JULY / AUGUST 2022 # 85

the Pathologist®

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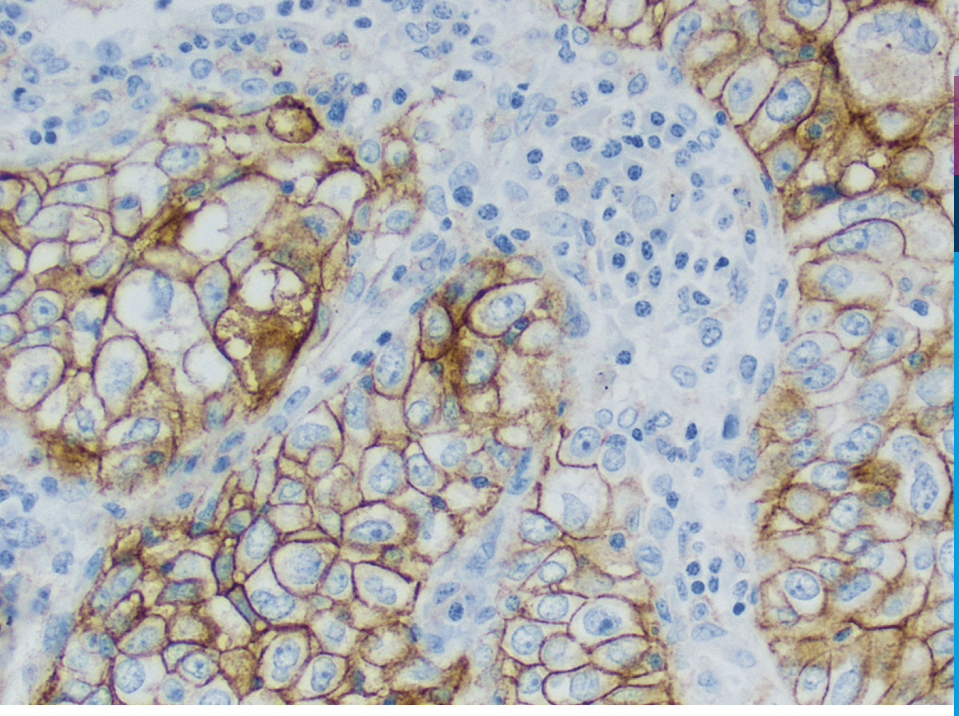
The Power List

A celebration of the great and inspirational minds in pathology and laboratory medicine



Join us for CAP22

PD-L1 CPS Scoring

Quick Tips for Challenging Cases

Presented by a Key Opinion Leader

Three 15-minute sessions
Sunday, October 9
10:30 | 12:30 | 2:30

Same Sessions offered
Monday, October 10
10:30 | 12:30 | 2:30

Booth 302 - no registration needed

Training Opportunities Presented by Agilent

PD-L1 CPS Training Utilizing the Atlas of Stains (1 hour)

August 30	10:00 am PT / 1:00 pm ET	Dr. Paler
September 29	10:00 am PT / 1:00 pm ET	Dr. Badve
November 9	10:00 am PT / 1:00 pm ET	Dr. Gown

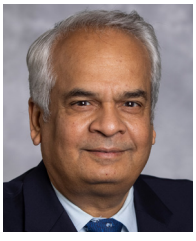
Register with your smart device.

PD-L1 IHC 22C3 pharmDx CPS Scoring Session (3 hour)

October 20	10:00 am PT / 1:00 pm ET	Dr. D'Arrigo
November 17	10:00 am PT / 1:00 pm ET	Dr. Badve

Register with your smart device.

Dr. Ronald Paler



Dr. Sunil Badve

Dr. Allen Gown

Dr. Corrado D'Arrigo

Agilent

Trusted Answers

D72710/01 AUGUST 2022

Residents Just Want to Have Fun

How to make good decisions in your pathology career – and enjoy yourself in the process

Life as a pathology resident is very different now to when I experienced it 40 years ago at the Mayo Clinic in Rochester, Minnesota. Back then, it was common for trainees to eat meals with their attendings, sharing anecdotes over food and drink, and to visit each other's homes for simple fellowship. We had a lot of fun during training. One of the buildings on the Mayo Clinic campus was next to a burger restaurant, so the residents stationed there had the duty of collecting lunch orders for the entire group. We would then use the pneumatic tube system to send hamburgers and French fries to people in other buildings (no drinks though – too messy!).

There was also an organization at Mayo Clinic called the Fellows' Film Society. Trainees decided what films to show (usually classics or world cinema) and the Mayo Foundation kindly let us use one of its large auditoriums. Viewing was open to the public (we charged a modest admission fee) and the auditorium was full for most showings. One night, we chose to show a "world cinema" film that backfired badly. No one on the society staff had previewed the German film with an intriguing name and, once the movie got going, it turned out to be X-rated, complete with German subtitles. The auditorium emptied like it was on fire and all the admission fees had to be returned!

Hindsight is a wonderful thing but, after a long and fulfilling career, I can share some advice that has served me well over the years – and that I think will serve the next generation, too.

1. Work hard. You will not succeed in life by cutting corners and skipping opportunities.
2. Cooperate with others. Nothing is gained in medicine in isolation and envy. Louis "Pepper" Dehner and I moved together to Washington University in 1989 and our friendship and professional work together only continued to grow – and our professional relationship spilled over to other faculty and trainees, which led to a lot of good projects. I am forever grateful to him for being my "big brother" as well as my boss.
3. Don't base life decisions on money or titles – base them on people. I enjoyed being associated with my colleagues at the University of Virginia. This, plus the scholarship, cooperative efforts, and cordial interactions, enhanced my experience there.
4. Prioritize your workload. You cannot be truly productive in your academic work if you are not given the time, resources, and tangible support to work on developmental projects.
5. Last, but certainly not least – have fun!

Mark Wick

Professor Emeritus of Pathology, Division of Surgical Pathology, University of Virginia School of Medicine, Charlottesville, Virginia, USA

When interpreting HER2 in metastatic breast cancer

The full spectrum of HER2 expression deserves more recognition

Identifying each level of HER2 expression, including low levels, may have a meaningful impact on clinical decision-making for patients with metastatic breast cancer.

Daiichi-Sankyo | AstraZeneca

Take a deeper look into HER2 expression at **ScoreHER2.com**

Contents

the Pathologist

ISSUE 85 - JULY / AUG 2022

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Credit: Image sourced from Shutterstock.com

A Step in the Right Direction

Researchers should be applauded for identifying a potential biomarker for sudden infant death syndrome (SIDS) – but let's rein in the sensationalism

Newborn babies should bring immediate joy to parents – opening a door into a world of experiences as infants become toddlers and toddlers become little people. But, for a desperately unfortunate few, sudden infant death syndrome (SIDS) changes everything. SIDS affects over 1,000 babies every year in the US alone, and though the risk is thought to be relatively low, the cause is still unknown – and so it is difficult to identify at-risk babies until it's too late.

In a recent study, researchers from The Children's Hospital at Westmead, Australia, identified a biomarker that could shed light infant risk of SIDS (1). Analyzing butyrylcholinesterase (BChE) activity in 722 dried blood spots of newborns taken two to three days after birth – including 67 newborns who suffered sudden unexpected death in infancy (26 SIDS and 41 non-SIDS) – they found that BChE-specific activity was lower in babies who died of SIDS compared with non-SIDS deaths and surviving controls.

Though the findings contribute to our growing understanding of SIDS, it's important to note that the research is still in its early days and does not represent the sole cause of the unexplained deaths. Many media outlets have picked up on the research and original press release, which stated that SIDS "may soon be a thing of the past (2)" – quite the sensationalist messaging.

Other factors have also been found to potentially affect an infant's risk of SIDS, so it's not possible to develop a definitive screening test for SIDS based on BChE alone. So what does the research tell us? "It shows that many babies who succumb to SIDS are different from birth," according to lead author Carmel Harrington, a researcher in the SIDS and Sleep Apnoea Research Group at The Children's Hospital at Westmead (3). At this stage, she admits, "Our finding offers nothing new to clinical practice."

Certainly, it's a baby step in the right direction, but not quite the miracle finding posited by the press release, social media, or news outlets.

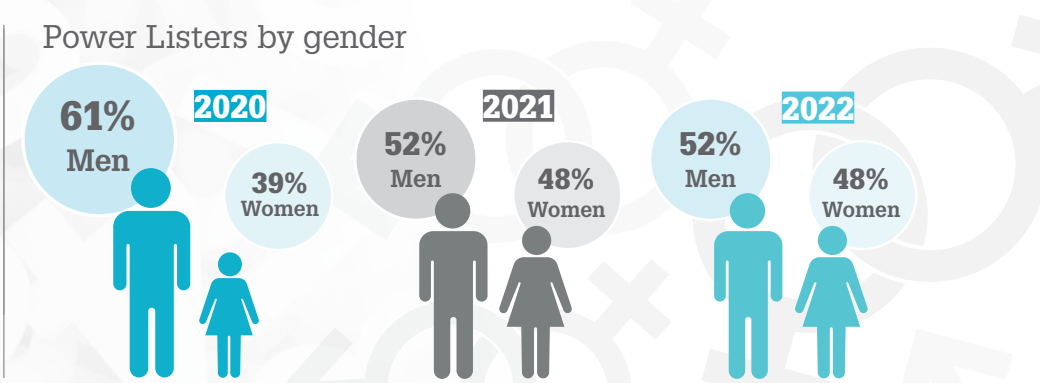
References

1. *CT Harrington et al., EBioMedicine, 80, 104041 (2022). PMID: 35533499.*
2. *The Sydney Children's Hospital Network (2022). Available at: https://bit.ly/3NKtFKh.*
3. *Nicoletta Lansese (2022). Available at: https://bit.ly/3xQKuxL.*

INFOGRAPHIC

The Pathologist Power List 2022 – in Numbers

We break down this year's Power List by nominations, country, and gender



WHAT'S IN THE NEWS?

A speedy summary of the latest in pathology news – including single-cell sequencing for lupus, tear film biomarker diagnostics, and more

Handheld Healthcare

To date, the development of point-of-care biomarker devices has been hindered by technological issues, including device sensitivity and sample contamination. Now, a South Korean team has developed a biosensor capable of generating nanostructured and nanoporous surfaces with unprecedented sensitivity and contamination resistance (1).

The Fire in Your Skin

Lupus is known to cause overactive immune response in patients, but the butterfly-shaped rashes that manifest across patients' bodies are not fully understood. A new study uses single-cell RNA sequencing analysis to show how otherwise healthy-looking skin in lupus patients predisposes them to flares and rashes (2).

Blubbering for Biomarkers

Because of tear fluid's high concentration of proteins, it offers an ideal opportunity for biomarker hunting. The fluid's small sample volume (and the proteins' wide dynamic range) present tough challenges – but now, researchers have developed a new in-strip approach to protein digestion and mass spectrometric analysis that significantly increases biomarker identification capabilities (3).

Embr-eye-onic Testing

The UK's National Genomic Test Directory has added 15 new tests and amendments to its menu, including new genetic testing for acute myeloid leukemia, solid tumors, and rare diseases. Included in the update is a new prenatal test for *RB1* gene mutations known to cause retinoblastoma, an eye cancer that is often hereditary and can be difficult to diagnose early. (4).

Biomarkers, Bloody Biomarkers

Research into blood neurofilament light (NfL) across a range of frontotemporal dementia syndromes and presymptomatic mutation carriers indicates that NfL elevation before phenoconversion is associated with disease severity. NfL could potentially be used as an early diagnostic and prognostic tool (5).

See references online at:
tp.txp.to/whats-in-the-news

Making Moves on Monkeypox

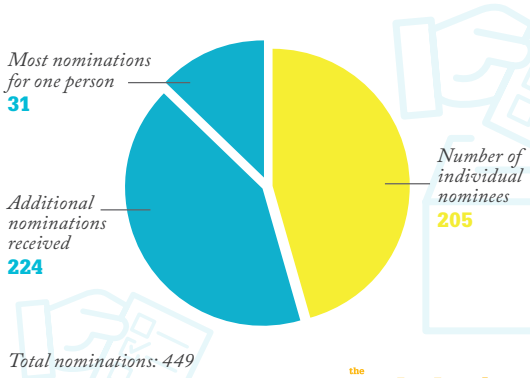
How is the world responding to the current global outbreak of monkeypox?

Widespread testing for monkeypox has not yet been introduced in countries such as the US and UK – but, if the need arises, could governments implement such plans? To diagnose monkeypox, samples from the blisters and scabs are taken and sent to the lab, but must be refrigerated (2–8°C) or frozen (-20°C or lower) within an hour of collection (1). Furthermore, monkeypox is a WHO Risk Group 3 pathogen and has specific guidance on who should perform PCR testing.

"The smallpox vaccine is thought likely to prove at least 80 percent effective against monkeypox as they are closely related viruses. Here in the UK, we stopped regularly vaccinating against smallpox way back in 1971," said Quinton Fivelman, Chief Scientific Officer at London Medical Laboratory, UK (2). "America's [CDC] says that, where possible, only vaccinated people (i.e., smallpox vaccination within the past 10 years) should perform laboratory work that involves handling specimens that may contain monkeypox virus."

Read the full article at:
tp.txp.to/moves-on-mkpox

Power Listers by country



A Ray of Hope Against Aggressive Cancers

A new method of analyzing FFPE tissues for telomerase activity could be used in aggressive cancer diagnostics

One possible culprit for immortality in human cancer cells is the presence of human telomerase reverse transcriptase (hTERT) activity. The correlation between hTERT's enzymatic activity and *TERT* expression levels in cancer has yet to be fully understood, but – building on previous work that established hTERT phosphorylation at threonine 249 (p-hTERT) in specific liver and pancreatic cancers – a Japanese research team has now identified that phosphorylated hTERT is common in many cancers with more aggressive characteristics.

The team developed a mouse monoclonal antibody capable of recognizing phosphorylated hTERT at threonine 249, reportedly the first effective tool for visualizing hTERT-RdRP in cancer through formalin-fixed, paraffin-embedded tissues. They then analyzed 1,523 cancer specimens with a variety of sites of origin to better understand the clinicopathological characteristics of hTERT-RdRP-active cancer.

The results showed that p-hTERT is associated with higher overall risk in aggressive lung, pancreatic, and liver cancers – regardless of TNM staging. Expression of p-hTERT is also strongly associated with "markers of squamous cell differentiation and aggressive features," indicating that this process is common in aggressive cancers. The team discovered that p-hTERT is associated with a number of oncological features such as "adenosquamous carcinoma (lung and pancreas), invasive type of cancer (lung), high serum alpha-fetoprotein level (liver), and triple-negative status (breast)" (1).

Though p-hTERT may have prognostic value in lung, pancreatic, and liver cancers, this was not evidenced in colon and stomach cancers. The team also discovered that, although p-hTERT expression increased alongside mitosis score in all of the aforementioned cancers, expression in colon and stomach cancers decreased as pathological grade increased. One potential reason for this difference is that other mechanisms, possibly in the tumor microenvironment, may regulate p-hTERT expression in these cancers.

