



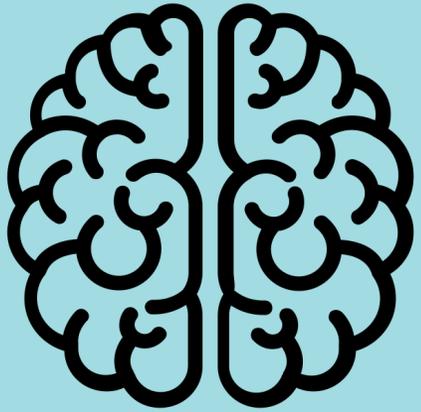
# About the Presenter:



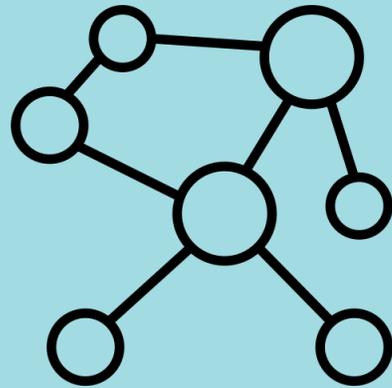
- 🧠 B.S. in Biological Sciences, Louisiana State Univ-Shreveport
- 🧠 B.S. in Psychology, Louisiana State Univ-Shreveport
- 🧠 M.A. in Experimental Psychology, Indiana State Univ
- 🧠 Currently a PhD student in the UIUC Neuroscience Program
- 🧠 Research Interests: Nutritional Cognitive Neuroscience, Cognitive Aging, and Health Disparities in Aging



# How Does Nutrition Support Brain Health?



Structure



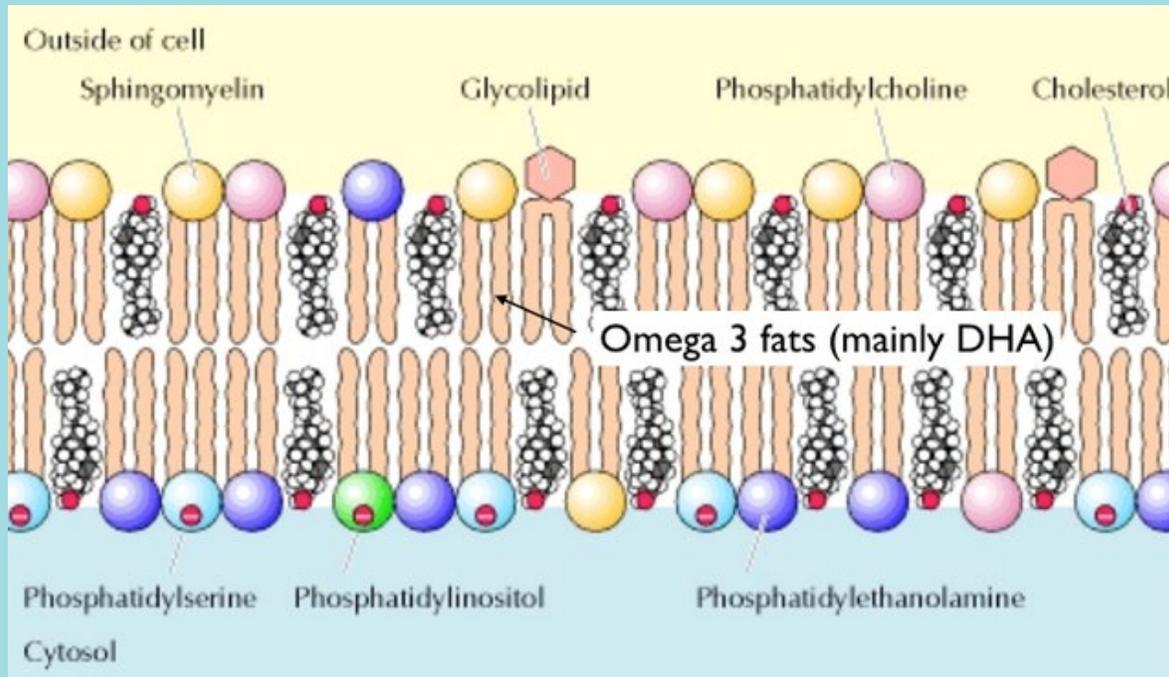
Neurotransmission



Cognitive Function



# Nutrition & Brain Health-Structure



1

## Primary Role

- ❖ Choline, Omega 3 PUFAS
- ❖ Milk, eggs, liver, salmon, peanuts<sup>2</sup>

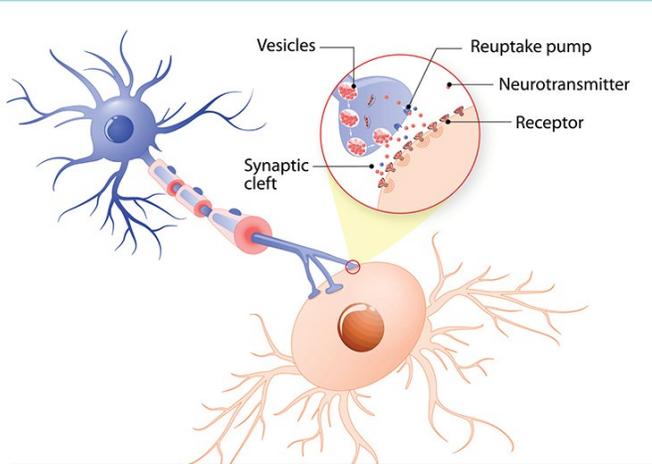
## Supporting Role

- ❖ Carotenoids (Lutein)
- ❖ Sweet potatoes, carrots, pumpkins, mangos, dark leafy greens<sup>2</sup>

