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Professional Education Series

Support. Inform. Educate. Empower.

The Soil, Biodiversity and Gut Microbiome Nexus: A Road Map for Practitioners

TODAY'S AGENDA:

- Introduction & Housekeeping
- Speaker Introduction
- Presentation
- Q&A
- Closing

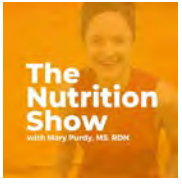
WEBINAR HOST:

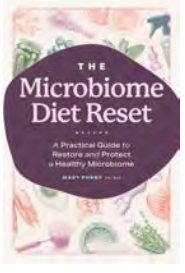
Keith Hine, MS, RD
VP of Healthcare, Sports & Professional Education
Orgain, LLC

WEBINAR PRESENTER:

Mary Purdy, MS, RDN
Award-Winning Integrative Eco-dietitian and Nutrition Educator
Adjunct Faculty Instructor, Bastyr University
Host of "The Good Clean Nutrition Podcast"

DISCLOSURES & AFFILIATIONS OF PRESENTER: MARY PURDY, MS, RDN, INTEGRATIVE "ECO-DIETITIAN"





PLANETARY HEALTH COLLECTIVE

BASTYR UNIVERSITY 19 78 VIS MEDICATRIX NATURAE

Orgain

AIHM ACADEMY OF INTEGRATIVE HEALTH & MEDICINE

INTEGRATIVE AND FUNCTIONAL NUTRITION ACADEMY™

Adjunct Faculty at Bastyr University & University of Illinois

Faculty with The Academy of Integrative Health and Medicine (AIHM) & **"**Integrative and Functional Nutrition Academy" (**IFNA)**

Nutrition and Sustainability Advisor, Big Bold Health

Steering Committee Member: Planetary Health Collective

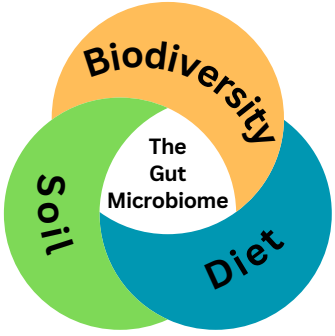
Governing Council Member: Coalition for Organic and Regenerative Agriculture

Host, "The Good Clean Nutrition Podcast" Orgain

Former Host of The Podcast "The Nutrition Show"

Author: "The Microbiome Diet Reset"

LEARNING OBJECTIVES



Describe the role that soil health and biodiversity play in supporting a healthy environment, secure food system and a resilient gut microbiome.

Evaluate the positive and negative impacts of specific foods and environmental inputs on the balance of the microbial population in the human intestinal tract

Recommend strategies to help support the human gut microbiome, soil health and biodiversity to improve human and planetary health.

NUTRITION IS THE FOUNDATION FOR OUR HEALTH

- Nutrients drive every chemical reaction in our body
- Our body functions in accordance with the amount of nutrients we provide to it.
- We are what we eat
- ***Kind of***

THE FOOD – ENVIRONMENT – MICROBIOME CONNECTION

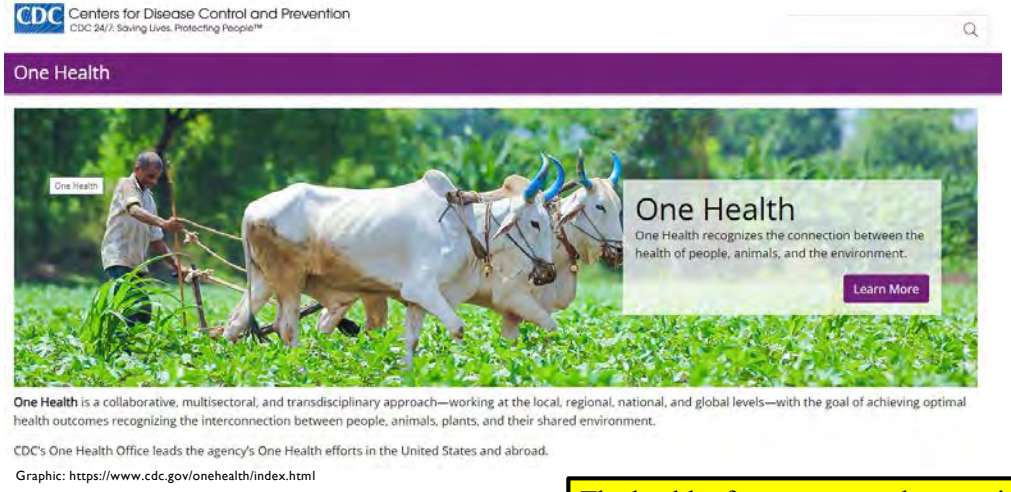
Our health and nutritional status is influenced via functional biochemical pathways AND via our microbiome

We are what we digest AND what our food and microbiome gets to eat

How we grow our food affects the health of the plant and thus the quality of the food and thus our gut microbiome.

We cannot talk about "nutritional value" without talking about our current industrial food and agricultural system

"ONE HEALTH"



Graphic: https://www.cdc.gov/onehealth/index.html

Human health is connected to the health of animals, plants, and environments.

The health of ecosystems, plants, animals, and humans heavily relies on the contribution of microbial communities.
Soils are a cornerstone of "One Health"

Banerjee, S. and van der Heijden, M. 2022. Nature Reviews. Soil microbiomes and one health
https://www.onehealthcommission.org/

CHAPTER ONE

THE FUNDAMENTALS: SOIL AND BIODIVERSITY

HEALTHY SOIL

- A living and life-giving natural resource.
- It is teaming with billions of bacteria, fungi, and other microbes that are the foundation of an elegant symbiotic ecosystem.

HEALTHY SOIL

"continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans."

- Clean air and water
- Bountiful crops and forests
- Productive grazing lands
- Diverse wildlife
- Beautiful landscapes.

https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health

THE IMPORTANCE OF MAINTAINING HEALTHY LIVING SOILS

Soils maintain a diverse community of organisms that:

help control **insect & weed pests and plant disease**

form beneficial **symbiotic associations** with plant roots

recycle essential **plant nutrients**

improve **soil structure**

Soils serve as a buffer to **protect delicate plant roots** from drastic fluctuations in temperature.

Healthy soil contributes to **mitigating climate change** by maintaining or increasing its **carbon content**

it is the foundation of food systems and the medium in which nearly all food-producing plants grow

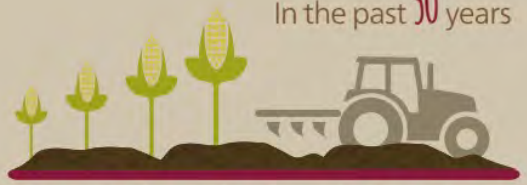
https://www.fao.org/3/au890e/au890e.pdf Food and Agriculture Organization, 2015. Healthy soils are the basis for healthy food production

SOILS, FOOD SECURITY & NUTRITION

1/3 of the world's soil has already been degraded.

