

# Extracting research evidence from publications



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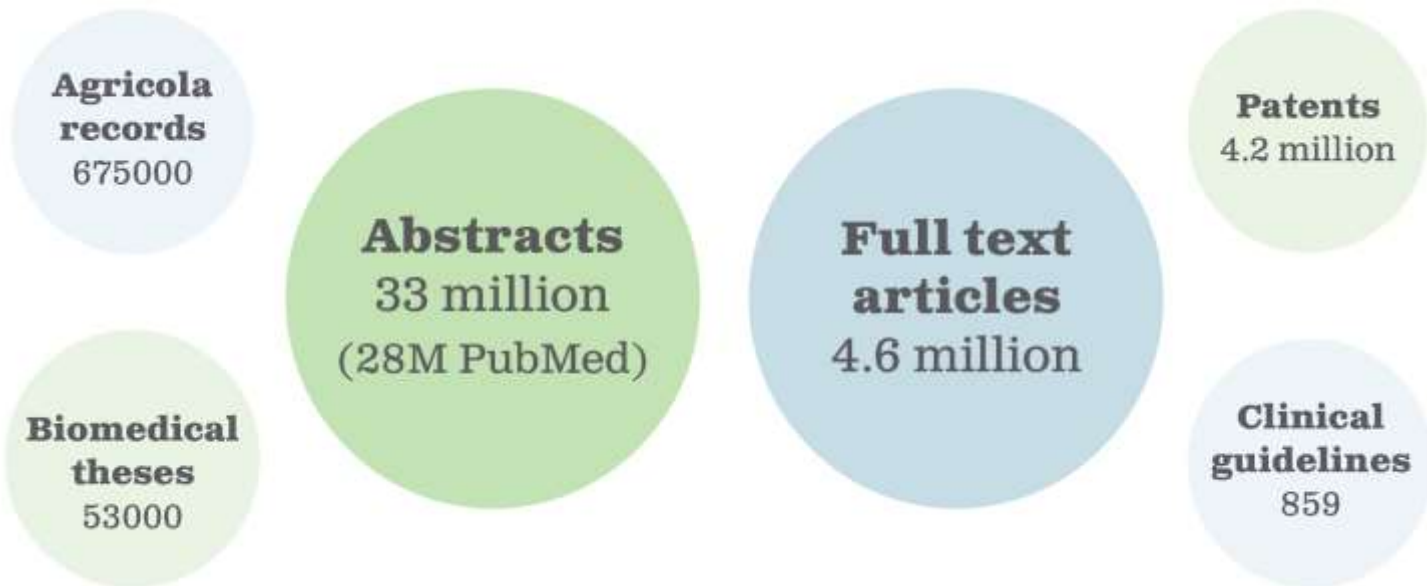
[helpdesk@europemc.org](mailto:helpdesk@europemc.org)

# Contents

- Available data (annotation types and sources)
- API operations and parameters
- Web service outputs
- Use case examples

# What is Europe PMC?

- A public database of life sciences research literature



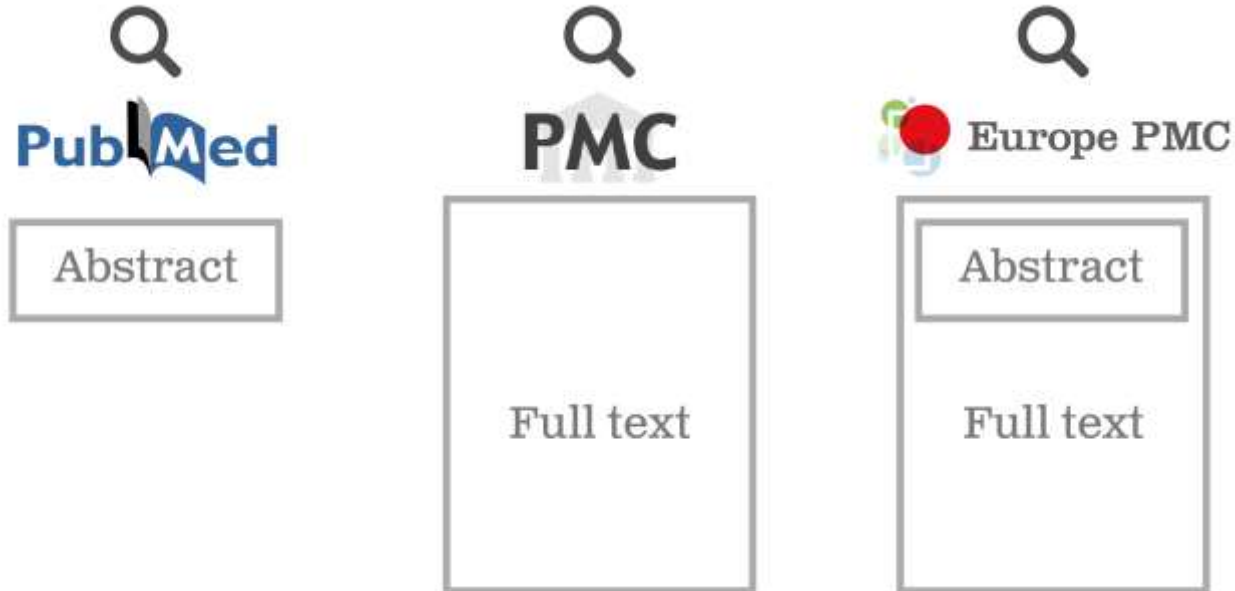
# What is Europe PMC?

- A designated repository of 28 life science funders



# Europe PMC and PubMed Central

- Europe PMC is a partner of PubMed Central USA
- Both databases share full-text content
- Europe PMC differs in the range of content & additional services