Reference

1. *Y Matsuda et al., J Pathol, 257, 172 (2022). PMID: 35094384.*

Finding Markers For Liver Cancer

A new tsRNA marker might just turn the tide for liver cancer patient outcomes

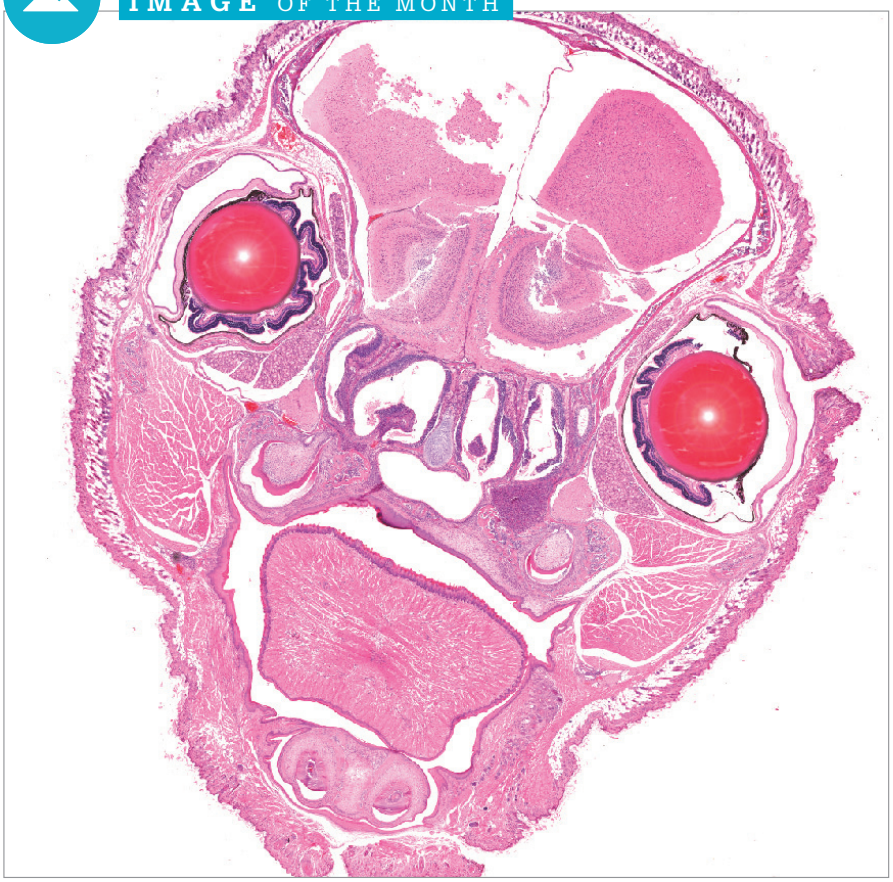
Hepatocellular carcinoma (HCC) is a common and often fatal liver cancer – but early detection could offer better outcomes for patients. Luckily, detection rates could be improved thanks to a recent study that showed a liver tsRNA – named tRF-Gln-TTG-006 – may have promise as an early blood biomarker for liver cancer. Alongside the knowledge that the tsRNA could indicate HCC, the team also found that it may play a biological role in the development of the disease (1).

Because the serum tsRNA signature in HCC has yet to be elucidated, the study adapted high-throughput sequencing capable of identifying hundreds of undiscovered tsRNAs. These new tsRNAs were then screened and vetted through a two-stage validation process, resulting in the discovery of tRF-Gln-TTG-006, which may identify HCC patients with significantly better accuracy than the commonly used α-fetoprotein biomarker.

Reference

1. *S Zhan et al., Front. Med, 16, 216 (2022). PMID: 35416630.*

IMAGE OF THE MONTH



(Mouse) Sugar Skull

This image is of a mouse skull with H&E staining, in both natural and inverted colors. The eyes have been altered where damaged when sectioning.

Our histopathology laboratory is one of the disciplines within Veterinary Diagnostic Services at the School of Veterinary Medicine, University of Glasgow. We offer a comprehensive diagnostic and research service; the samples we receive vary from raft cultures to tissues from many species – from the tiniest mosquito eggs to large farm animals and everything in between. We support the University of Glasgow Small Animal Hospital, undergraduate and postgraduate teaching, research institutes here at University of Glasgow, other universities, and commercial laboratories.

Our histology lab is fortunate enough to highlight the work we do through the fascinating images produced through our many staining techniques. This provides a microscopic view into the cellular makeup of many species using whole-slide imaging. Histology is where science meets art.

Credit: Frazer Bell, Lynn Stevenson, Lynn Oxford, and Jan Duncan.

Do you have a photo suitable for Image of the Month?
Send it to edit@thepathologist.com

An Unlikely Source of Inspiration

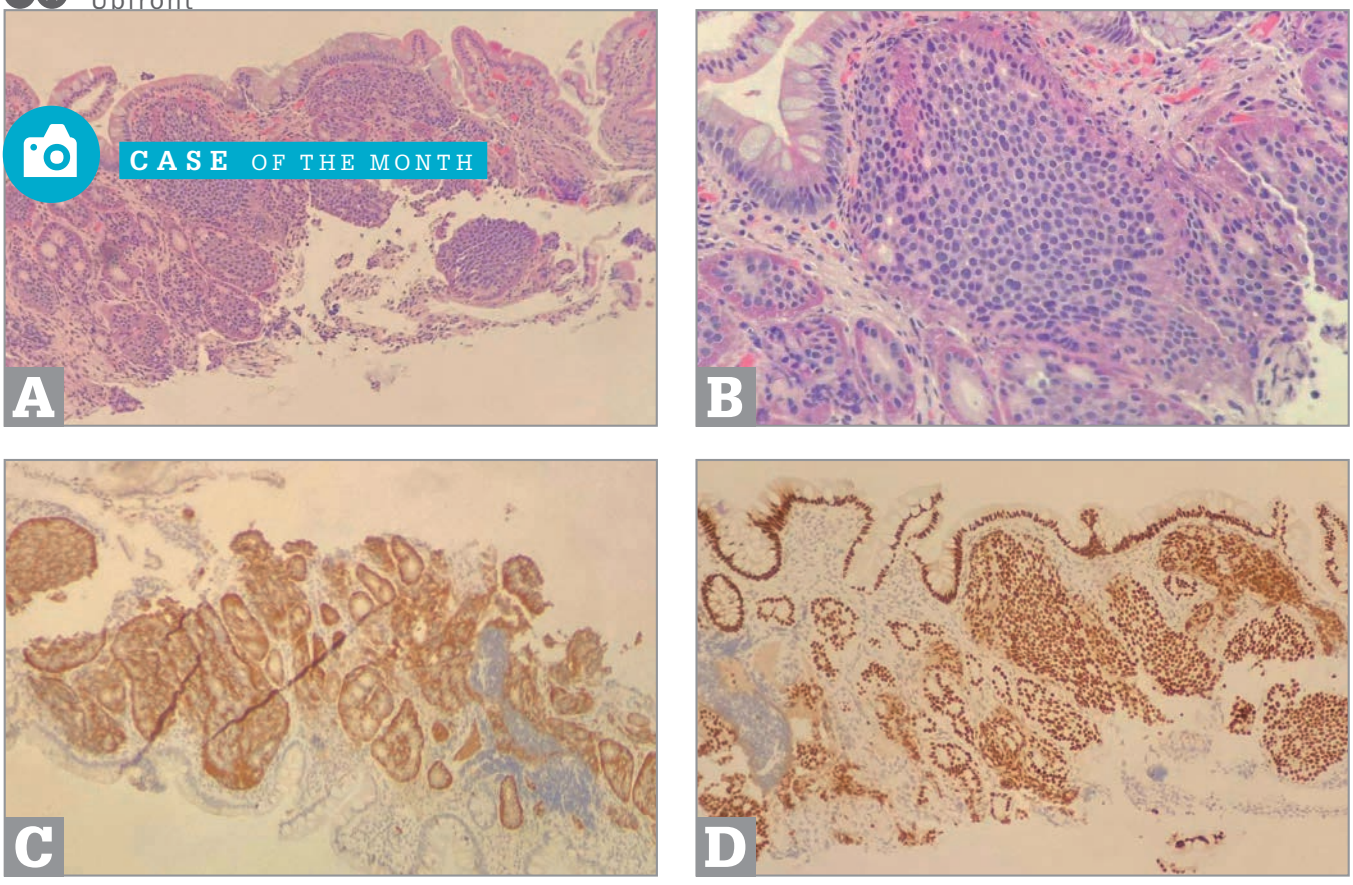
Why is the BCG vaccine an all-rounder for protection against multiple bacterial infections?

The Bacille Calmette-Guérin (BCG) tuberculosis (TB) vaccine is one of the most widely used vaccines globally, but it doesn't stop there – even at 101 years old, the vaccine may still be a source of inspiration for future vaccine design . It has previously been suggested that BCG's effects may extend beyond TB to protect newborns and infants against other bacterial and viral infections, but the mechanisms remain unclear. Might the answer lie in its origins?

Credit: Shutterstock.com.

To investigate, researchers from the Boston Children's Hospital and the Expanded Program on Immunization Consortium used mass spectrometry-based metabolomics of blood plasma to characterize BCG-induced responses in infants (1). They found that vaccinated patients had distinct metabolic and lipid profiles in their blood compared with unvaccinated patients and that the vaccine's effects on lysophosphatidylcholines (LPC) were associated with cytokine responses – suggesting that LPCs may contribute to the BCG vaccine's immunogenicity.

See reference online at:
tp.txp.to/src-of-inspo



Ileal polyp. A) Hematoxylin and eosin 10x; B) hematoxylin and eosin 40x; C) positive synaptophysin immunohistochemistry; D) positive chromogranin A immunohistochemistry. Courtesy of Gang He.

The following light microscopy images were obtained from a specimen resected via endoscopy. Immunohistochemistry was positive for synaptophysin and chromogranin A.

What differential diagnosis is indicated?

a) Well-differentiated neuroendocrine tumor
b) Primary adenocarcinoma
c) Metastatic adenocarcinoma
d) Primary gastrointestinal lymphoma

Answer to last issue's Case of the Month…

a) *No*

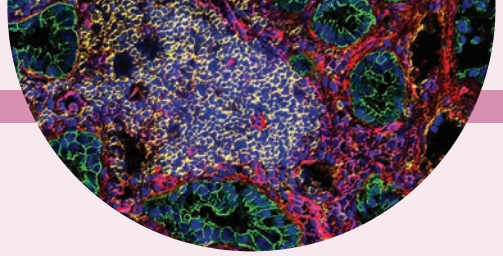
Histologic findings such as intestinal metaplasia and a superficial band of mononuclear cell-rich infiltrate below the foveolar epithelium highly suggest chronic active gastritis secondary to *Helicobacter pylori*. The organism has adhesins that exhibit tissue tropism for the epithelial layer of the less acidic antrum (1) and decreased microenvironmental acidity often results in proximal migration to the gastric body, fundus, or cardia. The microbe is only occasionally found in areas of intestinal metaplasia (2), making immunohistochemical identification within this biopsy specimen a relatively uncommon finding.

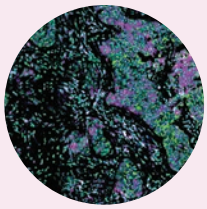
Submitted by Erina McKinney, University of Kansas School of Medicine, Kansas City, Kansas; Gang He, American Diagnostic Consultation & Services, New York; and Ting Zhao, Department of Pathology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, USA.

See reference online at: tp.txp.to/cotm-0822

To register your guess, please go to http://tp.txp.to/0822/case-of-the-month
We will reveal the answer in next month's issue!

Case of the Month is curated by Anamarija M. Perry, University of Michigan, USA.





MACSima™ Imaging System: A Powerful New Tool for Spatial Biology

Unlock the next level of biomarker discovery and cancer research

New tools in high-dimensional spatial biology are leading to rapid advances in cancer research, biomarkers, and therapeutic targets. The MACSima spatial biology platform is a fully automated, ultrahigh-content imaging system that allows users to take a deep dive into the composition, cellular relationships, and interactions of normal and diseased tissue – providing much-needed spatial context for up to hundreds of proteomic markers on single or multiple tissues – all while leaving the tissue intact.

A broad range of specific and reliable antibodies is required for a comprehensive view of cellular subsets and biomarkers. This can be achieved with selected combinations of validated recombinant and hybridoma-derived antibodies, or with an unbiased approach using standardized REAscreen™ MAX Plates containing up to 205 dried-down antibodies.

Unlike other approaches that require challenging conjugation processes or untested antibodies, the MACSima uses cyclic staining of readily available fluorochrome conjugates from an extensive reagent portfolio while maintaining the flexibility to incorporate other antibodies qualified for immunofluorescence.

As the field of spatial biology continues to surge, data analysis software (such as MACS® iQ View) specifically designed to analyze large multidimensional data stacks will be critical to understanding the complexity of tissues and tumor microenvironments. Automation and an end-to-end solution gives the MACSima Imaging Platform the power to overcome historical multiplexing challenges such as manual workflows, a lack of readily available validated antibodies, and the need for robust data analysis software. Now, the platform is demonstrating utility across a wide range of cancer and immunotherapy applications.

Predicting immunotherapy response in lung cancer

In a recent paper, Hinterleitner et al. discovered that platelets expressing PD-L1 (pPD-L1) interact with lung cancer cells and that the pPD-L1 expression level can predict immunotherapy responses in non-small cell lung cancer (NSCLC) (1). Using the MACSima Imaging Platform, the researchers confirmed that NSCLC samples with high pPD-L1 levels show lower numbers of T cells in the tumor microenvironment and fewer infiltrating T cells.

Discovery of CAR target candidates in pancreatic carcinoma

A new publication has revealed target candidates for CAR T cell-based immunotherapy of pancreatic adenocarcinoma (2). The research team, led by Miltenyi Biotec, used a smart combination of data mining, flow cytometry, and ultrahigh-content analysis with the MACSima Imaging Platform to bypass a major roadblock to cellular immunotherapy – the lack of suitable tumor-specific antigens.

New potential target pair for ovarian carcinoma cell therapy

Kinkhabwala et al. used MACSima Imaging Cyclic Staining Technology to analyze human glioblastoma, ovarian, and pancreatic carcinoma, and 16 healthy tissues (3). The researchers showed that EPCAM and THY1 are only co-expressed on ovarian cancer cells and not on healthy tissue, identifying a new potential target pair for CAR T cell-based therapy.

Validation with CAR T cells demonstrated efficient killing of double-positive cells only, suggesting reduced toxicity of CAR T cells.

Spatial proteomic mapping of the liver

By combining multiple spatial transcriptomic and proteomic approaches, Guilliams et al. located and characterized all cells within the murine and human livers on a cellular level (4).

A more complete characterization of the cellular makeup of liver tissue with ultrahigh-content analysis using the MACSima Imaging Platform would enable deeper insights into the effects of disease on the cellular composition and interactions in the liver.

For research use only.

References

1. *C Hinterleitner et al., "Platelet PD-L1 reflects collective intratumoral PD-L1 expression and predicts immunotherapy response in non-small cell lung cancer," Nat Commun, 12, 7005 (2021). PMID: 34853305.*
2. *D Schäfer et al., "Identification of CD318, TSPAN8 and CD66c as target candidates for CAR T cell based immunotherapy of pancreatic adenocarcinoma," Nat Commun, 12, 1453 (2021). PMID: 33674603.*
3. *A Kinkhabwala et al., "MACSima imaging cyclic staining (MICS) technology reveals combinatorial target pairs for CAR T cell treatment of solid tumors," Sci Rep, 12, 1911 (2022). PMID: 35115587.*
4. *M Guilliams et al., "Spatial proteogenomics reveals distinct and evolutionarily conserved hepatic macrophage niches," Cell, 185, 379 (2022). PMID: 35021063.*

In My View

Experts from across the world share a single strongly held opinion or key idea.

