




**UPDATE**

# WHAT'S NEW *in the* WORLD OF CARBOHYDRATES

October 10, 2019, 2-3 PM EDT

PRESENTED BY  
**Joanne Slavin, PhD, RD, Professor**

BROUGHT TO YOU THROUGH THE SUPPORT OF 


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## Joanne Slavin, PhD, RD



**Joanne Slavin, PhD, RD** is a professor in the Department of Food Science and Nutrition at the University of Minnesota and teaches Advanced Human Nutrition. With the help of current and former graduate students she has authored more than 300 scientific articles on dietary fiber, carbohydrates, whole grains, protein, snacking, and the role of diet in disease prevention. She has also given more than 350 scientific presentations around the world.

Dr. Slavin grew up on a dairy farm in Wisconsin which she still owns with her sisters. She has a B.S., M.S., and Ph.D. from the University of Wisconsin-Madison and is a Registered Dietitian (RD).

Dr. Slavin has the following disclosures to report: Dr. Slavin reports the following relevant disclosures: she has received research funding from Nexira, Taiyo, and Blue Prairie, all in the areas of dietary fiber and gut health, and she serves on the scientific advisory board for Tate and Lyle and Atkins Nutritionals. She certifies that no conflict of interest exists for this program.

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## Learning Objectives

**After completing this continuing education course, nutrition professionals should be able to:**

 <p><b>1. Discuss</b> the latest science behind carbohydrate recommendations.</p>	 <p><b>2. Understand</b> the key guidance relating to carbohydrates in the Dietary Guidelines for Americans (DGA).</p>
 <p><b>3. Identify</b> regulations that have been implemented relating to carbohydrates in foods.</p>	 <p><b>4. Communicate</b> to patients evidence-based recommendations for consuming carbohydrates.</p>

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## Outline

- **Update** latest science-based carbohydrate recommendations
- **Describe** how carbohydrate recommendations are developed in the DGAs
- **Discuss** the digestion and absorption of carbohydrates and how we determine high quality carbohydrates
- **Understand** new fiber regulations and regulations for added sugar and how they impact the Nutrition Facts panel
- **Appreciate** the metabolic health links with fiber and the microbiome
- **Describe** strategies to bridge the dietary fiber and whole grains gap

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## Carbohydrates in the Modern Diet

- Basis of most modern diets
  - Provide > ½ of kcals consumed by Americans
- Provide a readily-available source of energy
  - 4 kcal per gram
- Provide a wide variety of nutrients needed for health when consumed in “whole food” form
- Inexpensive, sustainable



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## Types of Carbohydrates

### Simple Carbohydrates (sugar)

- **Monosaccharide**
  - Made up of single sugar unit
  - Rarely occur in foods
- **Disaccharide**
  - Made up of two sugar units
  - Common in fruits (sucrose), milk (lactose), and starch digestion (maltose)
  - Also made industrially from any starch including corn, wheat, tapioca, potato, etc.

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## Types of Carbohydrates

### Complex Carbohydrates

Polysaccharide – made up of many sugar units

- Starch (digestible)
  - Different chemical forms – amylose (long chain, linear) and amylopectin (branched)
  - Found in grains including pasta, vegetables, legumes
- Dietary fiber (non-digestible)
  - Different chemical forms – including resistant starch
  - Found in grains, legumes, vegetables, nuts, seeds, fruits
  - Can be manufactured and added to foods and beverages

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## Does A Carbohydrate Equal a Carbohydrate? No

- **Chemistry**
  - Chain length – mono-, di-, polysaccharide
  - Branched vs. linear
- **Physiology**
  - Digestible vs. non-digestible
  - Speed of digestion and absorption – glycemic response
  - Fermentable vs. non-fermentable in gut
- **Physical structure**
  - In solution (beverage) or part of food
  - Associated substances (protein) or part of a seed or grain
  - Particle size – processing



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## What Use Are Carbohydrates?

