



UNIVERSITY of MARYLAND
SCHOOL OF MEDICINE
INSTITUTE FOR GENOME SCIENCES

IGS NEWSLETTER

FALL 2016

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Greetings Colleagues,

As we begin a new academic year, I'd like to reflect on the milestones and accomplishments of the past year.

Fiscal year 2016 represented a period of extraordinary progress for IGS. Our faculty submitted a total of 68 grant proposals and successfully competed for 19 new awards, which together with existing awards, boosted our research budget and exceeding the numbers for FY15 by more than 40%. The federal grant environment has become intensely competitive, so this is truly a noteworthy accomplishment and a reflection of our faculty's robust and innovative scientific research. The collective work of the IGS faculty members and staff resulted in 80 peer-reviewed publications—many in high-impact journals, including *Genome Research*, *mBio*, *Proceedings of the National Academy of Sciences*, *Nature* and *Nature Microbiology*. We also celebrated the well-deserved promotions of four of our faculty members this past year ([see page 5](#)). Needless to say, I'm very proud to be part of this distinguished group of investigators.

We successfully recruited two outstanding new faculty members in FY 16. [Dr. Seth Ament](#) and [Dr. David Serre](#) have joined IGS this fall and bring new expertise and energy to our research team. IGS continues advancing interdisciplinary science across the UMB campus, with collaborations with colleagues in the School of Medicine, the School of Nursing, the School of Law and the Dental School. We take seriously our mandate from Dean Reece to integrate genomics into the research enterprise at SOM and are always open to discussions about possible new collaborations.

Please join us for the [FY17 seminar series](#) in genomics, which runs from September 2016 through June 2017.

I hope you enjoy our fall newsletter and as always, I welcome your feedback.

Claire M. Fraser, PhD

*Dean's Endowed Professor in the School of Medicine
Professor of Medicine, Microbiology and Immunology
Director, Institute for Genome Sciences
University of Maryland School of Medicine*



Welcome to Seth Ament

Assistant Professor Psychiatry

IGS is very pleased to welcome [Dr. Seth Ament](#) who joined our faculty in September, coming from the Institute for Systems Biology in Seattle, Washington. Dr. Ament's research interests are focused on systems genetics approaches to elucidate molecular mechanisms of neuropsychiatric disorders. His research has involved developing both computational and experimental approaches to identify disease-associated genetic variants, genes and gene networks,

as well as large whole genome sequencing studies of complex diseases. He has already begun collaborating between IGS and the Department of Psychiatry at the UM SOM.

Dr. Ament graduated *cum laude* from Harvard in Biology and was awarded his doctorate in Neuroscience at the University of Illinois.



Seth Ament, PhD

2016 FOURTH ANNUAL FRONTIERS IN GENOMICS LECTURE

Atul Butte: Translating a Trillion Points of Data into Therapies, Diagnostics, and New Insights into Disease

Atul Butte, MD, PhD, gave the Fourth Annual Frontiers in Genomics Lecture on June 15th. He opened his presentation discussing the informatics data, and citing examples of how we can apply open-access data models for concrete discoveries in biomedicine and therapeutics. Dr. Butte discussed how big data forces scientists and biomedical investigators to reverse the

traditional scientific model of asking questions and then developing data support. When so much data already exists - and is increasingly available through open-access. Dr. Butte feels the approach should first focus on the questions, and instead of developing new data, investigators can then search out existing data to support their premise.



Atul Butte, MD, PhD

Baltimore Under Ground Science Space (BUGSS)

Mixing Scientists and Interested Public for a Dynamic Mashup

BY ANNE M ESTES, PHD

That old stereotypical image of academic scientists in ivory towers has morphed into today's interactive scientist, leading discussions in informal settings. The public is starting to see that scientists can be interesting people, passionate about their research and that discussing science and ideas is what scientists truly love to do.



BUGSS discussion

With that kind of valuable interaction in mind, I organized and moderated a microbiome panel discussion at the [Baltimore Under Ground Science Space \(BUGSS\)](#) May 20th program that closed out the microbially-themed art/science exhibit "Culture as Medium."

The diverse "culture" of the microbiome panel included a mix of scientists and local fermented food experts. IGS Bioinformatics Director, Owen White, a self-proclaimed "big data-geek", kept the discussion

lively and aimed at the public. Dr. White provided insight into microbiome research findings and the complications of federal policy in this emerging and fast-moving field. Another IGS faculty member, Dr. Emmanuel Mongodin, discussed his work on the complexity of MRSA colonization in the nose.