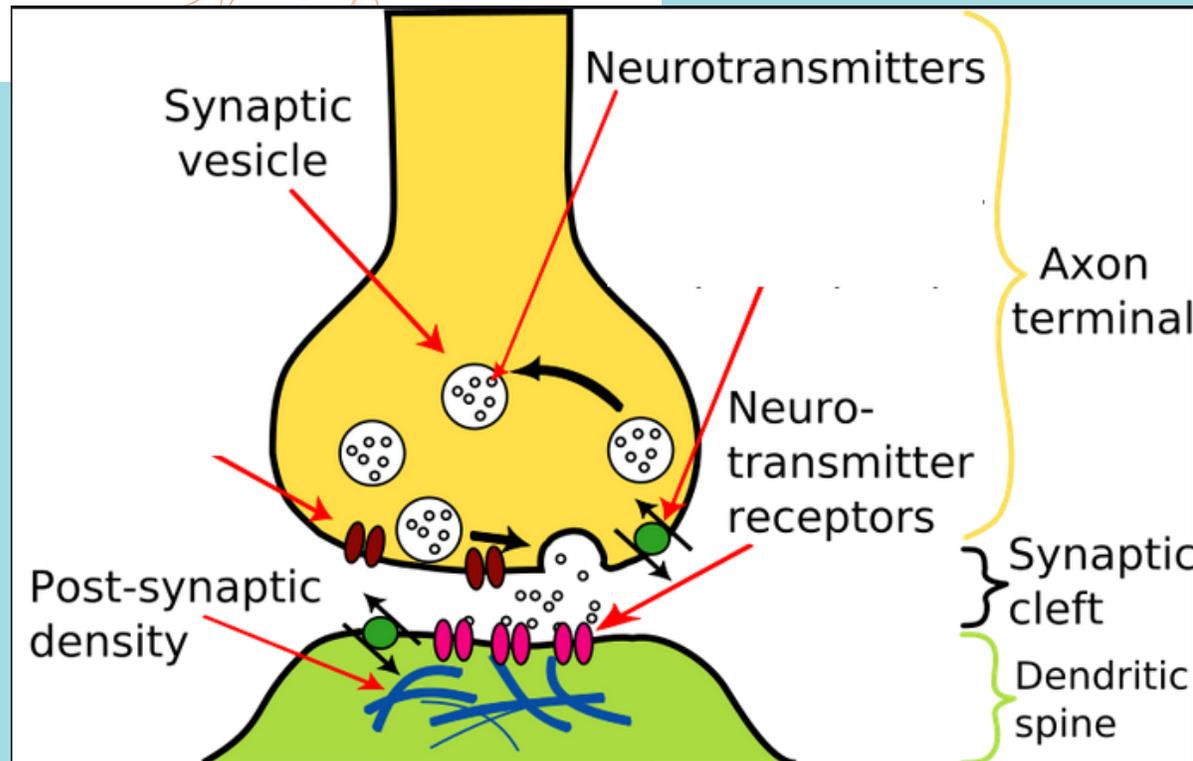
<https://www.patrickholford.com/advice/how-to-build-and-protect-brain-at-any-age>  
[https://www.health.harvard.edu/staying-healthy/listing\\_of\\_vitamins](https://www.health.harvard.edu/staying-healthy/listing_of_vitamins)



# Nutrition & Brain Health-Neurotransmission



1



2

Neurotransmitters: molecules that serve as the chemical signal for communication throughout the nervous system

## Classified by Function

- ❖ Excitatory-increase electrical excitability
- ❖ Inhibitory-decrease electrical excitability
- ❖ Neuromodulator-modulate the amount of neurotransmitter that is produced and released

1. <https://qbi.uq.edu.au/brain/brain-physiology/what-are-neurotransmitters>

2. <https://teachmephysiology.com/nervous-system/components/neurotransmitters/>

# Nutrition & Brain Health-Neurotransmission

Dietary Neurotransmitters	Neurotransmitter Precursors	Support Neurotransmission and Maintain Synapses
Acetylcholine (eggplant, spinach, strawberry)	Tryptophan → Serotonin & Melatonin	Calcium
Glutamate (seafood, cheese, mushroom)	Tyrosine & Phenylalanine → Dopamine, Norepinephrine & Epinephrine	Magnesium
GABA (oats, broccoli, spinach, tomato)	Histidine → Histamine	Zinc
Dopamine	Arginine → Nitric Oxide	Vitamin C
Serotonin	Threonine → Glycine	B Vitamins
Histamine	Choline → Acetylcholine	

1. Briguglio et al. (2018) Dietary Neurotransmitters: A Narrative Review on Current Knowledge

2. Gibson, G. E., & Blass, J. P. (1999). Nutrition and Brain Function. In G. J. Siegel, A. B.W., & R. W. Albers (Eds.), *Basic Neurochemistry: Molecular, Cellular and Medical Aspects* (6th ed.).

3. Huskisson, E., Maggini, S., & Ruf, M. (2007). The Influence of Micronutrients on Cognitive Function and Performance. *Journal of International Medical Research*, 35(1), 1–19.

