A Review on The Intergenerational Transmission of Human Microbiota

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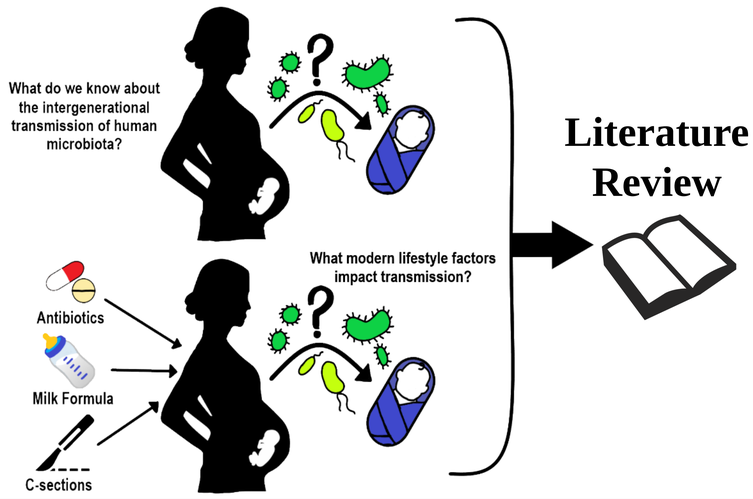
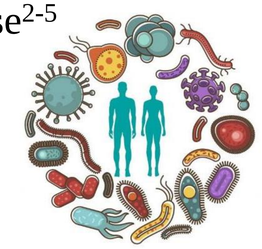
Fig 1. Graphical abstract



Background

Human Microbiome: all of the microbes that populate our bodies throughout our lifetimes. Shown to have a role in our health & disease[1]:

- Inflammatory bowel disease[2-5]
- Type 1 diabetes[6]
- Celiac disease[7-9]
- Colorectal cancer[10-11]
- Parkinson's disease[12]



Research Questions: What do we know of how are human microbes transmitted intergenerationally? What impacts transmission? (Fig 1)

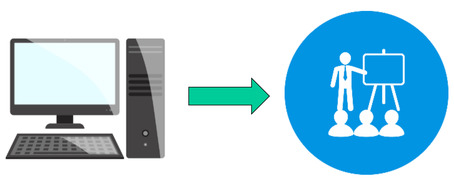
Project Aims

1) Collaborate in writing a review article.
2) Outline an approximate model of microbe transmission during and shortly after birth.

Methods

1) Gather recent publications using: Rutgers Library Database, PubMed, and EBSCO.

2) Summarize findings in a visual model.



Results

We have started drafting a review and outlining the model of transmission (Fig 2):

- Neonates are not born sterile because they are colonized during birth [13,14, 15-18] not in utero[19-21]
- They obtain primordial microbes from the mother through the matrilineal line[15-18]
- After birth, transmission happens through breastfeeding, family members and hospital rooms.[17,23-25]
- 3 month old infant guts are primarily colonized by Actinobacteria, Bacteroidetes and Proteobacteria phyla.[22]

