Society for Immunotherapy of Cancer

Advances in Cancer Immunotherapy™

Targeting the Gut Microbiome to Promote Response and Mitigate Toxicity to Immunotherapy

Jennifer Wargo MD, MMSc – R. Lee Clark Professor of Surgical Oncology & Genomic Medicine
University of Texas, MD Anderson Cancer Center – Houston TX, USA

Society for Immunotherapy of Cancer
Advances in Cancer Immunotherapy – A Focus on Toxicity Management
Future Directions for Research and New Management Approaches in Immunotherapy Toxicities
April 28, 2022

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Disclosure information

Advances in Cancer Immunotherapy – A Focus on Toxicity Management

Thursday April 28, 2022

Targeting the Gut Microbiome to Promote Response and Mitigate Toxicity to Immunotherapy

Jen Wargo

I have the following financial relationships to disclose:

Speaker's bureau / advisory boards: Imedex, Dava, Omniprex, Illumina, BMS, Roche – Genentech, GSK, Novartis, Astra-Zeneca, PeerView, Micronoma, Ella Therapeutics, Gilead
Stock options: Micronoma

-and-

I will discuss the following off label use and/or investigational use in my presentation:

Microbiome modulation strategies

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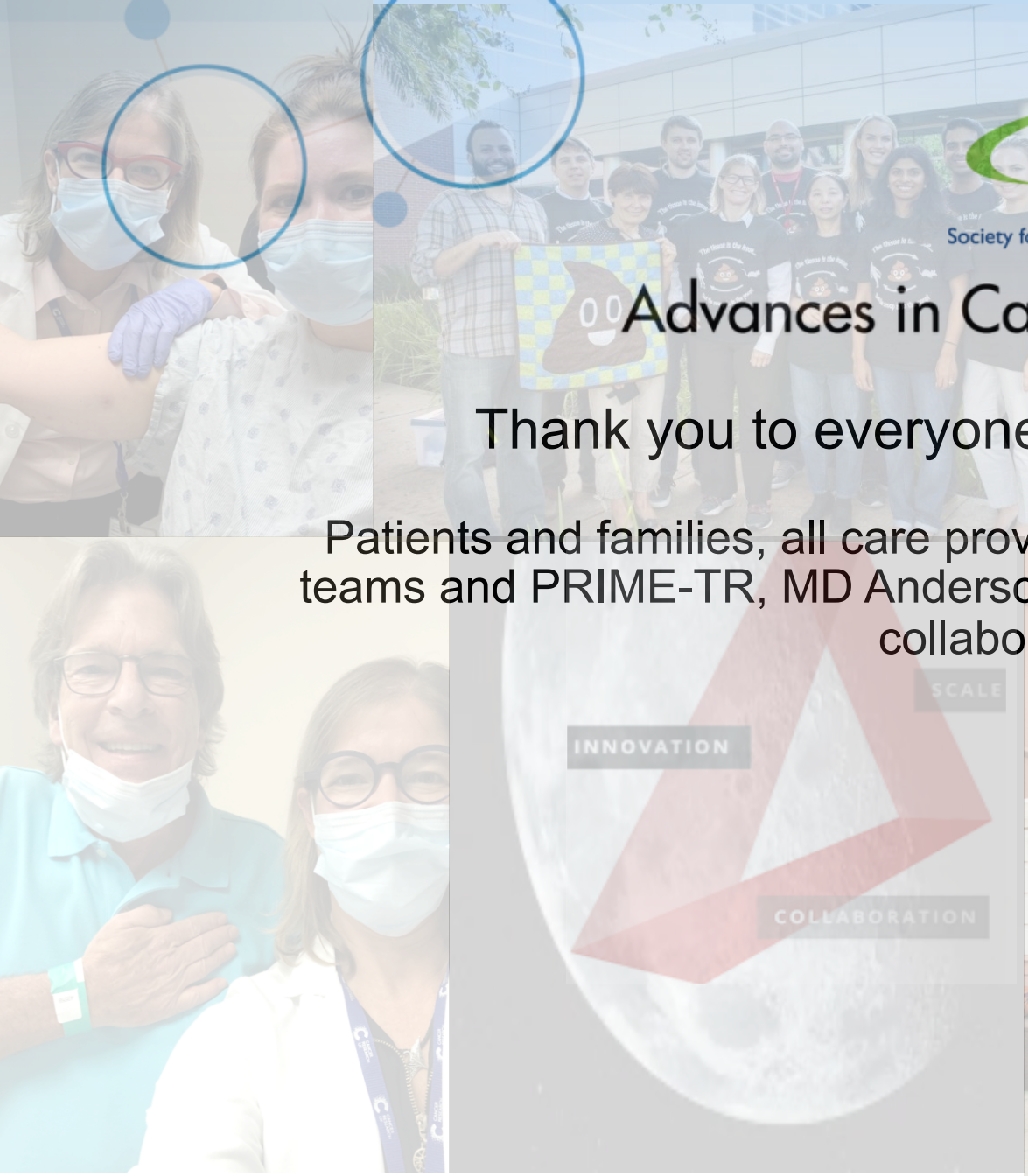
Thank you to everyone who contributed to this work!

Patients and families, all care providers, Melanoma Moonshot team, research teams and PRIME-TR, MD Anderson Cancer Center leadership, supporters and collaborators worldwide



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Targeting the Gut Microbiome to Promote Response and Mitigate Toxicity to Immunotherapy

I. Background and evidence that gut microbes can promote response to cancer immunotherapy

II. The role of gut microbes in mediating toxicity to immunotherapy

III. Understanding other factors that influence gut microbes and response (and toxicity) to treatment (with opportunities to target these)

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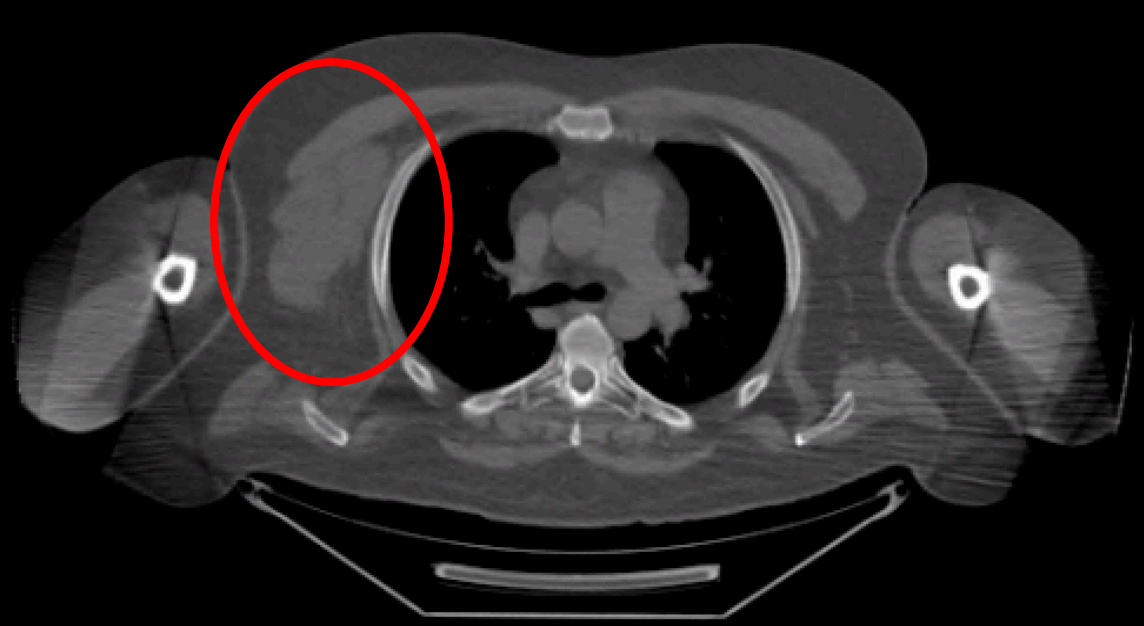
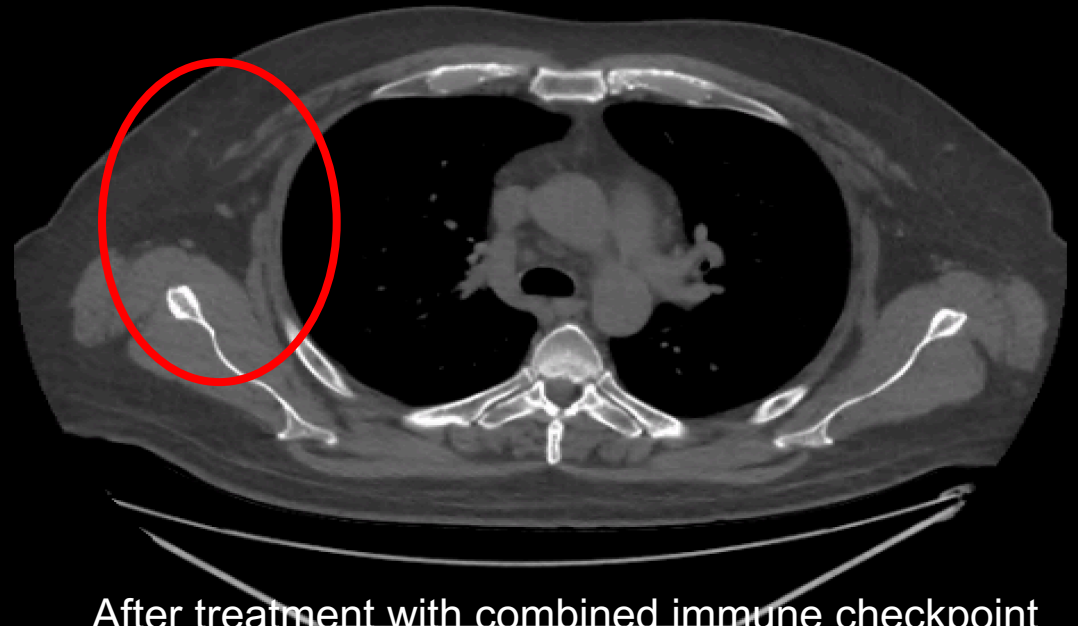
Treatment with immunotherapy can be very effective in treating solid tumors

However, treatment with immunotherapy may also be associated with toxicity

44 yo male with a history of multinodular goiter developed locoregional metastatic melanoma and was treated with neoadjuvant combined immune checkpoint blockade



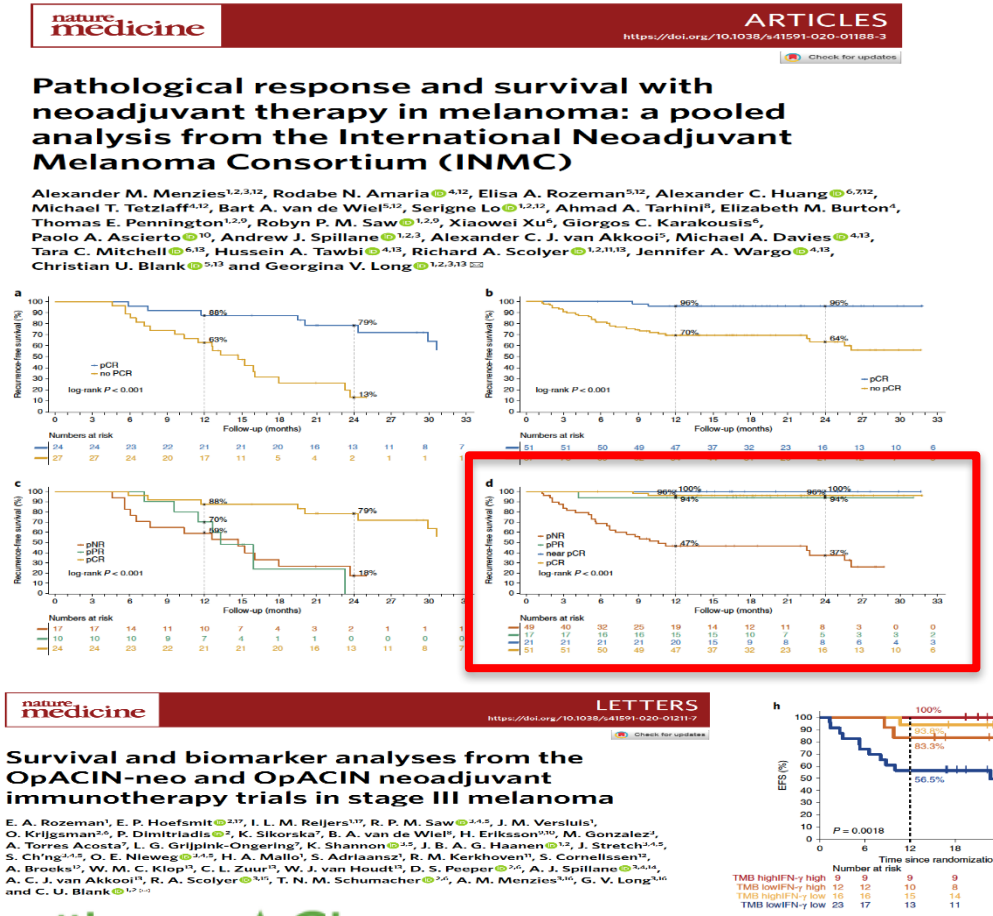
Pre-treatment



After treatment with combined immune checkpoint blockade (aCTLA-4 + aPD-1)

During treatment he developed thyrotoxicosis and lost 50 lbs then was profoundly hypothyroid, with enlargement of his thyroid and tracheal compression with a delay in surgery *(with a likely lifelong need for thyroid replacement hormone)*

Treatment with neoadjuvant immune checkpoint blockade is associated with benefit in most patients with melanoma treated (and now in other cancer types)



nature medicine ARTICLES
https://doi.org/10.1038/s41591-020-01188-3

Pathological response and survival with neoadjuvant therapy in melanoma: a pooled analysis from the International Neoadjuvant Melanoma Consortium (INMC)

Alexander M. Menzies[1,2,3,12], Rodabe N. Amaria[4,12], Elisa A. Rozeman[5,12], Alexander C. Huang[6,7,12], Michael T. Tetzlaff[4,12], Bart A. van de Wiel[5,12], Serigne Lo[1,2,12], Ahmad A. Tarhini[8], Elizabeth M. Burton[4], Thomas E. Pennington[1,2,9], Robyn P. M. Saw[1,2,9], Xiaowei Xu[6], Giorgos C. Karakousis[6], Paolo A. Ascierto[10], Andrew J. Spillane[1,2,3], Alexander C. J. van Akkooi[5], Michael A. Davies[4,13], Tara C. Mitchell[6,13], Hussein A. Tawbi[4,13], Richard A. Scolyer[1,2,11,13], Jennifer A. Wargo[4,13], Christian U. Blank[5,13] and Georgina V. Long[1,2,3,13]

nature medicine LETTERS
https://doi.org/10.1038/s41591-020-01211-7

Survival and biomarker analyses from the OpACIN-neo and OpACIN neoadjuvant immunotherapy trials in stage III melanoma

