Critical Reviews in Biochemistry and Molecular Biology ›
Volume 30, 1995 - Issue 6

Research Article

The Glut athione S-Transferase Supergene Family: Regulation of GST and the Contribution of the lsoenzymes to Cancer Chemoprotection and Drug Resistance Part I

John D. Hayes & David J. Pulford

Pages 445-520 | Published online: 26 Sep 2008

Cite this article https://doi.org/10.3109/10409239509083491

References Citations Metrics Reprints & Permissions Read this article

Abstract

The glut ion enzymes ound GST isoenzyr binding properti ted gene families e mem , are enco GST. Evidence etermining the sens the biochem mes contribu llutants, and products of oxidative stress.

A description of the mechanisms of transcriptional and posttranscriptional regulation of GST isoenzymes is provided to allow identification of factors that may modulate resistance to specific noxious chemicals. The most abundant mammalian GST are the class alpha, mu, and pi enzymes and their regulation has been studied in detail. The biological control of these families is complex as they exhibit sex-, age-, tissue-, species-, and tumor-specific patterns of expression. In addition, GST are regulated by a structurally diverse range of xenobiotics and, to date, at least 100 chemicals have been identified that induce GST; a significant number of these chemical inducers occur naturally and, as they are found as nonnutrient components in vegetables and citrus fruits, it is apparent that humans are likely to be exposed regularly to such compounds. Many inducers, but not all, effect transcriptional activation of GST genes through either the antioxidant-responsive element (ARE), the xenobiotic-responsive element (XRE), the GST P enhancer l(GPE), or the glucocorticoid-responsive element (GRE). Barbiturates may transcriptionally activate GST through a Barbie box element. The involvement of the Ah-receptor, Maf, Nrl, Jun, Fos, and NF-κB in GST induction is discussed. Many of the compounds that induce GST are themselves substrates for these enzymes, or are metabolized (by cytochrome P-450 monooxygenases) to compounds that can serve as GST substrates, suggesting that GST induction represents part of an adaptive response mechanism to chemical stress caused by electrophiles. It also appears probable that GST are regulated in vivoby reactive oxygen species (ROS), because not only are some of the most potent inducers capable of generating free radicals by redox-cycling, but H_2O_2has been shown to induce GST in plant and mammalian cells: induction of GST by ROS would appear to represent an adaptive respons and epoxide- .

Class alp reneoplastic nodules te to the multidru uman tumors and h l lines selec ass pi GST, althoug served. The mechani ctivation, stabiliza

In huma ss alpha, mu, and theta GST. The molecular basis for the variation in class alpha GST is not

known. Absence of certain class mu and theta GST can be attributed to deletion of the GSTMIgene in 50% of the population and deletion of the GSTTIgene in 16% of the population. The biological consequences of failure to express hGSTMI or hGSTTI protein can include susceptibility to bladder, colon, skin, and possibly lung cancer.

Key Words: glutathione S-transferases chemoprotection enzyme induction adaptive response antioxidants drug resistance population polymorphisms carcinogenesis.

Biotransformation of methyl isocyanate in the rat. Evidence for glutathione conjugation as a major pathway of metabolism and implications for isocyanate-mediated toxicities.
Source: American Chemical Society (ACS)
Tissue-specific induction of intestinal glutathione S-transferases by αβ-unsaturated carbonyl compounds
Source: Springer Science and Business Media LLC
The Ontogeny of Human Drug-Metabolizing Enzymes: Phase II Conjugation Enzymes and Regulatory Mechanisms
Source: American Society for Pharmacology & Experimental Therapeutics (ASPET)
Multiple hepatocyte-enriched nuclear factors function in the regulation of transthyretin and alpha 1-antitrypsin genes.
Source: American Society for Microbiology
Reversibility in Glutathione-Conjugate Formation
Source: Elsevier
Tissue distribution and subunit structures of the multiple forms of glutathione S-transferase in the rat
Source: Portland Press Ltd.
Regulation of glutathione S-transferase mRNAs by phenobarbital and 3-methylcholanthrene: analysis using cDNA probes
Source: Portland Press Ltd.
Biochemical effects of pure isomers of hexachlorobiphenyl -- hepatic microsomal epoxide hydrase and cytosolic glutathione S-transferase activities in the rat.
Source: Elsevier BV
Overexpression of a transporter gene in a multidrug-resistant human lung cancer cell line
Sourc
Purifi in
bacte
Sourc
Purifi
Cunn
S
In tible
and r
Sourc
Relev
susce
Sourc
Estrogen metabolism by conjugation.

Source: Oxford University Press (OUP)

Mouse glutathione S-transferase Ya subunit: gene structure and sequence.

Source: Mary Ann Liebert Inc

The mechanism of the reaction between glutathione and 1-menaphthyl sulphate catalysed by a glutathione S-transferase from rat liver.

Source: Portland Press Ltd.

Overview of Resistance to Systemic Therapy in Patients with Breast Cancer

Source: Springer New York

Elevation of glutathione-S-transferase activity as a stress response to organochlorine compounds, in the freshwater mussel, Sphaerium corneum

Source: Elsevier BV

The pharmacogenetics of chemical carcinogenesis.

Source: Ovid Technologies (Wolters Kluwer Health)

Stereoselective activation of vicinal dihalogen compounds to mutagens by glutathione conjugation.

