

# Optimizing Early Nutrition for Long-Term Benefits



*Presented by*

Sharon M. Donovan, PhD, RD, and Michael K. Georgieff, MD



ANNENBERG CENTER FOR HEALTH SCIENCES

AT EISENHOWER

*Imparting knowledge. Improving patient care.*

This activity is supported by an educational grant from  
**Reckitt | Mead Johnson Nutrition.**

# Faculty Presenters

## **Sharon M. Donovan, PhD, RD**

---

Professor and Melissa M. Noel Endowed Chair  
Director, Personalized Nutrition Initiative  
University of Illinois Urbana-Champaign  
Urbana, Illinois

## **Michael K. Georgieff, MD**

---

Martin Lenz Harrison Land Grant Chair  
Professor of Pediatrics, Obstetrics and  
Gynecology, and Developmental Psychology  
Executive Vice Chair of the Department of  
Pediatrics  
Director of the Center for Neurobehavioral  
Development  
University of Minnesota  
Minneapolis, Minnesota



# Faculty Disclosures

*It is the policy of the Annenberg Center to ensure fair balance, independence, objectivity, and scientific rigor in all programming. All faculty participating in accredited programs are expected to identify and reference off-label product use and disclose any relationship with those supporting the activity or any others whose products or services are discussed.*

## **Sharon M. Donovan, PhD, RD**

*Advisory Board*

Arla Foods Ingredients, ByHeart, Danone Institutes International, Danone North America

*Research Support*

ByHeart, IFF, Kyowa Hakka Bio, National Dairy Council, Nestlé

## **Michael K. Georgieff, MD**

*No relationships to disclose.*

Faculty have documented that this presentation will involve no discussion of unapproved or off-label, experimental, or investigational use.



# Learning Objectives



Identify nutrients critical for brain and cognitive development during the first 1,000 days



Associate potential early nutrient deficiencies with long-term consequences



Synthesize current research to recommend infant feeding practices that provide optimal support for brain and neurodevelopment



