The microbiome in health and disease

SAHMRI
South Australian Health & Medical Research Institute

A/Prof Geraint Rogers
SAHMRI Microbiome Research

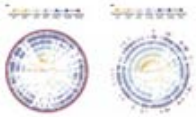
Microbiome Research

Flinders UNIVERSITY

Rise of the microbiome

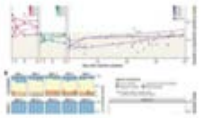
Science

AAAS



Population-based metagenomics analysis reveals markers for gut microbiome composition and diversity

BY ALEXANDRA ZHERNAKOVA, ALEXANDER KURILSHIKOV, ET AL. | APR. 29, 2016



Durable coexistence of donor and recipient strains after fecal microbiota transplantation

BY SIMONE S. LI, ANA ZHU, ET AL. | APR. 29, 2016

Gut microbes linked to eye disease

BY MITCH LESLIE | AUG. 18, 2015

Special issue: Microbiota at work

BY CAROLINE ASH, KRISTEN MUELLER | APR. 29, 2016

The right gut microbes help infants grow

BY ELIZABETH PENNISI | FEB. 18, 2016

How to give a C-section baby the potential benefits of vaginal birth

BY JENNIFER COUZIN-FRANKEL | FEB. 1, 2016

Your poor diet might hurt your grandchildren's guts

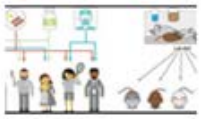
BY KATHERINE HARMON COURAGE | JAN. 13, 2016

Gut microbes give anticancer treatments a boost

BY MITCH LESLIE | NOV. 5, 2015

You're surrounded by your own personal cloud of microbes

BY HANAE ARMITAGE | SEP. 22, 2015



Cross-species comparisons of host genetic associations with the microbiome

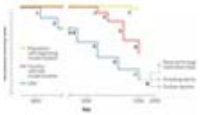
BY JULIA K. GOODRICH, EMILY R. DAVENPORT, ET AL. | APR. 29, 2016

Resurrecting the intestinal microbiota to combat antibiotic-resistant pathogens

BY ERIC G. PAMER | APR. 29, 2016

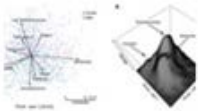
How colonization by microbiota in early life shapes the immune system

BY THOMAS GENSOLLEN, SHANKAR S. IYER, ET AL. | APR. 29, 2016



Antibiotic use and its consequences for the normal microbiome

BY MARTIN J. BLASER | APR. 29, 2016



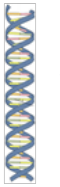
Population-level analysis of gut microbiome variation

