

# Evidence in Bloom: Exploring the Research Backed Benefits of School Gardens for Health, Learning & Well Being



Cynde Lane, MD



## My how life has changed!

In 1862 when President Lincoln established the USDA, 2/3 of Americans were farmers. By 1930 only 30% were farmers. Now only 2% are farmers, and only 14% live in rural, or non-metropolitan areas.

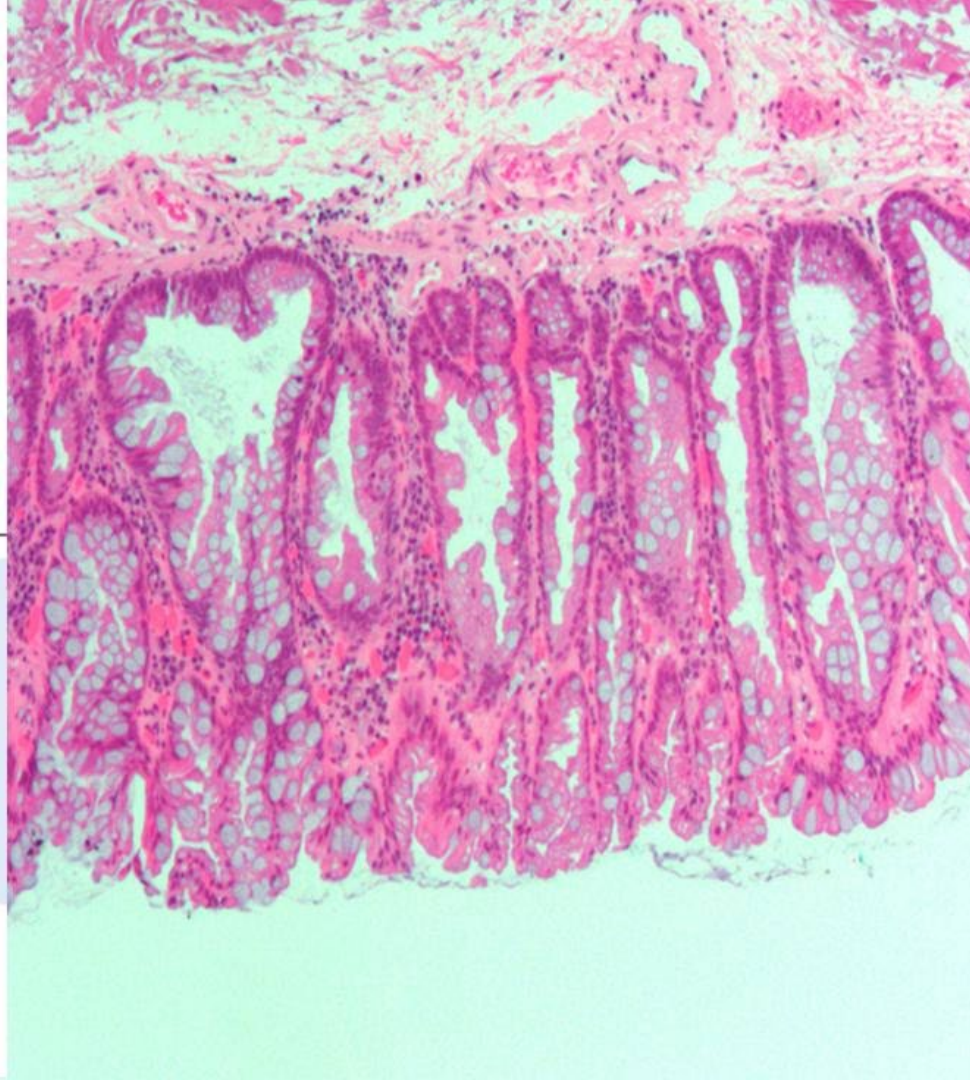
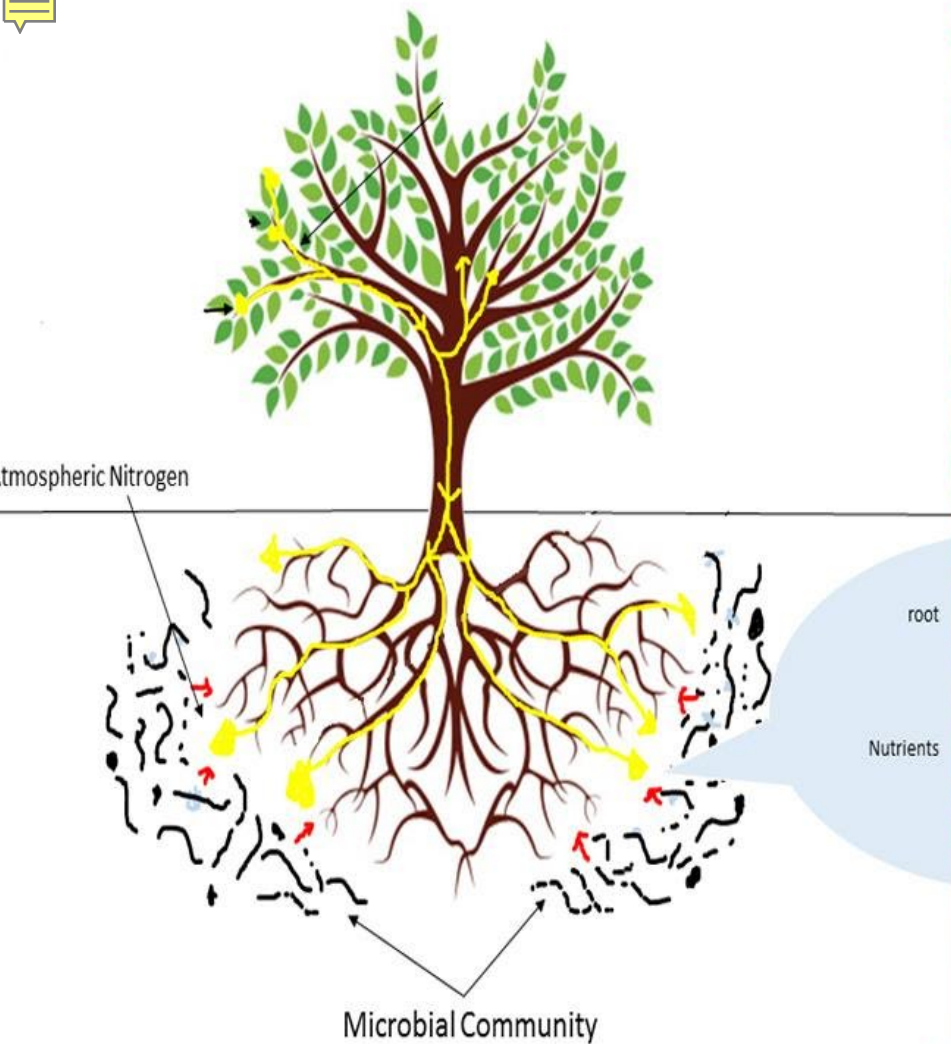


