





## Diet AND Inflammation

September 28  
12-1 pm

Register Today

Inflammation is a hot topic. Ne  
of all people who are looking f  
inflammation do so throug  
changes that include diet. f  
the science stand when  
foods and infl



# Housekeeping

- You are muted and your camera is turned off
- Write questions in Q&A section
- Continuing Education\* and Zoom recording will be available on [AmericanDairy.com](https://www.AmericanDairy.com)

CPEU & CME credit  
provided by New Jersey  
Academy of Nutrition &  
Dietetics and New Jersey  
American Academy of  
Pediatrics

#### Accreditation Statement:

This activity has been planned and implemented in accordance with the accreditation requirements of the Medical Society of New Jersey through the joint providership of Atlantic Health System and New Jersey Chapter, American Academy of Pediatrics. Atlantic Health System designates this live educational activity for a maximum of 1.0 *AMA PRA Category 1 Credits™* for September 28, 2023. Physicians should claim only the credit commensurate with the extent of their participation in the activity. Successful completion of this CME activity, which includes participation in the activity, with individual assessments of the participant and feedback to the participant, enables the participant to earn 1 MOC Part 2 points in the American Board of Pediatrics' (ABP) Maintenance of Certification (MOC) program. It is the CME activity provider's responsibility to submit participant completion information to ACCME for the purpose of granting ABP MOC credit.

In order to receive credit the participant must view 85% of the presentation and complete evaluation. Within 30-days of evaluation completion, the CME certificate will be issued to the attendee.

# Diet and Inflammation

Dr. Brad Bolling

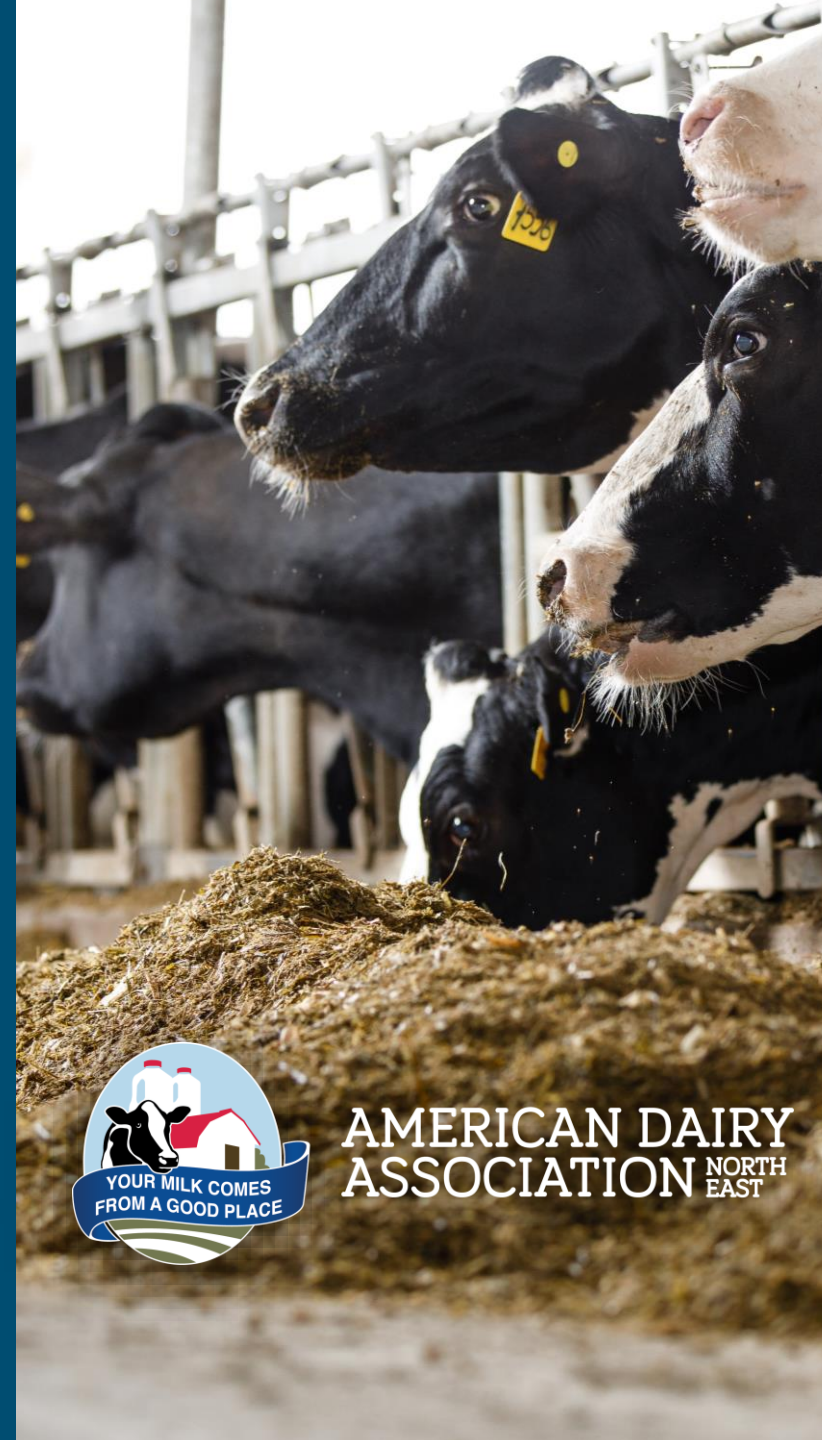
Associate Professor at University of Wisconsin-Madison

[@bwbolling](#)

Jim White, RD, ACSM

Exercise Physiologist, Owner of Jim White Fitness & Nutrition Studios

[@jimwhitefit](#)



AMERICAN DAIRY  
ASSOCIATION NORTH  
EAST





# Brad Bolling, PhD

## Speaker Disclosures

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**Research Funding:**

National Dairy Council  
UW Dairy Innovation Hub  
Fritz Friday Chair of Vegetable Processing  
Research  
Kikkoman USA R&D Laboratory  
Almond Board of California  
USDA HATCH WIS02094  
USDA NIFA AFRI WIS03038  
National Science Foundation  
UW-Madison Discovery to Product  
The Peanut Institute

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**Honoraria/Travel  
Support:**

American Dairy Association North East

**Patent:**

US 11,142,492 B2 (Methods Of Isolating Phenols)

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# Diet & Inflammation

Bioactives for health

Presented by Dr. Brad Bolling



AMERICAN DAIRY  
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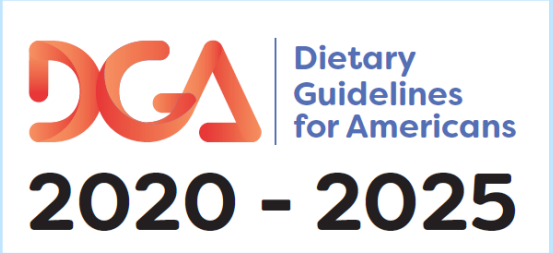
# True Cost of Food Measuring What Matters to Transform the U.S. Food System



500,000 deaths annually in US

\$1.1 Trillion for health care

# Recommended dietary patterns for health



## Following the *Dietary Guidelines* Can Help Improve Americans' Health

Each step closer to eating a diet that aligns with the *Dietary Guidelines* is associated with:



Lower Risk of Heart Disease



Lower Risk of Type 2 Diabetes



Lower Risk of Cancer



Lower Risk of Obesity



Lower Risk of Hip Fracture

- DGA: Healthy U.S.-Style Dietary Pattern
- DGA: Mediterranean-style Dietary Pattern
- DGA: Vegetarian Dietary Pattern
- Dietary Approaches to Stop Hypertension (DASH)



*Diet & risk of chronic disease (in healthy individuals)*

<https://www.fda.gov/food/food-labeling-nutrition/authorized-health-claims-meet-significant-scientific-agreement-ssa-standard>  
<https://www.nhlbi.nih.gov/health-topics/dash-eating-plan>



# Most Americans Do Not Follow a Healthy Dietary Pattern

Figure 1-6  
**Dietary Intakes Compared to Recommendations:  
 Percent of the U.S. Population Ages 1 and Older Who Are  
 Below and At or Above Each Dietary Goal**



\*NOTE: Recommended daily intake of whole grains is to be at least half of total grain consumption, and the limit for refined grains is to be no more than half of total grain consumption.

**Underconsumed nutrients of concern:**  
 potassium, dietary fiber, choline,  
 magnesium, calcium, vitamin A, vitamin  
 D, vitamin E, vitamin C, iron (adolescent  
 girls, women 19-50 y.o.)

# What Ultra-Processed Foods Are (and Why They're So Bad for You)

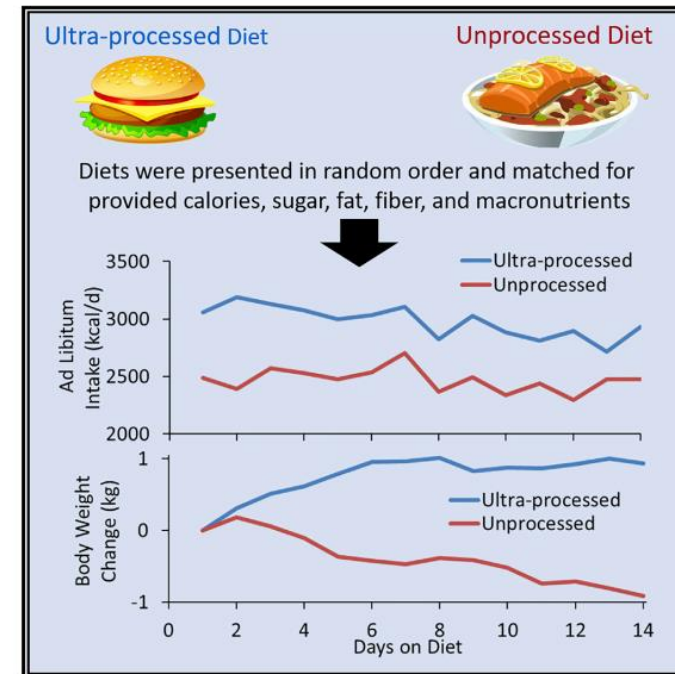
They've been altered to include fats, starches, sugars and hydrogenated oils



## Cell Metabolism Clinical and Translational Report

### Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of *Ad Libitum* Food Intake

#### Graphical Abstract



#### Authors

Kevin D. Hall, Alexis Ayuketah, Robert Brychta, ..., Peter J. Walter, Shanna Yang, Megan Zhou

#### Correspondence

kevinh@nih.gov

#### In Brief

Hall et al. investigated 20 inpatient adults who were exposed to ultra-processed versus unprocessed diets for 14 days each, in random order. The ultra-processed diet caused increased *ad libitum* energy intake and weight gain despite being matched to the unprocessed diet for presented calories, sugar, fat, sodium, fiber, and macronutrients.

#### Highlights

- 20 inpatient adults received ultra-processed and unprocessed diets for 14 days each
- Diets were matched for presented calories, sugar, fat, fiber, and macronutrients



## Ultra-processed

### Ultra-processed Menu

#### Day 3

##### Breakfast

Egg (Papetti's), turkey bacon (Jenni-O) and American cheese (Glenview Farms) on an English muffin (Sara Lee)

Tater tots (Monarch) with ketchup (Heinz)

Orange juice (Sun Cup) with NutriSource Fiber



## Unprocessed

### Unprocessed Menu

#### Day 1

##### Breakfast

Greek yogurt (Fage) parfait with strawberries, bananas, with Walnuts (Diamond), Salt and Olive Oil

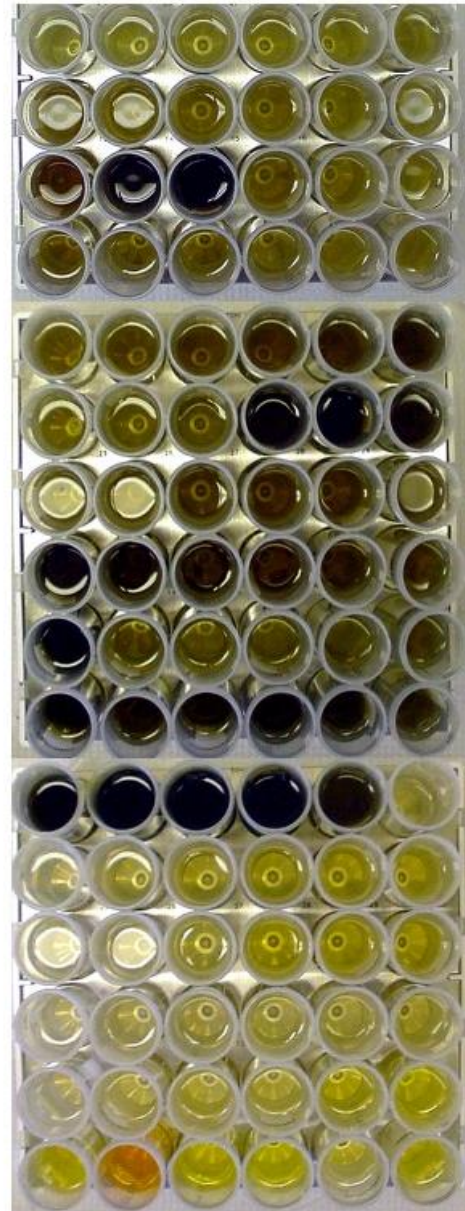
Apple Slices with Fresh Squeezed Lemon



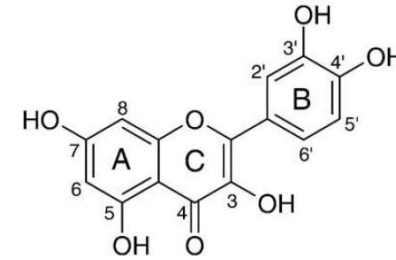
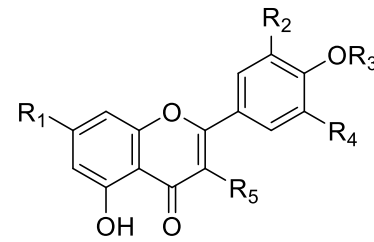




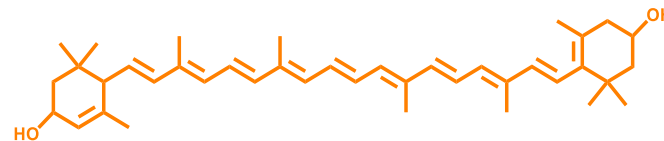
# Healthful diets include nutrients and bioactives



## Flavonols



Compound	R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	R <sub>5</sub>
Kaempferol	OH	H	H	H	OH
Rutin	OH	OH	H	H	<i>O</i> -rutinoside
Quercetin	OH	OH	H	H	OH
Quercitrin	OH	OH	H	H	<i>O</i> -rhamnoside
Isoquercitrin	OH	OH	H	H	<i>O</i> -glucoside
Myricetin	OH	OH	H	OH	OH
Isorhamnetin	H	OCH <sub>3</sub>	OH	H	OH



