A PLANT-BASED EATING PATTERN FOR THE PREVENTION AND TREATMENT OF TYPE 2 DIABETES

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Physicians Committee for Responsible Medicine
PCRM.ORG

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Learning Objectives

1. Discuss the health benefits of a plant-based eating pattern based on observational and randomized controlled studies.
2. List the potential mechanisms influencing insulin resistance and diabetes risk.
3. Describe various strategies for success when providing plant-based nutrition education and counseling.

2

Diabetes

3

Diabetes Statistics

- > 34 million people with diabetes.
- > 88 million people with pre-diabetes.
- 2-3X greater healthcare costs for Americans with diabetes.
- Cost is over $327 billion (direct and indirect)- reported in 2017.

https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf
Boyle JP, et al. *Popul Health Metr.* 2010;8:29.

4

Changes in Food Consumption

5

Changes in Consumption Since 1950

Calories	↑25%
Meat	↑68%
Cheese	↑317%
Milk	↓39%
Sugar sweetened beverages	↑356%
Butter	↓54%
Added fats/oils	↑67%
Sugar/HFCS	↑39%

United States Dept. of Agriculture
Worldindata.org
Drouin-Charter J, et al. Diabetes Care 2019;42:2181-2189.
Qi Q, et al. N Engl J Med. 2012;3676:1387-1396.

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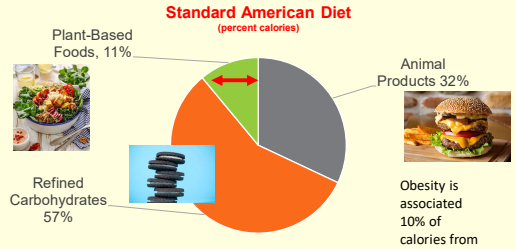
Current Intake of Americans



Obesity is associated 10% of calories from plants.

https://www.ers.usda.gov/data-products/food-consumption-and-nutrient-intakes/
Vincent HK, et al. J Hum Nutr Diet. 2010;23:20-29.

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Plant-Based Nutrition for Diabetes

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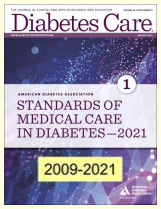

"...appropriately planned vegetarian, including vegan, diets are healthful, ***nutritionally adequate***, and may provide health benefits in the prevention and treatment of certain diseases."

American College of Lifestyle Medicine

Plant-Based Nutrition for Diabetes is Evidence-Based

Standards of Medical Care in Diabetes - 2021. *Diabetes Care* 2021;44:S57.
Endocr Pract. 2020;26:107-139.
Melina V, et al. *J Acad Nutr Diet.* 2016;116:1970-1980.Kelly, et al. ACLM doi:10.177/1559827620930962.

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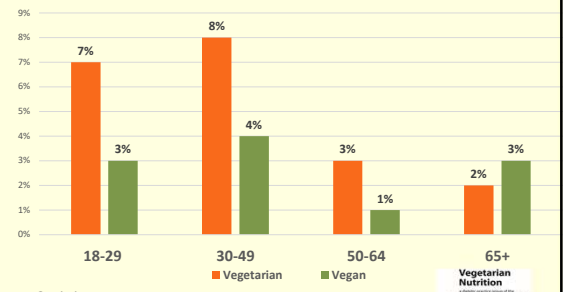
The Numbers of Vegetarians and Vegans in USA is Growing



www.Statistica.com

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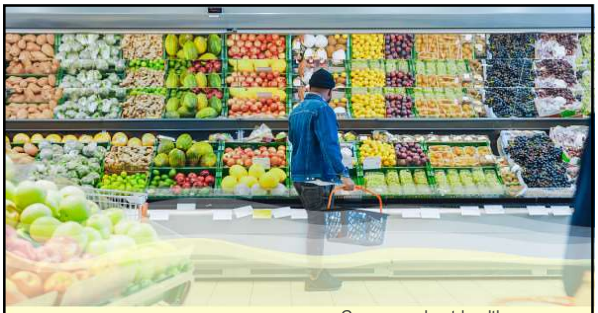

Plant-Based Eating has Increased during the Pandemic

- Concerns about health, hygiene, factory farming.
- Sales of meatless meat has increased 35%.

https://thebeet.com/coronavirus-has-made-consumers-more-aware-of-where-food-comes-from/

