# USDA Nutrition Research:
## *Food-based approaches to promoting nutritional & public health and decreasing chronic disease*

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***PAMELA STARKE-REED, PHD***

***DEPUTY ADMINISTRATOR***

***NUTRITION FOOD, SAFETY, AND PRODUCT QUALITY & NEW USES OF AG PRODUCTS***


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USDA

# *Human Nutrition NP107 2019-2024 Action Plan*

1. Linking Agricultural Practices and Beneficial Health Outcomes

2. Monitoring Food Composition and Nutrient Intake of the Nation

3. Scientific Basis for Dietary Guidance

4. Prevention of Obesity and Obesity-Related Diseases

5. Life Stage Nutrition and Metabolism

Nutr/Ag

Nutr Monitor

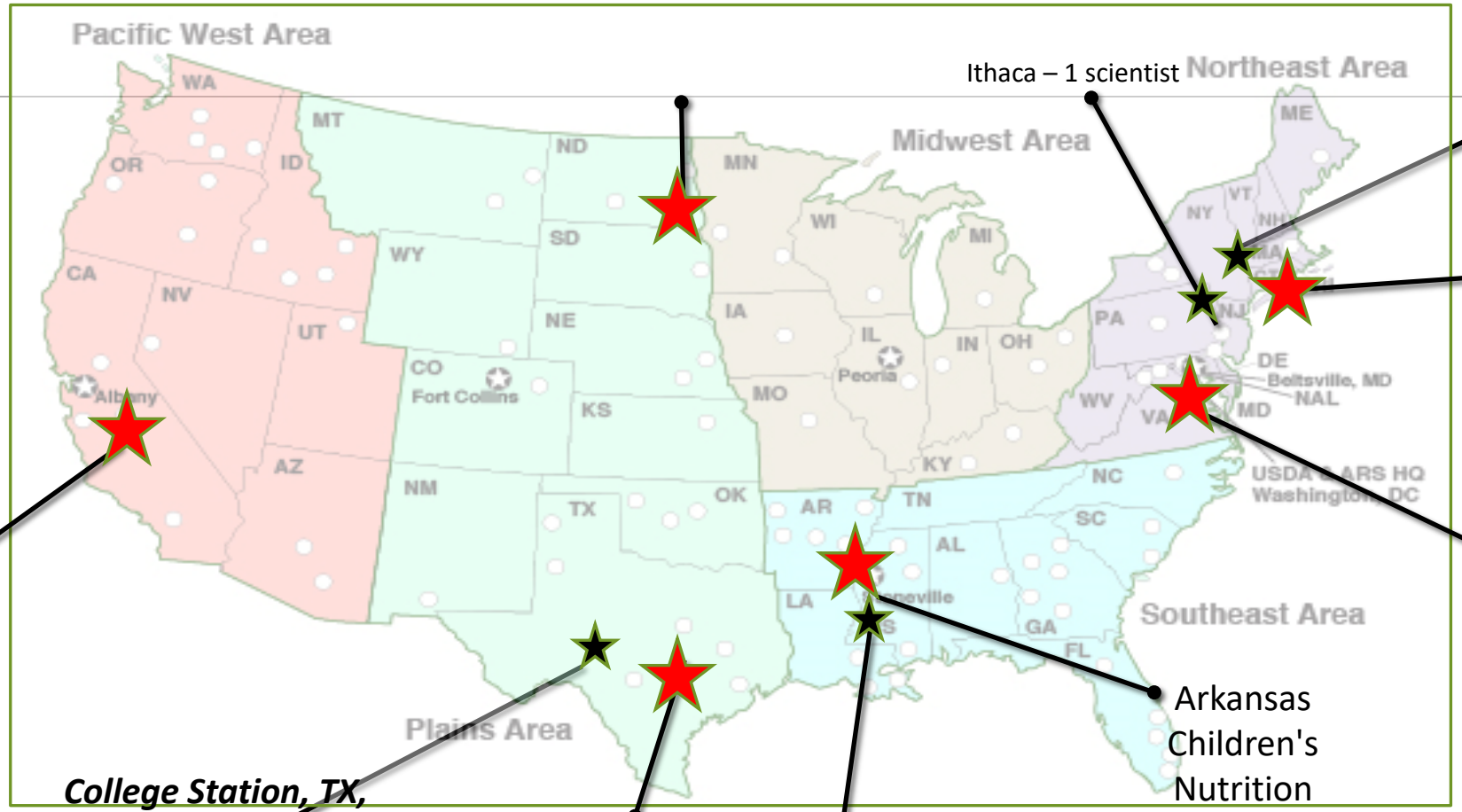
Dietary Guidance

Obesity

Life Stage

USDA

# USDA Human Nutrition Research Centers and Locations




Grand Forks Human Nutrition Research Center

Ithaca – 1 scientist

***Burlington, VT Food systems for New England - NEW***

Jean Mayer Human Nutrition Research Center on Aging

Western Human Nutrition Research Center

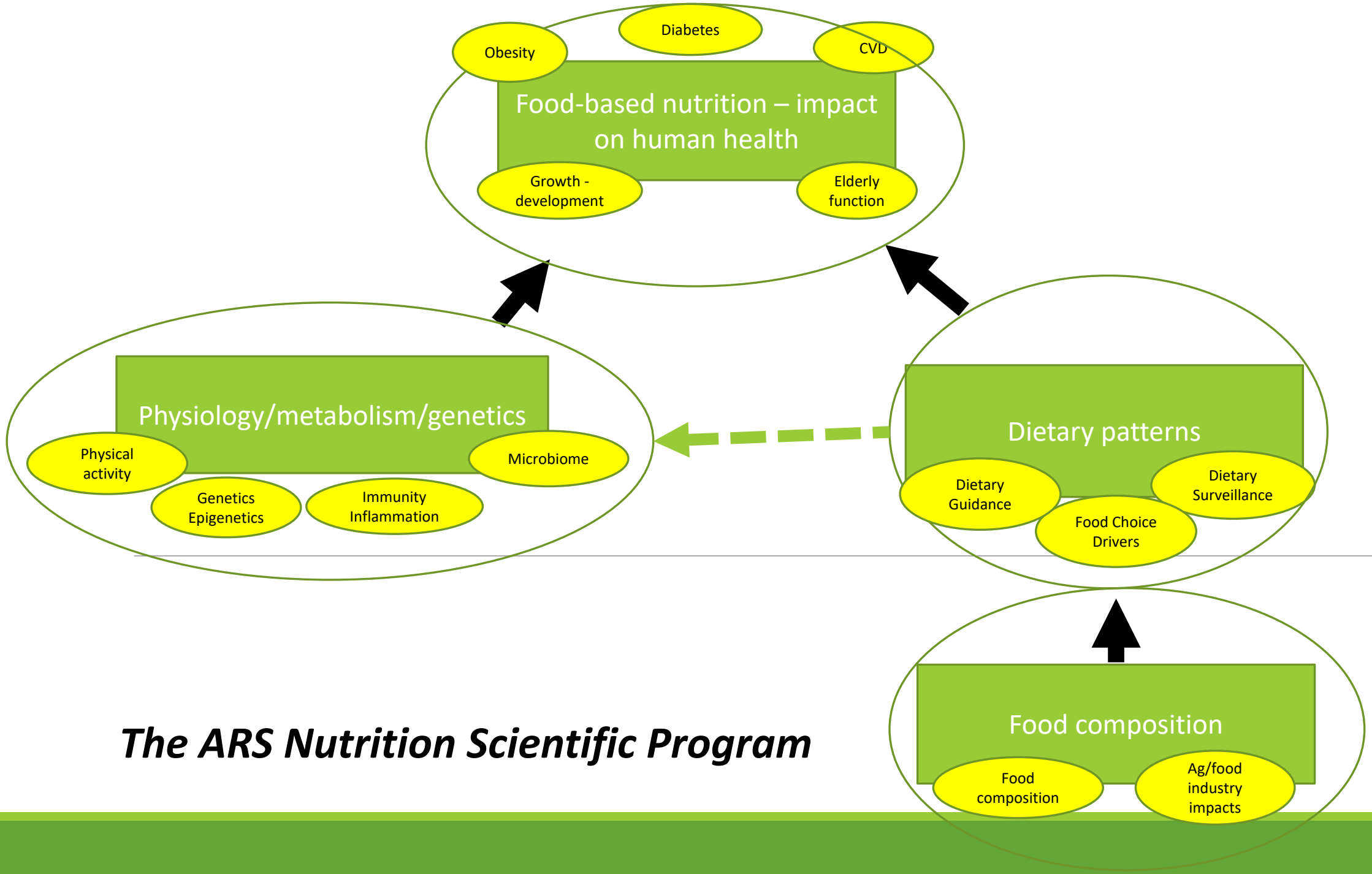
Beltsville Human Nutrition Research Center

Arkansas Children's Nutrition Center

***College Station, TX, Precision nutrition and responsive agriculture NEW***

Children's Human Nutrition Research Center

Stoneville, - 1 scientist




***The ARS Nutrition Scientific Program***

# New ‘Food Systems’ projects:

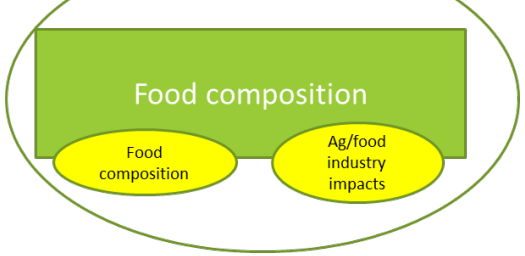
Burlington, VT

- Joint with the University of Vermont
- Diverse research team to include nutrition, environmental, animal, agronomic, food safety and social scientists

College Station, TX

- Joint with the Institute for Advancing Health Through Agriculture (IHA), Texas A&M University
- Focus on precision nutrition and responsive agriculture
- Emphasis on  big data and big ag approaches

# *Food Composition: The New Approach*

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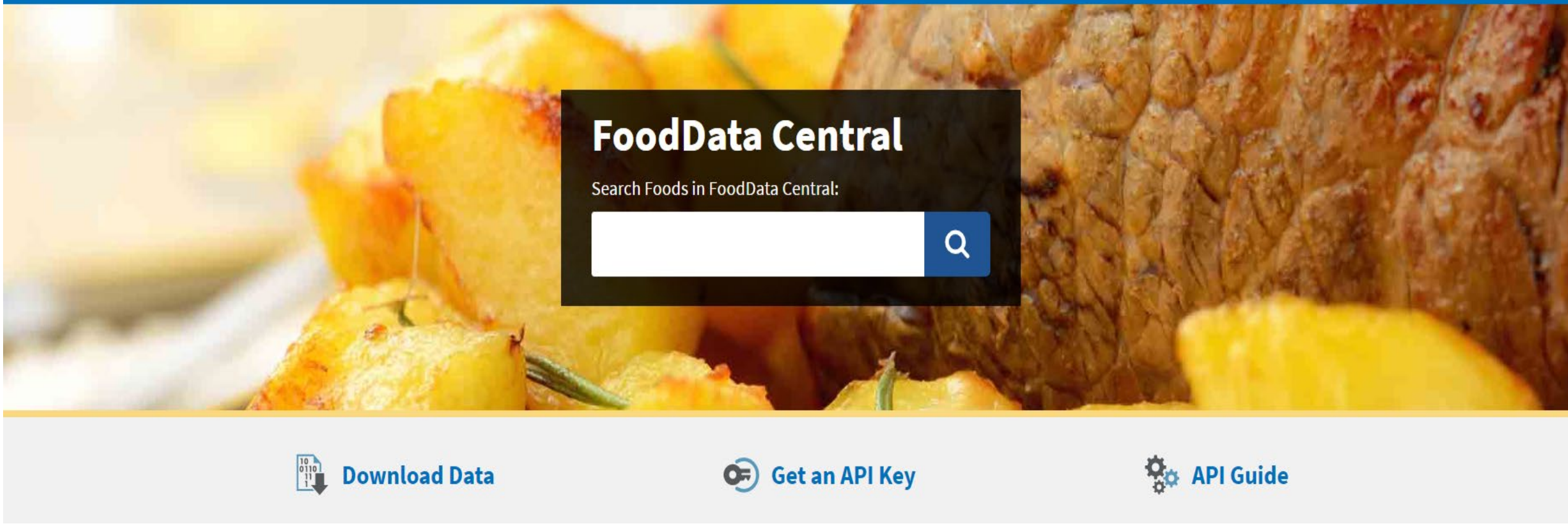


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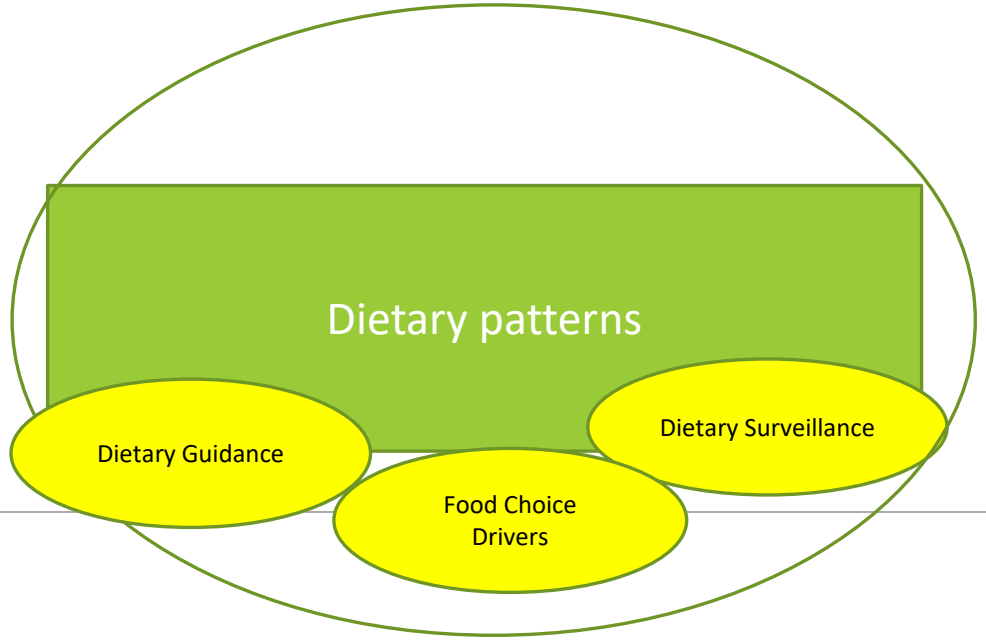
# *DIETARY PATTERNS*



***Nutrition Surveillance***

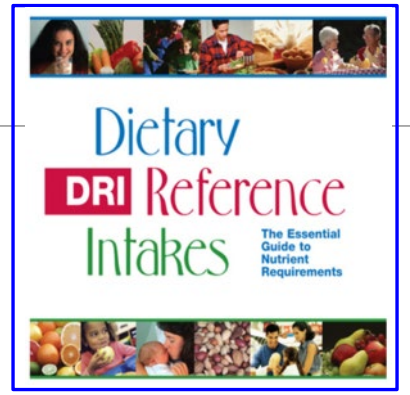
What We Eat in America NHANES

nhanes National Health and Nutrition Examination Survey

# *National survey data used for ….*

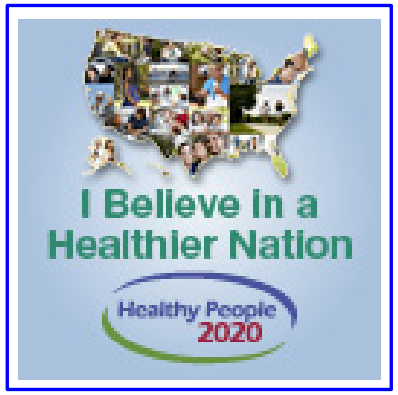

Federal Food Programs


Dietary Guidelines for Americans

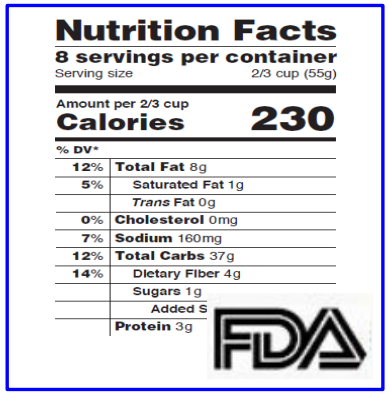



Dietary Reference Intakes

…and much more




Healthy People 2020




Food Labeling and Fortification


Food Safety and Risk Assessment

# *Factors affecting food choice*

???

***The relative reinforcing value of sweet versus savory snack foods after consumption of sugar- or non-nutritive sweetened beverages*** *Grand Forks, ND 2017*

***Perspectives on Barriers to Eating Healthy Among Food Pantry Clients*** *Houston, TX Health Equity 2017*

***A Randomized Controlled-Feeding Trial Based on the Dietary Guidelines for Americans on Cardiometabolic Health Indexes.*** *Davis, CA. Am. J. Clin. Nutr., 2018*

***Diet Quality for Sodium and Vegetables Mediate Effects of Whole Food Diets on 8-Week Changes in Stress Load*** *Davis, CA Nutrients 2018*

***Increasing dietary carbohydrate as part of a healthy whole food diet intervention dampens eight-week changes in salivary cortisol and cortisol responsiveness*** *Davis, CA Nutrients 2019*

***Authoritative parent feeding style is associated with better child dietary quality at dinner among low-income minority families*** *Houston, TX. Am. J. Clin. Nutr. 2018*

# *Dietary Guidance*

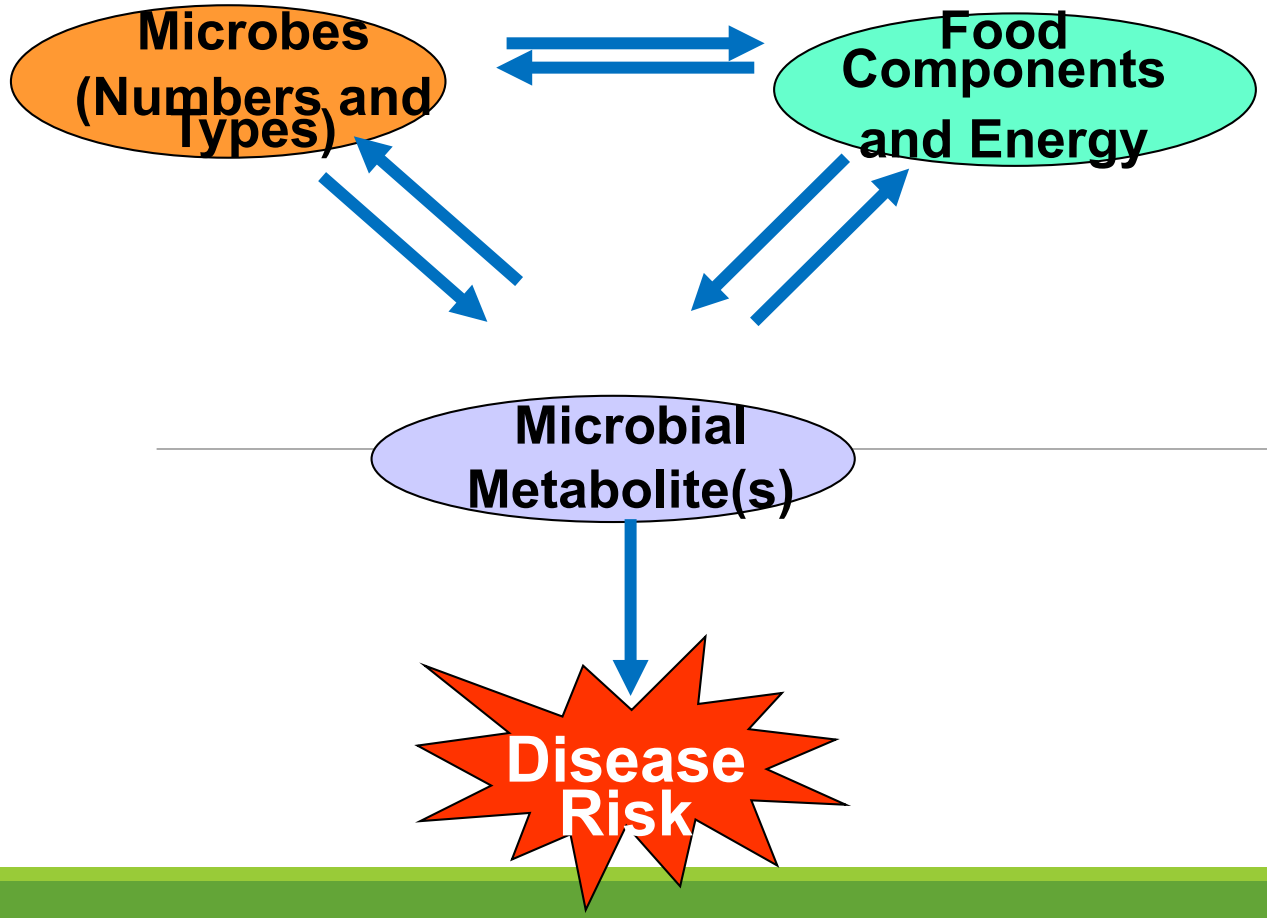

***A randomized controlled-feeding trial based on the Dietary Guidelines for Americans on cardiometabolic health indexes.*** *Davis, CA. Am. J. Clin. Nutr. 2018*

