

REFERENCES

- Adra CN, Mao XQ, Kawada H, Gao PS, Korzycka B, Donate JL, Shaldon SR, Coull P, Dubowitz M, Enomoto T, Ozawa A, Syed SA, Horiuchi T, Khaeraja R, Khan R, Lin SR, Flinter F, Beales P, Hagihara A, Inoko H, Shirakawa T, Hopkin JM. Chromosome 11q13 and atopic asthma. *Clin Genet* 1999; 55: 431-7.
- Ali-Osman F, Akande O, Antoun G, Mao JX and Boulamwini L. Molecular cloning, characterization, and expression in *Escherichia coli* of full-length cDNAs of three human glutathione S-transferase Pi gene variants. Evidence for differential catalytic activity of the encoded proteins. *J Biol Chem* 1997; 272: 10004-12.
- Allan JM, Wild CP, Rollinson S, Willett EV, Moorman AV, Dovey GJ, Roddam PL, Roman E, Cartwright RA, Morgan GJ. Polymorphism in glutathione S-transferase P1 is associated with susceptibility to chemotherapy-induced leukemia. *Proc Natl Acad Sci U S A* 2001; 98: 11592-7.
- Armstrong RN. Structure, catalytic mechanism, and evolution of the glutathione transferase. *Chem Res Toxicol* 1997; 10: 2-18.
- Armstrong RN, Rife C, Wang Z. Structure, mechanism and evolution of thiol transferases. *Chem Biol Interact* 2001; 133: 167-9.
- Arnantapunpong S. *Helicobacter pylori* infection in patients with dyspepsia. *Rajavithi Med J* 1999; 10: 17-26.
- Ates NA, Tamer L, Ercan B, Elipek T, Ocal K, Camdeviren H. Glutathione S-transferase M1, T1, P1 genotypes and risk for development of colorectal cancer. *Biochem Genet* 2005; 43: 149-63.
- Atisook K, Kachinthorn U, Luengrojanakul P, Tanwandee T, Pakdirat P, Puapairoj A. Histology of Gastritis and *Helicobacter pylori* Infection in Thailand: a Nationwide Study of 3776 Cases. *Helicobacter* 2003; 8: 132-41.
- Awasthi S, Srivastava SK, Ahmad F, Ahmad H, Ansari GA. Interactions of glutathione S-transferase-pi with ethacrynic acid and its glutathione conjugate. *Biochem Biophys Acta* 1993; 1164: 173-8.

- Aynacioglu AS, Nacak M, Filiz A, Ekinçi E, Roots I. Protective role of glutathione S-transferase P1 (GSTP1) Val105Val genotype in patients with bronchial asthma. *Br J Clin Pharmacol* 2004; 57: 213-7.
- Baek HY, Lim JW, Kim H, Kim JM, Kim JS, Jung HC, Kim KH. Oxidative-stress-related proteome changes in *Helicobacter pylori*-infected human gastric mucosa. *Biochem J* 2004; 379: 291-9.
- Bandyopadhyay U, Das D, Banerjee RK. Reactive oxygen species: oxidative damage and pathogenesis. *Curr Sci* 1999; 5: 658-66.
- Bellincampi L, Ballerini S, Bernardini S, Inserra A, Marchetti P, Boglino C, Donfrancesco A, Federici G. Glutathione transferase P1 polymorphism in neuroblastoma studied by endonuclease restriction mapping. *Clin Chem Lab Med* 2001; 39: 830-5.
- Bickley J, Owen RJ, Fraser AG, Pounder RE. Evaluation of the Polymerase Chain Reaction for Detecting the *urease C* gene of *Helicobacter pylori* in Gastric Biopsy Samples and Dental Plaque. *J Med Microbiol* 1993; 39: 338-44.
- Blaser MJ. *Helicobacter pylori* and the pathogenesis of gastroduodenal inflammation. *J Infect Dis* 1990; 161: 626-33.
- Blocki FA, Ellis LB, Wackett LP. MIF protein are theta-class glutathione S-transferase homologs. *Protein Sci* 1993; 2: 2095-102.
- Blocki FA, Schlievert PM, Wackett LP. Rat liver protein linking chemical and immunological detoxification systems. *Nature* 1992; 360: 269-70
- Board PG. Biochemical genetics of glutathione-S-transferase in man. *Am J Hum Genet* 1981; 33: 36-43.
- Board PG, Coggan M, Chelvanayagam G, Eastal S, Jermin LS, Schulte GK, Danley DE, Hoth LR, Griffor MC, Kamath AV, Rosner MH, Chrnyk BA, Perregaux DE, Gabel CA, Geoghegan KF, Pandit J. Identification, characterization, and crystal structure of the Omega class glutathione transferases. *J Biol Chem* 2000; 275: 24798-806.
- de Bruin WC, Wagenmans MJ, Peters WH. Expression of glutathione S-transferase alpha, P1-1 and T1-1 in the human gastrointestinal tract. *Jpn J Cancer Res* 2000; 91: 310-6.

