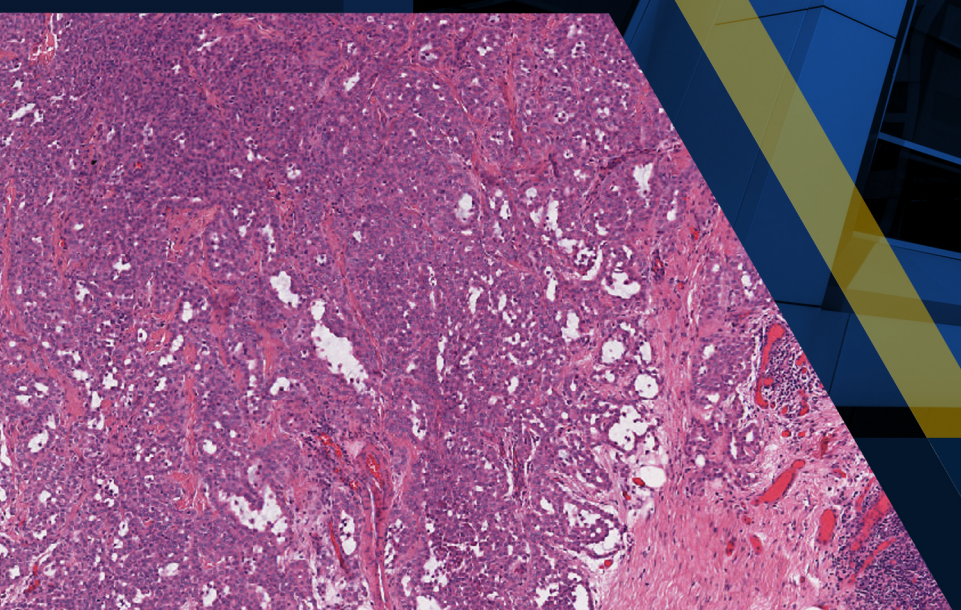
Annual Report

2019

Department of **Pathology**



MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN

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2019

Message **From the Chair**

This past year was marked with many amazing events! The Department of Pathology relocated its non-stat clinical laboratories, administration, informatics and education divisions along with all related faculty, trainees, and staff to the North Campus Research Complex (NCRC) over the summer and early fall of 2018. This massive undertaking was skillfully managed by Dr. Duane Newton, Christine Baker and the Pathology Relocation and Renovation Team (PRR), in cooperation with leadership at all levels in the Department. You can read more about our move in the PRR section of this report. Now that the relocation to NCRC is completed, we are busy working on renovation of our core laboratories at University Hospital (UH). The renovations will be completed over the next 4 years as individual laboratories are sequentially relocated, renovated, and moved into the new space within UH. Dr. Newton and the PRR team continue to facilitate this project with skill and diligence.

The Department's Strategic Council spent several months defining our strategic plan for the next five years. Over the course of these meetings, the Council proposed two primary and three secondary goals. The secondary goals are an expected result from success of the two primary goals:

Primary Goal 1: We will be leaders in breaking down barriers to improving faculty/staff engagement across a diverse department.

Primary Goal 2: We will elevate our brand as national leaders in precision medicine in a way that is aligned with our mission.

Secondary Goal 1: We will recruit, train, and retain the next generation of leaders in Pathology.

Secondary Goal 2: We will be a national leader in recruiting and developing academic faculty.

Secondary Goal 3: We will build a unified data sciences infrastructure to improve care, education, and research.

Our goals are focused on how the department impacts the world around us as well as the University of Michigan and our internal environment. Elevating our brand and increasing engagement will synergize to enhance recruitment of trainees, faculty, and staff, as well as to improve data sharing while better leveraging strengths in all aspects of our mission. Given these goals, it will be critical to enhance communication efforts to better educate students, lay persons, and colleagues in our health system that pathology provides a diverse and robust portfolio of medical services to clinicians and patients. These services are essential for understanding the underlying basis of disease, as well as potential next steps in defining disease diagnosis, guide therapy, and maintain health. As we pursue these goals, we will continue to provide the very best care to our patients and provide outstanding educational opportunities for our trainees, while engaging our faculty and staff.

In all three missions, our department continues to demonstrate outstanding performance. In FY 18, we experienced a 5.7% year-over-year growth in the number of billable tests processed, generating a 9.2% increase in gross revenues and a 5.7% increase in net patient revenues. Our research mission saw 53 awards granted from the NIH and was ranked 5th in the nation in NIH funding, 2nd in the nation in R01 funding. Total sponsored research spending totaled $32.8 mil-

lion. The department was home to 177 faculty, 1,065 staff, 23 clinical fellows, 26 residents, 21 PhD students, 62 postdoctoral fellows, and 85 student temporary employees.

This year's report provides an update on our Department's tri-partite mission of patient care, research, and education, along with efforts in quality, administration, and informatics. We are looking to the future with renewed vision and enthusiasm. We are excited to share our accomplishments with you and invite you to join us as the leaders and the best.

Charles A. Parkos, MD, PhD

Carl V. Weller Professor and Chair

Development

The Department of Pathology at the University of Michigan is most grateful to our alumni, faculty and staff, and friends who have made a gift to the programs in education, research, and patient care. In FY 19, the Department of Pathology received over $2.2 million in donations from foundations, trusts, former faculty and trainees, and others. If you would like to be a part of our future and wish to talk more about making a gift or including the department in your estate planning, please contact:

Jason Keech
Assistant Director of Development
jkeech@umich.edu
734-763-0866

PEOPLE

177 Faculty

- **41** / Instructional
- **72** / Clinical
- **34** / Research
- **34** / Supplemental

1065 Staff

- **85** / Student Temps

EDUCATION

119 Trainees

- **26** / Residents
- **11** / Clinical Fellows
- **62** / Postdoctoral Fellows
- **20** / MCP Graduate Students
- **35** / Medical School Instructors
- **41** / Graduate Student Mentors

MISSIONS / RESEARCH & CLINICAL

$77.4M
MS Annual Expense Budget

$153.1M
UMHS Annual Expense Budget

Ranked
#5 **In Funding**
Received by NIH in 2018

Received
53 **Awards** from NIH in 2018

$32.7M
Sponsored Spending in 2018

5.7% ↑
Growth in Billable Tests

Research Space Occupies
64,286SQFT
$329 DC/SF
$134 IDC/SF

Outpatient Phlebotomy in all Health Centers

OTHER

Partnerships

Michigan Medicine Laboratories (MLabs) is our national reference lab serving clients in need of Michigan expertise delivered personally, including molecular and genetic testing.

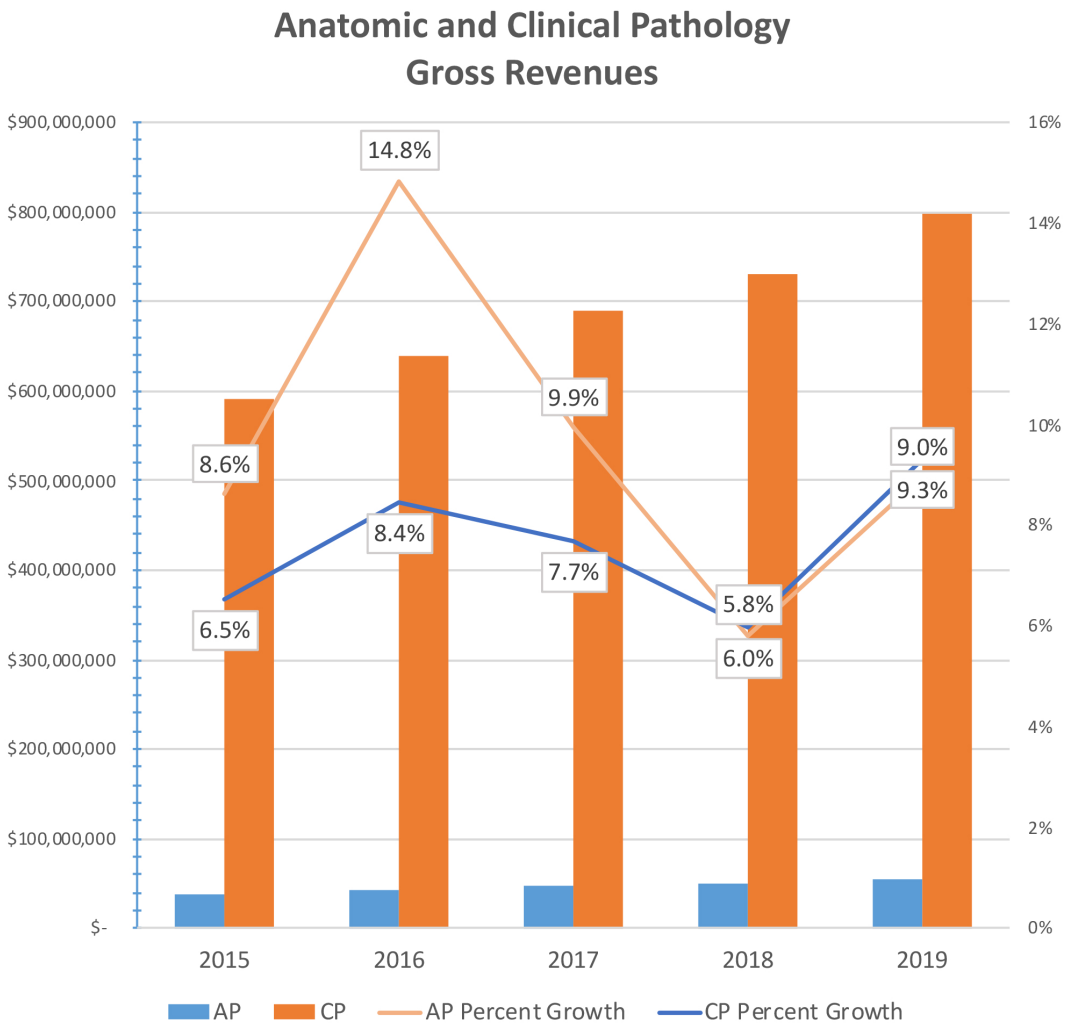
MidMichigan Health and Metro Health are affiliated health systems with Michigan Medicine and are served by our MLabs reference laboratory.

Ann Arbor Veteran's Administration Hospital Laboratories - Led by Michigan Medicine Pathology faculty.

Clinical **Mission**

Sustained growth requires increased personnel, equipment, and facilities. Over time, as we outgrew the University Hospital facilities, our laboratories became scattered across Ann Arbor leading to inefficiencies and duplication of equipment and staffing. For the past six years, the Department of Pathology has engaged in a plan to relocate our non-stat clinical laboratories to the North Campus Research Complex while renovating the hospital laboratories to improve on-site patient care. FY 2018 saw the culmination of the planning, building, and equipping of our new laboratory space with laboratory relocations scheduled for the summer of 2018.

The clinical laboratories are divided into four primary divisions: Anatomic Pathology, Clinical Pathology, Molecular Pathology, and MLabs.



Anatomic Pathology

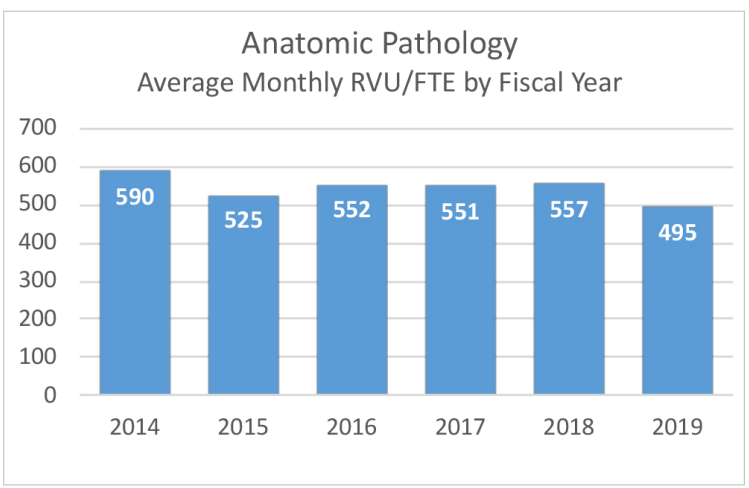
Jeffrey Myers, MD
Interim-Director, Anatomic Pathology

Lakshmi Priya Kunju, MD
Director, Surgical Pathology
Director, Genitourinary Pathology
Director, General Surgical Pathology

Celina Kleer, MD
Co-Director, Breast Pathology

Anatomic Pathology deals with testing of tissues, solid tumors, and cells as well as autopsies and forensics. Anatomic Pathology (AP) realized a 4.5% year-over-year growth from a total of 172,842 to 180,636 cases. The five-year growth rate showed a 17.5% increase. Over this same five-year time period, AP staffing decreased from 45.21 FTEs to 42.19 FTEs, a 6.7% decrease. On average, each clinical FTE in AP generates 495 RVUs/month. RVU stands for relative value unit and is an incomplete payer-imposed measure of professional work that has become an industry standard for monitoring clinical productivity.

The AP Clinical Service comprises several sections, including Surgical Pathology, Cytopathology, Dermatopathology, Ophthalmic pathology, Renal pathology, Neuropathology, Autopsy and Forensic pathology, and Pediatric/Perinatal pathology, each with its own Section Head. Surgical pathology includes multiple subspecialty services each with a designated Service Chief(s).



Surgical Pathology

Case volume for surgical pathology and related subspecialties, including extramural consultations was 118,890, which represents a 3.7% year-over-year increase and a 28.5% 5-year increase. *(See Chart on **pg. 62**)*

The surgical pathology section encompasses a general sign-out service and multiple subspecialty services, each with its own service chief or director. Clinical service provided by surgical pathology faculty includes frozen section coverage at University Hospital, C.S. Mott Children's Hospital, Frankel Cardiovascular Center, East Ann Arbor Medical Center, and Brighton Center for Subspecialty Care.

Bone and Soft Tissue Pathology

Bone and Soft Tissue pathology is focused on the diagnosis and study of diseases of the bone and surrounding soft tissues. The Bone and Soft Tissue consult cases grew at an annual rate of 12.8% with 1,259 cases in FY 19, a 72.0% increase over the past five years.

Breast Pathology

Breast pathology is a subspecialty of surgical pathology with expertise in the interpretation of breast lesions from various specimen types, including needle core biopsy, lumpectomy, and mastectomy specimens. In FY 19, the Breast Pathology service processed 2,927 cases, representing an 18.1% increase over FY 18.

Cardiovascular Pathology

Cardiovascular pathology examines the heart and blood vessels to determine the diseases of these organs, whether congenital or acquired in life. Cases may be surgical specimens from living patients or autopsy specimens from deceased patients.

Dermatopathology

Dermatopathology focuses on the study of cutaneous diseases at a microscopic and molecular level. The Dermatopathology service experienced an overall 2.4% decrease in FY 19 to 29,936 cases. This included a 0.9% drop in specimens from Michigan Medicine patients ("in-house" cases) which account for nearly 52% of the cases seen. Cases from patients outside of Michigan Medicine ("MLabs cases") were down 6.4%, from FY 18, but were still up 10% as compared to five years ago. The five-year total case volume for our Dermatopathology service grew by 9.4% in spite of the decreases seen in FY 19.

Endocrine Pathology

Endocrine pathology is the study of diseases of the endocrine system, including the thyroid, parathyroid, pituitary, endocrine pancreas, and adrenal glands. This service completed 426 consult cases in FY 19, a 5.4% increase from FY 18, and a 29.6% increase over the past five years.

Frozen Section/Intraoperative Consultations

Also known as cryosections, this procedure is used to perform rapid microscopic analysis of a specimen, most often used in oncological surgery to diagnose a tumor or to ensure tumor excisions are complete and the margins are clear. This prevents patients from having to undergo surgery a second time if the excision was not otherwise complete. The Frozen Section service performed 3,647 rapid analyses in FY 18, an increase of 3% over the prior year and 7% over the past five years.

Gastrointestinal/Hepatobiliary Pathology

Gastrointestinal pathology (GI) is a subspecialty of surgical pathology which deals with the diagnosis and characterization of neoplastic and non-neoplastic diseases of the digestive tract and accessory organs, such as the pancreas, gall bladder, and liver. The Gastrointestinal/Hepatobiliary Service completed 23,643 cases, a 3.1% year-over-year increase. Case volumes have grown by 19.7% over the past five years.

General Surgical Pathology/"Room 1"

General surgical pathology (also known as "Room 1") service handles biopsies and surgical resection specimens not covered by the other subspecialty areas. In FY 19, 13,172 general specimens were processed, a decrease of 3.8% over the prior year. This service experienced an 18.7% growth over the past five years.

Genitourinary Pathology

Genitourinary pathology (GU) is a subspecialty of surgical pathology which deals with the diagnosis and characterization of neoplastic and non-neoplastic diseases of the urinary tract, excluding medical disorders of the kidneys which fall under renal pathology. This includes diseases of the male genital tract and testes. The GU service processed 4,006 cases in FY 19, up 9.5% over the prior year and 59.6% over the past five years.

Gynecologic Pathology

Gynecologic pathology (GYN) is the subspecialty that deals with the study and diagnosis of disease involving the female genital tract. The GYN service processed 7,781 cases in FY 19, a 9.3% increase over the prior year. This represents a 25.3% growth over the past five years.

Head and Neck Pathology/Oral-Maxillofacial Pathology

Head and Neck pathology covers neoplastic diseases of the thyroid gland, salivary glands, and head and neck. Oral-Maxillofacial Pathology is concerned with the diagnosis and study of diseases affecting the oral and maxillofacial region and is sometimes considered to be a specialty of dentistry and pathology. Internally generated head and neck cases are included in the general surgical pathology service. Consult cases are handled by our head and neck service and amounted to 756 cases in FY 19, a 21.5% increase over FY 18 and a 104.3% increase over the past five years.

Neural and Neuromuscular Pathology

Neuropathology is a branch of pathology that focuses on the diagnosis of diseases of the central and peripheral nervous systems and non-neoplastic conditions targeting skeletal muscle. FY 19 saw

Andrew Sciallis, MD
Co-Director, Breast Pathology

David Gordon, MD
Director, Cardiac Pathology

Douglas Fullen, MD
Director, Dermatopathology

Thomas Giordano, MD, PhD
Director, Endocrine Pathology

Laura Lamps, MD
Director, Gastrointestinal Pathology

Kathleen Cho, MD
Director, Gynecologic Pathology

Jonathan McHugh, MD
Director, Head and Neck / Oral-Maxillofacial Pathology

Andrew Lieberman, MD, PhD
Director, Neuropathology

Victor Elner, MD, PhD
Professor, Ophthalmology

Raja Rabah, MD
Director, Pediatric Pathology

Jeffrey Myers, MD
Director, Pulmonary/Thoracic Pathology

Paul Killen, MD, PhD
Director, Electron Microscopy Laboratory

Judy Pang, MD
Director, Cytopathology

Jeffrey Jentzen, MD, PhD
Director, Autopsy & Forensic Pathology

a total of 1,252 cases as compared to 1,213 cases in FY 18, a 3.2% increase. Overall, the five-year service demands remained relatively stable with a 3.0% drop in case volumes due in large part to a decrease in internally generated muscle biopsies and transfer cases.

Ophthalmic Pathology

Ophthalmic pathology, which focuses on diseases of the eye and unique periorbital structures, continues to be supported primarily by Dr. Victor Elner, in collaboration with surgical, hemato-, dermato-, and neuropathology colleagues. This service accounted for 1,440 cases in FY 19, a 9.8% increase over the prior year and a 12.0% increase over the past five years.

Pediatric and Perinatal Pathology

This medical subspecialty is focused on childhood diseases as well as perinatal conditions affecting the placenta and fetus. The work includes pediatric surgical pathology cases as well as autopsies and placental examinations. Pediatric surgical pathology case volume of 3,739 reflects a 5.1% increase compared to FY 18 and a five-year increase of 8.9%. Placental exams increased by 5.3% to 2,162 cases in FY 19, a five-year increase of 23.1%. Pediatric fetal exams were up 7% while pediatric autopsies decreased 9.7%. Overall, Pediatric and Perinatal Pathology experience a year-over-year increase of 4.6% and a 14.7% five-year change.

Pulmonary/Thoracic Pathology

Pulmonary pathology is a subspecialty of surgical pathology that deals with the diagnosis and characterization of neoplastic and non-neoplastic diseases of the lungs, pleura, and mediastinum. In-house cases are not tracked separately from other surgical pathology cases. However, among consult cases, pulmonary pathology evaluated 2,580 cases, which represents a 6.8% increase over FY 18 and a 48.6% increase over the past five years.

Renal Pathology

The Renal pathology service focuses on the diagnosis and characterization of medical diseases (non-tumor) of the kidneys. This service completed 1,092 cases in FY 19 as compared to 1,295 in FY 18, a 15.7% decrease and a drop of 3.4% compared to FY 15.

Cytopathology

Cytopathology is a branch of pathology that performs diagnostic testing on samples consisting of individual cells, such as Pap smears, which account for just over two thirds of the samples. Our cytopathology service has shown modest growth over the past five years with 34,767 cases processed in FY 19, up 4.2% from FY 18 and 3.6% over the past five years.

Gynecologic and Non-Gynecologic Cytopathology

Gynecologic pap smears represent the bulk of the cytopathology cases and accounted for an increase of 587 cases in FY 19 compared to FY 18, a 2.6% year-over-year increase. There were 11,181 non-gynecologic cytopathology cases in FY 19 including 3,057 fine needle aspirations (FNAs) which are percutaneous or endoscopic needle biopsies increasingly important to diagnosis and tumor staging. There were 3,057 FNAs in FY 19, a 3.6% increase over FY 18, and 7,402 other non-gynecologic cytology samples representing a 9.8% year-over-year increase.

Fine Needle Aspiration

Fine needle aspirations (FNAs) are conducted to determine whether a tumor is malignant or benign prior to excision. In FY 19, 3,057 FNAs were conducted, a 3.6% increase over FY 18, and a 9.7% increase as compared to the prior five years.

Rapid Onsite Evaluation

Our cytopathologists perform rapid on-site evaluations at multiple clinics and procedure rooms throughout Michigan Medicine. This enables rapid diagnostics for patients while they are still at the medical center, eliminating the need for some follow-up visits.

Autopsy and Forensic Pathology

Hospital and forensic autopsies and examinations represent major activities within Anatomic pathology. Our fellowship-trained forensic pathologists handle forensic cases from Wayne, Monroe, Washtenaw, and Livingston Counties. All Michigan Medicine adult and pediatric autopsies as well as all forensic cases from Washtenaw and Livingston Counties are performed in the University Hospital morgue. Wayne and Monroe County forensic cases are performed at the Wayne County Medical Examiner's Office (WCMEO) in Detroit.

FY 19 saw a 4.0% increase in the total number of autopsies performed in the UH morgue, with an 29% increase over the past five years. This reflects disproportionate growth in the forensics practice (36%) and pediatric autopsies (26%) compared to adult hospital autopsies (17%) over that five-year period. Last year, there were 2,297 full autopsies and 3,373 total examinations at our Wayne County Medical Examiners Office, representing a 5% decrease and a 3% increase over the prior year, but a 2.5% and 15.5% increase over the past five years.

Due to a national shortage of fellowship-trained forensic pathologists, coupled with increasing forensic autopsy case volumes due to the opioid crisis in America, we have been challenged with filling open faculty positions for the past two years. By employing an academic physician recruitment service, Merritt-Hawkins, we were able to fill some of our open positions last year, but continue to seek additional forensic pathologists. In addition, we are learning to make effective use of pathologist assistants (PAs) as an important strategy for addressing the workforce shortages in forensic pathology.

Anatomic Pathology Consultation Service

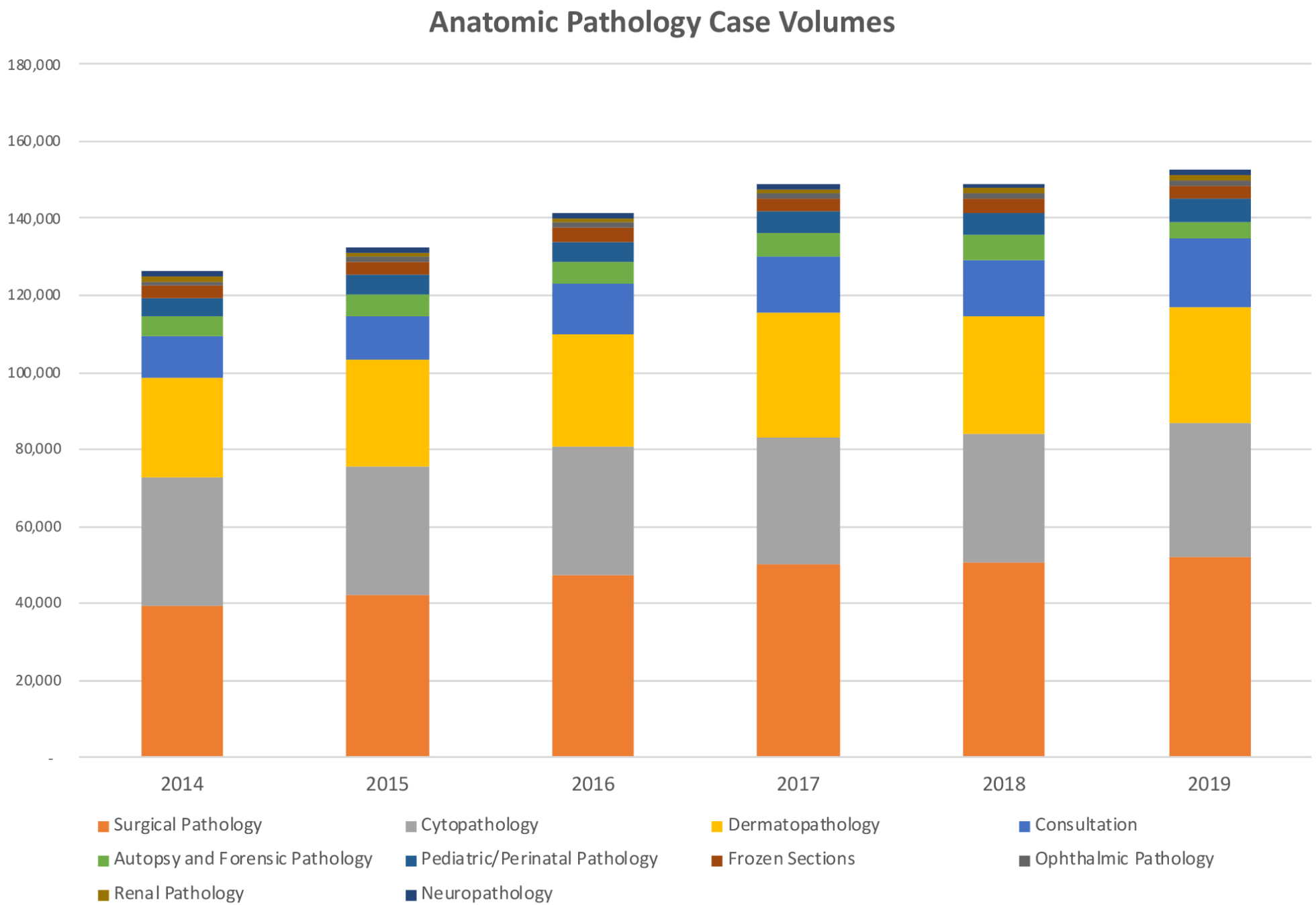
Our extramural AP consultation practice continued to grow to 16,633 cases (highest volume services shown on pg 12), representing a 9.9% year-over-year increase from FY 18 and a 52% five-year increase. The rare and challenging cases represented in this service challenge our faculty to continue to deepen their expertise and expose our trainees to cases otherwise rarely seen. This practice strengthens our brand at regional and national levels, leads to research opportunities in rare diseases, is fundamental to the success of subspecialty fellowships, drives revenue, and enhances patient recruitment to Michigan Medicine.