<https://doi.org/10.1177/147323000703500101>

4. Lieberman, H. R. (1999). Amino Acid and Protein Requirements: Cognitive Performance, Stress, and Brain Function. In *The Role of Protein and Amino Acids in Sustaining and Enhancing Performance* (pp. 289–307)



# Nutrition & Brain Health-Cognitive Function

## Primary Role

- ❖ Learning & Memory—Acetylcholine & Glutamate
- ❖ Attention & Focus—Noradrenaline & Gamma-aminobutyric Acid (GABA)
- ❖ Mood, Motivation, & Addiction—Serotonin & Dopamine
- ❖ Sleep—Melatonin

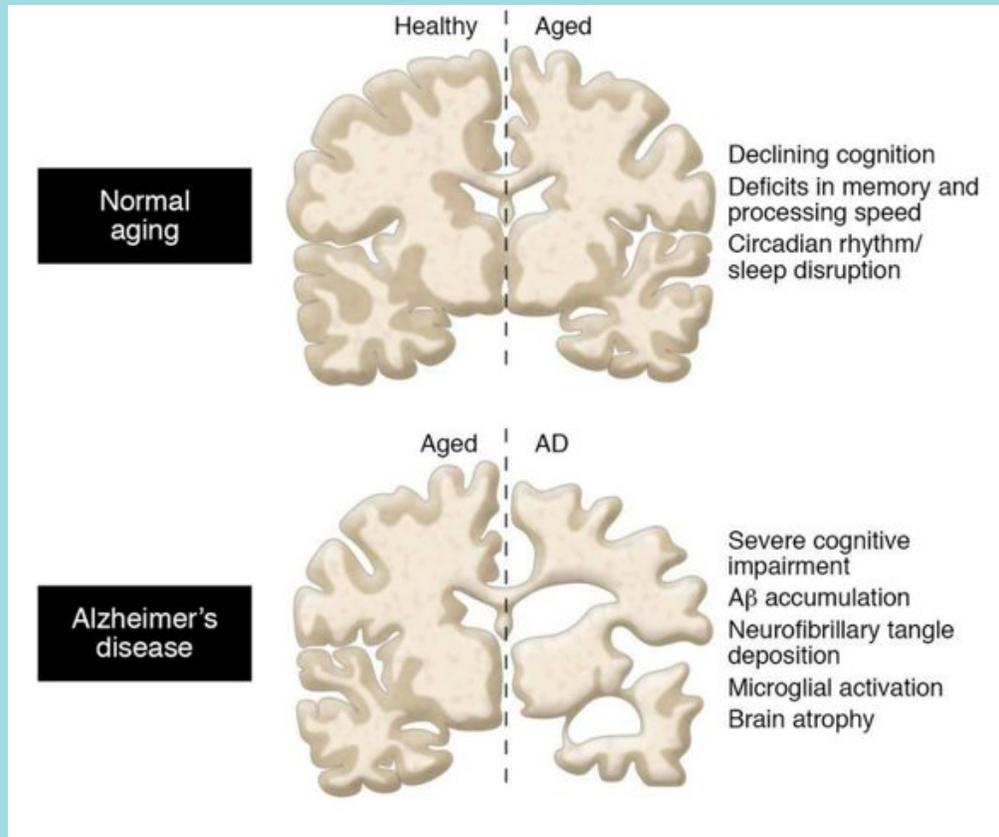


## Supporting Role

- ❖ Vitamins and minerals such as selenium and Vitamin E act as anti-inflammatory agents preserve brain structures
- ❖ Nutrients like glucose, magnesium, and B vitamins aid energy production and support metabolism



# Nutrition & Brain Health-Cognitive Aging



## Structural & Functional Changes

- Non-uniform cortical thinning and reduced volume
- Some functions are maintained while other decline

## Age-Related Changes to Nutrient Demands

- Reduced production & absorption of vitamin D/calcium<sup>1,2</sup>
- Age-Related Macular Degeneration & supplementing w/lutein
- Cholinergic system loss of function vs. neurodegeneration<sup>3</sup>

1. Gallagher, J Christopher. "Vitamin D and aging." *Endocrinology and metabolism clinics of North America* vol. 42,2 (2013): 319-32. doi:10.1016/j.ecl.2013.02.004

2. <https://www.scientificamerican.com/article/does-d-make-a-difference/>

3. Schliebs, R., & Arendt, T. (2011). The cholinergic system in aging and neuronal degeneration. *Behavioural brain research*, 221(2), 555–563. <https://doi.org/10.1016/j.bbr.2010.11.058>