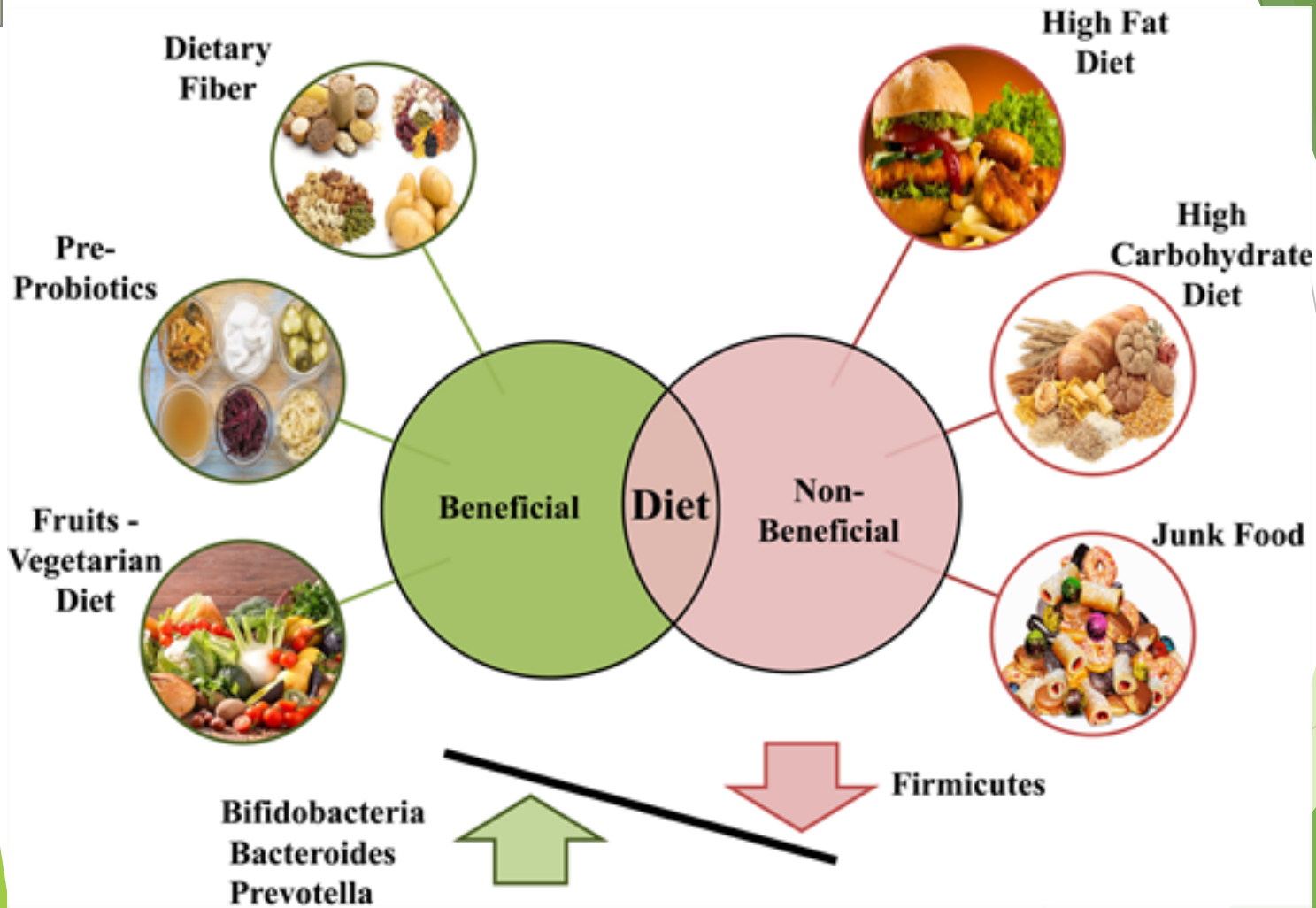
# Changes in Childhood in one generation 1970's - 2000's