Source: Elsevier BV

Tridiphane [2-(3,5-dichlorophenyl)-2-(2,2,2-trichloroethyl)oxirane] an atrazine synergist: Enzymatic conversion to a potent glutathione S-transferase inhibitor

Source: Elsevier BV

Differential induction of glutathione S-transferase subunits by phenobarbital, 3-methylcholanthrene and ethoxyquin in rat liver and kidney

Source: Elsevier BV

A Novel Membrane-bound Glutathione S-Transferase Functions in the Stationary Phase of the Yeast Saccharomyces cerevisiae

Source: American Society for Biochemistry & Molecular Biology (ASBMB)

Induction of Glutathione S-Transferase P-Form in Primary Cultured Rat Hepatocytes by Epide

Sourc

Gluta back

moth

Sourc

Metal

p enetic

po

Sourc

Max: ng

comp

Sourc

GST a

Source: Wiley

Expression and purification of the leucine zipper and DNA-binding domains of Fos and Jun: both Fos and Jun contact DNA directly.
Source: Proceedings of the National Academy of Sciences
Characterization of a novel α-class anionic glutathione S-transferase isozyme from human liver
Source: Elsevier BV
Effects of dietary clove in a high-fat diet/streptozotocin-induced diabetes rat model
Source: Wiley
Activity of mouse liver glutathione S-transferases toward trans,trans-muconaldehyde and trans-4-hydroxy-2-nonenal.
Source: Elsevier BV
Overexpression of Glutathione-S-Transferase, MGSTII, Confers Resistance to Busulfan and Melphalan
Source: Informa UK Limited
Allyl sulfur compounds and cellular detoxification system: effects and perspectives in cancer therapy
Source: Springer Science and Business Media LLC
An evolutionary perspective on glutathione transferases inferred from class-theta glutathione transferase cDNA sequences.
Source: Portland Press Ltd.
Glutathione S-transferases: Amino acid sequence comparison, classification and phylogenetic relationship
Source: Informa UK Limited
cis-platinum-mediated decrease in serum testosterone is associated with depression of luteinizing hormone receptors and cytochrome P-450scc in rat testis.
Source: The Endocrine Society
Ident
hydro
Sourc
Modif ons
betw ea of
stom
S
Th
leuco
Sourc
Aciflu ation of
homo
Sourc

The enzymatic conjugation of glutathione with bay-region diol-epoxides of benzo[a]pyrene, benz[a]anthracene and chrysene
Source: Oxford University Press (OUP)
Metabolic fate of the N,N-dialkylcarbamoyl moiety of thiocarbamate herbicides in rats and corn
Source: American Chemical Society (ACS)
Characterization of a novel glutathione S-transferase isoenzyme from mouse lung and liver having structural similarity to rat glutathione S-transferase 8-8
Source: Portland Press Ltd.
The development of glutathione S-transferase subunits in rat liver. Sensitive detection of the major subunit forms of rat glutathione S-transferase by using an e.l.i.s.a. method.
Source: Portland Press Ltd.
Molecular cloning and amino acid sequencing of rat liver class theta glutathione S-transferase Yrs-Yrs inactivating reactive sulfate esters of carcinogenic arylmethanols
Source: Elsevier BV
Effects of Copper Oxide Nanoparticles on Tissue Accumulation and Antioxidant Enzymes of Galleria mellonella L.
Source: Springer Science and Business Media LLC
System xc− and Thioredoxin Reductase 1 Cooperatively Rescue Glutathione Deficiency
Source: American Society for Biochemistry & Molecular Biology (ASBMB)
Glutathione S-transferase (transferase π) from human placenta is identical or closely related to glutathione S-transferase (transferase ϱ) from erythrocytes
Source: Elsevier BV
Biochemistry of multidrug resistance mediated by the multidrug transporter.
Source: Annual Reviews
A trip
Sourc
Struc S-
trans s with
the d
Sourc
H s mu
an
Sourc
Poter nst
carci
Sourc
Redox nzyme.
Source: Wiley

Developmental aspects of glutathione S-transferase B (ligandin) in rat liver.
Source: Portland Press Ltd.
Glutathione S-transferase subunits in the mouse and their catalytic activities towards reactive electrophiles.
Source: Springer Berlin Heidelberg
Chemical modification of rat liver microsomal glutathione transferase defines residues of importance for catalytic function.
Source: Portland Press Ltd.
Fifty years of benzo(a)pyrene
Source: Springer Science and Business Media LLC
Identification of volatile profiles of Rio Red grapefruit at various developmental to maturity stages
Source: Informa UK Limited
Purification and characterization of three distinct glutathione transferases from mouse liver
Source: American Chemical Society (ACS)
Sulfotransferase (SULT) 1A1 polymorphic variants *1, *2, and *3 are associated with altered enzymatic activity, cellular phenotype, and protein degradation.
Source: American Society for Pharmacology & Experimental Therapeutics (ASPET)
A LIVER ENZYME THAT CONJUGATES SULFOBROMOPHTHALEIN SODIUM WITH GLUTATHIONE
Source: American Society for Clinical Investigation
ATP-dependent glutathione S-conjugate export pump in the vacuolar membrane of plants
Source: Springer Science and Business Media LLC
Effects of lindane treatment on drug metabolizing enzymes and liver weight of CF1 mice
Sourc
Meat
mas
and a
Sourc
Conju
d
si
er and
me
Sourc
Solut
lex with
its ta
Sourc
Gluta
Source: Wiley