- Sweeteners/taste
- Food preservation/food safety
- Functional attributes like viscosity, texture, body, browning capacity
- Most readily available source of energy
- Fermentable substrate – dietary fiber, resistant starch, prebiotics



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## Tools for Assessing Carbohydrate Intake

TABLE 4.2 USING CHOICE (EXCHANGE) LISTS TO ESTIMATE CARBOHYDRATE CONTENT

Food Groups/Lists	Serving Size	Carbohydrates (g)
<b>Carbohydrate group</b>		
Starch	½ cup pasta; ½ potatoes; 1 slice bread	15
Fruit	1 small apple, peach, pear; ½ banana; ½ cup canned fruit (in juice)	15
<b>Milk</b>		
Nonfat		12
Low-fat		12
Reduced-fat		12
Whole		12
Other Carbohydrates	Serving sizes vary	15
Vegetables	½ cup cooked vegetables, 1 cup raw	5
<b>Meat/meat substitute group</b>		
Very lean	1 oz meat or cheese	0
Lean		0
Medium-fat		0
High-fat		0
Fat group	1 tsp butter, margarine, or oil; 1 T salad dressing	0

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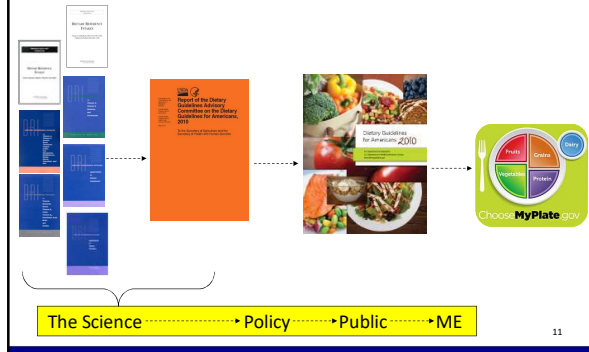
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## The Long Path from Science to Me




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## Carbohydrate Dietary Reference Intakes (DRI) - US and Canada

- 130 g/day Recommended Dietary Allowance (RDA) for carbohydrates
- 45-65% of calories from carbohydrates – Acceptable Macronutrient Distribution Range (AMDR)
  - 25% or less of calories from added sugars
  - No Tolerable Upper Intake Level (UL) for sugars
- 14 g/1000 kcalories dietary fiber
  - 38 grams for adult men
  - 25 g/day for adult female
  - 19 g/day for children
- No UL for fiber




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## The Dietary Guidelines for Americans: The Cornerstone of US Nutrition Policy & Regulation




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## The Science Behind the DGAs

### Dietary Guidelines Advisory Committee considers:

- Original systematic scientific reviews
- Existing systematic reviews, meta-analyses, and scientific reports
- Dietary data analyses
- Food pattern modeling analyses

### Issues technical report with nutrition and health recommendations

DHHS/USDA uses technical report and comments to develop updated *Dietary Guidelines*

### Scientific rationale is based on various research methods:



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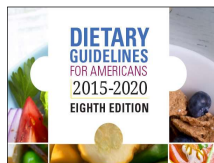
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## 2015-2020 DGA: A Snapshot

### Provides 5 Overarching Guidelines:

1. Follow a healthy eating pattern across the lifespan.
2. Focus on variety, nutrient density, and amount.
3. Limit calories from added sugars and saturated fats and reduce sodium intake.
4. Shift to healthier food and beverage choices.
5. Support healthy eating patterns for all.



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## 2015-2020 DGA: A Snapshot

### A healthy pattern includes:

- A variety of vegetables
- Fruits, especially whole fruits
- **Grains, half WG, but included enriched grains**
- Fat-free/low-fat dairy, including milk and yogurt
- A variety of protein-rich foods
- Oils

### A healthy pattern limits:

- Saturated fat: <10% of calories/day
- Trans fat: keep as low as possible
- Added sugars: <10% of calories/day
- Sodium: < 2,300 mg of sodium/day

*Shift from individual foods and ingredients to healthy eating patterns!* <sup>16</sup>

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## From Individual Foods to Healthy Eating Patterns

- Prospective, cohort studies find that higher intakes of dietary fiber, mostly from grains, reduce relative risk for cardiovascular disease.
- The highest intake of whole grains in these studies is 3 servings per day, thus the DGAs suggest that half of your 6 grain servings be whole grains.
- Consumption of enriched grains provides thiamin, riboflavin, niacin, iron, and folic acid.
- Although it is assumed that we should eat all whole grains, that is not supported by science; if enriched grains are not consumed, intakes of enriched nutrients and folic acid are below recommended amounts.
- Modeling exercises support that half of grains should be whole, the rest enriched.

