

Increasing Oral-Gut Axis Health Literacy in Underserved Communities with Community-Involved, Pantry-Accessible Nutrition Education: A Conceptual Framework and Program

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Abstract

In metropolitan U.S. areas, health inequities caused by socioeconomic disparity continue to influence oral health, nutritional status, and the risk of chronic diseases. Diets heavy in added sugars and poor in fiber and vital micronutrients are especially harmful to the oral–gut axis, which connects diet, microbial balance, inflammation, and systemic and neurological health. Due to institutional hurdles to health literacy, limited access to preventive health education, and food poverty, these eating habits are more common among low-income individuals. Only 36% of low-income parents in Chicago report being in good health, compared to 75% of parents with better incomes, underscoring the need for easily accessible, neighborhood-based health education programs. By converting nutrition science and the oral-gut axis into useful, low-barrier educational programs, Nourish Chicago, a community-engaged health literacy project, aims to close these gaps. Instead of measuring health outcomes, this article offers a conceptual framework and program design. Nourish Chicago places a strong emphasis on skill-based learning, immersive training, and delivery in familiar neighborhood settings. It is built on the principles of critical health literacy and community-engaged education. The program uses the oral–gut axis as a translation anchor to connect everyday food choices, such as sugar frequency, fiber intake, protein pairing, and snack timing, to oral and digestive health through simplified, biologically grounded explanations. Educational modules incorporate short demonstrations, hands-on activities, guided discussion, and bilingual take-home materials designed for pantry-accessible contexts. The framework outlines a structured science translation pipeline, core design principles, and adaptable module architecture intended for low-resource environments. By centering usability, prevention, and feasibility, this design-focused manuscript offers a replicable

model for educators and community partners seeking to strengthen practical health literacy while acknowledging structural constraints faced by underserved populations.

Keywords: community-engaged learning, health equity, critical health literacy, nutrition education, microbiome literacy, culturally responsive pedagogy, preventive public health, underserved urban communities

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Background: Health Disparities and the Need for Practical Health Literacy

Socioeconomic status continues to have a significant influence on health disparities in the US, influencing long-term chronic disease risk, food quality, and access to preventative treatment. Food poverty, restricted access to reasonably priced, nutrient-dense foods, and fewer opportunities for culturally appropriate nutrition instruction are all consequences of economic disparity in urban regions like Chicago. Only 36% of low-income parents thought they were in good health, compared to 75% of higher-income parents, according to a joint report by the Chicago Department of Public Health and Ann & Robert H. Lurie Children's Hospital (2018). This highlights how differences in access, resources, and health information environments are reflected in perceived and actual health outcomes.

Health literacy (HL) is a key determinant of health and well-being. The World Health Organization characterizes HL as the ability to access, understand, and use health information. Contemporary scholarship further emphasizes **critical health literacy (CHL)**, which includes critical reflection, empowerment, and action grounded in social context rather than only individual comprehension (Chinn, 2011; Nutbeam, 2000). In communities experiencing structural barriers (e.g., high food costs, limited transportation, language barriers, and mistrust of institutional messaging), HL interventions must be

designed to be practical, culturally relevant, and responsive to real constraints.

Conceptual Foundation: Critical Health Literacy, Community-Engaged Education, and Oral-Gut Axis Relevance

Nourish Chicago is based on CHL frameworks that emphasize empowerment through real-world skill development and introspection, positioning students as active interpreters of health information (Chinn, 2011; Mogford et al., 2011; Nutbeam, 2000). Furthermore, the program is in line with community-engaged techniques that emphasize delivery in familiar neighborhood settings, collaboration with local organizations, and iterative adaption based on community context (Cargo & Mercer, 2008; Israel et al., 2013).

Why the oral-gut axis?

According to biomedical research, dysbiosis and inflammation related to oral and systemic health are linked to dietary patterns, particularly high intake of refined carbohydrates and low intake of fiber (Kitamoto et al., 2020; Lamont et al., 2018; Tang et al., 2017). Food marketing and social media material often highlight discrete claims like natural ingredients or 0% fat while hiding added sugars, carbohydrate levels, and frequency of consumption. This issue is exemplified by sweetened drinks promoted as healthier substitutes. Refined carbohydrates are frequently present in processed foods that are marketed as healthy choices. When consumed

regularly, common foods like bananas or white rice contribute significantly to starch exposure; nevertheless, this context is rarely mentioned in public discourse.

