

Caries is a disease of the oral microbiome caused by sugar



Jeremy Horst Keeper DDS, PhD
Director of Clinical Innovation

why do cavities happen?



the dentistry story

Not brushing causes cavities.

Fillings stop cavities.

... and then you never get a cavity again.

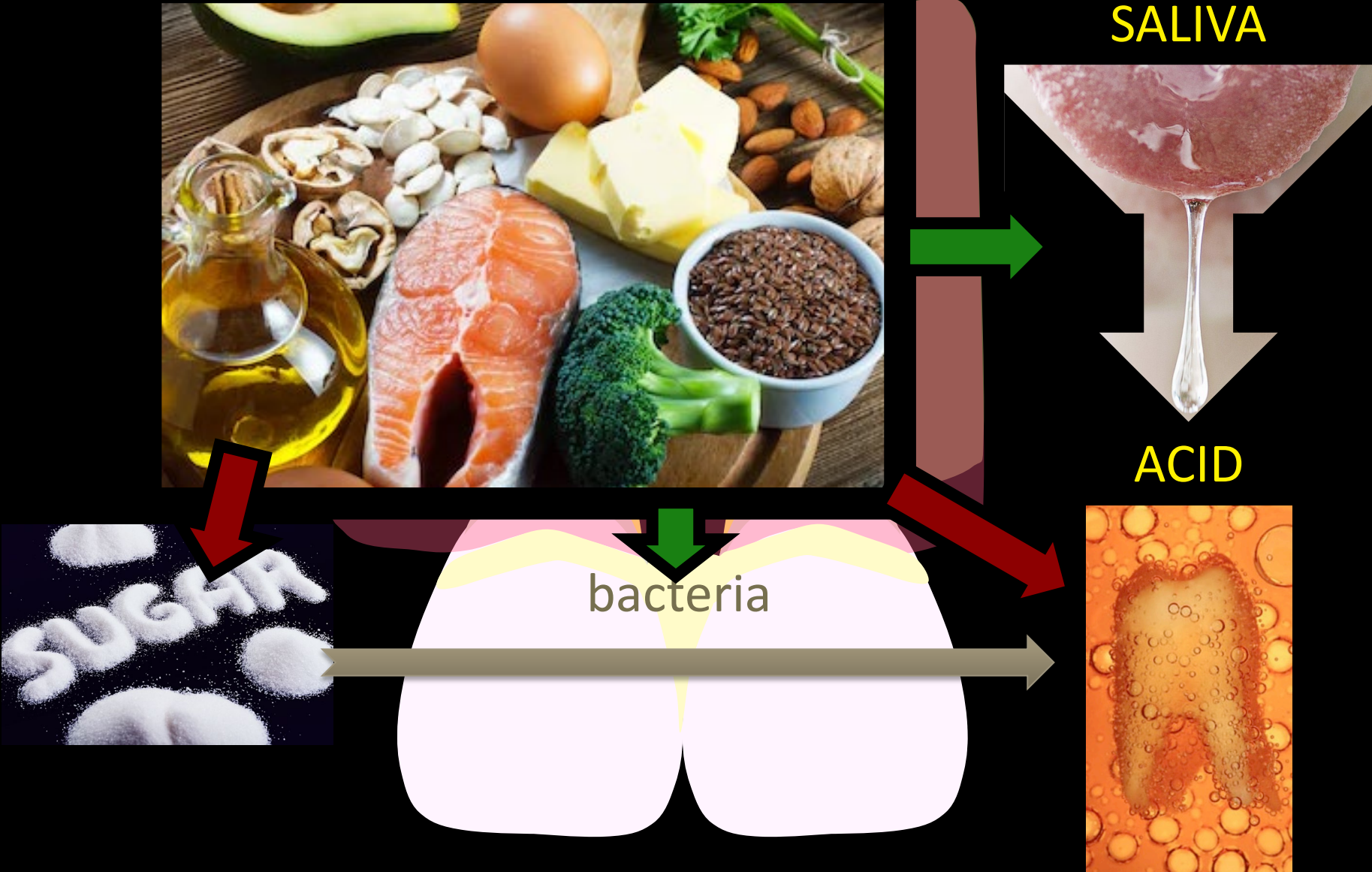


we've been hosed.

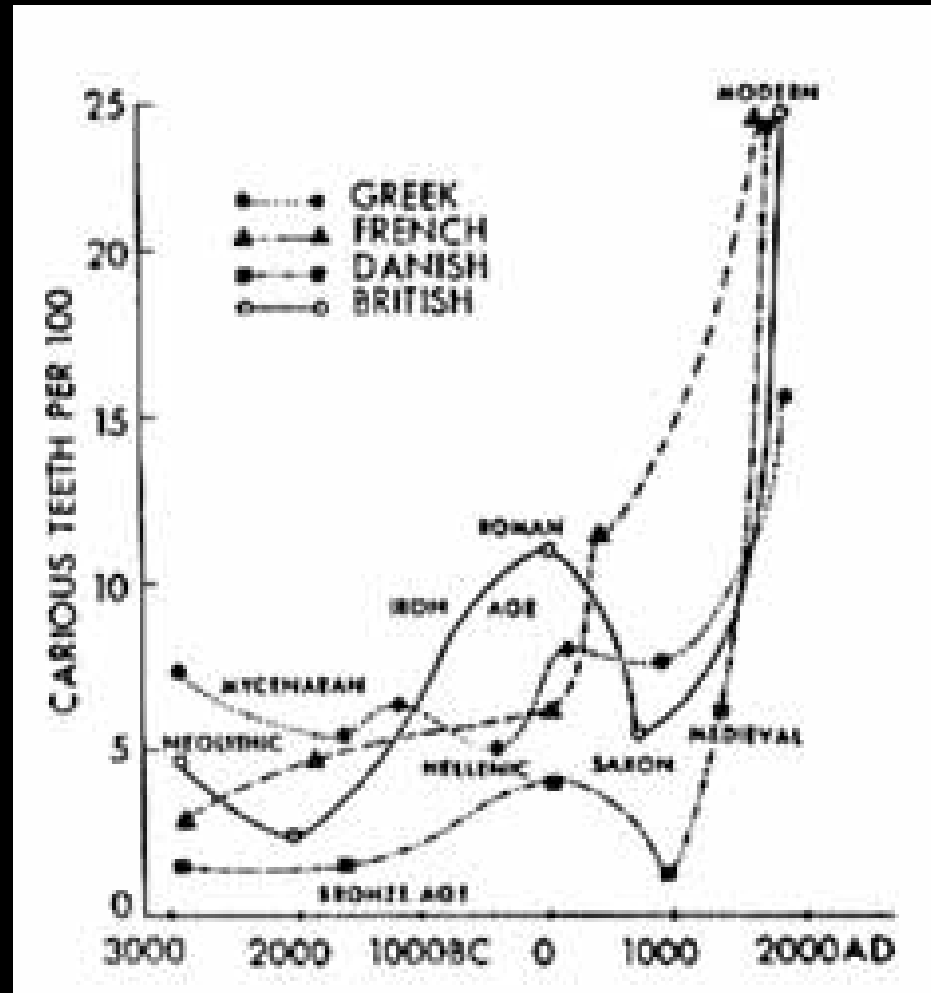
- Just kidding.
- 70% of GA cases recur in 1 year.
- Dentistry, cleanings, and brushing do not address the cause.



dental caries basics



Slavery-produced sugar and trans-Atlantic shipping drove caries in Europeans



Kean, 1980

sugar + time = caries

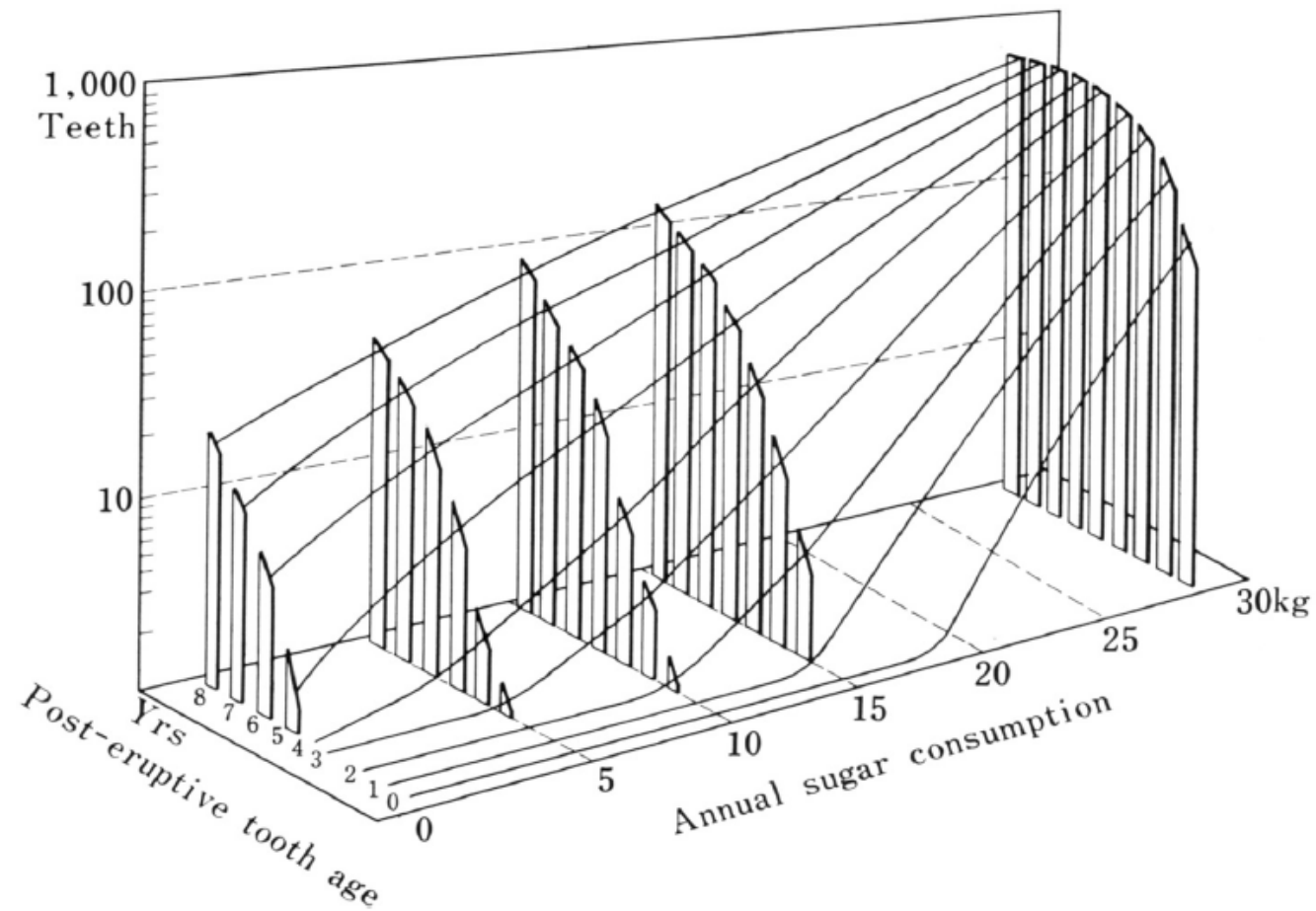


Figure 1 Three-dimensional model of the cumulative numbers of caries in upper central incisor teeth. Data were plotted on a log scale, by post-eruptive tooth age up to 8 years, and related to the average annual sugar consumption per head in Japan from 1935 to 1957 (Takeuchi et al. [14], with permission).