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Plant-Based Diet and Diabetes Prevention

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Vegetarians and Vegan Diets

Improve Risk Factors:
- Body weight
- Abdominal obesity
- Blood pressure
- Serum lipids
- Markers of inflammation
- Glucose levels

Reduce Risk of:
- Cardiovascular disease
- Diabetes
- Mortality
- Cancer
  - All
  - Colon
  - Prostate

Melina V, et al. *J Acad Nutr Diet.* 2016;116:1970-1980.
Le TL, *Nutrients.* 2014;6:2131-2147.
Levin N, et al. *J Clin Gastroenterol.* 1986;451-453.

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Seventh-day Adventist

- Christian denomination
- Encouraged to be healthy
- Encouraged to be vegetarian (about 50% are)
- Sets up a natural experiment to evaluate eating patterns and health outcomes
  - Adventist Mortality Study (40% to 80% ↑DM risk)
  - Adventist Health Study 1 (93% to 97% ↑DM risk)
  - Adventist Health Study 2 - >100,000 (ages 30-112)

Snowdon et al. AJPH 1985;75:507-512.
Fraser, GE. Am J Clin Nutr. 1999;70:532S-538S.
Le et al. *Nutrients.* 2014;6:2131-2147.

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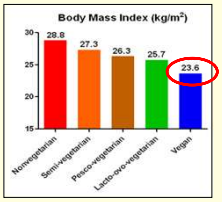
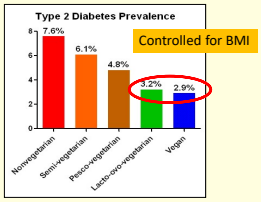
Adventist Health Study – 2 (N=60,903)





Tonstad, et al. *Diabetes Care.* 2009;32:791-796.

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3 Take-Aways

1. Body weight increases as animal products are added to the diet.
2. Diabetes risk increases as animal products are added to the diet
3. Even though weight gain drives diabetes, the risk of diabetes is significant even when controlling for body weight.

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Other Reports on Plant-Based Eating and Diabetes

- Plant-based eating patterns are associated with 30% reduction in DM risk.
- Increased consumption of red meat (>0.5 servings per day) over 4 years increases DM risk by 48%
- Taiwanese vegetarians have a 51% to 75% lower risk of diabetes.

Qian F, et al. JAMA Intern Med. 2019;179:1335-1344.
Pan A, et al. JAMA Intern Med. 2013;173:1328-1335.
Chiu T, et al. PLoS One. 2014;9:e88547.

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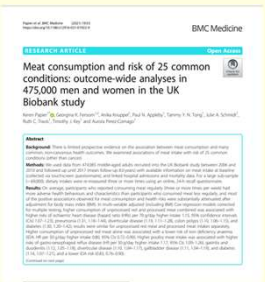
Meat Linked to Hospitalizations

- UK Biobank Study (N=474,985)
- Mean follow up = 8 years
- Red and processed meats (70 g):
  - Ischemic heart disease (15%)
  - Pneumonia (31%)
  - Diverticular disease (19%)
  - Diabetes (30%)
- Poultry (30 g):
  - GERD (17%), gastritis & duodenitis (12%), diverticular disease (10%), gall bladder disease (11%)
  - Diabetes (14%)



Papier K, et al. BMC Medicine. 2021;19:53.

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Low-Fat Vegan Intervention for Type 2 Diabetes (NIH funded)

- 22-week RCT of 99 individuals with T2D:
  - **Low-fat vegan group (N=49)**
    - Consume from "4 food groups"
    - Avoid all animal produces
    - Low-fat, low glycemic index
    - **No portion control**
  - **Control group (N=50)** (ADA: portion control of CHO, reduced calories 500 kcal/day)
- Both groups received intensive lifestyle therapy.

Barnard, et al. Diabetes Care. 2006;29:1777-1783.

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Results at 22 Weeks

	Vegan group N=49	Control N=50	P-Value
Carbohydrate intake	Increased	Decreased	
Fiber Intake	Doubled	Unchanged	
Reduced/eliminated Medications	43%	25%	0.01
Change in A1C w/o med changes	↓1.23	↓0.38	0.01
Body weight	↓ 6.5 Kg	↓3.1 Kg	<0.001
LDL cholesterol	↓22.6 mg/dL	↓10.7 mg/dL	0.02
AHEI scores	Increased	Unchanged	0.0001

Barnard, et al. Diabetes Care. 2006;29:1777-1783.