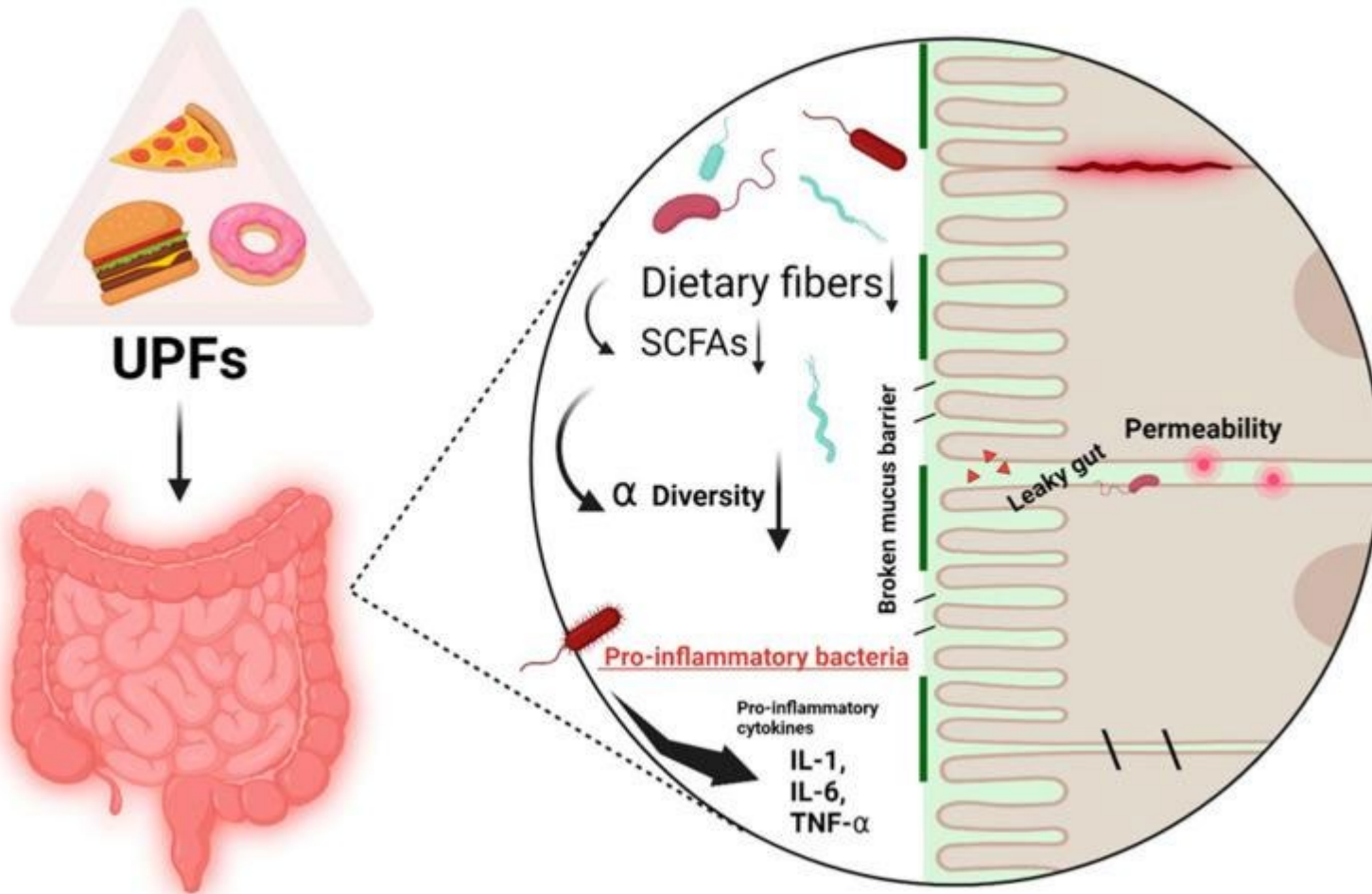
- Children spend half as much time outdoors
- Childhood obesity rates up 300%
- Large increase in processed food consumption:  
about 60% of US food consumption today
- Doubling of Type 2 diabetes in the population
- Rising rates of childhood depression, anxiety  
and suicide

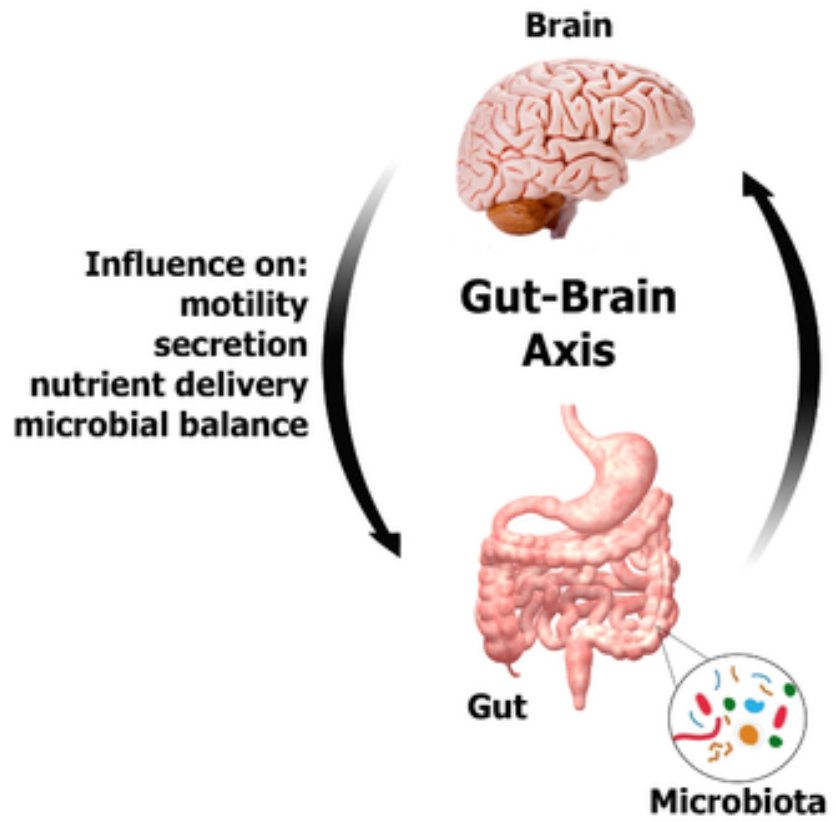
And then came the ultra processed food explosion!











