TEXAS A&M UNIVERSITY
Irma Lerma Rangel
College of Pharmacy

# PH.D. DEGREE IN PHARMACEUTICAL SCIENCES

**Mansoor A. Khan, Ph.D.**

Professor and Vice Dean

Texas Higher Education Coordination Board Site Visit

May 7, 2019

# OUTLINE

- RCOP – By the Numbers
- Why Ph.D. in Pharmaceutical Sciences?
- Program Elements
- Research Preparedness and Infrastructure
- Q&A

# BY THE NUMBERS: RCOP

- Campuses: 2
- Current students: 461
- Former Students: 759
- Faculty: 52
- Staff: 36
- Research Associates: 21
- Preceptors: >1260

# BIG IDEAS FROM SPRING 2016 FACULTY RETREAT

| Transformational Idea | Green | Orange | Pink |
|---|---|---|---|
| Develop strong graduate (PhD) and residency programs | 24 | 3 | 1 |
| Product devleopment center (convergence integration with TAMU) | 13 | 11 | 1 |
| State of the art teaching/learning center | 11 | 5 | 4 |
| College run mini-pharmacy/clinics | 11 | 3 | 3 |
| Collaborate with community health centers & pharmacy services | 10 | 8 | 3 |
| International scholars program - faculty recruitment | 10 | 7 | 5 |
| Establish pediatric and geriatric centers of excellence | 5 | 6 | 6 |
| Work with Clinicians/Pharmacist for solutions to adverse product evaluations | 2 | 12 | 6 |
| Personalized medicine kiosk | 1 | 6 | 7 |
| | | | |
| Change curriculum to a 2 + 2 program | 13 | 4 | 4 |
| Internationally collaborative pharmacy graduate program | 9 | 7 | 0 |
| Increase student quality | 8 | 4 | 2 |
| Move college closer to a teaching hospital | 5 | 2 | 9 |
| World renowned through global pharmacy | 5 | 0 | 8 |
| Transition COP into problem based learning curriculum | 4 | 6 | 3 |

# MISSION AND OBJECTIVES

**The mission of the Ph.D. program in Pharmaceutical Sciences (PHSC)** is to provide a comprehensive knowledge base that leads to drug discovery, design, and development of pharmaceutical dosage forms through basic and applied research in pharmaceutical sciences.

**Some objectives of the PHSC program are:**

- To provide a meaningful and important course of study that is currently unavailable in Texas A&M University.
- To train and create pharma and biotech entrepreneurs who will know how to leverage the vast knowledge and infrastructure of Texas A&M programs in engineering, veterinary medicine, Agri-Life, medicine, dentistry, biomedical sciences, physical and life sciences, business, and how to help advance drug and medication policies.
- To provide students with specific experiences in conceptual and technical research areas in the pharmaceutical sciences, e.g., pharmaceutics, medicinal chemistry, pharmacology, pharmacy administration, and basic sciences.

**Five Year Ph.D. Pharmaceutical Sciences Enrolment in National and Texas Universities**

| Year | 2014 | 2013 | 2012 | 2011 | 2010 |
|---|---|---|---|---|---|
| Nation | 3086 | 3094 | 3266 | 3109 | 3051 |
| UT Austin | 124 | 91 | 125 | 119 | 106 |
| U of Houston | 65 | 63 | 65 | 58 | 57 |
| Texas Tech | 38 | 38 | 37 | 38 | 43 |
| Texas Southern | 16 | 18 | 19 | 18 | 18 |

- Less than 10% of qualified applicants accepted in these programs
- Employment is almost 100% within 3 months of graduation (details provided in proposal)

**Five Year Ph.D. Pharmaceutical Sciences Graduations in National and Texas Universities**

| Year | 2014 | 2013 | 2012 | 2011 | 2010 |
|---|---|---|---|---|---|
| Nation | 565 | 589 | 497 | 471 | 450 |
| UT Austin | 19 | 12 | 21 | 13 | 13 |
| U of Houston | 7 | 13 | 7 | 14 | 1 |
| Texas Tech | 7 | 5 | 5 | 13 | 4 |
| Texas Southern | 6 | 1 | 3 | 0 | 0 |

**Please note that Texas A&M University System does not have ANY ENROLMENT or GRADUATION since we don't have the PhD program in pharmaceutical scinces. More than 60 institutions of higher education in US have PHD degrees in pharmaceutical sciences already**

# INTERNAL SUPPORT

- ***"We anticipate that the proposed degree (Ph.D. in PharmSci) would be complementary to the Ph.D. in Biomedical Sciences offered by CVM"*** **--Dean Eleanor Green, Vet Medicine**

- **"*A graduate program in pharmaceutical science in Rangel College has the potential to unite enterprise and education, making the State of Texas an epicenter for pharmaceutical development". "I firmly believe the formation of a graduate program in pharmaceutical science will be a game changer…"* Dean Katherine Banks – Engineering**

- **"*The area of pharmaceutical sciences is clearly the missing puzzle for formulations development at Texas A&M*" – Dean Mark Hussey – Agri-Life, Now President of TAMUK**

- **"I am writing to offer my highest support and best wishes for this worthy endeavor" – Former Dean Paul Ogden, Interim Senior VP and COO HSC, now Provost in TTUHSC El Passo**
- **"The HSC is fully committed to the success of the new Ph.D. program in pharmaceutical sciences". "I offer my strongest support for the establishment of this new doctoral program in the Texas A&M Irma Lerma Rangel College of Pharmacy. – Dean Carrie Byington, Exec Vice President and Dean COM**

- **"The letter represents my strongest endorsement for the proposal being submitted by your college to develop a Doctor of Philosophy (PhD) program in pharmaceutical sciences) – *Provost Anderson – TAMUK, Now President University of Maryland, Eastern Shore.***

# EXTERNAL SUPPORT

- "*Pharmaceutical product development strategies have dramatically changed after FDA's call for modernization… I believe that newer programs have a much better opportunity to integrate various disciplines.."* – *Diane Burgess, AAPS President (2002), CRS President (2010), Editor IJP.*

- *I am very pleased to see a much-needed multidisciplinary approach with concrete plans to connect pharmacy, engineering, basic science, medicine, and veterinary medicine… I support this proposal without reservations* – *Ajaz Hussain, President NIPTE*

# EXTERNAL SUPPORT – TEXAS PHARMA INDUSTRY

"*The Mylan research and Development group includes more than 2900 scientists worldwide…"Often times we face challenges with the lack of availability of talented PhD level scientists.."* Mylan Labs, San Antonio

"Please be assured of my full support for the mission of this new Ph.D. program in pharmaceutical sciences. I am confident that Allergan, Santen, Alcon/Novartis, Pfizer and other companies in the region will tremendously benefit with qualified graduates.." Mike Garrst, Former Senior VP of Allergan.