BY GWEN FALONY, MARIE JOOSSENS, ET AL. | APR. 29, 2016

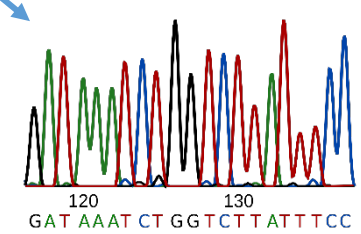
Culture-independent microbiology

Clinical sample

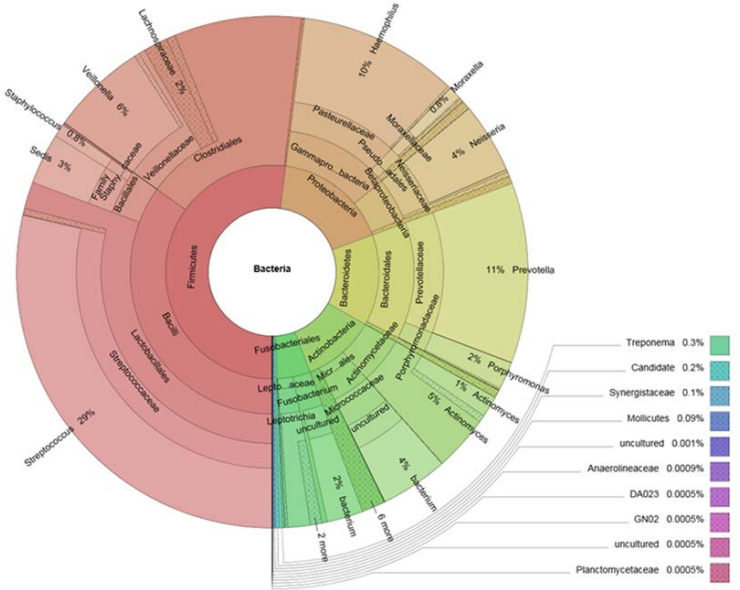
Culture-based microbiology



DNA



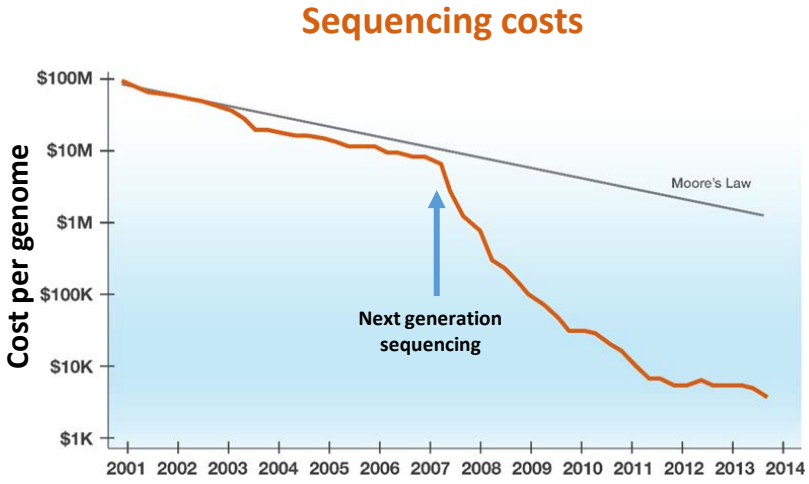
Sequence-based microbiology

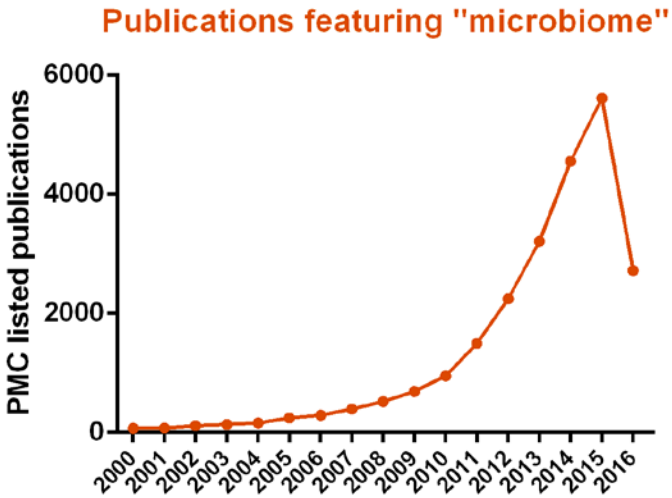


The sequencing revolution

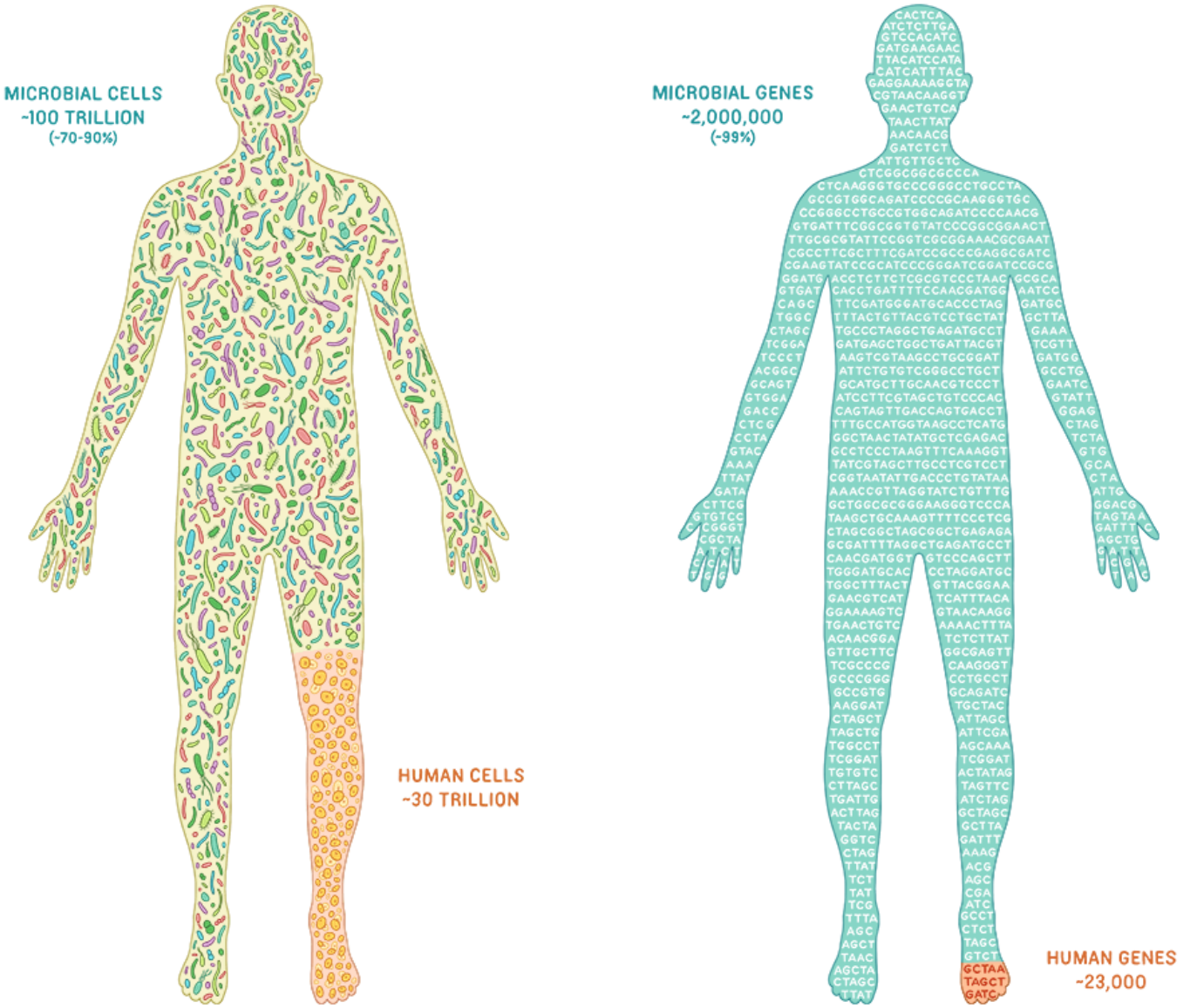
Human Genome Project
Completed 2003
Cost: $2,700,000,000

