

An aerial photograph of a lush mountain valley. A wide, light-colored river winds through the center of the valley. The surrounding hills are covered in dense green forests and terraced fields. In the foreground, a small village with several traditional stone and wood houses is visible, surrounded by more terraced fields. The overall scene is a beautiful, rural landscape.

H&P

DISCOVER

The Stanford Medical Student Journal
Volume 18 | Number 1 | Fall 2015

H&P

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LETTER FROM THE EDITORS

Dear Readers,

Thank you for taking the time to read the latest issue of *H&P*. This edition, entitled Discover, highlights the investigational impulse of clinicians and researchers that drives medicine forward. Entering the world of medicine endows the incredible gift of being surrounded by creative and compassionate individuals. Our resplendent body of peers possesses a commendable drive to push the limits of innovation and discovery, through research, art, and life. The same dedication that underlies our creative endeavors also motivates us to enhance our knowledge and serve our patients. Through this issue of *H&P*, we highlight the innovative spirit that drives medicine and the sciences forward.

Clinical and lab investigators share a common curiosity for the sciences and for discovery. In spite of this mutual creative drive, conflicts and differences of opinion often emerge between the two groups. Sasidhar Madugula (SMS III) artistically explores the sometimes tumultuous but ultimately collaborative relationship between the two fields of researchers through a clever allegory with a surprise ending. Regardless of the type of investigation, the common goal of medical research is to advance medicine and improve patient care. In a review about whole genome sequencing, Gabriel Rubio (SMS III) explores the progression of genetic testing from genome-wide association studies (GWAS) to whole genome sequencing (WGS) and discusses the expanding role of WGS within clinical settings. This issue of *H&P* also contains a photoessay highlighting the Stanford Medical Student Research Symposium that

took place in May 2015, serving as a tribute to the many Stanford medical students that dedicate time outside the classroom towards the basic and clinical sciences.

Beyond a drive to advance medicine through research, health care professionals of all levels of training, from medical students to attendings, aspire to heighten their clinical knowledge to better serve their patients. Steven Zhang (SMS II) describes his perspective on how the aggressive and competitive instinct of some medical students may underlie their desire to become better doctors. This same drive to discover and serve is often the reason behind the personal sacrifices that interweave into our lives and the lives of our families in our journey to become physicians. Emily Liu (SMS II) reflects on the challenges that her mother faced upon coming to America to have a place in medicine.

This issue of *H&P* also pays tribute to the sacrifices that others have made to allow us to discover and pursue knowledge, many times with no direct personal benefit. Christine Ryan (SMS III) dedicates her piece to the individuals who literally devoted their selves towards our anatomy education and reflects with hope on the past life of her donor. Lauren Pischel (SMS IV) considers the romantic irony that the same walls that witness our toiling in labs as we attempt to investigate the unknown also enclose the suffering of our patients. This proximity serves as a constant reminder of the ultimate reason behind our ambition to innovate and discover: to end and relieve pain.

On a lighter note, the innovative spirit that is pervasive amongst clinicians and researchers also plays a role in our daily lives, allowing us to push our limits and pursue adventures. Victoria Boggiano (SMS III), Paul Johannet (SMS III), and Dan Stoltz (SMS III) interview anatomy professors Drs. John Gosling, Sakti Srivastava, and Ian Whitmore to explore personal pursuits outside of the anatomy lab. From rock climbing to piloting to palm reading, our professors' creative energy extends well beyond medicine and teaching.

The arts serve as an additional innovative venue for many health care professionals. Joshua Wortzel (SMS II) demonstrates his poetic talents through a story contained in 55 words. In this issue, two photoessays serve as a tribute to the artistic talents of our peers. The Medicine and the Muse Symposium that took place in May 2015 showcases the creative expressions of Stanford medical students within the visual and performing arts. The Sketchy MD photoessay also returns to *H&P* for a second time, featuring inventive picture mnemonics by Michael Nedelman (SMS IV) and Larissa Miyachi (SMS III).

We are honored to showcase the innovative and dedicated spirit that is integral to Stanford School of Medicine, and we hope that you find inspiration in the talents and creative endeavors showcased in this issue of *H&P*.

Sincerely,
Sarah Waliany and Diane Wu

FEATURES

Whole Genome Sequencing: Challenges and Opportunities for Implementing Genomically-Informed Medicine 3

Gabriel R. Rubio

Personal Statement 6

Emily Liu

LEADERS IN MEDICINE

Interviews with Dr. John Gosling, Dr. Sakti Srivastava, and Dr. Ian Whitmore 8

Victoria Boggiano, Dan Stoltz, and Paul Johannet

HUMANITIES

A Conflict of Science: The Children's Tale 11

Sasidhar Madugula

I HOPE 13

Christine Ryan

The G2 Floor 14

Lauren Pischel

Pennyworth Post 15

Joshua Wortzel

COLUMNS

Why Gunning is Good 16

Steven Zhang

PHOTO ESSAYS

Medicine and the Muse Symposium 2015 17

Stanford Medical Student Research Symposium 19

Sketchy MD 21

Michael Nedelman and Larissa Miyachi

Whole Genome-Sequencing

Challenges and Opportunities for Implementing Genomically-Informed Medicine

GABRIEL R. RUBIO



Larissa Miyachi

Genomics and Modern Medicine

As we move beyond an era of limited diagnostics and generalized therapeutics, integrated genomic, epigenomic, transcriptomic, proteomic, and metabolomic data will be the key drivers of personalized medicine. This molecular data, combined with personal phenotypic and environmental information, may facilitate a comprehensive and dynamic assessment of medical risk to guide medical management [1]. The integration of whole genome sequencing (WGS) into the clinical decision processes that guide patient care is a key stepping stone to the goal of individualized care.

Although personal genomic information is becoming an increasingly common component of the patient-physician interaction, the capacity to interpret and manage this information relies on a foundation of genetic knowledge that is still expanding and coalescing. Clinically harnessing the full complexity of the human genome depends on the continued delineation of molecular interactions within the genome and their contributions to health and disease. Immense individual genetic variation combined with limited

normative reference data currently confines our ability to predict variant pathogenicity and prevents the immediate clinical application of genomic data in its entirety [2]. As WGS continues to become available beyond the academic sector, remaining technological and analytical challenges that restrict the full utilization of genomic data must be addressed with the transition toward widespread genomically-informed medicine.

Evolution of Diagnostic Genetic Testing

Physicians have long utilized familial history to assess pre-existing medical risk and to supplement diagnostic findings, guiding clinical management. The genomic revolution has allowed us to begin dissecting the molecular determinants of heritable disease risk to provide quantitative guidance for prevention, diagnosis, and therapy responsiveness.

Genome-wide association studies (GWAS) have marked a significant enhancement in the genomic resolution with which the genetic components of disease can be traced.

Using large case-control studies, GWAS evaluates the frequency with which single nucleotide polymorphisms (SNPs) co-segregate with chromosomal segments associated with specific diseases. This technique enables the evaluation of common genetic variations involved in conferring relative risk estimates for diseases; however, SNPs have been shown to account for less than 10% of common disease heritability [3, 4]. Although SNP array platforms have evolved into marketable direct-to-consumer products, skepticism about their overall utility has materialized due to a lack of generalizability and minimal capacity to alter medical decisions, preventing widespread clinical application.