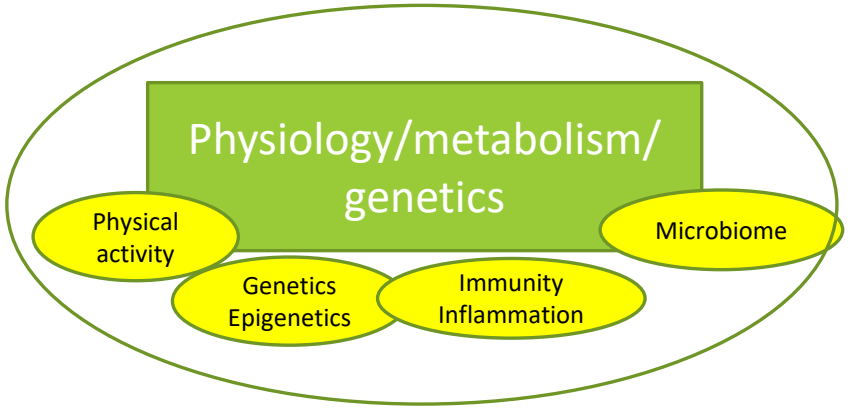
***A Randomized Controlled-Feeding Trial Based on the Dietary Guidelines for Americans on Cardiometabolic Health Indexes.*** *Davis, CA. Am. J. Clin. Nutr., 2018*

***Substituting whole grains for refined grains in a 6-wk randomized trial favorably affects energy-balance metrics in healthy men and postmenopausal women.*** *Boston, MA. Am. J. Clin. Nutr. 2017*

***Effect of varying quantities of lean beef as part of a Mediterranean-style dietary pattern on lipids and lipoproteins: a randomized crossover controlled feeding trial*** *Beltsville, MD. Am. J. Clin. Nutr. 2021*

# *Physiology, Metabolism, Genetics*



Bi-Directional Relationship between diet and microbiome:

***Dietary Vitamin K is Remodeled by Gut Microbiota and Influences Community Composition.*** *Boston, MA. Gut Microbes, 2021*

Microbiome influences the response to dietary components:

***5-(Hydroxyphenyl)-γ-Valerolactone-Sulfate, a Key Microbial Metabolite of Flavan-3-ols, Is Able to Reach the Brain: Evidence from Different in Silico, In Vitro and In Vivo Experimental Models*** *Beltsville, MD. Nutrients, 2019*

Dietary Modulation of the Microbiome

***Neonatal Diet Alters Fecal Microbiota and Metabolome Profiles at Different Ages in Infants Fed Breast Milk or Formula.*** *Little Rock, AR. Am. J. Clin. Nutr. 2020*

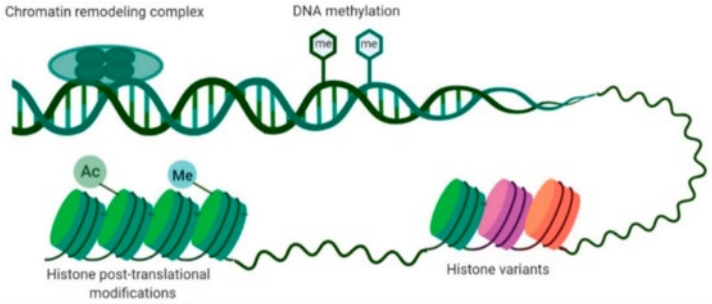
Translational Study

***Maternal High-Fat Diet Programs Offspring Liver Steatosis in a Sexually Dimorphic Manner in Association with Changes in Gut Microbial Ecology in Mice****. Little Rock, AR. Sci. Reports, 2018*

Dietary Modulation of the Microbiome and Health:

***Walnut Consumption Alters the Gastrointestinal Microbiota, Microbially Derived Secondary Bile Acids, and Health Markers in Healthy Adults: A Randomized Controlled Trial*** *Beltsville, MD. J. Nutrition 2019*

# *Genetics and Epigenetics*

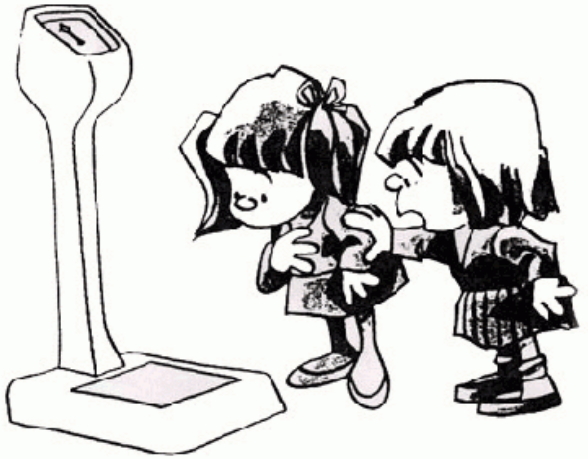



***Epigenomics and metabolomics reveal the mechanism of the APOA2-saturated fat intake interaction affecting obesity*** *Boston, MA. Am. J. Clin. Nutr. 2018*

***Bitter, Sweet, Salty, Sour and Umami Taste Perception Decreases with Age: Sex-Specific Analysis, Modulation by Genetic Variants and Taste-Preference Associations in 18 to 80 Year-Old Subjects*** *Boston, MA. Nutrients 2018*

***A genomic atlas of systemic interindividual epigenetic variation in humans*** *Houston, TX. Genome Biology 2019*

# *Obesity*



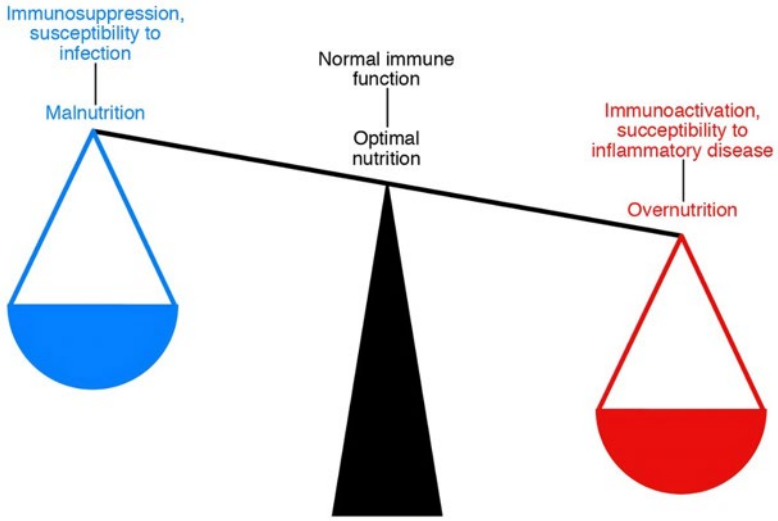

***Asprosin is a Centrally Acting Orexigenic Hormone.*** *Houston, TX. Nature Medicine, 2017.*

***Gut-Derived GIP Activates Central Rap1 to Impair Neural Leptin Sensitivity During Overnutrition.*** *Houston, TX. J. Clin. Invest., 2019.*

***The Effect of Obesity and Repeated Exposure on Pharmacokinetic Response to Grape Polyphenols in Humans.*** *Beltsville, MD. Mol. Nutr. Food Res., 2017*

***Efficacy of a Community- Versus Primary Care–Centered Program for Childhood Obesity: TX CORD RCT*** *Houston, TX. Pediatric Obesity, 2017*

# *Immunity/Inflammation*




***Human Breast-Milk Feeding Enhances the Humoral and Cell-Mediated Immune Response in Neonatal Piglets.*** *Little Rock, AR J. Nutrition, 2018*

***Lack of Differences in Inflammation and T-Cell Mediated Function Between Young and Older Women With Obesity****. Boston, MA. Nutrients, 2020*

***Substituting Whole Grains for Refined Grains in a 6-wk Randomized Trial has a Modest Effect on Gut Microbiota and Immune and Inflammatory Markers of Healthy Adults.*** *Boston, MA. Am. J. Clin. Nutr., 2017*

***EPA and DHA Differentially Modulate Monocyte Inflammatory Response in Subjects with Chronic Inflammation in Part via Plasma Specialized Pro-Resolving Lipid Mediators: A randomized, Double-Blind, Crossover Study***
*Boston, MA. Atherosclerosis, 2021*

# *Elderly Function/Healthy Aging*

***Avocado Consumption Increases Macular Pigment Density in Older Adults: A Randomized Controlled Trial.*** *Boston, MA. Nutrients, 2017*

***Nutrients and Bioactives in Green Leafy Vegetables and Cognitive Decline.*** *Boston, MA. Neurology, 2018*

***Long-term Dietary Flavonoid Intake and Risk of Alzheimer Disease and Related Dementias in the Framingham Offspring Cohort.*** *Boston, MA. Am. J. Clin. Nutr., 2020*

***Involvement of a Gut–Retina Axis in Protection Against Dietary Glycemia-Induced Age-Related Macular Degeneration.*** *Boston, MA. PNAS, 2017*

# *Diabetes*


***Effect of Macronutrients and Fiber on Postprandial Glycemic Responses and Meal Glycemic Index and Glycemic Load Value Determinations.*** *Boston, MA. Am. J. Clin. Nutr., 2017*

***Blackberry Feeding Increases Fat Oxidation and Improves Insulin Sensitivity in Overweight and Obese Males.*** *Beltsville, MD. Nutrients, 2018*

***Vitamin D Supplementation and Prevention of Type 2 Diabetes.*** *Boston, MA. New Eng. J. Med., 2019*

***Intratrial Exposure to Vitamin D and New-Onset Diabetes Among Adults With Prediabetes: A Secondary Analysis From the Vitamin D and Type 2 Diabetes (D2d) Study.*** *Boston, MA. Diabetes Care, 2020*

***An Anthocyanin-Rich Mixed-Berry Intervention May Improve Insulin Sensitivity in a Randomized Trial of Overweight and Obese Adults***. Beltsville, MD. 2019 Nutrients

# *Cardiovascular Disease*

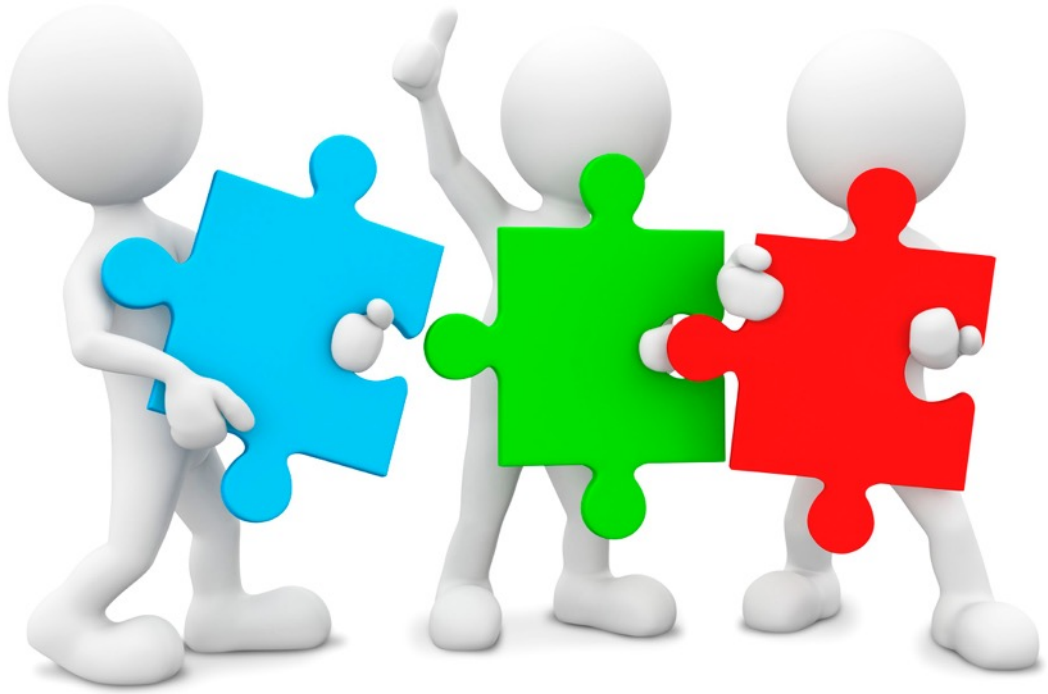


***High Levels of Avenanthramides in Oat-Based Diet Further Suppress High Fat Diet-Induced Atherosclerosis in Ldlr$^{-/-}$ Mice.*** *Boston, MA. J. Agric. Food Chem., 2018*

***Comparison of Diets Enriched in Stearic, Oleic, and Palmitic Acids on Inflammation, Immune Response, Cardiometabolic Risk Factors, and Fecal Bile Acid Concentrations in Mildly Hypercholesterolemic Postmenopausal Women—Randomized Crossover Trial.*** *Boston, MA Am. J. Clin. Nutr., 2019*

***Consumption of Cashew Nuts Does Not Influence Blood Lipids or Other Markers of Cardiovascular Disease in Humans: a Randomized Controlled Trial.*** *Beltsville, MD. Am. J. Clin. Nutr., 2019*

***Innovation to Create a Healthy and Sustainable Food System: A Science Advisory From the American Heart Association***. Boston, MA. Circulation. 2019



# Food and Nutrition Research partnering

- Other ARS Program: Food Production, Processing Safety
- Other USDA Agencies : NIFA, ERS, FNS
- Other Departments: working through the ICHNR with other departments & Agencies
- Academic Institutions
- Public-Private partnerships

# The Promise of Health Through Agriculture


Texas A&M AgriLife

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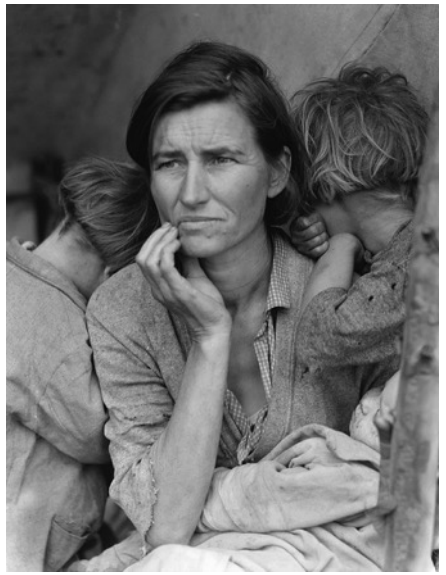
Patrick J. Stover, Ph.D.
Professor and Director

IHA.TAMU.EDU

# WWII Revolutionized Agriculture and the Food Supply





Food should be:
Abundant
Affordable
Accessible

~~Hunger~~
~~Food Insecurity~~

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# New Imperatives: *Agriculture and Food Systems*


| Historical Expectations | New Expectations |
| --- | --- |
| **Produce** | **Nourish and Sustain** |
| • Food<br>• Fiber<br>• Fuel | • Food for life-long health<br>• Protect and sustain our environment<br>• Ensure agriculture is economically viable |

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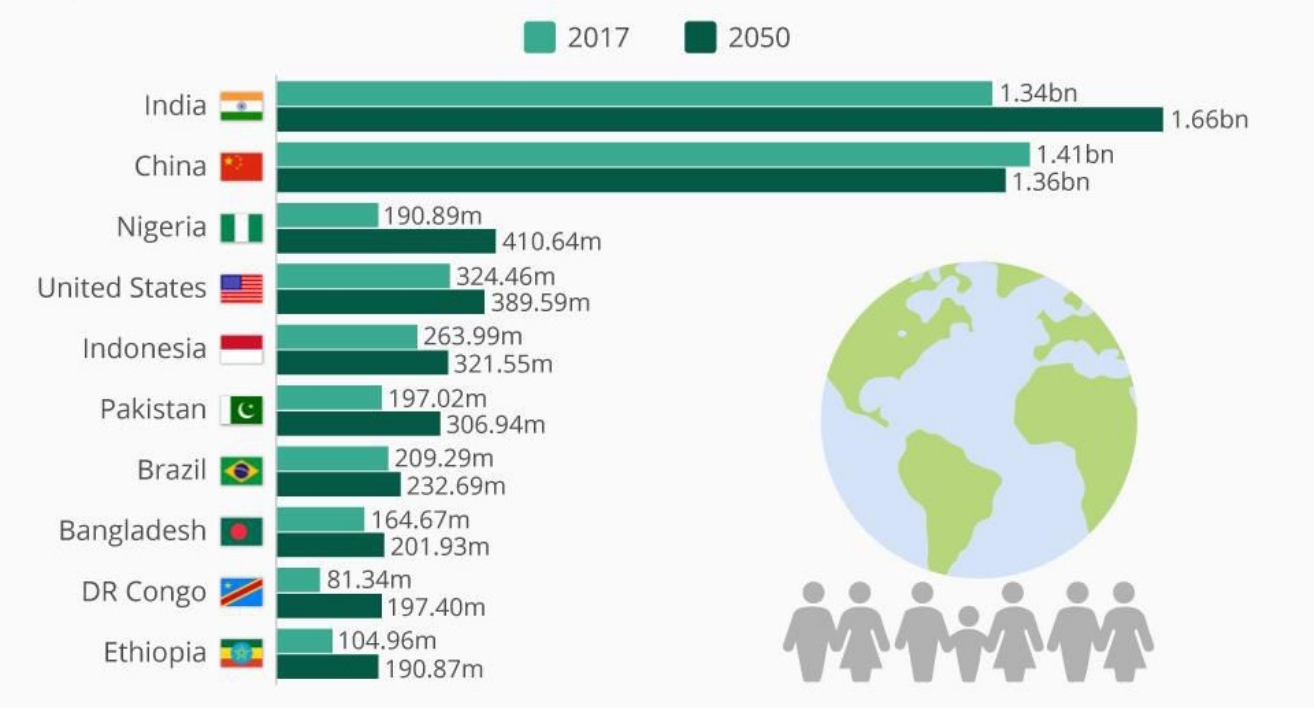
# Greatest Challenges of Our Time: *Population Growth and Farmland*

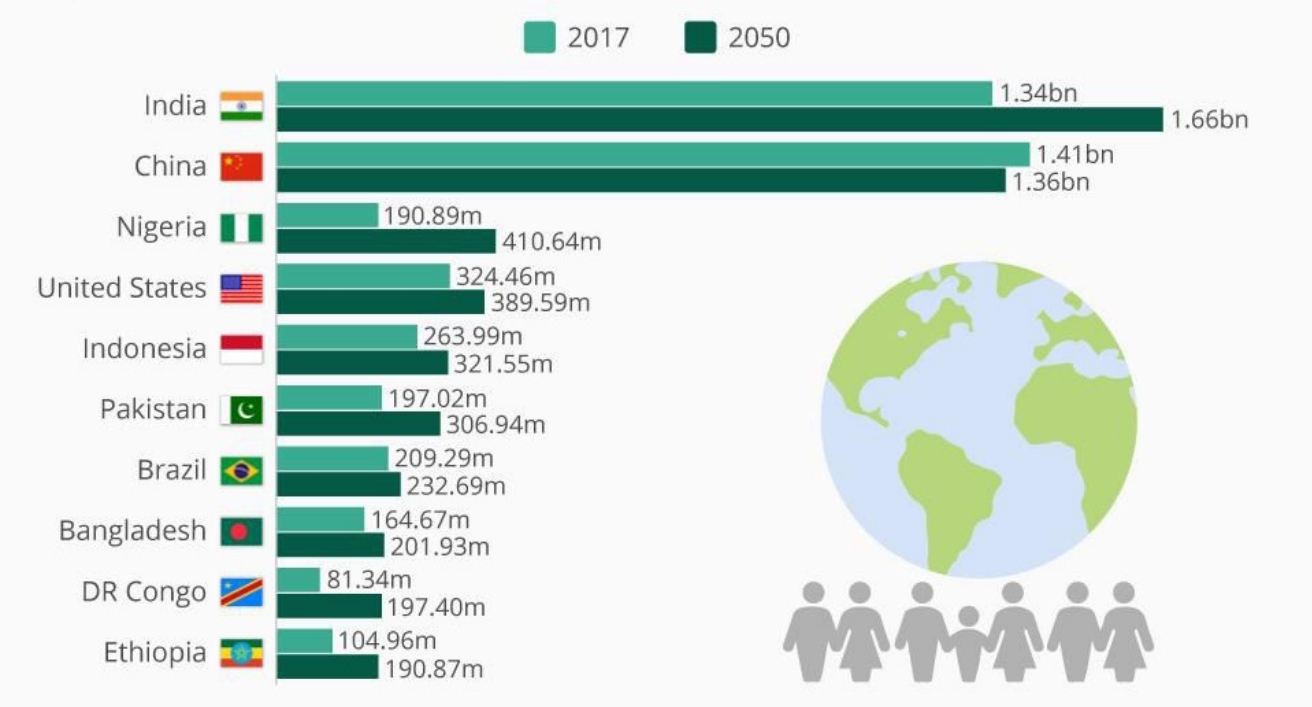



https://www.forbes.com/sites/niallmccarthy/2017/06/22/the-worlds-most-populous-nations-in-2050-infographic/#726189339f60

The U.S. loses about 175 acres of farmland every hour, mostly due to the expansion of urban and suburban areas.

