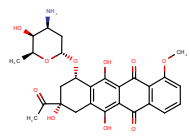
Daunorubicin

Summary	**Daunorubicin** is an anthracycline aminoglycoside used to induce remission of nonlymphocytic leukemia and acute lymphocytic leukemia.
Brand Names	*Cerubidine, Vyxeos*
Generic Name	Daunorubicin
DrugBank Accession Number	DB00694
Background	A very toxic anthracycline aminoglycoside antineoplastic isolated from Streptomyces peucetius and others, used in treatment of leukemia and other neoplasms.
Type	Small Molecule
Groups	Approved
Structure	 3D Download Similar Structures
Weight	Average: 527.5199 Monoisotopic: 527.179146153
Chemical Formula	$C_{27}H_{29}NO_{10}$
Synonyms Show All Synonyms	Acetyladriamycin Daunomycin Daunorubicin Daunorubicin liposomal Daunorubicina Daunorubicine Daunorubicinum Leukaemomycin C Rubidomycin
External IDs View As Table	DNR FI 6339 NSC 82151 RCRA Waste No. U059 RP 13057 RP-13057

PHARMACOLOGY

Indication

For remission induction in acute nonlymphocytic leukemia (myelogenous, monocytic, erythroid) of adults and for remission induction in acute lymphocytic leukemia of children and adults.

Daunorubicin is indicated in combination with cytarabine for the treatment of newly-diagnosed therapy-related acute myeloid leukemia (t-AML) or AML with myelodysplasia-related changes (AML-MRC) in adults and pediatric patients 1 year and older.[5]

Associated Conditions

Show 5 entries
Search

INDICATION TYPE	INDICATION	COMBINED PRODUCT DETAILS	APPROVAL LEVEL	AGE GROUP	PATIENT CHARACTERISTICS	DOSE FORM
Treatment of	Acute lymphoblastic leukaemias (all)			Create Account		•••••••••
Used in combination to treat	Acute myeloid leukemia with myelodysplasia-related changes	Combination Product in combination with: Cytarabine (DB00987)		Create Account		
Treatment of	Ewing's tumor			Create Account		•••••••••
Treatment of	Lymphoma, diffuse			Create Account		•••••••••
Treatment of	Myeloblastic leukemia			Create Account		•••••••••

Showing 1 to 5 of 9 entries
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Contraindications & Blackbox Warnings

Pharmacodynamics

Daunorubicin is an anthracycline antibiotic and antineoplastic agent.[5] It acts by inhibiting cellular reproduction through interference with DNA replication although it may contribute to the induction of cell death by increasing oxidative stress through the generation of reactive oxygen species and free radicals. As an antineoplastic agent, daunorubicin carries significant toxicities including cytopenias, hepatotoxicity, and extravasation reactions. Like other anthracyclines, daunorubicin also exhibits cardiotoxicity in proportion with the cumulative dose received over time.

Mechanism of action

Daunorubicin has antimitotic and cytotoxic activity through a number of proposed mechanisms of action: Daunorubicin forms complexes with DNA by intercalation between base pairs, and it inhibits topoisomerase II activity by stabilizing the DNA-topoisomerase II complex, preventing the religation portion of the ligation-religation reaction that topoisomerase II catalyzes.

TARGET	ACTIONS	ORGANISM
(A) DNA	intercalation	Humans
(A) DNA topoisomerase 2-alpha	inhibitor	Humans
(A) DNA topoisomerase 2-beta	inhibitor	Humans

Absorption

Daunorubicin was found to have a tmax of 2 h and a cmax of 24.8 µg/mL after a 90 min infusion of the liposomal formulation at a dose of 44 mg/m^2. [3]

Volume of distribution

Daunorubicin has a steady-state volume of distribution of 1.91 L/m^2 reported with the liposomal formulation.[1] The average volume of distribution reported for the liposomal formulation is 6.6 L. [5]

Protein binding

Not Available

Metabolism

Hover over products below to view reaction partners

Route of elimination

Daunorubicin is eliminated hepatically. 40% of daunorubicin is excreted in the bile while 25% is excreted in an active form (daunorubicin or daunorubicinol) in the urine.[7] In the liposomal formulation, only 9% of active molecules are excreted in the urine.[5]

Half-life

Daunorubicin has been determined to have a terminal half-life of 18.5 h (+/- 4.9).[1] Daunorubicinol, the primary active metabolite has been determined to have a terminal half-life of 26.7 h (+/- 12.8). The mean half-life of elimination of liposomal daunorubicin has been reported to be 22.1 h in pharmacokinetic studies and 31.5 h in official FDA labeling.[3,5]

Clearance

Daunorubicin has a clearance of 68.4 mL/h/m^2 determined using the liposomal formulation.[3]

Adverse Effects

Toxicity

Not Available

Pathways

Not Available

Pharmacogenomic Effects/ADRs

Show 10 entries

Search

INTERACTING GENE/ENZYME	ALLELE NAME	GENOTYPE(S)	DEFINING CHANGE(S)	TYPE(S)	DESCRIPTION
+ Cytochrome P450 1B1	---	(G;G) / (C;G)	G allele	ADR Directly Studied	The presence of this genotype in CYP1B1 may be associated with an increased risk of drug-induced cytotoxicity from daunorubicin therapy.
+ Heterogeneous nuclear ribonucleoprotein D0	---	(A;A) / (A;G)	A allele	ADR Directly Studied	The presence of this genotype in HNRNPD may be associated with an increased risk of drug-induced cytotoxicity from daunorubicin therapy.
+ SEC14-like protein 3	---	(T;T) / (G;T)	T allele	ADR Directly Studied	The presence of this genotype in SEC14L3 may be associated with an increased risk of drug-induced cytotoxicity from daunorubicin therapy.

INTERACTING GENE/ENZYME	ALLELE NAME	GENOTYPE(S)	DEFINING CHANGE(S)	TYPE(S)	DESCRIPTION
+ Inhibitor of nuclear factor kappa-B kinase subunit epsilon	---	(A;A) / (A;G)	A allele	ADR Directly Studied	The presence of this genotype in IKBKE may be associated with an increased risk of drug-induced cytotoxicity from daunorubicin therapy.
+ Retinoic acid receptor gamma	---	(C;C) / (C;T)	C>T	ADR Directly Studied	Pediatric patients who carry this genotype may be at a higher risk of experiencing anthracycline-induced cardiotoxicity when treated with daunorubicin.
+ Solute carrier family 28 member 3	---	(A;A) / (A;G)	G > A	ADR Directly Studied	Pediatric patients who carry this genotype may be at a higher risk of experiencing anthracycline-induced cardiotoxicity when treated with daunorubicin.
+ UDP-glucuronosyltransferase 1-6	UGT1A6*4	(T;T) / (G;T)	G > T	ADR Directly Studied	Pediatric patients who carry this genotype may be at a higher risk of experiencing anthracycline-induced cardiotoxicity when treated with daunorubicin.