E. A. Rozeman[1], E. P. Hoefsmit[2,17], I. L. M. Reijers[1,17], R. P. M. Saw[3,4,5], J. M. Versluis[1], O. Krijgsman[2,6], P. Dimitriadis[2], K. Sikorska[7], B. A. van de Wiel[6], H. Eriksson[1,10], M. Gonzalez[1], A. Torres Acosta[7], L. G. Grijpink-Ongering[7], K. Shannon[3,5], J. B. A. G. Haanen[1,2], J. Stretch[3,4,5], S. Ch'ng[3,4,5], O. E. Nieweg[3,4,5], H. A. Mallo[1], S. Adriaansz[1], R. M. Kerkhoven[11], S. Cornelissen[12], A. Broeks[12], W. M. C. Klop[13], C. L. Zuur[13], W. J. van Houdt[13], D. S. Peeper[2,6], A. J. Spillane[3,4,14], A. C. J. van Akkooi[14], R. A. Scolyer[3,15], T. N. M. Schumacher[2,6], A. M. Menzies[3,16], G. V. Long[3,16] and C. U. Blank[1,2]

MELANOMA palpable lymph nodes

- Nivolumab 3 + ipilimumab 1: 70% pathologic CR!!
- **No more TLND in >50%** of patients with palpable nodes in 5 years

BLADDER CANCER

- 50% pCR for T3 bladder cancers: wait and see
- Reduction cystectomies

MSI COLORECTAL CANCER

- 19/20 pCR for MSI CRC! (Haanen et al. *Nature Medicine*. 2020)
- In future in case of pCR: **NO surgery, but endoscopy + MRI**

LUNG, HEAD and NECK, ESOPHAGEAL and GASTRIC, BREAST, GBM

There is a still a critical need to improve responses to immunotherapy (and limit toxicity) in patients with established cancer, and opportunities to intercept & prevent cancer altogether

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Menzies et al, Rozeman et al, Nature Medicine 2021

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How can we better understand responses to therapy

(as well as treatment-related toxicity)?

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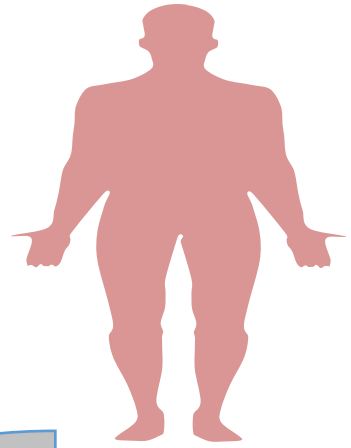
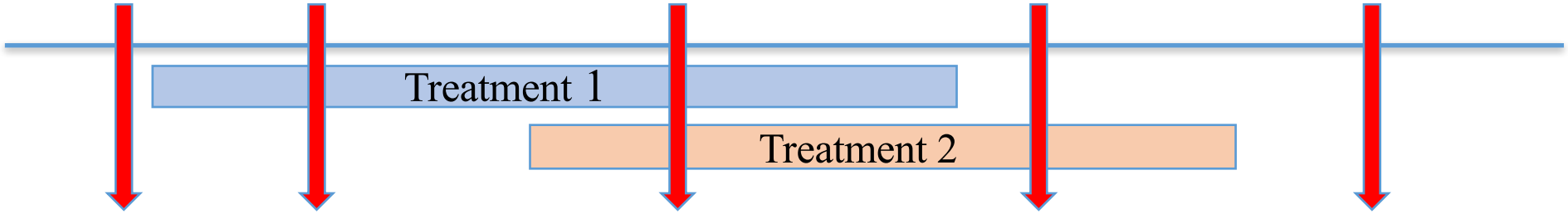
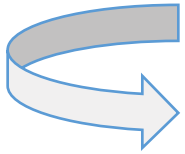
A powerful way to better understand responses is via “reverse translation” – where findings go from bedside to bench, and back again

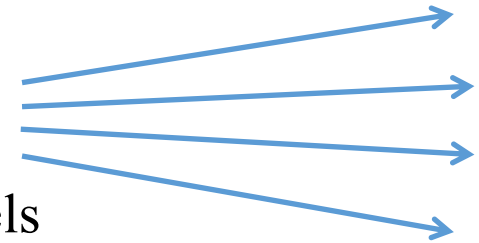


Translational research in patients with analysis of longitudinal tissue and blood samples





Murine models
(GEMM, PDX, etc)



Control
Treatment 1
Treatment 2
Treatment 1 + treatment 2

Mechanistic studies and therapeutic optimization in murine models

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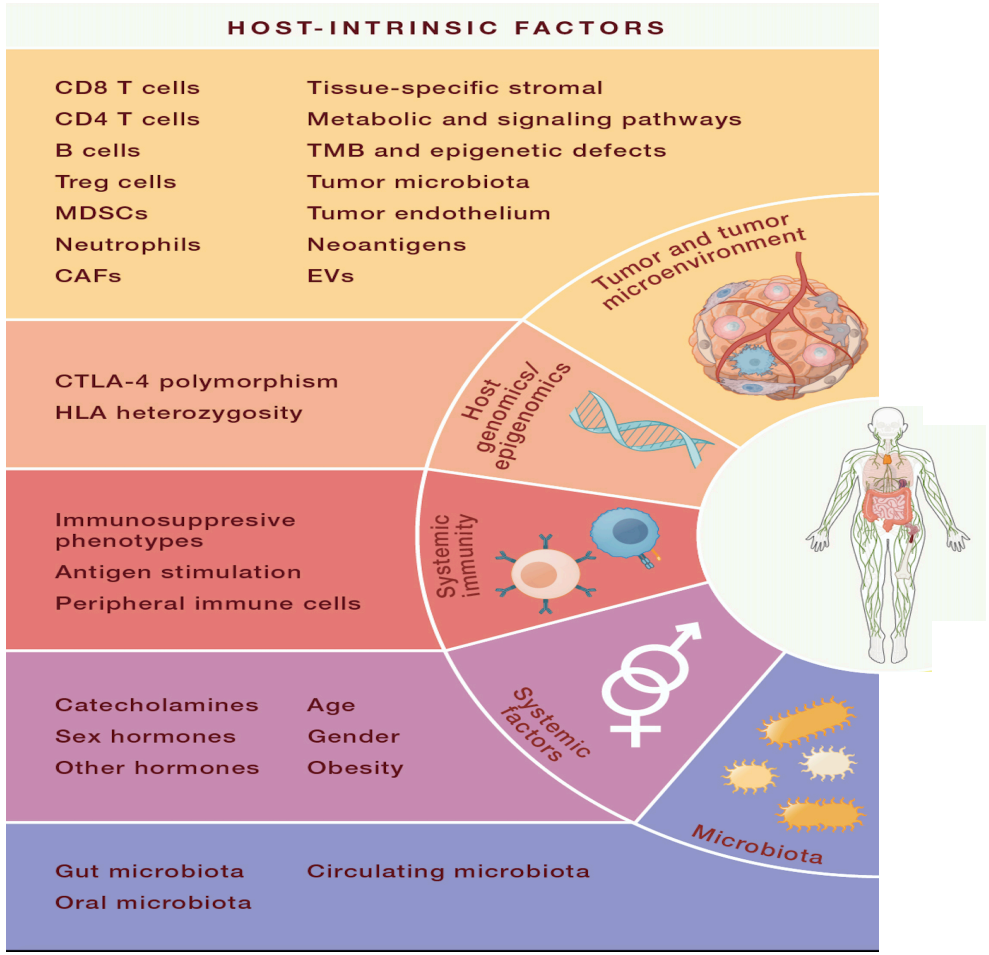
Through these types of approaches, we have identified a number of factors that impact tumor growth and response to cancer treatment that may be targeted



Morad et al, *Cell 2021*

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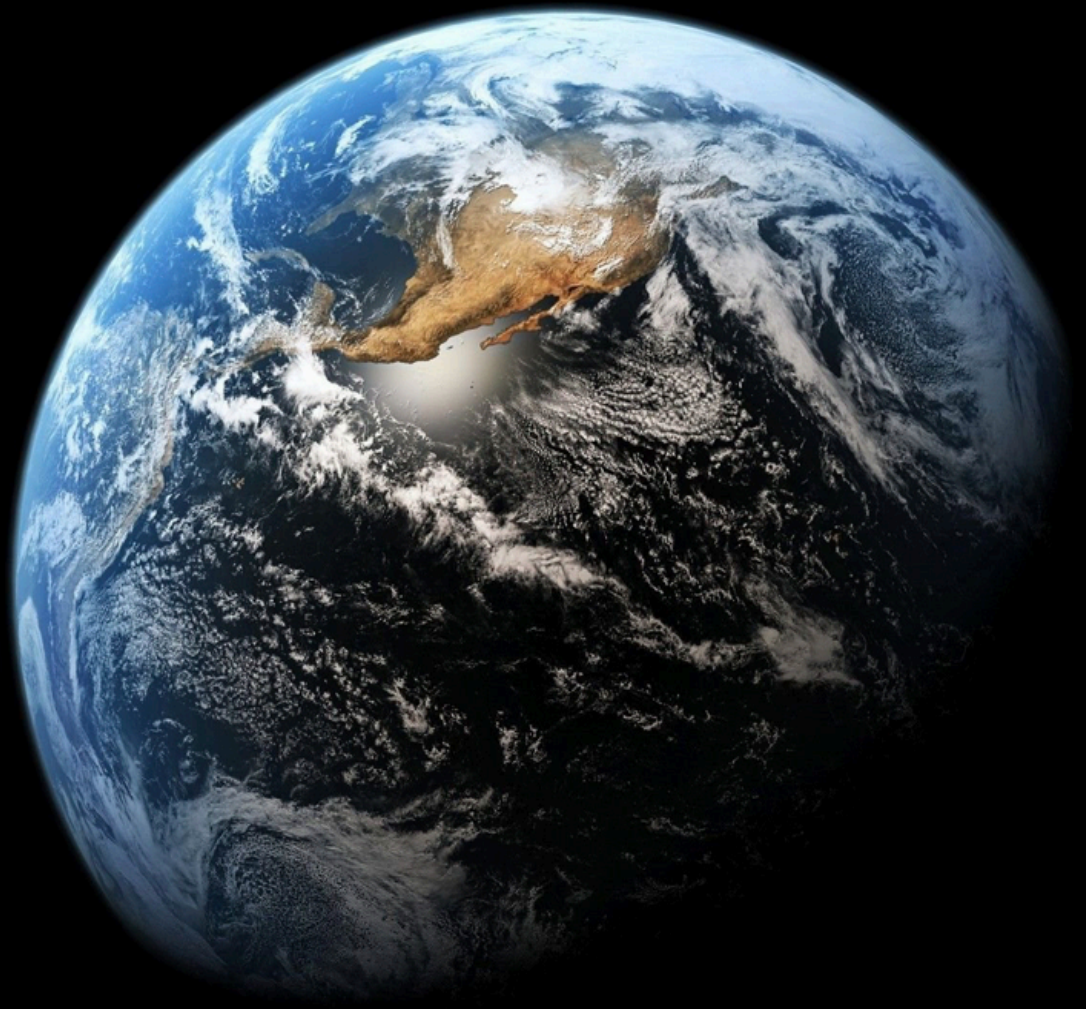

3.5 billion years ago,
microbes helped to shape the earth for future forms of life…

3.5 billion years later, it is now clear that microbes are pervasive in our environment (and within living organisms)

20,000 human genes in an individual

1%

2-20 million microbial genes in an individual

99%

inherently modifiable

Advances in next-generation sequencing have allowed us to better understand these microbes

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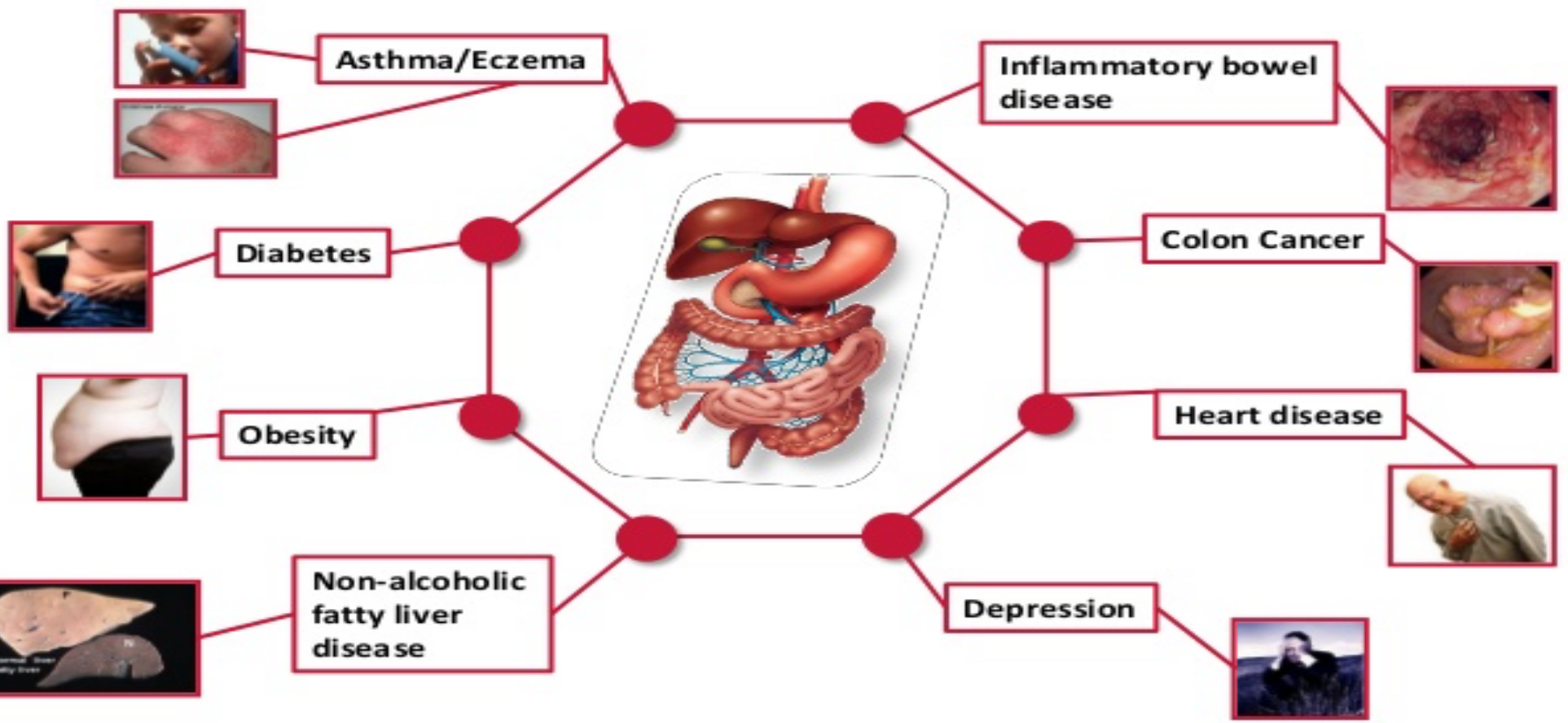
Disturbances of the gut microbiome (dysbiosis) are implicated in a large number of diseases