*American Farmland Trust*

# Greatest Challenges of Our Time: *Population Growth and Food/Nutrition*




https://www.forbes.com/sites/niallmccarthy/2017/06/22/the-worlds-most-populous-nations-in-2050-infographic/#726189339f60

## *Worldwide:*

*2019* - **690 M** malnourished people

*2030* - **840 M** malnourished people
- **2 billion** food insecure

## *In the United States:*

**50%** of all adults suffer from pre-diabetes or diabetes.

The treatment of diabetes alone is **160 billion/year**, more than the annual budget of many key federal agencies

"People with diabetes worldwide are at increased risk for liver, pancreatic, colorectal, endometrial, breast and bladder cancer. Women with diabetes are 27 percent likelier to develop cancer, compared with healthy women." Diabetologia, 2018

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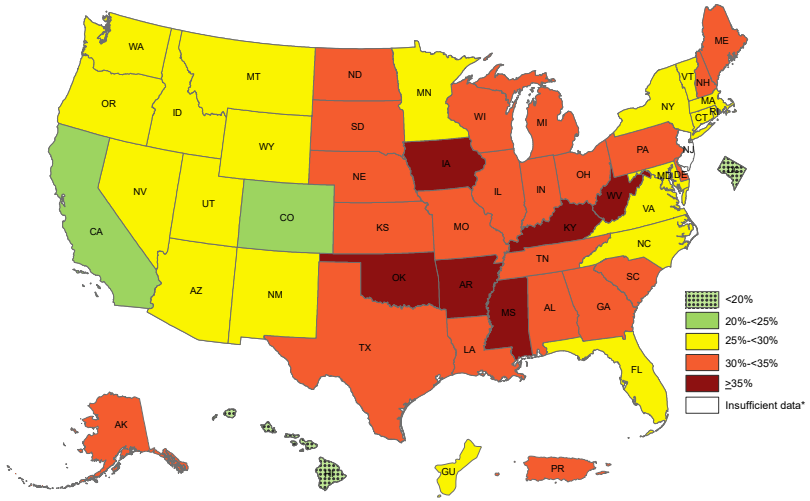
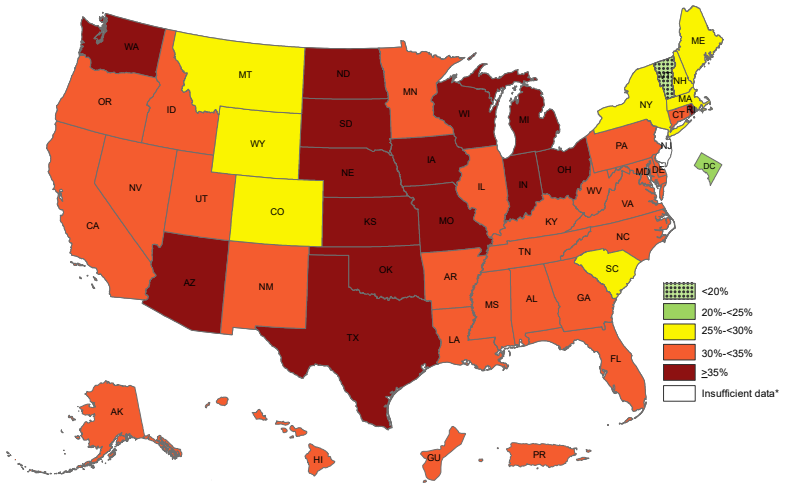
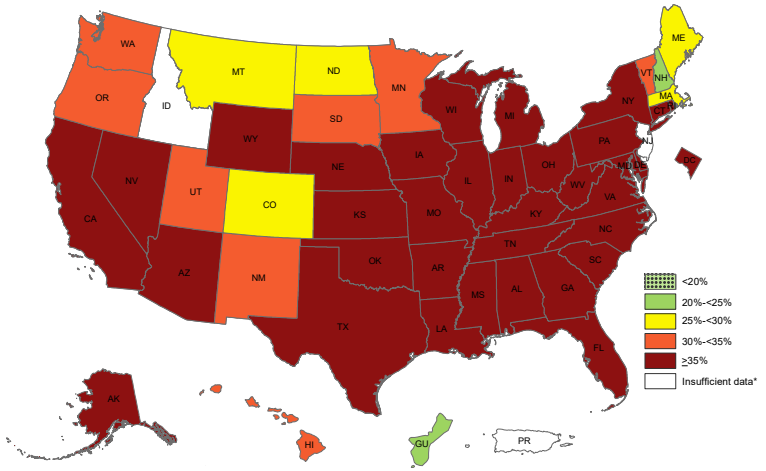
# Obesity Disproportionately Affects Minority/Underserved Groups




White




Hispanic




Non-Hispanic Black

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https://www.cdc.gov/obesity/data/prevalence-maps.html

# Agriculture & Food Systems: *Human Health*


"Human Nutrition Research—

The Committee directs USDA-ARS to provide to the Committee not later than 180 days after the enactment of this Act a report on the connection between how to advance science, policy, and practice for how healthier food enhances overall health, reduces obesity and related co-morbidity, and could lower health care costs."

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Texas A&M AgriLife

INSTITUTE FOR ADVANCING HEALTH THROUGH AGRICULTURE

# Going Forward: *New Imperatives for Food & Agriculture*

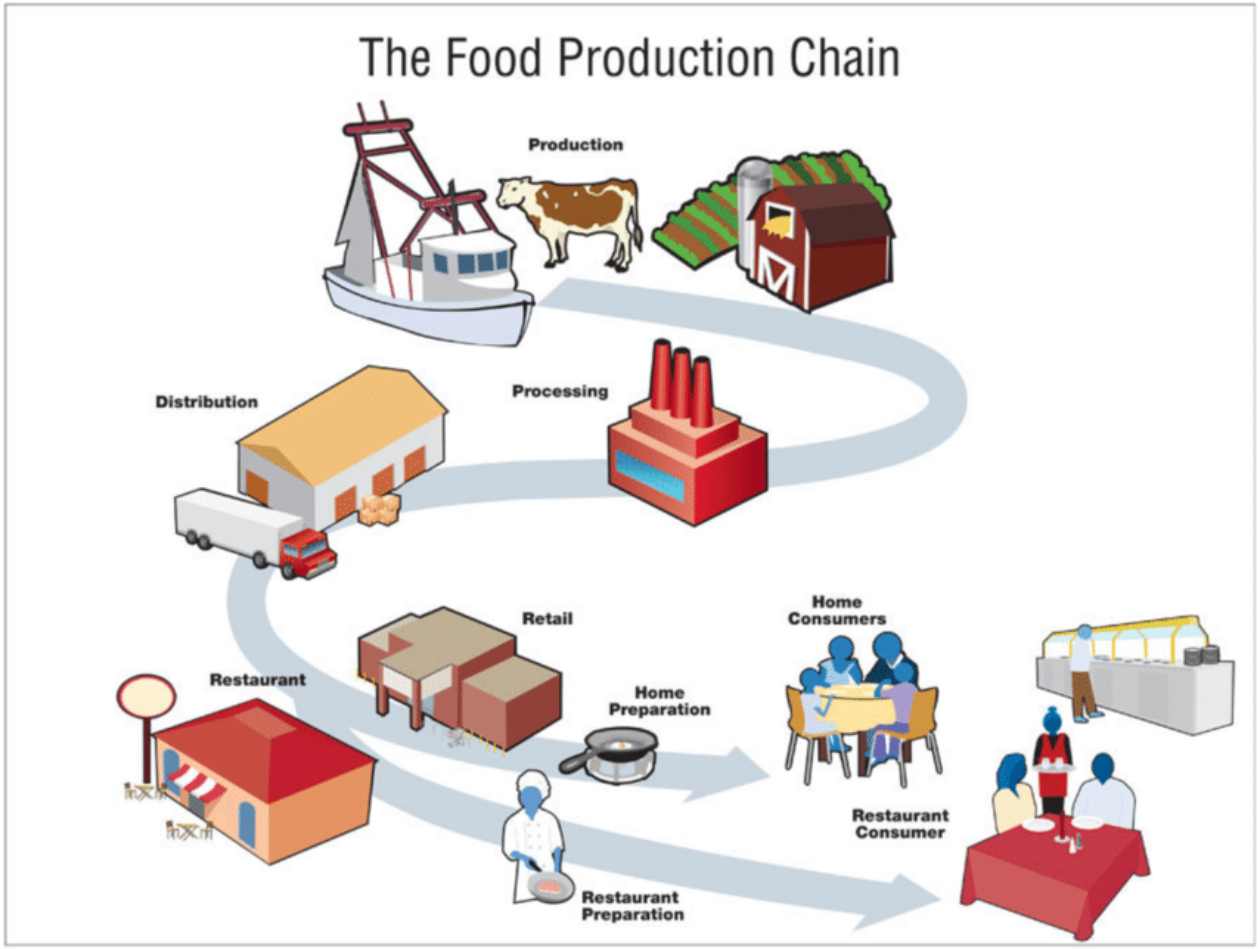
FOOD

PEOPLE

ECONOMICS

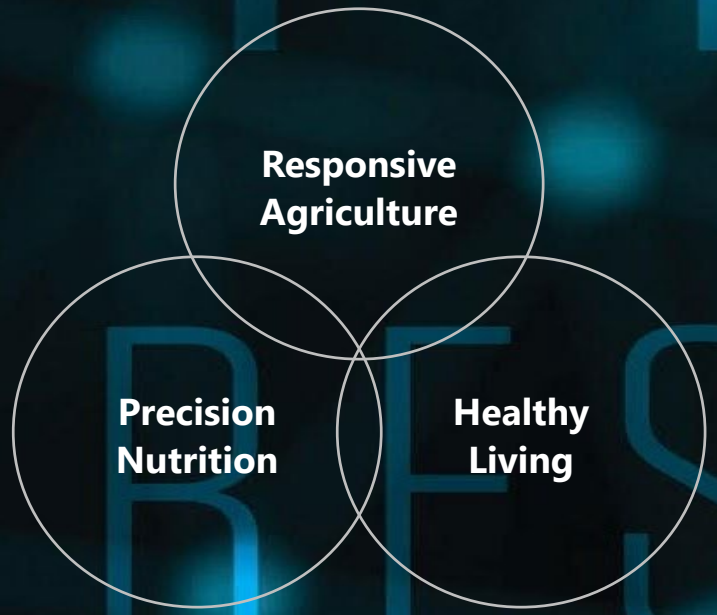
ENVIRONMENT

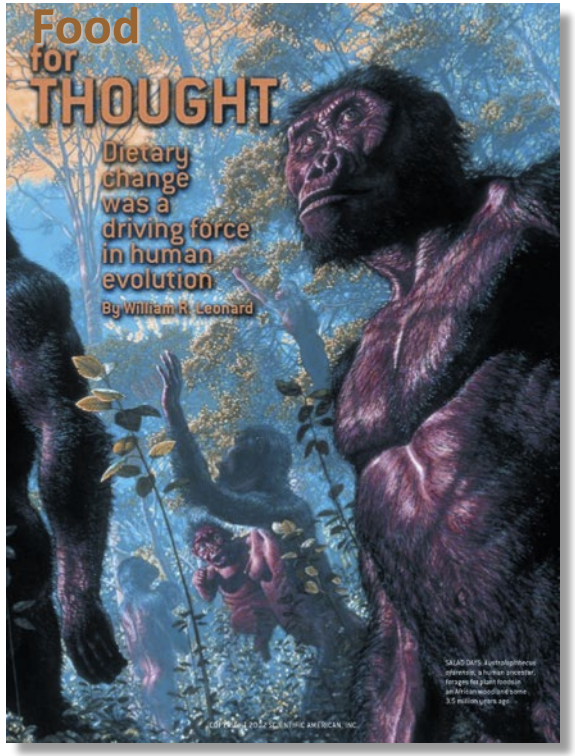
# The Vision: *A Food System Focused on Health*

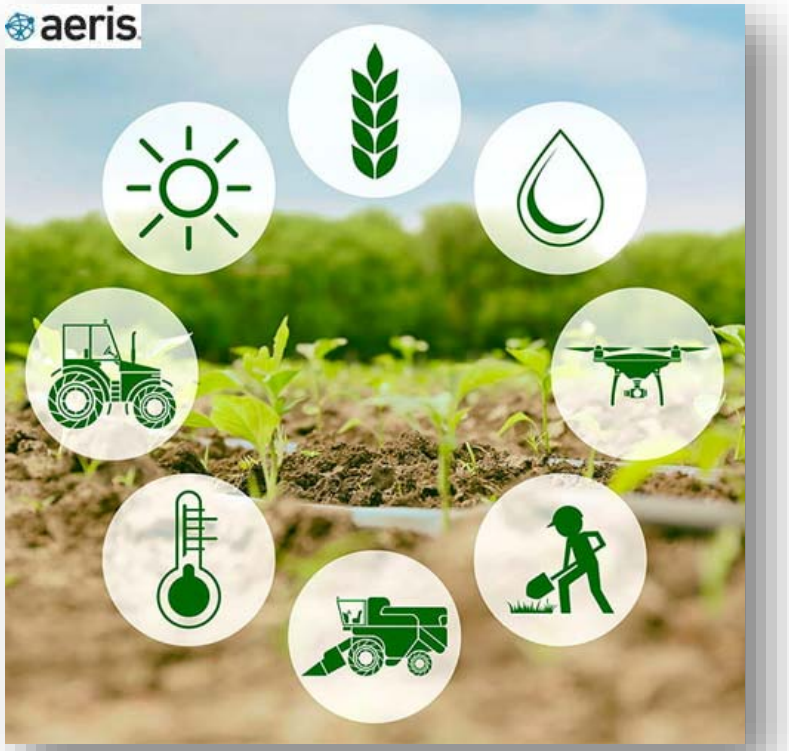



**Agriculture** as the solution to human, environmental and economic health

# Institute for Advancing Health Through Agriculture




**Gerald Fink**
Former Director
Whitehead Institute at the Massachusetts Institute of Technology

LASKER FOUNDATION

"I expect that in the year 2005 (when the entire human genome is scheduled to be mapped and sequenced), on the back of our foods, there are going to be a lot of things like that, because we are going to know a lot more about ourselves. And I think the field of nutrition, which, in my own opinion now, has not benefited from the advances in molecular genetics, will be a completely different field. That will be the most revolutionized field in the year 2005. And the reason is that we will know lots more, we will actually know something about nutrition so you won't pick up one day and say fat is good for you and the next day fat is bad for you. Because we will know that some people it is good for and some people it is bad for.

"We will be able to know what people can metabolize and what some people can't metabolize. ....We're going to have a new definition of what it means to be healthy."

*The Human Genome Project: Part Two: Ushering in a new era of molecular medicine.*
*Date of Publication: 1998*

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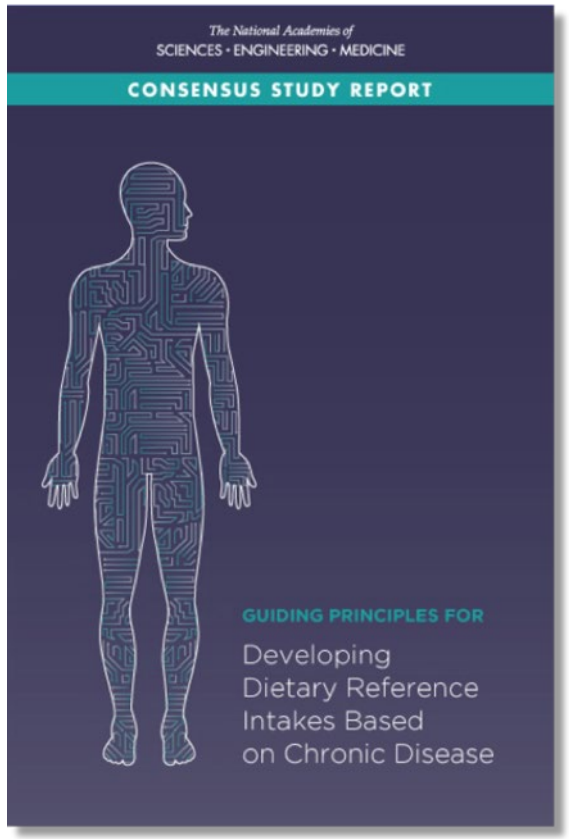
http://www.laskerfoundation.org/rprimers/hgp2.html

# Chronic Disease Endpoints:

## *Nutrient Deficiency Endpoints ➡ Chronic Disease Endpoints*




2017

- Diseases of nutrient deficiencies have a single cause and manifest similarly in most people in populations.
- Diet-related chronic diseases are complex in their etiology with many interacting risk factors (nutrition, sleep, exercise, genetics, etc) that exhibit great heterogeneity in populations and change over the lifespan.
- Stresses the need for common evidentiary standards across risk factors.

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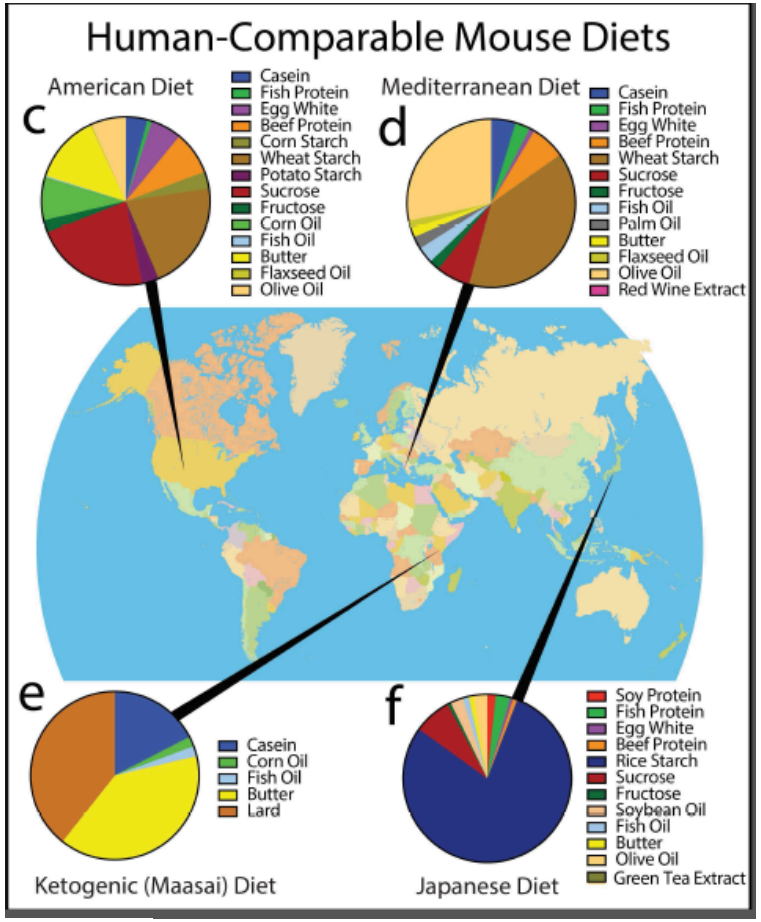
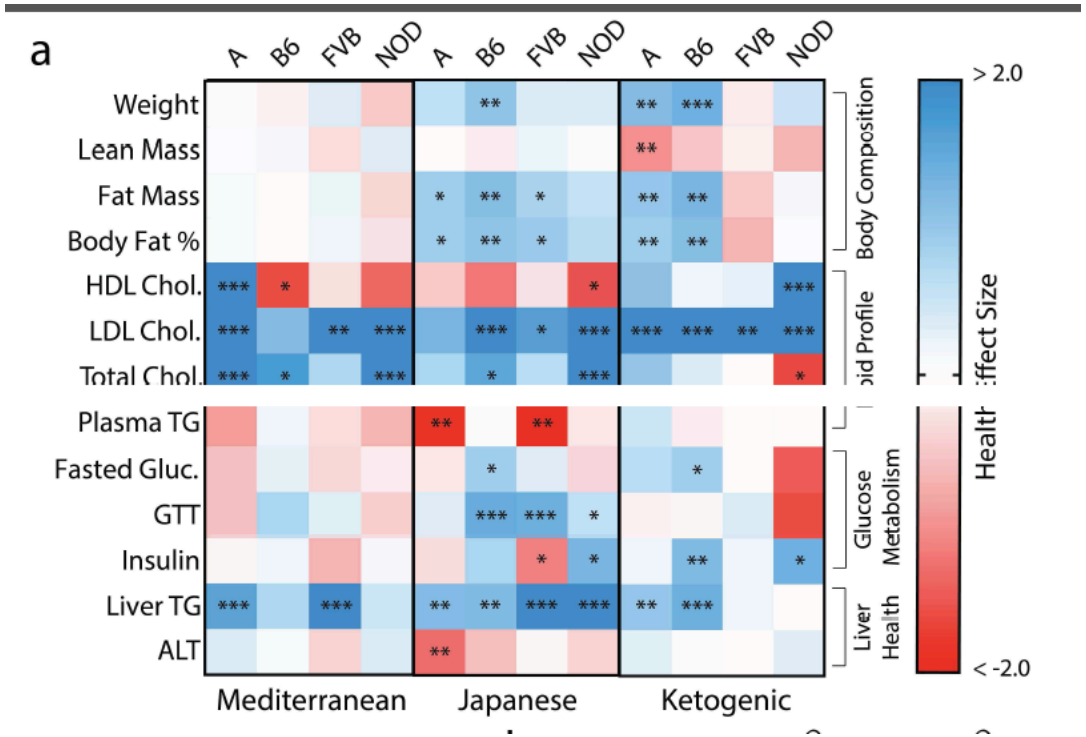
- Few chronic diseases are affected by:
  - single nutrients
  - single pathways
- Need system level markers that report on health (reduce to a wearable?).

