



FOOD *as* MEDICINE

Peter Stenvinkel



Hungry Planet: What The World Eats



Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017

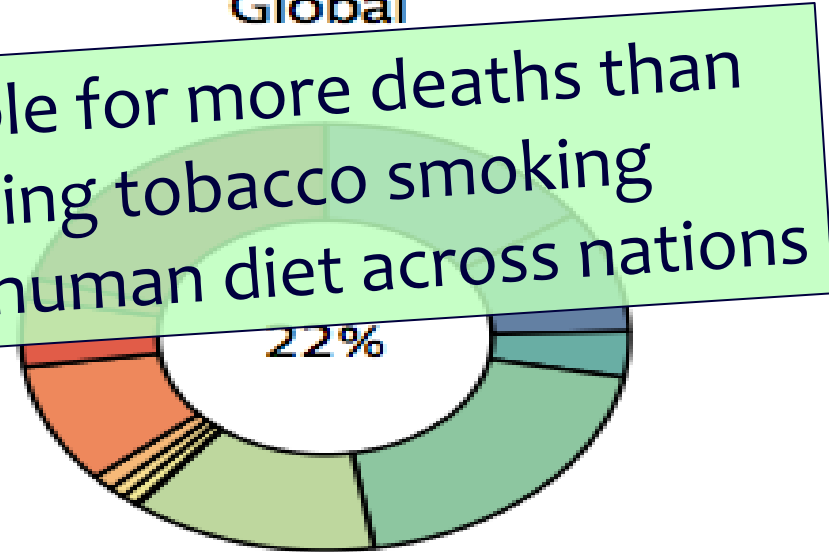
GBD 2017 Diet Collaborators*

Lancet 2019



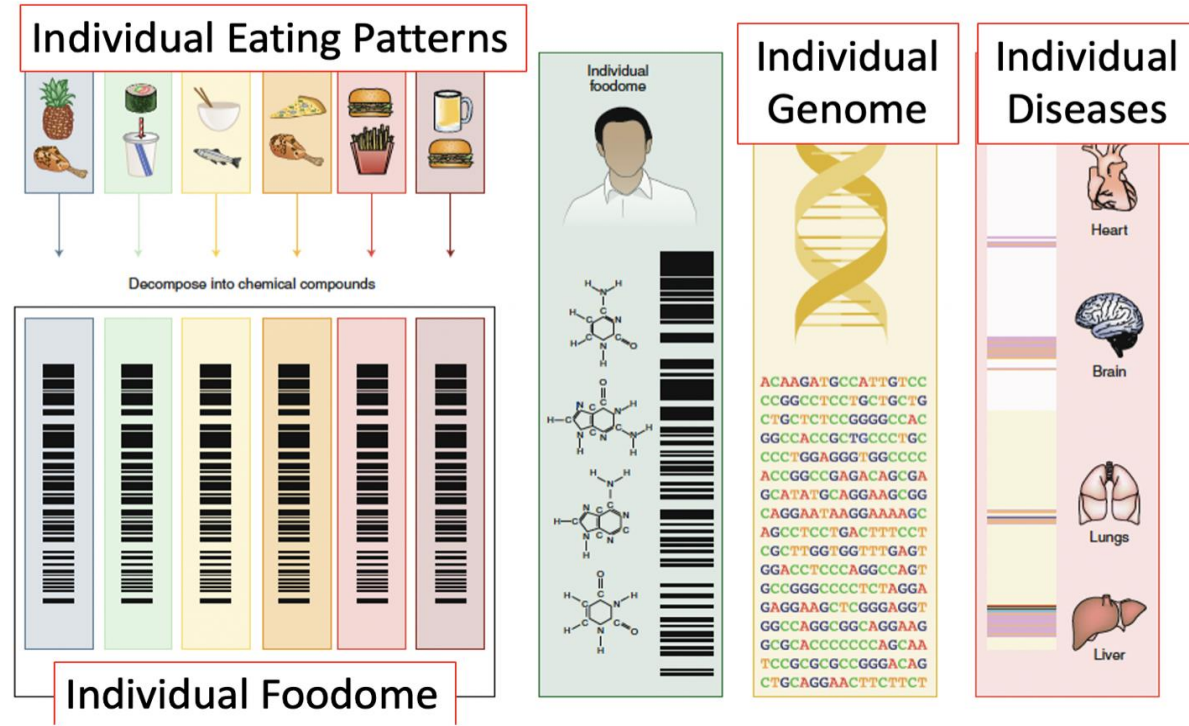
A Deaths

Global



- Suboptimal diet is responsible for more deaths than any other risks globally, including tobacco smoking
- Urgent need for improving human diet across nations

Linking the diet to the genome and disease



The complex foodome include >25,000 substances that make up the human diet

Foodome - a new discipline that studies the food and nutrition domains through the application and integration of advanced -omics technologies to improve well-being, health and knowledge



REVIEW SUMMARY

AGING

Antiaging diets: Separating fact from fiction

Mitchell B. Lee, Cristal M. Hill, Alessandro Bitto, Matt Kaeberlein*

Validated biomarkers of biological aging are required to match intervention to each person's distinct genetic and environmental context and thereby optimize individual healthy life span

At the buffet of antiaging diets, which is the best plate? Diets clockwise from top left: CR, time-restricted feeding, protein restriction, and ketogenic.

Equador



Different
effects on
the Foodome



USA



March 2021 volume 17 no. 3
www.nature.com/nrneph

nature reviews nephrology



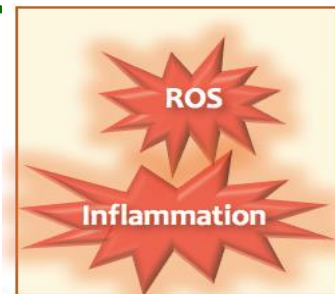
FOOD AS MEDICINE

Potential benefits in chronic
kidney disease

**Living well with
kidney disease**

Prioritizing quality of life

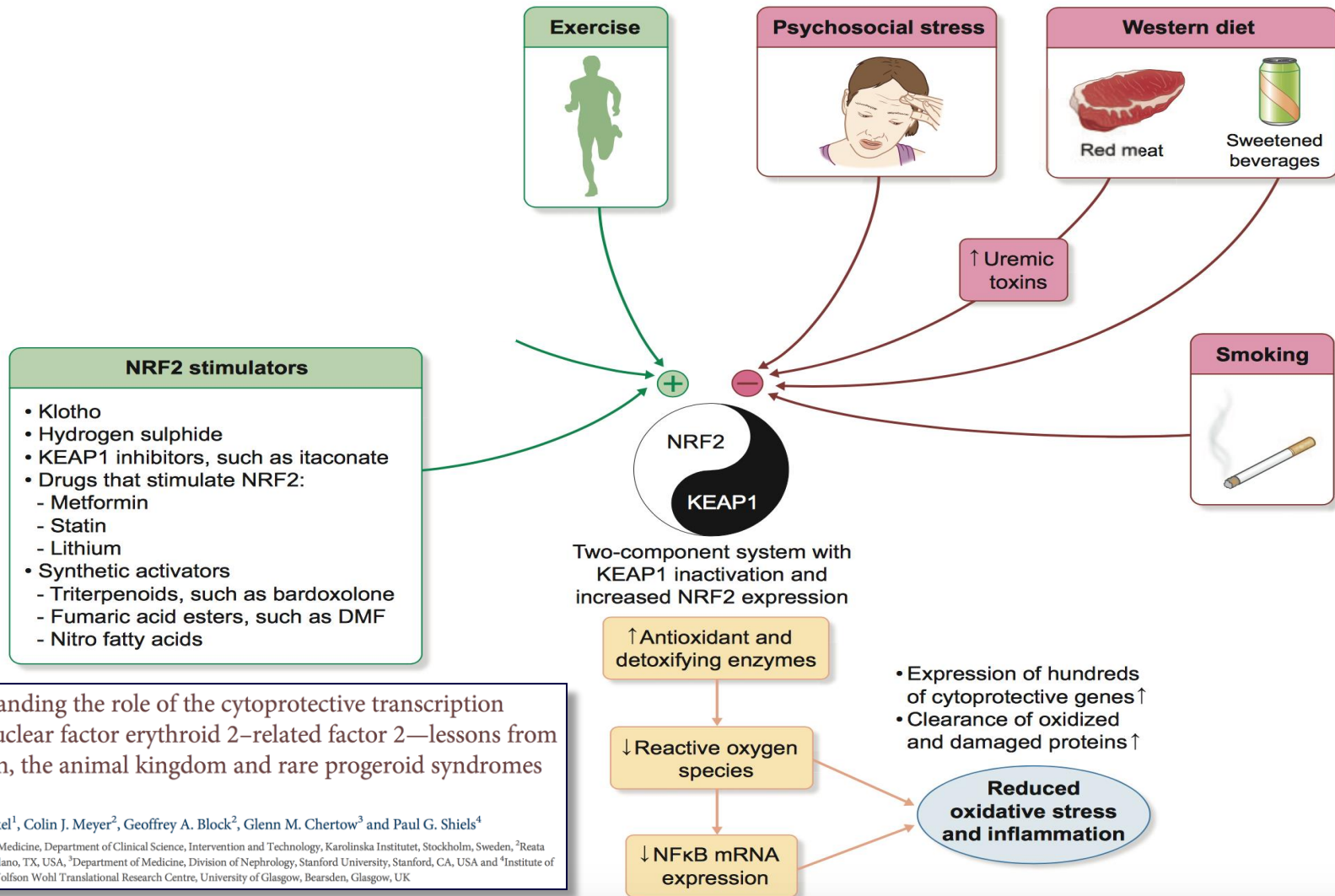
Target transcription factors involved
in inflammation and oxidative stress