95%
of our food
is directly or indirectly
produced on our soils

In the past 50 years



advances in agriculture technology
has led to increased food production,
but sometimes **with negative impacts on soils and the environment**

In many countries,
intensive crop production
has **depleted the soil,**
jeopardizing our ability
to maintain production
in these areas in the future

It can take up to

1000 years
to form **1 cm** of soil

Soil health and its fertility
have a direct influence on the
nutrient content of food crops

If conventional methods of growing food continue as is, we have 60 years of topsoil left.

https://www.scientificamerican.com/article/only-60-years-of-farming-left-if-soil-degradation-continues/

HEALTHY SOIL BENEFITS

Environmental Benefits

- More resilient to drought and flooding
- Sequesters carbon
- Supports biodiversity
- Detoxifies and neutralizes pollutants
- Support plant health/microbiome through their microbial community

Health Benefits

- Crops higher in micronutrients, phytochemicals
- Supports a healthy microbiome of the plant
- Exposure to soil is associated with a stronger immune system
  - Greater diversity of microbes on the skin and in the gut supports the gut microbiome
- The connection between soil microbiome and animal gut microbiome and human gut microbiome
  - Animals are eating soil daily via grazing

Tasnim N, et al Linking the Gut Microbial Ecosystem with the Environment: (2017)
Roslund et al. Biodiversity intervention enhances immune regulation (2020)
Brevik EC, Burgess LC. The Influence of Soils on Human Health. The Nature Education Knowledge Project. https://www.nature.com/scitable/knowledge/library/the-influence-of-soils-on-human-health-127878980/.
Banerjee, S. and van der Heijden, M. 2022. Nature Reviews. Soil microbiomes and one health

BACTERIA

MAJOR "PHYLA" (FAMILIES) OF BACTERIA IN THE HUMAN GUT

- **Bacteroidetes:**
- **Firmicutes:** lactobacillus
- **Proteobacteria:**
- **Actinobacteria**:
- **Verrucomicrobia:** Akkermansia

- The majority (90%) are in the Bacteroidetes & Firmicutes FAMILY

  Within each Family are many "genera"

MAJOR "PHYLA" (FAMILIES) OF BACTERIA IN THE SOIL

- **Bacteroidetes:**
- **Firmicutes:** Lactobacillus
- **Proteobacteria:**
- **Actinobacteria**:
- **Verrucomicrobia:**
- **Planctomycetes, Chloroflexi, WD272, Gemmatimonadetes**

Brown, K.; DeCoffe, D.; Molcan, E.; Gibson, D.L. Diet-Induced Dysbiosis of the Intestinal Microbiota and the Effects on Immunity and Disease. *Nutrients* 2012, *4*, 1095-1119

Ley, R. Prevotella in the gut: choose carefully. Nat Rev Gastroenterol Hepatol 13, 69–70 (2016).

Gurung M, Li Z, You H, et al. Role of gut microbiota in type 2 diabetes pathophysiology. *EBioMedicine*. 2020;51:102590.

CONNECTION BETWEEN SOIL AND PLANT MICROBIOME

Banerjee, S. and van der Heijden, M. 2022. Nature Reviews. Soil microbiomes and one health

FUNDAMENTALS: WHAT IS BIODIVERSITY?

DIVERSE LIFE ON THE PLANET: ANIMALS, PLANTS, INSECTS, MICROORGANISMS

IMPORTANCE OF BIODIVERSITY

Environmental Benefits

- Creates resilience in an ecosystem
- Supports soil and prevents soil loss
- Soil retains more water
- Certain plants/ecosystems store carbon
- Healthier plants more resistant to pests and disease
- Beneficial insects helpful for pest control and pollination

Health Benefits

- Variety of foods = greater abundance and spectrum of nutrients
- Consumption of 30 different plant foods/week associated with greater microbiome diversity
- Preserves foods that connect us to history, culture, spirituality
- Safeguards food security
- Creates resilience in communities

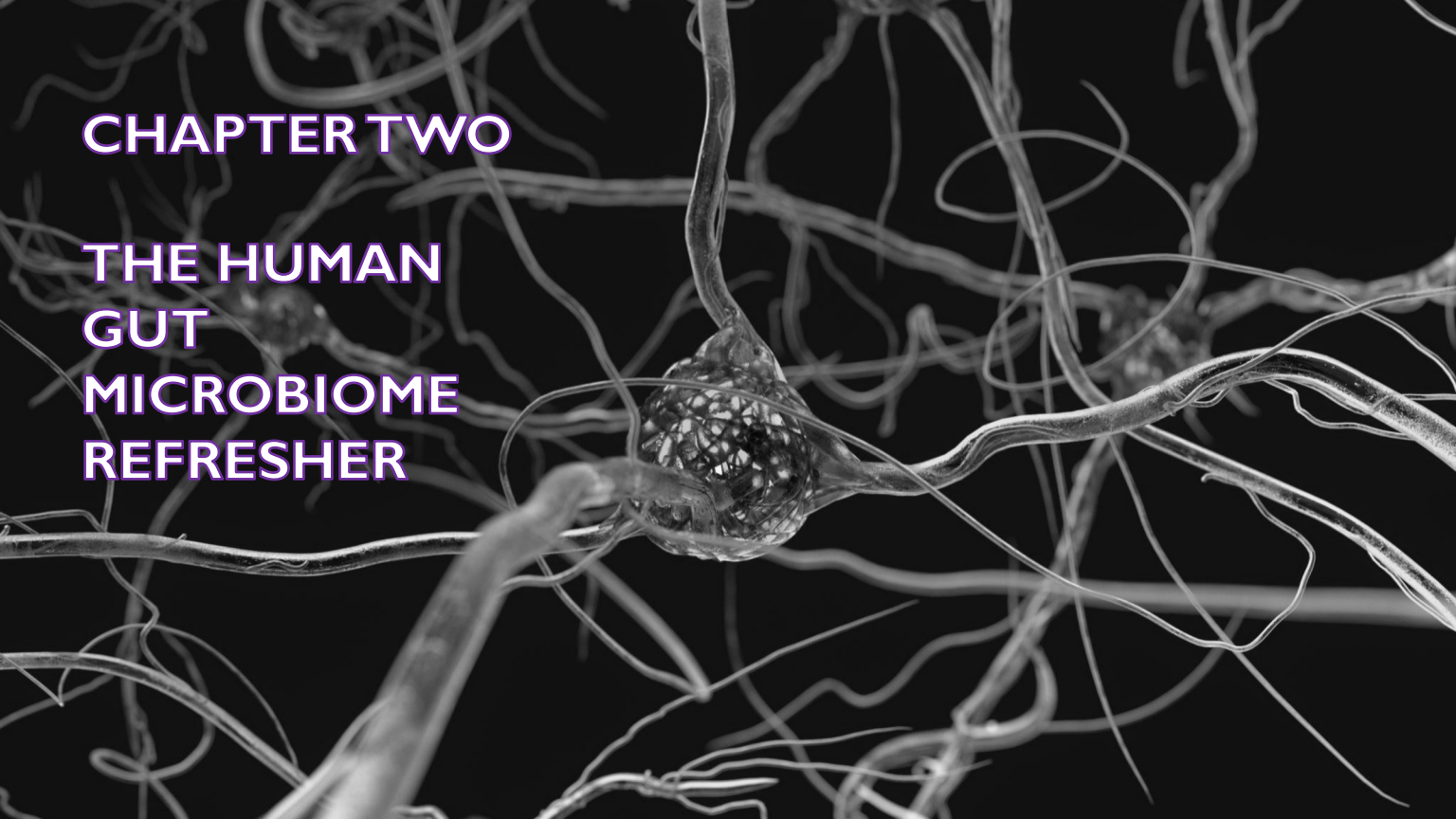
POLL/QUESTION: How many crops and animals make up the bulk of our calories?