Simplified guidelines like "carbs equal sugar" are frequently the foundation of community nutrition knowledge. This framework is devoid of biological context and fails to explain how dietary decisions affect systemic inflammation, gut health, or dental health. Understanding is further hampered by limited access to dental care and preventive dietary counseling. Routine dental appointments are less common than medical visits in many underprivileged communities, which limits access to information about the connection between food, oral health, and long-term wellbeing.

Nourish Chicago uses the oral-gut axis as a translation anchor to address this gap. This framework connects everyday dietary behaviors to oral and digestive health outcomes in a concrete and relatable way. Programming emphasizes sugar frequency, fiber intake, protein pairing, hydration, and snack timing. These concepts support understanding of how daily habits affect teeth, digestion, inflammation, and overall health. The emphasis remains on prevention and habit formation rather than clinical treatment. The goal focuses on strengthening practical health literacy within real food access constraints.

Important design note: Measured health outcomes are not claimed in this manuscript. Rather, it describes how principles related to the oral-gut axis might be turned into useful, low-barrier educational programming.

Program Context and Partnership Structure

Nourish Chicago is run by a faculty member specializing in Chemistry and Biochemistry with experience in applied medical research and biochemistry education. It started out as an outreach program sponsored by a grant aimed to decrease Health Disparity in the Greater Chicago Area. Student members of the American Society for Biochemistry and Molecular Biology (ASBMB) Student Chapter are among the on-

campus partners who assist with content creation and facilitation.

Nonprofits that specialize in bilingual, arts-driven programs for kids and families are examples of off-campus community partners. These collaborations make education socially and culturally relevant. Communities like Wheeling, Niles, and Prospect Heights were among Nourish Chicago's first target areas because partners saw a need for bilingual programming that linked typical food choices to useful health outcomes.

Positioning and terminology

The best way to characterize Nourish Chicago at this point is as a community-based, community-engaged health education project. This program is informed by principles of Community-Based Participatory Research (CBPR), particularly with respect to collaboration, contextual relevance, and accessibility (Cargo & Mercer, 2008). By holding programs in trusted community spaces and adapting content to local needs, we aim to lower the barriers that traditionally separate underserved populations from scientific health resources.

Program Design: Instructional Architecture and Delivery Model

Nourish Chicago uses a multimodal, experiential approach designed for low-resource contexts. Each module includes:

1. **Short demonstration-based instruction** (live or recorded)
2. **Simplified science explanation** tied to a single actionable message
3. **Hands-on activity** (label practice, snack-building, recipe demo)
4. **Printed take-home resource** (bilingual where applicable)
5. **Group discussion** using guided prompts to support reflection and confidence

This model reflects CHL best practices: knowledge is reinforced through demonstration, repetition, skill acquisition, and social learning rather than passive receipt of information (Chinn, 2011; Nutbeam et al., 2018).