Dr. Mary Regan, who has been a midwife for 19 years, and is now faculty at UMB School of Nursing, spoke of the importance of the microbiome during birth and the

first few years of a baby's life. Dr. Regan's maternal and infant microbiome research dovetailed nicely with the randomized control trials conducted by Noel Mueller, an epidemiologist at Johns Hopkins University. Dr. Mueller seeks to move the microbiome field beyond correlating disease and microbiome community types using randomized control trials tracking a patient's microbiomes during a variety of medical treatments. Meaghan and Shane Carpenter, local fermented foods experts and owners of [Hex Ferments](#), rounded out the panel. Their knowledge of the benefits and history of living, fermented foods and their importance for human health was deep and insightful. Dr. White and other panel members repeatedly thanked the Carpenters for providing nutritious and delicious foods, while educating the public on the importance of fermented foods for human health. Most exciting were the conversations, connections, and perhaps new collaborations made between the panel members.

The microbiome panel discussion closed the uniquely-Baltimore art-science exhibit "Culture as Medium." Curator Margaret McDonald of the Maryland Institute College of Art, described her vision of the exhibit as one that would grow throughout its stay to bring together the vibrant arts and

continued on pg 5



Dr. Fraser speaking to BUGSS audience

cutting-edge science communities of Baltimore. IGS Faculty and staff supplemented the culture medium by relaying their microbiome and genome science expertise to the public as part of the exhibit.

In addition to the microbiome panel discussion, Dr. Claire Fraser, the director of IGS, gave an

entrancing talk on the evolution of the field of microbial genomics and microbiome science. Robin Munro, a research assistant at IGS, and I were on hand to answer participant's questions about microbes during the performance art piece "1,000 Handshakes" by François-Joseph Lapointe, who aims to illustrate the metamorphosis of his bacterial

self through this series of 1,000 microbes sharing experiments. Walking the Lexington Market Metro stop to the Inner Harbor asking over 1,000 people to accept a "free handshake" from Dr. Lapointe elicited an amazing diversity of responses I'll never forget. "Culture as Medium" accomplished its mission of incorporating Baltimore's artistic and scientific signature during its run. The exhibit also brought together the arts and science in a different way and a new environment. Now let's watch what grows from that new inoculum.

For more posts about "Culture as Medium" and a link to the video recording of the microbiome panel see: www.mostlymicrobes.com/culture

IGS FACULTY PROMOTIONS



Drs. Julie Hotopp, Lynn Schriml, Rebecca Brotman and David Rasko

Congratulations to the following IGS faculty on their promotions:

Rebecca Brotman, PhD, and **Lynn Schriml, PhD**, both with an appointment in Epidemiology and Public Health, were promoted to the rank of Associate Professor. **Julie Dunning Hotopp, PhD**, with an appointment in Microbiology & Immunology, obtained tenure as Associate Professor. **David Rasko, PhD**, with an appointment in Microbiology & Immunology, was promoted to Professor.

New Tools for Cancer Detection: Update on Julie Dunning Hotopp's NSF Grant

[Julie Dunning Hotopp, PhD](#),

Associate Professor, Microbiology & Immunology, began researching lateral gene transfer (LGT) as a post-doctoral fellow in the early 2000s. LGT is the result of organisms sharing bits of their DNA with other organisms. In June 2015, Dr. Dunning Hotopp was awarded a three-year NSF grant to continue the development of informatics tools to identify LGT in genome sequencing data.

Genetic mutations can be beneficial or detrimental to organisms. The best understood mutations are those that involve alteration, insertion, or deletion of a single DNA basepair. Robust bioinformatics tools already exist to identify these "simple" mutations. But, there have been fewer optimal tools available to identify larger genetic mutations, like LGT. Dr. Dunning Hotopp and her team have pioneered most of these bioinformatics tools.

It is increasingly appreciated that LGT has the potential for profound effects on the biology of any organisms; however, progress in understanding the impact of LGT is limited by the lack of robust bioinformatics tools. The goal of this project is to develop virtual machines as bioinformatics resources to aid in the detection of large insertions of foreign DNA in genome sequences, and that

can be used by any researcher, whatever their expertise with informatics.

"In order for more researchers to delve into lateral gene transfer research, it will be useful to have tools available that don't require massive computational resources or informatics expertise to use," said Julie Dunning Hotopp.