# Literature as part of big data in biology

**33 million**

biomedical abstracts



in Europe PMC

**3 million**

genomic variants

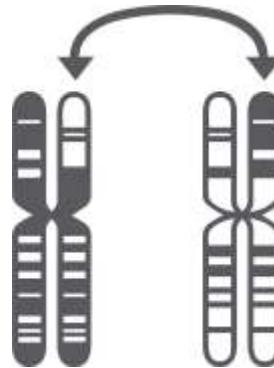


image by  
Jason D. Rowley

in dbVar

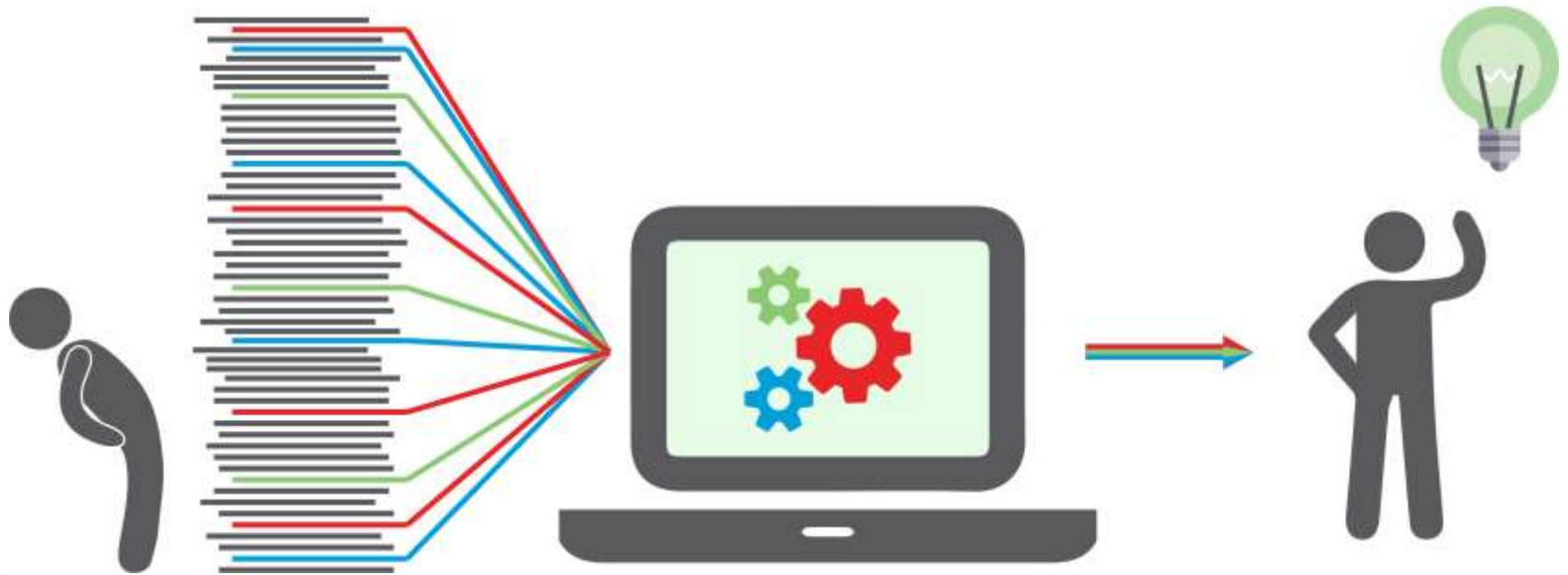
**138 000**

protein structures



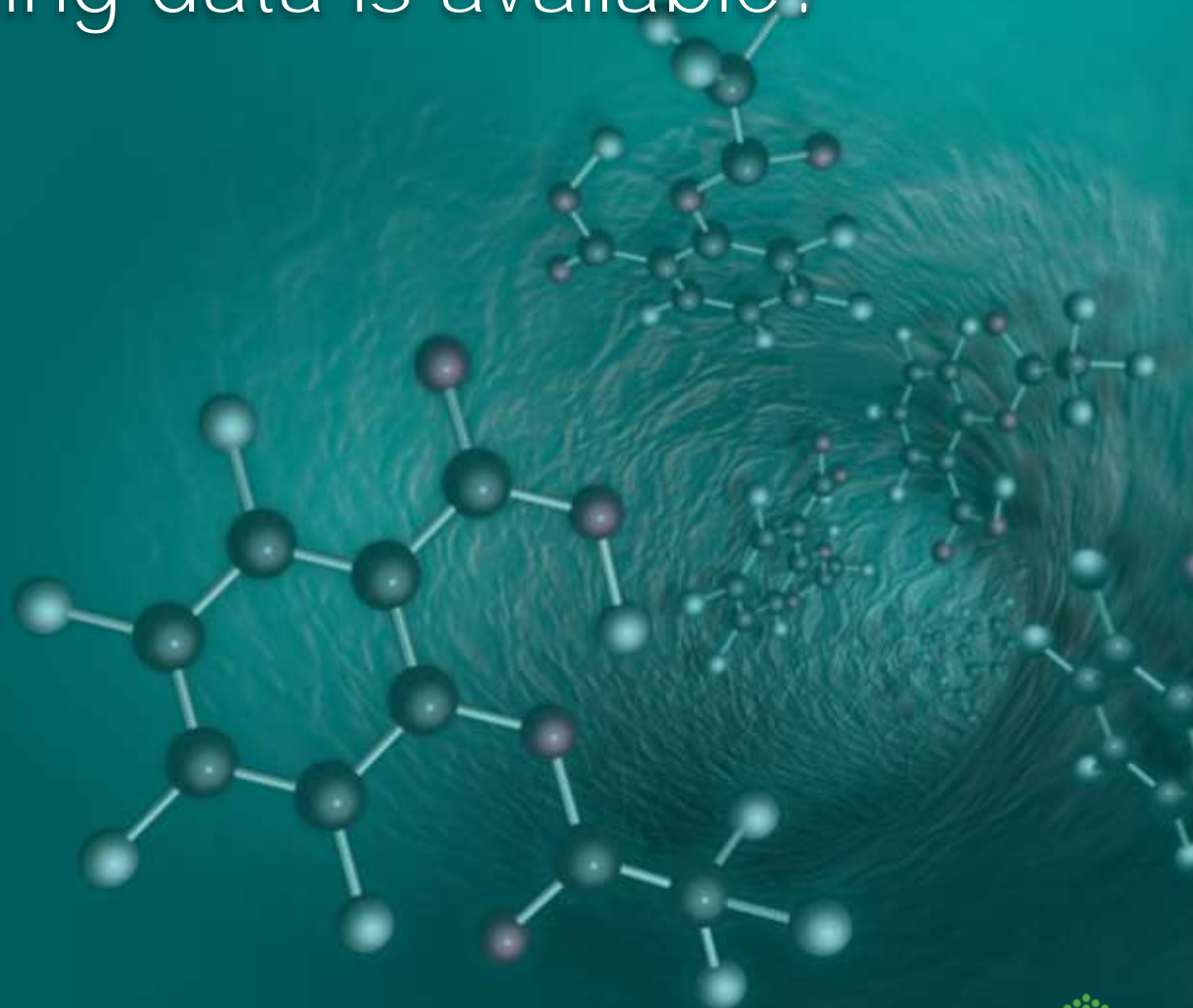
in PDBe

# Europe PMC community text-mining platform





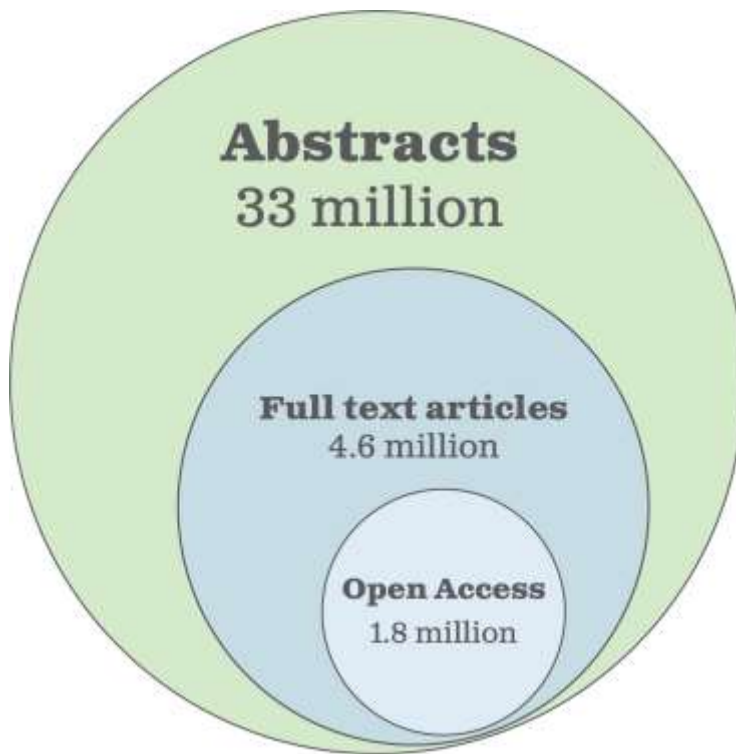
# What text-mining data is available?



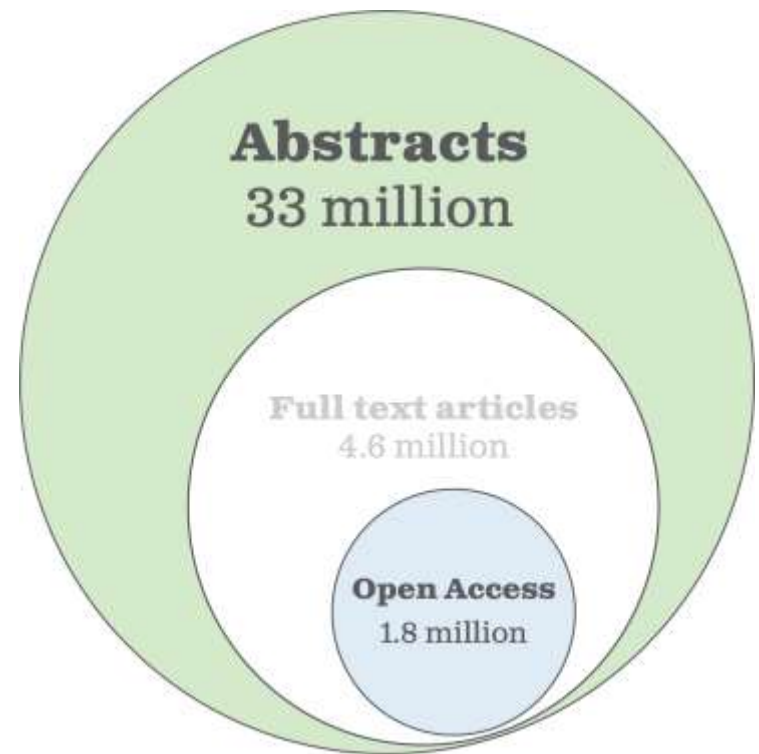


# What literature is covered?

Content in  
Europe PMC



Content for  
text-mining



# Text-mining outputs

Annotation: **chemical**

Methotrexate is an antimetabolite, a structural analogue of folic acid, which acts as an inhibitor of the enzyme dihydrofolate reductase (DHFR), leading to the depletion of

Annotation: **protein**

# Annotation providers

|                       | <b>Named Entities</b><br>(Accessions, Genes/Proteins, Chemicals, Organisms, Diseases, Gene Ontology) | <b>Gene Mutations</b> | <b>Gene-Disease relationships</b> | <b>Gene Functional annotations</b> | <b>Protein-protein interaction</b> | <b>Transcription factor - Target gene relationships</b> | <b>Biological event</b><br>(Phosphorylation events) |
|-----------------------|--|-----------------------|-----------------------------------|------------------------------------|------------------------------------|---|---|
| Europe PMC            | ✓  |                       |                                   |                                    |                                    |   |   |
| HES-SO/SIB            |  |                       |                                   | ✓                                  |                                    |   |   |