- Butkiewicz D, Grzybowska E, Phillips DH, Hemminki K, Chorazy M. Polymorphisms of the GSTP1 and GSTM1 genes and PAH-DNA adducts in human mononuclear white blood cells. *Environ Mol Mutagen* 2000; 35: 99-105.
- Caccuri AM, Lo Bello M, Nuccetelli M, Nicotra M, Rossi P, Antonini G, Federici G, Ricci G. Proton release upon glutathione binding to glutathione transferase P1-1: kinetic analysis of a multistep glutathione binding process. *Biochemistry* 1998; 37: 3028-34.
- Canalle R, Burim RV, Tone LG, Takahashi CS. Genetic polymorphisms and susceptibility to childhood acute lymphoblastic leukemia. *Environ Mol Mutagen* 2004; 43: 100-9.
- Catherton J. The clinical relevance of strain types of *Helicobacter pylori*. *Gut* 1997; 40: 701-3.
- Cave DR. Transmission and epidemiology of *Helicobacter pylori*. *Am J Med* 1996; 100: 12S-25S.
- Chauhan SD, Seggara G, Vo PA, Macallister RJ, Hobbs AJ, Ahluwalia A. Protection against lipopolysaccharide-induced endothelial dysfunction in resistance and conduit vasculature of iNOS knockout mice. *FASEB J* 2003; 17: 773-5.
- Chinprasatsak S, Wilairatana P, Visalwadi P. *Helicobacter pylori* prevalence in Northeastern Thailand. *J Trop Med Public Health*.1993; 24: 734-41.
- Coles B, Ketterer B. The role of glutathione and glutathione transferase in chemical carcinogenesis. *Crit Rev Biochem Mol Biol* 1990; 25: 47-70.
- Coles BF, Chen G, Kadlubar FF, Radominska-Pandya A. Interindividual variation and organ-specific patterns of glutathione S-transferase alpha, mu, and pi expression in gastrointestinal tract mucosa of normal individuals. *Arch Biochem Biophys* 2002; 403: 270-6.
- Correa P. *Helicobacter pylori* and gastric carcinogenesis. *Am J Surg Pathol* 1995; 19: S37-43.
- Correa P. *Helicobacter pylori* and gastric cancer: state of the art. *Cancer Epidemiol Biomarkers Prev* 1996; 5: 477-81.
- Crabtree JE. Immune and inflammatory responses to *Helicobacter pylori* infection. *Scand J Gastroenterol Suppl* 1996; 215: 3-10.

- Creaney J, Wijffels GL, Sexton JL, Sandeman RM, Spithill TW, Parsons JC. Fasciola hepatica: localisation of glutathione S-transferase isoenzymes in adult and juvenile liver fluke. *Exp Parasitol* 1995; 81: 106-16.
- Davies GR, Simmonds NJ, Stevens TR, Sheaff MT, Banatvala N, Laurenson IF, Blake DR, Rampton DS. *Helicobacter pylori* stimulates antral mucosal reactive oxygen metabolite production in vivo. *Gut* 1994; 35: 179-85.
- De Reuse H, Labigne A, Mengin-Lecreux D. The *Helicobacter pylori ureC* gene codes for a phosphoglucosamine mutase. *J Bacteriol* 1997; 179: 3488-93.
- Dessen P. GSTP1 (glutathione S-transferase pi). Atlas of Genetics and Cytogenetics in Oncology and Haematology [web site]. http://atlasgeneticsoncology.org/Gene/GC_GSTP1.html
- Dirr H, Reinemer P, Huber R. X-ray crystal structures of cytosolic glutathione S-transferases. Implications for protein architecture, substrate recognition and catalytic function. *Eur J Biochem* 1994; 220: 645-61.
- Dixon DP, Laphorn A, Edwards R. Plant glutathione transferases. *Genome Biol* 2002; 3: 1-10.
- Dooley CP, Cohen H, Fitzgibbons PL, Bauer M, Appleman MD, Perez-Perez GI, Blaser MJ. Prevalence of *Helicobacter pylori* infection and histiologic gastritis in asymptomatic persons. *N Engl J Med* 1989; 321:1562-6.
- Eaton DL, Bammler TK. Concise review of the glutathione S-transferases and their significance to toxicology. *Toxicol Sci* 1999; 49: 156-164.
- Farinati F, Cardin R, Della Libera G, Herszenyi L, Marafin C, Molari A, Plebani M, Uggè M, Naccarato R. The role of anti-oxidants in the chemoprevention of gastric cancer. *Eur J Cancer Prev* 1994: 93-7.
- Farinati F, Cardin R, Degan P, *et al.* Oxidative DNA damage accumulation in gastric carcinogenesis. *Gut* 1998; 42: 351-6.
- Ferrero RL, Kansau IN, Labigne A. Virulence factors produced by *H. pylori*. The immunobiology of *H. pylori* from pathogenesis to prevention. Lippincott-Raven Publishers, New York, 1997: 29-46.
- Fournier D, Bride JM, Poirie M, Bergé JB, Plapp FW Jr. Insect glutathione S-transferases, Biochemical characteristics of the major forms from houseflies susceptible and resistant to insecticides. *J Biol Chem* 1992; 267: 1840-5.

- Fridovich I. Superoxide anion radical ($O_2^{\cdot-}$), superoxide dismutase and related matters. *J Biol Chem* 1997; 272: 1815-7.
- Fryer AA, Bianco A, Hepple M, Jones PW, Strange RC, Spiteri MA. Polymorphism at the glutathione S-transferase GSTP1 locus. A new marker for bronchial hyperresponsiveness and asthma. *Am J Respir Crit Care Med* 2000; 161: 1437-42.
- Ghose C, Perez-Perez GI, Dominguez-Bello MG, Pride DT, Bravi CM, Blaser MJ. East Asian genotypes of *Helicobacter pylori* strains in Amerindians provide evidence for its ancient human carriage. *Proc Natl Acad Sci U S A* 2002; 99: 15107-11.
- Graham DY, Malaty HM, Evans DG, Evans DJ Jr, Klein PD, Adam E. Epidemiology of *Helicobacter pylori* in an asymptomatic population in the United States. Effect of race, and socioeconomic status. *Gastroenterology* 1991; 100: 1495-501.
- Grisham MB, Yamada T. Neutrophils, nitrogen oxides, and inflammatory bowel disease. *Ann N Y Acad Sci* 1992; 664: 103-15.
- Grisham MB, Ware K, Gilleland HE Jr, Gilleland LB, Abell CL, Yamada T. Neutrophil-mediated nitrosamine formation: role of nitric oxide in rats. *Gastroenterology* 1992; 103: 1260-6.
- Grisham MB, Mcdermott RP, Deitch EA. Oxidant defense mechanisms in human colon. *Inflammation* 1990; 14: 669-80.
- Guslandi M. A radical view of *Helicobacter pylori*. *Am J Gastroenterol* 1999; 94: 2797-8.
- Habig WH, Pabst MJ, Jakoby WB. Glutathione S-transferases. The first enzymatic step in mercapturic acid formation. *J Biol Chem* 1974; 249: 7130-9.
- Hakonarson H, Bjornsdottir US, Ostermann E, Arnason T, Adalsteinsdottir AE, Adalsteinsdottir AE, Halapi E, Shkolny D, Kristjansson K, Gudnadottir SA, Frigge ML, Gislason D, Gislason T, Kong A, Gulcher J, Stefansson K. Allelic frequencies and patterns of single-nucleotide polymorphisms in candidate genes for asthma and atopy in Iceland. *Am J Respir Crit Care Med* 2001; 164: 2036-44.