The Best-Kept Secret

The 21st Century Cures Act – and its potential to change the face of patient-centered care

By Michele Mitchell, Patient Advisor and Co-Chair of the University of Michigan Department of Pathology's Patient and Family Advisory Council, Ann Arbor, Michigan, USA

Knowledge is power – and both patients and healthcare professionals deserve as much knowledge as they can get. In my view, the 21st Century Cures Act, initially implemented in the US in 2016 and updated December 2020, offers knowledge that can help propel patient-centered care – but, surprisingly, even healthcare professionals are unfamiliar with the law and its recent updates.

The primary purpose of the update is to make health data accessible and available to patients through electronic formats such as smartphones and patient portals. Tucked away in the changes to the Cures Act are the new data-sharing regulations that bar healthcare providers, including laboratories, from engaging in any practice that may interfere with access, exchange, or use of electronic health information.

According to the US Government Federal Register, the new requirement prohibits the blocking of access to medical records and any attempt to interfere with the process. "Interference could take many forms. In addition to the prevention or material discouragement of access, exchange, or use […] interference could include practices that increase the cost, complexity, or other burdens associated with accessing, exchanging, or using [electronic health information] (EHI). Interference could also include practices that limit the utility, efficacy, or value of EHI that is accessed, exchanged, or used, such as by diminishing the integrity, quality, completeness, or timeliness of the data (1)." This provision lays the groundwork for giving patients control of their health information – including clinical or consultation notes, laboratory test results, imaging, and pathology reports – by requiring that it be available electronically in a fully automated manner and free of charge.

My husband and I had an experience which demonstrates the value of immediate access to health care records. We had no idea what could be causing the pain in Bill's intestines and mid-back region, but his mother died of colon cancer and he is also monitored for renal cancer due to a genetic mutation, so you can imagine our concern. After several sleepless nights, we made our way to our local hospital emergency room. Unfortunately, it was at the height of the Omicron surge in our state, so we sat in the busy ER for hours, anxiously awaiting test results. Through my own patient advocacy work, I was familiar with the Cures Act and wondered – could my husband's test results be in his patient portal in real time?

Sure enough, all his lab tests and CT scan results were available in his patient portal. Using the only device I had at the time, my smartphone, I searched online for explanations of the medical terms in the various reports to help me understand his condition. Before the emergency room doctor was able to deliver the news, we were surprised and relieved to discover that he had nothing more nefarious than his first-ever kidney stone.

Armed with this information, I went to the nursing station to ask when my husband might see the doctor. The nurse replied that the doctor was still "waiting on the labs and CT scan" – so I told her that the results were already available in my husband's portal, using my phone to show her the reports. She was unfamiliar with the new Cures Act requirement, so I took the opportunity to educate her on the basics of the new mandate. The nurse promptly paged the ER doctor – and, shortly thereafter, Bill received his discharge instructions, freeing up an emergency room pod for another patient.

Lorraine Rosamilia, Geisinger Health System, says, "The ability for

patients to own their medical data, securely access and maintain it in their portable devices, and provide time and health care worker economy for data transfer, are good technology advances (2)." The data can be used to mount and expand educational initiatives for health professionals, patients, and families; to take medical records into the next generation; to maximize patient safety; and to promote shared decision-making between clinicians and patients. It engages the patient population in transparent communication and supports family caregivers at a time of extraordinary stress.

Patients want to understand their health – and doctors should not possess information patients can't access. By giving patients immediate access to their medical data, the new rule can lead to true partnerships with care teams. It is my hope that this expanded view of care will lead to the creation of patient-inclusive diagnostic management teams (DMTs). These teams involve a number of experts who meet to discuss test selection and interpretation in a specific disease or group of diseases – but what if the idea were expanded to include patients? Laposata mentions the need for "a simpler process that considers privacy issues and ease of use so that an expert in one geographic location can help a pathologist or other healthcare provider elsewhere in a timely and consistently effective manner (3)." The Cures Act's medical information portability requirements could address his concern. In addition, "… diagnostic management teams improve diagnostic accuracy and ensure the patient gets the right therapy faster. Both benefits contribute to substantial reductions in the cost per healthcare encounter (4)." The Cures Act creates the opportunity to make visible every test a patient receives relative to their diagnosis – and paves the way for DMTs to form the future of every patient's healthcare team.

This type of expanded care will help patients understand the role that the pathologist and the laboratory play, encouraging mutually beneficial partnerships that, in turn, will elevate the field. In such a system, patients can access their test results, research, and formulate questions prior to a clinic visit, increasing efficiency. However, patients need vetted tools, applications, and information to gain a better understanding of reference ranges and medical terminology. That's why I believe more outreach by the provider community is vital – and I'm far from alone.

"The primary purpose of the update is to make health data accessible and available to patients through electronic formats such as smartphones and patient portals."

Thanks to the access granted by the Cures Act, opportunities for better-informed dialogues between patients and pathologists are already cropping up. Lija Joseph, a pathologist at Lowell General Hospital and a maverick in the field of pathology-patient consultations, echoed this in a recent article. "The 21st Century Cures Act will create additional opportunities where a patient and pathologist can finally meet as the patients access their pathology reports online," she writes. "They will see the pathologists' names on the reports and seek them out if they need more information (5)." At Lowell General, patients are already seeking out their pathologists for detailed information. When asked about the new law, Joseph says she has not yet seen an increase in her workload. However, she admits that "patients are not aware of the new law and hospitals have not been very eager to advertise this option!" The barriers to awareness are clear – so Joseph urges institutions to offer more education. "An active communication and outreach campaign is the most effective way to 'get the word out.'"

James Wisecarver, a pathologist at the University of Nebraska Medical (UofN) Center, is an early adopter of the notion of patients' meeting with their pathologists, so I was curious as to whether the Cures Act had impacted his work. "Since the new Cures Act rule, I have had two patients contact me regarding their pathology reports," he says. "One had a newly diagnosed cancer; the second was confused regarding the wording in the pathology report. In the cancer case, the patient had initially tried to contact her primary physician, but was unable to reach them. I welcome any calls regarding the information contained in my reports and I am also happy to sit down and review slides with patients. However, at the UofN Department of Pathology, we have only just begun to have conversations as to how best to respond when these calls eventually come in."

I also spoke with Anne Buckley, a pathologist at Duke Health System. She has made herself available to patients to review their pathology reports and conducts patient-pathology consultations in which she explains the complexities

of a patient's disease. She feels a sense of responsibility to patients and maintains that it is "the right thing to do." Buckley is so forward-thinking in this area that she includes her contact information within her pathology reports so that patients can get in touch. I asked her if she had seen heightened patient desire for contact since the emergence of the Cures Act – and she has. "Previously, I tended to get inquiries from patients who had spent years trying to get a diagnosis for a rare neuromuscular disorder. They wished to talk to me about their diagnostic odyssey and to discuss the level of certainty in the diagnosis of overly complex, chronic medical conditions. However, since the implementation of the new requirement, I have seen an increase in patient inquiries about cancer diagnoses (in my specialty, brain tumors) as they seek better understanding. Because molecular testing has become much more important in diagnosis and prognosis, patients often have questions about what molecular test results mean – and because pathologists are well-placed to explain molecular tests, we have a key role to play in patient education. The Cures Act has been beneficial and a timely development in that regard. Patients are increasingly active in their medical decision-making and pathologists are now more visible to patients as an additional source of information on their disease."

Since implementation, Buckley says, "I have received an increasing number of phone calls from patients about their pathology reports shortly after I sign them. Patients tell me that they really appreciate my taking the time to chat with them, because I can provide explanations, reassurance and general information on process (for instance, with delays). However, I cannot tell patients the next steps in treatment and I am not with them in person. In certain cases, it would be much better if they were to hear their diagnosis from their treating physician. I am available to talk to patients any time after diagnosis but, before I sign out a case with an unexpectedly bad outcome, I always contact the treating physician so that they have time to call the patient first. I am strongly in favor of patients' having full and timely access to their medical information and, in most cases, this immediate posting is helpful and empowering. However, we must be careful to structure the system so as not to leave patients stranded in front of a computer screen looking at reams of data without anyone to explain it. We must make sure we provide human contact and connection right at what may be one of the worst moments of a person's life." I could not agree more with Buckley, who clearly understands and is responding to the notion of patient-centered care.

The American Society for Clinical Pathologists supports the added information-blocking requirement in the Cures Act. Matthew Schulze, Director of ASCP's Center for Public Policy, supervises the group's public policy activities and works with their commission on development, implementation, and oversight. At the 2022 ASCP Leadership Conference, Schultz acknowledged that, although there have been concerns from physicians and other medical groups, the ASCP will not oppose the new law. He said, "The ASCP has a policy of supporting the right of patients to obtain their test results and has embarked on several initiatives to begin to address the issues."

Jeffrey Myers, a noted pathologist and Vice Chair of Clinical Affairs and Quality at the University of Michigan Department of Pathology, is also Chair of the ASCP Patient Champion Steering Committee. He says, "We need to shift the paradigm about how we share information with patients regarding their healthcare and become the conduit for what results mean. Labs are often the only constant in how patients receive care." And what about the issues around helping patients understand their results? "Patients are looking at reports they do not understand; we can help empower patients while also elevating the profession. We need to start sharing the right information at the right time and empower the lab community to do more outreach and partnering with clinicians to provide quality care to patients. We should do more outreach to patients who receive bad reports – people engage more when they get a bad result, so it may be wise to start there. Another problem is what patients do with the information they obtain – making phone calls to physicians, caregivers, and advocacy organizations that lend patient support could overburden the system. If the prime focus is to help patients, what we create might help physicians too as an indirect benefit."

Education on the Cures Act is the key to ensuring that patients and providers alike are aware of its benefits. This new law is empowering, but only if patients get the help they need to understand and interpret their reports. There is a vast amount of information and, unfortunately, misinformation on the internet. Patients will need vetted resources, reputable links, and more outreach from the provider community to patients to share test results, laboratory and pathology information in ways that are affirming and useful. This presents an opportunity for pathology and laboratory professionals to take the lead and begin to redefine the role they play in patient care and education.

The new Cures Act update is a true gift to patients. Having clinical and consultation notes, tests and laboratory results, imaging, and pathology reports freely and easily available is a game-changer. I believe it will redefine multidisciplinary care teams; in fact, I would call this new mandate the most consequential piece of legislation in patient-centered care in years. A cultural change in the field of medicine may be fast approaching – one that may be an important push toward precision medicine for all. My husband and I felt the power of the law; I hope you will, too.

See references online at: tp.txp.to/best-kept-scrt

Easing the Panic

How a pathology message pool can help put patients' minds at ease

By Sara M. Barcia, Golrokh J. Sepehr, and David Kindelberger, Atrius Health, Needham, Massachusetts, USA

One of the intentions of the 21st Century Cures Act – first passed in 2016 – was to ensure that patients have full, portable, cost-free access to their healthcare information. Over the past few years, many concerns have been raised among pathology and laboratory medicine communities in preparation for compliance with the Act. Among these concerns, the risk of potential psychological harm to patients sits at the top of the list. Having a biopsy is stressful enough and waiting to receive the report can add even more layers of anxiety – but, at the same time, understanding these highly technical reports can be challenging for patients. At my organization, we pathologists wanted to offer supportive resources to ease the panic our patients might feel when reading their report without fully understanding it and before speaking with the treating provider. We tried to put ourselves in our patients' shoes and, after talking with several pathology groups, we decided to offer three main services:

1. Providing a link to an approved online glossary of pathology-related terms.
2. Making the patient aware that they may be seeing these results before their treatment provider has seen them.
3. Offering a method for patients to directly contact a pathologist.

Though the first two goals were relatively easy to implement, the third was something we had not seen elsewhere – providing our Epic Beaker Analysts with an implementation challenge.

As an outpatient, predominantly biopsy-driven pathology lab, we are in a unique position to act as general pathologists. Because we can answer a variety of questions, we created a pathology message pool that allows patients to directly message us with questions about their pathology reports. Through a link on the report, patients can send messages via our patient portal (although we clarify that we prefer patients to discuss results with their doctor first and then message us if they have additional questions). Expected response time is three business days, but we usually answer questions within two. We also make it clear that the message pool is not for urgent clinical communication or a second opinion for reviewing slides.

The pool is currently monitored by a weekly rotating group of five pathologists. They have reported enjoying the interactions with patients and being able to answer questions that put people's minds at ease. Monitoring the message pool has not affected normal workflow and is done in addition to normal service workloads.

Since going live six months ago, the pathology message pool has had 30 patient messages, each taking approximately seven minutes of a pathologist's time to answer. Questions were mainly about skin and GI biopsy results, which is not what we anticipated; we expected to receive questions about cancer reports, particularly from our breast cancer patients. Some patients asked about the next steps they needed to take based on their reports and others had questions about terminology and the meaning of their diagnosis. In some instances, we were able to help our patients get in touch with appropriate clinicians for follow-up and treatments.

> *"Monitoring the message pool has not affected normal workflow and is done in addition to normal service workloads."*

Overall, we have enjoyed implementing this service and we know of no other pathology group providing direct contact via the patient portal. Patient feedback has been positive, with many thanking us for our prompt attention. In the few months since its implementation, we have seen a decrease in the frequency of messages through the pool, but we continue to let clinicians know the service exists and encourage them to bring it to the attention of patients undergoing biopsy. Going forward, we hope to increase our message volume and continue to provide this novel service – connecting patients with pathologists and making their healthcare journey more transparent.

The First 100 Informs the Next

A century of advocacy has offered many lessons – and the next 100 should be even greater

By E. Blair Holladay

Throughout this year, we've been celebrating the 100th anniversary of the American Society for Clinical Pathology (ASCP). Now that we are just over halfway through 2022, it's hard not to stop and reflect on the accomplishments pathologists and laboratory medicine professionals have made in the past century. To say that we have changed the face of medicine would be an understatement. The advances the laboratory has made in research and patient care have indelibly altered the way medicine is practised.

As part of our celebration, editorial board members of AJCP and Laboratory Medicine have written essays looking at how far we've come in pathology and laboratory medicine, covering topics such as vaccination resistance, how the clinical microbiology laboratory has evolved, the importance of hospital laboratory stewardship, how the evolution of cytopathology has influenced the diagnosis of cervical cancer, and more. It is astounding to see how much has changed over the last 100 years – and how much has stayed the same. The things that haven't changed have proven to be foundational for our field and, without them, we would not have been able to solidify our critical role in patient care.

Since its inception, ASCP has also been a fierce advocate for the laboratory on both the national and global stage. Medicine has changed drastically since 1922 and, over the 100 years since, the laboratory has faced its share of challenges. In the early years of ASCP, the Society saw the need for mandatory standards for laboratory professionals to ensure quality training and we have not lapsed on that commitment.

As laboratories have evolved over the years, so too has licensure, and ASCP has played a critical role in licensing laboratory professionals and ensuring that other professions do not encroach on the laboratory. In 2016, when the Centers for Medicare and Medicaid (CMS) sent a memo to CLIA inspectors stating that a bachelor's degree in nursing was equivalent to a bachelor's degree in biological sciences and therefore nurses would be allowed to perform high-complexity testing, ASCP pushed back. The Society argued that the two degrees were not equivalent and that nurses did not have the proper training to perform high-complexity laboratory testing. CMS received more than 10,000 comments on this issue, only a handful of which supported their position; consequently, there has never been a rule.

These are just two of the many issues ASCP has tackled in its history and, without a doubt, there will be many more in years to come. At the core of our society, we hold close that, without the laboratory – and the diagnostics, research, and everything else we provide – healthcare would be little more than a guessing game for patients and physicians. It is our calling and our duty to advance research, to educate ourselves and the public, to challenge injustices, and to advocate for the laboratory to ensure that we solidify our place at the center of healthcare – now and for the next 100 years.