Carcinogen metabolism genes, red meat and poultry intake, and colorectal cancer risk
Source: The University of North Carolina at Chapel Hill University Libraries
Changes in the composition of glutathione transferase subunits in rat liver after oral administration of Benzo[a]Pyrene
Source: Informa UK Limited
The human liver glutathione S-transferase gene superfamily: expression and chromosome mapping of an Hb subunit cDNA
Source: Oxford University Press (OUP)
Ligandin heterogeneity: Evidence that the two non-identical subunits are the monomers of two distinct proteins
Source: Elsevier BV
Glutathione S-Transferase Genotype polymorphism and Primary Open-Angle Glaucoma in an Italian population
Source: bioRxiv
Activation of NF-kappa B in vivo is regulated by multiple phosphorylations.
Source: Wiley
HIV-1 Vpr modulates macrophage metabolic pathways: a SILAC-based quantitative analysis.
Source: Public Library of Science (PLoS)
Olfactory-Related Quality of Life in Multiple Chemical Sensitivity: A Genetic-Acquired Factors Model.
Source: Multidisciplinary Digital Publishing Institute
The Role of Glutathione and Glutathione S-transferases in Plant Reaction and Adaptation to Xenobiotics
Source: Springer Netherlands
Glutathione S-transferase activities in rat liver: Effect of some factors influencing the meta
Sourc
Ampl -
encoc
Sourc
ATP-c
D ND A
VA
Sourc
Cause
Sourc
Pestic
Sourc

Polycyclic aromatic hydrocarbon-DNA adducts in smokers and their relationship to micronutrient levels and the glutathione-S-transferase M1 genotype.
Source: Oxford University Press (OUP)
Mechanism of Inhibition of CYP1A1 and Glutathione S-Transferase Activities in Fish Liver by Quercetin, Resveratrol, Naringenin, Hesperidin, and Rutin
Source: (:unav)
Mutations in Cu/Zn superoxide dismutase gene are associated with familial amyotrophic lateral sclerosis
Source: Springer Science and Business Media LLC
Novel theta class glutathione S-transferases Yrs-Yrs' and Yrs'-Yrs' in rat liver cytosol: their potent activity toward 5-sulfoxymethylchrysene, a reactive metabolite of the carcinogen 5-hydroxymethylchrysene.
Source: Elsevier BV
A DNA sequence of 15 base pairs is sufficient to mediate both glucocorticoid and progesterone induction of gene expression
Source: Proceedings of the National Academy of Sciences
In vitro degradation of some organophosphorus insecticides by susceptible and resistant diamondback moth
Source: Elsevier BV
Evidence that the Yb subunits of hepatic glutathione transferases represent two different but related families of polypeptides
Source: Wiley
Impacts of benzovindiflupyr on the embryonic development of zebrafish (Danio rerio)
Source: (:unav)
Multiple Canalicular Transport Mechanisms for Glutathione S-Conjugates TRANSPORT ON BOTH ATP- AND VOLTAGE-DEPENDENT CARRIERS
Sourc
Molec an Mu
class
Sourc
Propy din
(gluta
S
Inf
gluta
Sourc
Gene leate-
induc
Sourc

Denitrosation of the Anti-Cancer Drug 1,3-Bis(2-chloroethyl)-1-nitrosourea Catalyzed by Microsomal Glutathione S-Transferase and Cytochrome P450 Monooxygenases
Source: Elsevier BV
Gastroprotective and antioxidant effects of amiodarone on indomethacin-induced gastric ulcers in rats.
Source: Springer Science and Business Media LLC
The human glutathione S-transferases: a case-control study of the incidence of the GST1 0 phenotype in patients with adenocarcinoma.
Source: Oxford University Press (OUP)
Functional cooperativity between two TPA responsive elements in undifferentiated F9 embryonic stem cells.
Source: Wiley
Detoxification, Apoptosis, and Immune Transcriptomic Responses of the Gill Tissue of Bay Scallop Following Exposure to the Algicide Thiazolidinedione 49
Source: MDPI AG
Activity of rat liver microsomal glutathione transferase toward products of lipid peroxidation and studies of the effect of inhibitors on glutathione-dependent protection against lipid peroxidation.
Source: Elsevier BV
Polymorphism of Glutathione S-Transferase in Laboratory Rats
Source: Springer Science and Business Media LLC
Epoxidation of aflatoxin B1 by Aspergillus flavus microsomes in vitro: interaction with DNA and formation of aflatoxin B1-glutathione conjugate.
Source: Elsevier BV
Influence of chemotherapeutic drug-related gene polymorphisms on toxicity and survival of early breast cancer patients receiving adjuvant chemotherapy.
Sourc
Globa
Sourc
Nove
GLUT
Sourc
In
tilbene
ox
Sourc
Gluta
m
casta
Sourc
An Er
Source: Oxford University Press (OUP)

PHARMACOKINETICS AND PHARMACODYNAMICS OF CURCUMIN
Source: Springer US
Soybean metabolism of chlorimuron ethyl; physiological basis for soybean selectivity
Source: Elsevier BV
Interindividual differences in the in vitro conjugation of methylene chloride with glutathione by cytosolic glutathione S-transferase in 22 human liver samples
Source: Elsevier BV
Gene and Protein Characterization of the Human Glutathione S-Transferase Kappa and Evidence for a Peroxisomal Localization
Source: American Society for Biochemistry & Molecular Biology (ASBMB)
Identification and characterization of Ref-1, a nuclear protein that facilitates AP-1 DNA-binding activity.
Source: Wiley
Expression of the glutathione S-transferase placental form in human lung carcinomas.
Source: Oxford University Press (OUP)
Photoaffinity labeling of Arabidopsis thaliana plasma membrane vesicles by 5-azido-[7-3H]indole-3-acetic acid: identification of a glutathione S-transferase
Source: Proceedings of the National Academy of Sciences
Forward and reverse catalysis and product sequestration by human glutathione S-transferases in the reaction of GSH with dietary aralkyl isothiocyanates
Source: Portland Press Ltd.
Effects of derivatives of kahweol and cafestol on the activity of glutathione S-transferase in mice.
Source: American Chemical Society (ACS)
cDNA and deduced amino acid sequences of a human colon dihydrodiol dehydrogenase
Sourc
The r
muta
Sourc
Amin tic
differ
S
Gl the
risk o
Sourc
A pat S-
trans
Sourc
Drug focus: Pharmacogenetic studies related to cyclophosphamide-based therapy.