Case Volume							
	FY 14	**FY 15**	**FY 16**	**FY 17**	**FY 18**	**1-Yr**	**5-Yr**
Washtenaw / Livingston	365	327	359	407	412	1%	7%
UH (Adult)	188	183	168	189	218	15%	16%
UH (Peds)	37	31	41	43	43	0%	16%
Grand Total	**590**	**541**	**570**	**639**	**673**	**5%**	**12%**

Table: *Autopsy and Forensics Total Examinations at UH, Washtenaw and Livingston Counties.*

Wayne County ME Office Case Volumes							
	FY 13	**FY 14**	**FY 15**	**FY 16**	**FY 17**	**1-Yr**	**5-Yr**
Full Autopsies	1904	2242	2053	2359	2417	3%	21%
Total Exams	**2638**	**2921**	**2822**	**3226**	**3272**	**2%**	**19%**

Table: *Wayne County ME Office Case Volumes.*


Anatomic Pathology Case Volumes
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
2014
2015
2016
2017
2018
2019
Surgical Pathology
Cytopathology
Dermatopathology
Consultation
Autopsy and Forensic Pathology
Pediatric/Perinatal Pathology
Frozen Sections
Ophthalmic Pathology
Renal Pathology
Neuropathology


DeRoyal

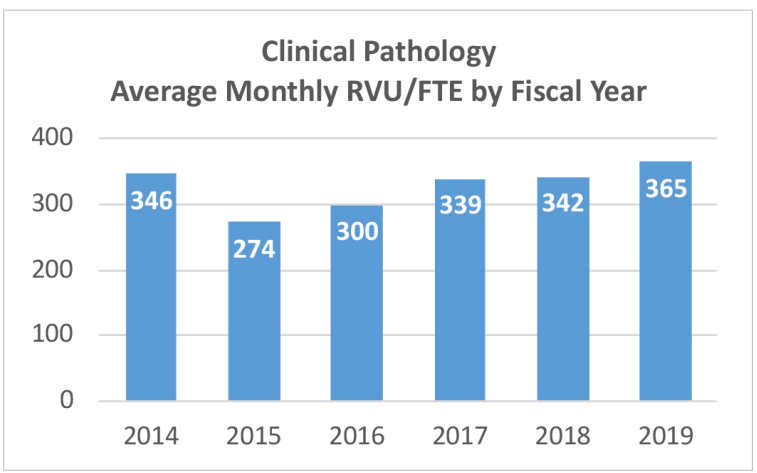
Clinical Pathology

Riccardo Valdez, MD
Director, Clinical Pathology

Donald Giacherio, PhD
Director, Chemical Pathology

The Clinical Pathology Division supports the diagnosis and management of disease through automated and/or manual testing of blood, urine, and other body fluids performed in a variety of subspecialty laboratories. In FY 19, Clinical Pathology (CP) realized 6,396,039 billed tests and $798,806,807 in gross revenue, representing 5.5% and 9.3% year-over-year growth, respectively. As compared to 2015, the CP Division experienced a 25.2% growth in billed tests and a 35.3% growth in gross revenue. Our clinical pathologists average 365 RVUs per month, with staffing levels essentially unchanged from FY 18 to FY 19 (12.12 FTE). (*See Chart of Billed Test Volumes on* ***pg. 64*** *of the Appendix*).

The subspecialty lab disciplines and support services comprising the CP Division include: Clinical Chemistry, Toxicology, Drug Analysis, Special Chemistry, Clinical Immunology, Hematology, and Coagulation (Clinical Core Laboratory service); Blood Bank, Apheresis, Cell Therapy (Transfusion Medicine service); Clinical Microbiology and Virology; Bone Marrow and Flow Cytometry (Hematopathology service); Cytogenetics; Molecular Diagnostics, Michigan Medicine Genetics Laboratory, and Dermatopathology Molecular Diagnostic Laboratory; Histocompatibility; Point-of-Care Testing; Phlebotomy and Specimen Processing.



Clinical Core Laboratory

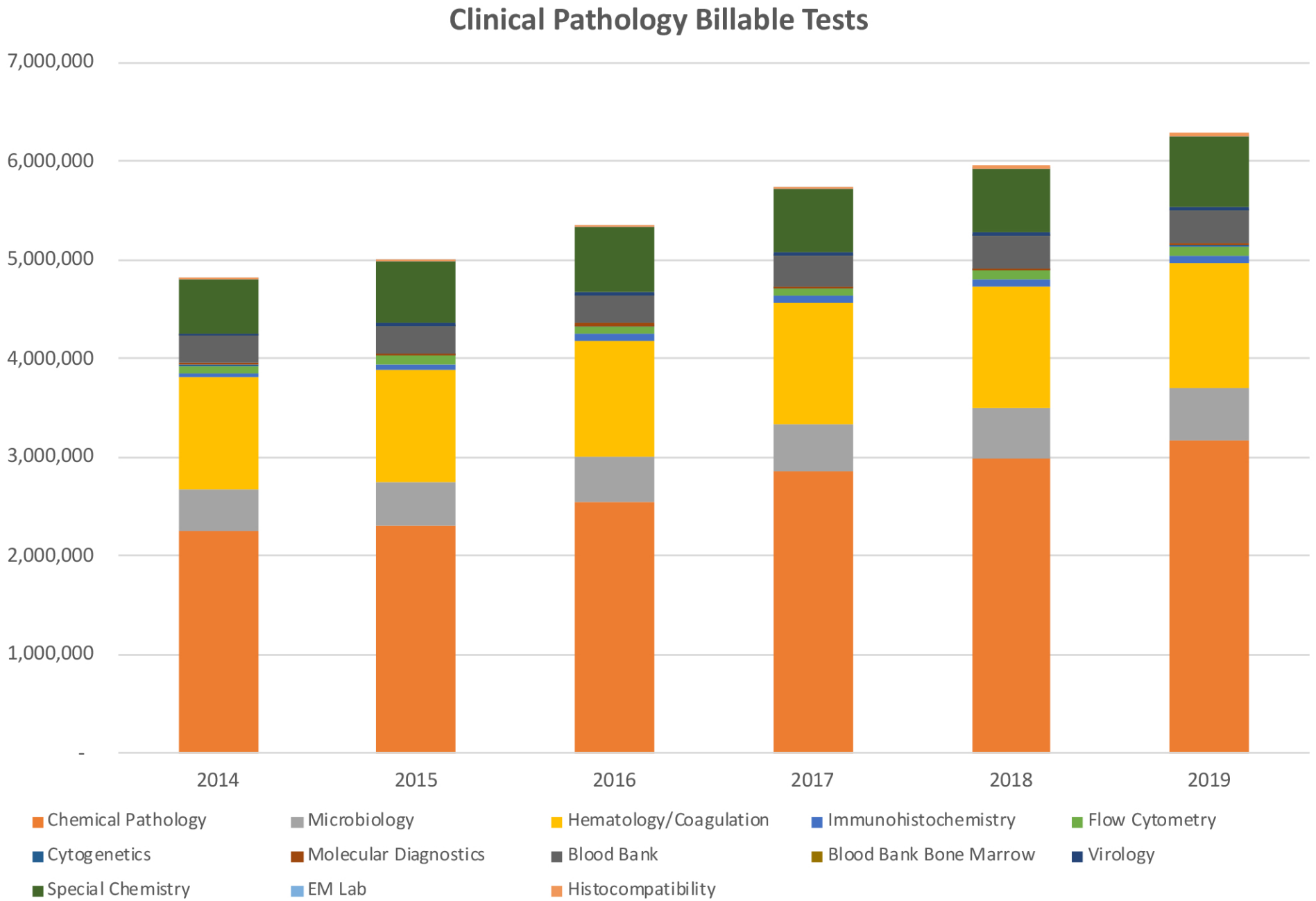
Clinical Chemistry, Toxicology, and Drug Analysis

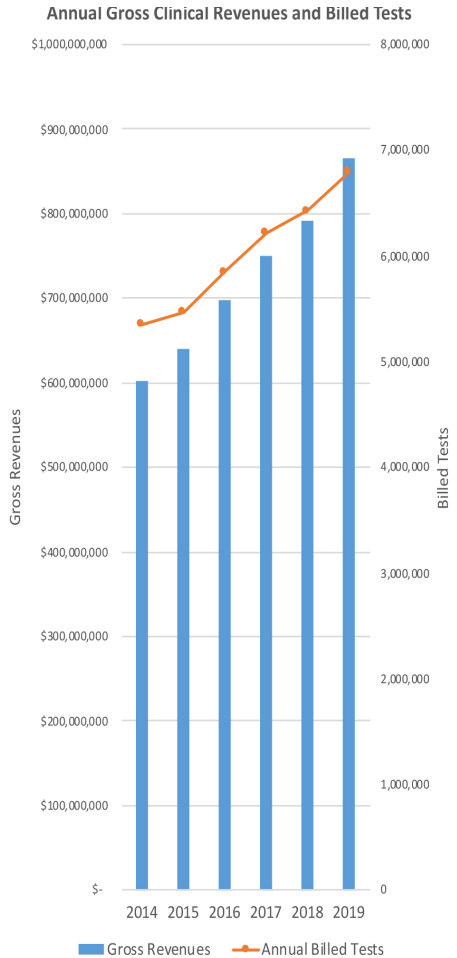
The majority of the tests run in the Clinical Core Laboratory are performed in Clinical Chemistry (3,880,585 tests per year). These tests include common analytes like sodium, potassium, glucose, and creatinine, but also other many other individual and panel tests, such as lipid profiles, allergy tests, and troponin for patients presenting with suspected coronary syndromes. Clinical Chemistry experienced a 6.6% increase in billed test volume when compared to FY 18, and a 33.1% increase over the past five years.

The chemistry lab completed a Request for Proposal (RFP) process to select the next generation chemistry and immunoassay automation platform and selected the Siemens ATELLICA system in FY 19. This new track and multi-analyzer system will be installed at the completion of Phase 2 of the University Hospital portion of the PRR project in FY 21. Two Roche c502 chemistry analyzers were installed in the existing automated section of the chemistry laboratory, upgrading capabilities for STAT testing of therapeutic drugs and drugs of abuse.

In the past year, the Clinical Core Laboratory successfully moved the Immunology section from Traverwood II, and the Special Chemistry section from University Hospital, to NCRC Building 23. With relocation, these two lab sections expanded testing capabilities by acquiring a new Bio-Rad BioPlex 2200 multiplex immunoassay analyzer, a Siemens Immulite 2500 chemiluminescent immunoassay analyzer, and a Phadia ImmunoCAP 250 allergy testing system.

Roche Integra 400 chemistry analyzers and Sysmex hematology analyzers were placed at West Ann Arbor Health Center and the new Brighton Health Center to better serve the patients now being treated at those infusion sites.


Clinical Pathology Billable Tests
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
2014
2015
2016
2017
2018
2019
Chemical Pathology
Microbiology
Hematology/Coagulation
Immunohistochemistry
Flow Cytometry
Cytogenetics
Molecular Diagnostics
Blood Bank
Blood Bank Bone Marrow
Virology
Special Chemistry
EM Lab
Histocompatibility



Robertson Davenport, MD
Director, Blood Bank and Transfusion Service

Lauren Smith, MD
Director, Hematopathology

The following represents a selected list of the tests changed, developed, and/or validated over past year in the clinical chemistry, toxicology, and drug analysis areas of the Clinical Core Lab:

- Testing for bupenorphrine and metabolites was validated in the Toxicology section.
- A pain management controlled substance panel by LC-MS QTOF was developed to support physicians managing patients taking multiple medications for chronic pain.
- The NephroCheck acute kidney injury test was implemented as a pilot with the Emergency Department.
- The thyroid testing algorithm was changed to improve the initial evaluation of suspected thyroid dysfunction.
- Fecal calprotectin testing, used to help distinguish IBD and IBS, was developed and validated for in-house testing.
- Anti-Mullerian hormone testing was developed and validated for in-house testing, helping to provide better service to our reproductive endocrinology colleagues.

Key personnel changes in FY 19 included the on-boarding of Carmen Gherasim, PhD, as the Director of Toxicology, and Janette Todd, MT, ASCP as the Administrative Manager of the Clinical Core Laboratory.

Hematology and Coagulation

The hematology and coagulation laboratories perform testing on blood and urine specimens to measure the various blood components (e.g. red blood cells, white blood cells, and platelets), assess clotting factor levels, determine the impact of medications on blood clotting processes, and help diagnose diseases of kidneys and urinary tract. These lab areas have experienced steady growth over the past five years, with a 2.5% year-over year test increase and a 10.5% five-year increase. In FY 19, the hematology and coagulation labs performed 1,268,568 tests.

Immunology & Special Chemistry

The Clinical Immunology and Special Chemistry labs perform testing to assess immune responses in patients with rheumatoid arthritis, lupus, scleroderma, and other similar conditions; testing for patients with protein disorders such as those seen in multiple myeloma and related disorders; and hemoglobin evaluations in patients with suspected red blood cell disorders. The Immunology lab experienced a 5.4% year-over-year and a 25.2% five-year increase in billed tests, completing 72,578 tests in FY 19. Highlights from these lab areas include the following:

- ADNA testing was moved to a more automated system which provides better correlation with reference methods and disease state.
- The ANA testing algorithm was changed to provide rheumatologists with a more complete one-stop evaluation of patients referred for potential systemic inflammatory disease.
- Syphilis screens performed by rapid plasma reagin (RPR) were moved to the BioPlex 2200 system.
- Eleven new serum protein electrophoresis coded comments were added.
- Dedicated effort was put forth by the faculty and staff to improve the resident training experience in Clinical Immunology and Special Chemistry.

Transfusion Medicine

Blood Bank, Immunohematology Reference Lab, Apheresis Procedure Unit, Cellular Therapy

In FY 19, the use of blood products increased by 2% as compared to FY 18, reflecting overall Michigan Medicine clinical activity. Blood utilization, however, remains 28.3% lower than five years ago, due to careful management of the blood supply. The Immunohematology Reference Laboratory's highly-complex activity increased by 17% year-over-year and nearly 285% over the past five years to 10,624 tests. The Cellular Therapies Laboratory processed 452 patient collections (up 6% over FY 18) and conducted 259 transplants, a 10% year-over-year increase. In conjunction with the Blood and Marrow Transplantation program, Transfusion Medicine successfully obtained approval from the UMHS Board to create the Michigan Medicine Center for Cell Therapy in FY 18. This Center facilitates the use of investigational and commercial cellular therapies for

Michigan Medicine patients by providing centralized resources for manufacturing, regulatory compliance, operational activities, and clinical care.

The notable 12% increase in unrelated transplants represents a programmatic shift toward these more complex transplants. The marked increase in CAR-T product (350%) reflects FDA approval for two commercial CAR-T products, Kymriah and Yescarta, which were introduced into the Cellular Therapies Laboratory in the past year. The new therapy protocols aid in the treatment of B-cell acute lymphoblastic leukemia and diffuse large B-cell lymphoma. CAR-T treatment is expected to continue to grow. Activity in the Apheresis Procedure Unit increased by 6%, primarily due to a 52% increase in red blood cell exchanges.

Transfusion Medicine acquired and/or replaced several pieces of equipment this year. The Apheresis Procedure Unit replaced the aging COBE Spectra apheresis devices with Spectra OPTIA devices. The Blood Bank acquired a Rad Source RS 3400 X-Ray Blood Irradiator, partially funded by a grant from the Department of Energy. The Cellular Therapies Laboratory acquired a Miltenyi CliniMACS cell separation platform to enable performance of CD34 selected allogeneic HPC transplants. (*See chart in Appendix on **pg 65**.*)

Hematopathology

Bone Marrow and Flow Cytometry

The hematopathology service is focused on the evaluation and diagnosis of blood, bone marrow, and lymph nodes disorders, both reactive and neoplastic, using a variety of techniques including routine microscopy and flow cytometry. In FY 19, 1,972 bone marrow and tissue biopsies taken from University Hospital patients were signed out by the hematopathology faculty, representing a 9.5% decrease as compared to FY 18. The diagnostic service also handled 1,407 cases associated with patients transferred to Michigan Medicine from external healthcare systems (8.6% decrease), as well as 1,423 cases referred for expert consultation by external providers (24.4% increase). The diagnostic consult service has grown by 118% over the past seven years. This is an 18.6% increase as compared to FY 18, and a five-year 40% increase in case volumes. Flow cytometry performed 105,598 billed tests in FY 19, a 5.9% increase as compared to FY 18, which includes 5,539 leukemia/lymphoma immunophenotyping panels signed out by the hematopathologists. Over the past five years, flow cytometry lab test volume has increased by 24.3%. This growth was primarily due to the increased number of charged antigens tested per case, which also promoted a 23.6% increase in revenues. Flow cytometry laboratory was moved from the University Hospital to the NCRC in FY 19, where it is co-located with the HLA lab to share resources including personnel and equipment.

Rajan Dewar, MBBS, PhD
Director, Hematology Laboratory

Daniel Boyer, MD, PhD
Medical Director, Clinical Flow Cytometry

Clinical Microbiology and Virology

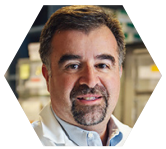
The microbiology and virology laboratories focus on identifying bacterial, fungal, and viral pathogens to aid in the diagnosis and treatment of patients. In FY 19, the Clinical Microbiology Laboratory processed 528,611 tests, a 4% increase over FY 18 and an 18.9% growth over the past five years. The virology laboratory processed 43,197 tests, an increase of 4.7% over FY 18 and a 34.7% growth over the past five years.

The Clinical Microbiology and Virology laboratories relocated to the NCRC this past year. Following the move, significant resources were directed toward the acquisition, validation, training, and implementation of new equipment, including a B.D. Kiestra™ Total Laboratory Automation system. This automated line will change workflows from body-site focused (urine, respiratory, etc.) to chronological reading of plates. The Kiestra line will improve efficiencies and is anticipated to reduce time to results by several hours. In addition to the Kiestra line, the laboratories also upgraded 12 FilmArray® stand-alone units to the FilmArray® Torch tower system, which saves space and allows for distribution of the platform in both the new NCRC laboratory as well as in the University Hospital laboratory to optimize patient turnaround time.

New test assays and processes were also brought online during the past year, including the CMV viral load, EBV viral load, digital gram stain technology, Helicobacter pylori antigen EIA, and Giardia/ Cryptosporidium EIA.

Jeffrey Warren, MD
Director, Clinical Immunology

Duane Newton, PhD, D (ABMM), FIDSA
Director, Clinical Microbiology Laboratory



Thomas Giordano, MD, PhD
Director, Molecular and Genomic Pathology

Noah Brown, MD
Director, Molecular Diagnostics Laboratory

Molecular and Genomic Pathology

Molecular diagnostics is the science of analyzing biological markers in the genome and proteome, an individual's genetic code, and how cells express their genes as proteins. These techniques are used to diagnose and monitor disease, detect risk, and decide which therapies will work best for individual patients. During the past year, the Division of Molecular and Genomic Pathology made significant progress in realizing its overarching mission of coordinating activities of the various molecular pathology laboratories within the Department of Pathology and to interface with the Michigan Molecular Genetics Laboratory within the Department of Pediatrics. In the summer of 2018, the six disparate laboratories relocated to contiguous state-of-the-art laboratories at the North Campus Research Complex.

Molecular Diagnostics Laboratory

In FY 19, the Molecular Diagnostics Laboratory (MDL) processed 20,106 billed tests as compared to 17,026 in FY 18, an 18.1% increase. This is a rapidly developing field, both in single gene testing and next generation sequencing panel testing (NGS panels). In the past year, the Molecular Diagnostics Laboratory added several new tests: a multi-probe FISH assay for the diagnosis of mesothelioma, quantitative testing for *PML/RARA* for monitoring patients with acute promyelocytic leukemia, *PDGFB* FISH testing to aid in the diagnosis of dermatofibrosarcoma protuberans, and *PIK3CA* mutation testing (by NGS) for PIK3 inhibitor therapy in breast cancer.

The use of solid tumor NGS panel testing also continues to grow (see figure) as the applications of this testing expand to other tumor types including breast cancer, thyroid cancer, and bladder cancer. In FY 19, this assay was selected as one of the few tests approved by the National Cancer Institute (NCI) for screening advanced cancer patients for potential enrollment in the Molecular Analysis for Therapy Choice (MATCH) – a large multi-institutional precision oncology trial. Reimbursement for this testing was also negotiated with Blue Cross Blue Shield of Michigan for several cancer types including lung, colorectal, melanoma, glioma, and gastrointestinal stromal tumor. This testing is being increasingly used internally over send-out commercial testing (e.g. Foundation Medicine; resulting in significant institutional savings) as well as by external Pathology (MLabs) clients due to the comprehensiveness of this panel for clinically actionable molecular alterations combined with a faster turn-around time and the ability to perform testing on extremely small/hypocellular biopsies and aspirates.

The laboratory also undertook several process improvement projects over the course of the year. In a collaborative effort with Anatomic Pathology, the process of obtaining solid tumor specimens for molecular testing was optimized to facilitate pathologist selection of the appropriate specimen for molecular testing, minimize the amount of time to obtain both internal and outside surgical pathology or cytology specimens, and facilitate communication regarding the timing of molecular testing in relation to oncologist appointments. These efforts have resulted in a 24-hour reduction in average time from when an order was placed to receipt within the lab. This role was also fulfilled without adding any additional FTEs.

Following the move to NCRC, laboratory leadership has taken advantage of molecular laboratory co-location by undertaking several cooperative efforts with other laboratories aimed at increasing efficiency, collaboration, and quality. These efforts include:

- The creation of a shared DNA extraction service with technologist cross-training between labs.
- Consolidated H&E slide review and sign-out of paraffin-based GU FISH testing performed by Cytogenetics into existing, high-volume paraffin FISH workflow of MDL;.
- Sharing of Illumina MiSeq NGS sequencer and automation currently idle within HLA laboratory to enable instrument redundancy, eliminate capital purchases, and lay the ground work for future sharing of NGS sequencers.
- Identification of validation samples for test development (e.g. Myeloid NGS) panel based on findings from other labs.
- Development, validation, and implementation of *PDGFB* FISH into existing FFPE FISH workflow in MDL in collaboration with Dermatopathology, Molecular, and Soft Tissue pathologists.

- Optimization of the apportionment of limited fluid samples to Flow cytometry and Molecular Diagnostics for lymphoma diagnosis.
- Confirmation of novel or equivocal NGS and FISH findings from MDL using alternative platforms within other labs.

In another process improvement project, NGS processes were amended to improve the uniformity of sequencing depth across specimens of varying quality and to reduce the percentage of specimens that fail DNA- and/or RNA-based NGS testing requiring re-extraction and/or repeat sequencing. These efforts have resulted in a 36% reduction in DNA failures/repeats (16.5% to 10.5%) and a 56% reduction in RNA failures/repeats (48.3% to 21.2%). Based on the current volume of solid tumor NGS testing, this effort has resulted in a savings of approximately $42,330/year. Each case not requiring repeat testing also results in a reduced TAT of approximately 3-5 days.

Finally, reducing the number of specimens that are rejected (QNS) or that fail after a testing attempt is also a key priority for the MDL. QNS/failed specimens result in a significant negative impact on patient care due to the need for repeated invasive procedures with associated treatment delay, complications, as well as possibly preventing patients from receiving efficacious targeted therapies. In previous years, the proportion of QNS/failed specimens was dramatically reduced through improvement to the microdissection process and by validating a process for extracting DNA/RNA from H&E slides for exhausted formalin-fixed, paraffin-embedded blocks as well as Diff-Quik or Papanicolaou-stained aspirate smear slides for cell blocks with low cellularity. Overall, these improvements have reduced the percentage of QNS/failed specimens from > 25% to < 2.2% in FY 19 (*see figure on **pg. 21***).

Cytogenetics

Cytogenetics involves testing samples of tissue, blood, or bone marrow to look for changes in chromosomes, including rearranged, missing, or extra chromosomes. Changes in certain chromosomes may be a sign of a genetic disease or condition, or some types of cancer. In FY 19, our Cytogenetics Laboratory processed 12,313 tests as compared to 9,296 in FY 18, a 32.5% increase. This increase is due in part to adding MidMichigan Health as an MLabs client in late March 2018, as well as adding a new multiple myeloma FISH (fluorescence in situ hybridization) panel in February 2018, which had previously been sent out to Mayo Laboratory, resulting in significant savings in send-out costs.

The Cytogenetics team undertook several process improvement efforts in FY 19. The Blood and Bone Marrow group implemented batch-banding technique to replace traditional coplin jar method, saving on average 2-hours tech time per day while maintaining the slides' quality. The Blood and Bone Marrow group also eliminated one culture for FISH-only blood cases and constitutional blood cases, saving tech time and reagent cost in both culture set-up and harvest processes. The Constitutional Blood section replaced the lengthy chromosome pair finding process with intact metaphase pictures, which allowed most technologists to complete a case within a day instead of the usual 1.5-2 days. After relocating to NCRC, Cytogenetics and Molecular Diagnostics worked together and consolidated DNA extraction activity from blood and bone marrow samples to be done in Molecular Diagnostics. All these changes allowed the Cytogenetics Laboratory to improve turn-around-times for oncology chromosome testing from 17 days to 7 days, while simultaneously experiencing more than a 30% year-over-year increase in test volumes. These process improvements were presented on a Quality Month Poster in October 2018. Finally, the 2019 CAP inspection of the Cytogenetics Laboratory was very successful, with no deficiencies noted.