Food as medicine: targeting the uraemic phenotype in chronic kidney disease

Denise Mafrá¹, Natalia A. Borges², Bengt Lindholm³, Paul G. Shiels⁴,
Pieter Evenepoel⁵ and Peter Stenvinkel³

- Sulforaphane (broccoli)
- Curcumin (tumeric)
- Antocyanins (berries)
- Flavonoids (red fruits)
- Quercetin (apple)
- Cinnamaldehyde (cinnamon)
- Rhizome (ginger)

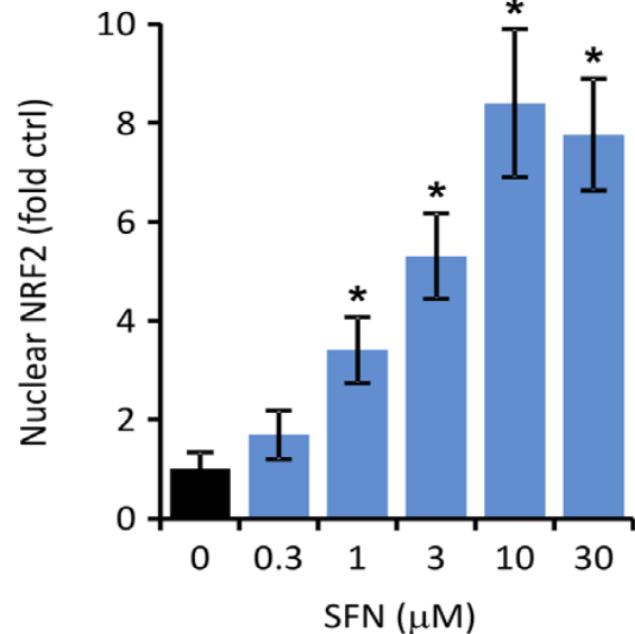
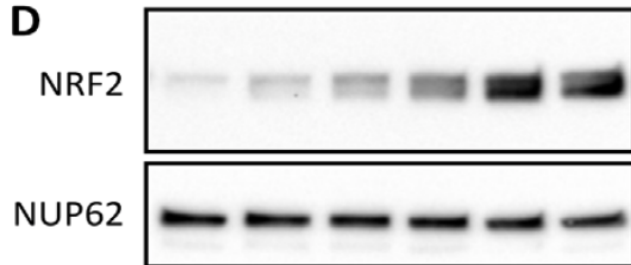


Understanding the role of the cytoprotective transcription factor nuclear factor erythroid 2–related factor 2—lessons from evolution, the animal kingdom and rare progeroid syndromes

Peter Stenvinkel¹, Colin J. Meyer², Geoffrey A. Block³, Glenn M. Chertow³ and Paul G. Shiels⁴

¹Division of Renal Medicine, Department of Clinical Science, Intervention and Technology, Karolinska Institutet, Stockholm, Sweden, ²Reata Pharmaceuticals, Plano, TX, USA, ³Department of Medicine, Division of Nephrology, Stanford University, Stanford, CA, USA and ⁴Institute of Cancer Sciences, Wolfson Wohl Translational Research Centre, University of Glasgow, Bearsden, Glasgow, UK

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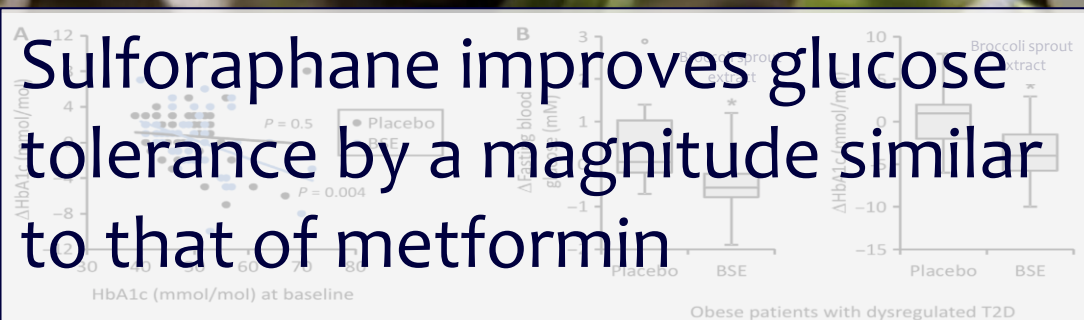
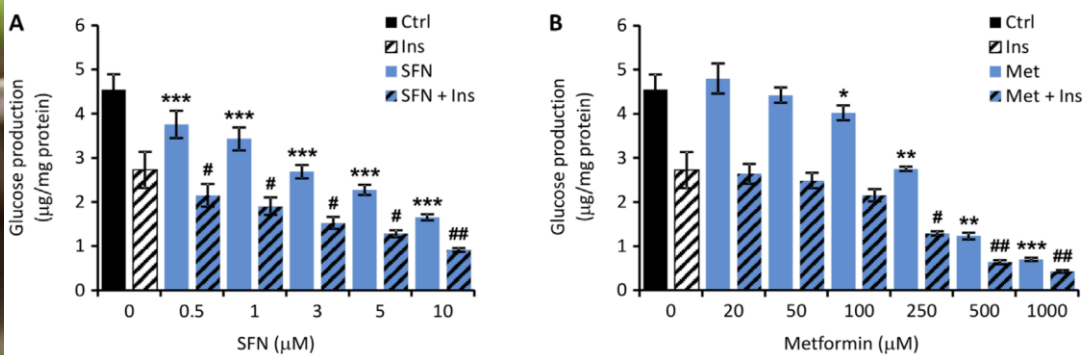


DIABETES

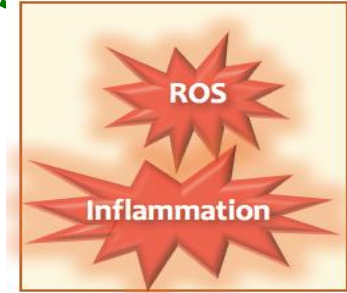
2017

Sulforaphane reduces hepatic glucose production and improves glucose control in patients with type 2 diabetes

Annika S. Axelsson,¹ Emily Tubbs,¹ Brig Mecham,² Shaji Chacko,³ Hannah A. Nenonen,¹ Yunzhao Tang,¹ Jed W. Fahey,⁴ Jonathan M. J. Derry,⁵ Claes B. Wollheim,^{1,6} Nils Wierup,¹ Morey W. Haymond,³ Stephen H. Friend,⁵ Hindrik Mulder,¹ Anders H. Rosengren^{1,5,7*}

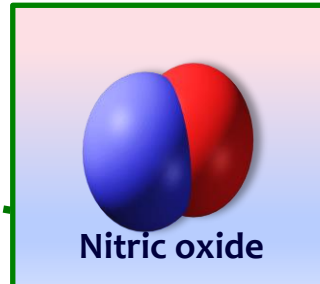


Sulforaphane improves glucose tolerance by a magnitude similar to that of metformin

