

**IMPORTANT:** This syllabus form should be submitted to OAA ([gsbs\\_academic\\_affairs@uth.tmc.edu](mailto:gsbs_academic_affairs@uth.tmc.edu)) a week before the start of each semester.

**NOTE to STUDENTS:** If you need any accommodations related to attending/enrolling in this course, please contact one of the Graduate School's 504 Coordinator, Natalie Sirisaengtaksin, PhD. We ask that you notify GSBS in advance (preferably at least 3 days before the start of the semester) so we can make appropriate arrangements.

**Term and Year:** Summer 2026

**Course Number and Course Title:**

**GS04 1273: Advanced Fluorescence Microscopy – Emphasis in live imaging and state-of-the-art technologies**

**Credit Hours:** 3

**Prerequisites (if any):** n/a

**Meeting Location:** GSBS Classroom

**Building/Room#:** BSRB S3.8355

**Class Meeting Schedule**

| Day   | Time          |
|---|---------------|
| May (19,21,26,28)<br>June (2,4,9,11,16,18,23,25,30) July (2 <sup>nd</sup> ) | 9 am to 12 pm |

**Program Required Course:** No

**Approval Code:** Yes

(If yes, the Course Director or the Course Designee will provide the approval code.)

**Audit Permitted:** Yes

**Classes Begin:** May 19<sup>th</sup> 2026

**Classes End:** July 2<sup>nd</sup> 2026

**Final Exam Week:** July 2<sup>nd</sup> (Project Presentations)

**Course Co-Director:**

**Adriana Paulucci, Ph.D.**  
Principal Research Scientist  
Director- Genetics Advanced Microscopy Laboratory  
Department of Genetics  
MDACC  
[apaulucci@mdanderson.org](mailto:apaulucci@mdanderson.org)  
713-794 1159

**Course Co-Director:**

**Travis Moore, Ph.D.**  
Assistant Professor  
Director – Center for Advanced Microscopy  
Department of Integrative Biology and Pharmacology  
UTHealth  
[travis.i.moore@uth.tmc.edu](mailto:travis.i.moore@uth.tmc.edu)  
713-500-6514

**NOTE:** Office hours are available by request. Please email me to arrange a time to meet.

**Teaching Assistant:**

Ryan Durham, Ph.D.  
UTHealth  
[Ryan.Durham@uth.tmc.edu](mailto:Ryan.Durham@uth.tmc.edu)

**Instructors:**

- Adriana Paulucci, Ph.D.**  
MDACC  
[apaulucci@mdanderson.org](mailto:apaulucci@mdanderson.org)
- Travis Moore, Ph.D.**  
UTHealth  
Email Address: [travis.i.moore@uth.tmc.edu](mailto:travis.i.moore@uth.tmc.edu)
- Leoncio Vergara, Ph.D.**  
Texas A&M  
[leovergara@tamu.edu](mailto:leovergara@tamu.edu)
- Alloysius Budi Utama, Ph.D.**  
Rice University  
[budiutama@rice.edu](mailto:budiutama@rice.edu)
- Reid Powell, Ph.D.**  
Texas A&M  
[rpowell@tamu.edu](mailto:rpowell@tamu.edu)
- Anna Karin Gustavsson, Ph.D.**  
Rice University  
[ag134@rice.edu](mailto:ag134@rice.edu)

**Course Description:** This course provides a comprehensive foundation in fluorescence microscopy, emphasizing both fundamental principles and advanced techniques for live imaging. Students will begin with core concepts, including fluorescence spectroscopy, spectral analysis and unmixing, microscope architecture and alignment, sample preparation, and the selection of fluorophores, endogenous probes, and biosensors.

Topics include wide-field and optical sectioning microscopy, with an in-depth examination of confocal imaging. Students will explore super-resolution techniques such as SIM, STED, SoRa, and STORM, as well as recent innovations in confocal super-resolution microscopy. Additional modalities include Total Internal Reflection Fluorescence (TIRF) microscopy for single-molecule studies, spinning disk microscopy with SoRa super-resolution, light-sheet microscopy, dual-camera systems, multiphoton imaging, and high-content imaging. A particular focus on protein dynamics in tissues, cells, and small organisms will highlight applications such as actin cytoskeleton remodeling.

Students will gain hands-on experience with advanced techniques including ratiometric imaging (e.g., calcium, pH, NADH), laser ablation, fluorescence recovery after photobleaching (FRAP), Förster resonance energy transfer (FRET), and fluorescence lifetime imaging microscopy (FLIM), all taught by experts in their respective fields. Beyond image acquisition, the course emphasizes proper image analysis and visualization in alignment with current microscopy guidelines to ensure data quality and reproducibility.