Log-linear relationship between sugar and caries

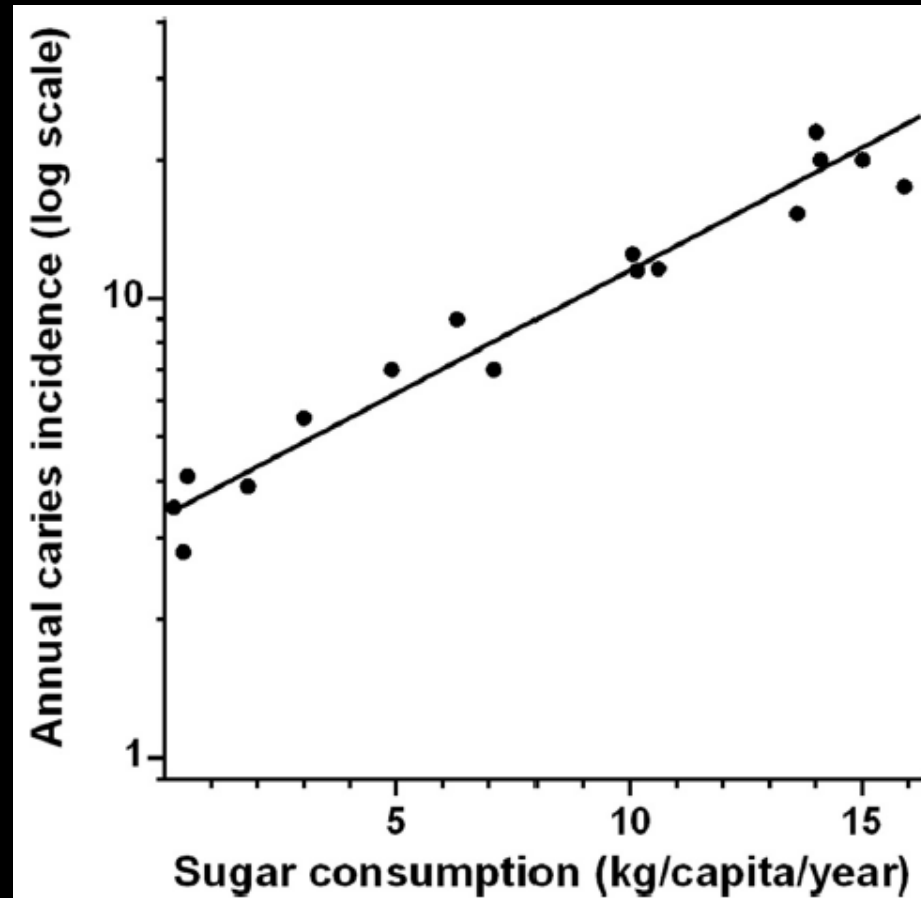


Figure 2 Relationship between annual per capita sugar consumption and annual caries incidence in lower first molar teeth. Data based on 10,553 Japanese children whose individual teeth were monitored yearly from the age of 6 to 11 years of age. Data plotted on a log scale. (Adapted from Koike [18]).

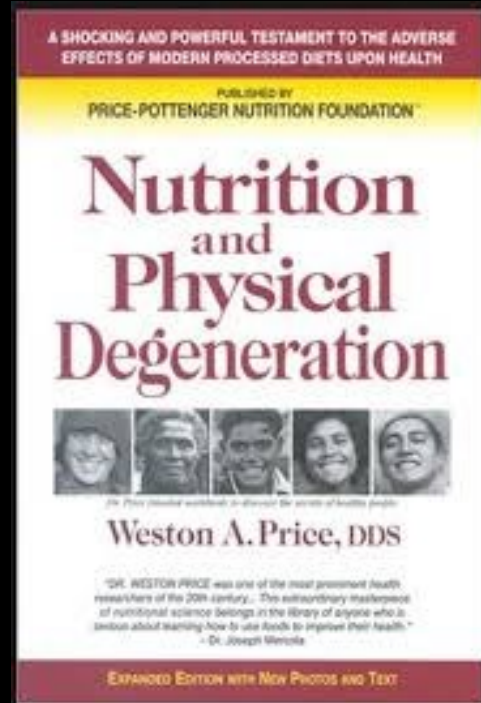
Trends in Consumption of Ultraprocessed Foods Among US Youths Aged 2-19 Years, 1999-2018

Lu Wang, PhD, MPH; Euridice Martínez Steele, PhD; Mengxi Du, MS, MPH, RD; Jennifer L. Pomeranz, JD, MPH, RD; Lauren E. O'Connor, PhD, MPH; Kirsten A. Herrick, PhD, MSc; Hanqi Luo, PhD; Xuehong Zhang, PhD; Dariush Mozaffarian, MD, DrPH; Fang Fang Zhang, MD, PhD

IMPORTANCE The childhood obesity rate has been steadily rising among US youths during the past 2 decades. Increasing evidence links consumption of ultraprocessed foods to excessive calorie consumption and weight gain, but trends in the consumption of ultraprocessed foods among US youths have not been well characterized.

RESULTS Dietary intake from youths were analyzed (weighted mean age, 10.7 years; 49.1% were girls). From 1999 to 2018, the estimated percentage of total energy from consumption of ultraprocessed foods increased from 61.4% to 67.0% (difference, 5.6% [95% CI, 3.5% to 7.7%]; $P < .001$ for trend), whereas the percentage of total energy from consumption of

Caries, obesity, diabetes, fatty liver disease, etc. result from ultraprocessed diets (*malnutrition*), which select for caries bacteria.



Indigenous foods Ultraprocessed foods

Change the Food, change the World



LEARN



GROW

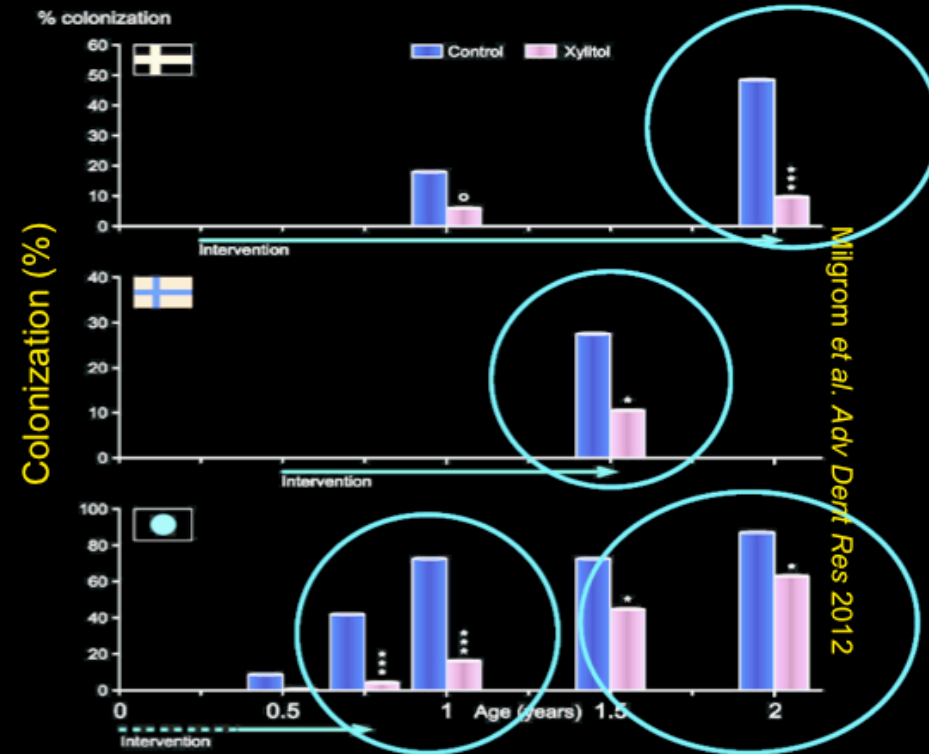


THRIVE

*Boston
Medical
Center*

Is the Oral Microbiome *clinically important?*

xylitol gum for new Moms!



Milgrom et al. Adv Dent Res 2012

decreased colonization
by treating mothers

Life cycle transmission



xylitol gum for new Moms!



$$\frac{365 \frac{\text{days}}{\text{year}} * 8 \frac{\text{g}}{\text{day}} * \frac{\$3.89}{57 \text{ tabs}}}{2 \frac{\text{g}}{\text{tab}}} = \$99.64/\text{year}$$

	prevent	start	freq	duration	eval	control	pubmed
n=195	71%	3mon	4/day	21mon	5yo	vs NaF 2/year	11145360
n=60	78%	10-36m	3/day	3mon	2y	vs NaF 2/year	24888659
n=173	71%	6mon	3/day	1year	4yo	vs NaF/xylitol/sorbitol	17164069

Horst. DCNA, 2018



less need for treatment
by treating mothers

Share that healthy plaque.