- Serotonin
- GABA
- Dopamine
- Acetylcholine
- Norepinephrine
- SCFA's



# Ultra-processed food exposure and adverse health outcomes



## Summary



Higher dietary exposure to ultra-processed foods was associated with a higher risk of adverse health outcomes in 32 out of 45 pooled analyses (71%)

## Study design



Umbrella review | 14 meta-analysis studies; 45 pooled analyses  
Ultra-processed foods; defined by the Nova classification

## Population



9 888 373 participants included; irrespective of health status and age

## Outcomes



See full paper for more parameters, including those with no evidence  
Mortality Cancer Cardiovascular health Gastrointestinal health  
Mental health outcomes Respiratory health Metabolic health

Evidence quality	Evidence credibility			
	Convincing	Highly suggestive	Suggestive	Weak
Moderate	Type 2 diabetes		All cause mortality	Overweight + obesity
Low	Adverse sleep Anxiety Combined common mental disorders	Obesity All cause mortality Heart disease related mortality Depression Wheezing	CVD* events combined† CVD* morbidity	CVD* related mortality Colorectal cancer Crohn's disease
Very low	CVD* related mortality	Type 2 diabetes	Abdominal obesity Overweight Cancer overall Colorectal cancer Hypertension	Low high density lipoprotein concentration Metabolic syndrome Non-alcoholic fatty liver disease



# Effectiveness of Gardening-Only, Cooking-Only and Combined Cooking and Gardening Programs in Elementary Schools to Improve Fruit and Vegetable Intake: A Systemic Review

*Nutrients* **2023**, **15**, 3008

<https://doi.org/10.3390/nu15133008>



**36 studies published in peer reviewed journals were analyzed:**

**9 gardening only programs,  
8 cooking only programs, and  
19 combined gardening and cooking programs  
in 14 countries. 50% in the US.**

**100% - Effective in improving gardening/cooking knowledge/skills**

**90% - Effective in improving attitudes and self efficacy to consume F&V**

**80% - Significant for improving willingness to try fruits and vegetables**

**68% - Significant increase in fruit and vegetable intake**

**62% - Improved preference for fruits and vegetables**



# WHO GETS MORE TIME OUTDOORS?





# Shinrin-Yoku

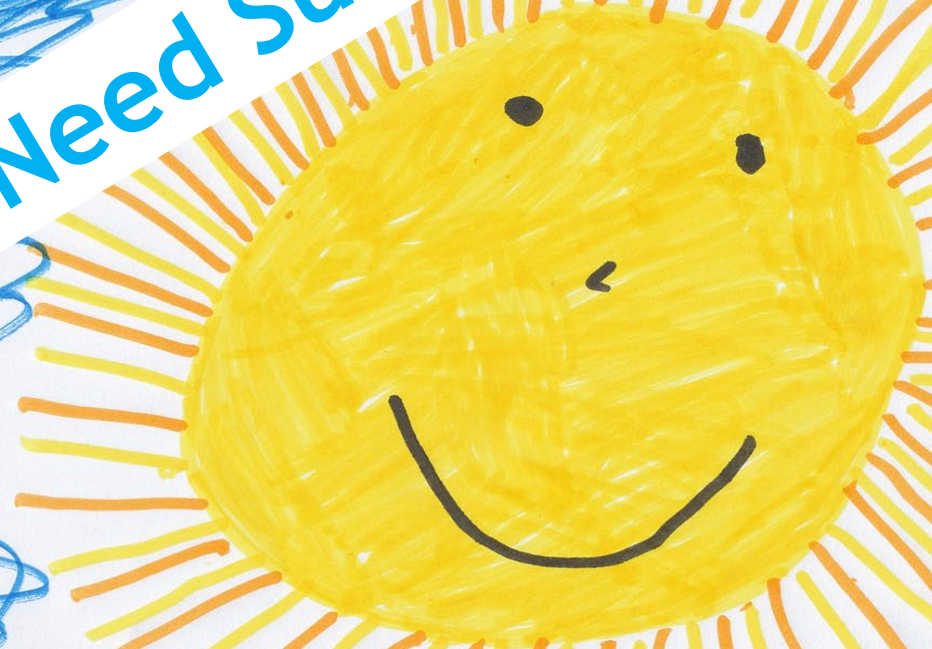


# Japanese “Forest Bathing” is Good Medicine

- ▶ A two hour forest walk raises the level of Natural Killer Cells by 50%, with effects seen for more than a week
  - ▶ Raises the levels of T Cells, neutrophils, and intracellular anti-cancer proteins
  - ▶ Decreases urine catecholamine levels and salivary amylase
  - ▶ Lowers blood pressure and heart rate
- 
- ▶ Q. Li, K. Morimoto et al. “Visiting a forest, but not a city, increases human natural killer activity and expression of anti cancer proteins, Int’l J. of Immunopathology and Pharmacology, Vol. 21, no.1, 117-127, 2008
  - ▶ M. Yamaguchi et al., “The Effects of Exercise in Forest and Urban Environments on Sympathetic Nervous Activity of Normal Young Adults”, The J. of International Medical Research, 2006; 34: 152-159



**Kids Need Sun!**





Happy  
Memory  
Attentive  
Learning



**SEROTONIN**



**MELATONIN**

Drowsy



Inattentive

ZZ

# Benefits of Sunlight



- Improved Sleep Cycles
- Improved Mood
- Immune System Activation
- Necessary for Normal Eye Development
- Vitamin D Production





**BOOSTS IMMUNITY**

**BUILDS  
STRONG BONES**



**IMPROVES  
BRAIN HEALTH**



**REDUCES RISK  
OF DIABETES AND  
MULTIPLE SCLEROSIS**

**MANAGES  
AUTOIMMUNE DISORDERS**



Outdoor light helps establishes diurnal rhythm

Adequate sleep enhances mood, immune system function, memory, attention span and school performance

Inadequate sleep associated with obesity, depression

Teens with 6 hours of sleep or less are 3X more likely to commit suicide than teens who get 8 hours of sleep

**On Don't Fry Day (and Every Day)**

# Slip, Slop, Slap & Wrap!®

A turtle has a built-in shirt.