| DisGeNET              |  |                       | ✓                                 |                                    |                                    |   |   |
| Open Targets Platform |  |                       | ✓                                 |                                    |                                    |   |   |
| IntAct                |  |                       |                                   |                                    | ✓                                  |   |   |
| NaCTEM                |  |                       |                                   |                                    |                                    |   | ✓   |
| PubTator (NCBI)       |  | ✓                     |                                   |                                    |                                    |   |   |
| NTNU/CNIO/BSC         |  |                       |                                   |                                    |                                    | ✓   |   |

# Annotation types

Genes/Proteins

Chemicals

Organisms

Diseases

Gene Ontology

Accession Numbers

Genetic mutations

Gene-Disease OpenTargets

Gene-Disease DisGeNET

Gene Function

Protein-protein Interactions

Transcription factor - Target gene

Phosphorylation event

# Annotation types

## PDBe > 2bk9

### Drosophila Melanogaster globin


**Source organism:** *Drosophila melanogaster*

**Primary publication:**

📖 [Bishistidyl heme hexacoordination, a key structural property in Drosophila melanogaster hemoglobin.](#)

de Sanctis D, Dewilde S, Vonnrhein C, Pesce A, Moens L, Ascenzi P, Hankeln T, Burmester T, Ponassi M, Nardini M, Bolognesi M

*J. Biol. Chem.* **280** 27222-9 (2005)