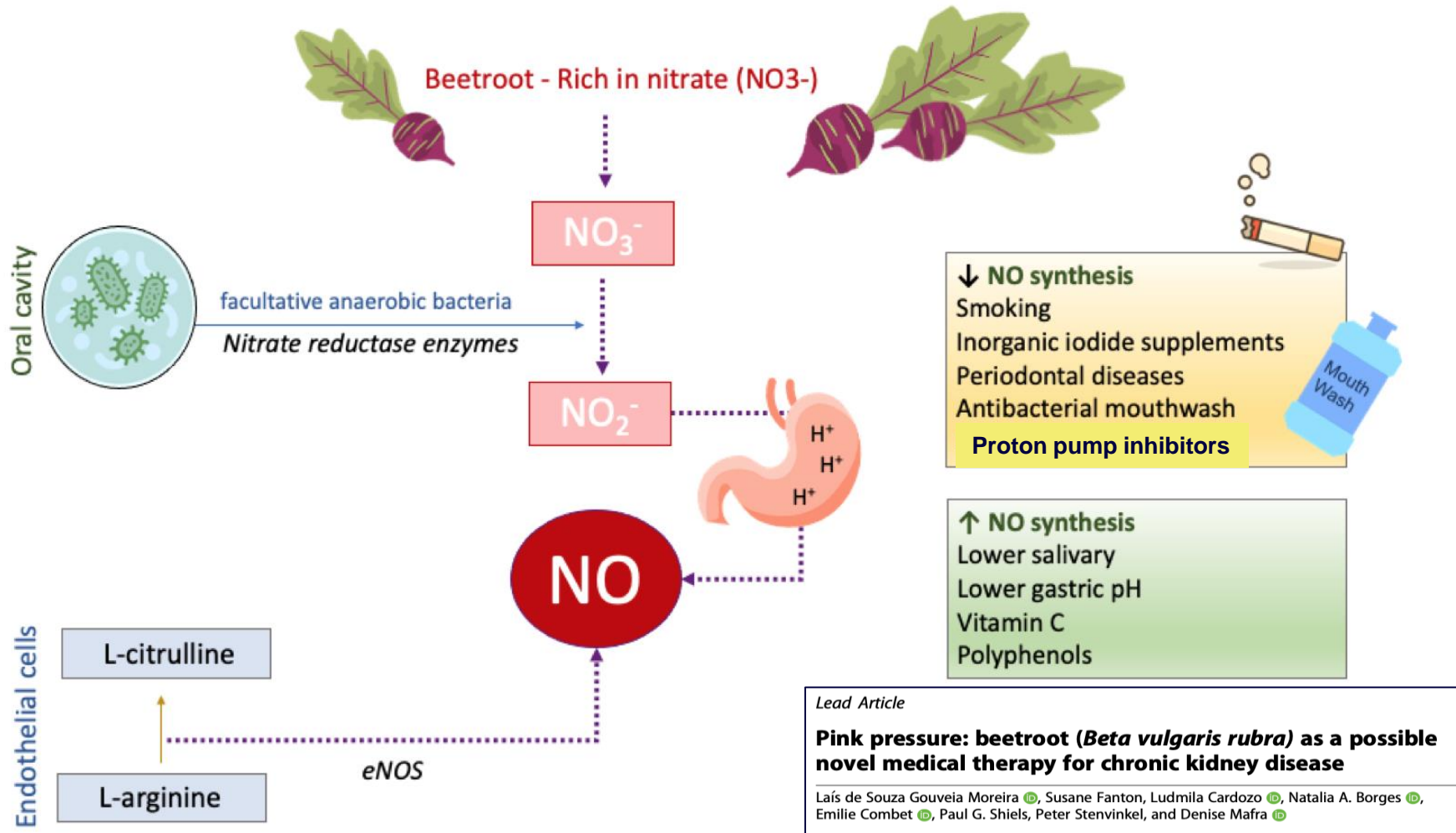


Food as medicine: targeting the uraemic phenotype in chronic kidney disease

Denise Mafra¹, Natalia A. Borges², Bengt Lindholm³, Paul G. Shiels⁴, Pieter Evenepoel⁵ and Peter Stenvinkel³✉



Nitrates (radish, beetroot, spinach)

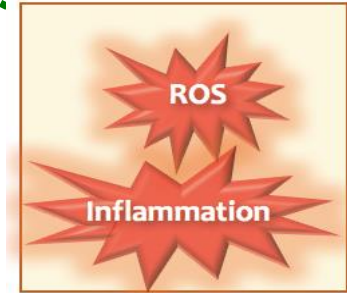
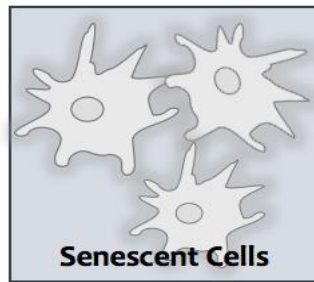


Lead Article

Pink pressure: beetroot (*Beta vulgaris rubra*) as a possible novel medical therapy for chronic kidney disease

Laís de Souza Gouveia Moreira , Susane Fanton, Ludmila Cardozo , Natalia A. Borges , Emilie Combet , Paul G. Shiels, Peter Stenvinkel, and Denise Mafra

- Quercetin (apple)
- Curcumin (tumeric)
- Fisetin (strawberries)
- Epigallocatechin (green tea)

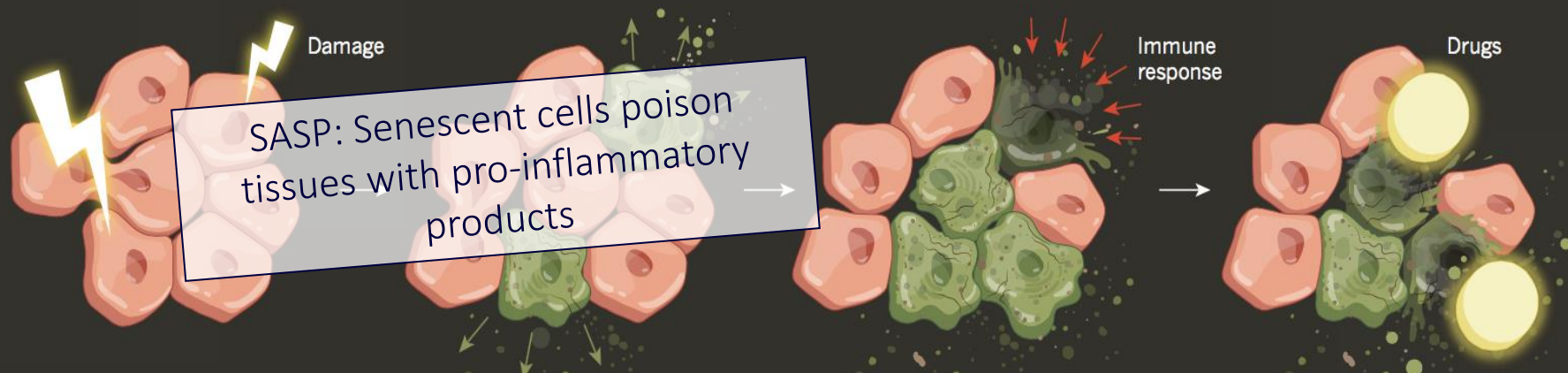


Food as medicine: targeting the uraemic phenotype in chronic kidney disease

Denise Mafrá¹, Natalia A. Borges², Bengt Lindholm³, Paul G. Shiels⁴, Pieter Evenepoel⁵ and Peter Stenvinkel³

BECOMING UNDEAD

Damage or disease can lead a cell down the path to senescence. Scientists are still finding out how cells behave once they get there — and how to get rid of them.



Senescent cells: an emerging target for diseases of ageing

Bennett G. Childs¹, Martina Gluscevic¹, Darren J. Baker^{1,2}, Remi-Martin Laberge³, Dan Marquess³, Jamie Dananberg³ and Jan M. van Deursen^{1,2}

KILL ZOMBIES

Research paper

EBioMedicine 2018



Fisetin is a senotherapeutic that extends health and lifespan

Matthew J. Yousefzadeh ^{a,1}, Yi Zhu ^{b,1}, Sara J. McGowan ^{a,1}, Luise Angelini ^{a,1}, Heike Fuhrmann-Stroissnigg ^a, Ming Xu ^b, Yuan Yuan Ling ^a, Kendra I. Melos ^a, Tamar Pirtskhalava ^b, Christina L. Inman ^b, Collin McGuckian ^a, Erin A. Wade ^a, Jonathon I. Kato ^a, Diego Grassi ^a, Mark Wentworth ^c, Christin E. Burd ^d, Edgar A. Arriaga ^e, Warren L. Ladiges ^f, Tamara Tchkonja ^b, James L. Kirkland ^b, Paul D. Robbins ^{a,*}, Laura J. Niedernhofer ^{a,*}

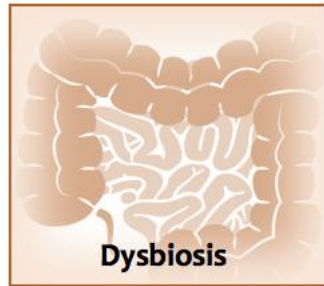
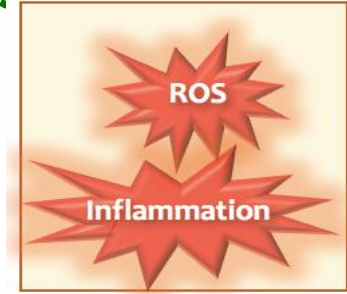
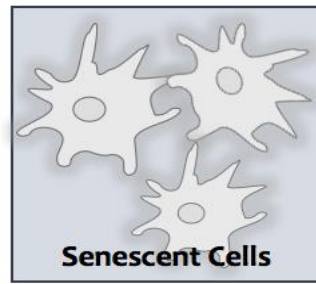
Of 10 flavonoids tested, fisetin was the most potent senolytic

Fisetin May be a Low-Hanging Fruit for Aging

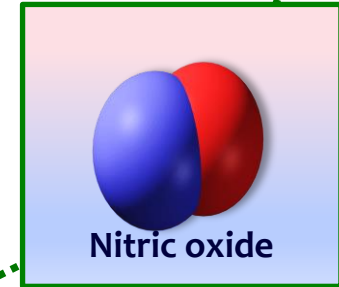
Steve Hill December 26, 2018

5

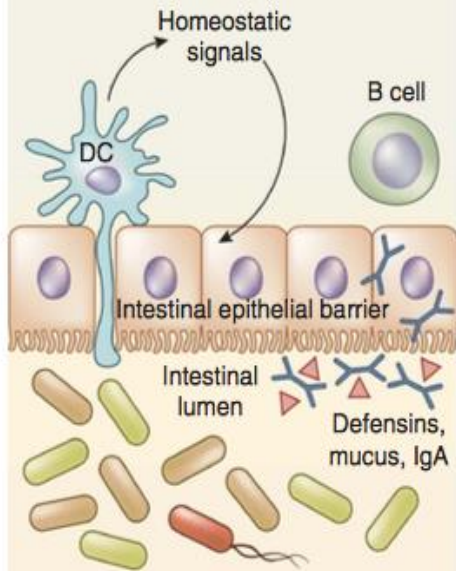
Fruit/Vegetable	Amount µg/g
Strawberry	160
Apple	26.9
Persimmon	10.6
Lotus Root	5.8
Onion	4.8
Grape	3.9
Kiwi	2.0
Peach	0.6
Cucumber	0.1