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Collaborating Early to Advance Precision Medicine

A look inside Thermo Fisher's CDx program with Garret Hampton

Companion diagnostic (CDx) tests are powerful tools in precision medicine and help advance more widespread use of targeted cancer therapies. The US Food Drug Administration (FDA) defines CDx as "essential for the therapeutic product's safe and effective use." Particularly when based on next-generation sequencing (NGS) technology, CDx tests make therapeutic decision-making more precise, reduce the overall cost of care and, most importantly, potentially help cancer patients live better, longer lives. When used broadly and early, these tests can help ensure that patients receive the right treatment – right away.

To advance precision medicine, CDx and targeted therapy development should be closely aligned. In fact, the FDA has provided a regulatory framework to encourage co-development of CDx tests and targeted therapies. For years, Thermo Fisher has worked closely with its biopharma partners and, in 2017, announced the first FDA-approved CDx for use in testing non-small cell lung cancer (NSCLC) patient samples, the Oncomine Dx Target Test. Since then, Thermo Fisher has secured regulatory approval for companion tests to enable the use of 11 targeted therapies in NSCLC and one in cholangiocarcinoma. Thermo Fisher currently provides the only globally distributable multi-biomarker NGS CDx solution that is approved and reimbursed by governments and commercial insurers in more than 15 countries, covering over 550 million lives globally.

Lately, Thermo Fisher has gained FDA approvals for companion diagnostics developed with Servier Pharmaceuticals for ivosidenib (TIBSOVO) in cholangiocarcinoma, and Eli Lilly and Company and Takeda Pharmaceuticals for selpercatinib (Retevmo) and mobocertinib (EXKIVITY) in NSCLC. The company also announced a multi-year global collaboration with AstraZeneca to develop companion diagnostics for targeted therapeutics in AstraZeneca's precision medicine portfolio. Through this agreement, the companies will co-develop CDx tests for use on the Ion Torrent Genexus System. Using this fully integrated and automated NGS platform, pathologists will be able to provide clinicians with test results that may guide faster and more effective patient treatment.

Garret Hampton, president of clinical next-generation sequencing and oncology at Thermo Fisher, discusses the value of co-developing companion diagnostics and how broader access to these next-generation sequencing-based tests can advance precision medicine…

Garret Hampton

President, Clinical Next-Generation Sequencing and Oncology, Thermo Fisher Scientific

Why are we seeing so much news about companion diagnostics now?

In 2020 alone, the FDA approved 20 new personalized drugs and biologics. As the pharma and biotech industry continues to develop targeted therapies, we should see a corresponding increase in CDx development. The FDA and other regulatory bodies encourage co-development of the test with the drug, stimulating collaboration between pharma and diagnostics companies earlier and more often.

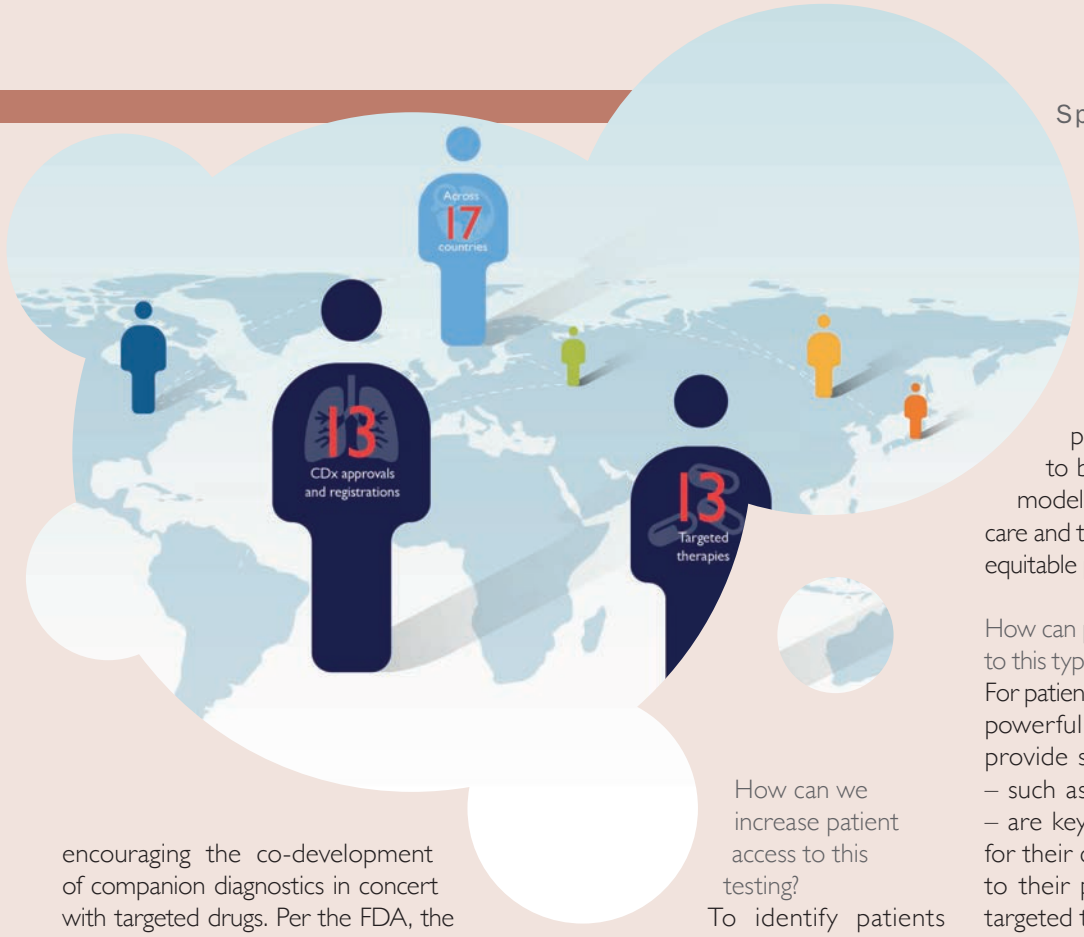
The pipeline for targeted therapies is growing larger and countries are establishing new regulatory pathways to ensure access to these treatments – so it is increasingly important for pharmaceutical and diagnostics companies to work hand-in-hand to give all patients access to precision medicine. Early and equitable access can improve outcomes at a population level – and that's certainly newsworthy.

Just as biopharma companies are innovating to support targeted therapy development, so too are diagnostic companies. Advancements to diagnostic technologies over the last several years are enabling more effective CDx development with the ability to read out many biomarker results at the same time. With sequencing equipment that is relatively easy to use thanks to increased automation and fully integrated workflows, more patients can access targeted sequencing results at their local hospitals. If appropriate, they can be quickly matched with one or more of a growing pool of targeted treatments when timely decisions are critical to patient outcomes. This is of particular importance with diseases such as lung or blood cancers, which are often diagnosed in later stages with no time to waste before starting treatment.

With an increasing number of approvals for NGS-based CDx tests, we're also seeing increased adoption of this technology. NGS is particularly well suited for CDx applications because it enables multi-biomarker testing from a single patient sample so that a clinician can see if a patient is a match for one of many targeted therapies. This multi-biomarker/multi-therapy approach is a unique value proposition that next-generation sequencing provides over other forms of testing.

What is the value of co-developing companion diagnostic solutions?

In 2014, the FDA issued guidance titled "In Vitro Companion Diagnostic Devices,"



encouraging the co-development of companion diagnostics in concert with targeted drugs. Per the FDA, the clinical performance and significance of the CDx should be established using data from the clinical development program of the targeted therapy.

The promise of precision medicine is not limited to the US; the availability of new regulatory pathways in countries around the world is enabling biopharma to take a global approach to new drug launches. This means that new therapies and accompanying CDx tests will move through regulatory approvals in multiple countries – creating new challenges, but also extending the potential reach of targeted therapies' benefits more broadly and equitably.

It also highlights the need for broader partnerships with CDx providers whose tests are globally distributable and who have an established track record of approvals and registrations in several countries. Deep partnerships, such as the one recently announced with AstraZeneca, enable better resource sharing and accelerate development. This collaborative approach has become the foundation for our CDx partnerships at Thermo Fisher, in many cases allowing our CDx to receive approval simultaneously with new targeted therapies.

How can we increase patient access to this testing?

To identify patients who are eligible for new targeted therapies – and intervene early to increase likelihood of success – clinicians need early and easy access to the results from NGS-based tests. Today, most testing is centralized in large reference labs. We need to ensure that NGS testing is financially viable and easy to use so that smaller community hospitals can adopt it. This will ultimately increase the amount of testing done where patients are diagnosed and treated.

The decentralization and democratization of NGS testing has been our vision and passion at Thermo Fisher. We are simplifying the technology for use in clinical labs, but we are still in the early stages. As a community, we must help generate evidence for clinical utility and ensure that in-house testing brings the superior patient outcomes we all hope for.

What barriers exist to match patients with these therapies?

We have made strides with the technology, but the clinical utility I referred to above is essential to ensure that these tests are reimbursed. As more studies are done, the evidence for NGS as an efficient and cost-effective CDx solution mounts. Ultimately, these data – and support from patient advocacy groups and policymakers – are what's needed to build sustainable reimbursement models that reflect the true cost of care and the correlation with better, more equitable patient outcomes.

How can patients ensure they have access to this type of testing?

For patients, information and advocacy are powerful tools. Advocacy groups that provide support, education, and tools – such as LUNGevity for lung cancers – are key to helping patients advocate for their care and enabling them to talk to their physicians about the value of targeted therapies and the tests needed to access them.

The number of beneficial therapies, many of which require CDx tests, has and continues to increase. It's no longer suitable to conduct one, or two, or three specific tests; patients need to be tested simultaneously for all biomarkers relevant to their disease. The ultimate value of this is time – patients do better overall if the first therapy they receive is the right therapy. If the treatment journey starts in the wrong place, the chances of a positive outcome decrease.

Ultimately, the healthcare system will provide more institutional support for precision medicine approaches such as NGS-based genetic testing because the opportunity for equity and economic benefit is compelling. As we see this future unfold, Thermo Fisher's early collaboration with biopharma partners on a global scale will continue in earnest so that the rising tide of discovery – from advances in NGS to promising new therapeutic targets – can lift us all as one.

For more information about Thermo Fisher's companion diagnostics solutions, visit oncomine.com/pharma.

the Pathologist
POWER LIST

It's hard to believe this is the seventh iteration of our annual Power List – celebrating the brightest stars in the galaxy of pathology and laboratory medicine! Our 2022 list includes great and influential minds from all corners of the lab – and each one was first nominated by you and then handpicked from the long list of names by our panel of 10 expert judges.

Do we believe our list is definitive? As ever, no! But we hope you find this year's selection not only inspirational, but also reflective of the brilliance found in so many areas of this wonderful field. This year, the list features five categories:

- **Ready for Take-Off**, for early-career "rising stars"
- **Ground Control**, for non-pathologist laboratory professionals
- **Voyage of Discovery**, for educators and mentors
- **First Contact**, for outreach and advocacy leaders
- **Strange New Worlds**, for those driving new discoveries and innovations

The 2022 Power List greets 48 newcomers and 27 returning stars– congratulations and we hope to see you continue your meteoric rise!

Welcome to The Power List!

IF YOU WANT TO READ MORE OR SHARE THE POWER LIST WITH A COLLEAGUE, IT CAN BE ACCESSED ONLINE (FOR FREE) AT THEPATHOLOGIST.COM/POWER-LIST/2022.

READY FOR TAKE-OFF

ADAM L. BOOTH

Cells brought Adam to pathology. As a premed student, he loved "learning about the cells and the biochemical and physiologic processes occurring inside them" and witnessing firsthand how physicians can greatly impact the welfare of their patients. His colleagues see him as a premier new-in-practice pathologist who has had an impressive start to his career and will only continue to grow. When asked for advice to newcomers, he says, "I'm just starting out, but I was told that you don't have to be a hero – show cases, ask questions, keep learning, and focus on being a good pathologist."

ANTHONY CARDILLO

The future of pathology lies in AI – and Anthony is no stranger to that fact. Kickstarting his career with a focus on AI ethics, Anthony has secured an informatics fellowship and clinical pathology faculty position at New York University. For the future, Anthony hopes to steer the field in the right direction for responsible use of AI in the lab. He predicts that writing patient notes won't exist in the near future, with everything integrated into the electronic medical record to create a continually evolving patient "story."

D. YITZCHAK GOLDSTEIN

"I have always dreamed of being a watchmaker," says Yitzchak. "The complexity and exactness required for maintaining adequate functioning of manual timepieces is astonishing." But, instead, Yitzchak became a watchmaker of the human body. Today, he is Director of Molecular Pathology Testing and of the Virology Laboratory at Montefiore Medical Center and Assistant Professor of Department of Pathology at Albert Einstein College of Medicine. His interest in molecular pathology arose from his admiration of nucleic acids' uses in healthcare – from genetic screening to identifying infectious organisms.

KATE FENNA

Just seven years into her career, Kate is Principal Clinical Biochemist and National Clinical Fellow at Hampshire Hospitals NHS Foundation Trust. She also works in the Office of the Chief Scientific Officer at NHS England and NHS Improvement. At the start of the pandemic, Kate took on the role of STP Training Officer, successfully managing five sites of trainees. She has already earned a number of prestigious awards and achievements – and her energy goes beyond medicine; a dance lover, Kate says her alter ego is "definitely a backing dancer for a huge A-lister like Beyoncé."

KATY HEANEY

Katy is Consultant Clinical Scientist and POCT Speciality Network Lead at Frimley Health NHS Foundation Trust, on behalf of the Berkshire and Surrey Pathology Network, and inspires colleagues through her passion for healthcare. During the pandemic, she took on the role of Point of Care Workflow Programme Lead COVID-19 Operational Supplies for the Department of Health and Social Care and spearheaded the #PathologyRoad campaign, which highlighted pathologists' work via social media. Her advice to the next generation? "Be curious; don't accept 'this is how it is' as an answer. Read about it, research it, ask those around you why."

LAILA NOMANI

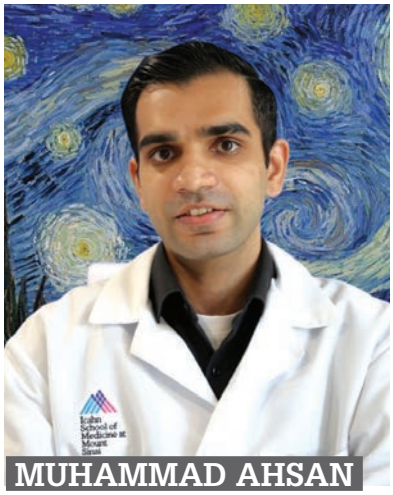
Laila is involved in every aspect of pathology, from education to quality assurance. Currently Assistant Professor at the Department of Pathology, Medical College of Wisconsin, Laila is a vital part of the cytopathology and head and neck pathology service, a member of multiple tumor boards, an author and contributor to Ace My Path, and a keen advocate for up-and-coming pathologists. She is also heavily involved in wellbeing, citing that "stress and burnout in pathology and laboratory medicine is real and we must advocate for prevention, early recognition, and provision of unequivocal support and empathy to those experiencing these challenges."