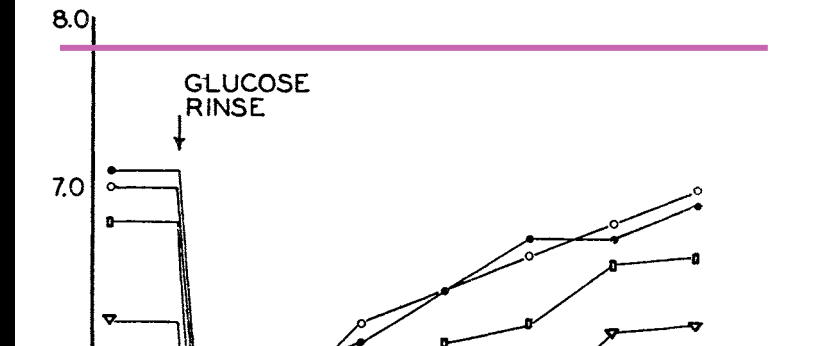
Window of infectivity



ROBERT M. STEPHAN

material material on teeth following rinsing the mouth with the glucose solution. The drop in pH was greatest and lasted for the longest time in the caries-active groups.

Fig. 1 shows the pH changes produced on the labial surfaces of the upper teeth of each caries-activity group. Fig. 2 shows similar changes for the labial surfaces of the lower teeth. These graphs show that there are striking differences between the different caries-activity groups. However, there was no essential difference between those who were completely caries-free (Group I) and



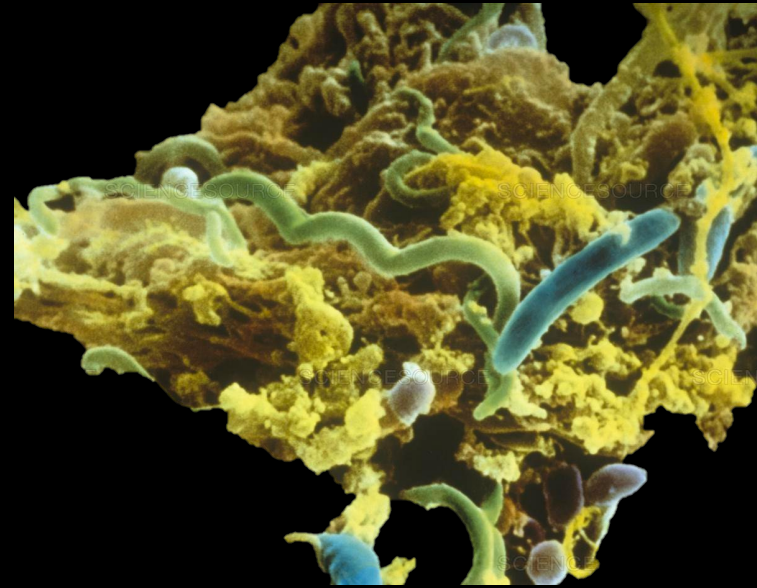
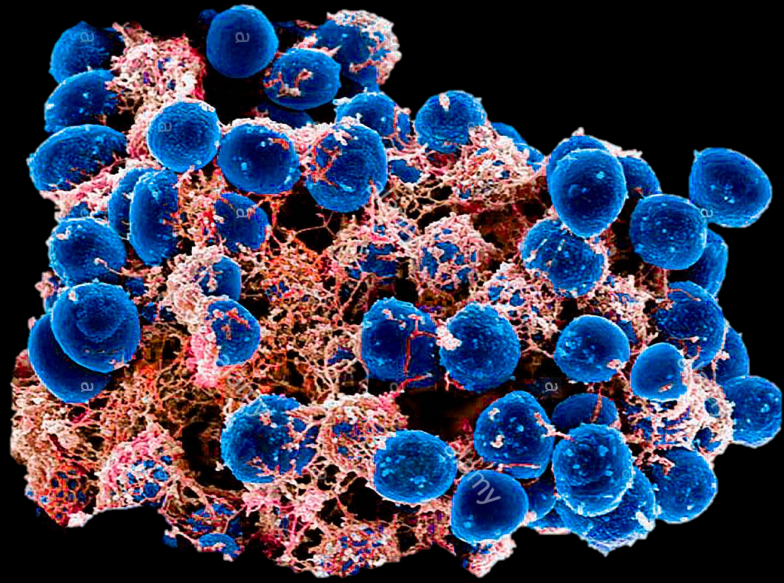
1944

local acidity of different areas of the mouth with caries, but found no pH value below 5.4. Since evidence has accumulated that decalcification of teeth prob-

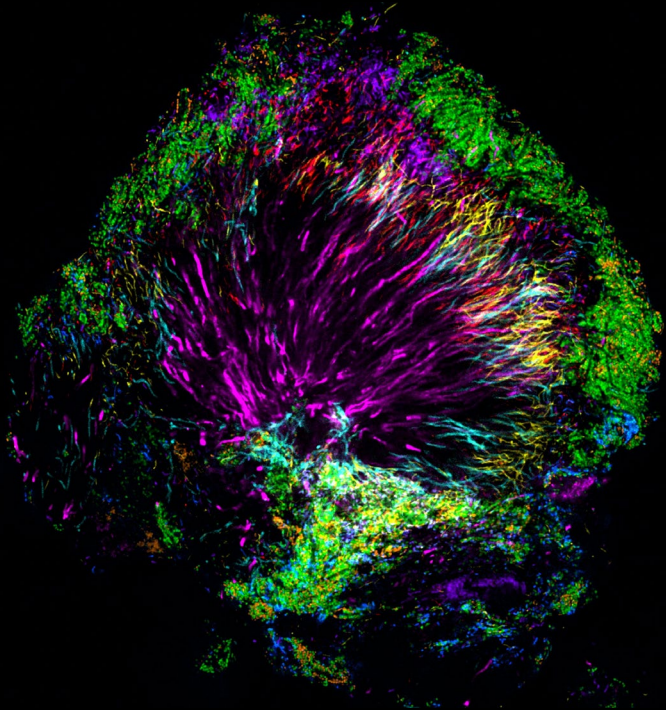
¹ The expenses of this investigation were defrayed in part by a grant from the Squibb Institute for Medical Research. Received for publication May 11, 1944.

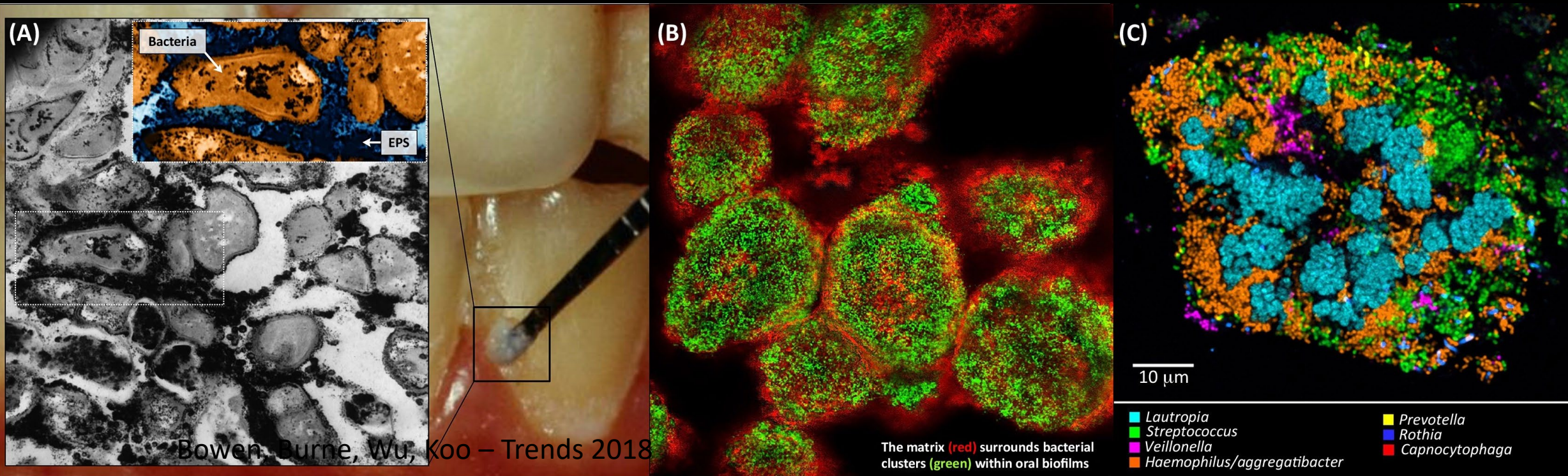
² Examples of other possible mechanisms for decalcification are removal of phosphate ions by phosphorylation (2) and removal of calcium ions by complex ion formation with polycarboxylic acids (3, 4). Individual differences in calcium and phosphate concentra-