- Fibers
- Prebiotics (soybeans, wheat)
- Soy food (tofu, soy milk)
- Polyphenols (grape, coffee, berries)
- Urolithin (berries, pomegranate)



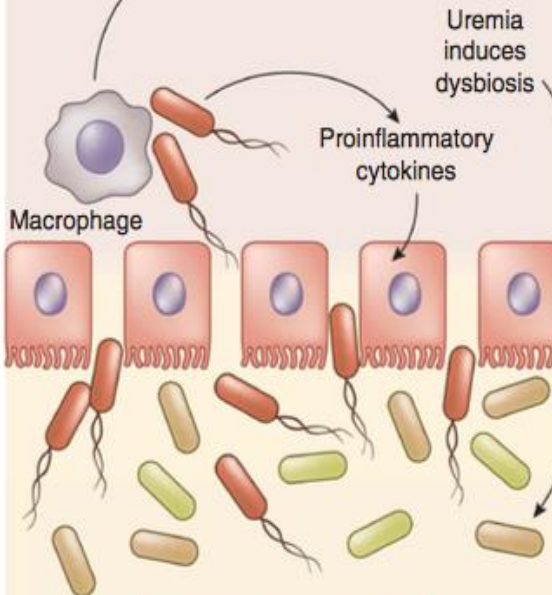
Healthy kidney



Symbiosis: pathobionts are kept in check, barrier integrity maintained

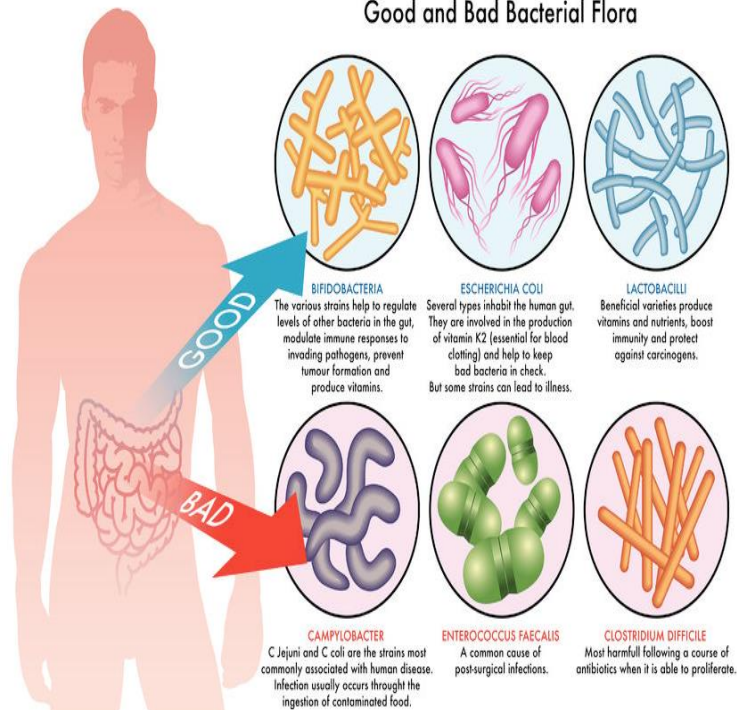
Uremia CKD/ESRD

Translocation of bacteria and bacterial products activates systemic inflammation (and CKD/ESRD complications?)



Dysbiosis: pathobiont overgrowth — promotes loss of barrier integrity

Good and Bad Bacterial Flora



Pathobionts



Symbionts



mini review

<http://www.kidney-international.org>

© 2013 International Society of Nephrology

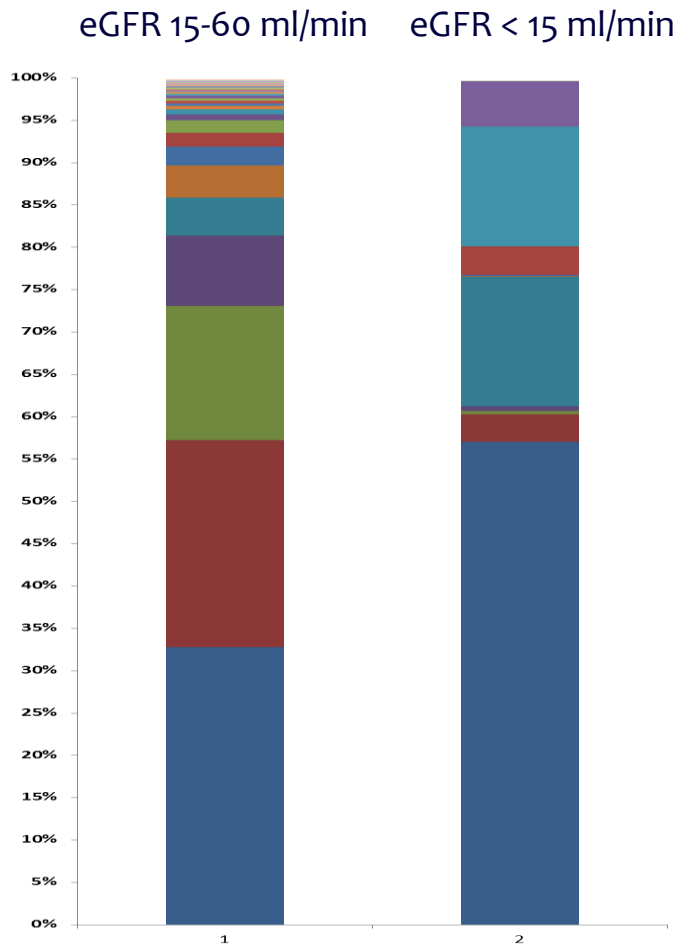
The intestinal microbiota, a leaky gut, and abnormal immunity in kidney disease

Hans-Joachim Anders¹, Kirstin Andersen¹ and Bärbel Stecher²

¹Nephrologisches Zentrum, Medizinische Klinik und Poliklinik IV, Klinikum der Universität München, Munich, Germany and

²Max-von-Pettenkofer Institut, Universität München, Munich, Germany

Lack of Microbial Biodiversity in Advanced Chronic Kidney Disease

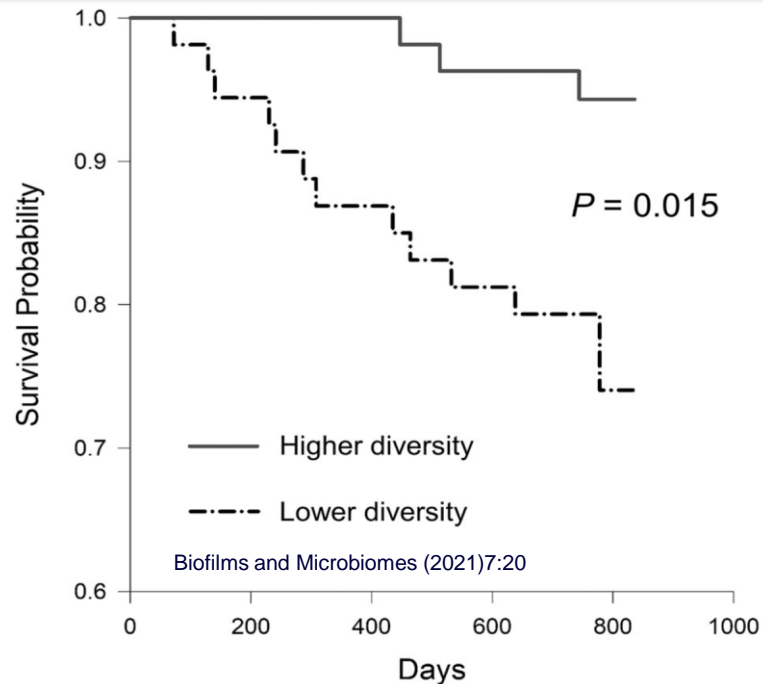


ARTICLE

OPEN

Gut dysbiosis and mortality in hemodialysis patients

Ting-Yun Lin¹, Ping-Hsun Wu^{2,3}, Yi-Ting Lin^{3,4} and Szu-Chun Hung^{1,2}



Biofilms and Microbiomes (2021)7:20

The industrialized microbiota has never before during evolution been experienced by Homo Sapiens

RESEARCH

REVIEW SUMMARY

MICROBIOTA

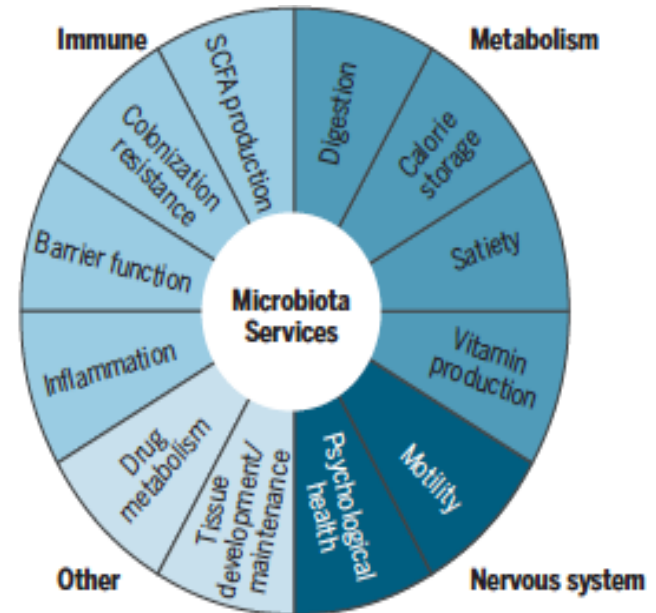
Vulnerability of the industrialized microbiota

Justin L. Sonnenburg* and Erica D. Sonnenburg*

> Nat Ecol Evol. 2017 May 8;1(6):161. doi: 10.1038/s41559-017-0161.