Focused DNA resequencing, on the other hand, has been a successful diagnostic tool for well-characterized and experimentally validated disease-predisposing and disease-causing genes, complementing standard clinical evaluation and aiding in risk stratification and preventative treatments [5]. These standard-of-care genetic tests have moved from single disease genes to gene panels and now to whole exome sequencing (WES) to inform rare disease etiology and facilitate disease gene discovery in both research and clinical settings.

WES initially demonstrated value within cancer research for characterization of glioblastoma into separate heterogeneous classifications based on exome sequencing, facilitating the shift toward targeted therapies based on cancer genotype [6]. Beyond the laboratory, WES was validated as a clinically useful diagnostic tool when it was first used to find a definitive molecular diagnosis of congenital chloride diarrhea, relieving uncertainty generated by the available diagnostics for that condition and leading to a therapeutic regimen for the exact causal determinants [7].

Although WES has been revolutionary for the identification of rare mutations causing structural and functional protein alterations, it does not capture the intronic or intergenic regions that make up greater than 98% of the human genome. Therefore, WGS provides an opportunity to further advance our understanding of the complete genomic determinants of disease. The plummeting cost of WGS has led to its preferential acquisition over other sequencing technologies. Consequently, single-gene and exome sequencing have expanded to cover the entire human genome, thereby increasing the complexity involved in managing genomic data.

The most important and critical distinction between WGS, previous sequencing, and chip-based arrays with regards to interpretability is the sheer magnitude of genetic variations observed that are novel or present at too low a population frequency to be detected on an array. Naturally, this complexity adds to the practical challenges of real-time clinical interpretation. This also raises questions about what to do with incidental discoveries of unknown significance that

require further genetic data, informatics, and experimental evidence to elucidate their relationship to disease [8].

Opportunities for Improvement

Expansion of WGS beyond the academic sector to the consumer market will require the medical field to accommodate the massive amounts of information that patients will bring to the clinic, irrespective of clinical indication. In response to this push toward utilization of personal genomic data, the American College of Medical Genetics and Genomics has recently published recommendations for the reporting and clinical follow-up of reportable genes [9]. Distinguishing disease-causing or -associated genetic variants from functional variants with neutral phenotype represents a key gap in knowledge surrounding the interpretation of genomic information; this deficit is a result of remaining technological and computational challenges [8]. Overcoming these challenges provides an opportunity for improvement as we begin to incorporate personal genomics into standard clinical practice.

Although technical hurdles of WGS are being overcome with blinding speed, problems of adequate coverage and reproducibility remain. Inadequate read depth in difficult genomic regions (e.g. highly repetitive DNA sequences) results in low confidence sequencing from which little information can be extracted. A recent study looking at the clinical utility of WGS and the frequency with which discovered genetic variants require medical action found that 10–19% of known inherited disease genes were not confidently covered to acceptable clinical standards [2]. Because of this source of error, discovery of potentially pathogenic genetic variants requires a significant increase in coverage depth and/or secondary validation by alternative methods prior to incorporation of information into clinical decision-making.

Additionally, the same issues of generalizability seen with the SNP arrays have complicated the use of genomic sequencing data, as we have been restricted to using the original reference sequence generated by the human genome project for alignment and assembly of WGS data [10]. Use of this normative genome is inherently flawed and has been shown to contain greater than 1.6 million minor alleles [11], erroneously leading to categorization as variants when an individual contains the major allele at one of these loci. This issue is likely to disappear, however, as continued improvement in sequencing platforms increases both the coverage as well as the read depth, making de novo assembly routine. Eliminating dependence on the current reference sequence will provide a wealth of major allele reference genomes for appropriate comparative analysis [12]. Major ongoing initiatives, such as the Million Veteran Program, UK Biobank, and Norwegian Mother and Child Cohort Study, among others, will significantly improve the ability to decipher and

interpret genomic information.

Currently, discordance surrounding clinical interpretation of incidentally discovered genetic variations of unknown significance remains considerable and contributes to variability in clinical assessment and action. Although reports suggest that the current state of medical education leaves physicians unable to interpret and communicate the results of genetic testing [13], this reason is likely superseded by, and a byproduct of, the incomplete genomics knowledge base upon which the practicing community relies. Because of the staggering amount of genetic variation observed in the human population, which was not fully appreciated prior to WGS, it is impractical to rely upon traditional experimental evidence to determine the pathogenicity of discovered personal DNA variations. The potential for clinical utilization of this genomic information that goes beyond well-characterized genetic mutations hinges upon the development of accurate molecular assays and computational models to predict the structural and functional changes of novel genetic variants [14]. These models will need to quantify risk with efficacy comparable to that of currently established markers of disease, and uniformly accepted guidelines on how to clinically assess pathogenicity will be needed in order to harness the full power of WGS.

Furthermore, as with all new advancements that fundamentally shift institutional paradigms, widespread use of WGS will necessitate a restructuring not only of multidisciplinary care teams but also of the systems that support healthcare delivery [5].

Conclusions

With science, medicine, and technology continuing to intersect with and provide heightened focus on the individual, WGS offers great promise in its potential to transform how we care for patients. The role of this technology within medical practice will continue to grow due to progress in the ability to experimentally and computationally investigate the mysteries that lie within the human genome. The establishment of robust clinical interpretation guidelines supported by curated data is critical to enter this new era of

personalized medicine and to achieve WGS-informed clinical management [15]. With high expectations, the plausibility for WGS to provide meaningful contributions to improve prevention, diagnosis, and treatment of disease is substantial.

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Personal Statement

EMILY LIU

I began my medical school personal statement describing a window. It was the window from the living room of our first apartment in America – apartment 16 or 18 in Park Arms, home to what seemed like the entire Chinese-American community of Little Rock, Arkansas. The window ran from floor to ceiling, and I spent days on end balancing on its sill. Now that I'm older (and have a better understanding of metaphors) I can draw the obvious parallel—the window frame framed my worldview. But that would be overselling both the point and the apartment, in which terrifying memories of cockroach infestations are barely colored in the rosy tones of childhood nostalgia.

As a child, though, I thought nothing of the metaphor—I was only waiting for my mother to come home and for my nightly story. In those days, she was a research fellow at the UAMS Winthrop P. Rockefeller Cancer Institute, which was a 10-minute walk from Park Arms. Years earlier, when I was 1-year-old, she had left my father, me, and a budding medical career as an oncologist in China for this fellowship. And when I first arrived in America on one hot Arkansas day wrapped in my father's arms and layers upon layers of winter clothing (my father thought it was winter in the good ole' States), I shrank away from my mother's embrace as if she were a stranger.