Palmer S. Advocating Biodiversity in Diets. Today's Dietitian. https://www.todaysdietitian.com/newarchives/ND20p46.shtml. Published November 2020. Accessed March 29, 2023.
Dinerstein et al. A "Global Safety Net" to reverse biodiversity loss and stabilize Earth's climate. *SCIENCE ADVANCES* 4 Sep 2020Vol 6, Issue 36

CURRENT STATISTICS

- 12 plants and 5 animals make up 75% of our calories
- 50% of our calories come from just three sources: rice, corn, and wheat.
- Since the 1900s, some 75% of plant genetic diversity has been lost as farmers worldwide have left their multiple local varieties and landraces for genetically uniform, high-yielding varieties.
- There are over 30,000 edible species

https://www.fao.org/3/y5609e/y5609e02.htm



CHAPTER TWO

THE HUMAN GUT MICROBIOME REFRESHER

MAJOR ROLES OF THE GUT MICROBIOTA

- Digestion and absorption of our nutrients (enhances absorption of minerals: iron, calcium)
- Creates SCFA's (Short Chain Fatty acids) that ensure the integrity of our gut lining
- Influences the development of and supports/informs/drives the activity of our immune function
- Protects against pathogens & aids in detoxification by metabolizing carcinogens
- Synthesizes amino acids and a variety of vitamins: Vitamin K, B12, Riboflavin, Biotin and Thiamine
- Helps to determine how much energy we burn, how we metabolize glucose and fats, how much fat we store
- Role in insulin sensitivity and modulating inflammation
- Modulates nervous system & synthesizes neurotransmitters
- Emerging research on the significant effect it has on brain function and mood – "Gut Brain Axis" via Vagus nerve

Bengmark, S. Processed foods, dysbiosis, systemic inflammation and poor health. *Current Nutrition & Food Science.* 2013;9:113-143.;
Mahan, L. Kathleen., Escott-Stump, Sylvia., Raymond, Janice L.Krause, Marie V. (Eds.) (©2015) *Krause's food & the nutrition care process* /St. Louis, Mo. : Elsevier/Saunders,

MICROBIOME & HUMAN HEALTH LINK

- **DYSBIOSIS:** Changes in the proportions of different gut flora populations have been found in many health conditions, including:
  - Inflammatory bowel disease, Celiac & Irritable bowel syndrome
  - Metabolic syndrome
  - Type 1 & 2 diabetes (often with excess adipose tissue)
  - Cardiovascular disease
  - Obesity (metabolically unhealthy extra weight)
  - Liver disease (including non-alcoholic steatohepatitis & cirrhosis)
  - Neuropsychiatric disease (including autism spectrum disorder, depression, and multiple sclerosis)
  - Autoimmune issues/diseases & inflammatory conditions
  - Asthma & Lung infections
  - Skin issues: acne, eczema

Bull MJ, Plummer NT. Part 1: The Human Gut Microbiome in Health and Disease. Integr Med (Encinitas). 2014;13(6):17-22;
Brown K, DeCoffe D, Molcan E, Gibson DL. Diet-induced dysbiosis of the intestinal microbiota and the effects on immunity and disease [published correction appears in Nutrients. 2012 Oct;4(11)1552-3]. Nutrients. 2012;4(8):1095-1119
Kristina M. Utzschneider, Mario Kratz, Chris J. Damman, Meredith Hullarg, Mechanisms Linking the Gut Microbiome and Glucose Metabolism, The Journal of Clinical Endocrinology & Metabolism, Volume 101, Issue 4, 1 April 2016, Pages 1445–1454, https://doi.org/10.1210/jc.2015-4251.
Davis CD. The Gut Microbiome and Its Role in Obesity. Nutr Today. 2016;51(4):167-174. Anhê, F.F., Jensen, B.A.H., Varin, T.V. et al. Type 2 diabetes influences bacterial tissue compartmentalisation in human obesity. Nat Metab 2, 233–242 (2020). Opazo MC, Ortega-Rocha EM, Coronado-Arrázola I, et al. Intestinal Microbiota Influences Non-intestinal Related Autoimmune Diseases. Front Microbiol. 2018;9:432. Published 2018 Mar 12.

INFLUENCED AND AFFECTED BY….?

Gestational age at birth & mode of birth	Maternal microbiome	Breastfed vs bottle fed	Antibiotics in childhood/adulthood
Current sanitation/hygiene measures	Environment: Urban versus Rural Settings	Medications	Antibiotics in food
Diet (explains ~50% of variation)	Low plant bio-diversity	Agriculture (Agrochemicals, Soil management & health)	Soil microbiome

Brown K, DeCoffe D, Molcan E, Gibson DL. Diet-induced dysbiosis of the intestinal microbiota and the effects on immunity and disease [published correction appears in Nutrients. 2012 Oct;4(11)1552-3]. *Nutrients*. 2012;4(8):1095-1119.
Blum WEH, Zechmeister-Boltenstern S, Keiblinger KM. Does Soil Contribute to the Human Gut Microbiome?. *Microorganisms*. 2019;7(9):287. Published 2019 Aug 23.

DIVERSITY OF MICROBES POSITIVELY ASSOCIATED WITH ONE HEALTH DIET-RELATED IMPACTS ON THE GUT MICROBIOME: HIGHLIGHTS

Supportive/Beneficial

- Fiber
- Diversity of foods
- Omega 3 fatty acids
- **Phytonutrients/phytochemicals/polyphenols**
- Probiotic-rich foods
- Foods grown in healthy rich soils

Less Supportive/Detrimental

- Ultra-processed and refined carbohydrates and sugar
- Poor quality and refined oils
- Processed meats
- Many of the foods that characterize the industrial food system

Blum WEH, Zechmeister-Boltenstern S, Keiblinger KM. Does Soil Contribute to the Human Gut Microbiome?. Microorganisms. 2019;7(9):287.
Singh, R.K., Chang, H., Yan, D. *et al.* Influence of diet on the gut microbiome and implications for human health. *J Transl Med* 15, 73 (2017)
Tindall, A et al. Walnuts and Vegetable Oils Containing Oleic Acid Differentially Affect the Gut Microbiota and Associations with Cardiovascular Risk Factors: Follow-up of a Randomized, Controlled, Feeding Trial in Adults at Risk for Cardiovascular Disease. The Journal of Nutrition, 2019;
Hills RD Jr, Pontefract BA, Mishcon HR, Black CA, Sutton SC, Theberge CR. Gut Microbiome: Profound Implications for Diet and Disease. Nutrients. 2019;11(7):1613. Published 2019 Jul 16
Zinöcker MK, Lindseth IA. The Western Diet-Microbiome-Host Interaction and Its Role in Metabolic Disease. *Nutrients.* 2018;10(3):365. Published 2018 Mar 17. doi:10.3390/nu10030365