Lina Shao, PhD
Director, Cytogenetics

Michigan Medicine Genetics Laboratories

The Molecular and Celluar Pathology Division continues to work closely with the Michigan Medicine Genetics Laboratory (MMGL). The MMGL offers a wide range of biochemical and genetic testing services, including germline testing for cancer predisposition of individual gene (e.g. *BRCA*, *PTEN*, *TP53*) and panels of relevant genes (Hereditary Breast and Ovarian Cancer Comprehensive Germline NGS Panel). Specifically, the MMGL is working closely with the MCTP to perform germline testing for those Michigan Medicine patients that undergo OncoSeq testing.

Marcelo Pando Rigal, PhD
Interim Director, HLA Tissue Typing

Histocompatibility Laboratory

The Histocompatibility Laboratory works to match donor organs

Aleodor Andea, MD
Director, Dermatopathology
Molecular Diagnostic Laboratory

with donors. As part of the mission of the Histocompatibility (HLA) Laboratory, implementation of NGS and PCR testing in the lab has advanced our molecular typing process in the form of improved clinical results with reduced typing costs and improved turn-around times.

In FY 19, the HLA laboratory experienced significant turnover in leadership positions including laboratory director, senior technologist in flow cytometry, and laboratory manager. In spite of these changes, the laboratory validated all new laboratory equipment acquired in relationship to the transition to the new laboratory space at the NCRC. In addition, with the aid of an interim laboratory director, Dr. Marcel Pando Rigal, a new automated virtual crossmatch tool was developed and implemented, which eliminates errors caused by manual work and produces a clear, easy-to-understand quality report for providers. This improvement greatly enhances immunological risk assessments and will ultimately help in improving patient outcomes.

In FY 19, the Histocompatibility Laboratory processed 23,480 billable cases, down 1.3% from FY 18, in which they processed 23,801 billable cases. The laboratory is performing more comprehensive testing for our patients, for accurate antibody identification, enabling better transplantation outcomes for our patients. In FY 19, 897 high resolution typings were completed, as compared to 968 in FY 18, a 7.3% decrease. Donor specific antibody testing increased 8.4% from 3,234 tests in FY 18 to 3,504 in FY 19. Flow crossmatches (allo) increased 1.2% from 545 to 552 in FY 18 and 19 respectively. In addition to these routine tests, there has been an ever-increasing need for additional testing, such as HLA-DP typing, supplemental antibody screening beads, surrogate crossmatches and auto crossmatches for kidney and extra-renal patients.

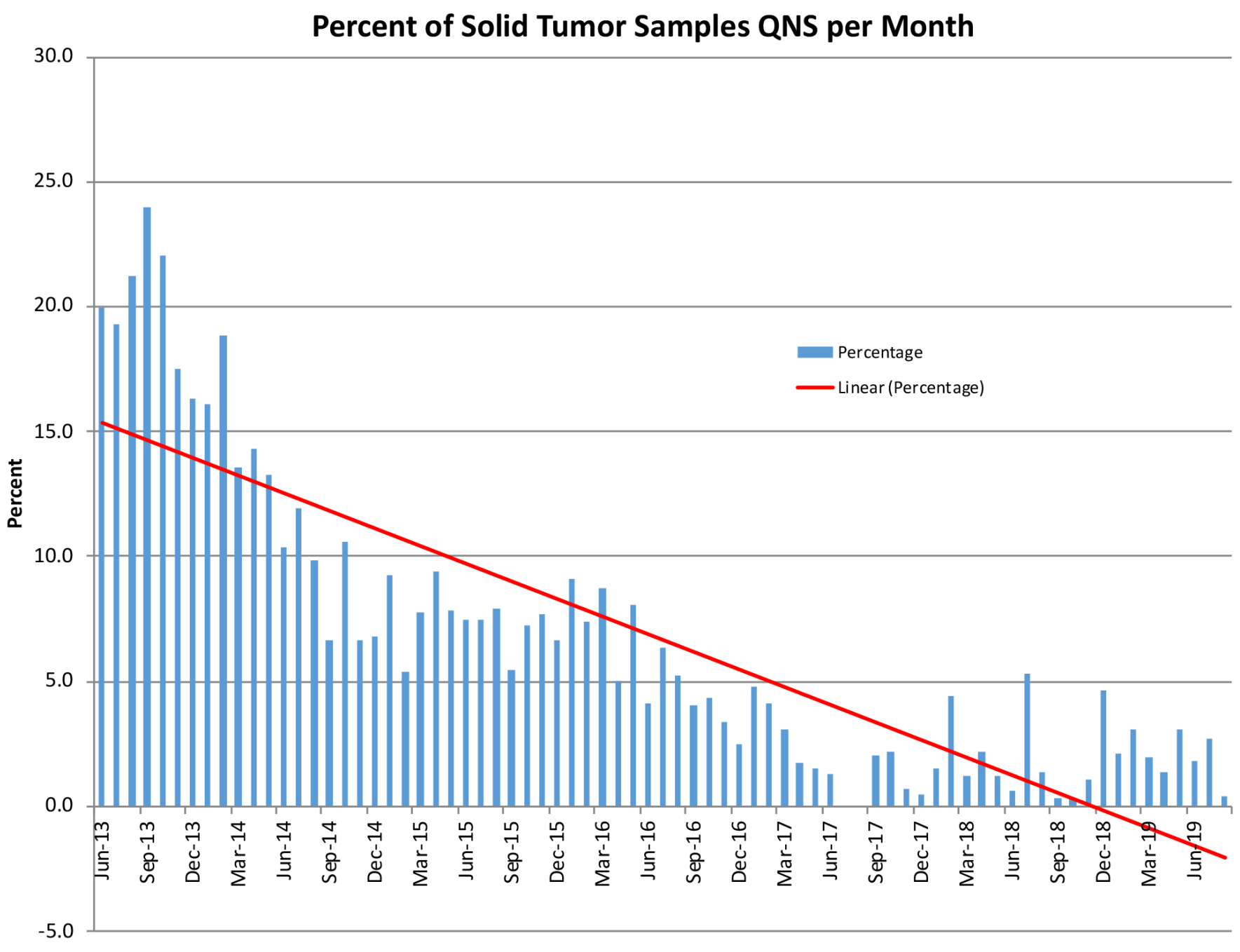
The laboratory also worked with the PRR team to merge with and incorporate the flow cytometry laboratory from University Hospital and the hematology morphology laboratory from the NCRC. The move, which took place in May 2019, resulted in many changes to laboratory layout and many staff underwent crosstraining between the disciplines. The laboratory also brought on a new laboratory manager, Usha Kota, BS, MT(ASCP), which has resulted in many process improvements including efficiency and a better turn-around-time in daily work, producing greater volumes of work with fewer staff.

The lab is recruiting a new director and in the meantime, has put on hold next generation sequencing work. It is poised and ready to embark on this testing in FY 20. The lab is now looking to improve serological and flow crossmatch techniques to improve quality and efficiency in both sections. Combining the technology between HLA and Heme-Flow will allow for enhanced collaboration and equipment utilization.

In FY 19, the HLA laboratory moved into the the new laboratory space at the NCRC with new equipment installed and validated, including the CytoFlex flow cytometry platform, a Sysmex XP300 Hematology Analyzer, the Quant Studie 6 Real Time PCR System, and the Biomek i5 Span 8 Liquid Handler. The new equipment has increased the efficiency of the labs, while reducing potential errors. The Quant Studio 6 enabled stat typings to be completed in 1.5 hours versus 4 hours, greatly facilitating organ donation and matching among critical patients. The Biomek i5 positions us for growth in next generation sequencing in the laboratory.

Dermatopathology Molecular Diagnostic Laboratory

The Dermatopathology Molecular Diagnostic Laboratory is focused on developing and offering new diagnostic and prognostic assays for melanocytic and non-melanocytic cutaneous neoplasms. Current test offerings include two related tests to help discriminate between benign and malignant melanocytic tumors, one based on FISH testing and one based on array CGH. Testing can be done in conjunction with full Dermatopathology consultation or as a stand-alone test. Test volumes increased 3% from 150 to 154 cases in FY 19.


Percent of Solid Tumor Samples QNS per Month
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
Percent
Percentage
Linear (Percentage)
Jun-13
Sep-13
Dec-13
Mar-14
Jun-14
Sep-14
Dec-14
Mar-15
Jun-15
Sep-15
Dec-15
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Sep-18
Dec-18
Mar-19
Jun-19

Michigan Center for **Translational Pathology**

Arul M. Chinnaiyan, MD, PhD
Director, Michigan Center for Translational Pathology

The Michigan Center for Translational Pathology (MCTP) was founded in 2007 under the directorship of Dr. Arul Chinnaiyan, as a collaborative effort between the University of Michigan Department of Pathology, Medical School, and Comprehensive Cancer Center (now named the Rogel Cancer Center), to foster research advances in molecular medicine and to apply those advances as quickly as possible to benefit patient care.

In 2011, the Michigan Oncology Sequencing Center (MI-ONCOSEQ), A CLIA-certified laboratory, was established to take advantage of the rapid advances in high-throughput DNA sequencing technologies with a goal of realizing "precision cancer medicine." This Center utilizes an integrative sequencing approach to provide a comprehensive landscape of the genetic alterations in individual tumor specimens for the purpose of identifying informative and/or actionable mutations.

This approach enables the detection of point mutations, insertions/deletions, gene fusions and rearrangements, amplifications/deletions, and outlier expressed genes. Furthermore, we can identify certain germline alterations that may also be relevant. We applied this to over 3,700 adult and pediatric patients thus far; a breakdown of the major cohorts for whom results are returned in the form of a molecular report is listed in the table (top right).

Cohort	Patients Enrolled/ Sequenced	Patients Enrolled/ Sequenced in FY 19
MO- (MiOncoseq)	1501	249
TP- (Tumor Profiling)	680	102
PO- (Peds Oncoseq)	497	115
MMRF (Multiple Myeloma)	723	132
GL- (Germline for MMGL)	309	191

Additionally, our sequencing facility supports a number of specialized programs and clinical studies. We intake and sequence samples from the Multiple Myeloma Research Foundation (>500 samples thus far) and have plans to extend the study into the next phase. Internally, we support the Michigan Medical Genetics Laboratories (MMGL), a comprehensive CAP/CLIA certified clinical genetics testing laboratories housed in the Department of Pediatrics, by providing them with sequencing data for select patients.

As our clinical sequencing program experienced increased demand, and with concurrent growth in outside entities offering clinical cancer sequencing services (such as Tempus), MI-ONCOSEQ will focus on metastatic prostate and breast cancers, cancers of unknown primary, and challenging cases with unusual or rare disease presentation. MI-ONCOSEQ will also serve clients we

have contractual agreements with and those that are requested through MLabs. We are also developing novel approaches for clinical sequencing as costs continue to decrease, and broadening the application of sequence data towards predicting response to immunotherapy and determination of epigenetic status.

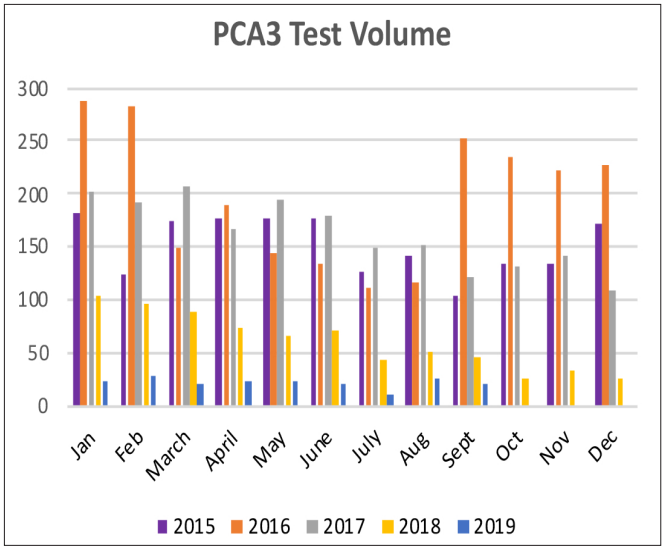
Listed below is a summary of revenues generated by the programs:

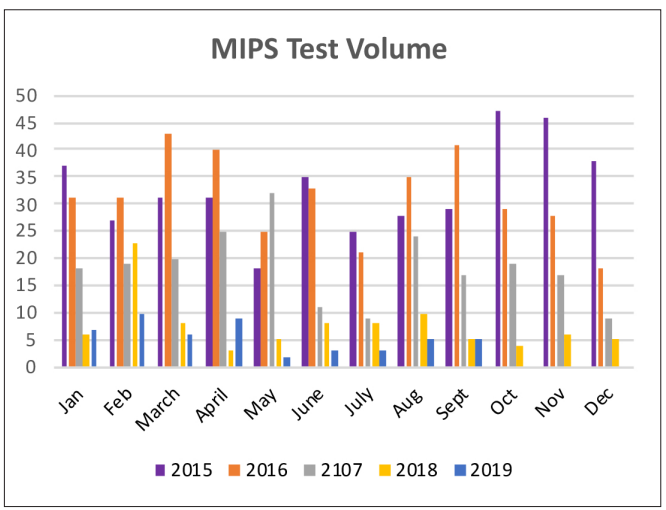
Program	FY 18 Revenue	FY 19 Revenue	2020 Projected Revenue
MMRF	$1,173,397	$513,308	$500,000
MMGL	$128,442	$281,697	$150,000

More recently MI-ONCOSEQ has been supporting several ongoing clinical trials/studies (charges based on select cases chosen for sequencing):

- **NCT00261456:** The IMPACT Study Immunotherapy in CDK12 Mutant Cancers (PI Alva)
- **NCT03456804:** An Open-Label, Parallel, Phase II Study of Single-Agent Oral ESK981 (Autophagy Inducer) in Men with Castrate-Resistant Prostate Cancer (CRPC) (PI, Heath)
- **NCT03562507:** Multi-center Trial of ESK981 in Combination With Nivolumab in Patients with Metastatic Renal Cell Carcinoma (ERICA) (PI Alva)
- **NCT03101566:** A Randomized Phase II Study of Nivolumab in Combination with Gemcitabine/Cisplatin or Ipilimumab as First Line Therapy for Patients with Advanced Unresectable Biliary Tract Cancer (PI Sahai)
- **NCT03287050:** FAST: Feasibility trial of Anti-PD(L)1 and SBRT in the Treatment of Advanced, Platinum-Refractory Urothelial Carcinoma (PI Alva)
- **NCT03242915:** Phase II multi-center study of pembrolizumab in combination with platinum-based doublet chemotherapy in patients with EGFR mutation and ALK positive NSCLC (Non-Small Cell Lung Cancer) with progressive disease following prior tyrosine kinase inhibitors (TKIs) (PI Gadgeel)
- **SU2C/PCF:** Prostate Cancer Foundation Dream Team Continuation of the CRPC 500 Cohort Study (PI Chinnaiyan)
- **POPCAP:** VA/PCF Precision Oncology Program for Cancer of the Prostate (PI Alva)
- **UMCC 2018.044:** Phase II Multi-Center Study of PARP inhibitor Rucaparib in Combination with Anti-PD-1 Antibody Nivolumab in Patients with Advanced or Metastatic Biliary Tract Cancer Following Platinum Therapy (PI Sahai)

In association with MLabs, MCTP's Molecular Testing Lab (MTL) receives orders for and carries out PCA3, Mi-Prostate Score (MiPS) and to a smaller extent, Cell Search Circulating Tumor Cell (CTC) assays. MTL processed a total of 2,114 PCA3 (862 clinical and 1,252 research samples) and 1,393 MiPS (141 clinical and 1,111 research samples) assays from January 2018 to July 2019.

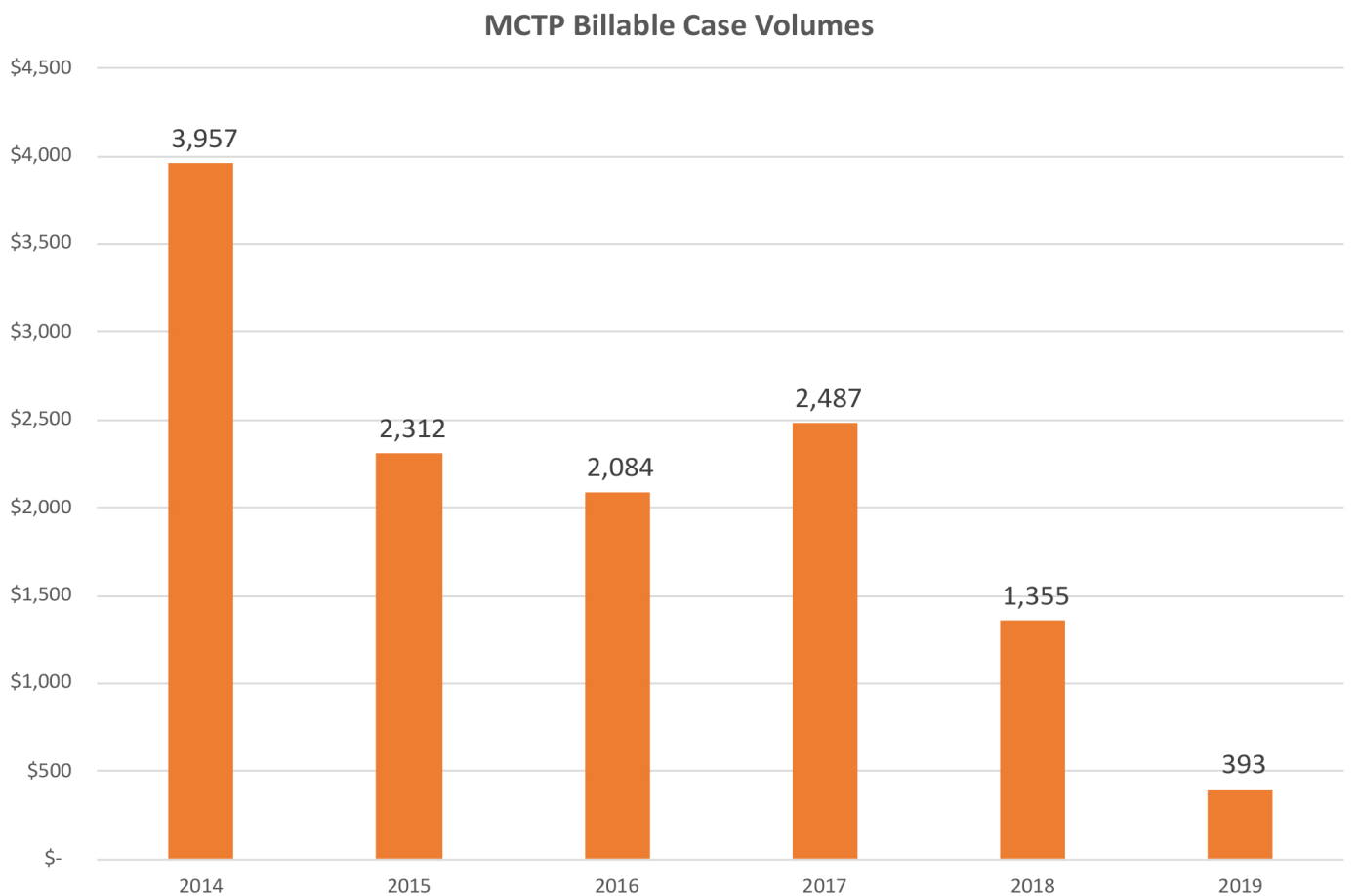


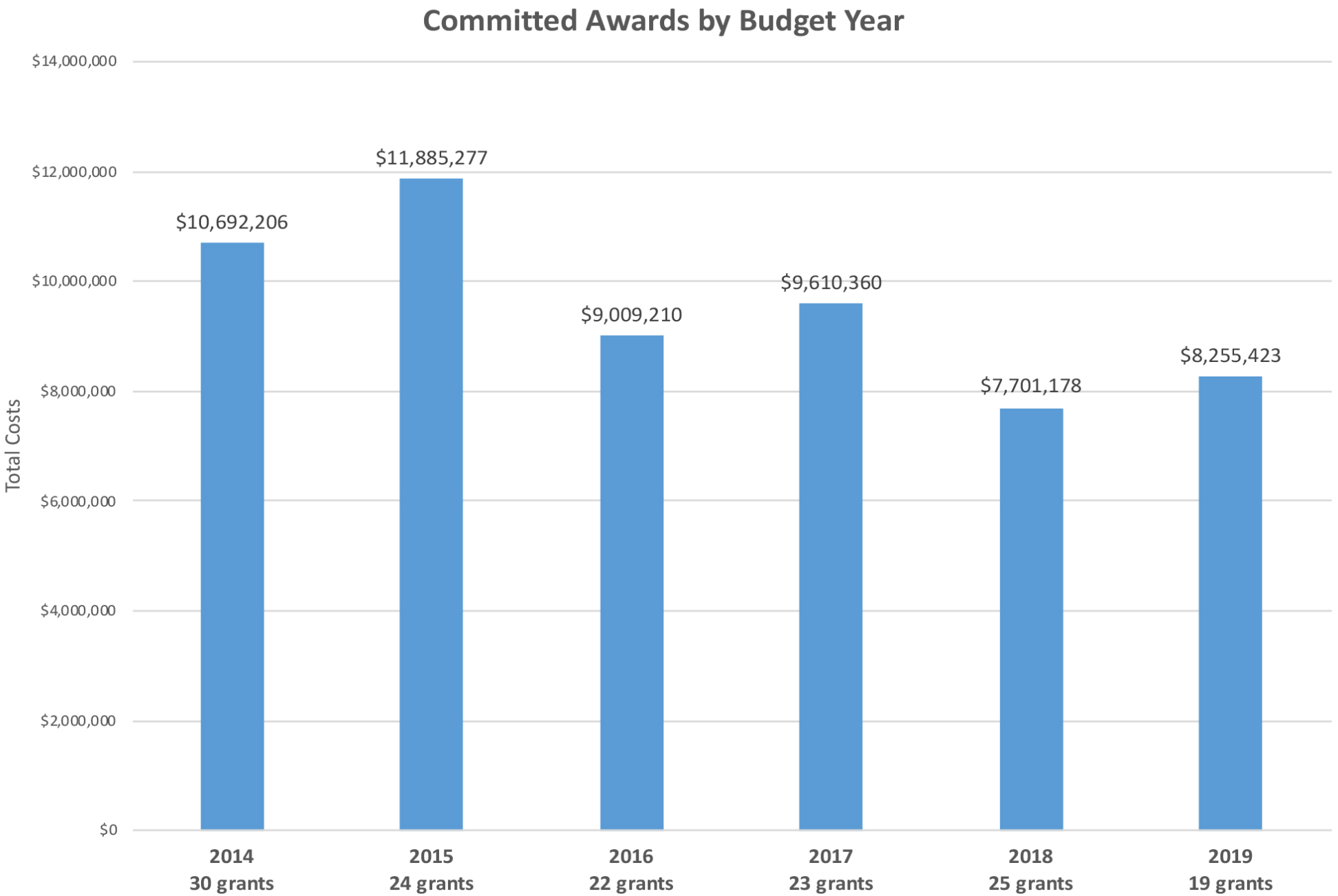


MTL also supports a number of clinical studies and research projects:

- **UMCC 2013.117**: A Randomized Phase II Study of Androgen Deprivation Therapy with or without PD 0332991 in RB-Positive Metastatic Hormone-Sensitive Prostate Cancer
- **ENACT Study**: A Clinical trial assessing the efficacy of enzalutamide in men with prostate cancer on active surveillance
- A Randomized Phase II trial of Abiraterone, Olaparib, or Abiraterone + Olaparib in Patients with Metastatic Castration-Resistant Prostate Cancer with DNA Repair Defects (c16-168)
- **UMCC 2016.106**: A Phase I Trial of Neoadjuvant Stereotactic Body Radiotherapy Prior to Radical Prostatectomy for High Risk Prostate Cancer

- **HUM00117711**: Targeted Early Detection Program in Men at High Genetic Risk for Prostate Cancer
- **HUM00148970:** EDRN Prostate MRI Biomarker Study and Reference Set.
- **MI-ONCOSEQ** (clinical sequencing program): The Tissue/ Informatics Core has been critical for the success of this program. The Core supports this study by participating in biospecimen procurement from biopsies and preparing samples to undergo sequencing in a CLIA-certified facility.
- Collaborative project, "Validation of Mitochondrial Markers for Prostate Cancer" with Samantha Maragh (National Institute of Standards and Technology).
- Collaborative project with Dr. Marc Goldstein, PI (Weill Cornell) to determine if the sensitivity and specificity of a semen PCA3 assay is superior to that of the current PCA3 urine assay.




Committed Awards by Budget Year
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
Total Costs
$10,692,206
$11,885,277
$9,009,210
$9,610,360
$7,701,178
$8,255,423
2014
30 grants
2015
24 grants
2016
22 grants
2017
23 grants
2018
25 grants
2019
19 grants

Michigan Medicine Laboratories (MLabs)

Jeffrey L. Myers, MD
Director, MLabs Reference Laboratory

Julia Dahl, MD
Associate Director, MLabs Reference Laboratory

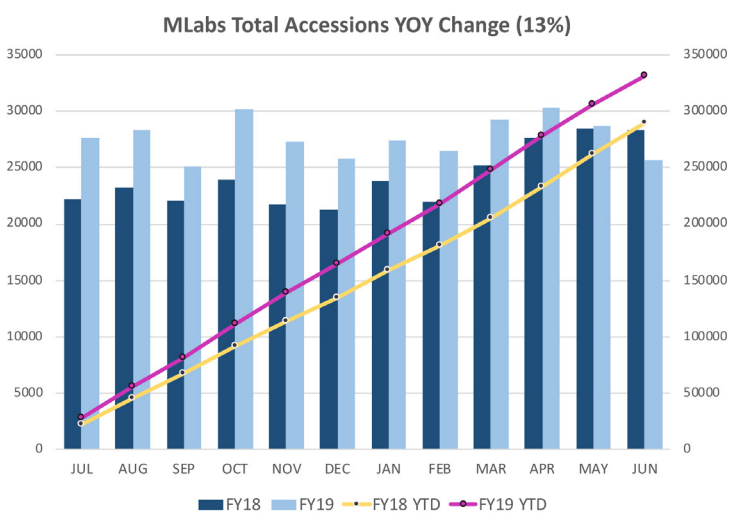
MLabs is a full-service reference laboratory that leverages the combined strengths of our faculty, trainees, staff, and state-of-the-art laboratories to revolutionize the experience of health care for providers and patients of strategic interest to Michigan Medicine and others outside our expanding health system network. Our continued successes in nurturing long-term relationships with a diverse portfolio of clients is predicated on the promise of expertise delivered personally with a passionate commitment to service excellence.