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Insulin Resistance and Oxidative Stress

- 24-week study, (N=74 DM) randomized to vegetarian diet or control diet
- Isocaloric (-500 kcal/day), meals were provided
  - Veg diet: (60% CHO, 15% Pro, 25% Fat)
  - Control: (50% CHO, 20% Pro, 30% Fat)
- Primary outcomes:
  - Insulin sensitivity
  - Volume of visceral and subcutaneous fat
  - Markers of oxidative stress

Kahleova, et al. Diabetic Medicine. 2011;28:1-11.

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Results – Veg vs. Control

- 43% vs 5% reduced medications (P < 0.001).
- Weigh loss: -6.2 kg vs. -3.2 kg (P = 0.001).
- ↑Insulin sensitivity 30% vs. 20% (P -0.04).
- ↓ Visceral and subcutaneous fat (P=0.007 and P=0.02, respectively).
- Greater reduction in markers of oxidative stress.
- Reductions in visceral fat correlated to improvements in oxidative stress and insulin sensitivity.

Kahleova, et al. Diabetic Medicine. 2011;28:1-11.

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Vegan Diet vs. Mediterranean Diet

- 62 overweight adults
- Randomized Crossover trial
- Medit – based on PREDIMED protocol: fruits, vegetables, legumes, fish, low-fat dairy, extra-virgin olive oil, avoidance of red meat and SFA
- Vegan – fruits, vegetables, whole grains, and legumes
- Both diets were *ad libitum*

Barnard N, et al. J Am Coll Nutr. 2021 Feb 5;1-31. https://doi.org/10.1080/07315724.2020.1869625

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Results

	Medit diet	Vegan diet	P-value
Weight loss	0.0 kg	-6.0 kg	*p* <0.001
HOMA-IR	Unchanged	Decreases	*p* = 0.21
OGIS	Unchanged	increased	*p* = 0.003
LDL-C	Unchanged	-15.3 mg/dL	*p* = 0.001
Systolic BP	-9.3 mmHg	-3.4 mmHg	*p* = 0.2
Diastolic BP	-7.3 mmHg	-4.1 mmHg	*p* = 0.58

Barnard N, et al. J Am Coll Nutr. 2021 Feb 5;1-31. https://doi.org/10.1080/07315724.2020.1869625

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Low-Fat, Plant-Based vs. Animal-Based, Ketogenic Diet

- Tests the carbohydrate-insulin model of obesity
- NIH Clinical center (inpatient study)
- 20 adults (mean age 29±1.4; BMI 27.8±1.3 kg m^{-2})
  - LF plant-based (PBD): 10.3% fat, 75.2% CHO; 1 kcal/g (High GL)
  - LC Ketogentic (LCD): 75.8% fat, 10% CHO; 2 kcal/g (Low GL)
  - Both *ad libitum,* minimally processed
  - Randomized, cross-over trial, 2 weeks, no washout
- Primary outcomes:
  - 1. Mean Energy intake for the 2-week diet period
  - 2. Mean Energy intake for the final week (allowing for physiological adaptations/carry over effects)

Hall et al, Nature Medicine. 2021;344-353.

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Results

- Energy density: LCD 100% greater (P<0.0001)
- Insulin secretion: PBD 60% greater (P<0.0001)
- Post prandial glucose: higher in PBD
- Glucose challenge: LCD impaired tolerance
- Fasting ketones: greater in LCD
- Weight loss:
  - Faster weight loss in LCD, mostly fat-free mass
  - No significant differences in body fat loss

Hall et al, Nature Medicine. 2021;344-353.

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Results

- Primary outcomes
  - Over 2 weeks: PBD led to 689±73 kcal/day less
  - For final week: PBD let to 544±68 kcal/day less
- Other outcomes: No difference in
  - Self-reported appetite/satiety
  - Pleasantness/familiarity with eating pattern

Hall et al, Nature Medicine. 2021;344-353.