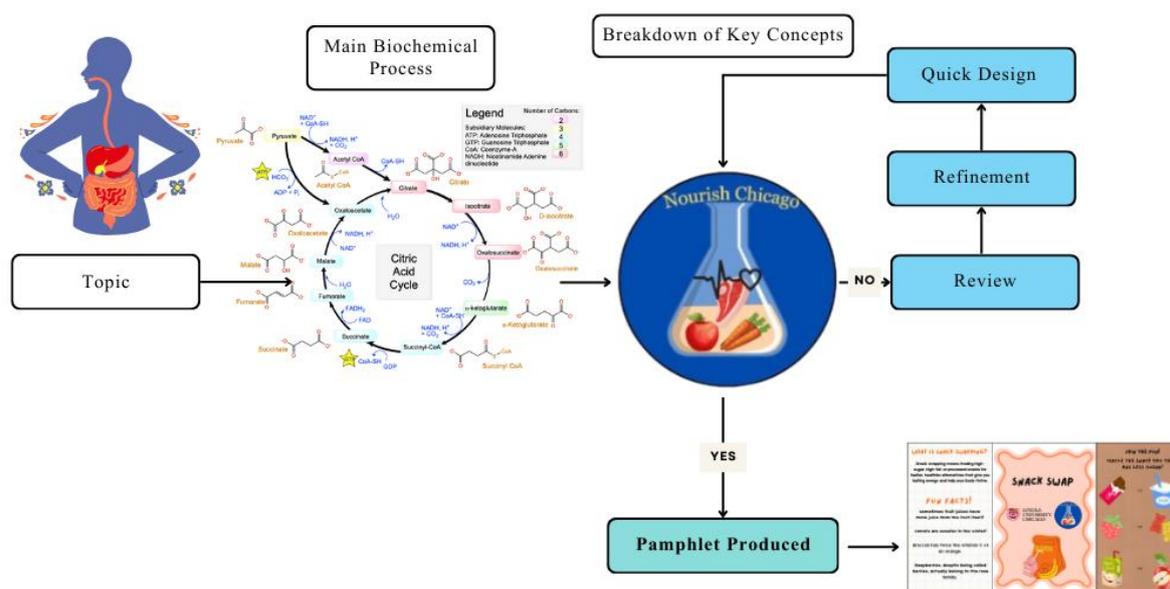
Translating Science for Community Audiences: A Practical Translation Pipeline

“translation pipeline” to connect complex biology to everyday actions:

Because oral–gut axis science can become overly technical, Nourish Chicago uses a

Scientific concept → **simplified science message** → **Concrete skill** → **Take-home behavior option**

Figure 1. The Concept Flowchart



This flowchart illustrates the iterative process of translating the topic of Oral-Gut-Axis into an identified biochemical concept (the citric acid cycle). From there, it goes through several stages, where it is broken down into essential ideas, examined for relevance and clarity and adjusted as necessary. If the product successfully translates the complex topic into a simplified science, the accessible, community-facing educational resources (pamphlets and practical learning tools) will be produced and distributed.

Examples used in programming design:

- **Inflammation and dysbiosis** → "Too much sugar too often feeds harmful bacteria" → Check labels for additional sugars. Swap protein and fiber snack combinations.

- **Fiber & microbial metabolites** → "Fiber helps your gut bacteria do helpful jobs" → Compare the grams of fiber in different foods. → Build a pantry-friendly high-fiber snack
- **Oral–gut connection** → "Your mouth bacteria can affect your stomach and body" → Discussion of sugar frequency → Make a timetable for "tooth-friendly" snacks.

Design constraint: The goal is not to teach mechanistic microbiology (e.g., immune cell pathways). The goal is to teach *usable and sustainable literacy*: how to interpret food information and make realistic choices.

To guide development and implementation, the initiative follows a set of design principles summarized in Table 1.

Table 1. Design Principles Guiding Nourish Chicago Programming

Design Principle	Description in Nourish Chicago
Low-Barrier Access	In order to eliminate the need for specialized resources, modules are made to be delivered in familiar community locations at a low cost with accessible equipment and variable configurations.
Cultural and Linguistic Responsiveness	Through partner-informed framing, culturally relevant food samples, and bilingual or simplified science brochures, educational materials and facilitation reflect community context.
Practical Health Literacy	Skills that participants can use right away, such reading nutrition labels, recognizing added sugars, and evaluating the amount of fiber and protein, are given priority throughout instruction.
Empowerment-Oriented Learning	Instead of prescriptive or shame-based messaging, activities promote critical thinking, self-assurance, and realistic goal-setting.
Science Translation for Relevance	Scientific conversion into precise, intelligible explanations that relate biological processes to daily choices.
Experiential and Multimodal Instruction	Demonstration, practical exercises, group discussions, and take-home materials with optional video resources are all used to reinforce learning.
Partnership-Driven Implementation	Program delivery and adaptation take place in partnership with community organizations, enabling modules to change in response to feedback and viability. Identifying the community leaders so they can lead it for sustainability of the program

Each workshop integrates these principles in practice through consistent instructional components and adaptive delivery strategies, described in Table 2.