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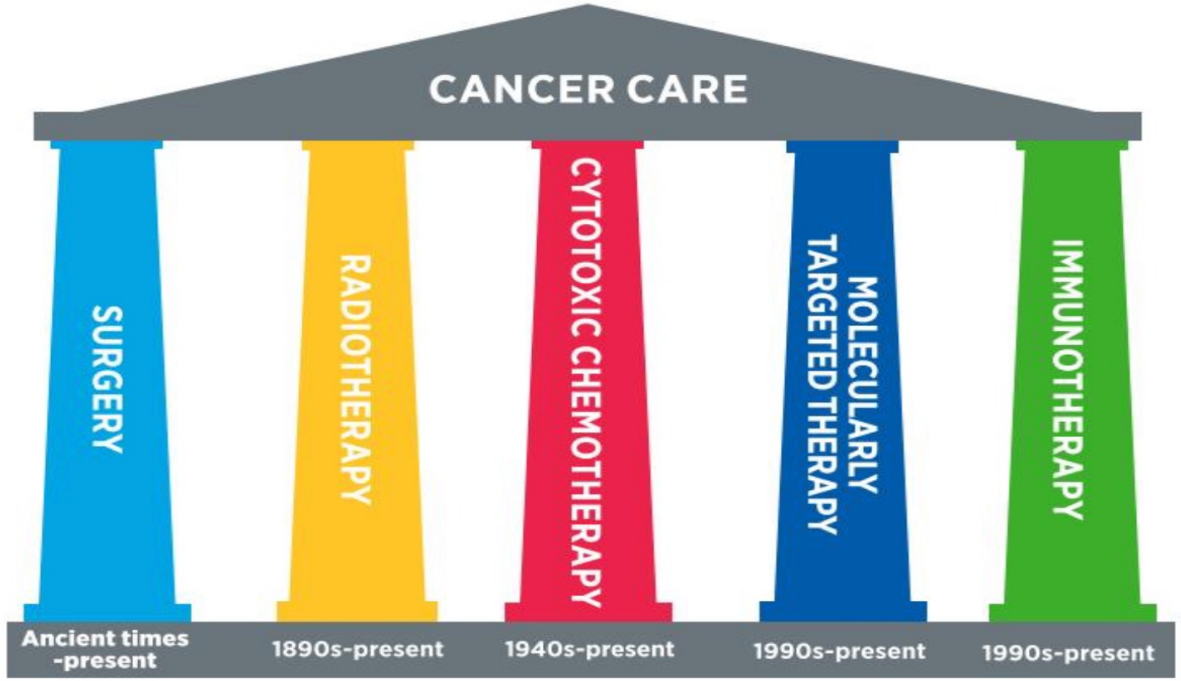
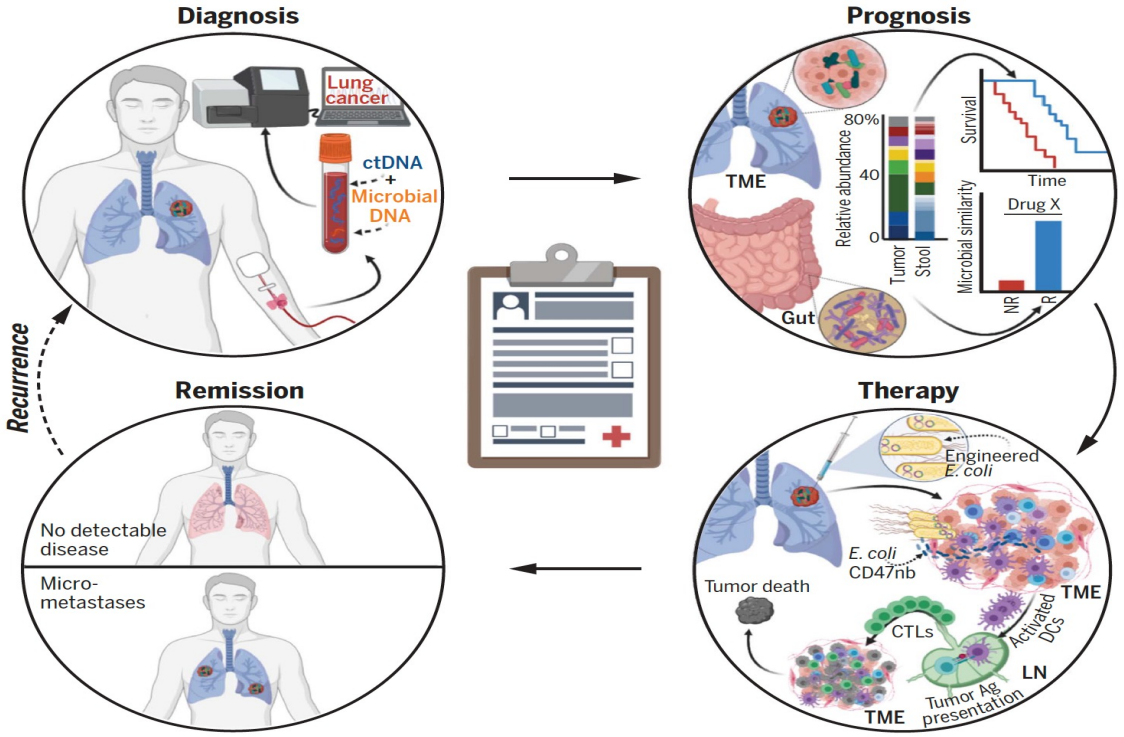
Could microbiome targeting become the next "pillar" of cancer care?

With strategies to monitor and modulate the microbiome to treat, intercept, and perhaps even prevent cancer altogether?



From AACR Cancer Progress Report



Sepich-Poore et al, Science 2021

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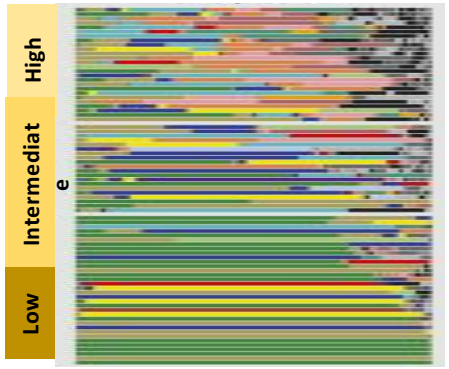
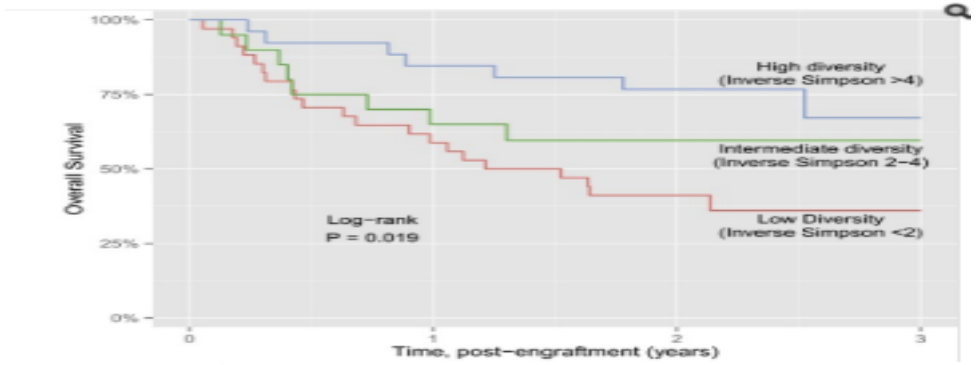
The gut microbiome may influence responses to SCT and checkpoint blockade

Diversity of the gut microbiome is associated with differential outcomes in the setting of stem cell transplant in patients with AML



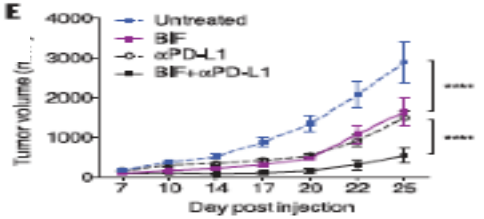


Taur…Pamer Blood 2014

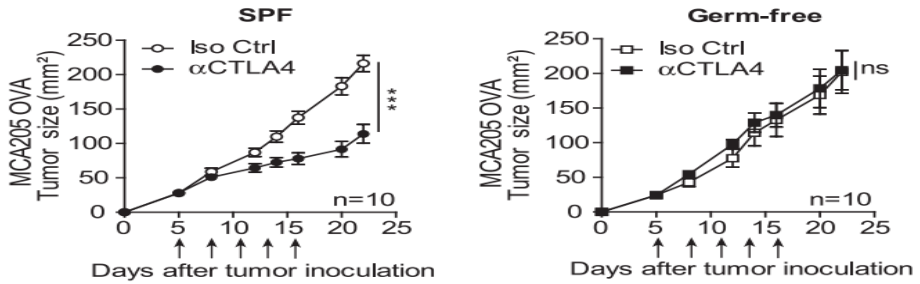
Composition of the gut microbiome is associated with differential responses to checkpoint blockade in murine models

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

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



Anticancer immunotherapy by CTLA-4 blockade relies on the gut microbiota



Sivan…Gajewski Science 2015, Vetizou…Zitvogel Science 2015

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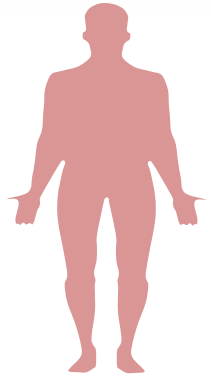
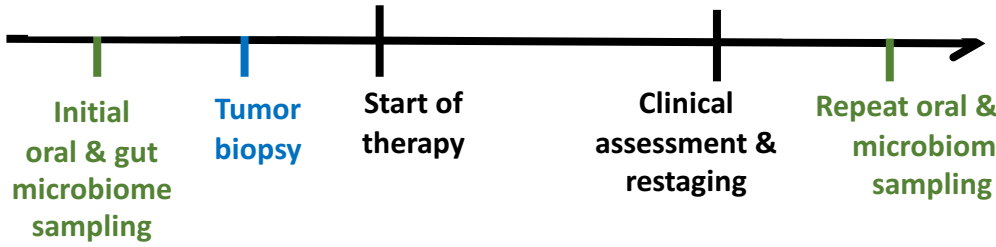
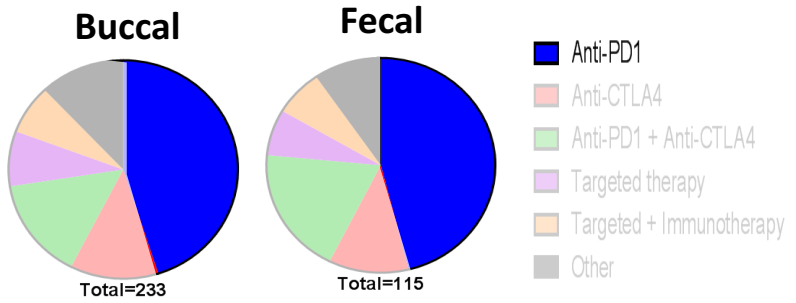
We studied oral and gut (fecal) microbiome in a large cohort of patients with metastatic melanoma going onto systemic therapy

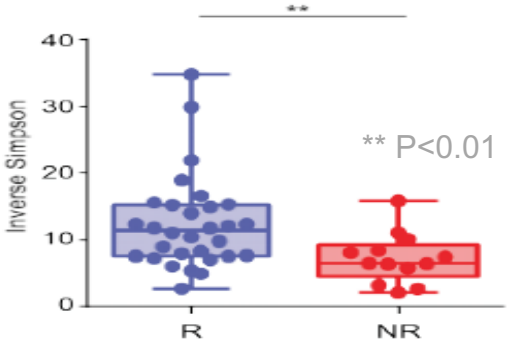


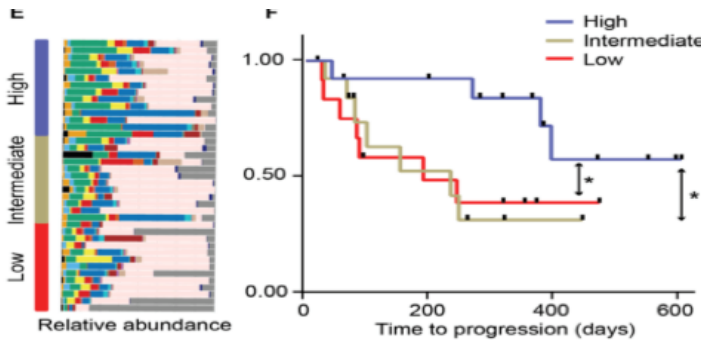
n = 233 patients

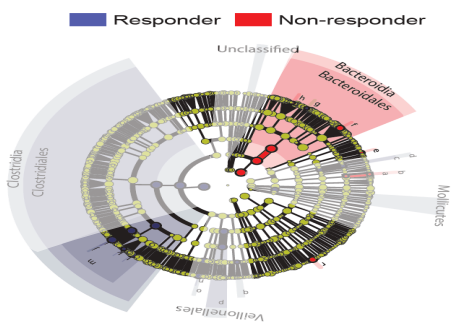


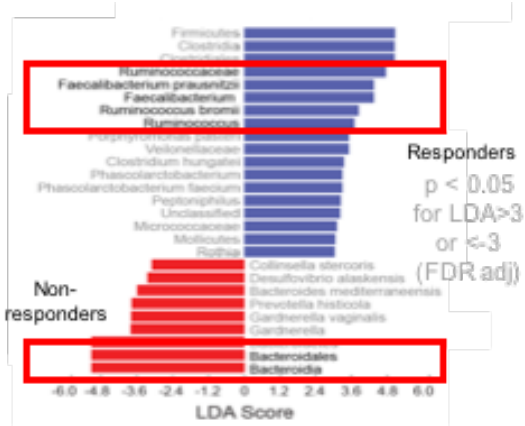


Microbiome sequencing & immune profiling was performed









Responders to anti-PD-1 had a higher diversity of gut bacteria associated with prolonged PFS (along with additional compositional differences)