Climate warming reduces gut microbiota diversity in a vertebrate ectotherm

Elvire Bestion^{1 2 3}, Staffan Jacob^{1 2 4}, Lucie Zinger^{2 5}, Lucie Di Gesu², Murielle Richard¹, Joël White², Julien Cote²



Intimate connections exist between microbiota and organ function

Processed Food – the Key Hallmark of Western Diet

SCIENCE ADVANCES | RESEARCH ARTICLE

March 2021

HEALTH AND MEDICINE

Processed foods and microvascular disease
Cell Metabolism

Clinical and Translational Report

CellPress

Matthew Snelson^{1*}, Sih Min Tan¹,
Tuong-Vi Nguyen¹, Sally A. Perle¹,
Mark Ziemann⁴, David Steer⁵,
Permal Deo⁷, Nicole J. Kellow⁸,
Josephine M. Forbes¹², Melinda

Ultra-Processed Diet
Intake and Weight Gain
Controlled Trial of

ARTICLE

doi:10.1038/nature13793

Intake of processed foods has increased and is associated with diseases such as chronic kidney disease. Consumption of a processed diet drives advanced glycation pathway, which reversed kidney injury. Consequently, kidney inflammation and injury via mouse model of diabetes, a high rate of kidney injury via suppression of foods cause inflammation that lead

Kevin D. Hall,^{1,5,*} Alexis Ayuketah,¹ Robynne T. Chung,¹ Elise Costa,¹ Amber Ahmed M. Gharib,¹ Juen Guo,¹ Rebecca Klaudia Raisinger,² Irene Rozga,¹ Michael¹ National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, Maryland
²National Institutes of Health Clinical Center, Bethesda, Maryland
³National Institute of Nursing Research, Bethesda, Maryland
⁴Singapore Institute for Clinical Sciences, Singapore
⁵Lead Contact

*Correspondence: kevinh@nih.gov
<https://doi.org/10.1016/j.cmet.2019.05.008>

Artificial sweeteners induce glucose intolerance by altering the gut microbiota

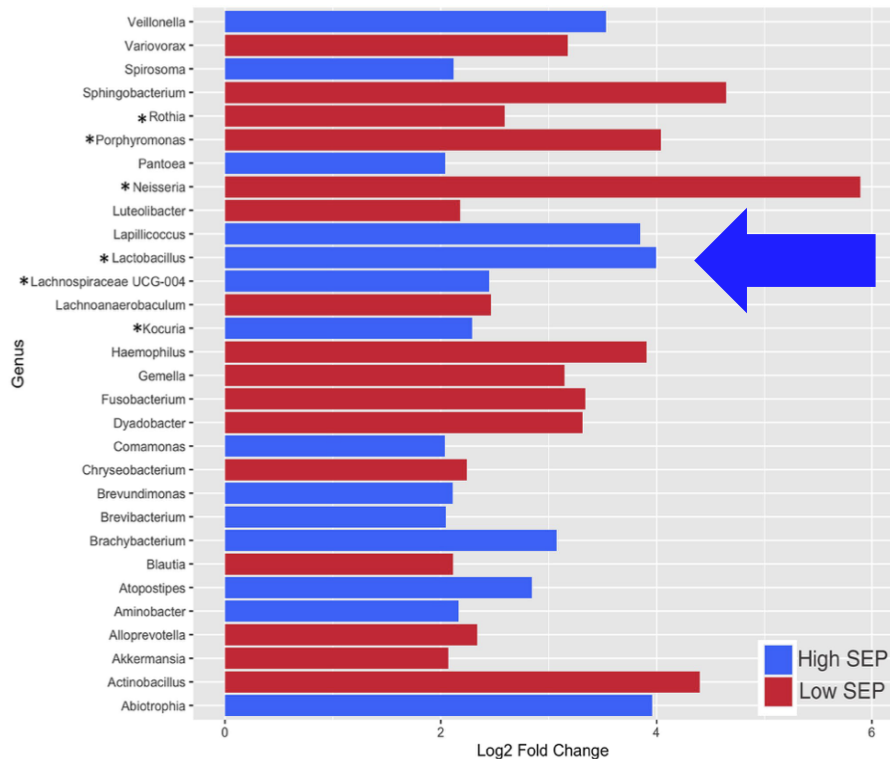
Jotham Suez¹, Tal Korem^{2*}, David Zeevi^{2*}, Gili Zilberman-Schapiro^{1*}, Christoph A. Thaiss¹, Ori Maza¹, David Israeli³, Niv Zmora^{4,5,6}, Shlomit Gilad⁷, Adina Weinberger², Yael Kuperman⁸, Alon Harmelin⁸, Ilana Kolodkin-Gal⁹, Hagit Shapiro¹, Zamir Halpern^{5,6}, Eran Segal² & Eran Elinav¹

OPEN

Socioeconomic position links circulatory microbiota differences with biological age

Hannah Craven^{1,10}, Dagmara McGuinness^{1,10}, Sarah Buchanan¹, Norman Galbraith², David H. McGuinness³, Brian Jones³, Emilie Combet³, Denise Mafra⁴, Peter Bergman⁵, Anne Ellaway⁶, Peter Stenvinkel⁶, Umer Z. Ijaz^{7,8} & Paul G. Shiels^{1,9}

Check for updates



Unfriendly gut bacteria linked to early ageing

June 22 2021



Eating unhealthily is associated with a higher risk of disease
GETTY IMAGES

Bacteria that live in the [human gut](#) and thrive on an unhealthy diet have been linked to premature ageing among Scotland's poor.

Those at high socioeconomic position possess more circulatory salutogenic bacteria

Hunting and gathering



Ancient agriculture



Modern Western diet



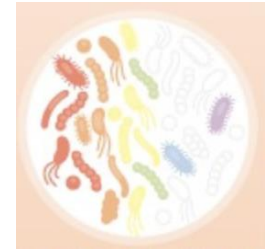
RESEARCH ARTICLE

Activation of the Nrf2 Cell Defense Pathway by Ancient Foods: Disease Prevention by Important Molecules and Microbes Lost from the Modern Western Diet

alkyl catechols

Donald R. Senger^{1,2*}, Dan Li¹, Shou-Ching Jaminet^{1,2}, Shugeng Cao³

1 Department of Pathology and Center for Vascular Biology Research, Beth Israel Deaconess Medical Center, Boston, Massachusetts, United States of America, **2** Department of Pathology, Harvard Medical School, Boston, Massachusetts, United States of America, **3** Department of Pharmaceutical Sciences, Daniel K. Inouye College of Pharmacy, University of Hawaii at Hilo, Hilo, Hawaii, United States of America



Loss of biodiversity
and function

Gut-microbiota-targeted diets modulate human immune status

Graphical abstract



A way to reintroduce evolutionary important foodborne microbes that have been lost over the course of sanitizing the industrialised environment

Authors

Hannah C. Wastyk,
Gabriela K. Fragiadakis,
Dalia Perelman, ..., Erica D. Sonnenburg,
Christopher D. Gardner,
Justin L. Sonnenburg

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erica.sonnenburg@stanford.edu (E.D.S.),
jls@stanford.edu (J.L.S.)

In brief

A 28-day, 280 randomized controlled trial study in humans investigating the longitudinal effects of a high-fiber or fermented-food diet shows their differential effects on the diversity of the microbiome, with the latter having a noticeable impact on reducing inflammatory markers and modulating immune responses.

