

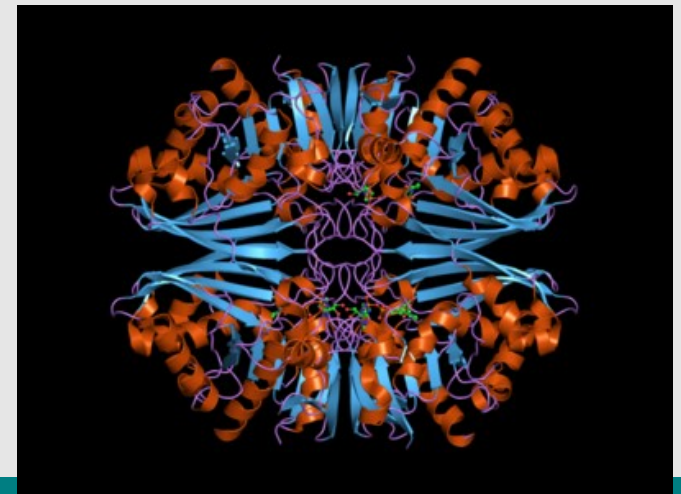
IntEnz

Integrated relational Enzyme database



Enzymes

- Enzymes are proteins that catalyze chemical reactions.
- Very important as many processes in biological cells need enzymes....
- As there are many enzymes in the world, a classification system was invented to help identify and name them...



NC-IUBMB

- In the 1950's the increasing amounts of known enzymes were causing confusion. No official nomenclature system for enzymes.
- The IUBMB created the International Commission on Enzymes in 1956 to deal with enzyme nomenclature
- Later replaced with the Nomenclature Committee of the International Union of Biochemistry and Molecular Biology (NC-IUBMB)