Showing 1 to 7 of 7 entries

‹ 1 ›

INTERACTIONS

Drug Interactions

This information should not be interpreted without the help of a healthcare provider. If you believe you are experiencing an interaction, contact a healthcare provider immediately. The absence of an interaction does not necessarily mean no interactions exist.

APPROVED | VET APPROVED | NUTRACEUTICAL | ILLICIT | WITHDRAWN | INVESTIGATIONAL | EXPERIMENTAL | ALL DRUGS

Show 5 entries

Search

DRUG	INTERACTION
	INTEGRATE DRUG-DRUG INTERACTIONS IN YOUR SOFTWARE
Abatacept	The risk or severity of adverse effects can be increased when Daunorubicin is combined with Abatacept.
Abciximab	The risk or severity of bleeding can be increased when Abciximab is combined with Daunorubicin.
Abemaciclib	The serum concentration of Abemaciclib can be increased when it is combined with Daunorubicin.
Acalabrutinib	The serum concentration of Acalabrutinib can be increased when it is combined with Daunorubicin.
Acenocoumarol	The serum concentration of Acenocoumarol can be increased when it is combined with Daunorubicin.

Showing 1 to 5 of 712 entries

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Food Interactions

No interactions found.

PRODUCTS

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Product Ingredients

INGREDIENT	UNII	CAS	INCHI KEY
Daunorubicin citrate	5L84T2Z6NP	371770-68-2	VNTHYLVDGVBPOU-QQYBVWGSSA-N
Daunorubicin hydrochloride	UD984I04LZ	23541-50-6	GUGHGUXZJWAIAS-UHFFFAOYSA-N

International/Other Brands

Cerubidin (Sanofi-Aventis) / Cérubidine (Sanofi-Aventis) / Daunoblastin (Pfizer) / Daunoblastina (Pfizer) / Daunorrubicina (GP-Pharm) / Maxidauno (Varifarma)

Brand Name Prescription Products

Show 5 entries

Search

NAME	DOSAGE	STRENGTH	ROUTE	LABELLER	MARKETING START	MARKETING END	
+ Cerubidine	Powder, for solution	20 mg / vial	Intravenous	Searchlight Pharma Inc	1971-12-31	Not applicable	
+ Daunorubicin Hydrochloride	Injection	5 mg/1mL	Intravenous	Hikma Pharmaceuticals USA Inc.	2018-01-02	Not applicable	
+ Daunorubicin Hydrochloride	Injection	5 mg/1mL	Intravenous	Hikma Pharmaceuticals USA Inc.	2018-01-02	Not applicable	
+ Daunorubicin Hydrochloride	Injection, powder, for solution	20 mg/1	Intravenous	sanofi-aventis U.S. LLC	2014-06-23	2014-11-11	
+ Daunorubicin Hydrochloride for Injection	Powder, for solution	20 mg / vial	Intravenous	TEVA Canada Limited	1998-03-04	2018-04-30	

Showing 1 to 5 of 11 entries

‹ 1 2 3 ›

Generic Prescription Products

Show 5 entries

Search

NAME	DOSAGE	STRENGTH	ROUTE	LABELLER	MARKETING START	MARKETING END	
+ **Cerubidine**	Injection, powder, for solution	20 mg/4mL	Intravenous	Bedford Pharmaceuticals	1998-06-01	2013-09-30	
+ **Daunorubicin Hydrochloride**	Injection, solution	5 mg/1mL	Intravenous	Teva Parenteral Medicines, Inc.	2004-04-01	2016-06-30	
+ **Daunorubicin Hydrochloride**	Injection, solution	5 mg/1mL	Intravenous	Hisun Pharmaceuticals Usa, Inc.	2020-01-20	Not applicable	
+ **Daunorubicin Hydrochloride**	Injection	5 mg/1mL	Intravenous	Bedford Pharmaceuticals	1998-06-01	2013-09-30	
+ **Daunorubicin Hydrochloride**	Injection, powder, for solution	20 mg/4mL	Intravenous	Hisun Pharmaceuticals Usa, Inc.	2019-04-25	2019-09-12	

Showing 1 to 5 of 8 entries

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Mixture Products

Show 5 entries

Search

NAME	INGREDIENTS	DOSAGE	ROUTE	LABELLER	MARKETING START	MARKETING END
+ **Vyxeos**	Daunorubicin (44 mg) + Cytarabine (100 mg)	Powder	Intravenous	Jazz Pharmaceuticals Ireland Limited	2021-07-06	Not applicable
+ **Vyxeos**	Daunorubicin (44 mg/20mL) + Cytarabine (100 mg/20mL)	Injection, powder, lyophilized, for suspension	Intravenous	Jazz Pharmaceuticals, Inc.	2017-08-03	Not applicable
+ **Vyxeos Liposomal**	Daunorubicin hydrochloride (2.2 mg/ml) + Cytarabine (5 mg/ml)	Injection, powder, for solution	Intravenous	Jazz Pharmaceuticals Ireland Ltd	2020-12-16	Not applicable
+ **VYXEOS LIPOSOMAL**	Daunorubicin (2.2 MG/ML) + Cytarabine (5 MG/ML)	Powder	Intravenous; Parenteral	Jazz Pharmaceuticals Ireland Limited	2019-01-29	Not applicable
+ **Vyxeos Liposomal**	Daunorubicin hydrochloride (2.2 mg/ml) + Cytarabine (5 mg/ml)	Injection, powder, for solution	Intravenous	Jazz Pharmaceuticals Ireland Ltd	2020-12-16	Not applicable

Showing 1 to 5 of 8 entries

‹ 1 2 ›

Unapproved/Other Products ⓘ

Show 5 entries

Search

NAME	INGREDIENTS	DOSAGE	ROUTE	LABELLER	MARKETING START	MARKETING END	
+ **Daunorubicin Hydrochloride**	Daunorubicin hydrochloride (20 mg/1)	Injection, powder, for solution	Intravenous	sanofi-aventis U.S. LLC	2014-06-23	2014-11-11	

Showing 1 to 1 of 1 entries

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CATEGORIES

ATC Codes

L01DB02 — Daunorubicin
- L01DB — Anthracyclines and related substances
- L01D — CYTOTOXIC ANTIBIOTICS AND RELATED SUBSTANCES
- L01 — ANTINEOPLASTIC AGENTS
- L — ANTINEOPLASTIC AND IMMUNOMODULATING AGENTS

L01XY01 — Cytarabine and daunorubicin
- L01XY — Combinations of antineoplastic agents
- L01X — OTHER ANTINEOPLASTIC AGENTS
- L01 — ANTINEOPLASTIC AGENTS
- L — ANTINEOPLASTIC AND IMMUNOMODULATING AGENTS

Drug Categories

Anthracycline Topoisomerase Inhibitor

Anthracyclines

Anthracyclines and Related Substances

Antibiotics, Antineoplastic

Antineoplastic Agents

Antineoplastic and Immunomodulating Agents

BCRP/ABCG2 Substrates

Cardiotoxic antineoplastic agents

Cytochrome P-450 CYP3A Inducers
Cytochrome P-450 CYP3A Inhibitors
Cytochrome P-450 CYP3A Substrates
Cytochrome P-450 CYP3A4 Inhibitors
Cytochrome P-450 CYP3A4 Inhibitors (strength unknown)
Cytochrome P-450 CYP3A4 Substrates