Table 2. How Nourish Chicago’s Design Principles Are Applied in Practice

Design Focus	Application in Programming
Low-Barrier Access	Workshops are hosted in senior houses, low income houses, libraries, community centers, and cultural halls; activities rely on no-cook or minimal-equipment formats; recipes include substitutions to accommodate inconsistent pantry availability.
Cultural and Linguistic Responsiveness	Handouts are provided in plain language and multiple languages when possible; food examples reflect common household and pantry items rather than idealized diets.
Practical Health Literacy	Participants practice locating added sugars, serving size, fiber, and protein on real product labels; comparisons highlight marketing versus nutritional reality.
Empowerment-Oriented Learning	Facilitated discussions invite reflection on what feels realistic and sustainable; emphasis is placed on informed choice and progress.
Science Translation for Relevance	A consistent translation sequence is used: scientific concept → simplified science explanation → practical skill → take-home behavior option.
Experiential and Multimodal Instruction	Each module combines short demonstrations, hands-on activities, discussion, and printed resources; recorded demonstrations support asynchronous learning.
Partnership-Driven Implementation	Community partners guide logistics and content relevance; modules are adapted based on real-world constraints and feedback.

Translating Science for Community Audiences

Because oral–gut axis science can become overly technical, Nourish Chicago applies a structured translation model that converts

biological concepts into usable health literacy tools. Examples of this translation process are summarized in Table 3.

Table 3. Examples of the Nourish Chicago Science-to-Practice Translation Model

Scientific Focus	Fundamentals	Simplified Science Message Used	Skill Developed	Example Learning Activity
Oral–gut connection	Good bacteria, bad bacteria	“What happens in your mouth affects your stomach and whole body.”	Connecting habits to body systems	Sugar-frequency discussion and snack-timing worksheet
Dysbiosis and sugar frequency	Sugar, protein, bad bacteria	“Too much sugar too often feeds harmful bacteria.”	Identifying added sugars on labels	Food Label Detective comparisons
Fiber and gut support	Fiber, good bacteria, bad bacteria	“Fiber helps your gut bacteria work for you.”	Comparing fiber content	Build a pantry-friendly fiber-rich snack
Protein and energy balance	Protein, lipid, good fat, bad fat, vitamins, fiber	“Protein helps you stay full and supports your body.”	Recognizing realistic protein sources	Snack Swap: fiber + protein pairing
Sugar, acid, and dental health	Sugar, good sugar, bad sugar	“Frequent sugar and acid can damage teeth over time.”	Recognizing frequency patterns	Personal snack schedule planning

Educational Modules: Practical Applications

Each Nourish Chicago workshop follows a standardized but adaptable structure to ensure consistency across sites while allowing

customization based on audience and setting. Each participant gets a “take-home kit” that contains the recipe, rules of the demo’s activity, and an informational pamphlet. The general module framework is presented in Table 4.

Table 4. Standard Module Structure for Nourish Chicago Workshops

Component	Format Used	Notes for Adaptation
Objective	1–2 practical learning outcomes	Prevents cognitive overload
Time	30–60 minutes	Flexible by age group and setting
Materials	Pantry-accessible foods and labels	Always includes substitutions
Demonstration	5–10 minute visual explanation	No technical jargon
Hands-On Activity	Label reading or snack building	Designed for minimal equipment
Discussion	3–5 guided prompts	Includes “what feels doable?”
Take-Home Resource	Handout + checklist	Bilingual when possible
Optional Extension	Video or family challenge	Supports learning beyond session

Educational Modules: Practical Applications

with low equipment needs and immediate applicability.

Module 1: Food Label Detective / Snack Swap

Objective: Build practical nutrition literacy skills by teaching participants to interpret label information (serving size, added sugars, fiber, protein) and apply this to snack choices within pantry constraints.

Background and Rationale: Food marketing and packaging often obscure sugar content and portion sizes. Label interpretation is a core health literacy competency that can be taught

Core Components:

- **Guided label comparison:** participants examine 2–4 snack items and identify added sugars, ingredient order, serving size, and fiber/protein content.
- **Discussion prompts:**
 1. What does “added sugar” mean and where do you see it?
 2. What surprises you about serving size?