How does the Oral Microbiome *work?*

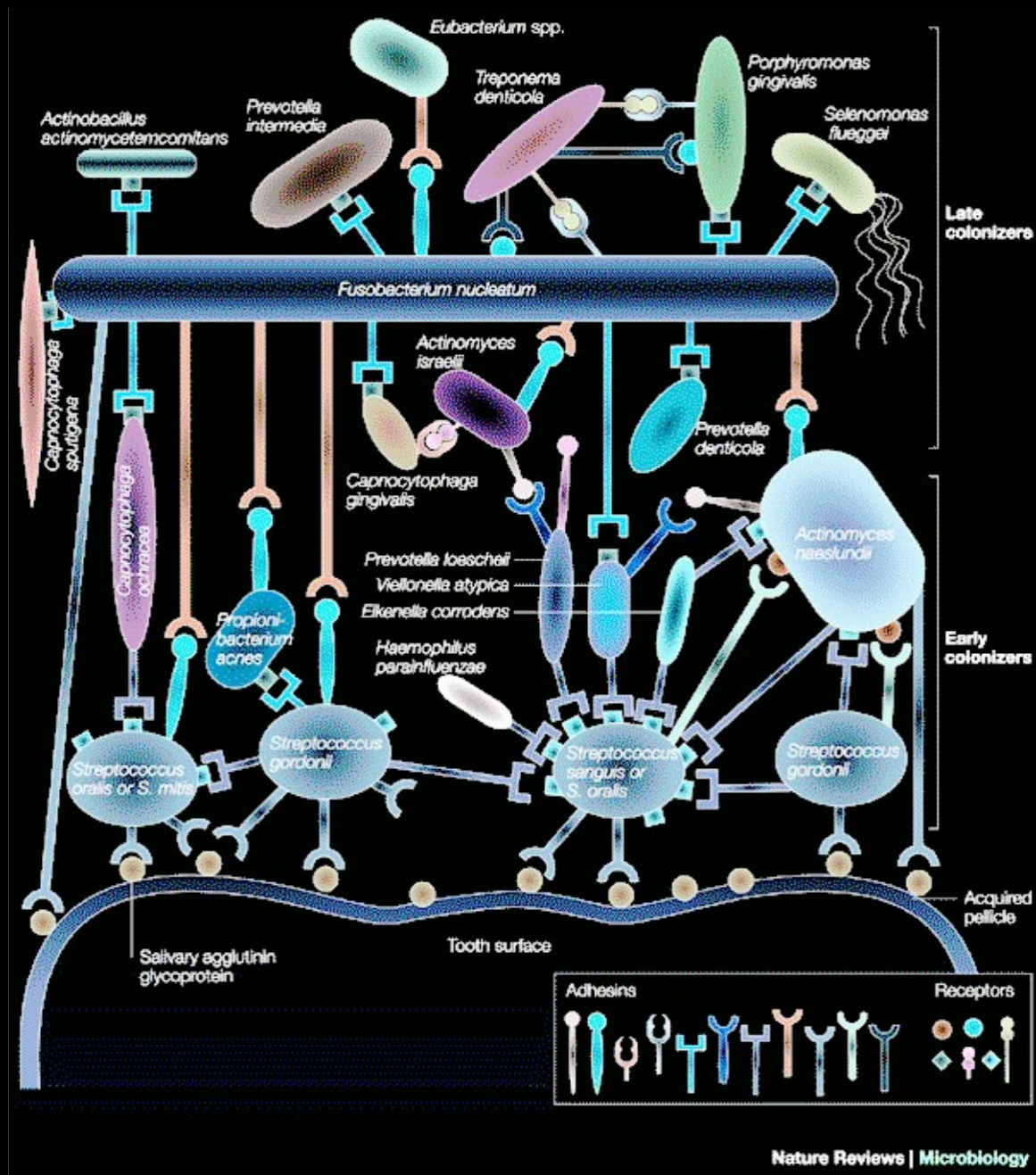


Not all plaque is the same.



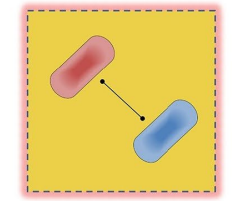
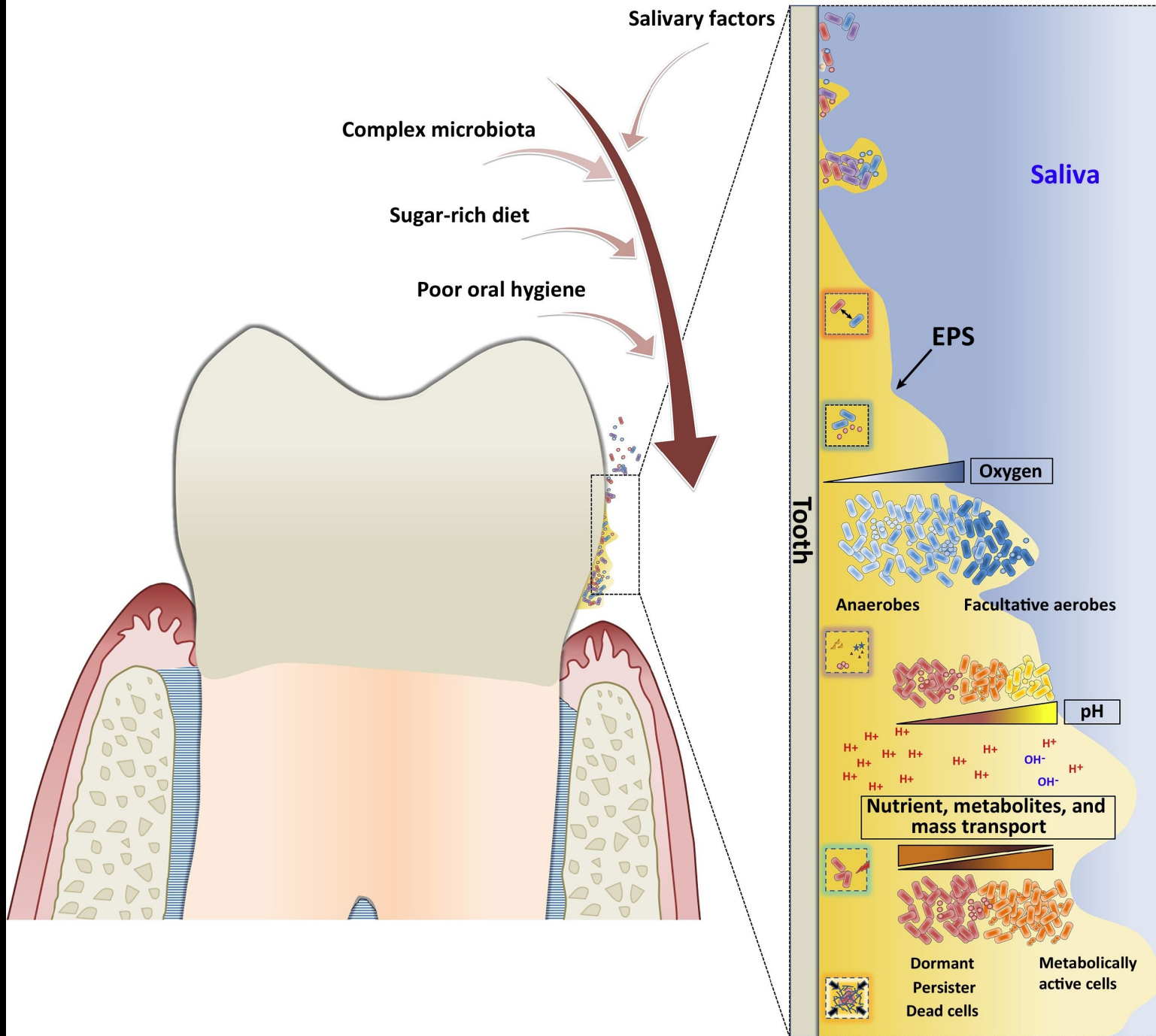


Bowen, Burne, Wu, Koo – Trends 2018

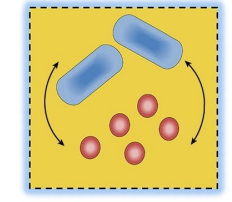


Nature Reviews | Microbiology

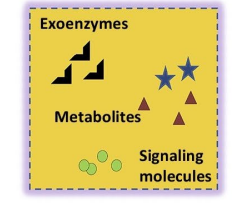
Bakaletz Nature Reviews 2004



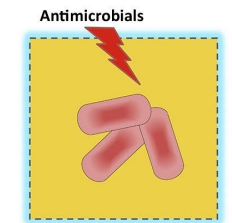
Competition



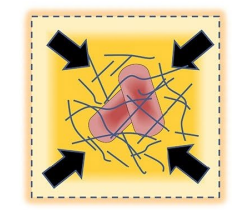
Symbiosis/cooperation



Enzyme/biomolecule retention-diffusion



Protection/resistance



Mechanical strength

Trends in Microbiology

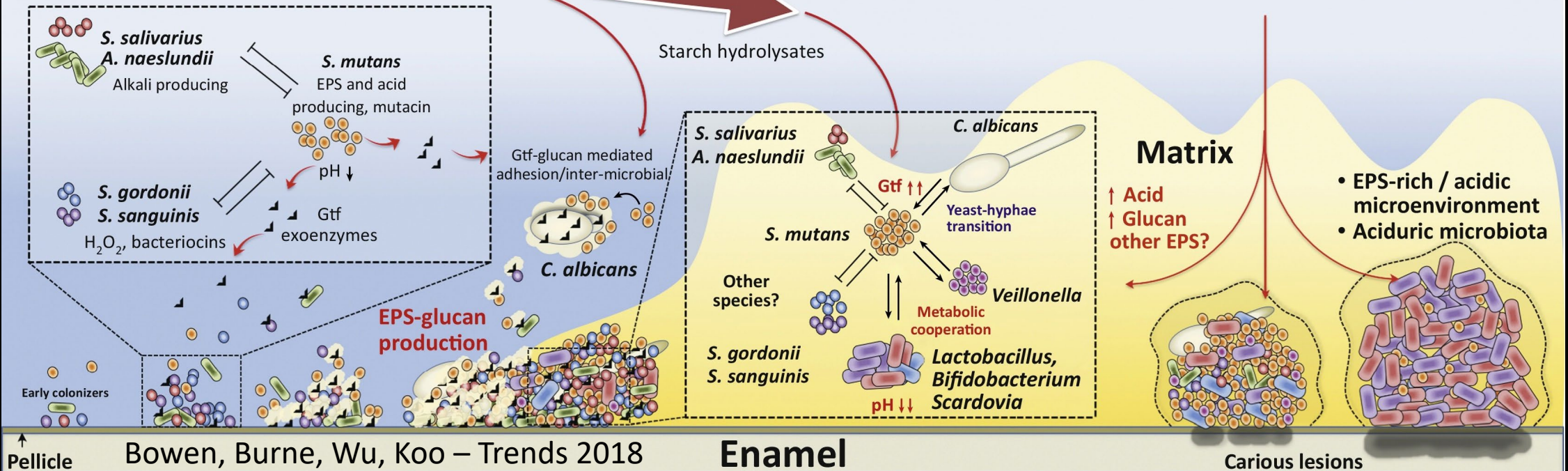
Battleground

High diversity

Lower diversity

Sucrose

Other fermentable sugars
(glucose, fructose, starch hydrolysates)