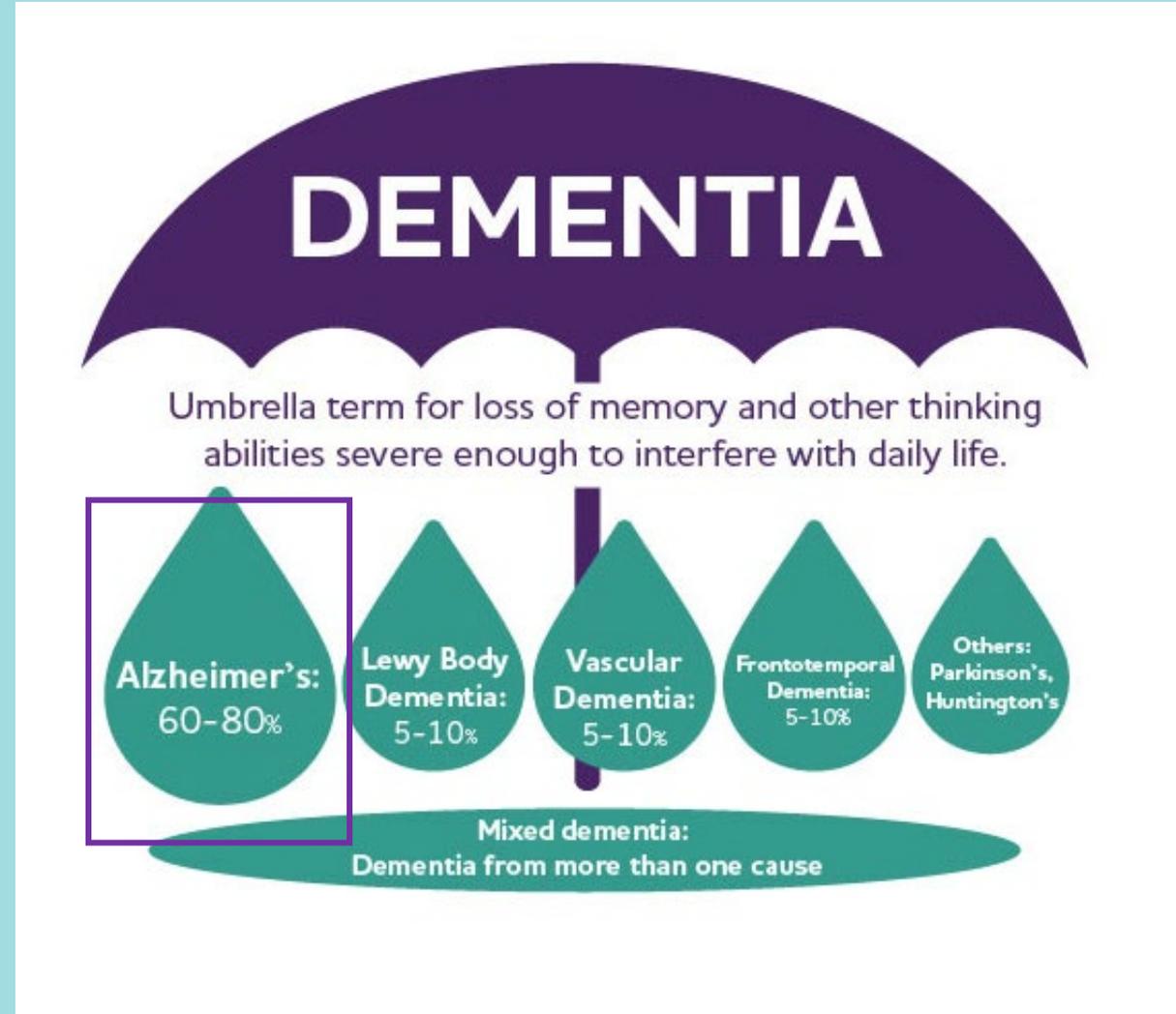


## Heritability<sup>1</sup>

- Early onset Alzheimer's
  - Rare, only 10% of AD cases
  - Amyloid precursor protein (APP), Presenilin 1 (PSEN1), Presenilin 2 (PSEN2)
- Late onset Alzheimer's
  - Apolipoprotein E, e4 variant (ApoE e4)

## Connection to Diabetes<sup>2</sup>

- Metabolic dysfunction/insulin resistance
- Vascular damage
- Cardiovascular disease



1. <https://www.alz.org/alzheimers-dementia/what-is-dementia>

2. [https://www.alz.org/national/documents/latino\\_brochure\\_diabetes.pdf](https://www.alz.org/national/documents/latino_brochure_diabetes.pdf)

# Why isn't there a pill that can cure dementia or cognitive decline?

1. Scientists are still working towards understanding the mechanism of action
  - a. Cognitive decline & dementia-like disorders are complex and have varied causes
  - b. Research needed on possible interactions including nutrient-nutrient & nutrient-drug
  - c. Research needed to provide sound dietary recommendations for certain nutrients
2. The majority of nutrition related knowledge comes from observational studies
  - a. Systematic reviews of interventions/randomized control trials<sup>1,2</sup>
  - b. Strongest support is for whole diets or broad dietary patterns<sup>3</sup>

1. McCleery, J., Abraham, R. P., Denton, D. A., Rutjes, A. W., Chong, L.-Y., Al-Assaf, A. S., ... Tabet, N. (2018). Vitamin and mineral supplementation for preventing dementia or delaying cognitive decline in people with mild cognitive impairment. *Cochrane Database of Systematic Reviews*. <https://doi.org/10.1002/14651858.CD011905.pub2>

2. Oulhaj, A., Jernerén, F., Refsum, H., Smith, A. D., & de Jager, C. A. (2016). Omega-3 Fatty Acid Status Enhances the Prevention of Cognitive Decline by B Vitamins in Mild Cognitive Impairment. *Journal of Alzheimer's Disease : JAD*, 50(2), 547–557. <https://doi.org/10.3233/JAD-150777>

3. McEvoy, C. T., Guyer, H., Langa, K. M., & Yaffe, K. (2017). Neuroprotective Diets Are Associated with Better Cognitive Function: The Health and Retirement Study. *Journal of the American Geriatrics Society*, 65(8), 1857–1862. <https://doi.org/10.1111/jgs.14922>