January, 2014
Human genome sequence <$1000
Less than the cost of a chest X-ray





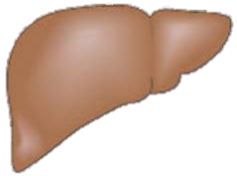
The human superorganism



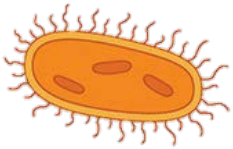
http://www.amnh.org

What has the microbiome ever done for us?

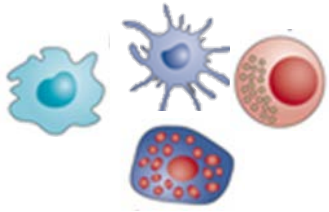
CNS function



Lipid and glucose metabolism



Prevention of infection



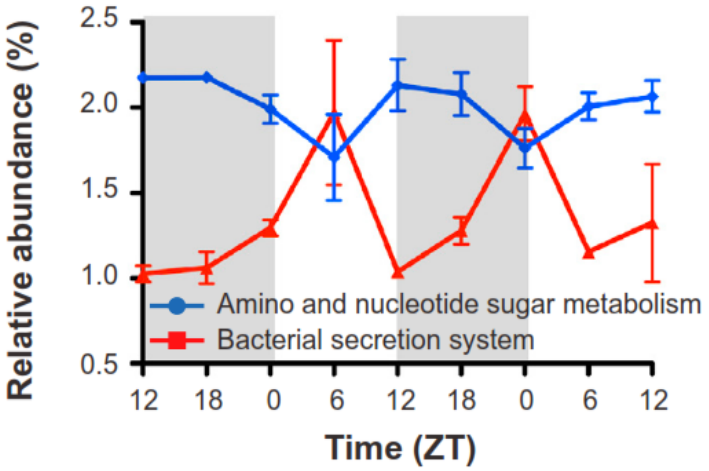
Immune regulation

Nutrition

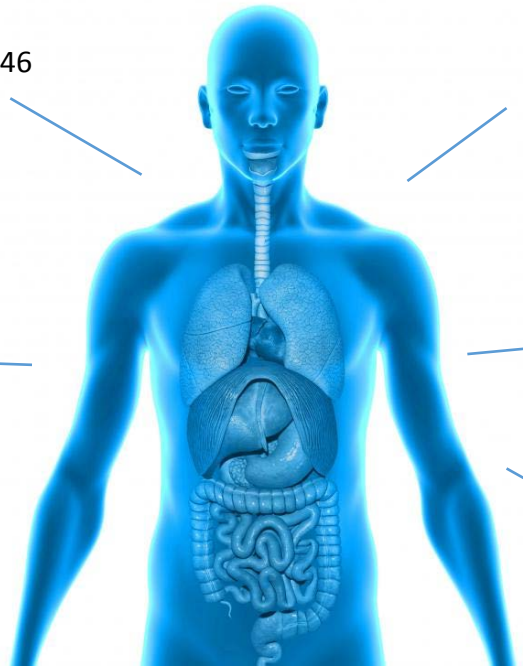
Circadian rhythm

Transkingdom Control of Microbiota Diurnal Oscillations Promotes Metabolic Homeostasis

Christoph A. Thaiss,[1] David Zeevi,[2] Maayan Levy,[1] Gili Zilberman-Schapira,[1] Jotham Suez,[1] Anouk C. Tengeler,[1] Lior Abramson,[1] Meirav N. Katz,[1,3] Tal Korem,[2] Niv Zmora,[3,4,5] Yael Kuperman,[6] Inbal Biton,[6] Shlomit Gilad,[7] Alon Harmelin,[6] Hagit Shapiro,[1] Zamir Halpern,[3,5] Eran Segal,[2] and Eran Elinav[1,*]



Dysbiosis and chronic inflammatory diseases



Depression
Mol Psychiatry. 2016.
doi: 10.1038/mp.2016.46

Atherosclerosis
J Am Heart Assoc. 2015;4(11).

Obesity
Science. 2013; 341; 6150

Cirrhosis
Nature. 2014;513:59-64.

Rheumatoid arthritis
Nat Med. 2015;21:895-905.