A pig uses mud as sunscreen.



The bumps over a camel's eyes act as a hat.



The black rings around a meerkat's eyes are sunglasses.



**ANIMALS ARE NATURALLY SAFE IN THE SUN. WE HAVE TO REMEMBER TO: SLIP, SLOP, SLAP & WRAP!®**

**Slip on a shirt, Slop on sunscreen, Slap on a hat, and Wrap on sunglasses whenever you go outdoors.**



The Friday before Memorial Day is

**Don't Fry Day**

[www.skincancerprevention.org](http://www.skincancerprevention.org)



United States  
Environmental Protection  
Agency



A Partnership Program of the U.S. Environmental Protection Agency

[www.epa.gov/sunwise](http://www.epa.gov/sunwise)

# The Myopia (Nearsightedness) Boom

- ▶ The incidence of myopia in the United States and Europe has doubled in the last fifty years, from 25% to 50% of young adults
- ▶ In eastern Asia the increase in myopia is even more dramatic. In China, sixty years ago, 10-20% of adults were myopic, but today up to 90% of teenagers are myopic. In Seoul, 96.5% of 19 year olds are myopic.
- ▶ 25% of east Asian young adults have a severe form of myopia, which stretches and thins the inner eye, increasing the risk of retinal detachment, cataracts, glaucoma, macular degeneration and blindness.

“The Myopia Boom” by Elie Dolgin, Nature Vol. 519 March 2015 pp.276-278



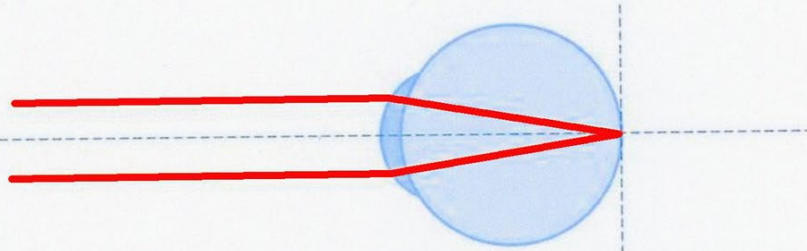
Newborn eyes: 0.7  
in. axial length

Adult eyes: 1.0 in.  
axial length

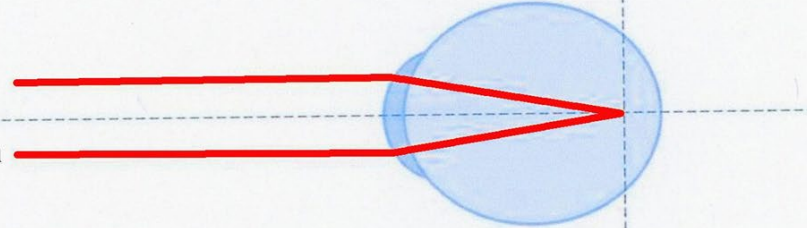
Infants and young  
children are usually  
somewhat hyperopic