- Halliwell B, Gutteridge JMC. Role of free radicals and catalytic metal ions in human diseases. An overview. *Methods Enzymol* 1990; 186: 1-85.
- Harries LW, Stubbins MJ, Forman D, Howard GC, Wolf CR. Identification of genetic polymorphisms at the glutathione S-transferase Pi locus and association with susceptibility to bladder, testicular and prostate cancer. *Carcinogenesis* 1997; 18: 641-4.
- Harris MJ, Coggan M, Langton L, Wilson SR, Board PG. Polymorphism of the Pi class glutathione S-transferase in normal populations and cancer patients. *Pharmacogenetics* 1998; 8: 27-31.
- Hayes JD, Mantle TJ. Use of immuno-blot techniques to discriminate between the glutathione S-transferase Yf, Yk, Ya, Yn/Yb and Yc subunits and to study their distribution in extrahepatic tissues. Evidence for three immunochemically distinct groups of transferase in the rat. *Biochem J* 1986; 233: 779-88.
- Hayes JD, McLellan LI. Glutathione and glutathione-dependent enzymes represent co-ordinatedly regulated defense against oxidative stress. *Free Radic Res* 1999; 31: 273-300.
- Hayes JD, Pulford DJ. The glutathione S-transferase supergene family: regulation of GST and the contribution of the isoenzymes to cancer chemoprotection and drug resistance. *Crit Rev Biochem Mol Biol* 1995; 30: 445-600.
- Hayes JD, Pulford DJ, Ellis EM, McLeod R, James RF, Seidegard J, Mosialou E, Jernstrom B, Neal GE. Regulation of rat glutathione S-transferase A5 by cancer chemopreventive agents: mechanisms of inducible resistance to aflatoxin B1. *Chem Biol Interact* 1998; 111-112: 51-67.
- Hayes JD, Strange RC. Potential contribution of the glutathione S-transferase supergene family to resistance to oxidative stress. *Free Rad Res* 1995; 22: 193-207.
- Heenan M, O'Driscoll L, Cleary I, Connolly L, Clynes M. Isolation from a human MDR lung cell line of multiple clonal subpopulations which exhibit significantly different drug resistance. *Int J Cancer* 1997; 71: 907-15.

- Helzlsouer KJ, Selmin O, Hung HY, Strickland PT, Hoffman S, Alberg AJ, Watson M, Comstock GW, Bell D. Association glutathione S-transferase M1, P1 and T1 genetic polymorphisms and development of breast cancer. *J Natl Cancer Inst* 1998; 90: 512-8.
- Hein DW, Grant DM, Sim E. Arylamine N-acetyltransferase (EC2.3.1.5) [web site]. <http://www.louisville.edu/medschool/pharmacology/NAT.html/2000>
- Henrion-Caude A, Flamant C, Roussey M, Housset C, Flahault A, Flahault A, Fryer AA, Chadelat K, Strange RC, Clement A. Liver disease in pediatric patients with cystic fibrosis is associated with glutathione S-transferase P1 polymorphism. *Hepatology* 2002; 36: 913-7.
- Hingamp P. Reactive oxygen species [web site]. http://biologie.univ-mrs.fr/upload/p76/Stress__tissus_2006.pdf
- Hirokawa K, Kawasaki H. Changes in glutathione in gastric mucosa of gastric ulcer patients. *Res Commun Mol Pathol Pharmacol* 1995; 88: 163-76.
- Hirvonen A. Polymorphisms of xenobiotic-metabolizing enzymes and susceptibility to cancer. *Environ Health Perspect* 1999; 107: 37-47.
- Hoensch H, Morgenstern I, Petereit G, Siepmann M, Peter WH, Roelofs HM, Kirch W. Influence of clinical factors, diet, and drugs on the human upper gastrointestinal glutathione system. *Gut* 2002; 50: 235-40.
- Holcombe C. *Helicobacter pylori*: the African enigma. *Gut* 1992; 33: 429-31.
- Howden CW, Hunt RH. Guidelines for the management of *Helicobacter pylori* infection. Ad Hoc Committee on Practice Parameters of the American college of Gastroenterology. *Am J Gastroenterol* 1998; 93: 2330-8.
- Hu X, Ji X, Srivastava SK, Xia H, Awasthi S, Nanduri B, Awasthi YC, Zimniak P, Singh SV. Mechanism of differential catalytic efficiency of two polymorphic forms of human glutathione S-transferase P1-1 in the glutathione conjugation of carcinogenic diol epoxide of chrysene. *Arch Biochem Biophys* 1997; 345: 32-8.
- Hubatsch J, Ridderstrom M, Mannervik B. Human glutathione transferase A4-4: an Alpha class enzyme with high catalytic efficiency in the conjugation of 4-hydroxynonenal and other genotoxic products of lipid peroxidation. *Biochem J* 1998; 330: 175-9.