Perhaps it was the memory of this moment that motivated our nightly ritual. Actually, I'm sure of it. My mother's greatest fear when she first left China was that she would become lost to me, and I to her. So, after my father and I arrived in the United States, she took special care to recite stories in Mandarin to me so that I would come to know her. The story of my mother finding her place in America is the usual, almost expected, immigrant story—how the daughter of a politically persecuted “black” capitalist family escaped China following the Cultural Revolution to become a research fellow, resident, and ultimately attending at a leading medical school. But alongside the immigrant story is a story of

memory and nostalgia, recognizing the loss and longing that accompany the uprooting and separation of a family.

During our days in Arkansas, I would follow my mother to her laboratory and a local free clinic where she volunteered to acquaint herself with local patients and hone her English language skills. With my mother, I first learned to pipette. With my mother, I ate my first slice of Papa John's pizza, provided free-of-charge to volunteers (and their hungry daughters). And so it seemed that she and I were pushing happily forward and onward to a bright *new* future. But at night, she would whisper to me of her childhood in Tianjin—of her grandmother and grandfather, her brothers and sister. These tales began innocently enough; there were domestic tableaux of household chores cheerfully done, school assignments completed at the kitchen table, clever sibling pranks, and—my favorite—sumptuous New Year's feasts of noodles and dumplings for longevity and wealth.



Nicholus Warstadt

Her grandfather was a landowner and tradesman who had dealt with the Americans during World War I, and her beloved grandmother—first in my mother's heart—was a famous beauty renowned throughout Tianjin for her alluring almond-brown eyes. These were exciting, exotic tales as good as any fairy tale. It was only years

later, when I happened upon a torn copy of *The Red Scarf Girl* in the public library, that I realized what my mother had been hiding: the food rationing, the Red Guards, the political reeducation, and the turmoil. Among these untold stories was her motivation to become a doctor. Her grandmother had died of ovarian cancer shortly after she was sent to the countryside to be reeducated; she was not allowed to return home to say goodbye.

These days, my parents often ask what I remember of my childhood. The apartment in Shijiazhuang? The taste of the *you tiao* and *dou jiang* sold by street vendors in China? The white Chevrolet Impala and how they first learned to drive? The road-trip from Little Rock to Wilmington, North Caro-

lina when my mother was accepted into her residency program? In truth, I remember all this and more. But it's balancing on the windowsill and hearing my mother's stories that resound most clearly in my memory. They were how I came to know my mother, as a person and as a doctor, both sides utterly intertwined in shaping her world and mine.

A good friend once remarked that there is a beautiful sort of parallelism to my mother's journey into medicine—"she

was denied the chance to even be at her family's bedside, but here you find her now, at the bedside of others. The gentleness of hands that first reached out for family have found new home reaching out to patients so foreign to her. And this is made more powerful still by the symbolism of giving up the very practice—oncology—that also represented her love." And yes, amidst all that beauty, there are elements of loss and longing, the specter of the past living inside the

"A good friend once remarked that there is a beautiful sort of parallelism to my mother's journey into medicine."

present, but the tragedy of her story is eclipsed by so much kindness, generosity and love.

It was through my mother that I first came to know medicine. This is true in all of the obvious ways: early days spent in the laboratory, the free clinic, and the hospitals where she had

worked. But my mother gave me so much more through the stories that she would tell me. She gave me her past and her nostalgia—she gave *my* story

a history. My half-remembered, half-imagined view from that window of that lone figure walking home is all the more real now as a result of our shared history. For it was only after I understood my mother's love and longing for all she left behind that I could understand the love of everything she had found, of everything she was coming home to, and of everything she gave to me—everything that first made medicine my home.



Rowza Rumma



Leaders in Medicine

Interview with
Dr. John Gosling,
Dr. Sakti Srivastava,
and Dr. Ian Whitmore

VICTORIA L. BOGGIANO
DAN STOLTZ
PAUL JOHANNET

Last December, we had the privilege of interviewing our anatomy professors, Drs. John Gosling, Sakti Srivastava and Ian Whitmore. These professors are the driving force behind a number of courses that provide in-depth knowledge about the human body and lay the foundation for bridging both anatomy and clinical practice. After spending scores of hours under their tutelage, we wanted to sit down with them and learn more about their lives outside of the dissection room.

Victoria Boggiano (VB): Dr. Gosling, we've heard that you are an avid rock-climber. When did you first start?

Dr. Gosling: I started rock climbing in 1957 when I was 13 years old. In those days, it was regarded as a lunatic sport. Protection was non-existent; hemp ropes and thick boots were all you had. I still loved it, right from the beginning. Fortunately, a career in academic medicine allowed me the flexibility to climb around the world. Recently, I was climbing in the Arrillaga Gym on campus when a student asked me how long I had been climbing. I told her 62 years, and she nearly fell over!

Dan Stoltz (DS): Of all the places you've climbed, which has been your favorite?

Dr. Gosling: If you're climbing snow peaks, then it's difficult to better the French Alps. Still, Yosemite is one of my favorite places to climb. I first managed to get into Yosemite in 1967. Back then, we did a fairly early ascent on Sentinel, which was a big free route that used to take two days to climb. You would climb for a day, spend the night on a ledge called Flying Butchers that was halfway to the top, and then finish the route the following day. It was a wonderful experience sitting on that ledge. There is a second route in Yosemite that I found to be spectacular, and that was the complete Glacier Point Apron. At the top of Glacier Point, there was a little wall with a parking lot overlook. I remember climbing over the wall and the tourists would cry out, "Good God where have you just come from?!" I remember one person was so impressed that he gave us a ride back down!

Paul Johannet (PJ): Dr. Whitmore, can you tell us about the first time you flew an airplane?

Dr. Whitmore: I first flew in 1973. Flying has always been in my family. My father was a navigator in the Royal Air Force and my sister is an aeronautical engineer. In fact, my appointment at Manchester led to my first opportunity to truly explore flying. One of my colleagues there introduced me to flying gliders at a site outside of Manchester. I started going there every weekend and even began staying for several weeks during the summer. I eventually became an instructor there.

VB: Dr. Srivastava, can you tell us about your interest in

the arts?

Dr. Srivastava: My interest in the arts contrasts somewhat from anatomy, which is very well-defined in terms of the structures you can see, touch, and measure. I've always been drawn to this opposite side of the spectrum to things that are mystical and esoteric. These parts of life are very meaningful to me because they cannot be easily defined or quantified.

DS: Does this mindset explain your interest in palm reading?

Dr. Srivastava: Yes, it certainly does. Growing up, I watched and learned from extended family members who viewed the art of palmistry as a gift rather than as a trade or commercialized endeavor. I supplemented what they taught me with my own reading. Now, I tend to view palmistry as another avenue to discover more about yourself, whether it be a strength, or in some cases, a weakness. It should be taken only as seriously as the individual wants it to be and utilized as an additional data point of who you are as an individual.

DS: It seems that you all have very different interests outside of medicine. Can you tell us about your shared interest in anatomy and about how you became anatomy professors?