MITUL B. MODI

"Never, ever give up!" is Mitul's message to fledgling pathologists – and, with plenty of accomplishments already under his belt, it's clear that he follows his own advice. Mitul is Dermatopathology Fellow at Loyola University Medical Center, and was previously Hematopathology Fellow at Albert Einstein College of Medicine, and a resident in Anatomic and Clinical Pathology at Pennsylvania Hospital in Philadelphia. Within a year of completing his residency in pathology at a tertiary care cancer center in Western India, Modi started another in the United States, where he rotated through pathology departments at five different institutions in five different states.

MOHAMMAD IBRAHIM BAROUQA

Mohammad's drive comes from two places: the educated insight of healthcare professionals and the outside-the-box thinking of tech-savvy innovators. Where some would see a contradiction, Mohammad sees his place in wider healthcare – a position where experts can combine their knowledge with cutting-edge technology to create the best outcomes for their patients. To him, being a pathologist or physician does not preclude anyone from participating in the technological race. A keen technologist, Mohammad believes that digital pathology and artificial intelligence (AI) have the potential to be great ancillary tools if used appropriately.



MUHAMMAD AHSAN

Following in the footsteps of his pathologist heroes, Muhammad has been a keen adopter of social media as a tool for promoting pathology education. A pathology resident at Chughtai Institute of Pathology, Muhammad spearheads the social media accounts for his institution – currently the only residency program in Pakistan with a social media presence. So far, he has been a shining example of how pathology can engage the public online. His advice to those looking to start a similar career? "Be creative and always put yourself forward for leadership roles."

ROJEET SHRESTHA

When his friends were preparing for their degrees, medicine was the last thing on Rojeet's mind. It wasn't until a bad case of typhoid that he realized the importance of laboratory science. Inspired by the treatment he received, he chose to work at a general and leprosy hospital – which further cemented his love for laboratory medicine. In his own words, "At the age of 22, I was fully determined to be a laboratory professional for the rest of my life." Today, Rojeet is a technical director at Indiana's Patients Choice Laboratories and has over 20 international awards to his name.

NEHA VARSHNEY

"A supportive department is crucial for the overall development of junior pathologists," says Neha. Although still in the early stages of her career, she has already proven herself a supportive colleague through her effective education of residents, for which she was lauded by nominators. Known for her aptitude and enthusiasm in the lab, Neha is also keenly involved in a number of committees on a local, state, and national level. She looks forward to the future of the field and anticipates great leaps in patient care in remote areas thanks to advancements in telepathology.

RYAN O'CONNELL

Described as providing "outstanding contributions" and having "an exceptional record of service," Ryan is an invaluable member of the Department of Pathology and Laboratory Medicine at UC Irvine. Not only did he take a central role in the development and validation of remote sign-out for frozen sections and primary diagnosis, Ryan also co-leads the Pathology Artificial Intelligence Interest Group and is a member and informatics specialist for the UCI-ICTS Critical-to-Quality Studio. Despite his many responsibilities, Ryan is also a dedicated teacher – regularly receiving praise from his trainees for his professionalism, project management, and leadership skills.

SASWATI DAS

Though still early in her career, Saswati has her eyes set firmly on the future. From her enthusiasm for AI to her admiration for the developments in spatial transcriptomics, her forward-thinking attitude is clear. Saswati is also interested in ethical dilemmas in the laboratory and how these need to be addressed to achieve better patient care. It's her opinion that soon, biosafety, pandemic preparedness, and crisis management will all take center stage in the field. Currently, she is Assistant Professor at Atal Bihari Vajpayee Institute of Medical College and Dr. Ram Manohar Lohia Hospital, Central Health, India.

SOUFIANE Z. AZDAD

Becoming a pathologist was the last thing Soufiane expected – but, after much convincing from a friend, he took the chance… and found his true calling. Today, he is a passionate advocate for technology in pathology. Among other things, he assisted in the design and manufacture of a new macroscopic examination device inspired by his first-ever day in the lab. "I was shocked to discover that the macroscopic examination was done in one shot [and] the specimen ended up fragmented in a bucket of formalin," he says. "I spent long nights thinking about how to resolve that problem."

GROUND CONTROL

ALLAN WILSON

"I have more than 45 years' experience working in the cervical screening program," says Allan, "but, over the last 15–20 years, I have been heavily involved in the introduction of significant changes culminating in the move to using HPV testing as the primary test and cytology as the triage test." As Lead Clinician for the Scottish Cervical Screening Programme, Allan's dedication to the field has helped to provide screening for Scottish patients. During the course of the pandemic, he was celebrated for his medical communication skills, which he displayed regularly on national and international television and radio news.

CARLO LEDESMA

For eight years, Carlo has been Director of the MLT and Phlebotomy Program at Rose State College in Midwest City, Oklahoma, where he has influenced many colleagues and hundreds of students during his tenure. As the oldest of eight siblings living in the Philippines, Carlo never thought it would be possible to enrol in post-secondary education – yet he successfully graduated from one of the most prestigious universities in Manila. Today, he helps students from similar backgrounds become laboratory professionals through the MLT program, which boasts an impressive 90 percent passing and employment rate.

COURTNEY HYLAND

Courtney wears many hats in her job: pathologists' assistant, laboratory medicine and pathology instructor, and assistant supervisor at Mayo Clinic, Minnesota. She also serves as an American Association of Pathologists' Assistants Board of Trustees member and has a passion for forensic pathology – holding a certification from the American Board of Medicolegal Death Investigators. If that wasn't enough, she also plays an invaluable role in the AAPA Forensic Task Force and leads the Content Review Team for the AAPA Grossing Guidelines. Courtney's responsibilities in reviewing and contributing to the Grossing Guidelines means she has a huge impact on patient care everywhere.

DAVID WELLS

The most unexpected moment of David's career was when he found himself leading the COVID-19 testing response for NHS England. Becoming the voice of laboratories during the pandemic is a testament to his skill in biomedical science. He was also responsible for expanding NHS testing capacity from 2,000 to 25,000 tests per day. David is now Chief Executive at the Institute of Biomedical Science, leading the professional body for biomedical scientists with more than 20,000 scientists, support staff, and students. David's unique positions, coupled with his experience and scientific contributions, have made a huge impact.

DIANE E. SPICER

It was in high school Advanced Biology class that Diane got her first taste of pathology. Those early days were spent dissecting and examining the anatomy of everything from frogs to fetal pigs. Today, Diane loves autopsy pathology and specializes in fetal and pediatric autopsies; she says, "This is what I was meant to do." Her work spans multiple organizations, collections, and publications, and she currently supports academic specimen materials for Johns Hopkins All Children's Hospital and the Congenital Heart Academy, where she has helped to provide invaluable study materials for cardiology and pediatric medicine.

EMILY LOTER

A noteworthy advocate for the pathologists' assistant community, Emily holds the role of Vice Chair of Education for the American Association of Pathologists' Assistants. Described as "an integral part of national PA education" and "a natural moderator with a calm, funny, confident manner," she is also a major contributor to three national conferences and has helped create a four-part series on diversity, equity, and inclusion in the field. Emily sees a bright future for the PAs, with their "scope of practice growing exponentially in the near future" and an increased presence in forensics, fellowships, and other high-level areas of responsibility.

LAURA SEVERS

After over a decade in laboratory medicine, Laura is still excited by all of the innovation and creation in the field. This innovation extends to recruitment too, and Laura hopes that we will start to see people taking more non-traditional routes into the field. "Not every path is straight and narrow," she says; organizations "need to embrace the beauty in diversity and provide support for those who want to have a career in laboratory medicine." Nominators complimented Laura on her professionalism and connection to her patients, calling her "an indispensable part of the patient care team."

LINDA SAYBURN

As the recipient of the 2021 Hospital Super Heroes Chairman's Outstanding Achievement Award, Linda is no stranger to accolades. Though she is an experienced biomedical scientist specializing in microbiology, Linda's colleagues believe that compassionate leadership is her greatest skill. As Pathology Operations Director, she led the establishment of COVID-19 testing in her region and successfully balanced the need to maintain existing services with the rapid development of new ones. Today she is valued as a supportive leader and a driver of equality in pathology – and sees herself as "a great believer in developing people and giving them opportunities."

NIKI BOISSO

"I was looking for jobs that would allow me to be involved in autopsy without having to be a doctor… I learned that there was a job that fit that description perfectly – pathologists' assistant." Stumbling into the world of pathology was one of the best things to happen to Niki's career; she now proudly works as Bellevue Hospital's (New York City) first and only PA. Niki is also an extremely active contributor to the American Association of Pathologists' Assistants via their Education Committee and (using her background in theater) on the production team for virtual events.

MALCOLM ROBINSON

When he was young, Malcolm's love of the sea led him to join the Royal Navy. Afterwards, his love of the lab led him to become a biomedical scientist. Today, Malcolm's focus is solely on charity – specifically through Harvey's Gang, the organization he founded to give young patients laboratory tours and healthcare education. The charity's aim is to offer comfort and understanding to children undergoing medical care. Inspired by one of his young patients – from whom the charity takes its name – Malcolm not only promotes appreciation of the field, but provides a vital service in positive patient experiences.

PATRICK KUMAH

It's hard to deny that Patrick is a leader in his field. Not only is he currently a Consultant Biomedical Scientist in gastrointestinal histopathology, but he was one of the first scientists in the UK to be appointed to the position. Through this role and his work in supporting the training and development of fellow biomedical scientists through the National Histopathology Reporting Conjoint Board, he has a positive impact on patients and colleagues everywhere. Patrick is excited for the opportunities that digital pathology offers to his field and hopes technology will yield a completely new standard of care for patients.

PAULO CUNHA TEIXEIRA

A driving force in the Portuguese National Technicians Institution, Paulo is also a biomedical scientist at the Polytechnic Institute of Coimbra and Vice-President of the Portuguese Association of Anatomical Pathology Technicians. Paulo has helped to improve many laboratories' immunohistochemistry capabilities and has implemented multiplex IHC methodology with great success – a rare feat in his home country of Portugal. He believes that the ability to sequence massive amounts of biological samples is one of the most important and impactful developments in the field. Nominators called him "an outstanding lab technician!"

SANAM KOIRALA

In the diverse specialty that is lab medicine, Sanam is uniquely aware of how important different career paths are. As CLIA Laboratory Medical Director at Solaris Diagnostics Laboratory, he is a role model for up-and-coming professionals looking for opportunities. Sanam believes that one of the biggest breakthroughs in the field is the increase in advanced degrees and doctorates in clinical laboratory science (DCLS), which offer advanced practice opportunities across educational institutions, clinical facilities, government organizations, and more. He strongly believes that DCLS programs help reduce diagnostic errors by improving communication between the clinical laboratory and health care providers.

VÉRALÚCIA "LOU" MENDES-KRAMER

Lou is a Forensic Pathologists' Assistant, Program Director, and Assistant Professor (Clinical) at the Wayne State University Pathologists' Assistant Program. Her interest in pathology began after shadowing pathologists in her undergraduate anatomy dissection laboratory; seeing autopsy and anatomy come together set her on course to become a forensic pathologists' assistant. Undeterred by advice that "PAs don't work in forensics," Lou achieved her dream position through a mix of interest, networking, and a lack of fear in breaking down barriers – and she hopes to see other PAs follow in her footsteps to make a positive impact on pathology workforce shortages.

XANDER VAN WIJK

Xander is a board-certified clinical chemist and Senior Director of Medical and Scientific Affairs at Beckman Coulter Diagnostics. He has extensive experience in clinical chemistry, mass spectrometry, blood gas testing, toxicology, and molecular diagnostic testing. At the University of California San Francisco, he investigated emerging clinical toxicology cases through collaboration with the California Poison Control System and discovered that the adverse effects and deaths caused by counterfeit drugs were due to high quantities of fentanyl. These published findings were broadly covered in the media, fulfilling Xander's desire to produce impactful work.

VOYAGE OF DISCOVERY

ANDREW FIELD

Andrew is Director of Anatomical Pathology at Sydpath St. Vincent's Hospital, Sydney, Australia. He has been committed to teaching and mentoring trainees, early career colleagues, and laboratory staff for over three decades and is a dedicated editor and contributor to international diagnostic classification and consensus efforts. Most of his committee and advisory work is done on a volunteer basis. He is past president of the Australian Society of Cytology and was recently appointed to the International Academy of Cytology Task Force for promoting cytology education and professional development in developing countries and to the IAC Membership and Site Selection Committees.

ANITA M. BORGES

Described as a "passionate mentor whose heart and soul is dedicated to pathology," Anita is a consultant histopathologist at SL Raheja Hospital, Mahim, and Director of the Centre for Oncopathology, Wadala, Mumbai. Her most memorable moment was being awarded the first Lifetime Achievement Award by the Indian Society of Head and Neck Oncologists – during which, as the daughter of a cancer surgeon, she was delighted to be introduced as a "pathologist who thinks like a surgeon." Her advice to those just starting out? "Work like a pathologist, but think like a clinician."

DAVID C. GAZE

Inspired to pursue pathology as a career at the age of 14, David is Senior Lecturer in Chemical Pathology and Director of Employability, School of Life Sciences, University of Westminster, London, and Co-Editor-in-Chief of Practical Laboratory Medicine. He is passionate about developing career opportunities for students through work-based learning opportunities, placements, and internships. Drawing on his three decades of experience, David advises, "Keep your options open. Be interested in many aspects of the profession and realize there are many job opportunities out there that need an understanding of the science and the industry in a wider context."

FATMA ALZAHRAA A. ELKHAMISY

"Why do diseases occur? What a brain-teaser! What a 'Nobel' science that works behind the curtain to support all clinical sciences in their mission!" says Fatma, discussing how pathology's "brain-challenging" nature sparked her interest in lab medicine. She is Assistant Professor of Pathology at Cairo's Helwan University; faculty in the Basic Medical Sciences Department, King Salman International University, Egypt; and Associate Fellow of the Association for Medical Education in Europe, UK. Fatma believes designing undergraduate pathology curricula is challenging but is committed to improving learning experiences by uncovering the causes of student dissatisfaction.

JAMES M. SZYMANSKI

James is Assistant Professor of Pathology and Assistant Director of Transfusion Medicine at Montefiore Medical Center/Albert Einstein College of Medicine. Described as a "truly highly respected educator, mentor, and pathologist," James mentors residents and fellows and holds daily teaching sessions for trainees in transfusion medicine. He is always in contact with trainees to ensure that they are on the right track, with one resident describing him as "one of the best clinical informatics and biomedical statistics teachers – spending a significant amount of time introducing trainees and assisting them in various statistical methods required for their research."

KAMRAN M. MIRZA

The recipient of several national teaching awards, Kamran is Associate Professor and Vice-Chair of Education, Department of Pathology and Laboratory Medicine, Loyola University Chicago Stritch School of Medicine. He is also co-founder of educational platform PathElective, the Digital Communications Fellowship in Pathology, HemeReports.com, and the PathPod podcast. His interest in pathology stemmed from watching a loved one pass away from cancer complications. He says, "I found myself curious about this 'monster' that grew within a person I loved so much."

L. JEFFREY MEDEIROS

Jeffrey is Professor and Chair of the Department of Hematopathology at the University of Texas MD Anderson Cancer Center. Coming from a family of teachers, he thought he would become a schoolteacher himself, but says, "One of the great things about pathology is that there are many opportunities for teaching and mentoring students and trainees. It is a good fit for me." Jeffrey's main concern is how little attention pathology gets in medical school, causing current graduates to know "less pathology than ever." But he is determined nonetheless, with nominators describing his dedication to medicine and teaching as "unsurpassed."