Type 2 diabetes
Nature. 2015; 10;528:262-6

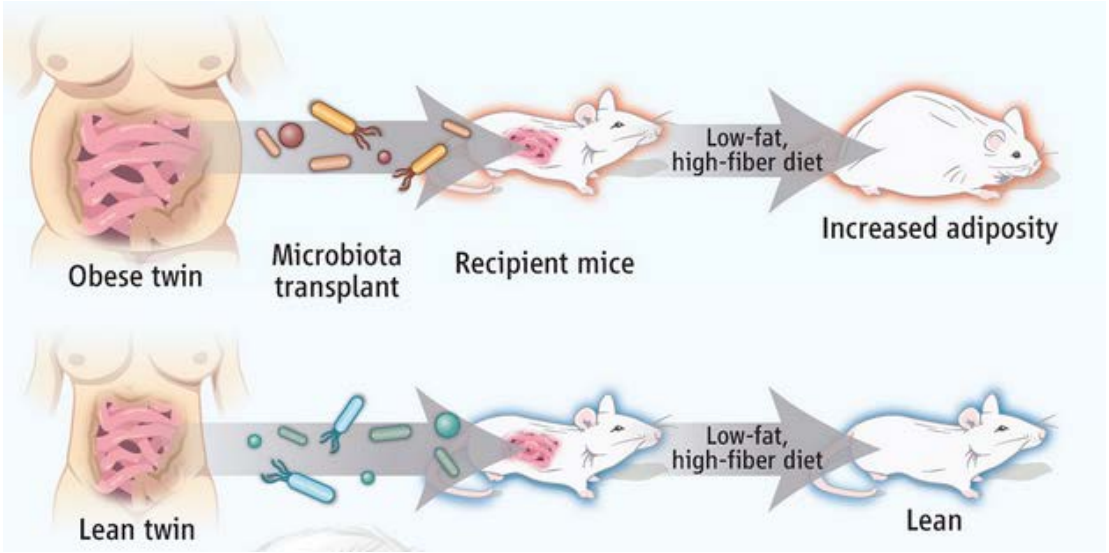
Cancer
Science. 2015 27;350:1079-84.

Is dysbiosis really to blame?

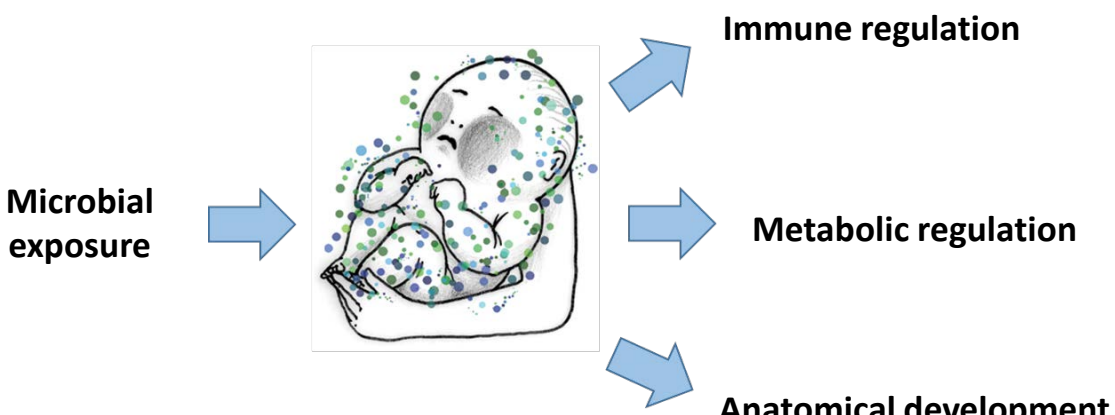
Cultured gut microbiota from twins discordant for obesity modulate adiposity and metabolic phenotypes in mice

Vanessa K. Ridaura[1], Jeremiah J. Faith[1], Federico E. Rey[1], Jiye Cheng[1], Alexis E. Duncan[2,3], Andrew L. Kau[1], Nicholas W. Griffin[1], Vincent Lombard[4], Bernard Henrissat[4,5], James R. Bain[6,7,8], Michael J. Muehlbauer[6], Olga Ilkayeva[6], Clay F. Semenkovich[9], Katsuhiko Funai[9], David K. Hayashi[10], Barbara J. Lyle[11], Margaret C. Martini[11], Luke K. Ursell[12], Jose C. Clemente[12], William Van Treuren[12], William A. Walters[13], Rob Knight[12,14,15], Christopher B. Newgard[6,7,8], Andrew C. Heath[2], and Jeffrey I. Gordon[1,*]

Science. 2013 September 6; 341(6150): . doi:10.1126/science.1241214.



Early life determinants of disease



Antibiotic exposure <12 months associated with increased risk of

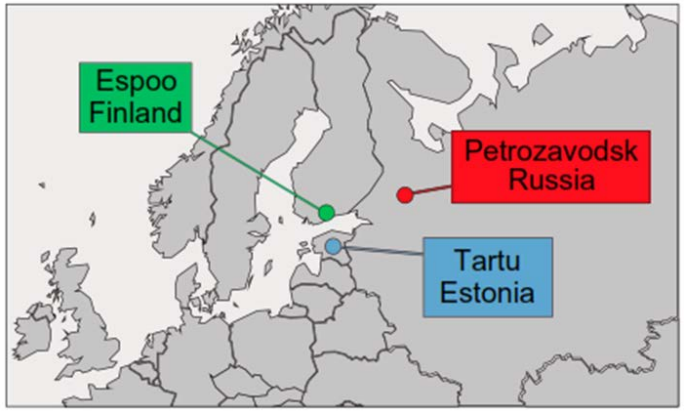
- Allergy and asthma at 6 years of age
- Wheezing and eczema at 8 years of age
- Inflammatory bowel disease
- Obesity, central adiposity, and type 2 diabetes
- Type 1 diabetes
- Depression, anxiety, or psychosis