Dr. Srivastava: Right from the first year of medical school, I fell in love with anatomy. It has always been my favorite subject. After graduating, I trained to become an orthopedic surgeon and practiced for many years, but I've always taught anatomy. I've also always been interested in computer technology. In fact, during medical school and my orthopedics fellowship, I took computer classes in the evening and eventually earned a diploma in computer education. I initially came to Stanford in 1999 to learn more about combining my interest in computers with medicine and surgery. I then had the opportunity to formally teach anatomy here, and I've been at Stanford ever since.

Dr. Gosling: I came to Stanford in 1975 to join a research project with my colleague John Dixon, who was investigating the physiology of the ureter. My interest was in the mechanism responsible for ureteric peristalsis. I thought that the control for this process would most likely be located at the proximal end. Together, John and I looked in the renal

calyces, and sure enough, there were a group of cells much like the interstitial cells of Cajal in the gut. It seems now that these are indeed pacemaker cells that control peristalsis from the kidney on down. Anyway, while I was working on this research, I taught anatomy to help pay my way, and apart from a stint in Hong Kong, I've been here since.

Dr. Whitmore: In 1984, Dr. Gosling recruited people from Manchester on a short-term basis to help offset a shortage of gross anatomists. I did this for two years but afterwards kept in contact with the anatomists here while I worked in London. Then, in 1996, I moved to California to teach anatomy at Stanford full-time.



Alice Eamsherangkoon

PJ: How has anatomy education evolved since you first studied it in medical school?

Dr. Srivastava: In medical school, I had 500 hours of gross anatomy. When you spend that much time in the dissection lab, it arms you with a deep understanding of anatomy that translates to clinical practice when you approach your patients, whether for physical examination or procedures. How many did you have, Ian?

Dr. Whitmore: I had 700 hours in the dissection lab.

Dr. Gosling: I had 750 hours. To me, an integral part of your learning experience is the epiphany that comes with anatomy dissection. You can then graft on additional technologies to reinforce what you've observed in the dissecting room. I champion that learning process.

Dr. Srivastava: We are very fortunate and privileged to offer a traditional cadaver-based course at Stanford that's augmented with technology. While I'm a big supporter of technology, I'm actually a bigger supporter of the traditional way of teaching. There is something profound about learning anatomy through cadaver-based dissections, and the depth of knowledge you attain translates directly to the clinic. When I was an intern, I had an attending who would

literally make me draw what I expected to find on an imaging study before I ordered it. He would take my drawing and put it in a file. When the results came back, he would hold my drawing up next to the CT scan for comparison. This routine was very unpleasant at the time, but in hindsight, it served as a powerful teaching tool. I've continued to use this mental framework whenever I advise imaging for a patient. It enhances your clinical acumen and increases your confidence in your physical examination techniques. If you don't see the finding on the X-ray, you don't doubt your finding - instead, you doubt the X-ray.

VB: We've heard that anatomy examinations have changed over the years too. Can you tell us about your most challenging exam?

Dr. Srivastava: My final anatomy exam was a daylong process that involved rotating through numerous specimen stations. The department chair was notorious for remaining silent at his table. He would simply raise his pointer like a wand and watch your eyes as he hovered it over different specimens. Eventually, he would tap one. You had no idea what he wanted to hear, so you would pick it up and just start talking about it. If he was satisfied, he took the pointer and tapped the next specimen.

Dr. Whitmore: I certainly experienced some odd questions. I remember being given a rib bone and being asked to identify exactly which numbered rib it was.

PJ: Turning back to anatomy education today, can you talk about the role of anatomy instruction in other medical school courses?

Dr. Srivastava: In the last several years, we have offered several electives, including bedside anatomy, operative anatomy and imaging anatomy, that aim to bolster the required anatomy course for all medical students. We've also integrated anatomy review sessions into the Practice of Medicine curriculum. In addition, we have started offering an anatomy review session for the core clerkships. The surgery sessions have been successfully running for several years, and most recently, we began offering a session for students in the OB/GYN clerkship. This year, we will start a review for the Internal Medicine clerkship, and next year, we hope to start one in Pediatrics.

DS: To end on a light note, if you could rename one anatomical structure in the human body, which structure would it be, and why?

Dr. Whitmore: Well, earlier, I think we mentioned a group of cells in the kidney responsible for ureteric peristalsis that deserve a better name. I propose that we call them the Gosling-Dixon cells.

A CONFLICT OF

THE CHILDREN'S TALE

SASIDHAR MADUGULA

When I was young, I used to go to elementary school. Mine housed your typical sugar-ridden set of grade-school kids; there was Carl, Sandy, Patrick, Meena, David, Anna, and Lisa. But the most interesting classmates I had were Clinical and Basic. I think their full names were Clinical McResearch and Basic Von Investigation. Fancy monikers, aren't they? Anyway, these two kids would be up to all sorts of antics, inside and outside of class. Clinical was the loud one—he was always making fantastic claims. After downing one too many skittles, he'd find patterns in everything. The number of homework assignments in a week. The number of kickballs Jimmy would kick out of the grassy field. The number of geese laying turds on the jungle gym. He once took a dime from each one of us in return for successfully predicting the lunch menu for a week. When some of us ran out of dimes, he started offering personalized services—I remember he went to that girl Anna's mansion once to try and figure out whether she'd be getting a pony for her birthday. One weird thing about Clinical, though, was that he used to get skittish about making patterns about people themselves; he was always going on about how he needed to check with his older brother Irbert first.

Most of us were amused by Clinical's quirks, but Basic was outright distressed. You see, Von Investigation was a quiet type, a pretty isolated kid. He did have some friends, but they rarely talked to anyone, even amongst themselves. We thought they secretly hated each other.

Basic loved doing pedantically detailed things that no one else was interested in, like folding origami scorpions for hours and making elaborately planned sand structures. He especially adored mixing things around: water to water bottle, then mix with a Juicy Fruit box, then add salt, then taste, spit it out, and make notes about it. I'm not sure how he was making notes, considering the rest of us didn't really know how to write our own names. Unlike Clinical, he was often broke but had a rich aunt whom he called "Aunt Eye Aych"—she was a nihilist and apparently didn't believe in normal names or spending habits. This aunt would give him money to buy notebooks and peculiar items (don't ask me what) to put in his mixtures. And he loathed Clinical because even though most of Clinical's amazing predictions didn't stand up to scrutiny or last more than a week, everyone would forget about that and cheer him on to conjecture about the next thing. "Nothing he does is rigorous! Nothing is reliable!" Basic would grumble. But no one ever knew what "rigorous" meant, so those types of comments were generally disregarded.

Clinical and Basic largely ignored one another, which was fine by the rest of us. Yet little did we know that a storm was building.

By some unhappy coincidence, both kids had an unhealthy obsession with dodgeball. In those days, dodgeball was where reputations were forged, friendships marred beyond help, and legends born. Clinical liked

OF SCIENCE

playing, but what he enjoyed even more was sitting on the sidelines and making notes about various team combinations. What mix of people makes for the most number of wins? How many fourth graders, how many fifth graders? Maybe put in a third grader as bait, allowing the older kids to do the real work. What formations are optimal in various gameplay conditions? Clinical's musings were endless. Basic, on the other hand, was very interested in constructing the perfect throwing technique. While the rest of us were learning how to divide numbers, he was learning how to divide vectors using a new book—he called it a “training grant” or something. He and his friends would spend recess throwing balls against the brick playground wall and recording themselves with video cameras or, as he called them, an “equipment grant.” We were all wondering who this formidable “Grant” fellow was by the end of it.