## Nutrients

- Vitamins
- Minerals
- Fiber



## Dairy is a good source of nutrients and bioactives



### Bioactives

$\alpha$ -lactalbumin  
 $\beta$ -lactoglobulin  
glycomacro-peptide  
lactoferrin  
polar lipids



### Bioactives

cultures  
probiotics  
peptides  
metabolites

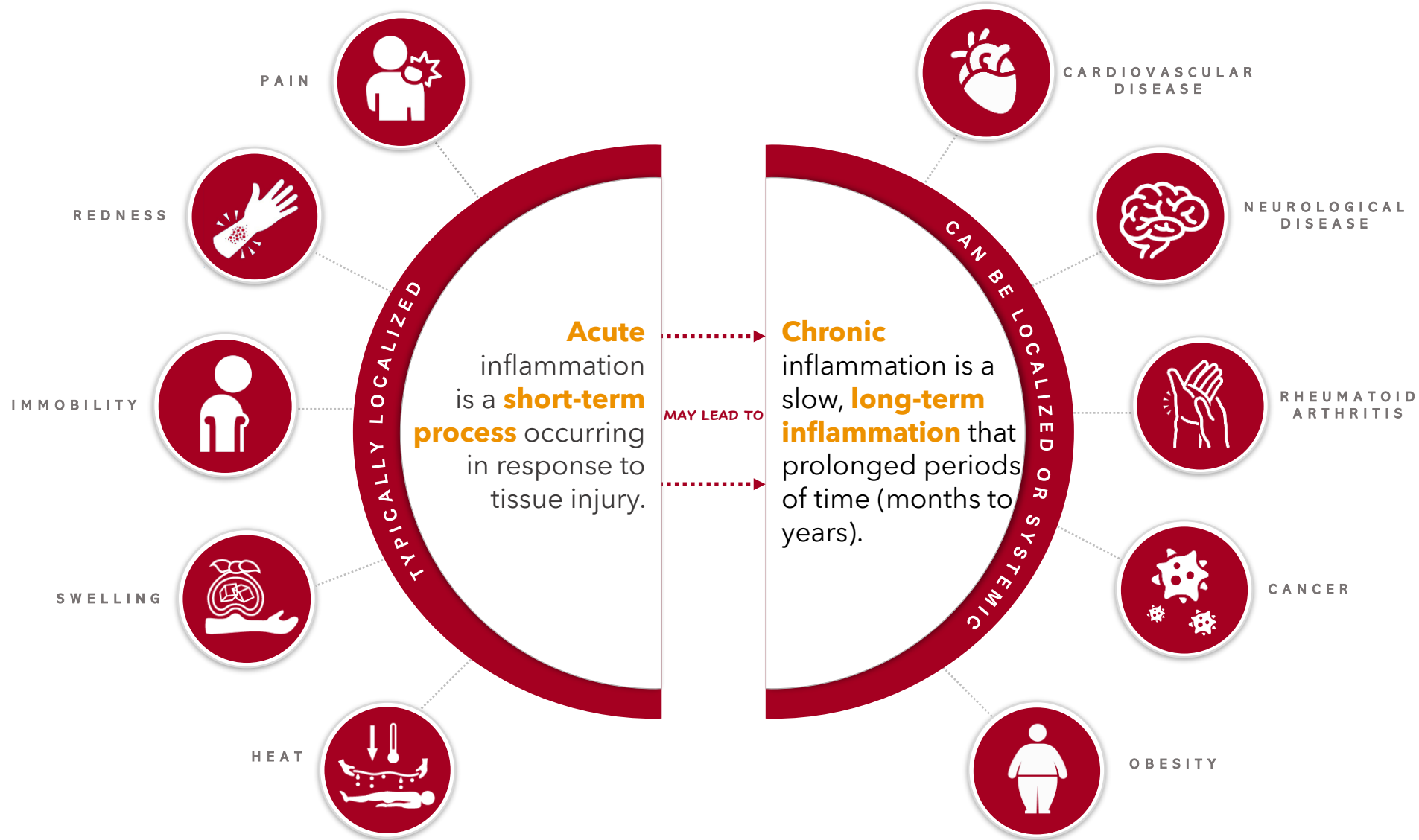


### Bioactives

cultures  
probiotics  
metabolites  
peptides  
exopolysaccharides

**INFLAMMATION** is a vital part of the immune system's response to injury and infection. It is one of the ways to defend against foreign invaders as well as a way to signal the immune system to heal and repair damaged tissue.

**ACUTE**



# Chronic Inflammation

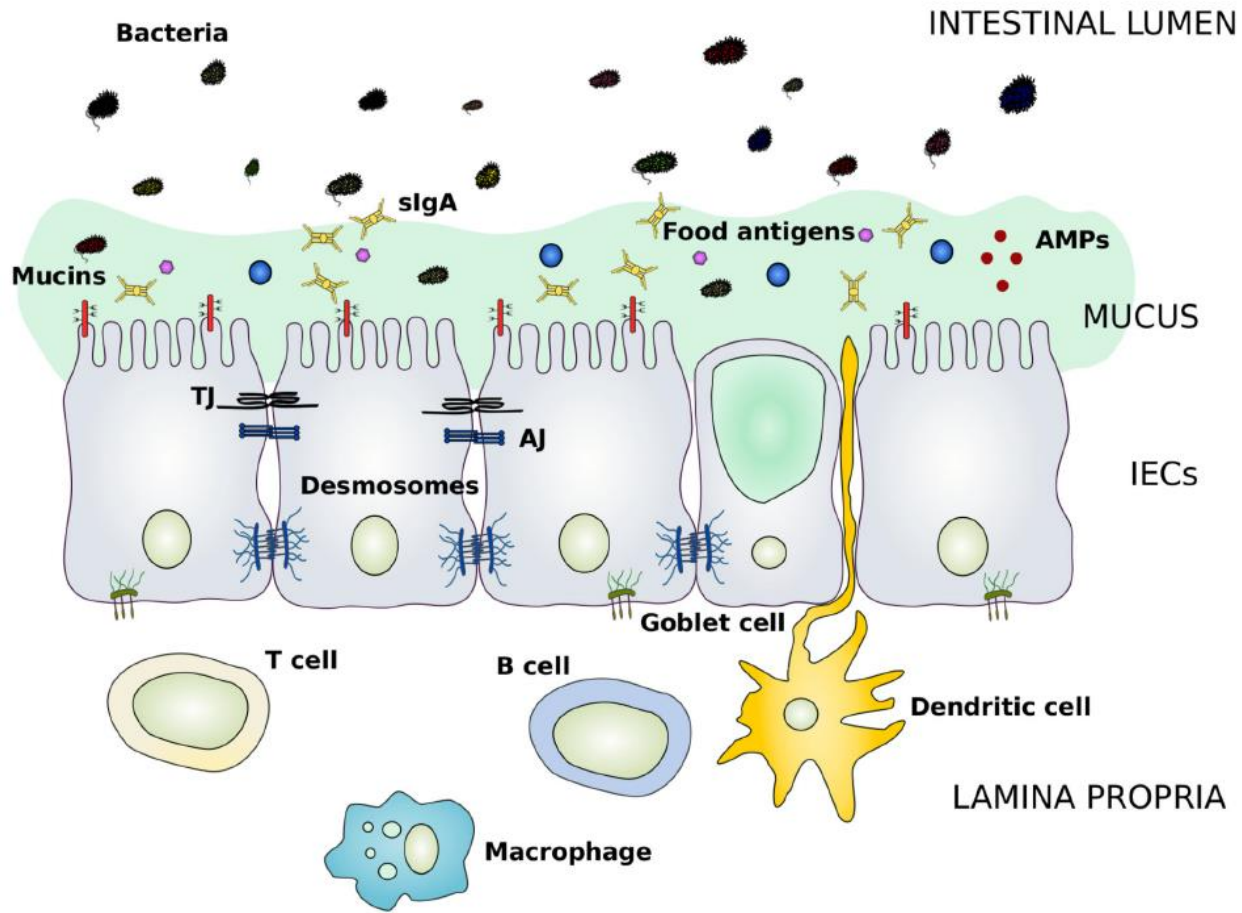
## Characteristics

- Low-grade & unresolved
- May not have outward symptoms
- Associated with chronic diseases
- Risks
  - *obesity*
  - *environmental chemical exposure*
  - *stress*
  - *nutrition*
  - *microbiome*





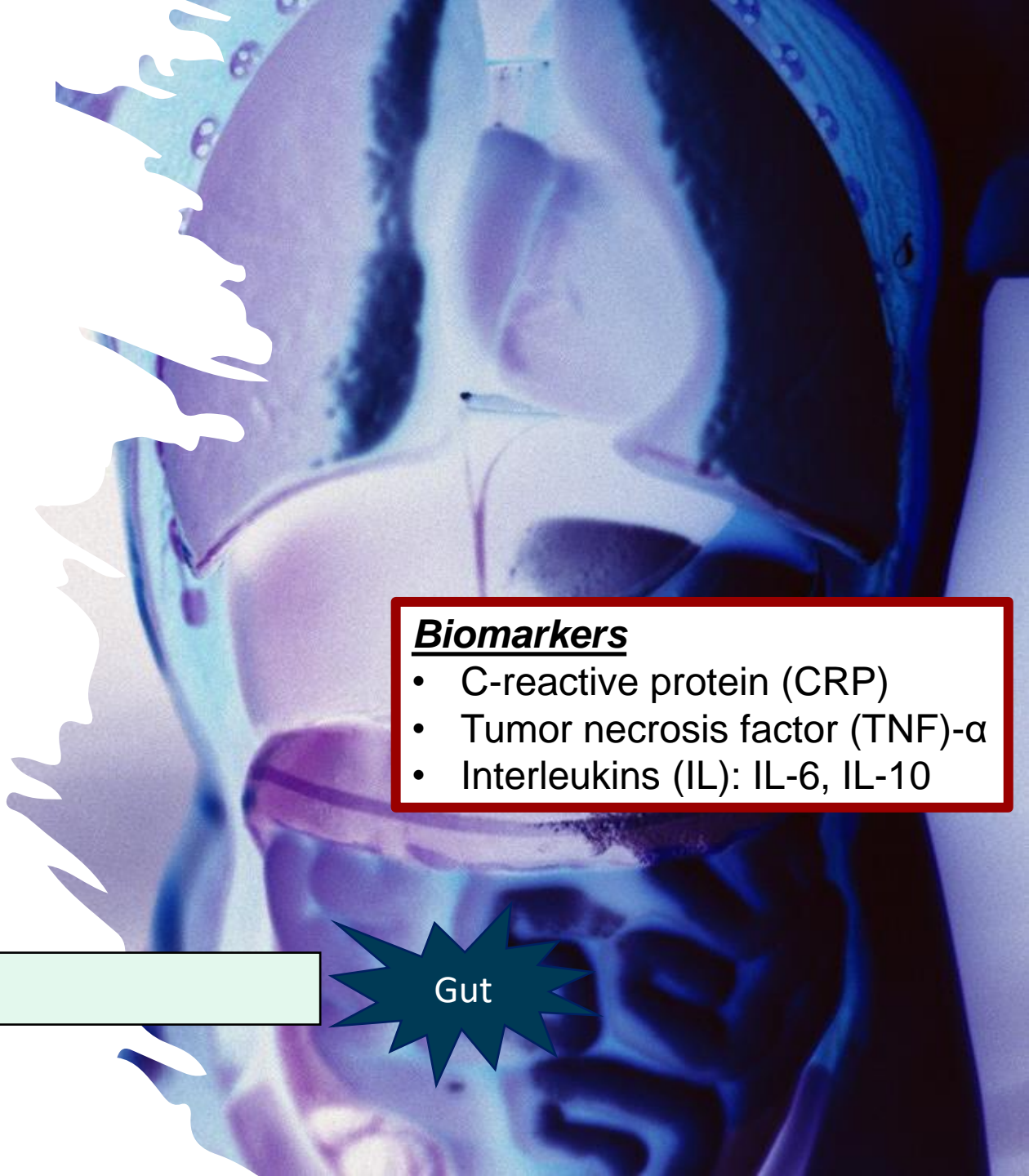
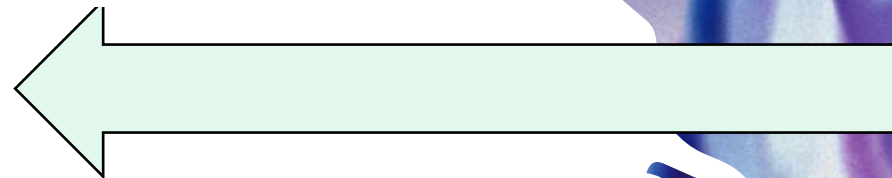
# Chronic Inflammation