- International Agency for Research on cancer, Schistosomes, Liver Flukes and *Helicobacter pylori*. IARC Monogr Eval Carcinog Risks Hum 1994 ; 61:1-241.
- Ishii T, Matsuse T, Teramoto S, Matsui H, Miyao M, Hosoi T, Takahashi H, Fukuchi Y, Ouchi Y. Glutathione S-transferase P1 (GSTP1) polymorphism in patients with chronic obstructive pulmonary disease. *Thorax* 1999; 54: 693-6.
- Israel DA, Peek RM. Pathogenesis of *Helicobacter pylori* induced gastric inflammation. *Aliment Pharmacol Ther* 2001; 15: 1271-90.
- Jain M, Kumar S, Rastogi N, Lal P, Uday C, Ghoshal UC, Tiwari A, Plant MC, Baiq MQ, Mittal B. GSTT1, GSTM1 and GSTP1 genetic polymorphisms and interaction with tobacco, alcohol and occupational exposure in esophageal cancer patients from North India. *Cancer Lett* 2006; 242: 60-7.
- Ji X, Zhang P, Armstrong RN, Gilliland GL. The three-dimensional structure of a glutathione S-transferase from the mu gene class. Structural analysis of the binary complex of isoenzyme 3-3 and glutathione at 2.2-A resolution. *Biochemistry* 1992; 31: 10169-84.
- Jhaveri MS, Morrow CS. Methylation-mediated regulation of the glutathione S-transferase P1 gene in human breast cancer cells. *Gene* 1998; 210: 1-7.
- Johansson AS, Stenberg G, Widersten M, Mannervik B. Structure-activity relationships and thermal stability of human glutathione transferase P1-1 governed by the H-site residue 105. *J Mol Biol* 1998; 278: 687-98.
- Jourenkova-Mironova N, Voho A, Bouchardy C, Wikman H, Dayer P, Benhamou S, Hirvonen A. Glutathione S-transferase GSTM3 and GSTP1 Genotypes and larynx cancer risk. *Cancer Epidemiol Biomarkers Prev* 1999; 8: 185-8.
- Jourenkova-Mironova N, Voho A, Bouchardy C, Wikman H, Dayer P, Benhamou S, Hirvonen A. Glutathione S-transferase GSTM1, GSTM3, GSTP1 and GSTT1 genotypes and the risk of smoking-related oral and pharyngeal cancers. *Int J Cancer* 1999; 81: 44-8.
- Juronen E, Tasa G, Veromann S, Parts L, Tiidla A, Pulges R, Panov A, Soovere L, Koka K, Mikelsaar AV. Polymorphic glutathione S-transferases as genetic risk factors for senile cortical cataract in Estonians. *Invest Ophthalmol Vis Sci* 2000; 41: 2262-7.

- Kachintorn U, Luengrojankul P, Atisook K, Theerabutra C, Tanwandee T, Boonyapisit S, Chinapak O. *Helicobacter pylori* and peptic ulcer diseases: prevalence and association with antral gastritis in 210 patients. *J Med Assoc Thai* 1992; 75: 386-92.
- Kamada K, Goto S, Okunaga T, Ihara Y, Tsuji K, Kawai Y, Uchida K, Osawa T, Matsuo T, Nagata I, Kondo T. Nuclear glutathione S-transferase pi prevents apoptosis by reducing the oxidative stress-induced formation of exocyclic DNA products. *Free Radic Biol Med* 2004; 37: 1875-84.
- Katoh T, Kaneko S, Takasawa S, Takasawa S, Nagata N, Inatomi H, Ikemura K, Itoh H, Matsumoto T, Kawamoto T, Bell DA. Human glutathione S-transferase P1 polymorphism and susceptibility to smoking related epithelial cancer; oral, lung, gastric, colorectal and urothelial cancer. *Pharmacogenetics* 1999; 9: 165-9.
- Kersulyte D, Mukhopadhyay AK, Velapatino B, Su W, Pan Z, Garcia C, Hernandez V, Valdez Y, Mistry RS, Gilman RH, Yuan Y, Gao H, Alarcon T, Lopez-Brea M, Balakrish Nair G, Chowdhury A, Datta S, Shirai M, Nakazawa T, Ally R, Segal I, Wong BC, Lam SK, Olfat FO, Boren T, Engstrand L, Torres O, Schneider R, Thomas JE, Czinn S, Berg DE. Differences in genotypes of *Helicobacter pylori* from different human populations. *J Bacteriol* 2000; 182: 3210-8.
- Keshavarzian A, Sedghi S, Kanofski J, List T, Robinson C, Ibrahim C, Winship D. Excessive production of reactive oxygen metabolites by inflamed colon: analysis by chemiluminescence probe. *Gastroenterology* 1992; 103: 177-85.
- van Lieshout EM, Tiemessen DM, Witteman BJ, Jansen JB, Peters WH. Low glutathione and glutathione S-transferase levels in Barrette's esophagus as compared to normal esophageal epithelium. *Jpn J Cancer Res* 1999; 90: 81-5.
- Lin HJ, Johansson AS, Stenberg G, Materi AM, Park JM, Dai A, Zhou H, Gim JS, Kau IH, Hardy SI, Parker MW, Mannervik B. Naturally occurring Phe151Leu substitution near conserved folding module lowers stability of glutathione transferase P1-1. *Biochim Biophys Acta* 2003; 1649: 16-23.