# Precision Nutrition: *Animal Models*

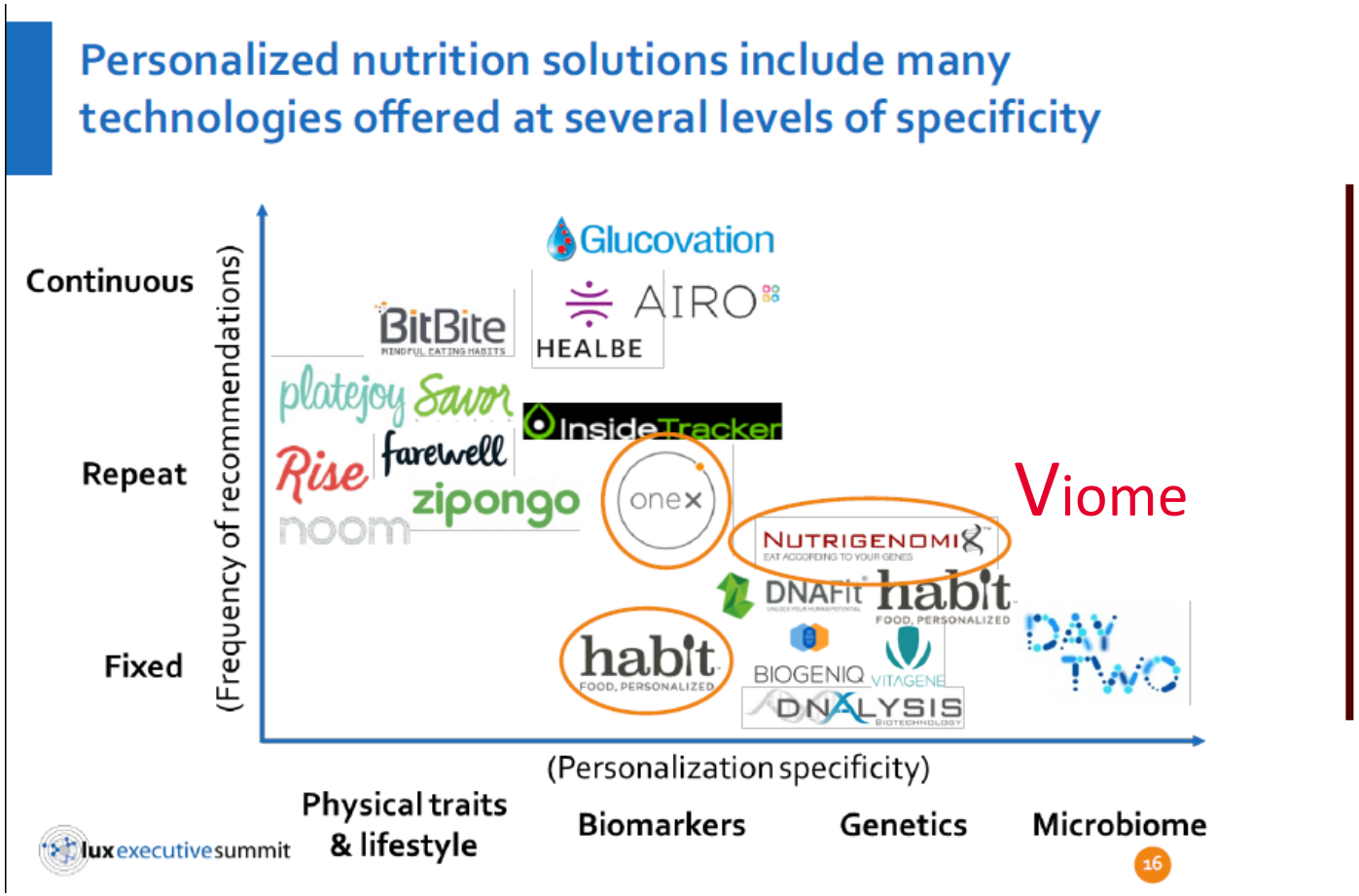



William T. Barrington[1,2], Phillip Wulfridge[3], Ann E. Wells[9], Carolina Mantilla Rojas[1], Selene Y.F. Howe[1], Amie Perry[4], Kunjie Hua[5], Michael A. Pellizzon[10], Kasper D. Hansen[3,6,7], Brynn H. Voy[9], Brian J. Bennett[5], Daniel Pomp[5], Andrew P. Feinberg[3], David W. Threadgill[1,4,8]*

*Genetics: Early Online, published on November 20, 2017 as 10.1534/genetics.117.300536*

# Precision Nutrition: *The How*




## Wearables

# Precision Nutrition: *The How?*

## *Population Approach vs. Precision Approach*

*Classification of subgroups?*

*How do we deal with the complexity of diet-related chronic disease and nutrition?*

*Can we find system-level biomarkers of diet-nutrition-function-disease?*

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## *Should We be Divorcing the Biology of Food and Health from Food Behaviors and Health?*

*Real world experiments*

# New Imperatives for Food & Agriculture

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The Imperative to Connect Agriculture and Health is clear…
…The Pathway to Connect Precision Nutrition and Agriculture is not.

## Questions:

What are the highest priorities to improve the food system and lower health care costs?

What does precision nutrition and nutrition security mean for food production?

Food and health equity is needed in underserved communities, how do we affect change within cultural contexts?

How can we establish greater public trust in science?

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INSTITUTE FOR ADVANCING HEALTH THROUGH AGRICULTURE

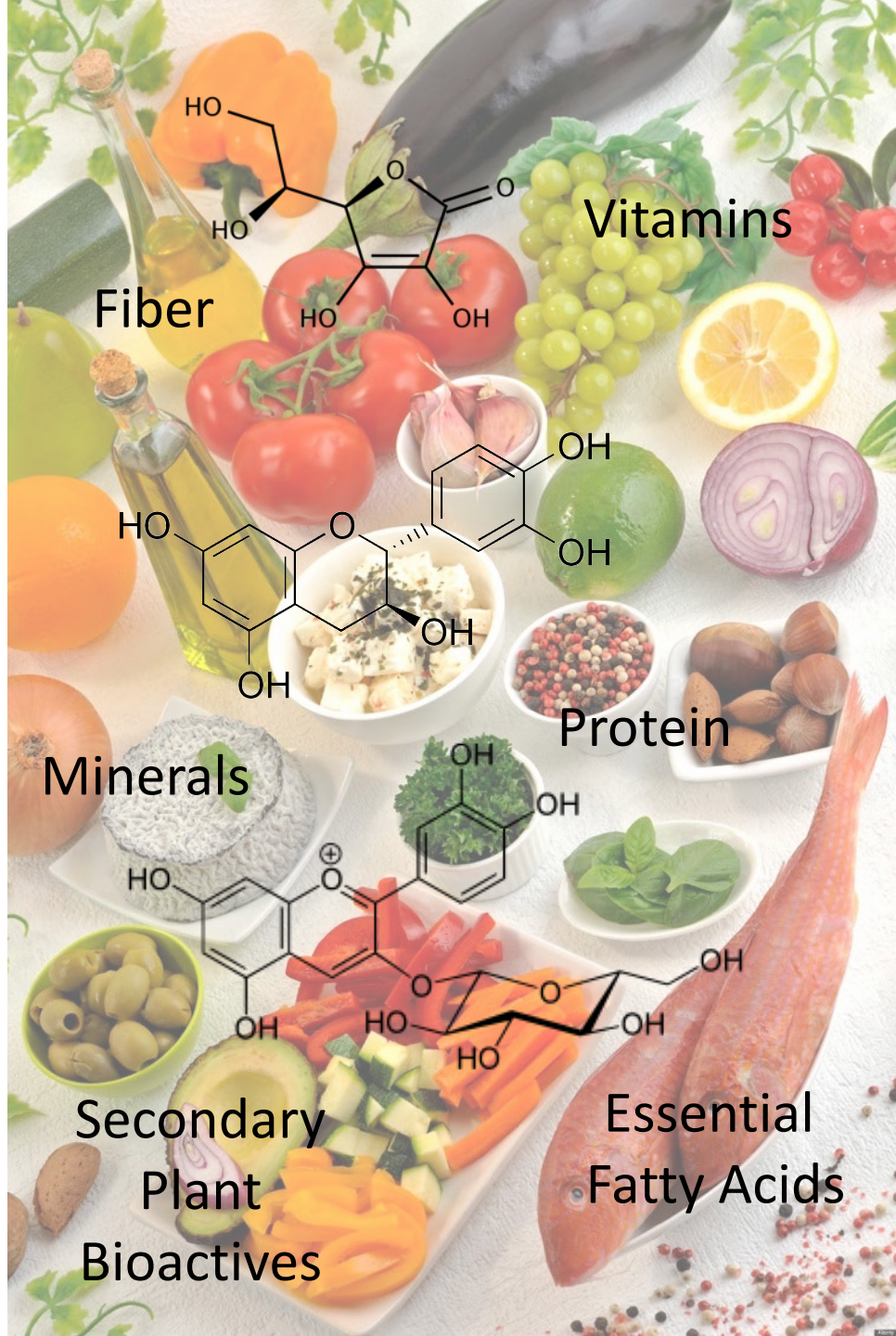
## We can dream – Technology

- We have the unprecedented ability to manage and engineer agriculture, food and the environment to achieve whatever goals we can imagine