Source: Future Medicine Ltd

Structure of the human genomic glutathione S-transferase-π gene

Source: Elsevier BV

Regulation of glutathione S-transferase Ya subunit gene expression: identification of a unique xenobiotic-responsive element controlling inducible expression by planar aromatic compounds.

Source: Proceedings of the National Academy of Sciences

Biotransformation in Fishes

Source: CRC Press

Role of cysteine residues in the activity of rat glutathione transferase P (7-7): elucidation by oligonucleotide site-directed mutagenesis.

Source: Elsevier BV

Human intestinal glutathione S-transferases.

Source: Portland Press Ltd.

Functional Genomics of the Human Glutathione Transferases

Source: John Wiley & Sons, Inc.

The human Pi class glutathione transferase sequence at 12q13-q14 is a reverse-transcribed pseudogene.

Source: Elsevier BV

Purification and characterization of human muscle glutathione S-transferases: Evidence that glutathione S-transferase ζ corresponds to a locus distinct from GST1, GST2, and GST3

Source: Elsevier BV

FMISO accumulation in tumor is dependent on glutathione conjugation capacity in addition to hypoxic state

Source: Springer Science and Business Media LLC

Two a f the murin

Sourc

Activa er.

Sourc

Cellul

S

Cry

Sourc

Gluta ces in men

Sourc

II. Iso PGF2α and PGE2 from PGH2☆

Source: Elsevier BV

Effects of phenol on glutathione S-transferase expression and enzyme activity in Chironomus kiiensis larvae

Source: Springer Science and Business Media LLC

The human glutathione S-transferase P1-1 gene: modulation of expression by retinoic acid and insulin.

Source: Portland Press Ltd.

Molecular biology of the aromatic hydrocarbon (dioxin) receptor

Source: Elsevier BV

The effect of phenobarbital induction on glutathione conjugation of diazinon in susceptible and resistant house flies

Source: Elsevier BV

Cloning, sequencing and characterization of the human alpha glutathione S-transferase gene corresponding to the cDNA clone pGTH2.

Source: Portland Press Ltd.

Variation in the expression of Mu-class glutathione S-transferase isoenzymes from human skeletal muscle : evidence for the existence of heterodimers

Source: Portland Press Ltd.

Partial Purification and Characterization of Glutathione S-Transferases Involved in DDT Resistance from the Mosquito Anopheles gambiae

Source: Elsevier BV

Activation of microsomal glutathione S-transferase activity by sulfhydryl reagents

Source: Elsevier BV

Complex haplotypes of metabolizingGSTM1gene deletion harbors signatures of a selective sweep in East Asian populations

Source: Cold Spring Harbor Laboratory

Purifi u class.

Sourc

The r rd

Yume

Sourc

Revei n

G

So

Assoc

Sourc

Gluta ferase

isoen nd in

the ra

Source: Portland Press Ltd.

Cloning and expression of a cDNA encoding a maize glutathione-S-transferase in E. coli
Source: Oxford University Press (OUP)
Alteration of glutathione transferase isoenzyme concentrations in human renal carcinoma.
Source: Oxford University Press (OUP)
Protection by transfected glutathione S-transferase isozymes against carcinogen-induced alkylation of cellular macromolecules in human MCF-7 cells
Source: Oxford University Press (OUP)
A pilot study of pi-class glutathione S-transferase expression in breast cancer: correlation with estrogen receptor expression and prognosis in node-negative breast cancer.
Source: American Society of Clinical Oncology (ASCO)
Characterization of melphalan-glutathione adducts whose formation is catalyzed by glutathione transferases
Source: Elsevier BV
NUCLEOTIDE SEQUENCE OF THE YEAST GLUTATHIONE S-TRANSFERASE CDNA
Source: Elsevier BV
Investigations on the microbial catabolism of the organic sulfur compounds TDP and DTDP in Ralstonia eutropha H16 employing DNA microarrays.
Source: Springer Nature
Glutathione S-transferase M1 and T1 polymorphisms: susceptibility to colon cancer and age of onset.
Source: Oxford University Press (OUP)
Glutathione S-transferase activity and isoenzyme distribution in ovarian tumour biopsies taken before or after cytotoxic chemotherapy.
Source: Springer Science and Business Media LLC
Tissu effects
on ca
conju
Sourc
Vinyli relation
to its
S
Bio
trans
Sourc
Gluta t strain
of ho
Sourc
Glutathione transferase isoenzymes from human testis

Source: Elsevier BV

Isoelectric focusing of glutathione S-transferases from rat liver and kidney.

Source: Portland Press Ltd.

Effect of Xylocarpus granatum Bark Extract on Amelioration of Hyperglycaemia and Oxidative Stress Associated Complications in STZ-Induced Diabetic Mice.

Source: Hindawi Limited

Antioxidant activity and hepatoprotective potential of Cedrelopsis grevei on cypermethrin induced oxidative stress and liver damage in male mice

Source: Springer Science and Business Media LLC

Cloning and characterization of the major hepatic glutathione S-transferase from a marine teleost flatfish, the plaice (Pleuronectes platessa), with structural similarities to plant, insect and mammalian Theta class isoenzymes.

Source: Portland Press Ltd.

Mapping genes encoding drug-metabolizing enzymes in recombinant inbred mice.

Source: Elsevier BV

Variations in the glutathione S-transferase subunits expressed in human livers.