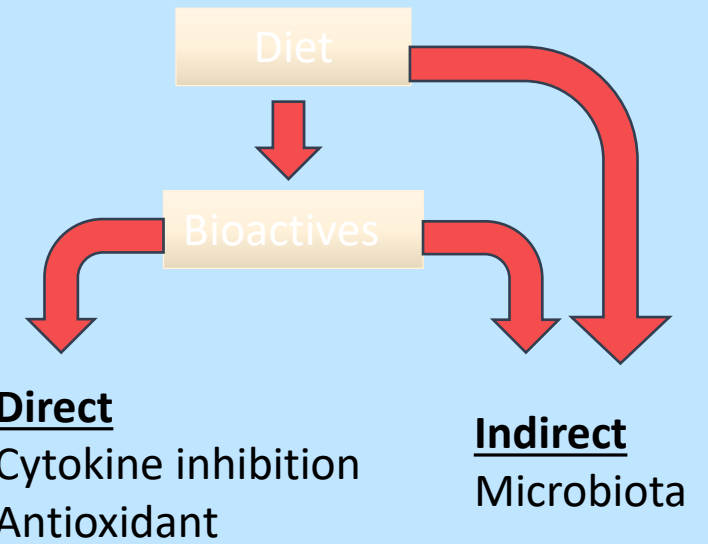
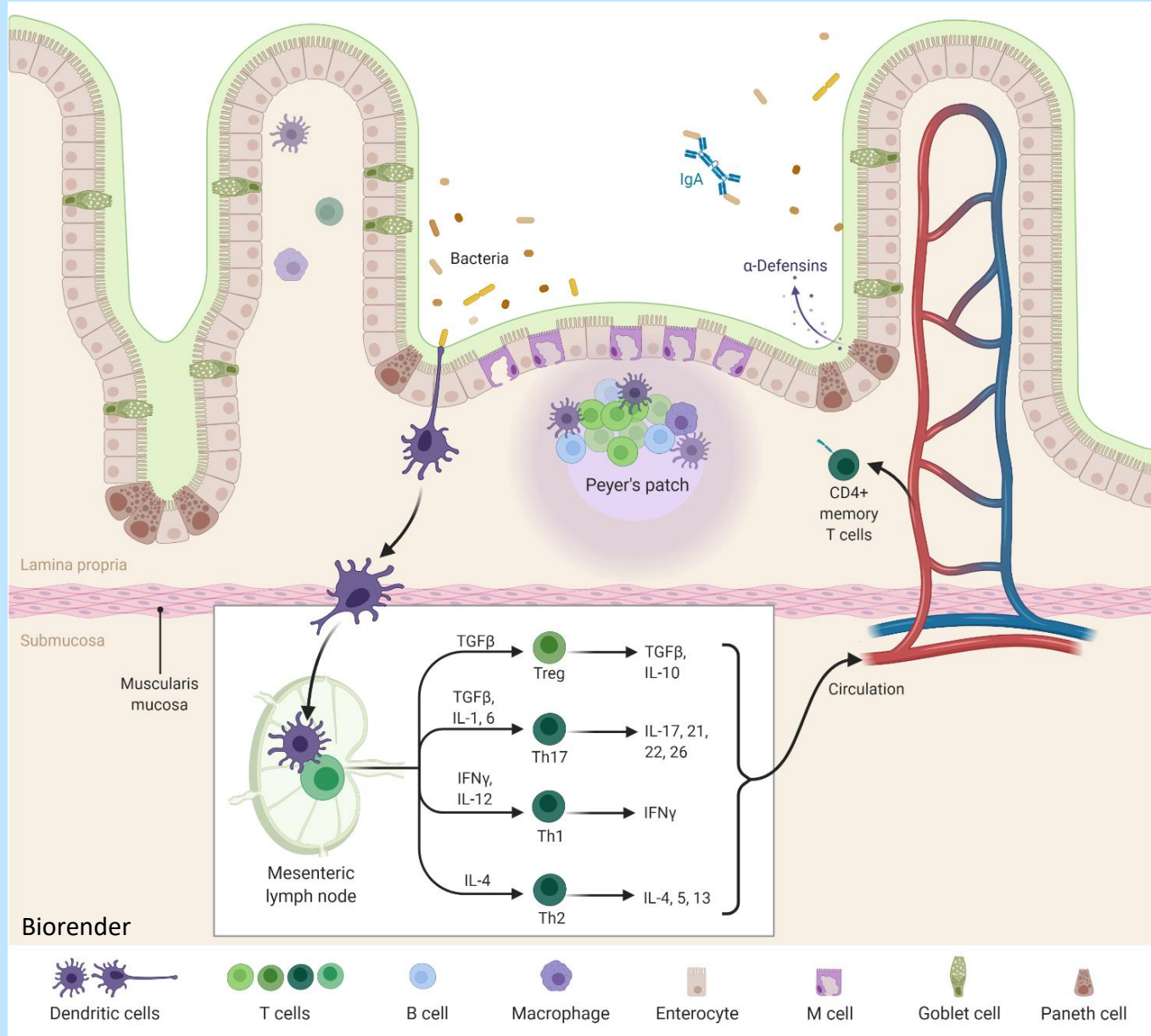
- Biomarkers**
- C-reactive protein (CRP)
  - Tumor necrosis factor (TNF)- $\alpha$
  - Interleukins (IL): IL-6, IL-10

## Tissues

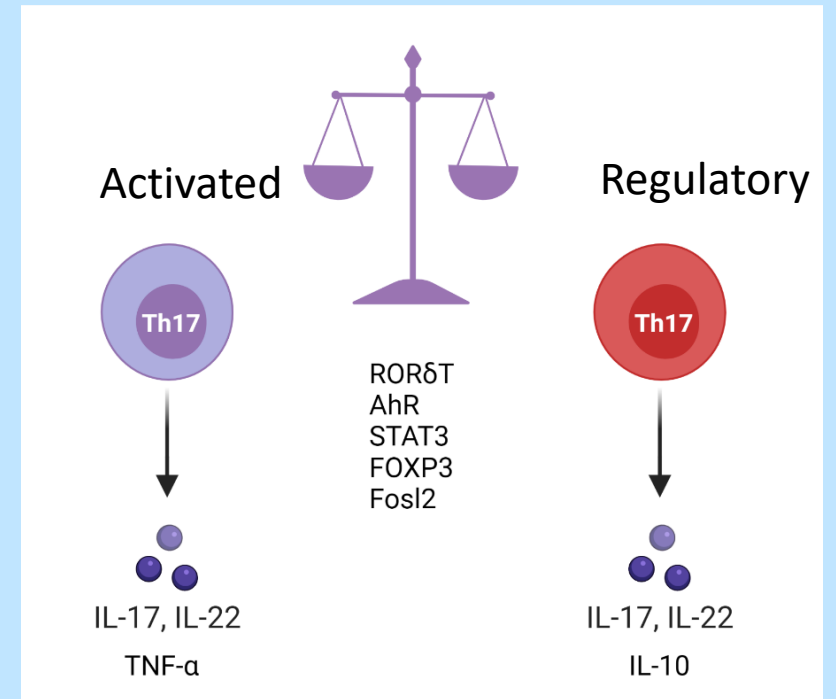
The gut is an important site of immune function



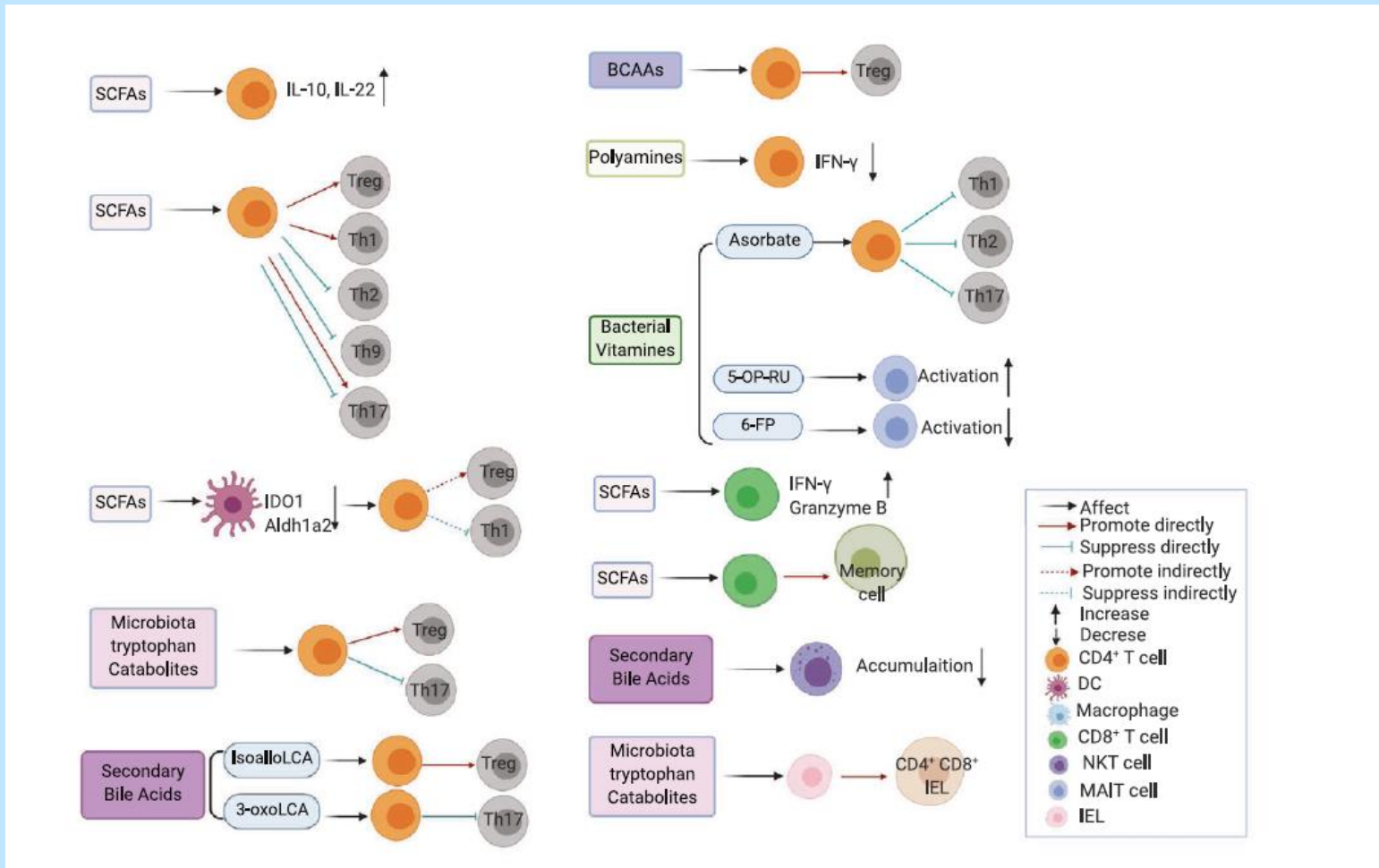
# Nutrients and bioactives interface with the intestinal immune system



## Th17 Plasticity



The gut is also linked to the immune system, brain, liver, lung, oral, and many others...



### Microbial metabolites involved in pathogenesis of:

- Inflammatory bowel diseases
- Diabetes
- Rheumatoid arthritis
- Systemic lupus erythematosus
- Cardiovascular disease
- Cancers



# The gut microbiota are integral to health

Factors include genetics, co-habitation, diet, age, environment, health history

NATURE MEDICINE | VOL 27 | FEBRUARY 2021 | 321-332

nature  
medicine

ARTICLES

<https://doi.org/10.1038/s41591-020-01183-8>

Check for updates

## Microbiome connections with host metabolism and habitual diet from 1,098 deeply phenotyped individuals

Francesco Asnicar<sup>1,16</sup>, Sarah E. Berry<sup>2,16</sup>, Ana M. Valdes<sup>3,4</sup>, Long H. Nguyen<sup>5</sup>, Gianmarco Piccinno<sup>1</sup>, David A. Drew<sup>5</sup>, Emily Leeming<sup>6</sup>, Rachel Gibson<sup>2</sup>, Caroline Le Roy<sup>6</sup>, Haya Al Khatib<sup>7</sup>, Lucy Francis<sup>7</sup>, Mohsen Mazidi<sup>6</sup>, Olatz Mompeo<sup>6</sup>, Mireia Valles-Colomer<sup>1</sup>, Adrian Tett<sup>1</sup>, Francesco Beghini<sup>1</sup>, Léonard Dubois<sup>1</sup>, Davide Bazzani<sup>1</sup>, Andrew Maltez Thomas<sup>1</sup>, Chloe Mirzayi<sup>8</sup>, Asya Khleborodova<sup>8</sup>, Sehyun Oh<sup>8</sup>, Rachel Hine<sup>7</sup>, Christopher Bonnett<sup>7</sup>, Joan Capdevila<sup>7</sup>, Serge Danzanvilliers<sup>7</sup>, Francesca Giordano<sup>7</sup>, Ludwig Geistlinger<sup>8</sup>, Levi Waldron<sup>8</sup>, Richard Davies<sup>7</sup>, George Hadjigeorgiou<sup>7</sup>, Jonathan Wolf<sup>7</sup>, José M. Ordovás<sup>9,10</sup>, Christopher Gardner<sup>11</sup>, Paul W. Franks<sup>12,13</sup>, Andrew T. Chan<sup>5,13,14,17</sup>, Curtis Huttenhower<sup>13,14,17</sup>, Tim D. Spector<sup>5,17</sup> and Nicola Segata<sup>1,15,17</sup>

The gut microbiome is shaped by diet and influences host metabolism; however, these links are complex and can be unique to each individual. We performed deep metagenomic sequencing of 1,203 gut microbiomes from 1,098 individuals enrolled in the Personalised Responses to Dietary Composition Trial (PREDICT 1) study, whose detailed long-term diet information, as well as hundreds of fasting and same-meal postprandial cardiometabolic blood marker measurements were available. We found many significant associations between microbes and specific nutrients, foods, food groups and general dietary indices, which were driven especially by the presence and diversity of healthy and plant-based foods. Microbial biomarkers of obesity were reproducible across external publicly available cohorts and in agreement with circulating blood metabolites that are indicators of cardiovascular disease risk. While some microbes, such as *Prevotella copri* and *Blastocystis* spp., were indicators of favorable postprandial glucose metabolism, overall microbiome composition was predictive for a large panel of cardiometabolic blood markers including fasting and postprandial glycaemic, lipemic and inflammatory indices. The panel of intestinal species associated with healthy dietary habits overlapped with those associated with favorable cardiometabolic and postprandial markers, indicating that our large-scale resource can potentially stratify the gut microbiome into generalizable health levels in individuals without clinically manifest disease.

Microbial species segregate into groups associated with more and less healthy plant- and animal- based foods.

Distinct microbial signatures discriminate between positive and negative metabolic health indices under fasting conditions

Microbial indicators of obesity are reproducible across varied populations.

The strongest microbiome habitual diet associations are driven by poorly characterized microbes.