Cytochrome P-450 CYP3A5 Inducers (strength unknown)
Cytochrome P-450 Enzyme Inducers
Cytochrome P-450 Enzyme Inhibitors
Cytochrome P-450 Substrates
Cytotoxic Antibiotics and Related Substances
Enzyme Inhibitors
Glycosides
Immunosuppressive Agents
Myelosuppressive Agents
Naphthacenes
Narrow Therapeutic Index Drugs
P-glycoprotein inducers
P-glycoprotein inhibitors
P-glycoprotein substrates
P-glycoprotein substrates with a Narrow Therapeutic Index
Topoisomerase II Inhibitors
Topoisomerase Inhibitors

Chemical Taxonomy
Provided by Classyfire

Description	This compound belongs to the class of organic compounds known as anthracyclines. These are polyketides containing a tetracenequinone ring structure with a sugar attached by glycosidic linkage.
Kingdom	Organic compounds
Super Class	Phenylpropanoids and polyketides
Class	Anthracyclines
Sub Class	Not Available
Direct Parent	Anthracyclines
Alternative Parents	Tetracenequinones / Aminoglycosides / Anthraquinones / Hexoses / O-glycosyl compounds / Tetralins / Anisoles / Aryl ketones / Alkyl aryl ethers / Oxanes show 12 more
Substituents	1,2-aminoalcohol / 1,4-anthraquinone / 9,10-anthraquinone / Acetal / Alcohol / Alkyl aryl ether / Alpha-hydroxy ketone / Amine / Amino saccharide / Aminoglycoside core show 32 more
Molecular Framework	Aromatic heteropolycyclic compounds
External Descriptors	quinone, aminoglycoside antibiotic, anthracycline (CHEBI:41977) / Anthracyclinones (C01907) / Anthracyclinones (LMPK13050002)

Affected organisms
Humans and other mammals

CHEMICAL IDENTIFIERS

UNII	ZS7284E0ZP
CAS number	20830-81-3
InChI Key	STQGQHZAVUOBTE-VGBVRHCVSA-N
InChI	InChI=1S/C27H29NO10/c1-10-22(30)14(28)7-17(37-10)38-16-9-27(35,11(2)29)8-13-19(16)26(34)21-20(24(13)32)23(31)12-5-4-6-15(36-3)18(12)25(21)33/h4-6,10,14,16-17,22,30,32,34-35H,7-9,28H2,1-3H3/t10-,14-,16-,17-,22+,27-/m0/s1
IUPAC Name	(8S,10S)-8-acetyl-10-{[(2R,4S,5S,6S)-4-amino-5-hydroxy-6-methyloxan-2-yl]oxy}-6,8,11-trihydroxy-1-methoxy-5,7,8,9,10,12-hexahydrotetracene-5,12-dione
SMILES	COC1=CC=CC2=C1C(=O)C1=C(O)C3=C(C[C@](O)(C[C@@H]3O[C@H]3C[C@H](N)[C@H](O)[C@H](C)O3)C(C)=O)C(O)=C1C2=O

REFERENCES

Synthesis Reference
Sylvie Pinnert, Leon Ninet, Jean Preud'Homme, "Antibiotic daunorubicin and its preparation." U.S. Patent US3989598, issued March, 1965.
US3989598

General References

1. Balis FM, Holcenberg JS, Bleyer WA: Clinical pharmacokinetics of commonly used anticancer drugs. Clin Pharmacokinet. 1983 May-Jun;8(3):202-32. doi: 10.2165/00003088-198308030-00002. [Article]
2. Cafaro A, Giannini MB, Silimbani P, Cangini D, Masini C, Ghelli Luserna Di Rora A, Simonetti G, Martinelli G, Cerchione C: CPX-351 daunorubicin-cytarabine liposome: a novel formulation to treat patients with newly diagnosed secondary acute myeloid leukemia. Minerva Med. 2020 Oct;111(5):455-466. doi: 10.23736/S0026-4806.20.07017-2. Epub 2020 Sep 21. [Article]
3. Mayer LD, Tardi P, Louie AC: CPX-351: a nanoscale liposomal co-formulation of daunorubicin and cytarabine with unique biodistribution and tumor cell uptake properties. Int J Nanomedicine. 2019 May 23;14:3819-3830. doi: 10.2147/IJN.S139450. eCollection 2019. [Article]
4. Saleem T, Kasi A: Daunorubicin . [Article]
5. FDA Approved Drug Products: VYXEOS (daunorubicin and cytarabine) liposome for injection, for intravenous use [Link]

6. Health Canada Approved Drug Products: daunorubicin solution for injection [Link]
7. FDA Approved Drug Products: Daunorubicin hydrochloride injection [Link]

External Links		
	Human Metabolome Database	HMDB0014832
	KEGG Drug	D07776
	KEGG Compound	C01907
	PubChem Compound	30323
	PubChem Substance	46508433
	ChemSpider	28163
	BindingDB	50368352
	RxNav	3109
	ChEBI	41977
	ChEMBL	CHEMBL178
	ZINC	ZINC000003917708
	Therapeutic Targets Database	DNC000517
	PharmGKB	PA449212
	PDBe Ligand	DM1
	RxList	RxList Drug Page
	Drugs.com	Drugs.com Drug Page
	Wikipedia	Daunorubicin
PDB Entries	110d / 152d / 1d10 / 1d11 / 1d33 / 1da0 / 1jo2 / 1o0k / 1vth / 1vti ... show 9 more	
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Clinical Trials

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Not Available	Completed	Not Available	Acute Lymphoblastic Leukemia (ALL)	1			tion to
Not Available	Completed	Not Available	Acute Myeloid Leukemia With Myelodysplasia-Related Changes / Treatment-Related Acute Myeloid Leukemia	1			tion to
Not Available	Completed	Treatment	Acute Biphenotypic Leukemia (ABL) / Acute Myeloid Leukemia / Myelodysplastic Syndrome / Untreated Adult Acute Myeloid Leukemia	1			tion to
Not Available	Completed	Treatment	Acute Lymphocytic Leukemia (ALL)	1			tion to
Not Available	Completed	Treatment	Ataxia-Telangiectasia (A-T)	1			tion to

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PHARMACOECONOMICS

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App pharmaceuticals llc
Teva parenteral medicines inc

Packagers
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Gilead Sciences Inc.
Sicor Pharmaceuticals
Specia Alfort
Teva Pharmaceutical Industries Ltd.