# The First 1,000 DAYS

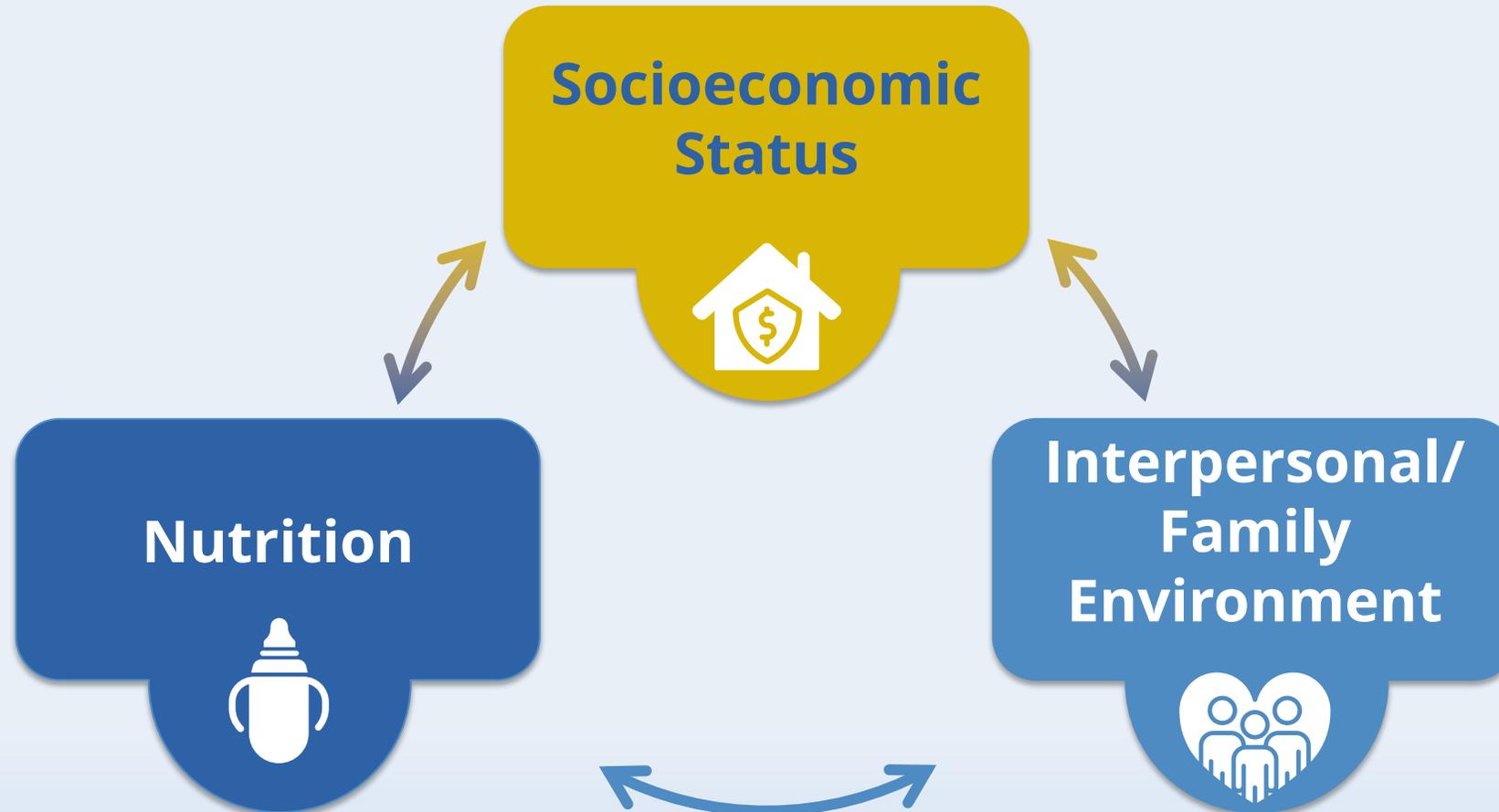


# Why the First 1,000 Days?

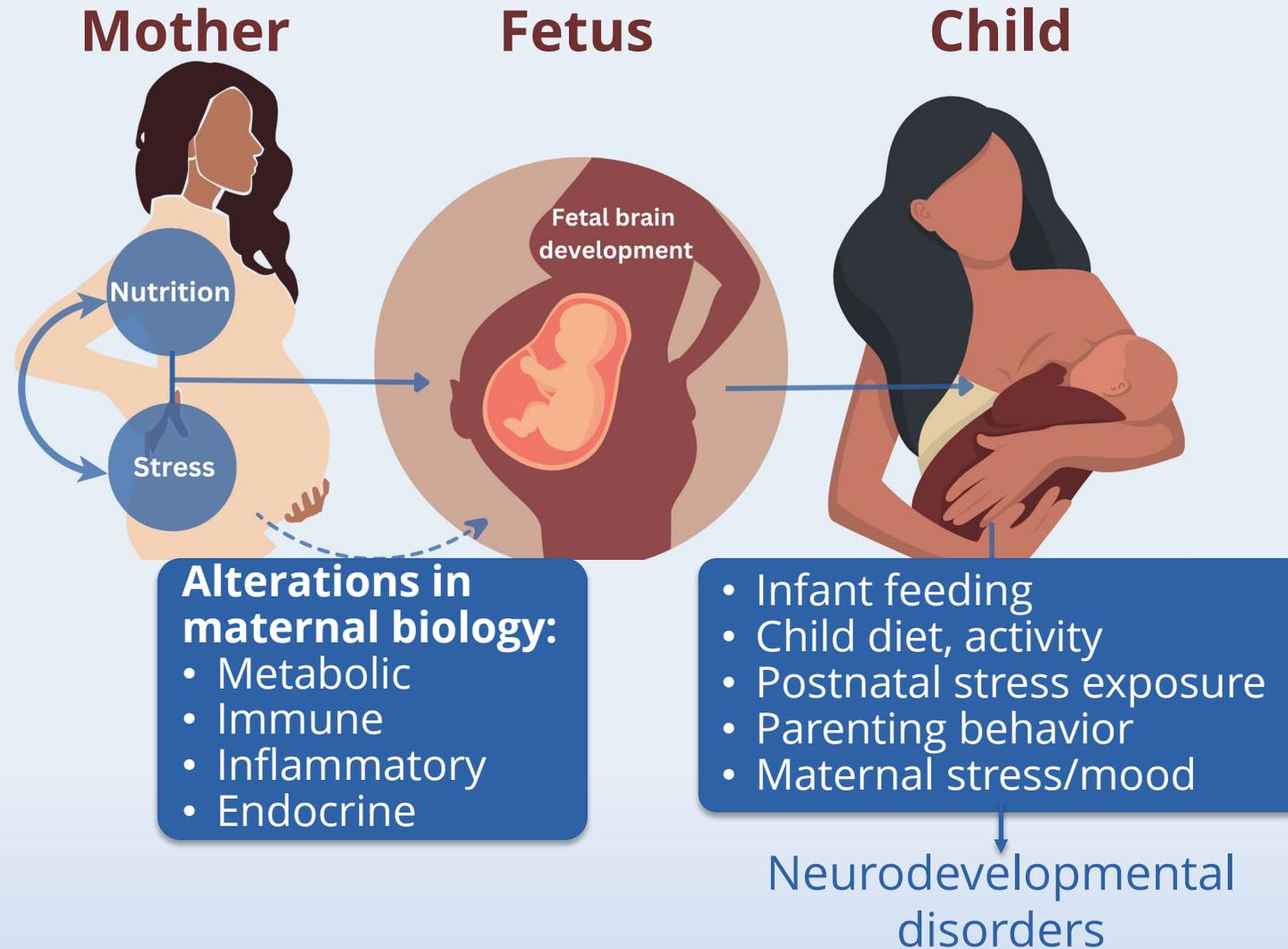
- Conception through the 2nd postnatal year
- Most active period of neurological development
- A critical window of opportunity to shape short- and long-term health trajectories
- Neural scaffolding impacts later development of higher cognitive functions
- Developmental origins of adult health and disease (DOHaD)



# Factors Affecting Early Neurodevelopment



# Nutrition, Stress, and Neurodevelopment



# Early Brain Development

**Monoamine neurotransmitter systems**  
(prenatally through at least age 3 years)

**Hippocampus**  
(28 wks gestation through 18 mo)

**Myelination**  
(32 wks gestation through 2 years)

**Prefrontal Cortex**  
(First 6 postnatal months through early adulthood)



# Nutrients Affecting Early Brain Development

- **Macronutrients**

- **Proteins\***
- **Specific fats (eg, LC-PUFAs)\***
- Glucose

- **Micronutrients**

- **Zinc\***
- **Copper\***
- **Iodine\***
- **Iron\***
- Selenium

- **Vitamins + cofactors**

- B vitamins (B6, B12)
- Vitamin A
- Vitamin K
- **Folate\***
- **Choline\***

\* Nutrients that play a role during critical or sensitive period identified during development



