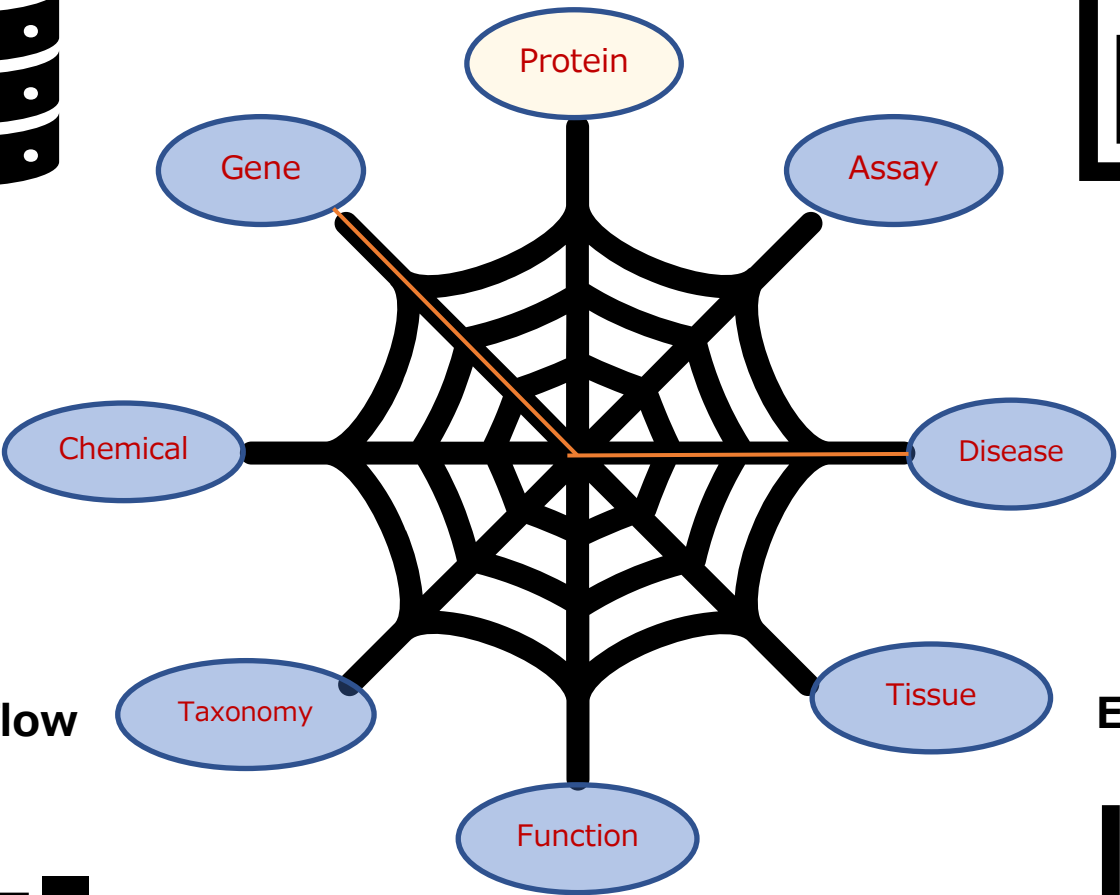
Workflow



Elpis Map

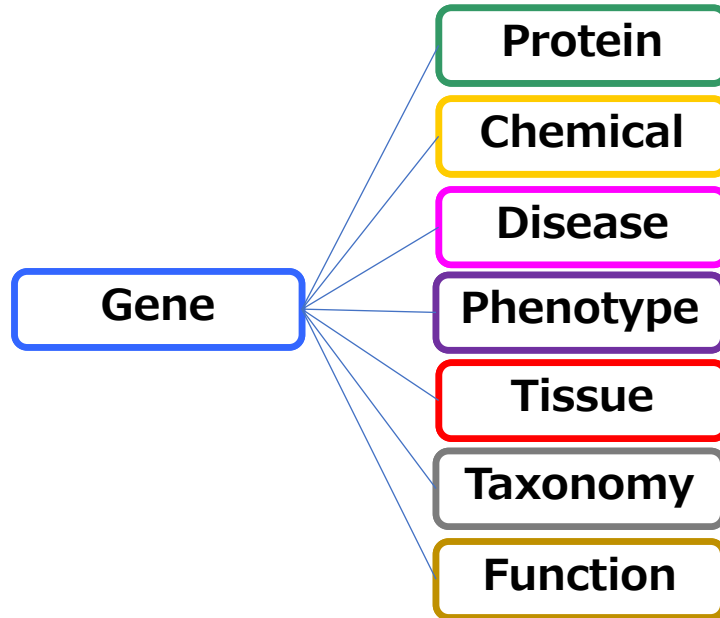
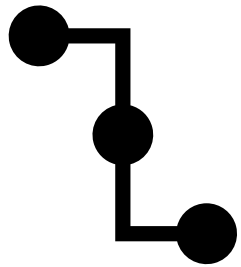


Exploration



# LSKB Interaction

Interaction



## 1) Text-Mining

- 20 years of PubMed literature (3 levels)
- Clinical Trial
- Assay Description

## 2) Assay Data

- Target Gene/Protein - Chemical
- Activities Endpoint
- Mode : Inhibition agonism/antagonism
- Expression: up/down regulation
- GWAS

## 3) Curated Annotation

- Disease Target
- Gene Ontology
- Pathway

## 4) AI Curated Annotation

- Mechanism of Action
- Gene RIF
- 20 years of PubMed literature  
(Toxicity associated Gene information)

