

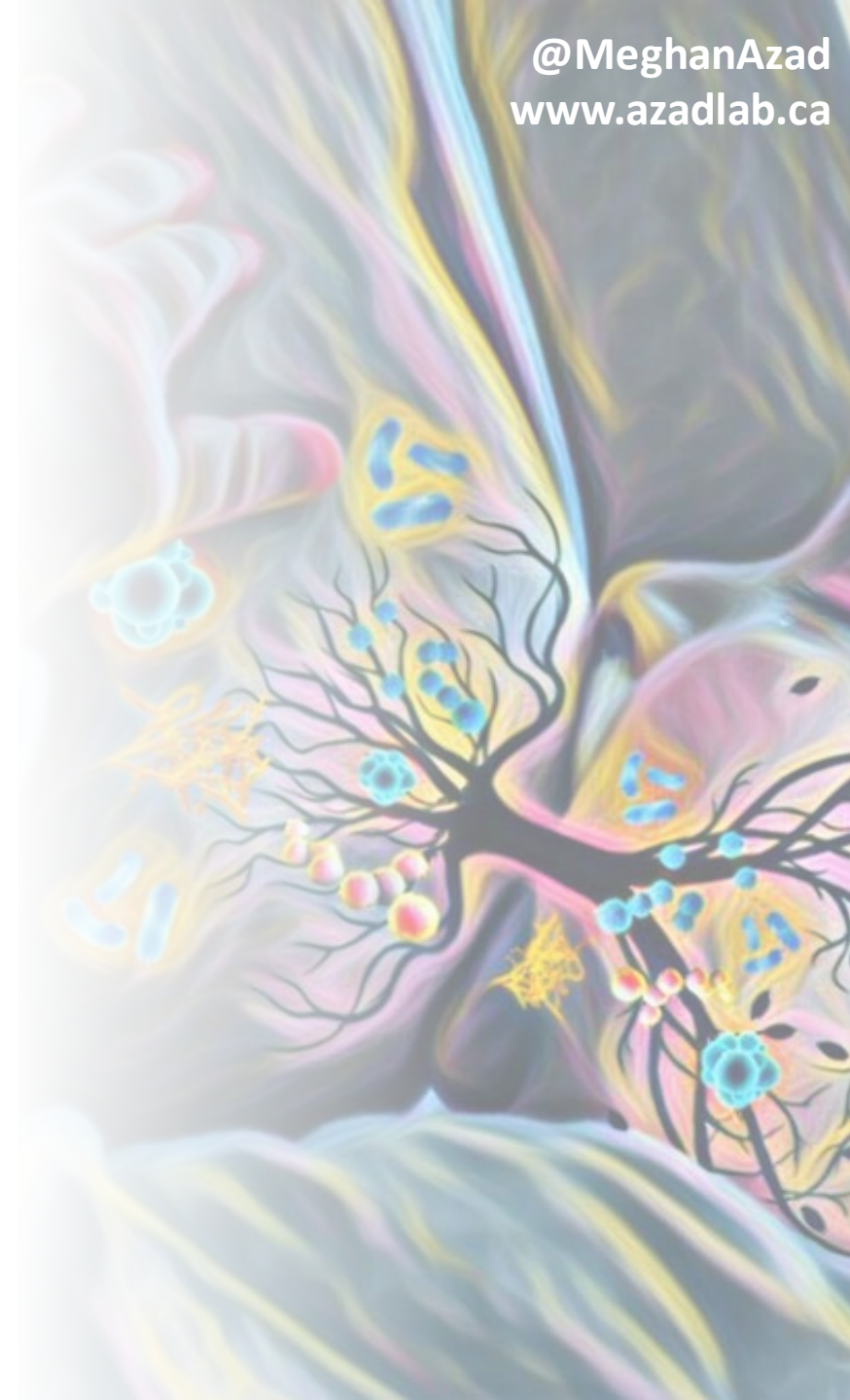
Human Milk: The Ultimate Superfood & Personalized Medicine

Meghan Azad, PhD

Canada Research Chair, Developmental Origins of Chronic Disease
Co-Director, Manitoba Interdisciplinary Lactation Centre (MILC)
Scientific Director, International Milk Composition Consortium (IMiC)
Deputy Director, CHILD Cohort Study



Meghan Azad



Disclosures

Research grants:

- ▣ Canadian Institutes of Health Research
- ▣ Allergy Genes and Environment (AllerGen) Network of Centers of Excellence
- ▣ Canadian Lung Association
- ▣ Research Manitoba
- ▣ Children's Hospital Foundation of Manitoba
- ▣ Prolacta Biosciences
- ▣ Bill and Melinda Gates Foundation
- ▣ Canada Foundation for Innovation
- ▣ W. Garfield Weston Foundation
- ▣ Health Data Research UK
- ▣ Canadian COVID Immunity Task Force

Unrestricted research funding:

- ▣ Canada Research Chairs Program
- ▣ Healthy Child Manitoba Office, Government of Manitoba
- ▣ Canadian Institute for Advanced Research (CIFAR)

Advisory Committee Membership:

- ▣ Malaika Vx

Conference presentation honoraria:

- ▣ Prolacta Biosciences

Last 3 years (Apr 2021)

personalized medicine

Meghan Azad

*“Human breastmilk is not only a perfectly adapted nutritional supply for the infant, but probably the most specific **personalized medicine** that he or she is likely to receive, given at a time when gene expression is being **fine tuned for life.**”*

Victora et al.
The Lancet
Breastfeeding Series (2016)



gairdner
LES PRIX CANADA GAIRDNER AWARDS

CESAR VICTORA, WINNER OF THE JOHN DIRKS CANADA GAIRDNER GLOBAL
HEALTH AWARD

Breastmilk is Superfood for Babies

naturemoms.com

Colostrum



The
Original
Liquid
Gold

I make milk.
What's **your** superpower?



© UNICEF/UNI122810/ASSELIN



**BREASTMILK
IS A BABY'S**



**FIRST
VACCINE.**

Breastmilk is Superfood for Babies

“Milk is really a genius fluid that was outrageously understudied. If we can identify components of human breast milk that are important, then we can understand the wisdom of milk—and take advantage of them.”

David Mills, UC Davis

Meghan Azad

Breast milk supplies more than just nutrition for babies.

Nature's first functional food

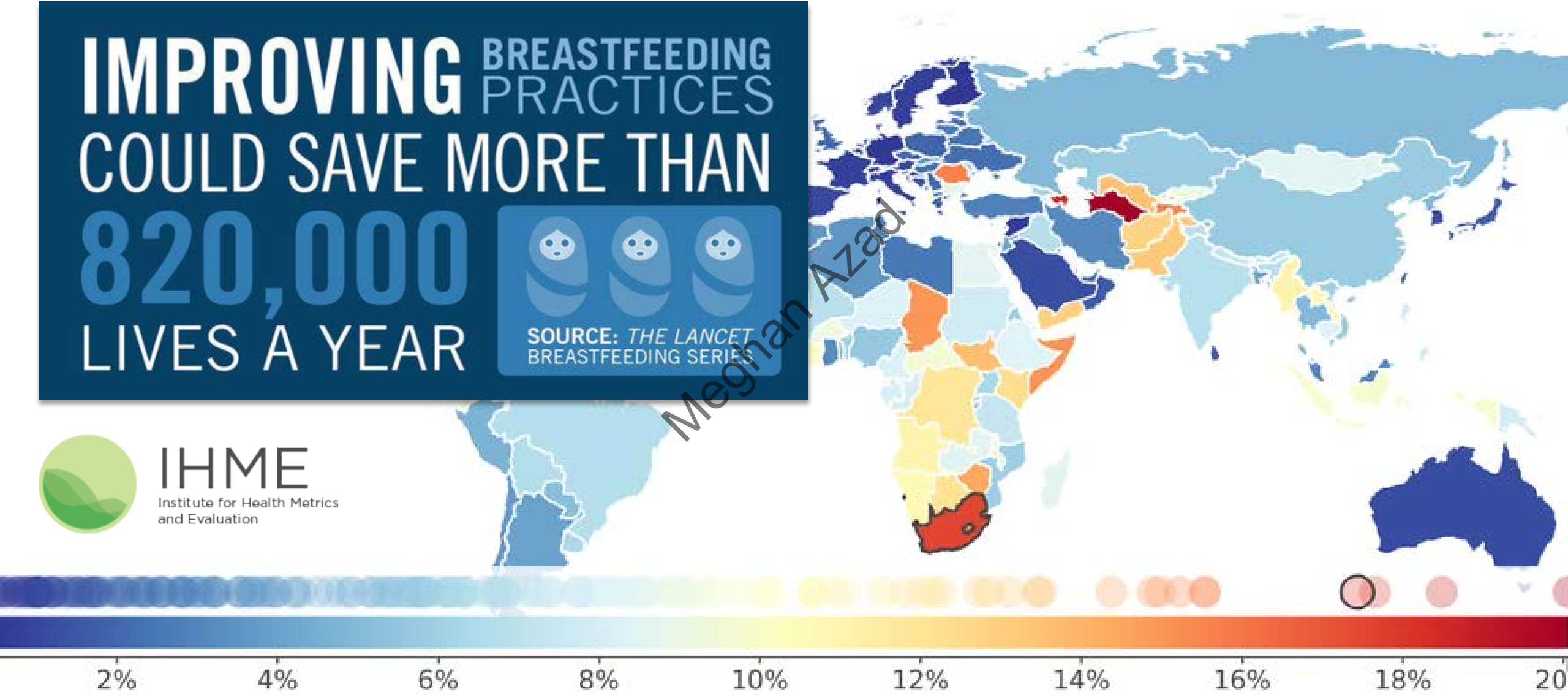
Breast milk feeds helpful microbes, fights harmful ones, provides immunity, and jump-starts a newborn's life

