

REFERENCES

- Bhamarapravati, N., Vajrasthira, S., & Thammavit, W. (1978). Liver Changes in Hamsters Infected with a Liver Fluke of Man, *Opisthorchis Viverrini* *. The American Journal of Tropical Medicine and Hygiene, 27(4), 787–794. doi: 10.4269/ajtmh.1978.27.787
- Bhandari, V., Giard, A., & Bateman, A. (1993). The complementary deoxyribonucleic acid sequence, tissue distribution, and cellular localization of the rat granulin precursor. Endocrinology, 133(6), 2682–2689. doi:10.1210/endo.133.6.8243292
- Bode, W., Gomis-Rüth, F. X., & Stöckler, W. (1993). Astacins, serralysins, snake venom and matrix metalloproteinases exhibit identical zinc-binding environments (HEXXHXXGXXH and Met-turn) and topologies and should be grouped into a common family, the 'metzincins'. FEBS letters, 331(1-2), 134–140.
- Boonpucknavig, S., Kurathong, S., Thamavit, W. (1986). Detection of antibodies in sera from patients with opisthorchiasis. J. Clin. Lab. Immunol. 19, 135e137.
- Bussolati, G., & Radulescu, R. T. (2011). Blocking Endogenous Peroxidases in Immunohistochemistry. Applied Immunohistochemistry & Molecular Morphology, 19(5), 484. doi:10.1097/pai.0b013e318219a6e6
- Cerdà-Costa, N., & Gomis-Rüth, F. X. (2014). Architecture and function of metallopeptidase catalytic domains. Protein science: a publication of the Protein Society, 23(2), 123–144. <https://doi.org/10.1002/pro.2400>
- Chaiyadet, S., Smout, M., Johnson, M., Whitchurch, C., Turnbull, L., Kaewkes, S., Sotillo, J., Loukas, A., Sripa, B. (2015a). Excretory/secretory products of the carcinogenic liver fluke are endocytosed by human cholangiocytes and drive cell proliferation and IL6 production. Int. J. Parasitol. 45, 773e781.
- Cheung, S. T., Wong, S. Y., Leung, K. L., Chen, X., So, S., Ng, I. O., & Fan, S. T. (2004). Granulin-epithelin precursor overexpression promotes growth and invasion of hepatocellular

carcinoma. *Clinical cancer research: an official journal of the American Association for Cancer Research*, 10(22), 7629–7636.

Davies, J. R., Wickstrom, C., Thornton, D. J. (2012). Gel-forming and cell-associated mucins: preparation for structural and functional studies. *Mucins*: Springer. p27-47.

Ditrich, O., Giboda, M., Scholz, T., & Beer, S. A. (1992). Comparative morphology of eggs of the Haplchorchiinae (Trematoda: Heterophyidae) and some other medically important heterophyid and opisthorchiid flukes. *Folia parasitologica*, 39(2), 123–132.

Duenngai, K., Boonmars, T., Sithithaworn, J., & Sithithaworn, P. (2012). Diagnosis of early infection and post chemotherapeutic treatment by copro-DNA detection in experimental opisthorchiasis. *Parasitology Research*, 112(1), 271–278. doi:10.1007/s00436-012-3134-0

Elkins, D. B., Sithithaworn, P., Haswell-Elkins, M., Kaewkes, S., Awacharagan, P., & Wongratanacheewin, S. (1991). *Opisthorchis viverrini*: relationships between egg counts, worms recovered and antibody levels within an endemic community in northeast Thailand. *Parasitology*, 102 Pt 2, 283–288.

Flavell, D. J., Pattanapanyasat, K., & Flavell, S. U. (1980). *Opisthorchis viverrini*: partial success in adoptively transferring immunity with spleen cells and serum in the hamster. *Journal of helminthology*, 54(3), 191–197.