# BERT (Bidirectional Encoder Representations from Transformers )

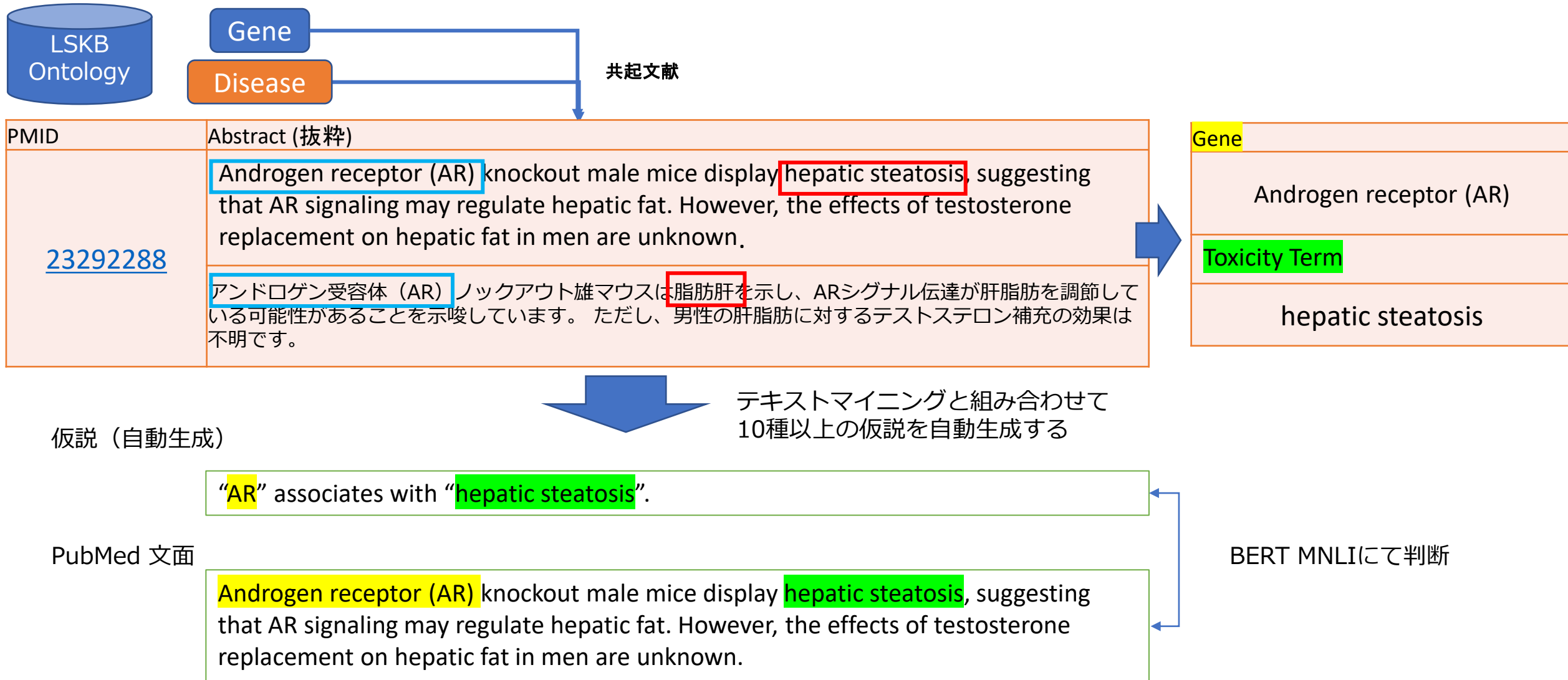
- BERTとは
  - Deep Learningにより 自然言語処理を行う手法
- BERTの特徴
  - 入力した文章の15%の単語を、確率的に別の単語で置き換えていくことで、文脈から置き換える前の単語を予測していく
  - 文章を文頭・文末の双方向から学習し、文脈を読めるようになった
  - 2018年当時の最高スコアを記録し、BERTは人工知能で初めて人間の平均の精度を超えた
- BERTのタスク
  - MNLI
    - Multi-Genre Natural Language Inferenceの略称で、GLUE（英語圏における自然言語処理の標準ベンチマーク）の指標の一つ。
    - 前提と仮説の内容上の関係に応じて「含意（entailment）」「矛盾（contradiction）」「どちらとも言えない（neutral）」といったラベルが付けられる。
- 事前学習モデル
  - **BioBERT**
    - LifeScienceに関してPubMedのAbstract、一部の本文を学習させたモデル
  - BlueBERT (NCBI)
  - PubMedBERT (Microsoft)

[https://ainow.ai/2019/05/21/167211/#Next\\_Sentence\\_PredictionNSP](https://ainow.ai/2019/05/21/167211/#Next_Sentence_PredictionNSP)

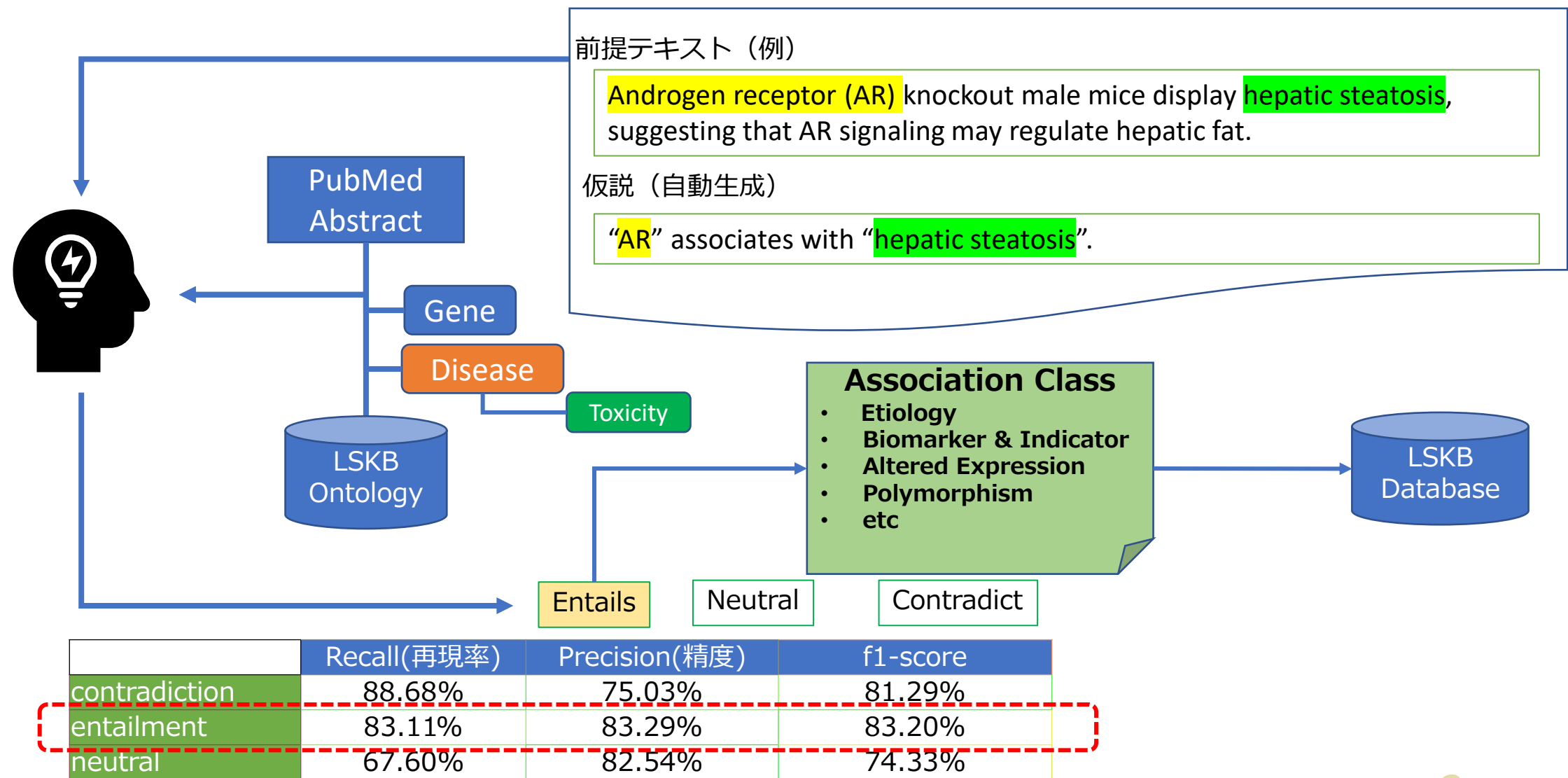
<https://buildersbox.corp->

[sansan.com/entry/2021/09/21/120000#%E5%9B%BA%E6%9C%89%E8%A1%A8%E7%8F%BE%E6%8A%BD%E5%87%BANER%E3%81%A8%E3%81%AF](https://buildersbox.corp-sansan.com/entry/2021/09/21/120000#%E5%9B%BA%E6%9C%89%E8%A1%A8%E7%8F%BE%E6%8A%BD%E5%87%BANER%E3%81%A8%E3%81%AF)

# PubMed Abstractから Toxicity Termの認識と 仮説の生成



# BERTによる遺伝子vs疾患(毒性)の関係性の判別概要



# 疾患関連 遺伝子情報

keyword : "als - amyotrophic lateral sclerosis"