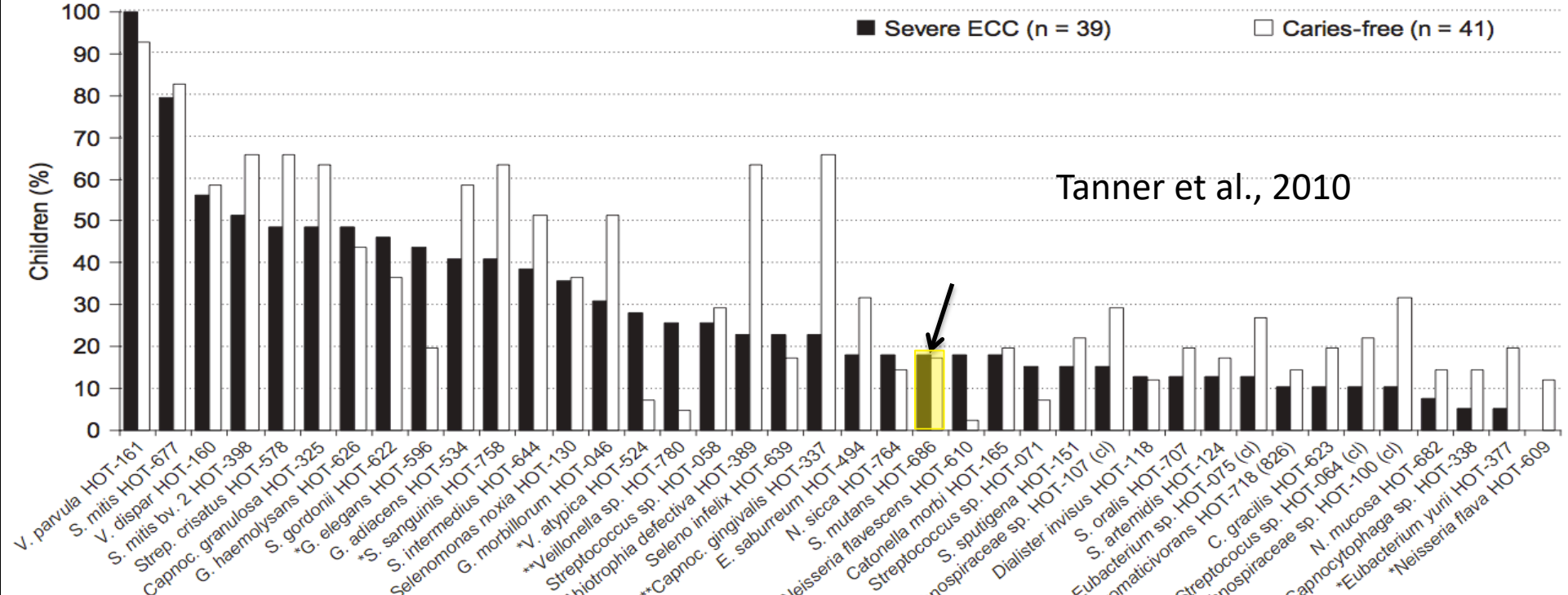
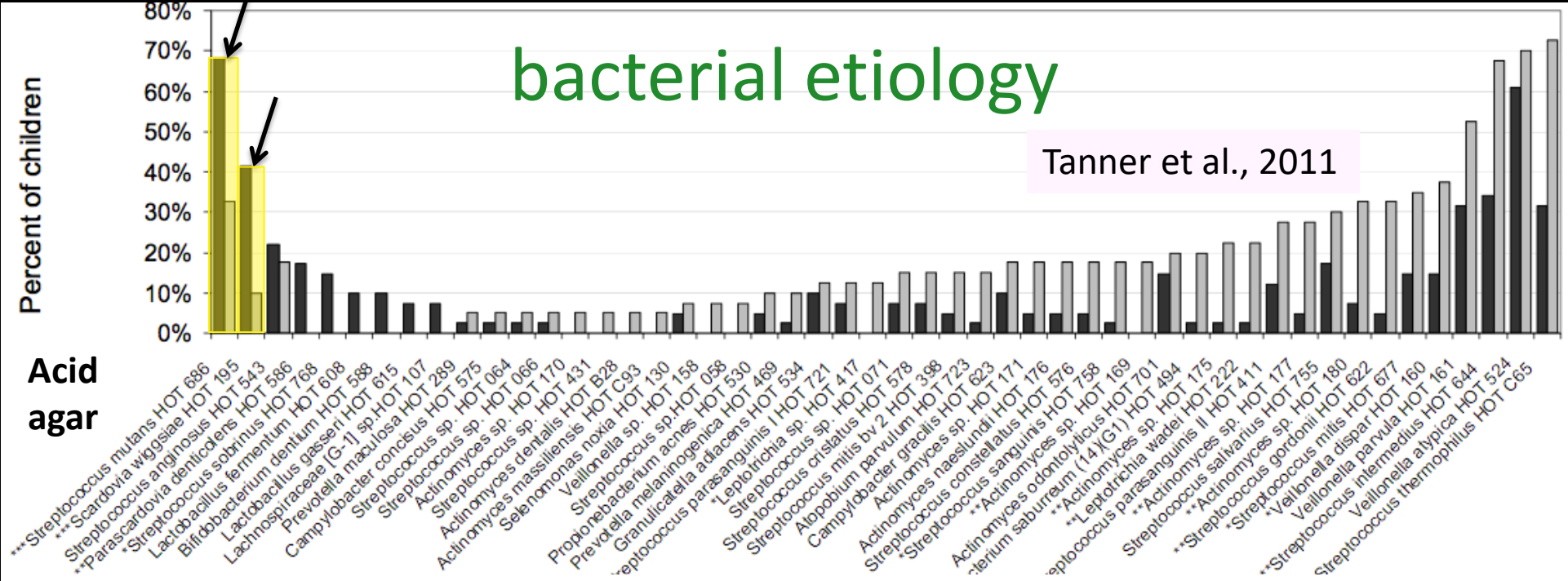
↑ Pellicle