# Diet-Cancer Research and the Foundational Role of Food Composition Data

**Janet A. Novotny, PhD**
Research Physiologist
Beltsville Human Nutrition Research Center
USDA, REE, ARS


USDA



# Multifunctional Nanoparticles


Laura Carson

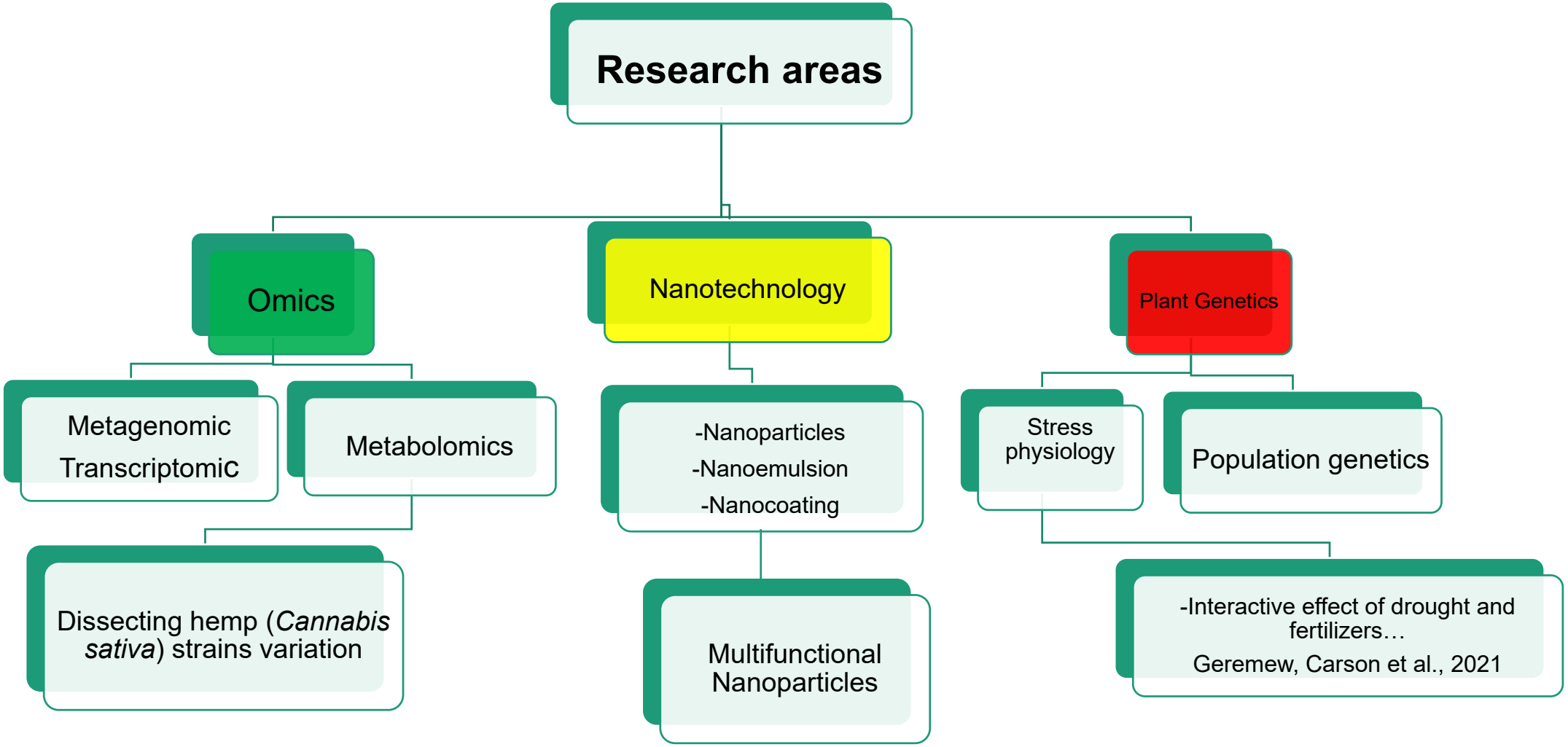
Addisie Geremew

and Huichen Wang


August 10, 2022

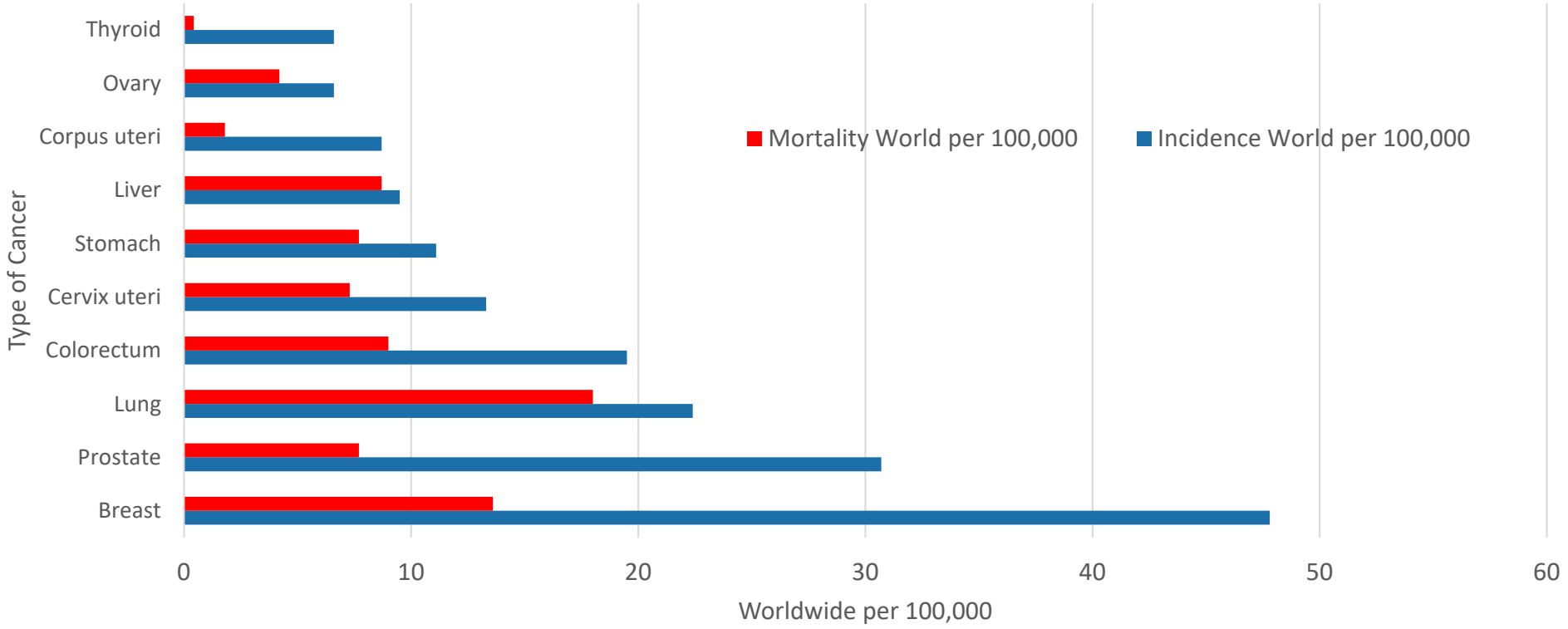
USDA Moonshot Webinar

# Introduction



# Introduction

Cancer  Incidence and Mortality Rates, Worldwide, Both Sexes, All Ages

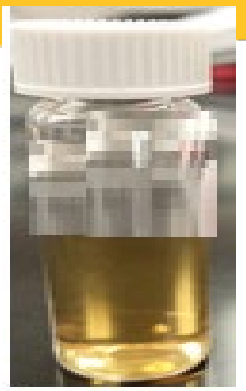


# PLANT FOCUSED

# Methods Microbial Studies

Plant

Plant Extraction

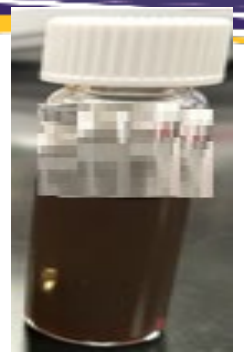


Plant Extract

+

Zn nitrate or Cu sulfate hydrate, silver nitrate

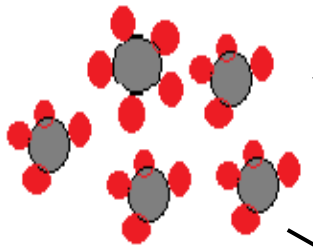
Bio-reduction



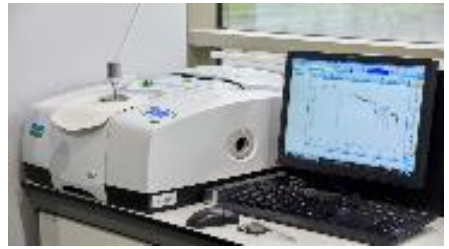
Synthesized nanoparticles

**NP synthesis**

Confirmation of NPs synthesis



Plant NPs

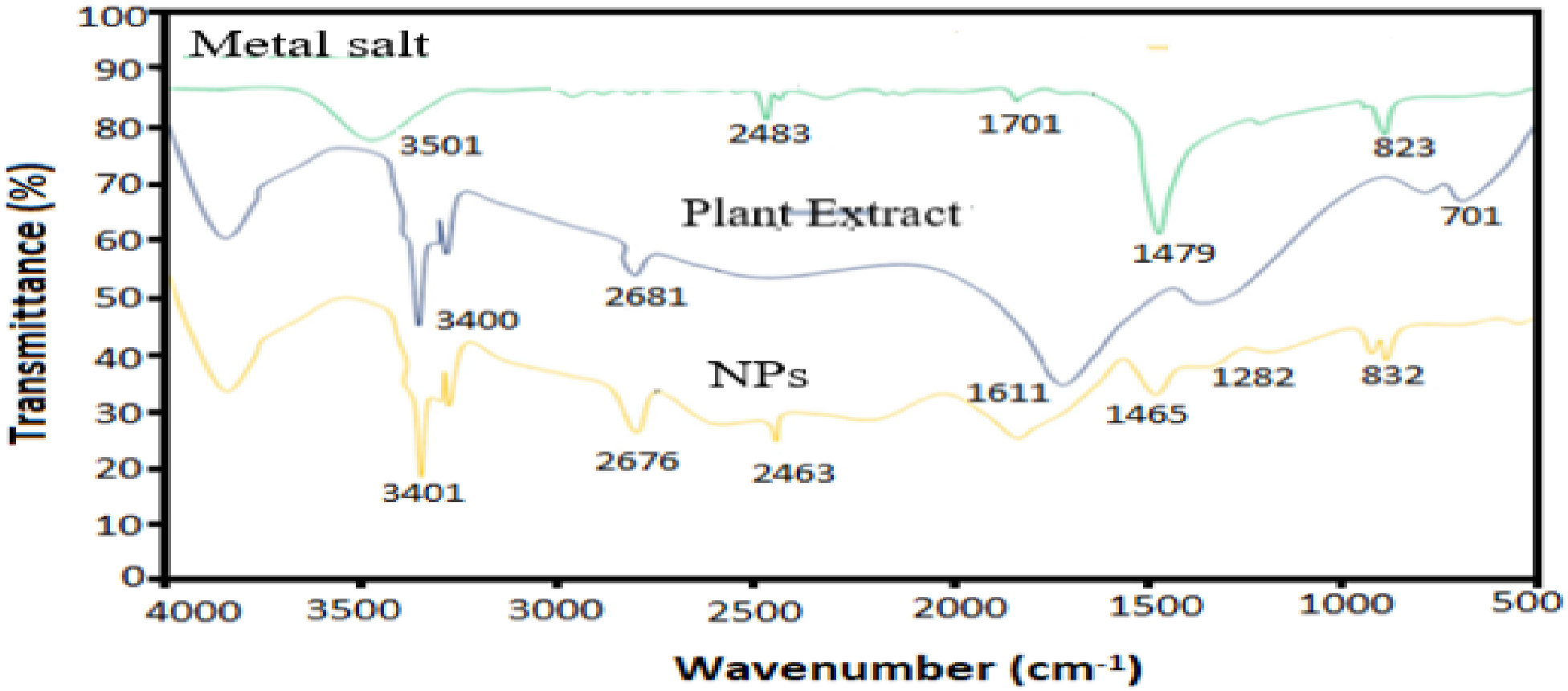


Functional group identification using FTIR

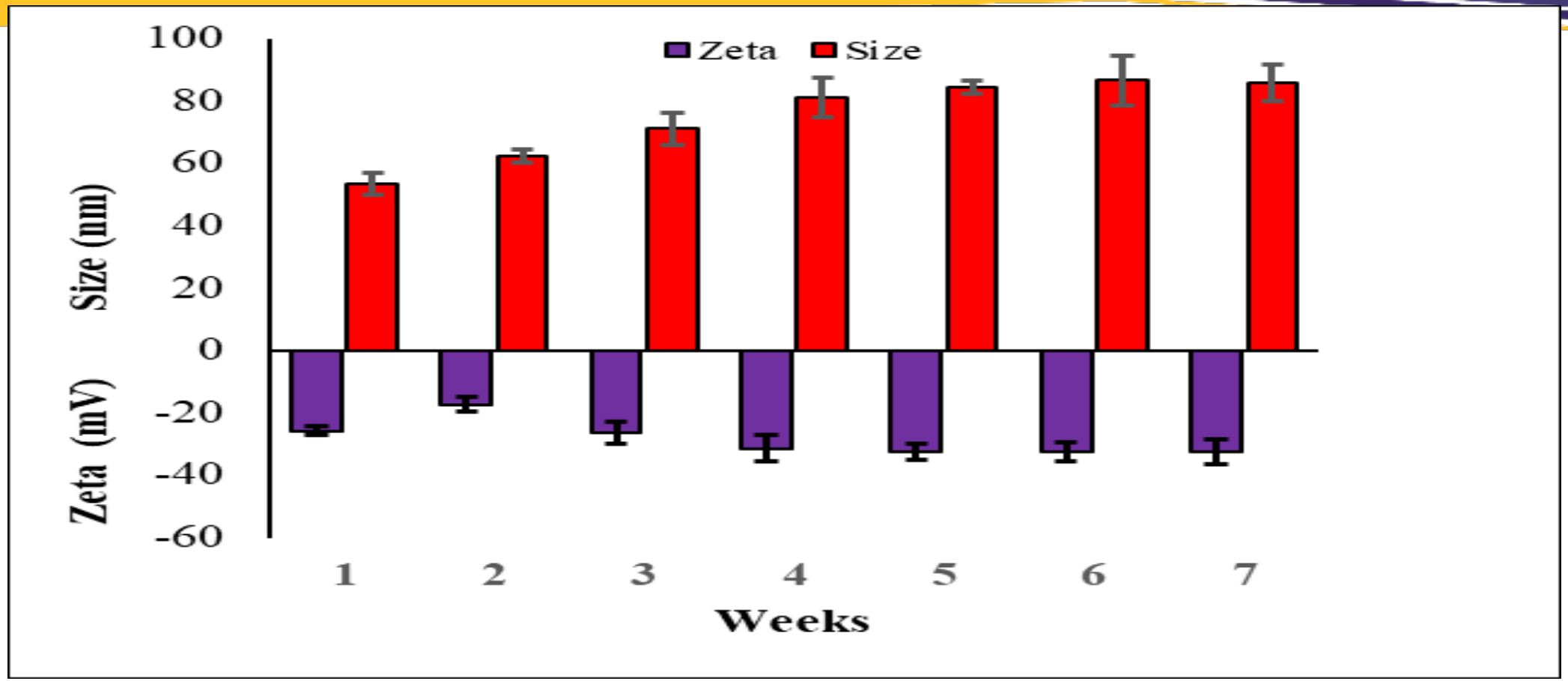
**NP Characterization**

Size and Zeta potential measurement using Litesizer

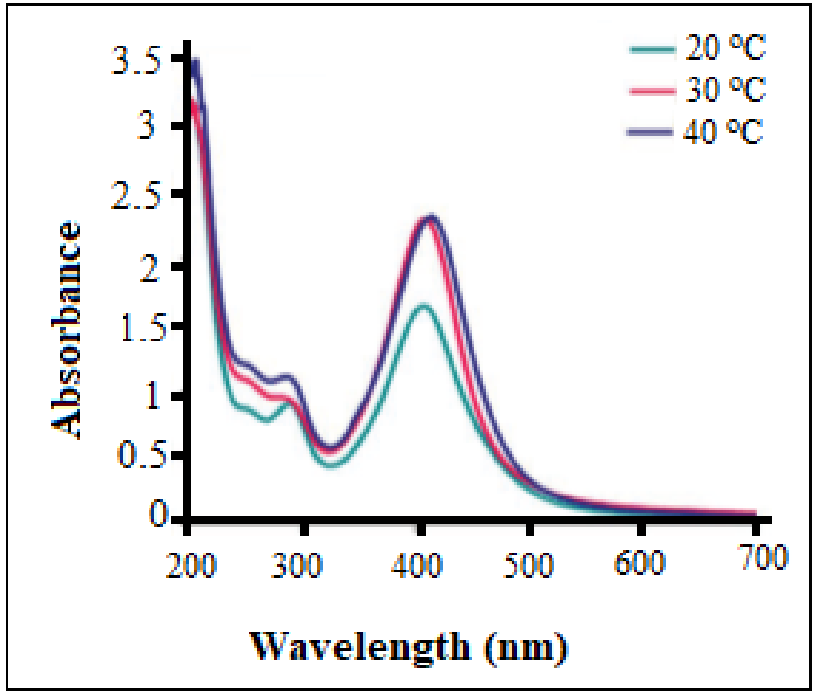
# Comparison of the FTIR spectra of the metal salts, *Plant* extract and NPs

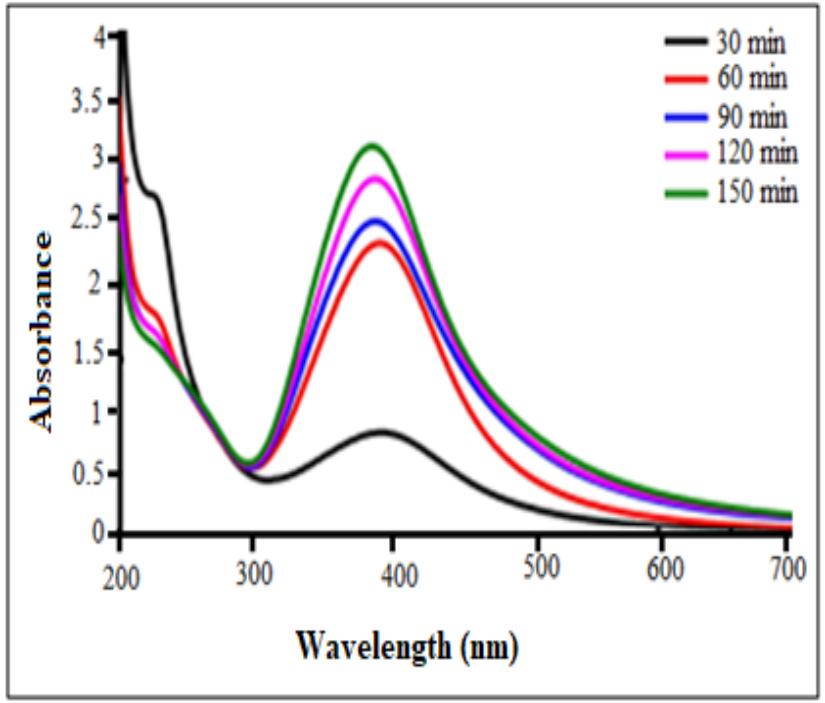


# Variation in particle size distribution and zeta potential of Rn-AgNPs across time



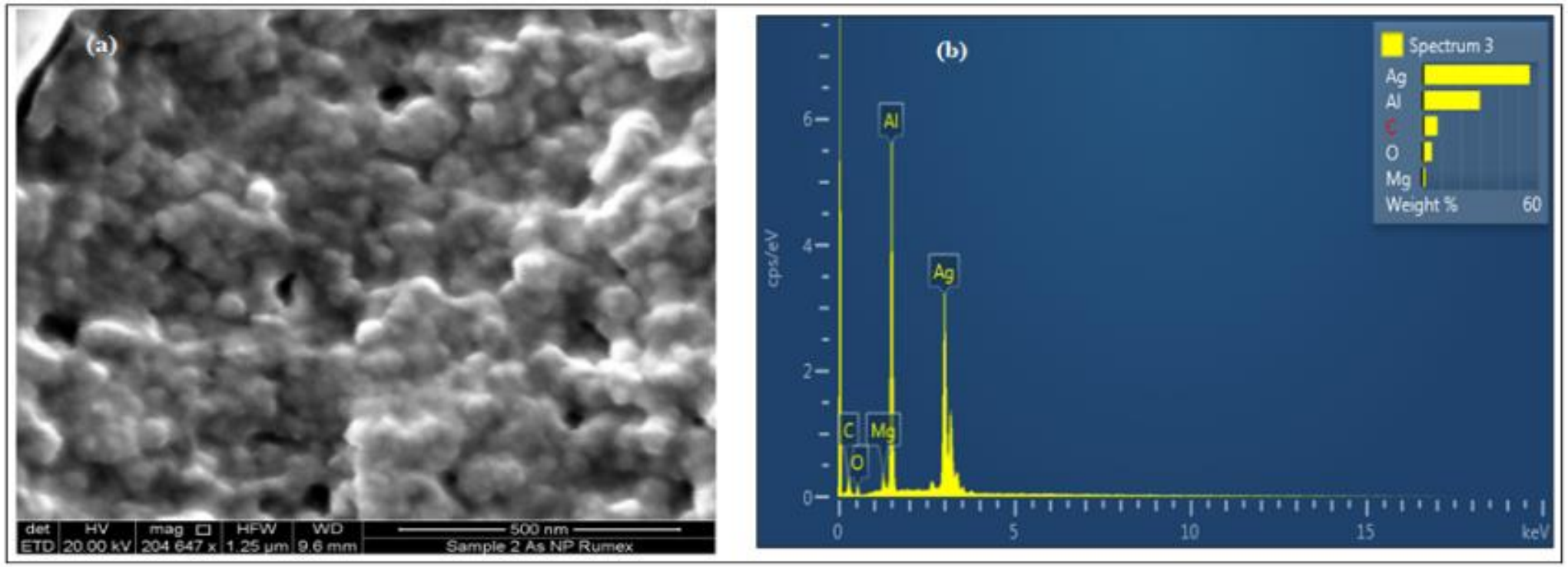
# Absorption Spectra of NPs




Left - various temperatures; right – time intervals.

# SEM micrograph (a) and EDX spectra (b) of synthesized NPs

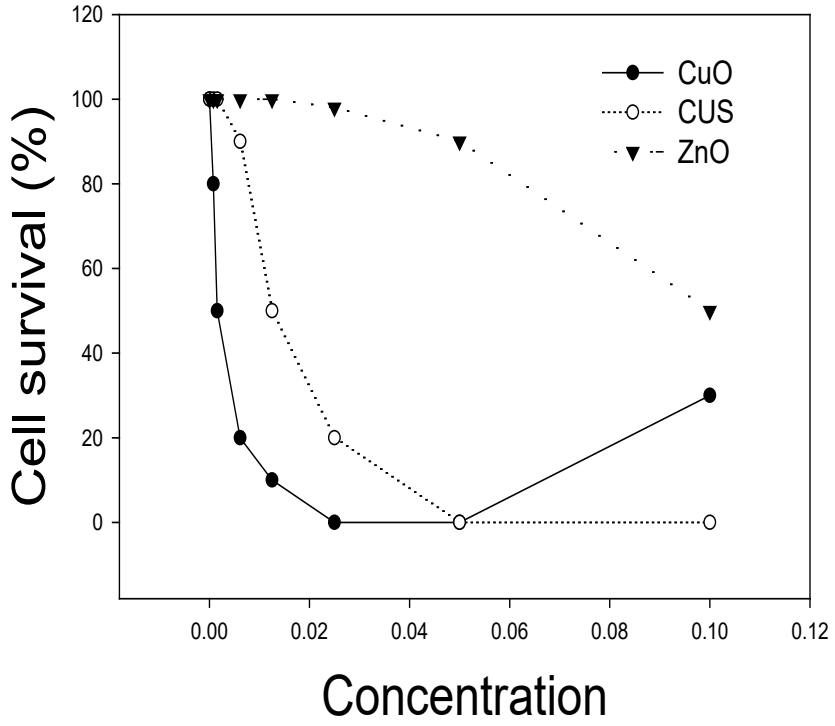


# Effect of NPs on Cancer Cell Studies

- 19 plant nanoparticles
  - The nanoparticles CuO NPs-A, CuO NP-B and ZnO NP- A
- Human cancer cells:
  1. Human lung cancer cells: A549
  2. Human skin fibroblast: AG1522
  3. Human cervix adenocarcinoma cells: HeLa(first immortalized human cells)