**Still, much to learn!**

Personalized Responses to Dietary Composition Trial (PREDICT 1)





**Aronia berry**



# Higher dietary anthocyanin and flavonol intakes are associated with anti-inflammatory effects in a population of US adults<sup>1</sup>

Aedin Cassidy,<sup>2</sup> Gail Rogers,<sup>3</sup> Julia J Peterson,<sup>4</sup> Johanna T Dwyer,<sup>3–5</sup> Honghuang Lin,<sup>6</sup> and Paul F Jacques<sup>3,4\*</sup>

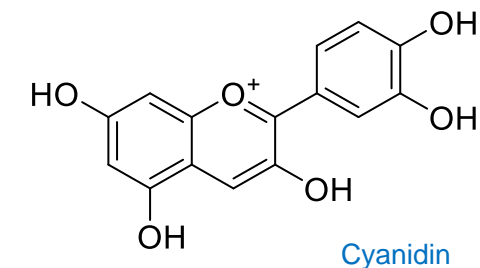
<sup>2</sup>Department of Nutrition, Norwich Medical School, University of East Anglia, Norwich, United Kingdom; <sup>3</sup>Jean Mayer USDA Human Nutrition Research Center on Aging and <sup>4</sup>The Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA; <sup>5</sup>Tufts University School of Medicine and Frances Stern Nutrition Center, Tufts Medical Center, Boston, MA; and <sup>6</sup>Section of Computational Biomedicine, Department of Medicine, Boston University School of Medicine, Boston, MA

TABLE 3

Associations between different flavonoid subclass intakes and a combined inflammation score in 2375 participants in the Framingham Offspring Study<sup>1</sup>

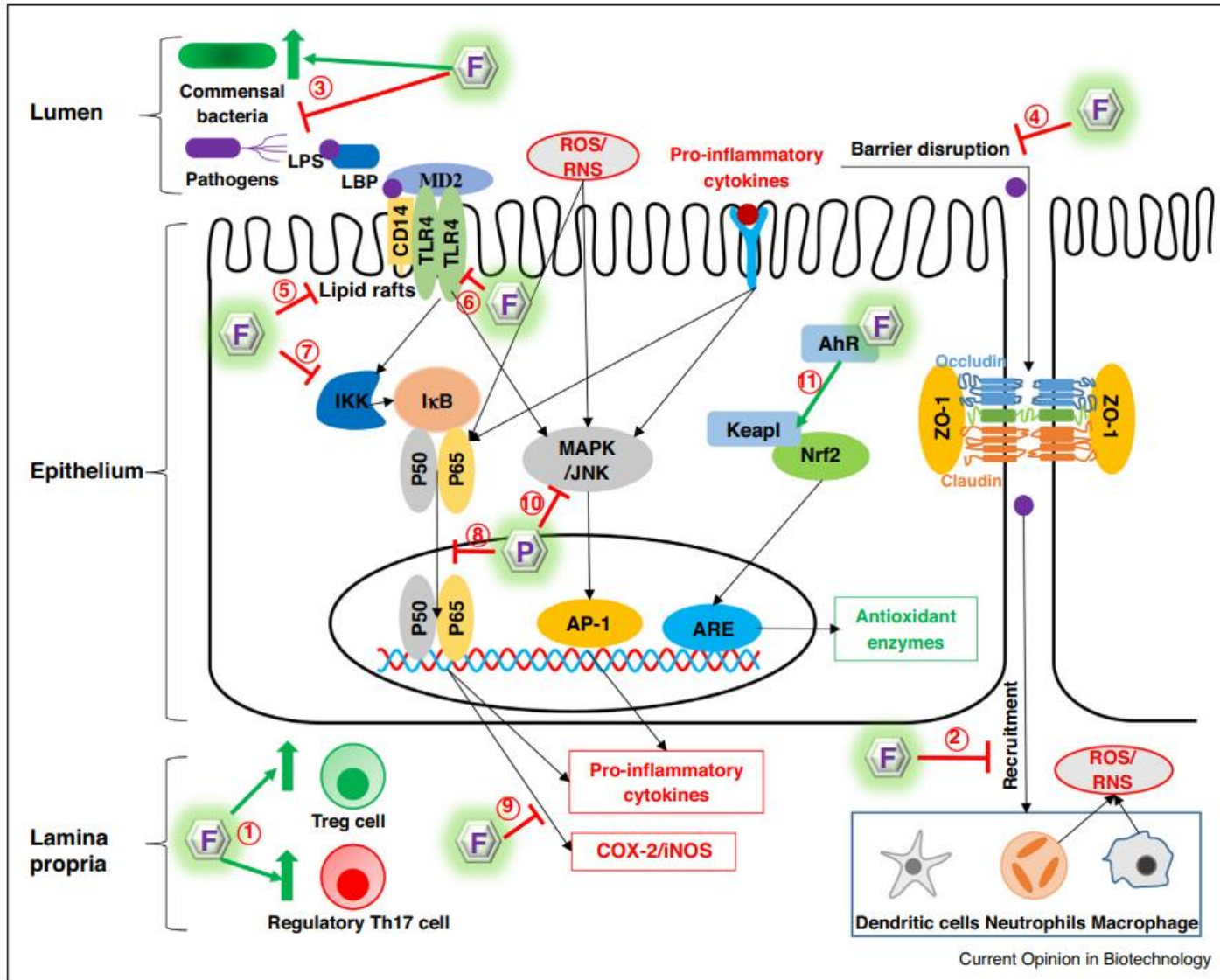
Inflammation score	Quintile categories of flavonoid intake					P-trend
	1	2	3	4	5	
<b>Flavonols</b>						
Model 1	0.88 (0.42, 1.33)	0.50 (0.06, 0.93)	0.05 (−0.39, 0.49)	−0.40 (−0.84, 0.04)	−0.72 (−1.16, −0.27)	<0.001
Model 2	0.43 (−0.03, 0.88)	0.33 (−0.11, 0.76)	0.11 (−0.33, 0.55)	−0.43 (−0.87, 0.02)	−0.29 (−0.75, 0.16)	0.01
<b>Flavones</b>						
Model 1	0.87 (0.42, 1.32)	0.04 (−0.39, 0.48)	0.12 (−0.32, 0.56)	−0.25 (−0.69, 0.19)	−0.46 (−0.91, −0.01)	<0.001
Model 2	0.36 (−0.10, 0.82)	−0.05 (−0.48, 0.38)	0.12 (−0.32, 0.56)	−0.08 (−0.52, 0.35)	−0.11 (−0.57, 0.35)	0.24
<b>Flavanones</b>						
Model 1	0.50 (0.06, 0.95)	−0.19 (−0.63, 0.26)	0.25 (−0.19, 0.69)	−0.12 (−0.56, 0.32)	−0.12 (−0.58, 0.33)	0.16
Model 2	0.12 (−0.33, 0.56)	−0.27 (−0.70, 0.17)	0.13 (−0.31, 0.57)	0.11 (−0.33, 0.55)	0.15 (−0.31, 0.60)	0.46
<b>Flavan-3-ols</b>						
Model 1	1.19 (0.74, 1.64)	−0.38 (−0.82, 0.06)	−0.06 (−0.50, 0.38)	−0.20 (−0.64, 0.24)	−0.25 (−0.69, 0.20)	0.02
Model 2	0.70 (0.25, 1.15)	−0.38 (−0.82, 0.05)	0.01 (−0.43, 0.44)	−0.05 (−0.50, 0.39)	−0.08 (−0.52, 0.37)	0.31
<b>Anthocyanins</b>						
Model 1	0.98 (0.54, 1.43)	0.18 (−0.25, 0.62)	0.25 (−0.19, 0.68)	−0.27 (−0.72, 0.17)	−0.86 (−1.30, −0.41)	<0.001
Model 2	0.77 (0.33, 1.22)	0.09 (−0.34, 0.52)	0.30 (−0.13, 0.74)	−0.36 (−0.80, 0.09)	−0.71 (−1.17, −0.25)	<0.001
<b>Polyflavonoids</b>						
Model 1	0.63 (0.18, 1.09)	0.30 (−0.14, 0.74)	−0.18 (−0.62, 0.26)	0.02 (−0.42, 0.46)	−0.48 (−0.92, −0.03)	0.002
Model 2	0.29 (−0.16, 0.74)	0.17 (−0.26, 0.60)	−0.13 (−0.56, 0.31)	0.01 (−0.44, 0.45)	−0.14 (−0.59, 0.31)	0.24
<b>Total flavonoids</b>						
Model 1	0.67 (0.21, 1.12)	0.52 (0.08, 0.96)	−0.28 (−0.72, 0.16)	−0.22 (−0.66, 0.22)	−0.39 (−0.84, 0.06)	0.001
Model 2	0.22 (−0.24, 0.67)	0.37 (−0.06, 0.81)	−0.17 (−0.61, 0.26)	−0.21 (−0.66, 0.23)	−0.01 (−0.47, 0.44)	0.34

<sup>1</sup>All values are adjusted (least-squares) mean inflammation scores; 95% CIs in parentheses. Model 1 was adjusted for age, sex, smoking (yes or no), and energy intake. Model 2 was adjusted as for model 1 and for nonsteroidal anti-inflammatory drug use (yes or no), BMI, cardiovascular disease (yes or no), diabetes (yes or no), and saturated fat and *trans* fat intakes. *P* values for the test of linear trend across quintile categories were based on linear regression models with the median intake of each quintile category assigned to individuals with intake in that category, and this quintile median variable was used as a continuous measure in regression models.

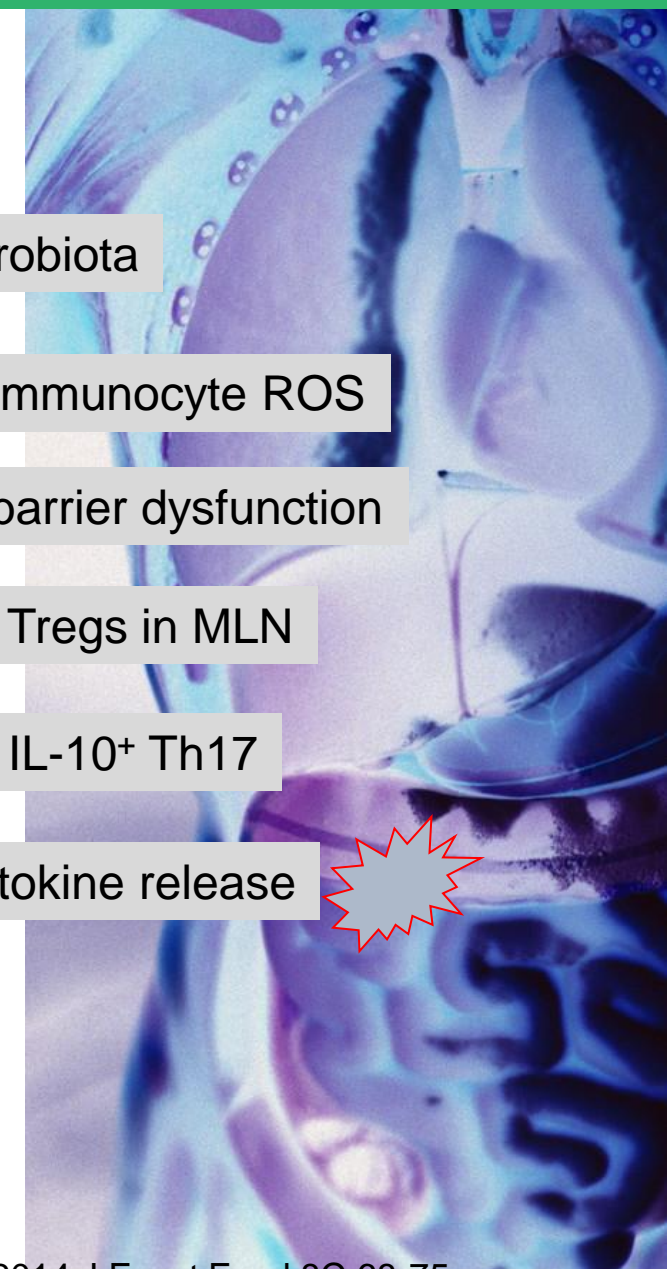




# Anti-inflammatory mechanisms of berry consumption



- Alters microbiota
- Reduces immunocyte ROS
- Prevents barrier dysfunction
- Increases Tregs in MLN
- Increases IL-10<sup>+</sup> Th17
- Inhibits cytokine release

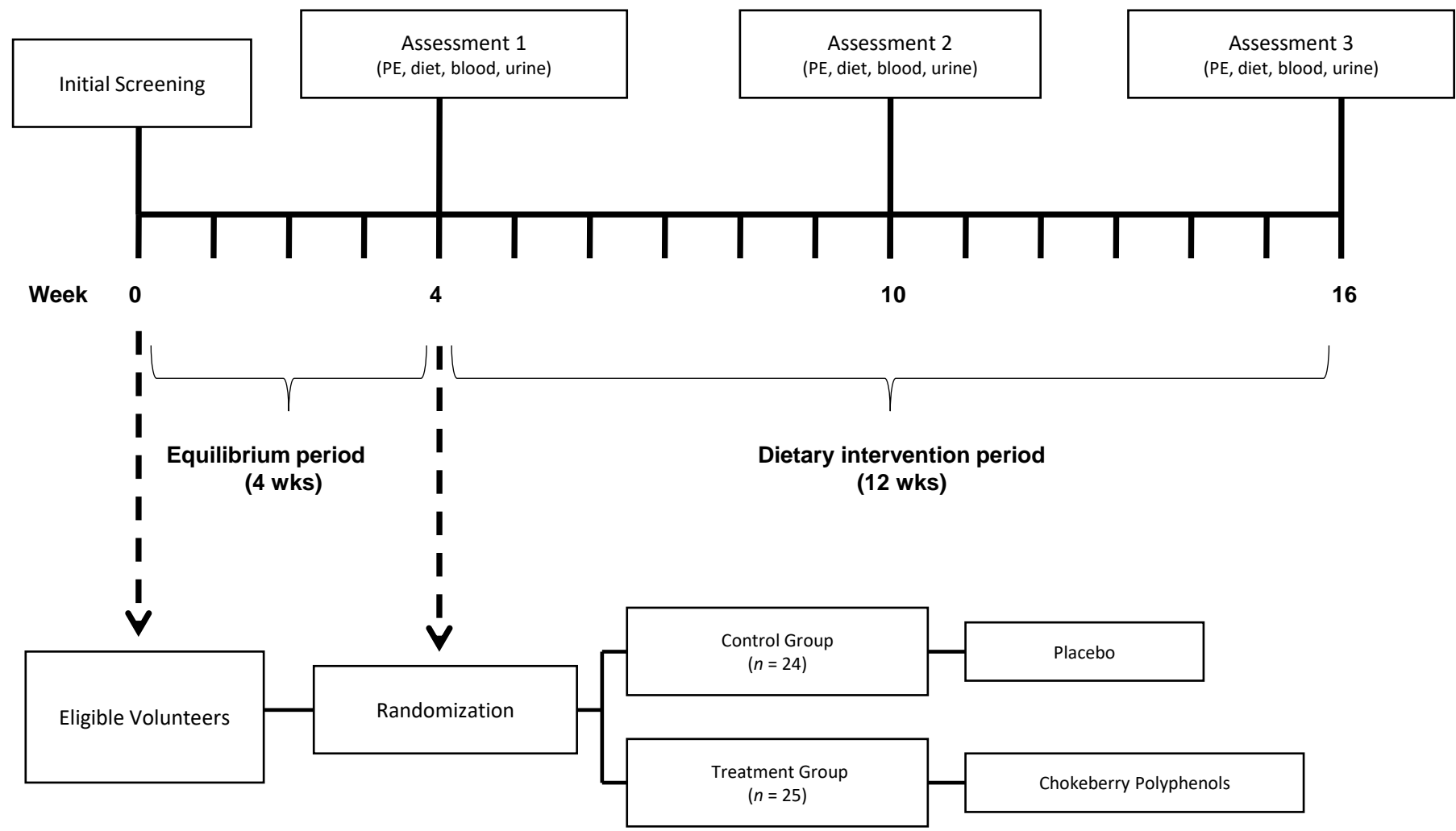


Martin et al., 2014 J Funct Food 8C:68-75  
 Martin et al., 2018 J Funct Food 44:48-57