One fateful day, the fifth graders arranged a dodgeball game between the two eccentric boys—even they had taken notice of these bizarre antics. Clinical, despite having acquired a peculiar sort of popularity, had managed to make a few enemies who called his work “wishy-washy.” They all joined Basic, who was protesting that his work was far from finished and requested an extension. Eventually, Basic relented and agreed to train his team. Game Day arrived quickly. The battle was fierce, with Clinical's superior team dynamics proving to be an even match for the Basic's stalwart technique. On either side, players dropped like *Drosophila*—a term that

frequented Basic's notebooks—until the notorious two were the only players left face-to-face on the field with dodgeballs in hand.

Then, something strange happened. Basic raised his arm to throw the ball, only to realize that he had never trained himself! Sure, he had invented the technique, but he had never practiced it himself, insisting that others would perfect the application. He missed Clinical by a mile, and his throw that day was forever christened “The First Grade Girl's Symposium”—we found that last word in the dictionary and were rather pleased with that feat. Clinical, on the other hand, found that in his scattered, ad hoc analysis he hadn't accounted for the singular case! He had no clue what to do in a one-on-one situation, dismissing the scenario as improbable. His throw also missed by a mile and was dubbed the “The Cafeteria Potato Mashers' Professional Development Conference.” The two boys looked at one another in embarrassment and finally laughed. Thus was born an unlikely friendship, with Clinical having learned the importance of rigor and Basic having learned that application is just as important as derivation.

A happy peace followed for some months. Then, one day, a limo pulled up to the school. A tall fifth grader with a smile stepped out. The kids on the playground stopped and watched. Clinical and Basic exchanged a worried glance. Translational O'Science III had arrived, and things would never be the same.

I HOPE
Christine Ryan

Dedicated to the individuals who donated to our anatomy education

I hope your hand held many hands –
the hand of your husband, your daughter, your grandson.

I hope your eyes saw many sights –
glorious sunsets, glowing moons, snow-capped mountains.

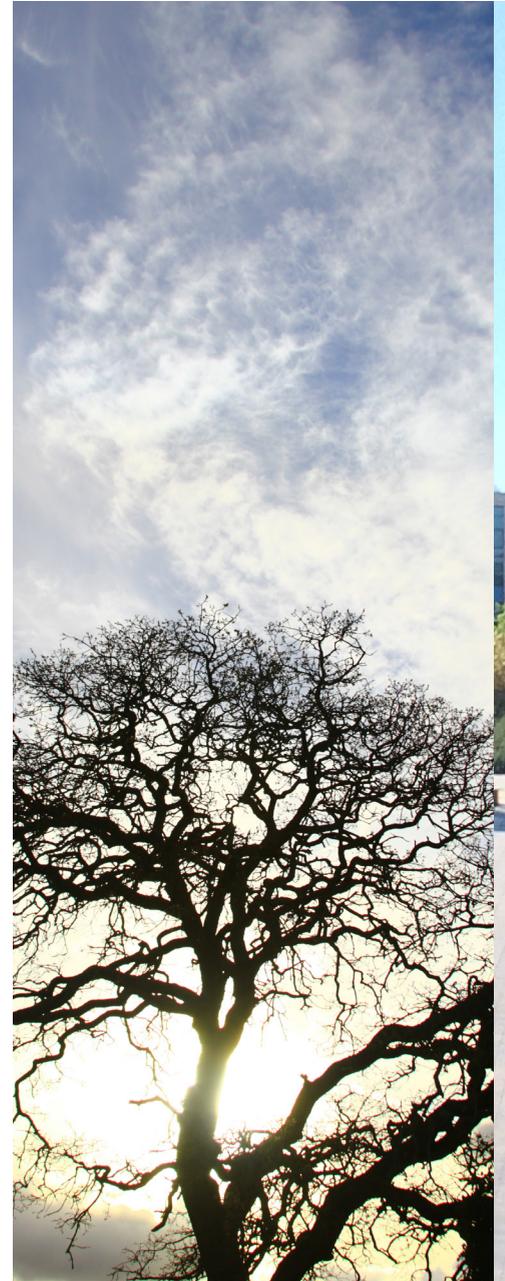
I hope your arms carried many gifts –
a squirming puppy, a newborn baby, a bouquet of pink carnations.

I hope your feet walked many places –
to the tops of hills, up the steps of your home, along the shores of the ocean blue.

I hope your ears heard many sounds –
crashing waves, pitter-patter raindrops, the words “I love you.”

I will never know the person you were inside –
what made you laugh, what made you cry, or who it was that brought a smile to your eyes.
But I hope.

I hope your final moments were filled with comfort and peace,
Spent with the ones whom you loved and loved you most –
Those who knew best of all, the precious gift you were to this world.