HIGHLIGHT ON PHYTOCHEMICALS/POLYPHENOLS

- Plants produce protective phytochemicals as part of their defense/immune system in response to stress, pests, adverse weather, and wildlife
- Affected by microbial composition in the soil
- These compounds have human health benefits
- Increases flavor profile

Bitter flavor (Emerging research)

- Bitter taste receptors exist throughout the intestinal tract
- Can trigger the release of the hormone GLP-1 which can help with appetite regulation, intestinal motility, insulin sensitivity
- The composition of these energy-harvesting bacterial populations may be controlled by taste receptors

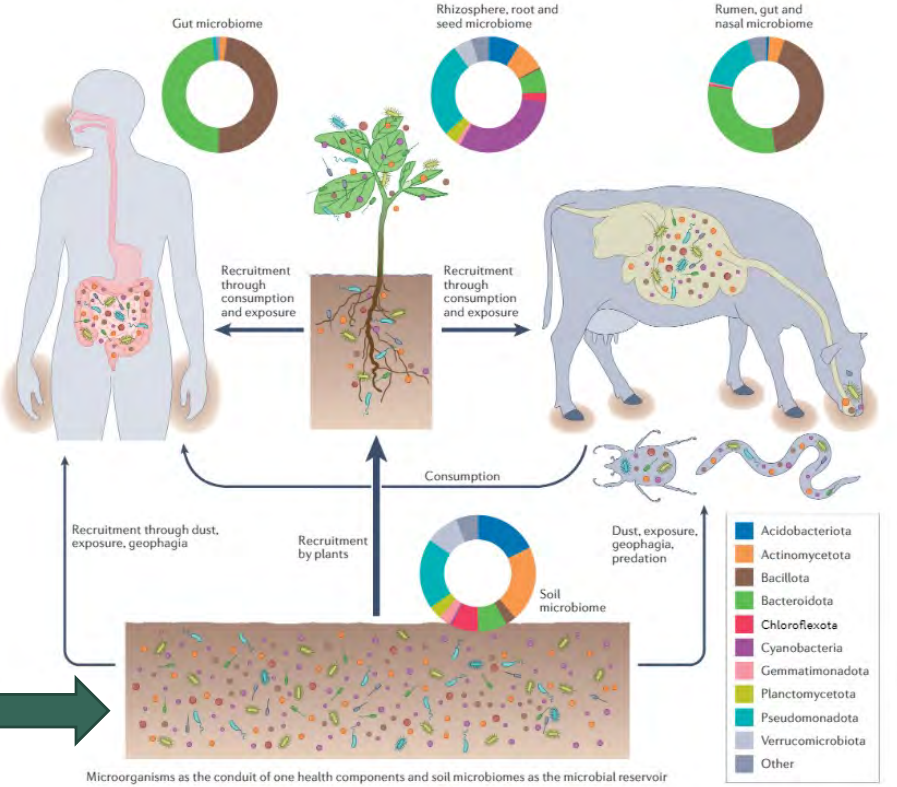
Montgomery, D; Bikle, A. What Your Food Ate : How to Heal Our Land and Reclaim Our Health. WW Norton & Co
Turner A, Veysey M, Keely S, Scarlett C, Lucock M, Beckett EL. Interactions between Bitter Taste, Diet and Dysbiosis: Consequences for Appetite and Obesity. Nutrients. 2018 Sep 20;10(10):1336
Rezaie P, Bitarafan V, Horowitz M, Feinle-Bisset C. Effects of Bitter Substances on GI Function, Energy Intake and Glycaemia-Do Preclinical Findings Translate to Outcomes in Humans? Nutrients. 2021 Apr 16;13(4):1317

CONNECTION TO PLANT MICROBIOME

- Plants have microbiomes too!
- Affected by the health of the soil
- Our microbiome is also affected by the microorganisms found on the plants we consume

Banerjee, S. and van der Heijden, M. 2022. Nature Reviews. Soil microbiomes and one health

SOIL MICROBIOME



Microorganisms as the conduit of one health components and soil microbiomes as the microbial reservoir

Banerjee, S. and van der Heijden, M. 2022. Nature Reviews. Soil microbiomes and one health