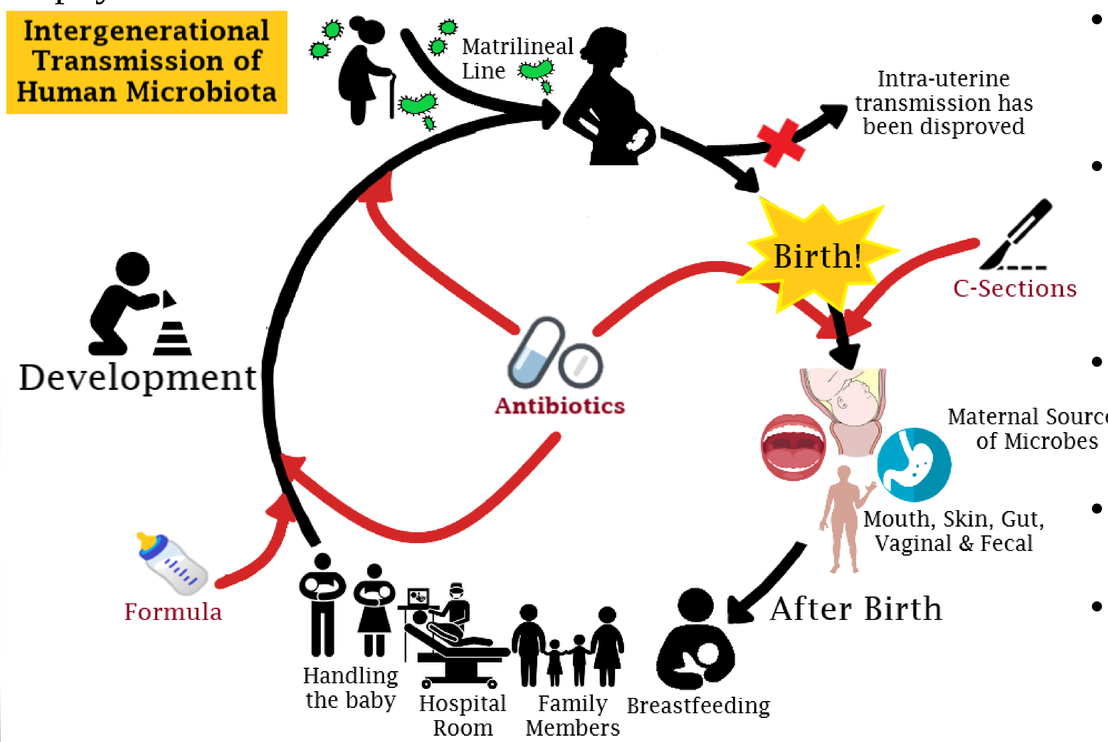


Fig 2. Intergenerational transmission of human microbes and microbiota stressors

- Modern life factors impact transmission: C-sections, antibiotics, and formula.[16-17,21,24]
- Vaginally born infants obtain vaginal microbes at birth, while C-section infants obtain skin microbes from the OR environment, first.[16]
- Exposure to antibiotics before birth reduces bacterial diversity & potentially leads to obesity.[27]
- Formula disrupts infant's intestinal microbiome colonization.[17,23]
- Pumped breastmilk has been associated with reduced *Streptococcus spp.* and *Veillonella dispar* in infant stool.[28]

Next Steps

With my project, I helped progress the writing of a review and outlined a model for transmission that includes some impact factors. Yet, other factors (diet, sleep disruption, hygiene) and the potentially restorative effects of direct breastfeeding remain to be explored.

References

1. Group, N.H.W., et al., *The NIH Human Microbiome Project.* Genome Res, 2009. **19**(12): p. 2317-23.
2. Machiels, K., et al., Gut, 2014. **63**(8): p. 1275-83.
3. Png, C.W., et al.,. Am J Gastroenterol, 2010. **105**(11): p. 2420-8.
4. Sokol, H., et al., Proc Natl Acad Sci U S A, 2008. **105**(43): p. 16731-6.
5. Willing, B.P., et al., Gastroenterology, 2010. **139**(6): p. 1844-1854 e1.
6. Murri, M., et al., BMC Med, 2013. **11**: p. 46.
7. De Palma, G., et al., BMC Microbiol, 2010. **10**: p. 63.
8. Nadal, I., et al., J Med Microbiol, 2007. **56**(Pt 12): p. 1669-1674.
9. Tjellstrom, B., et al., Am J Gastroenterol, 2005. **100**(12): p. 2784-8.
10. Wang, T., et al., ISME J, 2012. **6**(2): p. 320-9.
11. Wu, N., et al., Microb Ecol, 2013. **66**(2): p. 462-70.
12. Keshavarzian, A., et al., Mov Disord, 2015. **30**(10): p. 1351-60.
13. Escherich, T., Rev Infect Dis, 1988. **10**(6): p. 1220-5.
14. Bokulich, N.A., et al., Sci Transl Med, 2016. **8**(343): p. 343ra82.
15. Dominguez-Bello, M.G., et al., Gut, 2019. **68**(6): p. 1108-1114.
16. Dominguez-Bello, M.G., et al., Proc Natl Acad Sci U S A, 2010. **107**(26): p. 11971-5.
17. Palmer, C., et al., PLoS Biol, 2007. **5**(7): p. e177.
18. Biasucci, G., et al., Early Hum Dev, 2010. **86 Suppl 1**: p. 13-5.
19. Perez-Munoz, M.E., et al., Microbiome, 2017. **5**(1): p. 48.
20. Aagaard, K., et al., Sci Transl Med, 2014. **6**(237): p. 237ra65.
21. Stinson, L.F., et al., Front Microbiol, 2019. **10**: p. 1124.
22. Yassour, M., et al., Cell Host Microbe, 2018. **24**(1): p. 146-154 e4.
23. Knol, J., et al.,. J Pediatr Gastroenterol Nutr, 2005. **40**(1): p. 36-42.
24. Korpela, K., et al., Genome Res, 2018. **28**(4): p. 561-568.
25. Brooks, B., et al., Nat Commun, 2017. **8**(1): p. 1814.
26. Keski-Nisula, L., et al., Acta Paediatr, 2013. **102**(5): p. 480-5
27. Mueller, N.T., et al., Int J Obes (Lond), 2015. **39**(4): p. 665-70.
28. Fehr, K., et al., Cell Host Microbe, 2020.

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