ing explored once again. Scientists have focused on making better microbiome fostered by milk have documented how breast milk more than feed a newborn with bacteria. Mother's milk also

Child **mortality** (<5 years) attributable to **suboptimal breastfeeding** (2013)

IMPROVING BREASTFEEDING PRACTICES
COULD SAVE MORE THAN
820,000
LIVES A YEAR

SOURCE: THE LANCET BREASTFEEDING SERIES



Eight Great Reasons to Breastfeed Your Baby

#1 It's Convenient - Breast milk is always quick, clean, the right temperature and available.

#2 It's Perfect Food For Babies - Breast milk gives your baby exactly what he or she needs to grow and develop.

#3 Breastfed Babies Are Healthier - Breast milk contains antibodies that help a baby have fewer infections and allergies. It is easier to digest so your baby will have less diarrhea and constipation.

#4 Moms Are Healthier, Too - Medical research has linked breastfeeding to lowered risk of breast and ovarian cancer.

#5 Mom Gets Back Into Shape Faster - Breastfeeding burns extra calories and triggers the uterus to contract and return to its normal shape more quickly.

#6 It's Better For The Planet - Breastfeeding is never wasteful. Formula feeding results in discarded cans and bottles.

#7 Breastfeeding Builds Love - Skin-to-skin contact brings you and your baby close. It helps your baby feel secure.

#8 Breastfeeding Saves Money - Breastfeeding helps the family budget, by saving over \$1000 a year compared to formula.



Risk of
SIDS

36%



Respiratory
tract
infections

72%



Type 1
Diabetes

30%



Obesity
in adolescence
or adulthood

15-
30%

Eight Great Reasons to Breastfeed Your Baby

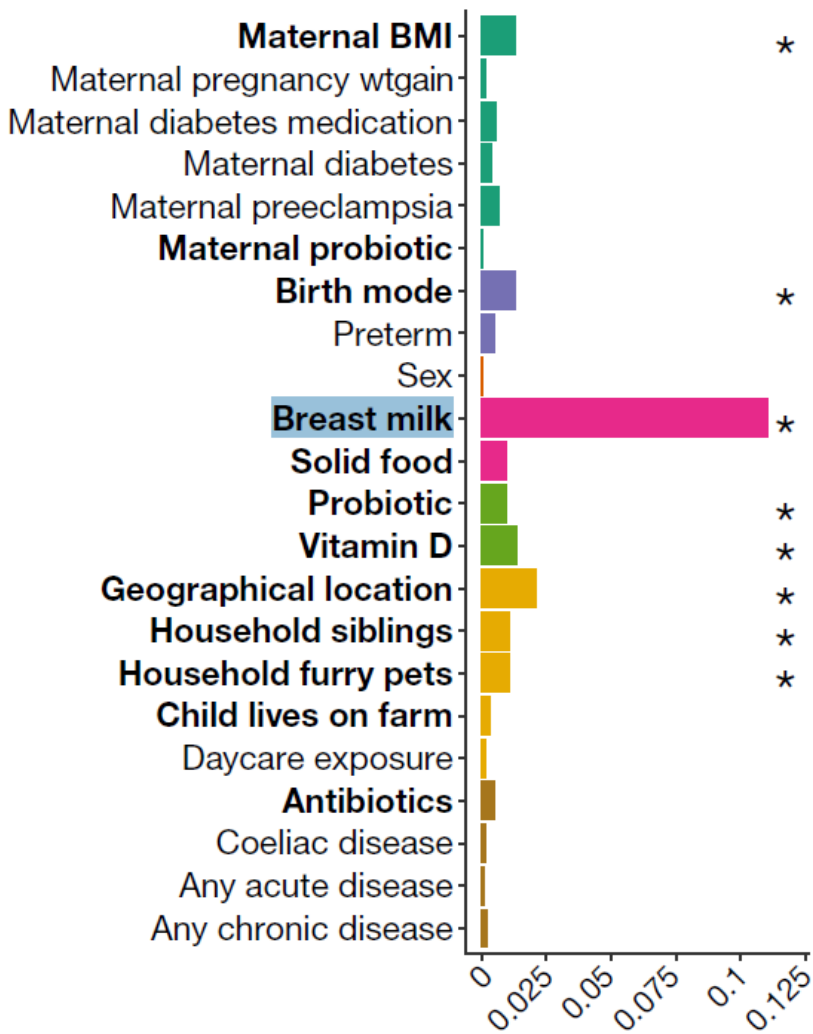
Nine



Azad et al. 2013 - CHILD



Stewart et al. 2018 - TEDDY



Developmental Origins of Health and Disease (DOHaD) and the Microbiome



Obesity
Allergies
Asthma
Diabetes
Cardiovascular Disease
Mental Disorders
etc...



*What happens
in the first 1000
days lasts a
lifetime*



*“Human breastmilk is not only a perfectly adapted nutritional supply for the infant, but probably the most specific **personalized medicine** that he or she is likely to receive, given at a time when gene expression **[and the microbiome]** is being **fine tuned for life.**”*

Victora et al.
The Lancet Breastfeeding
Series (2016)





Name
something
found in
human milk
that is not
found in
infant formula

DID YOU EVER WONDER WHAT'S IN... ?