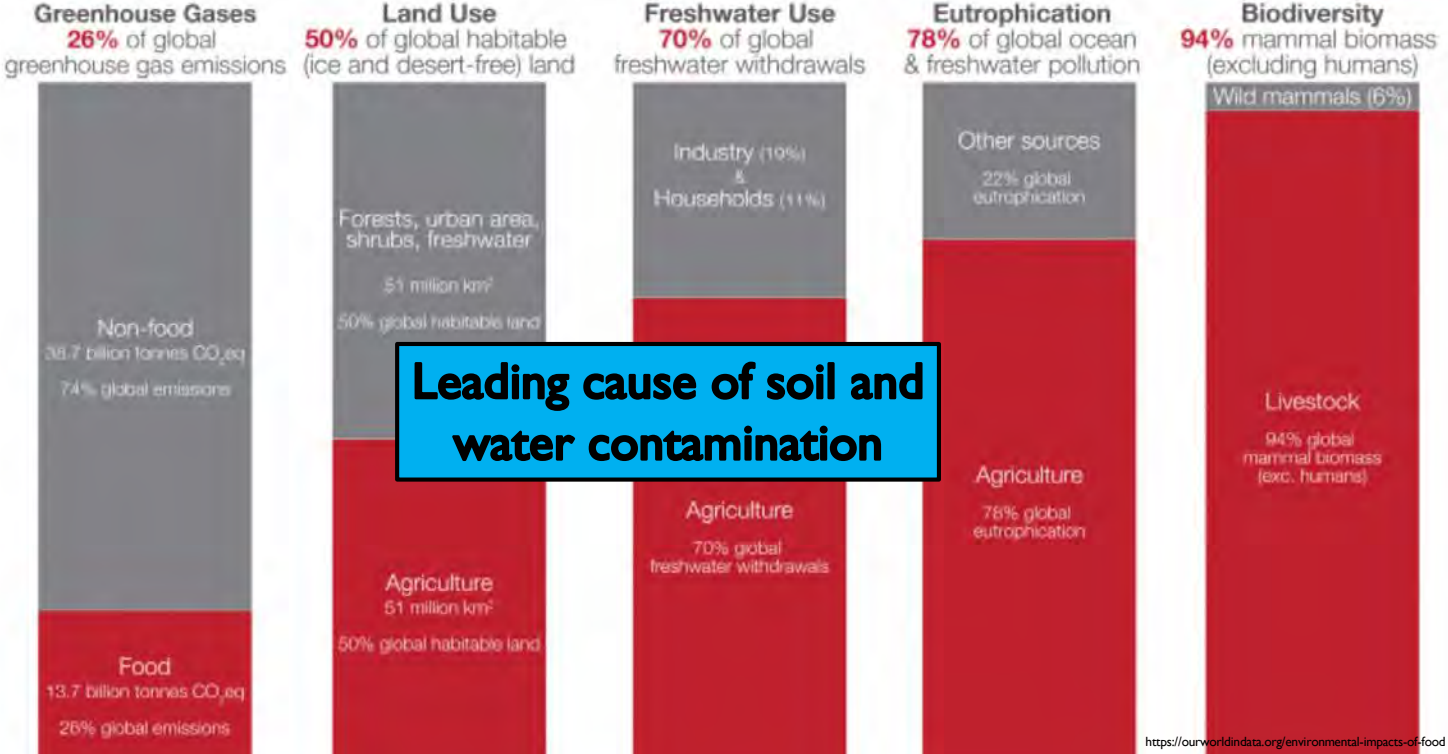
CHAPTER THREE

OUR CURRENT FOOD SYSTEM:

IMPACTS OF CONVENTIONAL FARMING PRACTICES ON SOIL, BIODIVERSITY, AND GUT MICROBIOME

What are the environmental impacts of food and agriculture?

Our World in Data



Leading cause of soil and water contamination

https://ourworldindata.org/environmental-impacts-of-food

IMPACT ON THE SOIL FROM INDUSTRIAL FOOD SYSTEM

80% of Deforestation

Rigorous soil management: tilling and ploughing

- Breaks up the plant roots and disrupts the underground microbial network → compromises top soil & nutrient delivery to plants

Industrial Animal Agriculture:

- **Overgrazing/traffic**: Soil compaction hurts soil health
- **Antibiotics:** Impact on soil microbiome & human gut microbiome

White, Brookline; Amos, Amylee; Regenerative agriculture Movement Ties Soil Microbiology to Health of the Human Microbiome. The HEN Post (Hunger and Environmental Nutrition) Spring/Summer 2022
https://www.unccd.int/

IMPACT ON THE SOIL FROM INDUSTRIAL FOOD SYSTEM

Monocultures: Reduce biodiversity of soil which compromises the nutrient delivery to plants.

- Plant immunity is affected
- Lack of diversity means more inputs necessary

Inputs/Agrochemicals: Pesticides and Fertilizers

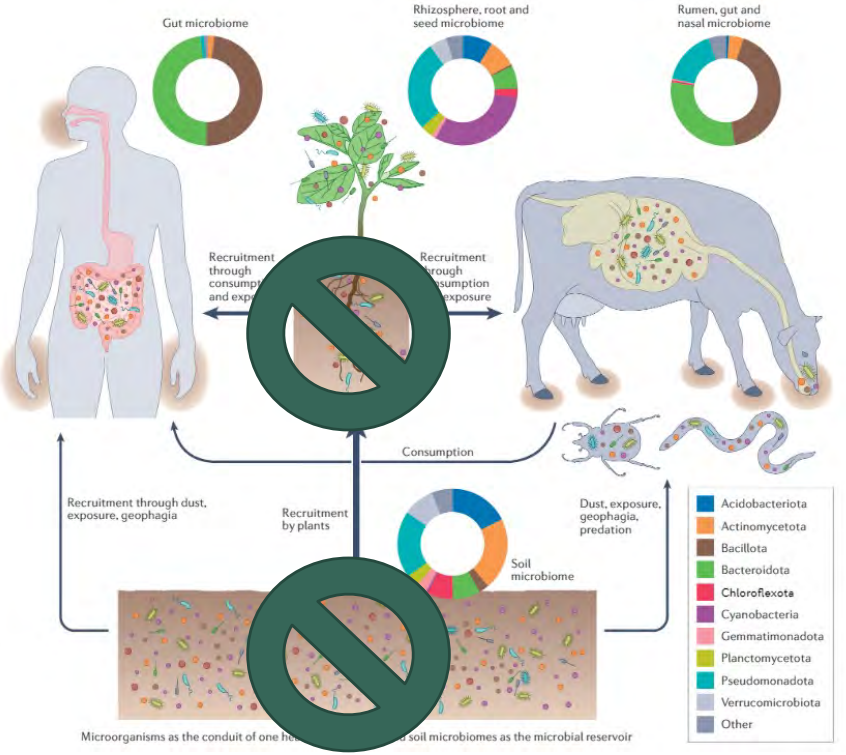
- Decrease soil bacteria, diminish plant immunity and increase susceptibility to disease/pests,
- Contaminate water supply and pollute air (affect wildlife)
- Decrease resilience of the soil
- **Fertilizers:** Breaks normal nutrient cycle & prevents plant from creating deep roots → lower nutrients
- **Pesticides:** Reduce phytochemical production; **D**isrupt soil microbiome; Harm pollinators, birds, wildlife

Healthy soils are the basis for healthy food production; Food and Agriculture Organization of the United Nations. Website. https://www.fao.org/soils-2015/news/news-detail/en/c/277682/ 2015 Accessed May 2022
Montgomery, D; Bikle, A. What Your Food Ate: How to Heal Our Land and Reclaim Our Health. WW Norton & Co
Lin, W. Et al. The Effects of Chemical and Organic Fertilizer Usage on Rhizosphere Soil in Tea Orchards. PLoS ONE 14; 2019

HIGHLIGHT ON EFFECTS OF GLYPHOSATE (HERBICIDE/WEED KILLER)

- Most extensively used herbicide in the world
  - Round up Ready (GMO) Soybeans (resistant to glyphosate)
  - Wheat desiccant
- Affects earthworm & microbial/mycorrhizal activity → affects the health of soil and plant
- Acts as a chelator in the soil: binds with nutrients in the soil system (zn, mn, cu) & decreases plant's uptake of minerals
- Blocks key pathways in the plant → direct damage to cellular systems
  - "Shikimate pathway" – key for making amino acids needed to build proteins
- Ingestion → disrupt gut microbiome →dysbiosis

Argou-Cardozo I, Zeidán-Chuliá F. Clostridium bacteria and autism spectrum conditions: A systematic review and hypothetical contribution of environmental glyphosate levels. *Medical Sciences*. 2018;6(2):29. doi:10.3390/medsci6020029.
Montgomery, D; Bikle, A. What Your Food Ate: How to Heal Our Land and Reclaim Our Health. WW Norton & Co.
Gama J, Neves B, Pereira A. Chronic Effects of Dietary Pesticides on the Gut Microbiome and Neurodevelopment. *Frontiers in Microbiology*. 2022;13. doi:10.3389/fmicb.2022.931440
Puigbò P, Leino LI, Rainio MJ, Saikkonen K, Saloniemi I, Helander M. Does Glyphosate Affect the Human Microbiota? *Life*. 2022;12(5):707. doi:10.3390/life12050707

