

The Developing Microbiome in the Perinatal and Neonatal Periods

Aagaard K, Ma J, Antony KM, Ganu R, Petrosino J, Versalovic J. The placenta harbors a unique microbiome. *Sci Transl Med.* 2014 May 21;6(237):237ra65. doi: 10.1126/scitranslmed.3008599. PMID: 24848255; PMCID: PMC4929217.

Arboleya S, Sánchez B, Solís G, Fernández N, Suárez M, et al. Impact of Prematurity and Perinatal Antibiotics on the Developing Intestinal Microbiota: A Functional Inference Study. *Int J Mol Sci.* 2016 Apr 29;17(5):649. doi: 10.3390/ijms17050649. PMID: 27136545; PMCID: PMC4881475.

Ardissone S, Fumeaux C, Bergé M, Beaussart A, Théraulaz L, et al. Cell cycle constraints on capsulation and bacteriophage susceptibility. *eLife.* 2014 Nov 25;3:e03587. doi: 10.7554/eLife.03587. PMID: 25421297; PMCID: PMC4241560.

Bauer H, Horowitz RE, Levenson SM, Popper H. The response of the lymphatic tissue to the microbial flora. Studies on germfree mice. *Am J Pathol.* 1963 Apr;42(4):471-83. PMID: 13966929; PMCID: PMC1949649.

Cantey JB, Pyle AK, Wozniak PS, Hynan LS, Sánchez PJ. Early Antibiotic Exposure and Adverse Outcomes in Preterm, Very Low Birth Weight Infants. *J Pediatr.* 2018 Dec;203:62-67. doi: 10.1016/j.jpeds.2018.07.036. Epub 2018 Aug 29. PMID: 30172430.

DiGiulio DB, Romero R, Amogan HP, Kusanovic JP, Bik EM, et al. Microbial prevalence, diversity and abundance in amniotic fluid during preterm labor: a molecular and culture-based investigation. *PLoS One.* 2008 Aug 26;3(8):e3056. doi: 10.1371/journal.pone.0003056. PMID: 18725970; PMCID: PMC2516597.

Dominguez-Bello MG, Costello EK, Contreras M, Magris M, Hidalgo G, et al. Delivery mode shapes the acquisition and structure of the initial microbiota across multiple body habitats in newborns. *Proc Natl Acad Sci U S A.* 2010 Jun 29;107(26):11971-5. doi: 10.1073/pnas.1002601107. Epub 2010 Jun 21. PMID: 20566857; PMCID: PMC2900693.

Dominguez-Bello MG, De Jesus-Laboy KM, Shen N, Cox LM, Amir A, et al. Partial restoration of the microbiota of cesarean-born infants via vaginal microbial transfer. *Nat Med.* 2016 Mar;22(3):250-3. doi: 10.1038/nm.4039. Epub 2016 Feb 1. PMID: 26828196; PMCID: PMC5062956.

Doolittle, W.F., Booth, A. It's the song, not the singer: an exploration of holobiosis and evolutionary theory. *Biol Philos* **32**, 5–24 (2017). <https://doi.org/10.1007/s10539-016-9542-2>

Esaïassen E, Fjalstad JW, Juvet LK, van den Anker JN, Klingenberg C. Antibiotic exposure in neonates and early adverse outcomes: a systematic review and meta-analysis. *J Antimicrob Chemother.* 2017 Jul 1;72(7):1858-1870. doi: 10.1093/jac/dkx088. PMID: 28369594.

Flannery DD, Dysart K, Cook A, Greenspan J, Aghai ZH, Jensen EA. Association between early antibiotic exposure and bronchopulmonary dysplasia or death. *J Perinatol.* 2018 Sep;38(9):1227-1234. doi: 10.1038/s41372-018-0146-3. Epub 2018 Jun 13. PMID: 29895965; PMCID: PMC6195849.

Gilbert SF. A holobiont birth narrative: the epigenetic transmission of the human microbiome. *Front Genet.* 2014 Aug 19;5:282. doi: 10.3389/fgene.2014.00282. PMID: 25191338; PMCID: PMC4137224.



Center for
Research, Education, Quality & Safety

Gomez de Agüero M, Ganal-Vonarburg SC, Fuhrer T, Rupp S, Uchimura Y, et al. The maternal microbiota drives early postnatal innate immune development. *Science*. 2016 Mar 18;351(6279):1296-302. doi: 10.1126/science.aad2571. PMID: 26989247.

Koren O, Goodrich JK, Cullender TC, Spor A, Laitinen K, et al. Host remodeling of the gut microbiome and metabolic changes during pregnancy. *Cell*. 2012 Aug 3;150(3):470-80. doi: 10.1016/j.cell.2012.07.008. PMID: 22863002; PMCID: PMC3505857.