# Nutrients and Critical Neurodevelopmental Processes

Neurologic Process	Cell Type	Function	Nutrient Example	At Risk During First 1,000 Days
Anatomy	Neuron	Division, migration, differentiation	Protein, carbohydrates, iron, copper, zinc, LC-PUFA, iodine, vitamins A, B6, D, and C	Global, hippocampus, striatum, cortex, retina
	Oligodendrocyte	Myelination	Protein, carbohydrates, iron, iodine, selenium, zinc, vitamins B6 and B12	Global
Chemistry	Neuron Astrocyte	Neurotransmitter concentration, receptor, reuptake	Protein, iron, iodine, copper, zinc, selenium, choline, vitamins B6 and D	Global, hippocampus, nucleus accumbens, VTA, cortex, cerebellum
Physiology & Metabolism	Neuron Oligodendrocyte	Electrical efficiency	Glucose, protein, iron, iodine, zinc, choline, copper	Global



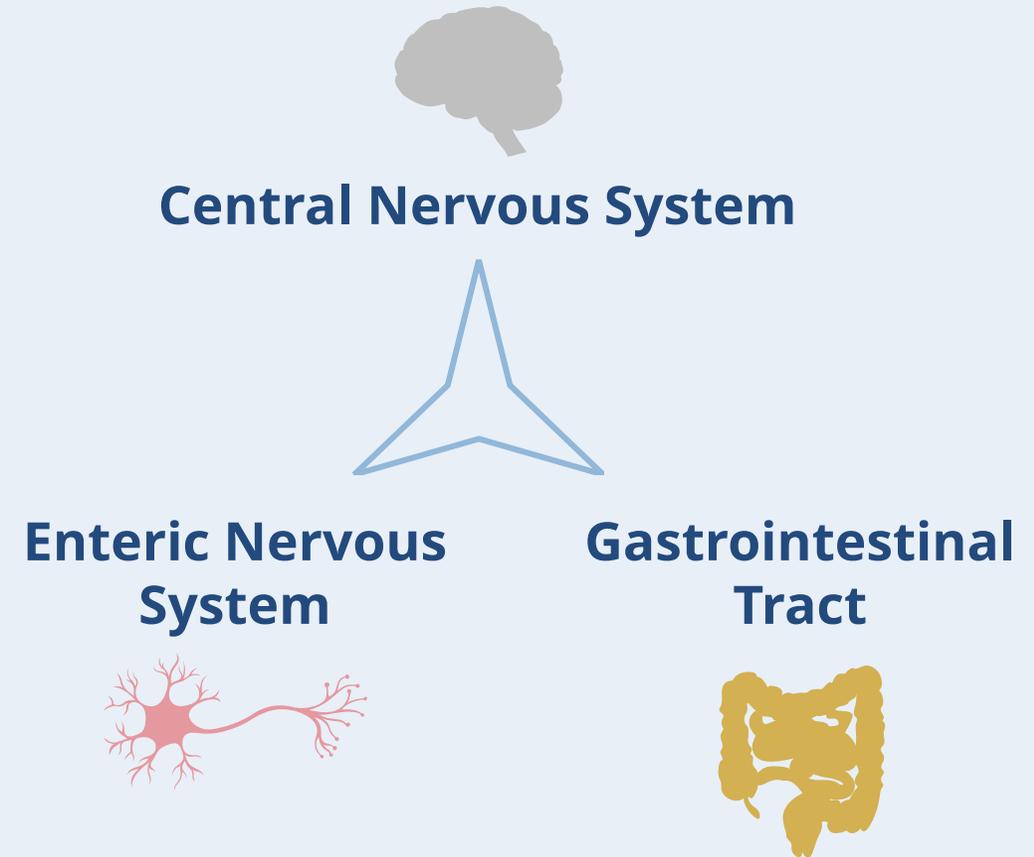
# Microbiota-Gut-Brain Axis

- **Microbiota**

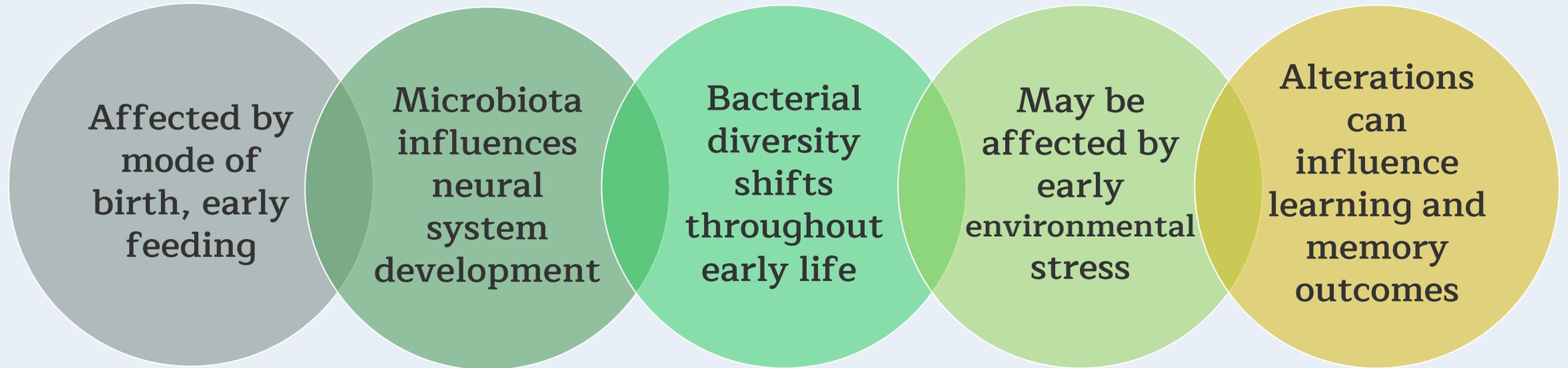
- Trillions of microorganisms within and on the body, primarily in the GI tract
- Key regulators of gut-brain function