Flohé, L., Budde, H., & Hofmann, B. (2003). Peroxiredoxins in antioxidant defense and redox regulation. *BioFactors*, 19(1-2), 3–10. doi:10.1002/biof.5520190102

Grys, T. E., Walters, L. L., Welch, R. A. (2006). Characterization of the StcE protease activity of *Escherichia coli* O157: H7. *Journal of bacteriology*, 188(13):4646-4653.

Hartley, B. S. (1960). Proteolytic enzymes. *Annual review of biochemistry*, 29, 45–72.

Hasnain, S. Z., Evans, C. M., Roy, M., Gallagher, A. L., Kindrachuk, K. N., Barron, L., et al. (2011). Muc5ac: a critical component mediating the rejection of enteric nematodes. *Journal of Experimental Medicine*, 2008(5):893-900.

- He, C., & Ohnishi, K. (2017). Efficient renaturation of inclusion body proteins denatured by SDS. *Biochemical and Biophysical Research Communications*, 490(4), 1250–1253. doi: 10.1016/j.bbrc.2017.07.003
- Hollingsworth MA, Swanson BJ. (2004). Mucins in cancer: protection and control of the cell surface. *Nat Rev Cancer*. Jan;4(1):45-60. doi: 10.1038/nrc1251. PMID: 14681689.
- Janechaiwat, J., Tharavanij, S., Vajrasthira, S., Chaicumpa, W. (1980). The immunological diagnosis of human opisthorchiasis and the humoral immune response to opisthorchis infection in the hamster. *J. Med. Assoc. Thai*. 63 (8), 439e447.
- Johansson, M. E., Larsson, J. M. H., Hansson, G. C. (2011). The two mucus layers of colon are organized by the MUC2 mucin, whereas the outer layer is a legislator of host–microbial interactions. *Proceedings of the national academy of sciences*, 108(Supplement 1):4659-4665.
- Johansson, M. E., Sjövall, H., & Hansson, G. C. (2013). The gastrointestinal mucus system in health and disease. *Nature reviews. Gastroenterology & hepatology*, 10(6), 352–361.
- Kaewkes S. (2003). Taxonomy and biology of liver flukes. *Acta tropica*, 88(3), 177–186.
- Kajima, S., Yokogawa, M., Tada, T. (1972). Raised level of serum IgE in human helminthiasis. *Am J. Trop. Med. Hyg.* 21, 913e918.
- Kool, M., Fierens, K., & Lambrecht, B. N. (2011). Alum adjuvant: some of the tricks of the oldest adjuvant. *Journal of Medical Microbiology*, 61(Pt_7), 927–934. doi:10.1099/jmm.0.038943-0
- Laha, T., Pinlaor, P., Mulvenna, J., Sripa, B., Sripa, M., Smout, M. J., ... Loukas, A. (2007). Gene discovery for the carcinogenic human liver fluke, *Opisthorchis viverrini*. *BMC Genomics*, 8(1), 189. doi:10.1186/1471-2164-8-189
- Larsson, J. M., Karlsson, H., Sjövall, H., & Hansson, G. C. (2009). A complex, but uniform O-glycosylation of the human MUC2 mucin from colonic biopsies analyzed by nanoLC/MSn. *Glycobiology*, 19(7), 756–766.