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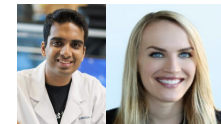
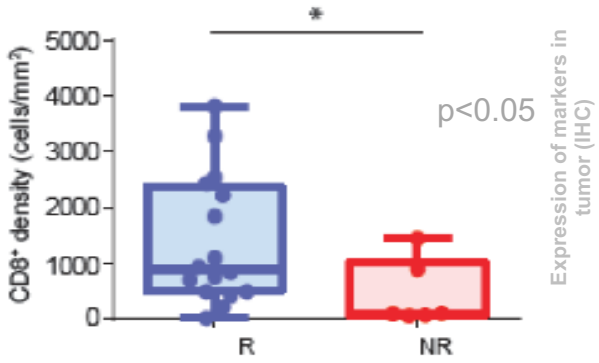
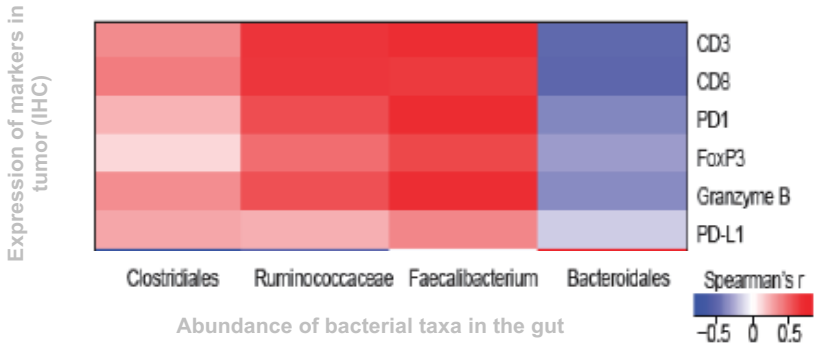
Gopalakrishnan et al, Science 2018

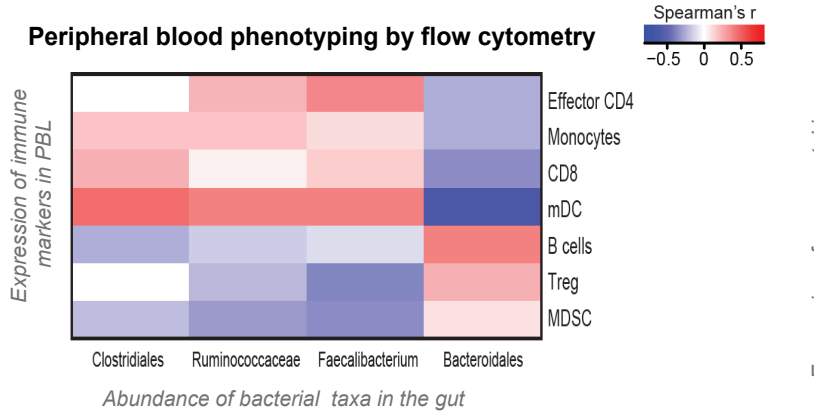
Deepak Gopalakrishnan PhD
Christine Spencer PhD



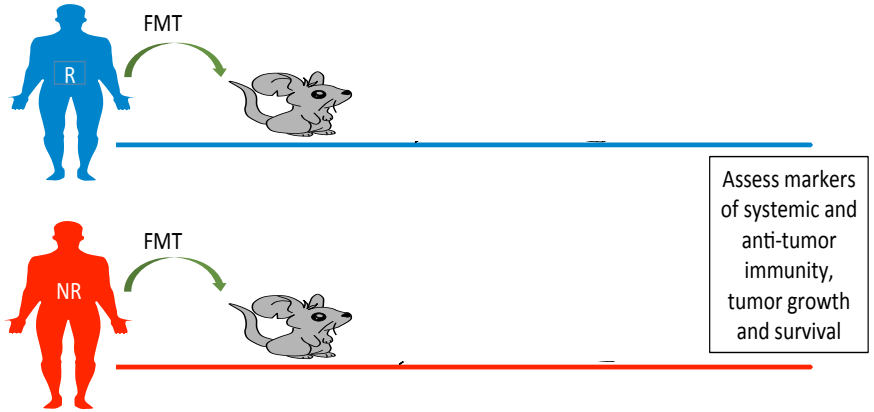
Importantly, "favorable" signatures in the gut microbiome were associated with enhanced immune responses in the tumor microenvironment

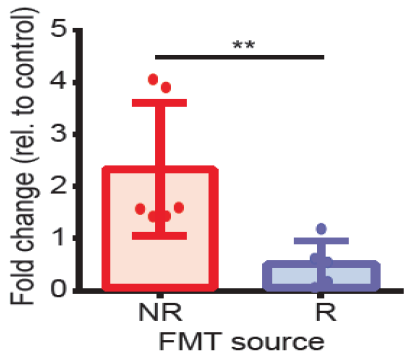


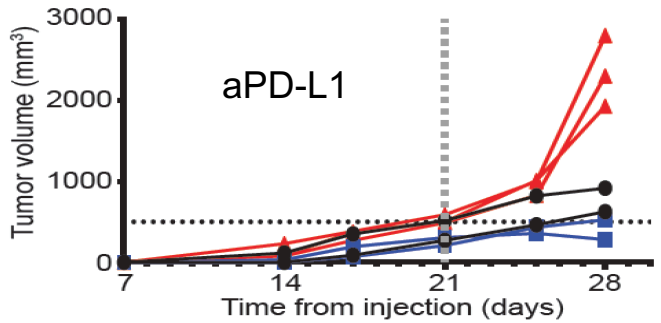




And mechanistic studies in germ free mice showed that fecal transplant could recapitulate the phenotype







Mechanistic insights suggest that this is mediated both at the level of the gut and mesenteric lymph node, and also potentially via metabolites produced by gut microbes potentially mediating distant effects

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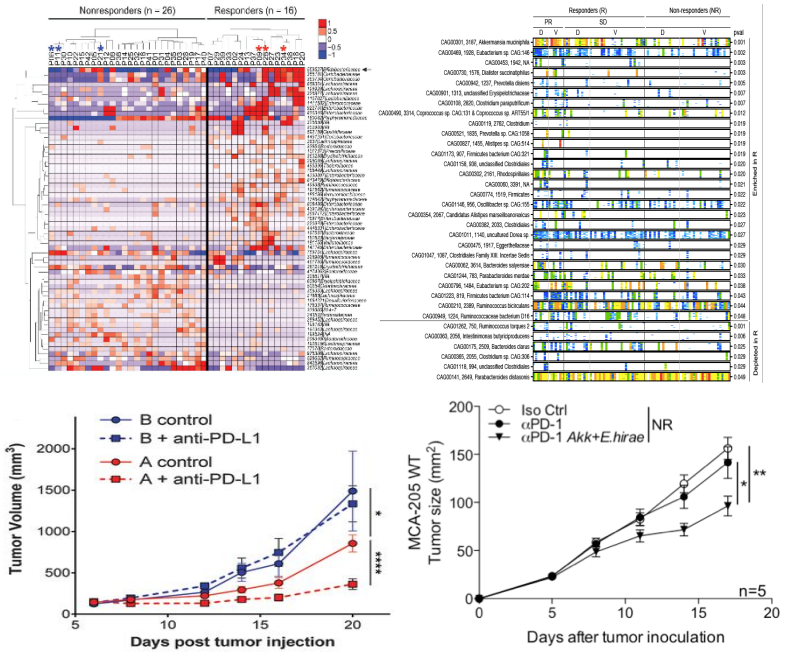
Gopalakrishnan et al, Science 2018

Luigi Nezi PhD

Alex Cogdill PhD

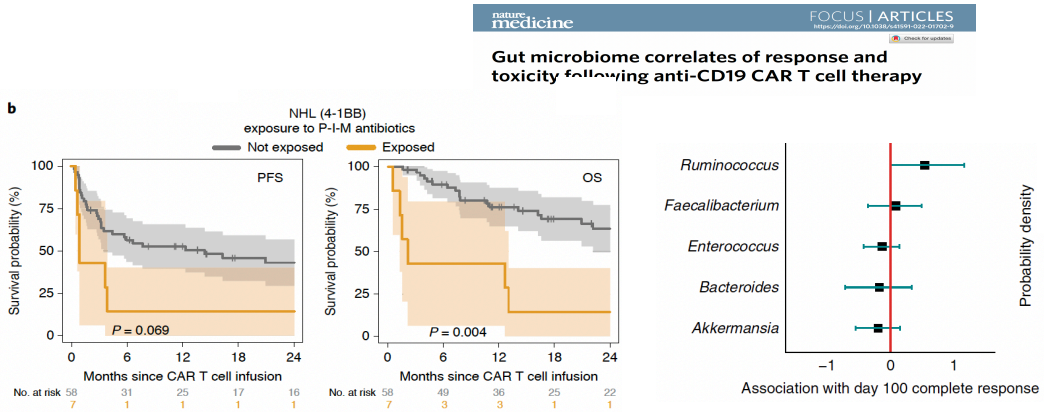
Numerous studies in human cohorts now support a link between the microbiome and response (and toxicity) to cancer therapy

Studies in patients with melanoma, RCC, and NSCLC demonstrate differential "signatures" in R vs NR to ICB



Matson et al, Routy et al, Science 2018

Gut microbes are also strongly associated with response and toxicity to CAR-T therapy, with patients receiving antibiotics demonstrating shorter survival and higher toxicity, and specific taxa in the gut microbiome associated with prolonged survival and lower toxicity



Smith et al, Nature Medicine 2022

However, complexities exist - as taxa associated with response and lower toxicity are not congruent across all cohorts (though some unifying functional aspects exist)

McCulloch et al, Nature Medicine 2022

Lee et al, Nature Medicine 2022

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Can we modulate the gut microbiome to enhance responses to immunotherapy?

(and/or to abrogate toxicity)

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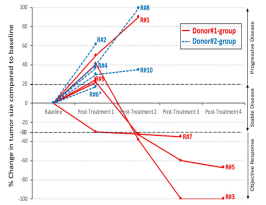
Efforts to target gut microbes to improve response to cancer treatment are proving to be effective

Clinical trials published in *Science* in 2021 demonstrate that treatment with fecal microbiota transplant (FMT) can overcome resistance to immunotherapy in patients with metastatic melanoma

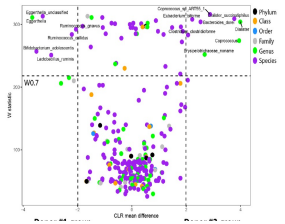
CLINICAL TRIALS

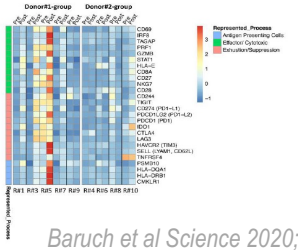
Fecal microbiota transplant promotes response in immunotherapy-refractory melanoma patients

Erez N. Baruch[1,2*†], Ilan Youngster[3,4], Guy Ben-Betzalel[1], Rona Ortenberg[1], Adi Lahat[5], Lior Katz[6], Katerina Adler[7], Daniela Dick-Necula[8], Stephen Raskin[4,9], Naamah Bloch[10], Daniil Rotin[8], Liat Anafi[8], Camila Avivi[8], Jenny Melnichenko[1], Yael Steinberg-Silman[1], Ronac Mamtani[11], Hagit Harati[1], Nethanel Asher[1], Ronnie Shapira-Frommer[1], Tal Brosh-Nissimov[12], Yael Eshet[4,8,13], Shira Ben-Simon[10], Oren Ziv[10], Md Abdul Wadud Khan[14], Moran Amit[15], Nadim J. Ajami[14], Iris Barshack[4,8], Jacob Schachter[1,4], Jennifer A. Wargo[14,16], Omry Koren[10], Gal Markel[1,2,17*‡], Ben Boursi[4,18,19‡]



- 10 patients treated
- Had progressed on multiple therapies
- 2 donors (both CR)
- 3 patients responded
- Changes in microbiome and immune infiltrates noted

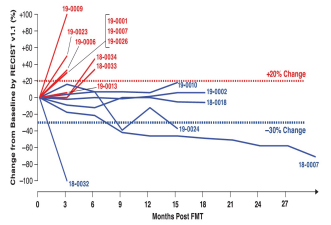




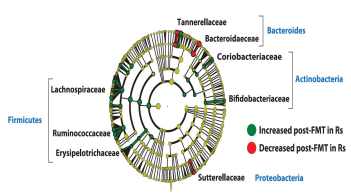
CLINICAL TRIALS

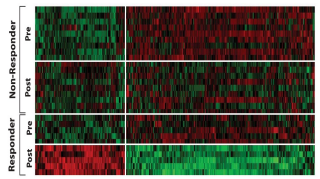
Fecal microbiota transplant overcomes resistance to anti-PD-1 therapy in melanoma patients

Diwakar Davar[1*], Amiran K. Dzutsev[2*], John A. McCulloch[2], Richard R. Rodrigues[2,3], Joe-Marc Chauvin[1], Robert M. Morrison[1], Richelle N. Deblasio[1], Carmine Menna[1], Quanquan Ding[1], Ornella Pagliano[1], Bochra Zidi[1], Shuowen Zhang[1†], Jonathan H. Badger[2], Marie Vetizou[2], Alicia M. Cole[2], Miriam R. Fernandes[2], Stephanie Prescott[2], Raquel G. F. Costa[2], Ascharya K. Balaji[2], Andrey Morgun[4], Ivan Vujkovic-Cvijin[5], Hong Wang[6], Amir A. Borhani[7], Marc B. Schwartz[8], Howard M. Dubner[8], Scarlett J. Ernst[1], Amy Rose[1], Yana G. Najjar[1], Yasmine Belkaid[5], John M. Kirkwood[1], Giorgio Trinchieri[2‡§], Hassane M. Zarour[1,9‡§]



- 15 patients treated
- Had progressed on prior anti-PD-1
- 7 donors (4 CR, 3. PR)
- 6 patients with clinical benefit
- Changes in microbiome and immune infiltrates noted, and serum metabolites





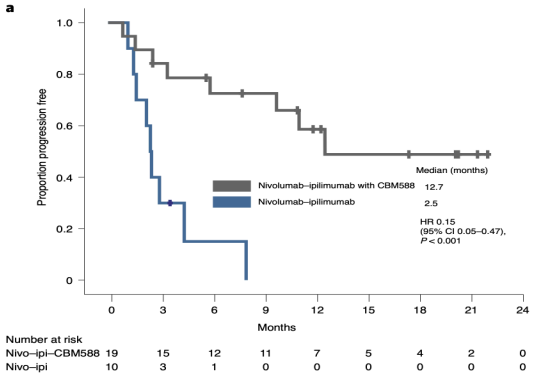
Baruch et al Science 2020; Davar et al Science 2021