**Disease** Amyotrophic Lateral Sclerosis Rare

T047:Disease or Syndrome

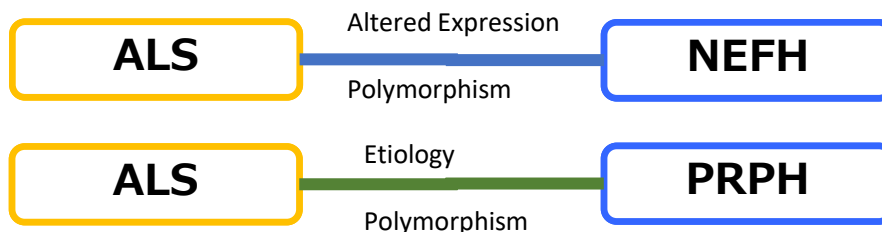
→ [Filter Condition\(s\)](#) [Send Gene ID](#) [Send Gene ID to Venn Diagram](#) [A](#)

Show 25 entries

	Gene ID	Gene Symbol	Gene Title	Organism	Association Class	# of Literature	# of PubMed Abstract (Associations)	# of Homonyms	Pathway	HPO	UniProt Association	Max Phase Drug/Exp	Gene Expression	Gene Expression (Ortholog)	# of GeneRIF	# of GeneRIF (Associations)	SNPs(rsID)	Gene in Disease Summary	Confidence Score
1	4744	<a href="#">NEFH</a>	neurofilament heavy chain	Homo sapiens	<ul style="list-style-type: none"><li>Altered Expression (GR)</li><li>Biomarker &amp; indicator (GR)</li><li>Etiology (GR)</li><li>Polymorphism (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Enhancement (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>	59	22	0	3	65	YES	0	0	6	7	6	6		0.317
2	5630	<a href="#">PRPH</a>	peripherin	Homo sapiens	<ul style="list-style-type: none"><li>Altered Expression (GR)</li><li>Etiology (GR)</li><li>Altered Expression (PM)</li><li>Biomarker &amp; indicator (PM)</li><li>Enhancement (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>	35	34	0	3	65	YES	0	0	3	2	2	3		0.317
3	1639	<a href="#">DCTN1</a>	dynactin subunit 1	Homo sapiens	<ul style="list-style-type: none"><li>Polymorphism (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>														
4	23435	<a href="#">TARDBP</a>	TAR DNA binding protein	Homo sapiens	<ul style="list-style-type: none"><li>Altered Expression (GR)</li><li>Biomarker &amp; indicator (GR)</li><li>Etiology (GR)</li><li>Inhibition (GR)</li><li>Polymorphism (GR)</li><li>Altered Expression (PM)</li><li>Biomarker &amp; indicator (PM)</li><li>Enhancement (PM)</li><li>Etiology (PM)</li><li>Inhibition (PM)</li><li>Polymorphism (PM)</li></ul>														
5	6334	<a href="#">SCN8A</a>	sodium voltage-gated	Homo sapiens	<ul style="list-style-type: none"><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li></ul>														

Showing 1 to 25 of 7,360 entries (filtered from 15,898 total entries)

## 関係性の概要分類(BERT)



Gene <a href="#">PRPH:peripherin</a>							
Disease <a href="#">Amyotrophic Lateral Sclerosis</a>							
→ <a href="#">Filter Condition(s)</a> <a href="#">Send PMID</a> <a href="#">Send PMID to Venn Diagram</a> <a href="#">A</a>							
Show 25 entries							
PMID	PubMed Title	PubMed Abstract Sentence Number	Extracted PubMed Abstract Texts	Classification	Found Synonyms		
2	12642616	A neurotoxic peripherin splice variant in a mouse model of ALS.	0	Peripherin, a neuronal intermediate filament (nIF) protein found associated with pathological aggregates in motor neurons of patients with amyotrophic lateral sclerosis (ALS) and of transgenic mice overexpressing mutant superoxide dismutase-1 (SOD1G37R), induces the selective degeneration of motor neurons when overexpressed in transgenic mice. Mouse peripherin is unique compared with other nIF proteins in that three peripherin isoforms are generated by alternative splicing.	<ul style="list-style-type: none"><li>Etiology</li><li>Polymorphism</li></ul>	<ul style="list-style-type: none"><li>amyotrophic lateral sclerosis</li><li>amyotrophic lateral sclerosis als</li><li>als</li></ul>	
3	12642616	A neurotoxic peripherin splice variant in a mouse model of ALS.	5	Using isoform-specific antibodies, Per 61 expression was detected in motor neurons of SOD1G37R transgenic mice but not of control or peripherin transgenic mice. The Per 61 antibody also selectively labeled motor neurons and axonal spheroids in two cases of familial ALS and immunoprecipitated a higher molecular mass peripherin species from disease tissue. This evidence suggests that expression of neurotoxic splice variants of peripherin may contribute to the neurodegenerative mechanism in ALS.	<ul style="list-style-type: none"><li>Polymorphism</li></ul>	<ul style="list-style-type: none"><li>als</li></ul>	
4	12642616	A neurotoxic peripherin splice variant in a mouse model of ALS.	6	The Per 61 antibody also selectively labeled motor neurons and axonal spheroids in two cases of familial ALS and immunoprecipitated a higher molecular mass peripherin species from disease tissue. This evidence suggests that expression of neurotoxic splice variants of peripherin may contribute to the neurodegenerative mechanism in ALS.	<ul style="list-style-type: none"><li>Etiology</li><li>Polymorphism</li></ul>	<ul style="list-style-type: none"><li>als</li></ul>	
5	14675609	Expression of peripherin in ubiquitinated inclusions of amyotrophic lateral sclerosis.	0	We evaluated the expression of the type III intermediate filament (IF) protein, peripherin (PRP), in ubiquitinated inclusions of motor neurons in amyotrophic lateral sclerosis (ALS). A previous study showed that overexpression of PRP in transgenic mice induces motor neuron disease with formation of PRP-containing inclusions before onset of symptoms [J. Cell Biol. 147 (3) (1999) 531].	<ul style="list-style-type: none"><li>Etiology</li></ul>	<ul style="list-style-type: none"><li>amyotrophic lateral sclerosis</li><li>amyotrophic lateral sclerosis als</li><li>als</li></ul>	

# Target Explorer : Glaucoma related Diseases



## MeSH Disease Classification

- ▣ Nervous System Diseases [C10]
- ▣ Eye Diseases [C11]
  - Asthenopia [C11.093]
  - Cogan Syndrome [C11.180]
  - ▣ Conjunctival Diseases [C11.187]
  - ▣ Corneal Diseases [C11.204]
  - ▣ Eye Abnormalities [C11.250]
  - ▣ Eye Diseases, Hereditary [C11.270]
  - ▣ Eye Hemorrhage [C11.290]
  - ▣ Eye Infections [C11.294]
  - ▣ Eye Injuries [C11.297]
  - ▣ Eye Manifestations [C11.300]
  - ▣ Eye Neoplasms [C11.319]
  - ▣ Eyelid Diseases [C11.338]
  - ▣ Lacrimal Apparatus Diseases [C11.496]
  - ▣ Lens Diseases [C11.510]
  - ▣ Ocular Hypertension [C11.525]
    - ▣ Glaucoma [C11.525.381]
      - Glaucoma, Angle-Closure [C11.525.381.056]
      - Glaucoma, Neovascular [C11.525.381.348]
      - ▣ Glaucoma, Open-Angle [C11.525.381.407]
        - Low Tension Glaucoma [C11.525.381.703]

Literature mining

AI-based Curation

OMIM/MedGen etc

Gene Expression

SNPs Information

Indication

Clinical Trial

Pathway

検索条件に入れた複数の疾患について  
様々なInteraction、文献情報などから  
ターゲットをランキング



# Target Explorer : Glaucoma related Diseases



About Contact

logout

Input :

- Angle Closure Glaucoma
- Glaucoma, Open-Angle
- Hydrophthamos
- Low Tension Glaucoma