D Randomized placebo-controlled trial



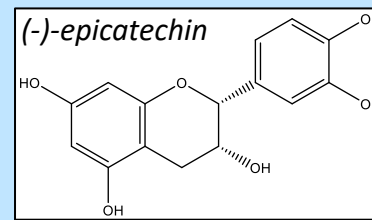
**Dose: 500 mg encapsulated aronia extract**  
**15% anthocyanins**



LDL ↓ 8%  
Total cholesterol : ↓ 10%

No changes in markers of inflammation or oxidative stress

# Polyphenols & Inflammation



*Adv Nutr* 2022;13:2070–2083



## Perspective: Flavan-3-ols and Cardiometabolic Health: First Ever Dietary Bioactive Guideline

Kristi M Crowe-White,<sup>1</sup> Levi W Evans,<sup>2</sup> Gunter GC Kuhnle,<sup>3</sup> Dragan Milenkovic,<sup>4</sup> Kim Stote,<sup>5</sup> Taylor Wallace,<sup>6,7</sup> Deepa Handu,<sup>8</sup> and Katelyn E Senkus<sup>1</sup>

<sup>1</sup>Department of Human Nutrition, The University of Alabama, Tuscaloosa, AL, USA; <sup>2</sup>USDA-ARS, Western Human Nutrition Research Center, Davis, CA, USA; <sup>3</sup>Department of Food and Nutritional Sciences, University of Reading, Reading, United Kingdom; <sup>4</sup>Department of Nutrition, University of California Davis, Davis, CA, USA; <sup>5</sup>State University of New York, Empire State College, Saratoga Springs, NY, USA; <sup>6</sup>Department of Nutrition and Food Studies, George Mason University, Washington, DC, USA; <sup>7</sup>Produce for Better Health Foundation, Washington, DC, USA; and <sup>8</sup>Academy of Nutrition and Dietetics, Chicago, IL, USA

*Adv Nutr* 2023;14:270–282

Advances in Nutrition 14 (2023) 270–282



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## Advances in Nutrition

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### Review

## Efficacy of Dietary Polyphenols from Whole Foods and Purified Food Polyphenol Extracts in Optimizing Cardiometabolic Health: A Meta-Analysis of Randomized Controlled Trials

Tonny Kiyimba<sup>1,2</sup>, Peter Yiga<sup>1,2</sup>, Michael Bamuwanye<sup>1</sup>, Patrick Ogwok<sup>1</sup>, Bart Van der Schueren<sup>2,3</sup>, Christophe Matthys<sup>2,3,\*</sup>

<sup>1</sup>Department of Food Science and Technology, Kyambogo University, Kampala, Uganda; <sup>2</sup>Clinical and Experimental Endocrinology, Department of Chronic Diseases and Metabolism, KU Leuven, Leuven, Belgium; <sup>3</sup>Department of Endocrinology, University Hospitals Leuven, Leuven, Belgium

“Moderate evidence supporting cardiometabolic protection resulting from flavan-3-ol intake in the range of 400–600 mg/d was supported in the literature.”

Among 46 RCTs with ~2500 participants...

No significant impact on IL-6 or CRP



### *Recent meta-analyses*

#### **Lycopene & tomato** [Curr Pharm Des 2023;29(21) 1671-1700]

- 34 RCTs
- ↔ CRP, IL-6, TNF- $\alpha$

#### **Almond** [Adv Nutr 2022;13(5):1462-1475]

- 16 RCTs
- ↓ CRP (-0.252 mg/L, 95% CI -0.43,-0 .06] at < 60 g/d
- ↔ TNF- $\alpha$

## Misconceptions about dairy and inflammation

Dairy is pro-inflammatory

Dairy is bad for gut health



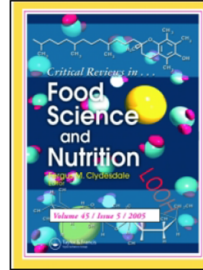
<https://www.health.harvard.edu/blog/dairy-health-food-or-health-risk-2019012515849>



# Dairy Foods Are Not “Pro-inflammatory”

 **The American Journal of  
CLINICAL NUTRITION**


**The Effects of Dairy Product and Dairy Protein Intake on Inflammation: A Systematic Review of the Literature**



Critical Reviews in Food Science and Nutrition

**Dairy products and inflammation:  
A review of the clinical evidence**

ISSN: 1040-8398 (Print) 1549-7852 (Online) Journal homepage: <http://www.tandfonline.com>

 **Advances in Nutrition**

*Milk and Dairy Product Consumption and Inflammatory Biomarkers: An Updated Systematic Review of Randomized Clinical Trials*

**Systematic Review  
27 Randomized Control Trials**

“This systematic review shows that consumption of dairy products [i.e., milk, cheese, yogurt] and proteins [i.e., whey, casein] has neutral to beneficial effects on biomarkers of inflammation.”

Nieman K, et al. The Effects of Dairy Product and Dairy Protein Intake on Inflammation: A Systematic Review of the Literature. *J Am Coll Nutr.* 2021 Aug; 40 (6) 571-582.

**Systematic Review  
52 Clinical Trials**

“Our review suggests that dairy products, in particular fermented products, have anti-inflammatory properties in humans not suffering from allergy to milk, in particular in subjects with metabolic disorders.”

Bordoni A, et al. Dairy Products and Inflammation: A Review of the Clinical Evidence. *Crit Rev Food Sci Nutr.* 2017 Aug 13; 57 (12): 2497-2525.

**Systematic Review  
16 Studies**

“The consumption of milk or dairy products did not show a proinflammatory effect in healthy subjects or individuals with metabolic abnormalities.”

Ulven SM, et al. Milk and Dairy Product Consumption and Inflammatory Biomarkers: An Updated Systematic Review of Randomized Clinical Trials. *Adv Nutr.* 2019 May 1; 10 (suppl\_2): S239-S250.

# Fermented Dairy Foods may be “anti-inflammatory”

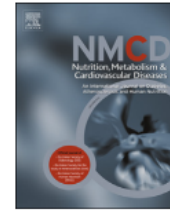
Nutrition, Metabolism & Cardiovascular Diseases (2023) 33, 471–482



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

Nutrition, Metabolism & Cardiovascular Diseases

journal homepage: [www.elsevier.com/locate/nmcd](http://www.elsevier.com/locate/nmcd)



SYSTEMATIC REVIEWS AND META-ANALYSES

## Effects of fermented dairy products on inflammatory biomarkers: A meta-analysis

Xiaofeng Zhang, Qiuping Luo, Xiaoxian Guan, Yujun Tang, Xiaoli Chen, Jinlan Deng, Jianming Fan\*

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Received 13 September 2022; received in revised form 25 November 2022; accepted 13 December 2022

Handling Editor: A. Siani

Available online 22 December 2022



## Systematic Review 14 Randomized Control Trials

yogurt (n = 9)  
fermented milk (n = 4)  
kefir (n = 2)

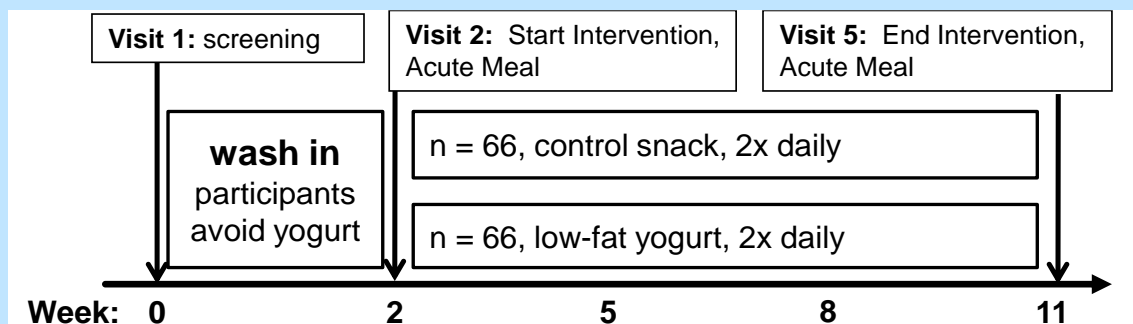
“...the consumption of FDPs was slightly associated with reduced inflammation...”

...further explorative work is required to investigate the effects of long-term use of FDPs as part of overall dietary patterns on chronic inflammation.”

# Yogurt and gut health



or



Nutrient	Low-fat Yogurt	Control (soy pudding)
Serving (g)	339 (12 oz.)	324
Calories (kcal)	330	330
Total fat (g)	3	3
Carbohydrate (g)	66	66
Protein (g)	9	6-9
Cholesterol	15	0
Sodium (mg)	180	165-210
Calcium (mg)	450	180-450
Vit. D (IU)	6.75	6.75
Vit A (IU)	1500	600

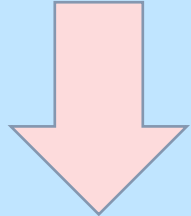
Non-obese: 18.5-27 kg/m<sup>2</sup>

Obese: 30-40 kg/m<sup>2</sup>



# Yogurt and gut health

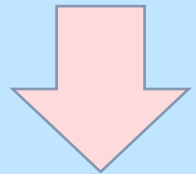
Overnight fast



Baseline (0 h blood draw)