# Diets that Support the Aging Brain

## Mediterranean Diet Pyramid

*A contemporary approach to delicious, healthy eating*

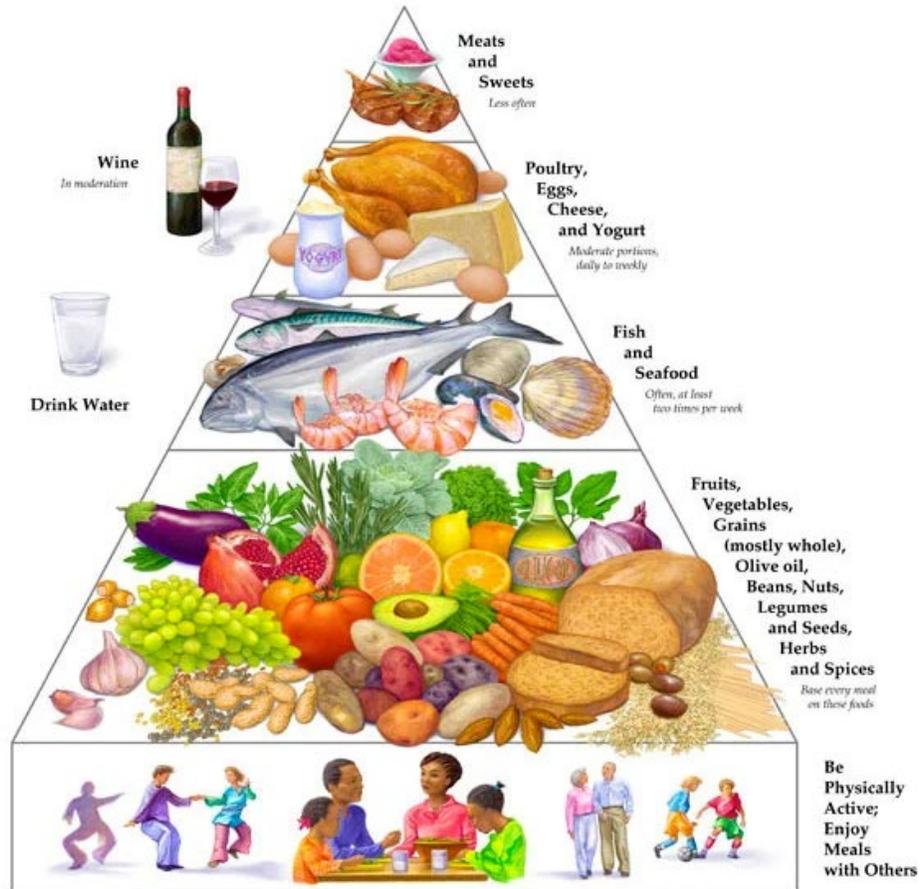


Illustration by George Middleton

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## WHAT'S ON THE MIND DIET?

AT LEAST THREE SERVINGS OF WHOLE GRAINS EACH DAY

AT LEAST ONE DARK GREEN SALAD AND ONE OTHER VEGETABLE EACH DAY

BERRIES AT LEAST TWICE A WEEK

AT LEAST A ONE-OUNCE SERVING OF NUTS EACH DAY

BEANS OR LEGUMES AT LEAST EVERY OTHER DAY

POULTRY AT LEAST TWICE A WEEK

FISH AT LEAST ONCE A WEEK

*If you don't drink alcohol, purple grape juice provides many of the same benefits.*

A FIVE-OUNCE GLASS OF RED WINE EACH DAY

NO MORE THAN ONE TABLESPOON A DAY OF BUTTER OR MARGARINE; CHOOSE OLIVE OIL INSTEAD

CHEESE, FRIED FOOD AND FAST FOOD NO MORE THAN ONCE A WEEK

PASTRIES AND SWEETS LESS THAN FIVE TIMES A WEEK

<http://images.huffingtonpost.com/2016-06-13-1465814960-6619965-minddietplan.jpg>

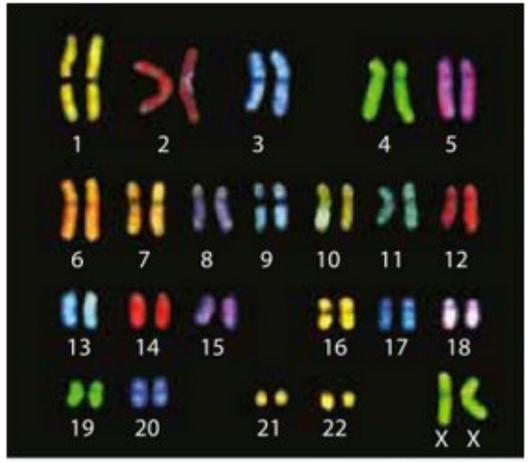
# More to the Story....