# Texas A&M Proposal

- Enrolment projections (10 students per year)
- Academics (in proposal)
- Admission standards (in proposal)
- Program degree requirements

**Table 2:** Semester Credit Hour Requirements by Category

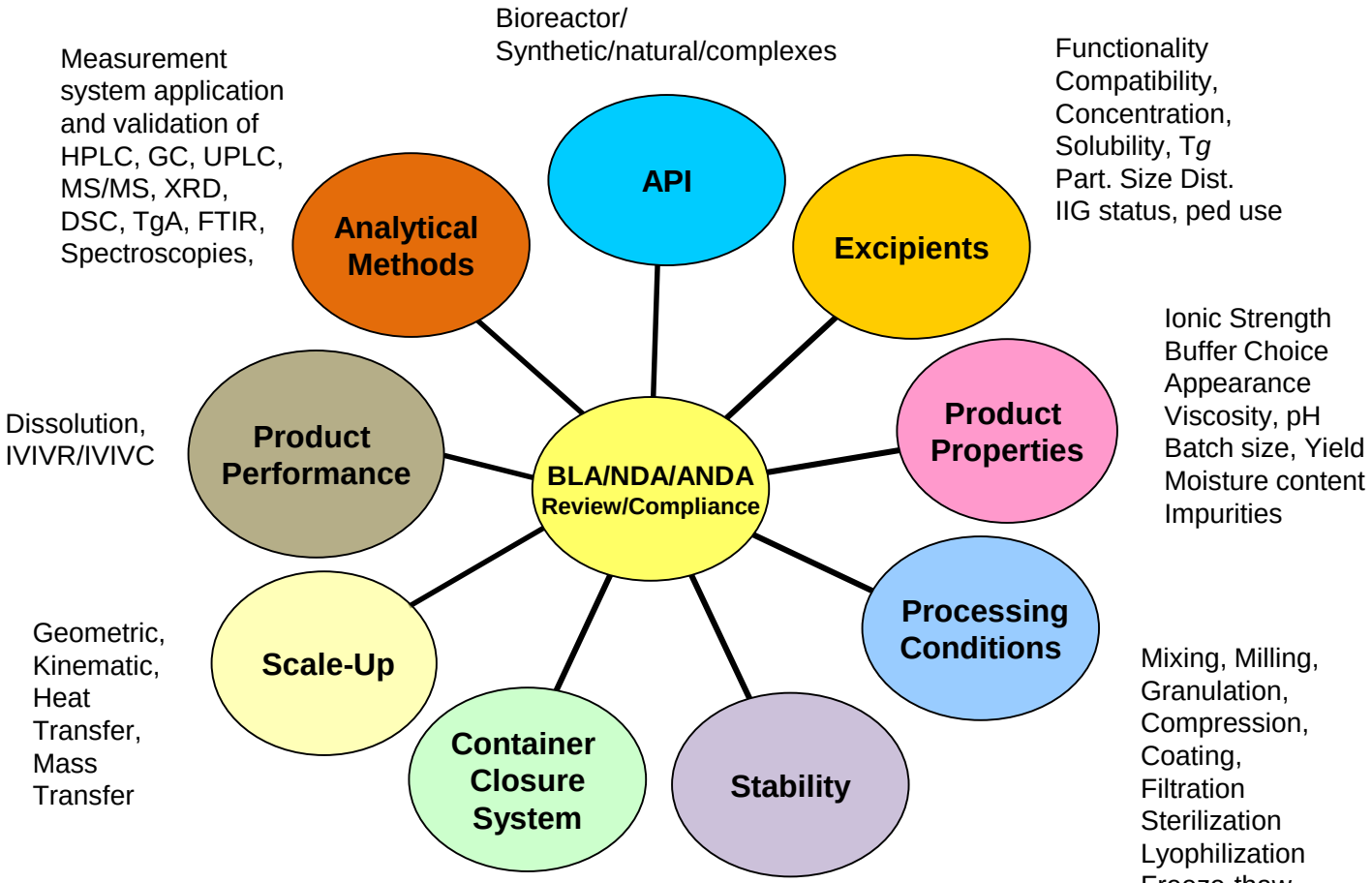
| Category | SCH Entering with a Bachelor's | SCH Entering with a Master's |
|---|---|---|
| Required Courses | 26 | 18 |
| Prescribed Electives | 14 | 8 |
| Electives | 12 | 6 |
| Dissertation | 38 | 28 |
| Other (Specify, e.g., internships, clinical work, residencies) | Lab rotations, seminars (2) | Lab rotations, seminars (2) |
| **TOTAL**[1] | 90 | 60 |

[1] Texas Education Code 61.059 (l) limits funding for doctoral students to 99 SCH. Programs may be allowed to require additional SCH, if there is a compelling academic reason.

# REQUIRED COURSES FOR ALL STUDENTS

| Table 4. Required/Core Courses | | |
|---|---|---|
| **Prefix and Number** | **Required/Core Course Title** | **SCH** |
| PHSC 610* | Biotech drugs and vaccine products | 4 |
| PHSC 611* | Drug delivery and formulations | 4 |
| PHSC 612* | Principles of drug actions | 4 |
| PHSC 613* | Laboratory rotations | 3 + 3 |
| PHSC 621* | Biostatistics or equivalent | 3 |
| PHSC 622* | Professionalism and ethics in research or equivalent | 3 |
| PHSC 623* | Seminar | 1+1 |

| Table 5. Prescribed Elective and Elective Courses | | |
|---|---|---|
| **Prefix and Number** | **Prescribed Elective Course Title** | **SCH** |
| PHSC 724* | Principles of pharmacology and toxicology | 3 |
| PHSC 725* | Biopharmaceutics and pharmacokinetics | 3 |
| PHSC 731* | Process and product development or equivalent | 2 |
| PHSC 732* | Controlled and targeted drug delivery | 3 |
| PHSC 733* | Drug degradation and product stability or equivalent | 3 |
| PHSC 734* | Vaccine delivery | 3 |
| PHSC 735* | Industrial pharmacy | 3 |
| PHSC 736* | Physical pharmacy | 3 |
| PHSC 737* | Transdermal and topical drug delivery | 3 |
| PHSC 738* | Cosmetic development | 2 |
| PHSC 739* | Pediatric dosage forms | 3 |
| PHSC 741* | Analytical/Bioanalytical techniques and validation | 3 |
| PHSC 742* | High throughput training in drug discovery and screening | 3 |
| PHSC 743* | Polymer chemistry or equivalent | 3 |
| PHSC 744* | Chemometrics and big data management or equivalent | 3 |
| PHSC 689* | Topics in pharmaceutical science | 1, 2, 3 |
| PHSC 752* | Nanotechnology for biomedical applications | 3 |
| PHSC 753* | Pk/PD and drug metabolism or equivalent | 3 |
| PHSC 754* | Toxicokinetics and predictive toxicology | 3 |
| PHSC 755* | In-vitro/in-vivo simulations and modeling | 3 |
| PHSC 756* | Advanced pharmacology | 3 |
| PHSC 757* | Herbal drugs or equivalent | 3 |
| PHSC 758* | Research in pharmaceutical science | 1,2,3 |
| PHSC 691* | Dissertation research | 3 |