- **Alterations associated with:**

- Psychiatric diseases
- Neurodevelopmental disorders
- Age-related diseases
- Neurodegenerative processes



# Microbiota-Gut-Brain Axis in the First 1,000 Days



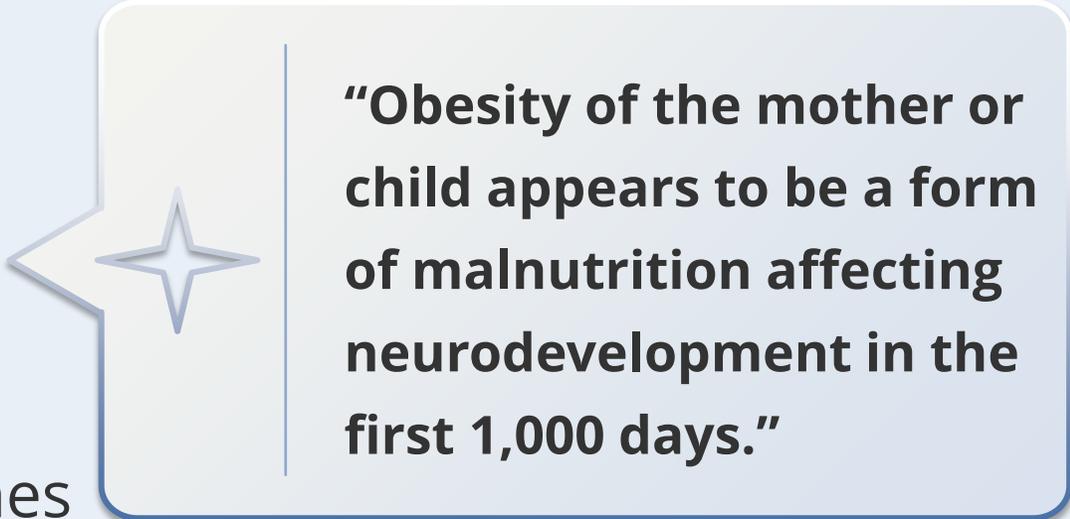
# Early Nutrition and Obesity

- **Maternal obesity during pregnancy**

- ↑ Risk of child having diabetes, obesity
- ↓ Breastfeeding initiation rates
- Delayed onset full milk production
- Insufficient milk supply
- Shortened duration of breastfeeding

- **Childhood obesity**

- May impact neurodevelopmental outcomes
- May result in poorer educational success



**“Obesity of the mother or child appears to be a form of malnutrition affecting neurodevelopment in the first 1,000 days.”**



# Early Nutrition and Health Outcomes

## Macronutrient Undernutrition

- Lower IQ scores
- Reduced school success
- Increased behavioral dysregulation

## Micronutrient Deficiency

- Iron → neurocognitive development
- Iodine → thyroid hormone
- Long-chain fatty acids → vision, neurocognitive development



# Human Milk



# 2022 AAP Policy Statement: Breastfeeding and the Use of Human Milk

- **Exclusive breastfeeding recommended through age 6 months, continued to 12 months of age**
  - No benefit to complementary food introduction before age 6 months
  - Introduction before age 4 months increases risk of overweight and obesity
- **More than 80% of mothers initiate breastfeeding**
  - 46% exclusively breastfeed through age 3 months
  - 26% exclusively breastfeed through age 6 months
- **Breastfeeding can be continued to age 2 years and beyond**