Dosage Forms Show 10 entries

Search

FORM	ROUTE	STRENGTH
Injection, powder, for solution	Intravenous	20 mg/4mL
Powder, for solution	Intravenous	20 mg / vial
Solution	Intravenous	21.40 mg
Injection, solution	Parenteral	20 mg
Injection, powder, for solution	Parenteral	20 MG/10ML
Injection	Intravenous	
Injection, powder, for solution	Intravenous	20 mg
Injection, powder, for solution; injection, powder, lyophilized, for solution		21.4 mg
Injection	Intravenous	5 mg/1mL
Injection, powder, for solution	Intravenous	20 mg/1

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Prices

UNIT DESCRIPTION	COST	UNIT
Daunorubicin 20 mg/4 ml vial	163.01USD	ml
Cerubidine 20 mg vial	50.4USD	vial
Daunorubicin 50 mg/10 ml vial	42.45USD	ml
Daunoxome 2 mg/ml vial	13.06USD	ml

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Patents

PATENT NUMBER	PEDIATRIC EXTENSION	APPROVED	EXPIRES (ESTIMATED)	
US7850990	No	2010-12-14	2027-01-23	
US8022279	No	2011-09-20	2027-09-14	
US8431806	No	2013-04-30	2025-04-22	
US8092828	No	2012-01-10	2029-04-01	
US8518437	No	2013-08-27	2026-06-07	
US9271931	No	2016-03-01	2027-01-23	
US10028912	No	2018-07-24	2034-09-29	
US10166184	No	2019-01-01	2032-10-15	
US10835492	No	2020-11-17	2032-10-15	

PROPERTIES

State Solid

Experimental Properties

PROPERTY	VALUE	SOURCE
melting point (°C)	208-209 °C	PhysProp
boiling point (°C)	190 °C	PubChem
water solubility	30000 mg/L at 25 °C	PubChem
logP	1.83	SANGSTER (1993)
pKa	7.85	PubChem

Predicted Properties

PROPERTY	VALUE	SOURCE
Water Solubility	0.627 mg/mL	ALOGPS
logP	1.68	ALOGPS
logP	1.36	Chemaxon
logS	-2.9	ALOGPS
pKa (Strongest Acidic)	8.01	Chemaxon
pKa (Strongest Basic)	10.03	Chemaxon
Physiological Charge	1	Chemaxon
Hydrogen Acceptor Count	11	Chemaxon
Hydrogen Donor Count	5	Chemaxon
Polar Surface Area	185.84 $Å^2$	Chemaxon
Rotatable Bond Count	4	Chemaxon
Refractivity	132.89 $m^3 \cdot mol^{-1}$	Chemaxon
Polarizability	53.7 $Å^3$	Chemaxon
Number of Rings	5	Chemaxon
Bioavailability	0	Chemaxon
Rule of Five	No	Chemaxon
Ghose Filter	No	Chemaxon
Veber's Rule	No	Chemaxon
MDDR-like Rule	No	Chemaxon

Predicted ADMET Features

PROPERTY	VALUE	PROBABILITY
Human Intestinal Absorption	-	0.6524
Blood Brain Barrier	-	0.9869

PROPERTY	VALUE	PROBABILITY
Caco-2 permeable	-	0.7227
P-glycoprotein substrate	Substrate	0.7862
P-glycoprotein inhibitor I	Non-inhibitor	0.636
P-glycoprotein inhibitor II	Non-inhibitor	0.9136
Renal organic cation transporter	Non-inhibitor	0.9213
CYP450 2C9 substrate	Non-substrate	0.7987
CYP450 2D6 substrate	Non-substrate	0.9116
CYP450 3A4 substrate	Substrate	0.5951
CYP450 1A2 substrate	Inhibitor	0.8777
CYP450 2C9 inhibitor	Non-inhibitor	0.9448
CYP450 2D6 inhibitor	Non-inhibitor	0.9231
CYP450 2C19 inhibitor	Non-inhibitor	0.9527
CYP450 3A4 inhibitor	Non-inhibitor	0.9157
CYP450 inhibitory promiscuity	Low CYP Inhibitory Promiscuity	0.9543
Ames test	AMES toxic	0.9224
Carcinogenicity	Non-carcinogens	0.9521
Biodegradation	Not ready biodegradable	0.9844
Rat acute toxicity	3.2275 LD50, mol/kg	Not applicable
hERG inhibition (predictor I)	Weak inhibitor	0.9888
hERG inhibition (predictor II)	Non-inhibitor	0.8916

ADMET data is predicted using admetSAR, a free tool for evaluating chemical ADMET properties. (23092397)

SPECTRA

Mass Spec (NIST) Not Available

Spectra

SPECTRUM	SPECTRUM TYPE	SPLASH KEY
Predicted GC-MS Spectrum - GC-MS	Predicted GC-MS	splash10-0006-9200300000-b86566e84001e30da377
Predicted MS/MS Spectrum - 10V, Positive (Annotated)	Predicted LC-MS/MS	splash10-03gi-0108090000-9b5e11033a781f155965
Predicted MS/MS Spectrum - 10V, Negative (Annotated)	Predicted LC-MS/MS	splash10-00os-0009020000-9b31c42030739d82aeb3
Predicted MS/MS Spectrum - 20V, Positive (Annotated)	Predicted LC-MS/MS	splash10-03ec-0209760000-26636262d4edaf9ceb53
Predicted MS/MS Spectrum - 20V, Negative (Annotated)	Predicted LC-MS/MS	splash10-002b-0109010000-a72365a9821b104a18cb
Predicted MS/MS Spectrum - 40V, Positive (Annotated)	Predicted LC-MS/MS	splash10-01ta-1724950000-4efae1952fe012fb5d6f
Predicted MS/MS Spectrum - 40V, Negative (Annotated)	Predicted LC-MS/MS	splash10-00l2-0319420000-c8216989f7cb67458285

Chromatographic Properties

Collision Cross Sections (CCS)

ADDUCT	CCS VALUE (Å^2)	SOURCE TYPE	SOURCE
[M-H]-	230.9855766	predicted	DarkChem Lite v0.1.0
[M-H]-	231.5901766	predicted	DarkChem Lite v0.1.0
[M-H]-	213.96645	predicted	DeepCCS 1.0 (2019)
[M+H]+	231.3484766	predicted	DarkChem Lite v0.1.0
[M+H]+	232.6141766	predicted	DarkChem Lite v0.1.0
[M+H]+	215.79134	predicted	DeepCCS 1.0 (2019)
[M+Na]+	231.5254766	predicted	DarkChem Lite v0.1.0
[M+Na]+	232.4401766	predicted	DarkChem Lite v0.1.0
[M+Na]+	221.39717	predicted	DeepCCS 1.0 (2019)

TARGETS

1. DNA — Details

Kind
Nucleotide

Organism
Humans

Pharmacological action
Yes

Actions
Intercalation

DNA is the molecule of heredity, as it is responsible for the genetic propagation of most inherited traits. It is a polynucleic acid that carries genetic information on cell growth, division, and function. DNA consists of two long strands of nucleotides twisted into a double helix and held together by hydrogen bonds. The sequence of nucleotides determines hereditary characteristics. Each strand serves as the template for subsequent DNA replication and as a template for mRNA production, leading to protein synthesis via ribosomes.