MARY L. MATTES

Mary is Assistant Professor, Chair, and Director of the Pathologists' Assistant Department at Rosalind Franklin University of Medicine and Science. Her initial interest in pathology arose while working for the University of Iowa's autopsy service as an undergraduate. "Working with families toward closure and helping to document findings after a patient had participated in clinical trials was personally and professionally rewarding," she says. Mary also enrolled in a sailing course out of curiosity four years ago and has been "hooked ever since!" Her advice for the incoming generation? "Have a voice and be the change you want to see."

MORAYMA REYES GIL

Morayma is Director of Thrombosis and Hemostasis Labs, Cleveland Clinic, Robert J. Tomsich Pathology and Laboratory Medicine Institute. She has published over 60 peer-reviewed articles, more than 20 book chapters, and is co-editor of Transfusion Medicine and Hemostasis. Morayma has received multiple awards throughout her career, including an Outstanding Mentorship of Minority Faculty Award and a Clinical Teaching Award; in 2020, she was awarded an NIH-sponsored mid-career fellowship with the C-Change Mentoring and Leadership Institute. Morayma believes that early exposure to pathology in medical school and recruiting medical students into the field is one of the field's major challenges today.

RAJENDRA SINGH

"Technology will never replace the pathologist; it will make you an augmented pathologist who will become the central focus of any personalized medicine system," says Raj, Director of Dermatopathology at Summit Health, New Jersey. As the founder of PathPresenter, he is dedicated to improving pathology education and training using digital pathology. Described as a "role model" and an "excellent leader," he continues to inspire trainees around the world. Raj's advice for the incoming generation of lab professionals? "There are no shortcuts to success – only sincerity with yourself and your work can help you reach the pinnacle of your career."

REBECCA L. JOHNSON

Rebecca is CEO Emeritus of the American Board of Pathology, Tampa, Florida. Her first lessons in anatomy and physiology took place on the Minnesota farm where she grew up. During her tenure at ABPath, she improved the Certification and Continuing Certification programs for pathologists. "I think that all board-certified pathologists, including non-time-limited diplomates, should voluntarily participate in the Continuing Certification Program to demonstrate their commitment to professionalism, life-long learning, and improvement in practice," she says. For those starting out in similar careers, she recommends, "Love what you do and have an insatiable curiosity to constantly learn and improve."

SA A. WANG

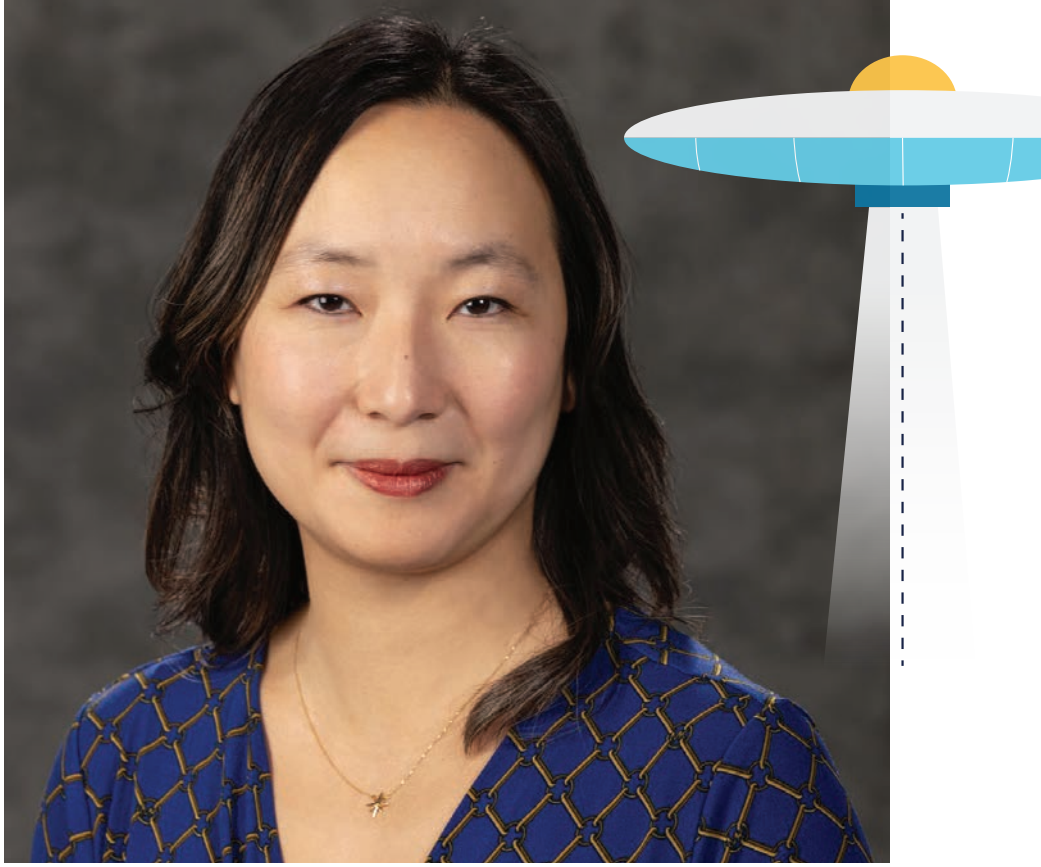
Sa is Professor of Pathology and Section Chief, Flow Cytometry, Department of Hematopathology at the University of Texas MD Anderson Cancer Center. She has been described as an "outstanding physician and teacher who consistently continues to inspire" those around her – actively engaging trainees in her routine signout sessions and hosting teaching conferences. When Sa was a trainee herself, her mentor and role model was Nancy Lee Harris. "She taught me to practice pathology beyond the microscope [...] She taught me the importance of prioritization, discipline, and personal connection in career development."

SANAM LOGHAVI

Sanam is Associate Professor in the Department of Hematopathology, University of Texas MD Anderson Cancer Center. An active and celebrated educator, Sanam is a frequent guest speaker on hematopathology and has raised awareness of the field via online education initiatives, podcasts, social media journal clubs, and more. Her work for PathElective achieved the prestigious CAP Pathology Advancement Award in 2021. To early career professionals, Sanam says, "Take pride in what you do! Pay attention to the details, but always have the big picture in mind; the ultimate goal is to help your patient." But most importantly? "Enjoy the ride."

SHERI SCOTT

Sheri is a Senior Lecturer and Biomedical Scientist at Nottingham Trent University and Fellow of the Institute of Biomedical Science. She has become a leader in establishing sustainable laboratory practices – an issue she believes is moving in the right direction. The funniest moment of Sheri's career was accidentally setting fire to the lab. "It's not as bad as it sounds!" she says. To the incoming generation of scientists, Sheri advises, "Retain your passion and enthusiasm for the science," so that you also retain your love for the role you play in patient health.



XIAOYIN "SARA" JIANG

Sara is Associate Professor of Pathology at Duke Health and has a strong presence on the regular pathology meeting circuit and notable leadership in PathPod and on social media. She is excited to see AI and deep learning become more integrated into daily pathology practice. If she weren't a pathologist, Sara would "combine all [her] extracurriculars and be a knitting, crafting, baking, podcasting, travel, and food writer!" Her advice to the incoming generation? "Don't do things just because you feel like they are what you 'ought to do' – pursue the things that interest you and bring you joy."

SYED T. HODA

Syed is Clinical Associate Professor and Director of Bone and Soft Tissue Pathology at NYU Langone Health. He says global medical culture needs to detox from the toxic, stressful, stiff profession he believes it has become. "Medicine needs a stat injection of creativity and wandering, instead of continuing the IV drip of aggression." This is echoed in his advice for new professionals. "You are a person who has become a pathologist, and it is worth prioritizing the person first above any career considerations [...] Growing as a person is the best way to grow as a pathologist – and far more important."

FIRST CONTACT

AARON ODEGARD

"Professional organizations like ASCP and ASCLS need passionate volunteers to shape the profession – take advantage of these organizations to grow and make a difference," says Aaron, who is Laboratory Quality Coordinator at Baptist Health System, Jacksonville, Florida. He is also on the ASCP's social media team and uses his own social media platforms to advocate for the lab's role in healthcare. His best career advice? "Be brave and take risks. They'll pay off in the long term."

AASTHA CHAUHAN

Aastha, a GI Pathology Fellow at the University of Minnesota, strives to increase pathology's visibility with initiatives such as Pathspotters and MatchToPath. She is also a featured author of the Ace My Path books, actively teaches pathology to medical students and residents to attract the best and brightest, and is part of the CAP Diversity, Equity, and Inclusion committee. If she were not a pathologist, she says, "I would probably be a travel journalist, visiting lesser-known places around the globe and writing about their culture, food, and people! Who knows? Maybe someday!"

AMY S. FOX

Amy played a significant role in Montefiore-Einstein's COVID-19 response, developed the Einstein Montefiore Summer High School Research Program that introduces students to science and medicine, and spearheaded the See, Test, & Treat program – offering free breast and cervical cancer screenings, same-day results, and follow-up care to women with limited or no health insurance. She is Executive Vice Chair of Pathology at Montefiore-Einstein Pathology, Professor of Pathology and Pediatrics at Albert Einstein College of Medicine, Chief of the Division of POCT and Outreach labs, Program Director of Clinical-Translational Research, and Director Emerita, Virology Laboratory at Montefiore Medical Center, Bronx, New York.

ANGHARAD DAVIES

"We have the ability to impact the care of more patients than any other discipline outside public health, yet many of our students and junior colleagues are unaware of the true value of pathology," says Angharad, who is Professor of Medical Microbiology at Swansea University Medical School, Wales, UK. Angharad's advocacy work focuses on engaging students and foundation doctors to improve specialty recruitment rates. "The challenge is to find ways to highlight the importance of what we do so that the brightest and best of the next generation are excited to be part of the 'science behind the cure.'"

CARLA L. ELLIS

Carla is an Associate Professor of Pathology at the Northwestern University Feinberg School of Medicine (Twitter: @theglasspusher). She is the director of Wellness, Diversity, and Inclusion, and of the Renal Pathology Service. She is also the founding president of the Society of Black Pathologists. Carla highlights that enduring microaggressions is one of the biggest challenges of her career. "It's a constant struggle; however, I believe that knowledge, education and the appropriate support system can help anyone better respond to them." Her advice for those just starting out? "Know two things: your worth and what you want."

CHERIE BECKETT

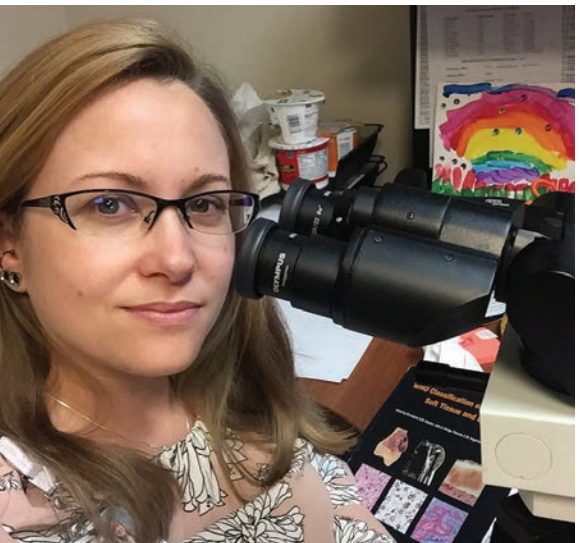
Cherie is Acting Senior Biomedical Scientist at the Princess Alexandra Hospital NHS Trust. She is dedicated to raising the profile of biomedical scientists, developing networks, and improving training. Cherie is also part of the #PathologyRoar steering group, an initiative led by healthcare scientists working with four professional bodies to develop videos that highlight pathology careers. For those starting out in a similar career, Cherie advises taking every opportunity available – and don't forget to network! She says, "The growing #IBMSChat network has certainly helped me to become exposed to opportunities, but also to form connections."

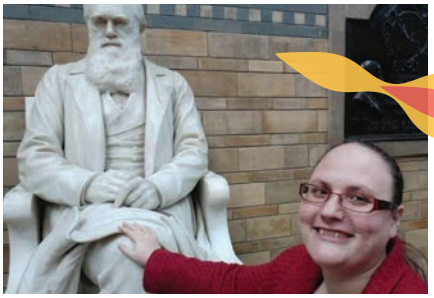
CONSTANTINE E. KANAKIS

Constantine is Resident Physician and Educator in Loyola Medicine's Department of Pathology and Laboratory Medicine. He is an outspoken advocate for many in the profession and regularly celebrates medical laboratory scientists and their work. He emphasizes that the passing of the Cures Act was one of the most important things to happen recently for laboratory medicine. "We are now beholden to leverage our availability and expertise to help patients better understand their diagnoses and help create a culture of accessible, amicable, patient-facing pathology for the benefit of patients everywhere and also medicine, healthcare, and science literacy at large."

CULLEN M. LILLEY

Cullen is an MD/MA candidate at Loyola University Chicago Stritch School of Medicine and co-founder of the educational platform PathElective.com. He is also the creator of the award-winning microbiology blog #MicroMedEd and an APC Society of '67 Kinney Scholar. He believes that the virtualization of medical school has "truly changed everything," highlighting that "it could help improve equity, but it also makes human connection more challenging." If he weren't a pathologist, Cullen would be a psychiatrist or family physician – but if he were not in medicine, he would be a musician or music educator.





ELAINE CLOUTMAN -GREEN

Elaine has been a leading advocate for healthcare science for over a decade, getting involved with outreach programs such as Pint of Science and Science for U. She is Consultant Clinical Scientist (Infection Control Doctor) and Joint Trust Lead Healthcare Scientist at Great Ormond Street Hospital and also runs a blog (girlymicrobiologist) to raise awareness of the field. From risk-assessing Komodo dragon imaging to undertaking the annual Reindeer Review to confirm that Santa and his reindeer are safe to attend the hospital, Elaine says infection prevention and control is "sometimes more humorous and unexpected than I'd ever given it credit for."

MICHAEL WILLIAMS

"Pathology has a lot to offer and is truly a hidden gem within medicine," says Michael, who started off in a surgery residency before realizing that the diagnostic side of medicine was his true calling. He is currently a second-year neuropathology fellow at the University of Alabama-Birmingham Department of Pathology and host of the Diversity in Pathology podcast, which educates people on the range of experiences and backgrounds in pathology. He believes that mental health should be discussed and emphasized more in professional settings to better balance the demands of training and working in the field.

NICOLE D. RIDDLE

Nicole is Senior Pathologist at Tampa General Hospital, Ruffolo, Hooper, and Associates, and Associate Professor and Associate Residency Program Director, Department of Pathology and Cell Biology at USF Health. She believes the lack of communication from other clinicians is a major challenge in pathology that needs more attention. "Patient care often suffers, but even physicians' lives would be more efficient and less stressful if they just understood what we do, how we do it, and what the words we use mean." Nicole is a passionate advocate for pathology in both her day-to-day work and her social media outreach.

RODNEY E. ROHDE

Rodney is Regents' Professor at Texas State University System and Associate Director at Translational Health Research Initiative (@txst_THR). He has demonstrated passionate and consistent advocacy for lab medicine and creatively uses multiple platforms for spreading the message, including peer-reviewed publications, radio shows, podcasts, blogs, presentations at international and national meetings, and TEDx talks. He believes the field's biggest breakthrough has been "the explosion of medical laboratory professionals and pathologists rising to the challenge to become global science communicators via social media and other forms of traditional media" – and is excited to join in the effort to raise the lab's profile.