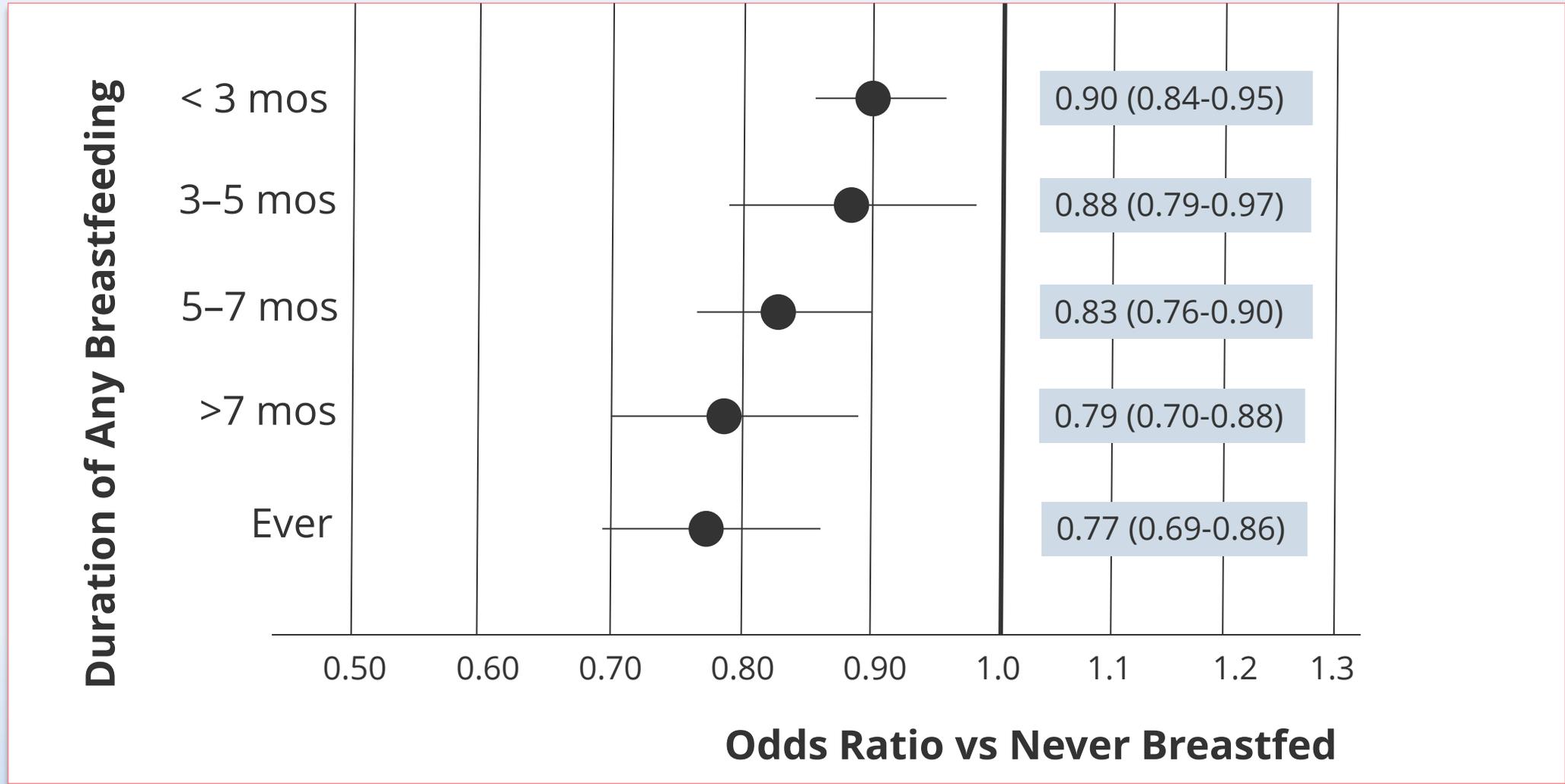


# Health Benefits of Breastfeeding for Mother and Infant

Outcome Area	% Lower Risk	Breastfeeding Duration
<b>Maternal Breastfeeding Benefits</b>		
Type 2 diabetes	30%	>12 months
Breast cancer	22%	Any breastfeeding
Hypertension	12%	>12 months
<b>Infant Breastfeeding Benefits</b>		
Lower respiratory tract infections	19%	Exclusive breastfeeding for 6 months
Severe diarrhea	30%	Exclusive breastfeeding for 6 months
Otitis media	43%	Exclusive breastfeeding for 6 months
Childhood obesity	22%	Ever breastfed



# Dose Response Relationship: Breastfeeding and Childhood Obesity



# Human Milk Is Nature's Precision Nutrition



“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.”