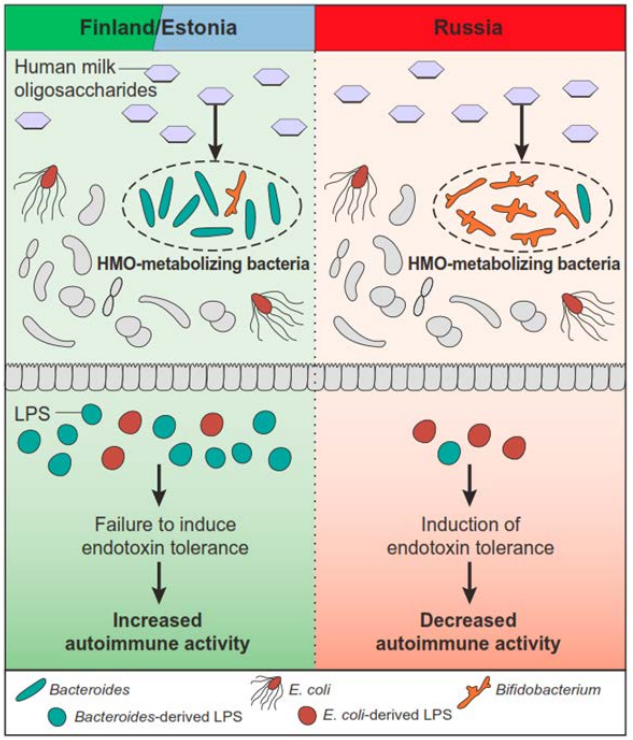
Early life determinants of autoimmunity

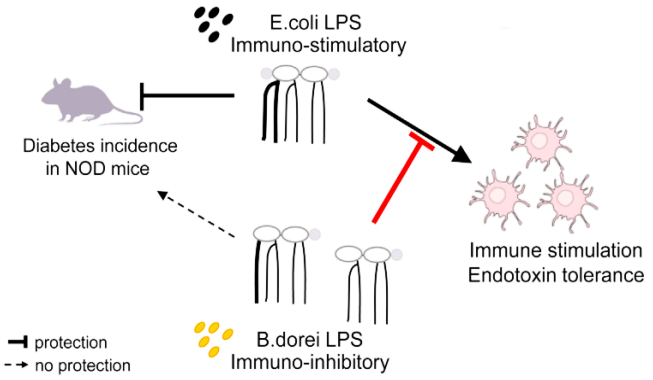
Variation in Microbiome LPS Immunogenicity Contributes to Autoimmunity in Humans

Tommi Vatanen,[1,2,22] Aleksandar D. Kostic,[1,3,4,22] Eva d'Hennezel,[5,22] Heli Siljander,[6,7,8] Eric A. Franzosa,[1,4] Moran Yassour,[1] Raivo Kolde,[3] Hera Vlamakis,[1] Timothy D. Arthur,[1] Anu-Maaria Hämäläinen,[9] Aleksandr Peet,[10] Vallo Tillmann,[10] Raivo Uibo,[11] Sergei Mokurov,[12] Natalya Dorshakova,[13] Jorma Ilonen,[14,15] Suvi M. Virtanen,[16,17,18] Susanne J. Szabo,[5] Jeffrey A. Porter,[5] Harri Lähdesmäki,[2] Curtis Huttenhower,[1,4] Dirk Gevers,[1,23] Thomas W. Cullen,[5,23] Mikael Knip,[6,7,8,19,23] on behalf of the DIABIMMUNE Study Group, and Ramnik J. Xavier[1,3,20,21,23,*]

Cell *165*, 842–853, May 5, 2016







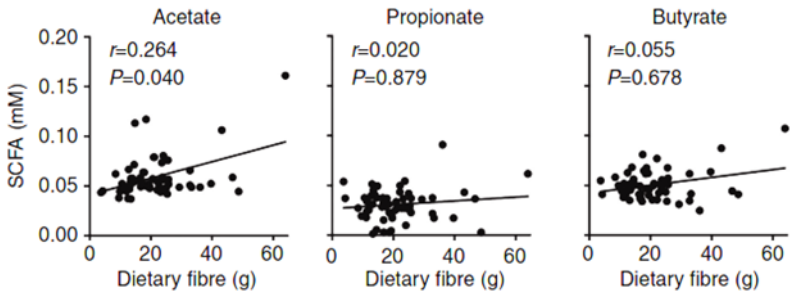
The prenatal influence of the microbiome

Evidence that asthma is a developmental origin disease influenced by maternal diet and bacterial metabolites