BREASTMILK

WATER

CARBOHYDRATES (energy source)

Lactose

Oligosaccharides (see below)

CARBOXYLIC ACID

Alpha hydroxy acid

Lactic acid

PROTEINS

(building muscles and bones)

Whey protein

Alpha lactalbumin

HAALET (human Alpha lactalbumin)

Made (refers to Tumour cells)

Lactoferrin

Many antimicrobial factors (see below)

Casien

Serum albumin

NON-PROTEIN NITROGENS

Creatine

Urea

Uric acid

Peptides (see below)

Amino Acids (the building blocks of proteins)

Alanine

Arginine

Aspartate

Cysteine

Glutamine

Glutamate

Isoleucine

Leucine

Lysine

Methionine

Phenylalanine

Proline

Serine

Threonine

Tyrosine

Valine

Carbamide (amino acid compound necessary to make use of fatty acids as an energy source)

Nucleotides (chemical compounds that are the structural units of DNA and RNA)

Adenosine monophosphate (5'-AMP)

3'-Cyclic adenosine monophosphate (3'-cyclic AMP)

5'-Cytidine monophosphate (5'-CMP)

Cytidine diphosphate choline (CDP-choline)

Guanosine diphosphate (GDP)

Guanosine diphosphate (GMP)

3'-Uridine monophosphate (3'-UMP)

5'-Uridine monophosphate (5'-UMP)

Uridine diphosphate (UDP)

Uridine diphosphate hexose (UDH)

Uridine diphosphate inositol (UDIP)

Uridine diphosphate uronic acid (UDPGA)

Several more nucleotides of the UDP type

FATS

Triglycerides

Long chain polyunsaturated fatty acids

Docosahexaenoic acid (DHA) (important for brain development)

Arachidonic acid (ARA) (important for brain development)

Unsaturated fatty acids

Alpha hydroxy acid (AHA)

Essential fatty acids (EFA)

Conjugated linoleic acid (CLA)

Free Fatty Acids

Monounsaturated fatty acids

Oleic acid

Palmitic acid

Heptadecanoic acid

Saturated fatty acids

Stearic

Palmitic acid

Lauroic acid

Myristic acid

Phospholipids

Phosphatidylcholine

Phosphatidylethanolamine

Phosphatidylserine

Phosphatidylcholine

Phosphatidylethanolamine

Phospholipids

Sphingolipids

Sphingomyelin

Gangliosides

Glycosphingolipids

Glycosphingolipids

Lactosylceramide

Globosylceramide (GB)

Glycoside (GB)

Sterols

Squalene

Lanosterol

Dimethylsterol

Hexosterol

Luposterol

Desmosterol

Stigmasterol

Cholesterol

7-dehydrocholesterol

Stigma and campesterol

7-cholesterol

beta-sitosterol

Vitamin D metabolites

Steroid hormones

VITAMINS

Vitamin A

Beta carotene

Vitamin B6

Vitamin B12 (Inositol)

Vitamin B2

Vitamin C

Vitamin D

Vitamin E

Vitamin K

Thiamine

Biotin

Niacin

Folic acid

Pantothenic acid

Biotin

Minerals

Sodium

Potassium

Iron

Calcium

Chloride

Phosphorus

Magnesium

Copper

Manganese

Iodine

Selenium

Chromium

Sulphur

Chromium

Cobalt

Ruineer

Nickel

Metal

Molybdenum (essential element in many enzymes)

Growth factors

(aid in the maturation of the intestinal lining)

Cytokines

Interleukin-1 (IL-1)

IL-2

IL-4

IL-6

IL-8

IL-10

Granulocyte colony stimulating factor (G-CSF)

Macrophage colony stimulating factor (M-CSF)

Platelet derived growth factor (PDGF)

Vascular endothelial growth factor (VEGF)

Hepatocyte growth factor (HGF)

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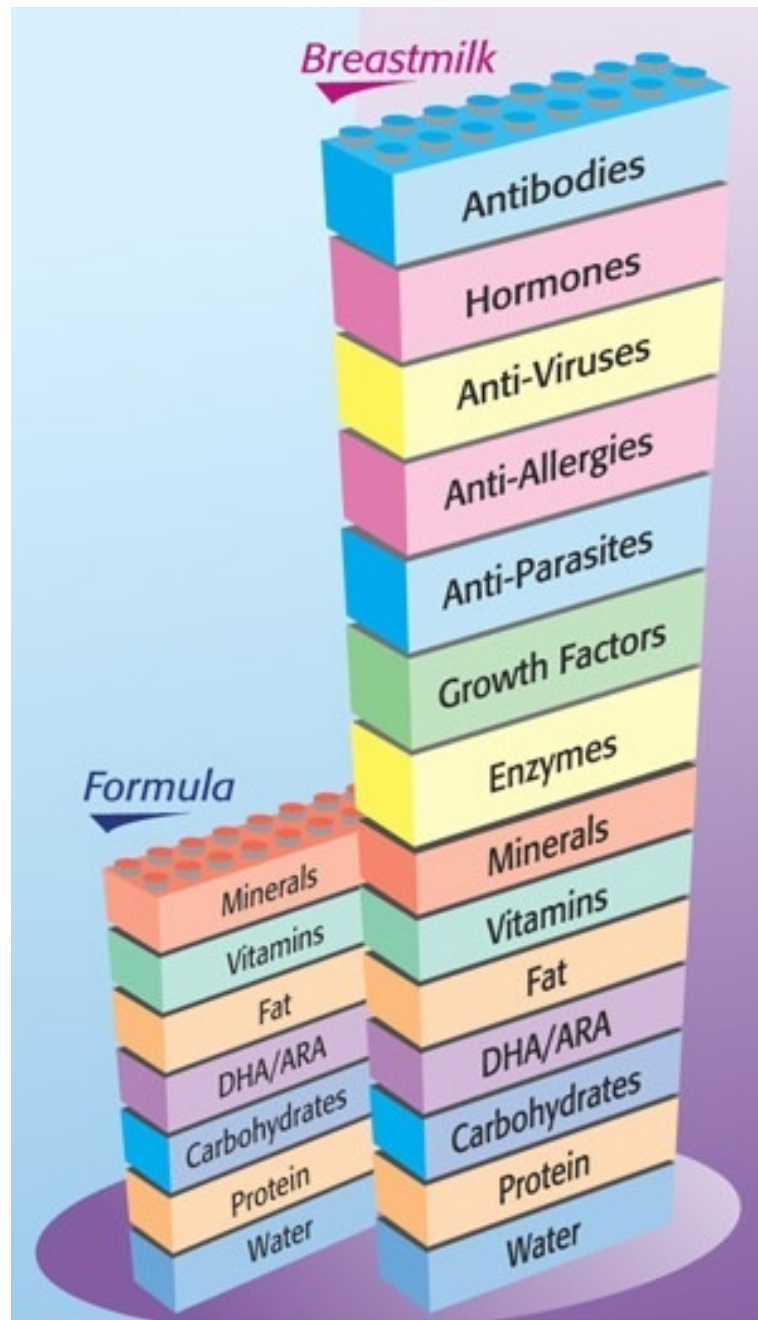
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Hepatocyte growth factor (HGF)

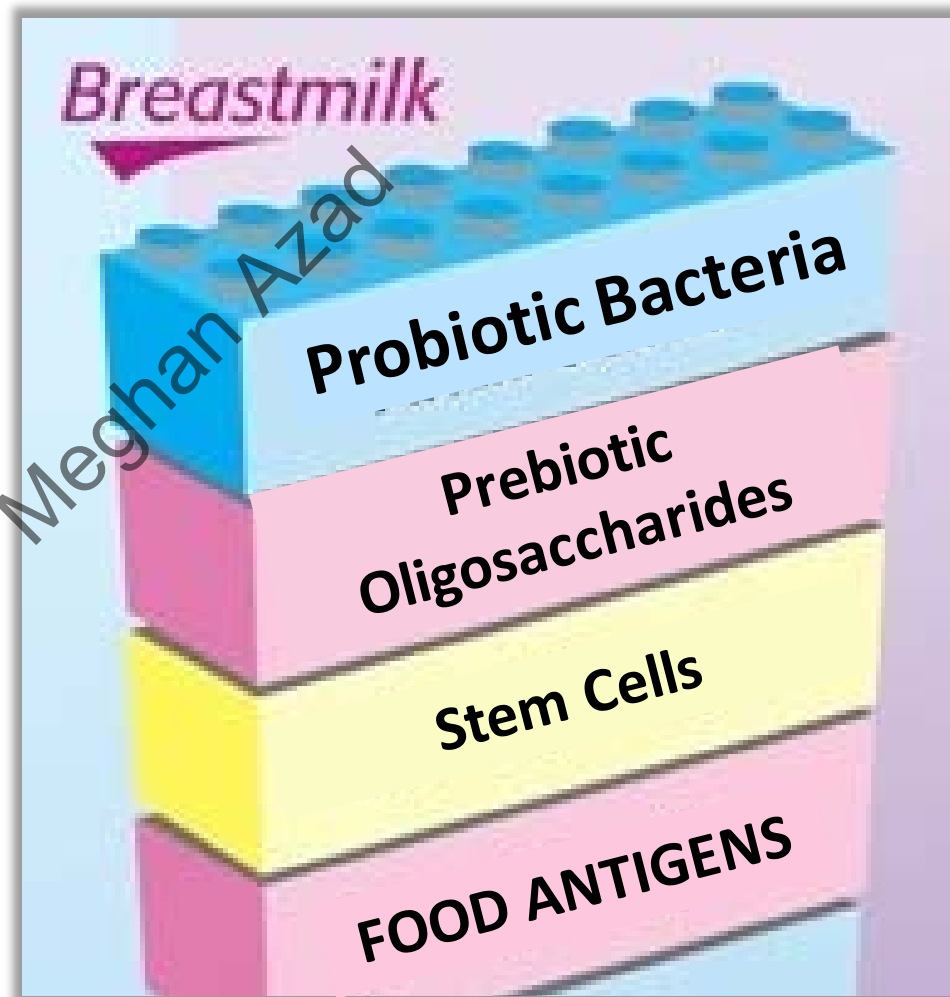
IL-1

IL-2

IL-4



PLUS:



The Canadian Healthy Infant Longitudinal Development (CHILD) Study

How do **genes** and the **environment** influence child health and development?