David Carreon



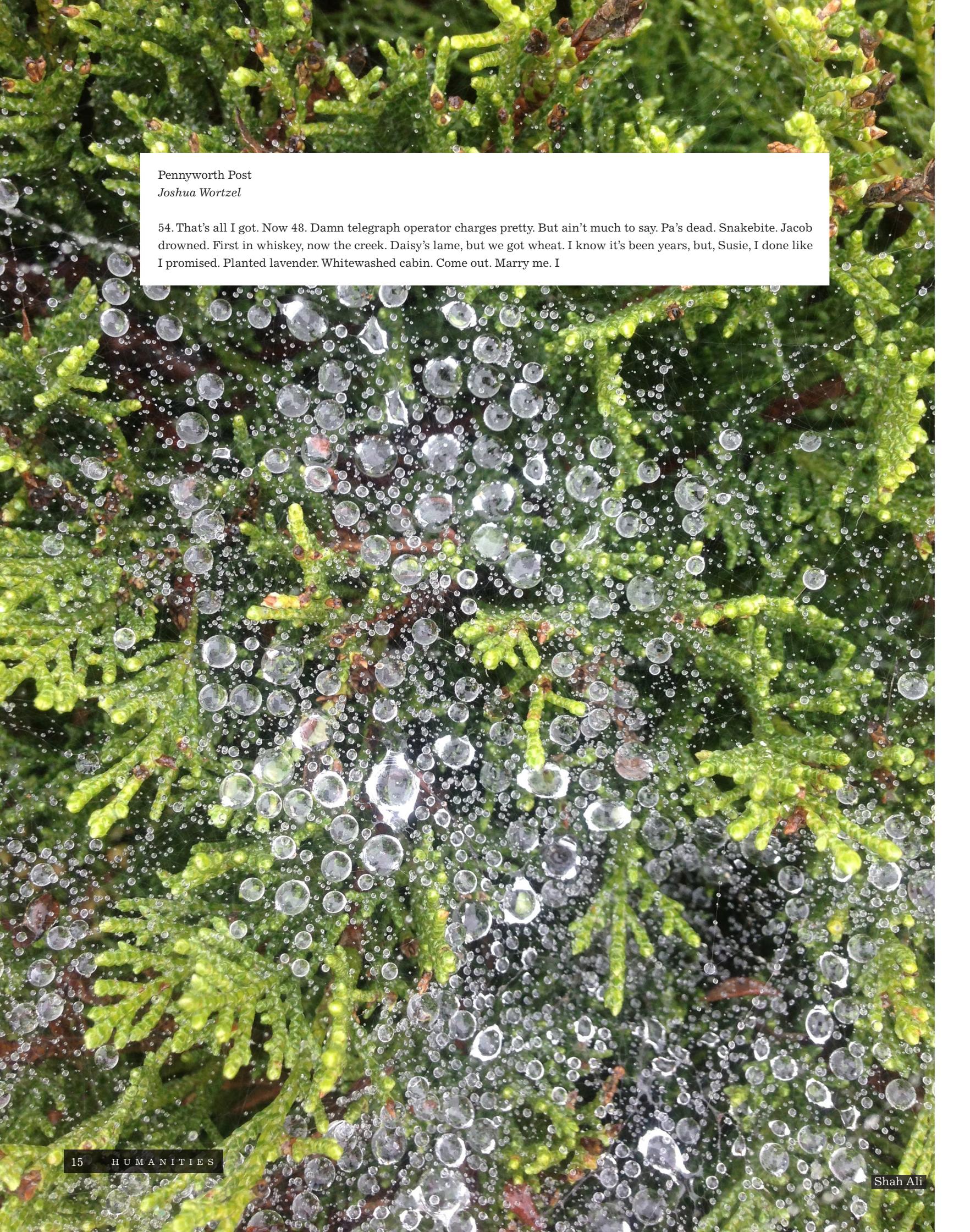
Larissa Miyachi

The G2 Floor
Lauren Pischel

What pain inside these places
Endless supply of sickness at the walls
Slipping, stumbling through the doors
and the buildings simply steps apart

You here in cancer
waiting
You there in lab
toiling for a Nobel Prize
You there in literature
studying suffering
Only separated by un-walked feet

And here am I
at your bedside.
Telling you you need to eat
and we are only a body apart
and I want to touch your skin
and feed you some of my life.
But I will walk out of here tonight
and marvel at how healthy people look
on the outside
flying on their bikes with summer skin.
And you will stay here
listening to your organs cry
as so much suffering and sadness stays.



Pennyworth Post
Joshua Wortzel

54. That's all I got. Now 48. Damn telegraph operator charges pretty. But ain't much to say. Pa's dead. Snakebite. Jacob drowned. First in whiskey, now the creek. Daisy's lame, but we got wheat. I know it's been years, but, Susie, I done like I promised. Planted lavender. Whitewashed cabin. Come out. Marry me. I

Why Gunning is Good

STEVEN ZHANG

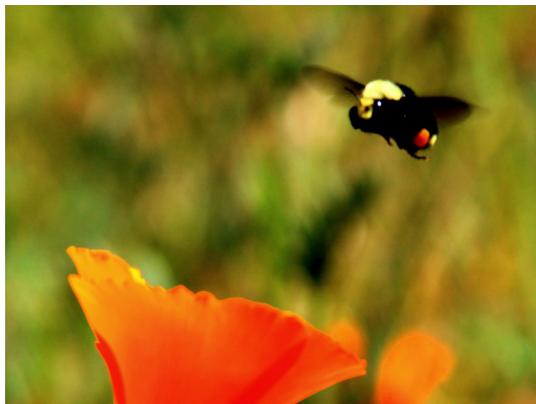
Let's agree that the medical school gunner is a jerk. He sits in the very first row of each class. He shoots for the top spot and usually gets it. He'll ingratiate himself with residents and attendings. He looms over the rest of us with shifty eyes, constantly surveying his surroundings to ensure that he remains above and beyond everyone else's reach. In each and every class, he'll blurt out answers to all the questions, even those whose answers could only be found on pages several chapters ahead in the syllabus.

What's worse, he's stingy. He frenetically studies alone. His notebooks, all of which are carefully highlighted and footnoted, are for himself and himself only. He doesn't share with anyone unless he can get something from them in return. So naturally, no one likes the gunner. Some may go as far as to outright despise him. But in medical school and for the many years of training awaiting us, we will need him, and we will need to embrace him.

Though usually considered a taboo, being a gunner isn't wrong or immoral in any way. At worst, a gunner might be a little selfish, maybe even arrogant, but he's only a mild annoyance. Yet somehow, it's the case that medical students go to great lengths to avoid being cast under the title's dreadful shadow. It's customary to hide our competitive dispositions under a cloak of nonchalance and ease.

And that's what a gunner really is in his most distilled form—a competitor. And there's nothing wrong with competition, as uncomfortable and strained as it may make us feel. Competing is healthy. It exposes our weaknesses. It provides us with a means of feedback. It makes us feel vulnerable, uncertain, and self-conscious. It bruises our swollen egos. But ultimately, it's what makes us better doctors. It feeds our constant urge to strive ahead and improve. And whether we like it or not, gunning was partly responsible for getting us into medical school. We merely outgunned our peers in standardized testing and in our classes. We outgunned them in taking on research projects and volunteering abroad. We outgunned them in interviewing and writing application essays. If it weren't for our fierce natures, we would never have had the privilege to don the white coat.

In fact, gunning is honorable. What we ignore is that the gunner volunteers to be despised. He accepts his place outside of the herd, to always be looking in, to be cast into the fringes of the community. It's a testimony to his dedication to becoming a better doctor. The ones who made it in medicine were, after all, once gunners who burned the midnight candle, who may have once rubbed their colleagues the wrong way, and who were a little too abrasive for our liking. And along with his black sheep mentality, the gunner is willing to challenge norms, to upend social and scientific orthodoxy in his effort to blaze ahead.



David Carreon

So really, gunning is a noble duty.

For his sacrifice, the gunner molds himself into a better doctor. He gains an understanding of medicine by paying a costly price out of his own pocket, but his patients will one day thank him for it. He may be disliked (and very likely even envied) by his colleagues, but he'll be a better doctor than the rest of us—more knowledgeable, more competent. As much as

we would hate to admit it, we would not mind sending our closest friends and family members—or even ourselves—to a gunner for care.

Anyone who chooses to make that trade—to sacrifice his social standing for his future patients—should be admired, not vilified.

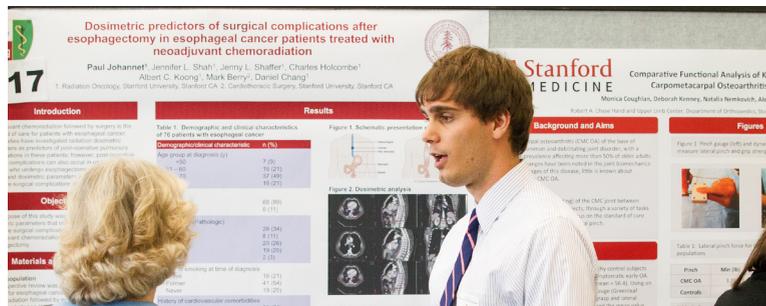
As medical students, we are all, in some form or another, gunners. We'll continue to try to outgun each other for the rest of our careers. It will continue well into our residencies, fellowships, and whatever paths we choose after that. Because the reality is that we have to compete in order to advance ourselves. Advance our skills. Advance our knowledge. Advance medicine. This striving part of us is immutable and obligatory, woven into the fabric of our identity and careers. For us, gunning will never end and we should welcome that truth.