Bioreactor/
Synthetic/natural/complexes
Measurement
system application
and validation of
HPLC, GC, UPLC,
MS/MS, XRD,
DSC, TgA, FTIR,
Spectroscopies,
Functionality
Compatibility,
Concentration,
Solubility, Tg
Part. Size Dist.
IIG status, ped use
API
Analytical Methods
Excipients
Ionic Strength
Buffer Choice
Appearance
Viscosity, pH
Batch size, Yield
Moisture content
Impurities
Dissolution,
IVIVR/IVIVC
Product Performance
Product Properties
BLA/NDA/ANDA
Review/Compliance
Processing Conditions
Geometric,
Kinematic,
Heat
Transfer,
Mass
Transfer
Scale-Up
Mixing, Milling,
Granulation,
Compression,
Coating,
Filtration
Sterilization
Lyophilization
Freeze-thaw
Agitation
Filling
Spray Drying
Container Closure System
Stability
Material, Geometry, Integrity
Headspace pressure, Leachables,
Fill volume, Terminal sterilization feasibility
Temperature, RH, Light,
Handling, Storage

# TEXAS A&M HUMAN CLINICAL RESEARCH FACILITY

hcrf.tamu.edu

# TEXAS A&M HUMAN CLINICAL RESEARCH FACILITY

HCRF includes:

- Facilities to conduct training and rehabilitation research
- Conference rooms and offices
- 12 beds for overnight research studies
- A metabolic kitchen
- A pharmacy compounding and sterile products room
- 4 procedure and research examination rooms
- DEXA and resting energy expenditure rooms

# TEXAS A&M NATIONAL CENTER FOR THERAPEUTICS MANUFACTURING

nctm.tamu.edu

# TEXAS A&M NATIONAL CENTER FOR THERAPEUTICS MANUFACTURING

NCTM bioprocess labs include:

- Upstream lab
- Downstream lab
- Analytical lab
- Cell culture lab

NCTM offers:

- Workforce development
- Operation-Technician training
- Continuing education courses
- BioFORCE STEM summer academies

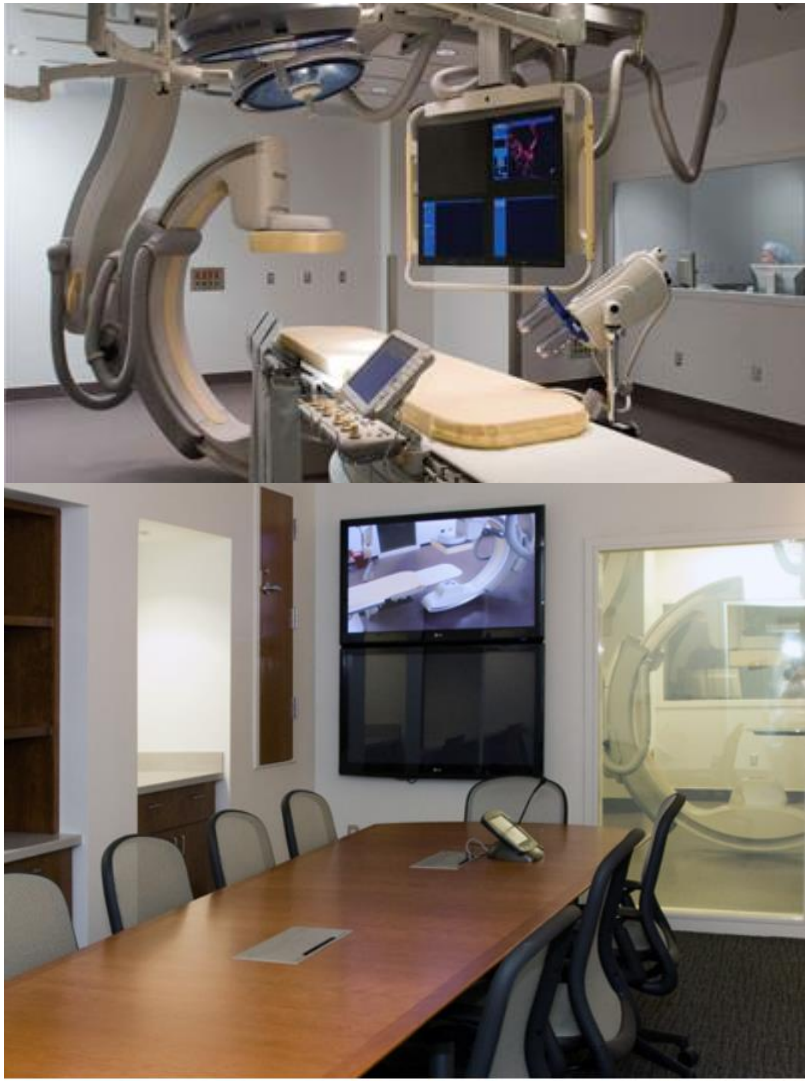
# TEXAS A&M INSTITUTE FOR PRECLINICAL STUDIES (TIPS)

tips.tamu.edu

# TEXAS A&M INSTITUTE FOR PRECLINICAL STUDIES (TIPS)

TIPS building amenities include:

- GLP compliant clinical pathology laboratory
- Three 600 $ft^2$ surgical suites, plus a hybrid imaging suite
- Large 150 person auditorium for meetings/training
- Conference rooms and sponsor work rooms w/video feed to labs

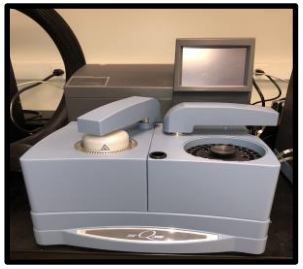


# PRODUCT DEVELOPMENT FACILITY IN COLLEGE STATION

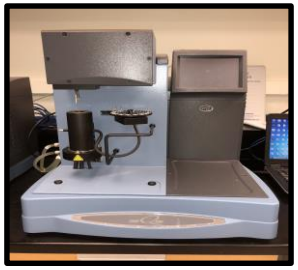

pharmacy.tamhsc.edu

# DR. RAHMAN'S/DR. KHAN's LAB AT RANGEL COLLEGE OF PHARMACY

Differential Scanning Calorimeter



Thermogravimetric Analyzer



## Analytical Facility

The Analytical Lab and Research Facility incorporates state-of-the-art laboratory equipment for performing chemical analyses, developing methods to aid in research, online-monitoring of process and product development.

Particle Size Analyzer

Texture Analyzer

## Manufacturing Facility

Our Manufacturing facility is a prototype of a pharmaceutical industry equipped with machines for making oral solid dosage forms. Training is provided for faculty and graduate students in equipment operation and research techniques from interdisciplinary departments.