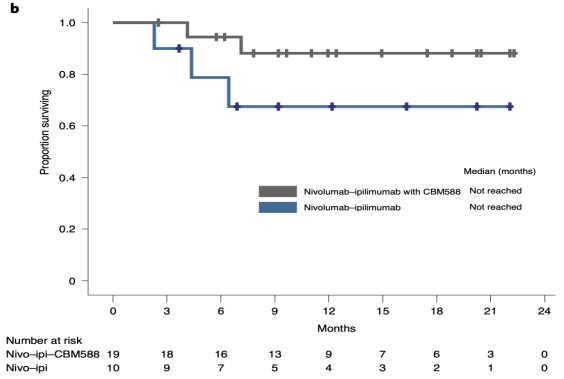
A recent clinical trial published in *Nature Medicine* demonstrated that treatment with a live bacterial product (CBM588) in combination with CTLA-4 and PD-1 blockade was effective in treating patients with metastatic renal cell carcinoma

nature medicine
FOCUS | ARTICLES
https://doi.org/10.1038/s41591-022-01694-6
Check for updates

OPEN

Nivolumab plus ipilimumab with or without live bacterial supplementation in metastatic renal cell carcinoma: a randomized phase 1 trial





Dizman et al Nature Medicine 2022

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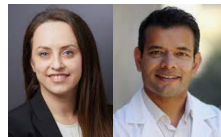
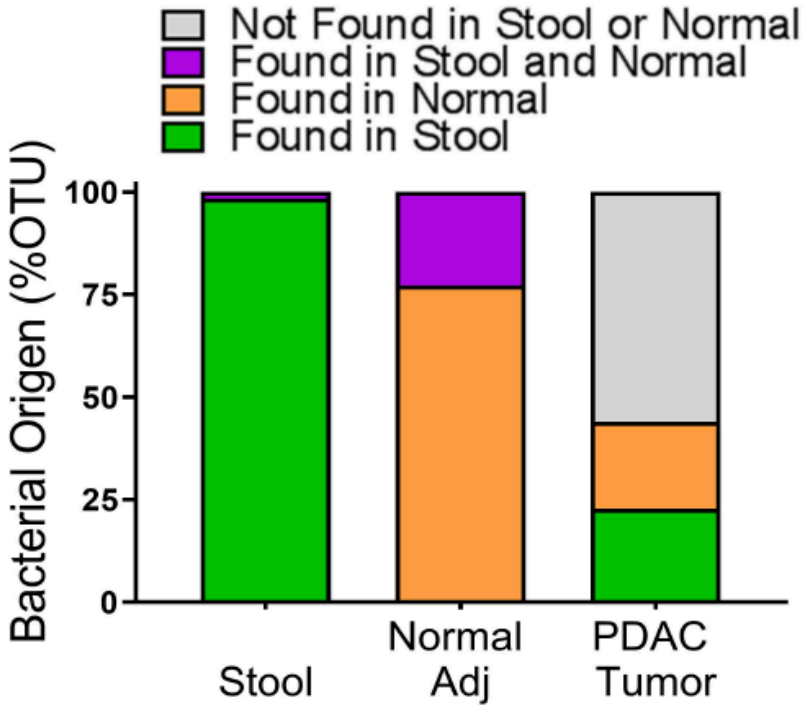
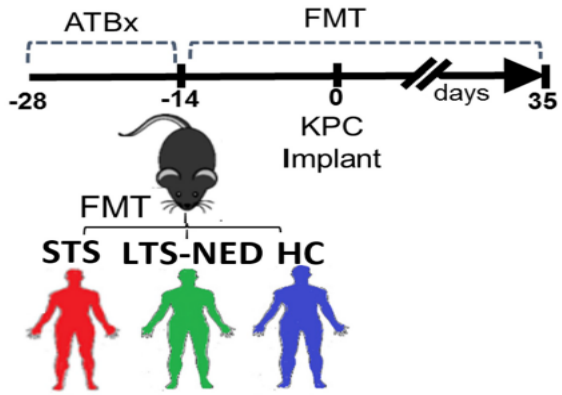
Erez Baruch MD PhD
Diwakar Davar MD

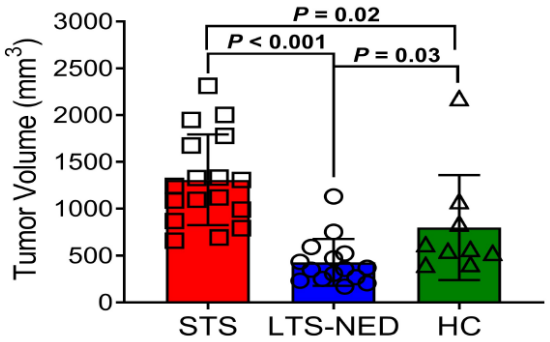
Nazli Dizman MD
Sumanta Pal, MD

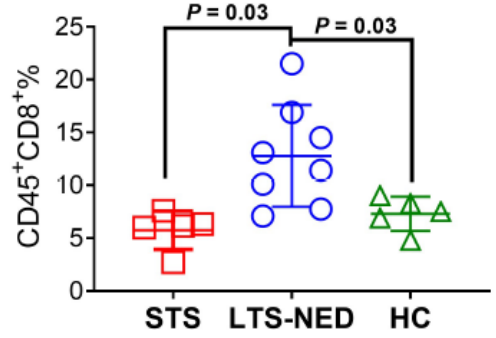


There is “cross-talk” between the gut and tumor microbiome, substantiating the rationale for FMT and other microbiome modulation strategies in other cancers









Clinical trials are underway using gut microbiome modulation (in patients with pancreatic cancer and colorectal cancer (PIs – McAllister, Overman)

Florencia McAllister MD PhD

Riquelme et al, Cell 2019

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What is the association between the gut microbiome and immunotherapy-induced autoimmunity?

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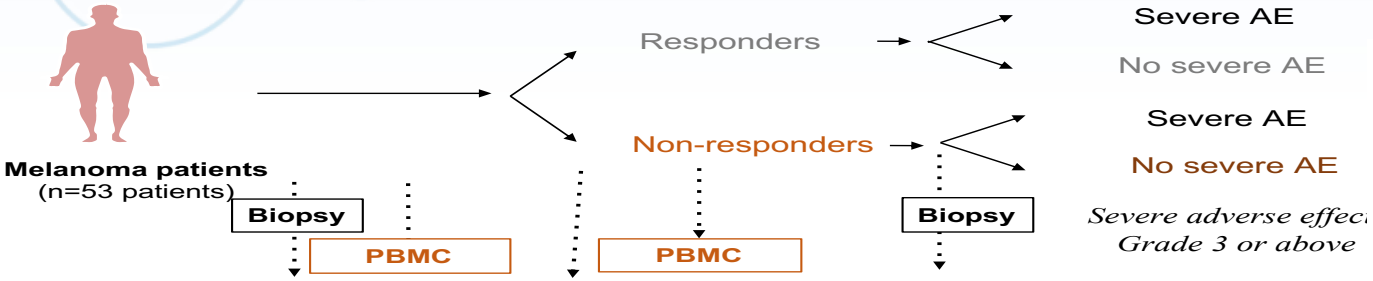
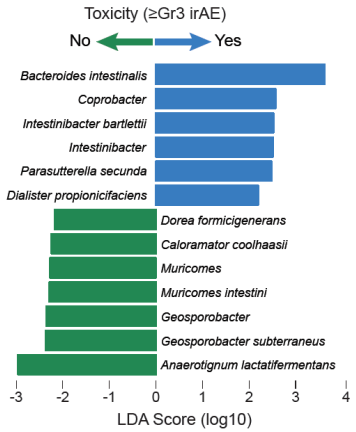
We studied this in human cohorts, and identified gut microbes associated with toxicity

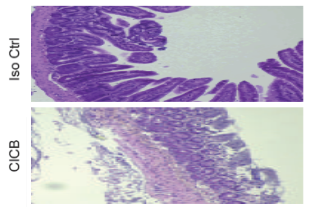


77% RECIST response rate

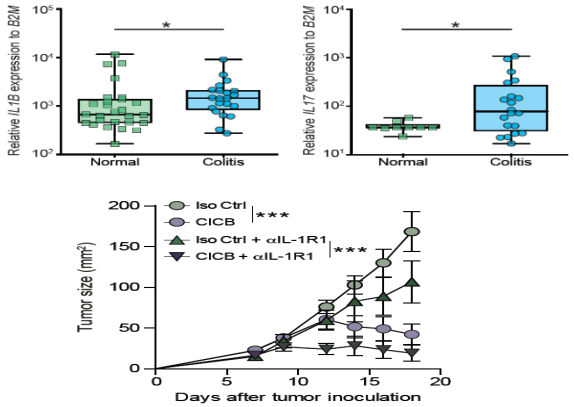
53% with ≥ grade 3, 40% discontinued therapy

Patients with ≥ Gr3 adverse events had a higher abundance of B. intestinalis in baseline microbiome samples, with validation in animal models (Zitvogel lab)





Mechanistically, this appears to be mediated via IL-1B and IL-17, and treatment with IL-1B blockade abrogates toxicity without impairing response

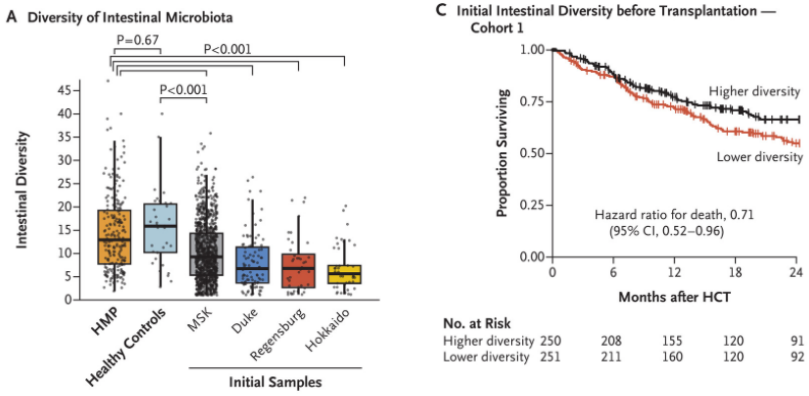


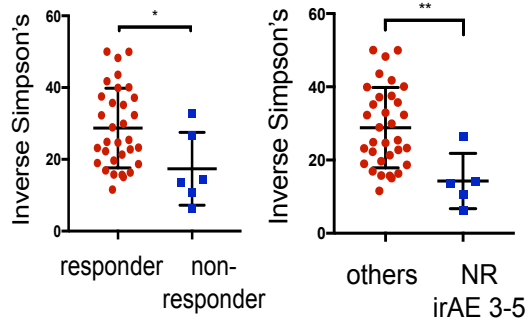
ORIGINAL ARTICLE FREE PREVIEW

Microbiota as Predictor of Mortality in Allogeneic Hematopoietic-Cell Transplantation

Jonathan U. Peled, M.D., Ph.D., Antonio L.C. Gomes, Ph.D., Sean M. Devlin, Ph.D., Eric R. Littmann, B.A., Ying Taur, M.D., Anthony D. Sung, M.D., Daniela Weber, M.D., Daigo Hashimoto, M.D., Ph.D., Ann E. Slingerland, B.S., John B. Slingerland, B.S., Molly Maloy, M.S., Annelie G. Clurman, B.A., et al.

February 27, 2020





Similar findings were observed in a cohort of melanoma patients treated with neoadjuvant ICB (Batten et al, AACR 2018)

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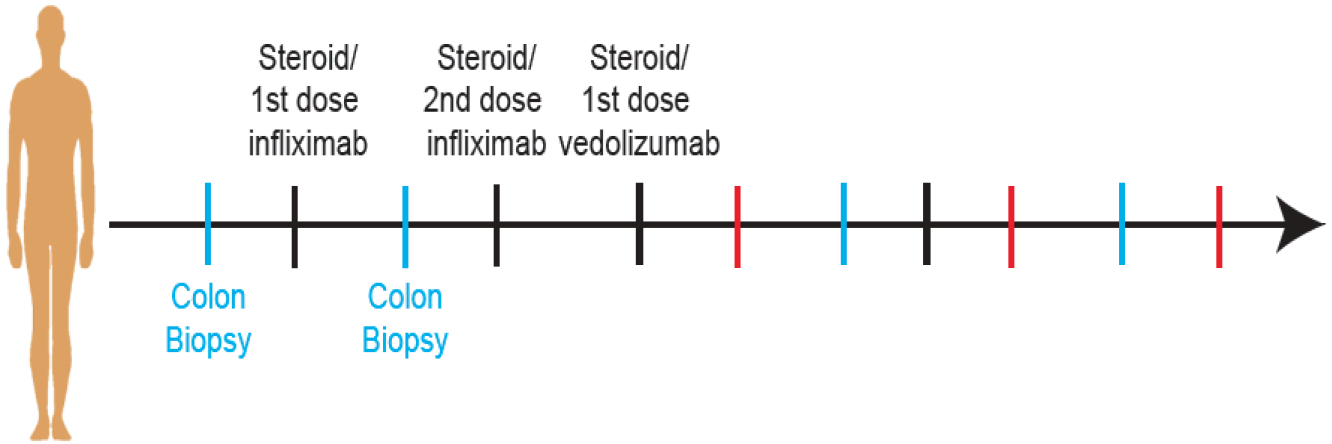
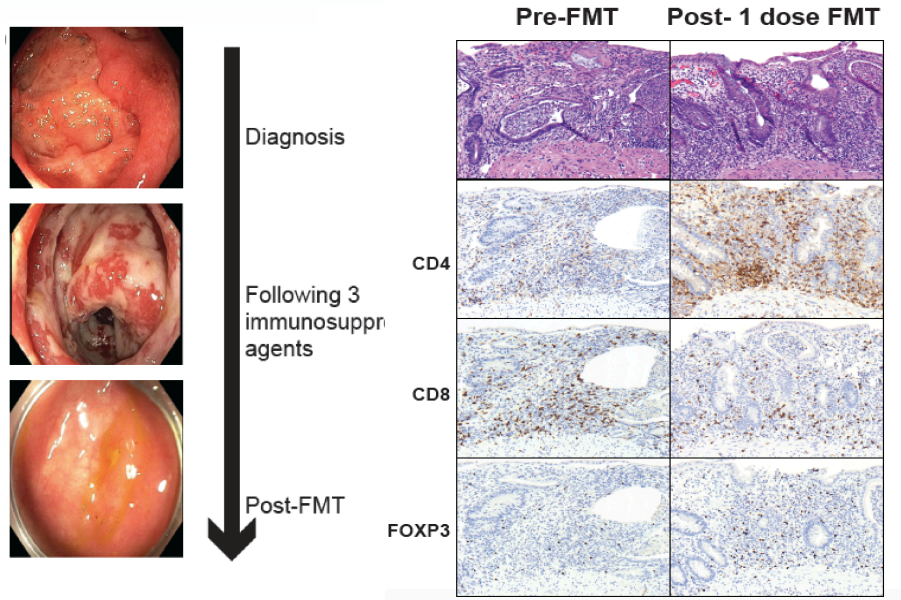
Andrews et al Nature Medicine 2021