- Lehker, M. W., Sweeney, D. (1999). Trichomonad invasion of the mucous layer requires adhesins, mucinases, and motility. *Sexually Transmitted Infections*, 75(4):231-238.
- Linden, S. K., Sutton, P., Karlsson, N. G., Korolik, V., & McGuckin, M. A. (2008). Mucins in the mucosal barrier to infection. *Mucosal Immunology*, 1(3), 183–197. doi:10.1038/mi.2008.5
- Lovis, L., Mak, T. K., Phongluxa, K., Soukhathammavong, P., Sayasone, S., Akkhavong, K., ... Felger, I. (2009). PCR Diagnosis of *Opisthorchis viverrini* and *Haplorchis taichui* Infections in a Lao Community in an Area of Endemicity and Comparison of Diagnostic Methods for Parasitological Field Surveys. *Journal of Clinical Microbiology*, 47(5), 1517–1523. doi:10.1128/jcm.02011-08
- Luo, Q., Kumar, p., Vickers, t. J., Sheikh, A., Lewis, W. G., Rasko, D. A., et al. (2014). Enterotoxigenic *Escherichia coli* Secretes a Highly Conserved Mucin-Degrading Metalloprotease to Effectively Engage Intestinal Epithelial Cells. *Infection and Immunity*, 82(2):509-521.
- Matchimakul, P., Rinaldi, G., Suttiprapa, S., Mann, V. H., Popratiloff, A., Laha, T., Pimenta, R. N., Cochran, C. J., Kaewkes, S., Sripa, B., and Brindley, P. J. (2015). Apoptosis of cholangiocytes modulated by thioredoxin of carcinogenic liver fluke, *International Journal of Biochemistry and Cell Biology*. <http://dx.doi.org/10.1016/j.biocel.2015.05.014>
- McGonigle, S., Dalton, J. P., & James, E. R. (1998). Peroxidoxins: A New Antioxidant Family. *Parasitology Today*, 14(4), 139–145. doi:10.1016/s0169-4758(97)01211-8
- McGuckin, M. A., Linden, S. K., Sutton, P., Florin, T. H. (2011). Mucin dynamics and enteric pathogens. *Nature Reviews Microbiology*, 9(4):265.
- McKerrow J. H. (1987). Human fibroblast collagenase contains an amino acid sequence homologous to the zinc-binding site of *Serratia* protease. *The Journal of biological chemistry*, 262(13), 5943.
- Mulvenna, J., Sripa, B., Brindley, P. J., Gorman, J., Jones, M. K., Colgrave, M. L., Jones, A., Nawaratna, S., Laha, T., Suttiprapa, S., Smout, M. J., & Loukas, A. (2010). The secreted and surface

proteomes of the adult stage of the carcinogenic human liver fluke *Opisthorchis viverrini*.

Proteomics, 10(5), 1063–1078.

Murray, P.J., Wynn, T.A. (2011). Protective and pathogenic functions of macrophage subsets. Nat.

Rev. Immunol. 11, 723e737. Nakjang, S., Ndeh, D. A., Wipat, A., Bolam, D. N., Hirt, R. P.

(2012). A novel extracellular metallopeptidase domain shared by animal host-associated

mutualistic and pathogenic microbes. PLoS One, 7(1):e30287.

Nesta, B., Valeri, M., Spagnuolo, A., Rosini, R., Mora, M., Donato, P., ... Serino, L. (2014). SsIE elicits

functional antibodies that impair in vitro mucinase activity and in vivo colonization by both

intestinal and extraintestinal Escherichia coli strains. PLoS pathogens, 10(5), e1004124.

doi:10.1371/journal.ppat.1004124.

Ninlawan, K., O'Hara, S.P., Splinter, P.L., Yongvanit, P., Kaewkes, S., Surapaitoon, A., et al. (2010).

Opisthorchis viverrini excretory/secretory products induce toll-like receptor 4 upregulation

and production of interleukin 6 and 8 in cholangiocyte. Parasitol. Int. 59 (4), 616e621.

Noach, I., Ficko-Blean, E., Pluvnagae, B., Stuart, C., Jenkins, M. L., Brochu, D., ... Boraston, A. B. (2017).

Recognition of protein-linked glycans as a determinant of peptidase activity. Proceedings of

the National Academy of Sciences of the United States of America, 114(5), E679–E688.

doi:10.1073/pnas.1615141114

Pinlaor, S., Sripa, B., Ma, N., Hiraku, Y., Yongvanit, P., Wongkham, S., ... Kawanishi, S. (2005). Nitrative

and oxidative DNA damage in intrahepatic cholangiocarcinoma patients in relation to tumor

invasion. World journal of gastroenterology, 11(30), 4644–4649.

doi:10.3748/wjg.v11.i30.4644

Rawlings, N.D., Barrett, A.J., Thomas, P.D., Huang, X., Bateman, A. & Finn, R.D. (2018) The MEROPS

database of proteolytic enzymes, their substrates and inhibitors in 2017 and a comparison

with peptidases in the PANTHER database. Nucleic Acids Res 46, D624-D632.

