

Bile Acids as Regulators of Inflammation

By Steven Sandberg-Lewis, ND, DHANP

Complete References

1. Ridlon JM, Bajaj JS. The human gut sterolbiome: bile acid microbiome endocrine aspects and therapeutics. *Acta Pharm Sin B*. 2015 Mar;5(2):99-105.
2. Staudinger JL, et al. The nuclear receptor PXR is a lithocholic acid sensor that protects against liver toxicity. *Proc Natl Acad Sci USA*. 2001;98:3369 – 3374.
3. Moore LB, et al. Pregnane X receptor (PXR), constitutive androstane receptor (CAR), and benzoate X receptor (BXR) define three pharmacologically distinct classes of nuclear receptors. *Mol Endocrinol*. 2002;16:977 – 986.
4. Li C, et al, Bile Acids and Farnesoid X Receptor: Novel Target for the Treatment of Diabetic Cardiomyopathy. *Curr Protein Pept Sci*. 2019;20(10):976-983.
5. Chávez-Talavera O, et al. Bile Acid Control of Metabolism and Inflammation in Obesity, Type 2 Diabetes, Dyslipidemia, and Nonalcoholic Fatty Liver Disease. *Gastroenterology*. 2017 May;152(7):1679-1694.e3.
6. Zhu J.-B., et al. Farnesoid X Receptor agonist obeticholic acid inhibits renal inflammation and oxidative stress during lipopolysaccharide-induced acute kidney injury. *Eur J Pharmacol*. 2018;838:60 – 68.
7. Fei J, et al. Obeticholic acid alleviate lipopolysaccharide induced acute lung injury via its anti-inflammatory effects in mice. *Int Immunopharmacol*. 2019;66:177 – 184.
8. Giaginis C, et al. High Farnesoid X Receptor (FXR) expression is a strong and independent prognosticator in invasive breast carcinoma. *Neoplasma*. 2017;64:633 – 639.
9. Zhang R J, et al. Farnesoid X receptor regulates vascular reactivity through nitric oxide mechanism. *Physiol Pharmacol*. 2012 Aug;63(4):367-72.
10. Huang C, et al. Identification of functional Farnesoid X Receptors in brain neurons. *FEBS Lett*. 2016;590: 3233 – 3242.
11. Massafra V, et al. Splenic dendritic cell involvement in FXR mediated amelioration of DSS colitis. *Biochim Biophys Acta (BBA)-Mol. Basis Dis*. 2016;1862:166 – 173.
12. Fiorucci S, et al. Activation of the Farnesoid-X Receptor protects against gastrointestinal injury caused by non steroidal anti-inflammatory drugs in mice. *Br J Pharmacol*. 2011;164:1929 – 1938.
13. Nijmeijer RM, et al. Farnesoid X Receptor (FXR) Activation and FXR Genetic Variation in Inflammatory Bowel Disease. *PLoS ONE*. 2011;6:e23745.
14. Attinkara R, et al. The Swiss IBD Cohort Study Group Association of genetic variation in the NR1H4 gene, encoding the nuclear bile acid receptor FXR, with inflammatory bowel disease. *BMC Res Notes*. 2012;5:461.
15. Eloranta JJ, Kullak-Ublick GA. The role of FXR in disorders of bile acid homeostasis. *Physiology (Bethesda)* 2008;23:286 – 295.