Thermo Fisher FTIR, NIR and Raman modular systems

High Shear granulator, KG5

10-station tableting machine

Quadro Co-Mill

V-blender, Model VH2

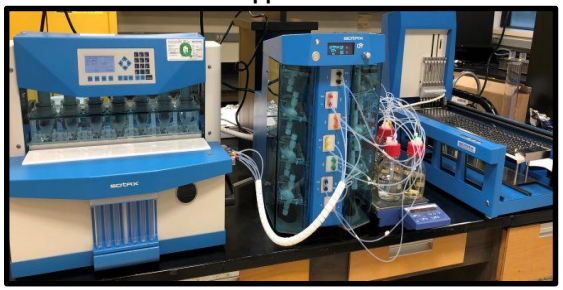
Fluid Bed Processor- Strea-1

HCT Mini Tablet Coater

# DR. KHAN'S/DR. RAHMAN'S LAB AT RANGEL COLLEGE OF PHARMACY

Dissolution USP apparatus I and II

USP apparatus IV



XRD, Bruker


UPLC-MS

## Product Characterization Facility

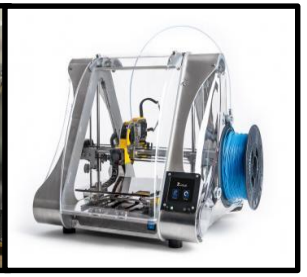
Dosage forms characterization facility incorporates state-of-the-art laboratory equipment's like Agilent Dissolution USP apparatus I and II Model 708-DS with autosampler. Three Agilent HPLC system, Model 1260 Infinity II HPLC's with autosampler and RI and PDA detectors. Waters UPLC-MS, Model Acquity UPLC QSM with Acquity PDA Detector and QDa detector. TA.XTPlus Texture Analyzer (Stable Microsystems Ltd). Laser diffraction particle sizer with solid and liquid samples measuring capability (PSA 1190, Anton Paar)

## Additive Manufacturing Facility

In additional to conventional manufacturing our facility is equipped with state of the art 3D printing machines like Selective Laser sintering (SLS) and Fused deposition modelling (FDM) for printing oral solid dosage forms for pediatrics. Training is provided for faculty and graduate students in equipment operation and research techniques from interdisciplinary departments.

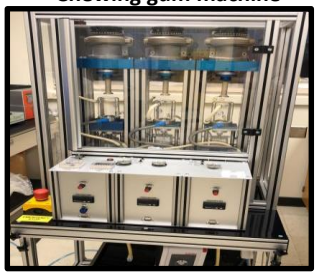
SLS 3D Printer

FDM 3D Printer



Chemical/Hyperspectral Imaging


Chewing gum machine



Near-IR, Raman and FTIR Combo

# DR. PALAKURTHI'S LABORATORY

- The Palakurthi Laboratory is interested in applying nanotechnology principles in drug delivery and targeting.

- The lab is working on the design and development of nanoparticle systems using lipids, proteins and polymers for targeting anticancer drugs, and drug combinations, to cancer cells for effective reversal of drug resistance in the cancer cells, particularly breast and ovarian cancers.

- A hybrid plasmid has been developed for Enzyme directed prodrug therapy for breast cancer.

- The lab has developed nanoparticles using zein, a corn protein, for oral delivery of drugs to treat inflammatory bowel disease (IBD).

- A novel in vitro drug release method for testing the bioequivalence of topical ophthalmic products is under investigation.


**Advion Expression LC-MS (CMS-L01 model) with Shimadzu HPLC (LC20AB model)**

**BD Accuri® C6 Flow cytometer**

# DR ZHU'S LAB

- Zhu's lab focuses on: (i) design of the stimuli-sensitive nanocarriers/drug conjugates in response to local stimuli, such as pH and matrix metalloproteinases (MMP); (ii) design of the novel nanomaterials to enhance the drug's cellular bioavailability through increasing cellular uptake and inhibiting multidrug resistance (such as drug efflux); and (iii) design of the novel polymers/nanomaterials for intracellular and organelle targeting.