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## Added Sugar vs. Total Sugar

- Sugars that are naturally-occurring within a food such as fruit and dairy are recommended
- Added sugars – reduce to 10% of calories as per the 2015 DGAs
- No difference in chemistry whether they are naturally-occurring in food or added to food
- No difference in physiology
- No analytical method to differentiate between added sugar and intrinsic sugar
- All fructose-containing sugars are low glycemic

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## Delivering Glucose to Body Cells

- **Glycemic response**
  - How quickly and how high blood glucose rises after carbohydrates are consumed
- **Glycemic index**
  - A ranking of how a food affects the glycemic response
- **Glycemic load**
  - Calculated by multiplying a food's glycemic index by the amount of available carbohydrates in a serving of food

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## Glycemic Index Varies Among Grain Foods

**Table 1. The average GI of common grain foods<sup>1</sup>**

High-carbohydrate foods	
White wheat bread*	75 ± 2
Whole wheat/whole meal bread	74 ± 2
Specialty grain bread	53 ± 2
Unleavened wheat bread	70 ± 3
Wheat roti	62 ± 3
Chapati	52 ± 4
Corn tortilla	46 ± 4
White rice, boiled*	73 ± 4
Brown rice, boiled	68 ± 4
Barley	28 ± 2
Sweet corn	52 ± 5
Spaghetti, white	49 ± 2
Spaghetti, whole meal	48 ± 5
Rice noodles†	53 ± 7
Udon noodles	55 ± 7
Couscous*	65 ± 4

Low GI	54 or less
Medium GI	55-69
High GI	70+

**Table 2. The GI of common pasta varieties<sup>2</sup>**

Food number and item	Commercial name	GI	
<b>Pasta</b>			
116	Pasta, penne, durum wheat flour	Penne rotelle (De Cecco)	47
117	Pasta, whole durum wheat flour	Penne (Barilla)	50
118	Pasta, whole durum wheat flour	Pennette integral (Barilla)	53
119	Pasta, whole durum wheat, whole-meal flour	Pennette integral (Copp)	48
120	Pasta, spaghetti, durum wheat flour	Spaghetti (Senici) (Vivarini)	51
121	Pasta, spaghetti, durum wheat flour	Spaghetti n°5 (Barilla)	33
122	Pasta, spaghetti, durum wheat flour	Spaghetti n°7 (De Cecco)	50
123	Pasta, spaghetti, whole-meal durum wheat flour	Spaghetti integral (Barilla)	35
124	Pasta, spaghetti, whole-meal durum wheat flour	Spaghetti integral (De Cecco)	55
125	Pasta, spaghetti, whole-meal durum wheat flour	Spaghetti integral (Miyata)	53
126	Pasta, durum wheat flour, whole, with egg, whole	Ravioles con Carne di Verdu (Pasta di Kana)	54
127	Pasta, tagliatelle, durum wheat flour, egg, dry	Tagliatelle all'uovo (Barilla)	55

<sup>1</sup>Friess et al. International Tables of Glycemic Index and Glycemic Load Values. Diabetes Care 2008 Dec; 31(12): 2281-2283.  
<sup>2</sup>Scapano et al. Glycemic Index and Glycemic Load of Commercial Italian Foods. Nutr Metab Cardiovasc Dis. 2010 May;20(5):419-29.

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## Fiber Agreement

- **Marker of a healthy diet**
  - Recommend whole grains, fruits, vegetables, legumes
- **Concept**
  - Carbohydrates and lignin that escape digestion in the upper GI tract but may be fermented in the gut
- **Nutrient**
  - According to 2002 Dietary Reference Intakes (DRIs)
- **Regulated**
  - On the Nutrition Facts panel – 25 g current Daily Value (DV), proposed to increase to 28 g DV
- **Health claims**
  - Oat bran, barley bran, and psyllium and CVD in US