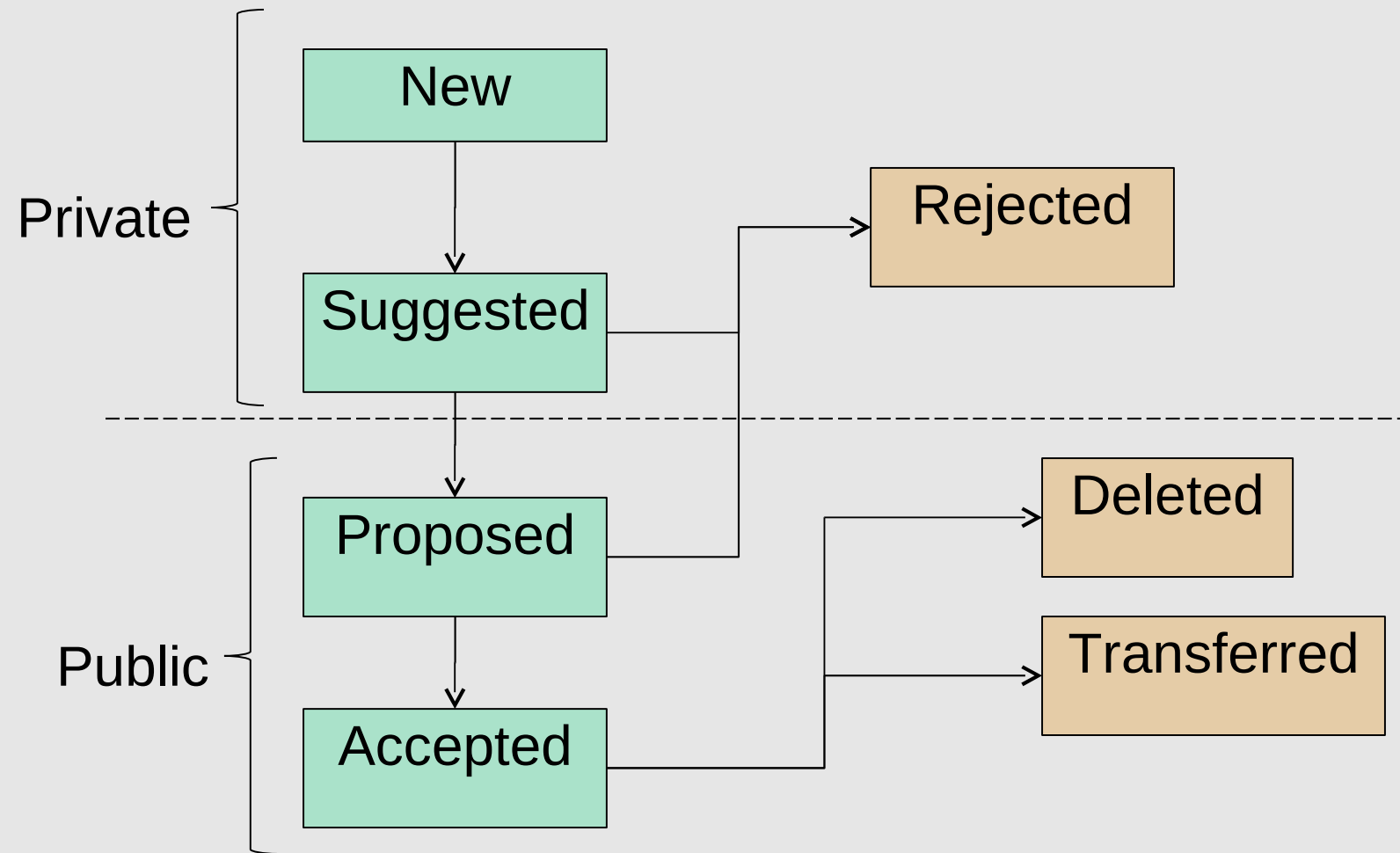
EC Numbers

- NC-IUBMB developed the Enzyme Classification number system (EC)
- Classification system is based on the reactions the enzymes catalyzed
- Classification:
 - Classes
 - Subclasses
 - Sub-subclasses
 - EC numbers (**E**nzyme **C**ommission)
- Example EC 1.1.1.1

EC Classification - Classes

- EC 1 – Oxidoreductases; catalyze oxidation/reduction reactions.
- EC 2 – Transferases; transfer a functional group e.g. Methyl group.
- EC 3 – Hydrolases; catalyse the hydrolysis of various bonds.
- EC 4 – Lyases; cleave various bonds by means other than hydrolysis and oxidation
- EC 5 – Isomerases; catalyse changes within one molecule.
- EC 6 – Ligases; joining of two molecules with concomitant hydrolysis of the diphosphate bond in ATP or a similar triphosphate.

EC numbers lifecycle



IntEnz (www.ebi.ac.uk/intenz)




[EBI](#) > [Databases](#) > [Enzymes](#) > [IntEnz](#)

IntEnz - Home

IntEnz (**I**ntegrated **r**elational **E**nzyme database) is a freely available resource focused on enzyme nomenclature. IntEnz is created in collaboration with the [Swiss Institute of Bioinformatics \(SIB\)](#). This collaboration is responsible for the production of the [ENZYME](#) resource. IntEnz contains the recommendations of the Nomenclature Committee of the [International Union of Biochemistry and Molecular Biology](#) (NC-IUBMB) on the nomenclature and classification of enzyme-catalysed reactions.

All data in IntEnz is freely accessible and available for anyone to use.

Search

You can use % as a wildcard, as well as some [special characters](#) 
Examples: 1.1.1.1, alcohol%, α -glucosidase
Or try the [advanced search](#).

Acknowledgements



IntEnz is funded by the European Commission under SLING, grant agreement number 226073 (Integrating Activity) within Research Infrastructures of the FP7 Capacities Specific Programme.

- [IntEnz home](#)
- [Advanced search](#)
- [Browse EC](#)
- :: [Data submission](#)
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- [Contact IntEnz](#)

News

20 Jan 2012

[IntEnz release 75](#)

A new release of IntEnz (<http://www.ebi.ac.uk/intenz>) is available, with 91 new EC numbers in the classification.

[More news...](#)

Partners



[Swiss Institute of Bioinformatics](#)

The ENZYME data are an

What's in IntEnz

- Official Enzyme nomenclature from **NC-IUBMB**
- Data from **ENZYME** database (SIB)
 - ◆ Cofactors
 - ◆ Extra cross references: UniProtKB/Swiss-Prot, Prosite
- Extra cross references: CSA, GO
- Enzyme spotlights
- Two different views of the same data:
 - ◆ IntEnz
 - ◆ ENZYME

The (official) enzyme nomenclature

- Classification:
 - Classes
 - Subclasses
 - Sub-subclasses
 - EC numbers (**E**nzyme **C**ommission)
- Nomenclature
- Reactions (as *plain text*)
- Comments
- Cross references: BRENDA, EXPASY, KEGG, ERGO, PDB, CAS registry
- Bibliographic references

Maintained by NC-IUBMB

IntEnz Entry

Classification system

EBI > Databases > Enzymes > IntEnz

[EC 1 - Oxidoreductases](#)