\$56M	Invested
500,000	Samples:
	Blood, Urine, Stool , Nasal Swabs, Dust, Breast Milk
200,000	Questionnaires
3600	Families
40+	Researchers
20+	Disciplines
8(+)	Years Follow-Up
93%	Retention



Human Milk



Completed or Underway

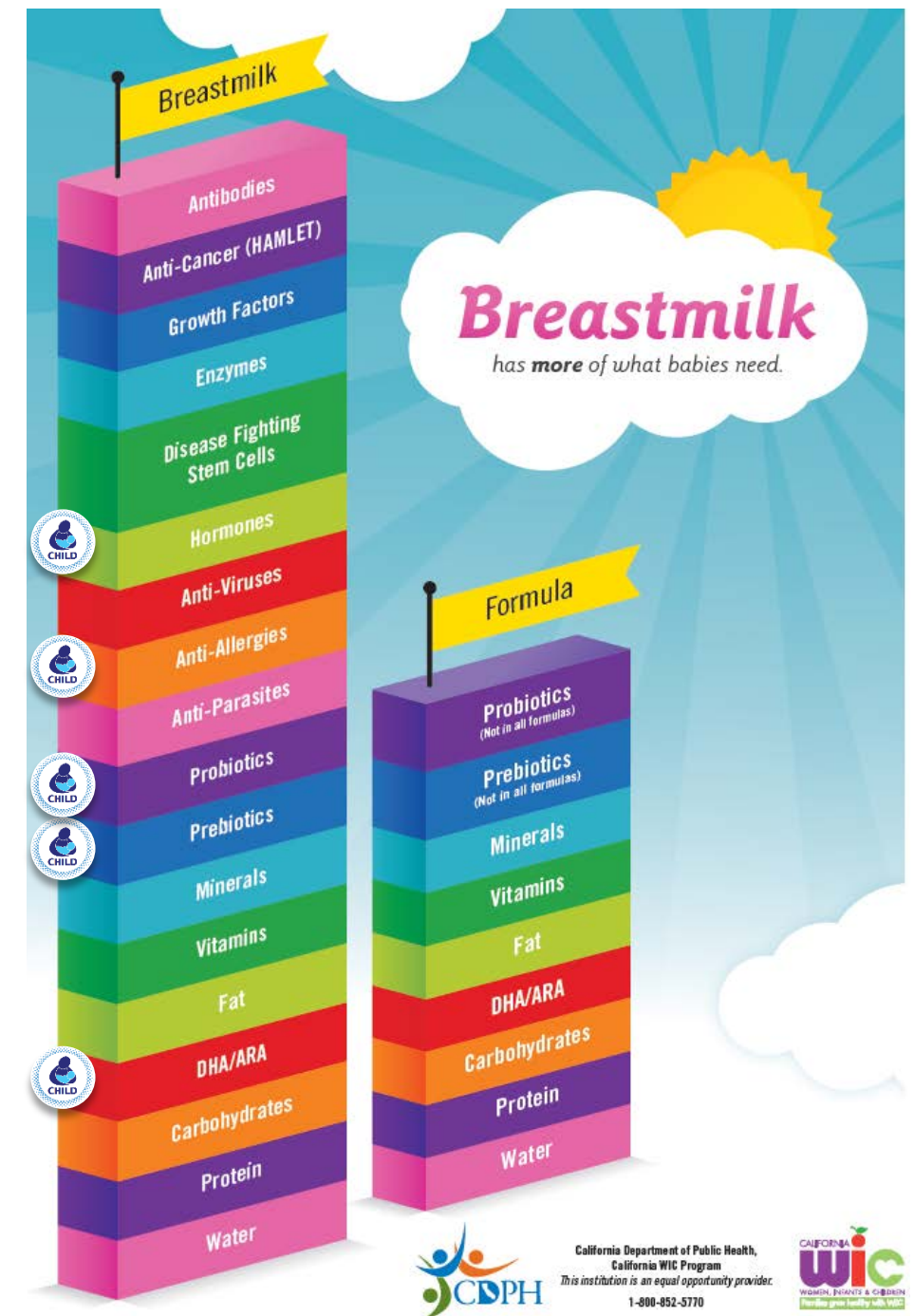
- **Endocrine Hormones** (C. Field, U. Alberta) – *Chan et al. Int J Obesity 2017*
- **Oligosaccharides** (L. Bode, UC San Diego) – *Azad et al. Am J Clin Nutr 2018*
- **Microbiota** (E. Khafipour, U. Manitoba) – *Moossavi et al. Cell Host & Microbe 2019*
- **Fatty Acids** (C. Field, U. Alberta) – *Miliku et al. Am J Clin Nutr 2019*
- **Cytokines** (J. Marshall, Dalhousie)
- **Peptides** (K. Hettinga, Wageningen University)

Coming Soon

- **Bioactive Proteins** (L. Bode, UC San Diego)
- **Antigen-specific Immunoglobulins** (T. Eiwegger, SickKids & ADI Inc.)
- **Proteomics** (Precision Biomarker Laboratory)
- **Untargeted Metabolomics** (M. Jain, UC San Diego)
- **Targeted Metabolomics** (Biocrates)
- **Micro & Macro nutrients** (L. Allen, USDA)