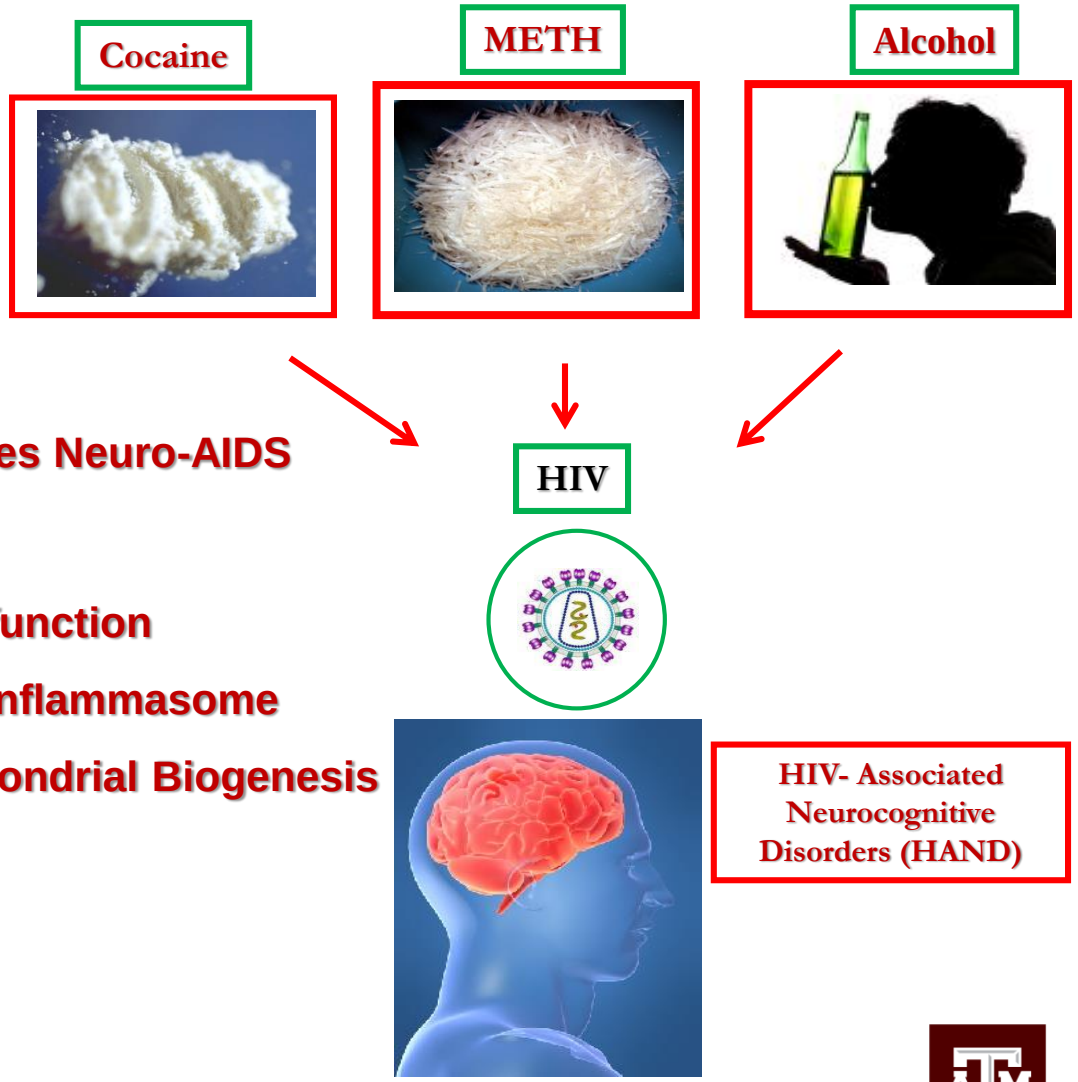
Flow cytometer

Confocal microscope

HPLC

Particle size and zeta potential analyzer

# Dr. Sami Thangavel's Lab
# Neuro-AIDS



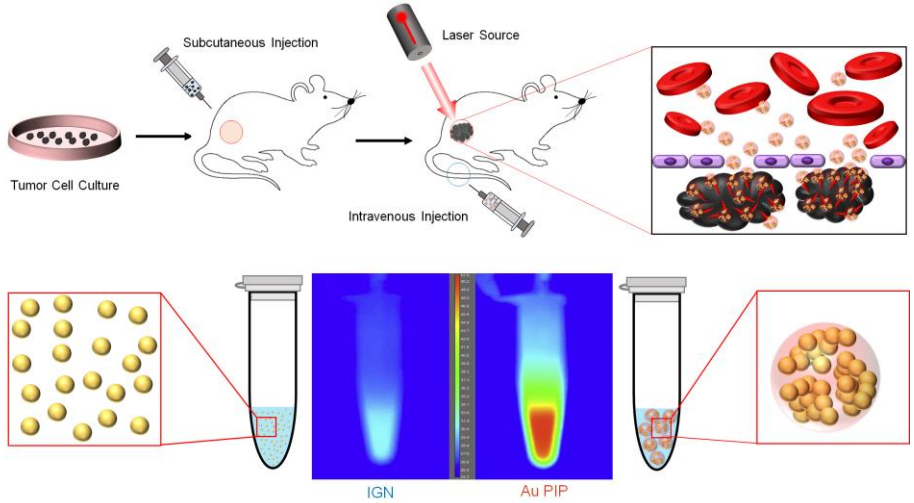

**HIV/AIDS and Drugs of Abuse Implicates Neuro-AIDS**

**Research Focuses on:**

- **Metabolic Deficits Impact CNS Dysfunction**
- **Role in Acquit phase proteins and Inflammasome**
- **Epigenetic Modification and Mitochondrial Biogenesis**

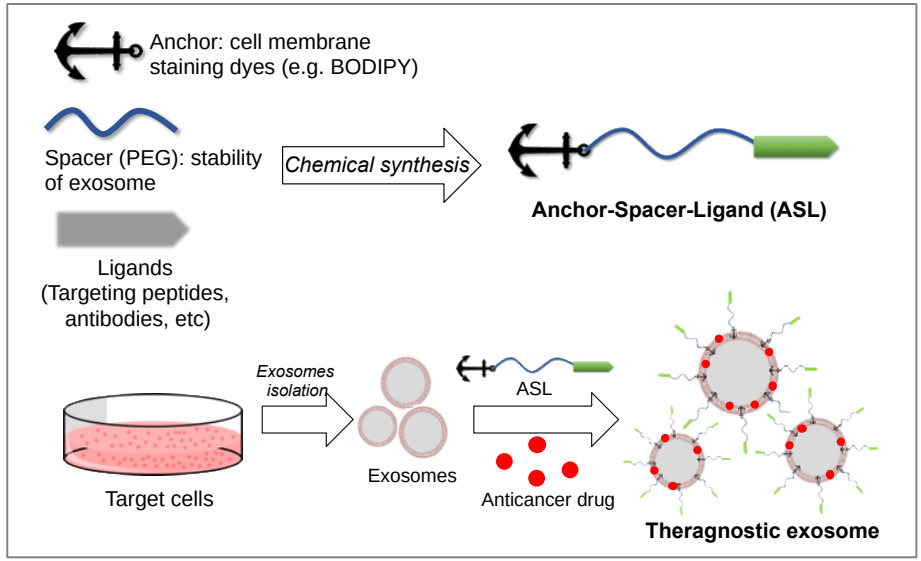
# Dr. Dongin Kim's lab

## Nanoconfinement Gold mediated Oncothermia




Gold Particle-in-Particle (PIP), in which gold nanoparticles are physically confined within PLGA-PEG nanoparticles, significantly enhances thermal energy production by red-shifting the gold nanoparticle's absorption spectra via a mechanism in which we call Nanoconfinement-Induced Therapeutic Enhancement (NITE). NITE mediated Gold PIPs significantly suppress breast, skin, and multi-drug resistant tumors.

## Active targeting Biological Nanoparticles

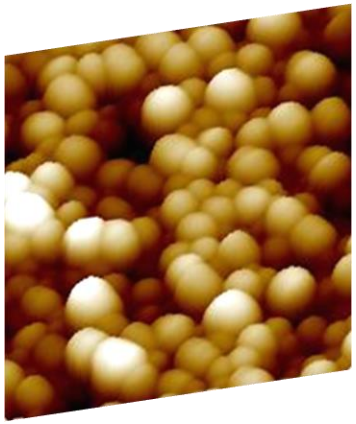



An innovative strategy for cancer therapy based on: (i) simple and economic protocol of mass production of pure immune cell exosomes, (ii) synthesis of active targeting moieties, (iii) physical labeling of ligands for active targeting therapy, and (iv) maximum intracellular delivery of exogenous drugs with no or minimum off-targeting side effects.

# MAJETI-LAB
# DRUG & DISEASE-NO BAR

- Well supported by basic and clinical collaborators
- Large or Small, we deliver ALL! It's all about DELIVERY!

**b-gal**
**465 kDa**

**E2**
**272.4 Da**

Amphotericin B; Atorvastatin
Cyclosporine A; Paclitaxel
Doxorubicin; Insulin
Tamoxifen etc

Curcumin; Coenzyme $Q_{10}$
Ellagic acid; EGCG, Urolithin A

***TBI***
**Epilepsy**
***Gulf War illness***
**Alzheimer's**
**Stroke**

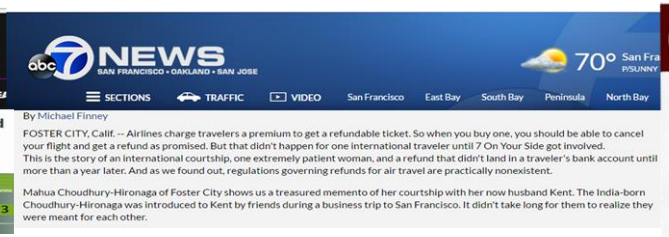
**Diabetes**
**Postmenopausal-dyslipidemia**
**Hypertension**
**Myocardial Ischemia**

***HIV***
***IBD***
***AKI***
***Lupus***
**Fungal infection**
***Leishmaniasis***

**Cancer (breast, lung, ovarian)**
**Arthritis**

# DR. CHOUDHURY'S RESEARCH







Research includes:

1) Early epigenetic biomarkers in preeclampsia and diabetes

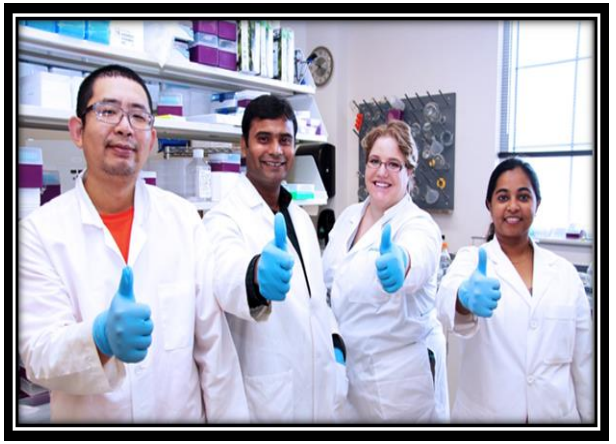
2) Effect of plastics in pregnancy complications and diabetes and obesity