Source: Elsevier BV

Purified transcription factor AP-1 interacts with TPA-inducible enhancer elements

Source: Elsevier BV

Expression of recombinant glutathione S-transferase pi, Ya, or Yb1 confers resistance to alkylating agents

Source: Proceedings of the National Academy of Sciences

Genetics of xenobiotic metabolism in Drosophila. I. Genetic and environmental factors affecting glutathione-S-transferase in larvae.

Source: Elsevier BV

Drug resistance in cultured rat liver epithelial cells spontaneously and chemically trans

Sourc

Expre) in HNC

Sourc

Molec MAPK c

So

CHAR MA-CLAS

Sourc

Purifi

gluta or marker.

Source: Elsevier BV

JNK1: A protein kinase stimulated by UV light and Ha-Ras that binds and phosphorylates the c-Jun activation domain

Source: Elsevier BV

The role of Barbie box sequences as cis-acting elements involved in the barbiturate-mediated induction of cytochromes P450BM-1 and P450BM-3 in Bacillus megaterium.

Source: Elsevier BV

Identification of an anion-transport ATPase that catalyzes glutathione conjugate-dependent ATP hydrolysis in canalicular plasma membranes from normal rats and rats with conjugated hyperbilirubinemia (GY mutant).

Source: Elsevier BV

Cloning, expression, and characterization of a class-mu glutathione transferase from human muscle, the product of the GST4 locus.

Source: Proceedings of the National Academy of Sciences

Purification and properties of housefly glutathione S-transferase

Source: Elsevier BV

Biochemical effects of dithiolthiones.

Source: Elsevier BV

Glutathione S-transferase P1 Ile105Val polymorphism and breast cancer risk: a meta-analysis involving 34,658 subjects.

Source: Springer Science and Business Media LLC

Analysis of the transcriptome data in Litopenaeus vannamei reveals the immune basis and predicts the hub regulation-genes in response to high-pH stress

Source: Public Library of Science (PLoS)

The effect of ω-3 polyunsaturated fatty acids on the liver lipidome, proteome and bile acid profile: parenteral versus enteral administration.

Sourc

Mech GST)

gene

Sourc

Huma

chara

S

Mu on by

antic en as

induc

Sourc

In vit nition

Sourc

Isolation of the human anionic glutathione S-transferase cDNA and the relation of its gene expression to estrogen-receptor content in primary breast cancer.
Source: Proceedings of the National Academy of Sciences
Liver glutathione S-transferase polymorphism in Japanese and its pharmacogenetic importance.
Source: Springer Science and Business Media LLC
□□□□□□□□□□□□□□□□□□□□ in vitro □□□□□□□□□□
Source: Pesticide Science Society of Japan
Role of metallothionein in zinc(II) and chromium(III) mediated tolerance to carbon tetrachloride hepatotoxicity: evidence against a trichloromethyl radical-scavenging mechanism.
Source: American Chemical Society (ACS)
Expression of Glutathione S-Transferase-π in Human Ovarian Cancer as an Indicator of Resistance to Chemotherapy
Source: Elsevier BV
Aflatoxins in aquatic species: metabolism, toxicity and perspectives
Source: Springer Science and Business Media LLC
Enzymatic conjugation of chlorambucil with glutathione by human glutathione S-transferases and inhibition by ethacrynic acid.
Source: Elsevier BV
Role of a mitogen-activated protein kinase pathway in the induction of phase II detoxifying enzymes by chemicals.
Source: American Society for Biochemistry & Molecular Biology (ASBMB)
The contribution of the C-terminal sequence to the catalytic activity of GST2, a human Alpha-class glutathione transferase
Source: Portland Press Ltd.
React ctivation
of the
Sourc
The e
Sourc
Gluta
S
Re
Sourc
Gluta
syner
Sourc
Inhibi Van
Lake fish liver

Source: Wiley

The effects of selenium and copper deficiencies on glutathione S-transferase and glutathione peroxidase in rat liver.

Source: Portland Press Ltd.

Genetic Polymorphisms of Glutathione S-Transferase Genes GSTM1, GSTT1 and Risk of Hepatocellular Carcinoma

Source: Public Library of Science (PLoS)

Quantification of human hepatic glutathione S-transferases.

Source: Portland Press Ltd.

Transformation of rat liver epithelial cells with v-H-ras or v-raf causes expression of MDR-1, glutathione-S-transferase-P and increased resistance to cytotoxic chemicals.

Source: Oxford University Press (OUP)

Establishing the Borderlines of Risk

Source: Springer US

Cyclopentenone Prostaglandins as Potential Inducers of Phase II Detoxification Enzymes 15-DEOXY-Δ12,14-PROSTAGLANDIN J2-INDUCED EXPRESSION OF GLUTATHIONE S-TRANSFERASES

Source: American Society for Biochemistry & Molecular Biology (ASBMB)

The myoD gene family: nodal point during specification of the muscle cell lineage

Source: American Association for the Advancement of Science (AAAS)

Evidence for cytosolic glutathione transferase-mediated denitrosation of nitrosocimetidine and 1-methyl-2-nitro-1-nitrosoguanidine.

Source: Oxford University Press (OUP)

Glutathione transferase isoenzymes from Bufo bufo embryos at an early developmental stage.

Source: Portland Press Ltd.