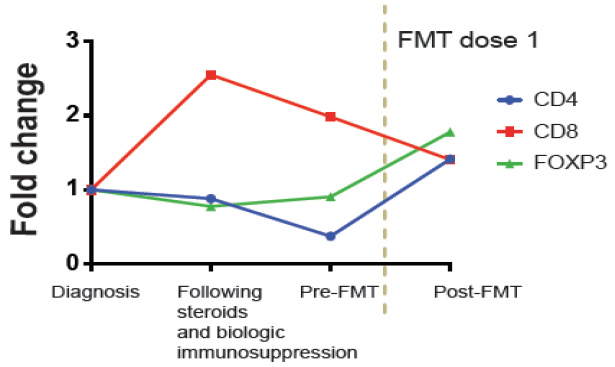
Gut microbiome modulation may also be helpful in treating immunotherapy toxicity

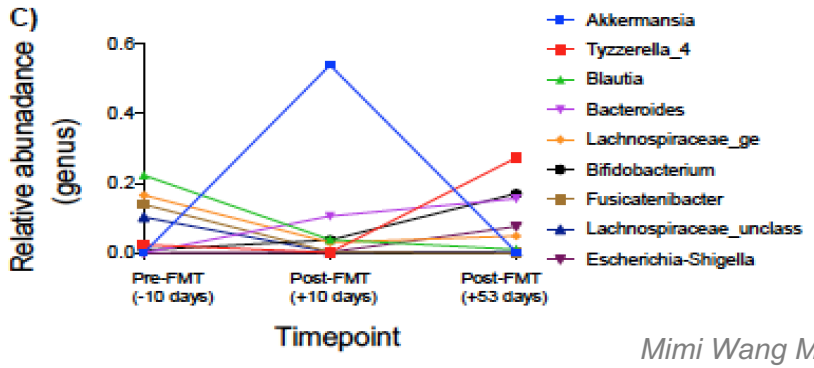




She was treated with FMT from a healthy donor and had complete resolution of all symptoms

50 yo female with metastatic urothelial cancer was treated with aCTLA-4 + a PD-1 and developed colitis refra...ry to steroids and aTNF





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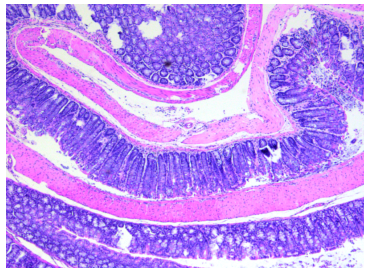
Wang et al, Nature Medicine 2018

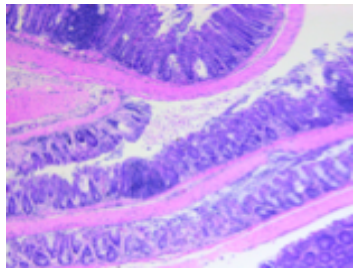
Mimi Wang MD PhD
Rob Jenq MD

We are working with others to generate better pre-clinical models of toxicity and to better understand how to target this (via gut microbiome modulation and other strategies)

Genetic model predisposed to colitis

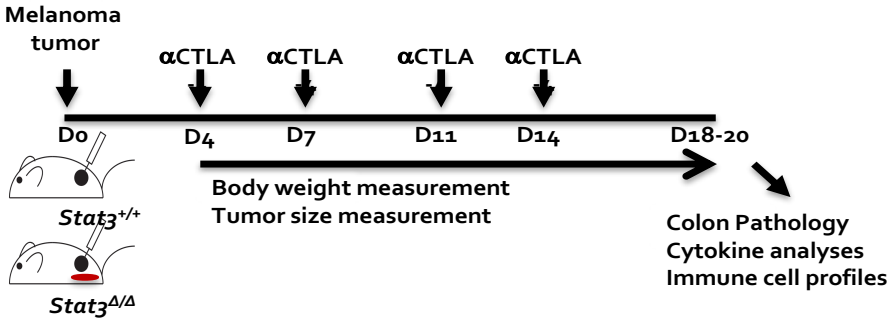


CD11c cre Stat3$^{+/+}$ Stat3-sufficient

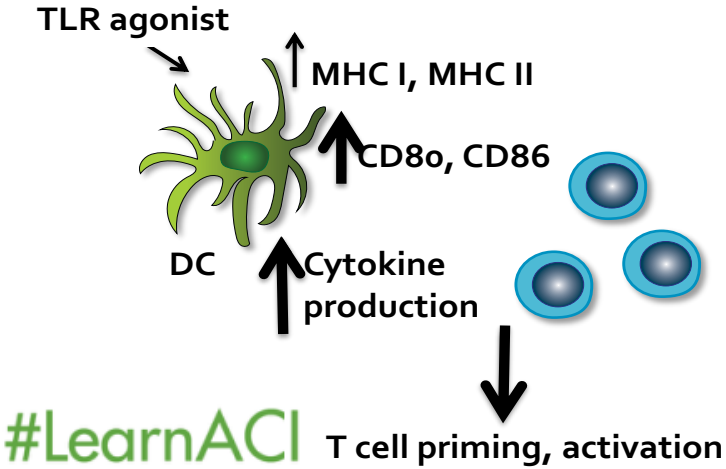


CD11c cre Stat3$^{f/f}$ Stat3-deficient

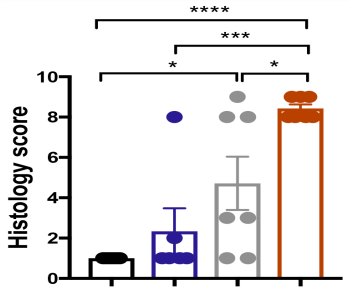
Experimental strategy



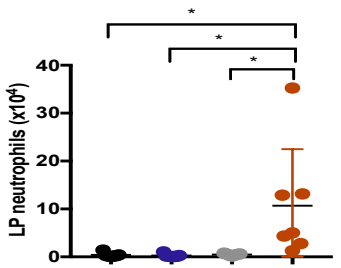
Colitis results from overactivation of intestinal DCs to microbiota



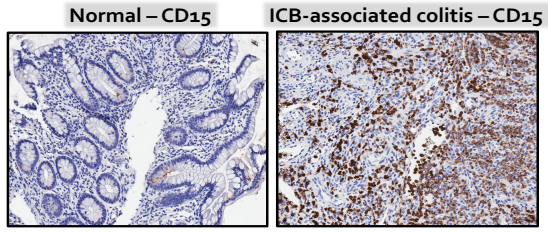
Mouse colon pathology



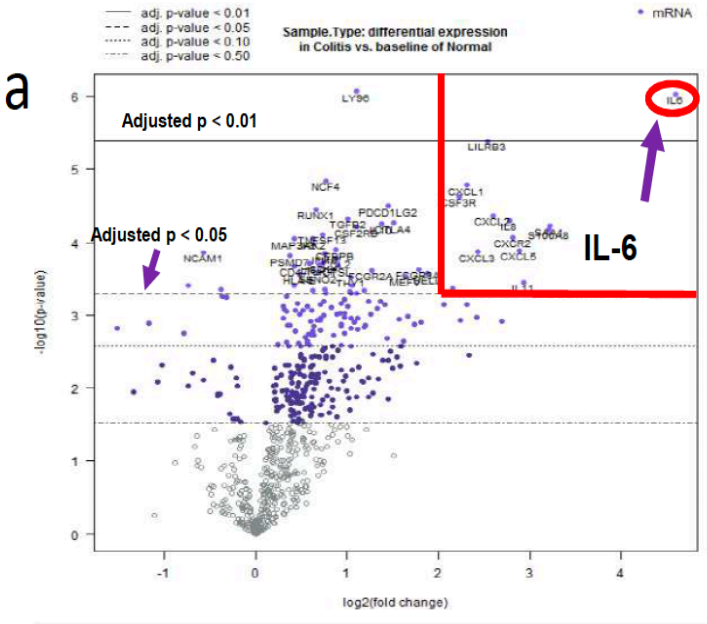
Colon LP Neutrophils



Matched human samples from patients on ICB with colitis



IL-6 is upregulated in the colon of patients with toxicity



Therapeutic targeting of IL-6 reduces toxicity *(and may improve anti-tumor response)*

Stephanie Watowich PhD

Adii Diab MD PhD

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*Watowich and Diab lab collaboration, manuscripts under review DO NOT POST**

Given the critical role of the gut microbiome, what is the role of diet (and other factors) in response to cancer treatment?

You are what you eat!

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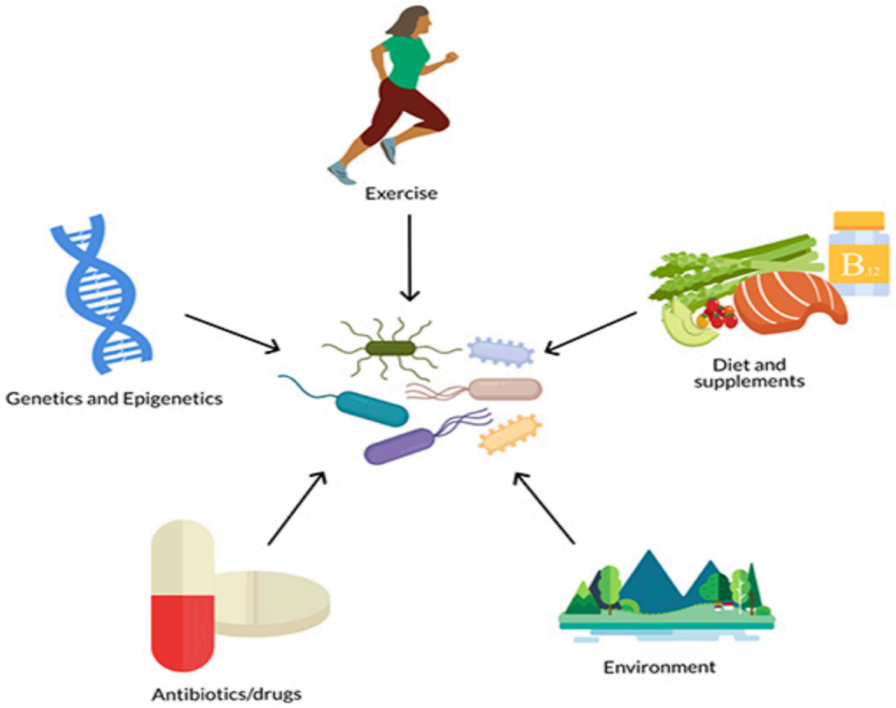
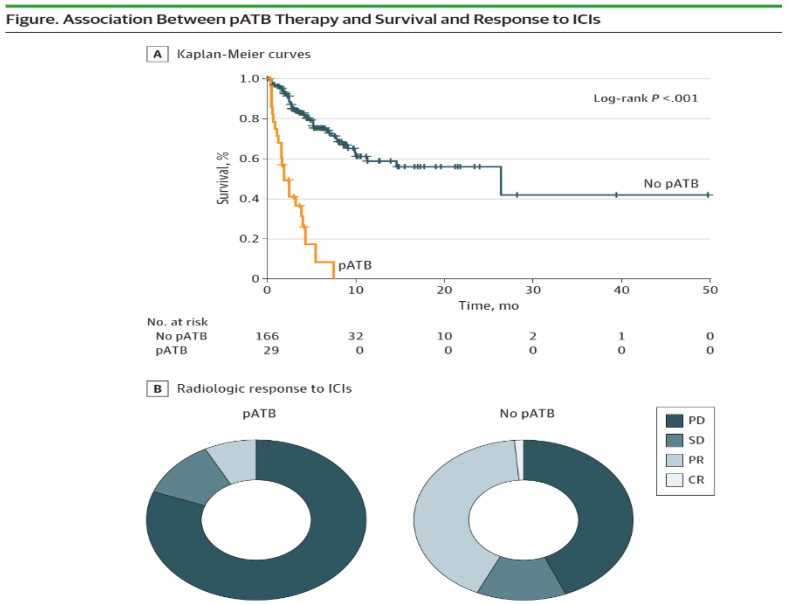
Microbes in the gut are influenced by a number of features including diet, antibiotics, and environmental factors



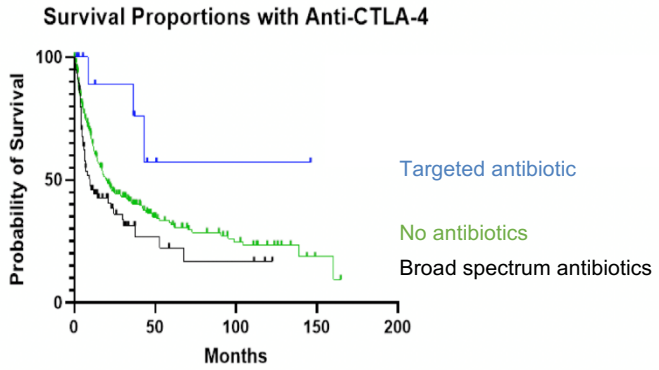
Hughes Frontiers in Nutrition 2020

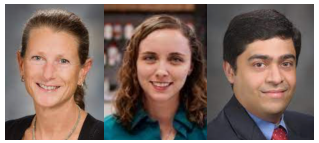
Numerous studies have shown that patients receiving antibiotics before treatment with immune checkpoint blockade (ICB) have worse outcomes (response and survival)



Pinato et al, *JAMA Oncology* 2019

However, some targeted antibiotic approaches may actually enhance response to ICB





Stephanie Watowich PhD
Liz Park PhD
Vivek Subbiah MD

These results have potential implications for patients with earlier stage disease, and implications far beyond cancer