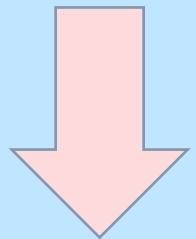


8 oz. yogurt or equivalent control



~ 10 min

Challenge meal



~ 30 min

Postprandial blood draws



**226 kcal**



**960 kcal**

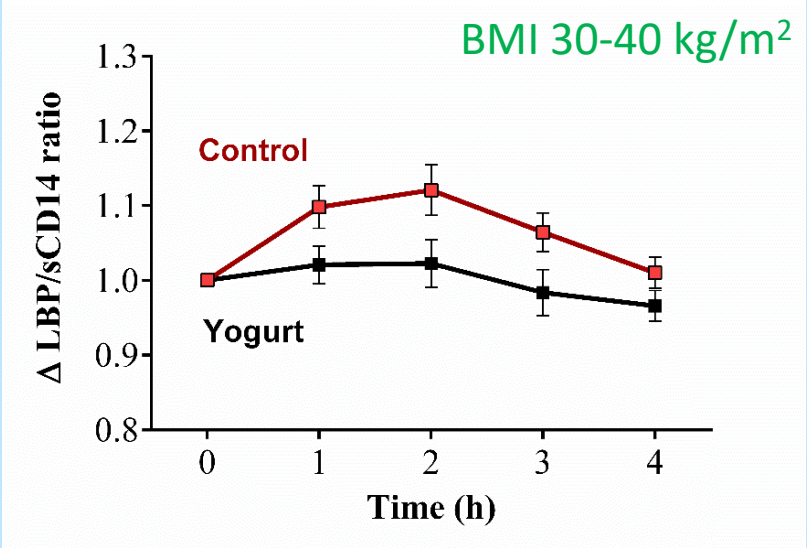
56-60 g fat

82 g carbohydrate

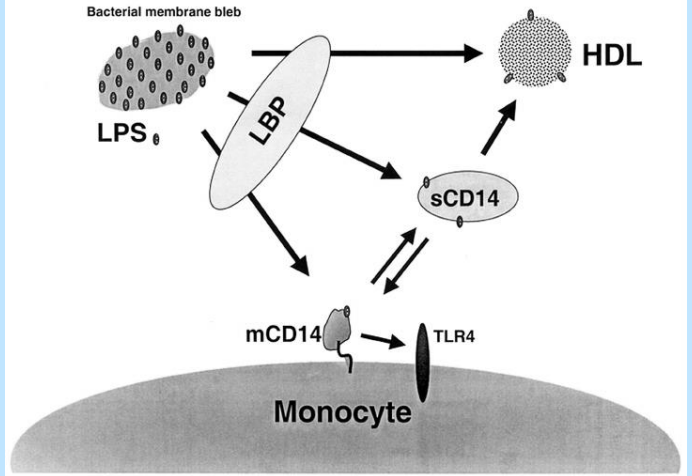
28-30 g protein

# Premeal consumption of yogurt reduces post-meal markers of gut barrier dysfunction and inflammation

Biomarker of barrier dysfunction

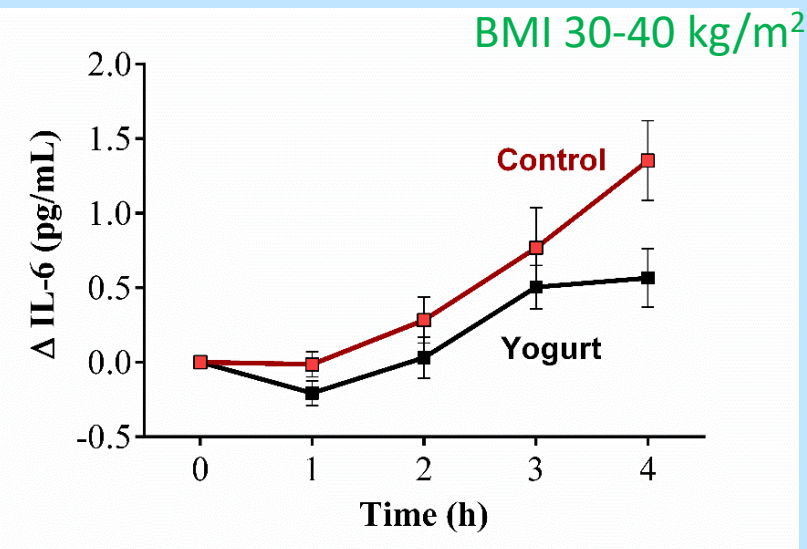


LBP: LPS-binding protein

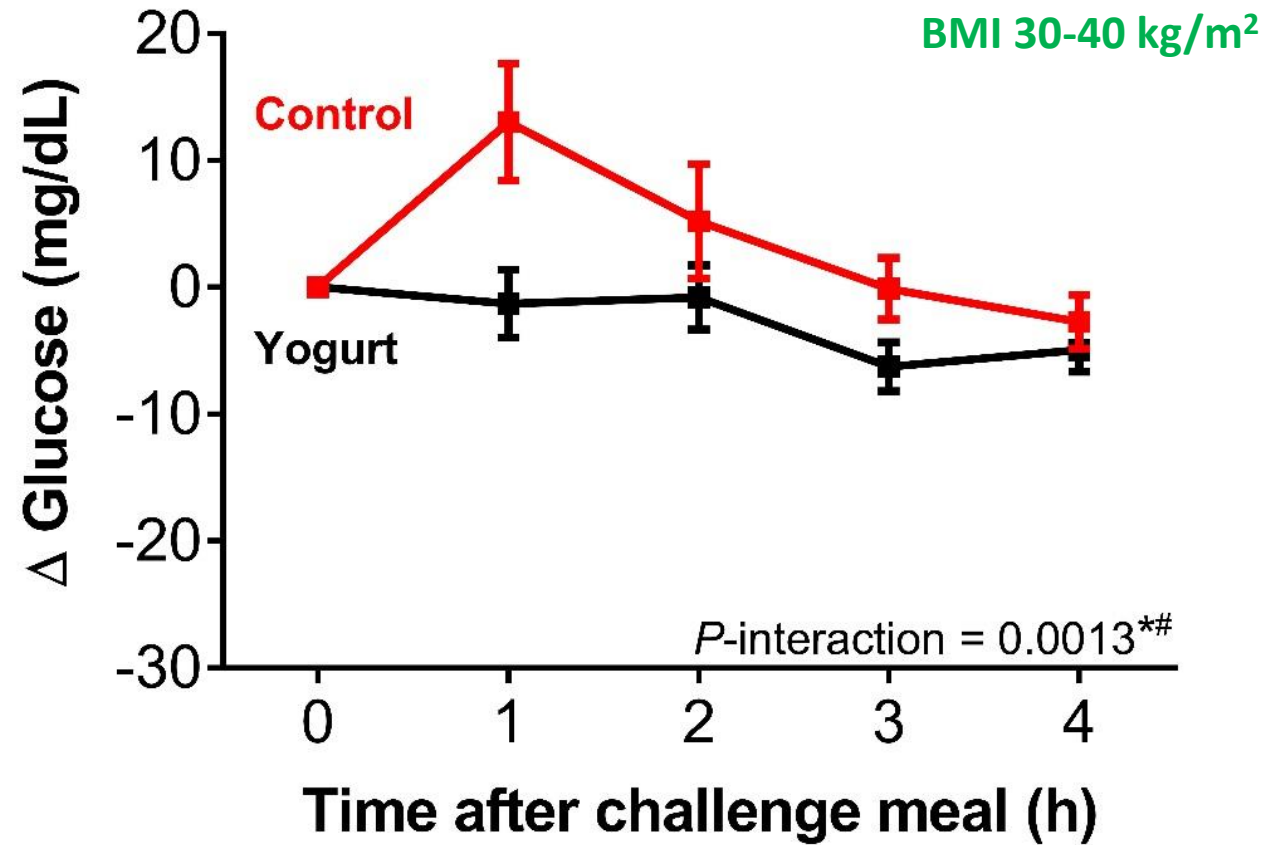


Vesy et al. Inf Immun. 2000; 68:2410-7

Biomarker of inflammation

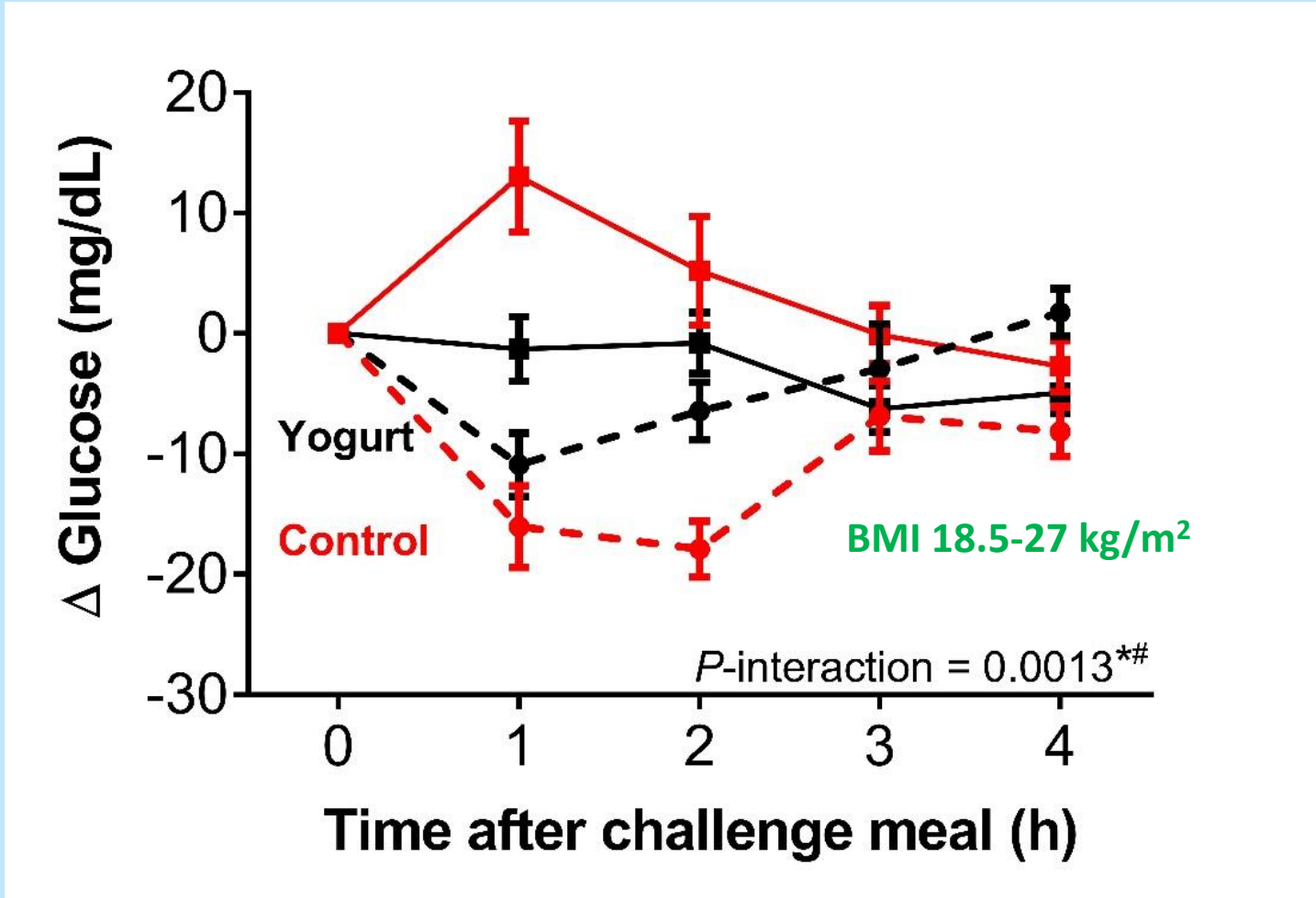


## Yogurt improves postprandial glucose responses





# Yogurt improves postprandial glucose responses



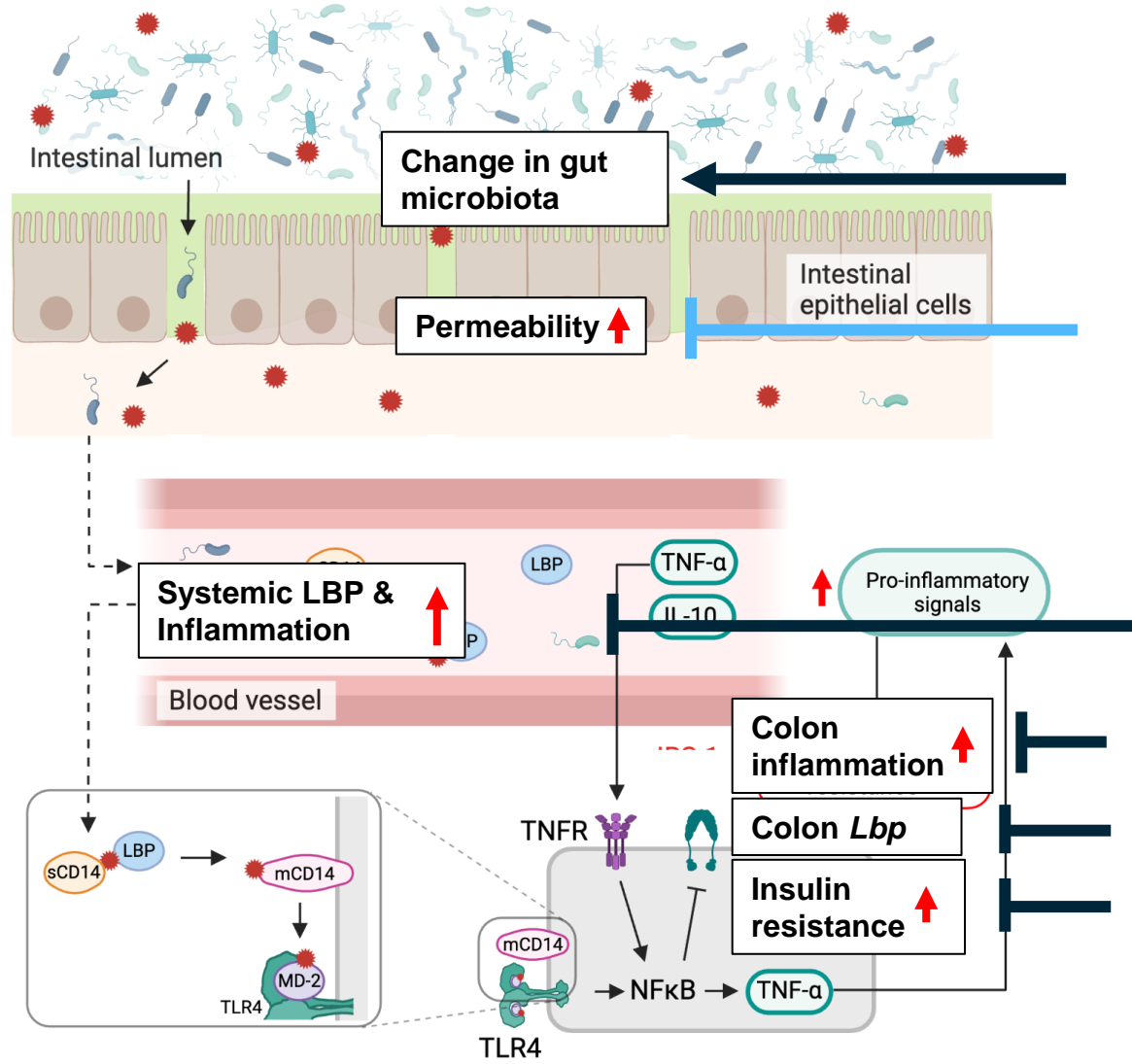
## Yogurt and gut health: Fasted responses after 9 wk consumption

Marker	(O) Yogurt	(O) Control	(N) Yogurt	(N) Control
sCD14	↔	↔	↔	↔
LBP/sCD14*	-5%	+11%	+12%	+17%
Endocab*	+5%	-1%	+6%	-2%
IL-6	↔	↔	↔	↔
hsCRP	↔	↔	↔	↔
TNF- $\alpha$ /sTNFRII*	-7%	-2%	-8%	+10%

P<0.05, \*treatment, #obesity

Pei et al., Br. J. Nutr (2017)

# Mechanisms of yogurt bioactives in the gut




  
**Yogurt supplementation**

Hasegawa et al. J Nutr. 2023;153:703-12  
 Pei et al. J Nutr. 2018; 148:1-7  
 Pei et al. Br J Nutr. 2017;118:1043-51  
 Putt et al. Food & Function; 2017;8: 406-14

*Summarized in:* Hasegawa & Bolling. Curr Opin Food Sci. 2023;51:101017



## Summary and conclusions

- The gut mediates the beneficial actions of nutrition and bioactives.
- Diet mediates immune health, more information needed on mechanisms from specific foods.
- Healthful dietary patterns include fruits, vegetables, whole grains, and dairy.
- Certain foods might modestly reduce biomarkers of inflammation, but more work is needed to confirm association with chronic disease risk.



Emerging evidence

Anti-inflammatory effects of yogurt consumption

Scientific agreement

Lack of direct pro-inflammatory response of dairy in healthy individuals at levels recommended in DGA

Consensus



2020 - 2025

- 3 c dairy for 1,600 to 3,200 kCal
- 2020-2025 Dietary Guidelines for Americans state:

*“ A healthy dietary pattern is associated with beneficial outcomes for all-cause mortality, cardiovascular disease, overweight and obesity, type 2 diabetes, bone health, and certain types of cancer (breast and colorectal)....”*



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<https://bolling.foodsci.wisc.edu/>

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## Speaker Disclosure

- Honoraria:
  - American Dairy Association North East
- *Other Disclosures:*
  - California Grapes,
  - Soy Institute,
  - Plenity,
  - National Cattlemen's Beef Association,
  - National Dairy Council

**POLL #1**

# POLL #2

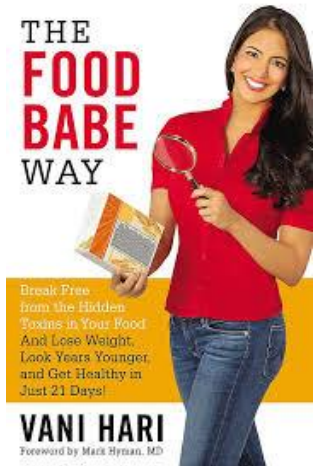


**What are people saying  
about dairy?**



# Dairy in the media in celebrity media spokespeople

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"Chemical defoamers are added to yogurt."



No: Coffee, alcohol, caffeine, tomatoes, peppers, mushrooms, eggplants, fungus, dairy, gluten, corn, soy, added sugar, artificial sweeteners, MSG, GMOs.