Gluta

Egypt

Sourc

Detox

Sourc

Gluta

tr

So

Contr

isozy

Sourc

The A

Sourc

The role of glutathione and glutathione S-transferases in the metabolism of chemical carcinogens and other electrophilic agents.
Source: Elsevier
Effects of indole-3-carbinol on biotransformation enzymes in the rat: in vivo changes in liver and small intestinal mucosa in comparison with primary hepatocyte cultures.
Source: Elsevier BV
Characterization of cysteine residues of glutathione S-transferase P: evidence for steric hindrance of substrate binding by a bulky adduct to cysteine 47.
Source: Elsevier BV
in vitro metabolism of azinphosmethyl in susceptible and resistant houseflies
Source: Elsevier BV
Glutathione S-transferase Ya subunit gene: identification of regulatory elements required for basal level and inducible expression.
Source: Proceedings of the National Academy of Sciences
Glutathione conjugation : a detoxification pathway for fenoxaprop-ethyl in barley, crabgrass, oat, and wheat
Source: Elsevier BV
Insecticide metabolism by multiple glutathione S-transferases in two strains of the house fly, Musca domestica (L)
Source: Elsevier BV
Comparison of the biotransformation of 1,3-butadiene and its metabolite, butadiene monoepoxide, by hepatic and pulmonary tissues from humans, rats and mice.
Source: Oxford University Press (OUP)
Strategies of antioxidant defense
Source: Elsevier BV
Melatonin ameliorates sodium valproate-induced hepatotoxicity in rats
Sourc
The c
dichl
Sourc
Effec uced
neop
S
At ced
Gluta
Sourc
Prote
Sourc
Struc genes
and related pseudogenes.

Source: Elsevier BV

Antioxidant Therapeutic Defenses Toward Redox Biology and Oxidative Stress

Source: Springer International Publishing

Correlation of azinphosmethyl resistance with detoxication enzyme activity in the light brown apple moth Epiphyas postvittana (Lepidoptera: Tortricidae)

Source: Elsevier BV

Forced evolution of glutathione S-transferase to create a more efficient drug detoxication enzyme.

Source: Proceedings of the National Academy of Sciences

Nucleotide sequence and intracellular location of the product of the fosfomycin resistance gene from transposon Tn2921.

Source: American Society for Microbiology

Genetic polymorphisms in CYP1A1, GSTM1, GSTP1 and GSTT1 metabolic genes and risk of lung cancer in Asturias.

Source: Springer Nature

A new role for phospholipase A2: protection of membranes from lipid peroxidation damage

Source: Elsevier BV

Possible function of Ah receptor nuclear translocator (Arnt) homodimer in transcriptional regulation.

Source: Proceedings of the National Academy of Sciences

Effects of the oxidative stress and genetic changes in varicose vein patients.

Source: SAGE Publications

v-maf, a viral oncogene that encodes a "leucine zipper" motif

Source: Proceedings of the National Academy of Sciences

Effect of the glutathione S-transferase inhibitor, tienilic acid, on biliary excretion of sulph

Sourc

The r ate

tumo

Sourc

Syne se fly

b

So

ATP-d product

of the

Sourc ET)

Roles

Sourc

Derived esterase activity in Drosophila sechellia contributes to evolved octanoic acid resistance.
Source: Wiley
Trimodal GSTT1 and GSTM1 Genotyping Assay by Real-Time PCR
Source: SAGE Publications
The MAPK signaling cascade.
Source: Wiley
Cloning and expression of a chick liver glutathione S-transferase CL 3 subunit with the use of a baculovirus expression system.
Source: Portland Press Ltd.
GSTM1 null polymorphism at the glutathione S-transferase M1 locus: phenotype and genotype studies in patients with primary biliary cirrhosis.
Source: BMJ
Mercapturic acid formation in the metabolism of propachlor, CDAA, and fluorodifen in the rat
Source: Elsevier BV
Dietary pesticides (99.99% all natural).
Source: Proceedings of the National Academy of Sciences
The mutagenic effect of 1,2-dichloroethane on Salmonella typhimurium I. Activation through conjugation with glutathion in vitro
Source: Elsevier BV
Bile acid inhibition of basic and neutral glutathione S-transferases in rat liver.
Source: Portland Press Ltd.
Effect of butylated hydroxytoluene on glutathione S-transferase and glutathione peroxidase activities in rat liver
Source: Elsevier BV
Resis o.
Sourc
Molec
Sourc
Isolat
trans
S
Im n the
latera
Sourc
A Rev
Sourc
Signif of the α μ and π classes

Source: Informa UK Limited

Formation and Fate of Nephrotoxic and Cytotoxic Glutathione S-Conjugates: Cysteine Conjugate β-Lyase Pathway

Source: Elsevier

Identification and Functional Characterization of Two Sigma Glutathione S-Transferase Genes From Bird Cherry-Oat Aphid (Hemiptera: Aphididae).

Source: Oxford University Press (OUP)

Oxidative stress and immunity in ADHD

Source: Wiley

Evidence that DDT-dehydrochlorinase from the house fly is a glutathione S-transferase

Source: Elsevier BV

Dichloroacetamide antidotes enhance thiocarbamate sulfoxide detoxification by elevating corn root glutathione content and glutathione S-transferase activity☆

Source: Elsevier BV

The basic glutathione S-transferases from human livers are products of separate genes.

Source: Elsevier BV

Ameliorative role of zinc on cypermethrin-induced changes in haematological parameters and oxidative stress biomarkers in rat erythrocytes

Source: Springer Science and Business Media LLC

Sirodesmin biosynthetic gene cluster

Source: Wiley

Structural analysis of a rat liver glutathione S-transferase Ya gene.