SARAH GLOGOWSKI

Sarah is a hematopathology fellow at UT Southwestern and serves as Chair of the CAP Residents Forum and ex officio member of the CAP Board of Governors. She believes pathology needs more engagement in advocacy efforts. "It's a situation where, if you're not at the table, you're on the menu. Due to budget neutrality, we're constantly fighting reimbursement cuts against our clinical colleagues." When looking for pathology residencies, Sarah recommends finding a program that supports your needs. "Case variability is always important but, to me, a supportive culture was critical – and this applies to both your staff and your co-residents."

SWIKRITY U. BASKOTA

Over the past few years, Swikrity has become well-known on social media for her passion for medical education and proactive advocacy for pathology trainees and candidates. She is Assistant Professor, Cytopathologist, and Surgical Pathologist in the Department of Pathology and Cell Biology at Columbia University Irving Medical Center. What sparked Swikrity's interest in lab medicine? "A pathologist's ability to make a diagnosis and guide clinical management and therapeutic decisions," she says. "It gave me a feeling of pathologists as a 'cornerstone of clinical medicine' during my intern year. Then and there, I knew I was going to be a pathologist."

VALERIE A. FITZHUGH

Valerie is Associate Professor and Chair, Department of Pathology, Immunology, and Laboratory Medicine at Rutgers New Jersey Medical School and Rutgers Robert Wood Johnson Medical School. She says the most unexpected moment of her career was becoming joint chair at two medical schools – "one being the school I went to!" Along her career journey, Valerie's inspiration has been Vivian Pinn, the first black woman to chair an academic pathology department (at Howard University). Her advice to the incoming generation? "Don't be afraid to say, 'I don't know.' Colleagues respect each other when they know their limits."

STRANGE NEW WORLDS

ANANT MADABHUSHI

A well-known figure in digital and computational pathology, Anant is Professor of Biomedical Engineering at Emory University. He says the most unexpected moment of his career came while presenting early work on using computer-derived image features from pathology slides to predict outcome and treatment benefit in breast cancer. "One of the investors asked me whether the premise of my work was that image features from a tissue slide could predict the underlying tumor biology and disease aggressiveness. I will never forget his reaction – 'I have a philosophical problem with that.' I have spent the years since proving him wrong!"

ANDREW JANOWCZYK

"I think the potential impact of [machine and deep learning] cannot be understated, but we need to be careful how we present them to non-practitioners, so as to not facilitate naivety towards the biases and challenges that employing them will create." says Andrew, who is Assistant Research Professor at Case Western Reserve University and Lausanne University Hospital. Andrew is an active leader in areas such as quality control in digital pathology and the democratization of computational approaches via his open-source blog, andrewjanowczyk.com.

CHRISTINA ZIOGA

Christina currently works as a consultant cytopathologist at the "G. Papanicolaou" General Hospital in Thessaloniki, Greece. She became fascinated by cytopathology while working in a laboratory as a junior technician before entering medical school. She says, "When I became a medical doctor, I immediately knew what residency I wanted to follow!" Since then, she has invented the diagnostic medicine ABCDE algorithm to support accurate interpretation of pathology and radiology data. Also a certified lifeguard and passionate first aid trainer, Christina says, "Never stop learning! Keep your books open and your Twitter feed active."

DAVID R. WALT

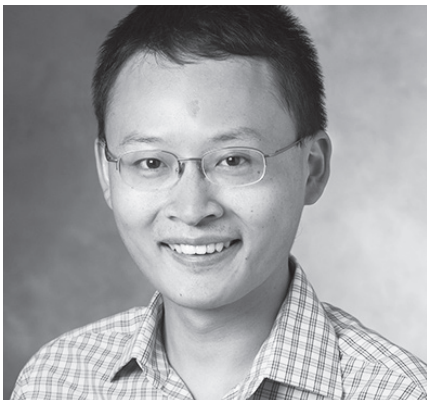
Frustrated by a "technology approach" to medical progress, David was motivated to join the field and bring up-and-coming technologies to clinical applications where they were not previously used. David advocates for technology to address "real needs" in clinical settings, not just to make use of novel innovations. It's no surprise, then, that he believes developments in sample preparation and handling have been sidelined, partly due to excessive focus on new measurement technologies. He is currently Professor of Biologically Inspired Engineering at the Wyss Institute, Harvard Medical School, and Professor of Pathology at Brigham and Women's Hospital.

ESTHER CONDE

A thoracic and molecular pathologist at Hospital Universitario 12 de Octubre in Madrid, Spain, Esther has worked hard to advance molecular and digital technologies within pathology. A pioneer in targeted therapies, she says, "While I was in the middle of my PhD project, the predictive role of *EGFR* mutations in patients with lung cancer was discovered. I felt very lucky to be one of the first pathologists to implement these assays!" What does she think is pathology's next leap forward? "The clinical use of AI for the assessment of predictive biomarkers in patients with cancer."

FAISAL MAHMOOD

A clear leader in computational pathology, Faisal is Assistant Professor at Harvard Medical School, Brigham and Women's Hospital, and Massachusetts General Hospital. When discussing the future of the field, Faisal believes that "AI will play an assistive role in making more accurate and reproducible diagnosis and prognosis. I am also convinced that AI will go beyond our current capabilities and allow us to make new discoveries." If you're just starting out in computational pathology, Faisal recommends to "be more collaborative – take the time to seek problems that matter the most before diving deep."



JAMES ZOU

As a computer scientist, James' interest in pathology stems from a desire to create AI that benefits people. Compelled by the field's proximity to patients and richness of data, James has earned a reputation as a trailblazer in computational pathology. Currently, James – who is Assistant Professor of Biomedical Data Science and an inaugural Chan-Zuckerberg Investigator at Stanford University – works on data valuation, reducing bias and stereotype in AI, bringing machine learning to health and biotechnology, and more. He also used to moonlight as a movie, theater, and restaurant reviewer!

JEROEN VAN DER LAAK

What could be more "science fiction" than having your pathology work supported by a neural network? It might not be as far-fetched as you think! Computer scientist Jeroen van der Laak and his computational pathology group have led the field in applying deep learning to pattern recognition in pathology, showing that AI-supported pathology is within reach. Jeroen has promoted research using the grand challenge platform, producing several landmark papers and a leading role in Bigpicture, a European IMI-supported initiative to promote AI research. Nominators say Jeroen "fits the bill of Strange New Worlds in every aspect!"

KATHERINE R. CALVO

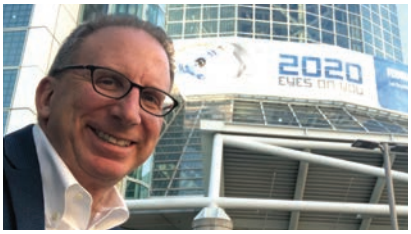
Katherine, a Senior Research Physician and Director of Automated Hematology at the National Institutes of Health, is perhaps best known for her group's discovery of the disease known as VEXAS – a condition caused by somatic mutations in the *UBA1* gene. Her interests stay close to the fold – when asked what she would be if not a pathologist, she says, "I would probably be a hematologist/oncologist." So why did she choose pathology? "I thought pathology was a great specialty for translational research, bridging advances in bench research on mechanisms of disease with patient diagnostics and, ultimately, therapeutics."

KATHLEEN H. BURNS

Kathleen is Professor of Pathology at Harvard Medical School and Chair of the Department of Oncologic Pathology at the Dana-Farber Cancer Institute. A physician-scientist, Kathleen's research focuses on the roles that self-propagating retrotransposons play in human disease, challenging the assumption that these elements are nonfunctional "junk DNA." Her lab was one of the first to develop strategies to map insertion sites of repetitive DNAs and transposable elements in the human genome, subsequently identifying transposon involvement in cancers and autoimmune diseases.

KEITH WHARTON

As Vice President and Medical Director at Ultivue, Keith is firmly focused on the future. His goal? "To bring single-cell omics and multiplex tissue labeling to diagnostic use, allowing pathologists to visualize in a histologic context the phenotype of every cell in a tissue biopsy." He hopes that, in the future, advances in omics and in digital and computational pathology will allow the assembly of a tissue and organ atlas to support the unambiguous identification of specific pathogenic cell types in patient biopsies. His advice to newcomers? "Do not allow the decisions of a committee to determine your destiny."



LEE COOPER

"What people call 'deep learning' has transformed our ability to interpret images," says Lee. "There was some great work analyzing whole-slide images prior to deep learning, but it was much harder to imagine systems that were fit for clinical use." Lee is Associate Professor of Pathology and Director of Computational Pathology, Northwestern University Feinberg School of Medicine. When asked about the funniest moment in career, he recalls, "One time in graduate school, I woke up to an email with the subject "WHO IS LEE COOPER?!?" I was analyzing whole-slide images on our department's computer cluster and had filled the drive, which locked everyone out!"

THE FUTURE OF THE LABORATORY IS

STRONGER TOGETHER

2022 marks the 100th anniversary of ASCP, and we are celebrating and honoring our members, without whom these 100 years of growth, innovation, and advancing pathology and laboratory medicine would not have been possible.

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MATTHEW G HANNA

"The field of machine learning in pathology has significant potential to transform the current pathology paradigm as we know it today," says Matthew, Assistant Attending and Director of Digital Pathology Informatics at Memorial Sloan Kettering Cancer Center. In the future, he anticipates that digital pathology will no longer be considered a separate branch of pathology, but just "pathology with the use of an improved digital workflow." He says the support from his wife and two children is "without a doubt the single most responsible reason for progress in my career and I appreciate all of their love and quality time."

THOMAS J. FUCHS

"The fact that we live in times where we can lessen human suffering by writing code is a unique and beautiful gift," says Thomas, Barbara T. Murphy Professor at Icahn School of Medicine at Mount Sinai, Chair and Dean in the Windreich Department of Artificial Intelligence and Human Health, and Co-Director of the Hasso Plattner Institute for Digital Health. Also founder and Chief Scientific Officer at Paige.AI, Thomas believes that human language is "too limited to describe the information density, and beauty, of H&E slides" and that AI will "supercharge" the role of pathologists in the future.

YINYIN YUAN

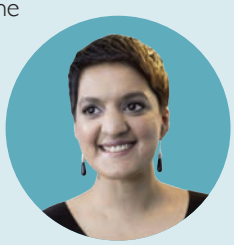
Yinyin, who leads the Institute of Cancer Research's Computational Pathology and Integrative Genomics team, is a well-known computational pathology researcher and one of the field's pioneers. She completed her postdoc in cancer bioinformatics, focusing on cancer genomics and omics data analysis, but she entered digital pathology almost by chance. Rather than working with numbers, Yinyin saw the potential of visualizing the tumor landscape's different cell types, rich morphological features, and diverse spatial patterns. She says, "This inspired me to study tumors as ecosystems using digital pathology by leveraging my computer science training in image analysis and machine learning."

Integrated Automation: A Different Approach

An interview with Divya Vijay Pratheek on Automata's leading role in lab integration

What role does automation currently play in the lab?

Different labs have vastly different levels of automation. I've been in this space for a long time and what surprises me is that quite a lot of labs, even those in the western world, haven't already fully adopted automation. I like to use a dishwasher analogy; if you have a machine that can wash dishes more efficiently, more consistently, and with more speed than a human, why wouldn't you use it? To me, having a person stand in front of a lab bench pipetting over and over is a waste of valuable time and expertise.



So what do lab automation solutions look like to Automata?

We take a very different approach to traditional lab automation. I've been working in product and lab automation in the biotech world for almost 10 years now and the biggest issue is achieving true automation and removal of manual touch points. Many "automated" devices in labs can integrate with other instruments, but still require manual involvement somewhere in the workflow – for instance, to transfer consumables between instruments.

Automata has expertise in robots so, for us, automation really comes down to engineering effective, integrated solutions – from scratch if necessary. Rather than having a human stand there and connecting different instruments or act as the conduit between different liquid handlers, we look at how you can get the most out of your lab – whether by changing the location of a particular instrument, creating a transport layer that will move consumables between instruments, or installing software that can integrate all your workflows. Once you begin to marry software and hardware for smooth workflows, you start to see how much efficiency automation can bring. In practice, our consultants come into labs to perform the process optimization, but they also provide long-term support so that each lab's processes are always fully optimized. Changes in a lab's goals should never matter, because automation should always be flexible.

How do you think that will change in the future?

I think we're moving toward a future of integrated labs. There is so much more to achieve that is already applied in other sectors. Take car manufacturing, for example. There, you have entire assembly lines of robots working together through different individual processes to create an automated workflow; the amount of manual interaction is very low. In the lab, these manual processes are things like capping, decapping, and liquid handling – but benchtop automation is just the beginning. The true revolution is the integration, through hardware and software, of every device in the workflow. Every lab in the future, whether research or clinical, will have removed manual interactions from their workflow – and, along with them, will have removed or reduced the chances of error, contamination, and wasted time. That's where the real value lies – in truly automating those repetitive manual steps. Automation will never replace the people in the laboratory – but it can free up personnel to spend their time where it matters most.

What advantages does this approach offer?

There are five core advantages:

1. a reduction in labor for manual tasks
2. dynamic process optimization
3. contamination reduction
4. complete traceability and remote functionality
5. scalability

Given the potential cost and training hurdles to automation, what should labs keep in mind?

Labs should consider the costs of their current manual processes compared with their automated counterparts – with an emphasis on the time, cost, efficiency savings the latter can bring. With all of those savings factored in, automation is often cheaper!

Managers should also consider that manual processes can sometimes cause errors. Automation promotes a reduction in errors and inconsistency. It's simple; a person won't do an experiment exactly the same way every time, but a robot will.

How do you determine a fit between a lab application and an automation solution?

We understand how important it is that standard operating procedures (SOPs) are validated for labs looking to scale up – and it's vital to automate SOPs in the most efficient way possible. We have integrated solutions offering flexibility, which means we can accommodate established workflows and instruments in your lab. We provide as much or as little consultation as each client wants. And there aren't many workflows or SOPs that aren't automatable – just ask us what's possible and you might be surprised!

What are some key applications that have seen particular success with Automata solutions?

We have seen particular success with ELISA, cell culture, drug discovery, and genomics workflows, to name just a few. Fortunately, with advances in technology, automation is now achievable for all kinds of labs – even those with highly specialized workflows. So far, there's not a single workflow that we haven't been able to automate in some capacity – and we always welcome a challenge!

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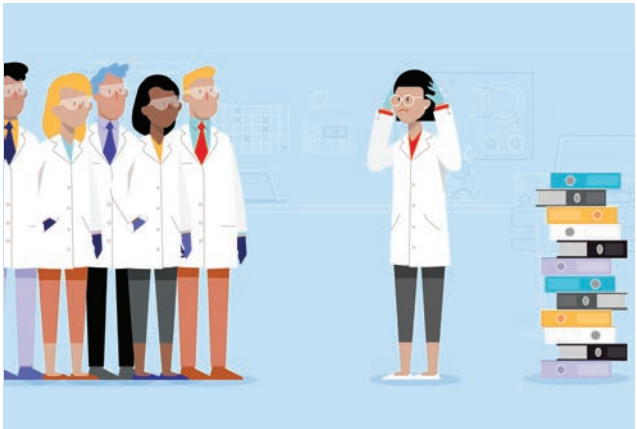

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Core Topic
Molecular Pathology

Causes and Consequences. A genome-wide analysis of individuals with clonal hematopoiesis (CH) has increased the number of germline associations with CH in European-ancestry populations from four to 14 and revealed key insights into the heterogeneity of these associations (1). An increased risk of a range of conditions was also found in individuals with CH.

Digging Deeper. A genome-wide association study of group B *Streptococcus* has identified variations in the bacteria that may be linked with disease onset time and invasion of the central nervous system (2) – highlighting the need to integrate microbial population genomics into clinical pathogen surveillance.