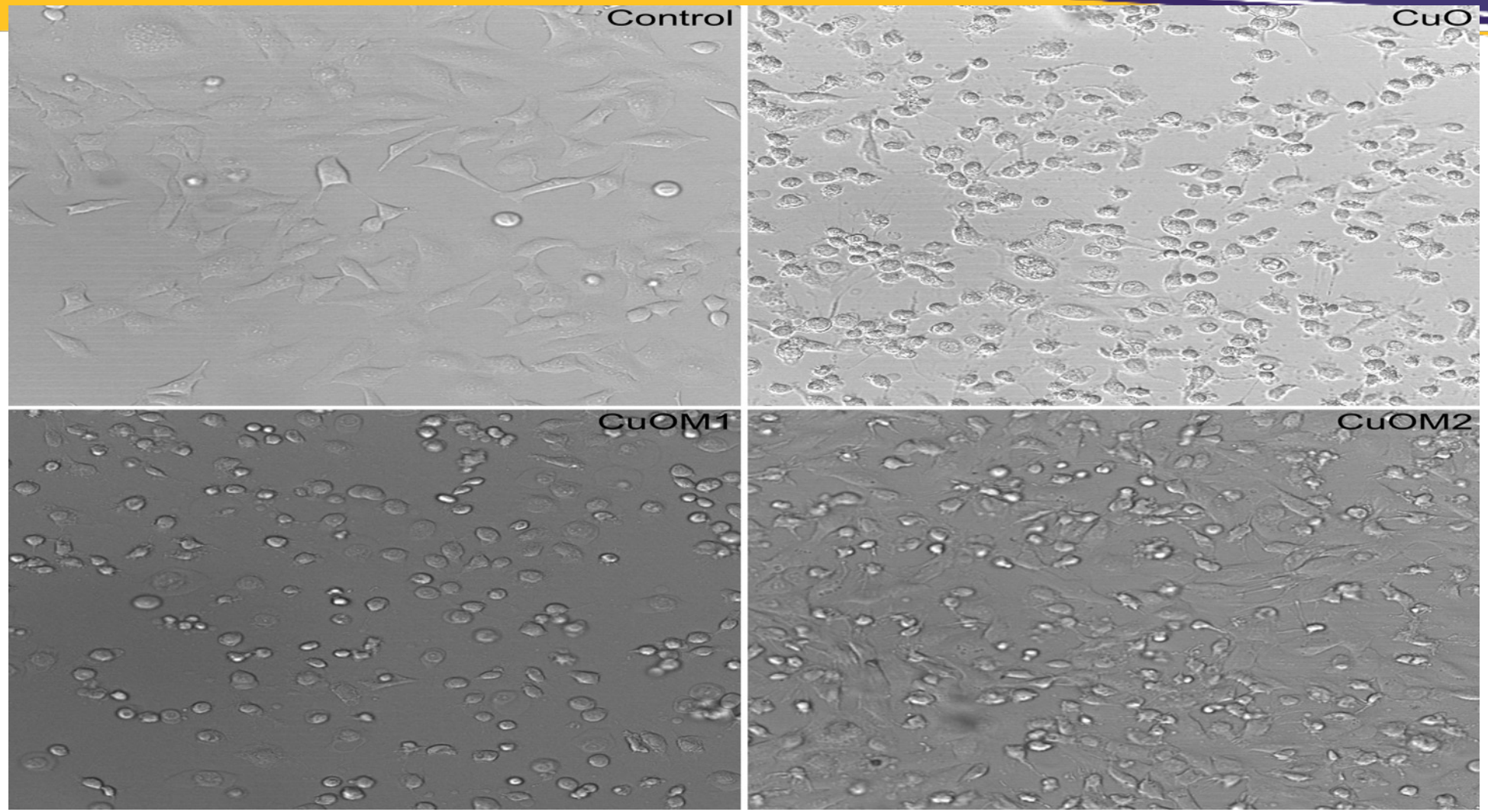
# Cell Survival Studies

AG1522

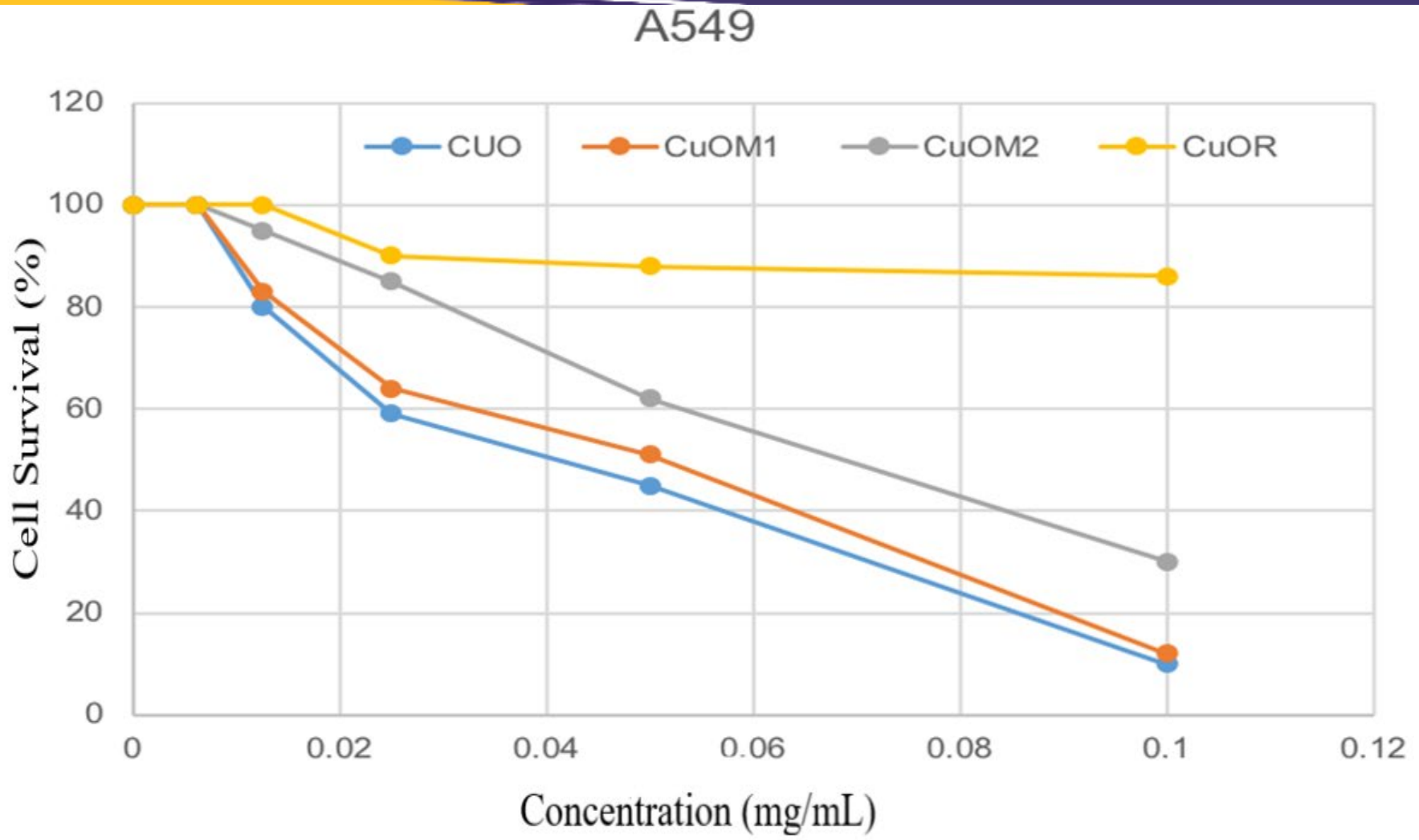



Similar to A549

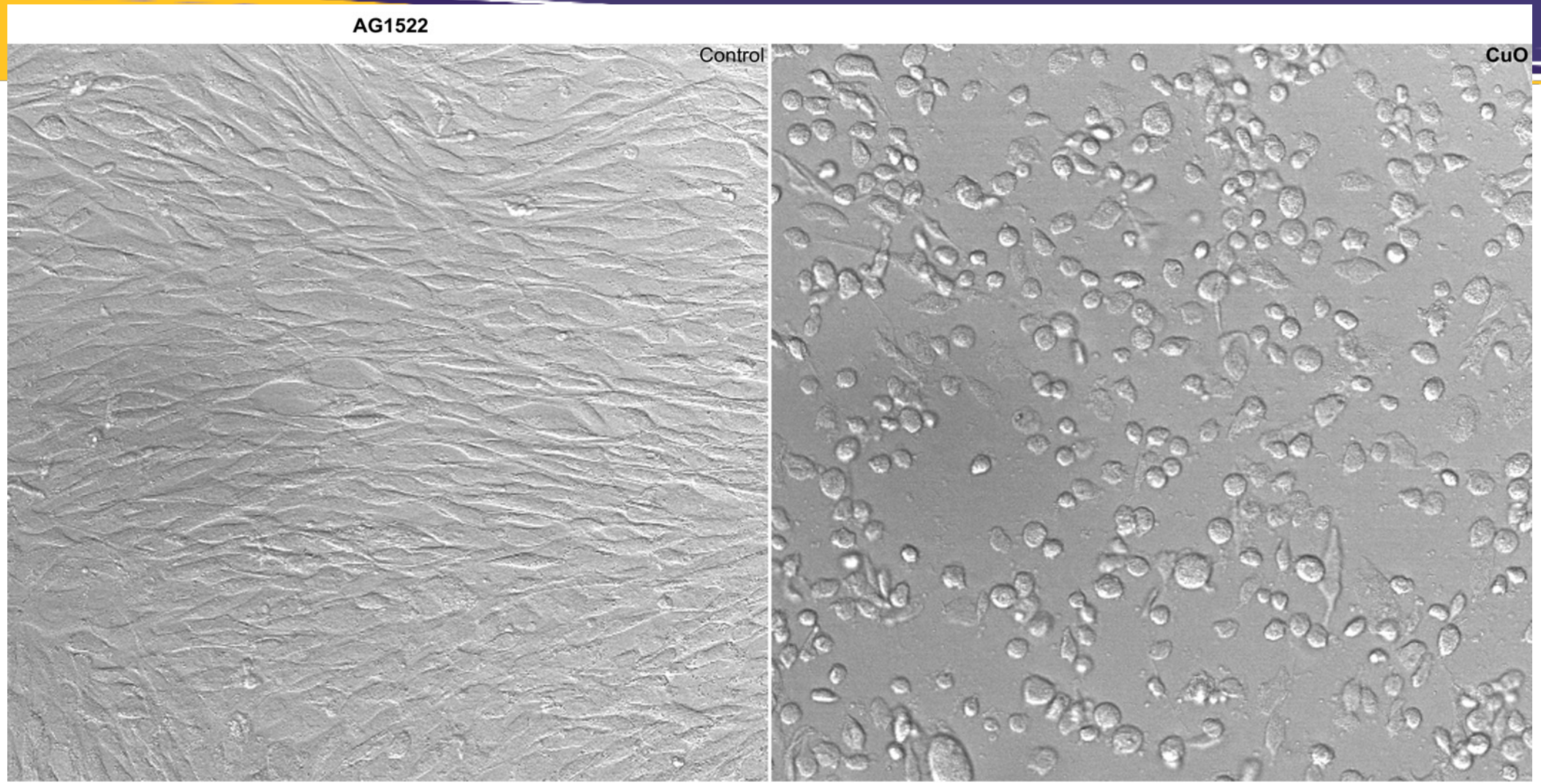
# Microscopic Studies – A549



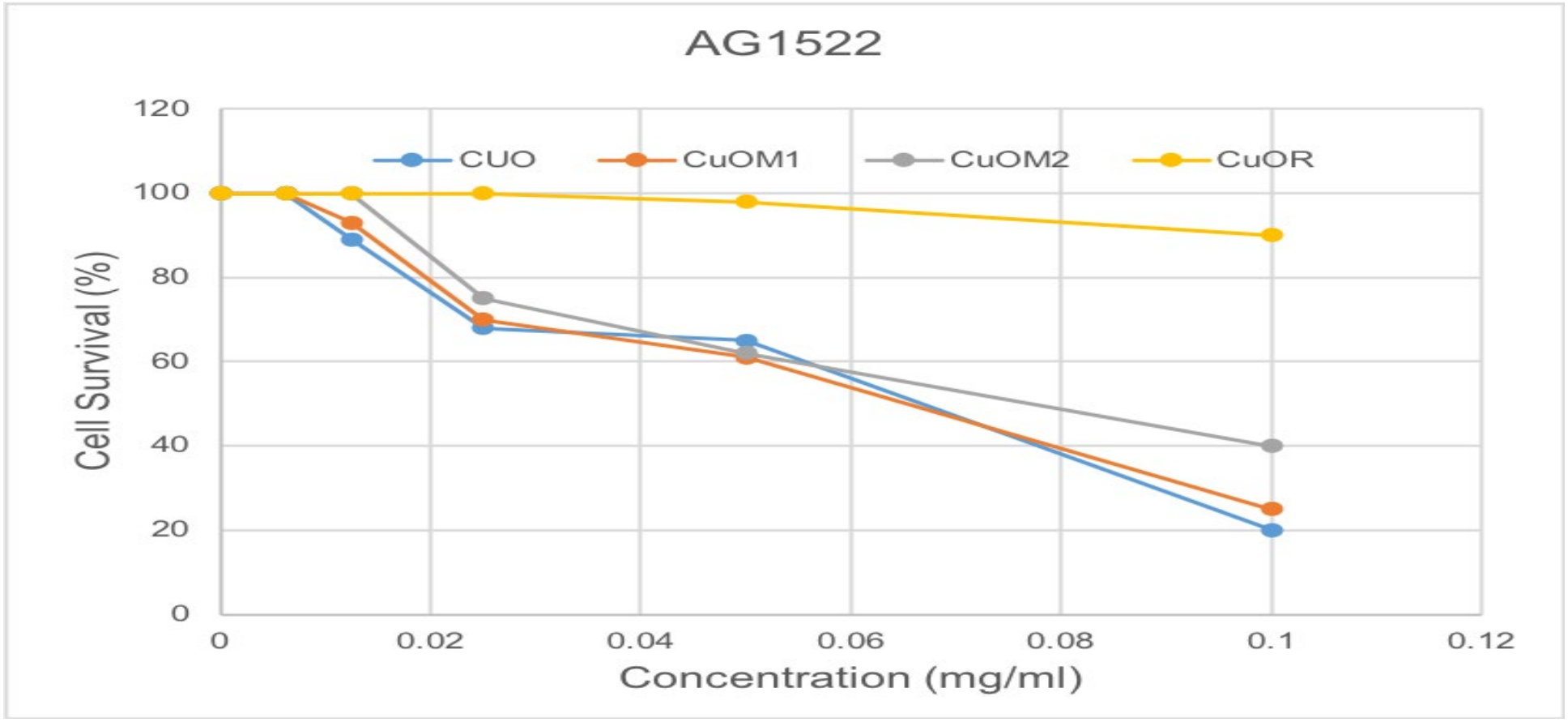
# Cell Survival Studies



# Microscopic Studies – AG1522



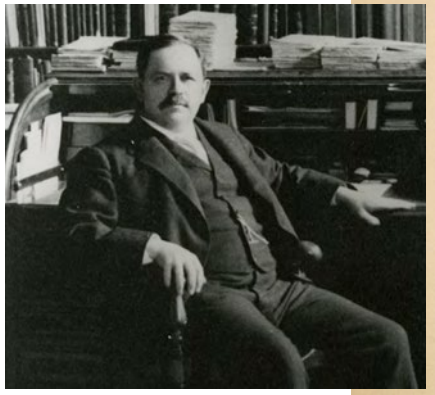
# Cell Survival Studies



# Preliminary Results

- CuO NPs significantly reduced cell survival in A549 and AG1522 cells
- ZnO NPs is mildly effective at cell killing in A549 and AG1522 cells
- A549 cells are more sensitive to CuO nanoparticle than AG1522 cells

# USDA has been monitoring the composition of the US food supply for more than 100 years



BULLETIN No. 28. 162

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS.

THE CHEMICAL COMPOSITION

OF

AMERICAN FOOD MATERIALS.

BY

W. O. ATWATER, Ph. D.,

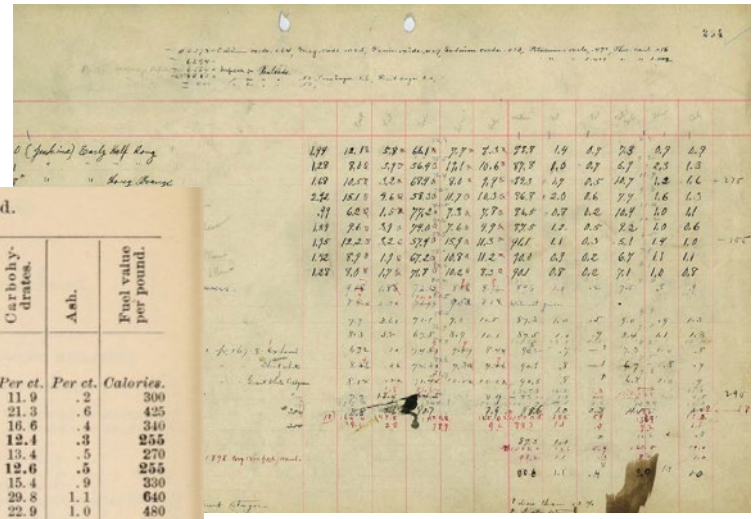
AND

CHAS. D. WOODS, B. S.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1896.

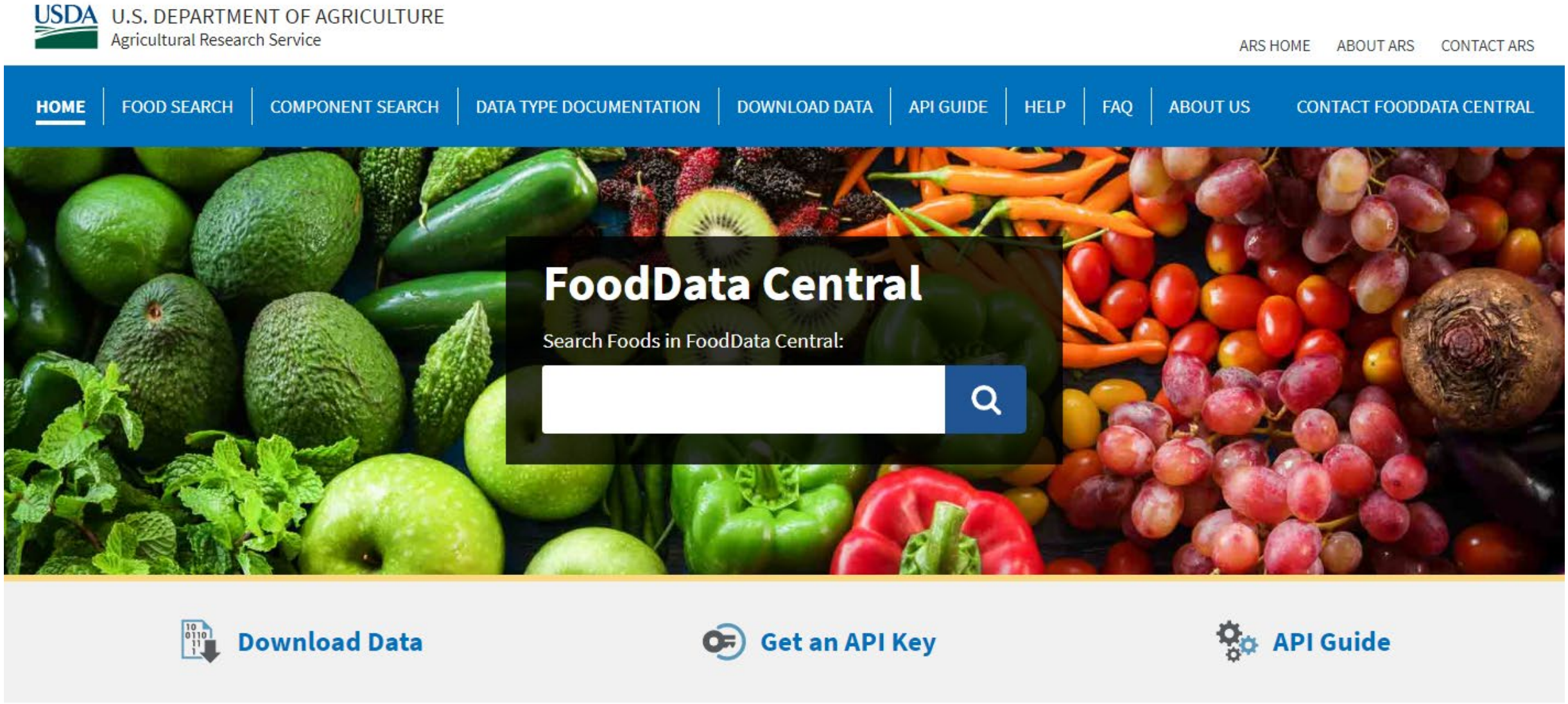


*Composition of American food products*—Continued.

| Food materials. | | Number of analyses. | Refuse. | Water. | Protein. | Fat. | Carbohydrates. | Ash. | Fuel value per pound. |
|---|---|---|---|---|---|---|---|---|---|
| VEGETABLE FOOD—continued. | | | | | | | | | |
| *Fruit, berries, etc., fresh.*[1] | | | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Calories. |
| Apples | Edible portion, Min | 10 | ..... | 77.3 | .1 | .2 | 11.9 | .2 | 300 |
| | Edible portion, Max | 10 | ..... | 84.1 | .8 | 1.4 | 21.3 | .6 | 425 |
| | Edible portion, Avg | 10 | ..... | 82.0 | .5 | .5 | 16.6 | .4 | 340 |
| | As purchased, Avg | 10 | 25.0 | 61.5 | .4 | .4 | 12.4 | .3 | 255 |
| Apricots | Edible portion, Avg | 11 | ..... | 85.0 | 1.1 | ..... | 13.4 | .5 | 270 |
| | As purchased, Avg | 11 | 6.0 | 79.9 | 1.0 | ..... | 12.6 | .5 | 255 |
| Bananas, yellow | Edible portion, Min | 3 | ..... | 66.3 | .6 | .2 | 15.4 | .9 | 330 |
| | Edible portion, Max | 3 | ..... | 82.1 | 1.6 | 1.4 | 29.8 | 1.1 | 640 |
| | Edible portion, Avg | 3 | ..... | 74.1 | 1.2 | .8 | 22.9 | 1.0 | 480 |
| | As purchased, Avg | 3 | 40.0 | 44.5 | .7 | .5 | 13.7 | .6 | 290 |
| Blackberries, as purchased | | 1 | ..... | 88.9 | .9 | 2.1 | 7.5 | .6 | 245 |
| Cherries, edible portion | | 1 | ..... | 86.1 | 1.1 | .8 | 11.4 | .6 | 265 |
| Citron melons, dried, as purchased | | 1 | ..... | 25.6 | | | | | |
| Cranberries, as purchased | Min | 2 | ..... | 87.6 | | | | | |
| | Max | 2 | ..... | 89.4 | | | | | |
| | Avg | 2 | ..... | 88.5 | | | | | |
| Figs, fresh, as purchased | | 28 | ..... | 79.1 | 1 | | | | |
| Grapes | Edible portion | 4 | ..... | 78.8 | 1 | | | | |
| | As purchased | 4 | 25.0 | 59.1 | 1 | | | | |
| | Min | 2 | ..... | 88.4 | | | | | |
| | Edible portion, Max | 2 | ..... | 90.2 | 1 | | | | |

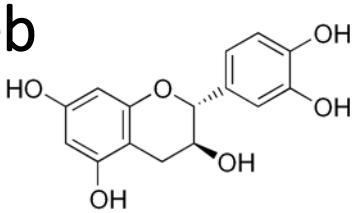
COMPOSITION OF AMERICAN FOOD PRODUCTS.

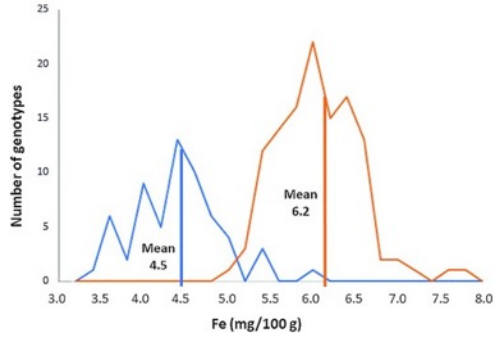
| Food materials. | | Number of analyses. | Refuse. | Water. | Protein. | Fat. | Carbohydrates. | Ash. | Fuel value per pound. |
|---|---|---|---|---|---|---|---|---|---|
| ANIMAL FOOD. | | | | | | | | | |
| *Beef, fresh.* | | | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Per ct. | Calories. |
| Brisket: Medium fat | Edible portion | 1 | ..... | 47.4 | 14.6 | 37.2 | ..... | 0.8 | 1,840 |
| | As purchased | 1 | 14.3 | 40.6 | 12.5 | 31.9 | ..... | .7 | 1,580 |
| Chuck, including shoulder: | | | | | | | | | |
| Very lean | Min | 2 | ..... | 71.7 | 19.6 | 3.9 | ..... | 1.0 | 560 |
| | Max | 2 | ..... | 73.8 | 21.3 | 7.7 | ..... | 1.0 | 690 |
| | Avg | 2 | ..... | 72.8 | 20.4 | 5.8 | ..... | 1.0 | 625 |
| | Edible portion, Min | 2 | 17.4 | 59.2 | 16.2 | 3.2 | ..... | .8 | 460 |
| | As purchased, Max | 2 | 18.4 | 60.2 | 17.4 | 6.4 | ..... | .8 | 570 |
| | As purchased, Avg | 2 | 17.9 | 59.7 | 16.8 | 4.8 | ..... | .8 | 515 |
| Lean | Min | 9 | ..... | 69.8 | 19.4 | 5.8 | ..... | .9 | 615 |
| | Max | 9 | ..... | 73.4 | 29.5 | 9.0 | ..... | 1.1 | 755 |
| | Avg | 9 | ..... | 71.2 | 19.9 | 7.8 | ..... | 1.1 | 700 |
| | Edible portion, Min | 9 | 18.1 | 47.6 | 14.3 | 4.5 | ..... | .7 | 475 |
| | As purchased, Max | 9 | 33.1 | 58.3 | 16.8 | 7.6 | ..... | .9 | 635 |
| | As purchased, Avg | 9 | 23.7 | 54.3 | 15.2 | 6.0 | ..... | .8 | 535 |
| Medium fat | Min | 7 | ..... | 64.3 | 18.0 | 9.5 | ..... | .9 | 770 |
| | Max | 7 | ..... | 69.7 | 19.8 | 15.2 | ..... | 1.0 | 1,005 |
| | Avg | 7 | ..... | 67.8 | 19.0 | 12.3 | ..... | .9 | 870 |
| | Edible portion, Min | 7 | 10.5 | 46.3 | 14.0 | 7.7 | ..... | .7 | 625 |
| | As purchased, Max | 7 | 28.1 | 60.3 | 16.8 | 12.4 | ..... | .8 | 815 |

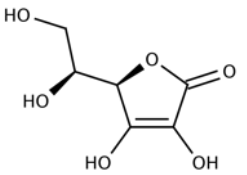



https://fdc.nal.usda.gov

# Food Data Central
## USDA's Food Information Web





**Primary Data Types**

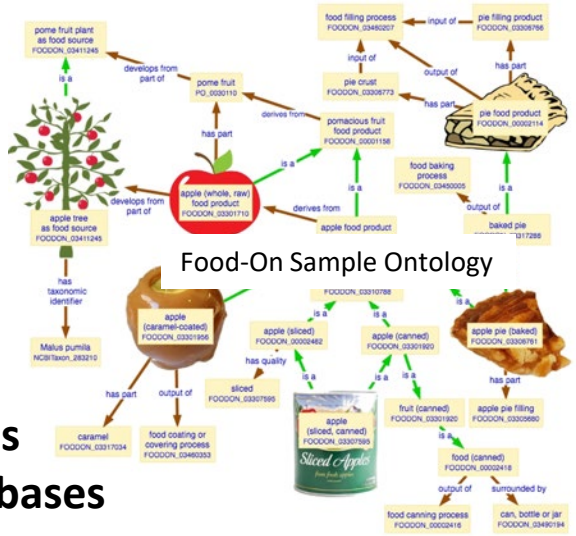
**Foundation Foods**
Basic foods and ingredients
Food variability, analysis approaches, sampling location, etc.