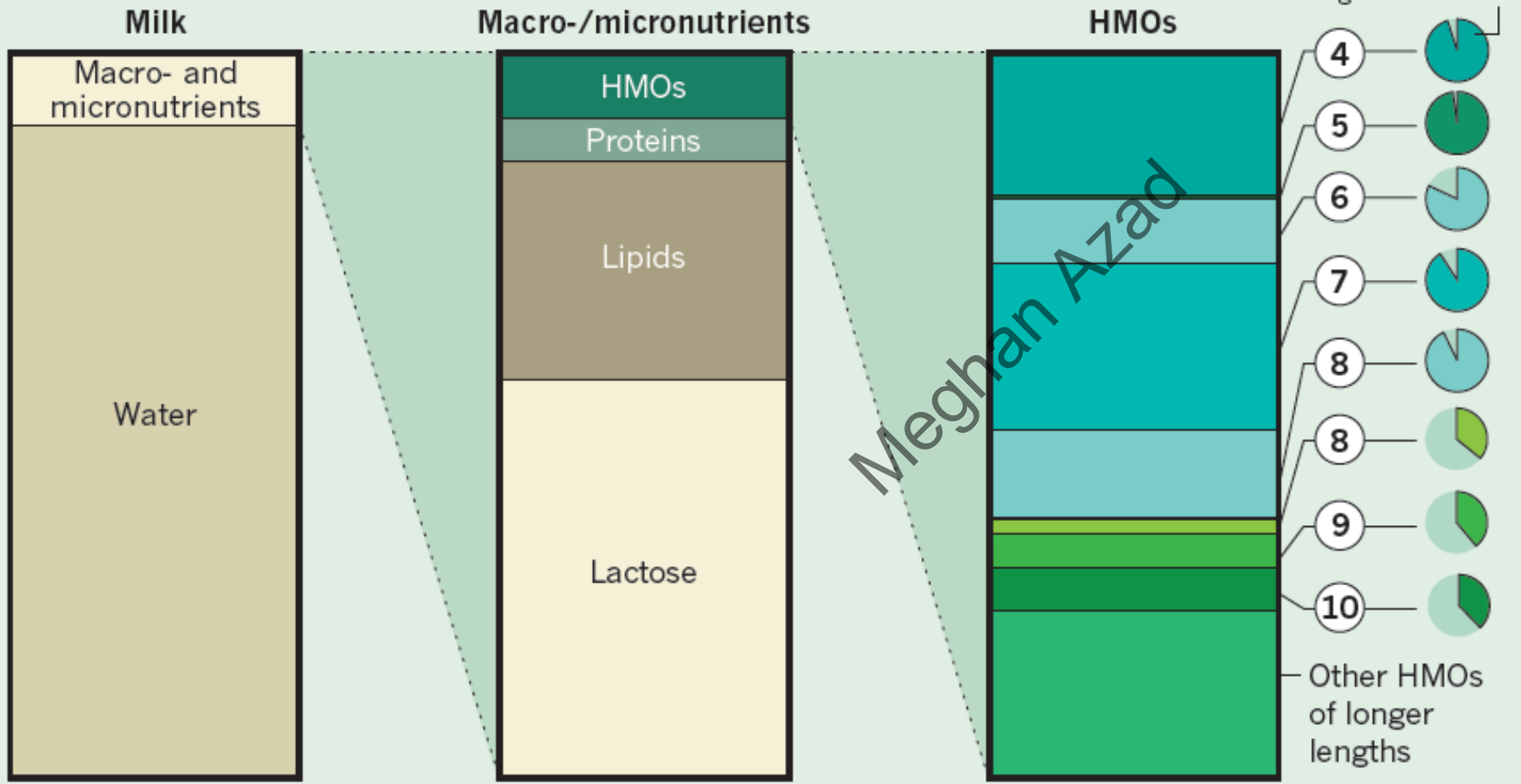
Wish List (Your name here! 😊)

- Toxins, Food Antigens, Artificial Sweeteners, Choline, Cortisol...



WHAT'S IN HUMAN MILK

Human milk oligosaccharides (HMOs) are food for friendly bacteria like *Bifidobacterium infantis*. Shorter chain HMOs in particular are almost entirely consumed by this microbe.



HMOs

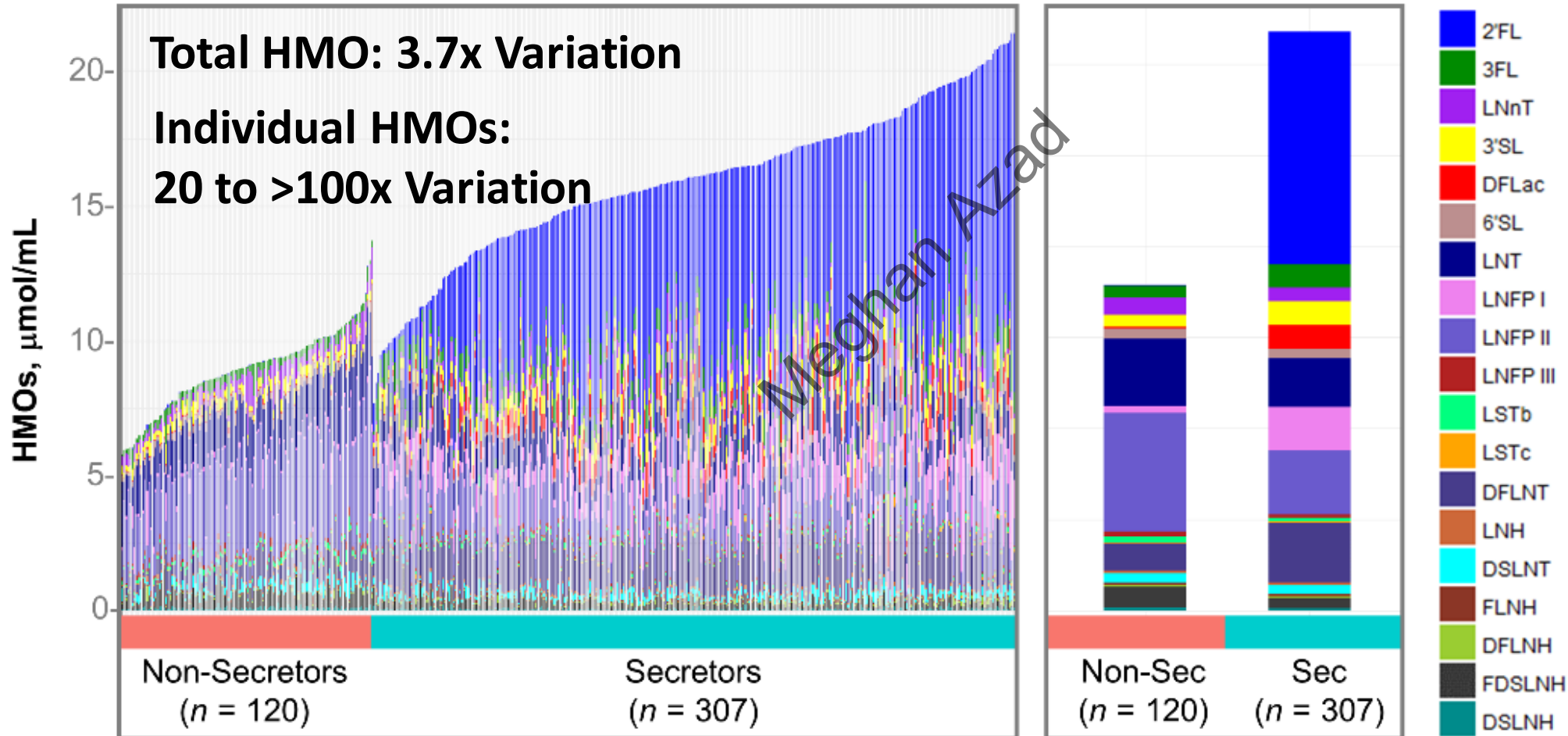
Non-digestible carbohydrates
Food for microbes
(not for baby!)

Structurally diverse & species-specific
Cows: ~40 vs
Humans: >100

Highly variable
(How & Why??)

Health Impact?