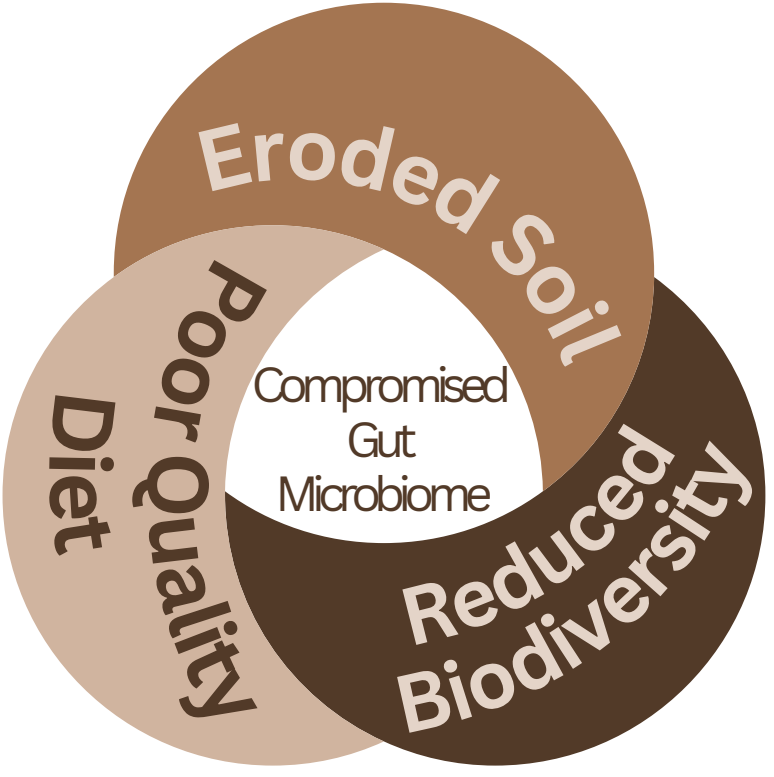


Banerjee S, van der Heijden MG. Soil microbiomes and One Health. *Nature Reviews Microbiology*. 2022;21(1):6-20. doi:10.1038/s41579-022-00779-w

OUR CURRENT FOOD SUPPLY: LESS NUTRIENT DENSE & DIVERSE THAN IT USED TO BE

- Most Americans don't meet many nutrient needs to begin with because of poor-quality processed diets and lack of access to healthy foods
- Foods produced by industrial agriculture/food model contain lower amounts of many nutrients
- Foods produced are lower in fiber, phytochemicals, Omega 3 fatty acids (affects gut MB)
  - Corn-fed beef = higher in Omega 6 fatty acids
- High in refined sugars, oils, and processed meats (affects gut MB)
- Ingredients going into ultra-processed foods are often subsidized
- There is a direct link between noncommunicable chronic diseases and the loss of diverse plant-based foods among indigenous communities worldwide.

Davis DR, Epp MD, Riordan HD. Changes in USDA food composition data for 43 garden crops, 1950 to 1999. J Am Coll Nutr. 2004 Dec;23(6):669-82.
Siegel KR, McKeever Bullard K, Imperatore G, et al. Association of Higher Consumption of Foods Derived From Subsidized Commodities With Adverse Cardiometabolic Risk Among US Adults. *JAMA Intern Med.* 2016;176(8):1124–1132
Sarkar D, Walker-Swaney J, Shetty K. Food Diversity and Indigenous Food Systems to Combat Diet-Linked Chronic Diseases. *Curr Dev Nutr.* 2019;4(Suppl 1):3-11. Published 2019 Sep 2. doi:10.1093/cdn/nzz099.


Eroded Soil
Poor Quality Diet
Reduced Biodiversity
Compromised Gut Microbiome

CHAPTER FOUR

THE BENEFITS OF ECOLOGICALLY FRIENDLY GROWING TECHNIQUES ON SOIL, BIODIVERSITY, AND MICROBIOME

TERMINOLOGY

Regenerative agriculture

Climate-friendly farming

Nature-positive

Environmentally friendly

Climate-smart agriculture

Ecologically friendly

Agroecology

Permaculture

Organic

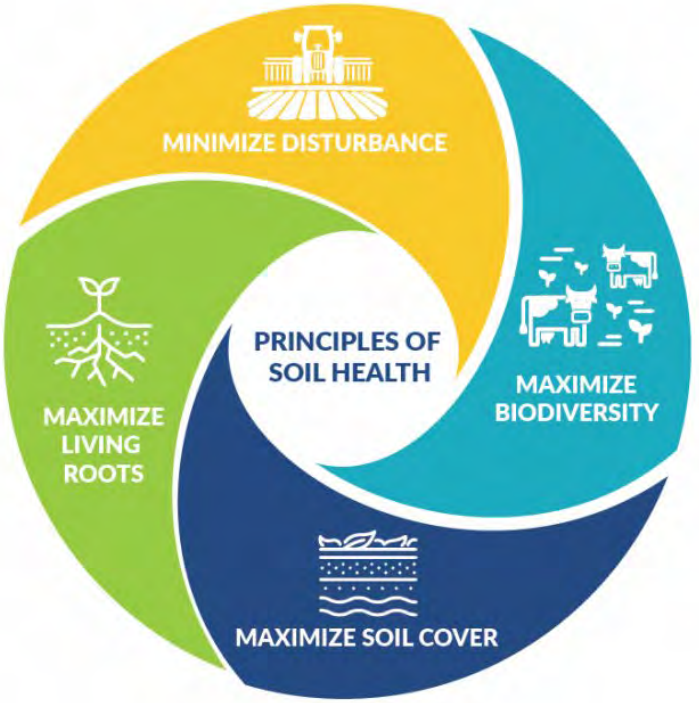
Biodynamic

AGRO-ECOLOGY"/"ORGANIC"/"CONSERVATION"/"REGENERATIVE AGRICULTURE": BUILDS HEALTH OF THE SOIL AND SYSTEM

- Minimize disturbances to soil: No tilling
- Maximize crop diversity/crop rotation = more soil microbe diversity
- Cover Crops: Keep soil/ground covered, Adds organic matter to soil and prevents soil erosion
- Crop rotation
- No synthetic chemicals
- Often Integrating Livestock
- Many permutations of these approaches

Chrisman S. What is regenerative agriculture? FoodPrint. https://foodprint.org/blog/regenerative-agriculture-definition/. Published July 21, 2022. Accessed March 29, 2023.
Moyer J, Stoll S, Schaeffer Z, et al. THE POWER of the PLATE: The Case for Regenerative Organic Agriculture in Improving Human Health. Rodale Institute. 2020. Accessed January 14, 2022
Healthy Food Team. The dirt on climate change: Regenerative agriculture and health care. Health Care Without Harm. https://noharm-uscanada.org/regenerativeagriculture. Published September 8, 2020. Accessed March 29, 2023.