Bowen, Burne, Wu, Koo – Trends 2018

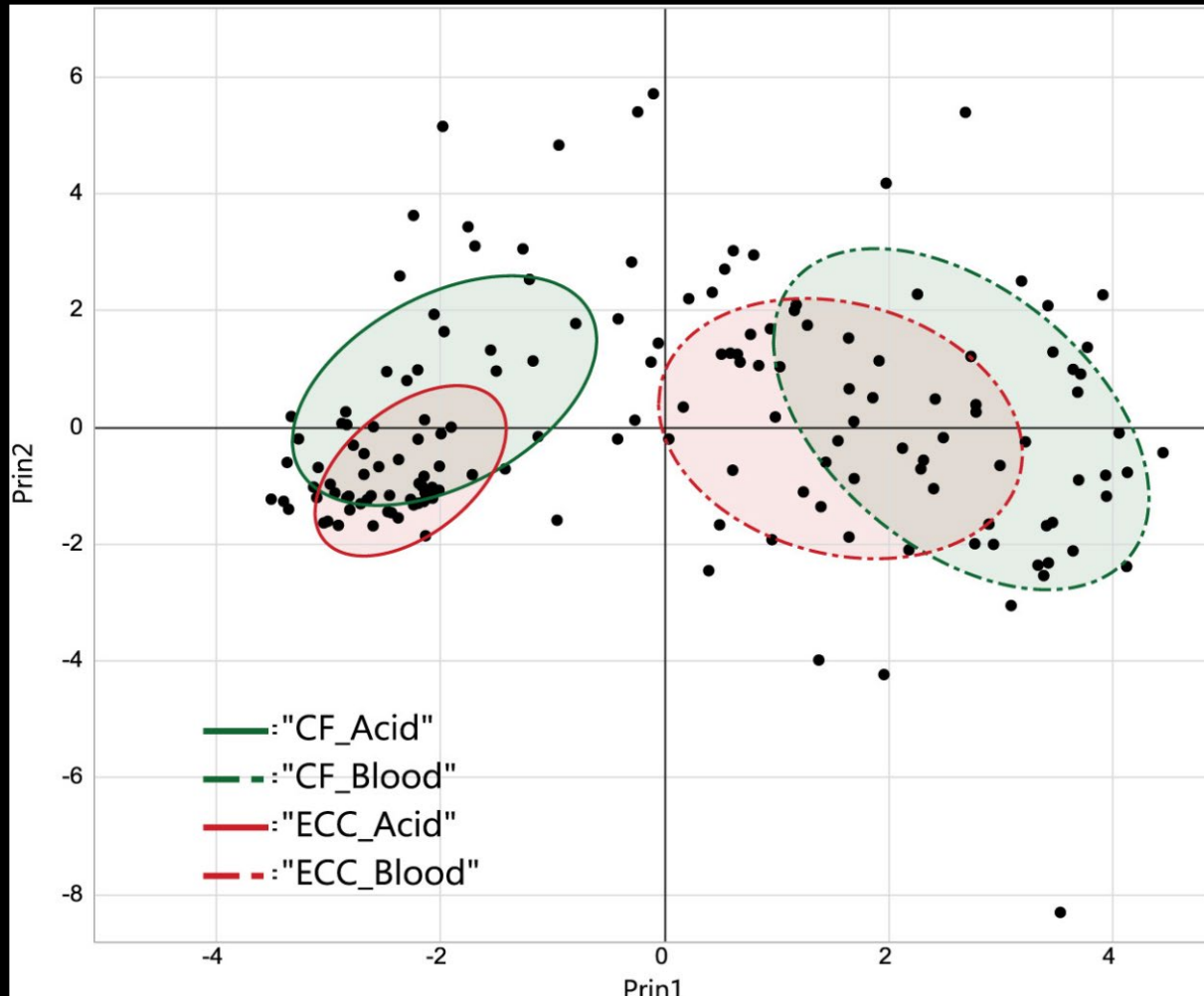
Enamel

Carious lesions

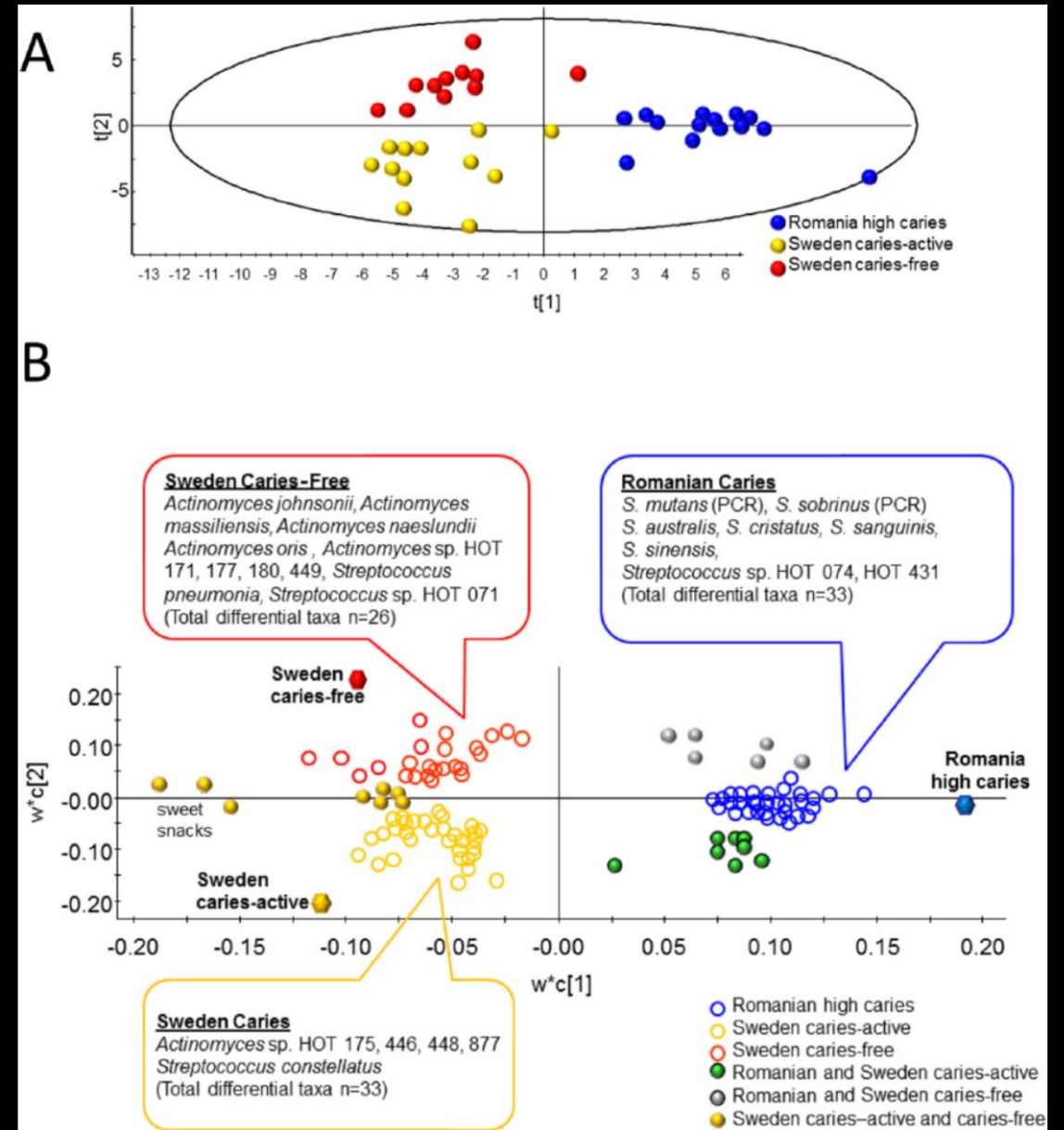
bacterial etiology



Bacteria do not tell the whole story

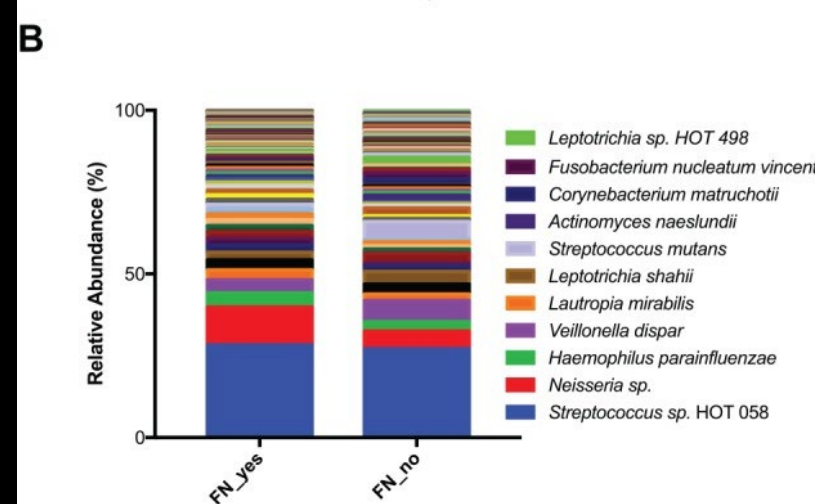
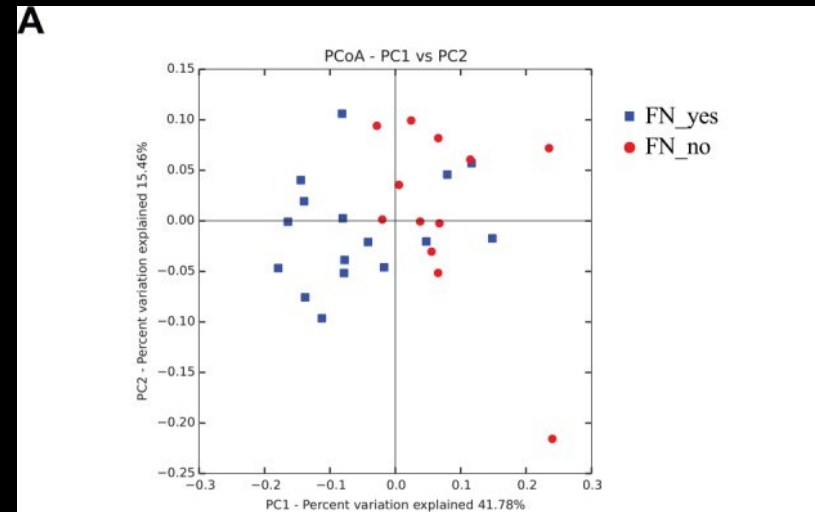
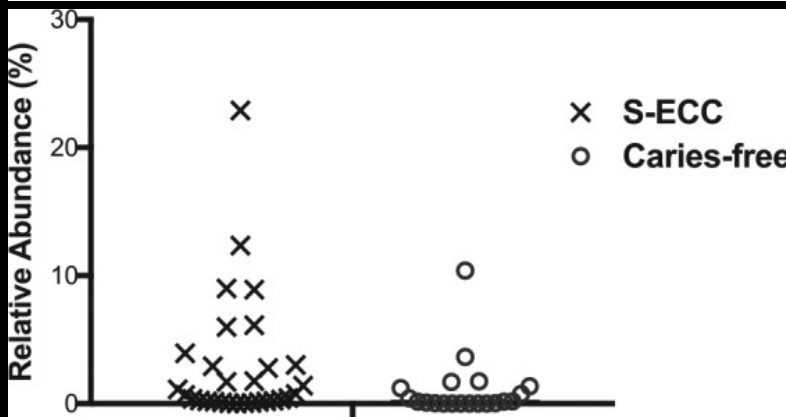
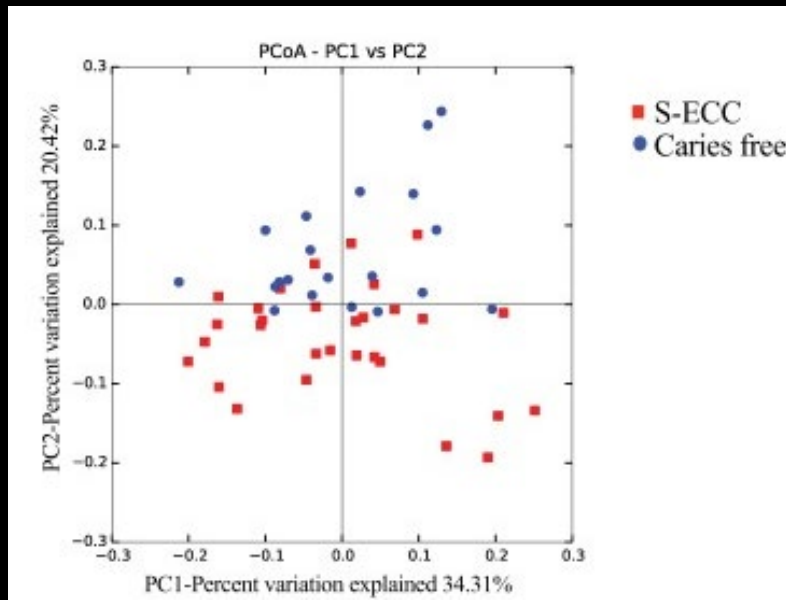


Tanner 2011



Johansson 2016

Bacterial distribution of First Nation children in Canada



Not very different in severe caries or Reservation

Conclusions

Sugar is converted in mature plaque to acid,
which demineralizes the tooth.

Sugar selects for cariogenic bacteria.

Infinite microbial combinations can facilitate caries,
and progressively become more cariogenic.

Cariogenic bacteria get passed down more.