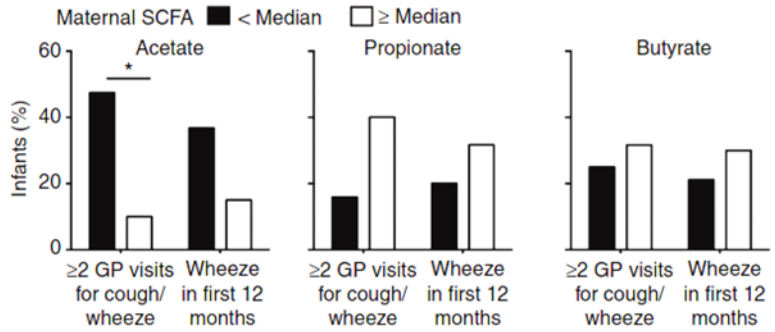
Alison N. Thorburn[1], Craig I. McKenzie[1], Sj Shen[1], Dragana Stanley[2], Laurence Macia[1], Linda J. Mason[1], Laura K. Roberts[1], Connie H.Y. Wong[1], Raymond Shim[1], Remy Robert[1], Nina Chevalier[1,3], Jian K. Tan[1], Eliana Mariño[1], Rob J. Moore[4,5], Lee Wong[6], Malcolm J. McConville[7,8], Dedreia L. Tull[8], Lisa G. Wood[9], Vanessa E. Murphy[9], Joerg Mattes[9], Peter G. Gibson[9] & Charles R. Mackay[1,10]

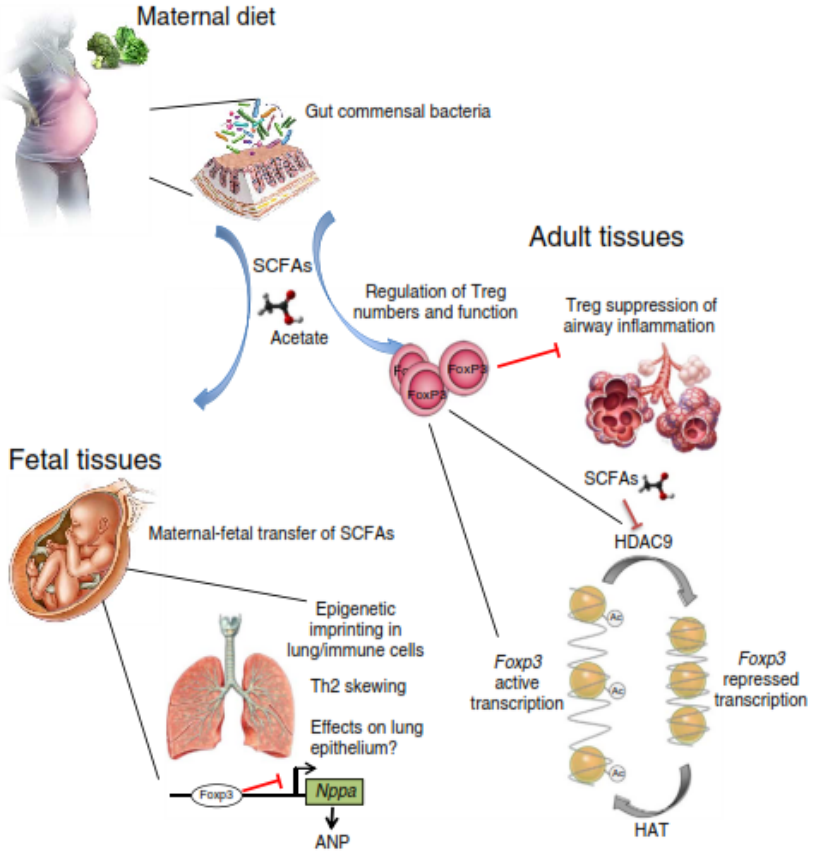
NATURE COMMUNICATIONS | 6:7320 | DOI: 10.1038/ncomms8320