PMID: 15917230 

**X-ray diffraction**

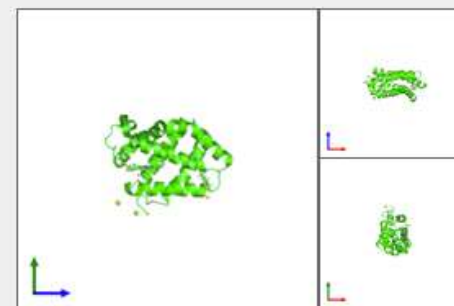
**1.2Å resolution**

**Released:** 20 May 2005

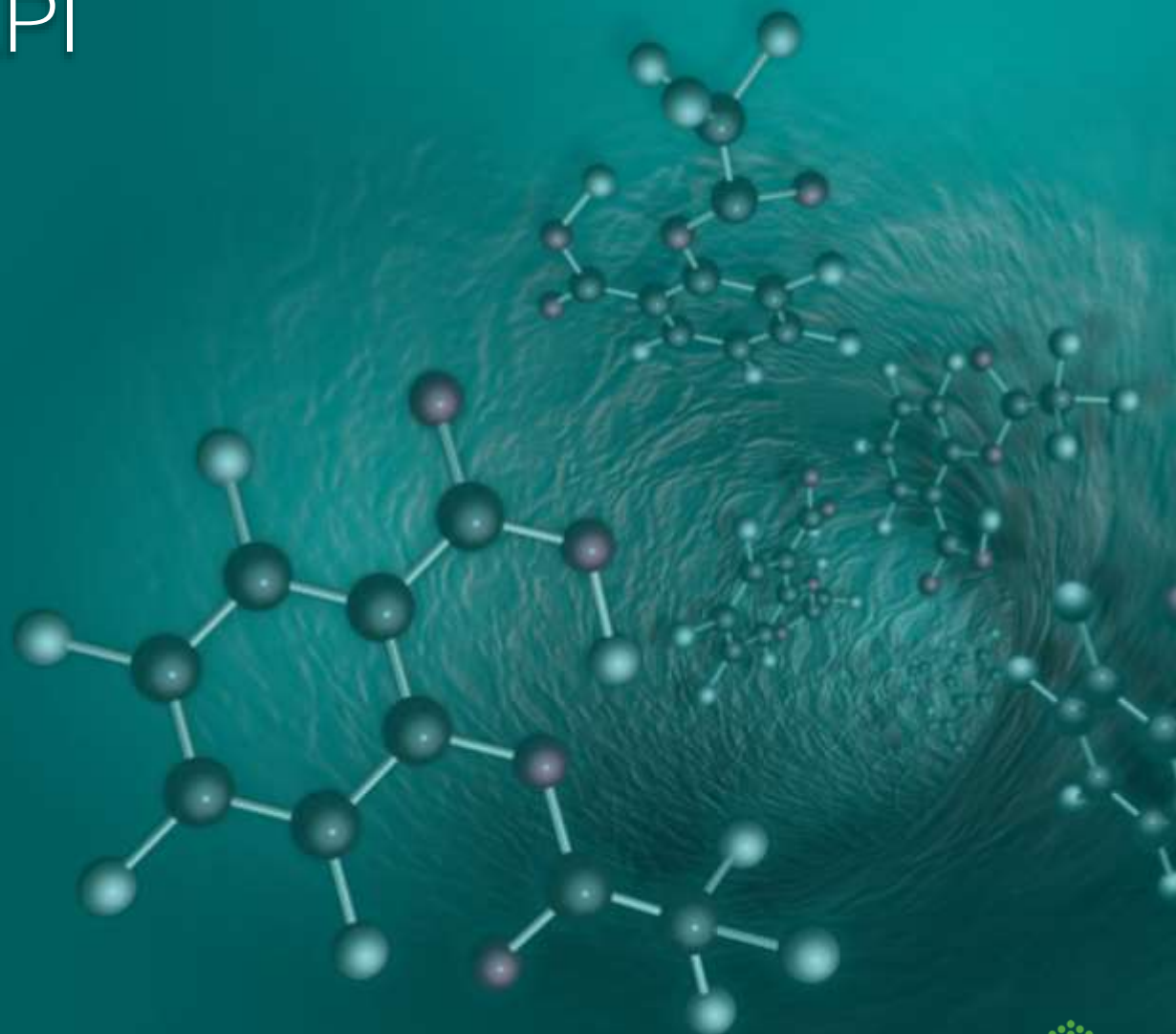
Model geometry



Fit model/data



# Annotations API



# Annotations API

 **Europe PMC**

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[Sign in or create an account](#)

[Europe PMC plus](#)

Search worldwide, life-sciences literature

[Q Search](#) [Advanced Search](#)

E.g. "breast cancer" HER2 Smith ]

[Developer resou...](#) [Articles RESTful ...](#) [Grants RESTful API](#) [SOAP web service](#) [Annotations API](#) [OAI service](#) [Bulk downloads](#)

## Europe PMC Annotations API

Europe PMC Annotations API provides text mining annotations contained in abstracts and open access full text articles, using the [W3C Open Annotation Data Model](#)

Created by Europe PMC

[Contact the developer](#)

[Apache License Version 2.0](#)

[ BASE URL: [/europepmc/annotations\\_api](#) , API VERSION: 0.0.2 ]



# API operations

[Show/Hide](#)[List Operations](#)[Expand Operations](#)

## annotations-api-controller : Europe PMC Annotations API

**GET****/annotationsByArticleIds**

Get the annotations contained in the list of articles specified

**GET****/annotationsByEntity**

Get the annotations of the articles which have at least one annotation tagging the specified entity

**GET****/annotationsByProvider**

Get the annotations of the articles which have at least one annotation provided by the specified provider

**GET****/annotationsByRelationship**

Get the annotations of the articles which have at least one annotation tagging both the specified entities (i.e. Gene-Disease relationship)

**GET****/annotationsBySectionAndOrType**

Get the annotations of the articles which have at least one annotation of a type (if specified) inside an article section (if specified). At least one value between section and type must be specified.

# Navigating results: pageSize and cursorMark

| Parameter | Value                          |
|-----------|--------------------------------|
| pageSize  | <input type="text" value="4"/> |

Search results: Page 1

|            |  |
|------------|--|
| Article 1: | Annotation 1<br>Annotation 2<br>Annotation 3 |
| Article 2: | Annotation 1                                 |
| Article 3: | Annotation 1<br>Annotation 2                 |
| Article 4: | Annotation 1                                 |

Page 2

|            |  |
|------------|--|
| Article 1: | Annotation 1<br>Annotation 2<br>Annotation 3 |
| Article 2: | Annotation 1                                 |
| Article 3: | Annotation 1<br>Annotation 2                 |
| Article 4: | Annotation 1                                 |

# Navigating results: pageSize and cursorMark

| Parameter  | Value                |
|------------|----------------------|
| cursorMark | <input type="text"/> |

| Response Body   |
|---|
| <pre>{<br/>  "nextCursorMark": 43.72716719<br/>  "cursorMark": 0,<br/>}</pre> |

# Filter

| Parameter | Value   |
|-----------|---|
| filter    | 1 (default)  |

Filter = 1

|            |                               |
|------------|-------------------------------|
| Article 1: | p53 (1)<br>p53 (2)<br>p53 (3) |
| Article 2: | p53                           |
| Article 3: | p53 (1)<br>p53 (2)            |
| Article 4: | p53                           |

# Filter

| Parameter | Value   |
|-----------|---|
| filter    | 1 (default)  |

Filter = 1

Filter = 0

|            |                               |            |  |
|------------|-------------------------------|------------|--|
| Article 1: | p53 (1)<br>p53 (2)<br>p53 (3) | Article 1: | p53 (1) cancer<br>p53 (2) human<br>p53 (3) MTX |
| Article 2: | p53                           | Article 2: | p53 mouse                                      |
| Article 3: | p53 (1)<br>p53 (2)            | Article 3: | p53 (1) tumour<br>p53 (2) GPCR                 |
| Article 4: | p53                           | Article 4: | p53 2gx9K                                      |

# Output

| Parameter | Value  |
|-----------|--|
| format    | JSON (default)  |

- JSON will produce a JSON representation of the articles and relative annotations
- XML will produce a XML representation of the articles and relative annotations
- JSON-LD will produce a JSON linked Data representation of the annotations. To see details about JSON-LD go to <http://europepmc.org/AnnotationsApi#jsonLD>
- ID\_LIST will produce a list of articles identifiers including pmcid if available

# API operations

[Show/Hide](#)[List Operations](#)[Expand Operations](#)

## annotations-api-controller : Europe PMC Annotations API

**GET****/annotationsByArticleIds**

Get the annotations contained in the list of articles specified

**GET****/annotationsByEntity**

Get the annotations of the articles which have at least one annotation tagging the specified entity

**GET****/annotationsByProvider**

Get the annotations of the articles which have at least one annotation provided by the specified provider

**GET****/annotationsByRelationship**

Get the annotations of the articles which have at least one annotation tagging both the specified entities (i.e. Gene-Disease relationship)

**GET****/annotationsBySectionAndOrType**

Get the annotations of the articles which have at least one annotation of a type (if specified) inside an article section (if specified). At least one value between section and type must be specified.