3) Anti-HIV condom material development

4) Reversal of metabolic diseases via nutraceuticals

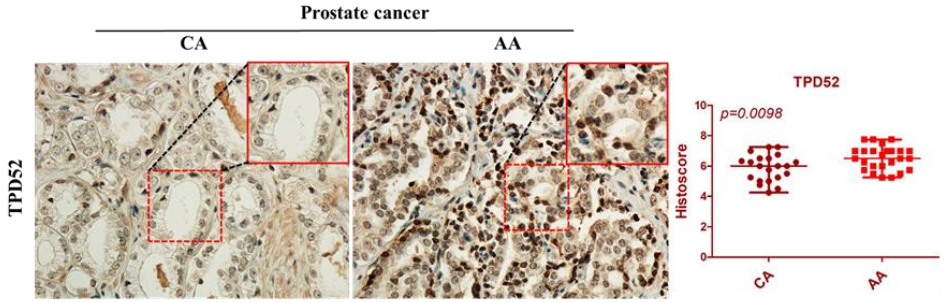
5) Epigenetic regulation during exercise

6) Epigenetic instrumentation development



# DR. ELMAGEED'S LABORATORY

Prostate cancer patient received anti-androgen therapy




Immunostaining of tissue sections of PCa with anti-TPD52 antibodies and its IHC score. *Sci Rep.* 2018 Nov 5;8(1):16335.

Human FFPE prostate cancer tissue blocks

Leica microtome to prepare tissue sections

Leica stainer to perform IHC of selected proteins

- Dr. Elmageed laboratory is focussing on translational research in the field of oncology and therapeutics including prostate, breast cancer and melanoma. This encompasses molecular and cellular biology and therapeutic approaches using in vitro and in vivo mouse model systems as well as human specimens. His laboratory has been actively involved in research training of international graduate students, scholars, postdoctoral fellows and junior faculty members at Texas A&M Health Sciences Center.

# DR. KUMAR'S LAB

Kumar's lab focuses on:

- (i) Understand the mechanism of intestinal restitution during inflammatory bowel disease (IBD) and development of intestinal-specific therapeutics.
- (ii) Understand gut-brain communication during obesity, and develop gut-dysbiosis associated therapeutics for Alzheimer's disease/mental health.
- (iii) Understand gut-liver communication during obesity associated hepatic steatosis.


Clinical pathology: cryostat

Clinical pathology: plate reader

Immunological imaging
Confocal microscope

Immunological Flow cytometer

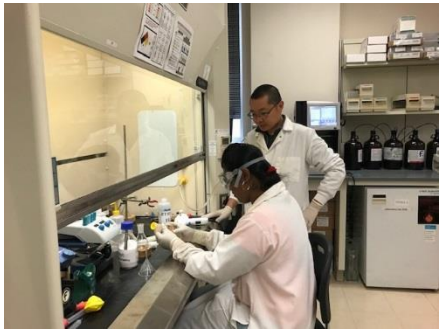
# DR. NUTAN'S RESEARCH LAB

- Liposomal delivery system of gene
- Solid lipid nanoparticles of curcumin for antitumor activity
- Biodegradable in situ injectable preparations for extended delivery of various drugs



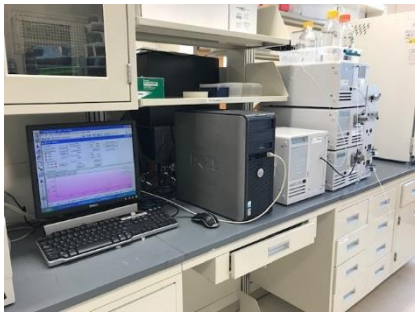
# THE LU LABORATORY AT COLLEGE OF PHARMACY

- The Lu lab is a medicinal chemistry laboratory working in the interface of organic synthesis and pharmaceutical sciences.
- The lab is engaged in the discovery of potential therapeutics for the treatment of cancer, neurodegenerative diseases and various disorders associated with the endocannabinoid system such as pain, drug-addiction and obesity.
- The lab has filed three patent applications, and one is in the stage of PCT application.
- The lab currently has three senior scientists, one research assistant, several student workers and two consultants. (Profs. K.C. Nicolaou and Apurba Bhatacharya).

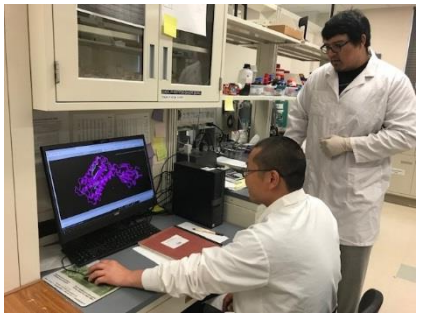


**Fume hoods & Automatic Flash Chromatography**


**Advion Mass Spectrometer**



**Chiral HPLC**

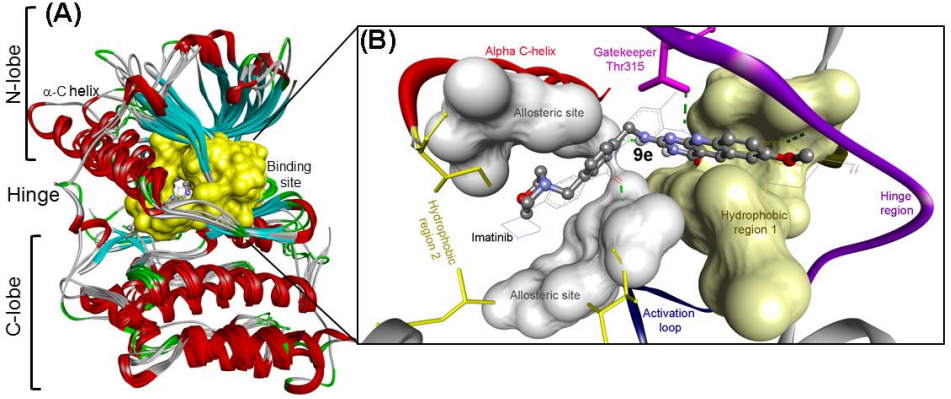


**Computer Modeling Station**

# Kinase-Targeted Cancer Therapy

## 1. Computer-Aided Drug Design


Full access to STAMPEDE supercomputer at UTAustin and Texas Advanced Computing Center (TACC) at TAMU

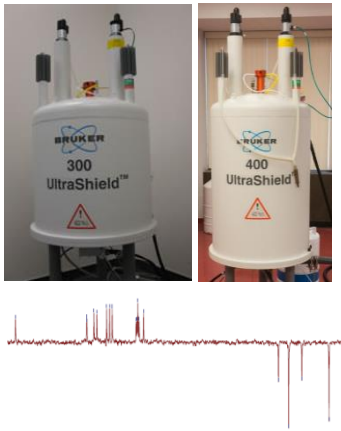



**(A)** Molecular overlay view of Abl, c-kit, FAK, Src, B-raf, and FLT1 kinases showing ATP binding site in yellow surface view.
**(B)** The binding mode of compound **9e** into Abl kinase.