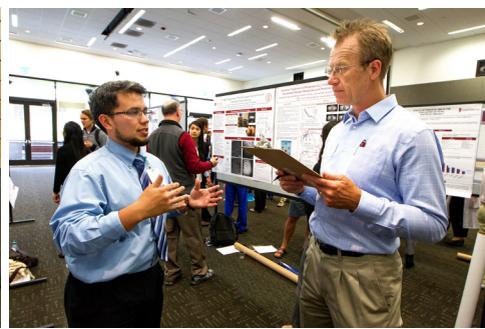
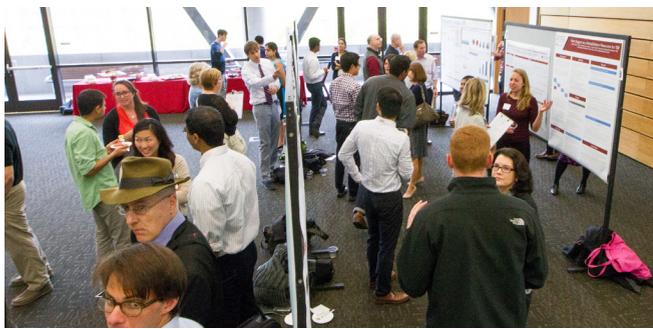
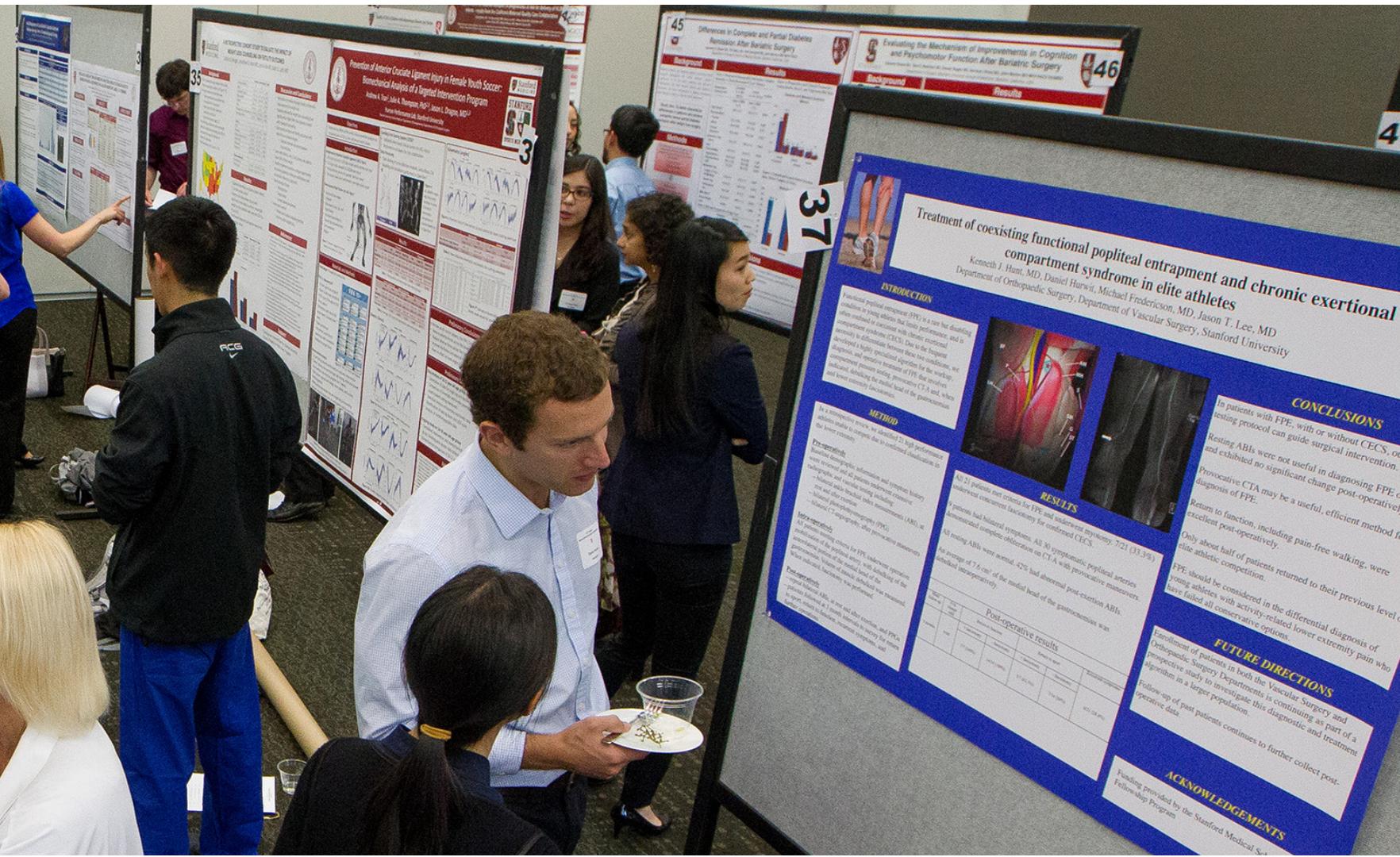
Competing is inherent to this profession, and that's what makes medicine so grueling and compelling. There will never be an end to gunning. And that's how it should be.

Stanford Medical Student Research Symposium 2015



The 32nd Annual Stanford Medical Student Research Symposium that took place on May 7, 2015 showcased poster presentations of 47 Stanford medical students of all years. Students presented their research in the fields of basic sciences, clinical investigation, informatics, health policy, community health, and more. Photos are courtesy of Norbert von der Groeben Photography.