# Get annotations by entity

**GET** **/annotationsByEntity**

Get the annotations of the articles which have at least one annotation tagging the specified entity

**Parameters**

| Parameter         | Value                                       |
|-------------------|---|
| <b>entity</b>     | <input type="text" value="(required)"/>     |
| <b>filter</b>     | <input type="text" value="1 (default)"/>    |
| <b>format</b>     | <input type="text" value="JSON (default)"/> |
| <b>cursorMark</b> | <input type="text" value=""/>               |
| <b>pageSize</b>   | <input type="text" value="4"/>              |

← Arabidopsis

cardiovascular disease

Staphylococcus aureus

p53

...

# Get annotations by provider

**GET** **/annotationsByProvider** Get the annotations of the articles which have at least one annotation provided by the specified provider

**Parameters**

| Parameter  | Value          |
|------------|----------------|
| provider   | Europe PMC     |
| filter     | 1 (default)    |
| format     | JSON (default) |
| cursorMark |                |
| pageSize   | 4              |

✓ Europe PMC

HES-SO\_SIB

OpenTargets

NaCTeM

IntAct

DisGeNET



PubTator\_NCBI

NTNU/BSC

# Get annotations by relationship

**GET** **/annotationsByRelationship**

Get the annotations of the articles which have at least one annotation tagging both the specified entities (i.e. Gene-Disease relationship)

| Parameter           | Value  |
|---------------------|--|
| <b>firstEntity</b>  | <input type="text" value="(required)"/>  |
| <b>secondEntity</b> | <input type="text" value="(required)"/>  |
| <b>filter</b>       | 1 (default)     |
| <b>format</b>       | JSON (default)  |
| <b>cursorMark</b>   | <input type="text"/>   |
| <b>pageSize</b>     | <input type="text" value="4"/>   |

← p53

← cancer

# Get annotations by section and/or type

**GET** **/annotationsBySectionAndOrType**

Get the annotations of the articles which have at least one annotation of a type (if specified) inside an article section (if specified). At least one value between section and type must be specified.

| Parameter  | Value                |
|------------|----------------------|
| type       | <input type="text"/> |
| section    | <input type="text"/> |
| filter     | 1 (default)          |
| format     | JSON (default)       |
| cursorMark | <input type="text"/> |
| pageSize   | 4                    |

✓

- Gene\_Proteins
- Organisms
- Chemicals
- Gene Ontology
- Diseases
- Accession Numbers
- Gene Function
- Gene Disease
- Protein Interaction
- Biological Event
- Gene Mutations
- TF\_TG

✓

- Title
- Abstract
- Introduction
- Methods
- Results
- Discussion
- Acknowledgments
- References
- Article
- Table
- Figure
- Case study
- Supplementary material
- Conclusion
- Abbreviations
- Competing Interests
- Author Contributions

# Get annotations by article iD

**GET** **/annotationsByArticleIds** Get the annotations contained in the list of articles specified

**Parameters**

| Parameter         | Value  |
|-------------------|--|
| <b>articleIds</b> | <div>Provide multiple values in new lines (at least one required).</div> |
| type              | <input type="text"/>   |
| section           | <input type="text"/>   |
| provider          | <input type="text"/>   |
| format            | <input type="text" value="JSON (default)"/>                              |

← MED:14670548, PMC:19992...  
(max 8)

# How to find the article iD

Article iD = SOURCE:EXTERNAL\_ID

□ Mechanisms and Physiological Roles of Mitophagy in Yeast.  
(PMID:29370687 PMCID:PMC5792711)

Abstract Citations BioEntities Related Articles External Links

[Fukuda T<sup>†</sup>](#), [Kanki T<sup>†</sup>](#)

[Affiliations](#) ▶

[Molecules and Cells](#) [23 Jan 2018, 41(1):35-44]

Type: review-article, Review, Journal Article

DOI: [10.14348/molcells.2018.2214](https://doi.org/10.14348/molcells.2018.2214)

Source External\_iD

Article iD = MED:29370687

## Source:

MED: PubMed/MEDLINE

PMC: PubMedCentral

PAT: Patents

AGR: Agricola (USDA/NAL)