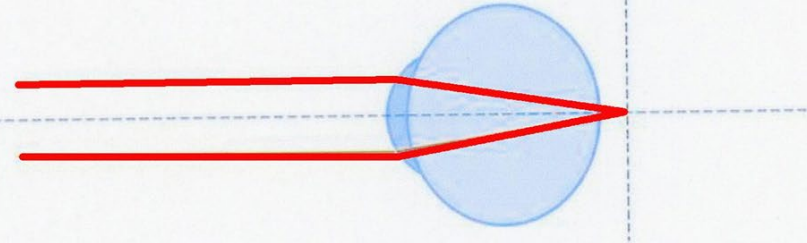
**Emmetropia**  
**Normal Vision**



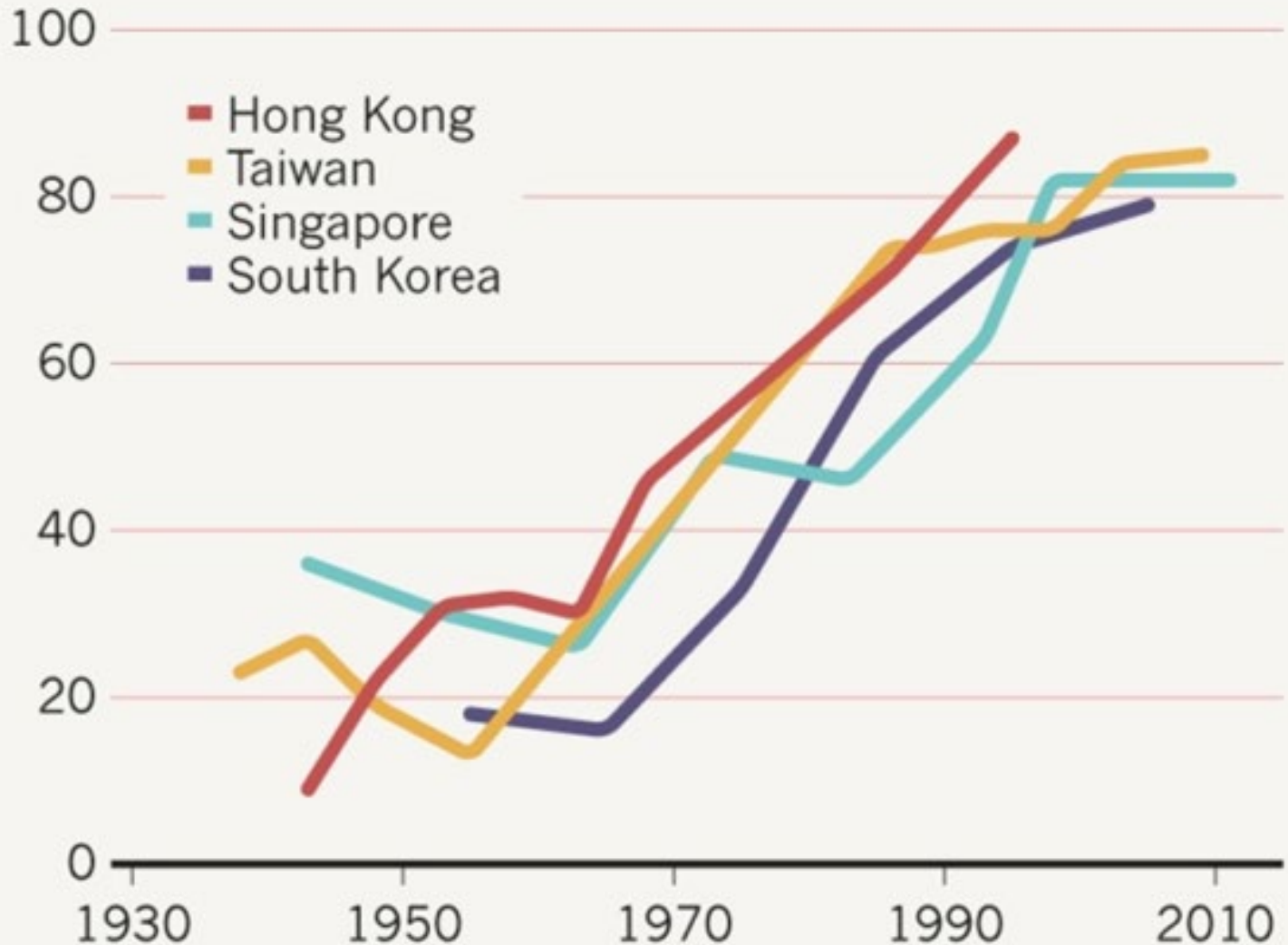
**Myopia**  
**Near Sighted Vision**

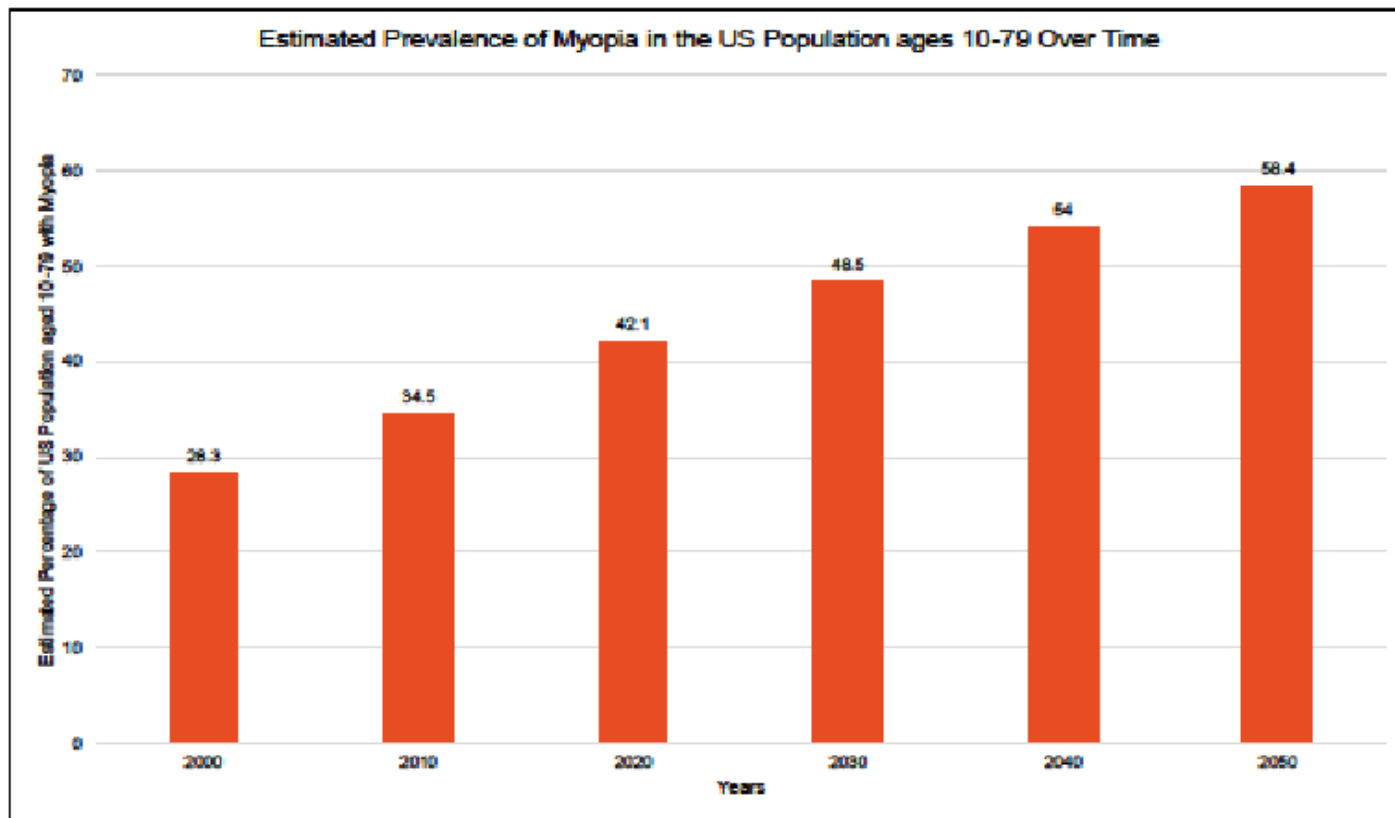


**Hyperopia**  
**Far Sighted Vision**



Estimated prevalence  
in 20-year-olds





<http://dx.doi.org/10.1016/j.optha.2016.01.006>

## Sydney Myopia Study

- ▶ 1,765 6 year olds and 2,367 12 year olds living in Sydney participated from 2003 - 2005.
- ▶ Children had a comprehensive eye exam including cycloplegic refraction. Parents and children completed detailed questionnaires on activity.
- ▶ Higher levels of outdoor activity, rather than sports per se, were associated with a lower incidence of myopia
- ▶ Indoor sports did not reduce the incidence of myopia
- ▶ Time spent in close visual work was only weakly associated with increased incidence of myopia