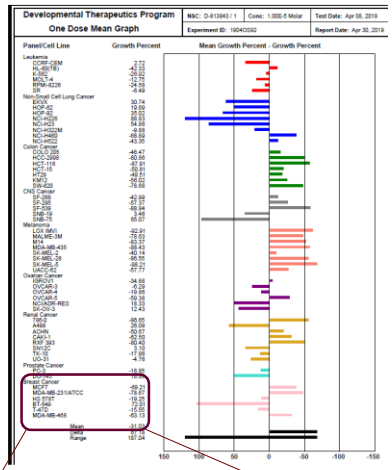
## 2. Synthetic Medicinal Chemistry

*CombiFlash Rf 200 (Teledyne Isco)*

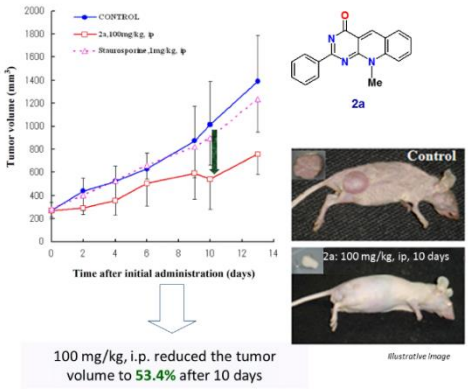
300 & 400 MHz BRUKER spectrometers (TAMUK & TAMU).






| Breast Cancer | |
|---|---|
| MCF7 | -69.21 |
| MDA-MB-231/ATCC | -78.67 |
| HS 578T | -19.25 |
| BT-549 | 72.01 |
| T-47D | -15.55 |
| MDA-MB-468 | -63.13 |
| Mean | -31.03 |




100 mg/kg, i.p. reduced the tumor volume to **53.4%** after 10 days

In vivo Antitumor activity of (**2a**) against A431 xenograft

***In vitro MTT assay against NCI 60 cell lines 13 out of 20 compounds were selected for further assays by NCI***

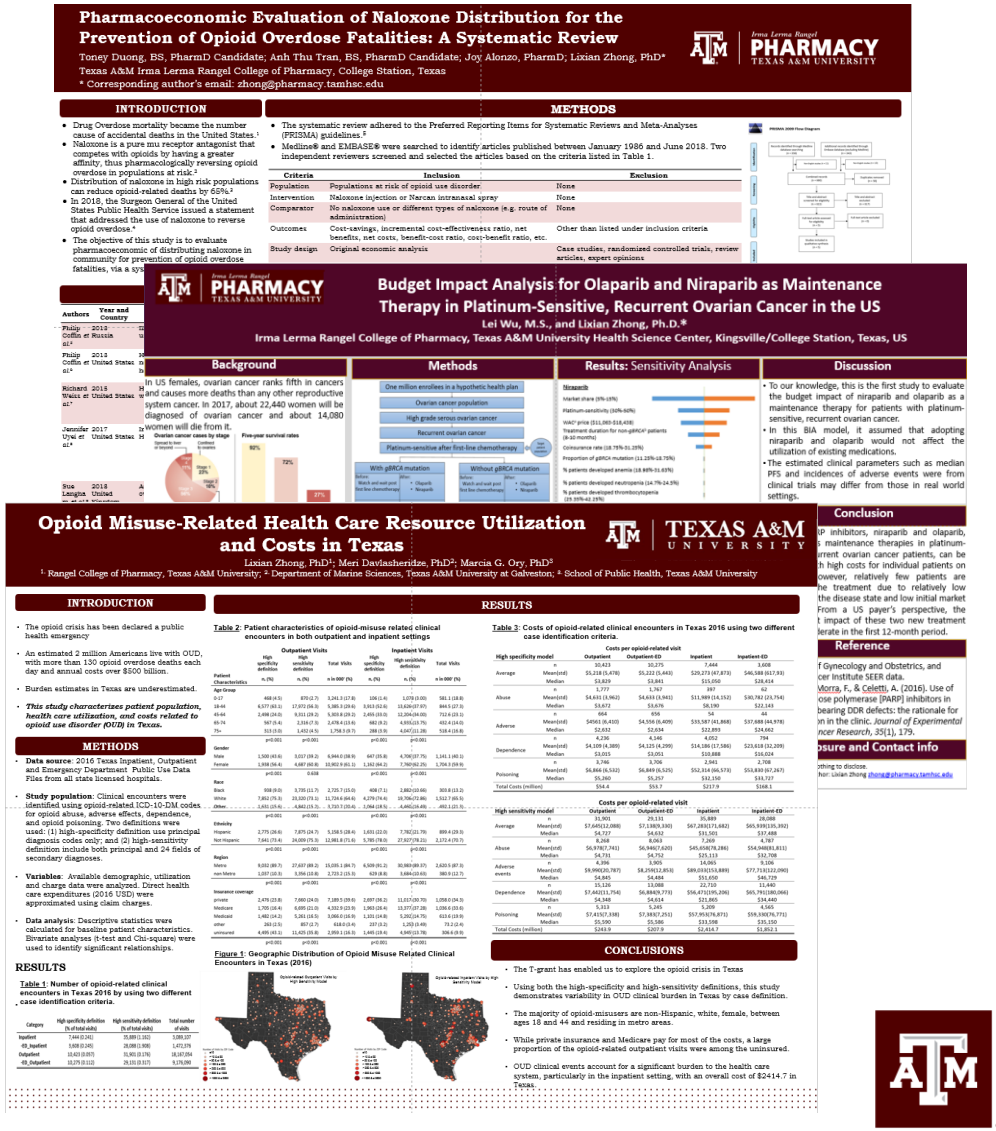
The ongoing research in Dr. Ali's lab focuses on computational design and chemical synthesis of potential antitumor agents by applying Targeted Cancer Therapy approach. Through this approach the aggressive and resistant HER2+ve breast cancer is targeted by integrating multidisciplinary drug design approaches to improve drug specificity. In addition, Dr.Ali has been actively involved in mentoring 4 Ph.D students (Joint grants) and 17 Pharm-D students (independent research study) at RCOP.

# DR. LIXIAN ZHONG'S LAB

- Dr. Lixian Zhong's lab focuses on Pharmacoeconomics and Outcomes Research in the disease area of oncology, neurological diseases and opioid use disorders.

- The lab is engaged in using large national and statewide healthcare data and economic modeling to study:

- Cost-effectiveness of novel interventions
- Healthcare costs and resource utilizations
- Comparative outcomes associated with different treatment options