CBA: Chinese biological abstracts

HIR: NHS Evidence

CTX: CiteXplore submission

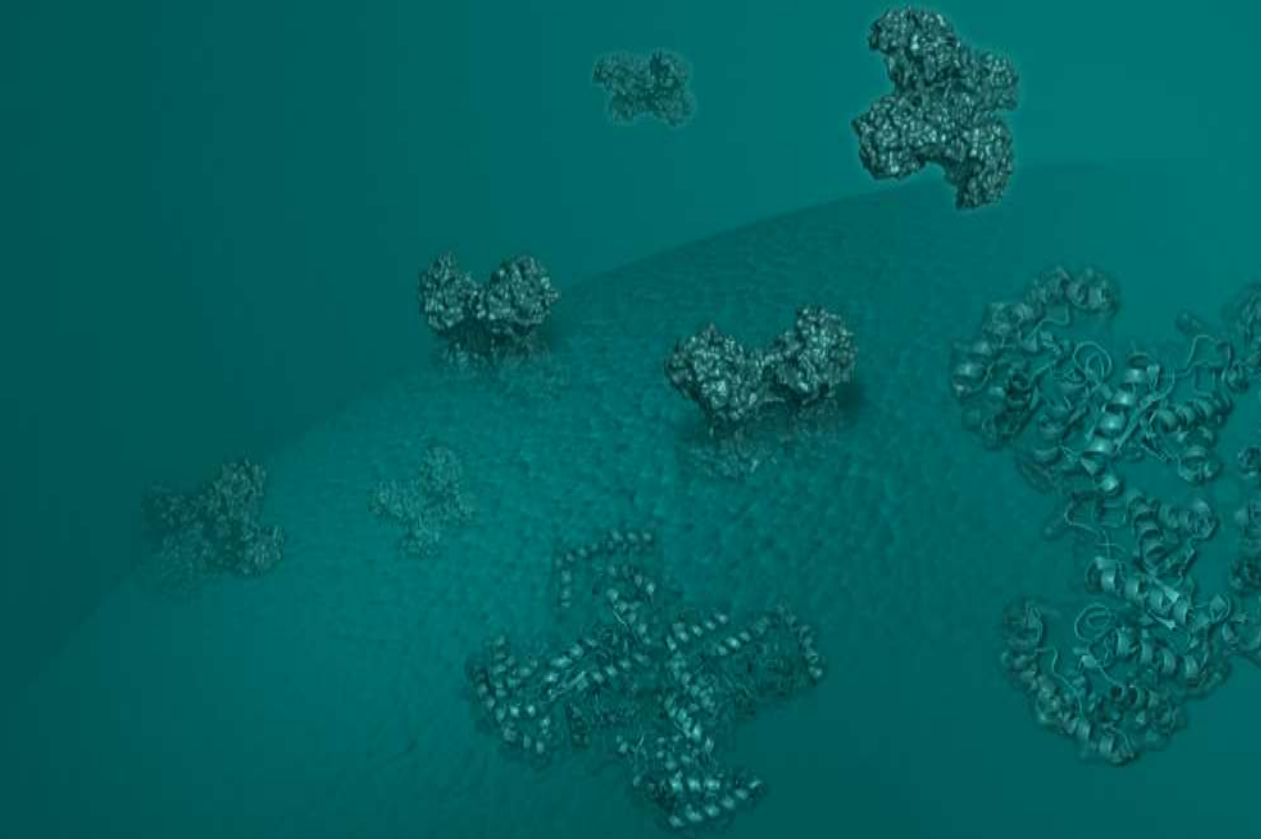
ETH: EThOS theses

CIT: CiteSeer

PPR: Preprints

NBK: NLM Books

# Use cases





Get chemicals mentioned in  
methods

# Get chemicals mentioned in methods

**GET** **/annotationsBySectionAndOrType**

Get the annotations of the articles which have at least one annotation of a type (if specified) inside an article section (if specified). At least one value between section and type must be specified.

| Parameter  | Value                                       |
|------------|---|
| type       | <input type="text" value="Chemicals"/>      |
| section    | <input type="text" value="Methods"/>        |
| filter     | <input type="text" value="1 (default)"/>    |
| format     | <input type="text" value="JSON (default)"/> |
| cursorMark | <input type="text"/>                        |
| pageSize   | <input type="text" value="4"/>              |

# Get chemicals mentioned in methods

GET

/annotationsBySectionAndOrType

Get the annotations of the articles which have at least one annotation of a type (if specified) inside an article section (if specified). At least one value between section and type must be specified.

## Request URL

```
https://www.ebi.ac.uk/europepmc/annotations_api/annotationsBySectionAndOrType?type=Chemicals&section=Methods&fil
```

## Response Body

```
{
  "nextCursorMark": 910.725210858,
  "cursorMark": 0,
  "articles": [
    {
      "source": "PMC",
      "extId": "PMC3926537",
      "pmcid": 3926537,
      "annotations": [
```

# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
▼ articles:
  ▶ 0: {...}
  ▶ 1: {...}
  ▶ 2: {...}
  ▶ 3: {...}
```

# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
▼ articles:
  ▼ 0:
    source: "PMC"
    extId: "PMC3926537"
    pmcid: 3926537
    ► annotations: [...]
```

# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
```

```
▼ articles:
```

```
▼ 0:
```

```
source: "PMC"
extId: "PMC3926537"
pmcid: 3926537
```

```
▼ annotations:
```

```
▶ 0: {...}
▶ 1: {...}
▶ 2: {...}
▶ 3: {...}
```

```
...
```

```
▶ 1254: {...}
▶ 1255: {...}
```

# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
▼ articles:
  ▼ 0:
    source: "PMC"
    extId: "PMC3926537"
    pmcid: 3926537
    ▼ annotations:
      ▼ 0:
        prefix: ""
        exact: "Calixarene"
        postfix: " Based Ion Selective Sensors "
        ► tags: [...]
        type: "Chemicals"
        section: "Methods (http://purl.org/orb/Methods)"
        provider: "Europe PMC"
```



# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
▼ articles:
  ▼ 0:
    source: "PMC"
    extId: "PMC3926537"
    pmcid: 3926537
    ▼ annotations:
      ▼ 0:
        prefix: ""
        exact: "Calixarene"
        postfix: " Based Ion Selective Sensors "
        tags: [...]
        type: "Chemicals"
        section: "Methods (http://purl.org/orb/Methods)"
        provider: "Europe PMC"
```

# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
▼ articles:
  ▼ 0:
    source: "PMC"
    extId: "PMC3926537"
    pmcid: 3926537
    ▼ annotations:
      ▼ 0:
        prefix: ""
        exact: "Calixarene"
        postfix: " Based Ion Selective Sensors "
        tags: [...]
        type: "Chemicals"
        section: "Methods (http://purl.org/orb/Methods)"
        provider: "Europe PMC"
```

## 4.1. Calixarene Based Ion Selective Sensors

The structure of calixarene ligands to interact with cations, anions, neutral species and their various combinations, is determined by the character of other functional groups bonded to the basic skeleton of

# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
▼ articles:
  ▼ 0:
    source: "PMC"
    extId: "PMC3926537"
    pmcid: 3926537
    ▼ annotations:
      ▼ 0:
        prefix: ""
        exact: "Calixarene"
        postfix: " Based Ion Selective Sensors "
      ▼ tags:
        ▼ 0:
          name: "Calixarene"
          uri: "http://purl.obolibrary.org/obo/CHEBI\_51198"
        type: "Chemicals"
        section: "Methods (http://purl.org/orb/Methods)"
        provider: "Europe PMC"
```

# Get chemicals mentioned in methods