Several years ago, she noticed that evidence of LGT occurred more frequently in cancerous cells than in healthy human cells. Her unusual insights earned her a 2015 NIH Director's Transformative Research Award, which supports exceptionally innovative research projects that are inherently risky and untested but with the potential to change fundamental paradigms in areas such as cancer. This project is leveraging her findings and will raise awareness for the importance of LGT. To facilitate this, Robin Bromley, a Research Assistant at IGS, is creating animated YouTube whiteboard videos to educate the public about lateral gene transfer. The bioinformatics tools are being developed by Shaun Adkins, Jonathan Crabtree, and James Matsumura, while Jain George is testing the tools with existing public datasets.

For more information, see:

www.igs.umaryland.edu/labs/lgthgt/



Julie Dunning Hotopp, PhD

"In order for more researchers to delve into lateral gene transfer research, it will be useful to have tools available that don't require massive computational resources or informatics expertise to use."

— JULIE DUNNING HOTOPP

Andrew Neuwald: Computational Approach to Deciphering Genomic Information

Sequence and structural determinants of protein function have long fascinated [Andrew F. Neuwald, PhD](#). The only IGS faculty member with an appointment in the Biochemistry & Molecular Biology department at the University of Maryland School of Medicine, Dr. Neuwald likes delving into Bayesian statistics and analysis to better understand protein “molecular machines”, which drive the cellular processes required for life.

Dr. Neuwald was fortunate to be at the proverbial ‘right place at the right time.’ After receiving his doctorate in molecular microbiology at the University of Iowa, he obtained post-doctoral training and a computer science degree at Washington University in the early days of genome sequencing. He trained in Bayesian statistics at the National Center for Biotechnology Information (NCBI) at the National Institutes of Health (NIH), before moving on to a faculty position at Cold Spring Harbor Laboratory. He was then recruited by Claire Fraser, PhD, to The Institute for Genome Research (TIGR) in 2006 and, shortly thereafter, to the IGS when it launched in 2007.

His background in biochemistry and computational biology has given him a valuable perspective in the way he examines large datasets. Managing and analyzing complex genomic data has become the key to better understanding disease mechanisms and solving health and environmental challenges.

Dr. Neuwald has been collaborating with Stephen F. Altschul, PhD, a senior investigator at the NCBI, to develop an innovative computing technique that, for very large datasets, is faster and more accurate than current methods. Genomic sequence data encodes information regarding the structure and function of proteins. The new program is called GISMO, an acronym for “Gibbs Sampler for Multi-Alignment Optimization.” Gibbs sampling, a statistical technique useful for solving highly complex optimization problems, is a central feature of the approach. GISMO’s rigorous statistical basis enables it to better distinguish between random noise and important biological signals — relevant patterns that can help scientists identify those sequence features determining the functional properties of a protein.



Andrew F. Neuwald, PhD

Conventional sequence alignment programs easily mistake random patterns in the data for biologically valid signals; indeed, unlike GISMO, nearly all such programs incorrectly report significant patterns in random sequences, which, of course, lack biological information.

A description of the new program was published in May in *PLOS Computational Biology*. GISMO is freely available to the biomedical research community through the [GISMO website](#).

GRC UPDATE

Update from the Genomics Resource Center (GRC)

The combined annual sequencing capacity of our two Illumina MiSeq sequencers, Illumina HiSeq4000 and HiSeq2500 sequencers, PacBio RS II and Sequel Systems, and two Oxford Nanopore MinIONs is more than 200 trillion basepairs of high-quality data. Our facility is now capable of sequencing the equivalent of four high-coverage human genomes per day. This year, we were among the earliest adopters of the Sequel System, the newest long-read sequencing systems platform from PacBio. Last year, we became one of the first PacBio Certified Service Provider on the east coast and one of only six such facilities worldwide. We have ongoing or completed sequencing projects with more than 85 investigators at the UM Schools of Medicine, Pharmacy, Dentistry, and Nursing, as well as important programs including the Greenebaum Cancer Center, Shock Trauma, and the Program in Personalized and Genomic Medicine (PPGM).



Lisa Sadzewicz, PhD, and Luke J. Tallon, co-directors, GRC

Recently, we were asked to submit new proposals to expand our work with the FDA focusing on the ongoing Ebola and Zika virus outbreaks. Our increased capacity ideally positions the GRC to compete for other similar contracts over the coming year.