3. Which snack seems “healthy” by marketing but not by label?

- **Snack-building activity:** participants assemble a “tooth- and gut-supportive” snack using pantry-friendly ingredients, emphasizing **fiber + protein pairing**.

Pantry-accessible design principles:

Every demonstration is based on common ingredients found in food pantries, school meal programs, and community distribution (e.g., oats, peanut butter, canned low-sodium meats/fish, canned fruit in water/juice, shelf-stable milk substitutes when practical, whole grain crackers when available). Recipes are written with minimal equipment assumptions and replacements.

Adaptations for different settings:

- **Libraries/community rooms:** pre-cut snack assembly + label analysis
- **Youth groups:** “label scavenger hunt” with a points system
- **Family settings:** take-home challenge: “find the added sugar line” on 3 items at home

Implementation Practicalities: Access, Setting, and Feasibility

To reduce barriers, workshops are delivered in community settings (libraries, community centers, cultural halls) rather than campus spaces. This supports accessibility and reduces intimidation that academic spaces can create. Because food resources vary widely, programming is designed to tolerate inconsistency:

- substitutions are built into recipes
- activities do not assume consistent pantry inventory
- modules can run with minimal or no cooking equipment

Acknowledged constraints: Equipment access (portable ovens, or portable boiling kettles, mixing bowls, measuring tools) cannot be assumed. Therefore, modules emphasize no-cook or minimal-equipment options by default.

Ethics and IRB Considerations

Rather than discussing study findings involving human participants, this publication discusses program design and pedagogical practices. However, depending on data collection techniques, age groups, and identifiability, future evaluation phases (such as gathering participant quotations, surveys, or recordings) might call for IRB review and informed consent processes.

Nourish Chicago will use a tiered, process-first evaluation approach that prioritizes participant voice, low participant burden, and practicality in order to promote responsibility and future scholarly contribution. Core process indicators, such as the number of workshops conducted, attendance ranges, languages utilized in instruction and materials, module kinds adopted, recruiting routes, and partner organization types, will be first documented by evaluation activities. In addition to open-ended prompts (such as “one thing I learned” and “one thing I will try”) and optional anonymous remark cards, participant feedback will be collected through quick, approachable techniques such 3–5 item exit surveys either orally or on paper. In order to discuss the session’s advantages, disadvantages, and recommended modifications, community partners will also be asked to take part in shorter, organized post-session debriefs.

Limitations and Design Challenges

Design-oriented health literacy programs face inherent limitations:

1. **Education is insufficient to address structural injustices.** Nourish Chicago focuses a strong emphasis on developing skills without suggesting that structural change is replaced by personal accountability.
2. **Food is not always readily available.** Distribution patterns, season, and location all affect pantry access. Program materials should stay adaptable and steer clear of “aspirational diets.”
3. **Oversimplification** is a problem when **science is simplified**, and biological

complexity is lost when practicality is emphasized. The application emphasizes usability while giving accuracy top priority.

4. **Over time, community involvement changes.** The capability of partnerships varies, and the development of shared governance, remuneration systems, and participatory decision-making processes may take some time.

Conclusion

Nourish Chicago provides a pantry-accessible, community-engaged strategy for converting nutrition science and the oral-gut axis into useful health literacy programs. Instead of focusing on measured results, this manuscript offers a program design and conceptual framework that emphasizes multimodal experience learning, culturally sensitive materials, and viability in the face of resource limitations. In order to improve evaluation and support further case-based or empirical publications, future phases will include organized process documentation and participant/partner input. We urge educators and community partners to modify this framework for local settings and to combine ethical evaluation methods that prioritize community voice with practice-driven programming.