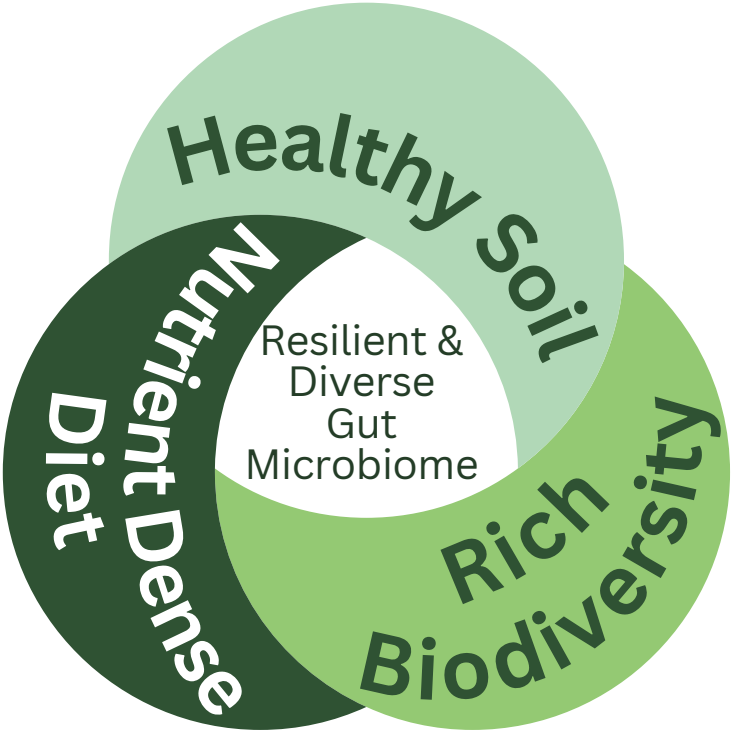
https://www.fao.org/3/au890e/au890e.pdf Food and Agriculture Organization, 2015. Healthy soils are the basis for healthy food production



Fertilizers and pesticides

Graphic: https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health

Banerjee S, van der Heijden MG. Soil microbiomes and One Health. *Nature Reviews Microbiology*. 2022;21(1):6-20. doi:10.1038/s41579-022-00779-w


Healthy Soil
Nutrient Dense Diet
Rich Biodiversity
Resilient & Diverse Gut Microbiome

BENEFITS OF ORGANIC/REGENERATIVE FARMING/AGROECOLOGY ON CROPS

- **Higher nutrient levels:** minerals and vitamin C, amino acids
- **Higher in phytochemicals:** beta carotene, anthocyanins
  - Prevent disease and **supports human gut microbiome**
- **Higher in Ergothioneine** ("ergo"): naturally occurring antioxidant
  - May reduce the risk of neurodegenerative diseases like Alzheimer's.
- **Greater diversity of microbiota than in conventionally grown crops**
- **Lower levels of heavy metals**
- **Higher phytonutrient levels in grass-fed meat/milk**
- **Increased organic intake was associated with** reduced incidence of infertility, birth defects, metabolic syndrome, non-Hodgkin lymphoma, and other health conditions.

Barański M, Srednicka-Tober D, Volakakis N, et al. "Higher antioxidant and lower- ", (2014).
Lori M., Symnaczik S., Mäder P., De Deyn G., Gattinger A. Organic farming enhances soil microbial abundance and activity—A meta-analysis and meta-regression. PLoS ONE. 2017;12:e0180442. doi: 10.1371/journal.pone.0180442.
Johansson E, Hussain A, Kuktaite R, Andersson SC, Olsson ME. "Contribution of Organically Grown- ", (2014).
"3 Studies That Show Healthy Soil- ", (2020).
Vigar et al., "A Systematic Review of Organic Versus Conventional Food Consumption"
Van Vliet, S et al. Health-Promoting Phytonutrients Are Higher in Grass-Fed Meat and Milk 20
Wassermann, B. et al. An Apple a Day: Which Bacteria Do We Eat With Organic and Conventional Apples? (2019)

THIS JUST OUT JAN 2022!

ENVIRONMENTAL SCIENCE

Soil health and nutrient density: preliminary comparison of regenerative and conventional farming

David R. Montgomery [1], Anne Biklé [2], Ray Archuleta [3], Paul Brown [4], Jazmin Jordan [4]

[1] Department of Earth and Space Sciences, University of Washington, Seattle, WA, United States
[2] Dig2Grow.com, Seattle, WA, USA
[3] Unaffiliated, Seymour, MO, USA
[4] Brown's Ranch, Bismarck, ND, USA

- **10 Farms** with no-till, cover crops, and diverse rotations produced crops with **higher "soil organic matter"** levels, soil health scores, and levels of certain vitamins, minerals, (Cu, Ca, Zn)
- Higher levels of **phytochemicals** (including phytosterols) with regenerative farming than conventional (promote immune health)
- **Regenerative grazing practices** produced meat with a **better fatty acid profile** & ratio. Higher in Omega 3's (supportive of Microbiome)

Montgomery DR, Biklé 2022. Soil health and nutrient density: preliminary comparison of regenerative and conventional farming. *PeerJ* 10:e12848
Montgomery d et al, Soil Health and Nutrient Density: Beyond Organic vs. Conventional Farming: Front. Sustain. Food Syst., 04 November 2021
LaCanne CE,. Regenerative agriculture: merging farming and natural resource conservation profitably. 2018.

DIRECT EXPOSURE TO SOIL AFFECTS HEALTH

- Exposure to outdoors/forests/soil/green spaces – helps build the immune system
- Greater exposure linked to increased diversity of microbes on skin and gut microbiome

- **Less Biodiversity in more urban and modern environments**
  - May contribute to an uneducated immune system
  - May increase susceptibility to immune-mediated diseases
  - Potentially contributes to asthma and allergies
  - Disproportionate impact on communities of color

Blum WEH, Zechmeister-Boltenstern S, Keiblinger KM. Does Soil Contribute to the Human Gut Microbiome?. *Microorganisms*. 2019;7(9):287. Published 2019 Aug 23.

Brevik EC, Slaughter L, Singh BR, et al. Soil and human health: Current status and future needs. Air, Soil and Water Research. 2020;13

Brevik EC, Sauer TJ. The past, present, and future of soils and human health studies. Soil. 2015;1(1):35-46. https://www-proquest-com.buproxy.bastyr.edu/scholarly-journals/past-present-future-soils-human-health-studies/docview/1757024005/se-2?accountid=1173. doi: http://dx.doi.org.buproxy.bastyr.edu:2048/10.5194/soil-1-35-2015

ROSLUND, MARJA I. PUHAKKA, Rikka GRÖNROOS, Mira, Biodiversity intervention enhances immune regulation and health-associated commensal microbiota among daycare children. *SCIENCE ADVANCES*•14 Oct 2020•Vol 6, Issue 42•DOI: 10.1126/sciadv.aba2578

Tasnim N, Abulizi N, Pither J, Hart MM, Gibson DL. Linking the Gut Microbial Ecosystem with the Environment: Does Gut Health Depend on Where We Live?. *Front Microbiol*. 2017;8:1935. Published 2017 Oct 6. doi:10.3389/fmicb.2017.01935

BENEFITS OF BEANS/LEGUMES ON THE ENVIRONMENT

Build soil & support healthy bacteria in a symbiotic relationship

"Fix Nitrogen": Working with the microbes in soil, they help take nitrogen out of the atmosphere and bring it into the soil where it gets used as fuel and acts as natural fertilizer

A mainstay of many cultures all over the world.