**Standard Reference (SR) Legacy**
~8000 foods & ~ 150 food components

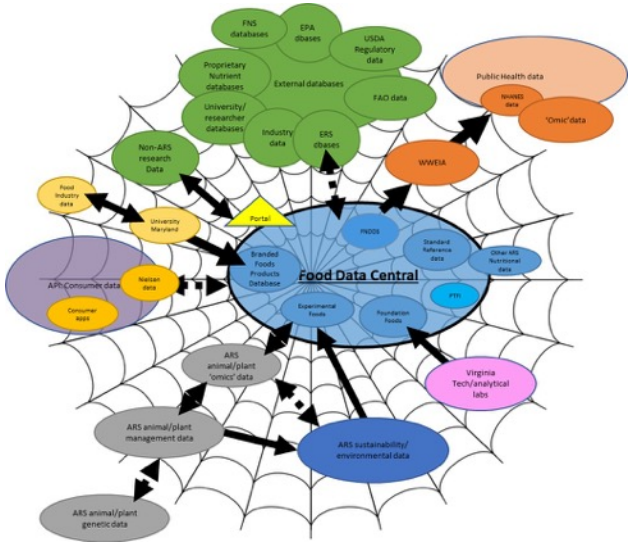
**Food and Nutrient Database for Dietary Studies (FNDDS)**
~7000 foods in a format of serving sizes to facilitate dietary surveys

**Global Branded Foods Database**
~400,000 foods
International: US, Canada, New Zealand, Costa Rica

**Experimental Foods Database**
Analysis by novel methodologies
Effects of preparation and processing
Impacts of environment and agricultural practices



Food-On Sample Ontology




**Progressive Design**

**Maps and connections among foods and food features**
**Crosstalk with other databases, including health databases**

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Agricultural Research Service

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HOME | FOOD SEARCH | COMPONENT SEARCH | DATA TYPE DOCUMENTATION | DOWNLOAD DATA | API GUIDE | HELP | FAQ | ABOUT US | CONTACT FOODDATA CENTRAL

# FoodData Central Search Results

FOOD SEARCH | COMPONENT SEARCH

ARS HOME › FOODDATA CENTRAL › FOOD SEARCH

Apple

Search Operators

Require All Words

Reset | Search

## Helpful Links

Search Tips

FAQ

Inventory and Update Log

## Other Resources

Dietary Supplement Ingredient Database

Dietary Supplement Label Database

Database for the Iodine Content of Common Foods

Foundation Foods (6) | SR Legacy Foods (89) | Survey Foods (FNDDS) (81) | Branded Foods (23,174) | Experimental Foods

## Foundation Foods

- Data for food components including nutrients derived from analyses, and metadata for a range of single foods and ingredients providing insights into variability. Foundation Foods highlight information on samples and acquisition details.
- Documentation and further details about Foundation Foods https://fdc.nal.usda.gov/docs/Foundation_Foods_Documentation_Apr2021.pdf

6 results

| NDB Number | Description | Most Recent Acquisition Date | SR Food Category |
|---|---|---|---|
| 9504 | Apples, fuji, with skin, raw | 2020-05-05 | Fruits and Fruit Juices |
| 9503 | Apples, gala, with skin, raw | 2020-05-05 | Fruits and Fruit Juices |
| 9501 | Apples, honeycrisp, with skin, raw | 2020-06-01 | Fruits and Fruit Juices |
| 9502 | Apples, granny smith, with skin, raw | 2020-05-26 | Fruits and Fruit Juices |
| 9500 | Apples, red delicious, with skin, raw | 2020-06-01 | Fruits and Fruit Juices |
| 9400 | Apple juice, with added vitamin C, from concentrate, shelf stable | 2021-02-01 | Fruits and Fruit Juices |

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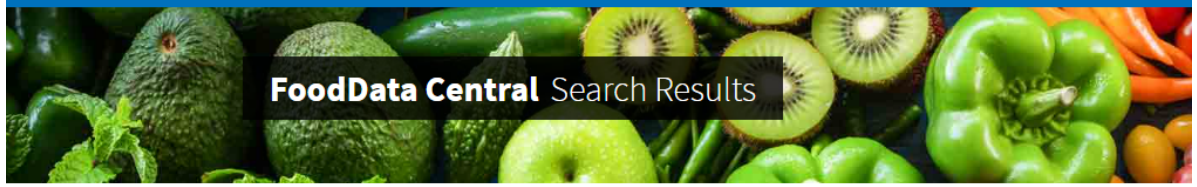



ARS HOME › FOODDATA CENTRAL › FOOD SEARCH › APPLES, GALA, WITH SKIN, RAW (FOUNDATION, 1750341)

# Apples, gala, with skin, raw

**Data Type:** Foundation **Food Category:** Fruits and Fruit Juices **FDC ID:** 1750341 **NDB Number:** 9503
**FDC Published:** 10/30/2020

Components | Individual Samples | Other Information

**Portion:** 100g

| Name | Average Amount | Unit | Deriv. By | n | Samples | Min | Max | Median | Footnote | Initial Year Acquired |
|---|---|---|---|---|---|---|---|---|---|---|
| **Proximates:** | | | | | | | | | | |
| Water | 84.6 | g | Analytical | 8 | Samples | 83.9 | 85.6 | 84.6 | | 2020 |
| Energy (Atwater General Factors) | 61 | kcal | | | | | | | | |
| Energy (Atwater Specific Factors) | 55 | kcal | | | | | | | | |
| Nitrogen | 0.02 | g | | | | | | | | |
| Protein | 0.13 | g | | | | | | | | |
| Total lipid (fat) | 0.15 | g | | | | | | | | |
| Ash | 0.3 | g | | | | | | | | |

| Name | Average Amount | Unit | Deriv. By |
|---|---|---|---|
| **Carbohydrates:** | | | |
| Carbohydrate, by difference | 14.8 | g | Calculated |
| Carbohydrate, by summation | 13.9 | g | Summed |
| Fiber, total dietary | 2.1 | g | |
| Sugars, Total NLEA | 11.8 | g | |
| Sugars, total including NLEA | 11.8 | g | |
| Sucrose | 2.06 | g | |
| Glucose | 2.01 | g | |
| Fructose | 7.76 | g | |
| Lactose | <0.15 | g | |
| Maltose | <0.15 | g | |

| Name | Average Amount | Unit | Deriv. By | n | Samples | Min | Max | Median | Footnote | Initial Year Acquired |
|---|---|---|---|---|---|---|---|---|---|---|
| **Minerals:** | | | | | | | | | | |
| Calcium, Ca | 7 | mg | Analytical | 8 | Samples | 5 | 9 | 7 | | 2020 |
| Iron, Fe | 0.06 | mg | Analytical | 8 | Samples | 0 | 0.15 | 0.05 | | 2020 |
| Magnesium, Mg | 4.9 | mg | Analytical | 8 | Samples | 4.2 | 5.7 | 4.9 | | 2020 |
| Phosphorus, P | 8 | mg | Analytical | 8 | Samples | 7 | 11 | 8 | | 2020 |
| Potassium, K | 106 | mg | Analytical | 8 | Samples | 85 | 126 | 104 | | 2020 |
| Sodium, Na | | | | | | | | | | |
| Zinc, Zn | | | | | | | | | | |
| Copper, Cu | | | | | | | | | | |
| Manganese, Mn | | | | | | | | | | |

| Name | Average Amount | Unit | Deriv. By | n | Samples | Min | Max | Median | Footnote | Initial Year Acquired |
|---|---|---|---|---|---|---|---|---|---|---|
| **Vitamins and Other Components:** | | | | | | | | | | |
| Thiamin | 0.011 | mg | Analytical | 8 | Samples | 0.01 | 0.02 | 0.01 | | 2020 |
| Riboflavin | 0.069 | mg | Analytical | 8 | Samples | 0.06 | 0.08 | 0.07 | | 2020 |
| Niacin | 0.089 | mg | Analytical | 8 | Samples | 0.07 | 0.1 | 0.092 | | 2020 |
| Vitamin B-6 | 0.032 | mg | Analytical | 8 | Samples | 0.019 | 0.038 | 0.034 | | 2020 |
| Folate, total | 1 | µg | Analytical | 8 | Samples | 0 | 6 | 0 | | 2020 |

# FoodData Central Search Results

FOOD SEARCH | COMPONENT SEARCH

ARS HOME › FOODDATA CENTRAL › FOOD SEARCH

**Search by Component**

Vitamin C, total ascorbic a

Search

**Default Sort Method**

Per 100 Unit Serving

**Filter Search Results**

Food Type Definitions:
About Food Type Definitions

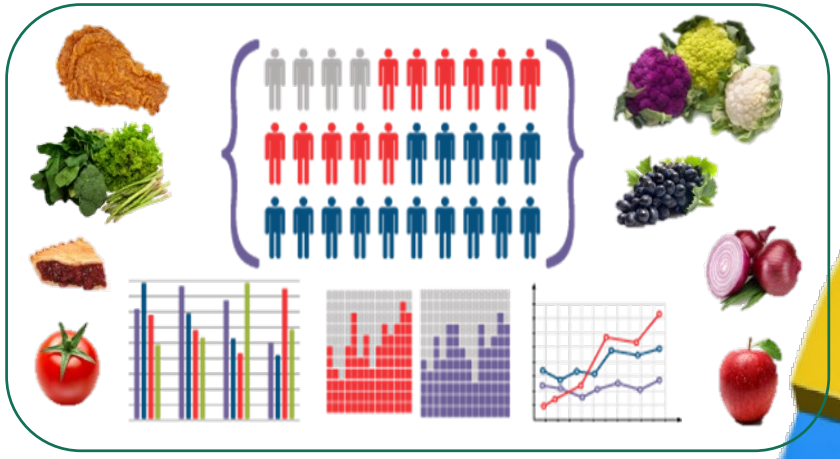
- [x] Foundation (76)
- [x] Survey (FNDDS) (31,618)
- [ ] Branded (11,874)
- [x] SR Legacy (13,956)

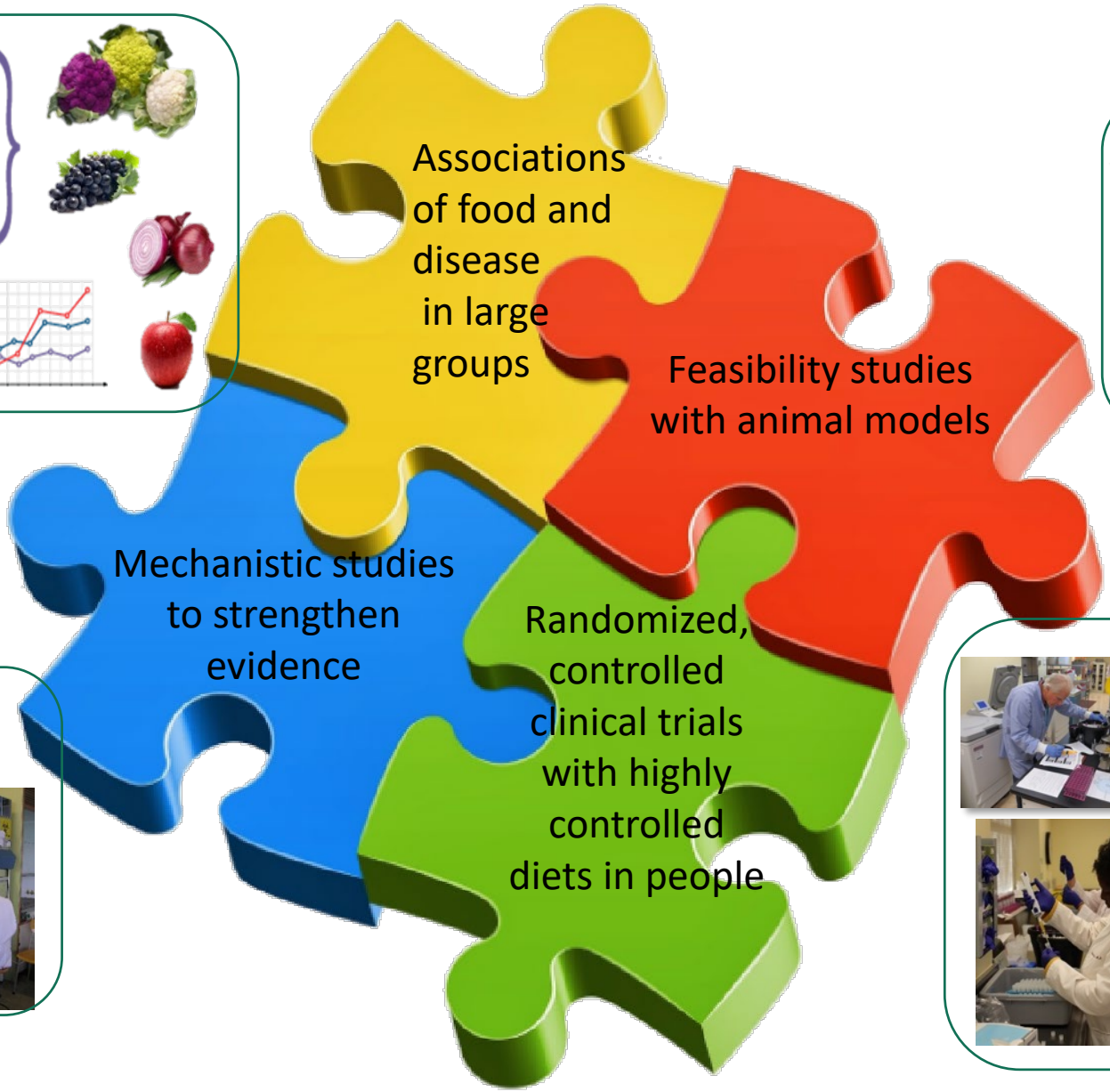
Download Results

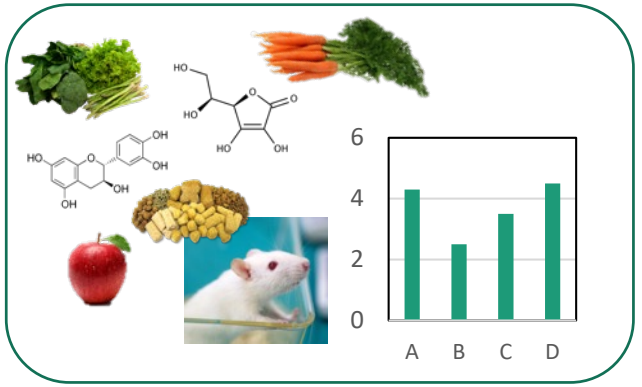
45650 results for "Vitamin C, total ascorbic acid"

| Identifier | Identifier Type | Type | Description | Serving Weight | Serving size weight unit | Serving Size | Vitamin C, total ascorbic acid per serving size (mg) | Vitamin C, total ascorbic acid per 100 unit serving (mg) |
|---|---|---|---|---|---|---|---|---|
| 9002 | NDB # | SR Legacy | Acerola juice, raw | 242 | g | 1 cup | 3870 | 1600 |
| 3022 | NDB # | SR Legacy | Babyfood, GERBER, 2nd Foods, apple, carrot and squash, organic | 99 | g | 1 serving | 2700 | 2730 |
| 9001 | NDB # | SR Legacy | Acerola, (west indian cherry), raw | 98 | g | 1 cup | 1640 | 1680 |
| 14424 | NDB # | SR Legacy | Beverages, Orange-flavor drink, breakfast type, with pulp, frozen concentrate. | 424 | g | 1 can | 1030 | 243 |
| 14426 | NDB # | SR Legacy | Beverages, Orange drink, breakfast type, with juice and pulp, frozen concentrate | 436 | g | 1 can | 827 | 190 |
| 11593 | NDB # | SR Legacy | Waxgourd, (chinese preserving melon), raw | 5700 | g | 1 waxgourd | 741 | 13 |
| 11100 | NDB # | SR Legacy | Brussels sprouts, frozen, unprepared | 907 | g | 1 package (2 lb) | 672 | 74.1 |
| 14268 | NDB # | SR Legacy | Beverages, Fruit punch drink, frozen concentrate | 418 | g | 1 can (12 fl oz) | 650 | 156 |
| 11112 | NDB # | SR Legacy | Cabbage, red, raw | 1134 | g | 1 head, large (about 5-1/2" dia) | 646 | 57 |
| 11094 | NDB # | SR Legacy | Broccoli, frozen, spears, unprepared (Includes foods for USDA's Food Distribution Program) | 907 | g | 1 package (2 lb) | 620 | 68.3 |
| 11163 | NDB # | SR Legacy | Collards, frozen, chopped, unprepared | 1361 | g | 1 package (3 lb) | 544 | 40 |
| 11090 | NDB # | SR Legacy | Broccoli, raw | 608 | g | 1 bunch | 542 | 89.2 |
| 35203 | NDB # | SR Legacy | Rose Hips, wild (Northern Plains Indians) | 127 | g | 1 cup | 541 | 426 |
| 92900100 | Food Code | Survey (FNDDS) | Fruit flavored drink, with high vitamin C, powdered, not reconstituted | 224 | g | 1 cup | 517 | 231 |

# Food Composition is Critical Part of Connecting the Pieces of the Research Puzzle






# “Brassica” or “Cruciferous” Family of Vegetables

Vitamin C
Folate
Carotenoids

Beta-Carotene → Vitamin A
Lutein

Vitamin E
Fiber
Flavonoids

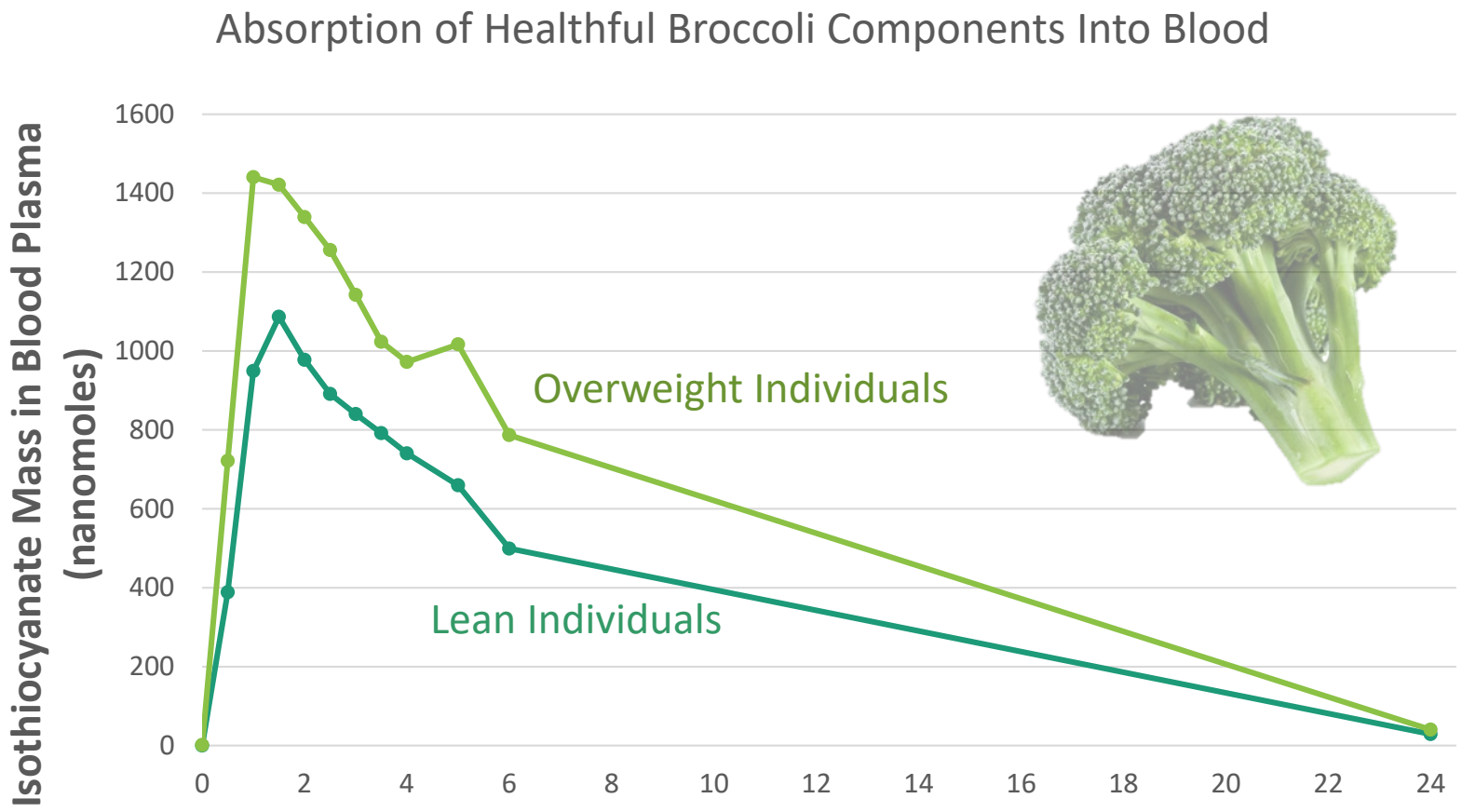
Kaempferol
Quercetin
Isorhamnetin

Vitamin K
Potassium
Glucosinolates

Glucoraphanin → Sulforaphane
Sinigrin → Allyl-Isothiocyanate
Others

*USDA Research Results*

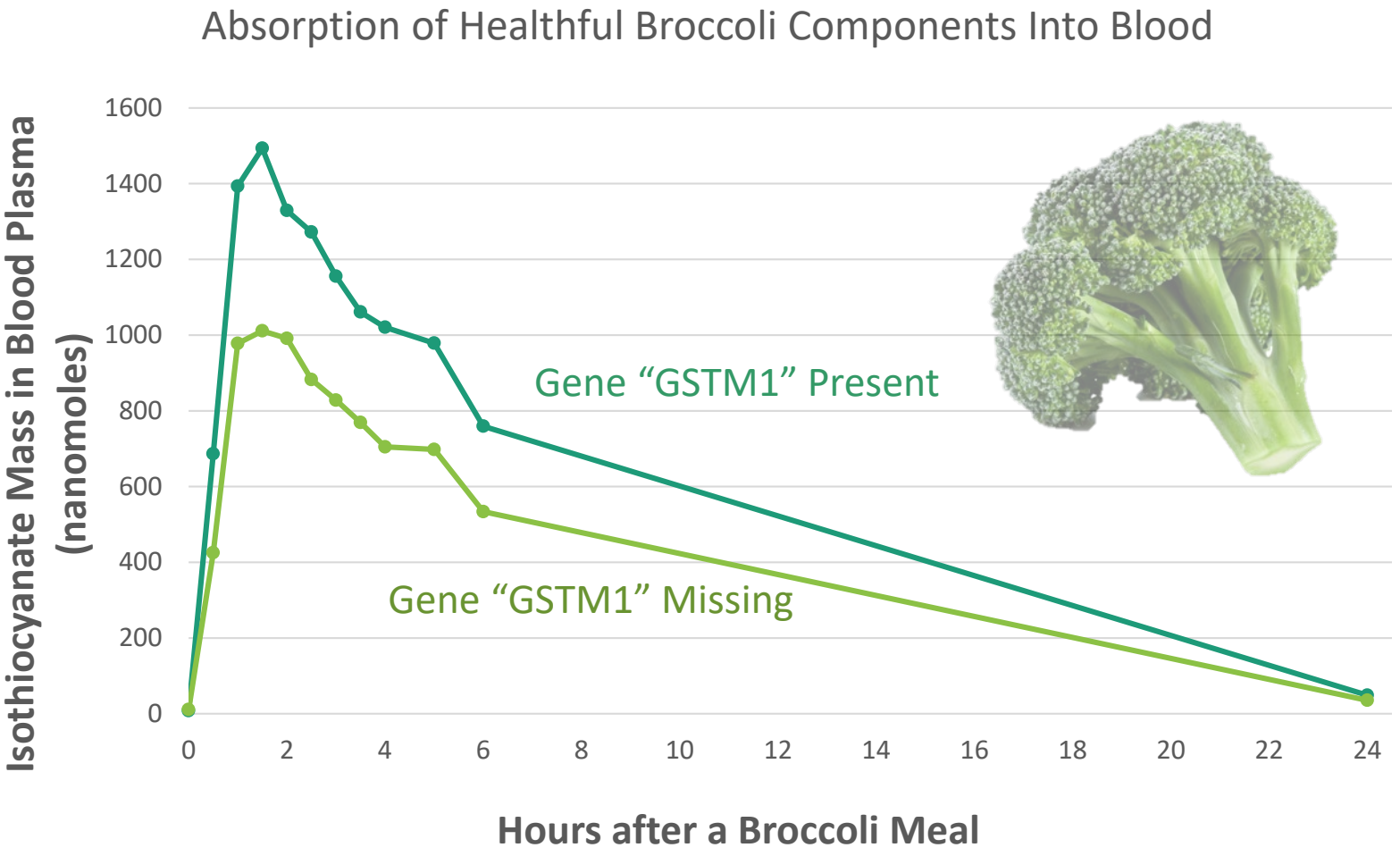
# A Person's Lean vs. Overweight Status Affects Circulating Levels of Healthful Dietary Compounds