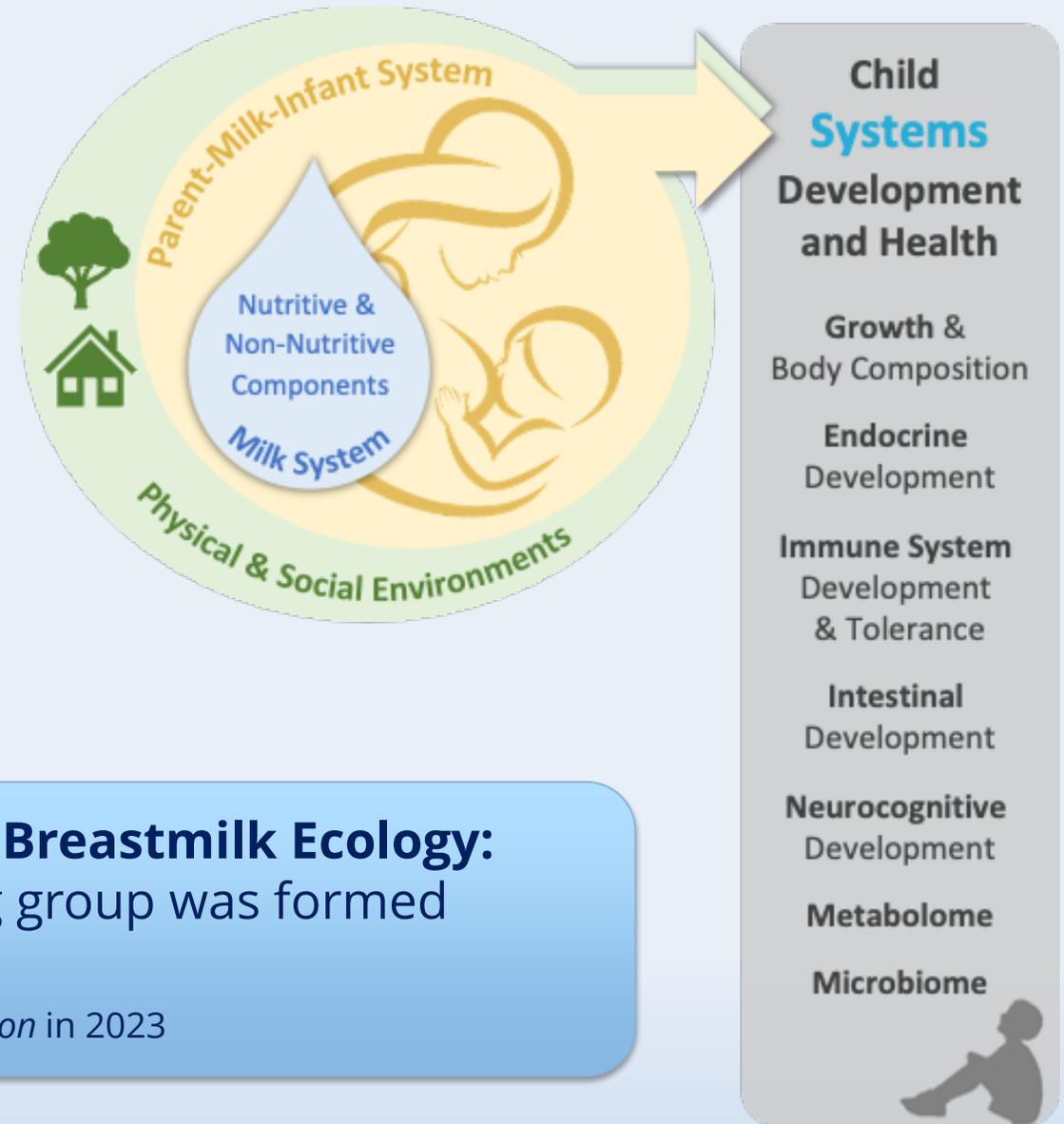
*Cesar Victora, PhD  
Emeritus Professor of Epidemiology  
Federal University of Pelotas Brazil*

Image: Jennifer Taranto/PicsArt



# Human Milk Is a Biological System

- HM is a *biological system* of many nutrients and non-nutritive bioactive components in a complex matrix.
- HM is a *system within a system* (parent-HM-infant triad) that intersects and interacts with internal (maternal biology) and external (diet, environment, infections) factors to shape composition



To better understand this complexity, the NIH **Breastmilk Ecology: Genesis of Infant Nutrition (BEGIN)** working group was formed

- Videos available at: <https://videocast.nih.gov/>
- Reports to be published in *American Journal of Clinical Nutrition* in 2023



# Multifunctional Actions of Human Milk Components

## Nourish

- **Essential and nonessential AA and FA**
- **Vitamins and minerals**

- *Some FA*
- *Some AA*
- *Vitamins A, C, D, K*
- *Selenium*
- *Enzymes*
- *Zinc*
- *Microbes*
- *Proteins/peptides*
- *Some FA*
- *Some AA*
- *Chemo/Cytokines*
- *Hormones*
- *Growth factors*
- *Immune cells*
- *HMO/Glycans*

## Communicate

- **Stem cells**
- **miRNA**
- **Flavor compounds**

- **Antibodies**
- **Urea**

## Protect

◆ FA, fatty acids; AA, amino acids.



# Human Milk Bioactives

## Human milk oligosaccharides (HMOs)

- **Complex carbohydrates** found in human milk
- **3rd most abundant** component
- Diversity, concentration, and structural complexity of HMOs are **uniquely human**
- Function as **prebiotics** help nurture a **balanced microbiota**
  - Contribute to **immune system function**

Immunologic proteins

Cytokines



# Human Milk Nutrients Supporting Neurodevelopment

## Macronutrients

### Fat

- CNS development
- LCPUFAs, MFGM

### Carbohydrates

- High concentration for brain energy demands

### Protein

- Sufficient protein supports neurodevelopment

## Micronutrients

### B vitamins

### Choline

### Iron

### Zinc

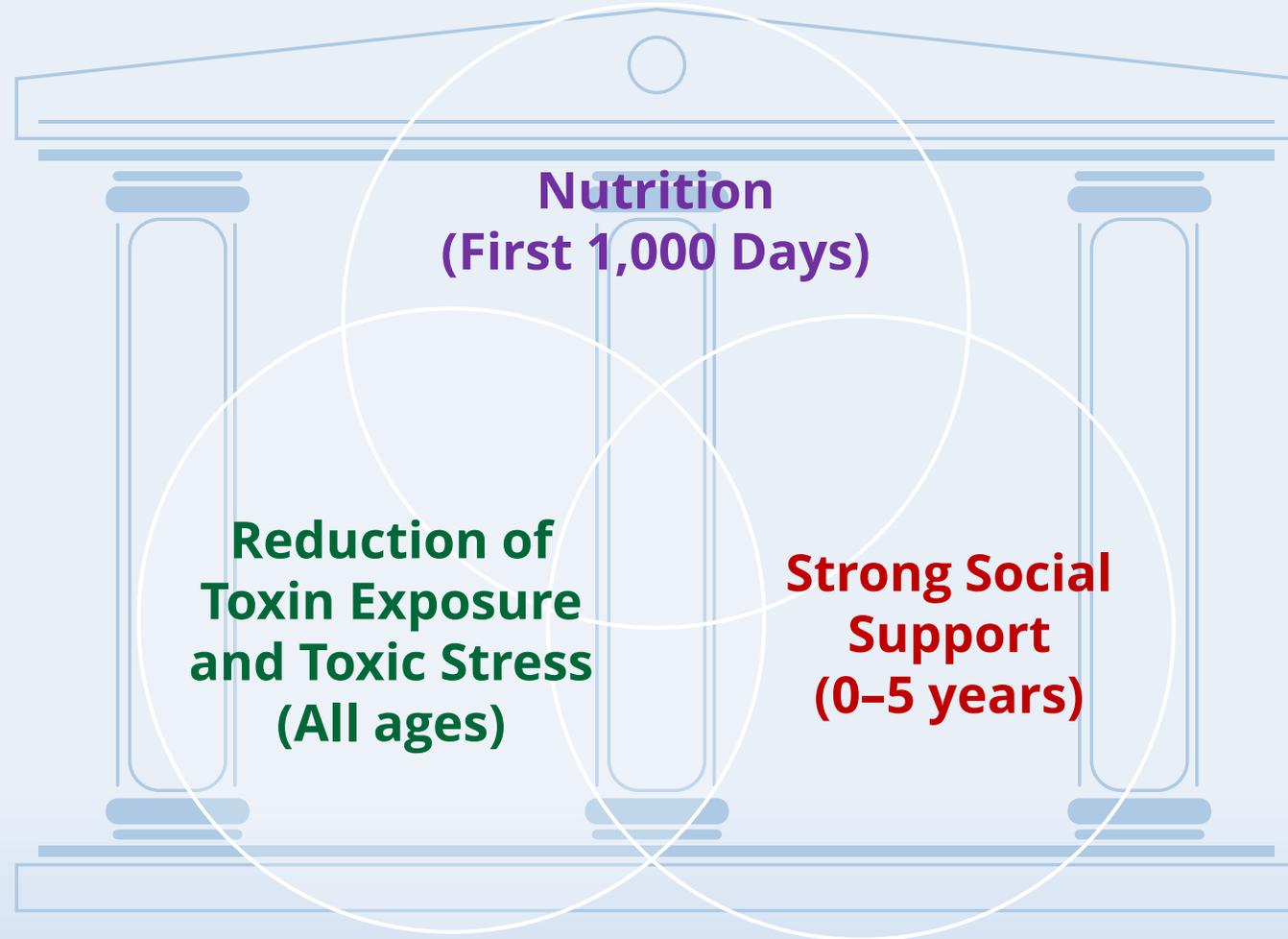
### Iodine



# **The First 1,000 Days: The Role of the Clinician in Optimizing Early Nutrition**



# The 3 environmental pillars of early brain development that work together across the first 1,000 days



# Protecting Brain Development: What Should We Do?

## Preconception Female Health

- Nutrition
- Weight management
- Stress reduction

## Gestational Health

- Nutrition
- Weight management
- Prenatal visits
- Stress reduction

## Postnatal (Mother)

- Breastfeeding support
- Nutrition
- Financial resources (stress reduction)
- Screening for depression
- Parenting skills

## Postnatal (Baby)

- Breastfeeding
- Nutrition
- Infant stimulation
- Language development



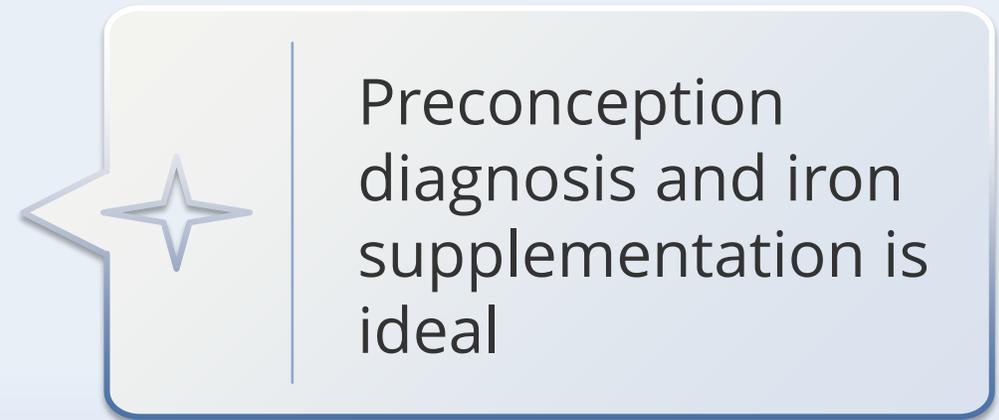
# Preconception Nutrition: Recommendations

- ★ Healthcare providers should be encouraged and trained to support and **provide advice on preconception nutrition, including optimizing adolescent nutrition and health.**
- ★ Healthcare providers should pay **particular attention to the body weight and BMI of women of reproductive age**, and where appropriate, provide advice for **modifying body weight** by improving diet, lifestyle and physical activity.
- ★ Focus on the **intake and status of some micronutrients** in women of reproductive age, **especially folate**. Dietary supplementation with iron, vitamin D, vitamin B<sub>12</sub>, iodine, and others may also be indicated in certain populations.



# Preconception Nutrition: Folic Acid and Iron

- **Folic acid supplementation prevents neural tube defects**
  - Supplement bioavailability > dietary bioavailability
  - **Preconception supplementation is critical**
    - » Neural tube closure occurs before day 28
- **Iron-deficiency anemia is common**
  - Maternal anemia
    - » ↑ Risk low birth weight (OR = 1.65)
    - » ↑ Risk preterm birth (OR = 2.11)
    - » ↑ Risk perinatal mortality (OR = 3.01)
  - Iron supplementation during pregnancy
    - » ↓ Risk of low birth weight
    - » Increases iron stores
    - » Prevents anemia in later gestation



# Preconception Nutrition: Iodine and Vitamin D

- **Iodine**

- Fetus depends on maternal thyroid hormone for 1st half of pregnancy
- Low iodine levels → low maternal thyroid hormone production
- Recent dietary trends (eg, salt restriction) → decreased iodine intake
- Supplementation after 6 to 8 weeks gestation less effective

- **Vitamin D**

- Necessary to meet calcium demands of fetus for bone mineralization
- Lack of consensus on normal levels and supplementation amount
- Maternal levels inversely associated with risk of:
  - » Low birth weight (RR = 0.65)
  - » Preterm birth (RR = 0.67)
  - » Small for gestational age (RR = 0.61)



# How Can Clinicians Support Breastfeeding?

- **Be knowledgeable** about breastfeeding
- **Educate** pregnant women about breastfeeding
- **Refer** to Certified Lactation Consultants (IBCLC) and/or RD with expertise in lactation
- Be prepared to **help when** breastfeeding difficulties occur
- **Advocate** to strengthen nutrition programs



# How Can Pediatricians and Child Care Providers Support Early Development?

- Understand which food sources supply critical nutrients needed for brain development
- Advocate to preserve and strengthen nutrition programs with a focus on maternal, fetal, and neonatal nutrition
- Focus nutrition education on the positives of healthy eating vs the avoidance of unhealthy foods
- Screen for neurodevelopmental concerns



# Optimizing Early Nutrition: Best Practices



# Breastfeeding: Initiation and Promotion

- Educate new parents before and during pregnancy
- Advocate for optimal hospital breastfeeding policies
- Proactive referral to Certified Lactation Consultants (IBCLC) and/or RD with expertise in lactation
- Become aware of and refer to community breastfeeding resources
- Increase knowledge and skills related to breastfeeding problems



# Breastfeeding: Vitamin and Mineral Supplementation

- **Vitamin D**

- Deficiency/insufficiency associated with rickets
- 400 IU/day for breastfed infants and infants taking < 32 oz/day infant formula

- **Iron**

- Supplementation for preterm infants
- More data needed for term infants
  - » Delayed cord clamping → increased iron stores



# Infant Formula: Components Inspired by Human Milk

## Fatty Acids & Milk Fats

- Human milk fat profile is unique compared to other mammalian milk
- LCPUFAs
- MFGM
  - Supports immune function
  - May decrease cognitive development gap

## Bioactives: HMOs

- Stimulates growth of beneficial bacteria
- Supports immune response



# Complementary Feeding

## AAP, ESPGHAN, and DGA 2020-2025 Nutrition Guidance

- Complementary foods important for nutrition and development
- Time of susceptibility to nutrient deficiencies and excess
- Key period for establishing healthy eating patterns and behaviors that influence trajectory of health throughout the life course
- The HOW of feeding is as important as WHAT is fed
- Careful consideration for iron supplementation

◆ AAP, American Academy of Pediatrics; ESPGHAN, European Society of Pediatric Gastroenterology, Hepatology, and Nutrition; DGA, Dietary Guidelines for Americans



American Academy of Pediatrics Committee on Nutrition. Kleinman RE, Greer FR, eds. Pediatric Nutrition. 7th ed. Elk Grove Village, IL: American Academy of Pediatrics;2014:123-139. Fewtrell M, et al. J Pediatr Gastroenterol Nutr. 2017;64(1):119-132. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020-2025. 9th Edition.

# Complementary Feeding (CF) Guidance

Topic Area	Guidance
Timing	<ul style="list-style-type: none"><li>• Exclusive <b>breastfeeding for about 6 months</b> is recommended</li><li>• Do not introduce CF before 4 months and do not delay beyond 6 months</li></ul>
What	<ul style="list-style-type: none"><li>• <b>Foods rich in iron and zinc</b> address important nutrient requirements in the breastfed infant and older infant</li><li>• Focus on <b>variety of foods and flavors</b> and <b>repeated exposures</b></li></ul>
Methods	<ul style="list-style-type: none"><li>• <b>Texture and consistency</b> offered should match infant's oral motor skills</li><li>• Proactively introduce foods with more advanced texture around 8 months of age, and finger foods around 9 months of age</li><li>• <b>Encourage responsive feeding</b>; watch for and respond to an infant's hunger and satiety cues</li></ul>



# Key Takeaways



The first 1,000 days of life are critical for neurological development.



Potential nutrient deficiencies should be addressed early to prevent detrimental long-term outcomes.



Clinicians play an essential role in supporting optimal maternal and infant feeding practices.