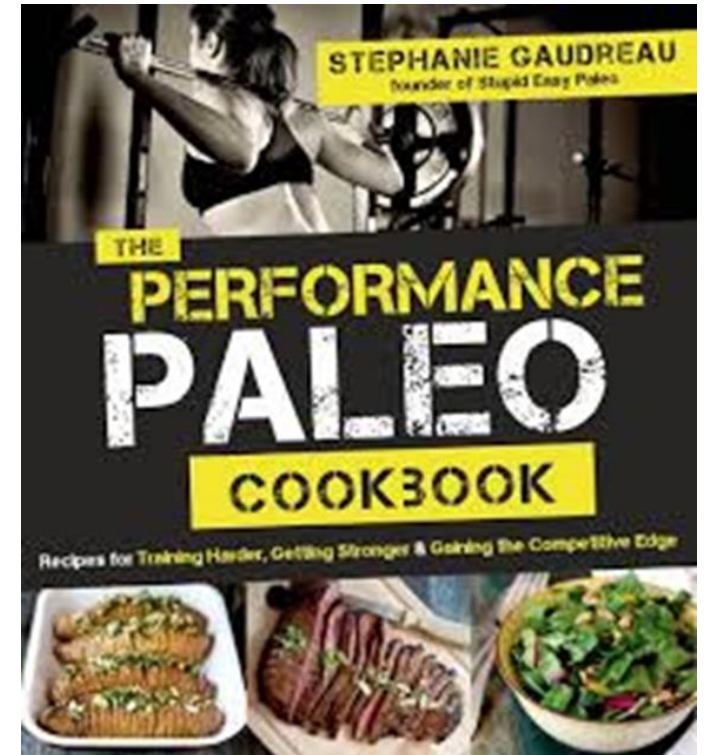
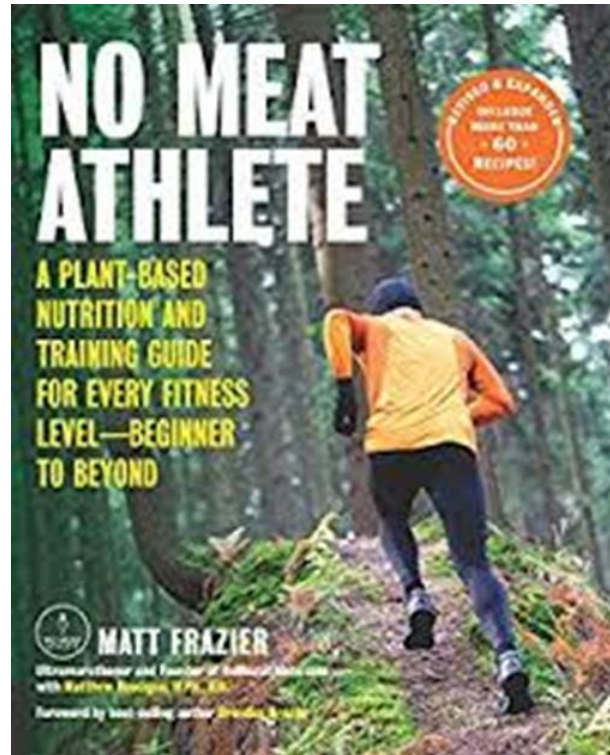
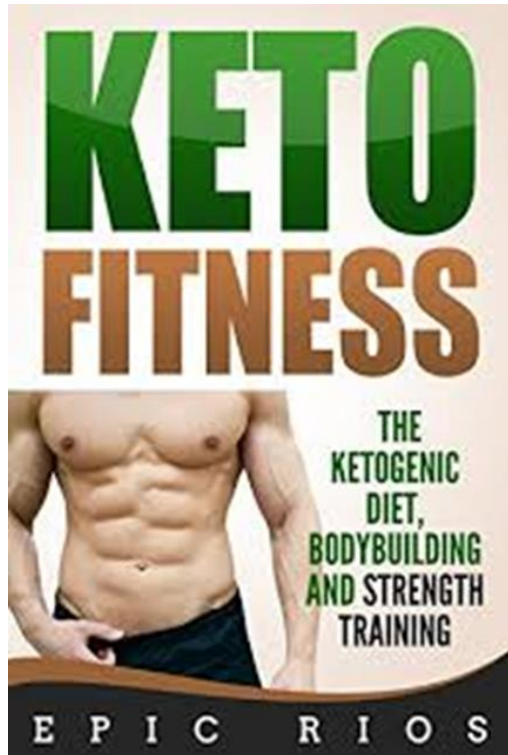
"Don't drink less than 2% milk because it contains more sugar than full fat"



"I just tried a goat milk cleanse for eight days to rid my system of parasites."

# Dairy in our media

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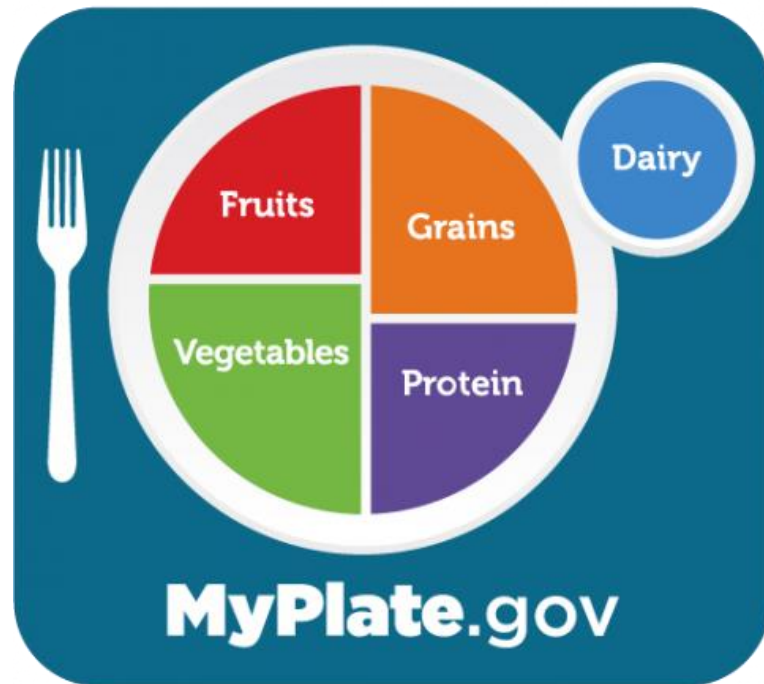


# Dairy in the community in our hometowns

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# Dairy and dietary recommendations



## HEALTHY EATING PLATE

The Healthy Eating Plate diagram shows a plate divided into four quadrants: Vegetables (green), Whole Grains (brown), Fruits (red), and Healthy Protein (orange). A yellow oil bottle icon labeled 'HEALTHY OILS' is above the plate, and a glass of water icon labeled 'WATER' is to the right.

Use healthy oils (like olive and canola oil) for cooking, on salad, and at the table. Limit butter. Avoid trans fat.

Drink water, tea, or coffee (with little or no sugar). Limit milk/dairy (1-2 servings/day) and juice (1 small glass/day). Avoid sugary drinks.

The more veggies – and the greater the variety – the better. Potatoes and French fries don't count.

Eat a variety of whole grains (like whole-wheat bread, whole-grain pasta, and brown rice). Limit refined grains (like white rice and white bread).

Eat plenty of fruits of all colors.

Choose fish, poultry, beans, and nuts; limit red meat and cheese; avoid bacon, cold cuts, and other processed meats.

**STAY ACTIVE!**  
© Harvard University

Harvard T.H. Chan School of Public Health  
The Nutrition Source  
[www.hsph.harvard.edu/nutritionsource](http://www.hsph.harvard.edu/nutritionsource)

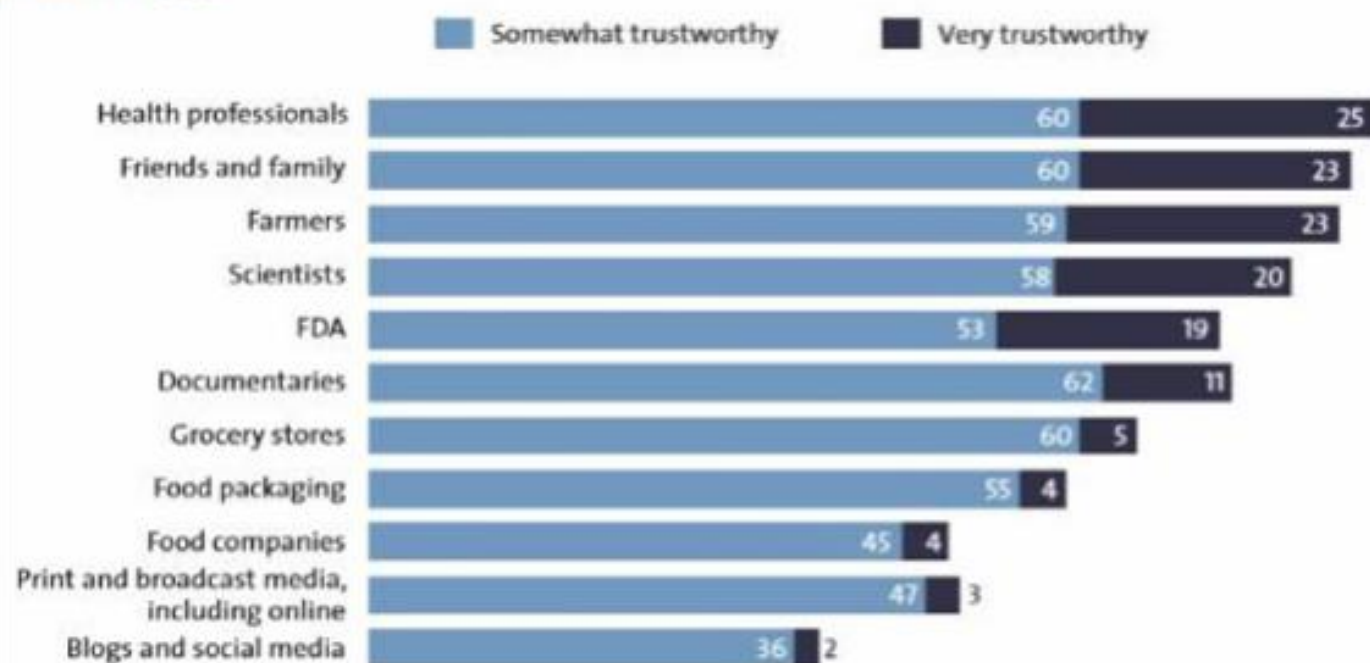
Harvard Medical School  
Harvard Health Publications  
[www.health.harvard.edu](http://www.health.harvard.edu)

# Conflicting Information Creates “Confusion”





### When you get information about the food you buy, how trustworthy do you find the following sources? (%)



Source: 2015 Science and Food Survey

THE CHICAGO COUNCIL ON GLOBAL AFFAIRS

What are the science-based  
recommendations on  
inflammation?

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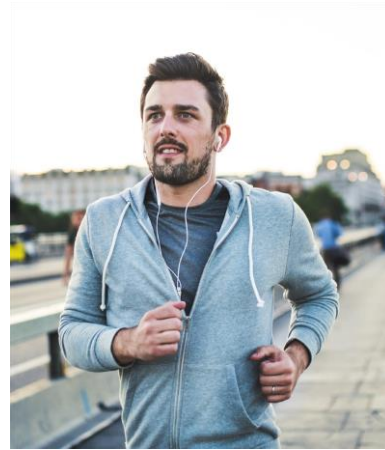
# Anti-inflammatory lifestyle practices

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**50%**  
**Stress**

American Psychological Association



**21%**  
**Exercise**

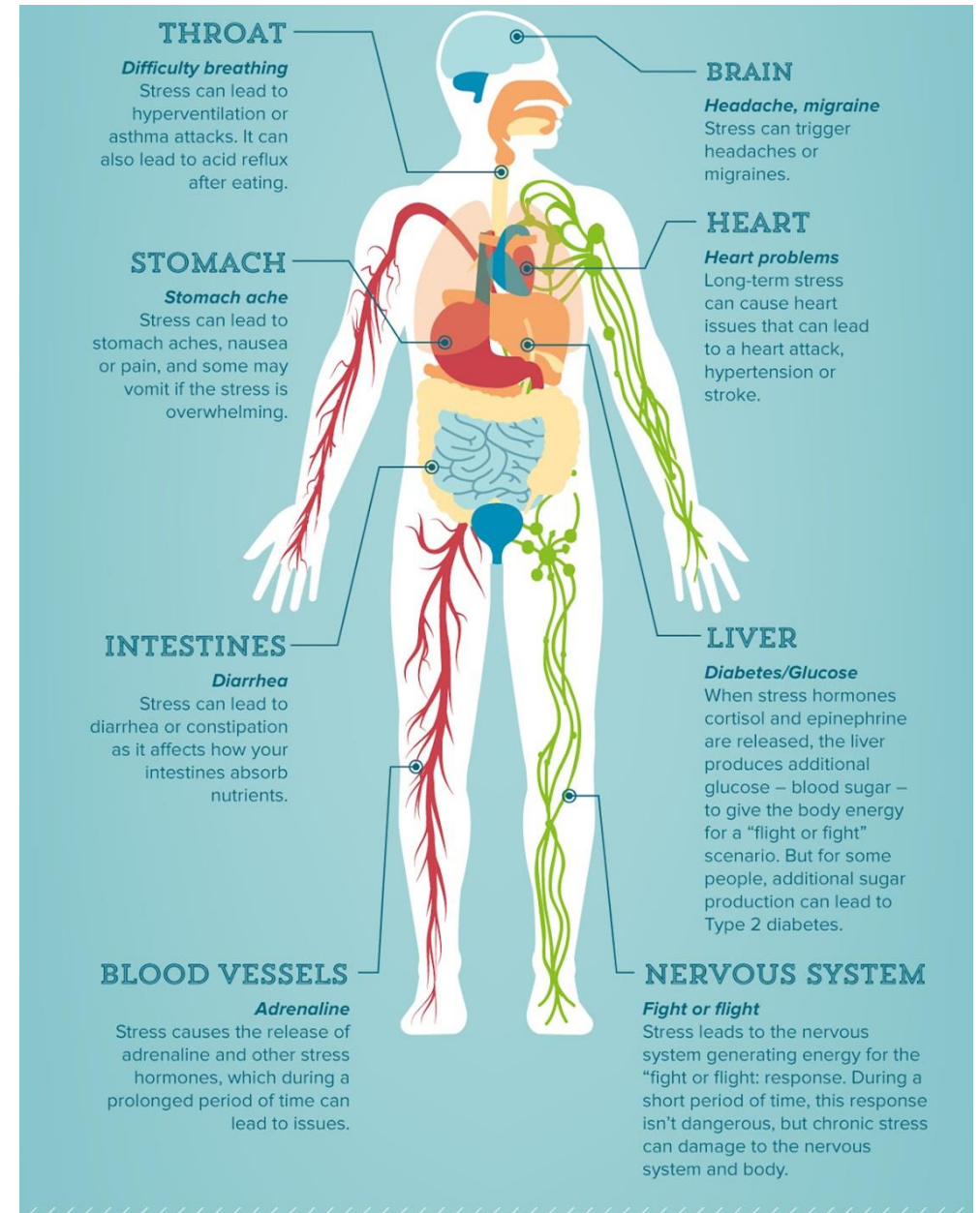
National Institute of Health



**40 M**  
**Sleep**

National Sleep Association

# Stress Causes Inflammation





# Stress

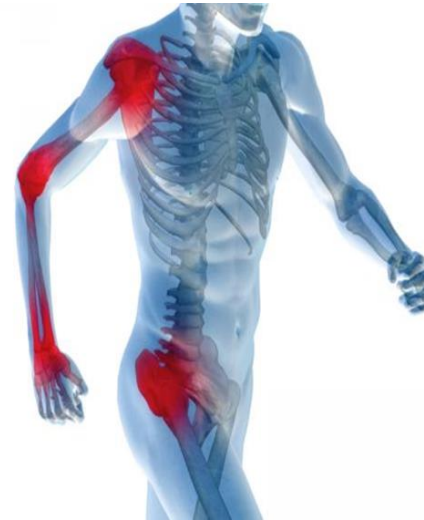
- Meditate
- Try deep breathing exercises
- Get a massage
- Yoga
- Tai Chi
- Acupuncture
- Biofeedback
- Prayer
- Volunteer Work
- Hobbies
- Playing with pets
- Shopping
- Keeping a Journal
- Therapy
- Behavioral modification
- Listening to music
- Time Management

Source: American Institute of Stress

# Exercise: Acute Inflammation vs Long Term Anti-Inflammatory Effects

---

- Acute, high intensity, or unaccustomed exercise causes the skeletal muscles to release pro-inflammatory molecules.
- A single bout of exercise may elevate oxidative stress which increases inflammation.
- According to research, exercise decreases inflammation in the long term by:
  1. Reducing fat mass
  2. Increasing the production of anti-inflammatory molecules



# Exercise recommendations for adults



## **Cardiovascular training**

- All healthy adults aged 18–65 years should participate in moderate intensity aerobic physical activity for a minimum of 30 min on five days per week, or vigorous intensity aerobic activity for a minimum of 20 min on three days per week.