Maternal fibre intake influences acetate levels

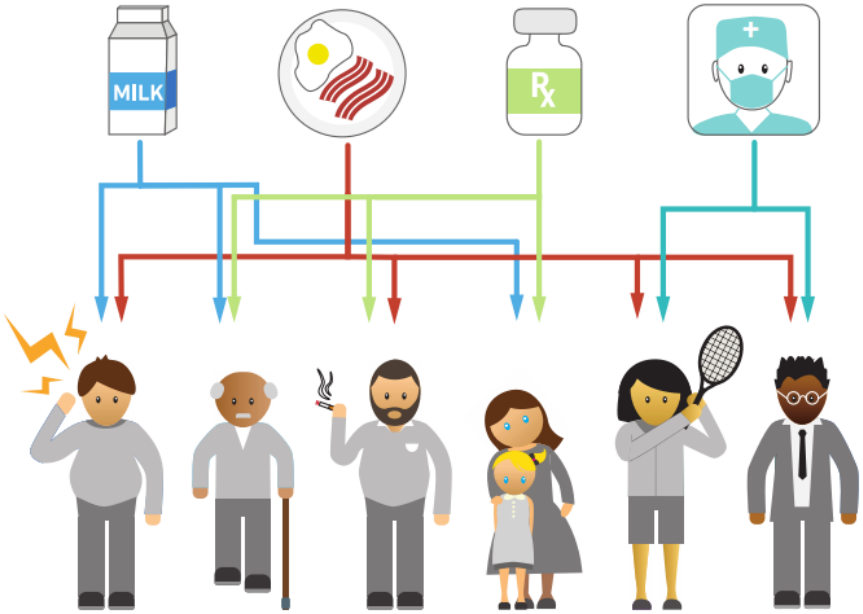


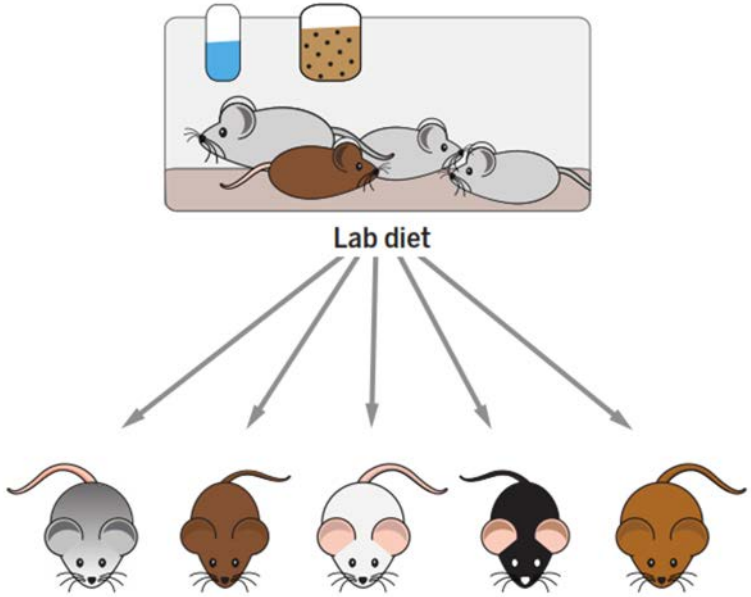
Maternal acetate levels during pregnancy influence rates of allergic airways disease in offspring





Microbiome and treatment outcomes





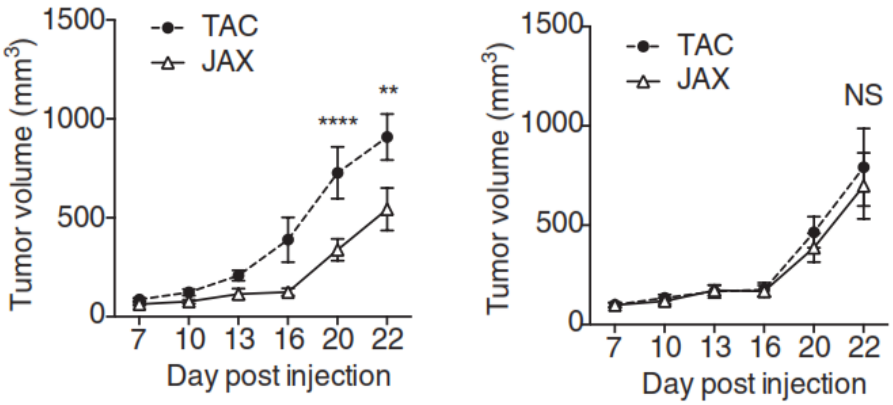
Goodrich et al., Science 2016: 352;6285:532-535.

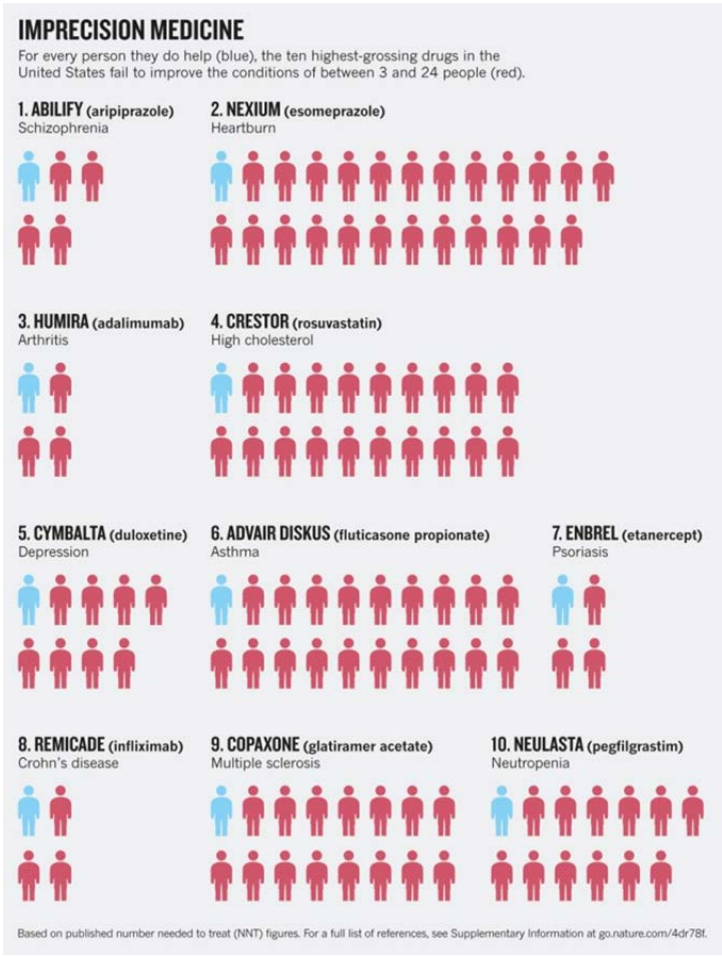
Determinants of microbiome composition

Commensal *Bifidobacterium* promotes antitumor immunity and facilitates anti–PD-L1 efficacy