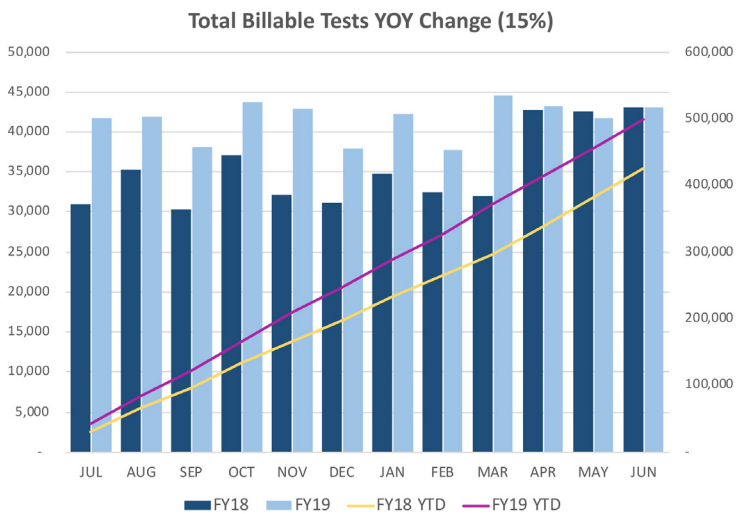
In FY 19, MLabs relocated from an off-site facility to the newly renovated space co-located within the Department of Pathology at the North Campus Research Complex. This relocation provided enhanced service opportunities with immediate access to IT support, faculty, trainees, and others, resulting in even greater opportunities to deliver personalized care to our providers and patients.

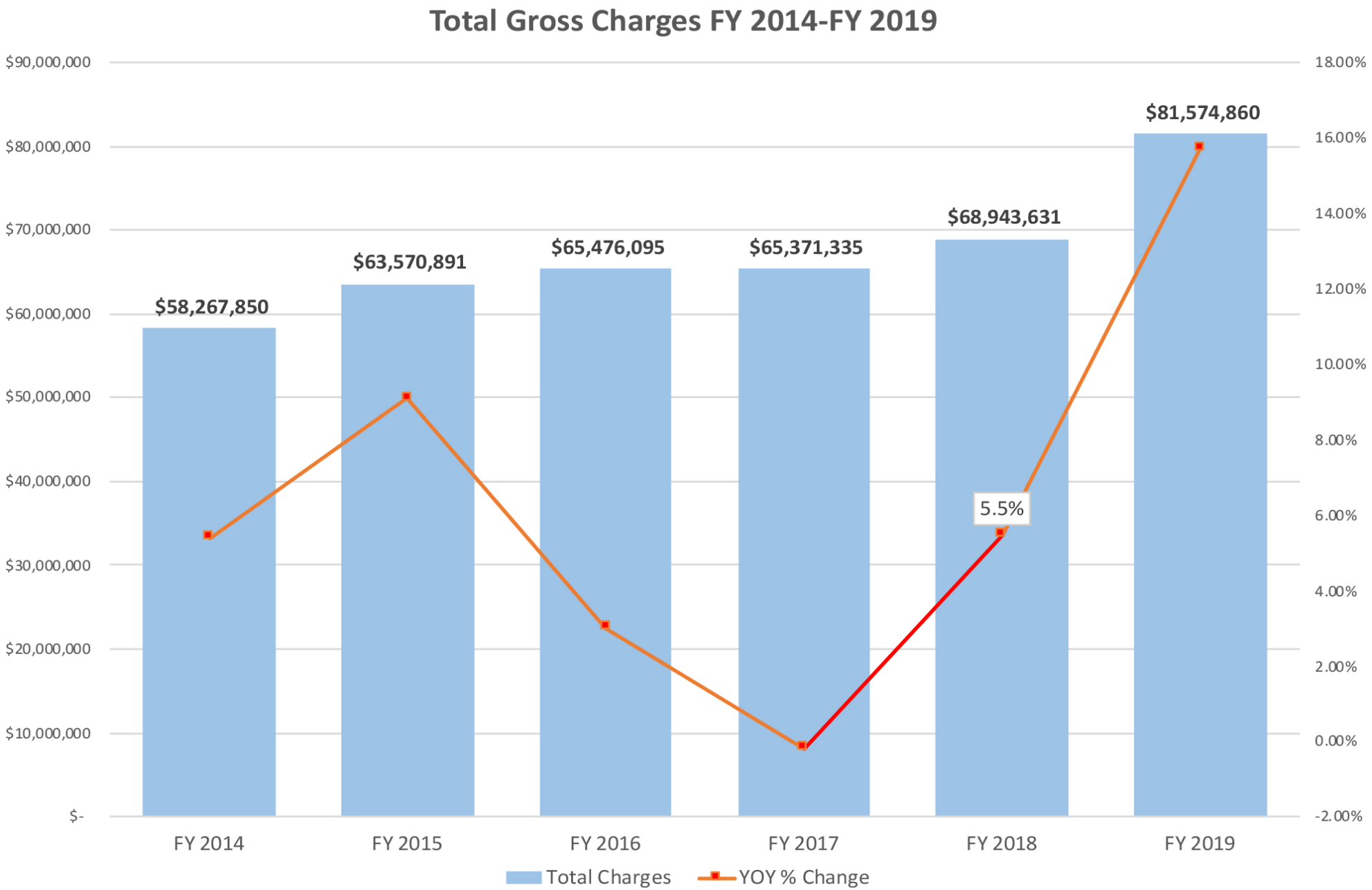
Total activity showed year-over-year growth of 13% measured as total number of accessioned cases (332,339) and 15% measured as total billable tests (498,851). Total gross charges grew at an annual rate of 15.7% compared to FY 18, showing strong sustained growth over the year. This continues a trend toward positive growth curves over the last five years; from FY 15 to FY 18, gross charges increased 28.3%.

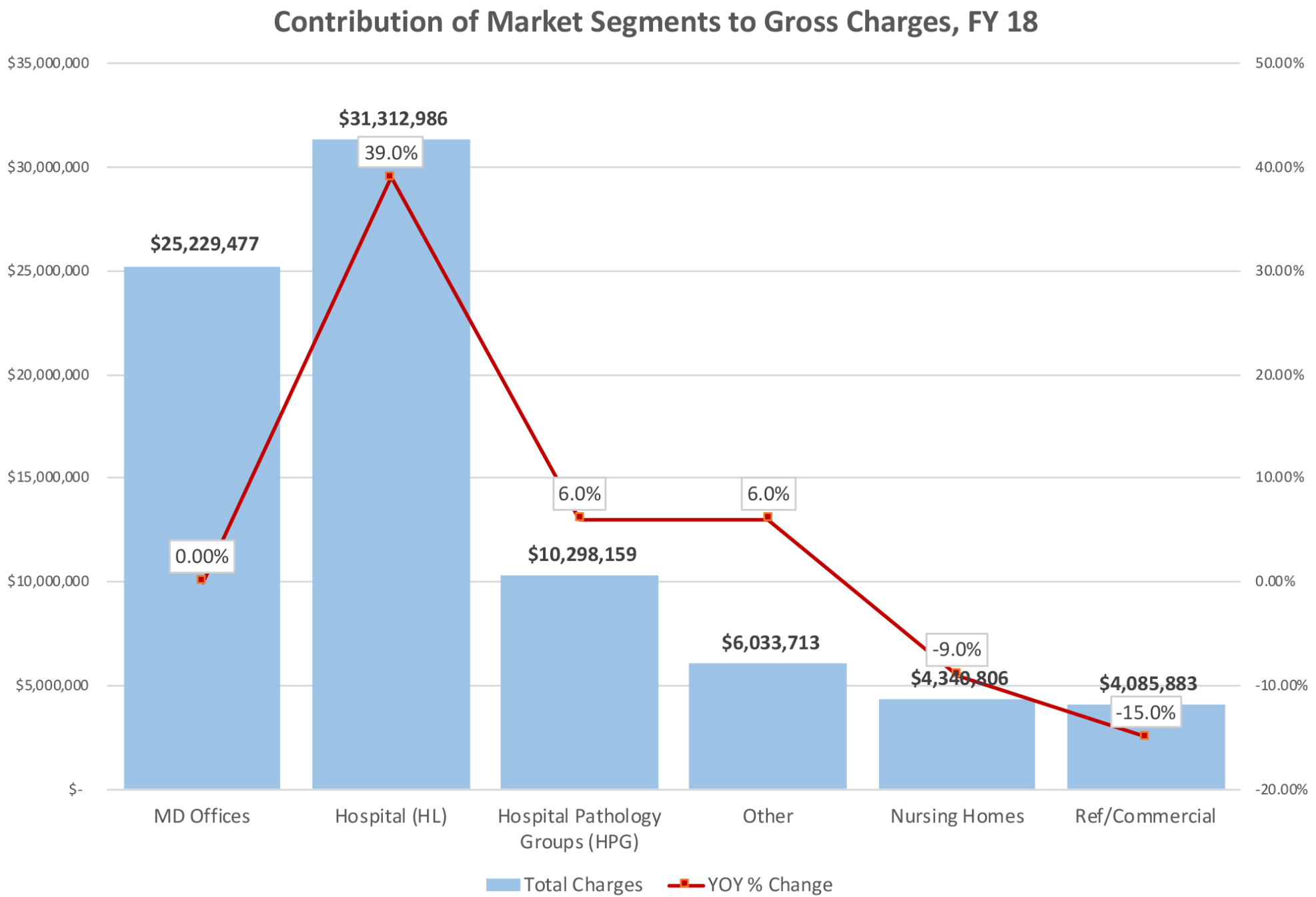
Hospitals and hospital-based pathology groups were the areas of greatest revenue growth in FY 19, showing year-over-year increases in gross charges of 64.5% and 6.87% respectively. This reflects the impact of onboarding MidMichigan Health and Metro Health as part of Michigan Medicine's network expansion strategy to provide world-class care in community-based hospitals. The physician office market remained steady. Taken together, these three market segments account for more than 82% of gross charges.

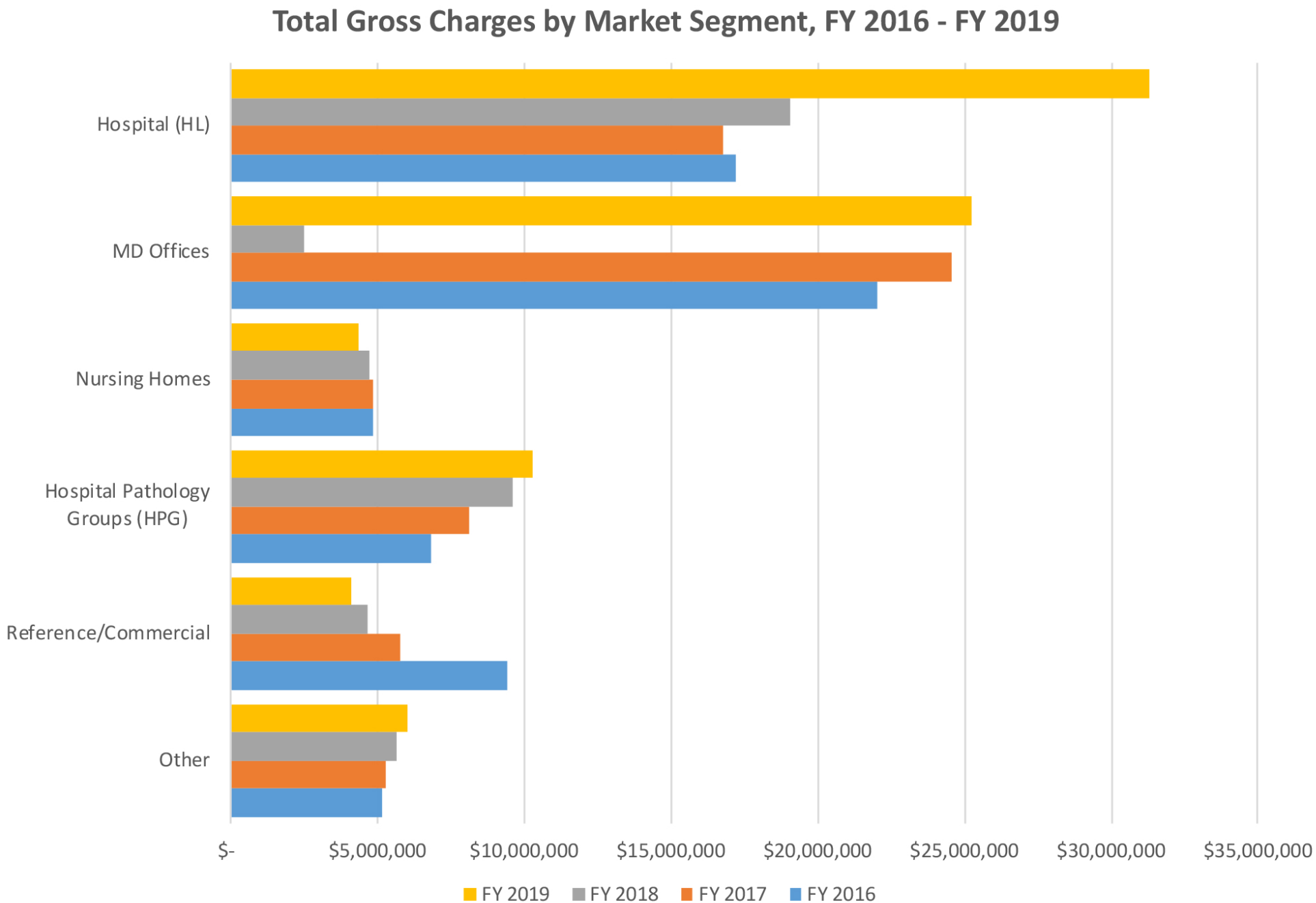
Growth in these market segments were partially offset by a 21% decline in gross charges associated with reference and commercial laboratory clients. This continues a trend that reflects declining share in the increasingly commoditized molecular testing market. New strategies for contracting these services at hospital system levels is a key priority for the coming fiscal year.






Total Gross Charges FY 2014-FY 2019
$90,000,000
$80,000,000
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
$-
18.00%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
-2.00%
$58,267,850
$63,570,891
$65,476,095
$65,371,335
$68,943,631
$81,574,860
5.5%
FY 2014
FY 2015
FY 2016
FY 2017
FY 2018
FY 2019
Total Charges
YOY % Change


Contribution of Market Segments to Gross Charges, FY 18
$35,000,000
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$-
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
-10.00%
-20.00%
$25,229,477
$31,312,986
$10,298,159
$6,033,713
$4,340,806
$4,085,883
0.00%
39.0%
6.0%
6.0%
-9.0%
-15.0%
MD Offices
Hospital (HL)
Hospital Pathology Groups (HPG)
Other
Nursing Homes
Ref/Commercial
Total Charges
YOY % Change


Total Gross Charges by Market Segment, FY 2016 - FY 2019
Hospital (HL)
MD Offices
Nursing Homes
Hospital Pathology Groups (HPG)
Reference/Commercial
Other
$-
$5,000,000
$10,000,000
$15,000,000
$20,000,000
$25,000,000
$30,000,000
$35,000,000
FY 2019
FY 2018
FY 2017
FY 2016

Veterans Affairs

Pathology & Laboratory Medicine

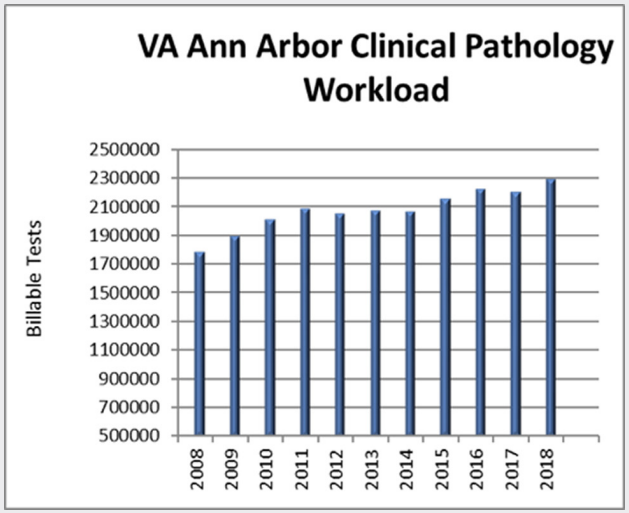
Stephen Chensue, MD, PhD
Director, Veteran's Administration Hospital Laboratories, VA

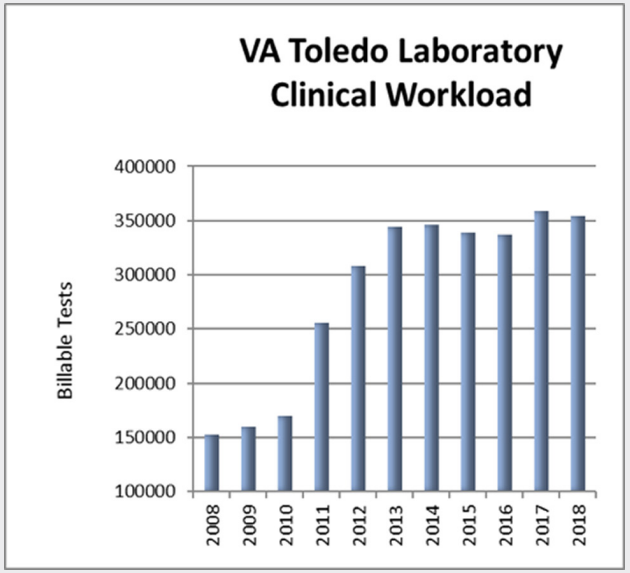
The Pathology and Laboratory Medicine Service of the Veterans Affairs Healthcare System in Ann Arbor, Michigan, is staffed by pathologists with a joint appointment at the University of Michigan Medical School. The VA Ann Arbor is a designated cancer center providing regional full-service clinical laboratory testing. They support anatomic pathology services in surgical pathology, cytopathology, and telepathology for VA Medical Centers in Battle Creek, Saginaw, Detroit, and Northern Indiana. In addition, chemistry and hematology testing is offered in Toledo, Ohio, and point-of-care testing is offered at community outpatient clinics in Flint and Jackson, Michigan. The data presented below are for the year that ended December 31, 2018.

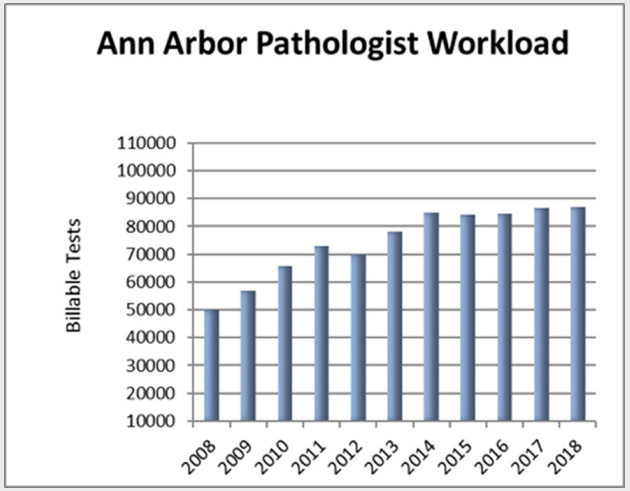
Clinical pathology workload in the Ann Arbor laboratory has increased at an average rate of 3% per year since 2008. The rate was blunted by a partial workload shift to a newly-expanded branch laboratory at the Toledo outpatient facility in 2011. Anatomic pathology workload has increased at an average rate of 6% per year since 2008. The VHA establishes high standards of quality and timeliness. Laboratory faculty and staff work hard to meet these standards, meeting clinical pathology STAT specimen turn-around time goals at least 98% of the time. Our outpatient phlebotomy team serviced 86% of patients in less than 10 minutes with >95% of patients indicating they are satisfied with their service on satisfaction surveys. In anatomic pathology, all service lines met or exceeded their targets in 2018. When compared to similar VA medical centers, the VA Ann Arbor workload is among the greatest. Pathologist productivity is among the highest with the lowest pathologist labor expense per billable test.

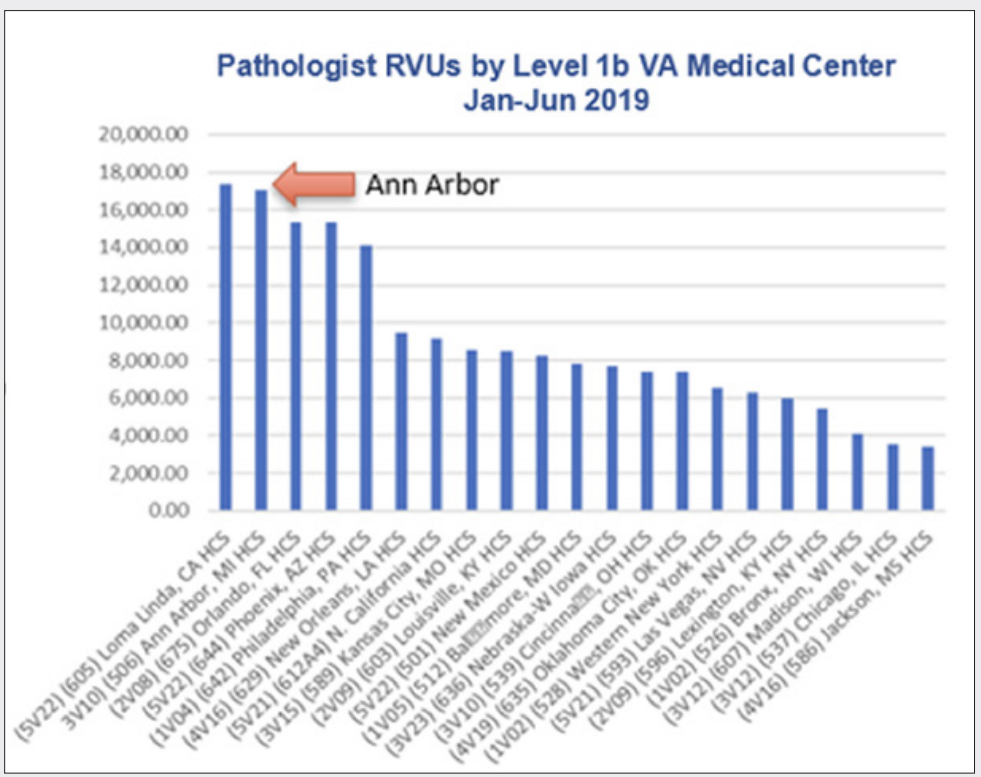
As part of a major modernization effort, the VA Ann Arbor laboratory has now completed the following initiatives. 1) acquired integrated clinical laboratory testing using a robotic track system to link multiple analyzers as well as to automate specimen processing storage and retrieval, 2) become the first VA in the nation to apply VA VistA computer integrated bar code tracking to Anatomic Pathology to reduce the potential for errors and to improve operational efficiencies, 3) introduce image analysis into hematology laboratory to augment differential analysis, 4) acquired instrumentation for spectroscopic molecular pattern analysis in microbiology for rapid bacterial and fungal identification at lower costs.

Service	Accessions	Target	%Meeting
Surgical Pathology	14,062	95% reported <2d	96.8%
Non-Gyn Cytology	2,965	95% reported <2d	97.1%*
Gyn Cytology	1,715	95% reported <14d	96.8%*
Frozen Section	566	95% reported <20min	99.3%
Autopsy	7	100% completed <30d	100%

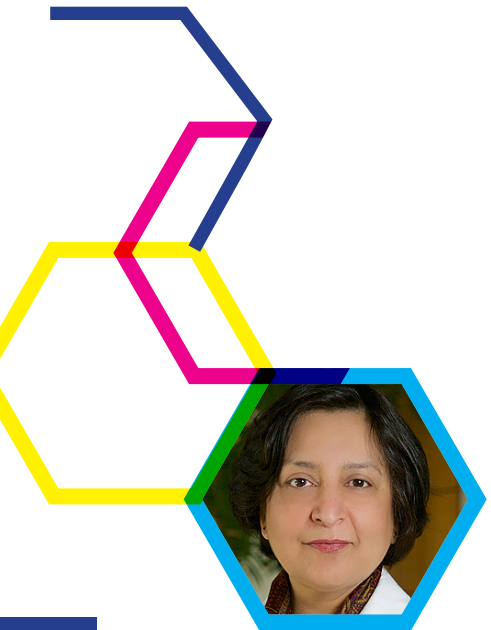

VA Ann Arbor Clinical Pathology Workload
Billable Tests
2500000
2300000
2100000
1900000
1700000
1500000
1300000
1100000
900000
700000
500000
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


VA Toledo Laboratory Clinical Workload
Billable Tests
400000
350000
300000
250000
200000
150000
100000
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Ann Arbor Pathologist Workload
Billable Tests
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Pathologist RVUs by Level 1b VA Medical Center
Jan-Jun 2019
20,000.00
18,000.00
16,000.00
14,000.00
12,000.00
10,000.00
8,000.00
6,000.00
4,000.00
2,000.00
0.00
Ann Arbor
(5V22) (605) Loma Linda, CA HCS
3V10) (506) Ann Arbor, MI HCS
(2V08) (675) Orlando, FL HCS
(5V22) (644) Phoenix, AZ HCS
(1V04) (642) Philadelphia, PA HCS
(4V16) (629) New Orleans, LA HCS
(5V21) (612A4) N. California HCS
(3V15) (589) Kansas City, MO HCS
(2V09) (603) Louisville, KY HCS
(5V22) (501) New Mexico HCS
(1V05) (512) Ba more, MD HCS
(3V23) (636) Nebraska-W Iowa HCS
(3V10) (539) Cincinna , OH HCS
(4V19) (635) Oklahoma City, OK HCS
(1V02) (528) Western New York HCS
(5V21) (593) Las Vegas, NV HCS
(2V09) (596) Lexington, KY HCS
(1V02) (526) Bronx, NY HCS
(3V12) (607) Madison, WI HCS
(3V12) (537) Chicago, IL HCS
(4V16) (586) Jackson, MS HCS

Research Mission



Asma Nusrat, MD
Director, Experimental Pathology

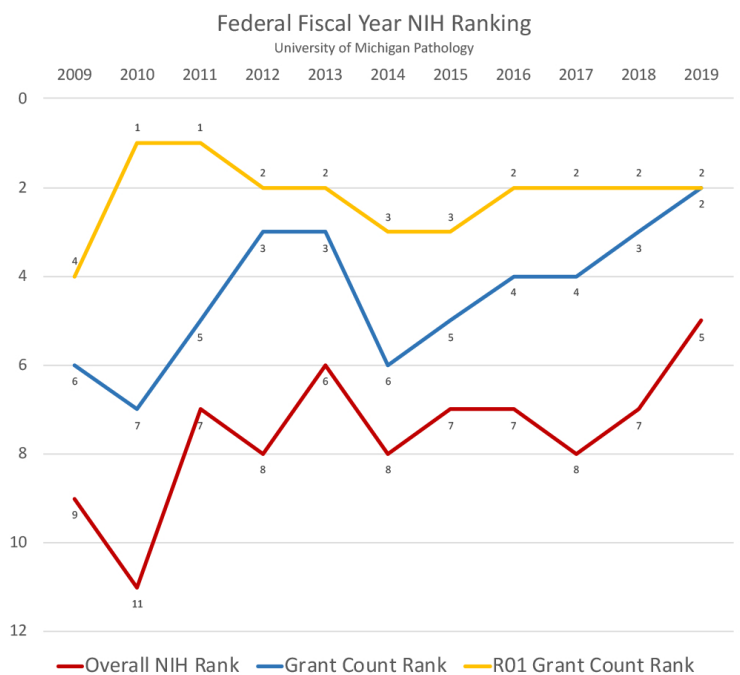
The research mission of the Department of Pathology is aimed at better understanding the mechanisms of disease and finding ways to treat or cure diseases. While many of the faculty have responsibilities within the clinical mission of the Department in addition to their research efforts, the Department also houses a Division of Experimental Pathology, which is home to 79 faculty representing 40 research laboratories with 15 endowed professorships.