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Potential Mechanisms of Plant-Based Eating Pattern

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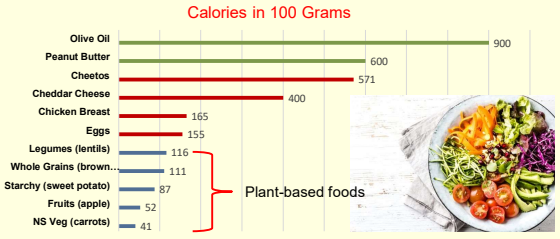
Plant-Based Foods Have a Low-Calorie Density



Hever J. J Geriatr Cardiol. 2017;14:355-368
Rizzo NS, et al. J Acad Nutri Diet. 2013;113:1610-1619.

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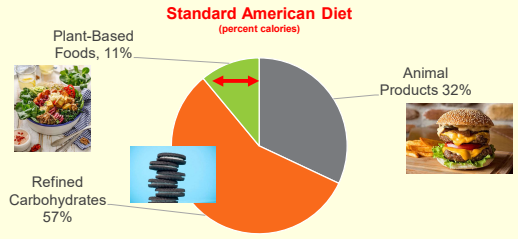
Current Intake of Americans



https://www.ers.usda.gov/data-products/food-consumption-and-nutrient-intakes/

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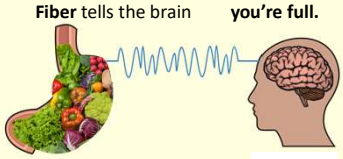
Fiber is Filling

Fiber tells the brain **you're full.**



Carbohydrate has 4 kcal/gram
Fat has 9 kcal/gram

119 calories

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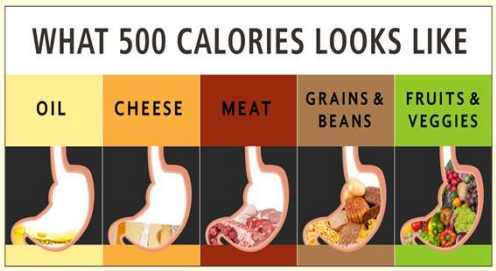

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Short Chain Fatty Acids (SCFA)

Non-digestible polysaccharides

Fermented by gut bacteria

SCFA:
- Butyrate
- Propionate
- Acetate

Esteve E, et al. Curr Opin Clin Nutr Metab Care. 2011;14:483-490
Shen J, et al. Mol Aspects Med. 2013;34:39-58
Tilg H, J Clin Invest. 2011;121(6):2126-2132
Bibiloni R, et al. Ann Nestle Eng. 2009;67:39-47

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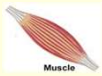
SCFA are Signaling Molecules

Enhance nutrient absorption
Improve gut barrier function

↓Endotoxin
↓Inflammation
↑Release of gut peptides
↑Glycemic control

↑Satiety
↓Food intake



↑Fatty acid oxidation

Cani PD, et al. Current Pharmaceutical Design. 2009;15:1546-1558
Allin KH, et al. Eur J Endocrinol. 2015;172:R167-R177
Tilg H, et al. Gut. 2014;63:1513-1521.
Conlon et al. Nutrients. 2015;7:17-44

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Fiber Intake in People with Diabetes

2 multi-country cohorts, follow up 8.8 years, 8,300 adults with DM

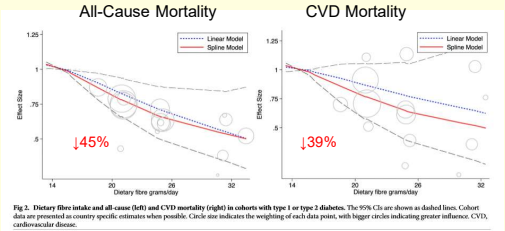

Fig 2. Dietary fibre intake and all-cause (left) and CVD mortality (right) in cohorts with type 1 or type 2 diabetes. The 95% CIs are shown as dashed lines. Cohort data are presented as country specific estimates when possible. Circle size indicates the weighting of each data point, with bigger circles indicating greater influence. CVD, cardiovascular disease.