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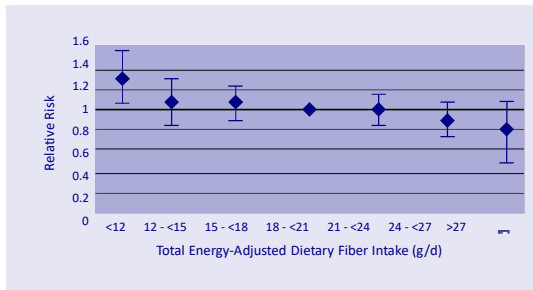
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## Relative Risk of Death from Coronary Heart Disease



Pereira et al, *Arch Intern Med*, 2004

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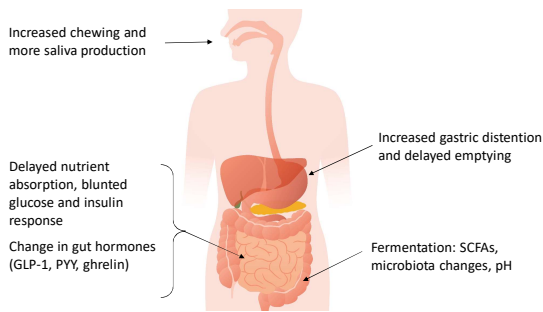
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## Fiber: Effects Throughout the GI Tract



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## Fiber in the Human Gut

- **Fibers** (pectin, inulin) can be extensively fermented (> 90%) or poorly fermented (purified cellulose, <10%)
- **Even fibers** that are extensively fermented can increase fecal biomass since bacterial mass increases and that also binds water
- **Feces** are about 75% water so surviving fiber or bacteria will increase fecal weight



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## Two Days in the Gut...

- **Absorption** of water, electrolytes
- **Bacterial** breakdown of carbohydrates, protein, phytochemicals (phytoestrogens, phenolic compounds)
- **Production** and absorption of short chain fatty acids, other bacterial metabolites
- **Feces** are 75% water, undigested fiber, bacteria, other unabsorbed nutrients

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## Changing Fiber Regulations by the FDA

Fiber's definition will now require each isolated and synthetic fiber (functional fiber) to have a proven health benefit.

- Qualifying health benefits include:
  - Lowering blood glucose and cholesterol levels
  - Lowering blood pressure
  - Improved laxation
  - Increase mineral absorption
  - Reduced energy intake
- Changes in specific GI taxa are not considered a direct health benefit

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## Fibers That Meet the Dietary Fiber Definition

- $\beta$ -glucan soluble fiber (as described in § 101.81(c)(2)(ii)(A)) (AOAC 992.28)
- Psyllium husk (as described in 101.81(c)(2)(ii)(A)(6)) (AOAC 991.43)
- Cellulose
- Guar gum
- Locust bean gum
- Pectin
- Hydroxypropylmethylcellulose

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## Additional Fibers Accepted by the FDA

- Mixed plant cell wall fibers
- Arabinoxylan
- Inulin and inulin-type fructans
- High amylose starch (RS2)
- Galactooligosaccharide
- Polydextrose
- Resistant maltodextrin/dextrin



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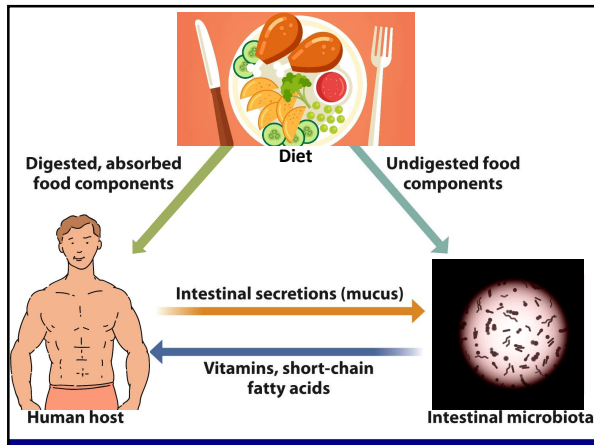
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## Microbiome Revolution



### Gut Microbes Associated with Obesity

- 12 Unrelated obese subjects on fat or carbohydrate restricted diet
- Monitored for one year
- Increase in Bacteroidetes correlates with change in weight

“All dis-ease begins in the gut.”  
“Let food be thy medicine and medicine be thy food.”