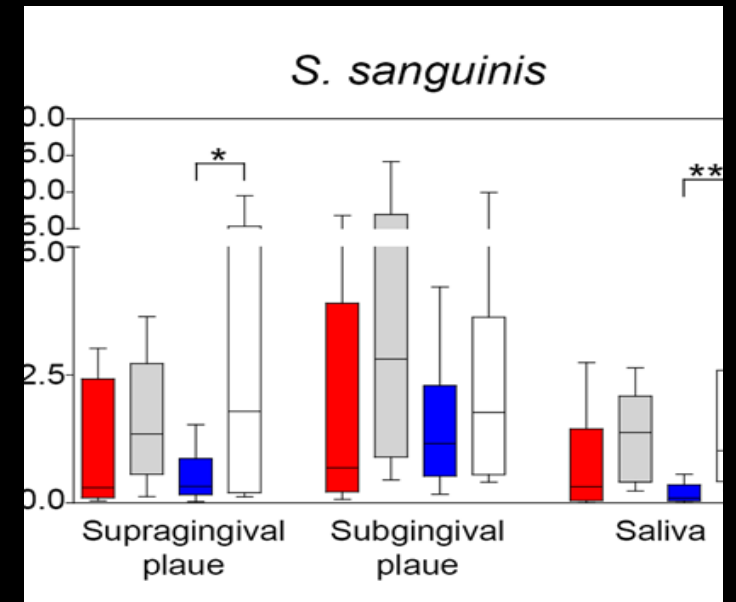
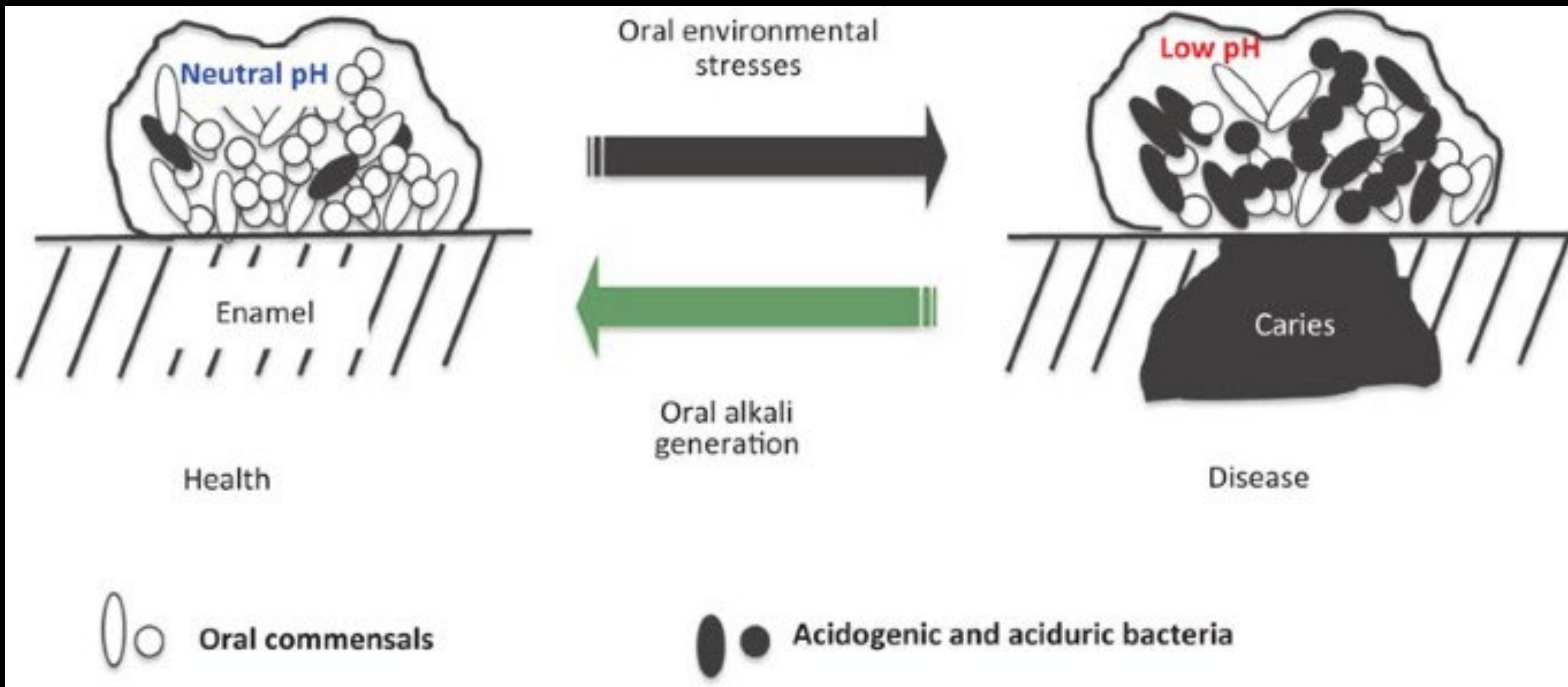
Anti- and Pre-biotics are emerging for caries.

Any other drugs
against these bugs?

Effective antimicrobial caries preventive medicines

- Xylitol gum for new Moms
- Arginine (food, toothpaste)
- Silver diamine fluoride (SDF)
- 10% povidone iodine

Arginine toothpaste mechanisms



Zhaeng et al., *Sci Rep* 2017

Arginine + F toothpaste

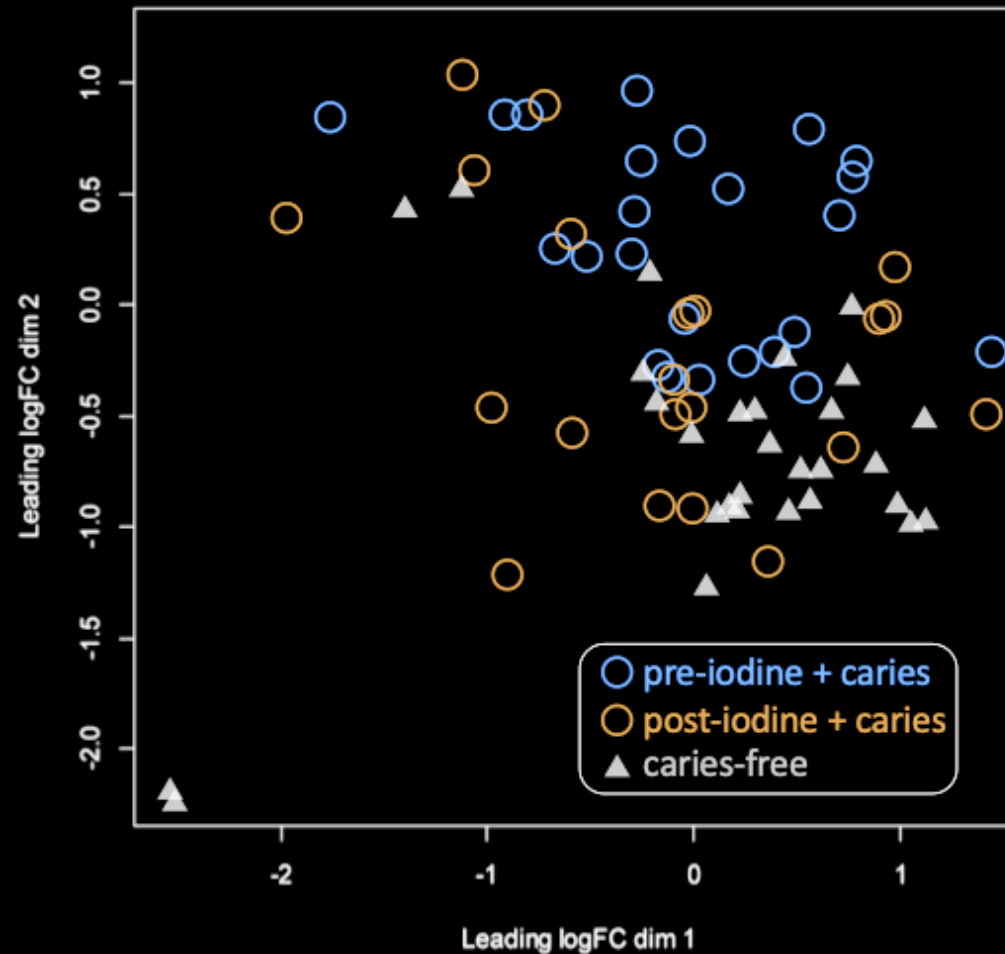
<u>Age</u>	<u>Size</u>	<u>[Arg]</u>	<u>Prevent vs F</u>	<u>Reference</u>
6-12y	6,000	1.5%	16.5%	Kraivaphan 2013
6-8y	6,074	1.5%	19%	Li 2015
4-6y	3,706	1.5%	16.8%	Petersen 2015

			<u>Arrest vs F</u>	
Elders	312	1.5%	11%	Souza 2013
Elders	346	1.5%	16%	Hu 2013

Estimated Prevented Fraction
 $22\% + (1-22\%)*17.5\% = 35.6\%$



Iodine shifts the microbiota to a healthy state



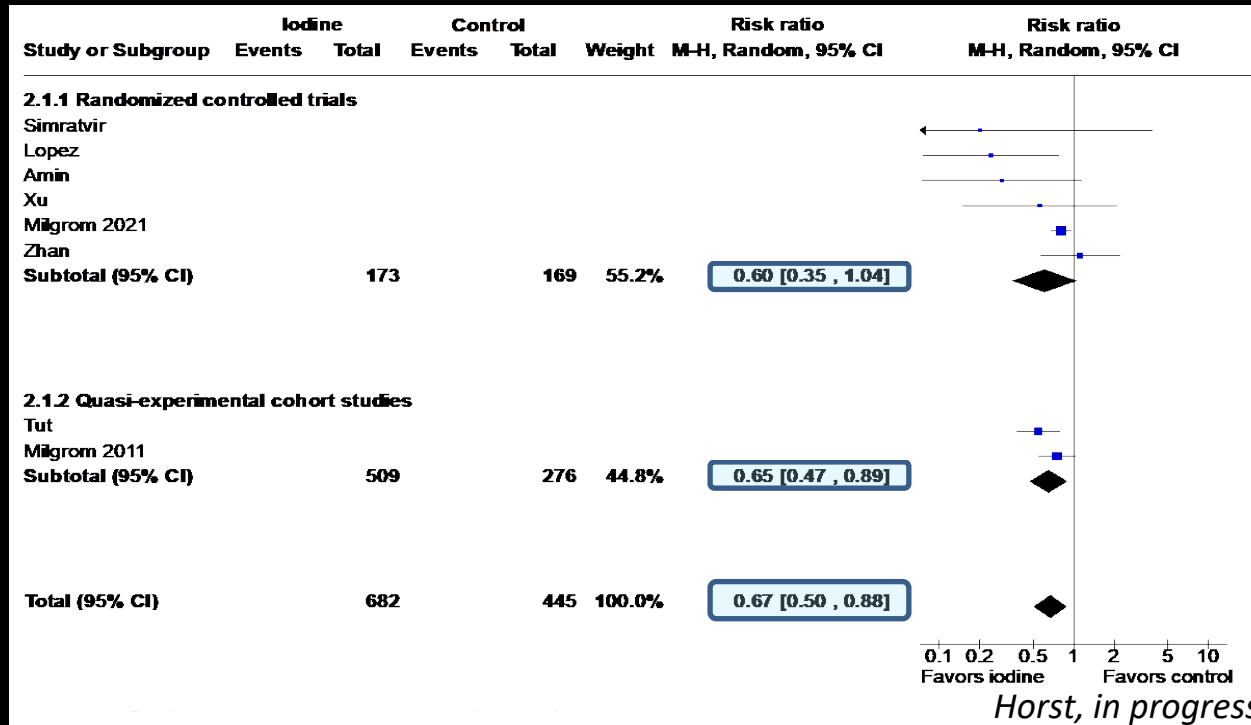
10% Povidone iodine
is an *antiseptic* that prevents
the bacterial manifestation
of the most common disease of childhood.