Reynolds A, et al. PLoS Med. 2020;17(3):e1003053

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Significant Cardio-Metabolic Outcomes

Reported benefits of higher fiber intake in people with diabetes:

- Glycemic control (HbA1C, fasting glucose, insulin resistance)
- Blood lipids (total and LDL-cholesterol)
- Body weight and BMI
- Inflammation – C-reactive protein
- Premature mortality

Reynolds A, et al. PLoS Med. 2020;17(3):e1003053

Vegetarian Nutrition
a dietetic practice group of the Academy of Nutrition and Dietetics

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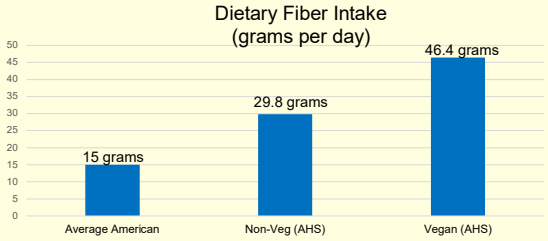
Vegetarians and Vegans Consume more Fiber



Clemens R. *J Nutr.* 2012;142:1390S-401S.
Rizzo NS. *J Acad Nutr Diet.* 2013;113:1610-1619.

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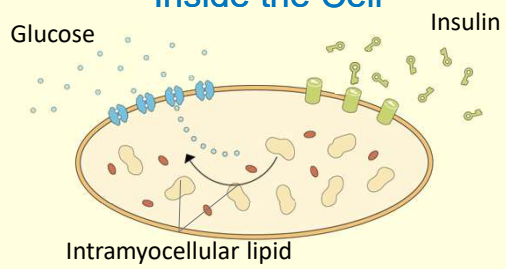
Inside the Cell



Compared with nonvegetarians (matched for age, BMI, body fat, energy intake, etc.), vegans have lower intramyocellular lipid content and higher insulin sensitivity.
High fat diet down regulates genes for oxidative phosphorylation and mitochondrial genesis.

Kim Y, et al. Metabolism. 2015;64:768-779. Goff LM, et al. Eur J Clin Nutr. 2005;59:291-298. Sparks L, et al. Diabetes. 2005;54:1926-1933.

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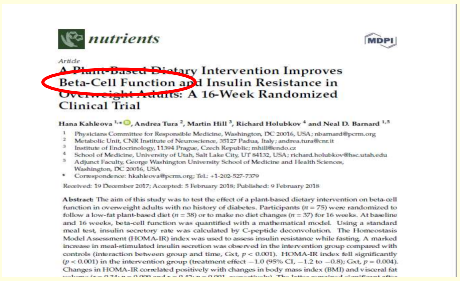

nutrients

MDPI

Article

A Plant-Based Dietary Intervention Improves Beta-Cell Function and Insulin Resistance in Overweight Adults: A 16-Week Randomized Clinical Trial

Hana Kahleova [1,*], Andrea Tura [2], Martin Hill [3], Richard Holubkov [4] and Neal D. Barnard [1,5]

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4 School of Medicine, University of Utah, Salt Lake City, UT 84132, USA; richard.holubkov@hsc.utah.edu
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* Correspondence: hkahleova@pcrm.org; Tel.: +1-202-527-7379

Received: 19 December 2017; Accepted: 5 February 2018; Published: 9 February 2018

Abstract: The aim of this study was to test the effect of a plant-based dietary intervention on beta-cell function in overweight adults with no history of diabetes. Participants (n = 75) were randomized to follow a low-fat plant-based diet (n = 38) or to make no diet changes (n = 37) for 16 weeks. At baseline and 16 weeks, beta-cell function was quantified with a mathematical model. Using a standard meal test, insulin secretory rate was calculated by C-peptide deconvolution. The Homeostasis Model Assessment (HOMA-IR) index was used to assess insulin resistance while fasting. A marked increase in meal-stimulated insulin secretion was observed in the intervention group compared with controls (interaction between group and time, Gst, $p < 0.001$). HOMA-IR index fell significantly ($p < 0.001$) in the intervention group (treatment effect −1.0 (95% CI, −1.2 to −0.8); Gst, $p = 0.004$). Changes in HOMA-IR correlated positively with changes in body mass index (BMI) and visceral fat

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Red Meat and Insulin Resistance and Beta-Cell Function

- Lack dietary fiber and phytochemicals
- Saturated and *trans* fats
- Heme-iron
- Branched chain amino acids
- Advanced glycation end products (AGE)
- Nitrates and nitrosamines

Wolk. *J Intern Med.* 2017;281:106-122.
Kim. *Metabolism.* 2015;64:768-779.