References

- Cargo, M., & Mercer, S. L. (2008). The value and challenges of participatory research: Strengthening its practice. *Annual Review of Public Health, 29*, 325–350. <https://doi.org/10.1146/annurev.publhealth.29.091307.083824>
- Chicago Department of Public Health, & Ann & Robert H. Lurie Children's Hospital of Chicago. (2018). *Healthy Chicago Survey: Data and documentation*. City of Chicago. https://www.chicago.gov/city/en/depts/cdph/sup_p_info/healthy-communities/hcs-data-and-documentation.html
- Chinn, D. (2011). Critical health literacy: A review and critical analysis. *Social Science & Medicine, 73*(1), 60–67. <https://doi.org/10.1016/j.socscimed.2011.04.004>
- Israel, B. A., Eng, E., Schulz, A. J., & Parker, E. A. (2013). *Methods for community-based participatory research for health* (2nd ed.). Jossey-Bass.
- Kitamoto, S., Nagao-Kitamoto, H., Hein, R., Schmidt, T. M., & Kamada, N. (2020). The bacterial connection between the oral cavity and the gut diseases. *Journal of Dental Research, 99*(9), 1021–1029. <https://doi.org/10.1177/0022034520924634>
- Lamont, R. J., Koo, H., & Hajishengallis, G. (2018). The oral microbiota: Dynamic communities and host interactions. *Nature Reviews Microbiology, 16*(12), 745–759. <https://doi.org/10.1038/s41579-018-0089-x>
- Mogford, E., Gould, L., & DeVoght, A. (2011). Teaching critical health literacy in the U.S. as a means to action on the social determinants of health. *Health Promotion International, 26*(1), 4–13. <https://doi.org/10.1093/heapro/daq049>
- Nutbeam, D. (2000). Health literacy as a public health goal: A challenge for contemporary health education and communication strategies. *Health Promotion International, 15*(3), 259–267. <https://doi.org/10.1093/heapro/15.3.259>
- Nutbeam, D., McGill, B., & Premkumar, P. (2018). Improving health literacy in community populations: A review of progress. *Health Promotion International, 33*(5), 901–911. <https://doi.org/10.1093/heapro/dax015>
- Tang, W. H. W., Kitai, T., & Hazen, S. L. (2017). Gut microbiota in cardiovascular health and disease. *Circulation Research, 120*(7), 1183–1196. <https://doi.org/10.1161/CIRCRESAHA.117.309715>
- World Health Organization. (2013). *Health literacy: The solid facts*. WHO Regional Office for Europe. <https://www.who.int/publications/i/item/WHO-EURO-2013-6073-45853-64974>

Author Bio:

Audrey Kho is a junior at Loyola University Chicago majoring in Chemistry with a strong interest in medical sciences and healthcare. She is a Provost Fellow and Research Assistant in the Department of Chemistry and Biochemistry at Loyola University Chicago, where she focuses on the development of Nourish Chicago, a community-engaged health literacy initiative. She is also actively involved with the nonprofit organization Perfect Pair, serving as Vice President of Programming for the LUC chapter. In addition to her academic and research work, Audrey serves as a medical assistant at Bolingbrook Christian Health Center in Bolingbrook, IL, providing care to patients from diverse socioeconomic

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Yinon Gankin is a Junior at Glenbrook South High School with a strong interest in the application of science to community health and wellness. He is actively involved in the Energy Sciences Research Program in partnership with Argonne National Laboratory and participates in the Nourish Chicago program at Loyola University Chicago, where he contributes to translating scientific and biochemical concepts into accessible community-based education. Yinon serves as a tutor at his school's Titan Learning Center and is on the board of the Medical Chapter club, reflecting his academic interests in medicine and dentistry. His long-standing passion for cooking has evolved into a scientific curiosity about the chemistry underlying food preparation and nutrition, further shaping his interest in metabolic health and science-informed community engagement.

Polina Pine, PhD, is a Senior Lecturer in the Department of Chemistry and Biochemistry at Loyola University Chicago, passionate about making science accessible, igniting curiosity, and reducing gaps in educational equality and accessibility. She has co-authored several illustrated biochemistry textbooks

designed to help students prepare for the MCAT (Medical College Admission Test) by presenting complex concepts visually and intuitively. Dr. Pine actively explores innovative instructional methods to enhance student understanding and engagement and leads community-focused initiatives, such as Nourish Chicago, promoting healthy, affordable life choices and connecting scientific knowledge to real-world health and wellness.

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