Highlights

- Diet intervention with systems profiling reveals links in diet-microbiome-immune axis
- High-fiber diet changes microbiome function and elicits personalized immune responses
- Fermented-food diet increases microbiome diversity and decreases markers of inflammation

August 2021

Dairy, fruits, vegetables, meat, cereals

Fermentation

- ↑ Nutrients
- Provides prebiotics, probiotics, EPSs
- ↑ Digestibility
- ↑ Phenolic acids, flavonoids, short-chain fatty acids, vitamins, and small peptides
- Improves organoleptic characteristics



Fermented Foods

Gut
microbiota

Gut microbiota modulation
↑ Intestinal barrier integrity

NF- κ B

↓ RANKL, MAPK
↑ IKK
↓ I κ B α phosphorylation
↓ TNF- α , MCP-1, NLRP3, caspase 1, IL-1 β

Nrf2

↑ HO-1, GPx, SOD, NQO1, GSH, GSTP
↓ ROS

- Immunomodulatory effects
- ↓ inflammation
- ↓ oxidative stress
- ↓ inflammaging

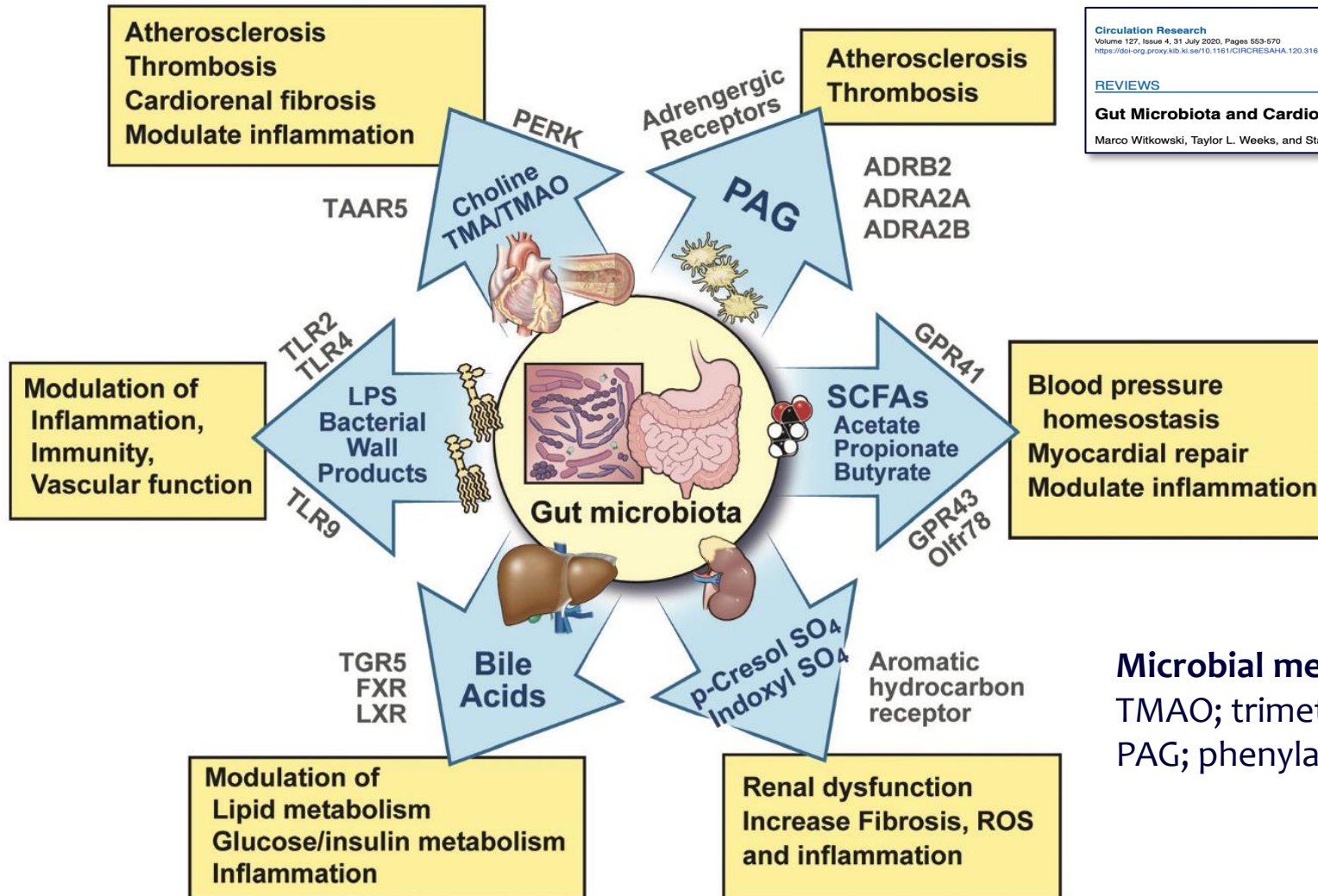
Benefits:

- Cardiovascular disease
- Diabetes Mellitus
- Chronic kidney disease

REVIEWS

Gut Microbiota and Cardiovascular Disease

Marco Witkowski, Taylor L. Weeks, and Stanley L. Hazen



Microbial metabolites:
TMAO; trimethylamine N-oxide
PAG; phenylacetylglutamine

Gut Microbiota-Dependent Trimethylamine *N*-Oxide (TMAO) Pathway Contributes to Both Development of Renal Insufficiency and Mortality Risk in Chronic Kidney Disease

Circ Res 2015

W.H. Wilson Tang, Zeneng Wang, David J. Kennedy, Yuping Wu, Jennifer A. Buffa, Brendan Agatista-Boyle, Xinmin S. Li, Bruce S. Levison, Stanley L. Hazen

An obligatory role for gut microbes in TMAO formation

Medical News & Perspectives

JAMA, 2019

TMAO and Heart Disease: The New Red Meat Risk?

Jennifer Abbasi

Over the past several decades, public health experts and physicians have pinned a hefty portion of the blame for heart disease on saturated fat. That's not without reason. The long-chain saturated fatty acids found in foods like steak, butter, and coconut oil raise artery-clogging low-density lipoprotein (LDL) cholesterol, a cause of atherosclerotic cardiovascular disease. At the same time, diets high in red meat have been strongly associated with heart disease and mortality.

But a problem has emerged: meta-analyses of dietary recall studies suggest that saturated fat intake may not be as tightly linked to cardiovascular disease and mortality risk as was previously thought. Cholesterol content likewise doesn't appear to adequately explain the hazards of a red meat-rich diet.

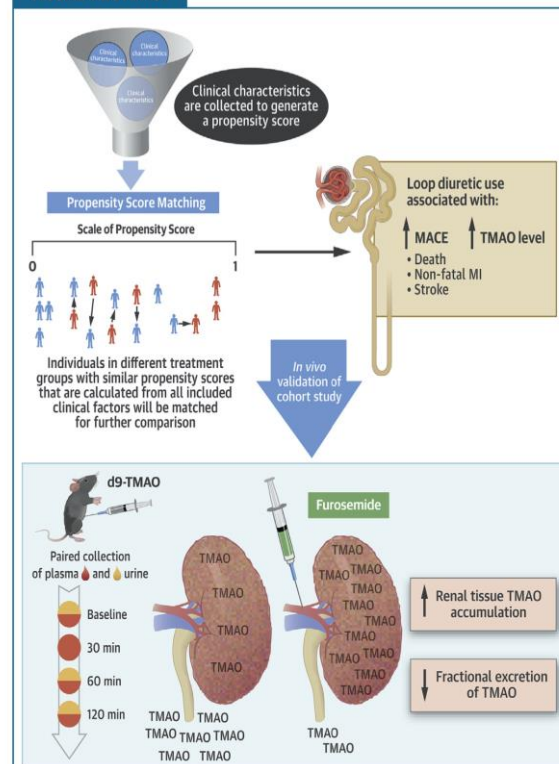
Now, researchers are homing in on



Loop Diuretics Inhibit Renal Excretion of Trimethylamine *N*-Oxide

Daniel Y. Li, MD,^{a,b} Zeneng Wang, PhD,^a Xun Jia, MD,^a Di Yan, MD,^c Diana M. Shih, PhD,^d Stanley L. Hazen, MD, PhD,^{a,c} Aldons J. Lusis, PhD,^d W.H. Wilson Tang, MD^{a,e,f}

VISUAL ABSTRACT



HIGHLIGHTS

- Uremic retention solutes predominantly eliminate through the kidneys largely via specific efflux channels in the proximal renal tubules.
- For the first time, we demonstrated in vivo that renal tubular excretion of TMAO can be inhibited by concomitant loop diuretic administration via competition at the level of renal transporters.
- We further observed accumulation of TMAO in the renal parenchyma, which implied differential distributions of TMAO across various tissues and/or systems as a consequence of efflux channel control.
- Poorer outcomes in patients who receive long-term loop diuretic agents may therefore be associated with metabolic perturbations, such as retention of metabolites like TMAO, beyond impaired glomerular filtration.