Filter Condition(s) Send Gene ID Send Gene ID to Venn Diagram A

Show 25 entries

Column visibility Copy Excel

	Rank	Gene ID	Gene Symbol	Gene Title	Organism	# of Disease	Association Class	# of OMIM	# of MedGen	HPO	UniProt Association	Gene Expression	# of GeneRIF	# of GeneRIF (Associations)	SNPs(rsID)	# of Literature	Pathway	Max Phase Drug/Exp	Confidence Score Mean	Confiden Score M
1	1	5737	PTGFR	prostaglandin F receptor	Homo sapiens	9	<ul style="list-style-type: none"><li>Etiology (GR)</li><li>Polymorphism (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>	0	0	0		0	3	3	0.17	18	0	4	0.24	
2	2	154	ADRB2	adrenoceptor beta 2	Homo sapiens	9	<ul style="list-style-type: none"><li>Etiology (GR)</li><li>Polymorphism (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>	0	0	0		0	2	1	0.03	2	0	4	0.24	
3	3	153	ADRB1	adrenoceptor beta 1	Homo sapiens	9	<ul style="list-style-type: none"><li>Etiology (GR)</li><li>Polymorphism (GR)</li></ul>	0	0	0		0	1	1	0.0	0	0	4	0.23	
4	4	1545	CYP1B1	cytochrome P450 family 1 subfamily B member 1	Homo sapiens	7	<ul style="list-style-type: none"><li>Altered Expression (GR)</li><li>Biomarker &amp; indicator (GR)</li><li>Enhancement (GR)</li><li>Etiology (GR)</li><li>Inhibition (GR)</li><li>Polymorphism (GR)</li><li>Altered Expression (PM)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Inhibition (PM)</li><li>Polymorphism (PM)</li></ul>	2	0	3	YES	0	93	76	4.52	184	0	0	0.23	
5	6	760	CA2	carbonic anhydrase 2	Homo sapiens	6	<ul style="list-style-type: none"><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li></ul>	0	0	0		0	0	0	0.1	57	1	4	0.22	
6	5	4653	MYOC	myocilin	Homo sapiens	7	<ul style="list-style-type: none"><li>Altered Expression (GR)</li><li>Biomarker &amp; indicator (GR)</li><li>Enhancement (GR)</li><li>Etiology (GR)</li><li>Inhibition (GR)</li><li>Polymorphism (GR)</li></ul>	0	0	2	YES	0	111	88	4.7	502	0	0	0.21	



# **Toxicity & Side Effect**

# 脂肪肝に関連する遺伝子リスト

## TOXICITY Hepatic steatosis

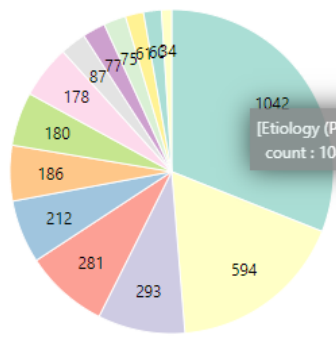
T047:Disease or Syndrome

Filter Condition(s) Send Gene ID Send Gene ID to Venn Diagram A

Show 25 entries

Column visibility Copy Excel

Association Class



X-axis: Gene ID Y-axis: LSKB\_SP\_ID

### 記載内容の分類

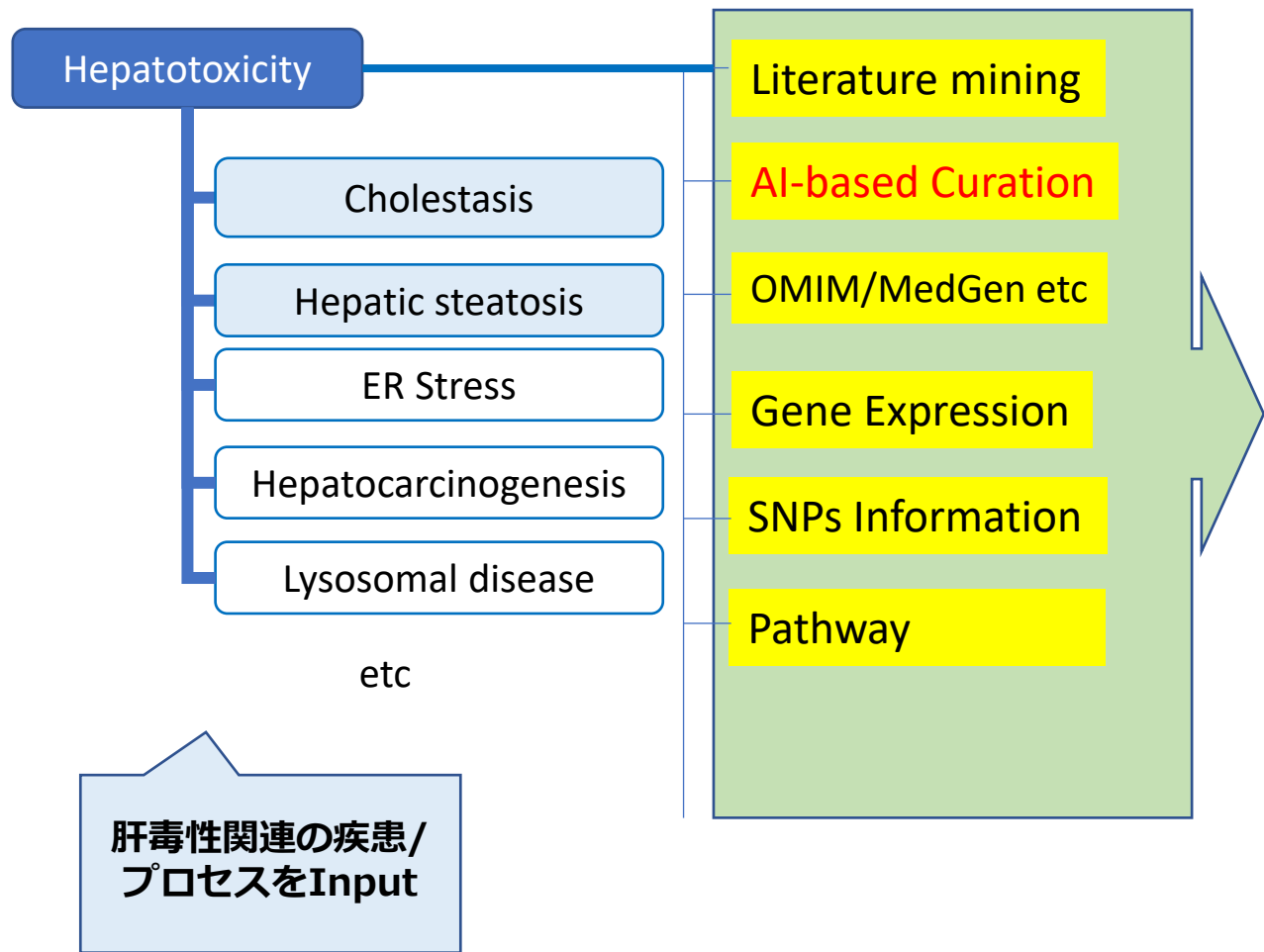
- Etiology
- Biomarker & Indicator
- Altered Expression
- Polymorphism
- etc