```
nextCursorMark: 910.725210858
cursorMark: 0
▼ articles:
  ▼ 0:
    source: "PMC"
    extId: "PMC3926537"
    pmcid: 3926537
    ▼ annotations:
      ▼ 0:
        prefix: ""
        exact: "Calixarene"
        postfix: " Based Ion Selecti
  ▼ tags:
    ▼ 0:
      name: "Calixarene"
      uri: "http://purl.obolibrary.org/obo/CHEBI_51198"
    type: "Chemicals"
    section: "Methods (http://purl.org/orb/Methods)"
    provider: "Europe PMC"
```

**CHEBI:51198 - calixarene**

MainChEBI OntologyAutomatic XrefsReactionsPat

ChEBI Name**calixarene**

ChEBI ID**CHEBI:51198**

Definition

A macrocycle composed of 1,3-phenylene groups linked by methylene groups. The number of 1,3-phenylene units in the macrocycle is denoted by the "*n*" in calix[*n*]arene name.

Stars

☆☆☆ This entity has been manually annotated by the ChEBI Team.

Get gene mutations in papers  
on diabetes

# Get gene mutations in papers on diabetes

**GET** **/annotationsByEntity**

| Parameter | Value  |
|-----------|--|
| entity    | <input type="text" value="diabetes"/>  |
| format    | <input type="text" value="ID_LIST"/>  |

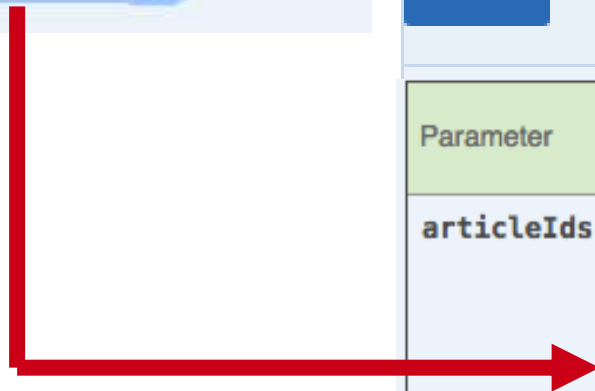
# Get gene mutations in papers on diabetes

**GET** **/annotationsByEntity**

| Parameter | Value                                 |
|-----------|---------------------------------------|
| entity    | <input type="text" value="diabetes"/> |
| format    | <input type="text" value="ID_LIST"/>  |

**GET** **/annotationsByArticleIds**

| Parameter  | Value  |
|------------|--|
| articleIds | <div>Provide multiple values in new lines (at least one required).</div> <div></div> |
| type       | <input type="text" value="Gene Mutations"/>  |



# Get gene mutations in papers on diabetes

```
#!/usr/bin/env python
'''
Created on 05 March 2018

@summary: This script retrives all gene mutations annotations along with "diabetes" annotations
@param: Entity name, Annotation type and Base URL

'''

import re
import pprint

''' For REST request '''
import urllib2
import json

pp = pprint.PrettyPrinter(indent=4)

def main():
    baseQueryURL = "https://www.ebi.ac.uk/europepmc/annotations_api/" # Base URL
    entity = "diabetes" # Entity name
    ann_type = "&type=Gene%20Mutations" # Annotation type

    # Get PMIDs for a given entity name
    ids = getArticleIDbyEntity(baseQueryURL, entity)

    # Get Annotations for a given type
    annotations = getAnnotationsbyType(baseQueryURL, ids, ann_type)

    # Print annotations
    pp.pprint(annotations)
```



# Get gene mutations in papers on diabetes

```
#!/usr/bin/env python
```

```
'''
```

```
Created on 05 March 2018
```

```
@summary: This script retrives all gene mutations annotations along with "diabetes" annotations
```

```
@param: Entity name, Annotation type and Base URL
```

```
'''
```

```
import re
import pprint
```

```
''' For REST request '''
```

```
import urllib2
import json
```

```
pp = pprint.PrettyPrinter(indent=4)
```

```
def main():
    baseQueryURL = "https://www.ebi.ac.uk/europepmc/annotations_api/" # Base URL
    entity = "diabetes" # Entity name
    ann_type = "&type=Gene%20Mutations" # Annotation type
```

```
    # Get PMIDs for a given entity name
    ids = getArticleIDbyEntity(baseQueryURL, entity)
```

```
    # Get Annotations for a given type
    annotations = getAnnotationsbyType(baseQueryURL, ids, ann_type)
```

```
    # Print annotations
    pp.pprint(annotations)
```

# Get gene mutations in papers on diabetes

```
'''Get list of PMIDs that contain "diabetes" mentions'''
def getArticleIDbyEntity(basequeryURL, entityName):

    get_entity = "annotationsByEntity?entity="
    format_type = "&format=ID_LIST"

    # API query
    query = basequeryURL + get_entity + entityName + format_type

    # List to store PMIDs
    id_list = list()

    # Call the API
    api_response = urllib2.urlopen(query, timeout=10)

    # Process the response
    response_data = api_response.read()
    json_data = json.loads(response_data)

    for key in json_data:
        if key == 'articles':
            for article in json_data[key]:
                source = article['source']
                pmid = article['extId']
                formatted_id = source + ":" + pmid
                id_list.append(formatted_id)

    # Returns PMID list
    return id_list
```

# Get gene mutations in papers on diabetes

```
'''Get gene mutation annotation for list of PMIDs'''
def getAnnotationsbyType(basequeryURL, pmid_list, annotation_type):

    get_annotations = "annotationsByArticleIds?articleIds="
    format_type = "&format=JSON"
    pmids = ",".join(pmid_list)

    # API query
    query = basequeryURL + get_annotations + pmids + annotation_type + format_type

    # Call the API
    get_response = urllib2.urlopen(query, timeout=10)
    response_data = get_response.read()

    # Returns annotations
    return response_data

if __name__ == '__main__':
    main()
```

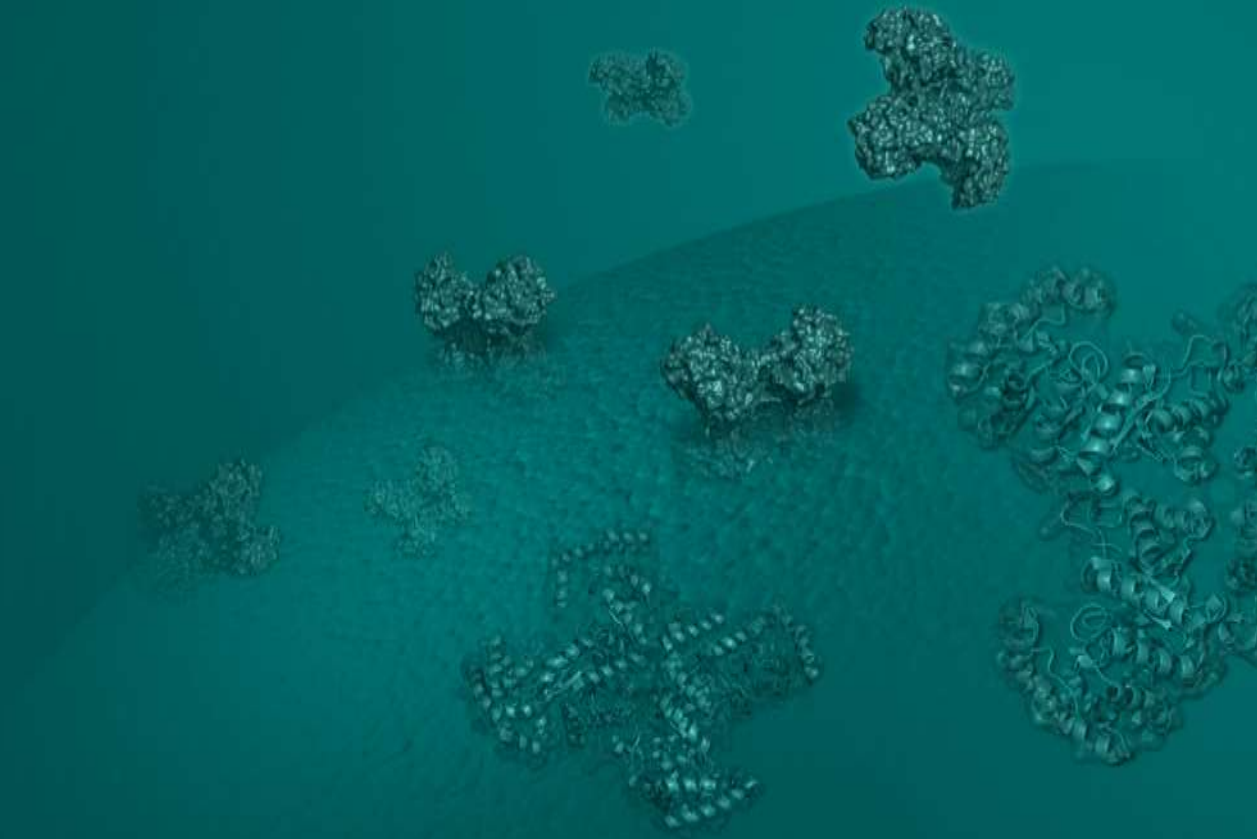
---

# Get gene mutations in papers on diabetes