Factors that affect this brain-nutrition relationship:

- Nutrient Status (normal or deficient levels)
- Biological Sex (pregnancy, menopause)
- Life Stage of Human Development
- Microbiome (August 4th: More Than a Gut Feeling)
- Genetic/Epigenetic profile

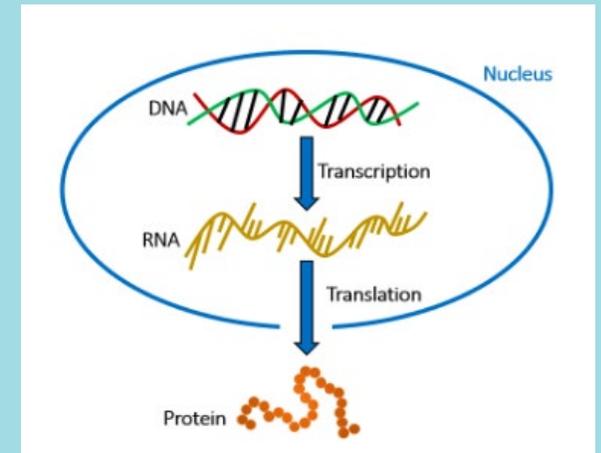


# Genetics, Nutrition, & Brain Health: Intro



1

1. Gene driven dysfunction—ApoE
2. Nutrition and gene expression—epigenetic modification of DNA
3. Genetic variability—individual responses to nutrient intake



2

1.<http://book.bionumbers.org/how-many-chromosomes-are-found-in-different-organisms/>

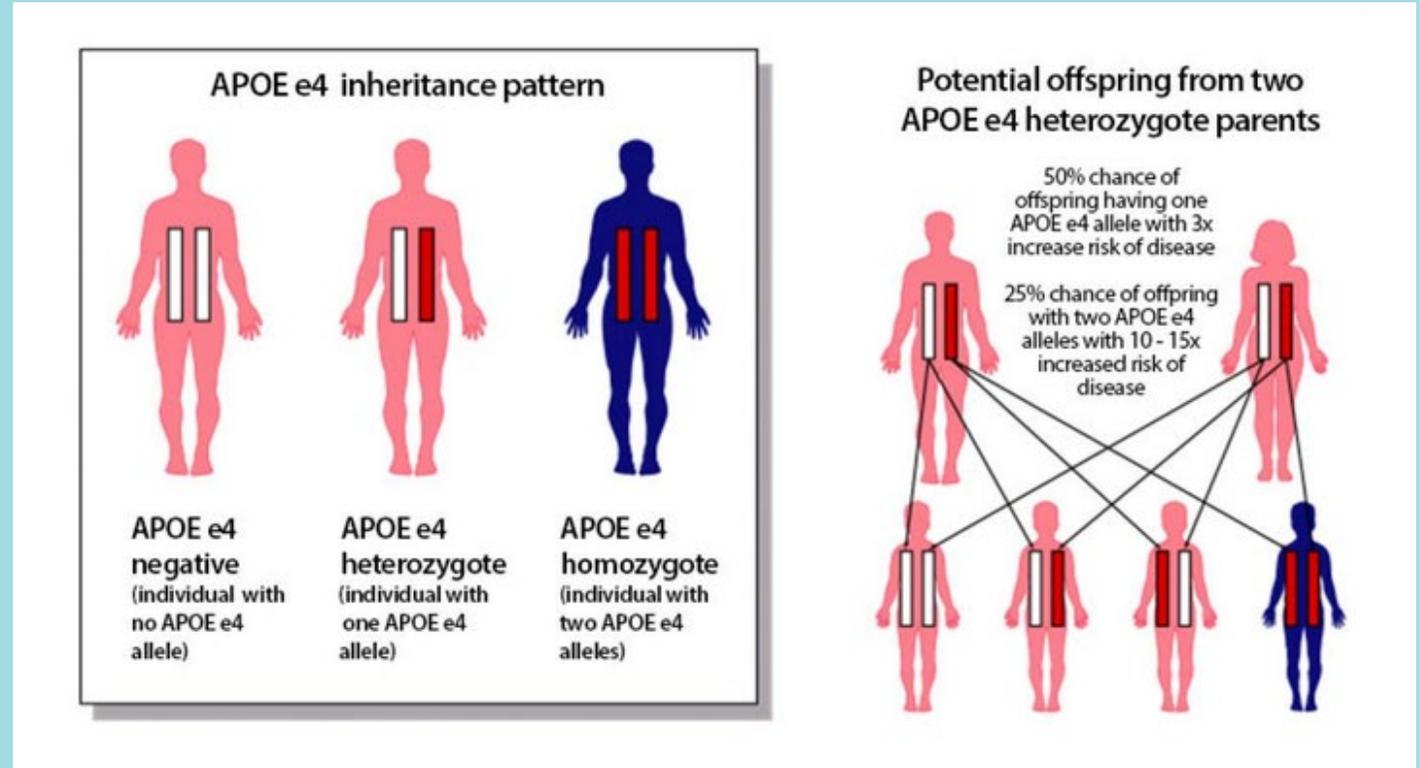
2.Tahvildari, Radin (2020). INTEGRATING SOLID-STATE NANOPORE SENSORS WITHIN VARIOUS MICROFLUIDIC ARRAYS FOR SINGLE-MOLECULE DETECTION, Doctoral Thesis

# Genetics, Nutrition, & the Aging Brain: ApoE

## Variants of the ApoE gene<sup>1</sup>

- ApoE e2, normal
- ApoE e3, protective
- ApoE e4, confers risk

	e2	e3	e4
e2	e2/e2	e2/e3	e2/e4
e3	e3/e2	e3/e3	e3/e4
e4	e4/e2	e4/e3	e4/e4



1. Asaro et al. (2020) Apolipoprotein E4 disrupts the neuroprotective action of sortilin in neuronal lipid metabolism and endocannabinoid signaling

2. <https://www.genetrace.com/learning-center/alzheimers-disease-apoe-gene-inherited/>