- Lin DX, Tang YM, Peng Q, Lu SX, Ambrosone CB, Kadlubar FF. Susceptibility to esophageal cancer and genetic polymorphisms in glutathione S-transferases T1, P1, and M1 and cytochrome P450 2E1. *Cancer Epidemiol Biomarkers Prev* 1998; 7: 1013-8.
- Listowsky I, Rowe JD, Patskovsky YV, Tchaikovskaya T, Shinani N, Shintani N, Novikova E, Nieves E. Human testicular glutathione S-transferases: insights into tissue-specific expression of the diverse subunit classes. *Chem Biol Interact* 1998; 111-112: 103-12.
- Lo HW, Ali-Osman F. Genomic cloning of hGSTP1*C, an allelic human Pi class glutathione S-transferase gene variant and functional characterization of its retinoic acid response elements. *J Biol Chem* 1997; 272: 32743-9.
- Lo HW, Ali-Osman. Structure of the human allelic glutathione S-transferase-pi gene variant, hGSTP1 C, cloned from a glioblastoma multiforme cell line. *Chem Biol Interact* 1998; 111-112: 91-102.
- Lu JJ, Perng CL, Shyu RY, Chen CH, Lou Q, Chong SK, Lee CH. Comparison of five PCR methods for detection of *Helicobacter pylori* DNA in gastric tissues. *J Clin Microbiol* 1999; 37: 772-4.
- Manar MH, Brown MR, Gauthier TW, Brown LA. Association of glutathione-S-transferase-P1 (GST-P1) polymorphisms with bronchopulmonary dysplasia. *J Perinatol* 2004; 24: 30-5.
- Mannervik B, Jensson H. Binary combinations of four protein subunits with different catalytic specificities explain the relationship between six basic glutathione S-transferases in rat liver cytosol. *J Biol Chem* 1982; 257: 9909-12.
- Mannervik B, Awasthi YC, Board PG, Hayes JD, Di Ilio C, Ketterer B, Listowsky I, Morgenstern R, Muramatsu M, Pearson WR. Nomenclature for human glutathione transferases. *Biochem J* 1992; 282: 305-6.
- Mannervik B, Alin P, Guthenberg C, Jensson H, Tahir MK, Warholm M, Jornvall H. Identification of three classes of cytosolic glutathione transferase common to several mammalian species: correlation between structural data and enzymatic properties. *Proc Natl Acad Sci U S A* 1985; 82: 7202-6.
- Mannervik B, Danielson UH. Glutathione transferase--structure and catalytic activity. *CRC Crit Rev Biochem* 1988; 23: 283-337.

- Marahatta SB, Punyarit P, Bhudisawasdi V, Paupairoj A, Wongkham S, Petmitr S. Polymorphism of glutathione S-transferase Omega gene and risk of cancer. *Cancer Lett* 2006; 236: 276-281.
- Martinez C, Martin F, Fernandez JM, Garcia-Martin E, Sastre J. Glutathione S-transferases mu 1, theta 1, pi 1, alpha 1 and mu 3 genetic polymorphisms and the risk of colorectal and gastric cancers in human. *Pharmacogenomics* 2006; 7: 711-8.
- Marshall BJ, Warren JR. Unidentified Curved Bacilli in the Stomach of Patients with Gastritis and Peptic Ulceration. *Lancet* 1984; 1311-15.
- Menegon A, Board PG, Blackburn AC, Mellick GD, Le Couteur DG. Parkinson's disease, pesticides and glutathione transferase polymorphisms. *Lancet* 1998; 352: 1344-6.
- Meyer DJ. Significance of an unusually low K_m for glutathione in glutathione transferases of the alpha, mu and pi classes. *Xenobiotica* 1993; 23: 823-34.
- Meyer DJ, Coles B, Pemble SE, Gilmore KS, Fraser GM, Ketterer B. Theta, a new class of glutathione transferases purified from rat and man. *Biochem J* 1991; 274: 409-14.
- Meyer DJ, Thomas M. Characterization of rat spleen prostaglandin H D-isomerase as a sigma-class GSH transferase. *Biochem J* 1995; 311: 739-42.
- Michels C, Raes M, Toussaint O, Remacle J. Importance of Se-glutathione peroxidase, catalase, and Cu/Zn-SOD for cell survival against oxidative stress. *Free Radic Biol Med* 1994; 17: 235- 48.
- Millar DS, Paul CL, Molloy PL, Clark SJ. A distinct sequence (ATAAA)_n separates methylated and unmethylated domains at the 5'-end of the GSTP1 CpG island. *J Biol Chem* 2000; 275: 24893-9.
- Miller DP, Neuberg D, de Vivo I, Wain JC, Lynch TJ, Su L, Christiani DC. Smoking and the risk of lung cancer: susceptibility with GSTP1 polymorphisms. *Epidemiology* 2003; 14: 545-51.
- Mitrunen K, Jourenkova N, Kataja V, Eskelinen M, Kosma VM, Benhamou S, Vainio H, Uusitupa M, Hirvonen A. Glutathione S-transferase M1, M3, P1, and T1 genetic polymorphisms and susceptibility to breast cancer. *Cancer Epidemiol Biomarkers Prev* 2001; 10: 229-36.

- Moffat GJ, McLanren AW, Wolf CR. Involvement of Jun and Fos Proteins in regulating transcriptional activation of the human pi class glutathione S-transferase gene in multidrug-resistant MCF7 breast cancer cells. *J Biol Chem* 1994; 269: 16397-402.
- Monks TJ, Lau SS. Glutathione conjugation as a mechanism for the transport of reactive metabolites. *Adv Pharmacol* 1994; 27: 183-205.
- Morita S, Yano M, Tsujinaka T, Ogawa A and Taniguchi M, Kaneko K, Shiozaki H, Doki Y, Inoue M, Monden M. Association between genetic polymorphisms of glutathione S-transferase P1 and N-acetyltransferase 2 and susceptibility to squamous-cell carcinoma of the esophagus. *Int J Cancer* 1998; 79: 517-20.
- Morita S, Yano M, Tsujinaka T, Akiyama Y, Taniguchi M, Kaneko K, Miki H, Fujii T, Yoshino K, Kusuoka H, Monden M. Genetic polymorphisms of drug-metabolizing enzymes and susceptibility to head-and-neck squamous-cell carcinoma. *Int J Cancer* 1999; 80: 685-8.
- Mulder GJ, Ouwerkerk-Mahadevan S. Modulation of glutathione conjugation in vivo: how to decrease glutathione conjugation in vivo or in intact cellular system in vitro. *Chem Biol Interact* 1997; 105: 17-34.
- Nishihara T, Maeda H, Okamoto K, Oshida T, Mizoguchi T, Terada T. Inactivation of human placenta glutathione S-transferase by SH/SS exchange reaction with biological disulfides. *Biochem Biophys Res Commun* 1991; 174: 580-5.
- Nomura A, Stemmermann GN, Chyou PH, Kato I, Prerez-Perez GI, Blaser MJ. *Helicobacter pylori* infection and the risk for duodenal and gastric ulceration. *Ann Intern Med* 1994; 1994 120: 977-81.
- Ogura K, Maeda S, Nakao M, Watanabe T, Tada M, Kyutoku T, Yoshida H, Shiratori Y, Omata M. Virulence factors of *Helicobacter pylori* responsible for gastric diseases in Mongolian gerbil. *J Exp Med* 2000; 192: 1601-10.
- Okumura T, Yamada T, Park SC, Ichinose A. No Val34Leu polymorphism of the gene for factor XIIIa subunit was detected by ARMS-RACE method in three Asian populations. *J Thromb Haemost* 2003; 1: 1856-7.
- Oscason M, Ingelman-Sunberg M, Daly AK, Nebert DB. Human cytochrome P450 (CYP) alleles [web site]. <http://www.imm.ki.se/CYPalleles/2000>