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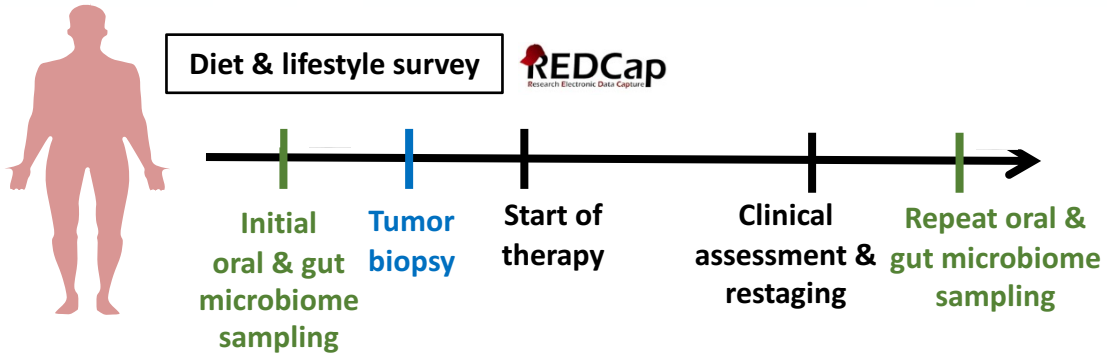
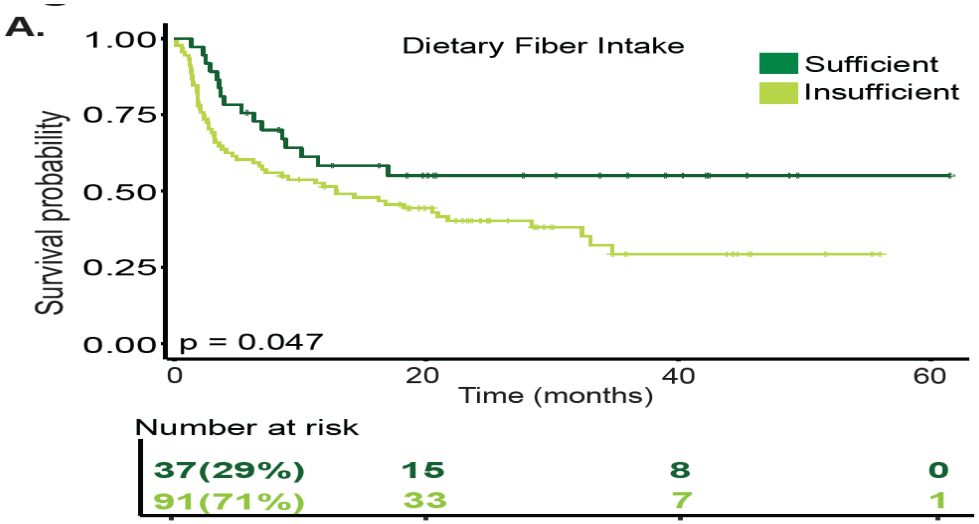
In our cohort, we also studied the influence of diet and lifestyle factors on the microbiome and response to immune checkpoint blockade

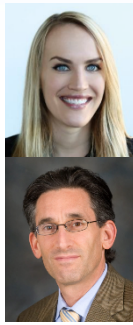




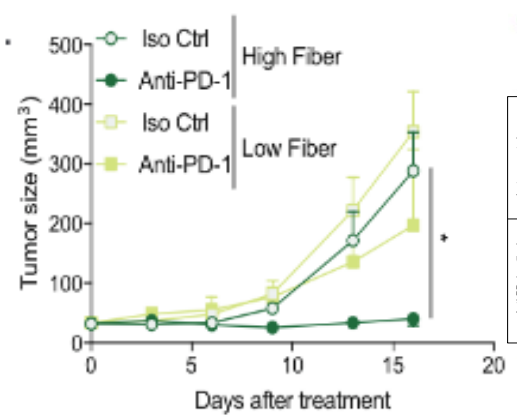
Patients reporting sufficient fiber intake (>20gm/day) have better outcomes on ICB

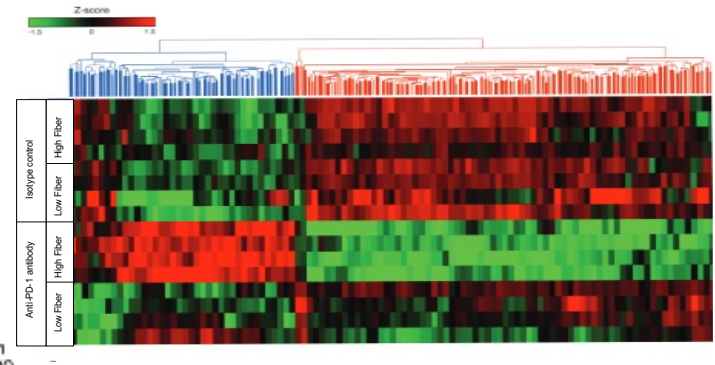
Christine Spencer PhD

Lorenzo Cohen PhD



These findings were recapitulated in pre-clinical models, demonstrating that mice given a low fiber fail to respond, and fail to activate T cell signaling pathways in the TME on treatment with anti-PD-1





Carrie Daniel MacDougall PhD
Jen McQuade MD
Giorgio Trinchieri PhD

Spencer et al, Science 2021

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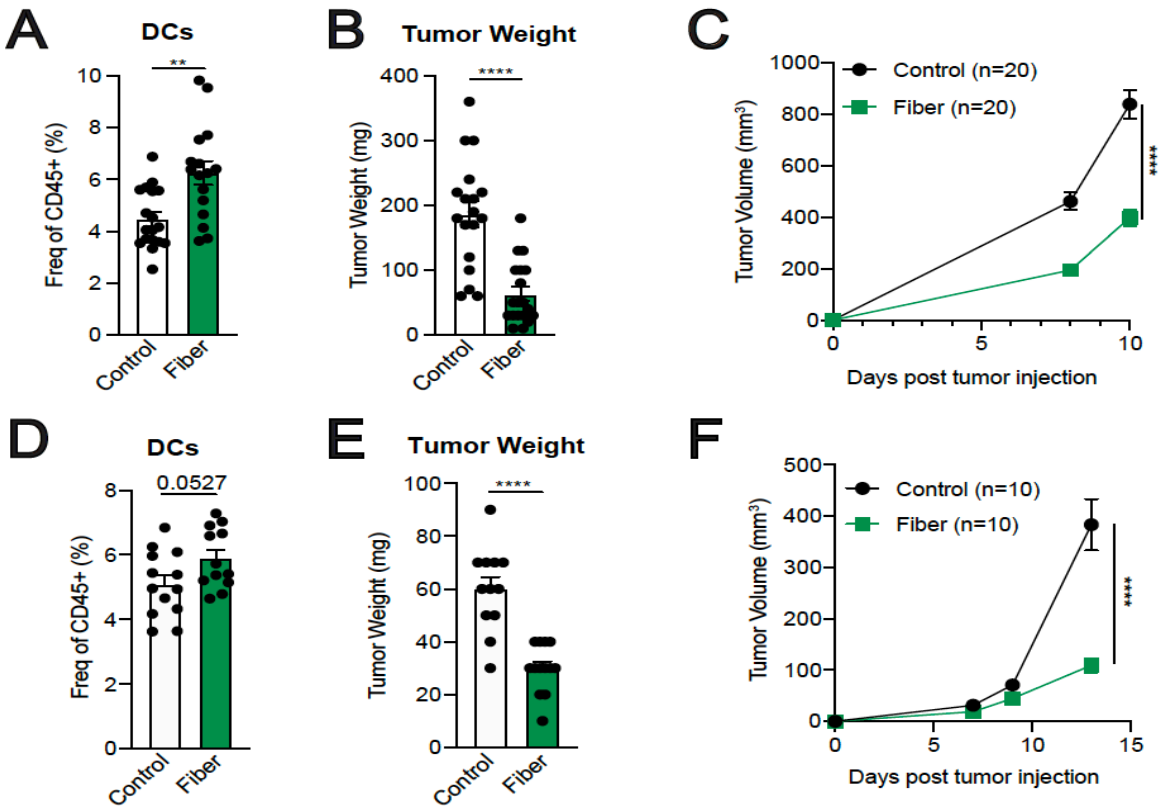
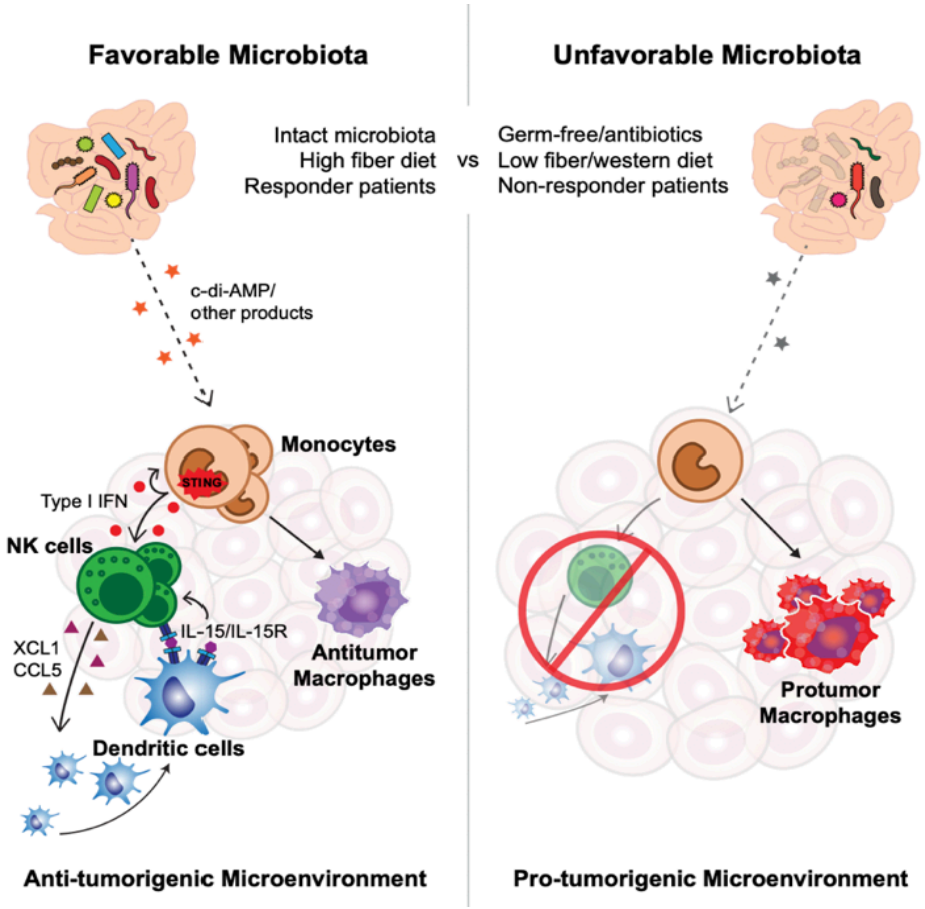
This data is galvanized by data from others that high dietary fiber intake promotes anti-tumor immunity

Mice treated with a high fiber diet have delayed tumor outgrowth and more DCs



Gut microbiota and dietary fiber shape the TME in part via monocyte reprogramming by STING-mediated IFN signaling



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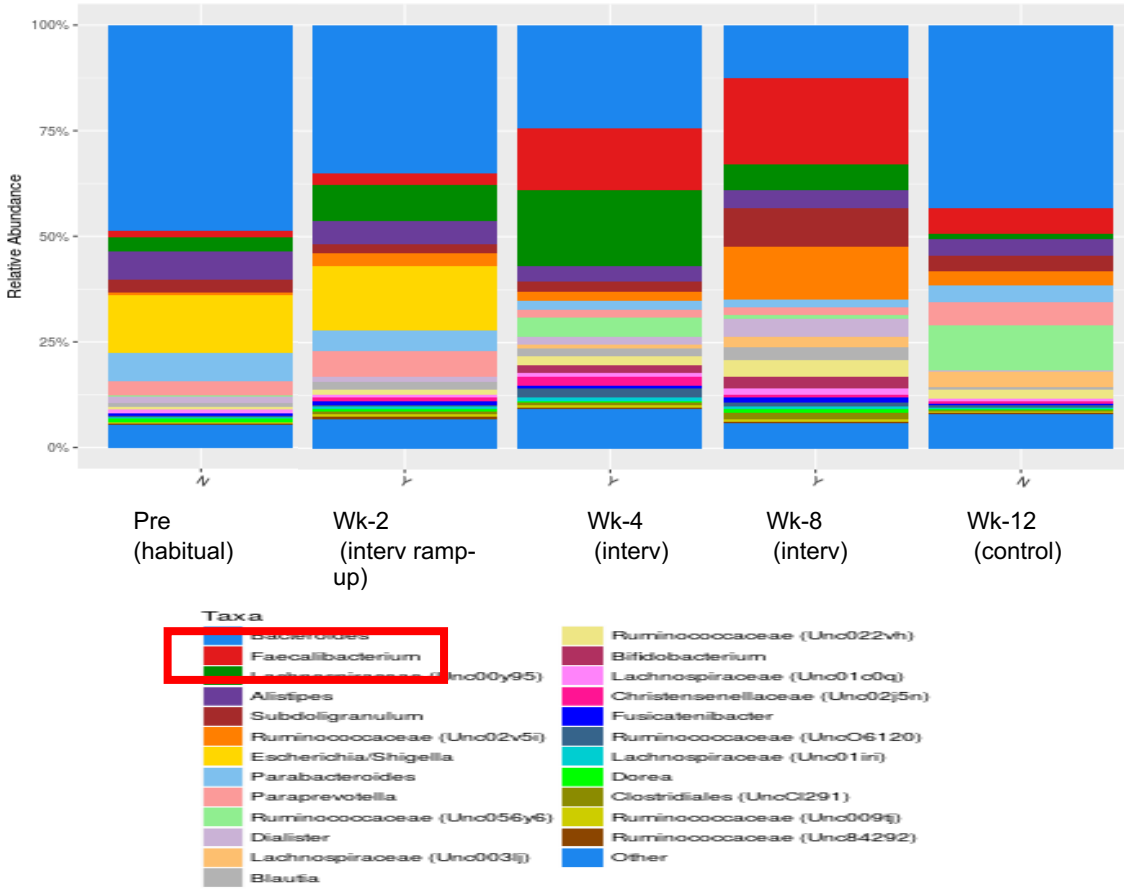
Lam et al, Cell 2021

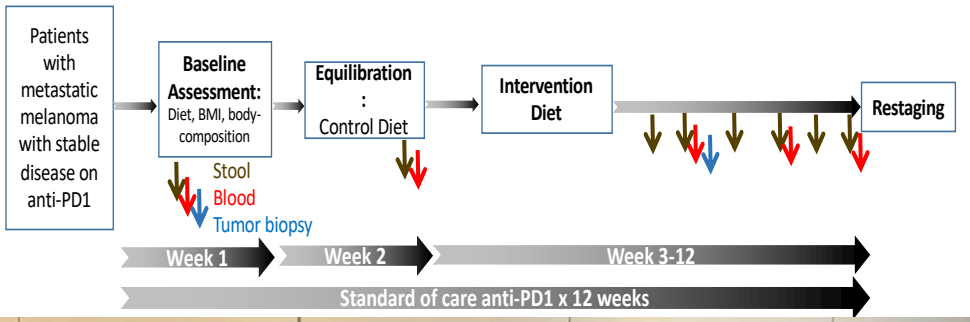
Romina Goldszmid, PhD

There is evidence that changes in diet can have an impact on gut microbes and associated physiology in a short time frame