Iodine anticaries mechanisms

- Epidemiologic association of Iodine against caries.
 - Tuverud.. *National Research Council* 1952
- Thyroid (Iodine) protects against caries in rats.
 - Bixler.. *JADA* 1956
- Iodine is a fast, safe, and effective intraoral antiseptic, prevents post-surgery infections.
 - Zinner.. *Oral Surg* 1961
- Iodine differentially kills caries bacteria (*S. mutans*) by concentration and exposure time.
 - Tanzer.. *Antimicrob Agents Chemother* 1977
- Iodine inhibits extracellular polysaccharide synthesis (GTF>FTF).
 - Tam.. *J Antimicrob Chemother* 2006
 - Furiga.. *Oral Microbiol Immunol* 2008
- Iodine + fluoride = better prevention in rats.
 - Iodine > fluoride on smooth surfaces
 - Iodine + fluoride = **additive** on smooth surfaces
 - Iodine + fluoride = **synergistic** on fissures (like **silver** & fluoride).
 - Caufield.. *J Dent Res* 1981
 - Caufield .. *Caries Res* 1981.
- Iodine clinically disinfects *S. mutans* for ≥ 1 week. Comes back low, stays low for 6 months.
 - Gibbons.. *Infect Immun* . 1974
 - Caufield and Gibbons.. *J Dent Res* 1979
 - Newbrun.. *Caries Res* 1980
 - Dasanayake.. *Community Dent Oral Epidemiol* 1993

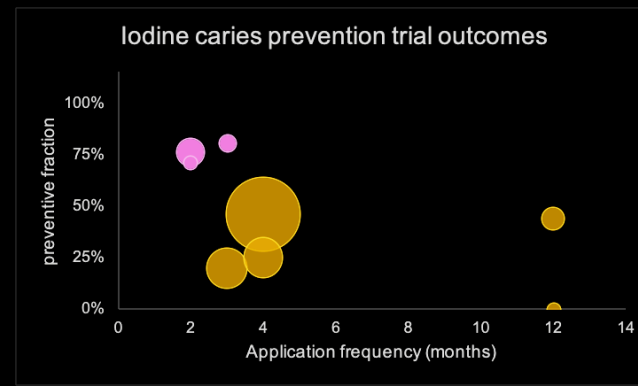
10% Povidone Iodine *q2-4mo* prevents caries at the PATIENT level = INCIDENCE



*images c/o
Betadine,
Humco*

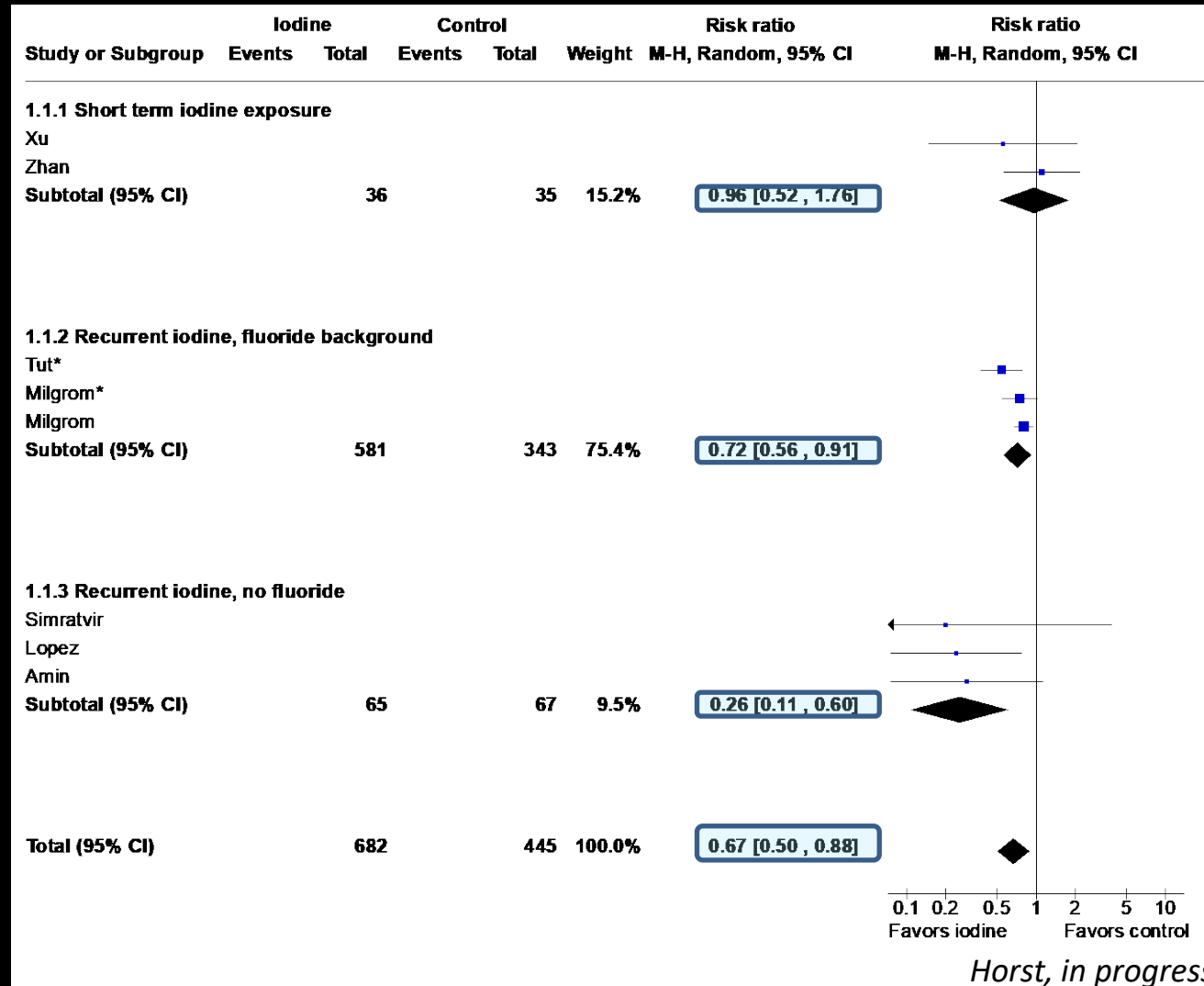


Full course = [http:// bit.ly / IodineCaries](http://bit.ly/IodineCaries)



c/o Jeremy Horst

Iodine application needs to continue ~seasonally, is not dependent on fluoride

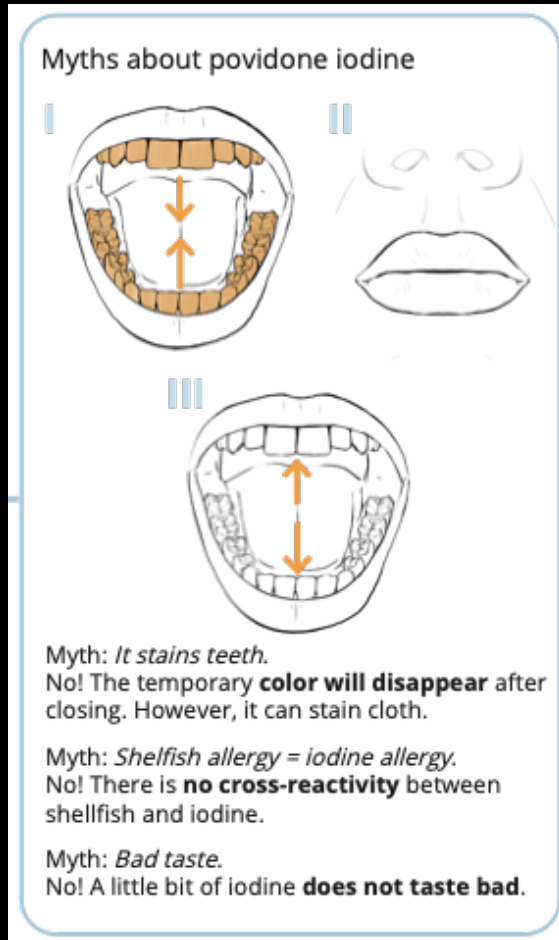


Application
needs to
persist.

Works with
Fluoride.

Stronger
effect in
younger
children,
without F ??

Iodine safety considerations



- Iodine is an essential nutrient.
- Allergy is overstated, mild: antihistamines.
- Seafood allergy connection is a myth.
- Plenty of safety studies.
 - 5% rinse every day for 6 months, no Δ thyroid hormones.
 - Ader.. *J Clin Endocrinol Metab* 1988.
 - Iodine is commonly used for mucositis prevention.
 - da Silveira Teixeira.. *Stomatologija* 2019.
 - Rahn.. *Dermatology* 1997.
 - Madan.. *J Cancer Res* 2008.
 - Vokurka.. *Support Care Cancer* 2005.
 - Roopashri.. *Contemp Clin Dent* 2011.
- Common use as dental ultrasonic irrigant.
- No contact dermatitis from intraoral use.

Full course = [http:// bit.ly / IodineCarries](http://bit.ly/IodineCarries)

HOW TO

apply Povidone Iodine for caries prevention.

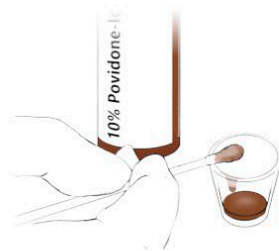


1 Dispense



Dispense 8 drops of 10% povidone-iodine.

2



Saturate one end of a cotton swab.

Note: To avoid too much iodine, do not re-dip after applying to teeth.

3 Dry



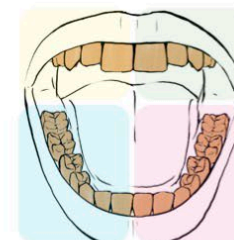
Ask the patient to swallow. Use cotton or suction to remove excess saliva.

4 Apply



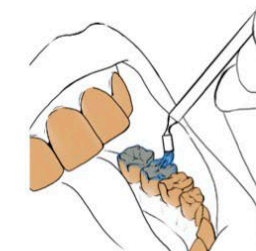
Roll the swab and push to release more iodine into high risk areas, like contact points and exposed roots.

5



Continue across all teeth. Keep mouth open for 10 seconds.

6 Optional fluoride varnish



Fluoride varnish may be applied.

Wait 30 minutes to eat or drink.



AAP

If parents can brush the teeth, they can place iodine too.



Good enough for me ...
& my kids

Effective antimicrobial caries preventive medicines

- Xylitol gum for new Moms
- Arginine (food, toothpaste)
- Silver diamine fluoride (SDF)
- 10% povidone iodine

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bit.ly / DrJeremy