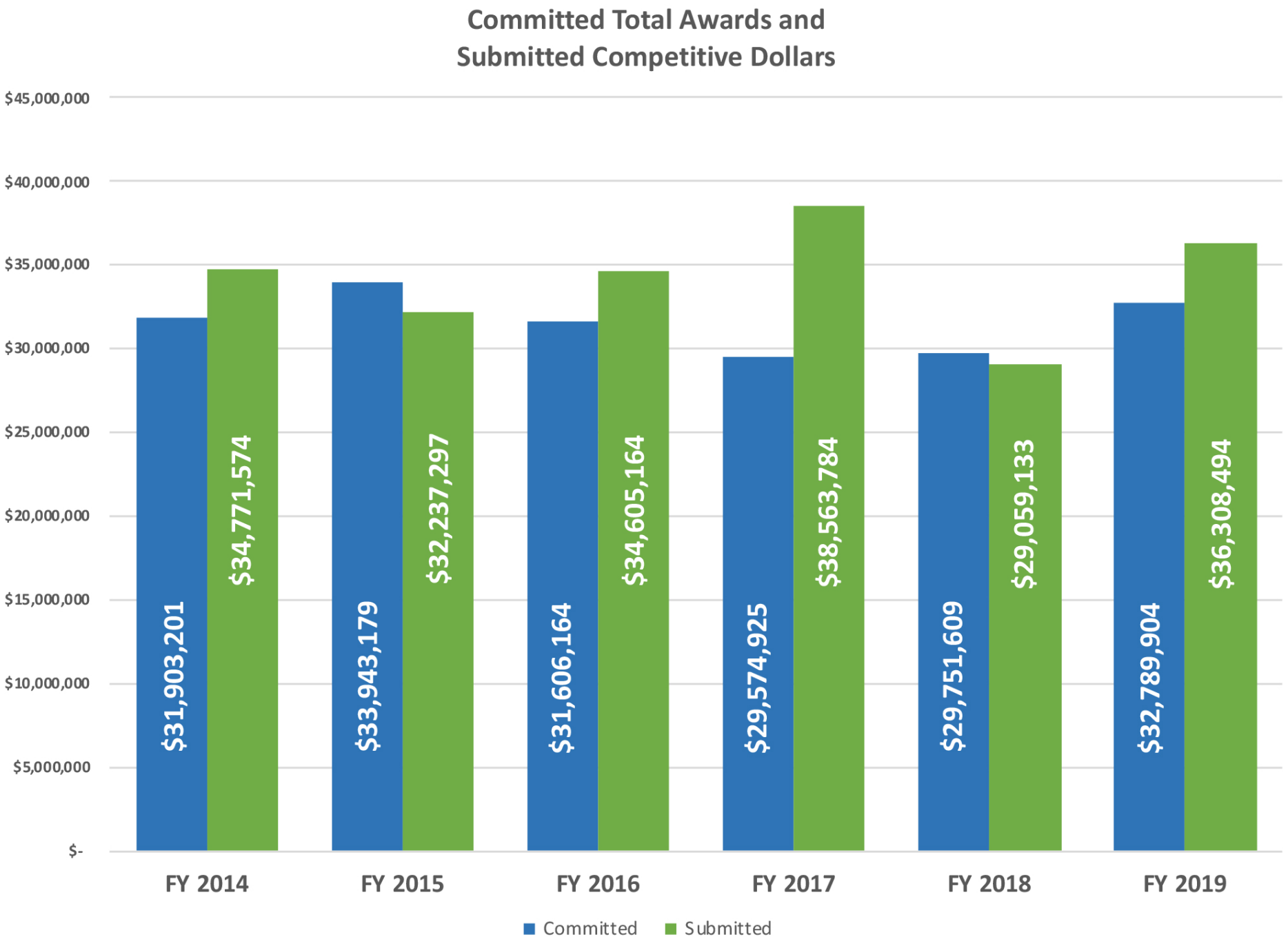
The Experimental Pathology faculty are both established and emerging young investigators occupying 61,827 sq. ft. of research space located in multiple buildings across the medical campus. These faculty are at the forefront of cutting-edge research that integrates new discoveries with the practice of medicine. Their scientific projects address many aspects of biology, disease pathogenesis and therapeutics.

Primary areas of research in the Division include aging, allergies, cancer biology, development and DNA repair, inflammation and immunology, mucosal inflammation and epithelial pathobiology, and neuropathology.

The new Mary H. Weiser Food Allergy Center, opened in FY 18, resulted in joint recruitments between Pathology and the Food Allergy Center. In December 2018, two of these joint recruits received endowed professorships through the Food Allergy Center. Dr. Chang Kim was named the Kenneth and Judy Betz Family Endowed Professor and Dr. Simon Hogan was named the Askwith Research Professor of Food Allergy.

In FY 19, our faculty received 53 awards from the NIH and ranked 5th in the nation in funding received by the NIH, up from 8th in FY 18, and 2nd in the nation when considering R01 grant awards and number of awards received. Total grants submitted in FY 19 was $36,308,494, up 25% over FY 18 and the total grants committed in FY 19 was $32,789,904, an increase of more than 10% over FY 18. Our total sponsored research spending in FY 19 was $32.7 million, down from $33.4 million in FY 18.




Committed Total Awards and
Submitted Competitive Dollars
$45,000,000
$40,000,000
$35,000,000
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$-
$31,903,201
$34,771,574
$33,943,179
$32,237,297
$31,606,164
$34,605,164
$29,574,925
$38,563,784
$29,751,609
$29,059,133
$32,789,904
$36,308,494
FY 2014
FY 2015
FY 2016
FY 2017
FY 2018
FY 2019
Committed
Submitted

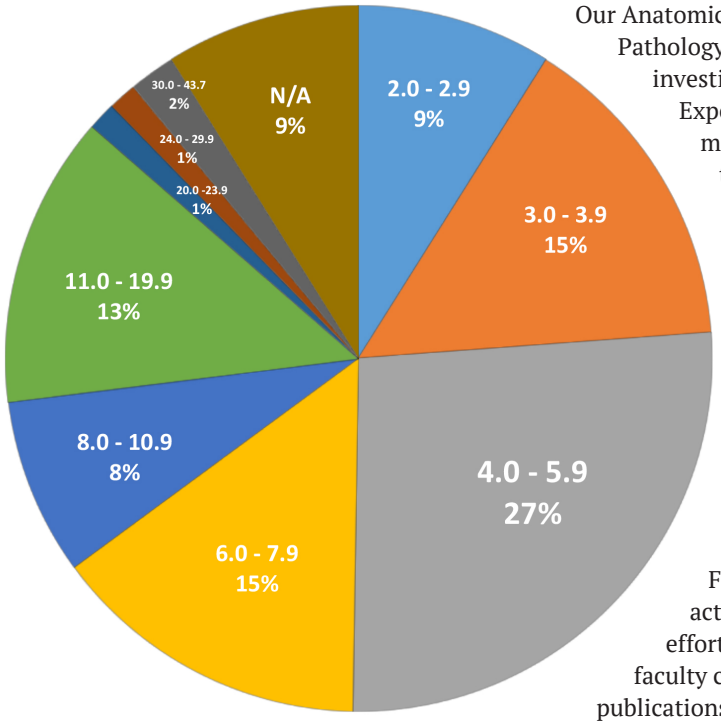


Chart: *Manuscripts published in FY 19 by journal impact factor.*

Our Anatomic and Clinical Pathology and Pathology Informatics faculty were principal investigators or co-investigators with our Experimental Pathology faculty on $11.7 million in funded grants, a testament to the dedication and versatility of our faculty. The Michigan Center for Translational Pathology (MCTP) held 19 grants valued at $8.26 million, which was a decrease in the number of grants held in FY 18 (25), but an increase of 7.2% in total funding.

These research efforts resulted in 409 peer-reviewed publications in FY 19, with 71 (17.4%) appearing in 36 high-impact journals (Impact Factor >10). Our clinical faculty were actively involved in the publication efforts of the Department, with AP faculty contributing to 320 peer-reviewed publications, CP faculty contributing to 113 peer-reviewed publications, MCTP faculty contributing to 32 peer-reviewed publications and Pathology Informatics faculty contributing to 11 peer-reviewed publications, with many of our publications engaging faculty from multiple divisions, illustrating the collaborative nature of the department.

Some of the key research highlights this year have included the following studies:

- **Dr. Arul Chinnaiyan** and the Michigan Center for Translational Pathology, along with the Department of Computational Medicine and Bioinformatics at the University of Michigan, used an exome capture RNA sequencing protocol to detect and characterize circular RNAs (circRNAs) across more than 2,000 cancer samples. Using capture sequencing, they built the most comprehensive catalog of circRNA species to date: MiOncoCirc, the first database to be composed primarily of circRNAs directly detected in tumor tissues. Using MiOncoCirc, they identified candidate circRNAs to serve as biomarkers for prostate cancer and were able to detect circRNAs in urine. They further detected a novel class of circular transcripts, termed read-through circRNAs, that involved exons originating from different genes. MiOncoCirc will serve as a valuable resource for the development of circRNAs as diagnostic or therapeutic targets across cancer types. This work was published in *Cell*, 2019 Feb 7; 176(4):869-881.
- **Dr. Gabriel Nuñez** and colleagues discovered that lipoteichoic acid (LTA), a molecule produced by Gram-positive bacteria, binds and activates NLRP6. In response to cytosolic LTA or infection with Listeria monocytogenes, NLRP6 recruited caspase-11 and caspase-1 via the adaptor ASC. Loss of Nlrp6 and Caspase 11 in mice led to less susceptibility to *L. monocytogenes* infection, however, administration of IL-18 to these mice restored their susceptibility to *L. monocytogenes*. This is a previously unrecognized innate immunity pathway triggered by cytosolic LTA that is sensed by NLKRP6 and exacerbates system Gram-positive pathogen infection via the production of IL-18. *Cell* 2018 Nov 29; 175(6):1651-1664.
- **Dr. Weiping Zou** and colleagues found that CD8+ T cells regulate tumor ferroptosis during cancer immunotherapy. Cancer immunotherapy restores or enhances the effector function of CD8+ T cells in the tumor microenvironment. CD8+ T cells activated by cancer immunotherapy clear tumors mainly by inducing cell death through perforin-granzyme and Fas-Fas ligand pathways. Ferroptosis is a form of cell death that differs from apoptosis and results from iron-dependent accumulation of lipid peroxide. Although it has been investigated *in vitro*, there is emerging evidence that ferroptosis might be implicated in a variety of pathological scenarios. It is unclear whether, and how, ferroptosis is involved in T cell immunity and cancer immunotherapy. Zou *et. al.* show that immunotherapy-activated CD8+ T cells enhance ferroptosis-specific lipid peroxidation in tumor cells, and that increased ferroptosis contributes to the anti-tumor efficacy of immunotherapy. T cell-promoted tumor ferroptosis is an anti-tumor mechanism, and targeting this pathway in combination with checkpoint blockade is a potential therapeutic approach. *Nature* 2019 May; 569(7755):270-274.

- **Dr. Andrew Lieberman** and colleagues analyzed the clinical, pathological, and biological features of nine age-dependent protein aggregation disorders that are caused by expansions of CAG repeats encoding polyglutamine (polyQ) tracts. An important conclusion from these analyses is that expanded CAG/polyQ domains are the primary drivers of neurodegeneration, with the biology of carrier proteins influencing disease-specific manifestations. Additionally, it has become apparent that CAG/polyQ repeat expansions produce neurodegeneration via multiple downstream mechanisms, involving both gain- and loss-of-function effects. This conclusion indicates that the likelihood of developing effective therapies targeting single nodes is reduced. The evaluation of treatments for premanifest disease will likely require new investigational approaches. Lieberman *et. al.* highlight the opportunities and challenges underlying ongoing work and provide recommendations related to the development of symptomatic and disease-modifying therapies and biomarkers that could inform future research. *Annu Rev Pathol* 2019 Jan 24;14:1-27.

Another measure of our faculty performance is their invited seminars. The majority of our faculty, 131, were invited to lecture at seminars, symposia, and other venues 694 times in FY 19.

Division	Faculty Invited	Invited Lectures
Anatomic Pathology	43	207
Clinical Pathology		104
Experimental Pathology	70	252
Pathology Informatics	3	31
Michigan Center for Translational Pathology	15	100
Total	**131**	**694**

Our faculty were extremely productive in terms of inventions and patents in FY 19, with 77 patient applications filed, 23 patents issued, 6 new invention reports filed and 9 new commercialization agreements finalized.

Invention Title	Inventors
Small-Molecule Inhibitors of Polycomb Protein EED	Ester Fernandez-Salas, Jianfeng Lu, Rohan Rej, Shaomeng Wang, Mi Wang, Chao-Yie Yang, Changwei Wang, Jeanne Stuckey
Composition for Monomer Ash1L Inhibitors and Method of Use Thereof	Jolanta Grembecka, Szymon Klossowski, Jing Deng, Tomasz Cierpicki, Hao Li, Hongzhi Miao, Eungi Kim, Trupta Purohit
AR113Q Knock-In Mice	Andrew Lieberman, Diane Robins
TAGTILE: A Customizable Dual-Probe Set Assay for Clinical Transcriptomics	Arul Chinnaiyan, Marcin Cieslik, Xuhong Cao
A Multiplexed Next Generation Sequencing Assay for the Early Detection of Prostate Cancer from Urine	Andi Cani, Arul Chinnaiyan, Kevin Hu, Scott Tomlins
Role of Nanoemulsion Vaccine in Chronic Cockroach Allergic Asthma	James Baker Jr., Nicholas Lukacs, Jessica O'Konek

Patent Title	Inventors
9H-Pyrimid0 [4,5-B]Indoles and Related Analogs as BET Bromodomain Inhibitors	Arul Chinnaiyan, Irfan Asangani
Compositions Comprising Thienopyrimidine and Thienopyridine Compounds and Methods of Use Thereof (5 patents issued)	Dmitry Borkin, Jolanta Grembecka, Tomasz Cierpicki, Jay Hess, Andrew Muntean, Duxin Sun
Machine Learning for Hepatitis C	Ulysses Balis, Yiwei Zhang, Ji Zhu, Akbar Waljee, Peter Higgins, Monica Tincopa, Anna Lok
Methods and Compositions for Inhibiting the Interaction of Menin with MLL Proteins (2 patents issued)	Jonathan Pollock, Jolanta Grembecka, Dmitry Borkin, Tomasz Cierpicki
MIPOL1-ETV1 Gene Rearrangements	Scott Tomlins, Saravana Dhanasekaran, Arul Chinnaiyan
ncRNA and Uses Thereof	Arul Chinnaiyan, John Prensner, Matthew Iyer
Recurrent Gene Fusions In Prostate Cancer (6 patents issued)	Rohit Mehra, Scott Tomlins, Daniel Rhodes, Arul Chinnaiyan
Stem Cell Factor Inhibitor (3 patents issued)	Sem Phan, Cory Hogaboam, Nicholas Lukacs, Vladislav Dolgachev, Steven Kunkel
Systems and Methods for Determining a Treatment Course of Action	Arul Chinnaiyan, Dan Robinson, Yi-Mi Wu
Systems and Methods for Electronically Mining Genomic Data	Mark Kiel, Kojo Elenitoba-Johnson, Megan Lim
Thienopyrimidine and Thienopyridine Compounds and Methods of Use Thereof	Jonathan Pollock, Jolanta Grembecka, Dmitry Borkin, Tomasz Cierpicki

Education Mission

Kathleen Cho, MD
Interim-Director, Division of Education Programs

Allecia Wilson, MD
Director, Residency Training Program

Education is another of the core missions of the Department of Pathology as part of an Academic Medical Center. The Department is a key provider of learning for medical students, graduate students, dental students, residents, and fellows. Our faculty have been among those most revered and remembered by graduates of the medical school, and have garnered formal recognition in the form of teaching awards over the years. In addition, many Pathology faculty members play key roles in education in other clinical departments throughout Michigan Medicine and in University departments outside of medicine. Similarly, our trainees are part of the educational process for their more junior counterparts and for others in the health system. The ways in which we fulfill this core mission are constantly evolving and adapting to new circumstances and demands.

In FY 19, our Education Division relocated to the North Campus Research Complex from the Medical Sciences 1 building. Residents and Fellows are now housed in newly renovated space with floor-to-ceiling windows overlooking the park-like setting of the NCRC campus. Located adjacent to the grossing room, and near the clinical laboratories, with several multi-headed teaching microscopes located in nearby rooms, residents and fellows are at the heart of the work being done in Pathology. The faculty suite is located directly above the educational space, ensuring easy access for questions and mentoring opportunities.

Graduate Medical Education – Pathology Residency Program

In FY 19, the University of Michigan Pathology Residency Program was the #1 ranked program in the United States among large public hospitals and was ranked 5th overall by Doximity, an online social networking service for U.S. physicians with over 400,000 verified physician members. In addition, 100% of our graduates from the past six years indicated that the training they received in our residency program was "excellent."

Program Type	Ranking by Reputation	Ranking by Research Output
All U.S. programs	5	13
All large public hospitals	1	2
Midwest programs	1	3

For our incoming resident cohort, we received 435 applications to fill 8 open slots. The number of applications decreased from 450, reflecting the smaller number of graduating medical students applying to pathology programs across the country. We still had an exceptionally-talented pool of applicants and were able to recruit high-caliber residents from a wide geographic region. Seven of our 2019 incoming first-year residents matched in AP/CP and one matched in AP/NP. All eight were highly ranked by UM in the National Residency Matching Program (NRMP) match.

This group includes graduates of medical schools all over the country:

- **Batoul Aoun, DO** / Lake Erie College of Osteopathic Medicine, Erie, PA
- **Geoffrey C. Halling, MD** / Wayne State University School of Medicine, Detroit, MI


UNIVERSITY OF MICHIGAN
Department of Pathology
David Nai, M.D
UNIVERSITY OF MICHIGAN
Department of Pathology
Dale Pinarlasi, M.D, PhD
UNIVERSITY OF MICHIGAN
Department of Pathology
Batool Anan, DO

- **Ryan E. Landvater, MD** / Robert Larner, M.D., College of Medicine at the University of Vermont, Burlington, VT
- **David W. Nai, MD** / University of Illinois College of Medicine, Chicago, IL
- **Emile S. Pinarbasi, MD, PhD** / The University of Texas Southwestern Medical School, Dallas, TX
- **Jaclyn M. Plotzke, MD** / Wayne State University School of Medicine, Detroit, MI
- **Julianne M. Szczepanski, MD** / University of Michigan Medical School, Ann Arbor, MI
- **Katelyn M. Zebrowski, MD** / Michigan State University College of Human Medicine, E. Lansing, MI

Our residency curriculum consists of daily didactic, gross, or slide presentations, 13 AP and 7 CP core subspecialty rotations, quality improvement course, Path 862 Translational Pathology course (combined with PhD students), and ASCP Lab Management University with certification.

A vibrant and varied morning Pathology Educational Series takes place most mornings at 8 am, from September through mid-June. In 2018-2019, there were approximately 180 conferences, most offering CME credit. They were presented by visiting faculty from other institutions, residents, fellows, staff, and departmental faculty. The morning conference series may be the one venue that most often draws together residents, fellows, AP faculty, and CP faculty.

In collaboration with our Division of Quality and Healthcare Improvement, our first- and second-year residents participated in quality improvement and patient safety projects as part of our quality improvement curriculum. Residents worked through web-based learning modules, attended lectures and discussions, and worked in teams on clinically-focused quality improvement projects. Data for knowledge assessment tests indicate a trend toward continuous improvement of the post-test mean scores, with significantly improved post-test over pre-test scores in each of the four years the curriculum has been administered.

Table 1. Comparison of pre- and post-test means for the three years of administration of the QI curriculum.

Year	Pre-test mean score	Post-test mean score	p-value (paired t-test)
2016	12.6	16	0.0001
2017	14.2	16.2	0.04
2019	14.1	17.4	0.02
2019	14.8	17	0.07

Our residents are highly-engaged members of the medical and pathology communities with many serving in local, regional, and national organizations (*see chart on **pg. 67** of the Appendix*)

Seven residents completed residency training in FY 19. All have begun fellowship training, with five continuing their training at U-M in surgical pathology, surgical pathology/pediatric pathology, cytopathology, hematopathology and breast pathology. Of the remaining two residents, one is now a genitourinary pathology fellow at Memorial Sloan Kettering and the other is a hematopathology fellow at Stanford.

Key achievements of our graduating residents include:

- All graduating residents earned certificates in Lab Management University
- All graduating residents participated in at least one cycle of the QI curriculum
- All graduating residents participated in a CAP inspection or mock inspection
- Two graduating residents completed the Healthcare Administration Scholarship Program, a 2-year certificate-level program covering various topics in healthcare administration, culminating in a senior administrative project.
- Our 5-year certification rate is 96% for first-time takers.

Libby Simon, MD
Chief Resident

Emily McMullen, MD
Assistant Chief Resident

John Kennedy, MD
HO IV

Shula Schechter, MD
HO IV

Brian Soles, MD
HO IV

Lauren Stanoszek, MD, PhD
HO IV

Steven Weindorf, MD
HO IV

Helen Worrell, MD
HO IV

Amanda Kitson, MD
HO III

Chelsea Styles, MD
HO III

Burke Van Norman, MD
HO III

Nicholas Zoumberos, MD
HO III

Ashley Smith, DO
HO II

Krista Chain, MD
HO II

Laura Griesinger, MD
HO II

Cisley Hines, MD
HO II

Ania Owczarczyk, MD, PhD
HO II

Alex Taylor, MD
HO II

Margaret Fang, MD
HO I

Efrain Gutierrez-Lanz, MD
HO I

Justin Kelley, MD, MPH
HO I

Lauren Kroll-Wheeler, MD
HO I

Natalia Liu, MD
HO I

Tim Miller, MD
HO I

Catherine Perez, MD
HO I

William Perry, MD, MPH
HO I

Batoul Aoun, DP
Incoming HO I

Geoffrey Halling, MD
Incoming HO I

Ryan Landvater, MD
Incoming HO I

David Nai, MD
Incoming HO I

Emile Pinarbasi, MD, PhD
Incoming HO I

Jaclyn Plotzke, MD
Incoming HO I

Julianne Szczepanski, MD
Incoming HO I

Katelyn Zebrowski, MD
Incoming HO I

2018-2019 **Pathology Residents**

Pathology Fellowship Program

The Department of Pathology offers 9 ACGME-approved fellowships with 16 approved positions plus an additional 8 clinical fellowship programs offering 11 positions. Our pathology Informatics 2-year fellowship program is in the process of converting to an ACGME-approved program in Clinical Informatics which will ultimately serve as the entire health system's mechanism for providing coverage of fellowship training in informatics, in all clinical specialties. Once approved, this program will be the only Clinical Informatics program to serve the Health System.

On July 1, 2018, we welcomed:

- Breast Pathology Fellow
  Ellen East, MD
- Bone and Soft Tissue Pathology Fellow
  Cody Carter, MD
- Cytopathology Fellow
  Miguel Rufail, MD, PhD
- Dermatopathology Fellows
  Grace Wang, MD and **Joseph Zahn, MD**
- Forensic Pathology Fellow
  Milad Webb, MD, PhD
- Gastrointestinal Pathology Fellow
  Jonathan Mowers, MD, PhD
- Genitourinary Pathology Fellow
  Zhichun Lu, MD
- Gynecologic Pathology Fellow
  Stephanie Skala, MD
- Hematopathology Fellows
  Sarmad Jassim, MD, **Shweta Chaudhary, MD,** and **Nick Olson, MD**
- Histocompatibility Fellow
  Kristina Davis, MD
- Molecular Genetics Fellows
  David Manthei, MD, PhD and **Eman Abdulfatah, MD, PhD**
- Neuropathology Fellows
  Kyle Conway, MD and **Andrew Pratt, MD**
- Pathology Informatics Fellow
  Keluo Yao, MD
- Pulmonary Pathology Fellow
  Jian Jing, BM, PhD
- Surgical Pathology Fellows
  Sara Hawes, MD, **Kenneth Hughes, MD**, **Dongmin Gu, MD, PhD,** and **Tanmay Shah, DO**

Madelyn Lew, MD
Director, Medical School
Pathology Education Curriculum

Medical Student Teaching

The Department has a long history of playing an integral role in pre-clinical medical student education. In *Foundations of Diagnostics & Therapeutics*, one of the first sequences encountered by medical students in the Scientific Trunk, we introduce the foundational principles of Pathology. This lays the groundwork upon which students build in subsequent organ-based fused sequences. Each of these include pathology lectures and many also utilize pathology laboratory sessions. Lectures and laboratories are conducted by many pathology faculty members including Madelyn Lew, Scott Owens, Evan Farkash, Paul Harms, Alexandra Hristov, Allecia Wilson, Kristine Konopka, Paul Killen, Scott Tomlins, Aaron Udager, Karen Choi, Angela Wu, Andrew Sciallis, May Chan, Charles Ross, Laura Cooling, and Kate McFadden. Under the direction of Dr. Madelyn Lew, Director of Medical Student Education for the Department of Pathology, our faculty members are working to continue integrating pathology content with other clinical and basic science elements in fused sequences and to incorporate new interactive methods of delivering education material.

