Published in final edited form as:

Birth Defects Res C Embryo Today. 2015 December ; 105(4): 227–. doi:10.1002/bdrc.21119.

Introduction

Sharon B. Meropol, MD, PhD^{1,2,3}, Michiko Watanabe, PhD⁴, and Rocky S. Tuan, PhD^{5,6}

¹Department of Pediatrics, Rainbow Babies and Children's and Hospital, Case Western Reserve University School of Medicine, Cleveland, OH

²The Center for Child Health and Policy, Rainbow Babies and Children's and Hospital, Case Western Reserve University School of Medicine,, Cleveland, OH

³Department of Epidemiology and Biostatistics, Case Western Reserve University School of Medicine, Cleveland, OH

⁴Congenital Heart Collaborative, Department of Pediatrics, UH Rainbow Babies and Children's Hospital, Case Western Reserve University School of Medicine, Cleveland, Oh

⁵Center for Cellular and Molecular Engineering, Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA

⁶Department of Bioengineering, University of Pittsburgh, Pittsburgh, PA

This issue of Birth Defects Research Part C. Embryo Today: Reviews spotlights the role of the microbiome in infant development. The term “microbiome” refers to the trillions of organisms we harbor, on our skin and within our respiratory and gastrointestinal tracts.

Fifteen years ago, Rainbow Babies and Children's visionary physician researchers John Kennell and Lydia Furman (Furman and Kennell, 2000) were early proponents of vaginal delivery, and kangaroo care (skin to skin contact) and breastfeeding immediately following birth, advising that these practices are associated with psychosocial, metabolic and immunologic benefits for full term and premature infants. We now have mounting and compelling evidence that each of these practices is beneficial for intergenerational transfer of the microbiome from mother to infant.

Modern techniques allow us to characterize in detail the diverse universe of our colonizing microorganisms that are ten times more numerous than our own cells. While traditionally these populations were thought of as benign squatters or in some cases harmful, there is increasing evidence that they play fundamental roles in our nascent developing immune and metabolic systems, even during early fetal development. A general theme of this issue's reviews is that the changes in microbiota number and diversity associated with modern

Corresponding author: Sharon B. Meropol, MD, PhD, The Center for Child Health and Policy, Rainbow Babies and Children's Hospital, 11100 Euclid Avenue, Cleveland, OH 44106; Sharon.meropol@uhhospitals.org.

Sharon B. Meropol

Guest Editor

Michiko Watanabe

Guest Editor and Deputy Editor

Rocky S. Tuan

Editor

environmental exposures (e.g., antibiotics, formula feeding, Cesarean section) can create dysbiosis, or alterations of our ancestral processes of microbiome development, with potentially profound downstream adverse consequences; these processes could contribute to the increasing prevalence of immunologic and metabolic conditions in the modern world, such as allergies, asthma, autoinflammatory diseases, and obesity. Of note is the potential link to behavioral and neurodevelopmental outcomes that include autism-like conditions. While our authors focus on the gastrointestinal microbiome, they touch on implications for skin and respiratory microbiota as well.

Meropol and Edwards provide a general overview of the potential influences of the developing infant microbiome, from a clinical perspective. Van Best *et al.* describe the evolutionary factors shaping gastrointestinal microbiome development, highlighting the succession of pioneer gut bacteria. They examine the potential for new treatments for dysbiosis induced by modern exposures, considering novel metabolomics and transcriptomics data. Groer *et al.* take us back to the prenatal period, when the fetal immune system is already being stimulated by maternally-derived bacteria. Unfortunately, the pre-term infant is especially vulnerable to metabolic insult and subsequent developmental derangement. An important role may be played by the mother's own genetic, metabolic and immunologic conditions. Koleva *et al.* offer fascinating details of how placental and amniotic bacteria are already colonizing and interacting with their fetal host, ideally setting the stage for a microbial environment that will promote optimal maturation of infant metabolic and immunologic systems. Bendtson *et al.* focus on the rising prevalence of chronic autoinflammatory diseases in the modern world, such as inflammatory bowel disease and diabetes mellitus. They provide fascinating details of how maternal influences, genetic elements and adverse environmental factors can combine to promote a chronic inflammatory state in the developing infant, mediated by the infant microbiome. Finally, Cryan et al. show how microbiota in early life shape the immune system and hence play a role in a host of disorders that have immune dysregulation. This role includes influencing neurodevelopment and behavior through their interaction with the maturing enteric nervous system.

We have just scratched the surface in understanding how the internal universe of maternal, fetal and infant colonizing microbiota, interacting with genetic and environmental factors, can influence optimal child development. These authors offer a thought-provoking glimpse into this rapidly evolving field.

The Teratology Society presented in 2015 the James G. Wilson Publication Award to Dr. Rodney R. Dietert of Cornell University in recognition of the best paper accepted and published in the journal *Birth Defects Research*, entitled "The Microbiome in Early Life: Self-Completion and Microbiota Protection as Health Priorities" (Dietert, 2015). Dr. Dietert also presented a lecture on the topic at the 2015 Teratology Society Annual Meeting. This reflects the Society's recognition of the crucial importance of this newly evolving story of the microbiome and the explosion in research in this area.

References

1. Dietert RR. The microbiome in early life: self-completion and microbiota protection as health priorities. *Birth Defects Res B Dev Reprod Toxicol.* 2014; 101:333–40. [PubMed: 25044451]
2. Furman L, Kennell J. Breastmilk and skin-to-skin kangaroo care for premature infants. Avoiding bonding failure. *Acta Paediatr.* 2000; 89:1280–1283. [PubMed: 11106036]

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript