

# The BOND-KIDS Project: Exploring the Nutritional Ecology of School-Aged Children Webinar

August 10, 2023



Photo Credit: Fitsum Aregawi, USAID



Knowledge Indicating Dietary Sufficiency

**BOND-KIDS**

Understanding the Nutritional Ecology  
of School-Aged Children

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Program Director-Nutrition  
NICHD/NIH



# Disclosures

No conflicts to disclose



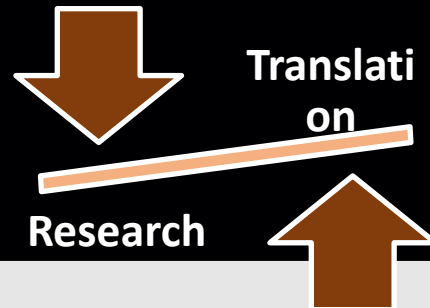
# Core Principles and Concept

# An Approach to Addressing the Role of Nutrition in Child Health



**Research**

Identify extant knowledge and critical research gaps and new approaches to address existing and emerging needs



**Translational**

Work with domestic and international authoritative agencies to translate evidence into practice and policy

**GOAL**

Improve the health of parents, children, households and communities

# Translational science: a continuum

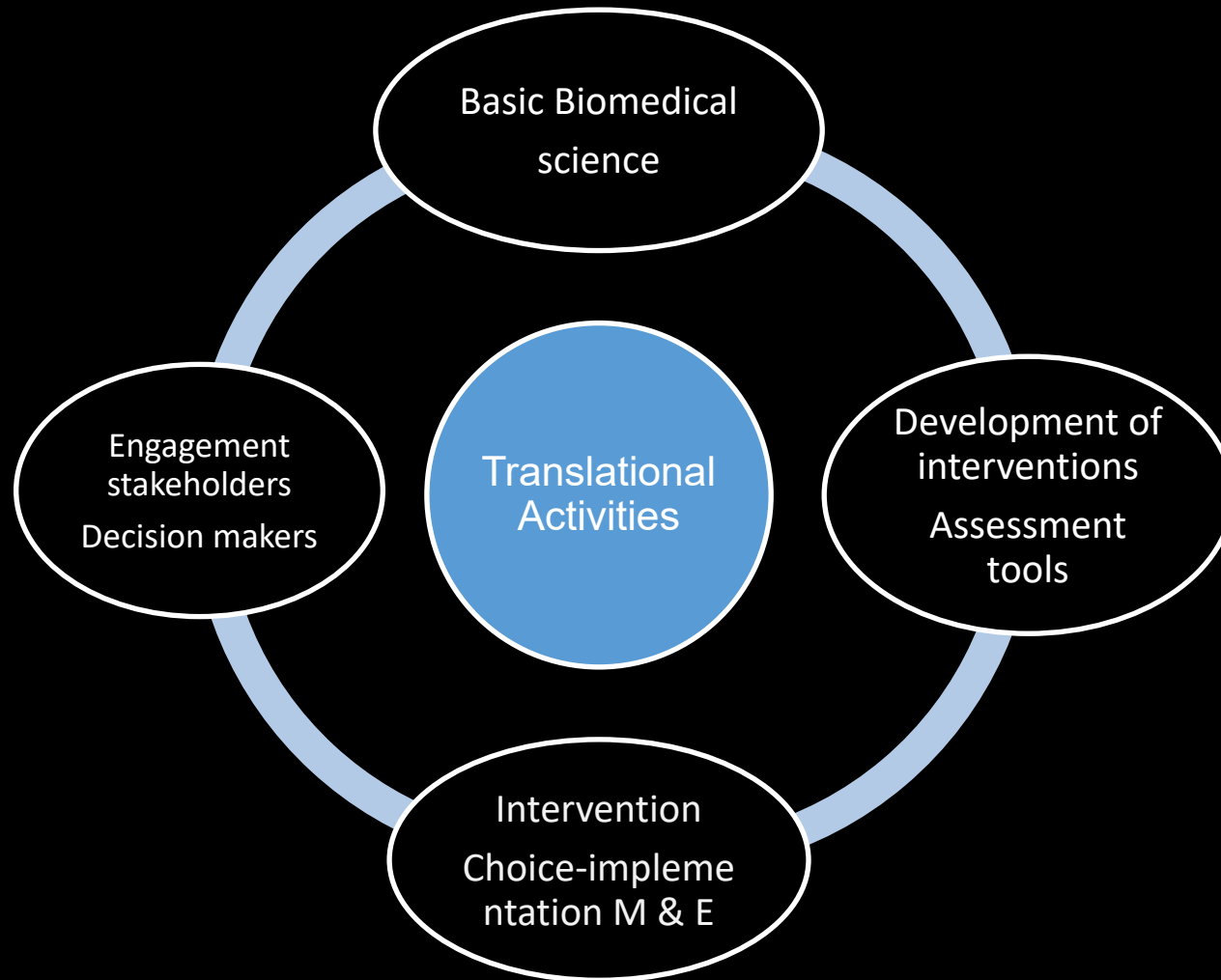


The translational science spectrum represents each stage of research along the path from the biological basis of health and disease to interventions that improve the health of individuals and the public.

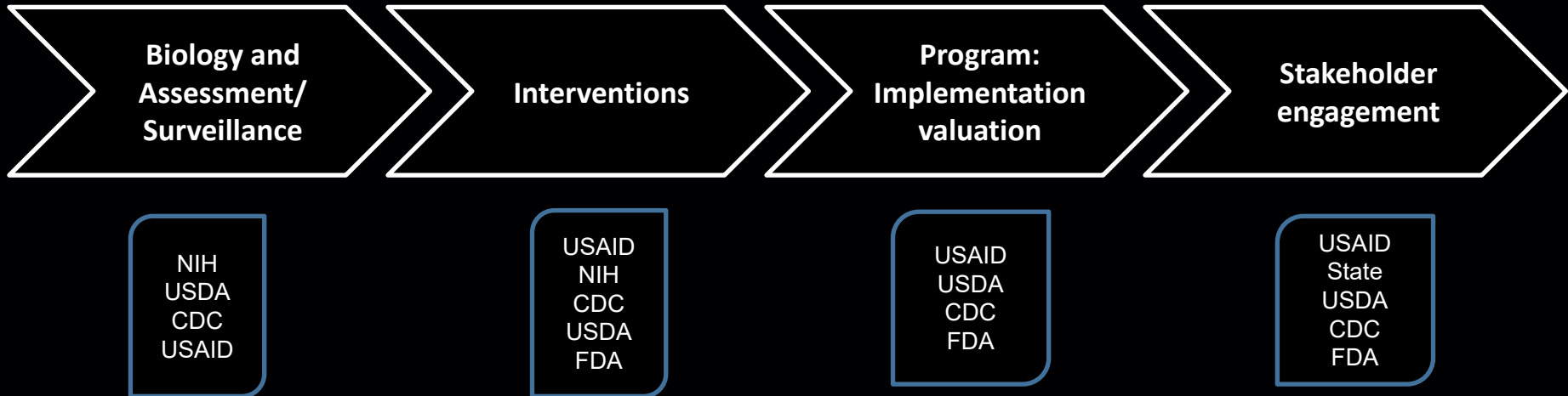
The spectrum is not linear or unidirectional; each stage builds upon and informs the others.

(from NIH's National Center for Advancing Translational Sciences [NCATS])

# The translational continuum: Diet and Health



# GNCPC mission: representing Components of the Continuum:







# *Biomarkers of Nutrition for Development*

**BOND**  
BIOMARKERS OF NUTRITION FOR DEVELOPMENT

Why the BOND platform?



- Support all aspects of discovery, development and deployment of evidence-informed methods to assess the role and impact of nutrition in health promotion, disease prevention and treatment.
- Specifically, develop consensus on accurate assessment methodologies that are applicable and relevant to users domestically and internationally in both the public and private sectors.
- Serve the breadth of the food and nutrition user community including:
  - ❖ Researchers (lab/clinical/surveillance)
  - ❖ Clinicians
  - ❖ Program (creators/implementors/evaluators)
  - ❖ Technical agencies/Policy makers (data consumers)



- Provide support for those agencies/organizations addressing the needs of school aged children.
- Engage relevant professional societies and civil society to foster the nutrition and school-aged children agenda.
- Utilize the existing BOND platform to achieve the goals of BOND-KIDS Phase I.
- BOND KIDS is intended to avoid duplicating existing/emerging activities and add value to the efforts of the global community to address the needs of school aged children by focusing on the evidence, i.e., what we know and what we don't and how we might
  1. address gaps in that evidence and,
  2. apply that evidence most effectively in support of sustainable and resilient programs and policies.
- BOND-KIDS is not intended to develop guidelines, recommendations or programs but rather support those agencies/organizations that do.



**KIDS**

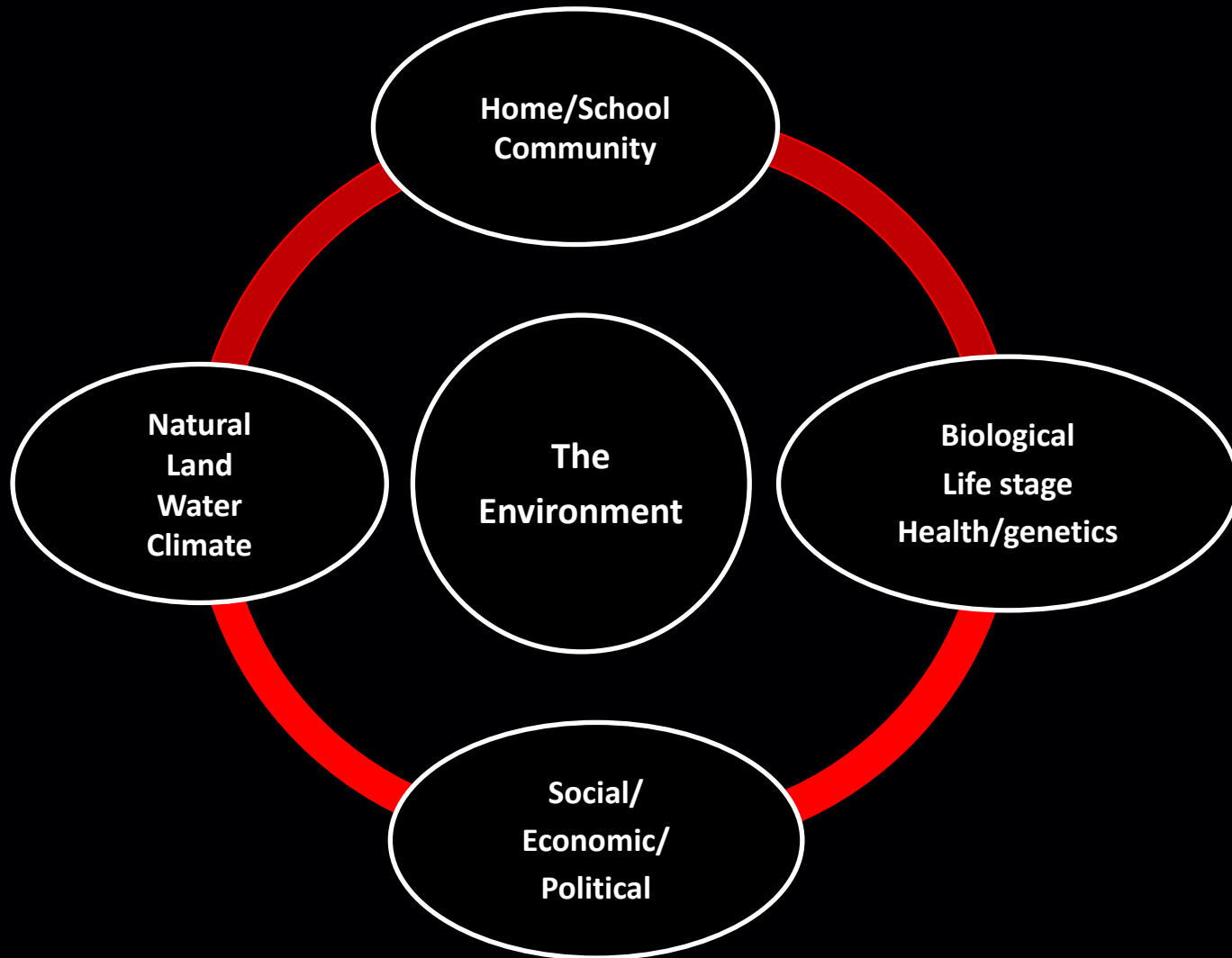
# Understanding the Nutritional Ecology

**Ecology:**

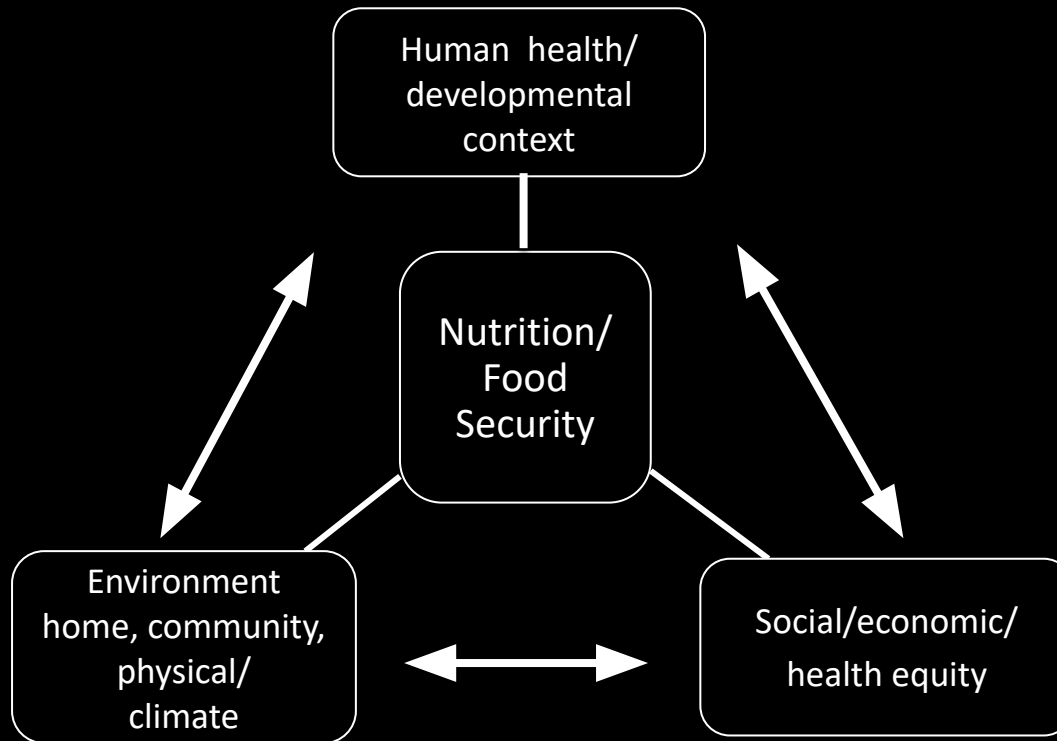
“the set of relationships existing between any complex system and its surroundings or environment.”

(Dictionary.com)

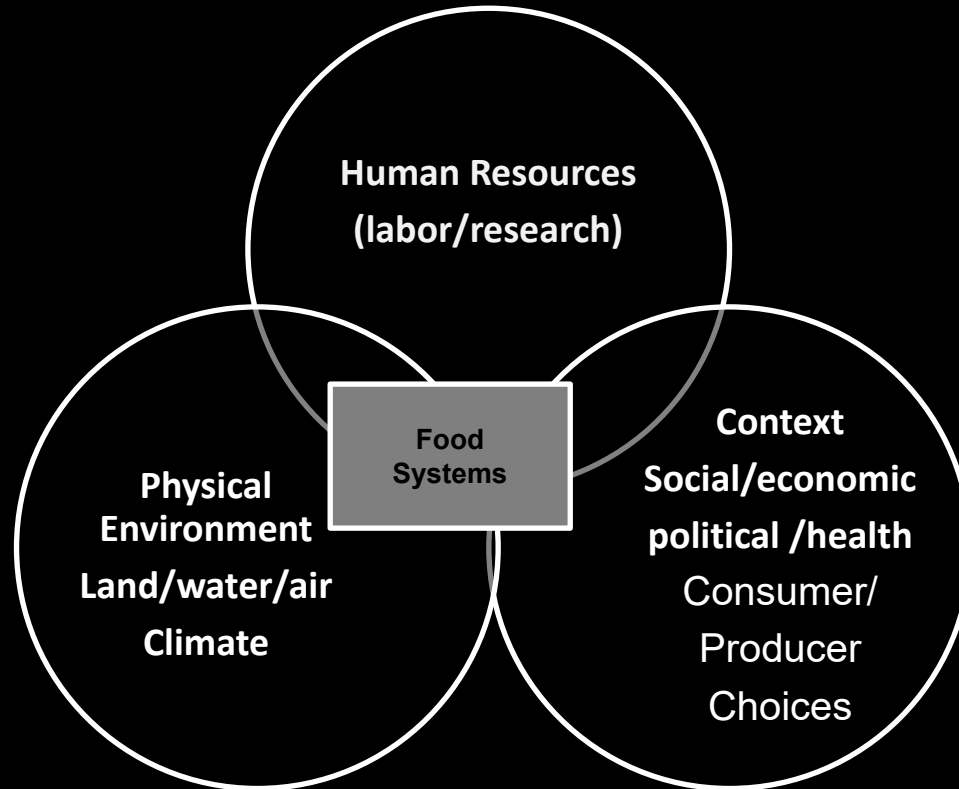
# The “Environment”- a holistic view



# Critical Drivers of Need

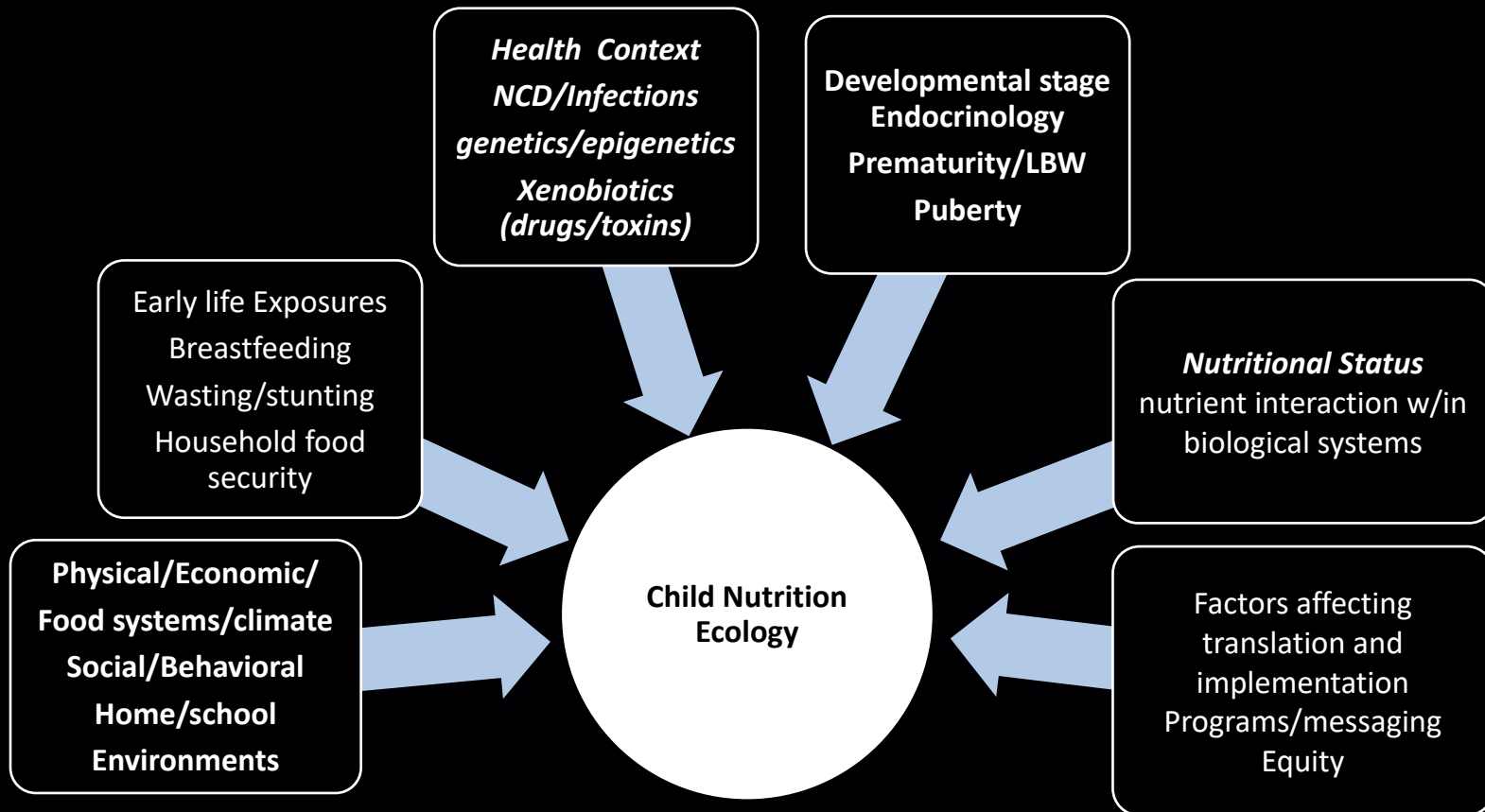


# A Critical Factor: Food Systems



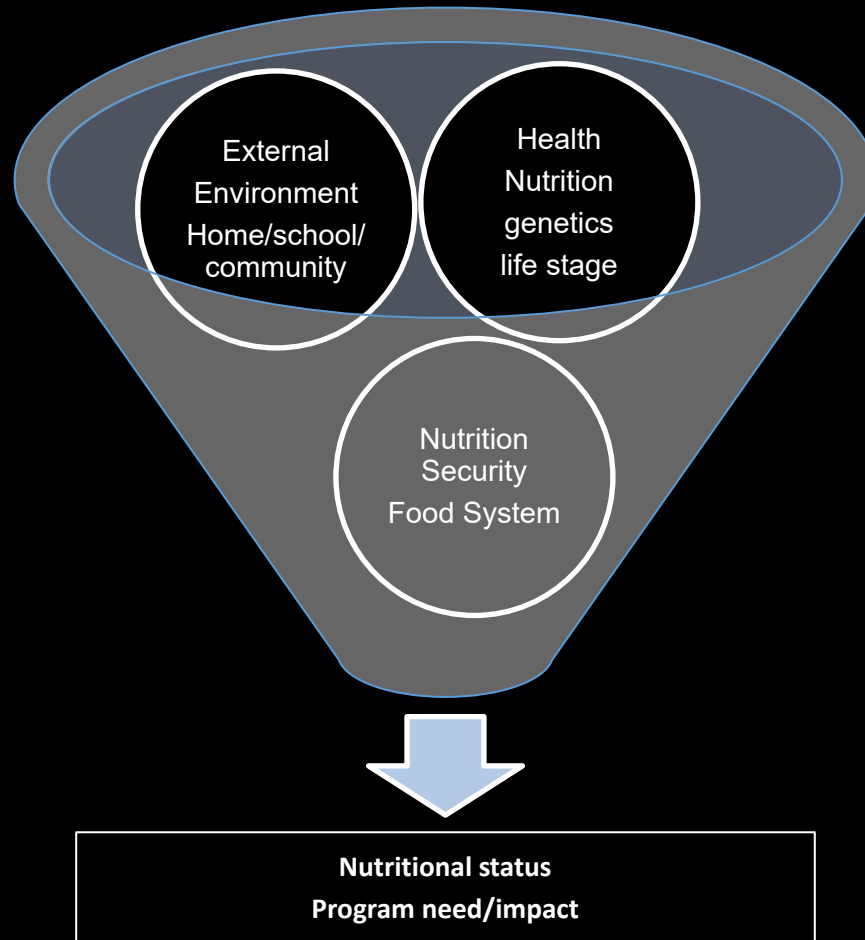
**“Food System (agricultural, marine, commercial): includes all processes and infrastructure involved in feeding a population: growing, harvesting, processing, packaging, transporting, marketing, consumption, and disposal of food and food-related items.” (Wikipedia)**

# The Child Nutrition Ecology: Sources of Variability





# Operationalizing the Ecological Approach to Nutritional Assessment

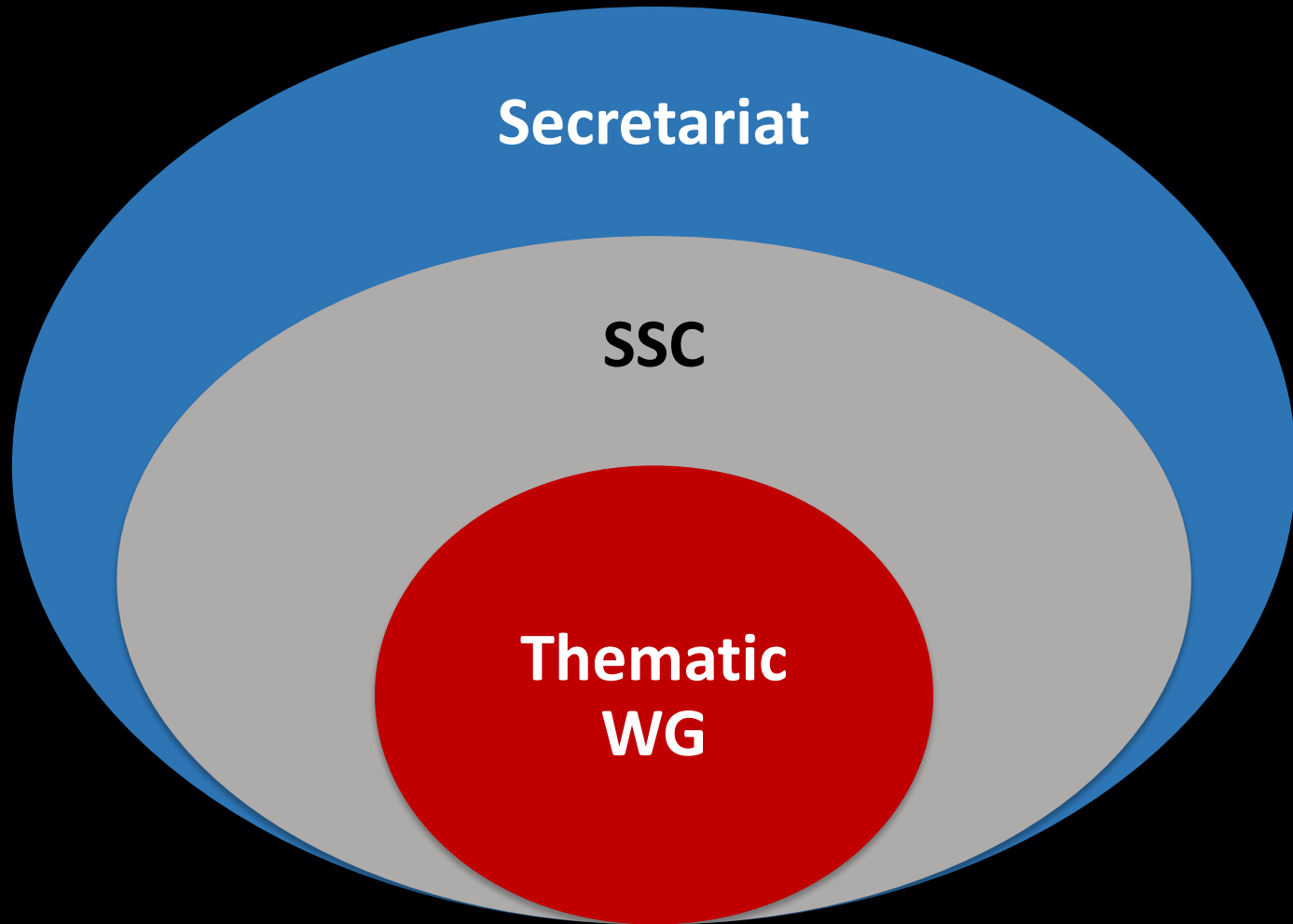


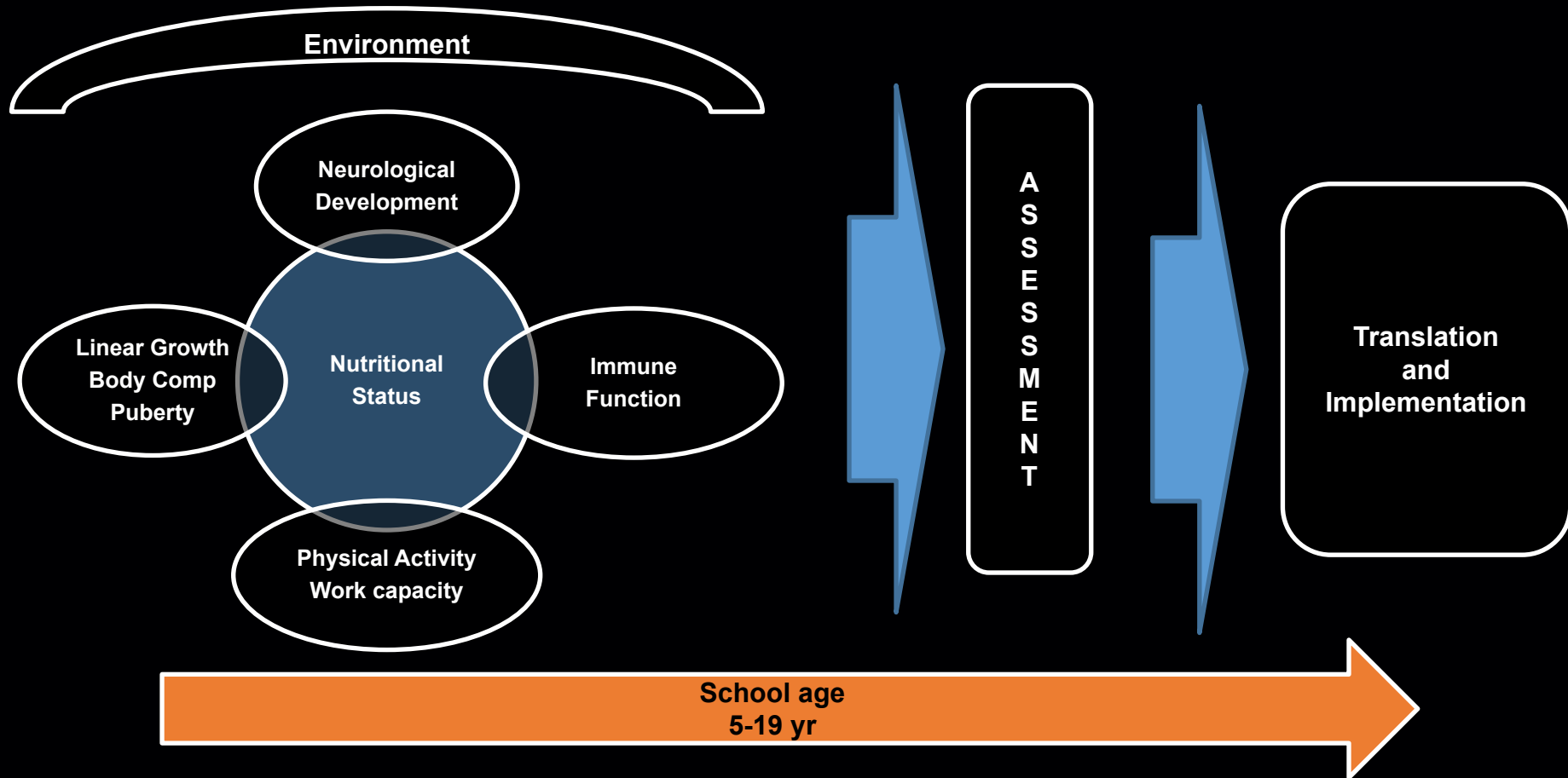


**BOND**  
BIOMARKERS OF NUTRITION FOR DEVELOPMENT

**KIDS**

Objectives, structure, and process





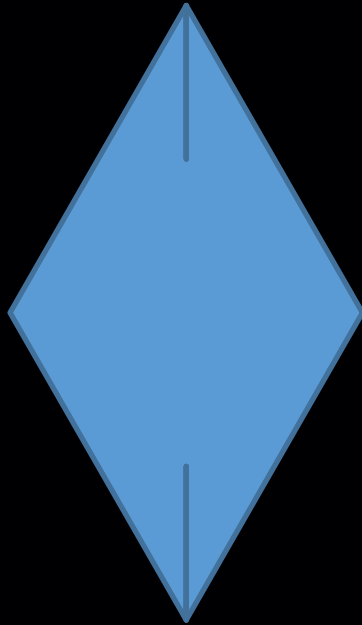


## Clinical Exam

Physical exam  
(anthropometry)

Family History

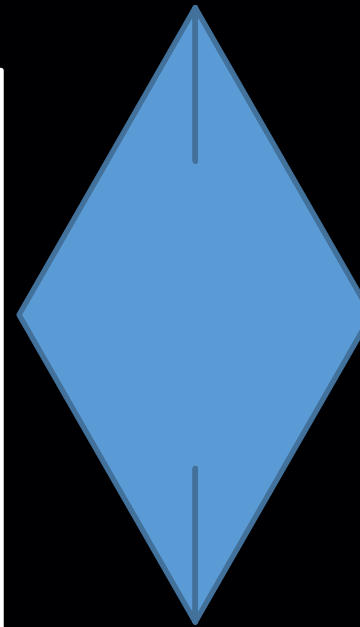
External environment  
Contextual Questions  
(health status  
assessment)  
including xenobiotics  
Social Determinants  
Community  
Physical environment  
Climate stress



## Diet/ Nutrition

Dietary Intake  
Assessment

Nutrient specific  
biochemical/biomarker  
assessment(s)



## Functional assessments

Growth

Neurodevelopment

Body composition/  
metabolic correlates

Immune function/  
Inflammation



- Publication and dissemination of BOND-KIDS outputs.
- Initiate efforts to implement research priorities to fill gaps
- Continue with efforts to translate the evidence in a manner that fits the collaborative mission
- Make the case for added value of integration of new data across relevant user groups (clinical/public health).
- Support stakeholder efforts to generate context specific, equitable, resilient and sustainable interventions, programs and guidance to support nutritional care of school-aged children in the US and globally..



THANK YOU!

# **BOND-KIDS: The Biology**

Connie M. Weaver, Ph.D.  
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[cmweaver@sdsu.edu](mailto:cmweaver@sdsu.edu)



# **WG1 Committee Members**

Michael Georgieff, University of Minnesota

Guillermina Girardi, NICHD

Ronald Kleinman, Massachusetts General  
Hospital

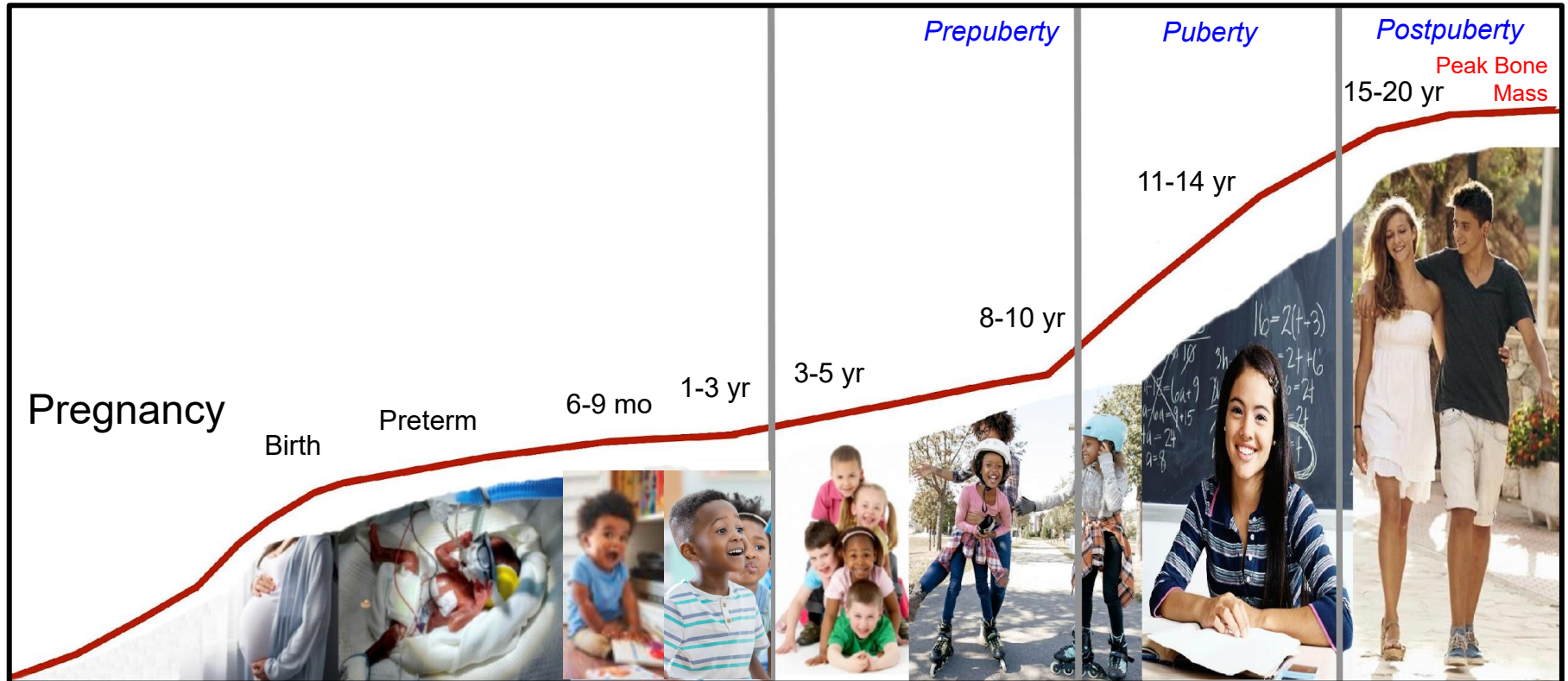
Usha Ramakrishnan, Rollins School of Public  
Health

Jennifer Sacheck, The George Washington  
University

Connie Weaver, San Diego State University

Babette Zemel, Children's Hospital of  
Philadelphia

# Development Periods



- Linear and bone growth
- Endocrine
- Neurodevelopment \*
- Muscle physiology \*
- Metabolism \*
- Immune system \*
- Reproduction health \*

## Key Periods

\*

\*

\*

# Outline

Section 1: Nutrient needs for growth and development

Section 2: Linear growth and body composition

Section 3: Neurodevelopment

Section 4: Physical Activity

Section 5: Immunocompetence and inflammation

# Nutrients of Public Health Concern

## In school-aged children

All Americans,  $\geq 1$  y old

- Vitamin D
- Calcium
- Potassium
- Sodium
- Added sugars

All Americans,  $\geq 2$  y old

- Saturated fat
- Fiber

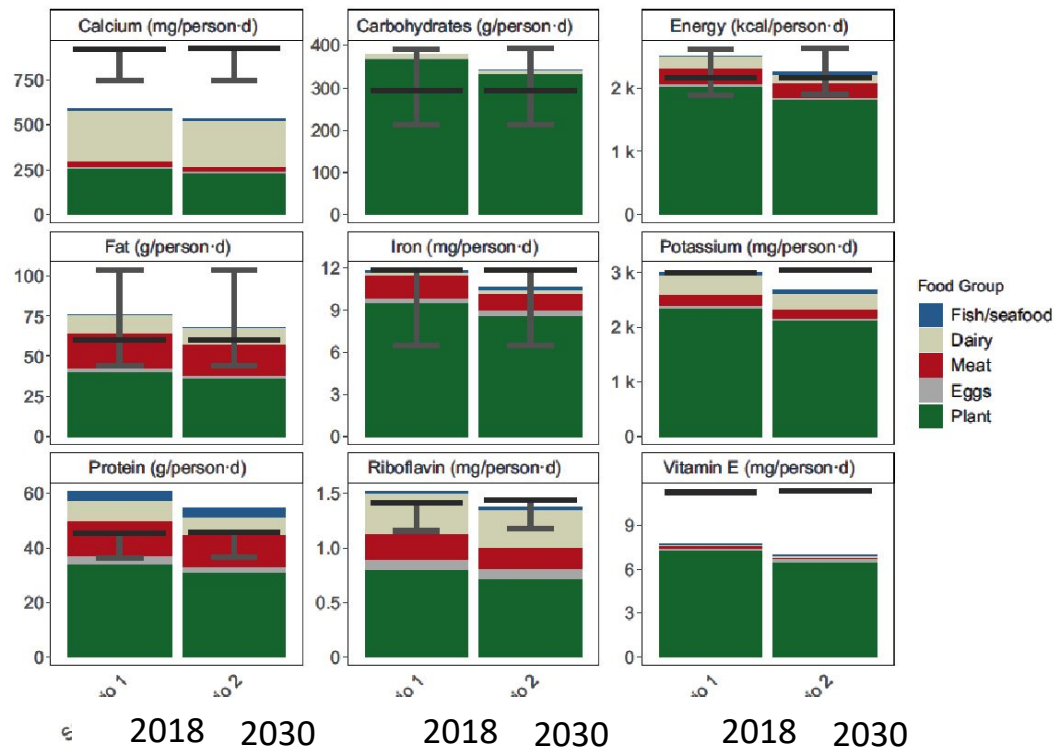
1. Nutrients over or under consumed by 5%;  
from What We Eat in America
2. With associated biological endpoint and clinical health consequences

Bailey et al. JJ Nutr 2021;151:1197–1204

# Global Nutrient Supply (per capita/day)

Black horizontal line=demographically weighted global target daily intake

Gray error bars= upper and lower safe intake values

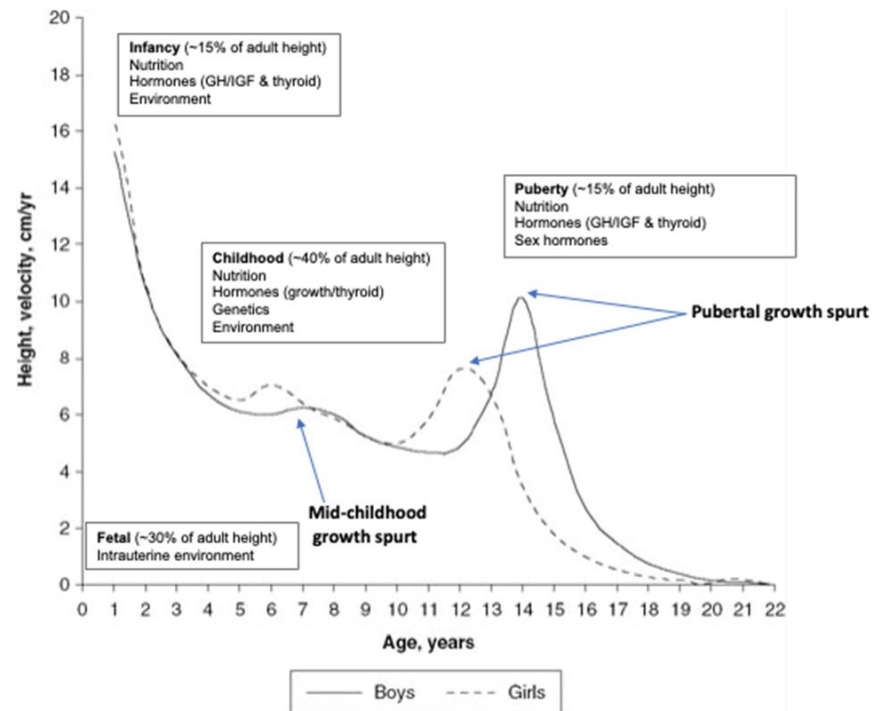


Smith et al. JN 2021

doi:/10.1093/jn/nxab199/6312058

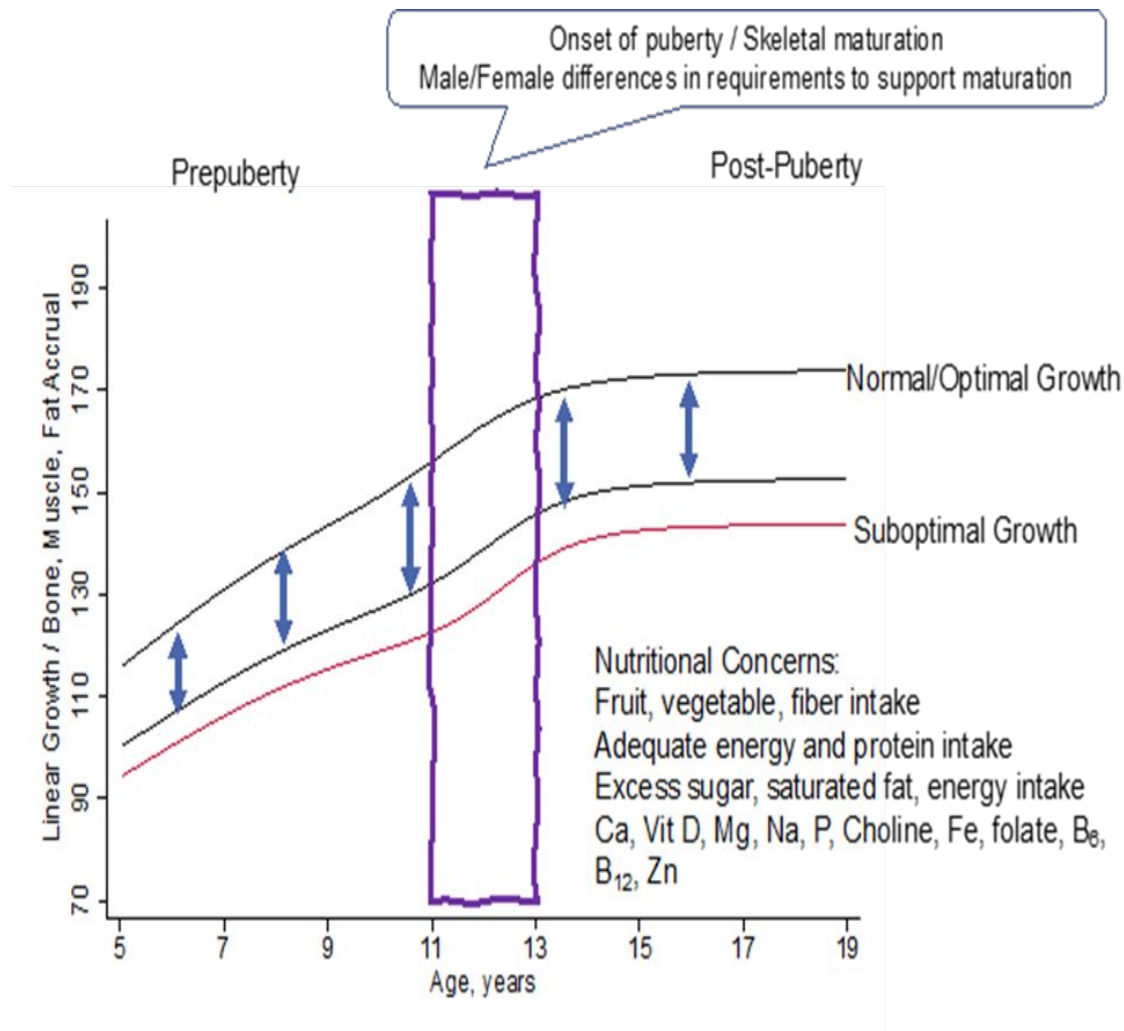
# Bone mass across the lifespan with optimal and suboptimal lifestyle choices

Growth tempo more reflective of growth process than single measure of size but lack standards

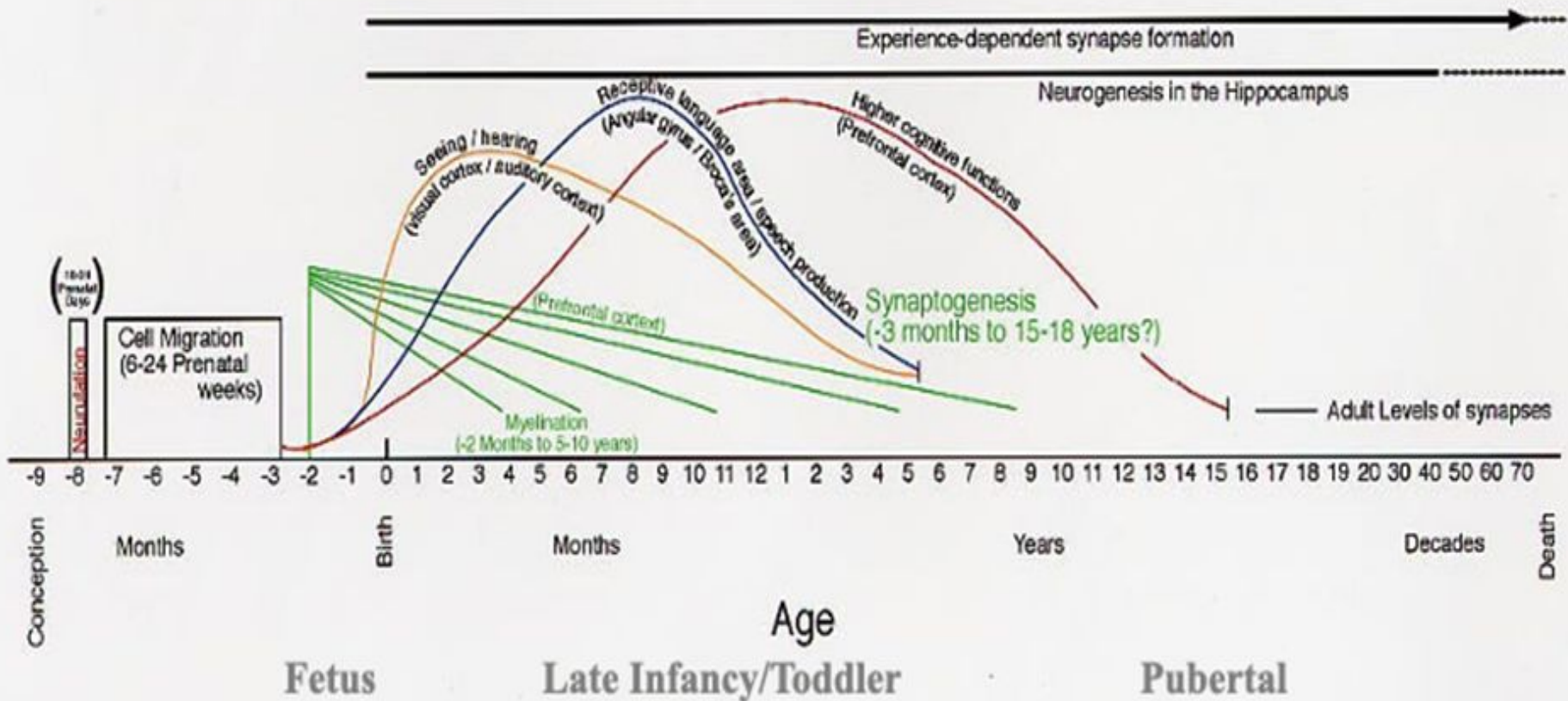


Adapted from Salkind, N. J. (2005). Physical development and growth. In Encyclopedia of human development (Vol. 1, pp. 1001-1007). SAGE Publications, Inc., <https://dx.doi.org/10.4135/9781412952484.n485>

# Linear Growth and Essential Nutrients



# Human Brain Development



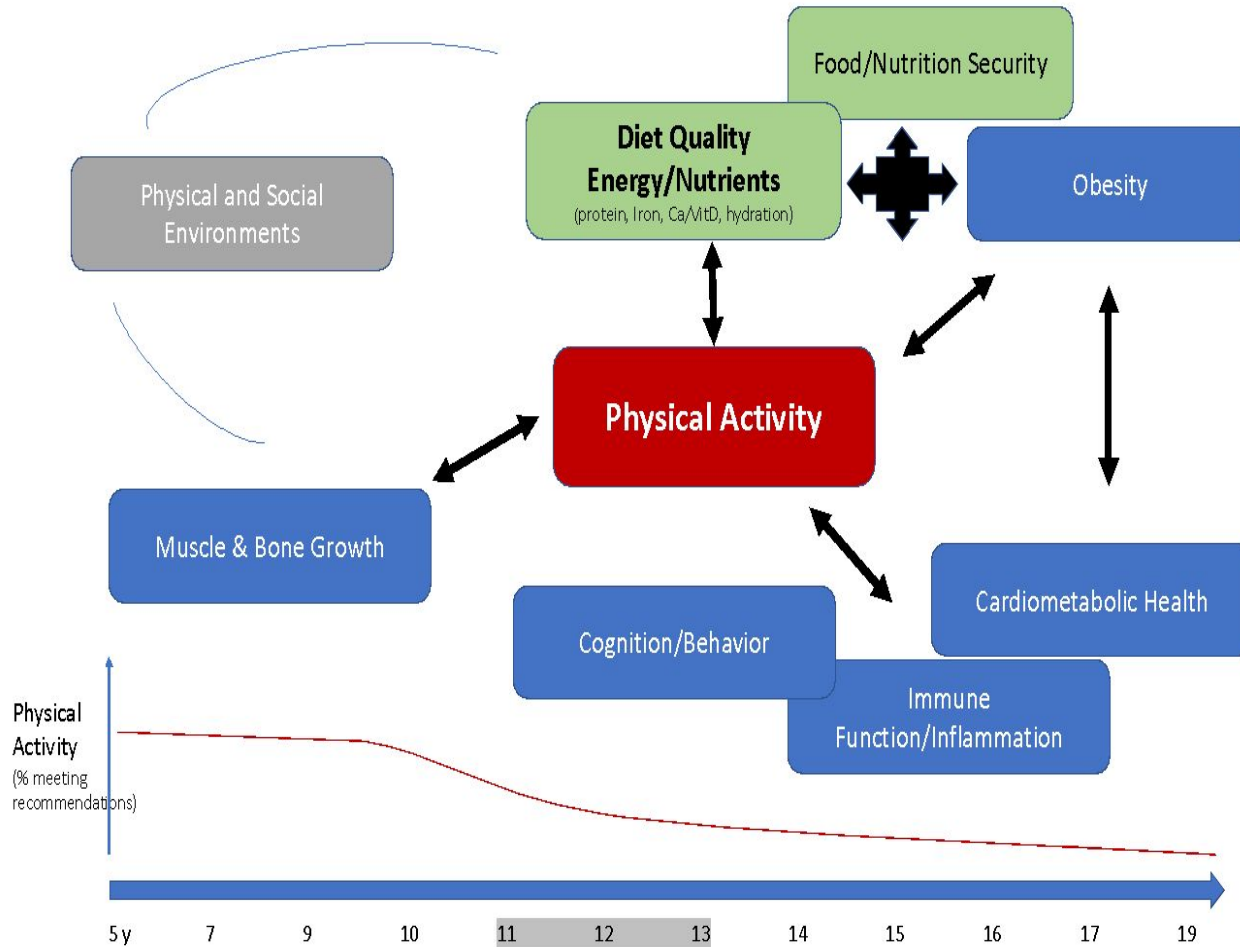


# Nutrients that particularly affect brain development and function

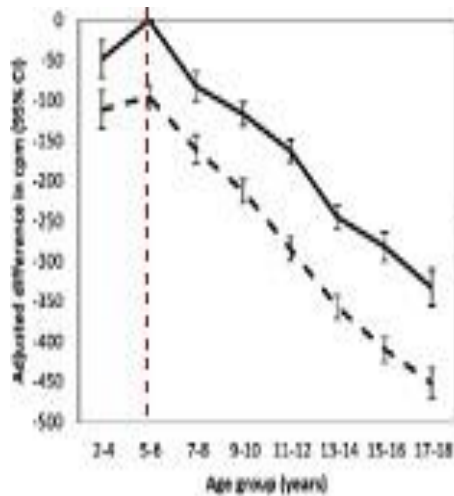
Conditions	Stunning <sup>1</sup> Underweight <sup>1</sup> Obesity <sup>1</sup>
Macronutrients	Proteins <sup>1,2,4</sup> Fats <sup>1,2,3</sup> LC-PUFA Glucose <sup>1,2,3</sup>
Micronutrients	Iron <sup>1,2,3,4</sup> Zinc <sup>1,2</sup> Copper <sup>1,2,3</sup> Iodine <sup>1,3</sup> Selenium <sup>1</sup> Vitamin A <sup>1,4</sup> B Vitamins (B6 <sup>3</sup> ,B12 <sup>1</sup> ) Folatet <sup>1,2,3,4</sup> Cholilne <sup>1,2,3,4</sup>

<sup>1</sup>Affects neuroanatomy: neurons, gila  
<sup>2</sup>Affects neurochemistry: neurotransmitters  
<sup>3</sup>Affects neurophysiology: electrical potential  
<sup>4</sup>Affects gene expression: epigenetics

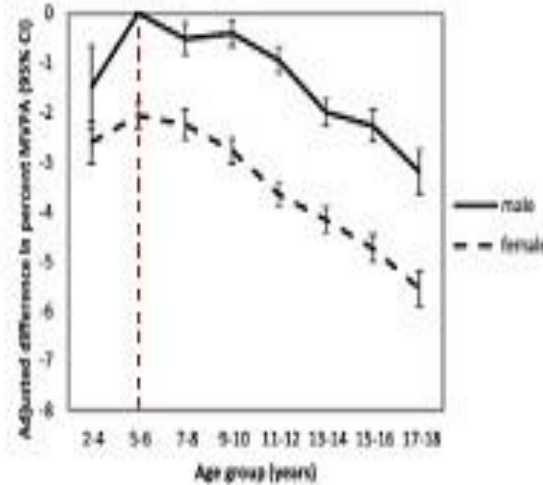
# Conceptual diagram of the inter-relationship between nutrient intake and physical activity in the context of environmental factors and related health outcomes in school-aged children



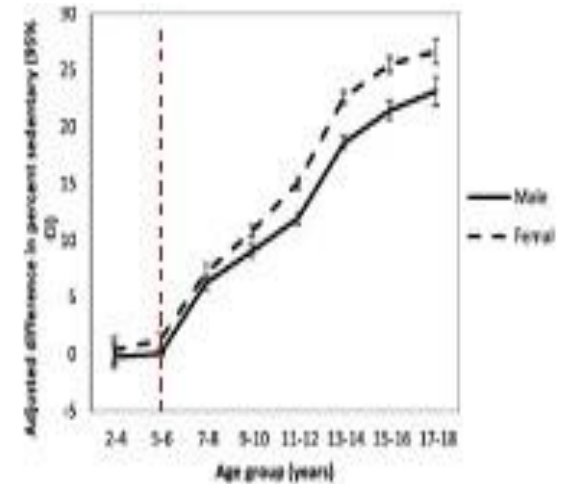
# Physical activity and sedentary time globally among school-aged children



Total Activity



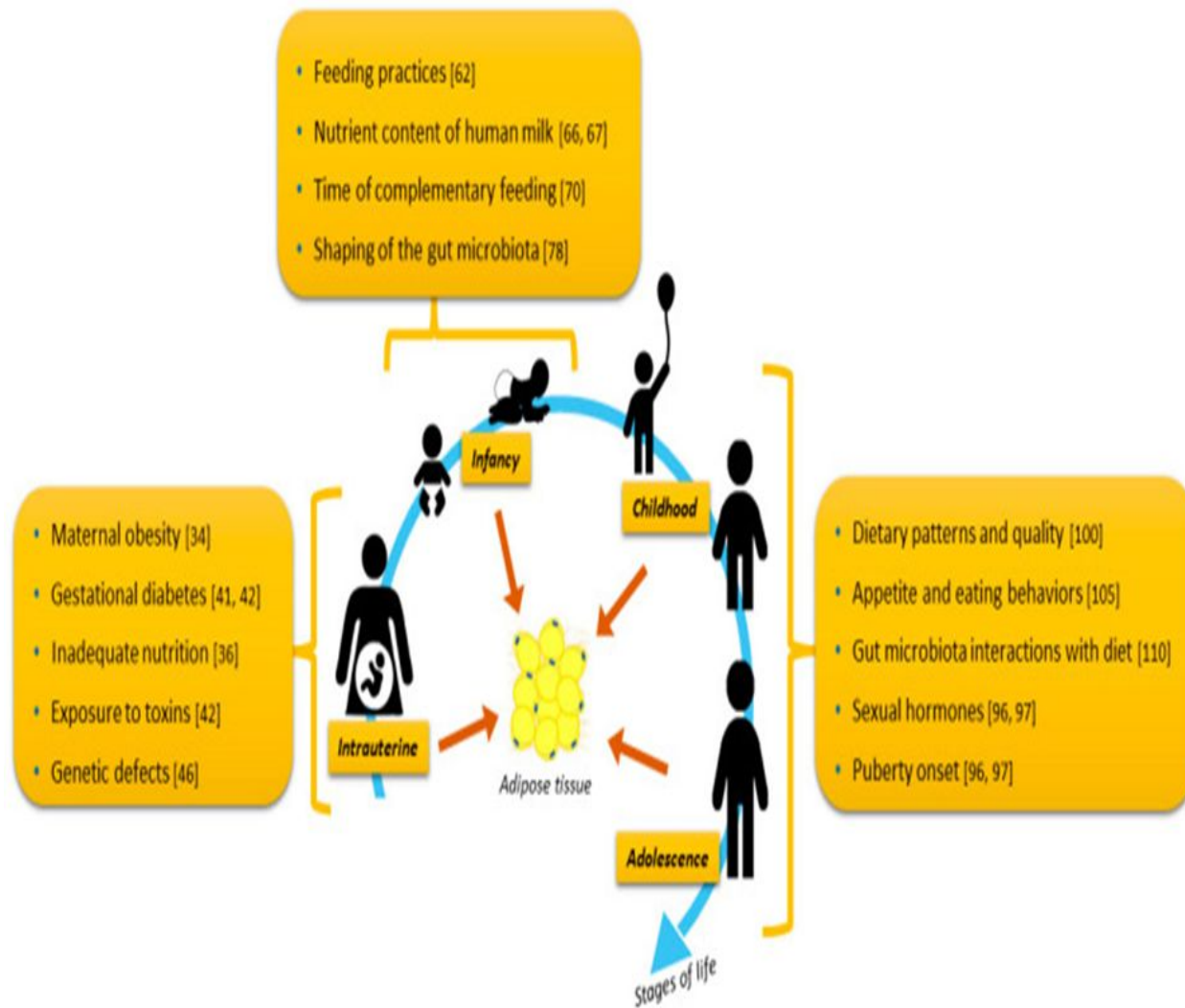
Moderate-to-Vigorous Activity



Sedentary Time

Data from the International Children's Accelerometry Database (ICAD, Cooper et al. 2015)

# Factors contributing to adipose tissue development and expansion from birth to adulthood



# Summary: Research Gaps/Future Opportunities for Biological Development of School Aged Children

- ***Nutrient requirements by developmental stage.*** Improved modeling of effects of individual nutrients and dietary and behavioral patterns for each of the three target age groups will lead to better age and sex-specific nutritional recommendations.
- ***Biomarkers and bioindicators.*** Validation of biomarkers and bioindicators for diet effects on biological systems and functional outcomes.
- ***Long-term consequences.*** Mechanisms of long-term effects of diet and compensatory responses to interventions among children who are at nutritional risk (for example, catch-up growth or nutritional excesses) on well-being and health.
- ***Nutrition as a factor in systems science.*** Use systems science to comprehensively study nutrition and functional outcomes of interest (for example, development, function, and reduction of risk of chronic disease) in school-aged children.

# **Biomarkers of Nutrition for Development (BOND)-KIDS:**

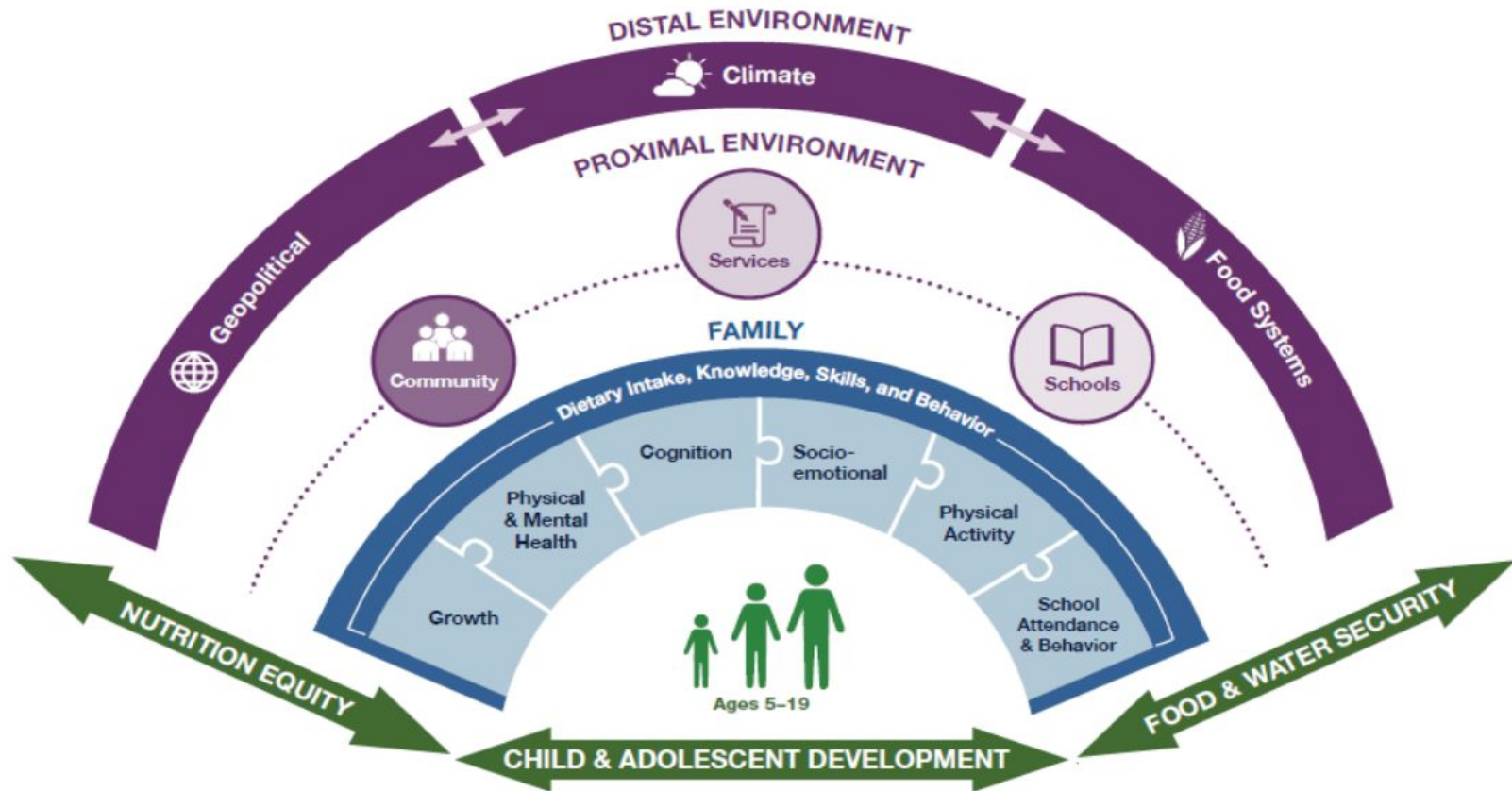
**Understanding the nutrition ecology and emerging research gaps in nutrition that impact school-aged children and adolescents' functioning**

Maureen Black, Ph.D.  
University of Maryland School of Medicine  
and  
RTI International

Dr. Black has no conflicts

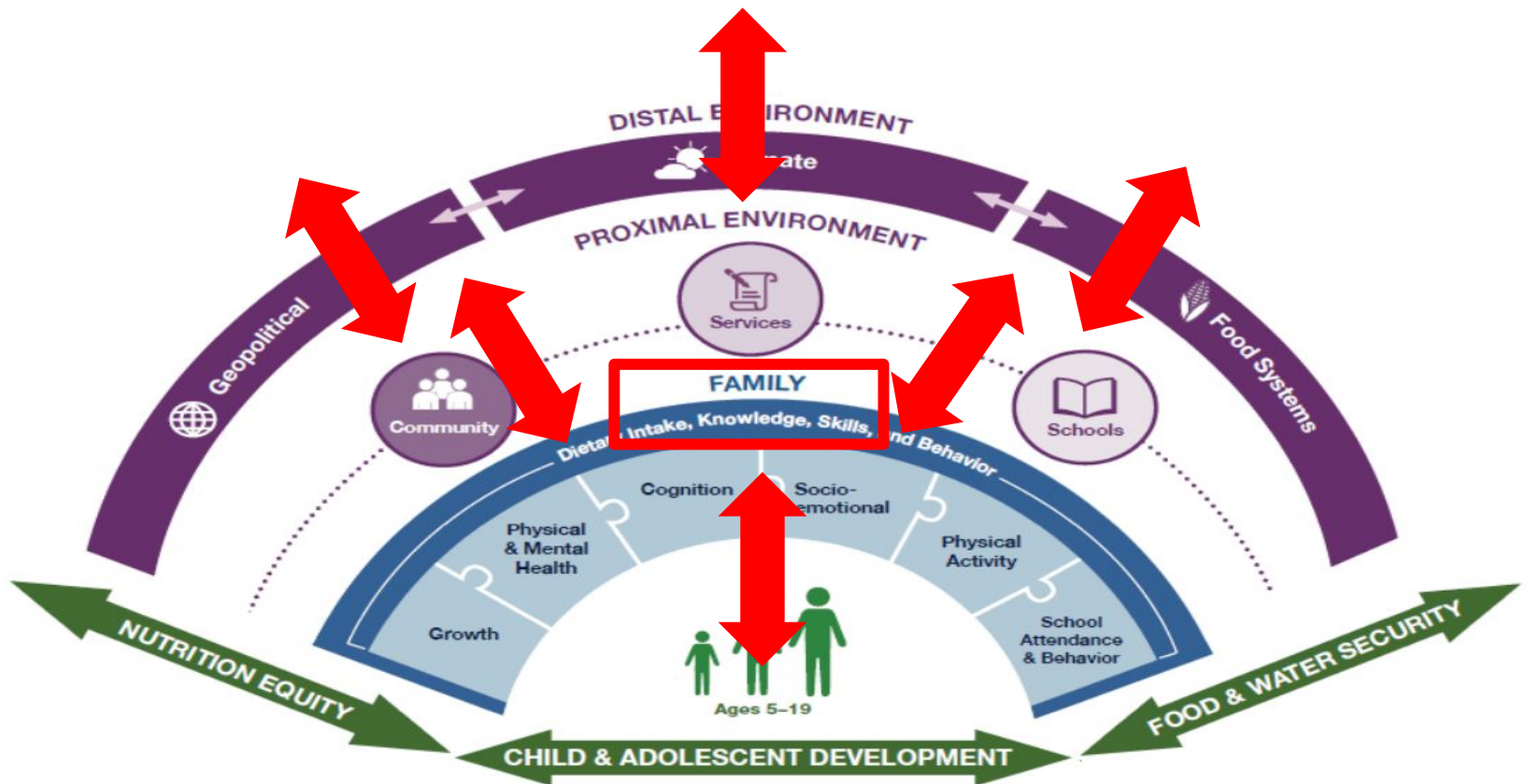
# Nutrition Ecology Framework

Impact of nutrition on children's health and well-being is dependent on nutrition ecology



# Nutrition Ecology Framework

Impact of nutrition on children's health and well-being is dependent on nutrition ecology





# Climate



## Issues

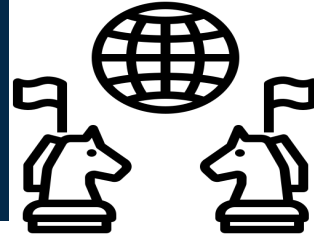
- Temperature
- Land use
- Water cycle
- Biogeochemical cycles
- Impact on food system
  - Yields and nutrient density

## Research

### Gaps/Recommendations

- Models to predict change in **nutritional quality of crops.**
- **Health consequences** of diminished grain quality and populations at risk.
- Solutions to maintain **plant nutritional quality.**

# Geopolitical



## Issues

- Urbanization
- Population migration
- Conflict/humanitarian emergencies
  
- Globalization of food supply – nutrition transition
  - Ultra-processed food
  - Added sugar, unhealthy fats

## Research Gaps/Recommendations

- **Surveillance** systems to identify **humanitarian crises**.
  
- **Mobilize responses to humanitarian crises**.

# Food Systems



## Issues

- Complex interacting components
  - agriculture, water, and forests
  - production, processing, storage, distribution
  - food retail, pricing, marketing, and consumer behavior
- Influenced by geopolitical, climate & policies

## Research Gaps/Recommendations

- Identify **leverage points for improving nutrition.**
- Identify modifiable features of food system that **strengthen or mitigate impacts of interventions on nutrition.**

# Community



## Issues

- Where children live impacts their nutrition ecology and health.
- Policies that support healthy lifestyles through environmental change (e.g., taxes on sugar sweetened beverages).

## Research Gaps/Recommendations

- Identify the most salient economic and **cultural barriers and enablers** to healthy nutrition.
- Build partnerships with community food providers to determine how to **improve nutrition options**.

# Services



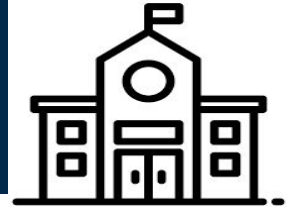
## Issues

- Access to healthcare, social services, & supplemental food
- Positive impact depends on eligibility, staff and infrastructure to facilitate referrals.

## Research Gaps/Recommendations

- **Integrate nutrition into health systems.**
- Economic impact of SNAP on communities
- Impact of changing **SNAP to focus on nutrition security.**

# Schools



## Issues

- Children consume  $\geq$  half of their daily meals & snacks at school.
- 50% of school-age children (388 million) in  $\geq$  161 countries receive school meals daily

## Research Gaps/Recommendations

- **Spillover effects from schools to households and community.**
- **Improve student participation in healthy school meals.**

# Family



## Issues

- Children learn food and eating values from caregivers' beliefs, practices, and access to food, including when, what, and how much to eat.
- Through food parenting children develop eating habits and autonomy.

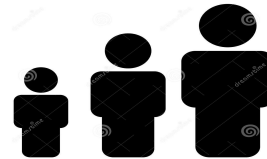
## Research Gaps/Recommendations

- Assess family dietary patterns, including the **emotional context of meals** by socioeconomic status, race ethnicity, locale, and culture.
- Help families provide **healthy nutrition** and children's **self-regulatory behaviors.**

# Cross Cutting Issues

- **Nutrition Equity**
- **Food and Water Security**
- **Child Development**
  - **School-age children (Age 5-9)**
  - **Early adolescent (Age 10-14)**
  - **Later adolescent (Age 15-19)**

Modifiable factors related to social and structural determinants of health and nutrition





# Conclusions

- Associations between nutrition ecology & child health & well-being
  - **proximal (community)**
  - **family**
- Failure to consider the nutrition ecology
  - **misinterpret findings**
  - **stall efforts to achieve health equity**
- Scaling up **evidence-based programs**
  - **improve nutrition ecology and child health and well-being**
  - benefits families, schools, communities, and societies.
- **Multi-level evidence-based policies**
  - all-of-society and health-in-all-policies approach
  - wide-spread benefits for future societies

# WG 2: Physical & social environments: Relation to children's nutritional ecology



Maureen Black, PhD  
Chair



Meg Bruening, PhD,  
MPH, RD  
WG member



Amy Carroll-Scott,  
PhD, MPH  
WG member



Jayna Markand Dave, PhD  
WG member



Elizabeth  
Yakes  
Jimenez, PhD,  
RDN  
Secretariat



Kristie Ebi, PhD, MPH  
WG member



Lora Iannotti, PhD  
WG member

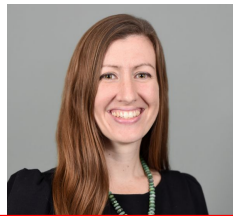


Susan Johnson, PhD  
WG member



Lorrene Ritchie,  
PhD, RDN  
WG member

## **WG 2: Physical & social environments: Relation to children's nutritional ecology**



**Thanks to Daniel Reitan and Andrew Bremer  
and the Eunice Kennedy Shriver National  
Institute, Child Health and Human Development**

**Thanks to Alison Steiber and the Academy of  
Nutrition & Dietetics**

# BIOMARKERS OF NUTRITION FOR DEVELOPMENT: KNOWLEDGE INDICATING DIETARY SUFFICIENCY

## FINDINGS FROM WORKING GROUP 3: ASSESSMENT

Saurabh Mehta, M.B.B.S., Sc.D.

Janet and Gordon Lankton Professor and Director, Program in International Nutrition  
Founding Co-Director, Center for Precision Nutrition and Health  
Division of Nutritional Sciences, Cornell University, Ithaca, New York, US



**Cornell Human Ecology**

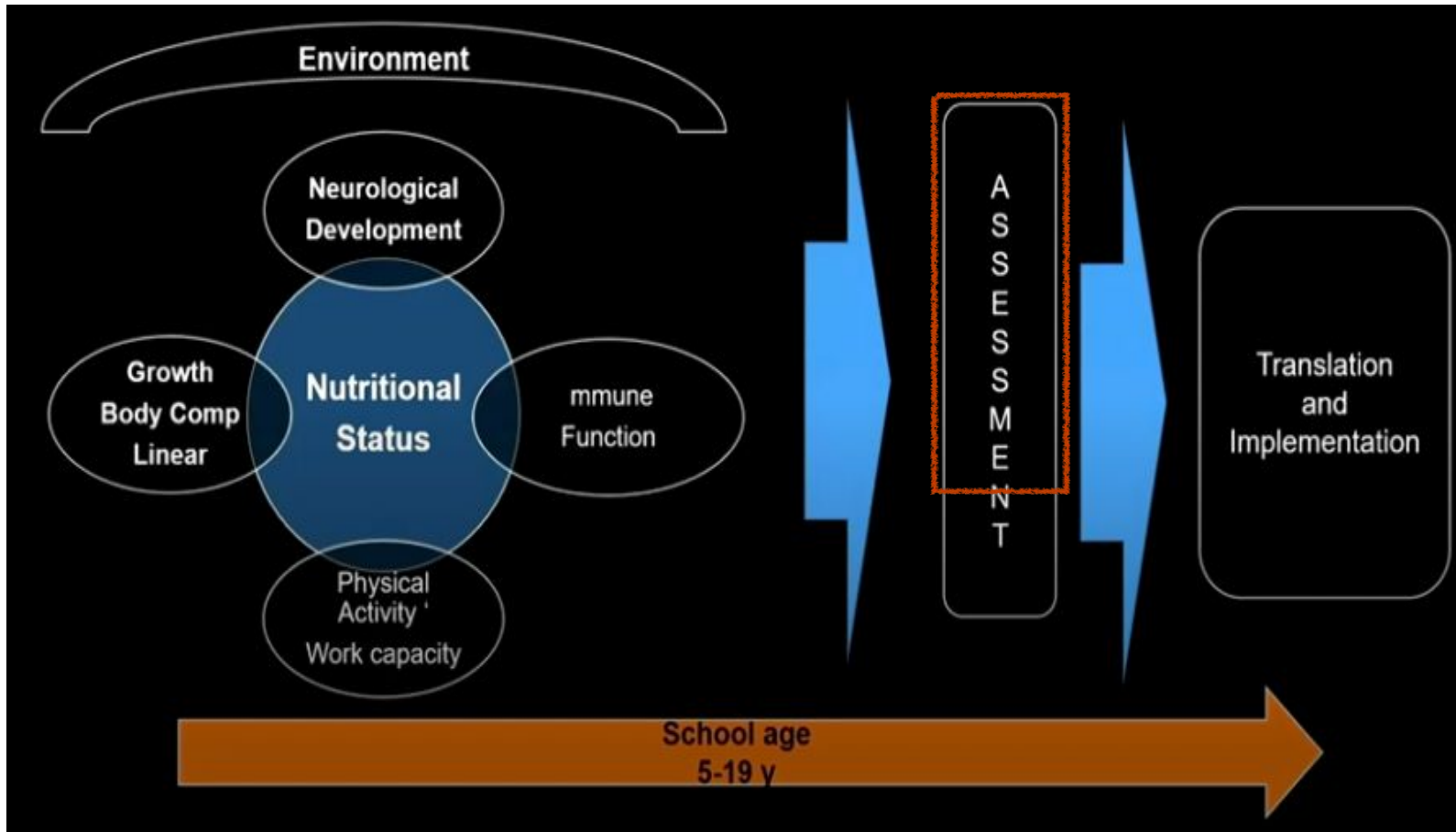
## DISCLOSURE

AFFILIATION/FINANCIAL INTERESTS (prior 12 months)	ENTITIES
Grants/Research Support	National Institutes of Health (NICHD, NIBIB, FIC, NCCIH) National Science Foundation Global Alliance for Improved Nutrition United States Department of Agriculture United States Agency for International Development HarvestPlus/International Food Policy Research Institute Department of Defense Centers for Disease Control and Prevention World Health Organization
Scientific Advisory Board/Consultant/Board of Directors (unpaid)	VitaScan World Economic Forum EAG on Frontiers of Nutrition
Speakers Bureau	None
Stock Shareholder	VitaScan
Employer	Cornell University
Other	N/A

## WG3 COMMITTEE MEMBERS

- Saurabh Mehta, Cornell University (WG3 Chair)
- Daniel J. Raiten, NICHD, NIH
- O. Yaw Addo, CDC
- Lindsay H. Allen, USDA
- Regan L. Bailey, Texas A&M University
- Christopher P. Duggan, Harvard TH Chan School of Public Health
- Reina Engle-Stone, University of California Davis
- Victor Owino, International Atomic Energy Agency
- Jennifer Savage Williams, The Pennsylvania State University
- Alison Steiber, Academy of Nutrition and Dietetics
- Gabriela V. Proaño, Academy of Nutrition and Dietetics
- Kimberlea Gibbs, NICHD, NIH

# WG3 REPORT OUTLINE: ASSESSMENT OF SCHOOL-AGED CHILDREN



## OVERVIEW OF WG3: FOCUS

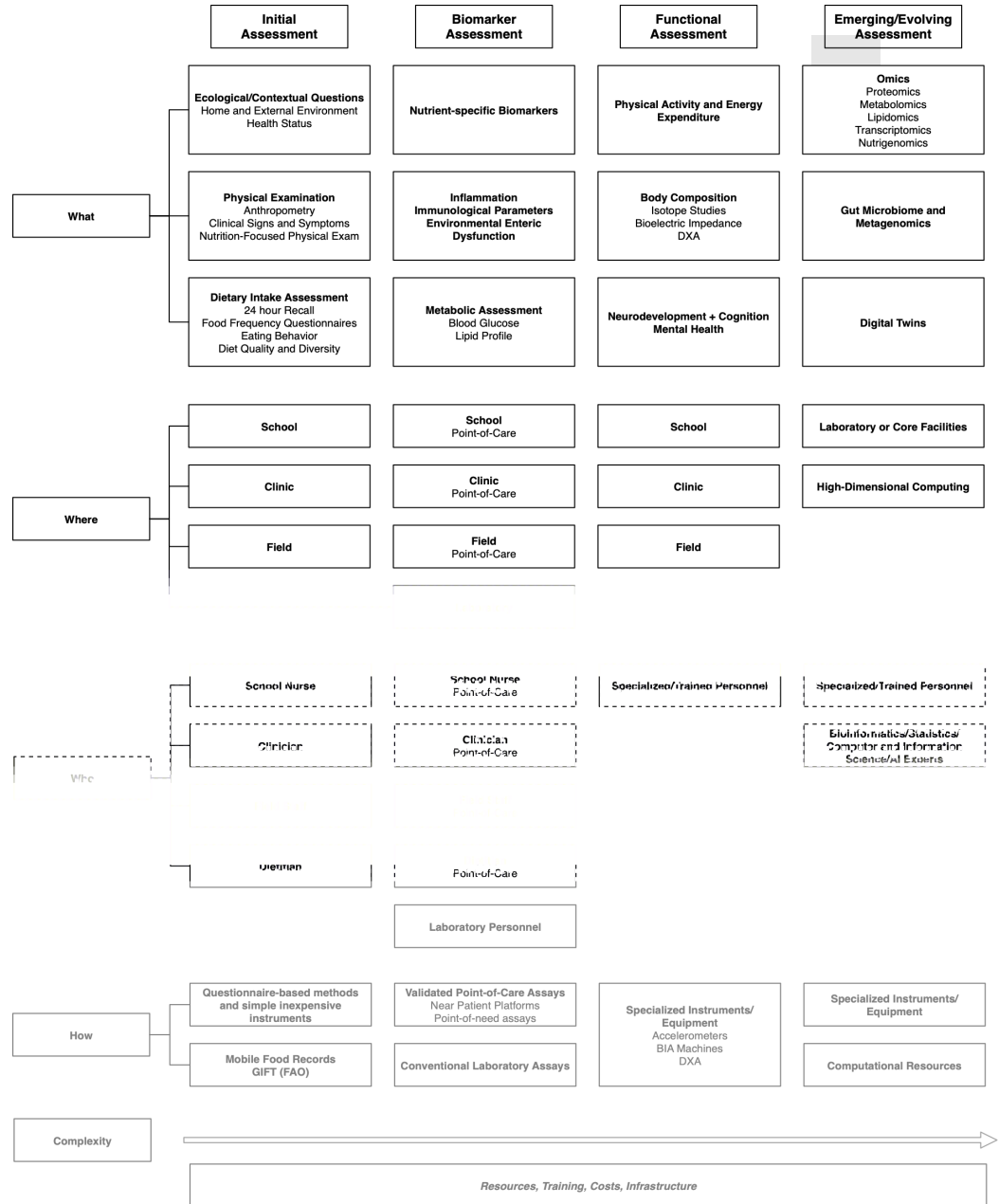
- Focus: Identification of key factors and measurements to support nutritional (**exposure, status, function, effect**) and other relevant measures of function and how they might be employed to assess the need for and impact of context-specific, equitable programs/interventions designed to provide nutritional support to school aged children

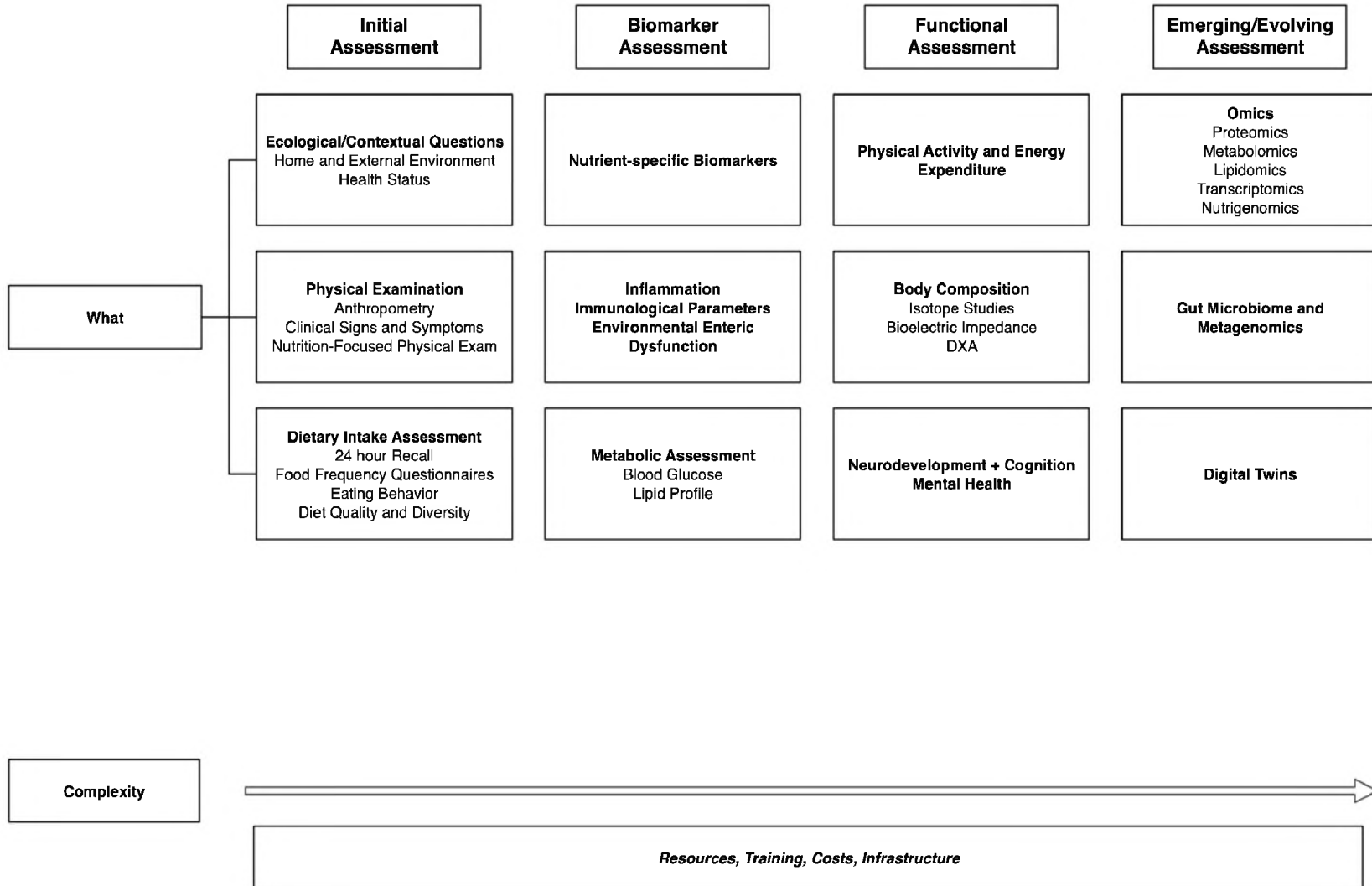


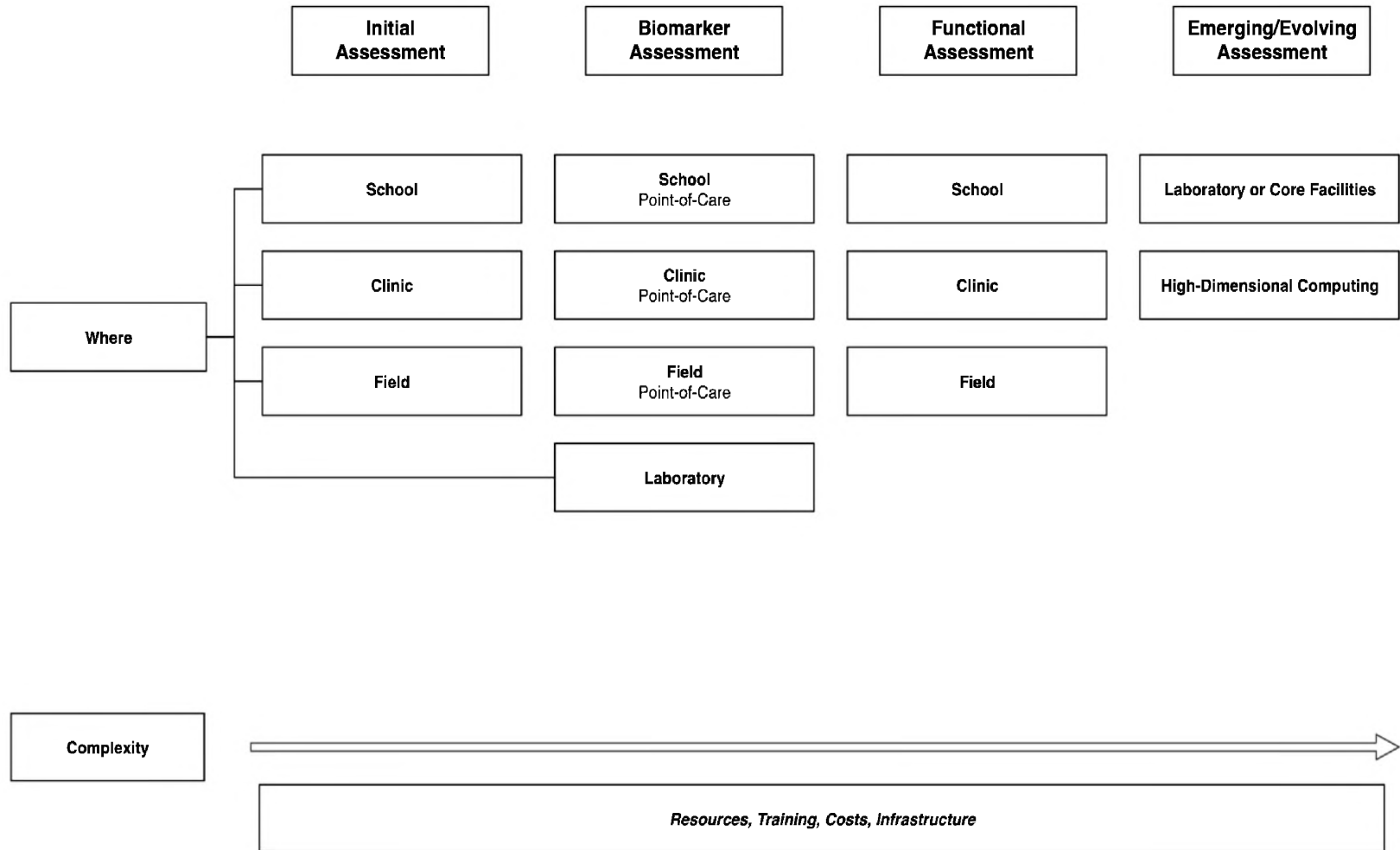
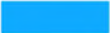
## WG3 REPORT

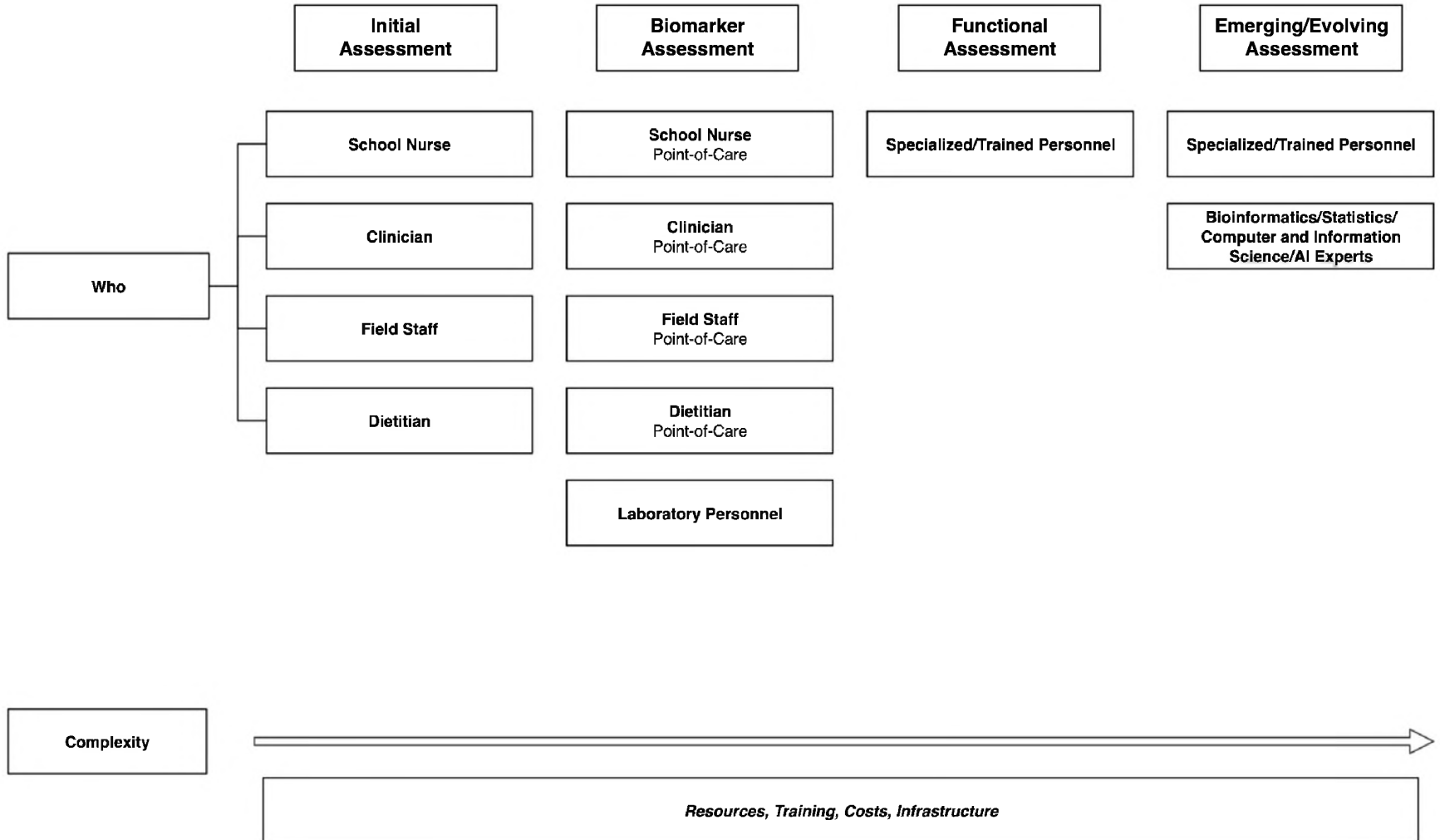
<b>SECTION</b>	<b>AUTHOR</b>
Physical exam	Chris Duggan
Current approaches to assessing dietary exposures	Regan Bailey & Carol Boushey
Assessment of specific nutrient status: nutrient status biomarkers	Lindsay Allen & Reina Engle-Stone
Linear growth assessments and interpretation with consideration for maturation stage in school-aged children	Yaw Addo
Body composition	Victor Owino
Physical activity	Scott Crouter
Neurodevelopment	Jennifer Savage Williams
Inflammation & immune function	Saurabh Mehta
Gastrointestinal health	Saurabh Mehta
Emerging/novel technologies for assessment of diet & health	Saurabh Mehta

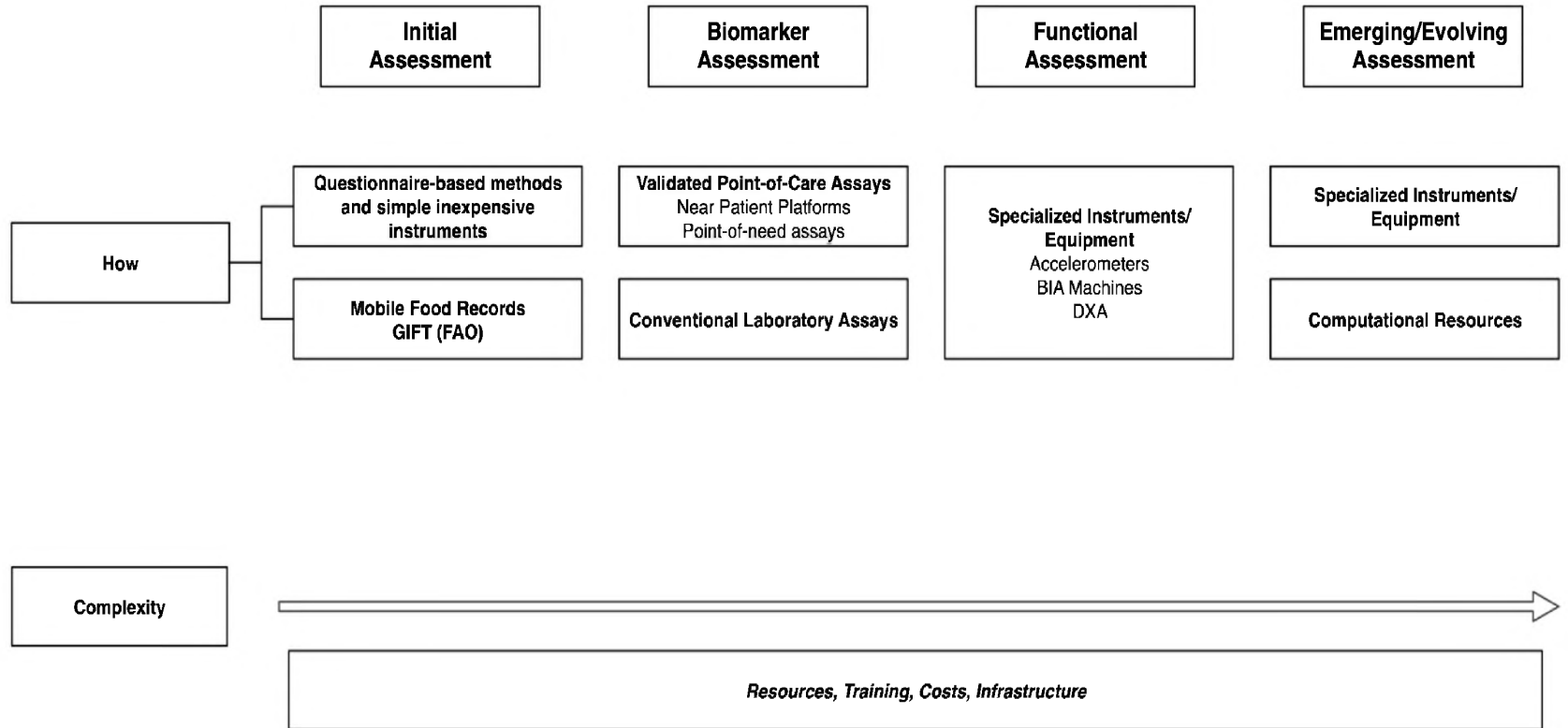
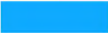
# COMPONENTS OF NUTRITIONAL ASSESSMENT











**OVERALL, THE INDICATORS REVIEWED IN THIS REPORT FALL INTO FOUR CATEGORIES:**



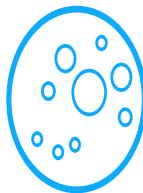
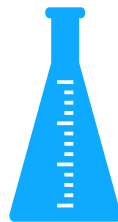
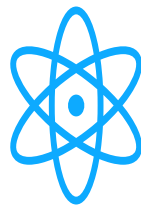
Those already monitored



Those that there is scientific consensus on but we need to build capacity, resources, or support their implementation



Those that we need to build diagnostic criteria or validate for use in field or school contexts



Those that are still emerging with limited evidence on functional relevance

## **THOSE ALREADY MONITORED**

These measures are routinely collected in schools on an annual or periodic basis.

1. Height
2. Weight
3. Fitness (e.g. Presidential fitness test)



**THOSE THAT  
THERE IS  
SCIENTIFIC  
CONSENSUS ON  
BUT WE NEED TO  
BUILD CAPACITY,  
RESOURCES, OR  
SUPPORT THEIR  
IMPLEMENTATION**

**Issue:** Capacity

These measures are validated for assessing the domains in WG1 report, but not implemented in certain contexts

1. Height velocity
2. Monitoring of micronutrient deficiencies

## **THOSE THAT WE NEED TO BUILD DIAGNOSTIC CRITERIA OR VALIDATE FOR USE IN FIELD OR SCHOOL CONTEXTS**

### **Issue:** Validation

These measures require further studies to define application to monitor child growth/development and for school contexts.

1. Screening tests for malnutrition and micronutrient deficiency
2. Assessment of immune function - which markers?

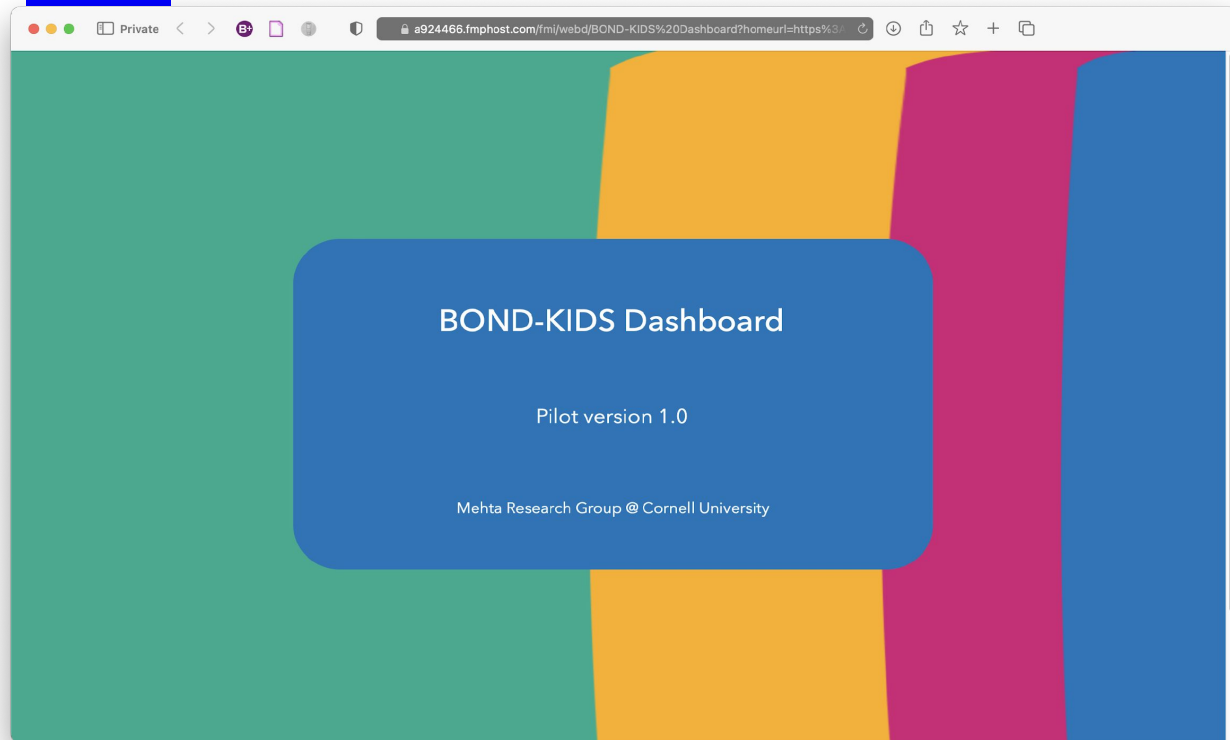
## THOSE THAT ARE STILL EMERGING WITH LIMITED EVIDENCE ON FUNCTIONAL RELEVANCE

**Issue:** Limited data

These measures require further research to determine if they are usable or feasible across different contexts and/or in children

1. Gut microbiome metrics like composition & diversity (clinical relevance?)
2. Metabolomics (diet assessment?)
3. 3D whole body imaging (anthropometry)

# BOND-KIDS DASHBOARD - LINK



<https://www.cpnh.cornell.edu/bond-kids>

# BOND-KIDS Dashboard

Search



Search by any field

Select a functional domain

Anthropometry & Body Composition

Chronological Age

Dietary Intake

Immune Function and/or Inflammation

Linear Growth

Malnutrition Screening

Maturation

Micronutrient Deficiency - Vitamin A

Neurodevelopment - Behavioral Observation

Measure	Age Group	Cost	Location	Feasibility: Infrastructure & Training
Subcutaneous and visceral adipose tissue, (quantitative) magnetic resonance imaging (MRI)	5-19y	\$\$\$		★★★★★
air displacement plethysmography	5-19y	\$\$\$		★★★★★
hydrostatic underwater weighing	5-19y	\$\$\$		★★★★★
Digital body imaging techniques based on smartphone technology	5-19y			★★★
Body mass index (height, weight)	5-19y	\$		★★
Body circumferences - e.g., mid-upper arm (MUAC), waist	5-19y	\$		★★
Skinfold thicknesses - e.g., triceps, subscapular	5-19y	\$\$		★★

Measures with info on age group, cost, location, and rating of feasibility for infrastructure and training

Suitable for application in clinic, school, and/or field environments

More details such as strengths and weaknesses

# BOND-KIDS Dashboard



	Measure	Age Group	Cost	Location	Feasibility: Infrastructure & Training	
Anthropometry & Body Composition	Fat mass (FM) & Fat free mass (FFM) - Body impedance analysis (BIA)	5-19y			★★★	...
Chronological Age	Stable isotope dilution techniques e.g., deuterium dilution technique	5-19y			★★★★	...
Dietary Intake	Total body calcium (bone mineral content), FM, FFM, Dual energy X-ray absorptiometry (DEXA)	5-19y			★★★★★	...
Immune Function and/or Inflammation	Intra-abdominal fat, visceral adipose tissue, fat in liver and muscles - computer-based tomography (CT scan)	N/A	\$\$\$		★★★★★	...
Linear Growth	Subcutaneous and visceral adipose tissue, (quantitative) magnetic resonance imaging (MRI)	5-19y	\$\$\$		★★★★★	...
Malnutrition Screening	air displacement plethysmography	5-19y	\$\$\$		★★★★★	...
Maturation						
Micronutrient Deficiency -						

Use case 1: Keyword “tanner”  
Result: single domain

# BOND-KIDS Dashboard

tanner 🔍 Show All ? ✕

Measure	Age Group	Cost	Location	Feasibility: Infrastructure & Training
Sexual maturity - Tanner Staging (Clinic-based)	8-18y	\$-\$\$\$		★
Bone age - radiograph of wrists - Greulich-Pyle (GP) atlas method	6-19y <span>i</span>	\$\$-\$\$\$\$		★★★
Bone age - radiograph of wrists - Tanner-Whitehouse (TW) scoring methods	5-19y <span>i</span>	\$\$-\$\$\$\$		★★★
Bone age - radiograph of wrists - Fels Method	5-19y			★★★★★
Bone age - ultrasonographic methods e.g., BonAge® sound velocity measure	5-17y <span>i</span>	\$\$\$\$		★★★★★
Bone age - computerized methods e.g., computer-assisted skeletal age score (CASAS)	5-19y			★★★★★

**Maturation**

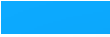
Use case 1: Keyword “tanner”  
See specific notes

# BOND-KIDS Dashboard

tanner

Measure	Age Group	Cost	Location	Feasibility: Infrastructure & Training
Sexual maturity - Tanner Staging (Clinic-based)	8-18y	-\$\$\$\$		★
Bone age - radiograph of wrists - Greulich-Pyle (GP) atlas method	6-19y	Cannot apply to children under 6 years		★★★
Bone age - radiograph of wrists - Tanner-Whitehouse (TW) scoring methods	5-19y	\$\$-\$\$\$\$		★★★★
Bone age - radiograph of wrists - Fels Method	5-19y			★★★★★
Bone age - ultrasonographic methods e.g., BonAge® sound velocity measure	5-17y	\$\$\$\$		★★★★★
Bone age - computerized methods e.g., computer-assisted skeletal age score (CASAS)	5-19y			★★★★★












Use case 1: Keyword "tanner"  
See strengths and limitations



# BOND-KIDS Dashboard

tanner  Show All ? ✕

Measure	Age Group	Cost	Location	Feasibility: Infrastructure & Training
Sexual maturity - Tanner Staging (Clinic-based)	8-18y	\$-\$\$\$		★
Bone age - radiograph of wrists - Greulich-Pyle (GP) atlas method	6-19y			
Bone age - radiograph of wrists - Tanner-Whitehouse (TW) scoring methods	5-19y			
Bone age - radiograph of wrists - Fels Method	5-19y			
Bone age - ultrasonographic methods e.g., BonAge® sound velocity measure	5-17y			
Bone age - computerized methods e.g., computer-assisted skeletal age score (CASAS)	5-19y			

Maturation

**Maturation**


Bone age - radiograph of wrists - Fels Method











**Strengths:**  
Calculate adult height prediction, very accurate

**Limitations:**  
Too complex

Use case 2: Keyword “vitamin”  
Result: multiple domains

# BOND-KIDS Dashboard

vitamin  Show All ? ✕

	Measure	Age Group	Cost	Location	Feasibility: Infrastructure & Training	
<p>Dietary Intake</p> <p>Micronutrient Deficiency - Vitamin A</p> <p>Nutrition Status</p>	Food records/diaries (1 or more days) - traditional/paper based	≥10y 	\$\$		★	⋮
	Mobile food records - smartphone based	≥10y 			★★★	⋮
	24-hour dietary recall (24HR) e.g., ASA24-Kids-2012	≥10y 	\$\$		★	⋮
	Food frequency questionnaire (FFQ)	≥10y 	\$\$		★	⋮
	Diet Quality Questionnaire (DQQ)	7-18y			★	⋮
	Direct observations	5-19y	\$\$		★	⋮

# SUMMARY OF FINDINGS

SECTION/TOPIC	POTENTIAL VIABLE OPTIONS FOR PROGRAMS
Physical exam	Intake exam; tools like STRONGkids: for detecting malnutrition; sufficient staff and adequate training for health professionals are required to conduct both initial and periodic follow-up assessments
Dietary exposures	DDQ periodically to assess dietary intake among school-age children
Nutrient status biomarkers	Still requires more validation; still costly, requires training and staff, and require enough time to see changes
Linear growth	Height velocity: serial measurements. In the absence of maturation data, height gains per unit time (i.e., height velocity, HV) offers the best metric to quantify short-term changes
Body composition	Skinfolds are the simplest method feasible in schools. Measures must be interpreted with appropriate cut-off points and in relation to the stage of maturation of the child or adolescent
Physical activity	Report vs. device based methods: A systematic approach or decision matrix should be considered in the decision-making process for device-based physical activity assessments
Neurodevelopment	Behavioral assessments, particularly direct child assessments, are the minimal set of measurement outcomes necessary to evaluate programs
Inflammation & immune function	CRP assessment may be the most affordable and available measurement out of the panel of potential inflammation markers that can be included in addition to the clinical outcomes or morbidity data to assess the potential impact of programs serving school-aged children
Gastrointestinal health	Microbiome: Still in the early phase EED: Use an ecological approach to assess
Emerging/novel technologies for assessment of diet & health	Still under development and validation

# GAPS

SECTION/TOPIC	GAP
Physical exam	Validation of standard clinical signs and symptoms for nutrient deficiencies Evaluation of current evidence on the validity and effectiveness of commonly used assessment tools
Dietary exposures	Greater ethnic & SES diversity among participants analyzed; proxy-less assessments for young children; validation of assessments for older children
Nutrient status biomarkers	Data on micronutrient status & interpretation thereof in children
Linear growth	Development of tools and capacity for considering maturation and height velocity alongside linear growth Determining the frequency of assessments in the context of changes in dietary exposure scenarios
Body composition	Evidence on the feasible techniques for school-based annual assessments
Physical activity	Determination of the tools to use in various settings
Neurodevelopment	Effective assessments that are lower in cost and easier to implement
Inflammation & immune function	Interpretation of cytokine panels and microbiome data
Gastrointestinal health	Development and validation of affordable non-invasive EED biomarkers that will be sensitive and provide consistent results across different geographic settings
Emerging/novel technologies for assessment of diet & health	Novel methods for dietary assessment needed for children and adolescents Reduce the care/treatment gap as many patients are lost to care in the turnaround time associated with conventional diagnostics

## Conclusions

- The overarching goal of the BOND-KIDS project and this report specifically, is to support the efforts of various stakeholders to determine context-specific approaches to assess the need for and impact of interventions designed to improve the diet, nutrition, and health of school-aged children
- This report described the current state of the evidence, relevance, and feasibility of -current approaches to assessment of dietary intake, specific nutrient status, and measures of key functional outcomes of importance to the developing school-aged children in the US and internationally

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# BOND-KIDS: *Translation & Implementation*

- Christina D. Economos, Ph.D.
- **Professor** | *New Balance Chair in Childhood Nutrition*
- **Dean** | *Friedman School of Nutrition Science and Policy*

# Economos Disclosures

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  - USDA
  - JPB Foundation
- Vice Chair, Roundtable on Obesity Solutions (ROOS), National Academies of Sciences, Engineering and Medicine (unpaid)
- Advisory Boards
  - Plezi Nutrition (unpaid/uncompensated):
  - New Jersey Healthy Kids Initiative, Rutgers University
  - Pennington Biomedical Greaux Healthy Scientific Advisory Committee



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**Mary Story**, Duke University

# Working Group 4 Task

- (1) Develop a framework for translating and implementing current and emerging evidence to address the need for implementation of context-specific evidence-based programs across the globe illustrating the factors and levels to be considered when selecting, implementing, and evaluating a nutrition program framework
- (2) Articulate principles integral to the implementation and translational framework.

Together, the framework and the overarching principles provide an approach to addressing gaps and achieving the individual potential as well as improving the human capital by investing in children 5 to 19 years of age.

# Implementation Science

- **Implementation science** (IS) is the study of methods to promote the adoption and integration of evidence-based practices, interventions, and policies into routine health care and public health settings to improve our impact on population health (NIH)
- Interventions poorly implemented – or not implemented at all – do not produce expected health benefits.
- IS seeks to systematically close the gap between what we *know* and what we *do* by identifying and addressing the barriers that slow or halt the uptake of proven health interventions and evidence-based practices.

# Consolidated Framework for Implementation Research (CFIR)

A systems-oriented framework for implementation of research findings or innovations into practice within five domains: characteristics of the innovation; the inner setting or who implements the innovation; the outer setting, or the external environment or context; individuals affected by the innovation; and the implementation process.

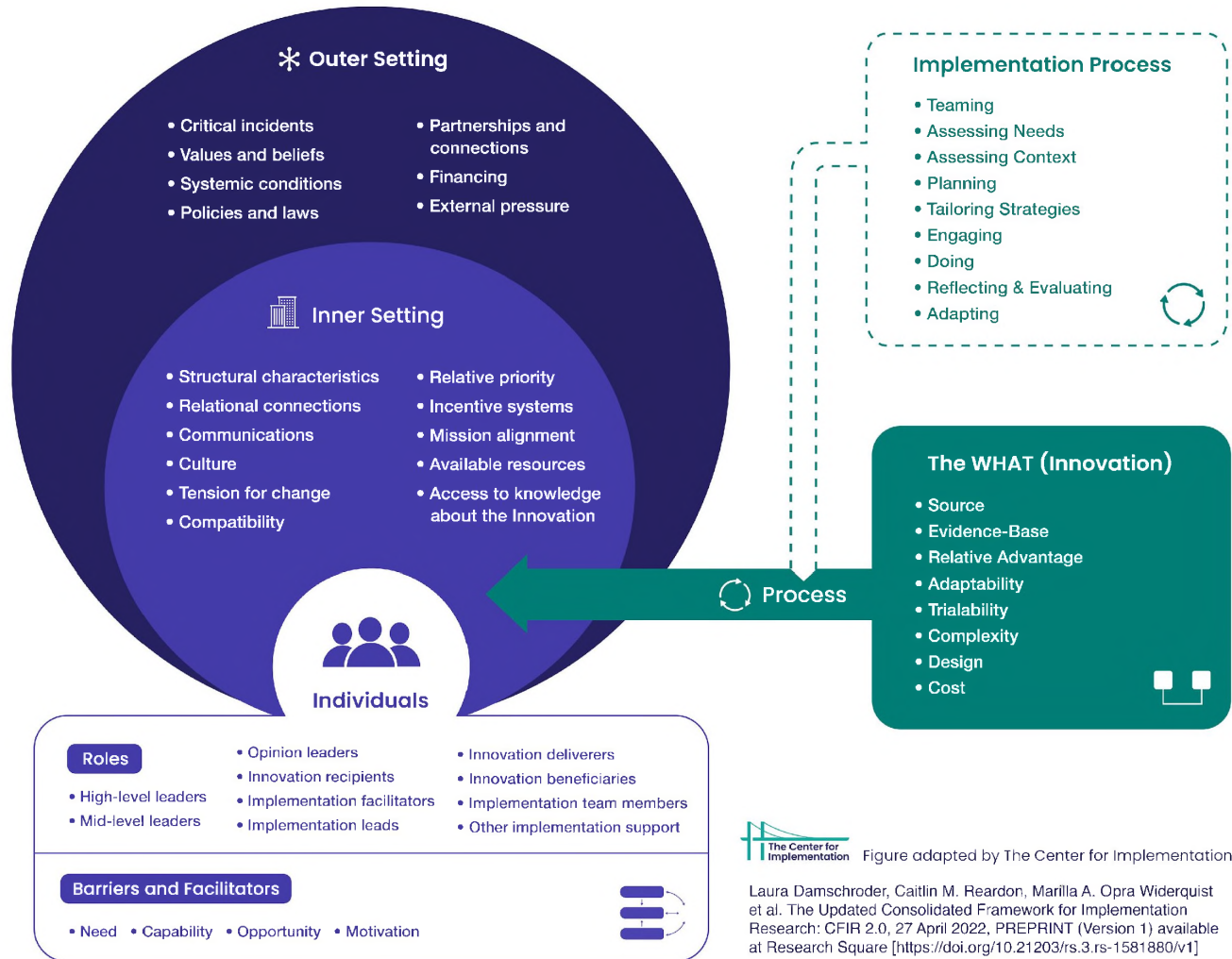


Figure adapted by The Center for Implementation

Laura Damschroder, Caitlin M. Reardon, Marilla A. Opra Widerquist et al. The Updated Consolidated Framework for Implementation Research: CFIR 2.0, 27 April 2022, PREPRINT (Version 1) available at Research Square [<https://doi.org/10.21203/rs.3.rs-1581880/v1>]



### What is RE-AIM?

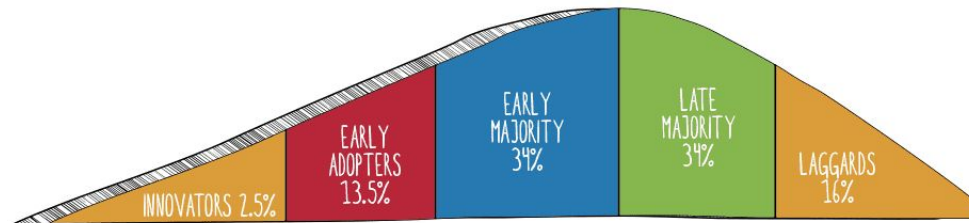
RE-AIM is a framework to guide the planning and evaluation of programs according to the 5 key RE-AIM outcomes: Reach, Effectiveness, Adoption, Implementation, and Maintenance.



### What is PRISM?

The Practical Implementation Sustainability Model (PRISM) includes key, multilevel contextual factors relevant to program implementation (including RE-AIM outcomes) throughout all stages from planning through sustainment.

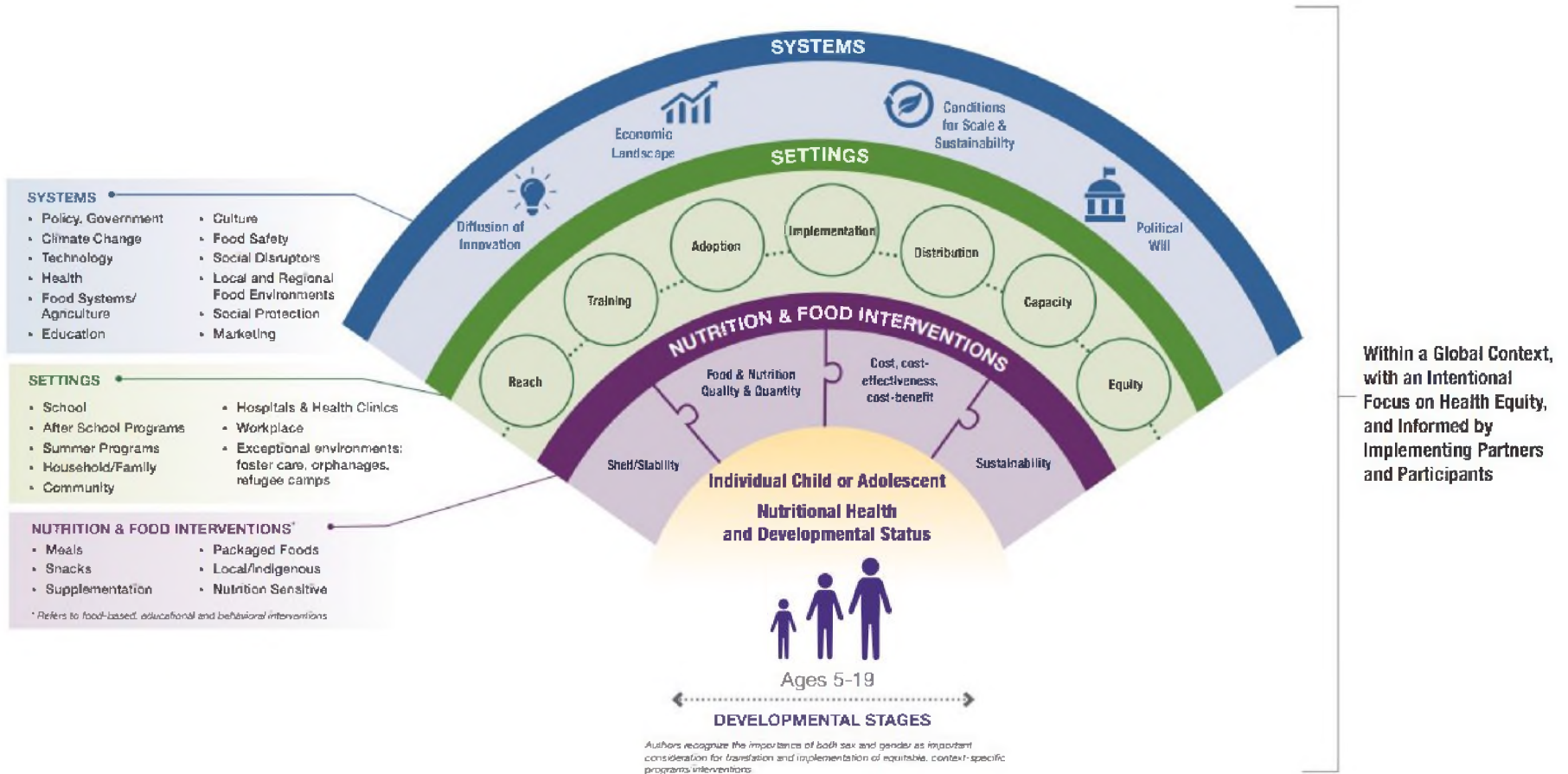
## DIFFUSION OF INNOVATION MODEL



ESSENTIAL MARKETING MODELS [HTTP://BIT.LY/SMARTMODELS](http://bit.ly/smartmodels)

- An innovation must be adopted by a group or organization, and there are different types of adopters based on their knowledge of and acceptance of new work - from innovators, who are the first to accept new methods or programs and early adopters to laggards, who adopt innovations only when forced to do so.
- The act of adoption is a process that begins with knowledge of the program or methodology.
- Characteristics of the innovation can help to accelerate adoption; these include relative advantage over the status quo, complexity of the innovation, and compatibility with the context into which it is placed

## Implementation Indicators suitable for use in real world settings to assess impact of nutrition programs and policies designed to reach children 5-19 years



# Overarching Principles Integral to the Implementation and Translation Framework

1. Intervention design must purposefully target developmental stages.
2. Transdisciplinary science facilitates collaboration and considers biology, ecology, and implementation science.
3. Equitable engagement of diverse stakeholders fosters inclusion, develops relationships, builds buy-in, and co-creates context-specific customization of interventions.
4. A range of contextual drivers including social, political, racial, historical, and economic impact nutrition programming.
5. Policies, interventions, and procedures developed in one setting may not be applicable to another.
6. Building for sustainability includes economic and financial analyses, appropriate fit within existing systems, and flexible adaptation.



<b>Role</b>	<b>Description</b>
Community Members	A group of people (e.g., parents, teachers, children) or organizations with a shared identity defined by function (e.g., a school district), geography (e.g., a rural region), religion, shared interests or characteristics (e.g., ethnicity), or by a combination of these dimensions. <sup>10,11</sup>
Organizational leaders	Individuals who contribute to decisions that can influence a program or its evaluation (e.g., access to human or financial resources)
Partner organizations	Government or nongovernment or industry entities that collaborate on program or evaluation activities
Policymakers	Officials who influence or make acts, laws, policies, regulations, or rules that can shape a program or its evaluation
Program colleagues, personnel, or staff	Those who plan, implement, or manage a program
Subject matter experts	Individuals with specialized knowledge or experience relevant to a program or its evaluation (laypersons or professionals)
Funders	Those who contribute financial resources to support a program or its evaluation

\*There can be overlap between the groups

# Key partnerships for effective collaborations