References

1. Aubel-Sadron G, Londos-Gagliardi D: Daunorubicin and doxorubicin, anthracycline antibiotics, a physicochemical and biological review. Biochimie. 1984 May;66(5):333-52. [Article]
2. Zunino F, Capranico G: DNA topoisomerase II as the primary target of anti-tumor anthracyclines. Anticancer Drug Des. 1990 Nov;5(4):307-17. [Article]
3. FDA Approved Drug Products: VYXEOS (daunorubicin and cytarabine) liposome for injection, for intravenous use [Link]

2. DNA topoisomerase 2-alpha

Details

Kind	Protein
Organism	Humans
Pharmacological action	Yes
Actions	Inhibitor
General Function	Key decatenating enzyme that alters DNA topology by binding to two double-stranded DNA molecules, generating a double-stranded break in one of the strands, passing the intact strand through the broken strand, and religating the broken strand (PubMed:17567603, PubMed:18790802, PubMed:22013166, PubMed:22323612). May play a role in regulating the period length of BMAL1 transcriptional oscillation (By similarity)
Specific Function	Atp binding
Gene Name	TOP2A
Uniprot ID	P11388
Uniprot Name	DNA topoisomerase 2-alpha
Molecular Weight	174383.88 Da

References

1. Aubel-Sadron G, Londos-Gagliardi D: Daunorubicin and doxorubicin, anthracycline antibiotics, a physicochemical and biological review. Biochimie. 1984 May;66(5):333-52. [Article]
2. Zunino F, Capranico G: DNA topoisomerase II as the primary target of anti-tumor anthracyclines. Anticancer Drug Des. 1990 Nov;5(4):307-17. [Article]
3. FDA Approved Drug Products: VYXEOS (daunorubicin and cytarabine) liposome for injection, for intravenous use [Link]

3. DNA topoisomerase 2-beta

Details

Kind	Protein
Organism	Humans
Pharmacological action	Yes
Actions	Inhibitor
General Function	Key decatenating enzyme that alters DNA topology by binding to two double-stranded DNA molecules, generating a double-stranded break in one of the strands, passing the intact strand through the broken strand, and religating the broken strand. Plays a role in B-cell differentiation
Specific Function	Atp binding
Gene Name	TOP2B
Uniprot ID	Q02880
Uniprot Name	DNA topoisomerase 2-beta
Molecular Weight	183265.825 Da

References

1. Aubel-Sadron G, Londos-Gagliardi D: Daunorubicin and doxorubicin, anthracycline antibiotics, a physicochemical and biological review. Biochimie. 1984 May;66(5):333-52. [Article]
2. Zunino F, Capranico G: DNA topoisomerase II as the primary target of anti-tumor anthracyclines. Anticancer Drug Des. 1990 Nov;5(4):307-17. [Article]
3. FDA Approved Drug Products: VYXEOS (daunorubicin and cytarabine) liposome for injection, for intravenous use [Link]

ENZYMES

1. Cytochrome P450 3A4

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate, Inhibitor
General Function	A cytochrome P450 monooxygenase involved in the metabolism of sterols, steroid hormones, retinoids and fatty acids (PubMed:10681376, PubMed:11093772, PubMed:11555828, PubMed:12865317, PubMed:14559847, PubMed:15373842, PubMed:15764715, PubMed:19965576, PubMed:20702771, PubMed:21490593, PubMed:21576599). Mechanistically, uses molecular oxygen inserting one oxygen atom into a substrate, and reducing the second into a water molecule, with two electrons provided by NADPH via cytochrome P450 reductase (NADPH--hemoprotein reductase). Catalyzes the hydroxylation of carbon-hydrogen bonds (PubMed:12865317, PubMed:14559847, PubMed:15373842, PubMed:15764715, PubMed:21490593, PubMed:21576599, PubMed:2732228). Exhibits high catalytic activity for the formation of hydroxyestrogens from estrone (E1) and 17beta-estradiol (E2), namely 2-hydroxy E1 and E2, as well as D-ring hydroxylated E1 and E2 at the C-16 position (PubMed:11555828, PubMed:12865317, PubMed:14559847). Plays a role in the metabolism of androgens, particularly in oxidative deactivation of testosterone (PubMed:15373842, PubMed:15764715,

	PubMed:22773874, PubMed:2732228). Metabolizes testosterone to less biologically active 2beta- and 6beta-hydroxytestosterones (PubMed:15373842, PubMed:15764715, PubMed:2732228). Contributes to the formation of hydroxycholesterols (oxysterols), particularly A-ring hydroxylated cholesterol at the C-4beta position, and side chain hydroxylated cholesterol at the C-25 position, likely contributing to cholesterol degradation and bile acid biosynthesis (PubMed:21576599). Catalyzes bisallylic hydroxylation of polyunsaturated fatty acids (PUFA) (PubMed:9435160). Catalyzes the epoxidation of double bonds of PUFA with a preference for the last double bond (PubMed:19965576). Metabolizes endocannabinoid arachidonoylethanolamide (anandamide) to 8,9-, 11,12-, and 14,15-epoxyeicosatrienoic acid ethanolamides (EpETrE-EAs), potentially modulating endocannabinoid system signaling (PubMed:20702771). Plays a role in the metabolism of retinoids. Displays high catalytic activity for oxidation of all-trans-retinol to all-trans-retinal, a rate-limiting step for the biosynthesis of all-trans-retinoic acid (atRA) (PubMed:10681376). Further metabolizes atRA toward 4-hydroxyretinoate and may play a role in hepatic atRA clearance (PubMed:11093772). Responsible for oxidative metabolism of xenobiotics. Acts as a 2-exo-monooxygenase for plant lipid 1,8-cineole (eucalyptol) (PubMed:11159812). Metabolizes the majority of the administered drugs. Catalyzes sulfoxidation of the anthelmintics albendazole and fenbendazole (PubMed:10759686). Hydroxylates antimalarial drug quinine (PubMed:8968357). Acts as a 1,4-cineole 2-exo-monooxygenase (PubMed:11695850). Also involved in vitamin D catabolism and calcium homeostasis. Catalyzes the inactivation of the active hormone calcitriol (1-alpha,25-dihydroxyvitamin D(3)) (PubMed:29461981)
Specific Function	1,8-cineole 2-exo-monooxygenase activity
Gene Name	CYP3A4
Uniprot ID	P08684
Uniprot Name	Cytochrome P450 3A4
Molecular Weight	57342.67 Da

References

1. Baumhakel M, Kasel D, Rao-Schymanski RA, Bocker R, Beckurts KT, Zaigler M, Barthold D, Fuhr U: Screening for inhibitory effects of antineoplastic agents on CYP3A4 in human liver microsomes. Int J Clin Pharmacol Ther. 2001 Dec;39(12):517-28. [Article]