The Aim of "Food as medicine" is the Generalized Application of Personalized Nutrition Based on **Solid Scientific** Support

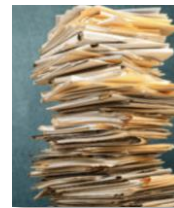
Solid scientific identification of bioactive nutrients



Nutritionists create food from bioactive nutrients



Environmentally unsustainable ingredients are excluded



Food is the single strongest lever to optimize human health and environmental sustainability

ENVIRONMENTAL IMPACTS OF FOOD



Responsible for
27%
of GHG emissions



70%
of freshwater
withdrawals



Main driver of biodiversity
loss and tropical
deforestation

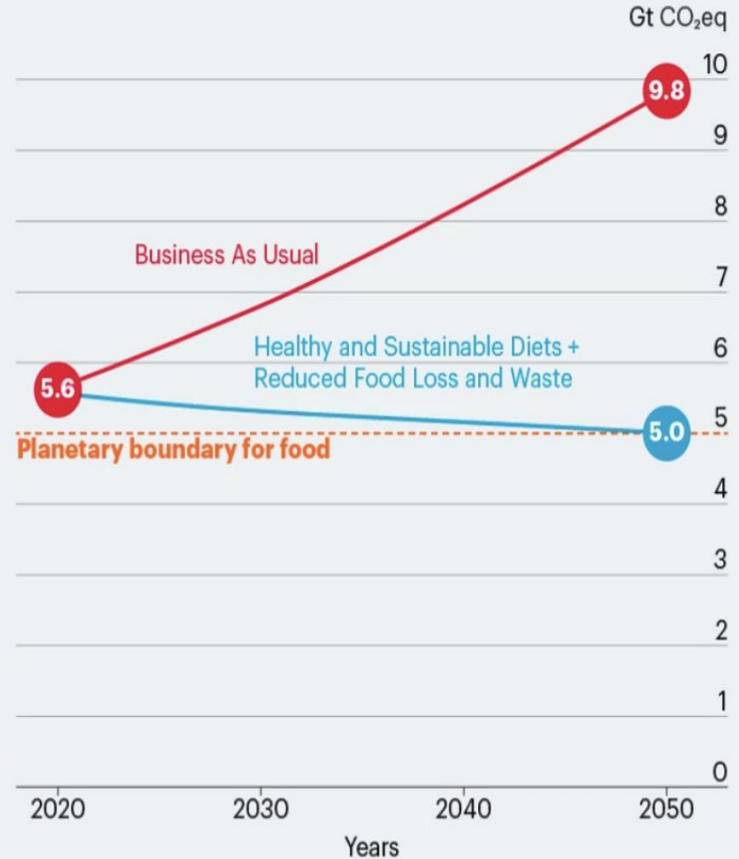


Increasing risk for future
pandemics



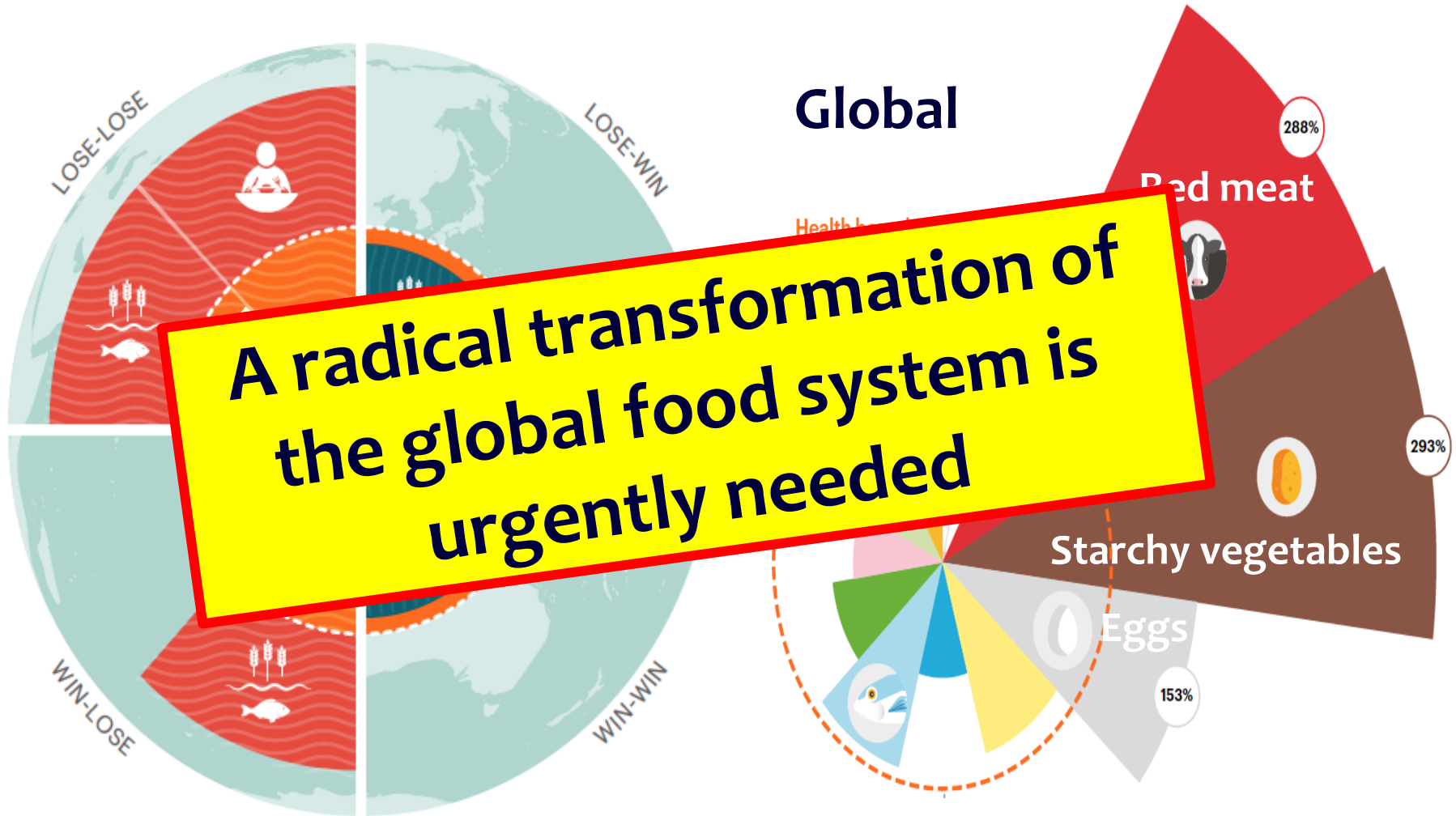
EAT-Lancet Commission

Emissions gap from food consumption



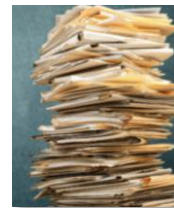
Global

**A radical transformation of
the global food system is
urgently needed**



The Aim of "Food as medicine" is the Generalized Application of Personalized Nutrition Based on **Solid Scientific** Support

Solid scientific identification of bioactive nutrients



Nutritionists create food from bioactive nutrients



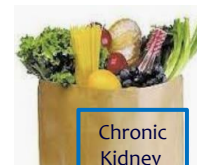
Environmentally unsustainable ingredients are excluded



Food influencers and chef's create cook books and menus



Commercially available grocery bags with tailor-made nutritional ingredients



Vision for the Future: Grocery Bags Based on Patients Individual “Foodome”



Bioactive nutrients that benefit health and/or counteract the negative effects of drug treatment on gut microbiota





ORIGINAL ARTICLE

INFECTIOUS DISEASES

The influence of non-steroidal anti-inflammatory drugs on the gut microbiome

Clin Microbiol Infect 2016

M. A. M. Rogers¹ and D. M. Aronoff²

1) Department of Internal Medicine, University of Michigan, Ann Arbor, MI and 2) Department of Medicine and Department of Pathology, Microbiology, & Immunology, Vanderbilt University School of Medicine, Nashville, TN, USA

ORIGINAL ARTICLE

Gut 2016

Proton pump inhibitors affect the gut microbiome

Floris Imhann,¹ Marc Jan Bonder,² Arnau Vich Vila,¹ Jingyuan Fu,² Zlatan Mujagic,³ Lisa Vork,³ Ettje F Tigchelaar,² Soesma A Jankipersadsing,² Maria Carmen Cenit,² Hermie J M Harmsen,⁴ Gerard Dijkstra,¹ Lude Franke,² Ramnik J Xavier,⁵ Daisy Jonkers,³ Cisca Wijmenga,² Rinse K Weersma,¹ Alexandra Zhernakova²

Sevelamer Use in End-Stage Kidney Disease (ESKD) Patients Associates with Poor Vitamin K Status and High Levels of Gut-Derived Uremic Toxins: A Drug–Bug Interaction?

Lu Dai¹, Birken K. Meijers^{2,3}, Bert Bammens^{2,3}, Hendriette de Zeeuw^{2,3}, Leon J. Schurgers^{4,5}, Abdul Rashid Qureshi^{1,6}, Peter Stenvinkel^{1,6,7} and Pieter Evenepoel^{2,3,6,†}

¹ Division of Renal Medicine and Baxter Novum, Department of Clinical Science, Intervention and Technology, Karolinska Institutet, 141 86 Huddinge, Stockholm, Sweden; lu.dai@ki.se (L.D.); toraqureshi@ki.se (A.R.Q.)
² Department of Microbiology Immunology and Transplantation, Nephrology and Renal Transplantation Research Group, KU Leuven University of Leuven, B-3000 Leuven, Belgium; birken.meijers@uzleuven.be (B.K.M.); bert.bammens@uzleuven.be (B.B.); jettiedezeew@uzleuven.be (H.L.D.)
³ Department of Nephrology, University Hospital Leuven, B-3000 Leuven, Belgium
⁴ Department of Biochemistry, Cardiovascular Research School Maastricht, Maastricht University, 6200MD Maastricht, The Netherlands; l.schurgers@maastrichtuniversity.nl
⁵ Correspondence: p.stenvinkel@ki.se (P.S.); pieter.evenepoel@uzleuven.be (P.E.)
⁶ Shared senior authorship