Rosano, G. L., & Ceccarelli, E. A. (2014). Recombinant protein expression in Escherichia coli: advances

and challenges. Frontiers in microbiology, 5, 172.

Rousseau, K., Swallow, D. M. (2012). Mucin methods: genes encoding mucins and their genetic variation with a focus on gel-forming mucins. *Mucins*: Springer. p1-26.

Sirisinha, S., Chawengkirikitkul, R., Haswell-Elkins, M. R., Elkins, D. B., Kaewkes, S., & Sithithaworn, P. (1995). Evaluation of a monoclonal antibody-based enzyme linked immunosorbent assay for the diagnosis of *Opisthorchis viverrini* infection in an endemic area. *The American journal of tropical medicine and hygiene*, 52(6), 521–524.

Sithithaworn P, Andrews RH, Nguyen VD, Wongsaroj T, Sinuon M, Odermatt P, Nawa Y, Liang S, Brindley PJ, Sripa B. (2012). The current status of opisthorchiasis and clonorchiasis in the Mekong Basin. *Parasitol Int*. Mar;61(1):10-6. doi: 10.1016/j.parint.2011.08.014. Epub 2011 Aug 25. PMID: 21893213; PMCID: PMC3836690.

Smout, M. J., Laha, T., Mulvenna, J., Sripa, B., Suttiprapa, S., Jones, A., Brindley, P. J., & Loukas, A. (2009). A granulin-like growth factor secreted by the carcinogenic liver fluke, *Opisthorchis viverrini*, promotes proliferation of host cells. *PLoS pathogens*, 5(10), e1000611. <https://doi.org/10.1371/journal.ppat.1000611>

Sobhon, P., & Apinhasmit, W. (1995). *Opisthorchis viverrini*: The tegumental cytoskeleton. *International Journal for Parasitology*, 25(7), 787–796. doi:10.1016/0020-7519(94)00208-6

Sripa, B. (2014). Infectious Diseases and Tropical Disease Pathology: SY16-3 Opisthorchiasis: from pathogenesis to control. *Pathology* 46 Suppl 2, S28.

Sripa, B., & Kaewkes, S. (2000). Localisation of parasite antigens and inflammatory responses in experimental opisthorchiasis. *International Journal for Parasitology*, 30(6), 735–740. Doi: 10.1016/s0020-7519(00)00054-0

Sripa, B., Haswell-Elkins, M. R., & Sinawat, P. (2003). Histological analysis of gallbladder disease in relation to opisthorchiasis in endemic areas of Thailand. *Acta tropica*, 88(3), 239–246. <https://doi.org/10.1016/j.actatropica.2003.09.007>