# Genetics, Nutrition, & the Aging Brain: ApoE

## Check for Understanding:

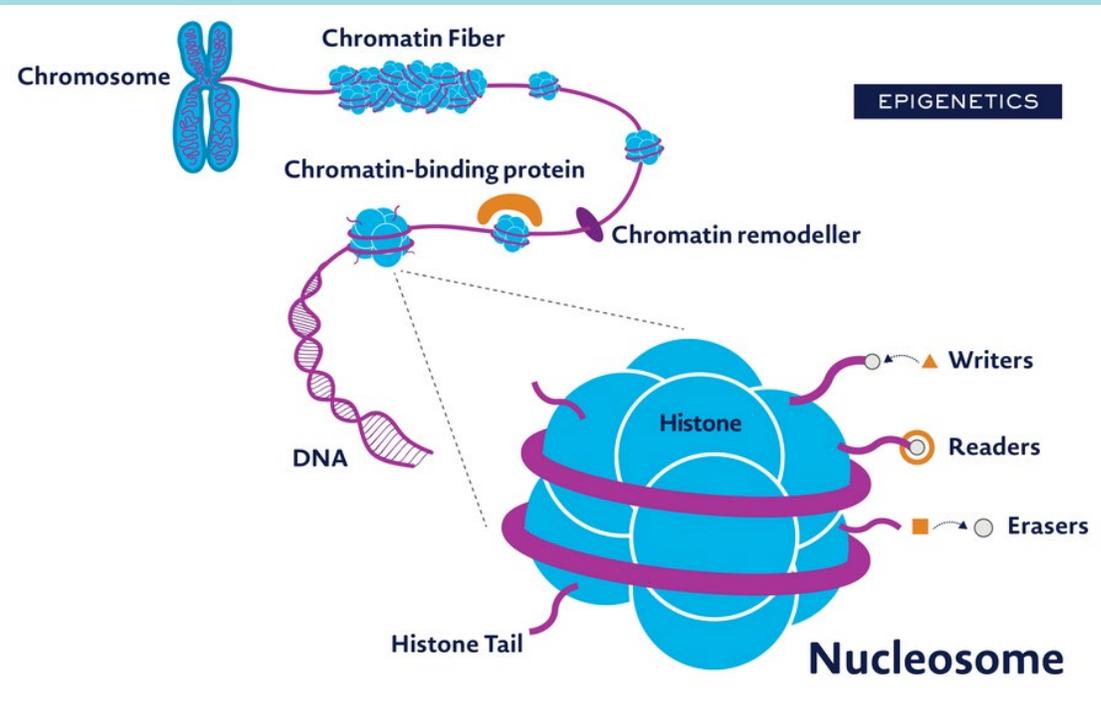
Imani has the genotype e3/e4 and her husband Hakim has a genotype of e4/e4. If they have 4 children, what is their chance of having offspring with two e4 alleles?

	e3	e4
e4	e4/e3	e4/e4
e4	e4/e3	e4/e4



# Epigenetics, Nutrition, and the Aging Brain

Epigenetics = Regulation of Gene Expression



<https://abbviescience.com/oncology/cancer-research/epigenetics>

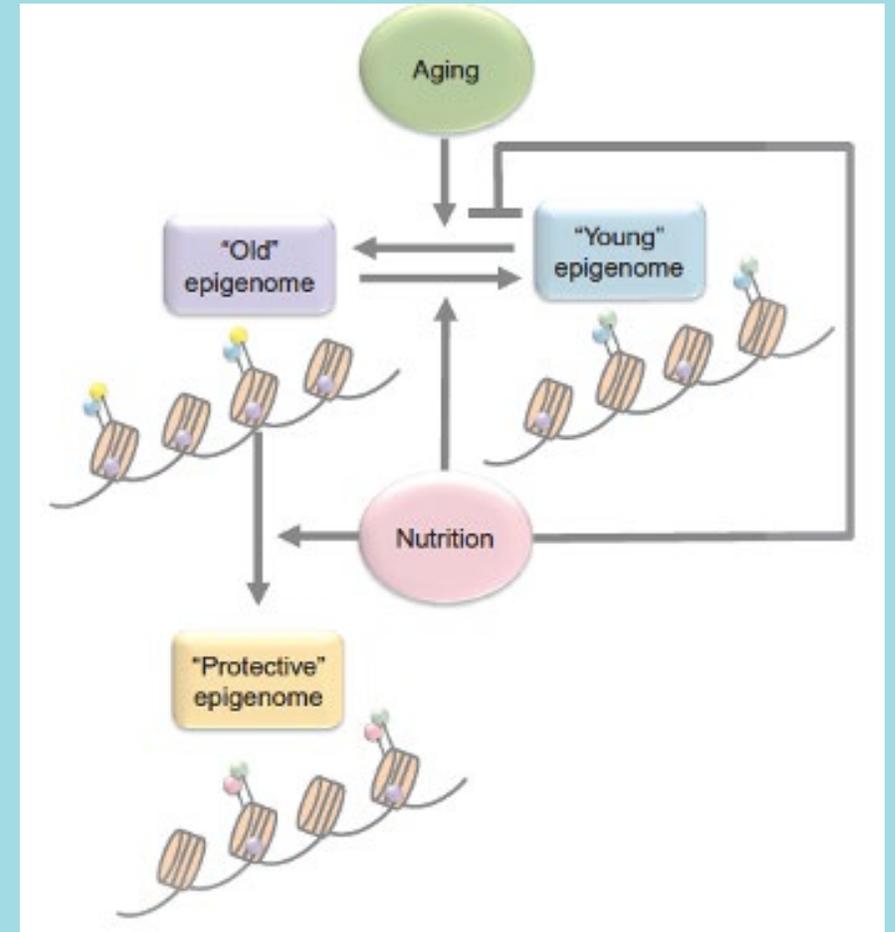
- DNA Methylation
  - Methyl Donors--Bioactive Phytochemicals, Zinc, Selenium, Vitamin A, Protein-Restricted Diet
- Histone Modification
  - Butyrate, organosulfur compounds
- Small Noncoding RNAs
  - Zinc, Vitamin D, & Selenium