HMOs in the CHILD Cohort



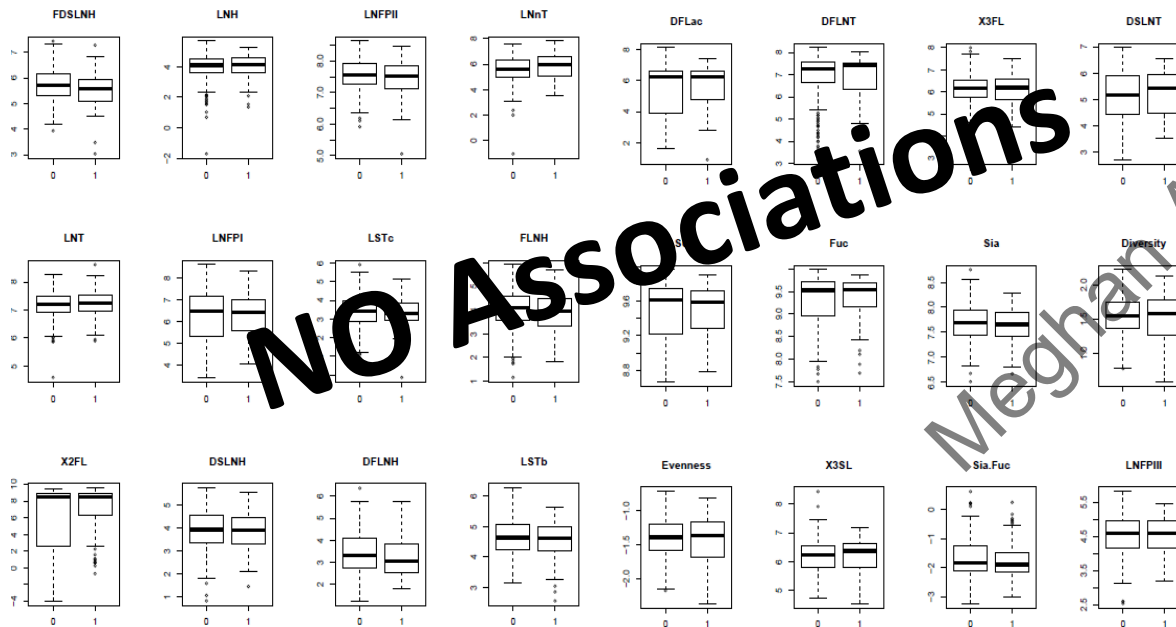
Lars Bode



Kozeta Miliku

HMOs & Infant Food Sensitization

N=430 dyads(59 sensitized vs. 362 controls); 19 HMOs

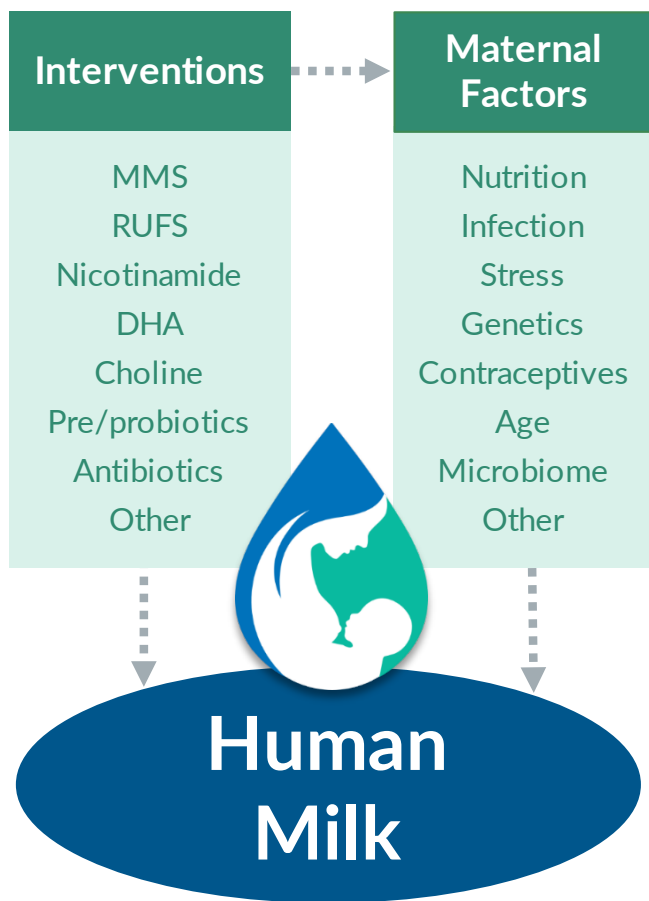


What is the
MECHANISM?

What about
OTHER milk
components?

OTHER conditions?

While no single HMO predicts food sensitization, the **overall HMO profile** does.