By the end of the course, students will be equipped to integrate advanced microscopy techniques into their research, generate hypotheses leveraging these technologies, and produce high-quality imaging data that adhere to rigor and reproducibility standards.

**Textbook/Supplemental Reading Materials** (if any)

- Handbook of Biological Confocal Microscopy by James Pawley (consultation only)
- Instructors will provide articles and chapters that supplement classes

**Course Objectives:** Upon successful completion of this course, students will be able to select and apply appropriate microscopy modalities and technologies to address specific biological questions within their research. Students will prepare a concise project proposal with specific aims, detailing their chosen microscopy approaches and justifying their relevance to an actual or hypothetical research project. In a final presentation, students will explain the principles underlying their selected techniques, outline their experimental design, including data acquisition and analysis strategies, and demonstrate how these methods produce high-quality, reproducible imaging data.

**Specific Learning Objectives:**

1. Understand the principles and applications of basic and advanced fluorescence microscopy techniques.
2. Identify and apply appropriate advanced imaging technologies to address research questions beyond the optical resolution limit.
3. Design and execute microscopy experiments, including sample preparation, data acquisition, analysis, and presentation.
4. Follow microscopy rigor and reproducibility guidelines to ensure data quality and reliability.
5. Optimize microscopy use in research projects and effectively communicate methodologies in scientific writing and presentations.

**Student Responsibilities and Expectations:** Students enrolled in this course are expected to complete the following activities each week.

1. Attend and actively participate in the weekly three-hour lecture. Lectures will conclude with breakout sessions or round-table discussions that serve as opportunities to evaluate student progress.
2. Attend and actively participate in the weekly three-hour lab session.
3. Take thorough notes and save all lab data for subsequent analysis.
4. Attend image analysis and breakout classes, which constitute a major component of the course grade.
5. Prepare for laboratories in advance by coordinating with lab partners and directing questions to the course director and co-director.
6. Prepare a final presentation featuring a hypothetical or actual research project that incorporates several microscopy modalities and technologies. Students will describe sample preparation, data collection

strategies, and expected results. To achieve this, students will need to meet outside of class and are encouraged to consult with Dr. Paulucci and Dr. Moore for guidance on project development.

**Academic Integrity:** Plagiarism and failure to properly cite scientific literature and other sources will not be tolerated and are grounds for dismissal from the course and further GSBS disciplinary action. Cheating or engaging in unethical behavior during examinations, including quizzes and the final, will result in dismissal from the course without credit and may lead to additional GSBS disciplinary action.

**Grading System:** Letter Grade (A-F)

**Student Assessment and Grading Criteria :**

| Percentage                              | Description   |
|---|---|
| Homework ( 20 %)                        | Students will have to prepare for laboratory classes together with their labmates. They will also have to meet their groups to discuss their projects and their final presentation. They will be encouraged to bring questions to Dr. Paulucci and Dr. Moore after each class during round table for discussions.                     |
| Imaging Analysis Exercises Quiz ( 10 %) | Students will have to analyse their data acquired in the lab with the guidance of instructors. These analyses will count as a test, or quiz.  |
| Presentation ( 30 %)                    | Students Final Detailed Presentation of 20 minutes per group. They will have to present a hypothetical project with chosen microscopy modalities and technologies, explain how they work, how they would collect their data and how they would analyse the data. They will have to answer questions from their peers and instructors. |
| Workshop or Breakout-Session ( 10 %)    | The breakouts will be interactive and involving image analysis and advanced microscopy data interpretation  |
| Participation and/or Attendance ( 30 %) | Students are expected to attend 3 hours lectures (TUE) and 3 hours lab (THU) per week. Participation will be evaluated in each class/lab.   |

**NOTE:** There will be a total of 19.5 hours dedicated to lectures, 15 hours dedicated to laboratory classes, 7.5 hours dedicated to breakout involving image analysis and 3 hours for students final presentations, totalizing 42 hours of in- class activities. We expect students to dedicate at least 20 hours outside of class to read articles and materials, prepare projects and presentation and discuss and prepare for the labs. Students will be encouraged to meet with course co-director (Dr. Paulucci) and co-director (Dr. Moore) to discuss their final projects plan and presentation in advance. They are expected to save some time for this outside of class activity.