## Time spent outdoors reduces the risk of myopia in children

- ▶ The Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) study, a multicenter study in the US, followed nearly 5,000 children from 1989 to 2010 to determine what factors characterized children who became myopic vs. those who did not.
- ▶ In the highest risk group, children with two myopic parents, the effect of time spent outdoors on their incidence of becoming myopic was dramatic. Those who spent the lowest amount of time outdoors (5 hours or less per week) had about a 60% risk of becoming myopic vs. only a 20% risk for those who spent 14 hours or more outside.
- ▶ Children with one or no myopic parents also benefited from more time outdoors.

Donald O. Mutti, OD, PhD, Optometry Time, July 23, 2013



# A School Intervention to Increase Outdoor Time Reduces New Onset Myopia and Myopic Progression

- Elementary students aged 7 - 11 in two nearby suburban schools in Taiwan
- The two schools were matched for age, baseline refraction, and myopia prevalence (47.75%/49.16%)
- The control school had 238 students participating with no special recess activities
- The intervention school had 333 students participating with 80 mins. Of outdoor time during school days
- After 1 year new onset myopia was significantly lower in the intervention group: 8.41% vs. 17.65% in the control group

Outdoor Activity during Class Recess Reduces Myopia Onset and Progression in School Children  
Wu, Pei-Chang et al.  
Ophthalmology , Volume 120 , Issue 5 , 1080 - 1085

# How does time outdoors prevent myopia?

- ▶ Exposure to much higher lumen levels than indoor light: 10,000 lumens outdoors under a tree with sunglasses on a bright day vs. 500 lumens in a well lit indoor space.
- ▶ High light levels stimulate dopamine production in the retina which has a feedback loop to relax the ciliary muscle
- ▶ Exposure to wide open distant visual stimulation with relaxation of ciliary muscles
- ▶ Substitution effect: Less time indoors doing close work seems to be a very small effect
- ▶ 2-3 hours of outdoor time in childhood reduces risk of myopia



# Myopia Complications



- Cataracts
- Glaucoma
- Retinal tears and detachment
- Chorioretinal atrophy
- Optic disc abnormalities
- Myopic macular degeneration
- Blindness: 39%-50% of 75 yr olds with high myopia will have uncorrectable visual impairment

A young child with light brown hair, wearing a blue baseball cap, a yellow t-shirt with a blue collar and blue stripes on the sleeves, and blue shorts, is sitting on the ground. The child is smiling broadly, showing their teeth, and holding a handful of dirt in their right hand. The background shows a wooden raised garden bed and some green grass. The overall scene is outdoors and bright.

# Kids Need Dirt!

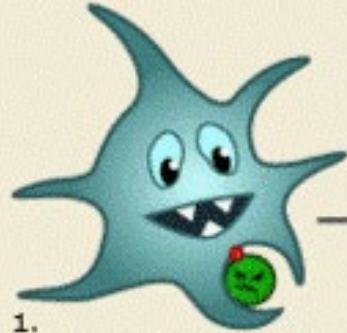
Less asthma, allergies, and autoimmune disease and promotes healthy immune system development

# Immune System

## Antigen Presentation

## Education

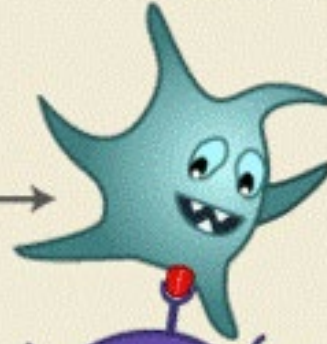
dendritic cell



1. A phagocyte "eats" a bacteria.



2. Parts of the bacteria (antigen) goes to the surface of the phagocyte



3. The phagocyte presents the antigen to a helper T cell




helper T cell

activated helper T cell



4. The helper T cell is activated.

A close-up photograph of a person's hands holding a large amount of dark, rich soil. The soil is mixed with numerous small, white, spherical perlite granules. The hands are positioned in the center and right of the frame, with the soil filling most of the space. The background is slightly out of focus, showing more soil and some green plant leaves.

# Antidepressant Microbes in Soil: *Mycobacterium Vaccae*

“Identification of an Immune-Responsive Mesolimbocortical Serotonergic System:  
Potential Role in Regulation of Emotional Behavior,” by Christopher Lowry et



DAVID R. MONTGOMERY  
AND ANNE BIKLÉ

# THE HIDDEN HALF OF NATURE

THE MICROBIAL ROOTS  
OF LIFE AND HEALTH

"Wonderfully fresh and exquisitely informed."—TIM McNULTY, *Seattle Times*



DIRT IS  
GOOD

The Advantage of Germs  
for Your Child's  
Developing Immune System

JACK GILBERT, Ph.D.  
AND ROB KNIGHT, Ph.D.  
WITH SANDRA BLAKESLEE



**Improves ADHD  
Symptoms**

# Lessons In Nature Boost Subsequent Classroom Engagement

- 100 paired comparisons of lessons in nature and lessons in classroom in 2, 3<sup>rd</sup> grade classrooms over 10 weeks, matched on teacher, class, topic, teaching style, week of the semester, and time of day.
- Classroom engagement measured by teacher ratings, independent photo based ratings, third party tallies of “redirects”, a composite index, and student ratings
- In 48 of 100 comparisons the nature lesson was a full standard deviation better than the classroom counterpart. In 20 of the 48 the nature lesson was two standard deviations better.