- Ovartlarnporn B, Piratvisuth T, Kulnauwakul S. The prevalence of *Helicobacter pylori* infection in dyspeptic patients and metronidazole sensitivity at Songklanagarind Hospital. Annual Scientific Meeting of the Gastroenterological Association of Thailand 1998; 42: 13-4.
- Pae CU, Kim JJ, Lee SJ, Lee CU, Lee C, Paik IH, Park HR, Yang S, Serretti A. Association study between glutathione S-transferase P1 polymorphism and schizophrenia in the Korean population. *Prog Neuropsychopharmacol Biol Psychiatry* 2003; 27: 519-23.
- Park JY, Schantz SP, Stern JC, Kaur T, Lazarus P. Association between glutathione S-transferase pi genetic polymorphisms and oral cancer risk. *Pharmacogenetics* 1999; 9: 497-504.
- Parsonnet J. Bacterial infection as a cause of cancer. *Environ Health Perspect.* 1995; 103: 263-8.
- Peek RM Jr, Moss SF, Tham KT, Perez-Perez GI, Wang S, Miller GG, Atherton JC, Holt PR, Blaser MJ. *Helicobacter pylori* cagA⁺ strains and dissociation of gastric epithelial cell proliferation from apoptosis. *J Natl Cancer Inst* 1997; 89: 863-8.
- Pemble SE, Taylor JB. An evolutionary perspective on glutathione transferases inferred from class-theta glutathione transferase cDNA sequences. *Biochem J* 1992; 287: 957-63.
- Pemble SE, Wardle AF, Taylor JB. Glutathione S-transferase class Kappa: characterization by the cloning of rat mitochondrial GST and identification of a human homologue. *Biochem J* 1996; 319: 749-754.
- Perez-Perez GI, Taylor DN, Biodhidatta L, Wongsrichanalai J, Baze WB, Dunn BE, Echeverria PD, Blaser MJ. Seroprevalence of *Helicobacter pylori* infections in Thailand. *J Infect Dis* 1990; 161: 1237-41.
- Peter WH, Wormskamp NG, Thies E. Expression of glutathione S-transferases in normal gastric mucosa and gastric tumors. *Carcinogenesis* 1990; 11: 1593-6.
- Phull PS, Green CJ, Jacyna MR. A radical view of the stomach: the role of oxygen derived free radicals and antioxidants in gastrointestinal disease. *Eur J Gastroenterol Hepatol* 1995; 7: 265-74.

- Pickette CB, Lu AY. Glutathione S-transferases: gene structure, regulation, and biological function. *Annu Rev Biochem* 1989; 58: 743-64.
- Pihan G, Regello G, Szabo S. Free radicals and lipid peroxidation in ethanol- or aspirin-induced gastric mucosal injury. *Dig Dis Sci* 1987; 32: 1395-401.
- Ploemen JH, van Ommen B, Bogaards JJ, van Bladeren PJ. Ethacrynic acid and its glutathione conjugate as inhibitors of glutathione S-transferases. *Xenobiotica* 1993; 23: 913-23.
- Pongchairerks P, Chalermksanyakorn P, Tanjapatkul M. Occurrence of intestinal metaplasia of the stomach in Thai patients with gastritis, benign ulcer, and gastric cancer. *J Surg Oncol* 1990; 43: 101-5.
- Ramsoekh D, van Leerdam ME, Rauws EA, Tytgat GN. Outcome of peptic ulcer bleeding, nonsteroidal anti-inflammatory drug use, and *Helicobacter pylori* infection. *Clin Gastroenterol Hepatol* 2005; 3: 859-64.
- Rebbeck TR. Molecular epidemiology of the human glutathione S-transferase genotypes GSTM1 and GSTT1 in cancer susceptibility. *Cancer Epidemiol Biomarkers Prev* 1997; 6: 733-43.
- Richardson CT. Pathogenetic factors in peptic ulcer disease. *Am J Med*. 1985; 79: 1-7.
- Reinemer P, Dirr HW, Ladenstein R, Schäffer J, Gallay O, Huber R. The three-dimensional structure of class pi glutathione S-transferase in complex with glutathione sulfonate at 2.3 Å resolution. *EMBO J* 1991; 10: 1997-2005.
- Rieder G, Hatz RA, Moran AP, Walz A, Stolte M, Enders G. Role of adherence in interleukin-8 induction in *Helicobacter pylori*-associated gastritis. *Infect Immun* 1997; 65: 3622-30.
- Rossjohn J, Polekhina G, Feil SC, Allocati N, Masulli M, De Illio C, Parker MW. A mixed disulfide bond in bacterial glutathione transferase: functional and evolutionary implications. *Structure* 1998; 6: 721-34.
- Robbin SL, Lotran RS, Kumar V. *Robbin Pathologic Basis of Disease*, 5th edition. WB Saunders, Philadelphia, 1994: 773-8.
- Rossini A, Rapozo DC, Amorim LM, Macedo JM, Medina R. Frequencies of GSTM1, GSTT1, and GSTP1 polymorphisms in a Brazilian population. *Genet Mol Res* 2002; 1: 233-40.