Bile Acids as Regulators of Inflammation

16. Inagaki T, et al. Regulation of antibacterial defense in the small intestine by the nuclear bile acid receptor. *Proc Natl Acad Sci U S A*. 2006;103:3920 – 3925.
17. Monaghan T, et al. Effective fecal microbiota transplantation for recurrent *Clostridioides difficile* infection in humans is associated with increased signalling in the bile acid Farnesoid X Receptor-fibroblast growth factor pathway. *Gut Microbes*. 2019;10:142 – 148.
18. Winston JA, et al. Ursodeoxycholic Acid (UDCA) Mitigates the Host Inflammatory Response during *Clostridioides difficile* Infection by Altering Gut Bile Acids. *Infect Immun*. 2020;88:e00045-20.
19. Liu H-M, Liao J-F, Lee T-Y. Farnesoid X Receptor agonist GW4064 ameliorates lipopolysaccharide-induced ileocolitis through TLR4/MyD88 pathway related mitochondrial dysfunction in mice. *Biochem Biophys Res Commun*. 2017;490:841 – 848.
20. Fiorucci S, et al, Bile Acid Signaling in Inflammatory Bowel Diseases. *Dis Sci*. 2021; 66(3): 674 – 693.
21. Kuhre RE, et al. Bile acids are important direct and indirect regulators of the secretion of appetite- and metabolism regulating hormones from the gut and pancreas. *Mol Metab*. 2018 May;11:84-95.
22. Rizzetto L, Fava F, Tuohy KM, Selmi C, Connecting the immune system, systemic chronic inflammation and the gut microbiome: The role of sex. *J Autoimmun*. 2018 Aug;92:12-34.
23. Prosberg M, et al. The association between the gut microbiota and the inflammatory bowel disease activity: a systematic review and meta-analysis. *Scand J Gastroenterol*. 2016 Dec;51(12):1407-1415.
24. Zhao H, et al. Systematic review and meta-analysis of the role of *Faecalibacterium prausnitzii* alteration in inflammatory bowel disease. *J Gastroenterol Hepatol*. 2021 Feb;36(2):320-328.
25. Winston JA, et al. Ursodeoxycholic Acid (UDCA) Mitigates the Host Inflammatory Response during *Clostridioides difficile* Infection by Altering Gut Bile Acids. *Infect Immun*. 2020;88:e00045-20.
26. Higuera-de la Tijera F, Servin-Caamano AI. Pathophysiological mechanisms involved in non-alcoholic steatohepatitis and novel potential therapeutic targets. *World J Hepat*. 2015 Jun 8;7(10):1297-301.
27. Willart MAM, et al. Ursodeoxycholic acid suppresses eosinophilic airway inflammation by inhibiting the function of dendritic cells through the nuclear farnesoid X receptor. *Allergy*. 2012 Dec;67(12):1501-10.
28. Bernardes-Silva CF, et al. Ursodeoxycholic acid ameliorates experimental ileitis counteracting intestinal barrier dysfunction and oxidative stress. *Dig Dis Sci*. 2004 Oct;49(10):1569-74.
29. Stefaniwsky AB, et al. Ursodeoxycholic acid treatment of bile reflux gastritis. *Gastroenterology*. 1985 Nov;89(5):1000-4.
30. Vang S, et al. The Unexpected Uses of Urso- and Tauroursodeoxycholic Acid in the Treatment of Non-liver Diseases. *Glob Adv Health Med*. 2014 May;3(3):58-69.
31. Zangerolamo L, et al. The bile acid TUDCA and neurodegenerative disorders: An overview. *Life Sci*. 2021 May 1;272:119252.
32. Rodrigues CMP, et al. Neuroprotection by a bile acid in an acute stroke model in the rat. *J Cereb Blood Flow Metab*. 2002 Apr;22(4):463-71.

Bile Acids as Regulators of Inflammation

33. Rivard AL, et al. Administration of tauroursodeoxycholic acid (TUDCA) reduces apoptosis following myocardial infarction in rat. *Am J Chin Med.* 2007;35(2):279-95.
34. Rodrigues CMP, et al. Neuroprotection by a bile acid in an acute stroke model in the rat. *J Cereb Blood Flow Metab.* 2002 Apr;22(4):463-71.
35. von Haehling S, et al. Ursodeoxycholic acid in patients with chronic heart failure: a double-blind, randomized, placebo controlled, crossover trial. *J Am Coll Cardiol.* 2012 Feb 7;59(6):585-92.