# A Walk In The Park Improves Attention

- ▶ 17 children aged 7 to 12 years old diagnosed with ADHD
- ▶ Examined the impact of 20 minute guided walks in three different settings: a city park and two well kept urban settings, on a digit span backwards test.
- ▶ Performance was substantially better after the green space walks, comparable to the effects seen with methylphenidate.
  
- ▶ Taylor, Andrea Faber and Kuo, Frances E., J. of Attention Disorders 2009; 12(5) 402-409



# Directed Attention



# Fascination


# School Gardens



**Academic  
Performance**

**Healthy Food  
Preferences  
and  
Consumption**

Berezowitz CK, Bontrager Yoder AB, Schoeller DA. School Gardens enhance academic performance and dietary outcomes in children. *J Sch Health*. 2015; 85; 508-518



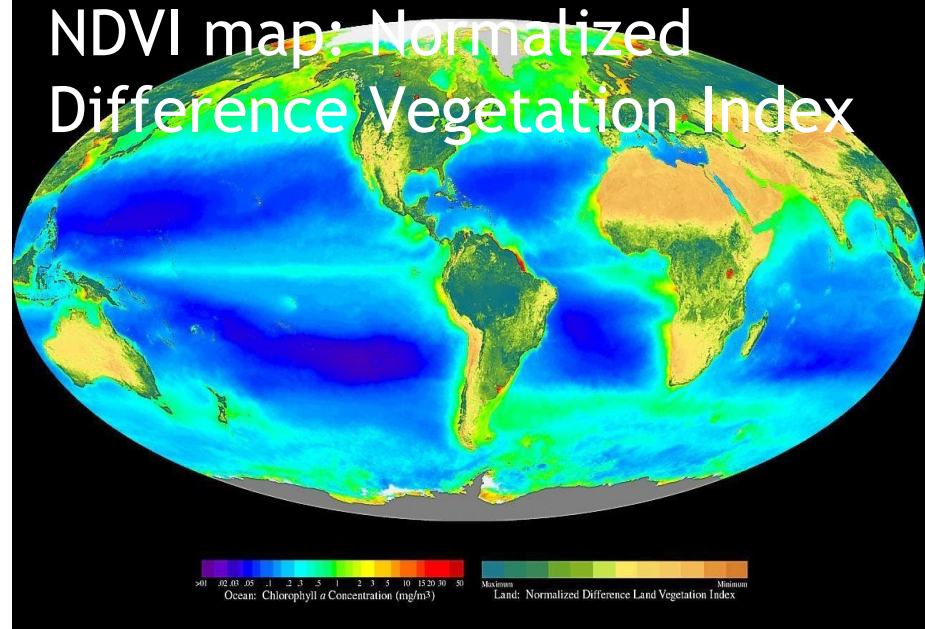
# Green Schoolyards Improve Children's Memory, Attention and Academic Performance

Gage Elementary School, San Diego, CA

# Massachusetts Study

- 905 Elementary schools in Massachusetts studied
- Greenness of school environment measured using satellite NDVI maps
- Performance of 3<sup>rd</sup> graders on the Massachusetts Comprehensive Assessment System tests compared to greenness of school environment.
- Controlled for socioeconomic status
- Students with greener environments consistently performed better on the MCAS

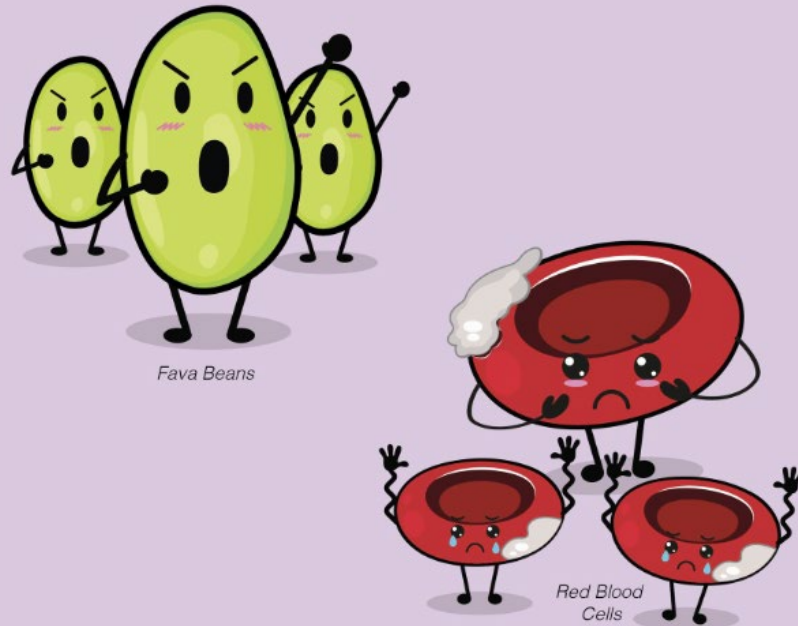
NDVI map: Normalized Difference Vegetation Index



Citation: Wu C-D, McNeely E, Ceden˜ o-Laurent JG, Pan W-C, Adamkiewicz G, et al. (2014) Linking Student Performance in Massachusetts Elementary Schools with the “Greenness” of School Surroundings Using Remote Sensing. PLoS ONE 9(10): e108548. doi:10.1371/journal.pone.0108548

Don't plant Fava Beans!

Exposure to fava beans  
Or fava bean pollen can  
trigger a hemolytic  
crisis in people with  
Glucose-6 phosphate  
dehydrogenase deficiency



# Fava Beans

The Arch Enemy of G6PD-Deficient Individuals

@SGFoodAgency



# Garden time ...

- Reduces anxiety and depression symptoms
- Reduces ADHD symptoms
- Reduces antisocial behavior
- Improves subsequent classroom engagement
- Improves test scores
- Increases students' consumption of fruits and vegetables
- Increases students' enthusiasm for school