	Gene ID	Gene Symbol	Gene Title	Organism	Association Class	# of Literature	# of PubMed Abstract (Associations)	Pathway	Gene Expression	Gene RIF	Gene RIF (Associations)	# of GeneRIF (Associations) for internal work	SNPs(rsID)
4	2740	[H] GLP1R	glucagon like peptide 1 receptor	Homo sapiens	<ul style="list-style-type: none"> <li>• Biomarker &amp; indicator (PM)</li> <li>• Etiology (PM)</li> <li>• Inhibition (PM)</li> </ul>	136	29	0	0	1	0	1	0
5	367	[H] AR	androgen receptor	Homo sapiens	<ul style="list-style-type: none"> <li>• Biomarker &amp; indicator (PM)</li> <li>• Etiology (PM)</li> </ul>	14				0	0	0	1
6	6524	[H] SLC5A2	solute carrier family 5 member 2	Homo sapiens	<ul style="list-style-type: none"> <li>• Biomarker &amp; indicator (PM)</li> <li>• Etiology (PM)</li> </ul>	37				0	0	0	0
7	3454	[H] IFNAR1	interferon alpha and beta receptor subunit 1	Homo sapiens	<ul style="list-style-type: none"> <li>• Biomarker &amp; indicator (PM)</li> <li>• Down Regulation (PM)</li> <li>• Etiology (PM)</li> <li>• Polymorphism (PM)</li> </ul>	4				0	0	0	0
8	5406	[H] PNLIP	pancreatic lipase	Homo sapiens	<ul style="list-style-type: none"> <li>• Biomarker &amp; indicator (PM)</li> <li>• Etiology (PM)</li> <li>• Up Regulation (PM)</li> </ul>	9				0	0	0	0
9	1268	[H] CNR1	cannabinoid receptor 1	Homo sapiens	<ul style="list-style-type: none"> <li>• Biomarker &amp; indicator (PM)</li> <li>• Down Regulation (PM)</li> <li>• Enhancement (PM)</li> <li>• Etiology (PM)</li> <li>• Inhibition (PM)</li> <li>• Up Regulation (PM)</li> </ul>	50	20	0	0	1	0	1	7
10	7124	[H] TNF	tumor necrosis	Homo sapiens	<ul style="list-style-type: none"> <li>• Biomarker &amp; indicator (GR)</li> </ul>	375	87	13	0	23	18	20	0

### 関係性の項目

- PubMed 文献共起
- BERTによる Association Class (PubMed/GeneRIF)
- Pathway
- Gene Expression
- GeneRIF
- SNP

# Tox. Target Explorer: Hepatotoxicity



Rank	Gene ID	Gene Symbol	Gene Title	Organism	# of Disease	Association Class	HPO
						<ul style="list-style-type: none"><li>Up Regulation (PM)</li></ul>	
4	2	7124	<span>[H]</span> TNF	tumor necrosis factor	Homo sapiens	6 <ul style="list-style-type: none"><li>Biomarker &amp; indicator (GR)</li><li>Down Regulation (GR)</li><li>Enhancement (GR)</li><li>Etiology (GR)</li><li>Inhibition (GR)</li><li>Polymorphism (GR)</li><li>Up Regulation (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Down Regulation (PM)</li></ul>	0
5	39	3309	<span>[H]</span> HSPA5	heat shock protein 70 class B member 5		<ul style="list-style-type: none"><li>Inhibition (GR)</li><li>Up Regulation (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li></ul>	0
6	45	1555	<span>[H]</span> CYP2B6	cytochrome P450 family 2 subfamily B member 6	Homo sapiens	6 <ul style="list-style-type: none"><li>Etiology (GR)</li><li>Polymorphism (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Down Regulation (PM)</li><li>Enhancement (PM)</li><li>Etiology (PM)</li><li>Inhibition (PM)</li><li>Polymorphism (PM)</li><li>Up Regulation (PM)</li></ul>	0
7	2038	24	<span>[H]</span> ABCA4	ATP binding cassette subfamily A member 4	Homo sapiens	3 <ul style="list-style-type: none"><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>	0
8	66	1401	<span>[H]</span> CRP	C-reactive protein	Homo sapiens	6 <ul style="list-style-type: none"><li>Enhancement (GR)</li><li>Etiology (GR)</li><li>Up Regulation (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Enhancement (PM)</li><li>Etiology (PM)</li><li>Inhibition (PM)</li><li>Polymorphism (PM)</li></ul>	0
9	187	1649	<span>[H]</span> DDIT3	DNA damage inducible transcript 3	Homo sapiens	3 <ul style="list-style-type: none"><li>Etiology (GR)</li><li>Biomarker &amp; indicator (PM)</li></ul>	0

Evidenceとともに  
毒性・有害事象に関わる  
ターゲットをリストアップ

Evidenceとともに  
毒性・有害事象に関わる  
ターゲットをリストアップ

Showing 1 to 25 of 10,112 entries (filtered from 22,101 total entries)



# Hepatotoxicity related Gene vs Drug

Inxight から臨床試験において急性肝炎など肝障害の報告があった79薬剤と Tox. Target Explorerにおいて上位 HepatoTox 関連 268 Gene に相当する Protein に対して活性の有無で Matrixを作成