2. Cytochrome P450 3A5

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Inducer
General Function	A cytochrome P450 monooxygenase involved in the metabolism of steroid hormones and vitamins (PubMed:10681376, PubMed:11093772, PubMed:12865317, PubMed:2732228). Mechanistically, uses molecular oxygen inserting one oxygen atom into a substrate, and reducing the second into a water molecule, with two electrons provided by NADPH via cytochrome P450 reductase (NADPH--hemoprotein reductase). Catalyzes the hydroxylation of carbon-hydrogen bonds (PubMed:10681376, PubMed:11093772, PubMed:12865317, PubMed:2732228). Exhibits high catalytic activity for the formation of catechol estrogens from 17beta-estradiol (E2) and estrone (E1), namely 2-hydroxy E1 and E2 (PubMed:12865317). Catalyzes 6beta-hydroxylation of the steroid hormones testosterone, progesterone, and androstenedione (PubMed:2732228). Catalyzes the oxidative conversion of all-trans-retinol to all-trans-retinal, a rate-limiting step for the biosynthesis of all-trans-retinoic acid (atRA) (PubMed:10681376). Further metabolizes all trans-retinoic acid (atRA) to 4-hydroxyretinoate and may play a role in hepatic atRA clearance (PubMed:11093772). Also involved in the oxidative metabolism of xenobiotics, including calcium channel blocking drug nifedipine and immunosuppressive drug cyclosporine (PubMed:2732228)
Specific Function	Aromatase activity
Gene Name	CYP3A5
Uniprot ID	P20815
Uniprot Name	Cytochrome P450 3A5
Molecular Weight	57108.065 Da

References

1. Wang T, Chen FY, Han JY, Shao NX, Ou-Yuang RR: [Study of CYP3A5 in drug resistance mechanisms in acute leukemia]. Zhonghua Xue Ye Xue Za Zhi. 2003 Jun;24(6):286-9. [Article]

3. NADPH--cytochrome P450 reductase

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate, Inducer
General Function	This enzyme is required for electron transfer from NADP to cytochrome P450 in microsomes. It can also provide electron transfer to heme oxygenase and cytochrome B5
Specific Function	Flavin adenine dinucleotide binding
Gene Name	POR
Uniprot ID	P16435
Uniprot Name	NADPH--cytochrome P450 reductase
Molecular Weight	76689.12 Da

References

1. Bachur NR, Gordon SL, Gee MV, Kon H: NADPH cytochrome P-450 reductase activation of quinone anticancer agents to free radicals. Proc Natl Acad Sci U S A. 1979 Feb;76(2):954-7. [Article]

4. Cytochrome P450 1B1

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Inhibitor
General Function	A cytochrome P450 monooxygenase involved in the metabolism of various endogenous substrates, including fatty acids, steroid hormones and vitamins (PubMed:10681376, PubMed:11555828, PubMed:12865317, PubMed:15258110, PubMed:20972997). Mechanistically, uses molecular oxygen inserting one oxygen atom into a substrate, and reducing the second into a water molecule, with two electrons provided by NADPH via cytochrome P450 reductase (NADPH--hemoprotein reductase) (PubMed:10681376, PubMed:11555828, PubMed:12865317, PubMed:15258110, PubMed:20972997). Exhibits catalytic activity for the formation of hydroxyestrogens from estrone (E1) and 17beta-estradiol (E2), namely 2- and 4-hydroxy E1 and E2. Displays a predominant hydroxylase activity toward E2 at the C-4 position (PubMed:11555828, PubMed:12865317). Metabolizes testosterone and progesterone to B or D ring hydroxylated metabolites (PubMed:10426814). May act as a major enzyme for all-trans retinoic acid biosynthesis in extrahepatic tissues. Catalyzes two successive oxidative transformation of all-trans retinol to all-trans retinal and then to the active form all-trans retinoic acid (PubMed:10681376, PubMed:15258110). Catalyzes the epoxidation of double bonds of certain PUFA. Converts arachidonic acid toward epoxyeicosatrienoic acid (EpETrE) regioisomers, 8,9-, 11,12-, and 14,15- EpETrE, that function as lipid mediators in the vascular system (PubMed:20972997). Additionally, displays dehydratase activity toward oxygenated eicosanoids hydroperoxyeicosatetraenoates (HpETEs). This activity is independent of cytochrome P450 reductase, NADPH, and O2 (PubMed:21068195). Also involved in the oxidative metabolism of xenobiotics, particularly converting polycyclic aromatic hydrocarbons and heterocyclic aryl amines procarcinogens to DNA-damaging products (PubMed:10426814). Plays an important role in retinal vascular development. Under hyperoxic O2 conditions, promotes retinal angiogenesis and capillary morphogenesis, likely by metabolizing the oxygenated products generated during the oxidative stress. Also, contributes to oxidative homeostasis and ultrastructural organization and function of trabecular meshwork tissue through modulation of POSTN expression (By similarity)
Specific Function	Aromatase activity
Gene Name	CYP1B1
Uniprot ID	Q16678
Uniprot Name	Cytochrome P450 1B1
Molecular Weight	60845.33 Da

References

1. Rochat B, Morsman JM, Murray GI, Figg WD, McLeod HL: Human CYP1B1 and anticancer agent metabolism: mechanism for tumor-specific drug inactivation? J Pharmacol Exp Ther. 2001 Feb;296(2):537-41. [Article]

5. Aldo-keto reductase family 1 member B1

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate
General Function	Catalyzes the NADPH-dependent reduction of a wide variety of carbonyl-containing compounds to their corresponding alcohols. Displays enzymatic activity towards endogenous metabolites such as aromatic and aliphatic aldehydes, ketones, monosacharides, bile acids and xenobiotics substrates. Key enzyme in the polyol pathway, catalyzes reduction of glucose to sorbitol during hyperglycemia (PubMed:1936586). Reduces steroids and their derivatives and prostaglandins. Displays low enzymatic activity toward all-trans-retinal, 9-cis-retinal, and 13-cis-retinal (PubMed:12732097, PubMed:19010934, PubMed:8343525). Catalyzes the reduction of diverse phospholipid aldehydes such as 1-palmitoyl-2-(5-oxovaleroyl)-sn -glycero-3-phosphoethanolamin (POVPC) and related phospholipid aldehydes that are generated from the oxydation of phosphotidylcholine and phosphatdyleethanolamides (PubMed:17381426). Plays a role in detoxifying dietary and lipid-derived unsaturated carbonyls, such as crotonaldehyde, 4-hydroxynonenal, trans-2-hexenal, trans-2,4-hexadienal and their glutathione-conjugates carbonyls (GS-carbonyls) (PubMed:21329684)
Specific Function	Aldose reductase (nadph) activity
Gene Name	AKR1B1
Uniprot ID	P15121
Uniprot Name	Aldo-keto reductase family 1 member B1
Molecular Weight	35853.125 Da

References

1. Loveless H, Arena E, Felsted RL, Bachur NR: Comparative mammalian metabolism of adriamycin and daunorubicin. Cancer Res. 1978 Mar;38(3):593-8. [Article]