[EC 1.14 - Acting on paired donors, with incorporation or reduction of molecular oxygen](#)

[EC 1.14.13 - With NADH or NADPH as one donor, and incorporation of one atom of oxygen](#)

[EC 1.14.13.39 - Nitric-oxide synthase](#)

[Read more about EC 1.14.13.39 ...](#)

IntEnz view

[ENZYME view](#)

[XML](#)

IntEnz Enzyme Nomenclature
EC 1.14.13.39

Accepted Name

Names

Accepted name: nitric-oxide synthase

Other names: NADPH-diaphorase
NO synthase
endothelium-derived relaxation factor-forming enzyme
endothelium-derived relaxing factor synthase
nitric oxide synthetase
nitric-oxide synthetase

Systematic name: L-arginine,NADPH:oxygen oxidoreductase (nitric-oxide-forming)

Reaction (Rhea)

Reaction

[\[RHEA:24668\]](#)

$2 \text{ L-arginine} + 3 \text{ H}^+ + 3 \text{ NADPH} + 4 \text{ O}_2 \Rightarrow 2 \text{ L-citrulline} + 4 \text{ H}_2\text{O} + 3 \text{ NADP}^+ + 2 \text{ nitric oxide}$

1. $2 \times \text{[RHEA:24661]} \text{ L-arginine} + \text{H}^+ + \text{NADPH} + \text{O}_2 \Rightarrow \text{N}^\omega\text{-hydroxy-L-arginine} + \text{H}_2\text{O} + \text{NADP}^+$

2. $1 \times \text{[RHEA:24665]} \text{ 2 N}^\omega\text{-hydroxy-L-arginine} + \text{H}^+ + \text{NADPH} + 2 \text{ O}_2 \Rightarrow 2 \text{ L-citrulline} + 2 \text{ H}_2\text{O} + \text{NADP}^+ + 2 \text{ nitric oxide}$

Cofactors

- [heme](#)
- [FAD](#)
- [5,6,7,8-tetrahydrobiopterin](#)
- [FMN](#)

Cofactor (ChEBI)

IntEnz entry continued

Comments:

The enzyme in brain, but not that induced in lung or liver by endotoxin, requires Ca^{2+} . The stoichiometry is not clear, but may involve a two-electron and a one-electron oxidation step.

Links to other databases

[BRENDA](#), [CSA](#), [ENZYME@ExPASy](#), [GO:0004517](#), [KEGG](#), [NC-IUBMB](#), [EC2PDB](#), CAS Registry Number: 125978-95-2

UniProtKB/Swiss-Prot: (33)

[\[show\]](#)

UniProt Links

References

1. Bredt, D.S. and Snyder, S.H.
Isolation of nitric oxide synthetase, a calmodulin-requiring enzyme.
Proc. Natl. Acad. Sci. USA **87**: 682-685 (1990). [PMID: [1689048](#)]
2. Knowles, R.G., Merrett, M., Salter, M. and Moncada, S.
Differential induction of brain, lung and liver nitric oxide synthase by endotoxin in the rat.
Biochem. J. **270**: 833-836 (1990). [PMID: [1700698](#)]
3. Moncada, S., Palmer, R.M.J. and Higgs, E.A.
Biosynthesis of nitric oxide from L-arginine. A pathway for the regulation of cell function and communication.
Biochem. Pharmacol. **38**: 1709-1715 (1989). [PMID: [2567594](#)]

Citations

[EC 1.14.13.39 created 1992]

Simple search



- Search by EC number:
 - 1.1.1.1
 - 1.2.3.12
 - 1.13.1.13
- Search by enzyme name:
 - Oxalate oxidase
 - Agarase
 - 3/4 collagenase
- Search by cross-reference:
 - Q42884
 - GO:0047948
- Search by compound:
 - Caffeine
 - CoA

Simple Search Example

The screenshot shows the EMBL-EBI IntEnz search interface. At the top, there is a search bar with the text 'Enter Text Here' and a 'Reset' button. Below the search bar is a navigation menu with options like 'Databases', 'Tools', 'EBI Groups', 'Training', 'Industry', 'About Us', and 'Help'. The main content area displays the search results for 'FMN', listing 10 enzyme entries with their EC numbers and names. A search bar at the bottom of the results area contains the text 'FMN' and a 'Search' button.