- Rowe JD, Patskovsky YV, Patskovska LN, Novikova E, Listowsky I. Rationale for reclassification of a distinctive subdivision of mammalian class Mu glutathione S-transferases that are primarily expressed in testis. *J Biol Chem* 1998; 273: 9593-601.
- Rowe JD, Nieves E, Listowsky I. Subunit diversity and tissue distribution of human glutathione S-transferases: Interpretations based on electrospray ionization-MS and peptide-specific antisera. *Biochem J* 1997; 325: 481-6.
- Ryberg D, Skaug V, Hewer A, Phillips DH, Harries LW, Wolf CR, OGREID D, Ulvik A, Vu P, Haugen A. Genotypes of glutathione transferase M1 and P1 and their significance for lung DNA adduct levels and cancer risk. *Carcinogenesis* 1997; 18: 1285-9.
- Saarikoski ST, Voho A, Reinikainen M, Anttila S, Karjalainen A, Malaveille C, Vainio H, Husgafvel-Pursiainen K, Hirvonen A. Combined effect of polymorphic GST genes on individual susceptibility to lung cancer. *Int J Cancer* 1998; 77: 516-21.
- Salinas AE, Wong MG. Glutathione S-transferases-- a review. *Curr Med Chem* 1999; 6: 279-309.
- Sambrook J, Russell DW. *Molecular Cloning: a laboratory manual* 3rd edition. Cold Spring Harbor Laboratory Press. Cold Spring Harbor, New York, 2001
- Sato K. Glutathione transferase as markers of preneoplasia and neoplasia. *Adv Cancer Res* 1989; 52: 205-55.
- Schipper DL, Wagenmans MJ, van Haelst U, Peters WH, Wobbes T, Verhofstad AA, Lange WP, Wagener DJ. Immunohistochemical determination of glutathione S-transferases in gastric carcinomas and in adjacent normal gastric epithelium. *Anticancer Res* 1996; 16: 565-71.
- Schmuck EM, Board PG, Whitbread AK, Tetlow N, Cavanaugh JA, Blackburn AC, Masoumi A. Characterization of the monomethylarsonate reductase and dehydroascorbate reductase activities of Omega class glutathione transferase variants: implications for arsenic metabolism and the age-at-onset of Alzheimer's and Parkinson's diseases. *Pharmacogenet Genomics* 2005; 7: 493-501.

- Schraufstatter I, Hyslop PA, Jackson JH, Cochrane CG. Oxidant-induced DNA damage of target cells. *J Clin Invest* 1988; 82: 1040-50.
- Seidegard J, Pero RW, Stille B. Identification of the trans-stilbene oxide-active glutathione transferase in human mononuclear leukocytes and in liver as GST1. *Biochem Genet* 1989; 27: 253-61.
- Setiawan VW, Zang ZF, Yu GP, Lu QY, Li YL, , Lu ML, Wang MR, Guo CH, Yu SZ, Kurtz RC, Hsieh CC. GSTP1 polymorphisms and gastric cancer in a high-risk Chinese population. *Cancer Causes Control* 2001; 12: 73-81.
- Sheehan D, Meade G, Foley VM, Dowd CA. Structure, function and evolution of glutathione S-transferases: implications for classification of non-mammalian members of an ancient enzyme superfamily. *Biochem J* 2001; 360: 1-16.
- Shenoy NR, Choughuley AS. Inhibitory effect of diet related sulphhydryl compounds on formation of carcinogenic nitrosamines. *Cancer Lett* 1992; 65: 277-332.
- Shepard TF, Platz EA, Kantoff PW, Nelson WG, Isaacs WB, Freije D, Febbo PG, Stampfer MJ, Giovannucci E. No association between the I105V polymorphism of the glutathione S-transferase P1 gene (GSTP1) and prostate cancer risk: a prospective study. *Cancer Epidemiol Biomarkers Prev* 2000; 9: 1267-8.
- Sherrat PJ, Pulford DJ, Harrison DJ, Green T, Hayes JD. Evidence that human theta glutathione S-transferase T1-1 can catalyze the activation of dichloromethane, a liver and lung carcinogen in the mouse. *Biochem J* 1997; 326: 837-46.
- Shirin H, Pinto JT, Liu LU, Merzianu M, Sordillo EM, Moss SF. *Helicobacter pylori* decreases gastric mucosal glutathione. *Cancer Lett* 2001; 164: 127-33.
- Sinning I, Kleywegt GJ, Cowan SW, Reinemer P, Dirr HW, Huber R, Gilliland GL, Armstrong RN, Ji X, Board PG. Structure determination and refinement of human alpha class glutathione transferase A1-1, and a comparison with the Mu and Pi class enzymes. *J Mol Biol* 1993; 232: 192-212.
- Smith G, Stanley LA, Sim E, Strange RC, Wolf CR. Metabolic polymorphisms and cancer susceptibility. *Cancer Surv* 1995; 25: 27-65.
- Sonnenberg A, Everhart JE. The prevalence of self-reported peptic ulcer in the United States. *Am J Public Health* 1996; 86: 200-5.