In the *Transitions to Clerkships* Course, Madelyn Lew authored one of the standardized patient presentations, which provides Blood Bank faculty an opportunity to participate in medical education as leaders of small group sessions. In the new *Surgery & Applied Sciences Clerkship*, students are introduced to the clinical practice of pathologists. For this clerkship, Madelyn Lew developed a curriculum to consolidate foundational principles learned in the Scientific Trunk and to introduce their clinical applications in the daily activities


Eman Abdulfatah, MD, PhD


Cody Carter, MD


Shweta Chaudhary, MD


Kristina Davis, MD


Ellen East, MD


Dongin Gu, MD


Sara Hall (Hawes), MD


Kenneth Hughes, MD


Sarmad Jassim, MD


Jian Jing, MD


John Kennedy, MD


Zhichun Lu, MD


David Manthei MD, PhD


Jonathan Mowers, MD


Nicholas Olson, MD


Drew Pratt, MD


Miguel Rufail, MD, PhD


Shula Schechter, MD


Tanmay Shah, DO


Caroline Simon, MD


Stephanie Skala, MD


Brian Soles, MD


Lauren Stanoszek, MD, PhD


Grace Wang, MD


Milad Webb, MD, PhD


Steven Weindorf, MD


Helen Worrell, MD


Keluo Yao, MD


Joseph Zahn, MD

Graduating Fellows 2018-2019

Fellow	New Position	Institution
Cody Carter	Pathologist	Loma Linda University Faculty Medical Clinic, Loma Linda, CA
Shweta Chaudhary	Pathologist	Appalachian Regional Healthcare Region-al Medical Center, Hazard, KY
Kristina Davis	Assistant Professor, HLA	Michigan Medicine, Ann Arbor, MI
Ellen East	Pathologist	St. Joseph Mercy Health System, Ypsilanti, MI
Dongmin Gu	Assistant Professor of Pathology & Laboratory Medicine	Rutgers University, Robert Wood Johnson Medical School, Piscataway, NJ
Kenneth Hughes	Pathologist	UT Health, San Antonio, TX
Sarmad Jassim	Hematopathologist	Beth Israel Deaconess Medical Center, Boston, MA
Jian Jing	Assistant Professor of Pathology	University of Colorado Anschutz Medical Campus, Aurora, CO
John Kennedy	GU Fellowship	New York Sloan Kettering
Zhichun Lu	Assistant Professor of Pathology & Laboratory Medicine	Boston University School of Medicine, Boston, MA
Nicholas Olson	Bone & Soft Tissue Fellowship	Mayo, Rochester, MN
Drew Pratt	Assistant Professor of Neuropathology	Michigan Medicine, Ann Arbor, MI
Miguel Rufail	Surgical Pathology Fellowship	Pennsylvania Hospital, Philadelphia, PA
Tanmay Shah	Pathologist	Michigan Pathology Specialist, PC, Grand Rapids, MI
Stephanie Skala	Assistant Professor, Gynecologic Pathology	Michigan Medicine, Ann Arbor, MI
Grace Wang	Assistant Professor	Virginia Commonwealth University, Richmond, VA
Milad Webb	Assistant Professor, Forensic Path	Wayne County Medical Examiner's Office & Michigan Medicine, Ann Arbor, MI
Steven Weindorf	Heme Fellowship	Stanford University, CA
Keluo Yao	Clinical Instructor of Pathology	University of California, San Francisco School of Medicine
Joseph Zahn	Dermatology Fellowship	Michigan Medicine, Ann Arbor, MI

Kristine Konopka, MD
Director, Pathology Clerkship
Program Director, Pulmonary Pathology Fellowship

of the Pathology Department. This curriculum utilizes different learning environments including small groups sessions, observation of clinical activities, and online modules. In the 4-5 Clinical Trunk, second-year medical students will rotate through Pathology on a weekly basis, observing autopsies and AP sign-out sessions as well as taking part in CP small group sessions.

In the Branches, faculty are participating both as Branch mentors as well as Science Advisors for the Diagnostics & Therapeutics Branch. Students in their third and fourth years can participate in a variety of integrated electives that include multiple disciplines to enhance their understanding of disease process, presentation, and management.

Pathology Elective Rotation

The Pathology Elective experience, under the direction of Dr. Kristine Konopka, has undergone improvements to tailor to the career goals of rotating students. Medical students now have a more structured framework in which they are assigned to specific pathology services correlated to their chosen career paths. Throughout this rotation, students select cases to write-up in order to enhance their understanding of clinic-pathologic correlations. Additionally, students are required to write an in-depth paper about a topic within Pathology that correlates to their own personal or career interests. While many of the students rotating in our elective may choose other fields of practice, a distinct subset take part in our Career Exploration elective to evaluate Pathology as a possible career choice. For these students, individualized mentoring is provided by faculty in the department, particularly from Kristine Konopka, Aaron Udager, and Madelyn Lew.

Molecular and Cellular Pathology Graduate Program

Zaneta Nikolovska-Coleska, PhD
Director of Molecular and Cellular Pathology Graduate Program

The Molecular and Cellular Pathology Graduate Program (MCP) is one of the Programs in Biomedical Sciences (PIBS) graduate programs and is supported through the Department of Pathology. The MCP Graduate Program, under the direction of Dr. Zaneta Nikolovska-Coleska, has 41 Pathology research mentors/labs from which to choose and 20 students performing their PhD thesis research in Pathology Department laboratories during FY 19.

In August 2018, our new MCP and PIBS students participated in a half-day event to discuss the program and to learn about available research rotation projects. Once the students selected their laboratory, they were encouraged to work with their mentors to attend mentoring sessions offered by Rackham's Office of Student Success and to prepare their mentoring plan. At the first thesis committee meeting, students present their proposal written in an R21 format.

Each year, the Director of the MCP meets with the students to discuss their progress. In addition, students are invited to an annual MCP Student Council meeting to hear students' opinions and suggestions. This is to ensure students remain on track and their needs are being adequately addressed during their thesis research work.

Students are also engaged with outreach and professional development activities to build their mentoring skills with younger students and undergraduates. In FY 19, the students participated in

- Michigan DNA Day
- Science Olympiad tutor
- Developing Future Biologists
- One Day Closer event volunteer
- Science Education & Engagement for Kids (SEEK)
- Michigan Health Sciences Pre-College Exposure Academy
- Habitat for Humanity
- miLEAD Consulting

In addition, the students organized the Department Research Symposium, held on November 9, 2018. They invited Dr. Mina Bissell, Lawrence Berkeley National Laboratory, as their keynote speaker.

MCP students participated in the 4th Annual Midwest Case Competition, competing in a field of sixteen teams. This competition gives graduate students an opportunity to work with a client to create solutions to real-life business problems. Second-year MCP student Siva Kumar Natarajan's "JSNT Team" (with Tanvi Gujarati, Physics; Jerry Mandukwe and Naincy Chandan, Pharmacology)

brought home the top prize. Second prize was awarded to K&P to the Max, a team comprised of fourth-year MCP students Paloma Garcia (Nuñez lab) and Kelly Kennaley (Tomlins lab) as well as Xingjian Ma (chemical engineering).

To address the social needs of the MCP students, a number of events are held each year, including a Student/Faculty picnic at Island Lake Park, a happy hour student/faculty mixer, a student camping trip to South Higgins Lake, and an ice cream social.

During this fiscal year, five students successfully completed their preliminary exams, which allowed them to pass to candidacy during their second year and begin to focus on their research thesis work. In addition, six students graduated with their PhD *(full chart on **pg. 68**)*:

Graduate	Current Company
Sierrah Grigsby	SUNY Downstate
James Ropa	Indiana University School of Medicine
Shayna Bradford	University of Michigan
Lorena Lazo de la Vega	Strata Oncology
Kelly Kennaley	University of Michigan
Yajia Zhang	University of Michigan

Our graduate students were successful in obtaining grants, travel awards and fellowships this year. Andi Cani received the Precision Health Award. Training grants were received by Angela Guo (Training in the Biomedical Research of Aging), Thaddeus Kunkel (Training Program in Translational Research), and Jessica McAnulty (Training Program in Translational Research), while six students obtained travel awards.

Student Name	Award
Rita Agazalho Avelar	Dr. Eleanor Lewis Award
Andi Cani	AACR Scholar-in-Training Award
Andi Cani	ASIP 2018 PISA Conference Travel Award
Andi Cani	Precision Health Scholars Award
Samantha Kemp	Moses Gunn Best Poster Award
Samantha Kemp	Poster honorable mention at Gordon Research Conference
Carrie-Anne Malinczak	The American Association of Immunologists Young Investigator Award. Autumn Immunology Conference
Abhijit Parolia	AACR Scholars-in-Training Award 2019
William Perry	Paul E. Strandjord Young Investigator Award, Academy of Clinical Laboratory Physicians and Scientists

The MCP students published ten first-author manuscripts and 14 co-author manuscripts in peer-reviewed journals. Five students received awards for their work.

Translational Pathology Training Grant

The NIH T32 Training Program in Translational Research, directed by Drs. Andrew Lieberman and Zaneta Nikolovska-Coleska, was funded and started on July 1, 2016. This T32 grant is supported by the NIH, National Institute of General Medical Sciences and supported 4 pre-doctoral trainees for year 3 of the 5-year cycle.

Trainee	Academic Program	Mentor	Years Trained
Karson Kump	Chemical Biology	Dr. Zaneta Nikolovska-Coleska	2nd
Samantha Kemp	Molecular & Cellular Pathology	Drs. Pasca di Magliano & Celina Kleer	2nd
Thaddeus Kunkel	Molecular & Cellular Pathology	Dr. Andrew Lieberman	1st
Filipe Cerqueria	Microbiology and Immunology	Dr. Nicole Koropatkin	3rd

Strongly affiliated with the T32 TPTR Program		
Andi Cani	Molecular & Cellular Pathology	Dr. Scott Tomlins
Hanjia Guo	Molecular & Cellular Pathology	Dr. David Lombard
Lucas Huffman	Neuroscience	Dr. Roman Giger
Shawn Whitefield	Microbiology & Immunology	Dr. Evan Snitkin

Mina Bissell, PhD was the Keynote Speaker at the 17th Annual Pathology Research Symposium.

Postdoctoral Research Fellows

The department is also home to 68 postdoctoral research fellows working in more than 20 laboratories within Pathology. These research fellows are training under the supervision of their faculty mentors, who provide them with funding and laboratory space to continue their research efforts until they are able to become successful, independent investigators. Each postdoctoral fellow's training is unique to the needs of the fellow, their research interest and the mentoring of their faculty lead.

Medical Technologist Training

Our clinical laboratories also train medical technologists who rotate through our labs. In FY 19, we trained 9 medical technology students. This training includes observation of specimen preparation and instrument operation with senior medical technologists, flow diagnostics and reporting with attending Pathologists, raw data analysis and QA/QC management education with the Medical Director. Monthly flow meetings are attended by the lab director, manager, and technologists to discuss technical issues, test development, and educational topics.

Conferences and Symposia

The Department of Pathology hosts numerous conferences and symposia each year to provide continuing education for our faculty, trainees, and staff as well as for professional development opportunities for pathologists and trainees from other institutions. In FY 19, we offered the following:

- New Frontiers in Pathology, September 27-29, 2018. The A. James French Lecture, "Nash in 2018: a surgical pathology perspective" was given by Dr. John Hart, Professor of Pathology at the University of Chicago.
- Pathobiology for Investigators, Students and Academicians (PISA) Conference "Molecular Mechanisms of Disease: Tissue Homeostasis, Immune Responses, and Cancer" was hosted by Pathology in Ann Arbor, MI on October 20-22, 2018. Dr. Asma Nusrat, Director of Experimental Pathology, led the conference.
- Society for Pediatrics held their annual Fall Meeting at the

Graduate Hotel, Ann Arbor, MI, on October 25-26, 2018. Saturday's symposium was directed by Raja Rabah, MD, Director of Pediatric and Perinatal Pathology at Michigan Medicine, and Sunday's Perinatal Symposium was directed by Amer Heider, MD, Assistant Professor of Cytopathology and Pediatric Pathology.

- 17th Annual Pathology Research Symposium, November 9, 2018. A symposium planned and led by graduate students. Keynote speaker was Mina Bissell, PhD, Distinguished Scientist, Biological Systems and Engineering Division, Lawrence Berkeley National Laboratory.
- 2nd T32 Retreat, November 8th, 2018. A T32 event where the trainees are presenting their research projects. Keynote speaker was James Shayman, MD, Agnes C. and Frank D. McKay Professor, Professor of Pharmacology and Internal Medicine, Michigan Medicine.
- 10th Annual CHAMP (Clinical, Hemato-, Anatomic, and Molecular Pathology) Research Day, February 7, 2019. A showcase of scientific presentations by departmental faculty and trainees. Keynote speaker was Dr. Jon Aster, Professor of Pathology at Harvard Medical School.
- The 10th Clinical Pathology Symposium, April 22, 2019. The 3rd Annual Batsakis Lecture, "Foodborne Disease Outbreak Investigations in Michigan: Notes from the Field" was presented by Justin Henderson, MPH.
- 2019 Pathology Informatics Summit, Pittsburgh, PA, May 6-9, 2019. Informatics Division served as conference secretariat and convener of this meeting. The Histology Image Analysis International Working Group Workshop, 2019, was held as a companion meeting, with the PI division serving as co-secretariat of this annual meeting. Pathology Informatics also organized the new R Language Workshop, a full-day offering held in conjunction with the Pathology Informatics Summit.
- Advances in Forensic Pathology, May 9-10, 2019. The 2nd Dolores M and John E Finger, MD Forensic Lecture Award was presented to Dr. Ian Burney, Director for the Centre for the History of Science, Technology and Medicine; Faculty of Biology, Medicine and Health at the University of Manchester, England.
- Association of Pathology Informatics Digital Pathology Workshop, December 13-14, 2019. Pathology Informatics serviced as co-secretariat for the second annual offering of this practicum, held at the University of Pittsburgh, with the 2020 offering to be held at the University of Michigan.

In addition, each week, there are numerous smaller conferences and seminars – whether they be multidisciplinary case conferences, tumor boards, research seminars, resident educational conference presentations, hematopathology educational conference presentations, or other educational opportunities for our faculty and trainees. There is a weekly research seminar series highlighting research from our own faculty and trainees as well as research conducted by special guest lecturers. This year, the A. James French Visiting Professorship hosted Wendy Frankel, MD (The Ohio State University Medical Center), Bruce Wenig, MD (Moffitt Cancer Center), Lyn Duncan, MD (Harvard University), and Pheroze Tamboli, MBBS (MD Anderson Cancer Center). The Young Visiting Professor Exchange hosted Ricardo Lastra (University of Chicago).

Pathology **Informatics**

Ulysses Balis, MD
Director, Pathology Informatics

The Division of Pathology Informatics (PI), which serves as one of the functional units of the overall Pathology Department, serves the tripartite missions of the department, including: clinical operations support, original research, and education. As an informatics division, it is somewhat unique among contemporary academic pathology departments, in that it maintains both its own technical staffing and associated IT infrastructure, with both elements being wholly contained within the department and similarly, under the exclusive direction of Pathology leadership. This autonomy affords the division both the ability to carry out internal prioritization of the department's many projects, as well as the ability to independently carry out original IT development efforts. In addition, the division hosts its own active thrusts in fundamental areas of information technology, machine vision and deep learning research, including: computational imaging of WSI subject matter, asset tracking solutions, computational pathology, natural language processing, and medical information interoperability.

Fundamentally, PI operates as a *service unit* within the greater department, covering a wide range of operational and strategic functions, with these various missions tied together by a centrally-governed team of superbly-trained information technology specialists.

The division is comprised of 3 faculty, one informatics fellow, and 43 full- or part-time staff. The critical mass of three full-time informatics faculty has allowed for the continued assignment of effort towards both intramural and extramural academic endeavors, with it still being the case that U-M's PI division remains the largest and fully Clinical Informatics-boarded Pathology Informatics academic unit in the US. The team, in its current lineup, allows coverage for all aspects of the broader fields of Pathology Informatics. In addition, the division added several critically-needed personnel, including provisioning and the long-sought position of division project manager.

Clinical Support Activities

Continuing in its ongoing efforts to assist with the departmental relocation to its new home at NCRC, the informatics division participated in many stabilization and optimization activities that involved information technology, at both the hardware and software abstraction layers. These efforts included the deployment of literally hundreds of network-attached devices (e.g. printers and scanners) as well numerous specialized devices throughout the health system (such as blood draw center kiosks). In addition, the applications subunit of the division carried out extensive refactoring of the PathTrack application, as described below, allowing it to operate at scale with sufficiently rapid user response characteristics.

Finally, as another signature initiative, the division was extremely active with the continued stabilization and enhancement of the complex and evolving MidMichigan reference laboratory electronic interface, with these changes allowing for greatly enhanced electronic lab order placement and results receipt by that client's collective staff.

The informatics team began a two-year upgrade project of the SCC software with a goal of creating an updated and unified version of the software, which will enable the vendor to maintain a single master-

copy of the software, as opposed to each client having its own master copy. This will allow for streamlined defect resolution and version upgrades.

Other projects undertaken included stabilization of the electronic interfaces for the new BD Kiestra™ Microbiology Automation Line, allowing for simplified support. New features and tracking locations were added to the PathTrack application, with ongoing stabilization and optimization of the program being completed. Portions of the program were rewritten to allow for hundreds of concurrent users to experience consistently rapid user-application response rates. Finally, kiosks were added to our blood draw stations to allow for better customer service.

Division of Quality & Healthcare Improvement

Scott Owens, MD
Director, Division of Quality and Health Improvement

The Division of Quality and Healthcare Improvement works across Divisions to support the efforts of each Division to ensure Departmental resources are used effectively and that the quality of care for patients is at the highest levels. As noted in the Education Division, the DQHI team engages in teaching quality improvement processes to our Residents so they can continue to implement these techniques throughout their careers, multiplying their efforts. In FY 19, the DQHI undertook several key initiatives.

Patient Asset Management Initiative (PAMI)

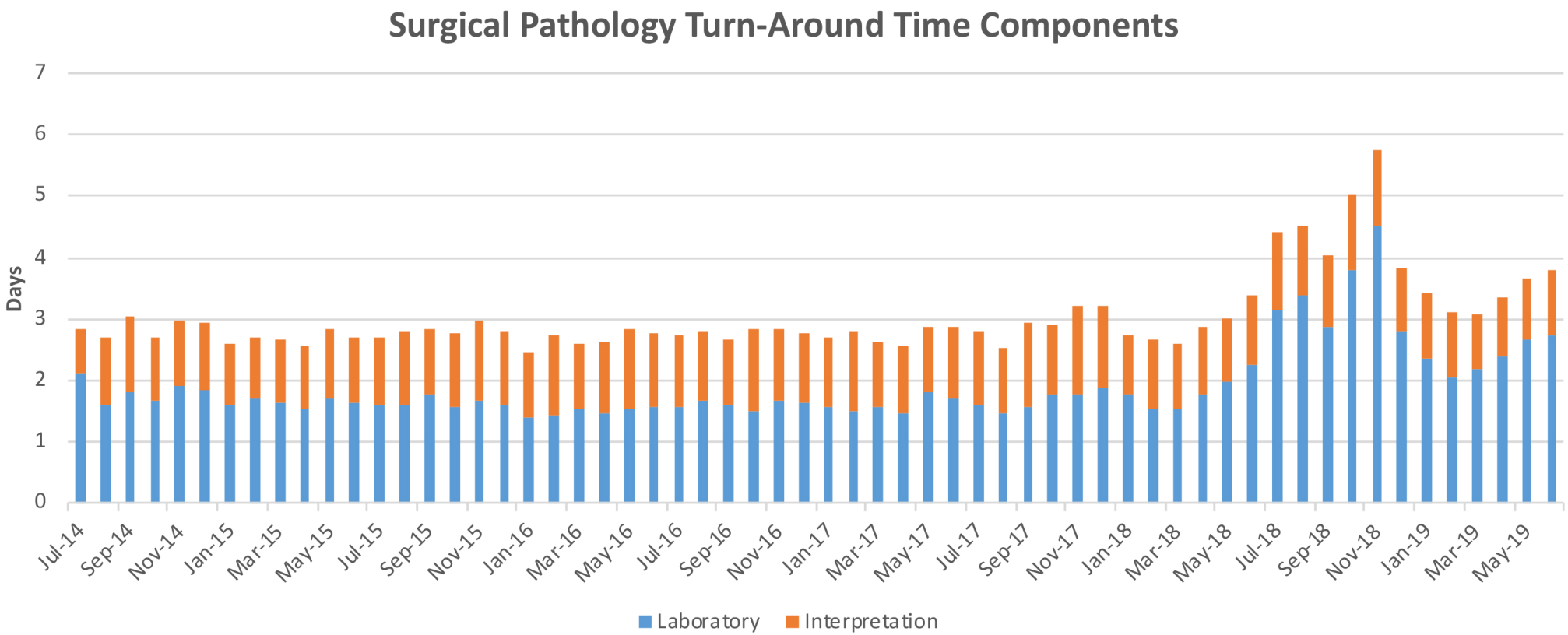
With guidance from a Steering Committee composed of departmental leadership, Amy Mapili continued her leadership in FY 19 as overall program manager of this departmental initiative aimed at stewardship of patients' physical and digital assets while in our care. Ultimately, the scope of this initiative will stretch from test ordering through archiving of physical materials (such as slides and blocks) and diagnostic data. This year's activity focused on the further implementation of PathTrack throughout the enterprise. PathTrack is a digital application developed by our partners in Pathology Informatics that has the ability to interact with the laboratory information system (Soft) to accurately track the movement of assets throughout the Department. The system is not designed to track work/assets at every event in the workflow, but rather to track at strategic points in the process that both provide updates on workflow and narrow the "search window" for assets that go missing. Early data suggest that over the first half of FY 19, well over a million patient assets were tracked using this tool. In addition, over a four-month period in the middle of calendar year 2019, the tool prevented the mis-routing of nearly 1,800 assets in the pathology ecosystem.

Feedback from users during deployment has been very positive. This year, under Amy's leadership and with additional work by Jeff Lott and the Pathology Informatics team, PathTrack was deployed at on-site phlebotomy locations throughout the main Michigan Medicine campus in a subproject that served both our departmental needs as well as being an institutional quality mandate from Michigan Medicine leadership. This portion of the project finished well ahead of schedule with positive results. Figures below highlight Amy's time schedule for the next phases of PathTrack deployment in off-site phlebotomy locations as well as additional work on asset storage/archiving as part of the larger PAMI project.

Laboratory Stewardship Initiative/Committee

Spearheaded by Project Manager Jeff Lott, this initiative continues to involve a partnership with leaders in Internal Medicine and the Michigan Program on Value Enhancement (MPrOVE; *http://ihpi.umich.edu/our-work/strategic-initiatives/mprove*), centered on the *Laboratory Stewardship Committee* (LSC), a sub-committee of the institutional Lab Formulary Committee co-chaired by Jeffrey Warren, MD (Pathology) and Timothy Laing, MD (Rheumatology). Dr. Ashwin Gupta, a Clinical Lecturer and Hospitalist in Internal Medicine with both experience in and enthusiasm for quality initiatives and test utilization-centered projects, shares leadership of the LSC with Lee Schroeder, MD, PhD. Work is continuing on several subprojects involving partnerships with stakeholders in Internal Medicine and Pathology, including:

- Optimization of *C. difficile* testing
- Ending complex and costly thrombophilia testing for inpatients



- Developing evidence-based reflex ordering systems for anti-nuclear antibody and thyroid hormone testing
- Creating a test utilization dashboard for feedback to providers

Efforts to optimize utilization of ANA testing have focused on elimination of inappropriate ordering of ANA subtype serological studies in the absence of a positive ANA screening test and/or the ordering of both the screening test and the subtype assays at the same time. Input from colleagues in Rheumatology has been elemental in this effort, and work with Drs. Schroeder and Riccardo Valdez as Director of the Clinical Labs, as well as laboratory management and staff, has ensured that changes in ordering and testing patterns have been both appropriate and manageable from workflow and volume standpoints.

Data Science

Since joining the DQHI team in late 2018 as a data scientist, Lukas Hager has made significant contributions to both the knowledge base and skillset of the team, as well as several departmental data projects. Working closely with John Hamilton from Anatomic Pathology (AP), Lukas helped to develop and display a number of metrics aimed at understanding AP workflow. Specifically, Lukas and John have developed displays of surgical pathology case turnaround

Table 1: Chart of TAT components (red – interpretation phase; blue – laboratory processing phase).