Source: Proceedings of the National Academy of Sciences

Comparative analysis of glutathione transferase genetic polymorphism, Helicobacter pylori and Epstein-Barr virus between the tumor area and the proximal and distal resec

Sourc

The p

Sourc

The c rases in

huma

S

Fo active

site o omplex

interr

Sourc

Induc otes

Sourc

Characterization of a human class-Theta glutathione S-transferase with activity towards 1-menaphthyl sulphate
Source: Portland Press Ltd.
Autoregulation plus upstream positive and negative control regions associated with transcriptional activation of the mouse P1450 gene
Source: Oxford University Press (OUP)
K region benzo (alpha) pyrene-4,5-oxide is conjugated by homogeneous gluthathione S-transferases.
Source: Springer Science and Business Media LLC
Glutathione transferase from human erythrocytes. Nonidentity with the enzymes from liver.
Source: Elsevier BV
Characterization of the basic glutathione S-transferase B1 and B2 subunits from human liver.
Source: Portland Press Ltd.
Role of glutathione S-transferases in protection against lipid peroxidation.
Overexpression of hGSTA2-2 in K562 cells protects against hydrogen peroxide-induced apoptosis and inhibits JNK and caspase 3 activation.
Source: American Society for Biochemistry & Molecular Biology (ASBMB)
Methylene chloride-induced DNA damage: an interspecies comparison.
Source: Oxford University Press (OUP)
Identification of a common chemical signal regulating the induction of enzymes that protect against chemical carcinogenesis
Source: Proceedings of the National Academy of Sciences
Expression of mammalian glutathione S-transferase 5-5 in Salmonella typhimurium TA1535 leads to base-pair mutations upon exposure to dihalomethanes
Sourc
Activi es of
Non-S
Sourc
Gluta ment.
Sourc
D
So
Assay
Sourc
Inorg and
bioac pix and
Agass
Source: Springer Science and Business Media LLC

The Interaction between GSTT1 , GSTM1 , and GSTP1 Ile105Val Gene Polymorphisms and Environmental Risk Factors in Premalignant Gastric Lesions Risk.
Source: Hindawi Limited
Plant phenols as invitro inhibitors of glutathione S-transferase(s)
Source: Elsevier BV
Purification and properties of the mediterranean fruit fly Ceratitis capitata W. glutathione S-transferase
Source: Elsevier BV
5α,6α-Epoxy-cholestan-3β-ol (cholesterol α-oxide): A specific substrate for rat liver glutathione transferase B
Source: Published by Elsevier B.V.
Molecular cloning and heterologous expression of a cDNA encoding a mouse glutathione S-transferase Yc subunit possessing high catalytic activity for aflatoxin B1-8,9-epoxide.
Source: Portland Press Ltd.
Evidence for the metabolism of mitozantrone by microsomal glutathione transferases and 3-methylcholanthrene-inducible glucuronosyl transferases.
Source: Elsevier BV
Class π glutathione S-transferase from pig lung
Source: Wiley
Monomeric Camelus dromedarius GSTM1 at low pH is structurally more thermostable than its native dimeric form
Source: Public Library of Science (PLoS)
Sex-dependent expression and growth hormone regulation of class alpha and class mu glutathione S-transferase mRNAs in adult rat liver.
Source: Portland Press Ltd.
Struc g
prote
Sourc
Metal s.
Sourc
Analy
p
So
Comp
trans
Sourc
The t ne
class ne at
2.2-A resolution.

Source: American Chemical Society (ACS)

The GSTM1 null genotype as a potential risk modifier for squamous cell carcinoma of the lung

Source: Oxford University Press (OUP)

Soluble glutathione transferase isoenzymes in Daphnia magna straus and their interaction with 2,4-dichlorophenoxyacetic acid and 1,4-benzoquinone

Source: Elsevier BV

Glutathione transferases as markers of preneoplasia and neoplasia.

Source: Elsevier

Suppression of glutathione transferase P expression by glucocorticoid.

Source: Elsevier BV

Selectivity of metal bioaccumulation and its relationship with glutathione S-transferase levels in gonadal and gill tissues of Mytilus galloprovincialis exposed to Ni (II), Cu (II) and Cd (II)

Source: Springer Science and Business Media LLC

Phorbol ester-inducible genes contain a common cis element recognized by a TPA-modulated trans-acting factor.

Source: Elsevier BV

Identification of neurons involved in the earthworm Amynthas hawayanus reflex activity

Source: Elsevier BV

MafB, a new Maf family transcription activator that can associate with Maf and Fos but not with Jun.

Source: American Society for Microbiology

Purification and characterization of three forms of glutathione S-transferase A. A comparative study of the major YaYa-, YbYb- and YcYc-containing glutathione S-trans

Sourc

Site-d Cys-47 induc

Sourc

Metal vage of fl

So

Role r in maize

Sourc

The C ed on 46 st

Source: Public Library of Science (PLoS)

Characterization of a Flavobacterium glutathione S-transferase gene involved reductive dechlorination.
Source: American Society for Microbiology
Characterization of two novel subunits of the α-class glutathione S-transferases of human liver
Source: Elsevier BV
Activity and Expression of Murine Small Maf Family Protein MafK (
Source: Elsevier BV
Studies on the mechanism of azinphosmethyl resistance in the predaceous mite, Neoseiulus (T.) fallacis (family: Phytoseiidae)
Source: Elsevier BV
Chromosomal assignments of genes for rat glutathione S-transferase Ya (GSTA1) and Yc summits (GSTA2)
Source: S. Karger AG
Adrenocorticotrophic-hormone-dependent regulation of a mu-class glutathione transferase in mouse adrenocortical cells.
Source: Portland Press Ltd.
Predicting the cytochrome P450 mediated metabolism of xenobiotics
Source: Ovid Technologies (Wolters Kluwer Health)
H2O2 from the oxidative burst orchestrates the plant hypersensitive disease resistance response
Source: Elsevier BV
Contribution of five amino acid residues in the glutathione-binding site to the function of human glutathione transferase P1-1.
Source: Portland Press Ltd.
Microsomal glutathione transferase. Purification in unactivated form and further chara
comp
Sourc
Effect After
its Or
Sourc
P
ac
Sourc
Inhibi ferases.
Sourc
Carci d other
antio
Source: Informa UK Limited