[CONTACT THE GRC](#)

IGS SEMINAR SERIES

Carl Yeoman Opened Series Sept 15th

Since 2011, IGS has been hosting a seminar series featuring the research of our leading collaborators and colleagues to highlight their research. Our series launched on September 15th with Carl Yeoman, PhD, from Montana State University, who spoke about "Biogenic amines: Biomarkers of bacterial vaginosis or precursors to vaginal dysbiosis." He highlighted the power of systems biology approaches integrating genome sequencing and metabolomics in better defining the interaction between the microbiome and the host. The [seminar series](#) will continue through May 2017 and is held in the Discovery Auditorium, 801 W. Baltimore St. in the UM BioPark.

IGS Hosts PacBio East Coast User Group Meeting

Pacific Biosystems – PacBio – hosted their East Coast User Group Meeting (UGM) at the Institute for Genome Sciences (IGS) in June 2016.

With the theme of “SMRT Sequencing Data for Carnivorous Plants, Hummingbirds, Mammalian Methylation, Repeat Expansions and More,” PacBio gathered nearly 200 scientists in downtown

Baltimore for the East Coast UGM. “SMRT” Sequencing is Single Molecule Real-Time Sequencing and is one of several next-generation sequencing technologies currently in use.

Several PacBio customers spoke, including Jerry Jenkins from HudsonAlpha, who talked about high-quality *de novo* plant genomes; Victor Albert of the University of Buffalo also spoke about plants and NIAID’s Brandon

DeKosky spoke about sequencing antibody repertoires. PacBio’s CSO Jonas Korlach highlighted some of the biggest advances seen from SMRT Sequencing, noting that there are now nearly 1,500 papers describing the use and value of this technology. Particularly productive topics include hospital-associated infections, base modifications in bacteria and phylogenetic profiling of microbial communities.

University of Maryland School of Medicine Researchers Provide New Insight into Deadly Fungal Infections

Study discovers molecular pathways that may lead to treatment

For many weakened patients in the hospital, fungal infections can be life-threatening. Some experts estimate that tens of thousands of patients die every year from these infections. Recent research has also found that some wounded soldiers in Iraq and Afghanistan have died after fungus from soil is driven deep into their wounds, causing untreatable infections.

A new study co-led by [Vincent Bruno, PhD](#) at IGS provided new insights into one of these microbes, the *Mucorales* fungi, which can cause fatal infections.

The study was published in the journal *Nature Communication* on July 22, 2016. The researchers delineated several key aspects of

the fungus that might help them develop treatments against this pathogen. For example, all of the mucormycosis-causing fungi tested contained several copies of a gene known to be involved in host invasion. Right now, there is no way to treat these fungal infections. A better understanding of the fungal biology will help researchers develop drugs that target essential element of its life cycle.

“I think this work is going to provide a significant resource for future fungal research,” said Dr. Bruno, assistant professor, microbiology and immunology at the University of Maryland School of Medicine. “Now we can dig into the data to find new targets for treatment.”



Vincent Bruno, PhD



Click to read more

IGS Receives Community Partnering Award from Baltimore City Community College Life Sciences Institute

In May, the Institute for Genome Sciences (IGS) was presented with the Community Partnership Award from the Baltimore City Community College (BCCC) Life Sciences Institute (LSI) in recognition of its contribution to several programs over the past six years.

In the nomination, BCCC detailed many aspects of the partnership, including the college's appreciation for the IGS faculty members who have mentored several student interns in the last six years. IGS has hired many BCCC students and given others excellent cutting-edge genomic research experience. In addition to their practical exposure to scientific research work and to hands-on laboratory experiences, IGS faculty members have worked with BCCC faculty in providing scientific content and guidance and have presented as guest lecturers. Dr. Joana Silva,

Associate Professor, Microbiology & Immunology, has been serving on BCCC LSI's Board of Directors for several years, helping guide LSI's scientific direction.

"IGS truly deserves the community partnership award because of such extensive support that has helped our students succeed and has added invaluable scientific benefits to our program," said Dr. Amrita Madabushi, Assistant Professor at the Life Sciences Institute at BCCC.

The following people were recognized for their roles with the partnership: **Drs. Joana Silva, Chamindi Seneviratne, Rebecca Brotman, Vincent Bruno, Michelle Giglio** and **Marcus Chibucos**. Dr. Joana Silva accepted the award on behalf of IGS on May 11, 2016 at a formal ceremony.