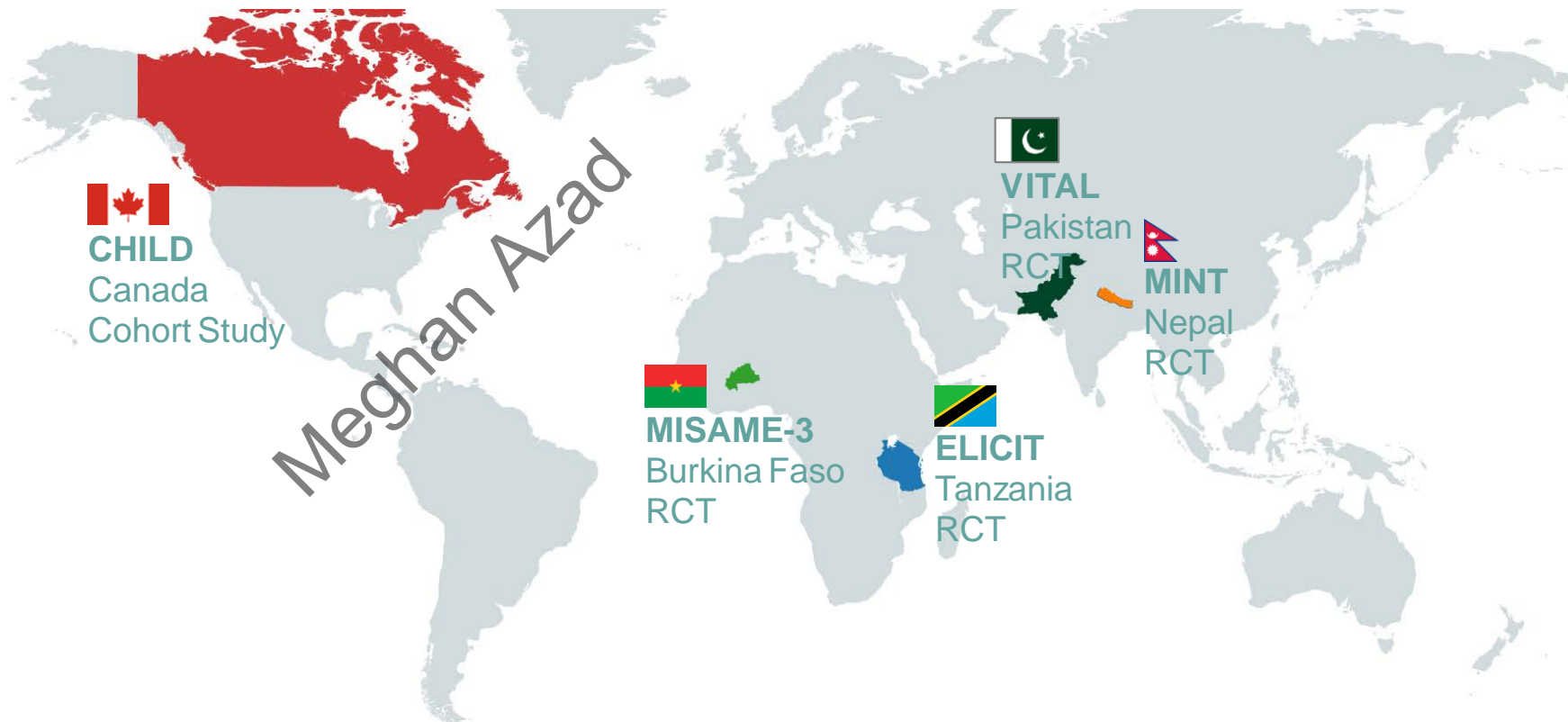


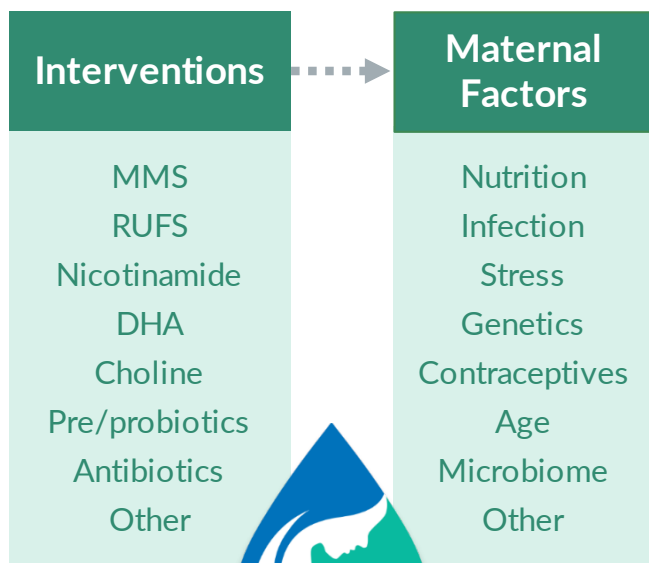
BILL & MELINDA
GATES foundation



IMiC

International
Milk Composition
Consortium





BILL & MELINDA
GATES foundation



Laboratory Partners

Macronutrients

Fat, Protein,
Carbohydrates

Micronutrients

Vitamins, Minerals

Bioactives

Microbiota

Bacteria, Fungi

Immunoglobulins

Oligosaccharides

Lactoferrin

Lysozyme

Cytokines

Hormones

miRNAs

Peptides

Immune Cells



Data Science Partners

Infant / Child Health

Growth & Body Composition

Nutritional Status

Gut Health

Neuro Development

Immune Development



N = 1000 dyads



Field Site Partners



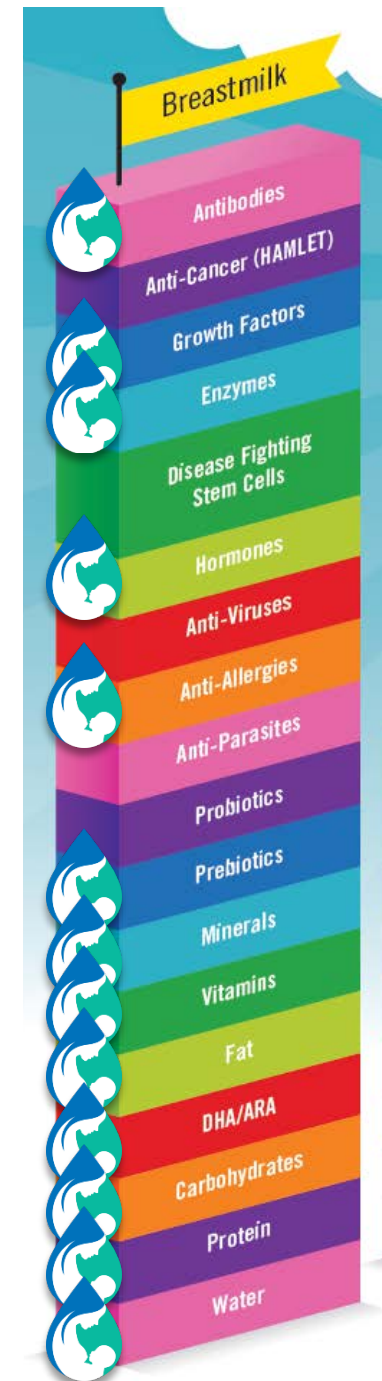
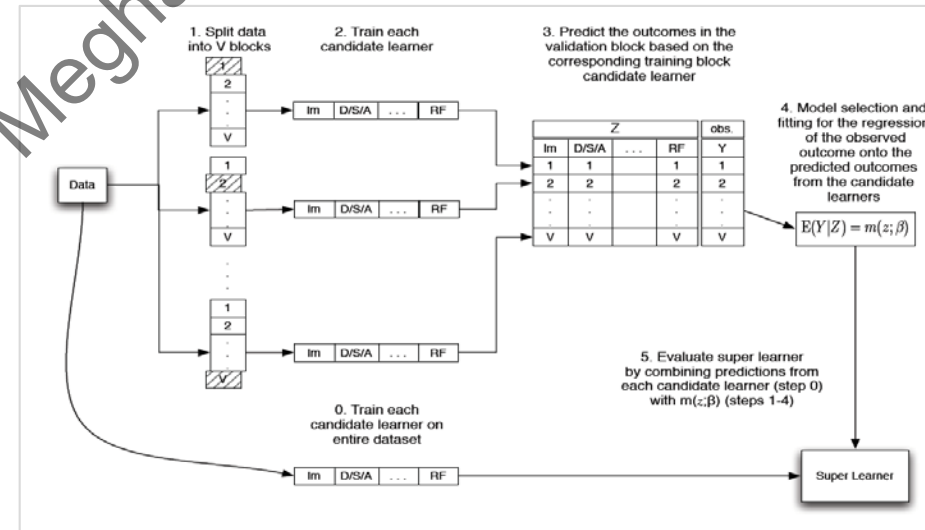
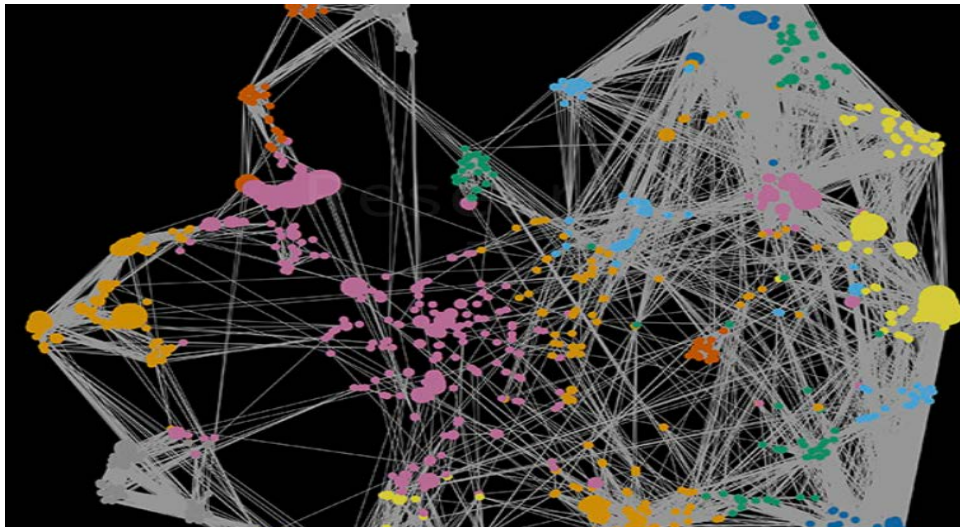
Nima Aghaeepour
Stanford Medicine

- Bioinformatics
- Multiomics
- Algorithm benchmarking
- Explainable artificial intelligence



Alan Hubbard
Berkeley Public Health

- Causal inference
- Machine learning
- Epidemiology
- Precision medicine





Meghan Azad PhD MSc
Human Milk & Epidemiology



Nathan Nickel MPH PhD
Public Health & Biostatistics



MILC

Manitoba
Interdisciplinary
Lactation
Centre



Infant Feeding & Lactation Database

- All mothers in Manitoba
- Report infant feeding at routine vaccination visits
- Data faxed to MILC using Teleform



Human Milk Biorepository

- General population at selected clinics & hospitals
- Targeted clinical studies
- Provide milk + additional research data
- Macronutrient profile + long-term storage



Manitoba Population Research Data Repository

- All mothers-infant dyads in Manitoba
- Administrative health + sociodemographic data
- Linked to all MILC data and samples

Knowledge Translation



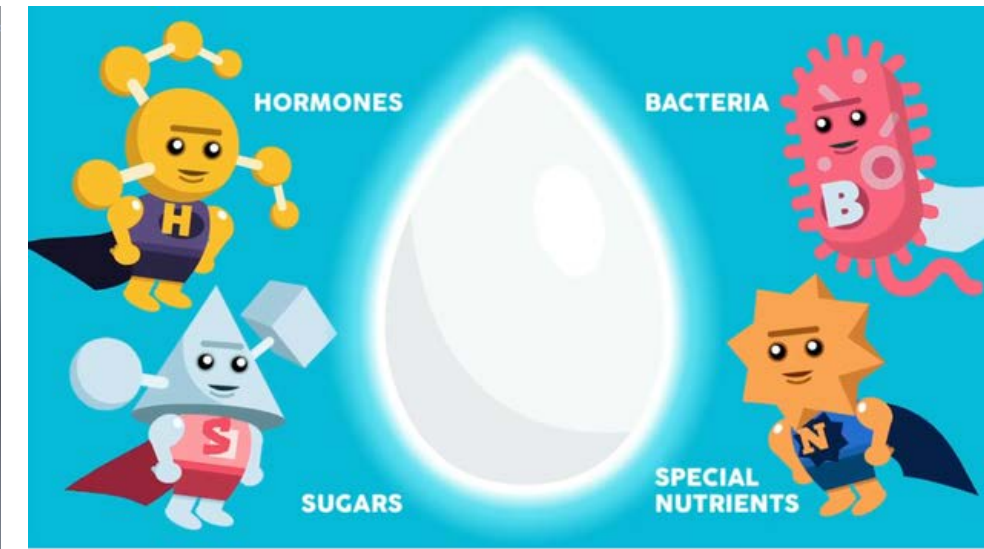
ROBIO ME COURSES

Home About Us Blog

BREAST MILK SCIENTIFIC

ACCESS HAS NOW ENDED: FREE online course for health professionals on the science of breast milk. Featuring 7 professors & scientists. 1 L-CERP & 1 CPD HOUR