Daniel et al, *confidential unpublished data* DO NOT POST

We are now running dietary intervention trials in combination with checkpoint blockade (funded by Seerave and other foundations)
Carrie Daniel, Jen McQuade, et al



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Testing diet as a precision intervention in cancer:

Carrie Daniel PhD MPH and Jen McQuade MD

Hypothesis: *A whole foods-based, fiber-rich diet will modulate the microbiome and enhance systemic and anti-tumor immunity*

Phase I — NED melanoma patients — In-progress
- Feasibility

Phase II — Biomarkers in the context of anti-PD1 therapy
- Changes in microbiome
- Changes in immunity

Phase III — Behavioral intervention diet studies
- Disease outcomes

DIET (Diet and Immune Effects Trial):

All calorie-containing food and beverages prepared and provided to patients

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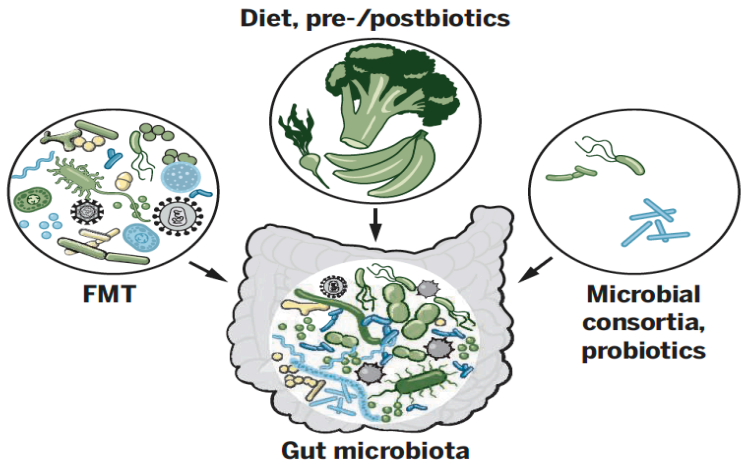
Strategies to alter gut microbiota to improve responses (and to reduce toxicity) are currently underway, but numerous considerations exist as we use these approaches

Strategies to alter gut microbiota

Fecal microbiota transplant (FMT) involves transfer of fecal microbiota from a donor to another individual. Alternatively, microbial consortia (targeted formulations used to augment host microbiota) are being developed. Diet, prebiotics, and postbiotics can also influence the microbial community.



Prior to treatment	During therapy	Assessing impact	Long-term effects
Patients - What patient population to treat? Treatment naïve or refractory? - Should the microbiome be profiled to stratify / select patients? **Pre-conditioning regimen** - Do we need to pre-treat the gut with antibiotics to facilitate engraftment? **How should we optimally modulate the gut microbiota?** - FMT? - How should FMT be administered? - How do we select donors? - Should patient fecal material be "banked" for later auto-FMT? - Diet, Designer Consortia? - Phage / antibiotics / other?	**What therapy should we combine with modulation of the gut microbiome?** - Immune checkpoint blockade (anti-PD-1)? - Other forms of immunotherapy? - Other therapy? **How do we optimally monitor patients during therapy?** - Microbiome analyses to assess engrafment / function? - Immune profiling? - Peripheral blood - Tumor **How can we facilitate stable engraftment?** - Should we recommend dietary changes? - Any medications to avoid?	**What are appropriate primary endpoints for such studies?** - Safety and tolerability - Engraftment - Others? **What are appropriate secondary endpoints?** - Response / Toxicity? - Radiographic (RECIST and / or irRC) - Rate of complete responses - Pathologic response (on biopsy or after neoadjuvant therapy) - Novel markers (ctDNA, immunophenotyping)	**Durability of engraftment** - How durable is engraftment? - What microbes / functional phenotypes in gut microbiota are associated with responses? And can these be used to design consortia? **Overall responses** - What is impact on overall and disease-specific survival? **Toxicity** - Can we uncouple toxicity and response to immunotherapy? **Other transplanted traits with FMT?** - Obesity? - Depression? - Any potentially favorable traits?

Adapted from McQuade et al, Lancet Oncology 2019

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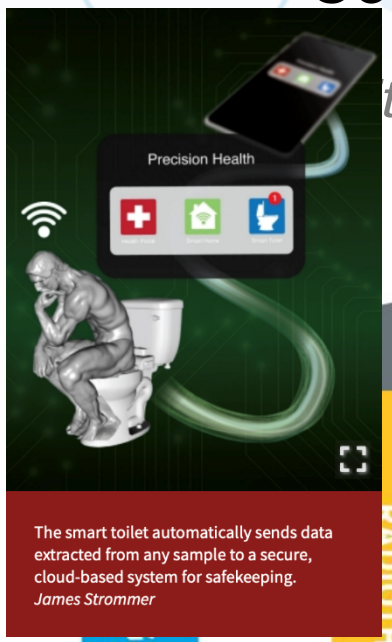
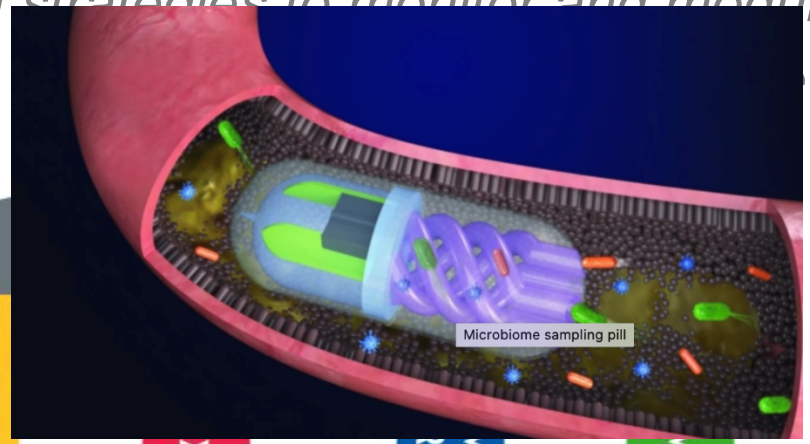
Wargo Science 2020; McQuade et al Lancet Oncology. 2019

Could microbiome targeting become the next "pillar" of cancer care?

...th strategies to monitor and modulate the microbi...
...vent cancer alto...

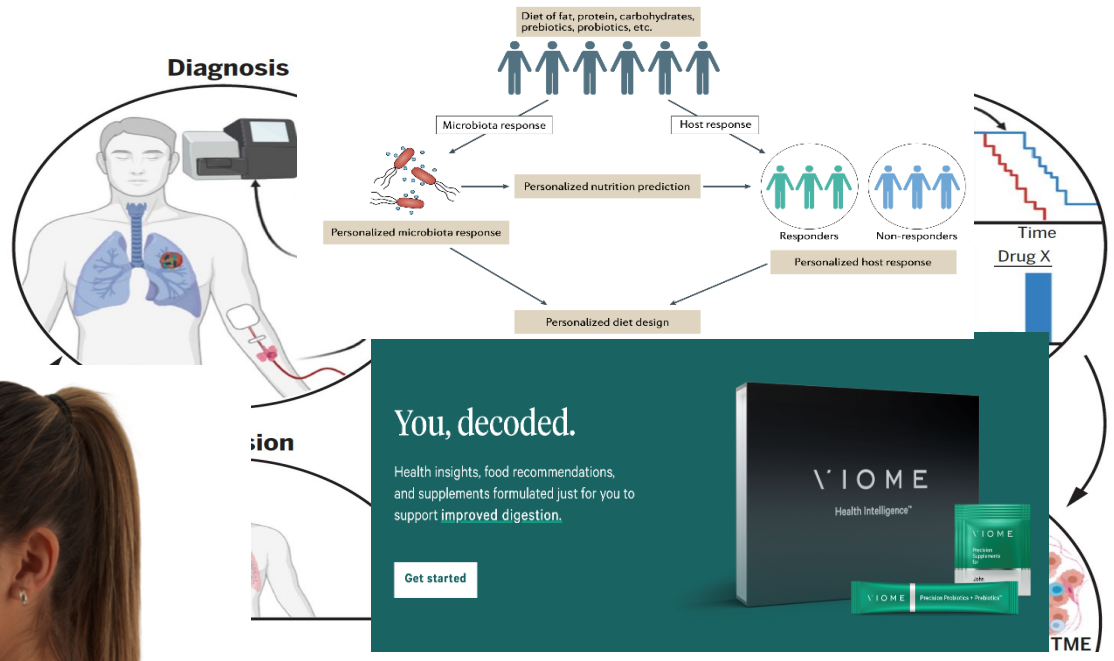


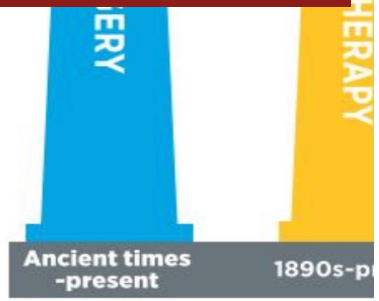
The smart toilet automatically sends data extracted from any sample to a secure, cloud-based system for safekeeping.
James Strommer



Diet–microbiota interactions and personalized nutrition

*Aleksandra A. Kolodziejczyk[1,4], Danping Zheng[1,2,4] and Eran Elinav[1,3]**





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Our Vision: The global leader in Breath Biopsy for early detection and precision medicine.

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Your Microbiome Could Play a Role in Your Covid-19 Response

Gut health could be an important piece in the Covid-19 puzzle

Markham Heid Feb 3 · 7 min read ★

From AACR Cancer Progress Report

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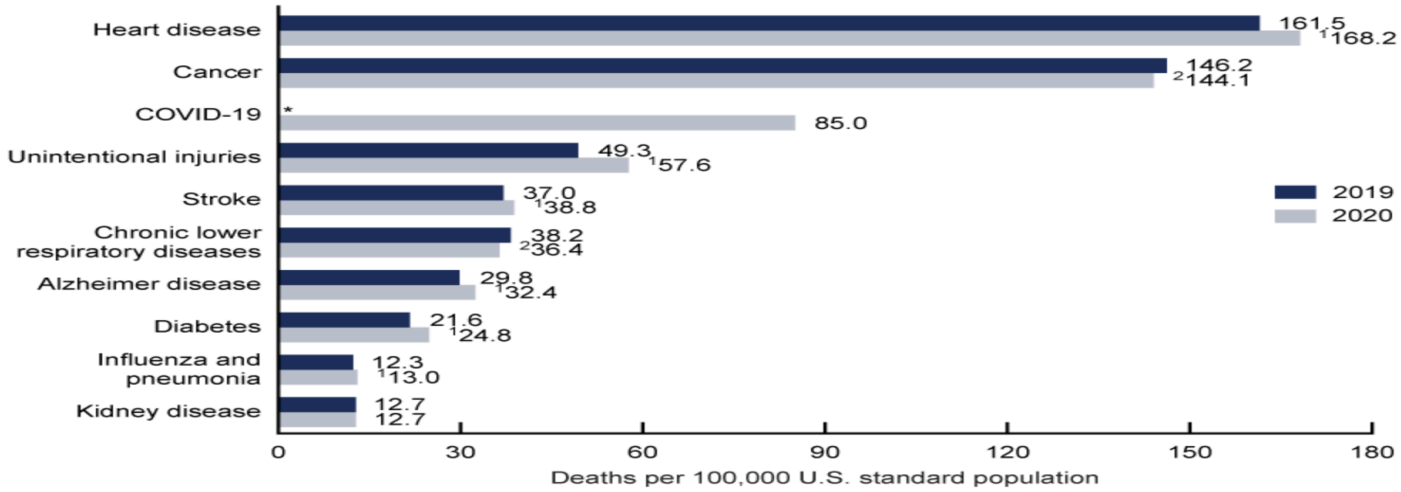
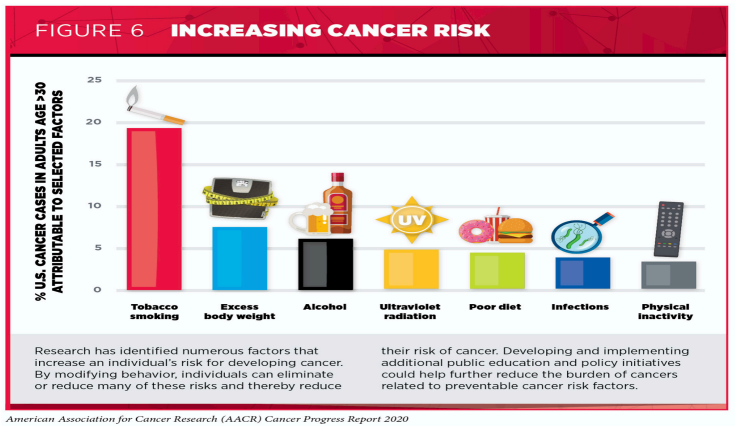
These same factors are influencing other diseases, and we can work together to make changes to promote overall health





American Association for Cancer Research (AACR) Cancer Progress Report 2020

Bolte et al, Gut 2021

Can we monitor and modulate gut microbes, diet, and other variables in cancer treatment, and to promote overall health?

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We can help address these issues on a global scale and also as individuals

The choices that we make every day have a tremendous impact on our microbiome and on our physiology - and also on our planet

Conclusions and potential implications of these findings:

- We have made significant progress in the treatment of melanoma and other cancers with the use of immunotherapy, however not all patients respond - and toxicity remains a major issue

- A deep understanding of the numerous factors that contribute to therapeutic response and toxicity are needed (including factors internal and external to the host – such as the microbiome)

- Multidisciplinary teams (involving patients, families, clinicians, basic & translational researchers, foundations / funding bodies, pharma) are all key in advancing the field, and we can learn a lot from each other to push the field forward faster

- There is still a great deal to learn, but the future is bright

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Patients and their families

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  - **Matt Wong MS, Senior Application Specialist**
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Sarah Johnson MS, Laboratory Manager
Golnaz Morad PhD, Post Doctoral Fellow
Manoj Chelvanambi, PhD, Post Doctoral Fellow
Elizabeth Park PhD, Post Doctoral CPRIT TRIUMPH Fellow
Mike White MD, Post Doctoral T32 Fellow
Matt Lastrapes, PhD candidate; Anik Banerjee PhD candidate
Russell Witt MD, Post-doctoral T32 Fellow
Sam Cass MD, Raymond Traweek MD – Postdoctoral T32 Fellows

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MDACC Collaborators

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