```
[
  {
    "source": "MED",
    "extId": "28729637",
    "pmcid": 5519666,
    "annotations": [
      {
        "prefix": "association between ",
        "exact": "rs499974",
        "postfix": " (MOGAT2) and a diac",
        "tags": [
          {
            "name": "rs499974",
            "uri": "http://identifiers.org/dbSNP:rs499974"
          }
        ],
        "type": "Gene Mutations",
        "section": "Abstract (http://purl.org/dc/terms/abstract)",
        "provider": "PubTator (NCBI)"
      }
    ]
  },
]
```

... Other use cases?

# Help and contacts



# Contact us



## Europe PMC Webservice Users Group

<https://groups.google.com/a/ebi.ac.uk/forum/#!forum/epmc-webservices>

Questions about Europe PMC

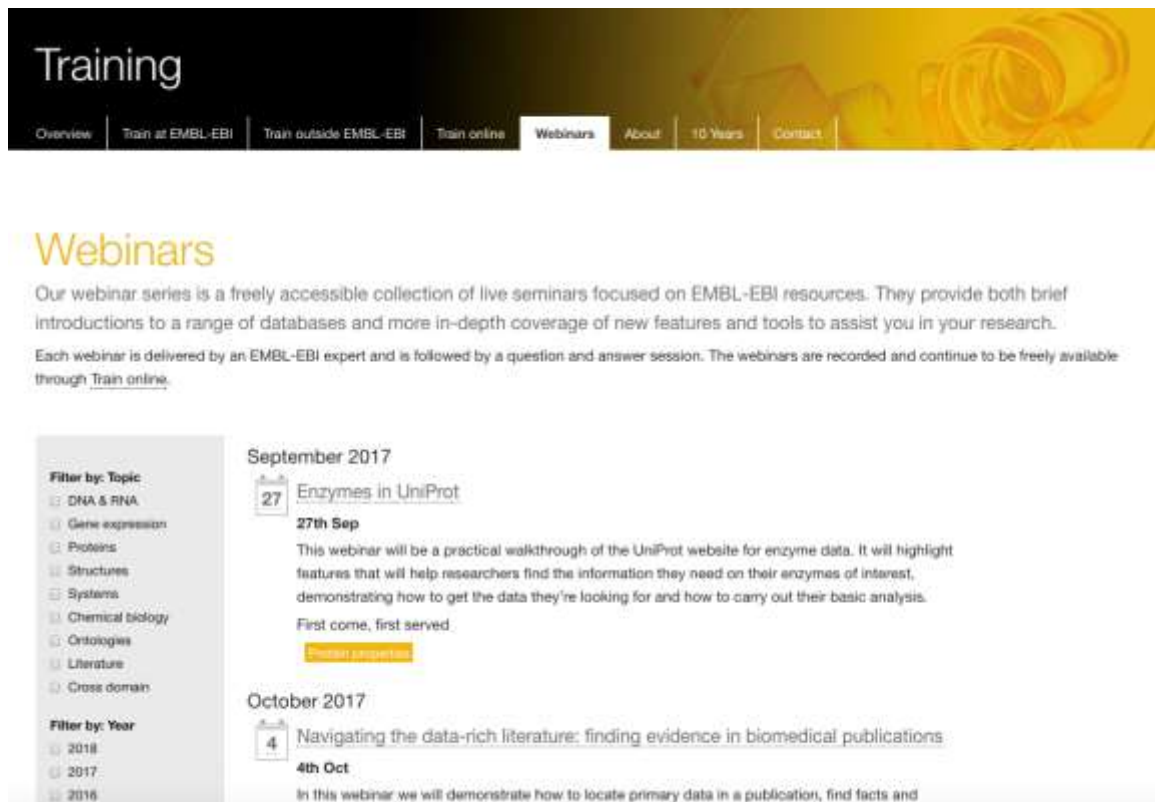
[helpdesk@europemc.org](mailto:helpdesk@europemc.org)



@EuropePMC\_News

# Upcoming webinars

See the full list of upcoming webinars at  
<http://www.ebi.ac.uk/training/webinars>



The screenshot shows the EMBL-EBI Training Webinars page. At the top is a navigation bar with links: Overview, Train at EMBL-EBI, Train outside EMBL-EBI, Train online, Webinars (selected), About, 10 Years, and Contact. Below the navigation bar is a section titled "Webinars" with a description: "Our webinar series is a freely accessible collection of live seminars focused on EMBL-EBI resources. They provide both brief introductions to a range of databases and more in-depth coverage of new features and tools to assist you in your research. Each webinar is delivered by an EMBL-EBI expert and is followed by a question and answer session. The webinars are recorded and continue to be freely available through [Train online](#)."

On the left side, there are two filter sections:

- Filter by: Topic**
  - ☐ DNA & RNA
  - ☐ Gene expression
  - ☐ Proteins
  - ☐ Structures
  - ☐ Systems
  - ☐ Chemical biology
  - ☐ Ontologies
  - ☐ Literature
  - ☐ Cross domain
- Filter by: Year**
  - ☐ 2018
  - ☐ 2017
  - ☐ 2016

The main content area lists upcoming webinars:

- September 2017**
  - 27 Enzymes in UniProt**  
**27th Sep**  
This webinar will be a practical walkthrough of the UniProt website for enzyme data. It will highlight features that will help researchers find the information they need on their enzymes of interest, demonstrating how to get the data they're looking for and how to carry out their basic analysis.  
First come, first served.  
[Enzymes in UniProt](#)
- October 2017**
  - 4 Navigating the data-rich literature: finding evidence in biomedical publications**  
**4th Oct**  
In this webinar we will demonstrate how to locate primary data in a publication, find facts and

## Feedback

Tell us what you think