"IGS truly deserves the community partnership award because of such extensive support that has helped our students succeed and has added invaluable scientific benefits to our program,"

— DR. AMRITA MADABUSHI
ASSISTANT PROFESSOR AT THE LIFE SCIENCES INSTITUTE AT BCCC



Drs. Amrita Madabushi, Chamindi Seneviratne, Joana Silva

Dr. Silva Receives Outstanding Mentor Award from the UMB Graduate Student Association

UMB's Graduate Student Association (GSA) established the Dr. Patricia Sokolove Outstanding Mentor Award to honor those whose work in aiding and mentoring graduate students is noteworthy. Every year, GSA selects one individual from submissions from all seven UMB schools.

Nominated by her students, [Dr. Joana Silva](#) received the 2016 Dr. Patricia Sokolove Outstanding Mentor Award. Dr. Silva is an Associate Professor at IGS and the department of Microbiology and Immunology at the University of Maryland School of Medicine.

Kyle Tretina, one of the graduate students who nominated Dr. Silva, said "Joana creates a healthy working environment and sets an excellent example as a scientist. She demonstrates a continuously positive attitude toward our work. I'm sure that she will leave an enduring mark on my work as a scientist for years to come."

IGS Hosts CURES Summer Camp: STEM Educational Outreach

In Summer/Fall 2015, UMB launched an innovative program called the [CURE Scholars Program](#). CURE, an acronym for the Continuing Umbrella of Research Experiences, is supported by the National Cancer Institute and is developed from a diversity-training model designed by NCI's Center to Reduce Cancer Health Disparities. The UMB CURE program is led by Dr. Robin Saunders and prepares promising middle school students in Baltimore for health care and research careers through hands-on experiences and intensive mentorship. "CURE is thrilled to have the opportunity to partner with IGS," Dr. Saunders commented, "It's imperative that we offer students meaningful STEM opportunities that will enrich and further their understanding of the field."

For two weeks in late June and early July, Michelle Giglio organized a camp for the CURE scholars in the BioPark as part of the 6-week

CURE summer program. Dr. Giglio, Associate Professor of Medicine, leads IGS Educational and Outreach initiatives and organized activities for the group of 25 students.

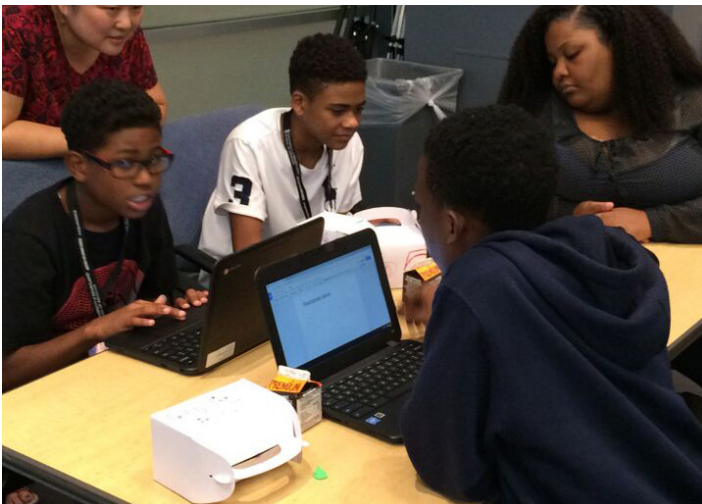
The program topics focused on teaching the students some basics of biology and ecology with activities including building models of DNA or cells, acting out the jobs of organelles, understanding ecosystems, taxonomic classification, sequence translation/variation, and learning about bacterial communities. Dr. Greg Carey from the School of Medicine also participated for one morning in the program and led an activity that illustrated metabolism.

Numerous volunteers helped with the program. Many CURE mentors, who have been working with the scholars since the fall were on hand to help. In addition, students from the Youth Works program and mentors from the [Nathan Schnaper Intern Program](#)

(NSIP) also helped. The NSIP is a summer internship program at the [UM Greenebaum Cancer Center](#) where undergraduate students conduct research in cancer laboratories and learn about translational medicine.

"It's imperative that we offer students meaningful STEM opportunities that will enrich and further their understanding of the field."