Wide Awake. Over 200 loci have been associated with insomnia, but how many more are yet to be discovered? A new study has identified 554 risk loci, including 364 novel loci, and suggests a strategy for prioritizing genes (3). The approach enabled researchers to establish specific hypotheses about the disorder that may have been missed using traditional methods.

The Rest Was History. *Trichuris trichiura* is a human-infective whipworm responsible for the neglected tropical disease trichuriasis. Using modern genome data and ancient samples from human and non-human primates, researchers have conducted the first population genomics study of *T. trichiura* (4). With samples spanning multiple continents, the results provide insight into zoonotic reservoirs of human-infective *T. trichiura* and establish a genetic framework for its genomic epidemiology.

Urgent Attention Required. Without proper diagnosis, genetic disorders in infants can progress rapidly and lead to severe morbidity or mortality if not treated immediately. To help overcome this, researchers have developed Genome-to-Treatment – an automated virtual system for diagnosing genetic conditions and informing acute treatment (5). The system achieves a diagnosis in 13.5 hours by expedited whole-genome sequencing and could help lead to better outcomes in children with genetic disorders requiring urgent care.

Flex with plexDIA. Researchers have developed a computational framework to increase throughput of sensitive proteomics. Named "plexDIA," the framework improves throughput in accordance with the number of labels without reducing accuracy or proteome coverage (6). In single human cells, the framework was able to quantify about 1,000 proteins per cell.

Star Struck. Using a computational algorithm known as "Starfish," researchers have identified six complex genomic rearrangement signatures in cancers from their copy number and breakpoint patterns (7). Benchmarking efforts revealed the signatures to be highly accurate and biologically meaningful. Three signatures had not been reported previously, including a unique signature the researchers called "hourglass chromothripsis" that is abundant in prostate cancer. The researchers highlighted that this signature is associated with mutant SPOP and may be linked to genome instability.

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Waiting in the Wings

Why isn't single-cell sequencing ready for clinical application?

By Tian Yu

The accurate identification of cellular phenotype, intercellular signaling networks, and the spatial arrangement of cells within organs is critical to providing a deeper understanding of physiological processes and the disruptions that cause disease. Cellular heterogeneity is a common feature of many malignancies – and so, techniques that allow us to detect and characterize oncologic cellular heterogeneity can help advance cancer diagnostics and therapies.

One promising technology for characterizing cellular heterogeneity is single-cell sequencing. Conventional bulk sequencing methods use many cells, but lose cell heterogeneity information after the signals are summarized and averaged. Conversely, single-cell techniques use next-generation sequencing to analyze the genetic content of individual cells, providing valuable insights into their unique functional characteristics.

Single-cell technologies have rapidly grown in scope and scale in recent years, and I believe they are poised to yield significant discoveries in the study of human disease. Molecular pathology is leading the charge with approaches, such as single-cell RNA sequencing, single-cell ATAC-seq (1,2), and single-cell DNA sequencing (3,4). Since single-cell sequencing was recognized as Nature's Method of the Year in 2013, use of the technique has dramatically increased; for example, single-cell multi-omics, which was little known in 2013, has grown in prominence, accounting for over 800 publications on PubMed. And yet, though there have been some early successes in using single-cell sequencing for diagnosing and treating cancer (5–9), there are still several challenges to address before it can be used in clinics. The most pressing issues include a lack of skilled lab professionals in single-cell sequencing, pre-analytical variation caused by differences in laboratory workflow, and the need for more standardized workflow and quality control methods.

Lack of skilled lab professionals

Unlike bulk sequencing approaches, which can be easily automated and performed on a relatively large scale, single-cell sequencing is still a rapidly developing field with varied techniques and methods. In the past few years, several research groups have systematically compared and contrasted available single-cell technologies (10–12), all with variations in chemistry, hardware, and software requirements. Such techniques require highly-qualified professionals who understand the technology and its mechanisms; put another way, accurate and reproducible results are highly dependent on skilled lab professionals. Indeed, the lack of trained and knowledgeable personnel has been one of the key barriers to moving single-cell sequencing from bench to bedside.

One possible solution? Increase the availability of training and education programs in single-cell sequencing technologies. There are single-cell service providers attempting to fill this gap but, because each cell's informative gene expression patterns can change under external stressors, they struggle to maintain sample quality and integrity during material transfer.

Another possible solution is laboratory automation. Several companies offer instruments and reagents that are not yet fully automated, but help to simplify steps and reduce hands-on time. The development of fully automated platforms that take in fresh tissue samples and perform sample processing, library preparation, sequencing, and bioinformatics analysis in a closed system would be the ideal situation; however, we are still a few years away from such systems.

"Each portion needs to be tackled individually with specialized expertise, but with a common goal of achieving standardized workflows."

The need for a standardized workflow

Though technology is rapidly progressing and commercial products are being developed to facilitate single-cell workflows, there is no standardization as to how labs conduct sample processing, library preparation, sequencing, and analysis. When asking what type of workflow and controls should be used, the usual response is, "it depends!" This lack of quality control has resulted in confounding results and a lack of reproducibility across laboratories. Variation can also be attributed to differences in lab

Tian Yu

practices, equipment, and reagents used, possible operator errors, and data analysis pipelines.

Research communities and commercial entities have been a part of many ongoing efforts to develop more standardized and reproducible methods for single-cell sequencing – a challenge that can be separated into bench and in silico portions. The bench portion includes all steps from sample acquisition to library preparation and sequencing, whereas the in silico portion covers all the bioinformatics steps of data processing, normalization, and statistical analysis. Each portion needs to be tackled individually with specialized expertise, but with a common goal of achieving standardized workflows. Furthermore, more research is needed to determine how to improve pre-analytical variations and workflow stability, as well as develop standardized quality control methods for single-cell sequencing.

Pre-analytical variation in workflow

There is a diverse range of methods for conducting single-cell sequencing experiments. The pre-analytical phase (all steps from cell isolation to library construction) is particularly variable because it often requires different specialized techniques that are not sufficiently standardized. There are several critical steps in this phase; for example, pathologists need to take care to ensure high-yield and viability of dissociated single cells from tissues, and protocol consistency with controls is required to minimize variability throughout the workflow. Cells often experience environmental stress when they are removed from their native state, so we must minimize the time between tissue collection and processing of a single cell suspension for sequencing.

The starting materials must be of the highest possible quality in all cases, which, of course, is highly dependent on the source. DNA and RNA from fresh tissue samples tend to be high quality, whereas nucleic acids extracted from frozen tissue or formalin-fixed tissues are typically much lower quality. Single-cell analysis requires a sufficient amount of high-quality cells; however, there is currently no single-cell stabilization method able to achieve the cell numbers and quality gained from fresh cells. This unsolved problem equates to long hours in the lab for scientists who conduct single-cell experiments and also limits wider adoption.

"With further technological developments and improved quality control standards, single-cell sequencing may soon be an invaluable part of disease diagnosis and treatment."

Over the years, scientists have developed their own techniques to address the problem, such as fixing single cells with methanol or cryopreservation, and there has been some progress; however, one solution for a single scenario often cannot be replicated in another lab or for a different type of cell or tissue. A standardized protocol for cell collection, stabilization, and processing is urgently needed to allow for wider and easier adoption of single-cell technology in the clinic.

Where do we go from here?

With further technological developments and improved quality control standards, we may see single-cell sequencing becoming an invaluable part of disease diagnosis and treatment – and not too far in the future. Single-cell genomics, transcriptomes, and proteomes may be used to construct a comprehensive molecular map of a tumor's cell types, helping researchers understand cancer progression, metastasis, and drug resistance. The ultimate objective is to gain new insight into the physiological mechanisms and pathological processes of diseases at the single-cell level. Emerging studies may lead to the development of new diagnostic markers or therapeutic targets, but only if we overcome the obstacles in our path.

As a first step, we must increase the availability of training and education programs in single-cell sequencing technologies. More research is also needed on improving consistency and stability in the workflow, particularly with sample preparation, collection, and stabilization. Finally, it is crucial to develop standardized quality control methods for single-cell sequencing that can be used across different labs, technologies, and cell types. By taking measures to overcome these key barriers, we become one step closer to the realization of single-cell sequencing for clinical use.

Tian Yu is Chief Scientific Officer of Truckee Applied Genomics, Reno, Nevada, USA.

See references online at: tp.txp.to/in-the-wings

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Intrigued by Biology, Fascinated by Death

Sitting Down With… Carla Valentine, museum curator and author based at St. Bartholomew's Hospital, London, UK

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What inspired you to pursue pathology in the context of mortuary science?
Biology intrigued me from a really young age. I was always interested in how things work – bodies, flowers, animals, everything. When I was around seven, my granddad died from a stroke in front of me. I was obviously slightly traumatized, but I was also fascinated by how someone goes from a walking, talking person to a dead one. I think I wanted to reclaim some of the trauma. I was reading a lot of Agatha Christie at the time, so I understood what forensics were and how they applied to crimes. That was all it took. I knew I wanted to work in pathology, but I honestly didn't want to work with live patients – I wanted to learn about death processes.

What title do you use?
There are so many different words that could describe my work. For me, it depends on the conversation. I might say "mortician," because people understand that it means I work with the dead. Conversely, most people at a cocktail party don't know what an anatomical pathology technologist is – although the Association of Anatomical Pathology Technology is making great strides in awareness.

What was your favorite part of mortuary work?
My favorite part was coming in each morning and going through the cases. I've worked in several different mortuaries and, in the last one, we had community deaths as well as hospital deaths. Every morning, I'd come in and have a look at the names, weigh, measure, and check the bodies. It was interesting because you might see a patient who had died of complications in the operating room and then a person who had died on the street with completely different pathologies. I don't want to make it sound like opening Christmas presents, but the anticipation of seeing an interesting variety of cases was exciting.

Autopsy can be a controversial subject – what are your thoughts on its place?
I support consented autopsies, which obviously happen a lot at hospitals. You might be surprised at the cases that happen, though. For example, you might imagine that a mother who had lost a baby would decline an autopsy – but they often say yes, because they appreciate the possibility of answering questions like: could it happen again? Was it something genetic? Is it something that could be treated in another child? I've learned not to guess what people will say and I have always been on the side of education.

Many people associate pathology with death, which can lead to negative stereotypes. How do you counter such misconceptions?
My opinion can only be based on my specialty, which is autopsies. But, since leaving my role as a senior APT, I've tried to do some good public relations for the career. I think pathology is considered a bit more glamorous these days. It's actually mortuary work where people really do think you are in the basement – and, to be fair, you are!

I just want people to understand the reality of death and how mortuaries work, so I've sort of turned into death's PR champion (which gets me into trouble sometimes!).

How do you feel knowing you challenge stereotypes of what people in forensics look like?
When I entered the field, I just went to the mortuary down the road and asked to volunteer. The embalmer I worked with was a woman. Then, at my first full-time job, I would work with a woman one morning and then all men the next. We all had different interests, but it was death that brought us together. I find that I actually experience more friction now, 20 years later.

"I was always interested in how things work – bodies, flowers, plants, animals, everything."

In the light of a global pandemic, do you find it more difficult to advocate for "death positivity?"
People are looking for life affirmation and I can't blame them. Everyone is a little bit sombered after the arrival of COVID-19. Exactly the same thing happened after the first and second world wars. As far as I'm concerned, I'm an ambassador of death understanding, preparation, and knowledge. Those are a bit different to "death positivity." And, in the context of a pandemic, that's a difficult brand to sell, isn't it?

How would you describe a healthy relationship with death?
All I can say about death is that the pain and fear you feel is because you've loved somebody so hard. It's inevitable and sometimes it comes too soon, but there's nothing to gain from wishing it away. It's not Frankenstein; we can't eradicate death, no matter how much people would like to. I think acceptance and understanding of death is just a part of love. It's not very scientific, but it's the best I can do.

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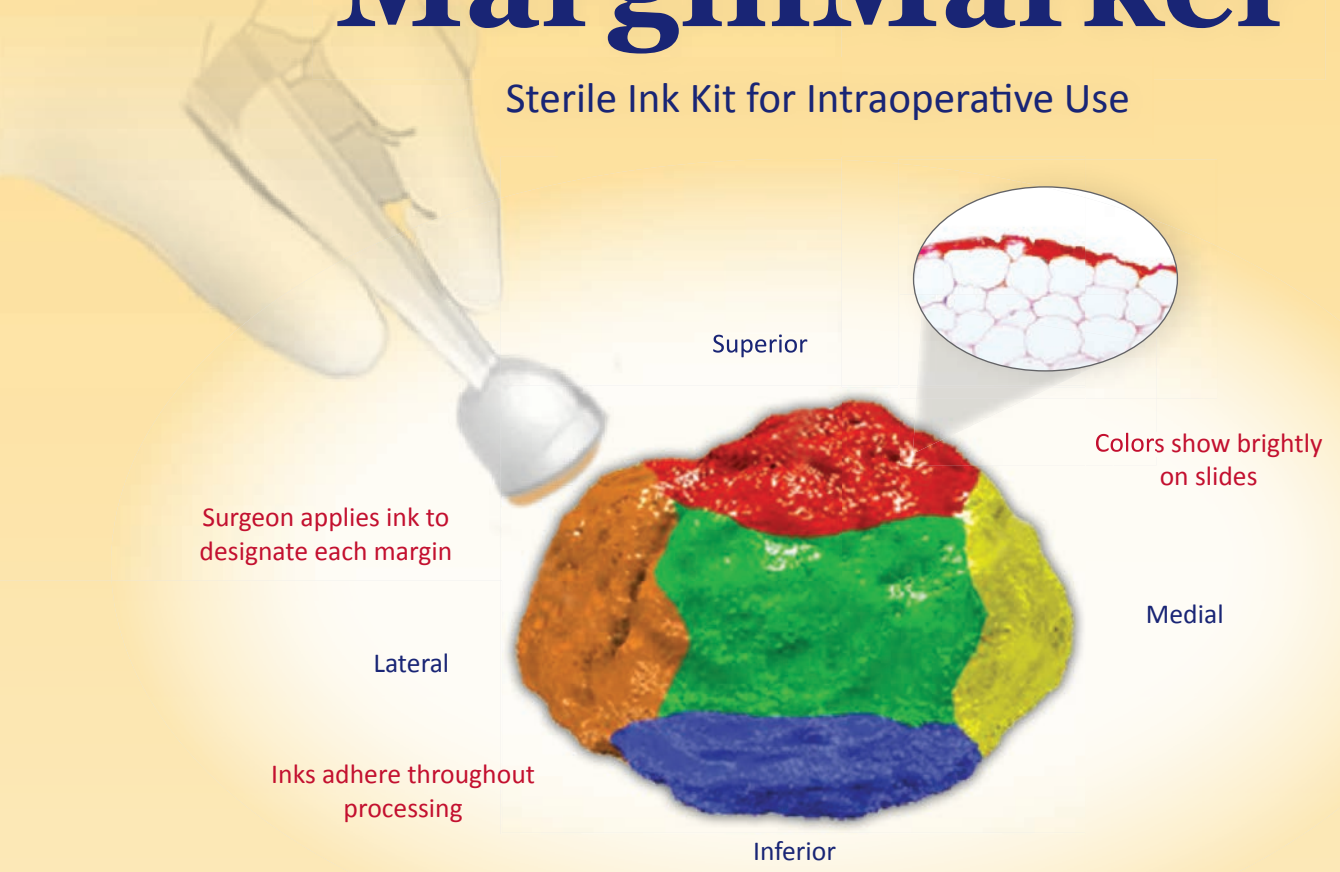

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