- Sripa, B., Jumnainsong, A., Tangkawattana, S., & Haswell, M. R. (2018). Immune Response to *Opisthorchis viverrini* Infection and Its Role in Pathology. *Advances in parasitology*, 102, 73–95.
- Sripa, B., Kaewkes, S., Sithithaworn, P., Mairiang, E., Laha, T., Smout, M., ... Brindley, P. J. (2007). Liver fluke induces cholangiocarcinoma. *PLoS medicine*, 4(7), e201. doi:10.1371/journal.pmed.0040201
- Sripa, B., Tangkawattana, S., & Sangnukul, T. (2017). The Lawa model: A sustainable, integrated opisthorchiasis control program using the EcoHealth approach in the Lawa Lake region of Thailand. *Parasitology international*, 66(4), 346–354. doi:10.1016/j.parint.2016.11.013
- Sripa, B., Tangkawattana, S., Laha, T., Kaewkes, S., Mallory, F. F., Smith, J. F., & Wilcox, B. A. (2015). Toward integrated opisthorchiasis control in northeast Thailand: the Lawa project. *Acta tropica*, 141(Pt B), 361–367. doi:10.1016/j.actatropica.2014.07.017
- Srivatanakul, P., Viyanant, V., Kurathong, S., Tiwawech, D. (1985). Enzyme-linked immunosorbent assay for detection of *Opisthorchis viverrini* infection. *Southeast Asian J. Trop. Med. Public Health* 16 (2), 234e239.
- Suttiprapa, S., Loukas, A., Laha, T., Wongkham, S., Kaewkes, S., Gaze, S., ... Sripa, B. (2008). Characterization of the antioxidant enzyme, thioredoxin peroxidase, from the carcinogenic human liver fluke, *Opisthorchis viverrini*. *Molecular and Biochemical Parasitology*, 160(2), 116–122. doi:10.1016/j.molbiopara.2008.04.010
- Suttiprapa, S., Matchimakul, P., Loukas, A., Laha, T., Wongkham, S., Kaewkes, S., Brindley, P. J., & Sripa, B. (2012). Molecular expression and enzymatic characterization of thioredoxin from the carcinogenic human liver fluke *Opisthorchis viverrini*. *Parasitology international*, 61(1), 101–106.
- Szabady, r. L., Yanta, J. H., halladin, D. K., Schofield, M. J., Welch, R. A. (2011). TagA is a secreted protease of *Vibrio cholerae* that specifically cleaves mucin glycoproteins. *Microbiology*, 157(2):516-525.

- Ta, B. T., Nguyen, D. L., Jala, I., Dontumprai, R., Plumworasawat, S., Aighewi, O., ... Suttiprapa, S. (2019). Identification, recombinant protein production, and functional analysis of a M60-like metallopeptidase, secreted by the liver fluke *Opisthorchis viverrini*. *Parasitology International*, 102050. doi:10.1016/j.parint.2019.102050
- Tarang, S., Kumar, S., & Batra, S. K. (2012). Mucins and toll-like receptors: kith and kin in infection and cancer. *Cancer letters*, 321(2), 110–119. <https://doi.org/10.1016/j.canlet.2012.01.040>
- Thamavit, W., Bhamaraprabhat, N., Sahapong, S., Vajrasthira, S., Angsubhakorn, S. (1978). Effects of Dimethylnitrosamine on Induction of Cholangiocarcinoma in *Opisthorchis viverrini*-infected Syrian Golden hamsters. *Cancer Research*, 38(12):4634-4639
- Thuwajit, C., Thuwajit, P., Kaewkes, S., Sripathi, B., Uchida, K., Miwa, M., & Wongkham, S. (2004). Increased cell proliferation of mouse fibroblast NIH-3T3 in vitro induced by excretory/secretory product(s) from *Opisthorchis viverrini*. *Parasitology*, 129(Pt 4), 455–464.
- Viranuvatti, V., Stitnimankarn, T. (1972). Liver fluke infection and infestation in Southeast Asia. In: Popper, H., Schaffner, F. (Eds.), *Progress in Liver Disease*. Grune & Stratton, New York, pp. 537e547.
- Wongratanacheewin, S., Sermswan, R. W., & Sirisinha, S. (2003). Immunology and molecular biology of *Opisthorchis viverrini* infection. *Acta tropica*, 88(3), 195–207.
- Worasith, C., Kamamia, C., Yakovleva, A., Duenngai, K., Wangboon, C., Sithithaworn, J., ... Bethony, J. M. (2015). Advances in the Diagnosis of Human Opisthorchiasis: Development of *Opisthorchis viverrini* Antigen Detection in Urine. *PLOS Neglected Tropical Diseases*, 9(10), e0004157. doi:10.1371/journal.pntd.0004157