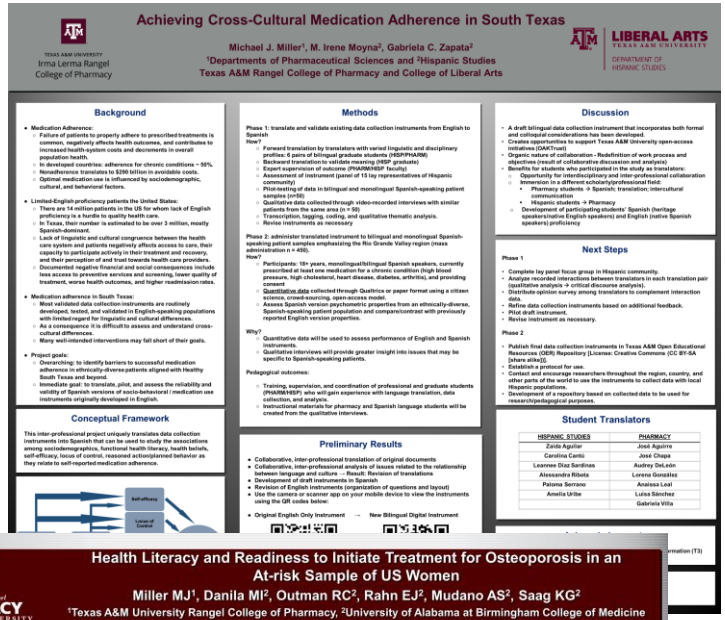


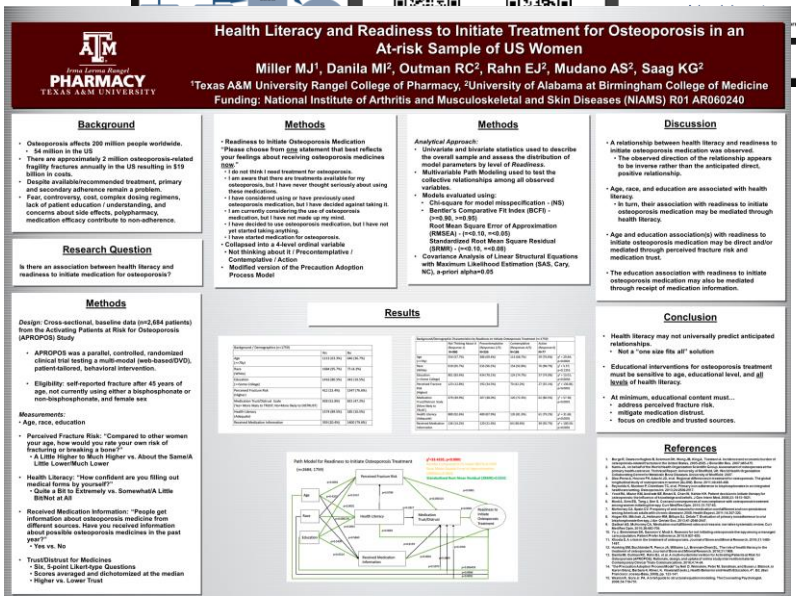
# MICHAEL J. MILLER, RPH, DRPH, FAPHA

- As a researcher, I use both primary and secondary data to study and refine methods to measure and identify those at risk for low health literacy, evaluate the literacy-sensitivity of pharmacy processes and environments, and identify interventions that improve health literacy and ensure optimal medication use and risk communication.

- My primary areas of clinical interest include cardiovascular-related disease, rheumatology, depression, and, most recently, infectious disease.

- From a process perspective, I also have a strong interest in treatment guideline concordance with respect to medication management as well as disparities in healthcare practices.



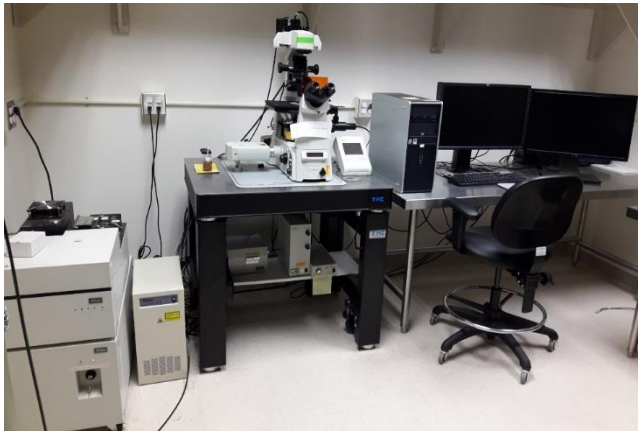



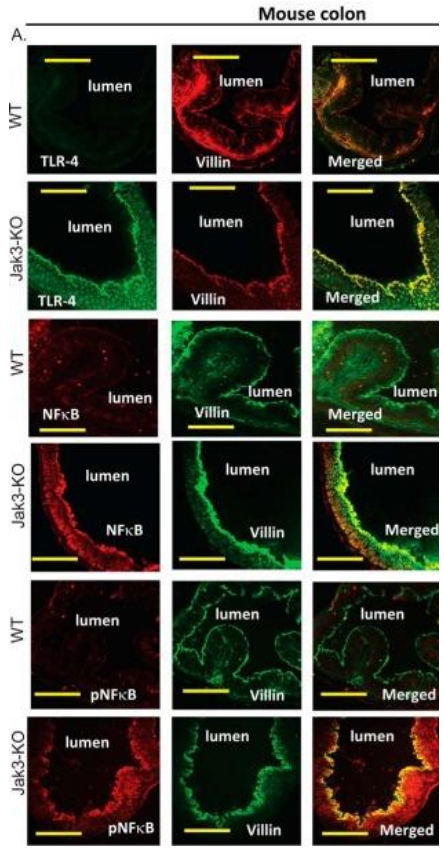
# DR. MISHRA'S LAB

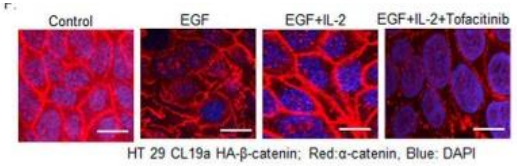
Dr. Mishra's lab focus:

- Role of drug transporters during chronic inflammatory diseases.

**Confocal microscope**





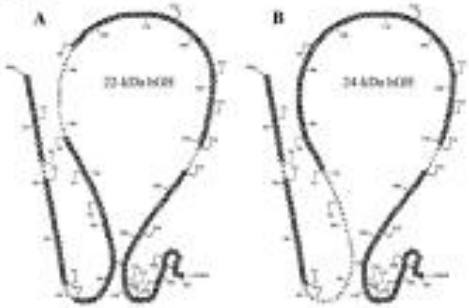




HT 29 CL19a HA-β-catenin; Red:α-catenin, Blue: DAPI

# Dr. Juan Bustamante

## Research Area

- Liver regeneration
- Maternal liver growth
- Growth hormone

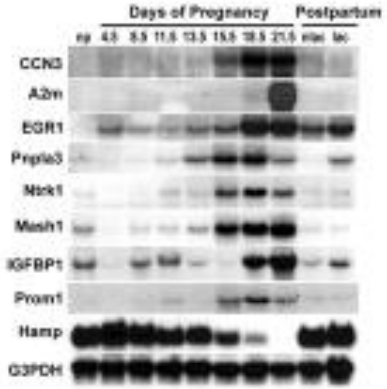


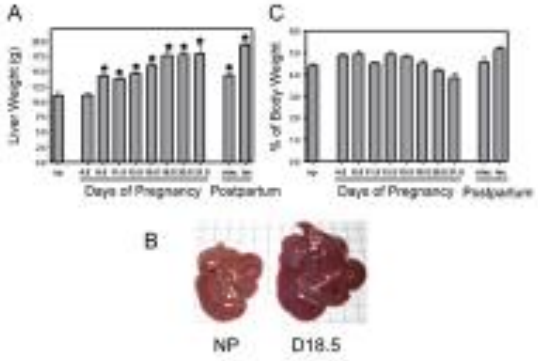

Clinical pathology: plate reader

Chiral HPLC

## Techniques

- proteomics
- molecular
- cellular biology
- *in* vitro
- mouse model




Clinical pathology: cryostat


# Thanks & Gig ’em!