6. Carbonyl reductase [NADPH] 1

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate
General Function	NADPH-dependent reductase with broad substrate specificity. Catalyzes the reduction of a wide variety of carbonyl compounds including quinones, prostaglandins, menadione, plus various xenobiotics. Catalyzes the reduction of the antitumor anthracyclines doxorubicin and daunorubicin to the cardiotoxic compounds doxorubicinol and daunorubicinol (PubMed:15799708, PubMed:17344335, PubMed:17912391, PubMed:18449627, PubMed:18826943, PubMed:1921984, PubMed:7005231). Can convert prostaglandin E to prostaglandin F2-alpha (By similarity). Can bind glutathione, which explains its higher affinity for glutathione-conjugated substrates. Catalyzes the reduction of S-nitrosoglutathione (PubMed:17344335, PubMed:18826943). In addition, participates in the glucocorticoid metabolism by catalyzing the NADPH-dependent cortisol/corticosterone into 20beta-dihydrocortisol (20b-DHF) or 20beta-corticosterone (20b-DHB), which are weak agonists of NR3C1 and NR3C2 in adipose tissue (PubMed:28878267)
Specific Function	15-hydroxyprostaglandin dehydrogenase (nadp+) activity
Gene Name	CBR1
Uniprot ID	P16152
Uniprot Name	Carbonyl reductase [NADPH] 1
Molecular Weight	30374.73 Da

References

1. Piska K, Koczurkiewicz P, Bucki A, Wojcik-Pszczola K, Kolaczkowski M, Pekala E: Metabolic carbonyl reduction of anthracyclines - role in cardiotoxicity and cancer resistance. Reducing enzymes as putative targets for novel cardioprotective and chemosensitizing agents. Invest New Drugs. 2017 Jun;35(3):375-385. doi: 10.1007/s10637-017-0443-2. Epub 2017 Mar 10. [Article]

7. Carbonyl reductase [NADPH] 3

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate
General Function	Catalyzes the NADPH-dependent reduction of carbonyl compounds to their corresponding alcohols (PubMed:18493841). Has low NADPH-dependent oxidoreductase activity. Acts on several orthoquinones, acts as well on non-quinone compounds, such as isatin or on the anticancer drug oracin (PubMed:15537833, PubMed:18493841, PubMed:19841672). Best substrates for CBR3 is 1,2- naphthoquinone, hence could play a role in protection against cytotoxicity of exogenous quinones (PubMed:19841672). Exerts activity toward ortho-quinones but not paraquinones. No endogenous substrate for CBR3 except isatin has been identified (PubMed:19841672)
Specific Function	3-keto sterol reductase activity
Gene Name	CBR3
Uniprot ID	O75828
Uniprot Name	Carbonyl reductase [NADPH] 3
Molecular Weight	30849.97 Da

References

1. Piska K, Koczurkiewicz P, Bucki A, Wojcik-Pszczola K, Kolaczkowski M, Pekala E: Metabolic carbonyl reduction of anthracyclines - role in cardiotoxicity and cancer resistance. Reducing enzymes as putative targets for novel cardioprotective and chemosensitizing agents. Invest New Drugs. 2017 Jun;35(3):375-385. doi: 10.1007/s10637-017-0443-2. Epub 2017 Mar 10. [Article]

TRANSPORTERS

1. ATP-dependent translocase ABCB1

Binding Properties Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate Inhibitor Inducer
General Function	Translocates drugs and phospholipids across the membrane (PubMed:2897240, PubMed:35970996, PubMed:8898203, PubMed:9038218). Catalyzes the flop of phospholipids from the cytoplasmic to the exoplasmic leaflet of the apical membrane. Participates mainly to the flop of phosphatidylcholine, phosphatidylethanolamine, beta-D-glucosylceramides and sphingomyelins (PubMed:8898203). Energy-dependent efflux pump responsible for decreased drug accumulation in multidrug-resistant cells (PubMed:2897240, PubMed:35970996, PubMed:9038218)
Specific Function	Abc-type xenobiotic transporter activity

Gene Name	ABCB1
Uniprot ID	P08183
Uniprot Name	ATP-dependent translocase ABCB1
Molecular Weight	141477.255 Da

References

1. Zhou G, Kuo MT: Wild-type p53-mediated induction of rat mdr1b expression by the anticancer drug daunorubicin. J Biol Chem. 1998 Jun 19;273(25):15387-94. [Article]
2. Gao J, Murase O, Schowen RL, Aube J, Borchardt RT: A functional assay for quantitation of the apparent affinities of ligands of P-glycoprotein in Caco-2 cells. Pharm Res. 2001 Feb;18(2):171-6. [Article]
3. Polli JW, Wring SA, Humphreys JE, Huang L, Morgan JB, Webster LO, Serabjit-Singh CS: Rational use of in vitro P-glycoprotein assays in drug discovery. J Pharmacol Exp Ther. 2001 Nov;299(2):620-8. [Article]
4. Tang F, Horie K, Borchardt RT: Are MDCK cells transfected with the human MDR1 gene a good model of the human intestinal mucosa? Pharm Res. 2002 Jun;19(6):765-72. [Article]
5. Takara K, Tanigawara Y, Komada F, Nishiguchi K, Sakaeda T, Okumura K: Cellular pharmacokinetic aspects of reversal effect of itraconazole on P-glycoprotein-mediated resistance of anticancer drugs. Biol Pharm Bull. 1999 Dec;22(12):1355-9. [Article]
6. Tang F, Ouyang H, Yang JZ, Borchardt RT: Bidirectional transport of rhodamine 123 and Hoechst 33342, fluorescence probes of the binding sites on P-glycoprotein, across MDCK-MDR1 cell monolayers. J Pharm Sci. 2004 May;93(5):1185-94. [Article]
7. Adachi Y, Suzuki H, Sugiyama Y: Comparative studies on in vitro methods for evaluating in vivo function of MDR1 P-glycoprotein. Pharm Res. 2001 Dec;18(12):1660-8. [Article]
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9. Takara K, Sakaeda T, Kakumoto M, Tanigawara Y, Kobayashi H, Okumura K, Ohnishi N, Yokoyama T: Effects of alpha-adrenoceptor antagonist doxazosin on MDR1-mediated multidrug resistance and transcellular transport. Oncol Res. 2009;17(11-12):527-33. [Article]
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11. Perez-Victoria JM, Chiquero MJ, Conseil G, Dayan G, Di Pietro A, Barron D, Castanys S, Gamarro F: Correlation between the affinity of flavonoids binding to the cytosolic site of Leishmania tropica multidrug transporter and their efficiency to revert parasite resistance to daunomycin. Biochemistry. 1999 Feb 9;38(6):1736-43. [Article]
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13. Chiodini B, Bassan R, Barbui T: Cellular uptake and antiproliferative effects of therapeutic concentrations of idarubicin or daunorubicin and their alcohol metabolites, with or without cyclosporin A, in MDR1+ human leukemic cells. Leuk Lymphoma. 1999 May;33(5-6):485-97. [Article]
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2. Multidrug resistance-associated protein 1