## **Weight training**

- Every adult should perform activities that maintain or increase muscular strength and endurance for a minimum of two days per week.

# Sleep and Impact on Inflammation

## Impact of Poor Sleep



Growth hormone  
Energy levels  
Immune system  
Testosterone



Fatigue  
Obesity  
Increase in cortisol

## Impact of Good Sleep



Fatigue



Mood  
Better reaction time  
Regulates metabolism  
Anti inflammatory properties  
when prolactin released  
Muscle repair



# Sleep



- <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.marieclaire.com%2Fhealth-fitness%2Fnews%2Fa13230%2Fnew-national-sleep-foundation-guidelines%2F&psig=AOvVaw05FFxW1XK3VBOdElsmxX6L&ust=1588552672473000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCLC48YK6lukCFQAAAAAdAAAAABAD>

# Sleeping Tips

## 10-3-2-1-0 Rule of sleeping

- 10 hours before bed no caffeine
  - 3 hours before bed no food, exercise or alcohol
  - 2 hours before bed no work related activities
  - 1 hour before bed no screen time (Turn off all devices)
  - 0 The number of times you hit the snooze button
- Sleepy time tea, time released melatonin
  - Room 68 degrees
  - Weighted blanket
  - Dark room (Shades)
  - White noise
  - Blue light therapy
  - Read before bed
  - Go to bed same time every night

**MYTH: Dairy products cause inflammation**

# Foods Found to reduce inflammatory biomarkers

**JN** THE JOURNAL OF NUTRITION

Development and Validation of Novel Dietary  
and Lifestyle Inflammation Scores FREE

## Foods Found to Reduce Inflammatory Biomarkers

- Apples
- Berries
- Tomatoes
- Deep yellow and orange fruits and vegetables
- Dairy foods (e.g., whole and low-fat milk, cheese and yogurt)
- Leafy green vegetables
- Cruciferous vegetables
- Nuts
- Legumes
- Fish
- Poultry
- Coffee
- Tea





# The evidence is clear – dairy foods do not cause inflammation

**Science Summary**  
**Dairy and Inflammation**




**Overview**

Dairy foods such as milk, cheese and yogurt are foundational foods in healthy dietary patterns recommended by the Dietary Guidelines for Americans (DGA). Healthy dietary patterns that include dairy foods are linked with lower risk of key chronic diseases such as type 2 diabetes, cardiovascular disease and obesity. These noncommunicable diseases are sometimes called “inflammatory diseases,” because they often co-occur with chronic, systemic inflammation. Lifestyle factors such as diet may impact chronic inflammation. Emerging evidence indicates that consuming dairy foods, including whole- and reduced-fat dairy foods, is not linked to increased levels of inflammatory markers. Some research indicates that consuming certain dairy foods may be linked to lower levels of some inflammatory markers.


**Healthy dietary patterns with dairy can help lower risk for chronic diseases linked with inflammation**

Chronic diseases like cardiovascular disease (CVD), type 2 diabetes (T2D) and obesity affect millions of Americans and result in high healthcare costs and lost productivity.<sup>1-3</sup> These conditions are also associated with higher levels of inflammatory markers.<sup>4-6</sup> A healthy diet is the foundation for prevention and management of several chronic diseases, including CVD, T2D and obesity.<sup>1-3</sup> The Scientific Report of the 2020 Dietary Guidelines Advisory Committee emphasizes this point, stating that risk factors for CVD, such as inflammatory markers, are “favorably influenced by habitual adherence to dietary patterns that include fruits, vegetables, whole grains, legumes, nuts, unsaturated vegetable oils, fish, seafood, [and] lower fat dairy products.”<sup>7</sup> The Healthy U.S.-Style Dietary Pattern in the 2020 DGA includes these foods, recommending 3 daily servings of low-fat or fat-free dairy foods for those 9 years and older, 2½ servings for children 4-8 years and 2 servings for children 2-3 years.<sup>8</sup> It also recommends 1½ to 2 servings of whole- and reduced-fat dairy foods for toddlers 12-23 months and small amounts of yogurt and cheese for infants 6 to 12 months, depending on developmental readiness.<sup>9</sup>

**Eating dairy foods is not linked to inflammatory markers in systematic reviews or meta-analyses**

Eating dairy foods does not increase levels of inflammatory biomarkers in individuals without a milk protein allergy, according to results of two meta-analyses and three systematic reviews. Six of the randomized controlled trials of healthy adults included in a meta-analysis by Benatar et al.<sup>10</sup> assessed the impact of low-fat or high-fat dairy foods on levels of C-reactive protein (CRP), a commonly used biomarker of inflammation produced by the liver. There were no differences in CRP levels between the dairy-rich diets and the control diets in four of these studies, even when higher-fat dairy foods were included in the dairy intervention. Zemel et al. reported lower levels of CRP at the end of a 28-day study,<sup>11</sup> and Stanciffl et al. also reported significantly lower CRP levels in the group consuming 3.5 daily servings of dairy foods.<sup>12</sup> Another meta-analysis used an “inflammatory score,” which combines many biomarkers

**The Effects of Dairy Product and Dairy Protein Intake on Inflammation: A Systematic Review of the Literature**



Nieman KM, Anderson BD, Cifelli CJ. *J Am Coll Nutr.* 2020;1-12.

Prevention and management of chronic inflammation is important because it can impact the development of various chronic diseases like cardiovascular disease and type 2 diabetes. Nearly 25% of American adults who want health benefits from foods look for lower inflammatory foods.<sup>1</sup> Many wonder how dairy foods impact inflammation. This systematic review of 27 randomized controlled trials<sup>2</sup> reported that dairy foods (e.g., milk, cheese and yogurt) have neutral to beneficial effects on biomarkers of inflammation.

In addition to examining the impact of dairy foods on biomarkers of inflammation, the review also examined the role of dairy proteins, casein and whey, on biomarkers of inflammation and found no adverse effects. While some studies have suggested animal protein intake may be associated with increased cardiovascular disease and mortality, all 8 trials in this review that investigated consumption of dairy protein on biomarkers of inflammation reported no effect.

**This review adds to a growing body of scientific evidence that finds adequate dairy consumption as part of a nutrient-rich, balanced diet is not adversely linked to chronic inflammation, but rather has potential beneficial effects on inflammation.<sup>2,3,4</sup>**

\*This review focused on trials including adults who were 1) healthy, 2) overweight/obese, but otherwise healthy and 3) overweight/obese with a chronic disease, but not with any diagnosis of severe inflammatory-related disorders. It also included dietary interventions with a minimum 2-week duration and a non-dairy or low-dairy control group.

Healthy Eating Pattern Including **Low-Fat Dairy Foods (e.g., low-fat milk, cheese, yogurt)** → Lower Chronic Inflammation → Reduced Chronic Disease Risk

**Why is inflammation important?**

Chronic inflammation is considered a symptom of a continuous out-of-balance immune system with higher amounts of pro-inflammatory signaling molecules. It is a key contributor to chronic disease risk – including metabolic diseases such as cardiovascular disease and type 2 diabetes. Diet impacts the body’s inflammatory state.

Not surprisingly, over the past decade, a robust body of literature has revealed a significant link between the consumption of dairy foods and reduced risk of metabolic diseases associated with chronic inflammation.<sup>5</sup>

**Does the saturated fat in dairy products cause inflammation?**

No. The anti-inflammatory effects of dairy products have been seen in dairy products regardless of their fat level. Clinical trials comparing low-fat and full-fat dairy have shown no differences in blood inflammatory biomarkers.<sup>6,7</sup>

**Does the lactose in dairy products cause inflammation?**

No. The evidence shows dairy foods, including those which contain lactose have neutral (no effect) or beneficial (anti-inflammatory) effects on biomarkers of inflammation.

A National Institute of Health expert panel on lactose intolerance (LI) suggests that even individuals with LI can include dairy foods in their diet. There are many strategies, including lactose free milk, natural cheeses and yogurt, that can help these individuals enjoy dairy foods and avoid nutrient shortfalls.<sup>8</sup>

National Dairy Council’s (NDC) mission is to bring to life the dairy community’s shared vision of a healthy, happy, sustainable world with science as our foundation. On behalf of America’s dairy farmers, NDC strives to help people thrive at every age through science-based information on dairy’s contributions to nutrition, health and sustainable food systems. For more information visit www.USDairy.com

www.USDairy.com | National Dairy Council | @NDCDairyCouncil | Dairy Nourishes NETWORK

**Dairy Good** Can Dairy Help Lower Inflammation? Watch later Share



MORE VIDEOS

0:15 / 2:35

YouTube



Dinner Appetizer

Grilled Halloumi and Veggie Skewers



Dinner Lunch

Fall Harvest Farmers Cheese Grain Bowl

Resources and recipes available on USDairy.com

# Case study: Feared dairy, gluten, meat caused inflammation

## Meet Victor

✓ Lost 93 pounds over 2 years

✓ Gained 100 pounds on his bench press

- Increased dairy, whole grains, fruits, vegetables in diet
- Reduce fried foods, refined carbohydrates
- Went to yoga 2x a week
- Slept 8 hours a night





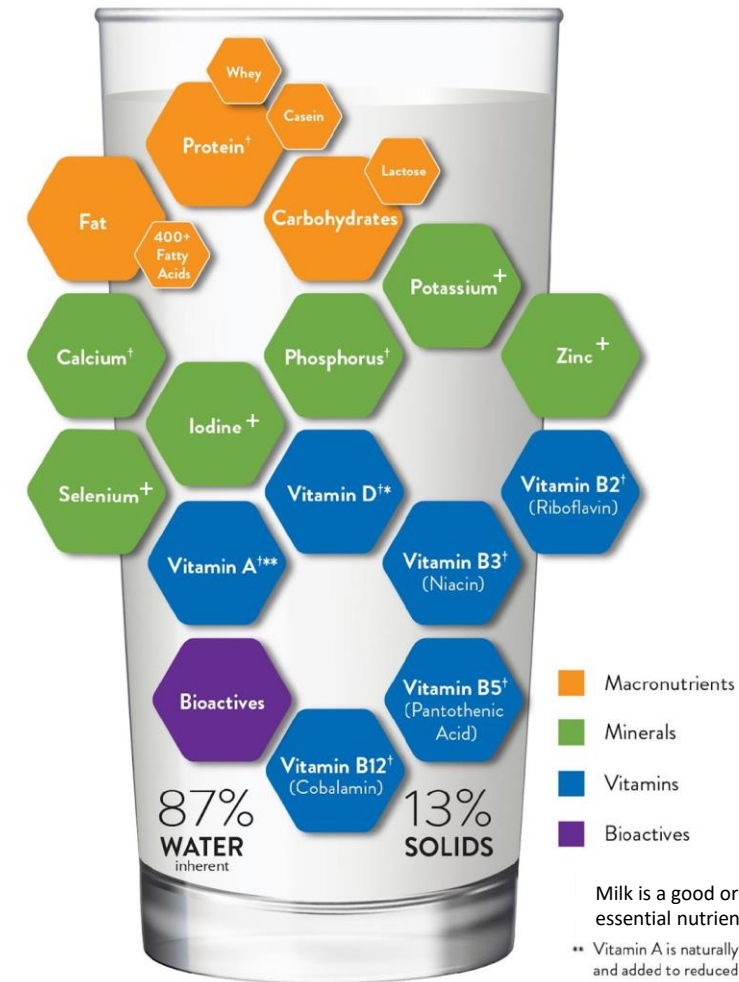
# Problem: Super restrictive diets



# Elimination of dairy = benefits lost

## Dairy delivers protein along with great taste

Dairy Food	Protein	Leucine
Low-fat Cheddar Cheese (1 oz)	7 g	0.61 g
Low-fat Milk (regular or lactose-free dairy milk) (8 oz)	8.5 g	0.8 g
Low-fat Cottage Cheese (4 oz)	14 g	1.44 g
Low-fat Greek Yogurt (8 oz)	18.5 g	1 g
Whey Protein Isolate Powder (unflavored) (1 scoop, 28 g)	24 g	3.2 g



FDA's Daily Value (DV) for potassium of 4700 mg is based on a 2005 DRI recommendation. In 2019, NASEM updated the DRI to 3400 mg. Based on the 2019 DRI, a serving of milk provides 10% of the DRI. FDA rule-making is needed to update this value for the purpose of food labeling.

Nutrition information obtained from: USDA FoodData Central:

Low-fat Cheddar Cheese (173439) Low-fat milk (170873) Cottage cheese (173417) Strawberry Greek yogurt (171300)

<https://fdc.nal.usda.gov/fdc-app.html#/>

Whey Protein Powder \*Stephan Van Vliet, et al. The Skeletal Muscle Anabolic Response to Plant- versus Animal-Based Protein Consumption. Journal of Nutrition. 2015.



---

## Victors Anti-inflammatory meal plan

- **Breakfast:** Plain yogurt, handful of nuts, handful of blueberries, coffee
- **Snack:** Avocado toast with smoked salmon, cucumber, tomato, tea
- **Lunch:** Salad with chicken, topped with cheese + Greek yogurt dressing
- **Snack:** Almond butter + apple
- **Dinner:** Fish, veggie + brown rice bowl



## #HaveAPlantWithDairy

- Cheese + apple
- Yogurt + blueberries + nuts
- Milk + fruit
- Cottage cheese + cucumbers
- Grilled halloumi and veggie skewers
- Veggie grain bowl with cheese
- Veggies + ranch-style Greek yogurt dip
- Fruit smoothie w/spinach





## Take home messages

- 3 servings dairy a day
- Limit inflammatory foods and habits
- Don't forget improving lifestyle habits
- Include anti-inflammatory foods
- However, we can enjoy ALL foods!





**@jimwhitefit**



**Jim White Fitness & Nutrition Studios**



**[www.jimwhitefit.com](http://www.jimwhitefit.com)**





Questions?

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[AmericanDairy.com](https://www.americandairy.com)

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<https://www.surveymonkey.com/r/82YQWX7>
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FROM A GOOD PLACE**