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*Hippocrates*

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## Fermentation By Microflora

Some evidence suggests fiber fermentation provides physiological benefit such as:

- Increased mineral absorption
- Stimulation of beneficial microbes (prebiotic)
- Decrease survival of pathogenic bacteria through reduction in pH
- Providing nourishment to colonocytes (SCFAs, butyrate) for increased cell growth and maintenance

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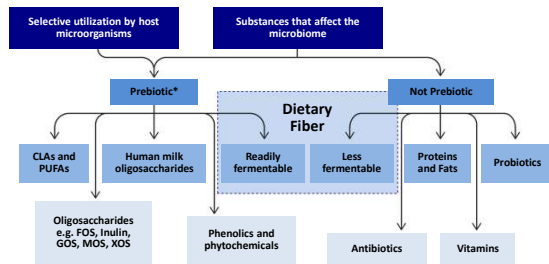
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## Prebiotic:

*A Substance That Confers a Health Benefit*



Gibson and Shepherd, *Aliment Pharmacol Ther*, 2005.  
2017 ISAPP Consensus Statement, 2017.

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## Prebiotic Dietary Fiber Sources

- Beta-glucan
- FOS, oligofructose, and inulin
- GOS
- Isomaltooligosaccharides
- Guar gum and PHGG
- Lactulose
- Resistant starch and maltodextrin
- Xylooligosaccharides and arabinooligosaccharides

Carlson J, et al. *Curr Dev Nut* 2018;2:nzy005.

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## FODMAPs

*Fermentable Oligo-, Di-, and Monosaccharides, And Polyols (FODMAP)*

Term coined in 2005 by Australian researchers who theorize that foods containing these carbohydrates worsen symptoms of digestive disorders: Irritable Bowel Syndrome (IBS) and Inflammatory Bowel Disease (IBD)

Gibson PR, Shepherd SJ. *Aliment Pharmacol Ther* 2005; 21: 1399 - 1409

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## FODMAPs

### Concerns with the FODMAP concept:

- Recommendations based on clinical observations; few research trials
- Efficacy of FODMAP concept not documented
- Grouping of all FODMAPs together, although perhaps easier for the patient, ignores physiological differences among FODMAPs
- No regulatory guidance or official databases for FODMAP content
- Low FODMAP diet is a low-fiber diet

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## Summary of Tolerance Data

- Dietary fiber – up to 80 g/day in vegetarians – no UL
- Resistant starch – 80 g
- Fructo-oligosaccharides – 10-15 g – diarrhea at 40 g
- FODMAP – fermentable oligo, di and monosaccharides and polyols
  - Most of published studies from Australia; interest with low-gluten and IBS patients



Grabitske and Slavin, *Crit Rev Food Sci Nutr*, 2009

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## What Microbes Do in the Body

- Produce additional energy otherwise inaccessible to the host
  - short chain fatty acids
- Produce vitamins in colon
  - Biotin, vitamin K
- Metabolize carcinogens
- Provide ability to harvest nutrients
  - Enhance calcium absorption
- Prevent colonization by pathogens
- Assist in the development of a mature immune system



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## Dietary Components That Alter Gut Bacteria

### Most of the human published studies:

- Dietary fiber (DF), resistant starch
  - Fermentation not accepted as physiological benefit in new FDA fiber definition
  - Fermentation is accepted in Canada
- Prebiotics
  - Oligosaccharides
- Probiotics
  - Fermented foods, yogurt, sauerkraut, kefir, sourdough

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## DF & Gut Microbiota: Review and Meta-analysis

- 64 studies, 2,009 participants
- DF resulted in higher abundance of Bifidobacterium and lactobacillus, as well as fecal butyrate concentration compared to placebo
- Fructans and GOS led to greater abundance of both Bifidobacterium and lactobacillus compared to control
- No differences between fiber intervention and comparators for alpha diversity, abundances of other pre-specified bacteria, or other SCFA concentration

So et al. *Am J Clin Nutr* 2018;107:965-983

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## Substituting Whole Grains for Refined Grains

- 49 men and 32 postmenopausal women were given WG or RG diets for 6 weeks
- Short term consumption of WGs in a weight-maintenance diet increases stool weight and frequency and has modest positive effects on gut microbiota, SCFAs, effector memory T cells, and the acute innate immune response
- No effect on other markers of cell-mediated immunity or systemic and gut inflammation

Vanegas et al. *Am J Clin Nutr* 2017;105:635-650.