— DR. ROBIN SAUNDERS



Snapshots of a Genomics Lab Experience from a Summer Intern

BY AMANDA CRONIN

For six weeks this summer, I learned about genomic science as an intern at the IGS. I am a student in the science research program at Horace Greeley High School in Chappaqua, New York. As part of this program, students choose a field of interest and find a professional mentor. My field of interest is microbiology and genomics and I was fortunate enough to have [Dr. Claire Fraser](#) agree to guide my research project. Dr. Fraser is a genomics pioneer and preeminent scientist in microbial genomic studies. So I headed to Maryland to learn genomics!

The basis of the study I worked on in Dr. Fraser's laboratory lies in the gut-brain axis, or the connection between the gut microbiome and brain functions. Studies have shown that bacteria living in the gut are capable of influencing the brain and altering behavior. Researchers wondered whether this axis would in turn influence the symptoms of certain neurological disorders, such as alcohol addiction. With this in mind, Dr. Greg Elmer at the UMD Department of Psychiatry designed an experiment where

groups of mice were exposed to different levels of ethyl alcohol solution. Our task at IGS was to extract DNA from these mouse fecal and organ samples, catalog the bacteria associated with these samples using genomics approaches, and when compared to the control (unexposed) mice.

My internship experience at IGS has changed my life. Previously, I was just an eager student wanting to learn more about the world of science. Now, I have learned two new programming languages, learned how to navigate two databases, and mastered DNA extraction processes. I also learned what being a scientist can mean, and the various types of jobs involved in scientific research.

I will be a senior in high school this fall and I look forward to analyzing the data of the study and report the results in a paper for my science research program. I want to thank all the staff at IGS who helped me throughout this internship, especially **Dr. Ryan VanYperen, Dr. Claire Fraser, and Dr. Michelle Giglio.**



Amanda Cronin

“My internship experience at IGS has changed my life. Previously, I was just an eager student wanting to learn more about the world of science. Now, I have learned two new programming languages, learned how to navigate two databases, and mastered DNA extraction processes.”

— AMANDA CRONIN

IGS Newsletter is produced by the **Institute for Genome Sciences** at the **University of Maryland School of Medicine.**

Jacques Ravel, PhD
Sarah Pick
Riham Keryakos

Scientific Editor
Managing Editor
Research Editor

The Microbiome Hits Popular Press

Two recent books about the microbiome have captured our attention and we highly recommend them. We share a review of Ed Yong's book and a review of Guilia Ender's book.

Multitudes of Praises for Ed Yong's "I Contain Multitudes"

Anne M. Estes, PhD, Post-Doctoral Fellow

Ed Yong's *"I Contain Multitudes"* gives you the secret tour of the amazing world of beneficial microbial-host interactions and the passionate, quirky scientists driving the work. The importance of microbes to humans hit the media with a superhero-sized *TWACK* five to seven years ago, when data from the Human Microbiome Project began to be published. Since then, the human microbiome has been implicated in everything from obesity and diabetes to anxiety and autism. Scores of books, good and not so, have been written in these early years of the microbiome, yet they all focus on the HUMAN microbiome. As a science blogger for *National Geographic* and writer for *The Atlantic*, Ed became engrossed with microbial-host interactions. If you've read a recent article on the human microbiome, chances are it was one of his. Here's the secret - people have been studying microbial-host interactions in insects, squid, plants, lichens, corals, and other mammals - for centuries! We often know MORE about how these other microbes interact with their hosts during development, on a molecular, cellular, ecological, and evolutionary aspect than we do with human-microbe interactions. In fact, it's this amazing field of non-human-microbe interactions that is the **foundation** the human microbiome work often stands upon. Clearly, Ed Yong has become as entranced by these non-human symbiosis stories as those of us who have been working on these symbioses for decades.

For more, see reviews:

<http://www.mostlymicrobes.com/book-review-yong-multitudes>



Anne Estes and Ed Yong at his book signing

Gut: The Inside Story of Our Body's Most Underrated Organ

by Guilia Enders

Review by amazon.com

For too long, the gut has been the body's most ignored and least appreciated organ, but it turns out that it's responsible for more than just dirty work: our gut is at the core of who we are. *Gut: The Inside Story of our Body's Most Underrated Organ* gives the alimentary canal its long-overdue moment in the spotlight. With quirky charm, rising science star Giulia Enders explains the gut's magic, answering questions like: Why does acid reflux happen? What's really up with gluten and lactose intolerance?

For more:

<https://www.amazon.com/Gut-Inside-Story-Bodys-Underrated/dp/1771641495>

https://en.wikipedia.org/wiki/Giulia_Enders

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