Watch Promo



The National Academies of
SCIENCES • ENGINEERING • MEDICINE

Advising the Nation

COMMITTEE ON SCANNING FOR NEW EVIDENCE ON THE NUTRIENT CONTENT OF HUMAN MILK

KATHLEEN M. RASMUSSEN (Chair), Cornell University, Ithaca, New York
MEGHAN AZAD, University of Manitoba, Canada
LARS BODE, University of California, San Diego
MICHELLE MCGUIRE, University of Idaho, Moscow
LAURIE NOMMSEN-RIVERS, University of Cincinnati, Ohio
IAN J. SALDANHA, Brown University School of Public Health, Rhode Island

Menu

THE CONVERSATION



Community support programs for breastfeeding have changed under COVID-19 restrictions. (Shutterstock)

Breastfeeding is recommended during pandemic, but coronavirus has changed support systems

May 7, 2020 3:03pm EDT

Merilee Brockway, Sarah Turner, University of Manitoba


Breastmilk is Superfood for Babies

“Milk is really a genius fluid that was outrageously understudied. If we can identify components of human breast milk that are important, then we can understand the wisdom of milk—and take advantage of them.”

David Mills, UC Davis

Breastfeeding Medicine, Vol. 14, No. 3 | Basic Science

A Pilot Study of Human Milk to Reduce Intestinal Inflammation After Bone Marrow Transplant

Pooja Khandelwal , Heidi Andersen, Lindsey Romick-Rosendale, Cynthia B. Taggart, Miki Watanabe, Adam Lane, Christopher E. Dandoy, Kelly E. Lake, Bridget A. Litts, Ardythe L. Morrow, Martin L. Lee, David B. Haslam, and Stella M. Davies

Published Online: 11 Apr 2019 | <https://doi.org/10.1089/bfm.2018.0199>









Received: 28 February 2020 | Revised: 10 May 2020 | Accepted: 19 May 2020

DOI: 10.1111/nmo.13920

ORIGINAL ARTICLE

Neurogastroenterology & Motility  WILEY

Human milk oligosaccharide supplementation in irritable bowel syndrome patients: A parallel, randomized, double-blind, placebo-controlled study

Cristina Iribarren^{1,2}  | Hans Törnblom² | Imran Aziz^{2,3}  | Maria K. Magnusson¹  | Johanna Sundin²  | Louise K. Vignæs⁴  | Ingvild Dybdrodt Amundsen⁴  | Bruce McConnell⁴ | Dorte Seitzberg⁴ | Lena Öhman^{1,2}  | Magnus Simrén^{2,5} 








Breastfeeding and COVID-19

Breastfeed to protect your infants and children from getting sick and for their healthy growth and development.

Breastfeeding is particularly effective against infectious diseases because it **strengthens the immune system** by transferring antibodies from you.



Characterization of SARS-CoV-2 RNA, Antibodies, and Neutralizing Capacity in Milk Produced by Women with COVID-19

 Ryan M. Pace,^a  Janet E. Williams,^b Kirsi M. Järvinen,^c Mandy B. Belfort,^d Christina D. W. Pace,^a Kimberly A. Lackey,^a Alexandra C. Gogel,^a Phuong Nguyen-Contant,^e Preshetha Kanagaiah,^e Theresa Fitzgerald,^e Rita Ferri,^c Bridget Young,^c Casey Rosen-Carole,^c Nichole Diaz,^c Courtney L. Meehan,^f Beatrice Caffé,^f  Mark Y. Sangster,^e  David Topham,^e Mark A. McGuire,^b Antti Seppo,^c  Michelle K. McGuire^a

RESEARCH LETTER


JAMA May 18, 2021 Volume 325, Number 19

SARS-CoV-2-Specific Antibodies in Breast Milk After COVID-19 Vaccination of Breastfeeding Women

Apr 24, 2020, 03:26pm EDT | 271,423 views

Breast Milk Studied As Potential Coronavirus Treatment



Marla Milling Contributor 

Health

I am a Forbes.com Contributor specializing in geriatric health and women's health articles.

DO YOU DO RESEARCH IN HUMAN MILK AND LACTATION? JOIN ISRHML TODAY!

WHAT IS ISRHML?



A vibrant and growing non-profit organization dedicated to the promoting excellence in research and the dissemination of research findings in the field of human milk and lactation from cell biology to public policy.

WHO CAN BE A MEMBER?

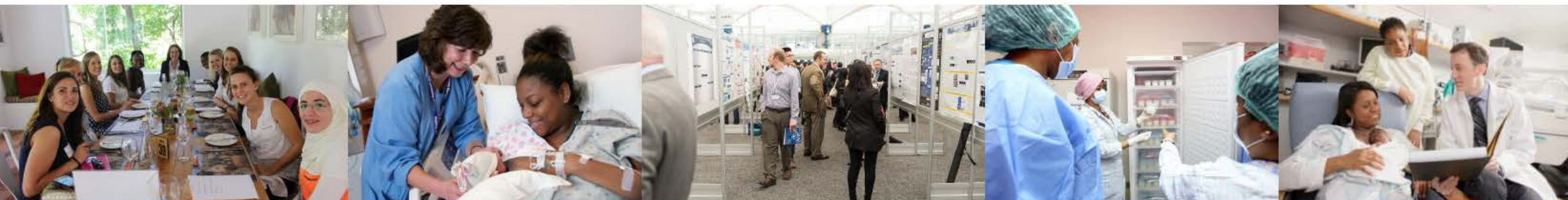
Members are affiliated with universities, medical centers, governmental agencies, NGOs and industry. ISRHML has four membership categories.

- Full- Active researchers
- Associate- Allied professionals
- Trainee- Researchers in training
- Emeritus -Retired researchers

WHAT ARE THE MEMBER BENEFITS?

-  **EDUCATION**
-  **COLLABORATION**
-  **INVOLVEMENT**
-  **CAREER GROWTH**
-  **TRAINEE EXPANSION PROGRAM (TEP)**
-  **SAVINGS**

**\$10k
Travel
Awards**





Natalie Rodriguez
Tricia Choquette
Rilwan Azeez
Stephanie Goguen

Nicole Fiorentino
Sarah Turner
Kelsey Fehr
Allison Daniel

Larisa Lotoski
Bridget McGann
Merilee Brockway
(Kozeta Miliku)



Manitoba: Elinor Simons, Allan Becker, Scarlet Salas & Team
National: PJ Subbarao, Stuart Turvey & Team
Collaborators: Lars Bode (UC San Diego, MoMI CORE)



Nathan Nickel (Manitoba Centre for Health Policy)
Drs. Raimondi & Kearns (Winnipeg Breastfeeding Centre)
MILC Club members

azadlab.ca | [@MeghanAzad](https://twitter.com/MeghanAzad) | meghan.azad@umanitoba.ca



THE W. GARFIELD WESTON
FOUNDATION



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Allergy, Genes and Environment Network

DEVOTION
Developmental Origins of Chronic Diseases in Children Network

BILL & MELINDA
GATES foundation

BREATHE
the lung association



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www.chairs-chaires.gc.ca

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POUR L'INNOVATION



Questions?

Meghan Azad, PhD

Canada Research Chair in Developmental Origins of Chronic Disease
Deputy Director, CHILD Cohort Study
Director, International Milk Composition (IMiC) Consortium
co-Director, Manitoba Interdisciplinary Lactation Centre (MILC)
co-Lead, international Perinatal Outcomes in the Pandemic (iPOP) Study
Children's Hospital Research Institute of Manitoba
Department of Pediatrics & Child Health, University of Manitoba, Canada

www.azadlab.ca

www.childstudy.ca

www.milcresearch.com

www.ipopstudy.com

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