Binding Properties | Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate, Inhibitor
General Function	Mediates export of organic anions and drugs from the cytoplasm (PubMed:10064732, PubMed:11114332, PubMed:16230346, PubMed:7961706, PubMed:9281595). Mediates ATP-dependent transport of glutathione and glutathione conjugates, leukotriene C4, estradiol-17-beta-o-glucuronide, methotrexate, antiviral drugs and other xenobiotics (PubMed:10064732, PubMed:11114332, PubMed:16230346, PubMed:7961706, PubMed:9281595). Confers resistance to anticancer drugs by decreasing accumulation of drug in cells, and by mediating ATP- and GSH-dependent drug export (PubMed:9281595). Hydrolyzes ATP with low efficiency (PubMed:16230346). Catalyzes the export of sphingosine 1-phosphate from mast cells independently of their degranulation (PubMed:17050692). Participates in inflammatory response by allowing export of leukotriene C4 from leukotriene C4-synthezing cells (By similarity). Mediates ATP-dependent, GSH-independent cyclic GMP-AMP (cGAMP) export (PubMed:36070769). Thus, by limiting intracellular cGAMP concentrations negatively regulates the cGAS-STING pathway (PubMed:36070769)
Specific Function	Abc-type glutathione s-conjugate transporter activity
Gene Name	ABCC1
Uniprot ID	P33527
Uniprot Name	Multidrug resistance-associated protein 1
Molecular Weight	171589.5 Da

References

1. Loe DW, Almquist KC, Cole SP, Deeley RG: ATP-dependent 17 beta-estradiol 17-(beta-D-glucuronide) transport by multidrug resistance protein (MRP). Inhibition by cholestatic steroids. J Biol Chem. 1996 Apr 19;271(16):9683-9. [Article]
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12. Evers R, Kool M, Smith AJ, van Deemter L, de Haas M, Borst P: Inhibitory effect of the reversal agents V-104, GF120918 and Pluronic L61 on MDR1 Pgp-, MRP1- and MRP2-mediated transport. Br J Cancer. 2000 Aug;83(3):366-74. [Article]
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3. ATP-binding cassette sub-family C member 10

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate
General Function	ATP-dependent transporter of the ATP-binding cassette (ABC) family that actively extrudes physiological compounds, and xenobiotics from cells. Lipophilic anion transporter that mediates ATP-dependent transport of glucuronide conjugates such as estradiol-17-beta-o-glucuronide and GSH conjugates such as leukotriene C4 (LTC4) (PubMed:12527806, PubMed:15256465). May contribute to regulate the transport of organic compounds in testes across the blood-testis-barrier (Probable). Mediates multidrug resistance (MDR) in cancer cells by preventing the intracellular accumulation of certain antitumor drugs, such as, docetaxel and paclitaxel (PubMed:15256465, PubMed:23087055). Does not transport glycocholic acid, taurocholic acid, MTX, folic acid, cAMP, or cGMP (PubMed:12527806)
Specific Function	Abc-type glutathione s-conjugate transporter activity
Gene Name	ABCC10
Uniprot ID	Q5T3U5
Uniprot Name	ATP-binding cassette sub-family C member 10
Molecular Weight	161627.375 Da

References

1. Hopper-Borge E, Xu X, Shen T, Shi Z, Chen ZS, Kruh GD: Human multidrug resistance protein 7 (ABCC10) is a resistance factor for nucleoside analogues and epothilone B. Cancer Res. 2009 Jan 1;69(1):178-84. doi: 10.1158/0008-5472.CAN-08-1420. [Article]

4. Broad substrate specificity ATP-binding cassette transporter ABCG2

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate
General Function	Broad substrate specificity ATP-dependent transporter of the ATP-binding cassette (ABC) family that actively extrudes a wide variety of physiological compounds, dietary toxins and xenobiotics from cells (PubMed:11306452, PubMed:12958161, PubMed:19506252, PubMed:20705604, PubMed:28554189, PubMed:30405239, PubMed:31003562). Involved in porphyrin homeostasis, mediating the export of protoporphyrin IX (PPIX) from both mitochondria to cytosol and cytosol to extracellular space, it also functions in the cellular export of heme (PubMed:20705604, PubMed:23189181). Also mediates the efflux of sphingosine-1-P from cells (PubMed:20110355). Acts as a urate exporter functioning in both renal and extrarenal urate excretion (PubMed:19506252, PubMed:20368174, PubMed:22132962, PubMed:31003562, PubMed:36749388). In kidney, it also functions as a physiological exporter of the uremic toxin indoxyl sulfate (By similarity). Also involved in the excretion of steroids like estrone 3-sulfate/E1S, 3beta-sulfooxy-androst-5-en-17-one/DHEAS, and other sulfate conjugates (PubMed:12682043, PubMed:28554189, PubMed:30405239). Mediates the secretion of the riboflavin and biotin vitamins into milk (By similarity). Extrudes pheophorbide a, a phototoxic porphyrin catabolite of chlorophyll, reducing its bioavailability (By similarity). Plays an important role in the exclusion of xenobiotics from the brain (Probable). It confers to cells a resistance to multiple drugs and other xenobiotics including mitoxantrone, pheophorbide, camptothecin, methotrexate, azidothymidine, and the anthracyclines daunorubicin and doxorubicin, through the control of their efflux (PubMed:11306452, PubMed:12477054, PubMed:15670731, PubMed:18056989, PubMed:31254042). In placenta, it limits the penetration of drugs from the maternal plasma into the fetus (By similarity). May play a role in early stem cell self-renewal by blocking differentiation (By similarity)
Specific Function	Abc-type xenobiotic transporter activity
Gene Name	ABCG2
Uniprot ID	Q9UNQ0
Uniprot Name	Broad substrate specificity ATP-binding cassette transporter ABCG2
Molecular Weight	72313.47 Da

References

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2. Ozvegy C, Litman T, Szakacs G, Nagy Z, Bates S, Varadi A, Sarkadi B: Functional characterization of the human multidrug transporter, ABCG2, expressed in insect cells. Biochem Biophys Res Commun. 2001 Jul 6;285(1):111-7. [Article]
3. Nakanishi T, Doyle LA, Hassel B, Wei Y, Bauer KS, Wu S, Pumplin DW, Fang HB, Ross DD: Functional characterization of human breast cancer resistance protein (BCRP, ABCG2) expressed in the oocytes of Xenopus laevis. Mol Pharmacol. 2003 Dec;64(6):1452-62. [Article]

5. ATP-binding cassette sub-family C member 6

Details

Kind	Protein
Organism	Humans
Pharmacological action	Unknown
Actions	Substrate

General Function	ATP-dependent transporter of the ATP-binding cassette (ABC) family that actively extrudes physiological compounds, and xenobiotics from cells. Mediates ATP-dependent transport of glutathione conjugates such as leukotriene-c4 (LTC4) and N-ethylmaleimide S-glutathione (NEM-GS) (in vitro), and an anionic cyclopentapeptide endothelin antagonist, BQ-123 (PubMed:11880368, PubMed:12414644). May contribute to regulate the transport of organic compounds in testes across the blood-testis-barrier (Probable). Does not appear to actively transport drugs outside the cell. Confers low levels of cellular resistance to etoposide, teniposide, anthracyclines and cisplatin (PubMed:12414644)
Specific Function	Abc-type glutathione s-conjugate transporter activity
Gene Name	ABCC6
Uniprot ID	O95255
Uniprot Name	ATP-binding cassette sub-family C member 6
Molecular Weight	164904.81 Da

References

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Drug created at June 13, 2005 13:24 / Updated at September 23, 2024 07:25