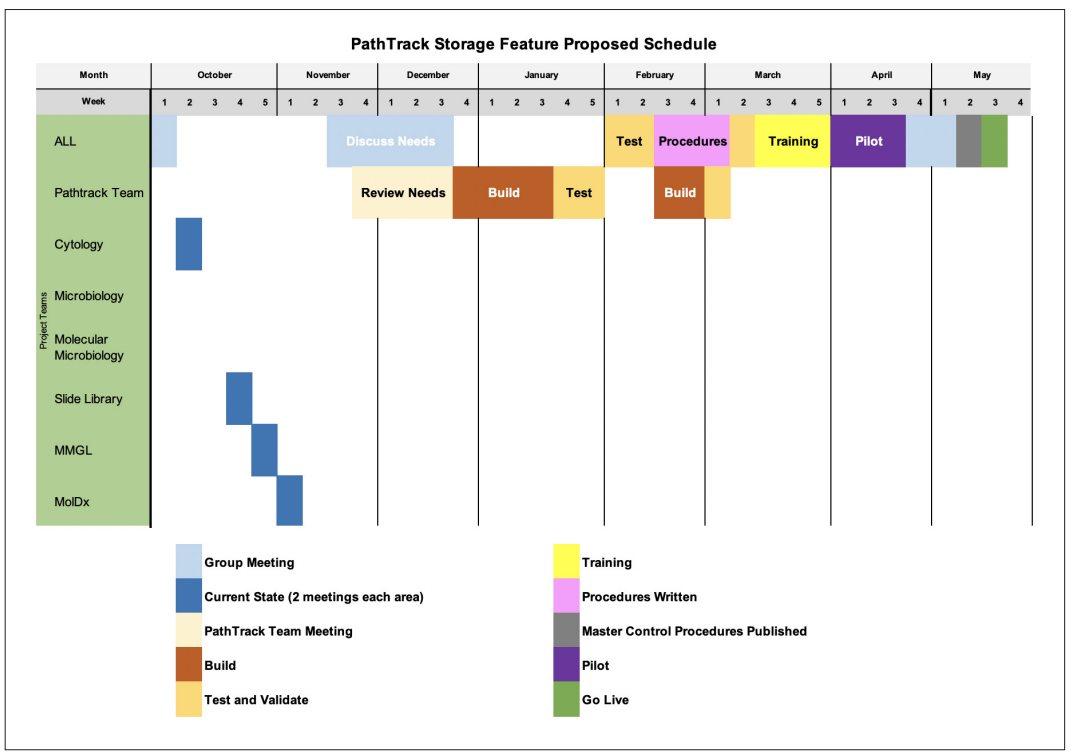
time (TAT) in service of one of the quality metrics identified by the University of Michigan Medical Group leadership that is tied to significant departmental incentive pay. Figures show examples of the output of this work, including a chart of TAT components (*See Table 1 on pg. 45*) and a live TAT control chart that updates hourly for continuous feedback on workflow.

In addition, Lukas and John have worked closely on better understanding other aspects of AP workflow, such as numbers of specimens received, numbers of tissue blocks generated per specimen, number of immunohistochemical stains ordered per specimen, and early progress on the relationship of these numbers to time-to-diagnosis. Finally, Lukas provided data support for the work of Jeff Lott on the Laboratory Stewardship Initiative.

Compliance, Accreditation, Quality, and Safety

Compliance manager Andrea Arlen spearheaded both a successful CAP inspection of our enterprise that was conducted by a team from the VA Medical Center in Los Angeles, and a CAP inspection of our peer institution at the University of Pennsylvania using a team composed of department faculty and staff members as inspectors and support personnel. Andrea, Jennifer Bell and, prior to her departure in the summer months, Margaret Rayer, worked with other DQHI team members and laboratory leaders in follow-up of issues identified by the CAP team that visited our institution, and this work resulted in a successful, two-year accreditation of our operations by CAP. In addition, Jennifer Bell has settled into her role as Safety and Preparedness Coordinator, working diligently to understand our work processes and partnering with other stakeholders throughout the institution to support our role in institutional safety and preparedness activities. She has also provided support for TempTrak environmental monitoring throughout our enterprise. In addition to his role in management and decision-making for DQHI operations, Brian Tolle has supported compliance and quality activities since Margaret Rayer's departure, including supporting Dr. Karen Choi (Assistant Professor, Gastrointestinal and Hepatobiliary Pathology, Surgical Pathology) in her role of managing cancer reporting protocols for both CAP compliance and Commission on Cancer accreditation for the Michigan Medicine Comprehensive Cancer Center.

Table 2: PathTrack Storage Feature Proposed Schedule.



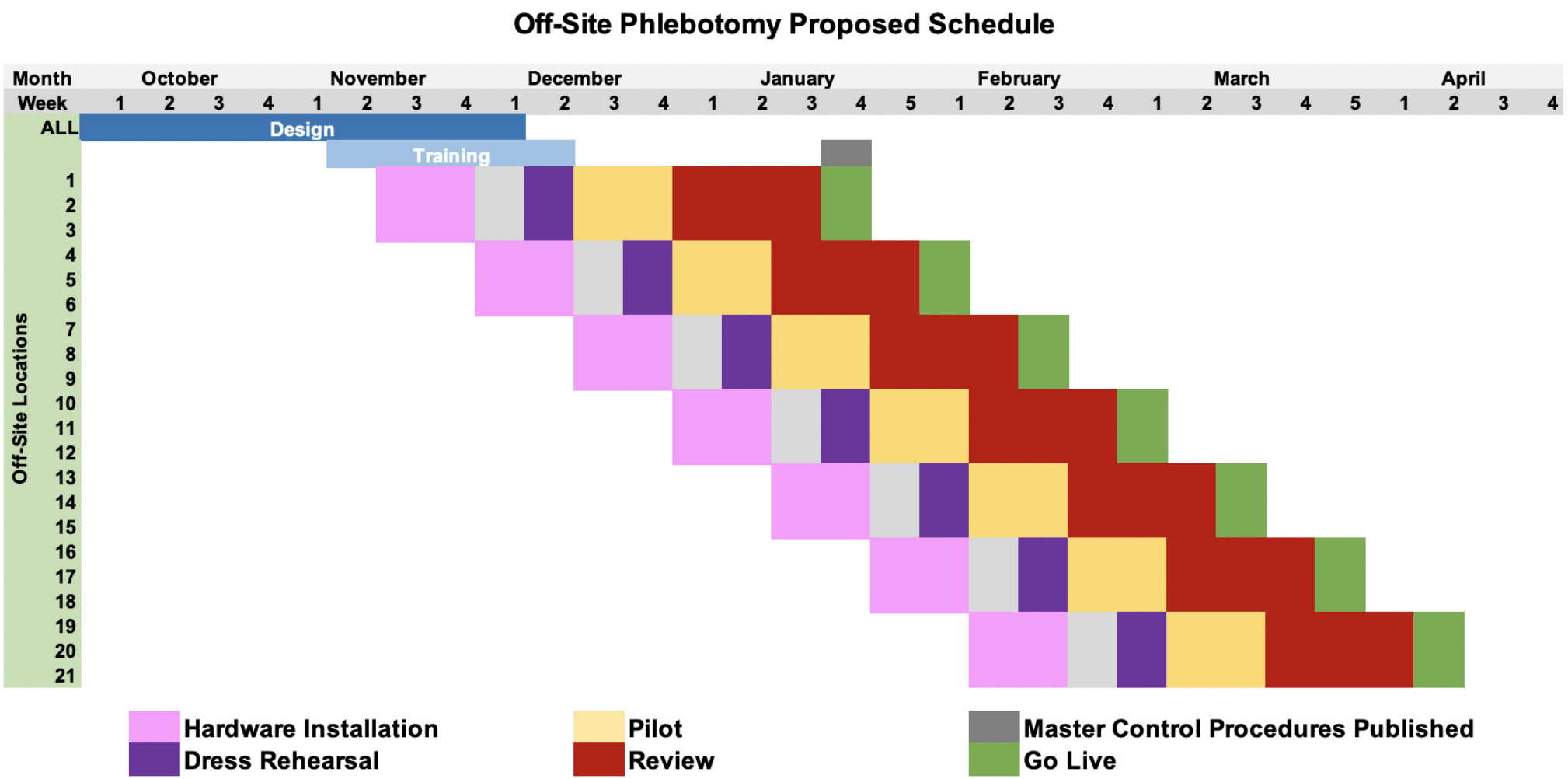


Table 3: Off-site Phlebotomy Proposed Schedule.

Finance & Administration

Martin Lawlor
Director, Finance and Administration

The Division of Finance and Administration, which is under the auspices of the Office of the Chair, is responsible for the business, operational, and fiscal affairs of the Department of Pathology, as mandated by the policies of the Chair, Michigan Medicine, and the University. In this section, key achievements of the Finance and Administration team are highlighted as well as the supporting services provided by this division. Martin Lawlor served on various departmental, health system, university, and professional committees including the Ambulatory Care Operating Committee, Cancer Center Ambulatory Care Coordinating Group (co-chair), Executive Committee for the Joint Venture Hospital Laboratories (chair), and the Association of Pathology Chairs – Pathology Department Administrators Committee.

Some key divisional highlights for this academic year include:

- Relocated clinical laboratories, education, and administration from various locations both on and off the main medical campus to the North Campus Research Complex, buildings 30, 35, 36 and 60.
- Reviewed faculty salaries and initiated equity adjustments.
- Conducted financial management didactics for new residents and Pathology Education series presentations.
- Held weekly open position reviews for all replacement and new positions, providing timely response to Departmental needs.
- Worked closely with Dr. Parkos and the vice chairs for a very successful recruitment year with many new recruits.

Administrative Support Center

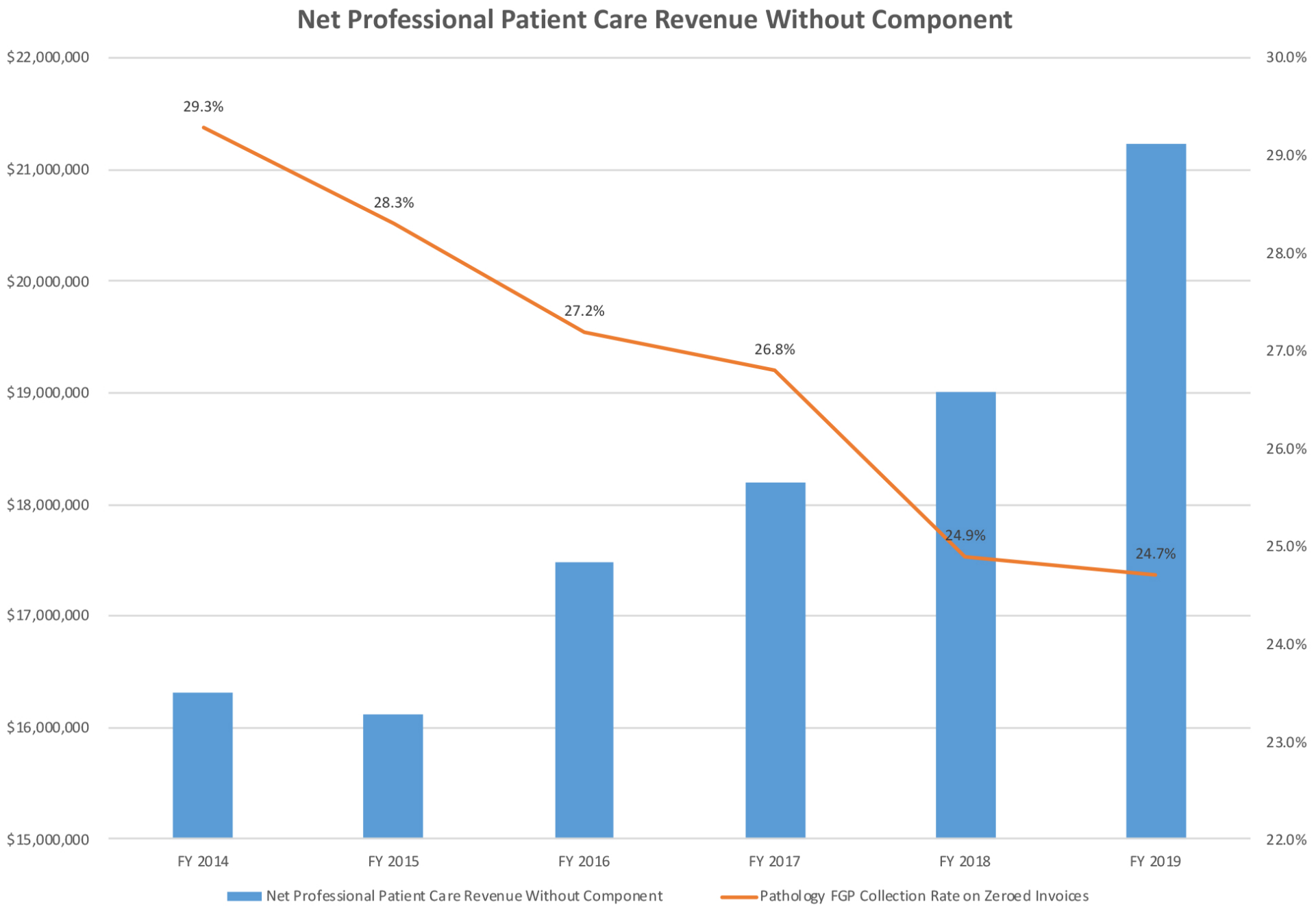
The administrative support center is divided into support services for the pathology laboratories; academic and business affairs; and human resources, faculty affairs, and education.

Pathology Laboratories

The administrative support center for pathology laboratories is responsible for the preparation and monitoring of all hospital laboratories' revenue, expense, capital budgets, personnel, and payroll systems. During this period, total laboratory expenditures were $140 million. Pathology is responsible for 9.6% of total hospital gross revenue and 3.7% of total expense.

The administrative support center team worked diligently in FY 19 to prepare for and undertake the relocation of the clinical laboratories, education division, pathology informatics division, and administration and finance division to the North Campus Research Complex. The relocation took place over the summer and early fall of 2018, led by the PRR team with the support of the Pathology Informatics team. The transition proceeded on schedule and without excess disruption. Throughout FY 19, our facilities managers and the PRR team diligently addressed issues as they arose, especially with unanticipated issues surrounding climate control and noise insulation in the new space. In addition, the PRR team continued their work on the UH renovation project, which is scheduled for the first laboratory and staff move to temporary locations over the winter of 2019-2020.

Members of the administrative support center team served as departmental liaisons with nursing and the office of clinical affairs,


Net Professional Patient Care Revenue Without Component
$22,000,000
$21,000,000
$20,000,000
$19,000,000
$18,000,000
$17,000,000
$16,000,000
$15,000,000
30.0%
29.0%
28.0%
27.0%
26.0%
25.0%
24.0%
23.0%
22.0%
29.3%
28.3%
27.2%
26.8%
24.9%
24.7%
FY 2014
FY 2015
FY 2016
FY 2017
FY 2018
FY 2019
Net Professional Patient Care Revenue Without Component
Pathology FGP Collection Rate on Zeroed Invoices

Pathology Income Statement Summary Trend

	FY 2013	FY 2014	FY 2015	FY2016	FY 2017	FY 2018	FY 2019
Revenue	$44,337,110	$43,804,977	$45,318,473	$47,860,984	$55,198,953	$56,182,296	$60,935,348
Expenses	($50,892,361)	($48,969,075)	($54,165,491)	($58,785,742)	($61,161,469)	($64,181,799)	($67,524,173)
Operating Income (Loss)	($6,555,251)	($5,164,098)	($8,847,018)	($10,924,758)	($5,962,516)	($7,999,503)	($6,588,825)
Investment income	$4,208,440	$4,198,290	$4,129,027	$4,005,433	$4,155,124	$4,419,114	$4,672,746
Operating Income (Loss) with Investment Income	($2,346,811)	($965,808)	($4,717,991)	($6,919,325)	($1,807,392)	($3,580,389)	($1,916,079)
Other Non Operating Income (See Notes*)	$7,541,747	$3,431,091	($2,323,113)	$1,569,012	($5,646,943)	$3,325,210	$1,253,166
Total Margin (with investment income and Other Non-Operating Income)	$5,194,936	$2,465,283	($7,041,104)	($5,350,313)	($7,454,335)	($255,179)	($662,913)
Change in Unrealized Gain and Loss	$4,089,094	$11,604,004	$213,862	($4,500,546)	($1,518,476)	$4,526,053	$1,762,408
Change in Net Assets	$9,284,030	$14,069,287	($6,827,242)	($9,850,859)	($8,972,811)	$4,270,874	$1,099,495

** Notes concerning Other Non-Operating Income*

Paradigm Payments

Paradigm Payments and investments in new faculty

CIF Payment

office of clinical safety, biomedical engineering, and hospital finance. They served on the quality month committee, pathology diversity, equity and inclusion committee, pathology patient and family advisory council, pathology social media committee and others. The team addressed patient safety issues and cooperated on process improvement initiatives with partners such as the Rogel Cancer Center, UH operating rooms, and various medical procedure units.

FY 18 Pathology Income Statement		
REVENUE	**FY 18**	**FY 19**
Patient Care Revenues	$20,089,169	$21,241,056
Michigan Medicine Service Payments	$8,512,424	$9,227,744
Net Total Research (Directs & Indirects)	$19,481,262	$23,908,501
Gifts and Other Income (Wayne/Washtenaw ME, etc.)	$8,099,660	$9,461,178
Total Revenue	**$56,182,515**	**$64,165,028**
EXPENSES		
Total Salaries	$49,435,747	$55,694,180
Total Non-Payroll Expense	$14,746,051	$17,910,827
Total Operating Expenses	$64,181,798	$73,605,007
Operating Margin (Loss)	$(7,999,283)	$(9,439,979)
Non-Operating Income and Expenses (1) *(includes Investment Income, UMHS Margin Sharing, Departmental Commitments, etc.)*	$7,744,324	$8,688,769
Total Margin	**$(254,959)**	**$(751,210)**

(1) Excludes funds transferred to the Clinical Investment Fund

Office of Academic and Business Affairs – Medical School

The office of academic and business affairs – medical school, is responsible for all administrative and academic operations associated with the Department, including management of department finances (budgets, contracts, research grants, forecasts, and analyses), as well as clinical billing (professional and technical front-end operations), in collaboration with the Chair and Administrative Director. David Golden implements and directs strategic goals for Medical School operations including development of policy and business plans, management of faculty compensation and departmental funds, and use of departmental facilities, including modifications, renovations, and reassignment of department space.

The office also manages the Michigan Medicine and All Funds expenditures and forecast processes. Key departmental metrics include:

- Total Medical School All Funds expenditure for FY 19 were $77.4 million and Hospital expenditure were $153.1 million.
- Hospital technical gross revenue for FY 19 was $864.2 million, compared to $791.4 million in FY 18, an increase of 9.2%.
- Professional fee gross charges were $90.3 million.
- Overall gross charges for Pathology's group practice were up 14% ($11.1 million)
- Pre- and post-award research enterprise management included 132 research proposals submitted to external sponsors this year with 43 of these submitted to the NIH.
- Committed awards for FY 19 were $29.8 Million, an increase of 10% compared to FY 18 committed awards.
- Actual sponsored research expenditures were $32.7 million, 1.5% decrease when compared to FY 18 actual research expenditures. Overall, the academic side of the Department saw an 8.3% increase ($2.5 Million) in federal and non-federal research revenues from FY 18 to FY 19.

Business Affairs

Business Affairs is responsible for oversight of all accounting and financial transactions for the Department as well as ensuring appropriate hospital and medical school funds flows. Our billing office handles all send-out, component, and MLabs billing, and any inter-departmental, MLabs or Hospital patient billing error corrections. The grants management office handles the day-to-day management of research funds to ensure compliance with funder requirements,

Thomas Morrow
Administrative Manager, Clinical Operations

Kristina Martin
Manager, Clinical Operations

Christine Rigney
Assistant Administrator, Operations, Division of Anatomic Pathology

David Golden
Director, Finance

Christine Shaneyfelt
Financial Analyst Senior,
Hospital

Mike McVicker
Financial Analyst Senior,
Medical School

John Harris
Manager, Research Administration

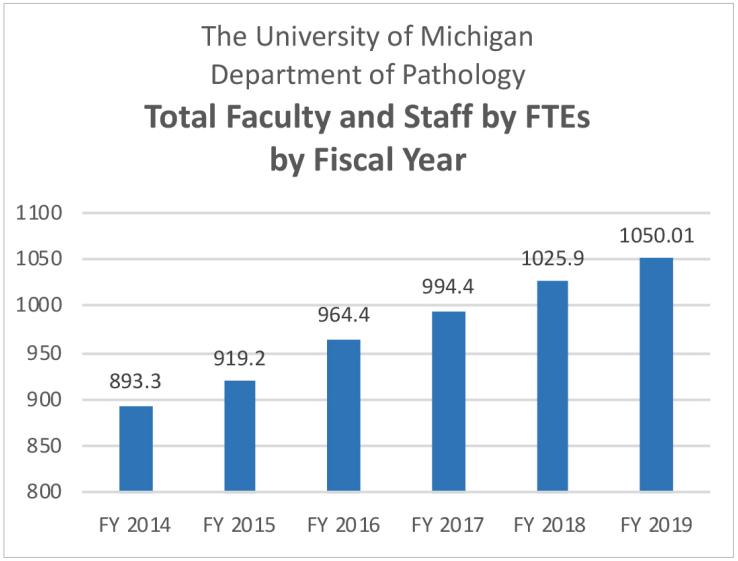
and to ensure the funds are distributed appropriately both within Pathology as well as across internal and external research groups.

Business Affairs is also responsible for Hospital and Medical School financial reporting and budget preparation for the Department and in administering numerous contracts, including those for the Washtenaw, Livingston, and Wayne County Medical Examiners contracts. As part of the budgeting process, they also develop and maintain the capital equipment process, prepare financial analyses, produce numerous *ad hoc* reports, and oversee the Pathology Relocation and Renovation project where they ensured contract terms were met, budgets managed, and capital investments were approved according to Michigan Medicine and Pathology procedures, and facilities were prepared for the 500-person move to the NCRC, which occured in late FY 18 and early FY 19. In addition, all faculty and staff effort and funding changes are processed through this unit.

Finance

The Department of Pathology is in a strong financial position and continues to thrive under the leadership of Dr. Charles Parkos and Martin Lawlor, with endowments and FFAE to support our clinical, research and educational missions exceeding $98.6 million. Michigan Medicine, Department of Pathology, was the first group to institute professional component billing in the state of Michigan. In FY 19, we experienced a widening gap between our revenues and expenses, with Revenues at $60.9 million, up 8.5% over FY 18 and expenses at $67.5 million, up 5.2% over FY 18, mostly due to increased staffing needs associated with our relocation to the NCRC. This resulted in an operating loss of $6.5 million. The loss was mostly offset by income from our investments, but the year ended with a net loss of $662,914. In FY 18, we also experienced a net loss of $255,178 as our non-operating and investment income was significantly lower than in prior years.

Michigan Medicine has long-range expansion and upgrades budgeted, including Pathology's Renovation and Relocation Project, that requires greater-than-average net budget increases as compared to those seen over the past decade. As a result, there is significant pressure on Departments to reduce expenses and increase revenues. While our revenues continue to grow, the collection rate is at its



lowest point in the past 15 years, at just 24.7% of charges. Meanwhile, in order to keep up with workloads, our faculty and staff FTEs have increased to 1,050.01 from 1,025.9 in FY 18. The combination of increased budgetary needs, increased workloads/staffing needs and decreased collection rates poses challenges for meeting Michigan Medicine targets for the Department. As a result, filling vacant staff positions has become more difficult. We are grateful to our staff, who have stepped up to take on additional duties to ensure the missions of Pathology continue to meet and exceed expectations.

We have outstanding faculty and staff who continue to support exceptional scholarship and clinical care. Our clinical services continue to grow and maintain the highest quality. New educational opportunities continue to attract top trainees and our future looks bright as we move forward in our new facilities, designed for the future. Overall, FY 19 has been a tremendous year for our department.

Human Resources, Faculty Affairs and Education

Our Staff Human Resources Team provides support for Pathology's hospital laboratories (approximately 824.6 FTEs) and Medical School support staff, including our research programs (approximately 225

FTEs). This includes processing all new hires, promotions, merit increases, orientation, as well as transfers when staff move to other departments, or terminations for those who leave our institution. They also help to coordinate employee recognition events and awards.

Faculty Affairs is responsible to coordinate appointments, reappointments, and promotions for our 143 active faculty and the 34 supplemental appointments in the Department. In FY 19, eighteen new faculty joined the Department of Pathology while we bid farewell to ten faculty members. Eighteen of our faculty successfully completed the promotion process.

Our faculty received numerous awards in recognition of their achievements in academics, research and clinical service: (*See Appendix on* ***pg 66.***)

Faculty Promoted in FY 19

Name	New Rank	Division
Muhajmad Nadeem Aslam	Assistant Research Scientist	EP
Noah Brown	Associate Professor	CP
Marcin Cieslik	Assistant Professor	MCTP
Veronica Azcutia Criado	Research Assistant Professor	EP
Saravana Dhanasekaran	Associate Research Scientist	MCTP
Paul Harms	Associate Professor	AP
Jeffrey Hodgin	Associate Professor	EP
Chandan Kumar	Associate Research Scientist	MCTP
Elizabeth Lawlor	Professor	EP
Madelyn Lew	Associate Professor	AP
Tianju Liu	Associate Research Scientist	EP
Andrew Muntean	Associate Professor	EP
Catherine Ptaschinski	Research Assistant Professor	EP
Thekkelnaycke Rajendiran	Associate Research Scientist	MCTP
Lee Schroeder	Associate Professor	CP
Xiaoju (George) Wang	Associate Research Scientist	MCTP
Yi-Min Wu	Associate Research Scientist	MCTP
Yi-Mi Wu	Associate Research Scientist	MCTP

The Education Office includes the Residency and Fellowship Training Programs (26 residents and 24 fellows in 9 ACGME and 7 non-ACGME programs), the Medical Student Education Teaching Programs for the M1 and M2 laboratories and the M4 Clerkship Program, as well as the Molecular and Cellular Pathology PhD program with 21 students actively pursuing their doctoral degrees. Management responsibilities are focused around curriculum management (including the Research Seminar Series), academic records, budget planning and financial operations, recruitment, and program activities such as the annual departmental research symposium. The department also holds two NIH training grants (PIs Nicholas Lukacs, PhD; Andrew Lieberman, MD, PhD, Zaneta Nikolovska-Coleska, PhD) which support 4 pre- and 6 post-doctoral trainees. The education office performs the human resource functions for the department's graduate students (31 including 6 non-MCP students with Pathology mentors and 4 training grant trainees).

Office of the Chair

The staff in the Office of the Chair coordinates the Advances in Forensic Medicine and Pathology conference, which was held for its ninth year in FY 19. They also reconcile departmental purchasing cards, renew medical licenses, process CME requests for faculty, coordinate and develop departmental communications including the *Inside Pathology* magazine, the Annual Report, and prepare numerous reports and presentations for various meetings. In addition, they provide support to the Chair and Department Administrator, including scheduling, travel arrangements, data collection, event planning, correspondence, committee support, and faculty recruitment.