***Our instructors: All main instructors for this course have many years of experience teaching graduation school with many years of experience in microscopy and managing microscopy laboratories.***

## CLASS SCHEDULE

| Date             | Duration | Lecture Topic   | Lecturer(s)                             |
|------------------|----------|---|---|
| May 19           | 10 m     | Course Introduction   | Adriana Paulucci & Travis Moore         |
|                  | 1h 10m   | Principles of Light Propagation and Fluorescence<br>Sample Preparation  | Adriana Paulucci                        |
|                  | 1h 10m   | Cameras and Image digitalization<br>Introduction to Resolution and Image Analysis                               | Leoncio Vergara                         |
|                  | 20 m     | Discussion and questions / Lab prep   | Adriana Paulucci                        |
| May 21<br>(Lab)  | 1h 30m   | Setting up a microscope for widefield and brightfield.<br>System Maintenance and Optical Aberrations            | Adriana Paulucci                        |
|                  | 1h 30m   | Imaging Fluorescent Samples. Proper Adjustments,<br>choices of objectives and Corrections                       | Leoncio Vergara                         |
| May 26           | 1h 15m   | Optical Sectioning and Confocal Microscopy,<br>Spatial Array Detectors for Confocal Super-Resolution            | Budi Utama                              |
|                  | 1h 15m   | Colocalization, Autofluorescence. Crosstalk, Unmixing<br>and Introduction to FRET                               | Adriana Paulucci                        |
|                  | 20 m     | Discussion and questions / Lab prep   | Adriana Paulucci & Budi Utama           |
| May 28<br>(Lab)  | 1h 30m   | Confocal Imaging  | Budi Utama                              |
|                  | 1h 30m   | FRET and Acceptor photobleaching with confocal<br>Spectral Unmixing and crosstalk                               | Adriana Paulucci & Ryan Durham          |
| June 2           | 1h 15m   | Introduction to Live imaging<br>(including FRAP ABLATION and Ratiometric Imaging)                               | Adriana Paulucci                        |
|                  | 1h 15m   | Live imaging with dual camera systems, TIRF,<br>Traction Force Microscopy and Speckle Microscopy                | Travis Moore                            |
|                  | 20 m     | Discussion and questions / Lab prep   | Adriana P. & Travis M.                  |
| June 4<br>(Lab)  | 1h 30m   | FRAP and Ablation   | Adriana Paulucci                        |
|                  | 1h 30m   | TIRF and dual camera systems<br>Actin cytoskeleton dynamics   | Travis Moore                            |
| June 9           | 1h 15m   | Super-Resolution Imaging Introduction<br>SIM, STED, STORM, MINIFLUX   | Travis Moore                            |
|                  | 1h 15m   | Super-Resolution Imaging: Applications and Analysis   | Travis Moore                            |
|                  | 20 min   | Discussion and questions / Lab prep   | Travis Moore                            |
| June 11<br>(Lab) | 3 hours  | Super-Resolution Lab (SIM, STORM & STED)  | Adriana P., Travis M.,<br>& Ryan Durham |
| June 16          | 1h 15m   | Single-molecule tracking and super-resolution imaging<br>in 3D using light sheet illumination and microfluidics | Anna Karin Gustavsson                   |
|                  | 1h 15m   | <b>Breakout:</b> Students Projects Presentations Prep   | Adriana P. & Travis M.                  |
| June 18          | 1h 15m   | Multiphoton and FLIM  | Leoncio Vergara                         |
| June 18<br>(lab) | 1h 30m   | FLIM laboratory   | Leoncio Vergara & Ryan Durham           |
| Jun 23           | 1h 15m   | FIJI Image Analysis, quantification with Rigor,<br>Planning proper Acquisition Matters                          | Leoncio Vergara                         |
| Jun 23           | 1h 30m   | <b>Breakout:</b> FIJI Image Analysis  | Leoncio Vergara                         |
| Jun 25           | 1h 15m   | High Content Imaging and Analysis   | Reid Powell                             |
| Jun 25           | 1h 30m   | <b>Breakout:</b> Open-source image analysis   | Reid Powell                             |
| Jun 30           | 1h 30m   | <b>Breakout:</b> Live Image Analysis  | Travis Moore                            |
| Jun 30           | 1h 30m   | <b>Breakout:</b> Course Review  | Adriana P. & Travis M.                  |
| Jun 30           | 1h 15m   | <b>Breakout:</b> Students Projects Presentations Prep   | Adriana P. & Travis M.                  |
| July 2           | 3 hours  | Students Project Presentations  | Adriana P. & Travis M.                  |