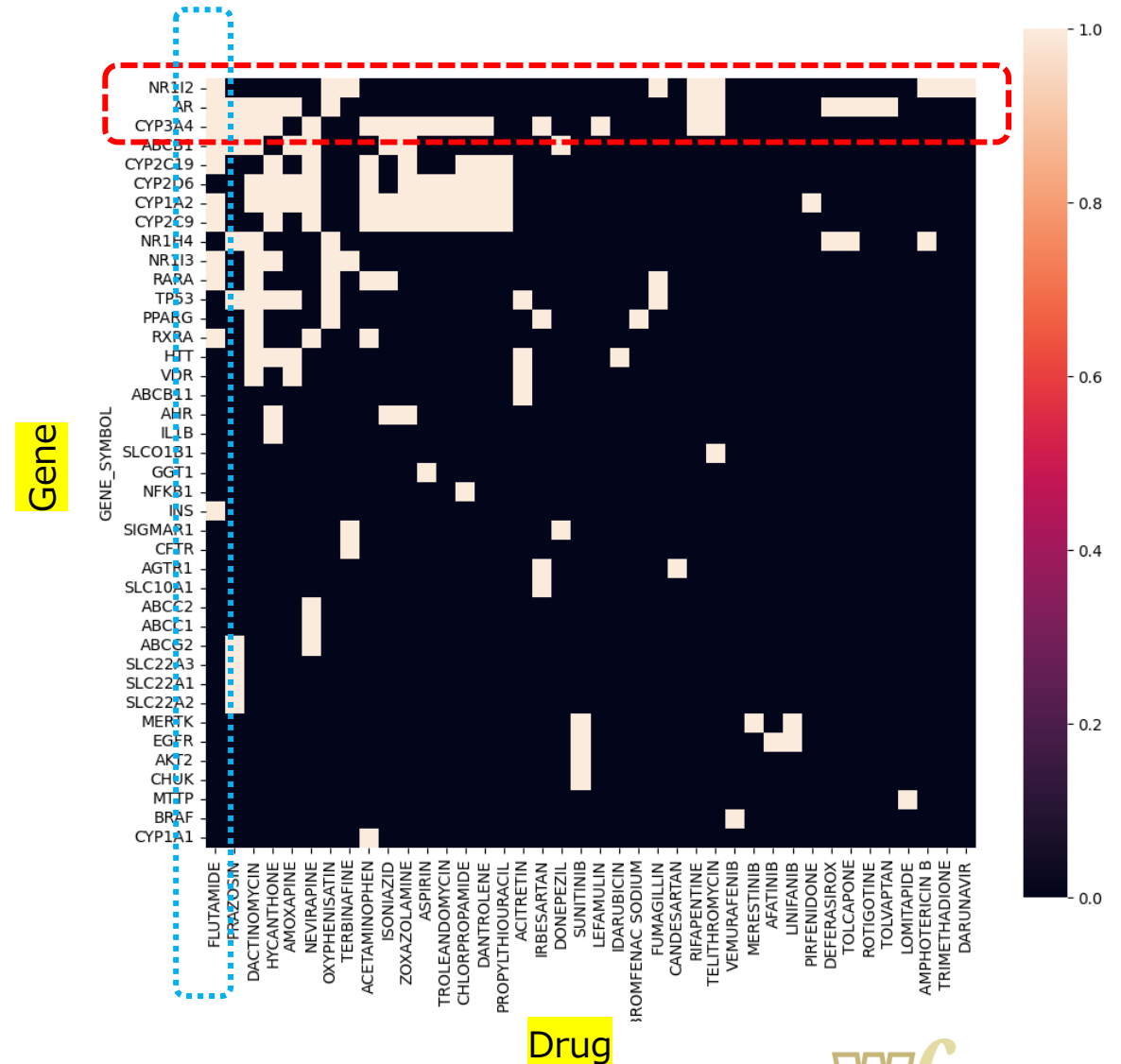
BERTにより関連性を抽出

Gene: 上位の遺伝子の Evidence

- NRI12: “Pregnane X receptor”の活性化が Acetoaminophenや ritonavir の hepatotoxicityを増強
- AR: アンドロゲン受容体(AR)ノックアウト雄マウスは肝脂肪症を示す
- CYP3A4: CYP3A4誘導が反応性代謝産物形成の増加を介してラパチニブ誘発肝毒性を増強

Drug:

- Flutamide
  - FDAの DILI Rankで vMost-DILI-Concern に該当
    - NRI12 : Pregnane X receptor Activator
    - CYP3A4: Inhibition
    - ABCB1: Active





# **Zebrafish Toxicity Experiment Support**

# 催奇形性に関連する遺伝子リスト

## Toxicity Teratogenesis

(beta version)

T046:Pathologic Function

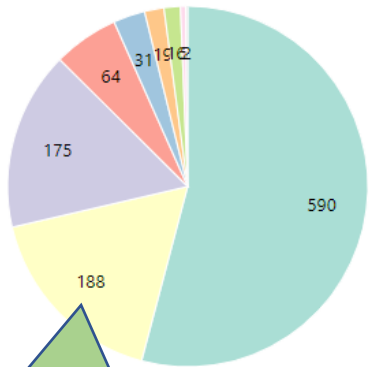


Filter Condition(s) Send Gene ID Send Gene ID to Venn Diagram A

Show 25 entries

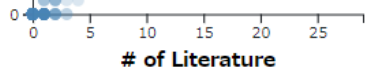
Column visibility Copy Excel

Association Class



### 記載内容の分類

- Etiology
- Biomarker & Indicator
- Altered Expression
- Polymorphism
- etc



	Gene ID	Gene Symbol	Gene Title	Organism	Association Class	# of Literature	# of Literature LV1	# of Literature LV2	# of PubMed Abstract (Associations)	Pathway	Gene Expression
1	51185	CRBN	cereblon	Homo sapiens	<ul style="list-style-type: none"><li>Etiology (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Inhibition (PM)</li><li>Polymorphism (PM)</li></ul>	28	18	17	14	0	
2	4524	MTHFR	methylenetetrahydrofolate reductase	Homo sapiens	<ul style="list-style-type: none"><li>Etiology (GR)</li><li>Polymorphism (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>	7			3	0	
3	324	APC	APC regulator of WNT signaling pathway	Homo sapiens	<ul style="list-style-type: none"><li>Polymorphism (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Polymorphism (PM)</li></ul>			1	1	1	
4	57167	SALL4	spalt like transcription factor 4	Homo sapiens	<ul style="list-style-type: none"><li>Etiology (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li></ul>	5	2	2	1	0	
5	6910	TBX5	T-box transcription factor 5	Homo sapiens	<ul style="list-style-type: none"><li>Etiology (GR)</li><li>Biomarker &amp; indicator (PM)</li><li>Etiology (PM)</li><li>Inhibition (PM)</li></ul>	2	1	1	5	0	

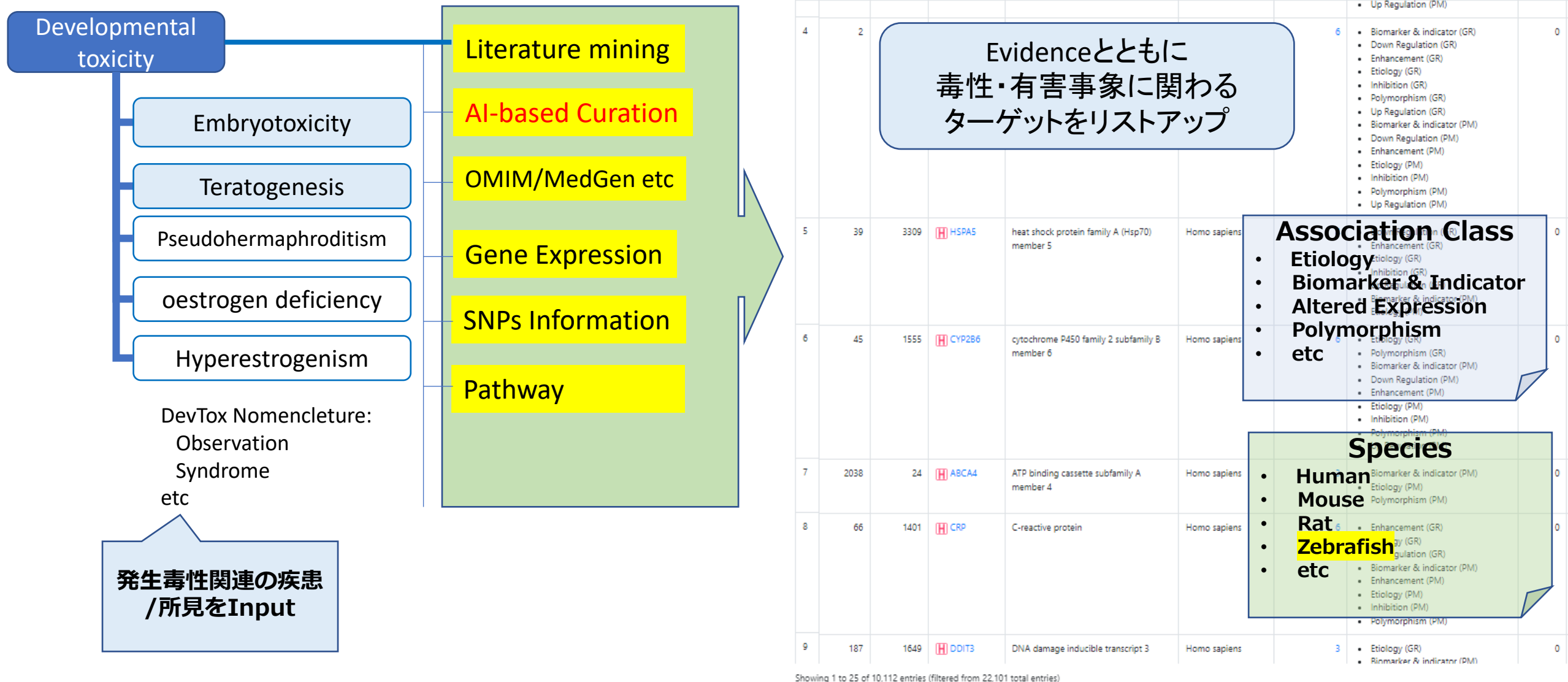
### 関係性の項目

- PubMed 文献共起
- BERTによる Association Class (PubMed/GeneRIF)
- Pathway
- Gene Expression
- GeneRIF
- SNP

Showing 1 to 25 of 871 entries (filtered from 2,440 total entries)