Received: 26 March 2020; Accepted: 22 May 2020; Published: 27 May 2020



ARTICLE

doi:10.1038/nature25979

Extensive impact of non-antibiotic drugs on human gut bacteria

Lisa Maier^{1,*}, Mihaela Pruteanu^{1,†,*}, Michael Kuhn^{2,*}, Georg Zeller², Anja Telzerow¹, Exene Erin Anderson¹, Ana Rita Brochado¹, Keith Conrad Fernandez¹, Hitomi Dose³, Hirotada Mori³, Kiran Raosaheb Patil⁴, Peer Bork^{2,5,6} & Athanasios Typas^{1,2}

RESEARCH

Open Access

Oral iron supplementation after antibiotic exposure induces a deleterious recovery of the gut microbiota

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THE POWER IS ON YOUR PLATE

Early vascular ageing



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Thanks
to



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Leon Schurgers, CARIM



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Annika Wernerson, KI



Magnus Söderberg, AZ



Paul Shiels, GU



Thomas Ebert, KI



Pieter Evenepoel,
Leuven



Louise Nordfors, KI

Epigenetic Diet



Isothiocyanates
Folic Acid

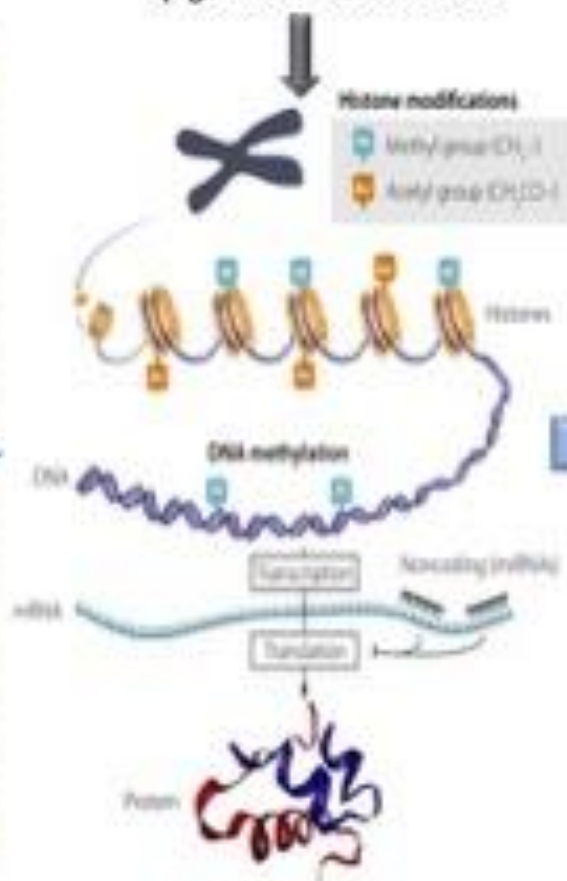


Vitamin B12 and choline



Betaine

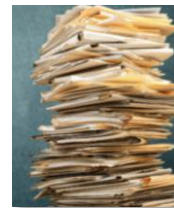
Epigenetic modifications



- Decreased epigenetic marks
- Slower DNAmAgeing
- Reduced susceptibility to age related diseases and mortality
- Increased health span

The Aim of "Food as medicine" is the Generalized Application of Personalized Nutrition Based on **Solid Scientific** Support

Solid scientific identification of bioactive nutrients



Nutritionists create food from bioactive nutrients



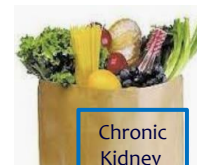
Environmentally unsustainable ingredients are excluded



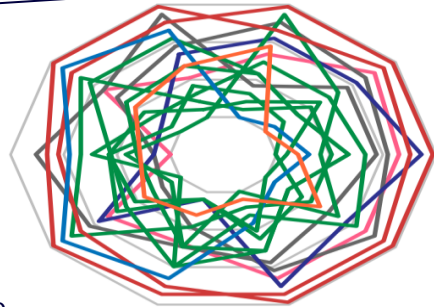
Food influencers and chef's create cook books and menus



Commercially available grocery bags with tailor-made nutritional ingredients



The skewing towards a more carnivorous diet has resulted in a dietary association with the diseasome of ageing



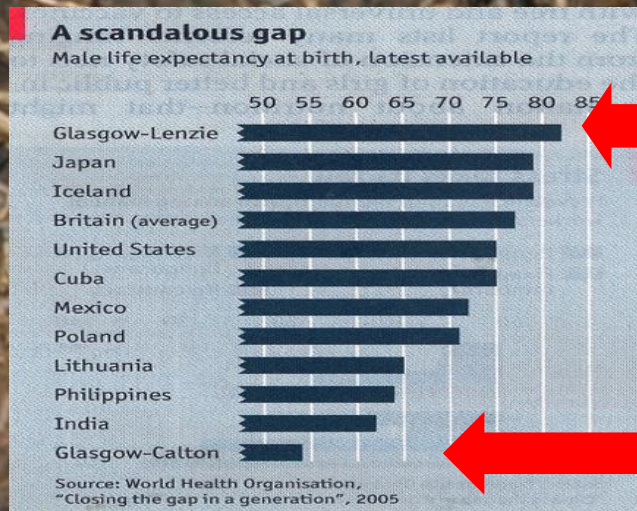
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Multiple health and environmental impacts of foods

Michael A Clark^{a,b,c,1}, Marco Springmann^{a,b}, Jason Hill^d, and David Tilman^{e,f,1}

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Glaswegians and Big Cats – What do They Have in Common?



Big cats and Glaswegians have much in common

RESEARCH ARTICLE

Pathology in Captive Wild Felids at German Zoological Gardens

Johannes Junginger^{1*}, Florian Hansmann^{1,2*}, Vanessa Herder^{1,2*}, Annika Lehmbecker^{1,2*}, Martin Peters³, Martin Beyerbach⁴, Peter Wohlsein¹, Wolfgang Baumgärtner^{1,2*}

- Obligate carnivores
- 0.5-22 yrs
- 38 animals

- Prevalent renal pathology in captive wild felids
- 87% Extensive renal pathology
- 50% Tumors
- Elevated inflammatory burden

- CKD highest mortality reason
- Prevalence
 - 35-80% geriatric domestic cat
 - 50-87% in zoo felids
 - Unknown status for wild felids

Glasgow



- Accelerated ageing
- Imbalanced diet- lacks fruit and veg
- Red meat consumption high
- Renal dysfunction
- Hyperphosphataemic
- High cancer incidence
- Large inflammatory burden
- Microbial dysbiosis

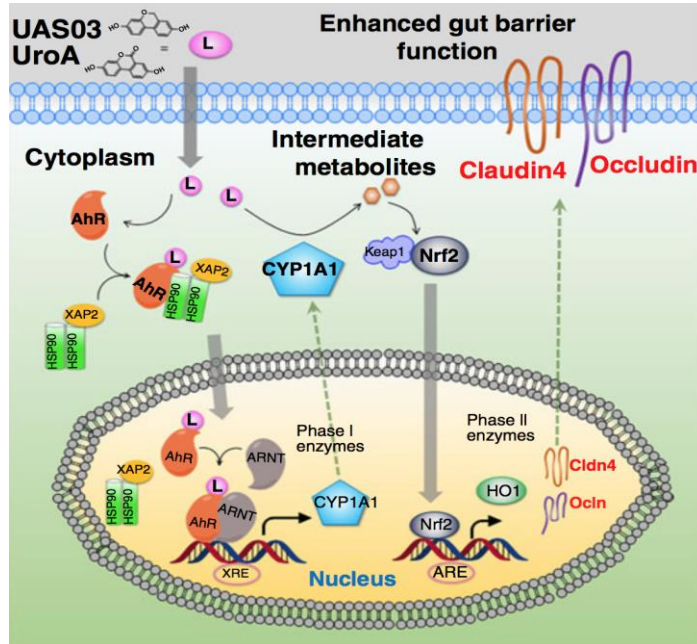
News > Science

Cheap red meat helps to kill off Glasgow's poorest men 30 years early

'You need to be able to afford to buy good-quality food. If you don't and you can't get quality red meat without additives, you're going to have an issue'

Enhancement of the gut barrier integrity by a microbial metabolite through the Nrf2 pathway

Rajbir Singh¹, Sandeep Chandrashekarappa², Sobha R. Bodduluri¹, Becca V. Baby¹, Bindu Hegde¹, Niranjan G. Kotla², Ankita A. Hiwale², Taslimarif Saiyed³, Paresh Patel³, Matam Vijay-Kumar⁴, Morgan G.I. Langille⁵, Gavin M. Douglas⁵, Xi Cheng⁴, Eric C. Rouchka⁶, Sabine J. Waigel⁷, Gerald W. Dryden⁷, Houda Alataissi⁸, Huang-Ge Zhang¹, Bodduluri Haribabu¹, Praveen K. Vemula² & Venkatakrishna R. Jala¹



- Urolithin A, a major microbial metabolite derived from polyphenolics of **berries** and **pomegranate fruits** displays anti-inflammatory, anti-oxidative, and anti-ageing activities.
- Urolithin A exerts barrier functions through activation of Nrf2-dependent pathways to upregulate epithelial tight junction proteins.
- Treatment with Urolithin A attenuated colitis in pre-clinical models by remedying barrier dysfunction in addition to anti-inflammatory activities.