The EAT-Lancet Commission on Food, Planet, Health, 2017. 2. (World Resources Institute, 2016)

BIONUTRIENT INSTITUTE'S DEVELOPING RESEARCH:

FOOD GROWN ORGANICALLY HAS A HIGHER POLYPHENOL CONTENT

HIGHER SOIL CARBON IS CORRELATED WITH HIGHER NUTRIENT LEVELS.

PERIODIC TABLE OF FOOD INITIATIVE

- Catalog the biomolecular composition of the world's food supply:
  - Macro and micronutrients
  - Specialized metabolites
  - Exogenous compounds

- Recognize the complex composition (bio-molecules)of food which can vary depending on numerous factors
  - Where and how food is grown and processed
  - Environmental conditions
  - Food system practices

GOAL: ENABLE DATA-DRIVEN SOLUTIONS TO IMPROVE HUMAN AND PLANETARY HEALTH.

https://foodperiodictable.org/

INDIGENOUS WAYS OF KNOWING ABOUT THE CONNECTION BETWEEN ENVIRONMENT AND HUMAN HEALTH

- Indigenous peoples have a longstanding understanding of the importance of biodiversity and its positive benefits on resilience
- Assumptions about what counts as legitimate scientific knowledge must be questioned[5].
- A greater appreciation of the wealth of information held as a result of humans living with and using species over hundreds or thousands of years must be developed.
- Learning from diverse ways of being has the potential to provide inspiration and evidence to shift our dominant approaches to food security.

Image Credit: Paul Wilkin RBG KEW

Antonelli A. Indigenous knowledge is key to sustainable food systems. *Nature*. 2023;613(7943):239-242. doi:10.1038/d41586-023-00021-4. https://www.nature.com/articles/d41586-023-00021-4.
Suárez-Torres J, Suárez-López JR, López-Paredes D, Morocho H, Cachiguango-Cachiguango LE, Dellai W. Agroecology and Health: Lessons from Indigenous Populations. *Curr Environ Health Rep*. 2017;4(2):244-251.

RESEARCH AT THE ILLINOIS INSTITUTE FOR SUSTAINABILITY ENERGY AND ENVIRONMENT

How regenerative farming practices lead to healthier soils and plants, which produce healthier food, which in turn influences gut health and, ultimately, overall human health.

- **Role of the microbiome in diseases**
- **Connection between regenerative agriculture and food quality**
- **Effects of pesticides and herbicides on the human microbiome.**

https://sustainability.illinois.edu/the-microbiome-connection-from-farm-to-food-to-human-health/

SUMMARY

- Soil health and biodiversity are key for environmental and human health, food security and climate resilience
- Healthier/diverse soil → healthier plant/plant microbiome and higher likelihood of higher nutrient density of plants
- The human gut microbiome profoundly influences human health
- The diversity and health of the gut microbiome is driven by health and microbial diversity of plants
- Agroecological growing practices → increased likelihood of healthier soil and increased biodiversity
- Plants with higher nutrient density → support human health
- Therefore…Agroecological growing practices improve human health?
- Further research on the soil-plant-human health connection an ongoing priority for planetary health.


CHAPTER FIVE:
WHAT CAN WE
DO?

YOU HAVE INFLUENCE

Encourage diet diversity

- Linked to a more diverse microbiome
- Fruit/veg/nuts/seeds/grains
- Herbs/spices count too
  - Garlic, onions, ginger
- Seasonal and local foods
- Preserves many traditional/indigenous foods
- Consumer demand drives change

Recommend more legumes & plant proteins

- **Beans**
- **Lentils**
- **Soy**
  - Ensure beans taste/look/sounds delicious



YOU HAVE INFLUENCE

Focus on foods that support Microbiome status

- **Fiber:** beans, nuts, seeds, whole grains, fruits/vegetables
- **Polyphenols:** fruits, vegetables, teas
- **Omega 3 fatty Acids:** fatty fish, walnuts, flaxseeds
- **Fermented/cultured foods**
- **Minimized highly processed sugar/carbs/oils/red meat**

Advocate/Encourage purchasing from farms with ecologically friendly growing practices for higher nutrient density WHEN possible

- Pesticide free
- Organic/regeneratively/agroecologically grown
- "Better meat": grass-fed/humanely raised: *higher in Omega 3's*

Singh, R.K., Chang, H., Yan, D. *et al.* Influence of diet on the gut microbiome and implications for human health. *J Transl Med* 15, 73 (2017)

EDUCATE ON LABELS

SUSTAINABLE NUTRITION

The University of Vermont Medical Center aims to have the most sustainable health care food service in the country.

Healthy Food at the UVM Medical Center

At The University of Vermont Medical Center, we understand that nutrition and food systems are inextricably linked to the health of our patients and our community. This is reflected in our commitment to serving fresh, locally produced, minimally processed foods, and to partnering with farmers throughout the region to supply healthier food to patients while boosting the local economy.

QUICK LINKS

- Nutrition Services
- Our Center
- Dining Services
- Menus & Dining Locations

YOU HAVE INFLUENCE

Encourage growing your own food/community gardens

- Connects people with soil and land and place
- Generates healthy sensory/spiritual experiences
- Promotes food sovereignty
- Associated with increased fruit and vegetable intake
- Start simple

Educate on connection between how we produce food and human health

- Handouts
- Podcasts
- Articles/blog posts
- Social Media
- Have resources in the office

YOU HAVE INFLUENCE

Be an Advocate/Get involved with policy

- **Incorporate sustainability in Dietary Guidelines**
- **Include regenerative agriculture in the Farm Bill**
  - https://regenerateamerica.com/
- **Look for local legislation about better access to fresh produce, more community gardens**

Look to Indigenous communities for leadership and wisdom

- **"Agro-ecology" movements & Traditional growing methods that protect health of the environment and produce healthy food**
- **Longstanding belief/understanding of how the health of land = connected to plants and community**
- **International Labor Organization of the UN:**
  - "The knowledge and practices of Indigenous Peoples are crucial to meeting the UN 2030 sustainable development goals [1]

Indigenous Peoples Are Agents of Change to Reach Sustainable Development. Cultural Survival. https://www.culturalsurvival.org/news/indigenous-peoples-are-agents-change-reach-sustainable-development. Published August 7, 2018. Accessed June 15, 2020.

CHANGE THE CONVERSATION

Move beyond discussions of how food affects individual health.

Start discussions about how our ***food system*** affects the environment and how that affects community and societal and individual health

Thank you for joining us today.

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Adjunct Faculty Instructor, Bastyr University
Host of "The Good Clean Nutrition Podcast"

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