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Plant-Based Meal Planning for Success: Individualization

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The Power Plate

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DSMES
diabetes self-management education and support

Plant-Based Nutrition Basics

1. Avoid animal products.
2. Go low fat.
3. ↓ Oil, nuts, avocado
4. Fill up on fiber.
5. WHOLE plant foods
6. Take vitamin B12.

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Vitamin B-12

Deficiency:
- Elevated homocysteine: (CVD risk)
- Macrocytic anemia: fatigue
- Neurological issues
  - tingling in fingers and toes
  - Poor cognition, dementia
- Other: poor digestion, bone health, FTT

Sources of Vitamin B-12
- Fortified foods
- Vegans should have a reliable supplement (Amount should be individualized)
  - 500 to 1,000 µg several times per week
  - Or, 50 to 100 µg per day
- Note: Metformin can reduce vitamin B12 absorption

Melina V, et al. J Acad Nutr Diet. 2016;116:1970-1980
Diabetes Care 2018;41:51-159.

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Meal Planning

Monday	Tuesday	Wednesday	Thursday	Friday
• B: • L: • D:	• B: • L: • D:	• B: • L: • D:	• B: • L: • D:	• B: • L: • D:

Don't forget leftovers and frozen meals.
No need to cook every day!



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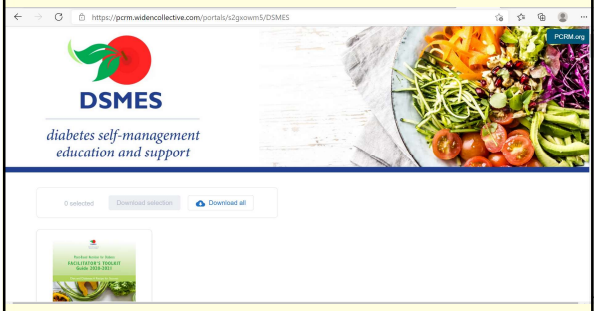

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What Should Patients Expect?

- Blood glucose changes:
  - Hypoglycemia – review prevention, recognition, and treatment
  - Slow decrease in glucose over time
  - Hyperglycemia – focus on low-GI carbohydrates
- Adjust insulin to carbohydrate
- Reduction in blood pressure
- Reduction in cholesterol
- Medication changes may be needed

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Why Do People Like It?

- No portion sizes
- No carbohydrate counting – for those not on insulin
- Major health benefits – addresses root cause
- Saves money

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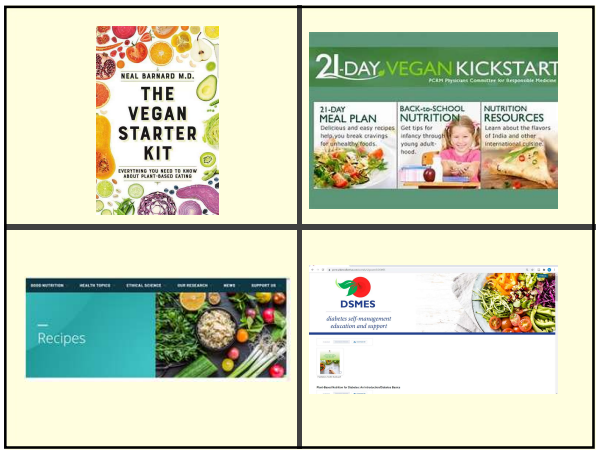

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Useful Websites/Recipes

- Vegetarian Nutrition DPG
- Plant-Based on a Budget
- Fat-free Vegan Recipes
- Forks Over Knives
- Oh She Glows
- Vegetarian Resource Group
- The Plant-Powered Dietitian
- Benbella Vegan

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Case Studies

Marc Ramirez

Betty Mizek

Vegetarian Nutrition
a dietetic practice group of the Academy of Nutrition and Dietetics
Experts in Plant-Based Nutrition

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Questions?

Vegetarian Nutrition
a dietetic practice group of the Academy of Nutrition and Dietetics
Experts in Plant-Based Nutrition

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Physicians Committee for Responsible Medicine
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The Vegetarian Nutrition Dietetic Practice Group (VN DPG) of the Academy of Nutrition and Dietetics strives to empower members to be the leading authority on evidence-based, plant-based nutrition for food and nutrition professionals, health care practitioners and the public.

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