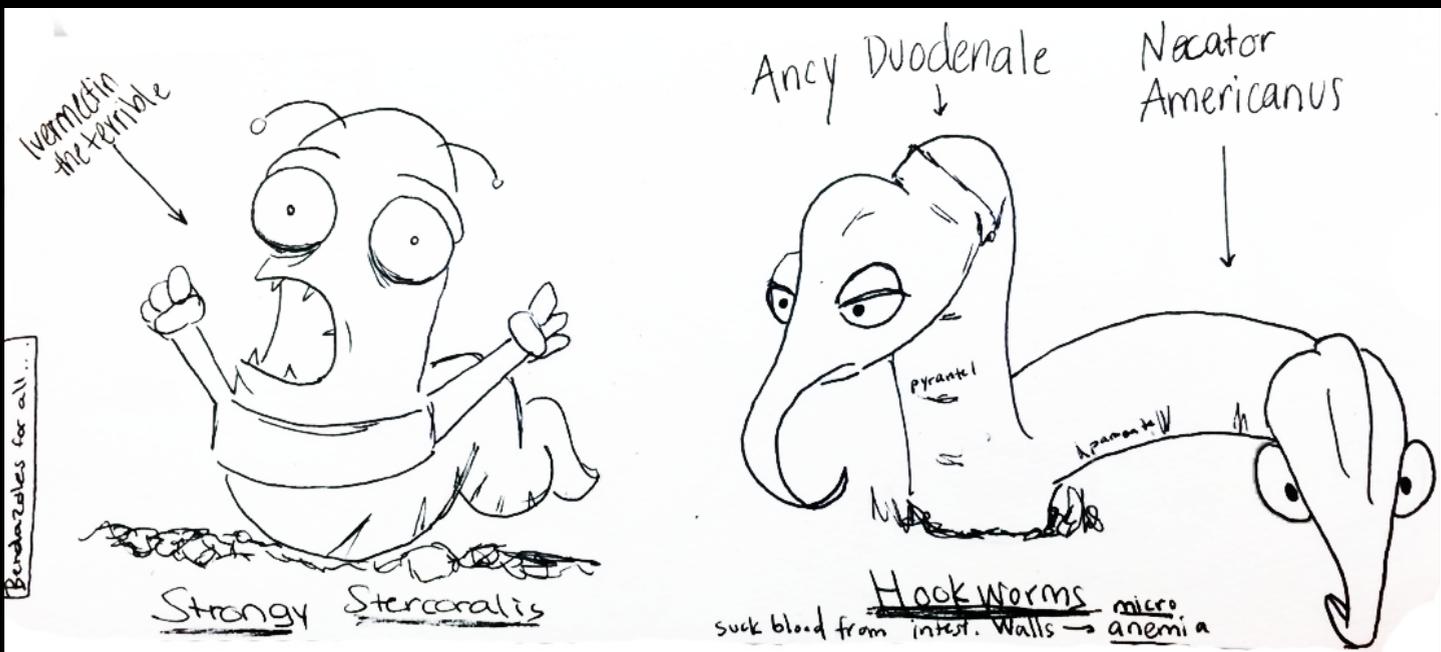
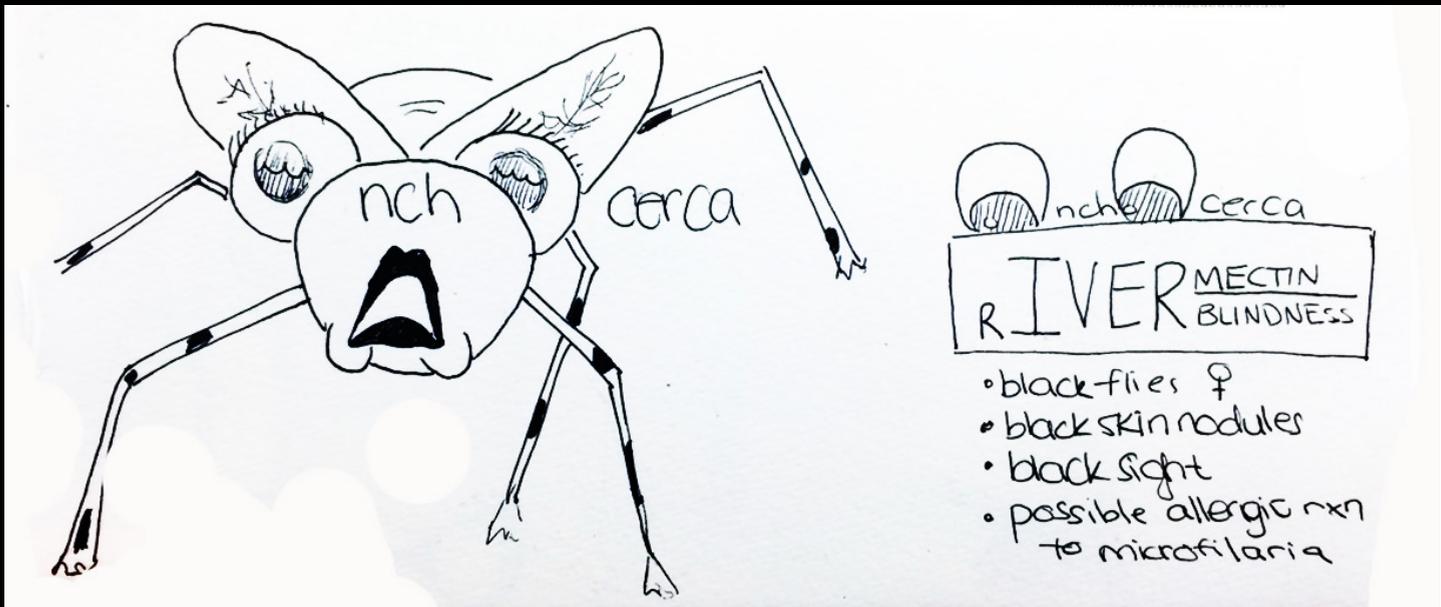


Medicine & The Muse Symposium 2015

The Medicine and the Muse Symposium that took place on April 27, 2015 featured various performances and artwork by students at Stanford School of Medicine. This artistic exposition also featured a discussion with guest speaker Dr. Perri Klass, awarding winner author and Director of the Arthur L. Carter Journalism Institute at New York University. Photos are courtesy of Norbert von der Groeben Photography.



Sketchy MD

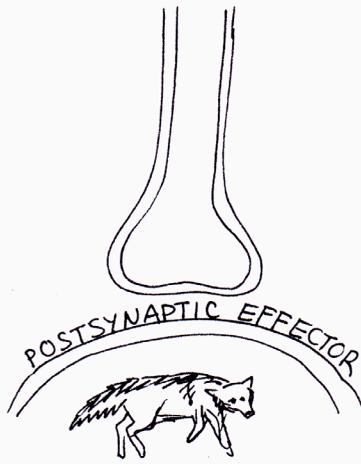


MICHAEL NEDELMAN

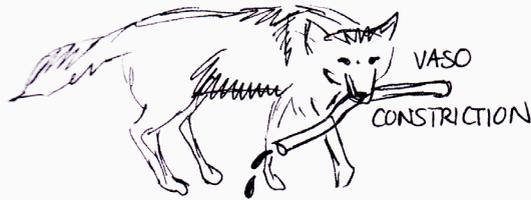
Won the crown



Alpha 1



Adrenergic receptors are GPCRs

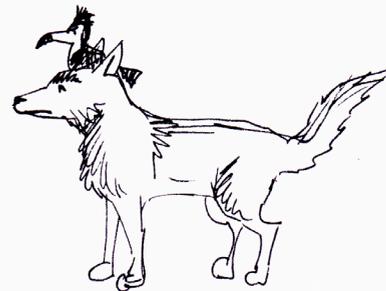


Alpha 2

"Alpha Taxan"



inhibits NE release via negative feedback



Alpha (wolf) adrenergic receptors

LARISSA MIYACHI