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Reset
Advanced Search
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News
IntEnz

EBI > Databases > Enzymes > IntEnz

IntEnz - Search result for 'FMN'

1 .. 10 of 47 | next >

1. [1.14.14.3](#)
alkanal monooxygenase (FMN-linked)
2. [1.14.14.5](#)
alkanesulfonate monooxygenase
3. [1.5.1.30](#)
flavin reductase
4. [1.5.1.29](#)
FMN reductase
5. [5.3.3.2](#)
isopentenyl-diphosphate Δ -isomerase
6. [4.2.3.5](#)
chorismate synthase
7. [2.7.7.2](#)
FAD synthetase
8. [2.7.1.26](#)
riboflavin kinase
9. [1.16.1.8](#)
[methionine synthase] reductase
10. [1.13.11.32](#)
2-nitropropane dioxygenase

FMN Exact phrase

Search

Advanced search

- Search by reaction participant:
 - CoA
 - CoA-SH
 - CoASH
 - Coenzyme-A

- Search by cofactor:
 - ➔CoA
 - ➔magnesium manganese (any)
 - ➔magnesium manganese (both)



Advanced Search Example

EBI > Databases > Enzymes > IntEnz

IntEnz - Search result for 'manganese OR CoA'

1 .. 10 of 362 | [next](#) >

1. [6.2.1.12](#)
4-coumarate—CoA ligase
2. [2.3.1.119](#)
icosanoyl-CoA synthase
3. [1.13.11.45](#)
linoleate 11-lipoxygenase
4. [4.1.1.2](#)
oxalate decarboxylase
5. [6.2.1.3](#)
long-chain-fatty-acid—CoA ligase
6. [2.8.3.8](#)
acetate CoA-transferase
7. [1.1.1.34](#)
hydroxymethylglutaryl-CoA reductase (NADPH)
8. [6.2.1.7](#)
cholate—CoA ligase
9. [6.2.1.4](#)
succinate—CoA ligase (GDP-forming)
10. [3.1.2.4](#)
3-hydroxyisobutyryl-CoA hydrolase

EMBL-EBI

Databases



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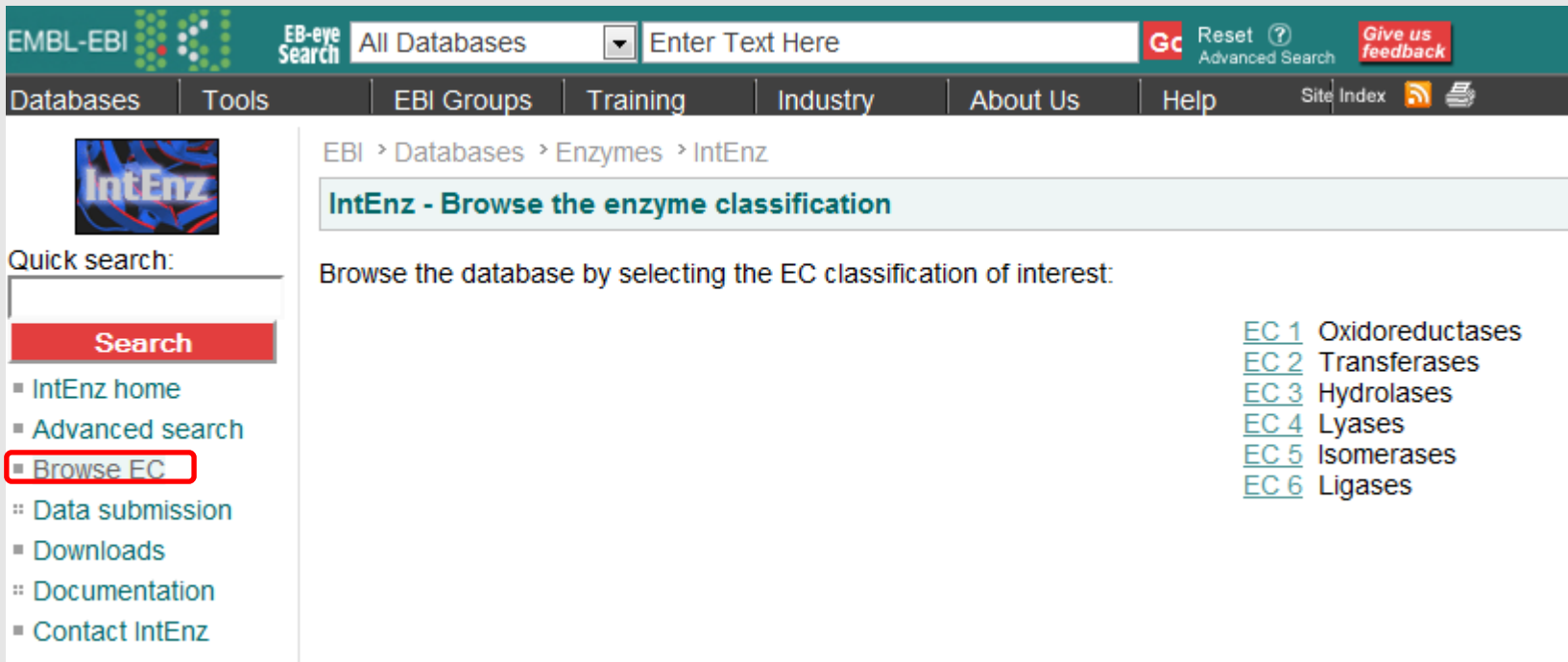
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22.05.09

