Carbonic anhydrase hydrates carbon dioxide (cytosol)

Jassal, B., May, B., Silverman, DN.

European Bioinformatics Institute, New York University Langone Medical Center, Ontario Institute for Cancer Research, Oregon Health and Science University.

25/08/2021

Introduction

Reactome is open-source, open access, manually curated and peer-reviewed pathway database. Pathway annotations are authored by expert biologists, in collaboration with Reactome editorial staff and cross-referenced to many bioinformatics databases. A system of evidence tracking ensures that all assertions are backed up by the primary literature. Reactome is used by clinicians, geneticists, genomics researchers, and molecular biologists to interpret the results of high-throughput experimental studies, by bioinformaticians seeking to develop novel algorithms for mining knowledge from genomic studies, and by systems biologists building predictive models of normal and disease variant pathways.

The development of Reactome is supported by grants from the US National Institutes of Health (P41 HG003751), University of Toronto (CFREF Medicine by Design), European Union (EU STRP, EMI-CD), and the European Molecular Biology Laboratory (EBI Industry program).

Literature references

Fabregat, A., Sidiropoulos, K., Viteri, G., Forner, O., Marin-Garcia, P., Arnau, V. et al. (2017). Reactome pathway analysis: a high-performance in-memory approach. *BMC bioinformatics, 18*, 142. ↗

Sidiropoulos, K., Viteri, G., Sevilla, C., Jupe, S., Webber, M., Orlic-Milacic, M. et al. (2017). Reactome enhanced pathway visualization. *Bioinformatics, 33*, 3461-3467. ↗

Fabregat, A., Jupe, S., Matthews, L., Sidiropoulos, K., Gillespie, M., Garapati, P. et al. (2018). The Reactome Pathway Knowledgebase. *Nucleic Acids Res, 46*, D649-D655. ↗

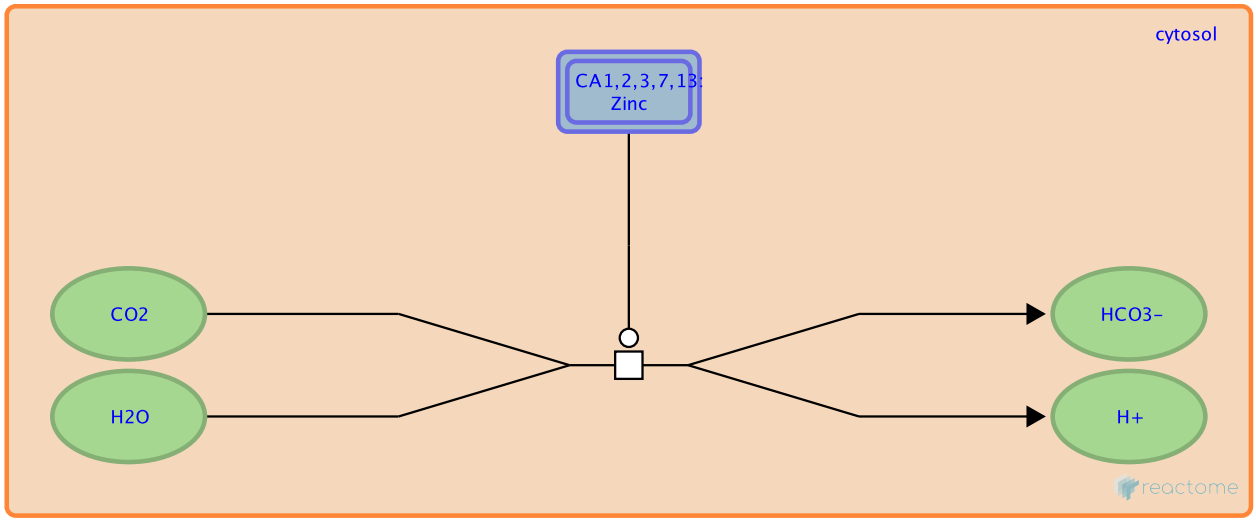
Fabregat, A., Korninger, F., Viteri, G., Sidiropoulos, K., Marin-Garcia, P., Ping, P. et al. (2018). Reactome graph database: Efficient access to complex pathway data. *PLoS computational biology, 14*, e1005968. ↗

Carbonic anhydrase hydrates carbon dioxide (cytosol)

Stable identifier: R-HSA-1475026

Type: transition

Compartments: cytosol



Carbonic anhydrase I (CA1, Khalifah 1971, Simonsson et al. 1982, Ren and Lindskog 1992), carbonic anyhydrase II (CA2, Tibell et al. 1984, Jones and Shaw 1983, Pesando 1975, Ghannam et al. 1986), carbonic anhydrase III (CA3, Carter et al. 1979, Tu et al. 1990, Tu et al. 1994, Tu et al. 1998, Silverman et al. 1993), carbonic anhydrase VII (CA7, Bootorabi et al. 2010, Gitto et al. 2010) hydrate carbon dioxide to yield bicarbonate and a proton. Carbonic anhydrase deprotonates water to yield a zinc-hydroxyl group and a proton which is transferred to external buffer molecules via histidine or glutamate residues in carbonic anhydrase. The hydroxyl group reacts with carbon dioxide in the active site to yield bicarbonate. A water molecule displaces the bicarbonate and the reaction cycle begins again (reviewed in Lindskog 1997). Depending on the concentrations of reactants the reaction is reversible.

CA2 and CA7 have high catalytic activity, CA1 has low activity (10% of the activity of CA2), and CA3 has very low activity (1% of the activity of CA2). CA1 and CA2 are found in erythrocytes. CA2 is also found in kidney, lung, and white muscle where it facilitates diffusion of carbon dioxide. CA3 is found in red muscle where it participates in resistance against oxidative stress.

Literature references

Simonsson, I., Jonsson, BH., Lindskog, S. (1982). A 13C nuclear magnetic resonance study of CO2/HCO-3 exchange catalyzed by human carbonic anhydrase I. *Eur J Biochem, 129*, 165-9.

Tu, C., Qian, M., Earnhardt, JN., Laipis, PJ., Silverman, DN. (1998). Properties of intramolecular proton transfer in carbonic anhydrase III. *Biophys J, 74*, 3182-9.

Silverman, DN., Tu, C., Chen, X., Tanhauser, SM., Kresge, AJ., Laipis, PJ. (1993). Rate-equilibria relationships in intramolecular proton transfer in human carbonic anhydrase III. *Biochemistry, 32*, 10757-62.

Pesando, JM. (1975). Proton magnetic resonance studies of carbonic anhydrase. II. Group controlling catalytic activity. *Biochemistry, 14*, 681-8.

Elder, I., Fisher, Z., Laipis, PJ., Tu, C., McKenna, R., Silverman, DN. (2007). Structural and kinetic analysis of proton shuttle residues in the active site of human carbonic anhydrase III. *Proteins, 68*, 337-43.

Editions

2011-08-06	Authored, Edited	May, B.
2012-05-16	Reviewed	Jassal, B., Silverman, DN.