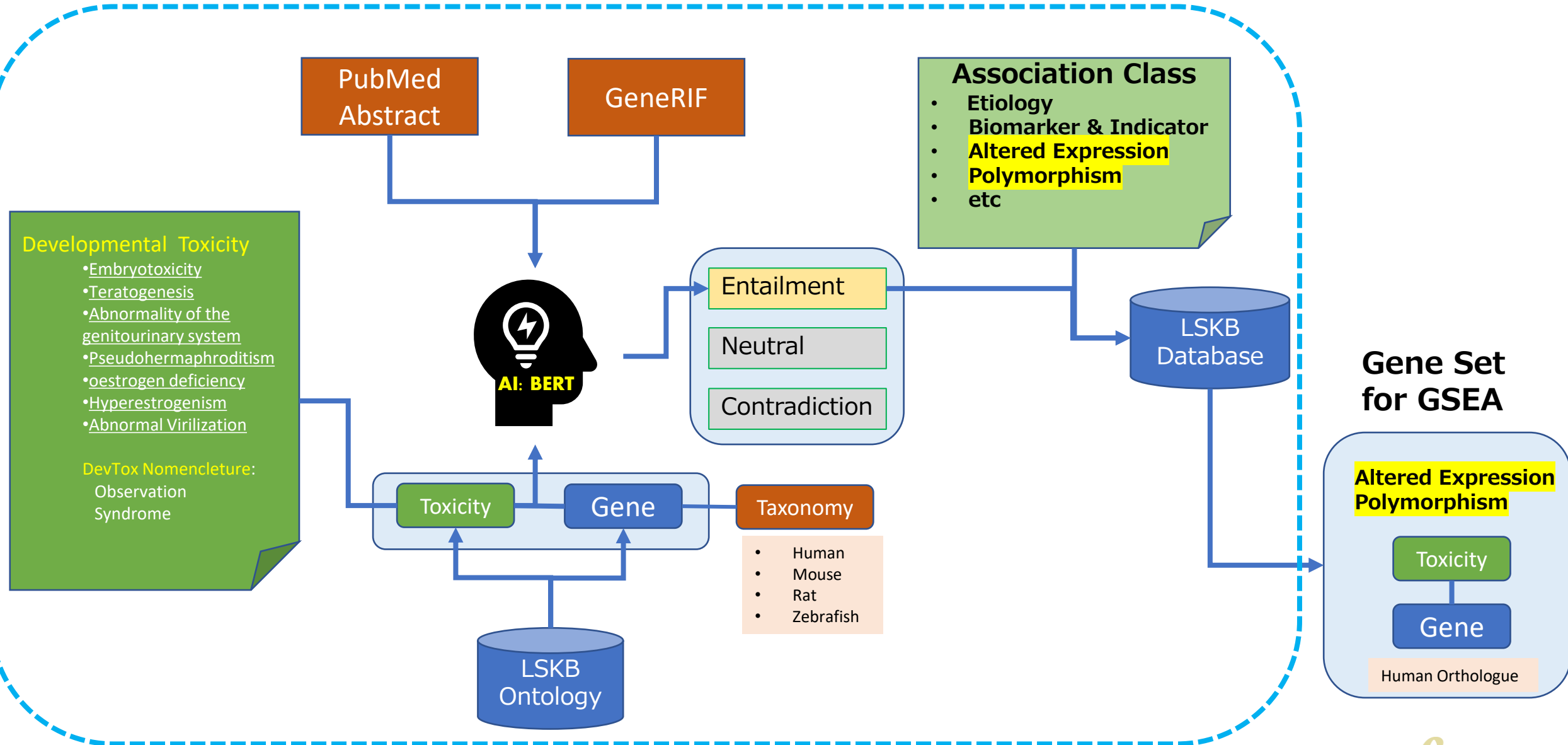
Previous 1 2 3 4 5 ... 35 Next

# Tox. Target Explorer: Developmental toxicity



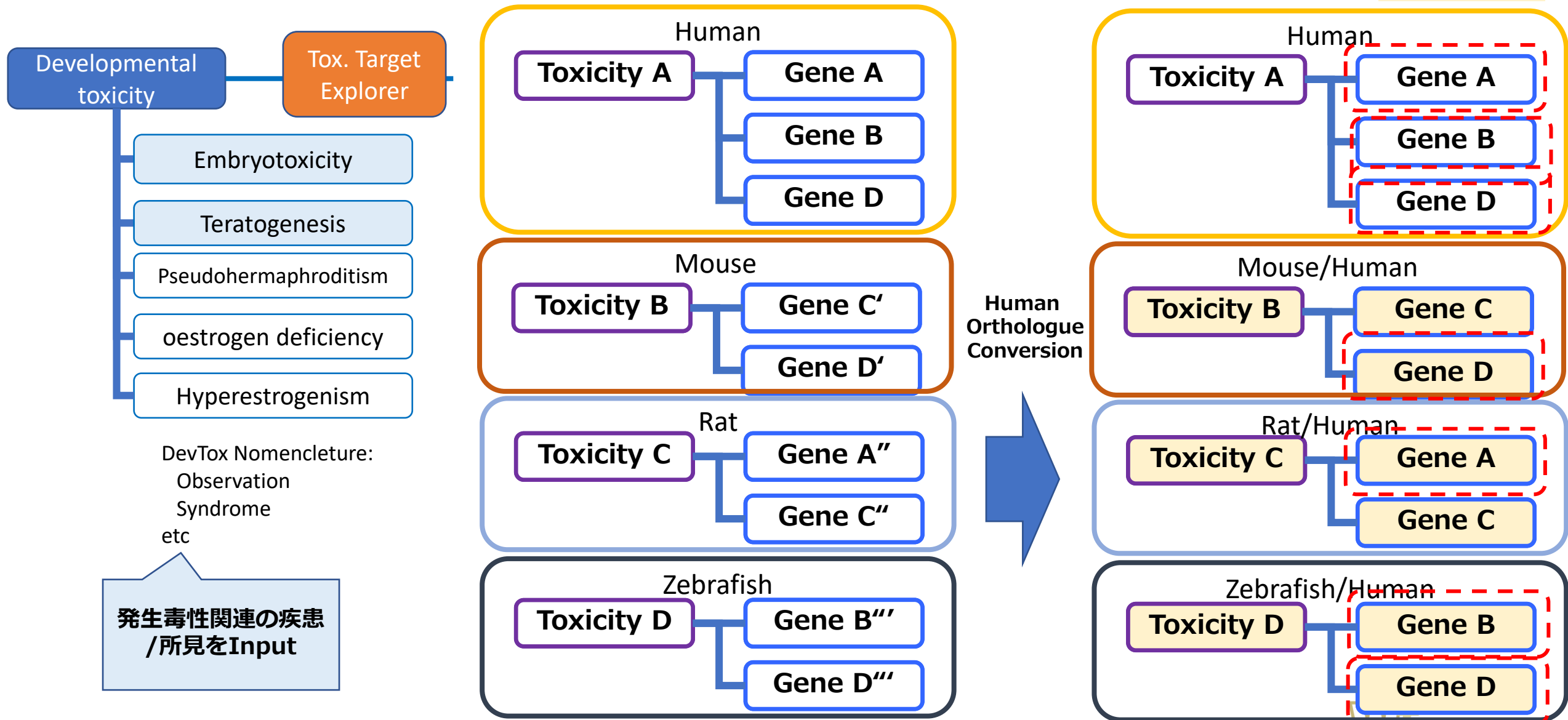


# LSKB: 発生毒性用GSEA Gene Set 作成プロセス



# Tox. Target Explorer: Species & Human Orthologue

Zebrfish  
Convertible  
Gene





# Developmental Toxicity estimation support by GSEA

Developmental toxicity

## Target Explorer

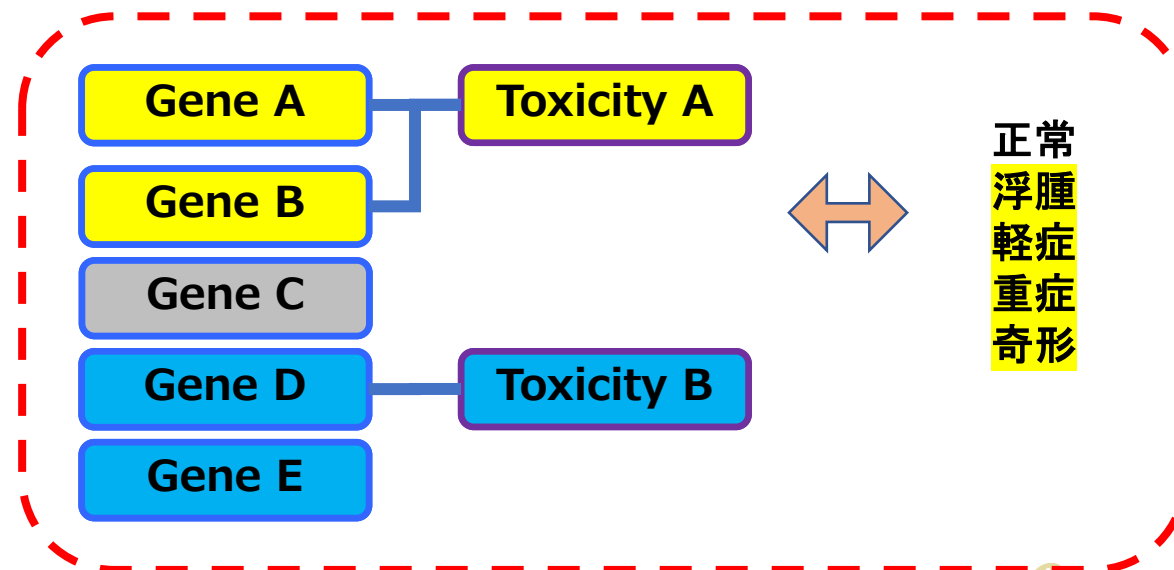
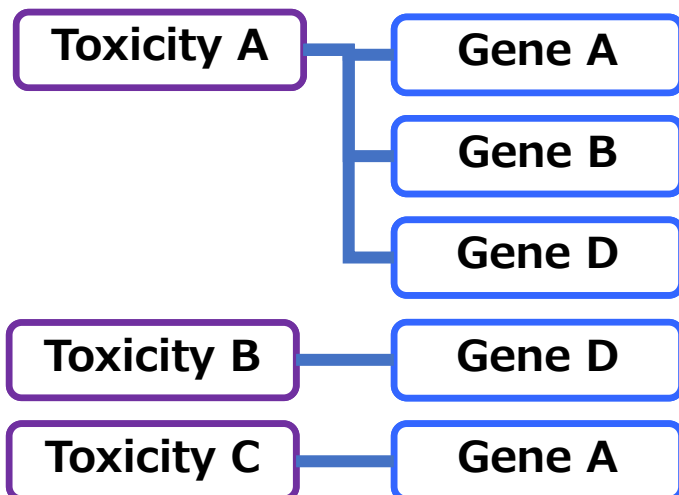
Text-Mining and AI curation  
PubMed literature  
GeneRIF  
Open Data  
UniProt  
MedGen  
Pathway  
Gene Ontology  
SNPs

Gene Expression

GSEA

Up-regulated  
Down-regulated

Zebrafish



# GSEA/Phenotype Comparison

黄: Up regulated  
青: Down regulated  
数字: FDRq-Value  
赤字: 0.25以下

	18	19	21	23	14	20	15	9	10	12	11	17
Drug	スルファサラジン	エリストロマイシン	アモキシリン	アモキシリン	サリドマイド	バルプロ酸	サリドマイド	サリドマイド	バルプロ酸	バルプロ酸	サリドマイド	サリドマイド
Amount	80	30	30	80	30	80	80	30	30	30	30	80
Phenotype	健常	健常	健常	健常	健常	浮腫	浮腫	軽症	軽症	重症	重症	奇形
	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP	ZF_EXP
Toxicity	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v	FDRq-v
Abnormal Virilization	0.953	0.531	0.869	0.781	0.957	0.135	0.965	0.878	0.987	0.197	0.538	0.607
Abnormality of the genitourinary system	0.438	0.296	0.887	0.27	0.951	0.68	0.966	0.672	0.987	0.707	0.898	0.182
Craniosynostosis	0.953	0.985	0.887	0.358	0.955	0.983	0.82	0.069	0.948	0.03	0.152	0.969
Depressivity	0.296	0.296	0.801	0.67	0.772	0.593	0.727	0.065	0.478	0.707	0.705	0
Diverticulum	0.968	0.531	0.628	0.33	0.772	0.135	0.727	0.894	0.948	0.673	0.538	0.969