The separation of glutathione transferase subunits by using reverse-phase high-pressure liquid chromatography.
Source: Portland Press Ltd.
Cloning and the nucleotide sequence of rat glutathione S-transferase P cDNA
Source: Oxford University Press (OUP)
Isolation and characterization of a human glutathione S-transferase Ha1 subunit gene.
Source: Elsevier BV
Metabolism of Natural and Xenobiotic Substrates by the Plant Glutathione S-Transferase Superfamily
Source: Springer Berlin Heidelberg
Multiple Forms of Human Glutathione S-Transferase and Their Affinity for Bilirubin
Source: Wiley
Enhancement of bacterial mutagenicity of bifunctional alkylating agents by expression of mammalian glutathione S-transferase.
Source: American Chemical Society (ACS)
Nucleotide sequence of a class μ glutathione S-transferase from chicken liver
Source: Elsevier BV
Purification to homogeneity and the N-terminal sequence of human leukotriene C4 synthase: a homodimeric glutathione S-transferase composed of 18-kDa subunits.
Source: Proceedings of the National Academy of Sciences
Increased constitutive c-Jun N-terminal kinase signaling in mice lacking glutathione S-transferase Pi.
Source: American Society for Biochemistry & Molecular Biology (ASBMB)
Dissection of metabolic pathways in the Db/Db mouse model by integrative proteome and acetylome analysis
Source: Royal Society of Chemistry (RSC)
Ident everal
mam ties.
Sourc
Gluta
Sourc
Sex-s
tr
So
Theta rvical
neopl
Sourc
A nov ase and
doubl
Source: Springer Science and Business Media LLC

In Vitro Effects of Some Antibiotics on Glutathione Reductase from Sheep Liver
Source: Informa UK Limited
NOMENCLATURE FOR HUMAN GLUTATHIONE TRANSFERASES
Source: Portland Press Ltd.
The conjugation of 4-nitroquinoline 1-oxide, a potent carcinogen, by mammalian glutathione transferases. 4-Nitroquinoline 1-oxide conjugation by human, rat and mouse liver cytosols, extrahepatic organs of mice and purified mouse glutathione transferase isoenzymes.
Source: Portland Press Ltd.
VI. The dechlorination of ?-hexachlorocyclohexane by microsomes and cytosol of rat liver
Source: Springer Science and Business Media LLC
Polymorphism of glutathione conjugation of methyl bromide, ethylene oxide and dichloromethane in human blood: Influence on the induction of sister chromatid exchanges (SCE) in lymphocytes
Source: Springer Science and Business Media LLC
Immunodetection with a monoclonal antibody of glutathione S-transferase mu in patients with and without carcinomas.
Source: Elsevier BV
Pulmonary pressure reduction attenuates expression of proteins identified by lung proteomic profiling in pulmonary hypertensive rats.
Source: Wiley
Phenobarbital induction of AP-1 binding activity mediates activation of glutathione S-transferase and quinone reductase gene expression
Source: Portland Press Ltd.
Oxidative stress in mitochondria
Sourc
The E
Sourc
Purifi ion
from it
hybri
S
St thyl-1,2-
Dihyc
Sourc
Chron A3) and
Yb2 (
Sourc
Cytosolic epoxide hydrolase.

Source: Elsevier BV

Participation of the phenolic hydroxyl group of Tyr-8 in the catalytic mechanism of human glutathione transferase P1-1.

Source: Portland Press Ltd.

The isolation of a fetal rat liver glutathione S-transferase isoenzyme with high glutathione peroxidase activity

Source: Elsevier BV

A subgroup of class α glutathione S-transferases Cloning of cDNA for mouse lung glutathione S-transferase GST 5.7

Source: Wiley

Effect of herbicide antidotes on glutathione content and glutathione S-transferase activity of sorghum shoots

Source: Elsevier BV

A pleiotropic response to phenobarbital-type enzyme inducers in the F344/NCr rat. Effects of chemicals of varied structure.

Source: Elsevier BV

GSTA4 protects renal fibrosis

Source: Wiley

The three-dimensional structure of class pi glutathione S-transferase in complex with glutathione sulfonate at 2.3 A resolution.

Source: Wiley

PLLA-PCys co-electrospun fibers for capture and elution of glutathione S-transferase

Source: Springer Science and Business Media LLC

ANALYSIS OF THE GLUTATHIONE S-TRANSFERASE (GST) GENE FAMILY

Source: Springer Science and Business Media LLC

Overexpression of centrosomal protein Nlp confers breast carcinoma resistance to paclit

Sourc

Increa STM1 genot

Sourc

The i

d

So

Huma ubunit cDNA

Sourc

Kinet the rat

Sourc

Effects of lead administration on developing rat kidney. I. Glutathione S-transferase isoenzymes.
Source: Elsevier BV
Identification, characterization, and crystal structure of the Omega class glutathione transferases.
Source: American Society for Biochemistry & Molecular Biology (ASBMB)
Copy Number Variation In Gluthatione S-Transferase Variants Using Multiplex Ligation-Dependent Probe Amplification In A Health Population In Goiânia – GO.
Source: Cold Spring Harbor Laboratory
A major inducer of anticarcinogenic protective enzymes from broccoli: isolation and elucidation of structure.
Source: Proceedings of the National Academy of Sciences
Brain Protection at the Blood–Cerebrospinal Fluid Interface Involves a Glutathione-Dependent Metabolic Barrier Mechanism:
Source: SAGE Publications
Effects of hyperbilirubinaemia on glutathione S-transferase isoenzymes in cerebellar cortex of the Gunn rat
Source: Portland Press Ltd.

Related research