Browsing IntEnz

- Browse the whole classification from the home page



The screenshot shows the IntEnz website interface. At the top, there is a navigation bar with the EMBL-EBI logo, an 'EB-eye Search' box with a dropdown menu set to 'All Databases', and a search input field containing 'Enter Text Here'. To the right of the search bar are links for 'Reset', 'Advanced Search', and 'Give us feedback'. Below the search bar is a horizontal menu with items: 'Databases', 'Tools', 'EBI Groups', 'Training', 'Industry', 'About Us', 'Help', 'Site', 'Index', and icons for RSS and a printer. The main content area has a breadcrumb trail: 'EBI > Databases > Enzymes > IntEnz'. Below this is a heading 'IntEnz - Browse the enzyme classification'. A sub-heading reads 'Browse the database by selecting the EC classification of interest:'. To the right of this text is a list of enzyme classes: 'EC 1 Oxidoreductases', 'EC 2 Transferases', 'EC 3 Hydrolases', 'EC 4 Lyases', 'EC 5 Isomerases', and 'EC 6 Ligases'. On the left side of the page, there is a sidebar with a 'Quick search:' box and a 'Search' button. Below the search box is a list of navigation links: 'IntEnz home', 'Advanced search', 'Browse EC' (highlighted with a red box), 'Data submission', 'Downloads', 'Documentation', and 'Contact IntEnz'.

Browsing via Enzyme entry

- Browse upwards from an enzyme entry

EBI > Databases > Enzymes > IntEnz

[EC 6 - Ligases](#)

[EC 6.2 - Forming Carbon-Sulfur Bonds](#)

[EC 6.2.1 - Acid-Thiol Ligases](#)

Contents

[EC 6.2.1.1](#) acetate—CoA ligase

[EC 6.2.1.2](#) butyrate—CoA ligase

[EC 6.2.1.3](#) long-chain-fatty-acid—CoA ligase

[EC 6.2.1.4](#) succinate—CoA ligase (GDP-forming)

[EC 6.2.1.5](#) succinate—CoA ligase (ADP-forming)

[EC 6.2.1.6](#) glutarate—CoA ligase

[EC 6.2.1.7](#) cholate—CoA ligase

[EC 6.2.1.8](#) oxalate—CoA ligase

[EC 6.2.1.9](#) malate—CoA ligase

[EC 6.2.1.10](#) acid—CoA ligase (GDP-forming)

[EC 6.2.1.11](#) biotin—CoA ligase

[p-coumaroyl-CoA ligase](#)
[D-coumaroyl-CoA synthetase](#)

Downloading IntEnz

- **IntEnzXML**
 - Individual enzymes/all of them
 - ASCII format/XChars-enhanced format
 - XSD available
 - Query/format using XSLT
- **enzyme.dat** file
 - Generated from IntEnz for SIB
- **BioPAX level 2**
 - A standard exchange format for biological pathway data
 - Based in OWL (semantic web)

IntEnz team and resources

Rafael Alcántara (Developer, EBI)

Kristian Axelsen (Curator, SIB)

Paula de Matos (Coordinator, EBI)

Anne Morgat (Curator, SIB)

Christoph Steinbeck (Team leader, EBI)

<http://www.ebi.ac.uk/intenz>

<ftp://ftp.ebi.ac.uk/pub/databases/intenz>

<http://sourceforge.net/projects/intenz>

intenz-help@lists.sourceforge.net

Exercises!



<http://www.ebi.ac.uk/intenz>