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## Recent Findings from the American Gut Project

- Diversity of microbes in the gut is much more vast than originally thought
- Migration from a non-westernized nation to the US is associated with a loss of gut microbiome diversity
- Subjects who ate more than 30 types of plant foods weekly had more diversity than subjects who ate only 10 types of plant foods
- Diversity has not been linked to a health outcome

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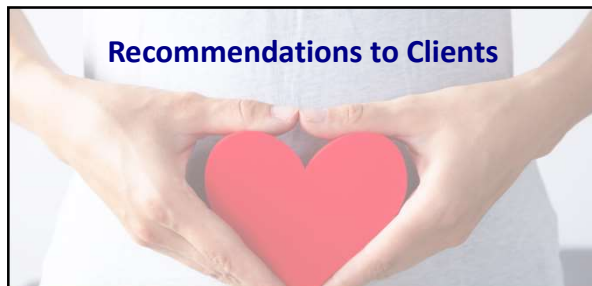
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## Recommendations to Clients



Most evidence resides with increasing dietary fiber and whole grains from a diverse set of foods

- Typical fiber intakes need to be doubled
- Too much fermentation can lead to digestive distress – FODMAPs

Emerging evidence on effect of dietary components on gut health and microbiome

- A variety of plant foods increase diversity of microbiota

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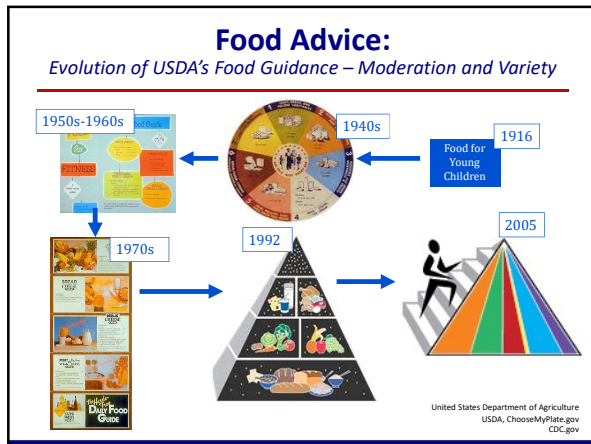
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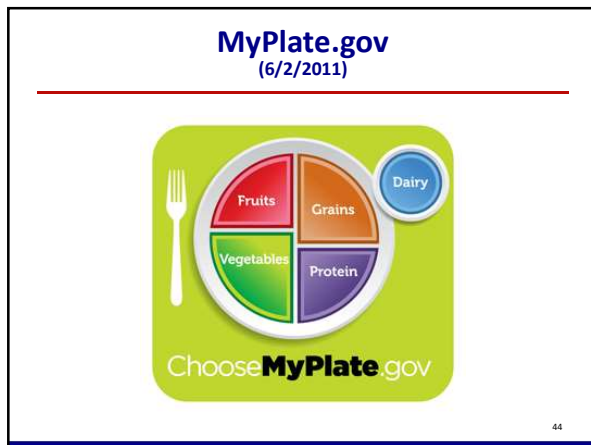
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### Conclusions

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- Dietary fiber is the universal positive “nutrient” while added sugar is the universal negative “nutrient”
- Healthier carbohydrate choices include whole and enriched grains, whole fruits, vegetables, low fat dairy, and legumes
- Enriched grains are important sources of nutrients including fortified folic acid and enriched thiamin, riboflavin, niacin, and iron
- Dietary fiber and whole grains are known to alter gut health, including changes in the microbiota
- Current trend toward low carbohydrate diets is not supported by evidence-based science. DRIs support 45-65% of our calories should come from carbohydrate staple foods including whole and enriched grains, vegetables, pulses, nuts, seeds, fruits, and low fat dairy.

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## Questions?

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## Credit Claiming

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4. Select "Start/Resume" to complete the course and submit the evaluation.
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