Madara J. Building an intestine--architectural contributions of commensal bacteria. *N Engl J Med*. 2004 Oct 14;351(16):1685-6. doi: 10.1056/NEJMcibr042621. PMID: 15483290.

Martinez FE, Ferri WAG, Leone CR, de Almeida MFB, Guinsburg R, et al; for Brazilian Neonatal Research Network. Early Empiric Antibiotic Use Is Associated With Delayed Feeding Tolerance in Preterm Infants: A Retrospective Analysis. *J Pediatr Gastroenterol Nutr*. 2017 Jul;65(1):107-110. doi: 10.1097/MPG.0000000000001490. PMID: 28644358.

Maynard CL, Elson CO, Hatton RD, Weaver CT. Reciprocal interactions of the intestinal microbiota and immune system. *Nature*. 2012 Sep 13;489(7415):231-41. doi: 10.1038/nature11551. PMID: 22972296; PMCID: PMC4492337.

Neish AS. Microbes in gastrointestinal health and disease. *Gastroenterology*. 2009 Jan;136(1):65-80. doi: 10.1053/j.gastro.2008.10.080. Epub 2008 Nov 19. PMID: 19026645; PMCID: PMC2892787.

Neu J, Walker WA. Necrotizing enterocolitis. *N Engl J Med*. 2011 Jan 20;364(3):255-64. doi: 10.1056/NEJMra1005408. PMID: 21247316; PMCID: PMC3628622.

Novitsky A, Tuttle D, Locke RG, Saiman L, Mackley A, Paul DA. Prolonged early antibiotic use and bronchopulmonary dysplasia in very low birth weight infants. *Am J Perinatol*. 2015 Jan;32(1):43-8. doi: 10.1055/s-0034-1373844. Epub 2014 May 2. PMID: 24792766.

Pammi M, Cope J, Tarr PI, Warner BB, Morrow AL, et al. Intestinal dysbiosis in preterm infants preceding necrotizing enterocolitis: a systematic review and meta-analysis. *Microbiome*. 2017 Mar 9;5(1):31. doi: 10.1186/s40168-017-0248-8. PMID: 28274256; PMCID: PMC5343300.

Preidis GA, Versalovic J. Targeting the human microbiome with antibiotics, probiotics, and prebiotics: gastroenterology enters the metagenomics era. *Gastroenterology*. 2009 May;136(6):2015-31. doi: 10.1053/j.gastro.2009.01.072. PMID: 19462507; PMCID: PMC4108289.

Rakoff-Nahoum S, Paglino J, Eslami-Varzaneh F, Edberg S, Medzhitov R. Recognition of commensal microflora by toll-like receptors is required for intestinal homeostasis. *Cell*. 2004 Jul 23;118(2):229-41. doi: 10.1016/j.cell.2004.07.002. PMID: 15260992.

Roy CC, Kien CL, Bouthillier L, Levy E. Short-chain fatty acids: ready for prime time? *Nutr Clin Pract*. 2006 Aug;21(4):351-66. doi: 10.1177/0115426506021004351. PMID: 16870803.

Shao Y, Forster SC, Tsaliki E, Vervier K, Strang A, et al. Stunted microbiota and opportunistic pathogen colonization in caesarean-section birth. *Nature*. 2019 Oct;574(7776):117-121. doi: 10.1038/s41586-019-1560-1. Epub 2019 Sep 18. PMID: 31534227; PMCID: PMC6894937.



Center for
Research, Education, Quality & Safety

Ting JY, Synnes A, Roberts A, Deshpandey AC, Dow K, et al; Canadian Neonatal Network and Canadian Neonatal Follow-Up Network. Association of Antibiotic Utilization and Neurodevelopmental Outcomes among Extremely Low Gestational Age Neonates without Proven Sepsis or Necrotizing Enterocolitis. *Am J Perinatol.* 2018 Aug;35(10):972-978. doi: 10.1055/s-0038-1632390. Epub 2018 Feb 23. PMID: 29475201.

Turnbaugh PJ, Bäckhed F, Fulton L, Gordon JI. Diet-induced obesity is linked to marked but reversible alterations in the mouse distal gut microbiome. *Cell Host Microbe.* 2008 Apr 17;3(4):213-23. doi: 10.1016/j.chom.2008.02.015. PMID: 18407065; PMCID: PMC3687783.

Willyard C. Could baby's first bacteria take root before birth? *Nature.* 2018 Jan 18;553(7688):264-266. doi: 10.1038/d41586-018-00664-8. PMID: 29345664.

<https://www.neb.com/tools-and-resources/feature-articles/addressing-challenges-in-microbiome-dna-analysis>