Community Service

In support of our mission as a non-profit healthcare provider, our faculty and staff engage in numerous service activities throughout the year. Some of the activities our faculty and staff engaged in this year included:

Local Activities (UM, Ann Arbor or Michigan)

- Relay for Life Teams to raise funds for cancer treatment
- Assisted MetroHealth in validating the Verify-Now assay for

Sarah Dudley-Short
Manager, Faculty Affairs

New Faculty 2018-2019

1st Row: *(Left to Right)*
Sara Abbott, MD
Roberta Caruso, MD, PhD
Matthew Cusick, PhD
Felipe da Veiga Leprevost, PhD
Vipulkumar Dadhania, MBBS
Kristina Davis, MD

2nd Row: *(Left to Right)*
Analisa DiFeo, PhD
Carol Farver, MD
Sean Ferris, MD, PhD
Wendy Fonseca Aguilar, DVM, PhD
Carmen Gherasim, PhD
Tao Huang, BM, PhD

3rd Row: *(Left to Right)*
Surinder Kumar, PhD
Cathryn Lapedis, MD
Winston Lee, MD, PhD
Anny-Claude Luissint, PhD
Drew Pratt, MBBS
Omar Rayes, MD

4thRow: *(Left to Right)*
Mark Schultz, PhD
Stephanie Skala, MD
Abdulsalam Soofi, PhD
Milad Webb, MD, PhD
Lanbo Xiao, PhD

aspirin and Plavix-specific platelet aggregation

- Gift of Life Michigan board and committee memberships
- Patient and Families Advocacy Committee (PFAC)
- Numerous Medical School and Health System committee leadership/membership, see our list of new leadership positions
- High school genetics, ethics, Doctors of the Future, and other programs as well as volunteering to coach or direct athletic programs
- High School Ethics Bowl judge
- Service on multiple non-profit boards of directors

National

- Assisted in multiple inspections for College of American Pathologists (CAP), American Association of Blood Banks (AABB), American Society for Histocompatibility and Immunogenetics (ASHI)
- Serving on multiple national and international professional organization boards and committees, see our list of new leadership positions added in FY 18.

International

- Exploring transport solutions for patient samples in remote African villages to laboratory testing facilities
- Developing Essential Diagnostic Test List for low resource settings
- Implementing comprehensive 8-marker flow cytometry to accurately diagnose acute pediatric and adult leukemia patients in low-middle income countries, implementing it in Addis Ababa, Ethiopia
- Cervical cancer screening initiative in India

Employee Recognition

The Department of Pathology recognizes the valuable contributions made by our faculty and staff alike. In FY 18, we recognized the years of service for faculty and staff who have served for 10, 20, 30 and even 40 years as well as those who received Above and Beyond Awards, as nominated by their peers. The number of employees who have been in the department for over 20 years speaks to the dedication of the employees as well as to the collegial atmosphere of our Pathology Department. In addition to this recognition event, the Department hosted an employee appreciation breakfast/dinner on May 2nd and a social event, the Fall Picnic at Wiard's Orchard, on September 15th. This was a well-attended and enjoyable event, in spite of the rainy weather! (*See chart of all 'Years in Service Recognition' in the Appendix on* ***pg 69***.)

This year we also honored our retirees: Dr. Lloyd Stoolman (Clinical Pathology Faculty, Flow Cytometry), Beth Cox (Cytogenetics), and Cindy Schall (Histocompatibility).

Lloyd Stoolman
Clinical Pathology Faculty,
Flow Cytometry

Beth Cox
Cytogenetics

Cindy Schall
Histocompatibility

Pathology Relocation & Relocation Project

Christine Baker
Project Manager, PRR

The Pathology Relocation and Renovation (PRR) project embraces the immense opportunity of creating new spaces for clinical pathology, at both the North Campus Research Complex (NCRC) and at University Hospital (UH). Christine Baker is the project manager for the PRR project and is responsible for facilitating and orchestrating the project tasks for the Pathology Department. She leads the planning, design,and activation activities and works closely with colleagues in the Michigan Medicine Facilities and in Architecture, Engineering, and Construction to ensure the project is on schedule, within scope, and on budget.

Construction for Phase 1 of PRR, which was the 140,000 square feet of newly renovated space at NCRC, finished in FY 18. The movement of laboratories and administrative groups to the new space started in May 2018 and completed in November 2018. The move enabled the consolidation of non-stat Pathology functions, including administration, many clinical faculty, and several major clinical laboratories, including Anatomic Pathology, Molecular Pathology, Microbiology, Immunology, and Special Chemistry. It also included the Education program, Finance and Administration, the Department of Quality and Health Improvement, Operations, Pathology Informatics, and the MLabs offices.

The UH Renovation proves to be a unique challenge for construction and activation, due to the requirement to keep all laboratories operational and functional 24-hours a day while constructing new spaces. The Design Team first developed a complicated, 19-phase construction effort spanning over 5 years. This proved to not only be too challenging operationally, but also a significant fiscal challenge.

The team reconvened and developed a streamlined 6-phase model to simplify the operational complexity and reduce the fiscal requirements.

The re-phasing of the project required a substantial update of the construction documents, as well as input from the laboratories about operational needs. This work was completed during the past fiscal year. Construction began in mid-FY 19, with the first phase, which includes Hematology and automation line, Toxicology and Chemistry, to be completed in early FY 21.

The UH Renovation includes a large, open, and expansive core laboratory including Hematology, Chemistry, Specimen Processing, Microbiology, and Anatomic Pathology. The added space and efficiencies will enable continued growth in processing and support for increased complexity of patient testing. The core laboratory will house updated and co-located automation lines for the Hematology and Chemistry labs with “nerve centers” located adjacent to the core lab. These nerve centers are designed to include administrative functions, training, and collaboration space.

Transfusion Medicine will be designed as a neighborhood, including an enlarged Blood Bank laboratory, a beautiful and patient-centric Apheresis Patient Care Unit, and an expanded Cell Therapy laboratory. The neighborhood has a nerve center in between all laboratory and patient care functions, allowing for cross-coverage between areas, training, and administrative functions. The new facilities will allow for more efficient operations, growth in apheresis and cell collection activities, and manufacturing of cellular therapies products, which will position Michigan Medicine to continue as

a leader in transfusion medicine. The Phlebotomy team and the Cytology team will also have new and updated spaces including a well-designed shared cart and supply storage area.

Beautiful amenities for staff, including numerous conference spaces, a large break room with natural light, lactation rooms, and locker rooms are included in the design as well as a unique and flexible space in UH South for education and training, and “hoteling” or “swing desks” for faculty and staff who are permanently located at NCRC, but whose patient care responsibilities bring them to the hospital complex.

Surgical Pathology In-House Case Volumes	2015	2016	2017	2018	2019	1 Yr	5 Yr
Breast	2,517	2,485	2,319	2,453	2,932	19.5%	16.5%
Gastrointestinal	19,802	22,807	23,789	22,938	23,643	3.1%	19.4%
Genitourinary	2,510	2,910	3,365	3,658	4,006	9.5%	59.6%
Gynecologic	6,210	6,759	6,965	7,122	7,781	9.3%	25.3%
Room 1	11,100	12,359	13,552	13,697	13,172	-3.8%	18.7%
Total	42,139	47,320	49,990	49,868	51,534	3.3%	22.3%
Cytopathology Case Volumes							
Aspirates	2,787	3,192	3,001	2,951	3,057	3.6%	9.7%
Cytology-Non Paps	7,743	6,855	6,668	7,402	8,124	9.8%	4.9%
Cytology-Paps	23,045	23,548	23,292	22,999	23,586	2.6%	2.3%
Total	33,575	33,595	32,961	33,352	34,767	4.2%	3.6%
Dermatopathlogy Case Volumes							
In-House Derms	14,182	15,712	15,229	15,595	15,459	-0.9%	9.0%
Squares	393	487	545	528	525	-0.6%	33.6%
MLabs	8,836	8,409	12,239	10,394	9,726	-6.4%	10.1%
Transfer/Consults	3,945	4,203	4,310	4,149	4,226	1.9%	7.1%
Total	27,356	28,811	32,323	30,666	29,936	-2.4%	9.4%
Autopsy and Forensics: UH, Washtenaw/Livingston, and Wayne Counties							
Washtenaw/Livingston	327	359	407	412	446	8.3%	36.4%
UH (adult)	183	168	189	218	215	-1.4%	17.5%
UH (peds)	31	41	43	43	39	-9.3%	25.8%
Total UH-Performed	541	568	639	673	700	4.0%	29.4%
Wayne (full autopsies)	2,242	2,053	2,359	2,417	2,297	-5.0%	2.5%
Wayne (total exams)	2,921	2,822	3,226	3,272	3,373	3.1%	15.5%
Total	3,462	3,390	3,865	3,945	3,869	-1.9%	11.8%
Pediatric and Perinatal Pathology Case Volumes							
Peds Surgery	3,433	3,277	3,514	3,558	3,738	5.1%	8.9%
Placentas	1,756	1,832	1,834	2,054	2,162	5.3%	23.1%
Pediatric Autopsies	29	20	28	31	39	25.8%	34.5%
Fetal Exams	147	164	178	212	232	9.4%	57.8%
Total	5,365	5,293	5,554	5,855	6,171	5.4%	15.0%

(continued)

Neuropathology Case Volumes							
Surgicals	764	748	846	773	838	8.4%	9.7%
Muscle Biopsies	224	175	156	139	93	-33.1%	-58.5%
MLabs Muscle Biopsies	150	194	178	189	228	20.6%	52.0%
Transfer/Consults	153	132	138	112	93	-17.0%	-39.2%
Total	1,291	1,249	1,318	1,213	1,252	3.2%	-3.0%
Other Pathology Case Volumes							
Ophthalmic	1,286	1,276	1,248	1,311	1,440	9.8%	12.0%
Renal	1,130	1,180	1,099	1,295	1,092	-15.7%	-3.4%
Anatomic Pathology Consult Case Voumes							
Gastrointestinal	3,148	3,345	3,449	3,566	3,832	7.5%	21.7%
Dermatopathology	2,422	2,754	3,381	3,017	3,151	4.4%	30.1%
Pulmonary	1,736	2,244	2,351	2,415	2,580	6.8%	48.6%
Bone and Soft Tissue	732	891	1,031	1,116	1,259	12.8%	72.0%
Gynecologic	660	902	1,008	1,067	1,235	15.7%	87.1%
Genitourinary	495	661	735	738	827	12.1%	67.1%
Breast	580	777	600	687	707	2.9%	21.9%
Head & Neck	370	552	548	622	756	21.5%	104.3%
Cytology	459	572	598	594	513	-13.6%	11.8%
Endocrine	331	381	414	407	429	5.4%	29.6%
Neuropathology	189	248	299	377	420	11.4%	122.2%
Pediatric	100	125	138	221	272	23.1%	172.0%
Total Consult Cases	11,222	13,452	14,552	14,827	15,981	7.8%	42.4%

Table 1 : *Anatomic Pathology Case Volumes 2014-2018 (From pg. 8)*

Clinical Pathology Billed Test Volumes								
	2014	2015	2016	2017	2018	2019	1 Yr	5 Yr
Clinical Chemistry								
Chemical Pathology	2,250,691	2,300,846	2,545,505	2,861,047	2,990,055	3,165,847	5.9%	37.6%
Special Chemistry	550,204	615,414	659,007	642,556	650,105	714738	9.9%	16.1%
Total	2,800,895	2,916,260	3,204,512	3,503,603	3,640,160	3,880,585	6.6%	33.1%
Transfusion Medicine								
Pathology Blood Bank	273,988	274,535	285,079	307,395	315,601	327,245	3.7%	19.2%
Blood Procurement	100,907	93,207	67,765	61,994	64,254	66414	3.4%	-28.7%
Blood Bank Bone Marrow	1,335	1,203	1,127	1,155	1,118	1,034	-7.5%	-14.0%
Transfusion/Apheresis	81,139	9,590	2,165	1,804	1,965	2008	2.2%	-79.1%
Total	457,369	378,535	356,136	372,348	382,938	396,701	3.6%	4.8%
Other Clinical Laboratories								
Hematology / Coagulation	1,124,250	1,146,563	1,186,694	1,220,890	1,236,698	1,268,568	2.6%	10.6%
Flow Cytometry	72,165	79,130	78,958	78,390	87,062	105598	21.3%	33.4%
Cytogenetics	8,466	8,104	8,283	8,399	9,296	12,313	32.5%	51.9%
Histocompatibility	26,199	25,051	24,152	21,085	23,801	23480	-1.3%	-6.3%
Clinical Microbiology	433,476	444,409	453,426	482,104	508,152	528,611	4.0%	18.9%
Molecular Diagnostics	17,665	20,384	20,736	15,899	17,026	20106	18.1%	-1.4%
Virology	16,594	32,072	35,064	38,801	41,266	43,197	4.7%	34.7%
Sendout Tests	96,852	116,160	141,648	129,294	126,650	151392	19.5%	30.3%
MCTP	3,957	2,312	2,084	2,487	1,355	393	-71.0%	-83.0%
Total	1,799,624	1,874,185	1,951,045	1,997,349	2,051,306	2,153,658	5.0%	14.9%
	5,057,888	5,168,980	5,511,693	5,873,300	6,074,404	6,430,944	5.9%	24.4%

Table 2 : *Clinical Pathology Billed Test Volumes (From pg. 14)*

Table 3 ***(Right):*** *Transfusion Medicine Number. (From pg. 17)*

Transfusion Medicine

Blood Bank Main Laboratory	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Change
Red Blood Cells	28,667	26,515	30,905	32,004	33,065	3%
Random/Pooled Platelets	47,264	20,959	6,009	6,080	5,880	-3%
Apheresis Platelets	873	6,394	10,120	10,648	11,000	3%
Plasma	8,688	6,642	6,997	7,267	7,073	-3%
Cryoprecipitate	4,979	6,011	6,431	7,404	7,840	6%
Total Components Transfused	**90,471**	**66,521**	**60,462**	**63,403**	**64,858**	**2%**
Immunohematology Reference Lab						
Antibody identifications	1,107	1,081	1,376	1,240	1,153	-7%
ABO resolution	150	156	111	187	233	25%
BMT	322	247	203	320	319	0%
Eulates	184	174	227	215	255	19%
Adsorptions	241	317	464	319	402	26%
Titers	259	303	324	295	477	62%
Special antigen typing			6,314	5,896	6,137	4%
Total Activity*	**2,763**	**2,801**	**9,861**	**9,097**	**10,624**	**17%**
**Includes procedures not listed above*						
Cellular Therapies Laboratory						
Collections processed	518	415	452	427	452	6%
Bags frozen	614	542	718	619	608	-2%
Transplants, autologous	137	116	122	136	130	-4%
Transplants, allogeneic	45	45	36	32	54	69%
Transplants, unrelated	69	61	44	67	75	12%
CAR-T products	-	-	4	12	54	350%
Total Transplants	251	222	202	235	259	10%
Apheresis Service						
Therapeutic plasmapheresis	1,313	1,389	1,207	1,220	1,310	7%
HPC collections	386	416	370	345	308	-11%
Donor pre-evaluations	258	243	219	255	308	21%
LDL apheresis	212	124	89	106	94	-11%
RBC exchange	96	120	103	112	170	52%
CART-T collections	-	-	4	12	33	175%
Total Procedures	**2,218**	**2,407**	**2,024**	**2,074**	**2,206**	**6%**

Faculty Awards 2018-2019

Faculty	Award Name	Organization
Henry Appelman, MD	President's Award	Arthur Purdy Stout Society of Surgical Pathologists
Ul Balis, MD	Appointed	American Board of Medical Specialties
Andrew Cani, MD	Precision Health Scholars Award	University of Michigan Medical School
Arul Chinnaiyan, MD, PhD	Outstanding Investigator Award	American Society for Investigative Pathology
Sarah Choi, MD	Top 5, 40-Under-Forty Award	American Society of Clinical Pathologists
Laura Cooling, MD	President's Award	AABB
	Plenary Abstract	2019 ASFA Annual Meeting
	"Top Downloaded Article"	*Transfusion Journal* 2017-2018
Eric Fearon, MD	Elected Fellow	American Association for the Advancement of Science (AAAS)
Carmen Gherasim, PhD	Travel Award	AACC
	Lab Director Travel Award	Clinical Applications to Mass Spectrometry
Thomas Glover, PhD, FACMG	Elected Fellow	American Association for the Advancement of Science (AAAS)
Jolanta Grembecka, PhD	Inaugural Rogel Scholar	University of Michigan Medical School
Tao Huang, MD	Resident Teaching Award	University of Michigan Medical School
Jeffrey Hodgin, MD, PhD	Precision Health Investigator Award	University of Michigan Medical School
Jeffrey Jentzen, MD	Helpern Lifetime Achievement Award	National Association of Medical Examiners
	Champion Award for Donations	Gift of Life Organ Procurement
Celina Kleer, MD, PhD	Outstanding Investigator Award	American Society for Investigative Pathology

(Continued)

Faculty	Award Name	Organization
	MiCHR Distinguished Clinical and Translational Research Mentor Award	University of Michigan Medical School
Steven Kunkel, PhD	Distinguished University Professor	University of Michigan Medical School
Laura Lamps, MD	F. K. Mostofi Distinguished Service Award	United States and Canadian Association of Pathology
Madelyn Lew, MD	Gender Equity Award	American Women's Association
	Elizabeth Crosby Award in Basic Sciences	Galens Medical Scoiety
	Kaiser Permanente Excellence in Teaching Award, Pre-Clinical	University of Michigan Medical School
	Token of Appreciation from Medical Students Award	University of Michigan Medical School
Nicholas Lukacs, PhD	MICHR Distinguished Mentorship Award	University of Michigan Medical School
Laurie McCauley, MD	Stephan H. Krane Award	American Society for Bone and Mineral Research
Yashar Niknafs, PhD	2018 Precision Health Scholars Award	University of Michigan Medical School
Zaneta Nikolovska-Coleska, PhD	Bayer Innovation and Discovery Award	American Association for Cancer Research
Gabriel Nunez, MD	Rous-Whipple Award	American Society for Investigative Pathology
Charles Parkos, MD, PhD	Elected Member	Association of American Physicians
Sethuramasundaram Pitchiaya, PhD	Valor Young Investigator Award	Prostate Cancer Foundaiton
Russell Ryan, MD	Junior Faculty Scholar Award	American Society of Hematology
	2018 Abeloff Scholar (for highest-rated V Scholar Award)	V Foundation

Table 5 : *List of Faculty and awards received 2018-2019 (From pg. 53)*

Table 6 ***(Right):*** *Full list of Departmental and Institutional Committee Service.*

Departmental and Institutional Committee Service

ACGME Self-Study Committee	Cytopathology Director Faculty Search Committee	Pathology Relocation and Renovation (PRR) Project Resident Representative
Advisory Committee on Promotions and Tenure	Histocompatibility Director Search Committee	(PRR) Executive Steering Committee
Advisory Council for Patient and Family Centered Pathology Care	Histology Committee	(PRR) Project Committee
Blood Transfusion Committee	House Officer Quality and Safety Council	Pathology Social Media Team Member
Clinical Pathology Director Search Committee	Laboratory Communications Committee	Phlebotomy Working Group
Clinical Pathology Operations Director Search Committee	Laboratory Formulary Committee	Program Evaluation Committee
Clinical Pathology Operations Committee	MLabs Executive Committee	Search Committee for Anatomic Pathology Director
Clinical Pathology Quality Assurance Committee	Pathology Diversity, Equity, and Inclusion Committee	Search Committee for HLA and Blood Bank Associate Director
Clinical Pathology Symposium Planning Committee	Pathology Document Control Vendor Selection Committee	Search Committee for Toxicology/Chemistry Faculty
Cytogenetics Faculty Search Committee	Pathology Executive Committee	

Professional Society Membership and Engagement

A. James French Society of Pathologists	American Society of Dermatopathology	International Society of Urological Pathology
Academy of Clinical Laboratory Physicians and Scientists	American Society for Histocompatibility and Immunogenetics	Michigan Association of Medical Examiners
American Academy of Family Physicians	American Society of Hematology	Michigan Society of Pathologists
American Association for Clinical Chemistry	American Society for Microbiology	Michigan State Medical Society
American Association of Blood Banks	Association for Molecular Pathology	National Association of Medical Examiners
American Association for Cancer Research	College of American Pathologists and Residents' Forum	Pan American Society for Clinical Virology
American Association for the Advancement of Science	Hans Popper Hematopathology Society	Rodger C. Haggitt Gastrointestinal Pathology Society
American Board of Pathology	Infectious Diseases Society of America	Society for Hematopathology
American Medical Association, and Resident & Fellow Section Delegates	International Association of Therapeutic Drug Monitoring and Clinical Toxicology	South Central Association for Clinical Microbiology
American Society for Bioethics and Humanities (ASBH)	International Society of Bone and Soft Tissue Pathology	United States and Canadian Academy of Pathologists, and Resident Advisory Subcommittee and Ambassadors
American Society for Clinical Oncology	International Society of Gynecological Pathologists	Washtenaw County Medical Society
American Society for Clinical Pathology, and Resident Representatives, Resident Council and Chair of the Resident Council	International Society for Heart and Lung Transplantation	
American Society for Clinical Oncology	International Society of Laboratory Hematology	

Graduate Student Thesis Defense and Current Positions

Name	Defense Date	Thesis Title	Mentor(s)	Current position	Current Company
Sierrah Grigsby	*12/12/2018*	*Interrogating DOT1L recruitment by MLL-fusion proteins MLL-AF9 and MLL-ENL towards the development of novel targeted therapy*	Zaneta Nikolovska-Coleska, PhD	1st year Medical Student	SUNY Downstate
James Ropa	*03/08/2019*	*Epigenetic and Transcriptional Regulation of Self Renewal in Acute Myeloid Leukemia*	Andrew Muntean, PhD	Postdoctoral Research Fellow	Indiana University School of Medicine
Shayna Bradford	*03/25/2019*	*Developing Novel Therapeutics for Chronic Kidney Disease*	Greg Dressler, PhD	Postdoctoral Research Fellow	University of Michigan
Lorena Lazo de la Vega	*04/30/2019*	*Comprehensive Molecular Profiling of Cancer Progression and Rare Cancers*	Scott Tomlins, MD, PhD and Kathleen Cho, MD	Data Curation Assistant	Strata Oncology
Kelly Kennaley	*05/03/2019*	*Identification and Characterization of TPRKB Dependency in TP53 Deficient Cancers*	Scott Tomlins, MD, PhD and Zaneta Nikolovska-Coleska, PhD	UMMS Research Administration Fellowship	University of Michigan
Yajia Zhang	*05/03/2019*	*Discovery and Characterization of Non-coding RNAs with Therapeutic and Diagnostic Potential in Prostate Cancer*	Arul Chinnaiyan, MD, PhD	Postdoctoral Research Fellow	University of Michigan

New National Leadership Positions - 2019

Faculty	Role
Laura Cooling, MD	Chair of Continuing Education Advisory Committee (CEAC) for the American Association of Blood Banks
David Lucas, MD	President, Association of Directors of Anatomic & Surgical Pathology
Joel Greenson, MD	President Elect, United States and Candadian Academy of Pathology
Asma Nusrat, MD	President, American Society for Investigative Pathology

New Department Leadership Appointments

Steven Kunkel, PhD	Interim Executive Vice Dean for Research and Chief Scientific Officer
Carmen Gherasim, PhD	Director of Toxicology
Lauren Smith, MD	Director of Hematopathology Fellowship

Table 7 ***(Above):*** *Full chart of Ph.D. Gradutes with Thesis Title, date, mentors, and current position and company. (From pg. 39)*

Table 8 ***(Left):*** *New National Leadership Positions from 2018-2019.*

Years of Service Recognition		
10 Years		
Ronald Allen	Moloy Goswami	Leina Mullins
Mary Nel Amr	Jeffrey Harrison	Satya Reddy
Ingrid Apel	Pamela Howard	Priya Sawhney
Jennifer Babinchak	Xia Jiang	Cassandra Snyder
Tamika Brooks	Nancy Knott	Kristy Wendt
Mary Currie	Lindsay Kochan	Timothy Williams
Beth Gibson	John Larock	
Marie Goldner	Roohee Marshall	
20 Years		
Jyoti Athanikar	Laura Labut	Javed Sidiqqui
Kristopher Crosier	Binita Naylor	Lidia Tedla
Dawn Jucha	Tonya Rauch	
Christine Kwierant	Cynthia Schuholz	
30 Years		**40 Years**
Terri Bauer	AJ Dudus	Larry Clayton
Jennifer Bergendahl	Jane Ferguson	Bill Hubbard
Laurie Chopko	Robert Jones	Vicki Pierzynski
Susan Clark	Rebecca Roberts	
Annette Collins		

Above and Beyond Award Recipients		
Anatomic Pathology	**Pathology Informatics**	
Nick Miller	Allen Ano	Oliver Bichakjian
Debra Woodard	Bill Hubbard	Ramesh Surisetty
DQHI		
Andrea Arlen		
Clinical Pathology		
Blood Bank		
Brooke Boone	Steve Holden	Jon Schroeder
Donna Brown	Nicole Hunt	Laura Trescott
Julie Butcher	Monica Irelan	Julia Voss
Emily Chadwick	Shelby Perry	Holly Wilson
Amy Clevenger	Razma Rudnickaite	Li Yang
Meredith Hoag	Karen Schairer	Lian-Fai Yee
Chemical Pathology	**Immunopathology**	
Shannon St. Andrew	Kimberly Gray	
Multidisciplinary Team - PathTrack		
Terrence Barrette	Joshua Jacques	Kristina Martin
Kathy Davis	Todd Kandow	Thomas Morrow
Mary Deis	Jodi Kennedy-Stanfield	Ann Rosin
Mary Deis	Diana Khiterer	Brian Royer
Devon Fera	Sravan Kumar Kilaru	Jennifer Slater
Melvina Grayson	Beth Lawless	Rita Spiegelberg
John Hamilton	Jeffrey Lott	Renee Stoklosa
William Hubbard	Ryan MacFadden	Cindy Straub
Michelle Hunter-Clark	Amy Mapili	Mary Tocco
Eric Jedynak	Stephen Marshall	

Table 9 ***(Right):*** *Years of Recognition and Above and Beyond Award Recipients (From pg 55.)*

Annual Report by Pathology Communications: Lynn McCain, Editor; Brent Temple, Design and Layout; Elizabeth Walker and Camren Clouthier, Photography and Editing.

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