Exencephaly	0.953	0.951	0.801	0.358	0.955	1	0.878	0.678	0.736	0.886	0.152	0.838
Familial caudal dysgenesis	0.968	0.964	0.887	0.781	0.772	0.629	0.727	0.896	0.987	0.285	0.152	0.969
Hernia	0.953	0.763	0.869	0.827	0.772	0.089	0.907	0.07	0.174	0.617	0.097	0.828
Hypospadias, penile	0.953	0.979	0.63	0.968	0.955	1	0.455	0.065	0.523	0.617	0.176	0.719
Lesion	0.518	0.296	0.63	0.358	0.772	0.43	0.878	0.069	0.322	0.707	0.561	0.103
oestrogen deficiency	0.198	0.296	0.63	0.315	0.645	0.629	0.82	0.016	0.316	0.03	0.053	0.103
Oligohydramnios	0.625	0.979	0.801	0.354	0.955	0.66	0.878	0.672	0.51	0.707	0.152	0.969
pathologic fistula	0.296	0.979	0.63	0.602	0.955	0.051	0.998	0	0.015	0.707	0.053	0.224
Persistent Embryonic Structure	0.605	0.687	0.801	0.692	0.772	0.43	0.727	0.016	0.322	0.707	0.305	0.188
Protrusion	0.953	0.979	0.801	0.395	0.772	0.773	0.901	0.423	0.987	0.707	0.283	0.164
Scoliosis	0.968	0.278	0.869	0.765	0.772	1	0.965	0.423	0.485	0.075	0.613	0.969
Skin tags	0.298	0.992	0.887	0.968	0.759	0.68	0.878	1	0.987	0.384	0.921	0.969
Spina Bifida	0.968	0.975	0.966	0.412	0.772	1	0.727	1	0.555	0.285	0.123	0.969
Teratogenesis	0.968	0.964	0.887	0.333	0.772	0.784	0.878	0.065	0.174	0.131	0.152	0.969

# まとめ

- LSKB (Life Science Knowledge Bank) の概要
  - 多彩なInteraction
- Deep Learning (BERT)により PubMed/GeneRIF を解釈
  - 多様な仮説の自動生成により 遺伝子と疾患の関連性を取得
- 疾患関連遺伝子情報
  - 複数の関連疾患を纏めてターゲットを探索
- 毒性 副作用関連遺伝子情報
  - 複数の疾患/プロセスから エビデンスに基づく関連遺伝子の探索
- 疾患あるいは毒性関連遺伝子の探索
  - 多様で効率的なフィルタリング
- Zebrafish 発生毒性試験の遺伝子発現データ解析
  - Zebrafish 発生毒性用Gene Set作成

ご清聴ありがとうございました。

ご質問は

[support@lskb.jp](mailto:support@lskb.jp)

までお願いいたします。



<https://www.lskb.jp/>