Charron, Vinyard, Ross, Seifried, Jeffery, Novotny (2018) Brit J Nutr 120:1370-1379

*USDA Research Results*

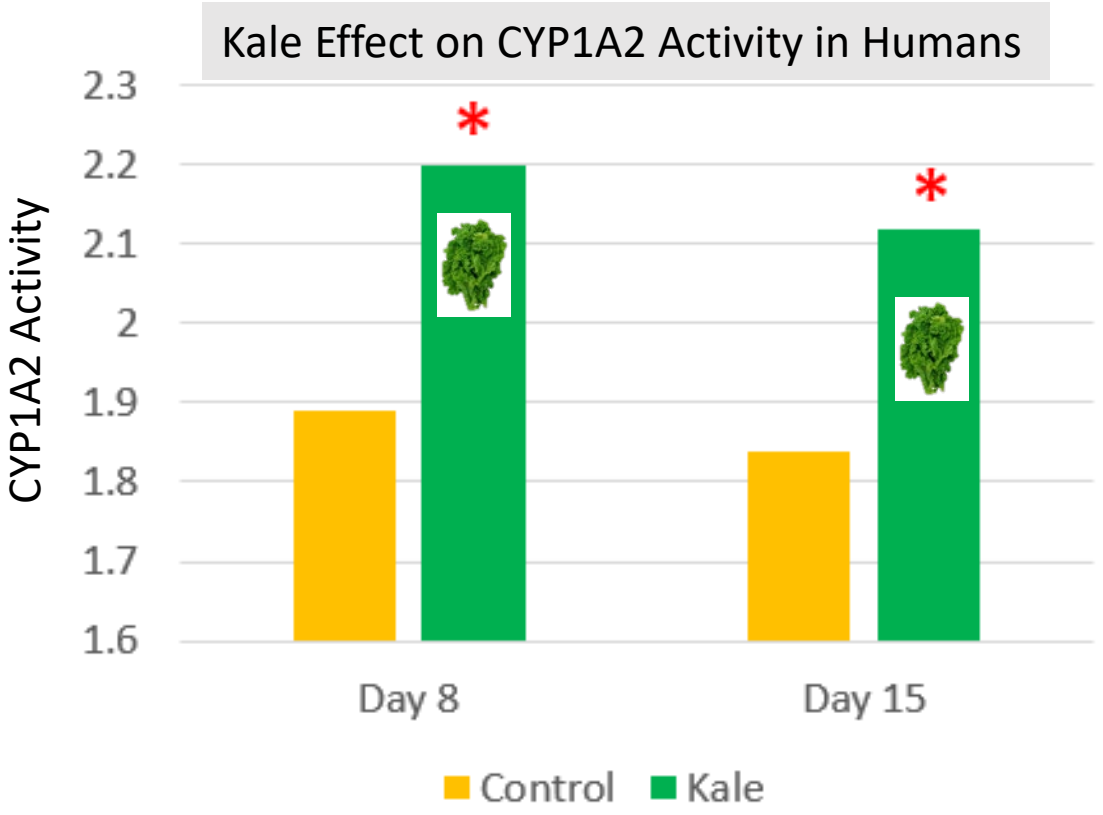
# A Person's Genes (Genotype) Can Affect Circulating Levels of Healthful Dietary Compounds




Charron, Vinyard, Ross, Seifried, Jeffery, Novotny (2018) Brit J Nutr 120:1370-1379

*USDA Research Results*

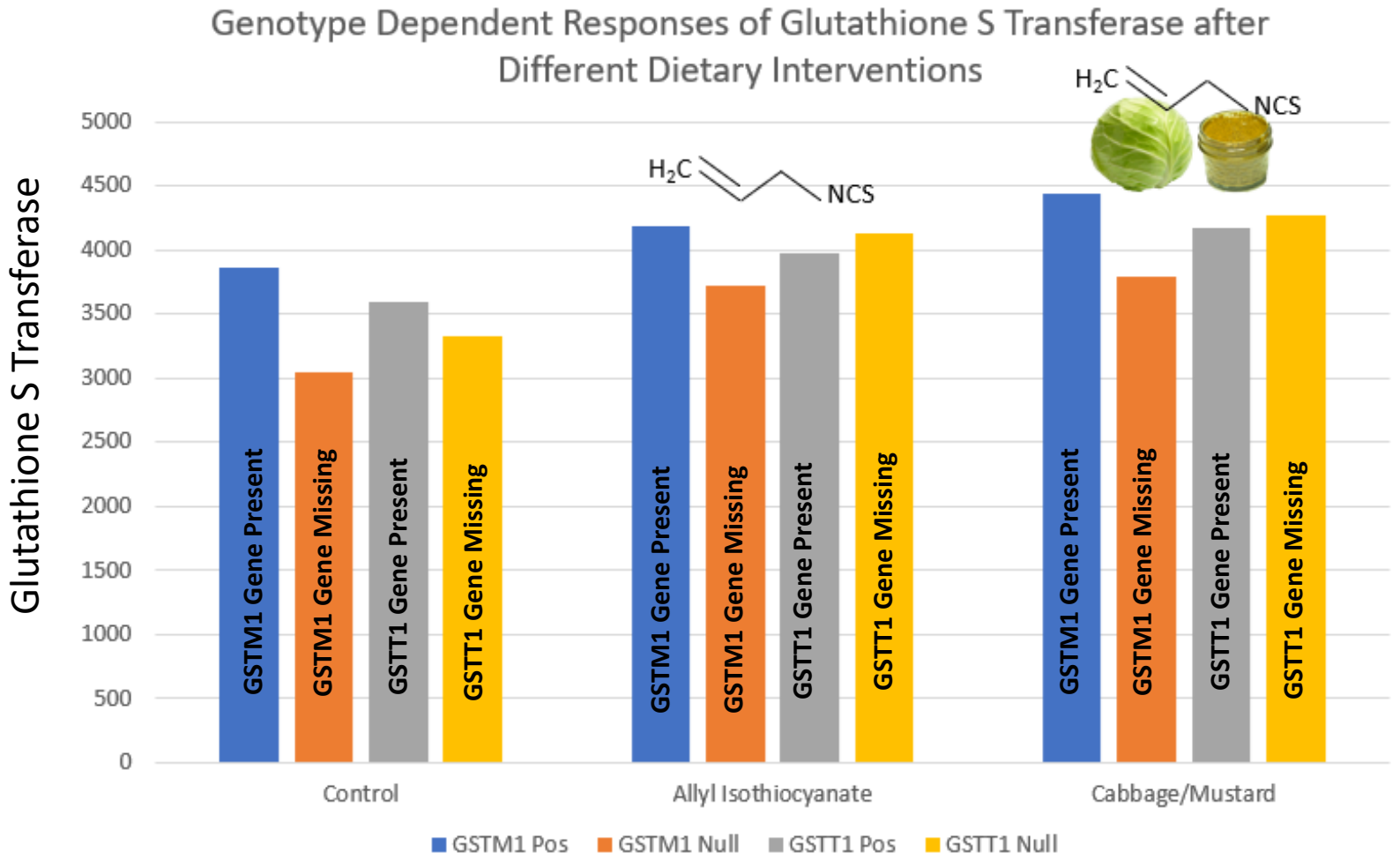
# Food Components Can Up-Regulate Detoxification Enzymes, An Important Mechanism of Dietary Cancer Prevention




Charron, Novotny, Jeffery, Kramer, Ross, Seifried (2020) J Funct Food 64: 103624

*USDA Research Results*

# Our Genes Can Affect How Food and Food Components Up-Regulate Our Detoxification Enzymes




Charron, Clevidence, Albaugh, Kramer, Vinyard, Milner, Novotny (2013) J Nutr Biochem 24: 894-902

# *USDA Research Results*

USDA is using a cutting-edge methods for broad assessment of nutrient metabolism, for use in novel artificial intelligence efforts to better understand diet and cancer prevention.

Broccoli-Derived Metabolomics Response

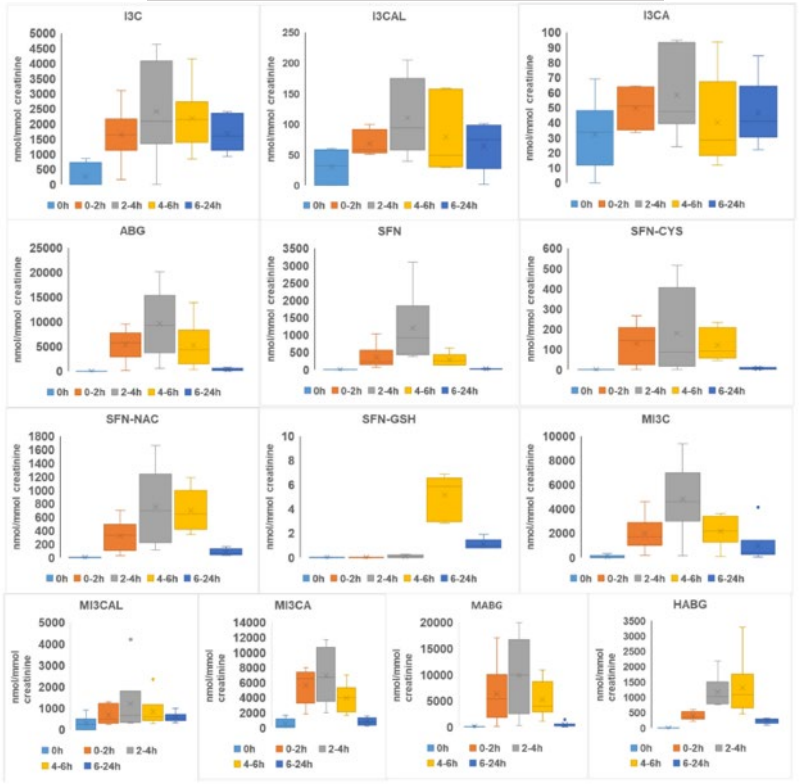



Fig. 3. The concentration of glucosinolates metabolites in human urine (Normalized with creatinine level, nmol/mmol).

Kale-Derived Metabolomics Response

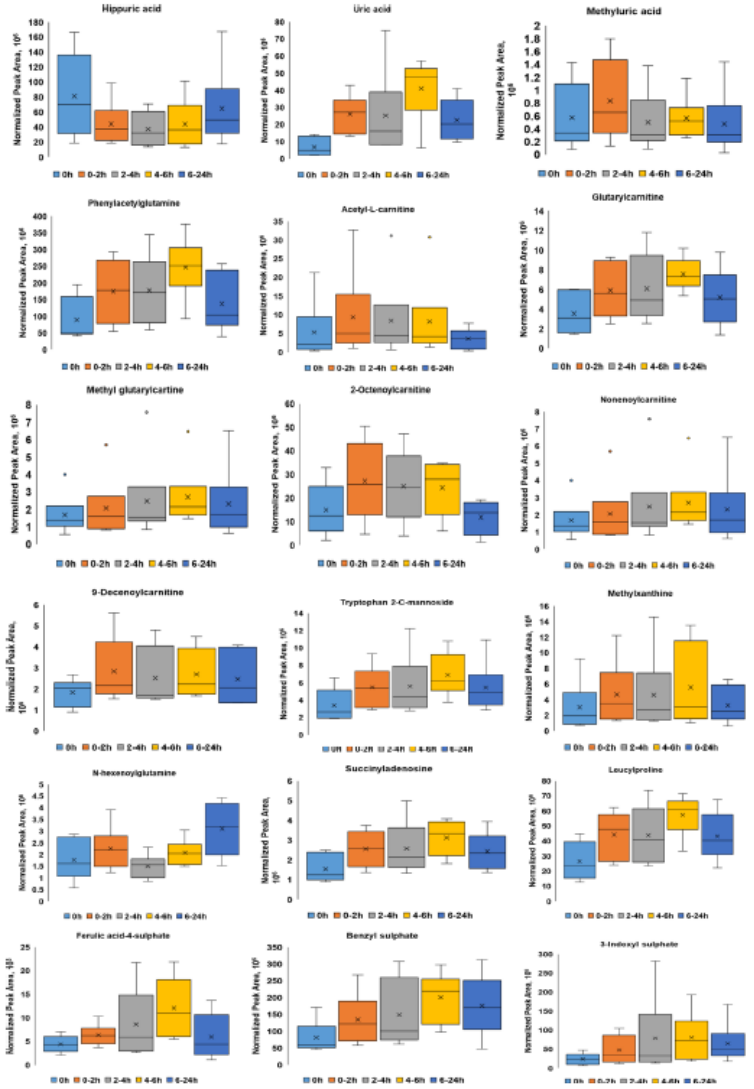


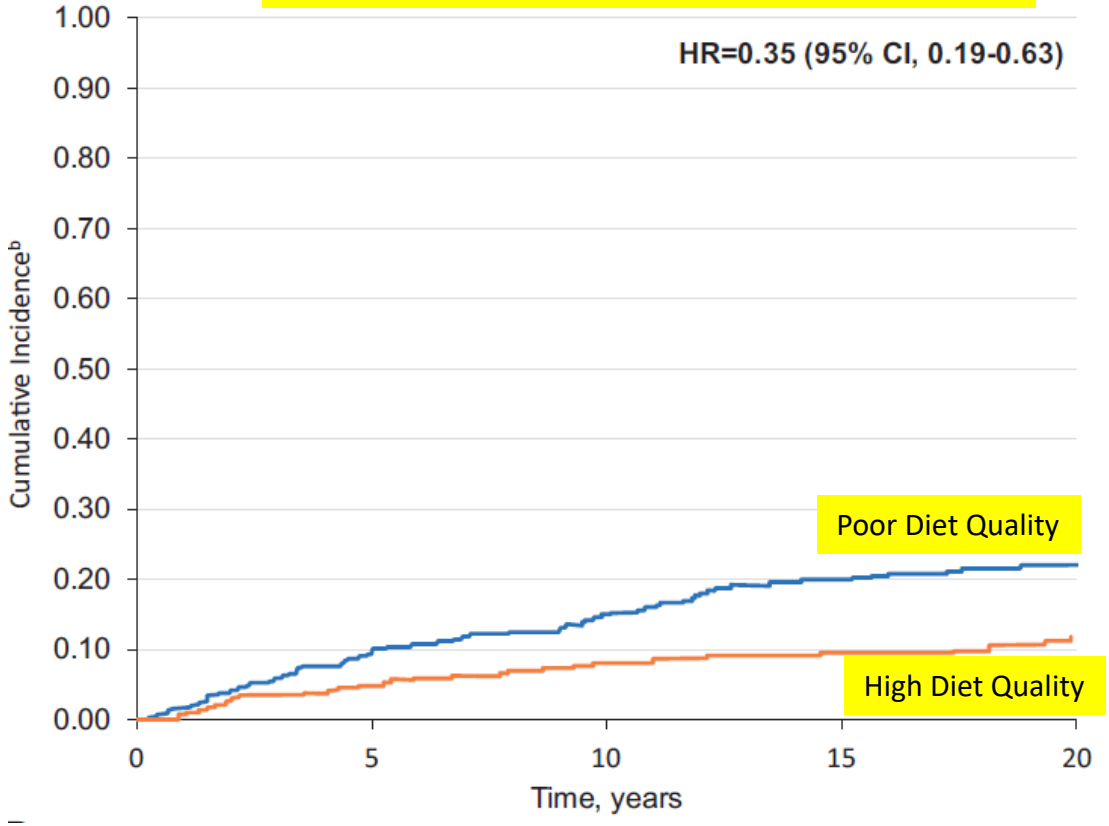

Figure 2. Urinary metabolites trends with respect to time based on the normalized peak area.


Sun, Charron, Liu, Novotny, Harrington, Ross Seifried, Chen (2020) J Agric Food Chem 68: 14307-14318

Sun, Charron, Liu, Novotny, Peng, Yu, Chen (2020) Food Chem 309: 125660

# The Whole Diet Matters

## Cancer Mortality and Diet Quality

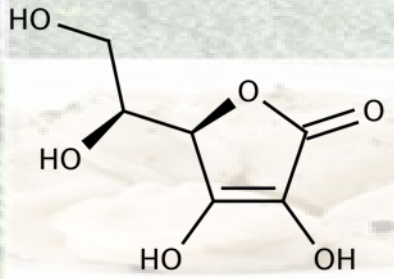


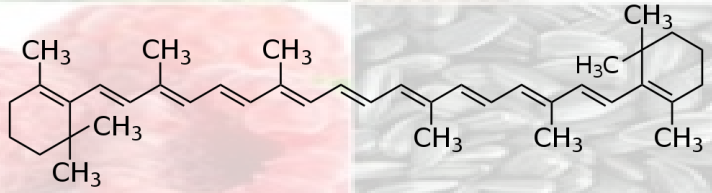

## Mortality Associated with Different Food-Related Groups

| | Hazards ratio* (95% CI) | |
|---|---|---|
| HEI components | All-cause mortality† | Cancer-specific mortality‡ |
| Vegetables | 0.67 (0.52 to 0.86) | 0.65 (0.38 to 1.14) |
| Meat | 0.82 (0.60 to 1.11) | 0.66 (0.37 to 1.20) |
| Grain | 0.92 (0.71 to 1.20) | 1.25 (0.82 to 1.91) |
| Fruit | 0.71 (0.51 to 0.98) | 0.58 (0.32 to 1.03) |
| Dairy | 0.78 (0.65 to 0.94) | 0.86 (0.57 to 1.30) |
| Fat | 0.90 (0.71 to 1.15) | 0.65 (0.42 to 1.02) |
| Saturated fat | 0.72 (0.60 to 0.86) | 0.55 (0.36 to 0.86) |
| Cholesterol | 1.00 (0.83 to 1.19) | 1.03 (0.74 to 1.43) |
| Sodium | 1.04 (0.81 to 1.35) | 0.75 (0.46 to 1.23) |
| Variety | 0.76 (0.63 to 0.97) | 0.67 (0.41 to 1.10) |
| Overall | 0.59 (0.45 to 0.77) | 0.35 (0.19 to 0.63) |

Deshmukh et al. (2018) NJCI Cancer Spectrum






USDA's initiatives
to broaden available information
about the composition of foods
and to expand the food information web
while also conducting cutting-edge research
will continue to advance our understanding
of cancer prevention through diet.

USDA