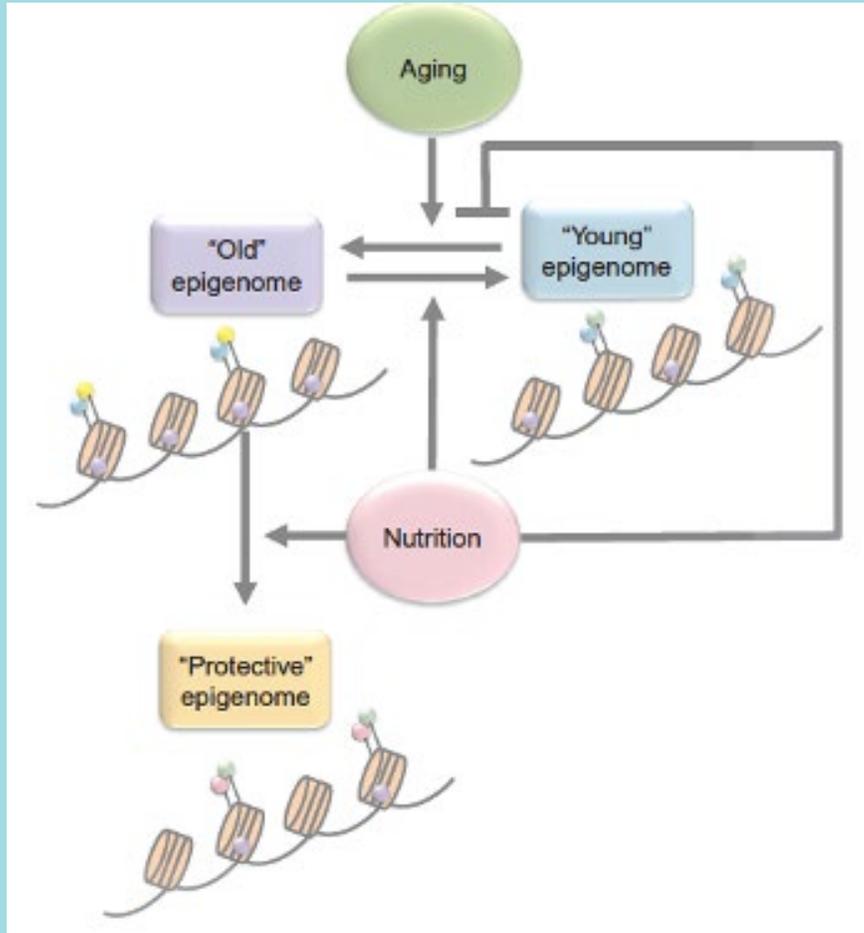
# Epigenetics, Nutrition, and the Aging Brain

## Example 1:

DNA methylation can effect neuronal functioning with consequences related to learning and memory (Liu et al., 2009)



# Epigenetics, Nutrition, and the Aging Brain



## Example 2

The newly described phenomena of epigenetic assimilation and tissue dedifferentiation<sup>2</sup>

- Normal Aging vs. Alzheimer's Disease

1. Ford, D., Ions, L. J., Alatawi, F., & Wakeling, L. A. (2011). The potential role of epigenetic responses to diet in ageing. *The Proceedings of the Nutrition Society*, 70(3), 374–384. <https://doi.org/10.1017/S0029665111000851>

2. Oh, G., Ebrahimi, S., Wang, S. *et al.* Epigenetic assimilation in the aging human brain. *Genome Biol* 17, 76 (2016). <https://doi.org/10.1186/s13059-016-0946-8>



# Key Take-Aways

1. The strongest evidence-based nutritional recommendation for delaying cognitive decline is to adhere to a diet that mirrors the Mediterranean or MIND diets.
2. Genetic and epigenetic influences are important for understanding cognitive aging, but their impact account for a much lower percent than modifiable lifestyle factors like diet, exercise, and microbiome health.



# Resources

- List of Vitamins & Minerals: Harvard Health Publishing
  - Recommended doses and important considerations:  
[https://www.health.harvard.edu/staying-healthy/listing\\_of\\_vitamins](https://www.health.harvard.edu/staying-healthy/listing_of_vitamins)
- MIND Diet: <https://mind-diet-trial.org/>
- Healthy Delicious Food at Every Age: <https://www.harvardpilgrim.org/public/docs/healthy-delicious-food>
- 2015-2020 Dietary Guidelines for Americans:  
[https://health.gov/sites/default/files/2019-09/2015-2020\\_Dietary\\_Guidelines.pdf](https://health.gov/sites/default/files/2019-09/2015-2020_Dietary_Guidelines.pdf)
- Personalized Nutrition- DNA Based Diets
  - <https://www.scientificamerican.com/article/personalized-nutrition-the-latest-on-dna-based-diets/>



*Next Week....*

# Exercise & Mental Health



Emily Erlenbach

PhD Student in Kinesiology and Community Health



*Thank You!*