- Stanulla M, Schrappe M, Brechlin AM, Zimmermann M, Welte K. Polymorphisms within glutathione S-transferase genes (GSTM1, GSTT1, GSTP1) and risk of relapse in childhood B-cell precursor acute lymphoblastic leukemia: a case-control study. *Blood* 2000; 95: 1222-8.
- Stoehlmacher J, Park DJ, Zhang W, Groshen S, Tsao-Wei DD, Yu MC, Lenz HJ. Association between glutathione S-transferase P1, T1, and M1 genetic polymorphism and survival of patients with metastatic colorectal cancer. *J Natl Cancer Inst* 2002; 94: 936-42.
- Stucker I, Hirvonen A, de Waziers I, Cabelguenne A, Mitrunen K, Cenee S, Koum-Besson E, Hemon D, Beaune P, Lorient MA. Genetic polymorphisms of glutathione S-transferases as modulators of lung cancer susceptibility. *Carcinogenesis* 2002; 23: 1475-81.
- Sunberg K, Johansson AS, Stenberg G, Widersten M, Seidel A, Mannervik B, Jernstrom B. Differences in the catalytic efficiencies of allelic variants of glutathione transferase P1-1 towards carcinogenic diol epoxides of polycyclic aromatic hydrocarbons. *Carcinogenesis* 1998; 19: 433-6.
- Suwanagool P, Atisook K, Pongpech P, Dhiraputra C, Luengrojanakul P, Kachintorn U. *Helicobacter pylori*: a comparison of CLO test and Giemsa's stain with culture in dyspeptic patients. *J Med Assoc Thai* 1993; 76: 185-9.
- Suzuki T, Matsuo K, Ito H, Hirose K, Wakai K, Saito T, Sato S, Morishima Y, Nakamura S, Ueda R, Tajima K. A part history of gastric ulcers and *Helicobacter pylori* infection increase the risk of gastric malignant lymphoma. *Carcinogenesis* 2006; 27: 1391-7.
- Taylor DN, Parsonnet J. Epidemiology and natural history of *Helicobacter pylori* infection. Raven Press, New York, 1995; 551-63.
- Their R, Pemble SE, Kramer H, Taylor JB, Guengerich FP, Ketterer B. Human glutathione S-transferase T1-1 enhances mutagenicity of 1,2-dibromoethane, dibromomethane, and 1,2,3,4-diepoxybutane in *Salmonella typhimurium*. *Carcinogenesis* 1996; 17: 163-166.
- Tsuchida S, Sato K. Glutathione transferases and cancer. *Crit Rev Biochem Mol Biol* 1992; 27: 337-84.

- To-Figueras J, Gene M, Gomez-Catalan J, Pique E, Borrego N, Carrasco JL, Ramon J, Corbella J. Genetic polymorphism of glutathione S-transferase P1 gene and lung cancer risk. *Cancer Causes Control*. 1999; 10: 65-70.
- To-Figueras J, Gene M, Gomez-Catalan J, Pique E, Borrego N, Caballero M, Cruellas F, Raya A, Dicenta M, Corbella J. Microsomal epoxide hydrolase and glutathione S-transferase polymorphisms in relation to laryngeal carcinoma risk. *Cancer Lett* 2002; 187: 95-101.
- Verhulst ML, van Oijen AH, Roelofs HM, Peters WH, Jansen JB. Antral glutathione concentration and glutathione S-transferase activity in patients with and without *Helicobacter pylori*. *Dig Dis Sci* 2000; 45: 629-32.
- Wachirawat W, Hanucharurnkul S, Suriyawongpaisal P, Boonyapisit S, Levenstein S, Jearanaisilavong J, Atisook K, Boontong T, Theerabutr C. Stress, but not *Helicobacter pylori*, is associated with peptic ulcer disease in a Thai population. *J Med Assoc Thai* 2003; 86: 672-85.
- Wallace JL. The role of nerve-immune interactions in the pathogenesis of peptic ulcer. *The immunobiology of H. pylori*. 1997: 201-12.
- Wallace JK. The role of inflammation in acid secretion and ulceration. *Mucosal Immunology Update* 1994; 2: 3-5.
- Wang X, Wang L, Yuan Y. Expression of pi glutathione S-transferase in intestinal metaplasia and its relationship with *Helicobacter pylori* infection. *Zhonghua Yi Xue Zazhi* 2002; 82: 1033-6.
- Wang J, Deng Y, Cheng J, Ding J, Tokudome S. GST genetic polymorphisms and lung adenocarcinoma susceptibility in Chinese population. *Cancer Lett* 2003; 201: 185-93.
- Warholrm M, Rane A, Alexandrie AK, Monaghan G, Rannug A. Genotypic and phenotypic determination of polymorphic glutathione transferase T1 in a Swedish population. *Pharmacogenetics* 1995; 5: 252-4.
- Warner HR. Superoxide dismutase, aging, and degenerative disease. *Free Radic Biol Med* 1994; 17: 249-58.
- Watson MA, Stewart RK, Smith GB, Massey TE, Bell DA. Human glutathione S-transferase P1 polymorphisms: relationship to lung tissue enzyme activity and population frequency distribution. *Carcinogenesis* 1998; 19: 275-80.

- Welfare M, Monesola Adeokun A, Bassendine MF, Daly AK. Polymorphisms in GSTP1, GSTM1, and GSTT1 and susceptibility to colorectal cancer. *Cancer Epidemiol Biomarkers Prev* 1999; 8: 289-92.
- Whitbread AK, Tetlow N, Eyre HJ, et al. Characterization of the human Omega class glutathione transferase genes and associated polymorphisms. *Pharmacogenetics* 2003; 13: 131-44.
- Wilairatana S, Kladchareon N, Israsena S, Wilairatana P. Epidemiology of peptic ulcer disease in Thailand. *Gastroenterol Jpn.* 1991; 26: 265-6.
- Wilce MC, Parker MW. Structure and function of glutathione S-transferases. *Biochim Biophys Acta* 1994; 1205: 1-18.
- Wodegiorgis S, Ahmed RC, Zhen Y, Erdmann CA, Russell ML, Goth-Goldstein R. Genetic polymorphism in three glutathione S-transferase genes and breast cancer risk. Lawrence Berkeley National Laboratory, California, 2002 [web site]. <http://repositories.cdlib.org/lbnl/LBNL-50365>
- Yim JJ, Yoo CG, Lee CT, Kim YW, Han SK, Shim YS. Lack of association between glutathione S-transferase P1 polymorphism and COPD in Koreans. *Lung* 2002; 180: 119-25.
- Zimniak P, Nanduri B, Pikula S, Bandorowicz-Pikula J, Singhal SS, Srivastava SK, Awasthi S, Awasthi YC. Naturally occurring human glutathione S-transferase GSTP1-1 isoforms with isoleucine and valine in position 104 differ in enzymic properties. *Eur J Biochem* 1994; 224: 893-9.
- Zuntar I, Kalanj-Bognar S, Topic E, Petlevski R, Stefanovic M, Demarin V. The glutathione S-transferase polymorphisms in a control population and in Alzheimer's disease patients. *Clin Chem Lab Med* 2004; 42: 334-9.