Ayelet Sivan,[1*] Leticia Corrales,[1*] Nathaniel Hubert,[2] Jason B. Williams,[1] Keston Aquino-Michaels,[3] Zachary M. Earley,[2] Franco W. Benyamin,[1] Yuk Man Lei,[2] Bana Jabri,[2] Maria-Luisa Alegre,[2] Eugene B. Chang,[2] Thomas F. Gajewski[1,2†]

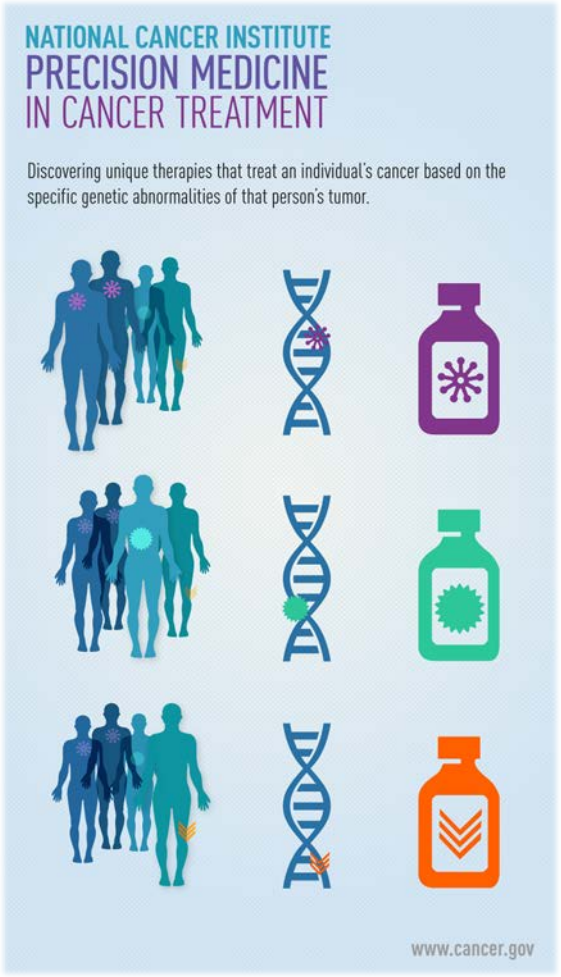
SCIENCE 27 NOVEMBER 2015 • VOL 350 ISSUE 6264





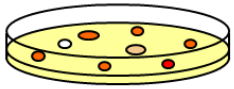
Using microbiome analysis to guide therapy

"Doctors have always recognized that every patient is unique, and doctors have always tried to tailor their treatments as best they can to individuals. You can match a blood transfusion to a blood type — that was an important discovery. What if matching a cancer cure to our genetic code was just as easy, just as standard? What if figuring out the right dose of medicine was as simple as taking our temperature?"
- President Obama, January 30, 2015



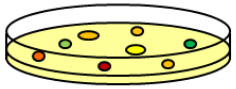
A precision approach to respiratory medicine

Chocolate agar + Bacitracin
35-37 C, 5-10% C02, 40-48h



Haemophilus influenzae
Moraxella catarrhalis
Streptococcus pneumoniae
Staphylococcus aureus

MacConkey agar
35-37 C, air, 40-48h



Pseudomonas aeruginosa

Antibiotic
susceptibility testing

Disease course

A Novel Microbiota Stratification System Predicts Future Exacerbations in Bronchiectasis

Geraint B. Rogers[1], Nur Masirah M. Zain[2], Kenneth D. Bruce[2•], Lucy D. Burr[1], Alice C. Chen[1], Damian W. Rivett[3], Michael A. McGuckin[1], and David J. Serisier[1,4•]

[1]Immunity, Infection, and Inflammation Program, Mater Research Institute, University of Queensland, and Translational Research Institute, Woolloongabba, Queensland, Australia; [2]Institute of Pharmaceutical Science, King's College London, and [3]Division of Ecology and Evolution, Department of Life Sciences, Imperial College London, London, United Kingdom; and [4]Department of Respiratory Medicine, Mater Adult Hospital, South Brisbane, Australia

AnnalsATS Volume 11 Number 4 | May 2014

Treatment efficacy

The effect of long-term macrolide treatment on respiratory microbiota composition in non-cystic fibrosis bronchiectasis: an analysis from the randomised, double-blind, placebo-controlled BLESS trial

Geraint B Rogers, Kenneth D Bruce, Megan L Martin, Lucy D Burr, David J Serisier

Adverse outcomes

Inhaled Corticosteroids and the Risk of Pneumonia in People With Asthma

A Case-Control Study

Tricia McKeever, PhD; Timothy W. Harrison, MD; Richard Hubbard, MD; and Dominick Shaw, MD

CHEST 2013; 144(6):1788–1794

Challenges and opportunities

How do we balance treatments for discrete conditions against their impact on other physiological systems?

Can we manage the human microbiome to influence patient health and therapeutic efficacy?

Thank you

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INFECTION & IMMUNITY
Microbiome Research

Flinders UNIVERSITY